New York State Energy Research and Development Authority

Radar Monitoring of Bird and Bat Movement Patterns at the Maple Ridge Wind Power Facility, Lewis County, New York

Final Report

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Radar Monitoring of Bird and Bat Movement Patterns at the Maple Ridge Wind Power Facility, Lewis County, New York

Final Report

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EXECUTIVE SUMMARY

- This report presents results of a study conducted by New Jersey Audubon Society, for New York State Energy Research and Development Agency (NYSERDA) to assess flight dynamics and movement patterns of aerial vertebrates at the Maple Ridge Wind Power Facility (MRWPF), Lewis County, New York. Specifically, our objectives were to (1) estimate the nightly and seasonal numbers and passage rates of aerial vertebrates (i.e., birds, bats) at our study site on the wind power facility, (2) estimate altitudinal distributions of bird/bat movements and determine the number and proportion that occur at altitudes deemed a "risk" for collisions with wind turbines (3) determine flight directions of bird/bat "targets" in the study area (4) investigate how meteorological conditions, both local and meso-scale, affect flight dynamics and behavior and (5) compare our results to those from other studies, especially a pre construction study conducted at the same site.

- The study was conducted during the spring and fall of 2007 and 2008 using a dual marine radar system. Data were collected nightly between sunset and sunrise the following morning. The radars were fitted with standard 6.5' open array antennas, which produce a fan-shaped electromagnetic beam 1.23° wide x 20° high. In our system, one radar unit was mounted to the side of a 12' long trailer operated with the antenna rotating in the vertical plane. The antenna sweeps from horizon to horizon, describing a 180° arc above radar level every 2.5 seconds. Data collected with the radar in this orientation were used to generate target passage magnitude, passage rates and altitudinal distribution estimates. The second radar unit, mounted on the top of the trailer, operated with the antenna rotating in the horizontal plane, describing a 360° arc every 2.5 seconds. Data collected with the radar in this orientation provided information on target flight direction.

- During the study period, we detected approximately 575,000 targets flying through our sampling areas within the MRWPF. Our data showed extensive within-season variation in the number of targets detected nightly, suggesting that seasonal bird/bat movements, were temporally episodic. Despite high variability within seasons and between years, we found that mean target passage magnitude was significantly greater in 2007 (2314.08 ± SE 201.21) compared with 2008 (1304.92 ± SE 110.14). This appeared to result specifically from differences between the Fall/Early periods (31 Jul – 30 Sep) in each year (Fall/Early 2007: mean = 3129.89 ± SE 393.78, Fall/Early 2008: mean = 1195.21 ± SE 153.98). For 2007, comparisons among seasons suggested that nightly mean passage was greatest in the Fall/Early compared with Spring (~15 Apr – 15 Jun, mean = 1908.78 ± SE 241.56) and Fall/Late periods (1 Oct – 30 Nov, mean = 1643.66 ± SE 314.64). We did not find among-season differences in nightly passage for 2008. Results of comparisons of target passage rate between years and among seasons were similar to target passage magnitude. Mean passage rate was significantly greater in 2007 (163.54 ± SE 14.50) compared to 2008 (86.14 ± SE 6.80), resulting primarily from differences between Fall/Early periods (2007: mean = 220.69 ± SE 28.57, 2008: mean = 78.51 ± SE 9.68). For 2007, target passage rates were again significantly greater in the Fall/Early period compared to Spring (mean = 156.06 ± SE 20.16) and Fall/Late (mean = 92.80 ± SE 18.04) periods but we found no statistical differences among seasons in 2008. Our data also suggest that target numbers began to increase during the first hour after sunset, peaked 3-4 hours after sunset and decreased gradually afterward as sunrise approached.

- The distribution of targets recorded across all altitudinal strata (i.e., 14, 100 m strata, equivalent to approximately 0.75 nautical miles) did not appear to vary significantly between seasons or among seasons. Regardless of season or year, the number of targets we recorded generally increased with altitude to peak between 200 and 400 m and declined asymptotically as altitude increased above 500 m. In our analyses of target flight altitude, we focused primarily on the two lowest altitudinal strata we sampled (i.e., 0-100 m, 101-200 m) as these were likely the ones that had the greatest potential to inform us about potential risk to birds and bats at the MRWPF.

- During our study, we detected more than 50,000 targets flying at or below 100 m. Our data showed extensive within-season variation in the proportion of targets recorded 0-100 m (i.e., relative to all targets recorded) and the number of targets recorded in this stratum, regardless of year. Statistical comparison of proportions of detection did not suggest a significant difference between years but did reveal differences among seasons. Proportions of targets in the 0-100 m stratum were significantly greater in Spring (mean = 0.14 ± 0.01) and Fall/Late (mean = 0.14 ± 0.01) periods compared to Fall/Early (mean = 0.09 ± SE 0.00). In contrast, the number of targets we recorded in the 0-100 m stratum was significantly different between years (2007: mean = 185.40 ± SE 15.67, 2008: mean = 129.90 ± SE 11.22) but not among seasons. Generally, the proportion of targets detected in the 0-100 m stratum was greatest in the first hour after sunset, then decreased and remained relatively constant until sunrise. Hourly changes in number of targets detected in this stratum followed a pattern similar to that described for targets recorded across all altitudinal strata.

- During our study, we detected more than 67,000 targets flying between 101 and 200 m. Proportions of targets detected in the 101-200 m stratum were not statistically different between years. Still, they were statistically greater in Spring (mean = 0.20 ± 0.01) than in Fall/Early (mean = 0.13 ± 0.00) and Fall/Late (mean = 0.13 ± 0.01). For the number of targets detected in this stratum, we found significant differences between years (2007: mean = 308.47 ± SE 25.50, 2008: mean = 185.35 ± SE 16.23) and among seasons (Fall/Early: mean = 269.27 ± SE 27.00 and Spring: mean = 237.14 ± SE 21.63 significantly greater than Fall/Late: mean = 219.93 ± SE 30.95). The proportion of targets detected in the 101-200 m stratum was greatest in the first hour after sunset, then decreased and remained relatively constant until sunrise. Again, hourly changes in number of targets detected in 101-200 m stratum followed a pattern similar to that described for targets recorded across all altitudinal strata. These patterns were similar to ones we observed for the 0-100 m stratum.

- Second-order mean vectors of target flight directions recorded during Spring 2007and 2008 were oriented toward 44° and 41°, respectively. Vectors for each year were significantly different from random and results of Hotelling's two-sample *F*-test suggested that second-order mean vectors for Spring 2007 and 2008 were not statistically different. For Fall/Early 2007 and 2008, second-order mean vectors of target flight directions were oriented to 197° and 212°, respectively and both were statistically different from random. Again, Hotelling's two-sample *F*-test suggested that second-order mean vectors were not significantly different from each other. Second-order mean vectors for Fall/Late 2007and 2008 were oriented toward 203° and 205°, respectively, were significantly different from random, but not statistically different from each other. Finally, Hotelling's two-sample *F*-test also suggested that second-order vectors for the Fall/Early and Fall/Late periods within either year were not statistically different.

- Our multi model inference approach to examine environmental factors underlying patterns of target passage and flight altitude suggested candidate models that included a combination of weather variables (Expanded models) and in some cases Julian day, were the most consistent and significant modifier of passage magnitude and passage rate. Among the various meteorological factors evaluated for their affect on the timing and magnitude in migrating birds, wind conditions have been repeatedly identified as a principal driver. Our data support this thesis as wind was one of the most consistent contributors to Expanded model performance. Wind vectors that facilitated movement (i.e., tailwinds) toward seasonally appropriate goals, that is, north in spring and south in fall, were important elements in the best performing models. In fall, especially during the early period, decreasing temperature and increasing barometric pressure tendencies were also important contributors to Expanded model performance. Changing wind fields are often associated with changes in temperature in barometric pressure gradients. Dropping temperature and rising barometric pressure can signal the infiltration of air masses from the north, bringing northerly winds favorable for southward migration. Within the context of best performing Expanded models, Julian day was a significant determinant of passage magnitude and rate in Fall/Late 2007 and in all seasons during 2008. In spring, our results suggest that magnitude and rate of passage increase throughout the season and then decrease as the migration period comes to an end. For the Fall periods, magnitude and rate both declined as the season progressed.

- Julian day was the most consistent predictor for the proportion of targets we recorded below 200 m. Parameter estimates suggest that during migration periods (i.e., spring, fall), the proportion of low flying (i.e., ≤ 200 m) birds and bats increased. In spring, decreasing atmospheric pressure and temperature, and conditions producing winds with a strong westerly component tended to be associated with an increase in the proportion of targets detected below 200 m. These conditions could signal the onset of storms and accompanying precipitation, which could cause birds and bats to lower their flight altitudes. Falling barometric pressure, reduced visibility and headwinds were weakly associated with an increase the proportion of targets flying below 200 m in fall. These conditions generally portend the approach of a low pressure system and with it, southerly winds and precipitation. Flying low in the opposing winds and under conditions that produce adverse weather may save energy and allow an individual to respond quickly in the event that it must land. The number of targets we detected flying below 200 m appeared to respond to conditions similar to those associated with overall movement magnitude at all altitudes. Regardless of season, increasing visibility, reduced cloud cover, increasing temperatures and tailwinds were all significant predictors of target detections below 200 m. These results reflect the greater tendency for birds and bats to increase activity under these conditions.

- Our results suggested that synoptic weather patterns producing wind conditions appropriate for directing individuals northward toward the breeding grounds were important predictors of migration events in spring. At temperate latitudes, this generally means southerly winds prevalent after the passage of a warm front and on the western side of a high pressure system. Between 60 and 65% of targets we detected during the two spring seasons were when weather patterns produced generally calm winds or prevailing southerly winds. Still, weather systems that produced these wind conditions occurred only about 40% of the time. In contrast, synoptic conditions that are usually associated with northerly winds occurred on nearly 60% of the nights we sampled but accounted for only 35-40% of the total targets we detected. These results suggest that birds, and possibly bats, were selective about the conditions under which they were actively migrating.

- Results from these synoptic weather analyses for targets recorded below 200 m followed similar patterns to what we observed for target magnitude across all altitudinal strata. In spring, birds and bats flying at low altitudes appeared to prefer calm or lightly variable wind conditions associated with stable, high-pressure systems across the region. These conditions occurred less than 10% of the nights we sampled but accounted for more than 30% of all the targets recorded below 200 m. In contrast, condition associated with the passage of a cold front that produces northwesterly winds occurred on average 40% of the nights in spring but account for only 20% of the targets recorded in the two lowest altitudinal strata. Patterns in fall were much less informative, with no clear pattern emerging from analyses of synoptic weather and targets flying at low altitudes. Differences between spring and fall may be related greater constraints on birds and bats as they migrate northward to breeding areas.

- In general, our results were comparable to those reported from other studies using marine radar to assess potential risk at proposed or operational wind power facilities in the region. Importantly, the number of targets detected, target passage rate, flight altitude and the number of targets flying below 100 m we observed during the Fall/Early periods were similar to those reported during a pre construction assessment conducted from 5 August through 3 October 2004 at the MRWPF. The strength of this study was primarily in that it was conducted over a two-year period, during almost entire migration periods (Spring: April – early June, Fall: August – mid November) and over an entire night from sunset to sunrise the following morning. Interannual, seasonal and diel variability in environments and meteorological conditions are widely acknowledged. By capturing this variability through extended observation, our study provided a more comprehensive understanding of movement patterns in aerial vertebrates in the Tug Hill Plateau region and the MPRWF.

1.0 INTRODUCTION

As the demand for renewable sources of energy continues to increase in the United States, so, too will the need for a better understanding of how these rapidly growing sectors impact wildlife populations. For example, the use of wind resources to produce energy commercially in the U.S. started in the early 1980s and has grown exponentially as an industry. By the end of 2009, 36 states had operational, utility-scale wind facilities, with the U.S. containing approximately 20% of wind capacity worldwide (AWEA 2009). The construction of wind power facilities expanded at an even greater pace in subsequent years, with more than double the wind-power capacity installed in the first quarter of 2011 than in the first quarter of 2010 (AWEA 2011). The average height and size of wind turbines have also increased over time (Wiser and Bolinger 2008). These developments have led to concern about potential negative impacts of wind power development on wildlife and their habitats, particularly migratory birds and bats, and have prompted calls for the development of standard guidelines for identifying, assessing, and monitoring those potential impacts (USFWS 2010).

Over the last two decades, construction of tall structures (e.g., digital television towers, wind turbines, cellular phone towers) that penetrate the lower strata of the atmosphere (i.e., up to 1000 feet) has increased at a rapid rate (Shire et al. 2000, National Research Council 2007). Demands for improved communications capabilities and alternative energy have spurred this growth, not only in the number of tall structures, but also their overall height.

Several studies have documented significant bird mortality at tall communication towers (Crawford, 1981, Kemper 1996) and the USFWS estimates that between four and five million birds may be killed each year from colliding with tall structures (Manville 2000). Studies conducted at wind power projects in different regions, sited in different habitat types and with varying configurations, indicate that the potential for collision incidents between aerial vertebrate biota (i.e., birds, bats) and wind turbines exists (e.g., Orloff and Flannery 1992, Johnson et al. 2002, Kerns and Kerlinger 2004, Fiedler et al. 2007, *cf* citations in Arnett et al. 2008) to varying degrees, but most frequently involves nocturnally migrating passerines and bats (Kunz et al. 2008). Other structures that penetrate the air space used by aerial vertebrates, such as buildings and power lines also are known to cause mortality during episodic migration events (*cf* citations in Erickson et al. 2005 regarding bird mortality).

Indices of bird and bat flight dynamics (e.g., movement magnitude, altitude of flight, direction) are critical for evaluating the potential risk that tall structures (e.g., wind turbines, communication towers, buildings, bridges) pose to aerial vertebrate biota. Regulatory agencies, natural resource managers and developers require this information to compare relative risk of tall structures, especially when they are proposed for areas known to support high densities of birds or bats. Additionally, stakeholders require information about other locations so that comparisons among sites can be made and characteristics of the specific site slated for development can be evaluated in a relevant context.

As with any large structures on the landscape, wind turbines can be hazardous to flying organisms (see review in Kuvlesky et al. 2007). Negative impacts to bats, for example, have been documented in several post-construction studies in the United States (Johnson et al. 2004, Arnett et al. 2008, Piorkowksi et al. 2010) and Europe (Rydell et al. 2010). Bat mortality at wind farms can be caused by collision with moving or stationary blades (Johnson et al. 2004, Cryan and Barclay 2009), or barotraumas (i.e., rapid decompression) near moving blades (Baerwald et al. 2008). In some cases, bats may be attracted to wind turbines (Horn et al. 2008). Large raptors also appear to be susceptible to injury or death by wind turbines (Hunt 2002, Hoover and Morrison 2005, Smallwood and Thelander 2008) and there is also concern about the potential for adverse effects on migratory songbird and shorebird populations (Johnson et al. 2002, Kerlinger et al. 2010). Less is known about the extent of mortality on these groups at wind power developments, but comparisons are difficult to make because of incomplete development of mortality inference methods (Kuvlesky et al. 2007, Smallwood 2007). Although Erickson et al. (2005) suggested that passerine mortality is low at wind power facilities, other studies that collision risk may be at especially high for this group (Osborn et al. 2000, Mabee et al. 2006).

In 2007 and 2008, New Jersey Audubon Society (NJAS), in collaboration with Old Bird, Incorporated (OBI), North East Ecological Services (NEES), undertook a project for New York State Energy Research and Development Authority to quantify movement patterns (e.g., passage magnitude, flight altitude, flight direction) of aerial vertebrates at the vicinity of the Maple Ridge wind power facility in Lewis County, New York. The intent of this work was to provide information that could be used to support decisions regarding future development of wind resources in the state of New York. The scientific information presented in this report provides essential biological data that will inform development of policy, and support review processes by federal agencies such as the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers, and state agencies including the New York Department of Environmental Conservation.

1.1 Scope of Report

The following report describes the radar study conducted by New Jersey Audubon Society (NJAS) at the Maple Ridge Wind Power Facility (MRWPF), Lewis County New York. Other aspects of the study (i.e., monitoring flight dynamics of birds and bats using acoustic detection of birds) will be covered in separate reports.

Radar technology can provide important information about movement patterns of aerial vertebrates that otherwise could not be acquired conventional techniques (e.g., monitoring of high flying and distant individuals, monitoring at night, accurate estimates of flight altitude). We also present results of data analyses and discussion of these results in the context of collision risk and the findings of other relevant studies. Nevertheless, several caveats should be considered when evaluating results of this or other similar studies. Because our sampling was limited to two spring,and two fall seasons, caution should be exercised when extending our results to longer time frames. Interannual variability in temporal patterns of avian migration is well documented (*cf* citations in Alerstam 1990, Berthold 1996). Similarly, we advise caution before applying inferences from this study to other areas or physiographic regions. Our radars were configured to sample relatively small volumes of space compared to the extent migration and other types of bird and bat movement (e.g., post-breeding dispersal, post-fledging dispersal) likely occurs in Tug Hill Plateau region, where the Maple Ridge Wind Power Facility is located.

Our inability to distinguish between birds and bats during radar monitoring, or distinguish among species in each of these taxa, also is important to note. Flight behavior (e.g., migration phenology, altitude) of several avian taxa (e.g., passerines) overlap with those reported for bats (Larkin 1991, Bruderer and Boldt 2001, Kunz and Fenton 2003). Consequently, we could not determine the relative contribution of birds or bats in spatial or temporal patterns we observed. Future studies focused on flight dynamics and behavior of migrating birds and bats in the region must include tasks that provide this type of information. Furthermore, that we experienced some detections that were attributable to large-bodied, fast-flying insects (e.g., dragonflies [Order Odonata], moths (Order Lepidoptera]) is important to note. Although we attempted to remove insect contamination through image-processing steps, our inability to remove it completely is certain. To reflect our uncertainty about the identity of aerial vertebrates in our radar data, we refer to entities detected by the radars as "targets," throughout this report. This is a widely used term in radar parlance for any object detected by radar.

Additionally, we use the term "target" rather than "individual" or "flock" because the number of birds or bats represented as single entities by the radar was unknown. Some studies report the ability to distinguish small, medium, large and flock-like targets by evaluating the relative strength or amount of radar return energy. This approach is problematic because inherent physical properties of radar affect the amount of energy reflected by a detected object, the basis by which target size would be evaluated. Distance between target and radar, a target's orientation relative to the radar and the location of a target in the radar beam (i.e., central versus peripheral) are among several characteristics that affect the amount of energy a target reflects. These characteristics influence target detection simultaneously, so can seriously confound target size classifications. Given these difficulties, we classified all detections as single targets. Thus, indices of movement magnitude we report are likely underestimates of the total number of inidividuals passing through the study site and the number that we recorded in any altitudinal strata.

1.2 GOALS AND OBJECTIVES

The goal of this study was to provide an improved understanding of bird and bat movement patterns at the MRWPF, Lewis County New York. Specifically, our objectives were to (1) estimate the nightly and seasonal numbers of aerial vertebrates (i.e., birds, bats) passing through our study site on the wind power facility, (2) estimate altitudinal distributions of bird/bat movements and determine the number and proportion that occur at altitudes deemed a "risk" for collisions with wind turbines (3) determine flight directions of bird/bat "targets" in the study area (4) investigate how meteorological conditions, both local and meso-scale, affect flight dynamics and behavior and (5) compare our results to those from other studies, especially a pre-construction study conducted at the same site.

2.0 METHODS AND STATISTICAL APPROACHES

2.1 RADAR EQUIPMENT AND CONFIGURATION

We used a dual mobile marine radar system to collect data on bird and bat flight dynamics and behavior. This system consisted of two 25 kW Furuno X-band marine radars (frequency = 9410 GHz, wavelength = 3 cm, model # FAR2127BB, Furuno Electric Company, Nishinomiya, Japan) mounted on a trailer 12' long x 6' wide x 8' high (Fig. 1). Our radar system was powered with 110V AC through connections at each of the turbines where the equipment was sited.

The radars were fitted with standard 6.5' open array antennas (Fig. 1), which produce a fan-shaped electromagnetic beam 1.23° wide x 20° high. The antennas rotate simultaneously to monitor various bird/bat flight dynamics and behavior patterns. In our system, one radar unit was mounted to the side of a 12' long trailer and operates with the antenna rotating in the vertical plane (i.e., "vertically-oriented radar"). This is accomplished by mounting radar to the side of the trailer so that the antenna turning unit rotates perpendicular to the ground (Fig. 1). The antenna sweeps from horizon to horizon, describing a 180° arc above radar level (arl), 20^{o} wide (Fig. 2). Data collected with the radar in this orientation were used to generate target (i.e., birds, bats) movement estimates and to quantify altitudinal distributions of targets (see Fig. 3 for data image example). The vertical radar was positioned so that the antenna swept an arc from West to East to maximize the number of targets detected as aerial vertebrate biota moved South to North to North to South during spring and fall migration periods, respectively. The second radar unit, mounted on the top of the trailer (Fig. 1) operated with the antenna rotating in the horizontal plane (i.e., "horizontally-oriented radar"), describing a 360° arc every 2.5 seconds (Fig. 4). Data collected with the radar in this orientation provided information on flight direction (see Fig. 5 for data image example). The radar units also are equipped with an integrated global positioning system (GPS) and target-tracking feature that allowed us to determine each target's coordinates and quantify target flight directions.

Our radars can be set for detection ranges of 0.125 - 96 nautical miles (nm); however, ranges of ≤ 3 nautical miles are generally the upper limit for detecting bird and bats, depending on their size. For the vertically-oriented radar, we set the range to 0.75 nm (approximately 1400 m) to ensure detection of small passerines that typically migrate at night. We set the horizontally-oriented radar's range to 1.0 nm. Pulse lengths (i.e., rate that electromagnetic energy is transmitted) for our radars can be set from 0.07 - 1.2 μsec. For both radars, we used a 0.15 μsec pulse length. Short pulse lengths provide better target resolution and more accurate location and distance estimates. Similarly, short detection ranges result in improved resolution of small passerine or bat-sized targets.

The radars we use feature color-coded target representation that indicates return signal strength or "reflectivity." The radar processor unit assigns targets to one of 28 reflectivity categories and its graphics processor unit converts these into 28 distinct color bins. Given our particular settings for the radar units, targets were presented on the viewing monitor as ellipses in shades of green, yellow or red, with green representing the lowest reflectivity values and red representing the highest. This allowed us to discriminate and remove weak reflectors from images that could have been insects or atmospheric particulates. In our analyses, we chose to use only targets with color values associated with the red spectrum (i.e., greatest reflectivity values). This meant that our target passage estimates were conservative, as some of the weaker reflectors in the yellow spectrum and possibly the higher green spectrum values were likely birds or bats.

Each radar's processor unit was connected directly to a computer equipped with a PCI frame grabber circuit board. Using proprietary scheduling software developed by NJAS, we can automatically capture radar image data as bitmap files for any interval and for any duration. During this study we collected data images for five consecutive radar antenna sweeps (i.e., every 2.5 seconds), every 10 minutes, or a maximum of 30 images/hr. We chose 10-minute intervals because we believe this minimized the possibility of double counting targets in consecutive samples. With the radar's range set to 1 nm, a target moving 20 miles/hr would cross the widest part of our sample space (i.e., two nautical miles) in approximately six minutes.

2.2 Data Collection Time Frame and Study Sites

Generally, the Tug Hill Plateau region, on which the MRWPF is located, is a matrix of open crop fields and pastures, successional old field and shrubland, woodlots, wooded wetlands, and riparian zones, with larger tracts of contiguous forest in western region. Although topographic relief in the area of the MRWPF is generally low, mildly undulating land forms throughout the facility, woodland patches and wind turbines in the landscape had the potential to create extensive backscatter of electromagnetic energy, also known as "ground clutter" (Fig. 6). This backscattered energy can occlude the detection of other "reflectors" of the radar's electromagnetic pulses, such as birds and bats. Typically, marine radars are equipped with the ability to suppress "ground clutter." Still, the algorithm used to accomplish this also attenuates signal strength for all radar reflectors, which is particularly problematic when attempting to detect small targets like birds or bats that reflect relatively small amounts of energy. To address this, we spent four days prior to the spring 2007 data collection period and two days before the start of the fall 2007 data collection period assessing potential study sites.

Radar data were collected by our system during the spring and fall of 2007 and 2008. Data collection in spring 2007 commenced on 26 April and on 11 April in spring 2008. The difference in start dates between years resulted from our inability to access our study site because of later snow melt in 2007. Spring data collection was completed on 15 June in each year. Fall data collection periods began on 31 August and ended 15 November in both years. For analysis purposes, we divided the Fall season into "Early" (31 July – 30 September) and "Late" (1 October – 30 November) segments because the southbound migration period is considerably protracted, with distinctly different taxa migrating throughout the period. For example, birds migrating nocturnally during August and September are generally long-distance migrants, mostly passerines and shorebirds (Family Charadriidae). In October and November nocturnally migrating birds are typically short and medium distance migrants, including passerines, some shorebirds, waterfowl and owls. Furthermore, most southbound bat migration activity occurs during July – September is not a major component of nocturnal activity during the latter part of our sampling period.

To the extent possible, data were collected from sunset to sunrise the following morning on all days during data collection periods. On occasion, power outages at the turbine resulted in the use of a gas-powered generator to supply electricity to the radar system. On rare instances, power outages at the turbine and malfunctioning of the generator resulted in some data loss. We located our radar system at two different sites within the MRWPF; one for the spring and one for the fall data collection periods. Our rationale for doing this was to provide the best field of view for detecting migrating birds and bats as they approached the facility during northbound and southbound passage periods. Because the MRWPF is oriented along a NW – SE axis (Fig. 7), we sited our radar system along the SW boundary of the facility in the spring and the NE boundary in the fall. Spring and fall data collection sites were in the southern region of the MRWPF. During spring data collection periods, our radar system was sited at 43° 42.971' N, 75° 33.283' W, in close proximity to wind turbine generator (WTG) 104 (Fig. 7). The site was approximately 561 m above sea level. During fall data collection periods, our radar system was sited at 43° 42.754' N, 75° 30.218' W, in close proximity to WTG 90 (Fig. 7). The site was approximately 544 m above sea level and approximately 4.17 km east (95.6°) of the spring site (Fig. 7).

Both sites experienced some unwanted ground clutter from the surrounding landscape, including other wind turbines in within one nautical mile (nm) of the radar. Nevertheless, this was generally restricted to an area north of the spring radar site, which partially occluded approximately 70° of survey area (335° – 45°, Fig. 8) and also north of the fall radar site, which partially occluded 65° of survey area (340° – 45°, Fig. 8).

2.3 Data Processing and Analysis

We collected data on 53 days for 459 hours of data/radar during spring 2007, 106 days for 1230.5 hours in fall 2007, 62 days for 588.4 hours in spring 2008 and 105 days for 1253.9 hours in fall 2008 (Table 1). In total, we reviewed approximately 106,000 images/radar (i.e., 3532 hours of data collection, 30 images/hr,). For details of data collection during each season and data collection period, see Appendices 1-6.

We conducted image reviews to determine occurrences of bird/bat movement episodes and identify precipitation events, insect contamination or any other unwanted radar energy propagation. Precipitation and insects typically have distinct characteristics that allow trained observers to distinguish them from bird and bat targets. Data images with precipitation, insect contamination or any other unwanted propagation were removed from subsequent data analyses either using data processing software developed by NJAS or by manually removing images from data sets before analyses. In extreme cases (e.g., continuous rain), we removed entire nights of data from analysis.

We did not correct our data to account for target detectability as a function of distance from the radar unit. Variability in target size within a single sampling bout or across the study period, variability in the radar beam's shape and the position of a target within the beam relative to where the beam's strength is greatest are a few of the factors that could confound attempts to correct for target detectability as a function of distance from the radar. Given these factors and our restriction to using only targets represented in the highest reflectivity categories in our analyses, our estimates of target passage and passage rates represent an index of the actual number of birds and bats passing through the area. Still, we believe an index of target passage,

passage rates, flight altitude and flight direction provides useful data for assessing potential risk to birds and bats at the MRWPF and for comparisons with other radar studies.

2.3.1 *Vertically-oriented radar*

Using image-processing software developed by NJAS, we extracted target information from data images collected with the vertically-oriented radar. The integrated image processing software performs the following tasks:

- Identifies the sample area and creates a template (Fig. 9) to remove stationary radar reflectors (i.e., ground clutter, sea clutter, main bang).
- Removes targets with low signal strength likely to be insects (i.e., based on color value).
- Smooths the data and locates and marks the centroid of each discrete target that remains.
- Exports a text file that includes information on every target's signal strength and its position (i.e., the distance of its centroid) in the *X*- and *Y*-planes relative to the radar's position.
- Outputs a bitmap image showing the transformed data with marked targets (Fig.10). This last feature allows us to review the data processing output to identify possible spurious targets and remove them from subsequent data analysis steps.

Using an analysis software program developed by NJAS staff, we summarized target counts, movement rates and altitudinal distribution (i.e., target position in the *Y*-plane relative to radar's position) for 10 minute- and hourly-intervals. The software's output includes the total number of targets recorded in each image and the mean number of targets recorded in each five-image sample. Our analysis software also quantifies the number of targets recorded in discrete altitudinal bins (e.g., 100 m). We configured the software to assign targets to one of 14, 100 m (i.e., 1400 m or approximately 0.75 nm) altitudinal bins. The software also has a threshold feature that allowed us to filter out data with unusually high target counts, typically an indication of precipitation or insect contamination.

The results of analyses in this report are based on the average for each five-image sampling bout, which occurred at 10-minute intervals. These values are summed for the entire night's data collection (sum of the sample averages) to generate hourly, daily and nightly movement estimates. We believe using the sum of the sample averages is a more accurate assessment for the number of targets crossing through the study area because it minimizes the effect of enumerating the same targets multiple times during a single sampling bout. Analyses to quantify variation in target counts in successive images in a sampling bout indicated that coefficients of variation (CV) were very low (< 2%).

We used General Linear Model procedures (GLM, Zar 2009) to investigate the affects of SEASON (Spring, Fall-Early, Fall-Late) and YEAR (2007, 2008) and the interaction between the two factors on number of targets recorded (TR, sum of 10-minute sample means) and movement rates (i.e., targets recorded/nautical mile/hour, TR/hr). The same statistical approach was used to investigate the effect of these factors on the proportion and number of targets recorded in two altitudinal strata, ≤ 100 m (PROP100, TR100) and 100 >≥ 200 m (PROP200, TR200). We chose these two strata because they are likely the most relevant to the heights of wind turbines birds and bats would encounter at the MRWPF. When GLM procedures suggested significant affects of predictor variables (i.e., SEASON, YEAR, SEASON*YEAR interaction) on response variables, we conducted *post hoc* pairwise comparisons. *Post hoc* comparisons were pre-planned and made only between years for each season (e.g., Spring 2007 vs Spring 2008, Fall-Early 2007 vs Fall-Early 2008) and among seasons within each year (e.g., 2007: Spring vs Fall-Early, Spring vs Fall-Late) and we used Bonferroni adjustments to control for multiple comparisons. We used Kolmogorov-Smirnoff two-sample tests (Corder and Foreman 2009) to compare altitudinal distributions among unique SEASON/YEAR combinations (e.g., SP07, FA07, SP08, FA08).

2.3.2 *Horizontally-oriented radar*

We used NJAS-developed software to calculate target directions from images collected with the horizontally radar. To calculate a target's direction of movement, the program uses the end point of a target's trail and the target position (Fig. 11). We analyzed one image/hour of data collected and targets for each hour were compiled. As directional data are inherently circular, we used circular statistical approach to generate mean vectors (directional tendency, Mardia and Jupp 2000), vector lengths (*r*, strength of directional tendency, Mardia and Jupp 2000) and test statistical significance (i.e., Rayleigh's *Z* test, Zar 2009). We calculated second-order mean vectors (i.e., mean of mean vectors) for each SEASON and YEAR separately and tested for statistical significance using Hotelling T^2 test (Mardia and Jupp 2000).

2.4 WEATHER PATTERNS AND BIRD/BAT FLIGHT DYNAMICS

2.4.1 *Local weather conditions*

For all analyses, we used local climatological data collected at the Watertown International Airport (43.992° N, 76.002° W) and purchased from the National Weather Service's (NWS) National Climatic Data Center web site (http://www.ncdc.noaa.gov/oa/ncdc.html). We selected this station because of its proximity to our study site (approximately14.5 miles) and the consistency and completeness of the data available during the study period. Although the MRWPF collected weather data, data sets were incomplete for the periods covered by this study and were missing several weather variables (e.g., cloud cover, ceiling, visibility, precipitation).

We took a multi model inference approach (Burnham and Anderson 2002) to investigate relationships between several weather variables (Table 2) and the four response variables used in previously described analyses: TR, TR/hr, PROP100 and PROP200. *A priori*, we identified three weather variable groups that migrating birds and bats likely respond to: (1) sky conditions, which included cloud cover, ceiling, visibility and precipitation, (2) atmospheric conditions, such as dry bulb temperature [in degrees Celsius], dry bulb dew point [in degrees Celsius] and barometric pressure [in millibars] and (3) wind conditions (i.e., velocity and direction) (see Table 2 for descriptions of each variable). In addition to models consisting of weather variables in each specific grouping, we assessed the performance of date (i.e., Julian day, quadratic form of Julian day).

Given the difficulty using circular data (i.e., wind directions) in linear statistical analyses (Mardia and Jupp 2000), we calculated headwind/tailwind vectors (THV, vectors parallel to the assumed direction of migration) and sidewind vectors (SWV, vectors perpendicular to the assumed direction of migration) using an equation proposed by Piersma and Jukema (1990):

$$THV = W \cos\alpha + \sqrt{\{A^2 - (W \sin \alpha)^2\}} - A,$$

where W is the wind velocity, A is the bird's air velocity, and α is the difference between wind direction and the assumed directional goal of movement ± 180° (see Appendix 7 for diagram and derivation of equation). Using wind vectors effectively resolves the circular variable, wind azimuth, into its rectangular components (i.e., cosine and sine), and incorporates wind speed. Thus, this conversion provides a way to examine the entire affect of wind on movement patterns. This particular wind vector equation assesses wind conditions relative to the assumed axis of movement.

We used actual mean vectors of movement derived from data collected with the horizontally-oriented radar for each season and period as the assumed directional goal of movement in the calculations of THV and SWV). The strength or weakness of tailwinds, headwinds and crosswinds (i.e., SWV) is known to affect migration behavior in birds (Liechti 2006). In our analyses, we also considered assumed migration directions of "north" (i.e., 360°) in spring and "south" (i.e., 180°) in fall. We modeled THV and SWV for each assumed migration direction separately to see which performed better at capturing variance in response variables.

Prior to model building procedures, we conducted Pearson's product moment correlation analyses (Zar 2009) to identify weather variables in each grouping (i.e., sky conditions, atmospheric conditions and wind conditions) that might be correlated. When variables exhibited correlation coefficients ≥ 0.5 (i.e., positive or negative) they were not included together in the same model. Results of Pearson's product moment correlation analyses for each season/year combination (e.g., Spring 2007, Fall/Late 2008) are presented in Appendices 8 – 13. *Post hoc*, we took an information-theoretic approach (Burnham and Anderson 2002) to evaluate model performance among the multiple models we tested.

In our multi model approach, we did not test a truly "global" model. Given the highly correlated nature of several weather variables (e.g., ceiling and cloud cover, temperature and dew point) and that Julian day and its quadratic form were also highly correlated, we believed it was inadvisable to include all variables into a single model. The likelihood that variance inflation resulting from multicolinearity would cause this model to outperform all other models was high. Instead we tested six "expanded" models, which included uncorrelated weather variables in combination with Julian day or its quadratic form. Expanded-1 included all uncorrelated weather variables (i.e., SEASON/YEAR specific, based on Pearson's product moment correlation analyses) and THV/SWV based on flight directions derived from data collected with the horizontally-oriented radar. Expanded-2 included Julian day (JD) and all uncorrelated weather variables, except any that were correlated with Julian day (see Appendices 8 – 13 for specific SEASON/YEAR correlations) and Expanded-3 included the quadratic form of Julian day (JD-Q) and any weather variables included in Expanded-2.

"Expanded" models 4-6 included all uncorrelated weather variables and THV/SWV based on a generalized migration direction of "north" (i.e., 360°) in spring and "south" (i.e., 180°) in fall. These models followed after "Expanded" models 1-3, that is, Expanded-4 included only uncorrelated weather variables, Expanded-5 included Julian day (JD) and all uncorrelated weather variables, except any that were correlated with Julian day and Expanded-6 models included the quadratic form of Julian day (JD-Q) and any weather variables included in Expanded-2 models. We present the variables included in "Expanded" models used for each SEASON/YEAR combination (e.g., Spring/2007) in Appendix 14.

Model performance was evaluated using Akaike Information Criteria corrected for small sample sizes (AIC_c). We considered models with the lowest AIC_c scores and with ΔAIC_c values > 2 compared to the model with the next lowest AIC_c values to be the "best performing" model or the model with the "strongest support" (Burnham and Anderson 2002). Models with ΔAIC_c values ≤ 2 of the model with the lowest score was considered equal. We also present estimates for parameter included in "best performing" models to indicate the direction of the relationship with the response variable (i.e., positive, negative). Additionally, we provide R^2 values for parameters in models with the strongest support to suggest which may have contributed to model performance.

2.4.2 *Synoptic weather conditions*

We used NWS surface weather maps (Fig. 12) generated at 0000 Greewich Mean Time (GMT, 2000 Eastern Standard Time) and 1200 GMT to determine the position of synoptic weather systems (i.e., meso scale atmospheric condition) relative to the. The position of the reference location, in this case, the MRWPF, was then plotted on a generalized synoptic weather map (Fig. 13, after Richardson 1976, Lank 1983). For statistical purposes, we defined five regions on the synoptic map based on geostrophic wind patterns (Table 3). For each Season/Period combination we used one-way Likelihood Ratio χ^2 tests (Zar 2009) to test the null hypothesis that the proportion of TR across the five synoptic weather conditions was not significantly different (i.e., equal proportions). We used the same statistical approach to test null hypotheses for TR/hr, TR100 and TR200.

Additionally, we used two-way Likelihood Ratio χ^2 tests (Zar 2009) to test the null hypothesis that the distribution of TR across the five synoptic weather conditions was not significantly different from the proportional occurrence of the five synoptic conditions. If we failed to reject the null hypothesis, then we might infer that bird and bats preferentially "used" particular synoptic conditions disproportionate to their occurrence. Again, we used the same statistical approach to test null hypotheses for TR/hr, TR100 and TR200 for each SEASON/YEAR combination.

2.4.3 *Effect of wind condition of flight direction*

We investigated relationships between vectors of bird/bat movement for each SEASON/YEAR combination and wind directions using circular-circular correlation coefficients (Fisher 1993, Mardia and Jupp, 2000). This method is analogous to the Pearson product-moment correlation commonly used for linear data. As with Pearson's correlation, this coefficient ranges from -1 to +1, with the former indicating a perfect negative correlation, the latter a perfect positive correlation, and 0 indicating no correlation. The significance of the correlation is tested using the jackknife method described in Zar (2009). We used circular-linear correlation coefficients

(Fisher 1993, Mardia and Jupp 2000) to examine relationships between vectors of bird/bat movement and tailwind/headwind vectors (THV). The circular-linear correlation coefficient ranges from 0 – 1, so there is no index for negative correlations. The calculation of significance for correlations followed Mardia and Jupp (2000), using their approximation of the F distribution. Finally, we used Watson-Williams F-tests (Fisher 1993, Mardia and Jupp 2000) to compare SEASON/YEAR specific mean wind vectors with corresponding mean vectors of corresponding bird/bat movement. This test determines if mean angles of two or more samples differ significantly by comparing the lengths of the mean vectors for each sample with that for the pooled data of the samples. The resulting F statistic is the same as Fisher's variance ratio statistic, which is commonly used in linear statistics.

2.5 General Statistical Methods

Prior to statistical analyses, we evaluated response and predictor variables to determine if they met assumptions of parametric tests we proposed to use. If assumptions were not met, we transformed data or used non-parametric tests. Based on these assessments, we used the log transformation to normalize the response variable representing number of targets recorded (TR), hourly rates of targets recorded (TR/hr) and targets recorded within two altitudinal strata (TR100, TR200). We used arcsine transformations to normalize variables represented as proportions (e.g., proportion of targets recorded in various altitudinal strata). Although we present results of statistical analyses that used transformed variables, we present summary statistics (e.g., means, standard errors) for response variables in their untransformed state in textual, tabular and graphical accounts, unless otherwise indicated.

All standard statistical analyses were performed using SAS® 9.2 (SAS Institute, Inc. 2004) and SYSTAT® 11.0 (SYSTAT Software, Inc. 2004). Statistical tests involving directional data (i.e., flight direction, circular-circular comparisons, circular-circular and circular-linear correlations) were performed using Orianna© 4.0 (Kovach Computing Services 2011). We considered results of statistical tests significant at $\alpha \leq 0.05$.

3.0 RESULTS

3.1 Target Passage and Passage Rates

Summary statistics for all response variables for each SEASON*YEAR are presented in Appendix 15.

Targets recorded (i.e., TR, sums of the 10-minute sample averages) and target passage rates (TR/hr) varied widely within and among seasons and between years (Tables 4 – 9, Figs. 14 – 16, see Appendix 8 for summary statistics from each SEASON*YEAR combination (Appendices 9 – 20 for tabular and graphical presentations of data). Kolmogorov Smirnov (K-S) two-sample tests suggested that 2007 and 2008 cumulative frequency distributions, which characterize daily changes in target movements, were significantly different for the Fall/Early season (maximum difference = 0.295, P = 0.01, Fig. 17, upper right), but not for the Spring (maximum difference = 0.220, P = 0.15, Fig. 17, upper left) or Fall/Late seasons (maximum difference = 0.182, P = 0.41, Fig. 17, lower left).

Despite high variability in TR, we found statistically significant YEAR ($F_{1, 321}$ = 16.86, $P <$ 0.0001) and SEASON ($F_{2, 320}$ = 4.71, P = 0.009) effects. TR was significantly greater in 2007 compared with 2008 (2007: mean = 2314.08 ± SE 201.21, 2008: mean = 1304.92 ± SE 110.14). Significantly more targets were recorded in Fall/Early (mean = 2162 ± SE 228.16) compared to Spring (mean = 1526.19 ± SE 131.51) and Fall/Late (mean = 1611.82 ± SE 220.90) (both Ps < 0.01).

We also found a significant SEASON*YEAR interaction ($F_{2, 317}$ = 3.78, P = 0.02). Among the between-year *post hoc* comparisons (i.e., 2007 vs 2008 for each season), we found that TR for Fall/Early-2007 (mean = 3129.89 ± SE 393.78) was significantly greater (Fig. 18 upper, Table 10) than Fall/Early-2008 (mean = 1195.21 ± SE 153.98). No other between-year differences were statistically significant (Fig. 18 upper, Table10). For 2007 among-season comparisons, Fall/Early was significantly greater than Spring (mean = 1908.78 ± SE 241.56) and Fall/Late (mean = 1643.66 ± SE 314.64), however, they were not significantly different from each other (Fig. 18 upper, Table 10). No among-season differences were statistically significant for 2008 (Fig. 18 upper, Table 10).

Results for TR/hr were similar to those found for TR. We found significant YEAR ($F_{1, 321}$ = 18.70, P < 0.0001) and SEASON ($F_{2, 320}$ = 9.57, P < 0.0001) effects. TR/hr was significantly greater in 2007 (mean = 163.54 ± SE 14.50) compared to 2008 (mean = 86.14 ± SE 6.80). Spring (mean = 120.66 ± SE 10.76) and Fall/Early (mean = 149.60 ± SE 16.35) were both significantly greater than Fall/Late (mean = 90.55 ± SE 12.61), however, they were not statistically different from each other.

The SEASON*PERIOD interaction for TR/hr was also significant ($F_{2, 317}$ = 3.77, P = 0.02). Only the Fall/Early 2007 vs 2008 comparison was significant among the between-year *post hoc* comparisons with 2007 (mean = 220.69 ± SE 28.57) being greater than 2008 (mean = 78.51 ± SE 9.68) (Fig. 18 lower, Table 10). *Post hoc* comparisons among seasons in 2007 indicated that TR/hr was significantly greater in Fall/Early than in Spring (mean = 156.06 ± SE 20.16) and Fall/Late (mean = 92.80 ± SE 18.04). None of the differences among seasons in 2008 were statistically significant.

TR also varied with time relative to sunset. When averaged across entire seasons within particular years (e.g., Spring 2007, Fall/Early 2008), peak TR generally occurred 3 – 4 hours after sunset, regardless of season (Figs. 19 – 21) and then declined gradually afterward as sunrise approached. K-S two-sample tests suggested that cumulative frequency distributions, which characterized hourly changes in target detections, were not significantly different between years for a particular season or among seasons within a given year (all Ps > 0.90, Fig. 22).

3.2 TARGET ALTITUDE

The altitudinal distribution of targets recorded across all altitudinal strata did not appear to vary significantly between seasons or among seasons. Regardless of season or year, altitudinal distributions of recorded targets generally increased with altitude to peak between 200 and 400 m (Figs. 23, 24, 25), and declined asymptotically as altitude increased above 500 m. Results from

Kolmogorov-Smirnov two-sample tests suggest that proportional distribution of targets recorded across all altitudinal strata were not significantly different between years for any season or among seasons within a given year (all Ps > 0.90, Fig. 26). Approximately 50% of all targets recorded occurred from below 400 m (Fig. 26).

Altitudinal distribution also varied relative sunset. During Spring 2007 and 2008, the greatest proportion of low altitude targets we recorded (i.e., 0 – 300 m above radar level) occurred during the first hour after sunset (Fig. 27), declined gradually throughout the night and reached their lowest proportions as in the last hour before sunrise. Fall 2007 appeared to follow a similar pattern (Fig. 28); however, the pattern in Fall 2008 appeared distinctly different. The peak of low altitude targets occurred was relatively low during the first hour after sunset, peaking approximately two hours later. Afterwards, the low altitude targets declined gradually throughout the night to reach their lowest levels (Fig. 28).

3.2.1 *0-100 meter stratum*

Our data also suggest extensive within-season variation in PROP100 (i.e., the proportion of targets recorded ≤ 100 m relative to all targets recorded) and TR100 (i.e., number of targets recorded ≤ 100 m) in 2007 and 2008, regardless of season (Tables 4 – 9, Figs. 29, 30, 31). Still, KS two-sample tests suggested that cumulative frequency distributions characterizing daily changes in PROP100 were not significantly different between 2007 and 2008 during Spring, Fall/Early or Fall/Late (maximum difference range 0.2045 – 0.2548, all $Ps \geq 0.06$, Fig. 32).

We found a significant SEASON effect on PROP100 ($F_{2, 321} = 9.99$, $P < 0.0001$). Spring (mean = 0.14 ± 0.01) and Fall/Late (mean = 0.14 ± SE 0.01) were significantly greater than Fall/Early (mean = 0.09 ± SE 0.00), but not significantly different from each other. Although a significant YEAR effect ($F_{1, 321} = 1.75$, $P = 0.19$) was not apparent, a SEASON*YEAR interaction was ($F_{2, 321} = 11.28$, $P < 0.0001$). Between-year *post hoc* comparisons suggested that PROP100 was significantly greater in Spring 2007 (mean = 0.12 ± SE 0.01) compared to 2008 (mean = 0.11 ± SE 0.01) (Fig. 33, Table 11). In contrast, PROP100 was significantly greater in Fall/Early 2008 (mean = 0.12 ± 0.01) compared with 2007 (mean = 0.07 ± SE 0.00) and this pattern was similar for Fall/Late (2007: mean = 0.12 ± 0.01, 2008: mean = 0.16 ± SE 0.02) (Fig. 33, Table 11). Among-season differences in PROP100 were all significant in 2007 (all Ps < 0.02, Fig. 33, Table 11). In 2008, PROP100 was Fall/Late was significantly greater than Spring ($t = 2.69$, $P < 0.008$) and Fall/Early ($t = 2.29$, $P = 0.02$), but Spring and Fall/Early were not statistically different ($t = 0.42$, $P = 0.67$) (Table 11).

For TR100, we found a significant YEAR effect ($F_{1, 321} = 11.50$, $P = 0.0008$), with the number of targets detected at or below 100 m being greater in 2007 (mean = 185.40 ± SE 15.67) than in 2008 (mean = 129.90 ± SE 11.22). Still, neither the SEASON effect nor the SEASON*YEAR interaction were statistically significant (SEASON: $F_{1, 321} = 1.95$, $P = 0.14$, SEASON*YEAR: $F_{2, 321} = 2.22$, $P = 0.11$).

Hourly changes in PROP100 and TR100 also showed marked within-season and between-year (Figs. 34, 35, 36, Tables 4 – 9). Generally, PROP100 was greatest in the first hour after sunset, then decreased and remained relatively constant until sunrise. Hourly changes in TR100 followed a pattern similar to that described for targets recorded across all altitudinal strata. That is, the peak of targets recorded in the 0-100 m stratum generally occurred two – four hours after sunset, regardless of season (Figs. 34, 35, 36), declining gradually afterward as sunrise approached. KS two-sample tests suggested that cumulative frequency distributions characterizing hourly changes in targets detected were not significantly different between 2007 and 2008 during Spring, Fall/Early or Fall/Late (maximum difference range = 0.0769 – 0.1286, all *P*s > 0.95, Fig. 37).

3.2.2 *101-200 meter stratum*

Similar to PROP100, PROP200 (i.e., the proportion of targets recorded 100 > and ≤ 200 m relative to all targets recorded) and TR200 (i.e., number of targets recorded 100 > and ≤ 200 m) exhibited extensive within-season variation in 2007 and 2008, regardless of season (Tables 4 – 9, Figs. 29, 30, 31). KS two-sample tests suggested that cumulative frequency distributions characterizing daily changes in PROP200 was significantly different between 2007 and 2008 during Fall/Early (maximum difference = 0.2623, $P = 0.03$, Fig. 38, upper right). Nevertheless, statistical differences in cumulative frequency distributions were not evident between 2007 and 2008 during Spring (maximum difference = 0.2187, $P = 0.15$, Fig. 38, upper left) or Fall/Late seasons (maximum difference = 0.2500, $P = 0.11$, Fig. 38, lower left).

We found a significant SEASON effect on PROP200 ($F_{2, 321} = 4.47$, $P = 0.01$). Spring (mean = 0.20 ± 0.01) was significantly greater than Fall/Early (mean = 0.13 ± 0.00) and Fall/Late (mean = 0.13 ± 0.01) (all *P*s < 0.01), but Fall/Early and Fall/Late were not statistically different from each other ($P = 0.77$). Our analysis revealed no YEAR effect ($F_{1, 321} = 2.22$, $P = 0.13$), but we did find a significant SEASON*YEAR interaction ($F_{2, 321} = 15.28$, $P < 0.0001$). Between-year *post hoc* comparisons suggested that PROP200 was significantly greater in Spring 2007 (mean = 0.20 ± SE 0.01) compared to 2008 (mean = 0.15 ± SE 0.01) (Fig. 39, Table 12). In contrast, PROP200 was significantly greater in Fall/Early 2008 (mean = 0.17 ± 0.01) and Fall/Late 2008 (mean = 0.18 ± 0.02) compared with their respective 2007 counterparts (Fall/Early: mean = 0.13 ± 0.00, Fall/Late mean = 0.12 ± 0.01) (Fig. 39, Table 12). In 2007, PROP200 was significantly greater in Spring than Fall/Early and Fall/Late (all Ps < 0.0001, Table 12), but Fall/Early and Fall/Late were not statistically different. PROP200 was not significantly different among any seasons in 2008 (Table 12).

For TR200, we found a significant YEAR ($F_{1, 321} = 7.30$, $P = 0.0008$) and SEASON effect ($F_{2, 321} = 13.68$, $P = 0.0003$). Still, the YEAR*SEASON interaction was not statistically significant ($F_{2, 321} = 2.74$, $P < 0.07$). TR200 was significantly greater in 2007 (mean = 308.47 ± SE 25.50) than 2008 (mean = 185.35 ± SE 16.23). Fall/Late (mean = 219.93 ± SE 30.95) was significantly smaller than Spring (mean = 237.14 ± SE 21.63; $t_{200} = 3.09$, $P < 0.007$) and Fall/Early (mean = 269.27 ± SE 27.00; $t_{210} = 3.60$, $P < 0.001$). Still, Spring and Fall/Early were not statistically different from each other ($t_{234} = 0.47$, $P = 1.00$).

Similar to targets recorded 0-100 m arl, hourly changes in PROP200 and TR200 also showed marked within-season and between-year patterns (Figs. 34, 35, 36, Tables 4 – 9). Again, similar to PROP100, PROP 200 was greatest in the first hour after sunset, then decreased and remained relatively constant until sunrise. Hourly changes in TR200 followed a pattern similar to that described for targets recorded across all altitudinal strata. That is, the peak of targets recorded in the 0-100 m stratum generally occurred two – four hours after sunset, regardless of season (Figs. 34, 35, 36), declining gradually afterward as sunrise approached. KS two-sample tests suggested that cumulative frequency distributions characterizing hourly changes in targets detected were not significantly different between 2007 and 2008 during Spring, Fall/Early or Fall/Late (maximum difference range = 0.0769 – 0.0909, all *P*s > 0.95, Fig. 40).

3.3 Relationships Between Target Passage and Altitude

We found a negative relationship between PROP100 and TR (targets recorded, all altitudinal strata) across all SEASON/YEAR combinations. That is, as TR increased, PROP100 decreased regardless of season or period (Figs. 41, 42). These relationships were statistically significant for all data collection periods (all *P*s < 0.05, Table 13). TR explained from 7-62% of the variation (i.e., R^2) in PROP100 although this

We found a similar negative relationship between PROP200 and TR (targets recorded, all altitudinal strata) across all SEASON/YEAR combinations. These relationships were statistically significant for all data collection periods (all *P*s < 0.05) except Fall/Late 2007 and 2008 (Table 14).

3.4 Target flight direction

Second-order mean vectors of target flight directions recorded during Spring 2007and 2008 were oriented toward 44° and 41°, respectively (Fig. 43). First-order mean vectors and associated statistics are given for Spring 2007 and 2008 in Appendices 16 and 17, respectively. Grand Mean vectors for each year were significantly different from random (2007: Hotelling's F_{51} = 46.973, $P < 0.0001$, 2008: Hotelling's F_{60} = 87.69, $P < 0.0001$). Results of Hotelling's two-sample *F*-test suggests that vectors for Spring 2007 and 2008 were not statistically different (F_{111} = 1.91, $P = 0.15$).

For Fall/Early 2007 and 2008, second-order mean vectors of target flight directions were oriented to 197° and 212°, respectively (Fig. 44). First-order mean vectors and associated statistics are given for Fall/Early 2007 and 2008 in Appendices 18 and 19, respectively. Grand Mean vectors for each year were significantly different from random (2007: Hotelling's F_{59} = 4.38, $P < 0.02$, 2008: Hotelling's F_{40} = 11.36, $P < 0.0002$), however they were not significantly different from each other (Hotelling's two-sample F_{111} = 1.90, $P = 0.16$).

Second-order mean vectors for Fall/Late 2007and 2008 were oriented toward 203° and 205°, respectively (Fig. 45). First-order mean vectors and associated statistics are given for Spring 2007 and 2008 in Appendices 20 and 21, respectively. Grand Mean vectors for each year were significantly different from random (2007: Hotelling's F_{45} = 19.22, $P < 0.0001$, 2008: Hotelling's F_{43} = 21.89, $P < 0.0001$). Nevertheless, Hotelling's two-sample *F*-test suggests that vectors for Fall/Late 2007 and 2008 were not statistically different (F_{88} = 0.93, $P = 0.40$).

Hotelling's two-sample F-test also suggested that Grand Mean vectors for the Fall period within either year were not statistically different (Fall/Early vs. Fall/Late 2007: $F_{109} = 1.34$, $P = 0.27$, Fall/Early vs. Fall/Late 2007: $F_{87} = 0.14$, $P = 0.87$).

3.5 Effects of Meteorological Conditions on Target Passage, Altitude and Direction

3.5.1 *Local conditions*

SEASON/YEAR results of multi-model comparisons for each response variable (i.e., TR, log-transformed, TR/hr, log-transformed, PROP100, arcsine transformed, TR100, log-transformed, PROP200, arcsine transformed, TR200, log-transformed) are presented in Tables 14, 16, 18, 20, 22 and 24. Estimates and partial R^2 values for parameters in the best performing models are presented in Tables 15, 17, 19, 21, 23 and 25.

3.5.1.1 Spring 2007 (Model comparisons: Table 14; Parameter estimates: Table 15)

Among candidates, the Expanded-4 model (i.e., uncorrelated weather variables, see Appendix 12 for variables included) appeared to have the greatest support for explaining variability in TR, that is, based on lowest AIC_c score and model weight ($w_i = 0.99$). Seventy percent of the variation in TR during Spring 2007 was captured by this model. Partial R^2 values suggest that cloud cover, temperature were major contributors to model performance. Parameter estimates suggested that TR increased with decreasing cloud cover (negative [-] estimate), increasing visibility, temperature and barometric pressure (positive [+] estimates) and tailwinds (positive [+] estimate). The Expanded-4 model was similarly effective at explaining variation in TR/hr, (lowest AIC_c score, $w_i = 0.99$, $R^2 = 0.71$). Parameter estimate direction and their contribution to model performance were the same as for TR.

For PROP100, the Temperature/Pressure model had the lowest AIC_c score and highest model weight ($w_i = 0.95$) and an R^2 of 0.38, suggesting strong support for the model. Both parameters in the model were negative, suggesting that PROP100 increased as temperature or barometric pressure decreased.

The Temperature/Pressure and Dew Point models performed equally well in explaining variability in PROP200 (i.e., lowest Δ AIC_c scores, within 2 of each other), although model weight for the Dew Point model was higher ($w_i = 0.37$ versus 0.16). Both models explained approximately 12% of the variation. For the Temperature/Pressure model, temperature appeared to contribute more substantially to model performance (partial $R^2 = 0.27$ versus 0.12). Both temperature and dew Point parameters were negative, suggesting that PROP200 increased as they decreased.

For TR100, the Expanded-1 and Expanded-4 models had the strong support and performed similarly well (Δ AIC_c scores, within 2), although model weight for the former was more than double that of the latter (w_i = 0.64 versus w_i = 0.29). Each model explained approximately 55% of the variation in TR100. Signs for for cloud cover (-), visibility (+), temperature (+), barometric pressure (+) and THV (+) parameter estimates were the same as those we found for targets recorded across all altitudinal strata (TR).

The Expanded-4 model had strongest support among candidates considered in explaining variability inTR200 (w_i = 0.86, R^2 = 0.72). Similar to best performing models for TR100, cloud cover and temperature contributed most to model performance (combined partial R^2 = 0.58) and directions for estimates of primary parameters were the same.

3.5.1.2 Fall/Early 2007 (Model comparisons: Table 16; Parameter estimates: Table 17)

Among candidate models tested for TR, Expanded-4, -5 and -6 had the strongest support and performed similarly (all Δ AIC_c scores within 2), although Expanded-4 had the greatest model weight (w_i = 0.37). The three models also explained a similar amount of variation in TR (all R^2s 0.27-0.29). Among model parameters, visibility (+),and THV (+) appeared to have the most influence on model performance (combined partial R^2s = 0.24).

The same three Expanded models, along with Julian day (JD), had the strongest support among candidates tested for TR/hr. Model weights (w_i = 0.21-0.24) and R^2s (0.30-0.33) were greater for the Expanded models than the Julian model (w_i = 0.11, R^2 = 0.16). For the Expanded models, Julian day (-), visibility (+) and THV (+) explained nearly all the variability in TR/hr. In the Julian day model, the parameter estimate was negative, suggesting that TR/hr decreased as the season progressed (i.e., Julian day increased).

For both PROP100 and PROP200, the Julian day-quadratic models (JD^2) had the greatest support (w_i = 0.50 and w_i = 0.52, respectively). The linear estimate was positive and quadratic estimate negative, indicating that the proportion of targets detected in these two altitudinal strata increased through the early part of the season then decreased as the season progressed.

The Expanded-4 model had the strongest support among candidates tested for TR100 and TR200. Models weights were 0.60 and 0.56, respectively and this model explained 31% and 36% of the variation in TR100 and TR200, respectively. In both cases, the barometric pressure (-) and THV (+) parameter estimates were the primary contributors to model performance.

3.5.1.3 Fall/Late 2007 (Model comparisons: Table 18; Parameter estimates: Table 19)

For TR and TR/hr, the Expanded-5, -6 and JD models had the strongest support among candidates. Model weight was highest for the Expanded-5 model (w_i = 0.34) and lowest for the JD model (w_i = 0.23). The two Expanded models captured 49% of the variation in TR and TR/hr, while the JD model explained approximately 29%. The Julian day (-) and THV parameters appeared to underlie performance in both Expanded models (combined partial R^2s = 0.47). Parameter signs suggested that TR and TR100 decreased as the season progressed and increased under tailwind conditions. Similar to the Expanded models, the Julian day parameter estimate was negative the JD model.

Among candidates models tested for PROP100, JD and JD^2 had the strongest support, although model weight for the former was more than double that of the latter (w_i = 0.54 versus w_i = 0.25). Both models explained approximately 15% of the variation in PROP100. The parameter estimate, Julian day, in the JD model was positive, suggesting that the number of targets detected at or below 100 m increased as the season progressed. Estimates for Julian day (+) and Julian day-quadratic in the JD^2 model indicate that PROP100 increase then decreased during the Fall/Late 2007 period.

The JD, Ceiling/Precipitation and Dew Point models had the strongest support among candidates tested for PROP200. Model weights ranged from 0.14 (Dew Point) to 0.33 (JD), however, none of the models were captured much of the variation in PROP200 (all R^2s ≤ 0.07). In the Ceiling/Precipitation model, the estimate for precipitation was positive, suggesting that PROP200 increased when precipitation was present.

For TR100 and TR200, the Expanded-5, -6, JD and THV/SWV models all were supported as the strongest candidates. Nevertheless, the two Expanded models had higher model weights (~0.27) and explained more variation (R^2 = 0.38) than the JD and THV/SWV models. Among the parameters included in the Expanded models, Julian day (-) and THV (+) appeared to account for model performance. For the Expanded and JD models, the Julian day estimate was negative, suggesting that TR100 and TR200 decreases as the season progressed. In the Expanded and THV models, the THV parameter estimate was positive, indicating that the response variables increased with tailwinds.

3.5.1.4 Spring 2008 (Model comparisons: Table 20; Parameter estimates: Table 21)

Among the candidate models tested for TR, Expanded-3, -2, -6 and -5 had the strongest support. Model weights were similar for each (range 0.20-0.25) and each explained approximately 47% of the variation in TR. Regardless of which model was considered, cloud cover (-) and temperature (+) appeared to have the most influence on model performance (combined R^2s = 0.43). Parameter estimates for these two variables suggest that TR increase as cloud cover decreased and temperature increase.

For TR/hr, all the Expanded models and the Temperature/Barometric Pressure model outperformed all other candidates. Model weights ranged from 0.08 (Temperature/Barometric Pressure) to 0.20 (Expanded-2 and -3). Each of the Expanded models individually accounted for between 43% and 47% of the variation found in TR/hr, while the Temperature/Barometric Pressure model captured approximately 33%. Similar to TR, cloud cover (-) and temperature (+) appeared to have the most influence on model performance (combined partial R^2s = 0.42).

Expanded models -1, -2, -4, -5 and -6 were all strong determinants of PROP100. However, Expanded-4 and -6 had greater models weights (w_i = 0.23-0.25) compared to -1 and -2 (w_i = 0.10). All the supported models explained considerable variation in PROP100 (R^2s = 0.59-0.62). Regardless of model, temperature was the primary factor underlying model performance (partial R^2 = 0.48). Parameter estimates for temperature (-), THV (+) and SWV (+) suggest that as PROP100 increased as temperatures decreased, and winds became more southeasterly (i.e., positive THV and SWV during northbound migration), regardless of which model was considered.

For PROP 200, Expanded models -5 and -6 had the strongest support, with similar model weights (w_i = 0.41 and 0.36, respectively) and coefficients of determination (R^2s = 0.56). Regardless of model, temperature (-) and SWV (+) had the largest partial R^2s, 0.28 and 0.12, respectively. Parameter estimates suggest that as temperature decreased and SWV became more easterly (i.e., positive SWV), PROP 200 increased.

All Expanded models were supported among candidates tested for TR100 and TR200. For TR100, model weights ranged from 0.09 (Expanded-5) to 0.18 (Expanded-1) and models captured approximately 34% of the variation. Model weights ranged from 0.12 (Expanded-5) to 0.23 (Expanded-1) for TR200 and models captured approximately 39% of the variation. Cloud cover (-) and THV (+) appeared to underlie model performance for TR100 (combined partial R^2s = 0.23), while cloud cover (-) and temperature (+) were apparent drivers for TR200 (combined partial R^2s = 0.26). Parameter estimates suggested that TR recorded ≤ 200 m increased under clearing cloud cover, increasing temperatures and tailwind conditions.

3.5.1.5 Fall/Early 2008 (Model comparisons: Table 22; Parameter estimates: Table 23)

Expanded-2, -3, -5 and 6 had the strongest support among candidates tested for TR and TR/hr. Model weights ranged from 0.17 (Expanded-6) to 0.28 (Expanded-2) for TR and 0.17 (Expanded-6) to 0.31 (Expanded-2) for TR/hr. Models explained approximately 31% to 34% depending on model and response variable. Regardless of model, Julian day (-), visibility (+) and temperature (-) were major contributors to model performance. TR and TR/hr appeared to decrease as a function of date within season, and correspondingly with temperature, and increase with improved visibility.

For PROP100, the JD^2, Cloud Cover/Visibility, Ceiling/Precipitation and THV/SWV models had the strongest support. Model weights ranged from 0.12 (Ceiling/Precipitation) to 0.21 (Cloud Cover/Visibility). Still, these models explained very little variation in PROP100 (R^2s = 0.07-0.09).

Only the JD^2 model had support among candidates tested for PROP200. Model weight for JD^2 was 0.60 and it explained 17% of the variation in the response variable. The linear parameter of the model was positive and the quadratic, negative, suggesting that PROP200 increased, then decreased as the season progressed.

Among candidate models tested for TR100, Expanded-2, -3 and -5 had the strongest support. Model weight was greatest in Expanded-2 (w_i = 0.30) and lowest in Expanded-5 (w_i = 0.14) The three models explained similar amounts of variation in TR100 (R^2s = 0.28-0.30). Regardless of model, temperature (-) appeared to contribute most to model performance. The parameter estimate indicated that targets detected at ≤ 100 m increased with falling temperatures.

For TR200, Expanded-2, -3 -5 and -6 models, and the Temperature and Dew Point models had the greatest support. Model weights for the Expanded models ranged from 0.14 (Expanded-6) to

0.22 (Expanded-2), while model weights for the remaining two models were 0.11. Expanded models captured approximately 27% of the variation in TR200, while the Temperature and Dew Point models explained approximately 10%. Similar to TR100, temperature (-) appeared to have a marked influence on Expanded model performance (partial $R^2 = 0.18$). Parameter estimates indicated that TR200 decreased as the season progress (Julian day – negative) and increased with decreasing temperature and improved visibility (+).

3.5.1.6 Fall/Late 2008 (Model comparisons: Table 24; Parameter estimates: Table 25)

Expanded models -5 and -6 were all strong determinants of TR and TR/hr. Model weights were 0.52 and 0.47 for each response variable, respectively, and the models explained 68% of their variation. Julian day (-),and SWV (+) appeared to be the primary factors contributing to model performance (combined partial R^2s = 0.58). TR and TR/hr decreased as the season progressed but increased as winds became more northeasterly (positive THV and SWV).

Only the Temperature/Barometric Pressure model had support among candidates tested for PROP100. Model weight was 0.90 and this two-parameter model explained 28% of the variation in PROP100. However, barometric pressure (-) explained all the variation, with PROP100 decreasing as barometric pressure increased.

For PROP200, the Temperature/Barometric Pressure, JD, Dew Point and THV models performed better than other candidate models. Model weight for the Temperature/Barometric Pressure model ($w_i = 0.30$) was twice that of the next best supporting model (i.e., JD). Although the Temperature/Barometric Pressure model only explained 11% of the variation in PROP200, this was considerably greater than the other supported models (all R^2s ≤ 0.03). .

Among candidate models, Expanded-5 and -6 had the strongest support for predicting TR100 and TR200. Model weights were 0.51 and 0.48 respectively for TR100 and 0.44 and 0.45 for TR200. These models explained 68% of variation in each response variable. The combined partial R^2s for Julian day (-),and SWV (+) were 0.64, suggesting they were the predominant factors underlying model performance for TR100 and TR200.

3.5.2 *Synoptic weather conditions*

3.5.2.1 Spring 2007 (Figure 46)

Results of the one-way Likelihood Ratio χ^2 tests suggested that the proportions of TR across the five synoptic conditions were not equal ($P = 0.0006$). We found similar results for the response variables TR/hr, TR100 and TR200 (all Ps < 0.02). For all response variables, proportions under condition "5" (0.33-0.37), which typically produces calm wind conditions (Table 3, Fig. 13), were greater than under all other conditions. Proportions were never more than 0.20 for any other synoptic condition, regardless of response variable.

For all response variables, differences between the proportions of TR across synoptic conditions and the proportional occurrence of those conditions during the Spring 2007 data collection period were significantly different (two-way Likelihood Ratio χ^2 tests, TR: $\chi^2 = 40.01$, df = 4, $P < 0.0001$, TR/hr: $\chi^2 = 40.01$, df = 4, $P < 0.0001$, TR100: $\chi^2 = 36.98$ df = 4, $P < 0.0001$, TR200: χ^2

= 40.14, df = 4, $P < 0.0001$). For TR, synoptic conditions "2," which typically produces NW winds, occurred nearly 50% of the time during Spring 2007. However, only 20% of the targets detected were done so under these conditions. In contrast, condition "5" occurred only on 6% of the nights during the data collection period, but 37% of the targets recorded occurred on these nights. This pattern was consistent for all the other response variables.

3.5.2.2 Fall/Early 2007 (Figure 47)

One-way Likelihood Ratio χ^2 tests for each response variable suggested that proportions were not equal across synoptic conditions (all Ps ≤ 0.0005). For all response variables, proportions under condition "4" (32-37%) were greater than under all other conditions. The smallest proportions were apparent under condition "3" (3-6%), regardless of which response variable we considered.

Proportional target values were not significantly different from the proportional occurrence of the five synoptic conditions during this data collection period, regardless of response variable (all Ps > 0.05) although for TR, the two-way Likelihood Ratio χ^2 test was near-significant ($P = 0.06$).

3.5.2.3 Fall/Late 2007 (Figure 48)

Of the four response variables considered, the proportions for TR, TR/hr and TR100 were all statistically different across synoptic condition (all Ps < 0.04). Only TR200 was not ($\chi^2 = 8.75$ df = 4, $P = 0.07$). However, proportions across synoptic conditions did not differ from the proportional occurrence of those conditions, regardless of response variable (all Ps > 0.20).

3.5.2.4 Spring 2008 (Figure 49)

One-way Likelihood Ratio χ^2 tests for each response variable suggested that proportions significantly different across synoptic conditions for TR ($\chi^2 = 16.77$ df = 4, $P < 0.002$) and TR/hr ($\chi^2 = 12.87$ df = 4, $P = 0.01$). For these response variable, proportions were greatest under condition "5" (32 and 35% for TR and TR/hr, respectively) and smallest under condition "4" (~10%). However, proportions were not significantly different for TR100 ($\chi^2 = 4.50$ df = 4, $P = 0.34$) or TR200 ($\chi^2 = 5.88$, df = 4, $P = 0.20$).

Proportions across the five synoptic conditions for each response variables were significantly different from the proportional occurrence of those conditions (two-way Likelihood Ratio χ^2 tests, all Ps < 0.007). For TR and TR/hr, this appeared to be related primarily to conditions "1", "2" and "5". Conditions "1" and "2" occurred 69% of the time but only accounted for 39% of the targets detected or rate of detection. In contrast, condition "5" occurred only 8% of the time but accounted for approximately 35% of the targets detected or rate of detection. The pattern was similar for TR100 and TR200.

3.5.2.5 Fall/Early 2008 (Figure 50)

One-way Likelihood Ratio χ^2 tests suggested that proportions were not significantly different across synoptic conditions, regardless of response variable (all *P*s > 0.21). However, two-way Likelihood Ratio χ^2 tests suggested that proportions across the five synoptic conditions for each response variables were significantly different from the proportional occurrence of those conditions (all *P*s < 0.04). For TR and TR/hr, conditions "2" and "5" appeared to be most responsible for these differences. Condition "2" occurred 32% but only accounted for 19% of the all targets detected, while condition "5" occurred 11% of the time but accounted for 21% of the detections. The pattern was similar for TR100 and TR200.

3.5.2.6 Fall/Late 2008 (Figure 51)

For all response variables, proportions under each synoptic condition were significantly different (one-way Likelihood Ratio tests, all *P*s ≤ 0.05). For all response variables, condition "2" and "4" had the greatest proportion (26-31%), while condition "3" had the smallest proportion (4%-11%).

Proportions across the five synoptic conditions for each response variables were significantly different from the proportional occurrence of those conditions (two-way Likelihood Ratio χ^2 tests, all *P*s < 0.04). Significance differences appeared related primarily to differences in proportions for conditions "1" and "4". We classified 34% of all nights as condition"1", but proportions for response variables only ranged from 16-19%. On contrast, condition "4" occurred 16% of the time, but accounted for 27-32%, depending on response variable.

3.5.3 *Effects of wind on flight direction*

For each SEASON/YEAR combinations we found significant and positive correlations (all *P*s < 0.05, Table 26) between wind and target directions. Similarly, we found significant correlations between THVs and all target directions for each SEASON/YEAR combinations (all Ps < 0.05, Table 27). Interestingly, however, we found significant differences for SEASON/YEAR - specific wind vectors (Fig. 52) and corresponding target vectors (all *P*s ≤ 0.02, Table 28).

4.0 DISCUSSION

In the following "Discussion" sections, we compare our results to those reported in other marine radar studies conducted primarily to assess potential impacts of wind power development. Specifically, we will compare results from this study with those reported in Mabee et al. (2005) for a pre construction radar study conducted at MRWPF. Still, caution should be used when interpreting differences between this and some other studies because of inherent differences in equipment, data collection procedures and analytical approaches. Several of the studies cited in this section, including the Mabee et al. study, used a single 12 kW X-band radar with the antenna rotating parallel to the ground (i.e., what we refer to in this report as "horizontally-oriented"). Data collected with the radar in this orientation are used to estimate target passage magnitude, passage rates and flight direction. Many practitioners then periodically rotate this unit 90° so that the antenna spins perpendicular to the ground (i.e., what we refer to in this report as "vertically-oriented"). Data collected with the radar in this orientation are used to estimate target altitudes. In this study, we used two 25 kW X-band radars operating simultaneously as described in the "Methods" section and used data collected from the vertically oriented radar to enumerate the numbers of targets and rates of passage. Given that our radars were more powerful (i.e., 25 kW versus 12 kW) than used in some studies, specifically the one used by Alaska Biological Research at the MRWPF (Mabee et al. 2005) may have given us greater ability to resolve small targets at greater distances (Desholm et al. 2006).

Several of the studies we cite for comparison use manual methods to estimate the number, altitude and flight direction of targets detected by their radar. These methods may be subject to observer biases, especially because most of these studies are conducted at night and for many consecutive hours. Additionally, these studies do not archive the image data produced by their radars. In these cases, investigators are unable to conduct quality control assessments of their data analyses. In contrast, we used automated image data collection and software-based image processing, which allows for standardized assessment of target movement indices (i.e., magnitude, altitude and direction), data quality control and improved precision of estimates.

Finally, data collection schema can produce differences in various estimates, such as passage magnitude or rates. Except for Mizrahi et al. (2008), the terrestrial studies we cite for comparison conducted radar observations for shorter periods during a given season compared to our MRWPF study. Our review of relevant literature suggested that most impact-assessment studies using marine radar focus on what is the assumed peak of movement for a given season. For example, two different studies conducted in northern New York during fall migration covered only two month periods in September and October (Mabee et al. 2005) or from mid August through mid October (Kerns et al. 2007), while a study from western New York was conducted for only 30 days in September and October (Cooper et al. 2004b). Additionally, many of the studies we reviewed began their radar observations approximately one hour after sunset and continued for approximately six hours (Cooper et al. 2004a, 2004b, Mabee et al. 2005, 2006, Plissner et al. 2006), far less than the average number of hours/night we made. Data collection in these studies also appeared to focus on what was assumed to be the nightly peak of movement.

Differences in diel and seasonal radar observation periods are noteworthy and must be accounted for when comparing target movement and movement rate estimates among studies. Estimates that include significant sampling during non-peak periods of movement, as in our study, can be lower than reported in studies with markedly fewer hours of observation focused on peak movement periods. Specifically, the Mabee et al. (2005) pre-construction radar study at the MRWPF, was conducted between 5 August and 3 October 2004 for approximately six hours starting at 2000 and ending 0200 the following morning. Additionally, extending sampling periods provides insight into times of day and during a season when bird and bats may be most vulnerable (i.e., migration periods, take off and landing, Richardson 2000). We believe that broader temporal coverage is essential to a comprehensive understanding of how tall structures might affect bird and bat flight dynamics and behavior.

4.1 TARGET PASSAGE AND PASSAGE RATES

In this section, we discuss our findings regarding the number of targets we recorded and rate of passage through our study site on the MRWPF. Although using target passage rates as an index of migration magnitude allows for comparisons among studies, they can be misleading. This is especially true when differences in data collection methods (e.g., hours of radar operation) are not fully explored. Furthermore, target movement rates as a measure of migration magnitude can obfuscate what is likely the more important metric for assessing collision risk, that is, the total number of birds and bats exposed to the tall structure in question.

4.1.1 *Effects of season and period on passage magnitude and rate*

Generally, target passage (TR) and passage rate (TR/hr) ranged 2-3 orders of magnitude within a single SEASON/YEAR and coefficients of variation were > 0.80. These results indicate that seasonal bird/bat movements, especially during migration periods (i.e., nocturnal), were temporally episodic. Given that we were monitoring the entire spectrum of bird and bat fauna in the air space occurring at our study sites and that the phenology of movement varies widely within and among taxa (i.e., age, sex, species), this was not surprising.

TR and TR/hr were greater during the Fall/Early season compared to other SEASON/YEAR combinations. Southbound bird and bat migration, which for some species begins in mid-July, typically includes large numbers of juveniles, which could explain the seasonal differences we observed. Seasonal differences also may have been related post-breeding dispersal in birds, which for some species can occur in late July at temperate and northern latitudes (Alerstam 1990), or in part to greater bat activity during the post breeding season (i.e., August and September) compared to other times of year (Arnett et al. 2008, Horn et al. 2008). Seasonal differences in movement indices generated from marine radar data have been reported widely (*cf* studies listed in Kerns et al. 2007, Table 7, p. 31) and whether spring or fall exhibits greater numbers of migrants depends primarily on the location under consideration and how it corresponds spatially to migration flyways and breeding areas.

Passage magnitude and rate indices were also greater in Fall/Early 2007 compared to 2008 but inter annual differences were not apparent for other seasons. This could be explained by variation in weather conditions that directed birds and bats away from our study site or could have been symptomatic of reduced breeding success that resulted in fewer southbound migrants. Regardless of cause, this result supports the need for multi-year studies so that inter annual variability can be accounted for.

Our passage rate estimates (TR/hr) for the Fall/Early season (149 ± 16.35, 2007 and 2008 combined) were similar to those reported by for the pre construction study conducted in 2004 (165.7 ± 27.2, North Station, 150.9 ± 19.2, South Station; Mabee et al. 2005). However, it is important to acknowledge that our estimates are based on approximately twice as many hours of data collection per night on average, half of which would be considered "off-peak." This would generally reduce the estimate compared to the one generated by Mabee et al. Comparisons by season with other studies conducted in New York State are similar in that they are within the same order of magnitude (Kerns et al. 2007). Still, there is considerable variability, which may be attributable to spatial and temporal differences in movement patterns among study locations or could be related to differences in radar equipment, data processing or data collection timeframes among studies.

4.1.2 *Diel patterns of passage magnitude*

Temporal patterns in nightly movements we observed were distinct, predictable and generally consistent with those reported for nocturnal landbird migration (Gauthreaux 1971, Åkesson et al. 1996). That is, migrants ascended rapidly within the first hour after sunset, numbers increased markedly and peaked approximately two-four hours after sunset, then declined gradually until the following morning. Although Mabee et al. (2005) only collected data from 2200 through 0100, they reported a similar temporal pattern.

Åkesson et al. (1996) suggest that various bird species make nocturnal migration ascents at different times relative to sunset and civil twilight, which could result in the two-three hour interval to reach peak numbers that we observed. Horn et al. (2008) and Reynolds (2006) suggest that bats in West Virginia and New York, respectively, exhibit similar within-night activity patterns as reported for birds, but whether this behavior is widespread is unclear because data are lacking.

4.1.3 *Environmental factors affecting variation in passage magnitude and rate*

4.1.3.1 <u>Date and local weather conditions</u>

Inherent circannual time programs entrained by photoperiod are well-known instigators of migratory behavior in birds (Gwinner and Helm 2003). Although, seasonally appropriate migration behavior is often predictable, daily variation is less so, and likely affected to a great extent by interactions between the physiological condition of individuals (Berthold 1996) and the environment (e.g., weather conditions, Richardson 1978, 1990a). Furthermore, date within season and local and regional weather conditions are intrinsically linked. For example, in the northern hemisphere, air temperatures increase with the onset of spring, continue this trend through the summer and decline as day length decreases with the onset of autumn. At temperate latitudes, the onset of spring and progress toward summer is accompanied by increasing penetration of tropical air masses.

Our multi model inference approach for examining environmental factors underlying patterns of target passage and flight altitude suggest candidate models that included a combination of weather variables (Expanded models) and in some cases Julian day, were the most consistent and significant modifier of passage magnitude and passage rate (i.e., TR, TR/hr). Among the various meteorological factors evaluated for their affect on the timing and magnitude in migrating birds, wind conditions have been repeatedly identified as a principal driver (Nisbet and Drury 1968, Alerstam 1978, 1979, Richardson 1978, 1990a, 1990b, Pyle et al. 1993, Butler et al. 1997, Liechti and Bruderer 1998, Weber et al. 1998, Åkesson and Hedenström 2000, Williams et al. 2001, Erni et al. 2002).

Our data support this thesis as wind was one of the most consistent contributors to Expanded model performance. Wind vectors that facilitated movement (i.e., tailwinds) toward seasonally appropriate goals, that is, north in spring and south in fall, were important elements in the best performing models. In fall, especially during the early period, decreasing temperature and increasing barometric pressure tendencies were also important contributors to Expanded model performance. Changing wind fields are often associated with changes in temperature in barometric pressure gradients. Dropping temperature and rising barometric pressure can signal the infiltration of air masses from the north, bringing northerly winds favorable for southward migration.

Within the context of best performing Expanded models, Julian day was a significant determinant of passage magnitude and rate in Fall/Late 2007 and in all seasons during 2008. In Spring, our results suggest that magnitude and rate of passage increase throughout the season and then decrease as the migration period comes to an end. For the Fall periods, magnitude and rate declined as the season progressed. These finding are consistent with what we know about season-specific temporal patterns of migration in birds. Furthermore, bat migration and overall bat activity is greatest during July and August and declines considerable after September (Reynolds 2006), which would be consistent with our results.

Although climatological conditions in part appear to underlie the evolution of migration in bats (Fleming and Ebby 2003), their proximate affect on variability in migration patterns is not well described. Given that migrating bats face similar ecological and physiological constraints (e.g., energy conservation) of prolonged flight, it is likely they respond in similar ways to weather conditions that favor transport between migration goals. More work in this area is needed to improve our understanding of which weather conditions put migrating bats are at greatest risk from colliding with tall structures that penetrate the atmosphere.

4.1.3.2 Synoptic weather conditions

Our results suggested that synoptic weather patterns producing wind conditions appropriate for directing individuals northward toward the breeding grounds were important predictors of movement events in Spring. At temperate latitudes, this generally means southerly winds prevalent after the passage of a warm front and on the western side of a high pressure system, or in the light and variable winds near the center of high pressure areas (*cf* citations in Richardson 1978, 1990a, Alerstam 1990).

Between 60 and 65% of targets we detected during the two spring seasons were when weather patterns produced generally calm winds or prevailing southerly winds. However, weather systems that produced these wind conditions occurred only about 40% of the time. In contrast, synoptic conditions that are usually associated with northerly winds occurred on nearly 60% of the nights we sampled but accounted for only 35-40% of the total targets we detected. These results suggest that birds, and possibly bats, were selective about the conditions under which they were actively migrating. Birds can reduce energetic costs significantly by migrating under favorable winds (i.e., tailwinds, Gauthreaux 1991, Piersma and van de Sant 1992, Liechti et al. 2000), thus large migration events are often coincidental with these conditions (Richardson 1972, 1974, Able 1973 Blokpoel and Gauthier 1974, Pyle et al. 1993, Williams et al. 1977, 2001). This may be especially important for species that rely on nutrient reserves acquired prior to or during migration to initiate nesting and egg laying (i.e., capital breeders). Flying under favorable wind conditions may insure that birds and bats are not delayed arriving on the breeding grounds, which could result in a competitive disadvantage (Sandberg 1996, Norris and Marra 2007). The energy they save by flying under conditions that facilitate movement during migration may improve success during the breeding season.

Results from analyses of data from the Fall/Early and Late periods in 2007 were not similarly informative. We found no differences between the targets we detected, the rate of detection or detection in the two lowest altitudinal strata across synoptic conditions and the proportional occurrence of those conditions throughout the sampling period. Birds migrating south after the breeding season may not be as selective about the conditions under which they depart to wintering areas as they are not under the same energy constraints as they are during migration to the breeding grounds (Sandberg 1996, Sandberg and Moore 1996, Norris and Marra 2007). Although we did not investigate this, the temporal occurrence of synoptic conditions suitable for southbound migration may have been out of synchrony with migration schedules such that birds began bouts of migration under sub optimal conditions.

In Fall 2008, birds and bats appears to be most active during periods of calm wind disproportionately from the occurrence of this condition. These conditions might be most suitable for bats when they are foraging during the post breeding periods. Nevertheless, activity was lower than expected under synoptic conditions that typically produce northerly winds. One possible explanation might be that wind velocities were too high during those nights when synoptic conditions produced northerly winds, so birds and bats avoided migrating. Bird migration appear to diminish when wind velocities exceed approximately 30 kph (Mizrahi unpublished data) and this appears to be similar for bats (Arnett et al. 2009).

4.2 Passage in the Lowest Altitudinal Strata

Determining flight altitudes of birds and bats is an essential element in assessing the potential effects of tall structures on aerial vertebrates. Most investigators working on environmental impact assessments of tall structures, such as wind turbines, limit their evaluation of potential risk to the altitudinal strata immediately associated with a wind turbine's rotor swept area. However, expanding the range considered as "risky" may provide improved insight into the broader extent of potential impacts.

Birds often fly at altitudes that minimize energy costs (Bellrose 1971, Bruderer et al. 1995). Which altitudinal stratum an individual chooses appears to be primarily a response to changing wind fields (Able 1970, Alerstam 1985, Gauthreaux 1991, Bruderer et al. 1995). Headwinds and atmospheric turbulence can increase energy expenditures during flight (Bruderer 1978, Williams et al. 2001). With respect to the latter, the atmosphere is often more turbulent and turbulence extends higher into the atmosphere over land and along coastlines than over water (Kerlinger and Moore 1989). This results primarily from an absence of thermal convection and topographic relief over water. Low altitude winds can often be faster and more persistent over water compared to land (Hüppop et al. 2006), which could explain low altitude flights by birds over water when tailwinds are present. Furthermore, when wind conditions are favorable across many strata, birds may select lower altitudes to avoid lower temperatures, relative humidity and partial pressure of oxygen typical of higher altitudes. These conditions could accelerate water loss and convective heat loss, which could reduce flight efficiency (Carmi et al. 1992, Klassen 1996, Liechti et al. 2000).

4.2.1 *Effects of season and period*

We found significant among-season variability in the proportion of targets flying in the two lowest altitudinal strata we considered (i.e., ≤ 100 m, 100 > ≤ 200 m). The proportion and number of birds flying at low altitudes was greater during the spring compared to the two fall periods, regardless of year, suggesting that this may represent a consistent behavior pattern. Again, this supports the premise that multi-season, multi-year studies are important for instilling confidence in inferences drawn from results.

The proportion of targets we detected flying at or below 100 m were consistent with finding from several other studies conducted in New York and the northeastern US (*cf* Kerns et al. 2007). Unfortunately, the Mabee et al. (2005) pre-construction radar study at the MRWPF only presented the mean altitude for targets they detected so we cannot make a direct comparison. We opted to use proportions and numbers of targets in altitudinal strata because, flight altitudes typically are high variable and thus the mean and an index of variation (e.g., standard error) are usually not informative. Nevertheless, the Mabee et al. study reported a mean passage rate (i.e., targets/km/hr) for targets detected flying ≤ 125 m at both of their study sites (11.4 ± SE 1.4). We made a similar calculation for targets detected flying ≤ 100 m during the Fall/Early periods (1 August – 30 September) during both years of our study and found a slightly higher but similar result (15.43 ± SE 1.6).

Although our data were processed so that targets were assigned to one of 14 altitudinal bins, we calculated a mean flight altitude targets detected for the Fall/Early 2007 and 2008 periods so that a comparisons could be made with other studies. Our mean flight altitudes (2007: 499.82 ± SE 16.48 m, 2008: 433.57 ± SE 15.64 m) were very similar to mean flight altitudes reported in other studies conducted in the region (Kerns et al. 2007). Interestingly, our result for 2007 was nearly identical to the mean flight altitude Mabee et al. (2005) reported from the "North" site during their pre construction study at the MRWPF.

4.2.2 *Diel patterns in altitudinal distribution*

Hourly variation in proportion of targets we recorded at or below 200 m appeared to follow similar patterns regardless of season or year. That is, the greatest proportion of targets we recorded at or below 200 m was greatest during the first hour after sunset, declined gradually over the course of the night and was lowest at sunrise. In contrast, the number of targets detected in the two lowest altitudinal strata we considered followed a similar pattern to target detections across all strata; numbers were generally low at the onset of migration, approximately one hour after sunset, peaked two-three hours after sunset and declined gradually afterwards until sunrise the following morning.

These two data sets and our analysis of correlations between movement magnitude and altitude suggest several important relationships. As nocturnal activity peaked, the proportion of birds and bats flying at low altitudes was relatively small, but this was also the time when the greatest number of individuals were aloft. Conversely, during periods when the proportions of birds and bats flying at low altitudes are greatest (i.e., around sunrise) the number of birds and bats are low.

Similar relationships were alluded to in radar studies of bird migration in New England (Nisbet 1963), the Gulf of Mexico (Able 1970) and apparent in studies conducted in the mid Atlantic Appalachian Mountain region, coastal New Jersey and on Block Island, RI (Mizrahi et al. 2008, 2009, 2010). They are important to consider when evaluating the risk of collision with tall structures. Although the thesis that nocturnal migrants may be at greatest risk of collision during ascent and descent has been suggested (e.g., Richardson 2000), the greatest number of individuals may be exposed to risk during the peak periods of migration, as was the case in our study. Using proportions of targets detected in various altitudinal strata allows for comparison among studies, however, they can be misleading. In our study, numerically greater numbers of individuals were detected in those lowest strata during the nightly peak of movement. Still, the proportions of individuals in these altitudinal strata, relative to the total, were not. Again, the total number of birds and bats exposed to the tall structure in question is likely the more important measure of risk.

4.2.3 *Environmental factors affecting variation in flight altitude*

4.2.3.1 Date and local weather conditions

Julian day was the most consistent predictor for the proportion of targets we recorded below 200 m. Parameter estimates suggest that during migration periods (i.e., spring, fall), the proportion of low flying (i.e., ≤ 200 m) birds and bats increased. This could have resulted if the conditions that produced lower altitude flights became increasingly more frequent as the spring and fall progressed, or that species with a tendency to fly at lower altitudes were more prevalent as Julian day increased. Differences in flight altitudes during migration among avian taxa have been widely reported (Alerstam 1978, 1990).

Weather conditions are known to affect the vertical distribution of birds in the atmosphere. Headwinds, strong crosswinds and indices of approaching adverse weather conditions (e.g., precipitation) often lead to reductions in flight altitude (Richardson 1978, 1990a, 1990b). Generally, our results were mixed with respect to this thesis as it applied to the proportion of targets detected in below 200 m. Relationships between local weather conditions were not as pronounced compared to other studies we conducted (Mizrahi et al. 2008, 2009) and their importance varied depending on season and period.

In spring, decreasing atmospheric pressure and temperature, and conditions producing winds with a strong westerly component tended to be associated with an increase in the proportion of targets detected below 200 m. These conditions could signal the onset of storms and accompanying precipitation, which could cause birds and bats to lower their flight altitudes.

Falling barometric pressure, reduced visibility and headwinds were weakly associated with an increase the proportion of targets flying below 200 m in fall. These conditions generally portend the approach of a low pressure system and with it, southerly winds and precipitation. Flying low in the opposing winds and under conditions that produce adverse weather may save energy and allow an individual to respond quickly in the event that it must land.

The number of targets we detected flying below 200 m appeared to respond to conditions similar to those associated with overall movement magnitude at all altitudes. Regardless of season, increasing visibility, reduced cloud cover, increasing temperatures and tailwinds were all significant predictors of target detections below 200 m. These results reflect the greater tendency for birds and bats to increase activity under these conditions.

4.2.3.2 Synoptic weather conditions

Results from these synoptic weather analyses for targets recorded below 200 m followed similar patterns to what we observed for target magnitude across all altitudinal strata. In spring, birds and bats flying at low altitudes appeared to prefer calm or lightly variable wind conditions associated with stable, high-pressure systems across the region. These conditions occurred less than 10% of the nights we sampled but accounted for more than 30% of all the targets recorded below 200 m. In contrast, condition associated with the passage of a cold front that produces northwesterly winds occurred on average 40% of the nights in spring but account for only 20% of the targets recorded in the two lowest altitudinal strata. Patterns in fall were much less informative, with no clear pattern emerging from analyses of synoptic weather and targets flying at low altitudes. Differences between spring and fall again may be related greater constraints on birds and bats as they migrate northward to breeding areas.

4.3 FLIGHT ORIENTATION

Mechanisms used by migrating birds to find their way between breeding and wintering grounds have been studied extensively (*cf* citations in Gauthreaux 1980, Alerstam 1990, Berthold 1991). "Pilotage," the use of visible features in the landscape as a guide (e.g., coastlines, rivers, mountain ranges), is often associated with diurnal migrants (Kerlinger 1989, Alerstam 1990, Berthold 1991), although some nocturnal migrants also exhibit this behavior (Bingman et al. 1982). On the other hand, "orientation," the use of an environmental cue or cues that provide directional information (e.g., celestial rotation, Earth's magnetic inclination) appears to be more prevalent in nocturnal migrants (e.g., passerines, shorebirds) (Able and Bingman1987).

Wind conditions, however, can play an important role in modifying the directional behavior of flying vertebrates (Richardson 1990b). Our results suggest that the targets we observed responded to wind conditions, both direction alone and direction and speed together (i.e., tailwind/headwind vectors). In spring, birds and bats we recorded flew primarily in a northeasterly direction. In fall, the mean vector of flight was southwesterly. The nocturnal flight directions are similar to ones reported in other radar studies conducted in at the MRWPF (Mabee et al. 2005), the Appalachian mountains (Mabee et al. 2006, Mizrahi et al. 2008) and mid-

Atlantic coastal regions (Drury and Nisbet 1964, Mizrahi et al. 2008, Mizrahi et al. 2010, Geo-Marine 2010).

We found that mean vectors of prevailing winds and wind vectors at sunset were significantly correlated with flight directions recorded during all SEASON/YEARS (e.g., Spring 2007, Fall/Late 2008). Furthermore, mean wind vectors were significantly different from vectors we estimated from nightly movements. These results together and what appears to be a consistent pattern of flight direction in aerial vertebrates in the mid-Atlantic, including New York State, suggests that birds and bats were either selective about the wind conditions under which they flew, or that they were able to compensate for differences between wind directions and their directional goals. Clearly, these hypotheses are not mutually exclusive and could be operating in tandem to produce the behaviors we observed.

5.0 CONCLUSIONS

Our results suggested that the movement of aerial vertebrates through the study area was substantial and comparable to several other similar studies conducted in the region. The flight altitudes of many thousands of birds and bats could have resulted in their encountering structures 100-200 m in height. Whether those encounters would have resulted in collisions is an open question that is beyond the scope of this study. Our results also shed light on meteorological conditions that modify flight dynamics and behavior. Furthermore, they suggested weather patterns that might affect when birds and bats may have the greatest probability of encountering a tall structure during daily movements or along their migration routes if one was in its flight path.

In general, our results were comparable to those reported from other studies using marine radar to assess potential risk at proposed or operational wind power facilities in the region. Importantly, the number of targets detected, target passage rate, flight altitude and the number of targets flying below 100 m we observed during the Fall/Early periods were similar to those reported during a pre construction assessment conducted from 5 August through 3 October 2004 at the MRWPF. The strength of this study was primarily in that it was conducted over a two-year period, during almost entire migration periods (Spring: April – mid June, Fall: August – mid November) and over an entire night from sunset to sunrise the following morning. Interannual, seasonal and diel variability in environments and meteorological conditions are widely acknowledged. By capturing this variability through extended observation, our study provided a more comprehensive understanding of movement patterns in aerial vertebrates in the Tug Hill Plateau region and the MPRWF.

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Table 1. Total and mean hours of data collection by period (i.e., diurnal, nocturnal) and season. Diurnal periods ran from sunrise to sunset the same day and nocturnal periods ran from sunset to sunrise the following morning.

		Total hours	Mean hours	± SE	N
2007					
	Spring	458.83	9.00	0.67	51
	Fall-Early	641.17	10.51	0.13	61
	Fall-Late	577.55	12.83	0.30	45
	Totals	1677.55	10.67	0.16	157
2008					
	Spring	588.35	9.49	0.09	62
	Fall-Early	670.48	10.99	0.13	61
	Fall-Late	595.77	13.24	0.06	45
	Total	1855	11.04	0.13	168

Table 2. Types of data used in analyses to investigate relationships between local weather conditions and bird/bat flight dynamics (e.g., target passage, altitude, direction) observed at the Maple Ridge Wind power Facility, spring and fall, 2007 and 2008. Data used in analyses were derived from local climatological data sets acquired from National Climate Data Center (NCDC) for Watertown International Airport, Watertown, NY.

1	Cloud cover (% of sky covered by clouds or fog, in increments of 25%).
2	Ceiling (vertical visibility estimated in kilometers, converted to meters)
3	Horizontal visibility (estimated in kilometers, converted to meters)
4	Precipation (drizzle, rain, snow; classified as 0 [No] or 1 [Yes])
5	Dry bulb temperature (in degrees Celsius)
6	Dry bulb dew point temperature (in degrees Celsius)
7	Barometric pressure (measuree in inches, converted to millibars)
8	Wind direction (measures in 10° increments as direction from which winds originate)
9	Wind speed (measured in knots, converted to meters/second)
10	Tailwind/Headwind vector (calculated wind vector along an axis parallel to assumed direction of migration goal [i.e., S ↔ N, SW ↔ NE]. Tailwinds have positive values and headwinds have negative values [see Appendix 1 for equation used in calculation]).
11	Sidewind vector (calculated wind vector along an axis perpendicular to assumed direction of migration goal [i.e., S ↔ N, SW ↔ NE]. Sidewind vectors have positive values from the east in spring and from the west in fall [calculations are similar to those shown in Appendix 1]).

Table 3. Synoptic weather classifications based on geostrophic wind circulation patterns (after Richardson 1976, Lank 1983).

Class	Description
1	Southerly winds, from SE to WSW, except immediately following a cold front. Typically occurs on the east side of a cold front or south of a passing warm front
2	Northwesterly winds, from west to north. Frequently occurs after passage of a cold front, in areas NE of a high pressure system or SW of low pressure
3	Northeasterly winds, from north to southeast. Can occur after passage of a cold front, in areas SE of high pressure or N and W of low pressure
4	The center of a low pressure system and the area immediately around a cold front. Also, areas in the immediate vicinity of a cold front. Often associated with precipitation
5	Calm weather at the center of a high pressure system or in poorly organized areas south of a stationary front.

Table 4. Results of marine radar image analyses for data were collected on 51 days during spring 2007 at the Maple Ridge Wind Power Facility, Lowville. Lewis County, New York. "Total targets" are the number of birds/bats detected in all images collected. "Sum of the sample means" refers to the target count averaged over the five successive images that constitute a sample (i.e., every 10 minutes from sunset to sunrise the following morning). These values are summed for the entire night's data collection to generate a passage estimate. "Target detection rate" represents the number of targets detected per kilometer of passage front per hour. We also present the proportion and number of targets detected within the three lowest altitudinal strata (i.e., 100, 200, 300 m).

Date	Total targets	Sum of the sample means	Target detection rate	Proportion of targets <=100 m	Number of targets <=100 m	Proportion of targets 101-200 m	Number of targets 101-200 m	Proportion of targets 201 -300 m	Number of targets 201-300 m
04/26/07	3584	717	52.49	0.14	99.23	0.12	85.02	0.15	109.63
04/27/07	208	40	2.93	0.41	16.54	0.24	9.42	0.14	5.58
04/28/07	406	94	6.88	0.85	79.88	0.02	1.85	0.00	0.46
04/29/07	4107	820	60.04	0.19	157.73	0.35	288.91	0.19	155.14
04/30/07	2634	525	39.10	0.19	98.26	0.33	171.21	0.15	79.53
05/01/07	779	155	10.66	0.14	21.09	0.16	25.47	0.13	19.50
05/02/07	3012	602	44.84	0.32	194.07	0.34	207.46	0.10	62.56
05/03/07	4974	995	75.40	0.15	152.43	0.32	318.66	0.17	167.03
05/04/07	16029	3206	242.96	0.07	219.01	0.14	446.03	0.10	318.62
05/05/07	962	188	14.25	0.26	48.47	0.35	65.47	0.09	17.00
05/06/07	19822	3963	305.69	0.05	186.93	0.12	479.03	0.13	498.42
05/07/07	28539	5705	440.06	0.04	221.69	0.12	669.67	0.14	793.01
05/08/07	11393	2278	172.63	0.09	206.95	0.21	468.48	0.14	319.32
05/09/07	16293	3258	251.31	0.04	125.78	0.11	343.34	0.12	394.73
05/10/07	9439	1887	145.56	0.06	115.75	0.17	311.67	0.18	335.06
05/11/07	1919	380	29.84	0.23	86.73	0.24	91.68	0.14	52.28
05/12/07	549	110	8.49	0.37	40.67	0.30	32.86	0.09	10.22
05/13/07	2606	521	40.92	0.22	116.76	0.30	157.54	0.14	73.77
05/14/07	11906	2382	187.08	0.14	327.31	0.17	397.33	0.18	438.55
05/15/07	3145	630	49.48	0.24	149.44	0.14	91.14	0.12	74.72
05/16/07	299	60	4.71	0.43	25.89	0.22	13.44	0.05	2.81
05/17/07	3649	734	57.65	0.13	98.97	0.20	143.62	0.13	98.77
05/18/07	3681	738	59.04	0.28	207.91	0.37	270.26	0.14	101.45
05/19/07	4961	995	79.59	0.28	273.77	0.37	372.65	0.12	115.12
05/20/07	549	111	9.05	0.64	71.37	0.23	25.27	0.04	4.45
05/21/07	8938	1788	145.73	0.13	230.85	0.28	497.91	0.19	334.87
05/22/07	21292	4259	340.69	0.03	125.42	0.08	323.25	0.09	391.86
05/23/07	18138	3630	295.86	0.10	357.44	0.20	743.29	0.18	637.42
05/24/07	12503	2500	199.98	0.12	289.93	0.24	608.05	0.19	480.08
05/25/07	6476	1296	105.63	0.10	123.48	0.24	307.19	0.19	243.15
05/26/07	8769	1754	142.96	0.07	127.21	0.14	245.63	0.19	328.24
05/27/07	7386	1478	122.78	0.11	161.89	0.16	241.13	0.10	148.48
05/28/07	3052	611	49.80	0.26	161.76	0.30	182.98	0.17	105.90
05/29/07	7635	1531	127.18	0.06	85.02	0.17	258.48	0.24	361.75
05/30/07	8252	1649	136.98	0.12	195.43	0.25	411.85	0.20	321.73
05/31/07	8794	1756	145.87	0.11	193.89	0.22	389.38	0.16	282.95
06/01/07	8924	1782	150.93	0.09	154.56	0.18	312.71	0.16	278.16
06/02/07	15717	3142	266.12	0.09	287.27	0.16	496.18	0.17	525.97
06/03/07	6125	1224	103.67	0.08	94.72	0.11	133.49	0.18	225.02
06/04/07	4388	876	72.77	0.06	50.11	0.11	94.03	0.11	95.63
06/06/07	1478	294	24.90	0.12	34.81	0.21	60.87	0.20	58.08
06/07/07	16416	3298	279.34	0.02	75.94	0.05	174.99	0.09	289.90
06/08/07	13600	2719	234.90	0.03	83.17	0.06	157.74	0.11	304.89
06/09/07	11259	2255	194.82	0.09	192.47	0.17	389.15	0.20	459.65
06/10/07	15908	3180	274.73	0.11	358.22	0.19	596.70	0.18	580.31
06/11/07	33735	6750	583.15	0.10	685.30	0.17	1126.30	0.17	1167.52
06/12/07	36244	7246	613.73	0.10	753.31	0.18	1326.69	0.15	1078.38
06/13/07	17885	3578	303.05	0.12	443.72	0.21	751.21	0.20	712.80
06/14/07	7949	1593	137.62	0.13	201.00	0.21	337.48	0.19	298.40
06/15/07	20783	4156	359.05	0.14	585.12	0.22	901.07	0.15	640.11
Totals	**477091**	**95439**	**7802.90**	**0.10**	**9394.67**	**0.17**	**16555.24**	**0.14**	**12947.64**
Means	**9512**	**1903**	**159.97**	**0.17**	**187.89**	**0.20**	**331.10**	**0.14**	**291.98**
Minimum	**208**	**40**	**2.93**	**0.02**	**16.54**	**0.02**	**1.85**	**0.00**	**0.46**
Maximum	**36244**	**7246**	**613.73**	**0.85**	**753.31**	**0.37**	**1326.69**	**0.24**	**1167.52**

Table 5. Results of marine radar image analyses for data were collected on 61 days during Fall/Early 2007 (31 July - 30 September) at the Maple Ridge Wnd Power Facility (MRWPF). "Total targets" are the number of birds/bats detected in all images collected. "Sum of the sample means" refers to the target count averaged over the five successive images that constitute a sample (i.e., every 10 minutes from sunset to sunrise the following morning). These values are summed for the entire night's data collection to generate a passage estimate. "Target detection rate" represents the number of targets detected per kilometer of passage front per hour. We also present the proportion and number of targets detected within the three lowest altitudinal strata (i.e., 100, 200, 300 m).

Date	Total targets	Sum of the sample means	Target detection rate	Proportion of targets <=100 m	Number of targets <=100 m	Proportion of targets 101-200 m	Number of targets 101-200 m	Proportion of targets 201 -300 m	Number of targets 201-300 m
07/31/07	10849	2169	223.08	0.05	113.16	0.13	279.10	0.19	405.65
08/01/07	8932	1789	154.56	0.07	133.79	0.14	250.76	0.17	307.45
08/02/07	5549	1103	85.08	0.09	103.76	0.17	188.64	0.25	274.91
08/03/07	19068	3815	294.28	0.06	218.48	0.10	389.34	0.15	577.21
08/04/07	37932	7588	585.31	0.03	243.05	0.09	701.55	0.15	1126.24
08/05/07	6486	1299	100.20	0.05	64.29	0.11	138.79	0.13	173.44
08/06/07	37475	7495	568.00	0.04	297.20	0.08	583.40	0.13	977.20
08/07/07	3828	765	57.97	0.12	92.53	0.11	83.13	0.16	120.31
08/08/07	54730	10945	829.45	0.09	1012.51	0.16	1702.04	0.17	1809.43
08/09/07	18635	3727	282.44	0.07	254.00	0.13	500.20	0.19	701.00
08/10/07	54756	10952	829.98	0.03	306.02	0.06	676.25	0.09	1035.48
08/11/07	27134	5425	404.04	0.04	235.72	0.09	501.23	0.15	789.94
08/12/07	5603	1125	83.79	0.08	90.55	0.12	129.51	0.12	138.54
08/13/07	61116	12225	895.05	0.04	547.88	0.09	1090.96	0.14	1717.05
08/14/07	4466	891	65.23	0.10	88.98	0.13	116.71	0.17	152.62
08/15/07	12527	2500	183.04	0.05	117.95	0.13	321.31	0.17	419.89
08/16/07	44949	8991	647.30	0.04	363.65	0.09	819.31	0.15	1332.98
08/17/07	27908	5581	408.61	0.03	174.58	0.07	363.56	0.10	553.94
08/18/07	15379	3075	225.13	0.05	141.36	0.09	272.33	0.13	411.69
08/19/07	15067	3010	216.70	0.07	200.97	0.13	388.76	0.19	582.54
08/20/07	7923	1584	114.04	0.08	120.95	0.15	239.51	0.17	274.70
08/21/07	4793	957	67.77	0.06	52.71	0.14	133.78	0.17	164.52
08/22/07	3813	761	53.89	0.08	62.27	0.15	113.36	0.22	165.25
08/23/07	5491	1098	77.75	0.12	128.98	0.18	197.36	0.22	237.36
08/24/07	13794	2756	192.02	0.06	167.63	0.08	220.58	0.16	454.14
08/25/07	10940	2190	152.58	0.08	182.37	0.15	330.10	0.17	375.34
08/26/07	54263	10852	756.08	0.10	1139.34	0.15	1678.11	0.17	1877.50
08/27/07	14301	2861	199.33	0.08	237.27	0.15	443.12	0.23	658.58
08/28/07	7499	1496	104.23	0.09	131.87	0.18	268.12	0.16	243.98
08/29/07	8616	1724	118.21	0.07	120.06	0.17	286.73	0.20	336.36
08/30/07	30540	6110	418.94	0.07	447.15	0.12	728.84	0.15	895.09
08/31/07	18948	3788	259.73	0.08	285.28	0.14	529.78	0.23	873.43
09/01/07	8270	1655	111.70	0.09	157.09	0.18	297.18	0.19	311.99
09/02/07	3739	752	50.76	0.09	68.78	0.20	150.84	0.19	144.61
09/03/07	15120	3022	203.97	0.07	216.66	0.16	478.88	0.22	659.76
09/04/07	10886	2173	146.67	0.10	213.19	0.14	303.81	0.18	390.84
09/05/07	4559	911	60.54	0.06	54.15	0.13	119.50	0.16	149.47
09/06/07	2177	433	28.34	0.05	21.48	0.14	58.87	0.20	87.71
09/07/07	1742	346	22.65	0.08	28.40	0.15	50.45	0.18	62.96
09/08/07	34027	6803	452.10	0.11	772.33	0.18	1221.97	0.23	1579.44
09/09/07	2677	535	35.02	0.08	41.77	0.12	65.75	0.16	86.14
09/10/07	14746	2949	193.01	0.10	287.58	0.16	473.97	0.22	648.36
09/11/07	2923	585	37.72	0.08	44.23	0.10	56.04	0.14	82.06
09/12/07	15120	3021	197.72	0.10	288.31	0.14	424.18	0.21	631.57
09/13/07	3853	769	49.58	0.08	64.07	0.15	116.36	0.17	129.13
09/14/07	3544	711	45.84	0.08	59.18	0.11	74.83	0.15	105.13
09/16/07	6395	1277	81.12	0.06	77.88	0.10	127.40	0.13	163.74
09/17/07	7601	1520	95.16	0.08	123.38	0.14	213.77	0.15	223.77
09/18/07	2781	554	35.19	0.09	47.21	0.17	96.02	0.14	78.89
09/19/07	3440	688	43.07	0.05	37.20	0.15	103.60	0.17	114.40
09/20/07	35268	7054	435.30	0.11	746.84	0.14	974.66	0.20	1386.28
09/21/07	5134	1029	63.50	0.07	76.76	0.15	152.53	0.17	178.78
09/22/07	16668	3335	205.80	0.08	280.32	0.12	415.97	0.18	605.45

Table 5. Continued

09/23/07	14696	2943	179.05	0.04	116.75	0.07	193.05	0.09	268.15
09/24/07	1806	362	22.02	0.06	21.05	0.18	64.34	0.20	73.56
09/25/07	2954	589	35.83	0.07	38.88	0.14	79.96	0.14	82.95
09/26/07	7960	1592	96.86	0.09	135.80	0.12	196.00	0.15	238.80
09/27/07	5251	1050	62.99	0.11	110.78	0.13	138.97	0.15	152.97
09/28/07	41365	8273	496.34	0.05	436.40	0.10	819.60	0.15	1209.60
09/29/07	22947	4589	275.32	0.06	260.18	0.09	413.96	0.14	661.54
09/30/07	3777	756	45.36	0.05	34.03	0.09	68.85	0.13	97.88
Totals	954736	190923	13462.33		12736.988		22617.593		30769.6943
Means	15651.41	3129.89	220.69	0.0723	208.80	0.1297	370.78	0.1680	504.42
Minimum	1742	346	22.02	0.0279	21.05	0.0617	50.45	0.0911	62.96
Maximum	61116	12225	895.05	0.1210	1139.34	0.2006	1702.04	0.2492	1877.50

Table 6. Results of marine radar image analyses for data were collected on 45 days during Fall/Late 2007 (1 October - 15 November) at the Maple Ridge Wnd Power Facility (MRWPF). "Total targets" are the number of birds/bats detected in all images collected. "Sum of the sample means" refers to the target count averaged over the five successive images that constitute a sample (i.e., every 10 minutes from sunset to sunrise the following morning). These values are summed for the entire night's data collection to generate a passage estimate. "Target detection rate" represents the number of targets detected per kilometer of passage front per hour. We also present the proportion and number of targets detected within the three lowest altitudinal strata (i.e., 100, 200, 300 m).

Date	Total targets	Sum of the sample means	Target detection rate	Proportion of targets <=100 m	Number of targets <=100 m	Proportion of targets 101-200 m	Number of targets 101-200 m	Proportion of targets 201 -300 m	Number of targets 201-300 m
10/01/07	6202	1242	74.51	0.03	36.85	0.08	103.13	0.15	185.24
10/02/07	5799	1160	68.64	0.01	17.00	0.04	45.81	0.07	79.61
10/03/07	15139	3029	181.73	0.08	234.09	0.12	361.94	0.19	563.82
10/04/07	33340	6668	389.24	0.07	437.20	0.11	711.00	0.15	973.00
10/05/07	22587	4521	263.91	0.07	337.87	0.11	508.00	0.16	711.17
10/06/07	4770	952	54.83	0.10	91.41	0.16	154.87	0.21	197.98
10/07/07	18756	3752	216.10	0.07	261.66	0.10	369.68	0.14	514.71
10/08/07	14585	2916	167.95	0.10	284.10	0.12	347.88	0.16	478.44
10/09/07	7254	1454	82.64	0.08	114.85	0.10	143.32	0.14	206.25
10/10/07	4049	810	46.04	0.11	88.62	0.14	113.43	0.19	152.44
10/12/07	53507	10703	608.33	0.10	1056.96	0.13	1418.61	0.18	1970.49
10/13/07	8150	1630	91.44	0.14	220.80	0.10	170.80	0.10	156.80
10/14/07	8689	1737	97.44	0.10	180.12	0.14	236.09	0.16	276.07
10/15/07	21274	4255	238.70	0.10	415.82	0.14	575.83	0.19	802.44
10/16/07	11203	2237	125.49	0.05	114.02	0.07	163.74	0.11	252.19
10/17/07	4189	839	46.46	0.08	69.10	0.14	120.97	0.19	162.03
10/18/07	1902	380	21.04	0.05	18.78	0.10	36.36	0.14	51.35
10/19/07	1974	393	22.05	0.06	24.89	0.11	41.41	0.13	51.56
10/20/07	5246	1053	58.32	0.09	97.95	0.11	117.42	0.16	164.19
10/21/07	1368	275	15.23	0.06	17.09	0.10	28.55	0.12	34.17
10/22/07	1086	215	10.55	0.32	68.90	0.12	26.53	0.19	41.77
10/23/07	27764	5553	311.52	0.10	578.42	0.14	761.23	0.17	940.83
10/24/07	17392	3475	194.95	0.08	266.34	0.10	333.27	0.15	528.48
10/25/07	8458	1691	92.46	0.11	184.53	0.15	258.31	0.21	353.67
10/26/07	93	19	1.03	0.45	8.58	0.10	1.84	0.23	4.29
10/27/07	1895	378	20.41	0.21	79.99	0.27	100.93	0.16	61.64
10/28/07	9470	1895	101.06	0.10	195.30	0.14	258.14	0.16	309.36
10/29/07	1073	215	11.61	0.09	19.04	0.10	22.24	0.17	36.27
10/30/07	1232	253	13.49	0.06	14.17	0.09	23.21	0.11	28.75
10/31/07	520	102	5.44	0.11	11.57	0.13	13.34	0.17	17.65
11/01/07	5128	1025	56.76	0.11	113.33	0.15	149.51	0.17	172.10
11/02/07	2582	515	27.13	0.11	56.05	0.14	74.20	0.13	68.81
11/03/07	3746	746	39.30	0.09	69.70	0.11	81.65	0.11	82.25
11/04/07	910	180	9.60	0.22	40.35	0.08	14.84	0.15	27.49
11/05/07	611	124	6.53	0.45	55.81	0.11	14.21	0.14	17.05
11/06/07	7002	1400	72.86	0.09	126.76	0.01	14.40	0.02	27.99
11/07/07	7253	1448	75.36	0.10	142.14	0.14	208.03	0.18	254.14
11/08/07	4741	944	49.13	0.05	47.19	0.10	93.19	0.07	64.71
11/09/07	2290	459	25.10	0.13	60.13	0.20	91.40	0.16	75.16
11/11/07	1551	314	17.39	0.06	18.22	0.07	22.47	0.05	15.79
11/12/07	1879	376	21.09	0.27	101.05	0.35	131.07	0.15	57.63
11/13/07	817	165	8.59	0.02	3.43	0.07	12.32	0.07	12.12
11/14/07	1124	227	11.54	0.18	41.60	0.12	26.86	0.20	46.45
11/15/07	2981	596	30.29	0.31	184.14	0.23	138.15	0.20	117.96
Totals	**361581**	**72321**	**4083.282**		**6605.9325**		**8640.16253**		**11346.35908**
Means	**8217.75**	**1643.66**	**92.80**	**0.1223**	**150.13**	**0.1239**	**196.37**	**0.1493**	**257.87**
Minimum	**93**	**19**	**1.03**	**0.0147**	**3.43**	**0.0103**	**1.84**	**0.0200**	**4.29**
Maximum	**53507**	**10703**	**608.33**	**0.4516**	**1056.96**	**0.3486**	**1418.61**	**0.2258**	**1970.49**

Table 7. Results of marine radar image analyses for data were collected on 62 days during spring 2008 at the Maple Ridge Wind Power Facility, Lowville. Lewis County, New York. "Total targets" are the number of birds/bats detected in all images collected. "Sum of the sample means" refers to the target count averaged over the five successive images that constitute a sample (i.e., every 10 minutes from sunset to sunrise the following morning). These values are summed for the entire night's data collection to generate a passage estimate. "Target detection rate" represents the number of targets detected per kilometer of passage front per hour. We also present the proportion and number of targets detected within the three lowest altitudinal strata (i.e., 100, 200, 300 m).

Date	Total targets	Sum of the sample means	Target detection rate	Proportion of targets <=100 m	Number of targets <=100 m	Proportion of targets 101-200 m	Number of targets 101-200 m	Proportion of targets 201 -300 m	Number of targets 201-300 m
04/11/08	1747	349	23.19	0.05	18.38	0.05	17.38	0.05	19.18
04/13/08	342	69	4.66	0.30	20.78	0.17	11.90	0.13	8.68
04/14/08	2004	399	26.93	0.20	81.03	0.20	81.23	0.16	63.91
04/15/08	6501	1299	89.07	0.16	212.80	0.19	247.97	0.16	213.20
04/16/08	14622	2924	197.05	0.09	253.77	0.12	354.95	0.15	450.14
04/17/08	6737	1346	90.85	0.07	97.30	0.11	142.05	0.12	163.63
04/18/08	10450	2088	143.17	0.11	219.79	0.12	250.96	0.15	310.90
04/19/08	17867	3572	244.53	0.03	90.56	0.05	166.93	0.07	252.90
04/20/08	6686	1337	93.00	0.05	64.99	0.08	107.98	0.12	155.18
04/21/08	5966	1195	83.26	0.03	38.66	0.10	121.38	0.13	152.83
04/22/08	6755	1347	93.85	0.05	66.00	0.12	158.13	0.16	214.96
04/23/08	5016	1005	64.79	0.09	88.36	0.17	165.90	0.19	192.14
04/24/08	3541	713	50.49	0.11	79.13	0.17	122.22	0.21	147.79
04/25/08	9529	1940	135.16	0.04	87.14	0.09	167.15	0.12	230.06
04/26/08	2729	544	38.52	0.15	81.93	0.16	89.70	0.17	93.89
04/27/08	4896	980	69.40	0.05	49.44	0.08	78.46	0.12	115.69
04/30/08	1141	224	16.10	0.14	31.21	0.14	31.41	0.18	39.85
05/01/08	1585	313	22.92	0.09	28.83	0.11	34.36	0.09	28.83
05/02/08	7971	1595	116.58	0.02	31.62	0.04	62.23	0.09	145.67
05/03/08	7464	1492	109.05	0.03	38.58	0.04	62.57	0.07	98.15
05/04/08	5939	1187	86.91	0.20	240.24	0.20	237.04	0.24	284.01
05/05/08	17624	3527	257.79	0.14	489.91	0.16	566.35	0.21	729.05
05/06/08	2200	447	42.91	0.21	92.65	0.20	87.77	0.22	99.76
05/07/08	1434	287	21.71	0.04	12.01	0.05	15.61	0.04	11.41
05/08/08	2974	592	44.86	0.19	113.86	0.22	132.57	0.19	111.67
05/09/08	9690	1937	146.79	0.03	50.77	0.06	109.34	0.07	141.13
05/10/08	4710	944	71.54	0.13	118.65	0.18	167.35	0.15	143.90
05/11/08	20081	4018	304.50	0.03	112.45	0.06	255.91	0.13	533.24
05/12/08	1957	395	29.93	0.10	39.76	0.16	64.39	0.14	53.69
05/13/08	8635	1727	132.98	0.08	146.00	0.13	231.60	0.18	307.80
05/14/08	10385	2077	157.40	0.05	109.40	0.10	210.20	0.11	229.00
05/15/08	3967	796	61.40	0.22	174.97	0.25	198.25	0.24	188.21
05/16/08	4368	872	67.26	0.17	148.53	0.20	175.88	0.23	199.83
05/17/08	6044	1207	94.80	0.20	240.44	0.26	310.74	0.24	294.96
05/18/08	351	72	5.65	0.27	19.49	0.44	31.38	0.08	5.54
05/19/08	1332	268	21.01	0.23	62.17	0.25	66.60	0.27	71.02
05/20/08	11296	2259	173.94	0.19	438.56	0.23	509.55	0.21	471.16
05/22/08	1181	243	19.44	0.14	34.77	0.17	40.33	0.15	36.42
05/23/08	1320	263	21.00	0.28	74.12	0.27	70.73	0.26	67.14
05/24/08	3176	635	50.70	0.22	137.56	0.19	121.16	0.30	189.34
05/25/08	21309	4264	334.28	0.09	377.39	0.13	571.90	0.16	689.96
05/26/08	14938	2986	238.86	0.14	422.97	0.21	614.47	0.21	628.26
05/27/08	549	110	8.80	0.19	20.44	0.26	28.45	0.27	29.85
05/28/08	1784	356	28.43	0.21	75.23	0.21	74.23	0.22	79.82
05/29/08	1492	297	24.21	0.08	23.29	0.08	23.69	0.19	56.93
05/30/08	5228	1047	83.60	0.05	52.87	0.09	94.73	0.12	123.97
05/31/08	5007	1004	80.31	0.11	109.88	0.19	193.10	0.22	225.18
06/01/08	1200	241	19.28	0.11	26.71	0.18	43.38	0.22	52.42
06/02/08	4692	941	76.69	0.15	137.38	0.23	212.59	0.26	240.06
06/03/08	1867	372	30.32	0.14	50.41	0.08	28.89	0.07	24.91
06/04/08	4717	941	76.69	0.05	45.28	0.13	118.10	0.20	187.12
06/05/08	2458	492	40.79	0.07	35.83	0.08	38.83	0.07	33.83
06/06/08	7641	1534	124.79	0.08	124.27	0.13	204.37	0.12	190.32
06/07/08	6851	1367	111.41	0.07	99.77	0.14	193.35	0.13	183.57

Table 7. Continued

06/08/08	10802	2160	176.05	0.06	126.18	0.15	334.74	0.18	398.33
06/09/08	8510	1702	141.39	0.05	78.00	0.14	231.60	0.14	234.80
06/10/08	4335	870	70.91	0.06	55.39	0.14	122.62	0.14	123.43
06/11/08	2308	462	37.65	0.07	34.03	0.17	78.47	0.26	121.91
06/12/08	9297	1858	151.15	0.05	101.12	0.11	199.65	0.11	196.65
06/13/08	8505	1703	141.20	0.08	130.35	0.12	201.24	0.14	245.49
06/14/08	6999	1401	116.16	0.08	111.90	0.14	190.76	0.15	210.58
06/15/08	4506	902	73.52	0.09	80.07	0.14	128.11	0.17	151.73
Totals	377,208	75,494	5711.57	0.09	6855.39	0.13	10004.92	0.12	8693.78446
Means	6521.51	1305.33	96.13	0.13	116.67	0.16	161.73	0.17	189.67
Minimum	342.00	69.00	4.66	0.02	12.01	0.04	11.90	0.04	5.54
Maximum	21309	4264	334.28	0.30	489.91	0.44	614.47	0.30	729.05

Table 8. Results of marine radar image analyses for data were collected on 61 days during fall 2008 (31 July - 30 September, Fall-Early) at the Maple Ridge Wnd Power Facility (MRWPF). "Total targets" are the number of birds/bats detected in all images collected. "Sum of the sample means" refers to the target count averaged over the five successive images that constitute a sample (i.e., every 10 minutes from sunset to sunrise the following morning). These values are summed for the entire night's data collection to generate a passage estimate. "Target detection rate" represents the number of targets detected per kilometer of passage front per hour. We also present the proportion and number of targets detected within the three lowest altitudinal strata (i.e., 100, 200, 300 m).

Date	Total targets	Sum of the sample means	Target detection rate	Proportion of targets <=100 m	Number of targets <=100 m	Proportion of targets 101-200 m	Number of targets 101-200 m	Proportion of targets 201 -300 m	Number of targets 201-300 m
07/31/08	10455	2096	158.84	0.07	153.97	0.11	231.55	0.15	305.13
08/01/08	4657	930	70.36	0.11	99.85	0.14	128.41	0.18	167.95
08/02/08	14225	2843	168.23	0.05	145.50	0.07	198.06	0.12	329.57
08/03/08	11701	2340	174.28	0.06	148.99	0.11	249.18	0.17	397.17
08/04/08	8058	1610	119.70	0.08	121.28	0.09	140.46	0.15	245.36
08/05/08	2904	582	43.27	0.13	73.75	0.17	101.21	0.20	115.84
08/06/08	11026	2206	161.24	0.07	143.85	0.10	225.48	0.18	393.14
08/07/08	9899	1982	144.87	0.11	211.63	0.14	271.70	0.20	400.24
08/08/08	11754	2353	172.27	0.06	142.53	0.10	241.03	0.17	400.37
08/09/08	4036	805	58.84	0.18	144.21	0.23	182.30	0.21	167.54
08/10/08	5709	1143	83.54	0.12	137.54	0.16	177.99	0.19	216.03
08/11/08	10075	2013	144.92	0.07	139.26	0.12	241.96	0.18	357.44
08/12/08	5931	1186	88.33	0.11	132.38	0.16	193.97	0.26	304.15
08/13/08	4525	904	64.02	0.12	110.88	0.18	160.42	0.22	203.38
08/14/08	8172	1636	115.66	0.11	184.38	0.16	258.65	0.20	328.52
08/15/08	3113	623	44.04	0.12	76.85	0.16	98.26	0.18	112.67
08/16/08	1870	373	26.37	0.13	46.67	0.19	72.61	0.21	78.99
08/17/08	1208	241	16.76	0.15	37.11	0.27	64.64	0.22	51.87
08/18/08	1190	239	16.39	0.13	30.93	0.17	39.57	0.18	43.98
08/19/08	6186	1234	85.84	0.10	120.49	0.13	156.59	0.20	241.97
08/20/08	2340	468	32.09	0.15	70.40	0.15	70.80	0.21	96.40
08/21/08	3589	716	49.09	0.12	83.59	0.16	116.71	0.17	122.89
08/22/08	2499	497	34.08	0.15	75.18	0.21	106.40	0.21	103.22
08/23/08	1043	207	14.17	0.10	19.85	0.19	39.69	0.19	38.50
08/24/08	7515	1500	102.85	0.12	184.43	0.18	269.46	0.23	350.70
08/25/08	6913	1382	93.28	0.07	90.56	0.09	127.14	0.16	226.30
08/26/08	4022	804	54.18	0.13	100.75	0.14	115.54	0.15	120.54
08/27/08	2980	599	40.37	0.09	51.06	0.16	93.27	0.15	91.86
08/28/08	1935	390	26.28	0.14	56.03	0.23	91.50	0.24	92.91
08/29/08	684	138	9.17	0.10	13.32	0.16	21.99	0.12	16.95
08/30/08	11617	2322	151.97	0.07	171.90	0.10	237.66	0.16	376.57
08/31/08	5837	1163	77.17	0.07	78.90	0.10	117.36	0.15	172.55
09/01/08	3135	628	41.04	0.15	92.55	0.19	122.19	0.24	153.84
09/02/08	3793	759	55.20	0.04	27.61	0.17	130.27	0.28	211.51
09/03/08	1375	273	17.60	0.11	30.97	0.21	58.37	0.17	45.07
09/04/08	2779	555	35.78	0.13	72.10	0.19	105.45	0.21	116.23
09/05/08	3663	733	47.97	0.30	222.32	0.42	306.97	0.16	118.86
09/07/08	4597	922	58.48	0.25	228.85	0.26	243.69	0.19	172.69
09/08/08	1227	250	16.09	0.19	48.29	0.29	71.92	0.21	53.59
09/09/08	12870	2574	163.27	0.09	237.60	0.13	345.40	0.21	538.20
09/10/08	3739	743	46.45	0.06	46.90	0.09	68.36	0.14	104.72
09/11/08	90	16	1.00	0.08	1.24	0.29	4.62	0.18	2.84
09/12/08	42	5	0.31	0.29	1.43	0.45	2.26	0.24	1.19
09/13/08	125	22	1.38	0.24	5.28	0.15	3.34	0.31	6.86
09/14/08	85	14	0.88	0.05	0.66	0.11	1.48	0.42	5.93
09/15/08	374	76	4.68	0.17	12.60	0.18	13.41	0.32	23.98
09/16/08	4941	984	60.64	0.11	110.33	0.16	152.75	0.15	146.97
09/17/08	17197	3439	209.23	0.08	290.37	0.11	393.55	0.17	571.53
09/18/08	17976	3594	218.35	0.11	388.07	0.16	586.80	0.20	711.56
09/19/08	2457	493	29.95	0.10	50.36	0.17	83.67	0.18	89.09
09/20/08	5180	1036	63.03	0.08	84.00	0.16	161.00	0.16	167.80
09/21/08	38495	7698	467.69	0.11	810.89	0.15	1162.85	0.20	1545.80
09/22/08	10349	2071	124.08	0.10	203.12	0.12	258.15	0.18	362.61
09/23/08	7620	1521	91.25	0.08	122.16	0.14	205.59	0.19	295.62

Table 8. Continued

09/24/08	6744	1348	62.54	0.11	145.11	0.15	208.48	0.20	265.04
09/25/08	4857	972	57.44	0.08	79.85	0.15	145.89	0.16	153.09
09/26/08	840	167	9.87	0.14	23.06	0.21	35.19	0.11	17.69
09/27/08	7074	1416	83.67	0.11	156.73	0.12	168.34	0.13	178.95
09/28/08	3826	766	44.65	0.05	40.84	0.09	68.87	0.08	60.26
09/29/08	8808	1763	102.77	0.07	130.30	0.10	174.74	0.14	238.19
09/30/08	2724	545	31.39	0.16	86.63	0.20	107.64	0.17	92.83
Totals	364,650	72,908			7,148		10,233		13,123
Means	5977.87	1195.21	78.51	0.11	117.18	0.17	167.75	0.19	215.14
Minimum	42.00	5.00	0.31		0.66		1.48		1.19
Maximum	38495	7698	468		811		1163		1546

Table 9. Results of marine radar image analyses for data were collected on 45 days during fall 2008 (1 October - 15 November, Fall-Late) at the Maple Ridge Wnd Power Facility (MRWPF). "Total targets" are the number of birds/bats detected in all images collected. "Sum of the sample means" refers to the target count averaged over the five successive images that constitute a sample (i.e., every 10 minutes from sunset to sunrise the following morning). These values are summed for the entire night's data collection to generate a passage estimate. "Target detection rate" represents the number of targets detected per kilometer of passage front per hour. We also present the proportion and number of targets detected within the three lowest altitudinal strata (i.e., 100, 200, 300 m).

Date	Total targets	Sum of the sample means	Target detection rate	Proportion of targets <=100 m	Number of targets <=100 m	Proportion of targets 101-200 m	Number of targets 101-200 m	Proportion of targets 201 -300 m	Number of targets 201-300 m
10/01/08	18171	3635	209.36	0.12	436.10	0.15	553.32	0.18	638.34
10/02/08	962	194	11.16	0.25	49.21	0.34	66.15	0.12	23.59
10/03/08	25388	5080	292.19	0.15	750.35	0.18	914.43	0.22	1127.33
10/04/08	36036	7208	414.59	0.11	813.49	0.15	1067.92	0.19	1403.76
10/05/08	32334	6467	367.57	0.07	482.81	0.10	632.62	0.12	762.42
10/06/08	35270	7050	400.18	0.09	650.03	0.10	697.00	0.16	1093.38
10/07/08	7458	1485	84.29	0.08	121.86	0.11	158.30	0.14	200.91
10/08/08	145	30	1.68	0.35	10.55	0.26	7.86	0.12	3.72
10/09/08	5862	1171	65.69	0.15	176.59	0.15	174.59	0.19	220.54
10/10/08	25566	5109	286.61	0.07	341.32	0.07	334.92	0.10	527.37
10/11/08	23455	4690	259.40	0.08	352.92	0.12	557.28	0.09	439.51
10/12/08	9006	1802	99.67	0.20	364.76	0.39	710.12	0.21	375.37
10/13/08	8960	1792	99.11	0.20	360.20	0.40	716.00	0.25	455.40
10/14/08	24763	4953	274.30	0.09	461.24	0.22	1076.89	0.22	1066.29
10/15/08	3466	692	37.84	0.15	107.01	0.51	355.38	0.21	148.54
10/16/08	17929	3585	200.86	0.08	290.94	0.10	346.92	0.15	534.88
10/17/08	12860	2573	140.51	0.15	380.95	0.32	817.12	0.18	466.58
10/18/08	4167	835	45.03	0.07	62.12	0.09	74.14	0.11	91.17
10/19/08	1752	350	18.87	0.11	38.36	0.11	38.16	0.14	48.74
10/20/08	2392	479	25.83	0.31	147.79	0.48	228.69	0.17	80.70
10/22/08	1988	400	21.31	0.14	54.93	0.11	43.26	0.15	59.15
10/23/08	5956	1185	63.12	0.06	70.83	0.08	93.11	0.09	101.27
10/24/08	331	67	3.57	0.25	16.80	0.19	12.75	0.03	2.23
10/25/08	1056	209	11.13	0.16	34.04	0.16	34.24	0.11	22.17
10/26/08	484	96	5.05	0.21	19.83	0.32	30.55	0.09	8.93
10/27/08	2812	561	29.55	0.24	132.27	0.22	126.09	0.12	68.23
10/29/08	2849	572	29.73	0.21	118.25	0.17	97.78	0.14	79.51
10/30/08	2740	551	28.64	0.09	51.28	0.06	30.77	0.05	30.16
10/31/08	9708	1944	101.05	0.09	166.61	0.09	179.42	0.15	297.77
11/01/08	6012	1203	66.54	0.10	122.66	0.09	110.05	0.14	162.88
11/02/08	707	143	7.92	0.15	21.24	0.19	26.50	0.05	7.69
11/03/08	619	124	6.77	0.05	5.61	0.07	8.61	0.04	4.61
11/04/08	882	172	9.39	0.05	8.19	0.02	3.90	0.06	10.14
11/05/08	3245	648	35.39	0.09	60.31	0.09	55.91	0.10	65.90
11/06/08	5327	1062	57.27	0.09	100.08	0.10	105.06	0.12	131.98
11/07/08	362	69	3.72	0.07	5.15	0.08	5.53	0.03	1.91
11/08/08	441	86	4.58	0.16	13.46	0.16	13.85	0.15	12.48
11/09/08	493	98	5.23	0.60	58.44	0.32	31.01	0.03	2.78
11/10/08	1973	395	20.81	0.28	111.31	0.20	79.48	0.17	68.87
11/11/08	2316	461	24.26	0.12	56.53	0.09	40.61	0.14	65.89
11/12/08	518	102	5.37	0.18	18.31	0.20	20.28	0.08	7.88
11/13/08	241	42	2.21	0.06	2.61	0.10	4.36	0.02	1.05
11/14/08	343	66	3.47	0.20	13.28	0.18	11.74	0.07	4.81
11/15/08	418	83	4.31	0.35	29.39	0.25	20.85	0.10	8.14
Totals	**347,763**	**69,519**			**7,690**		**10,714**		**10,935**
Means	**7903.70**	**1579.98**	**88.30**	**0.16**	**174.77**	**0.18**	**243.49**	**0.13**	**248.52**
Minimum	**145.00**	**30.00**	**1.68**		**2.61**		**3.90**		**1.05**
Maximum	**36036**	**7208**	**415**		**813**		**1077**		**1404**

Table 10. Post hoc pairwise comparisons of mean targets detected (target count averaged over the five successive images that constitute a sample collected every 10 minutes and target passage rate (mean targets/hour. Pairwise comparisons were pre-planned and represent ones believed to be relevant for assessing between-year differences within for specific seasons and among-season differences with a specific year.

Comparisons	Mean targets detected		Target passage rate	
	t-statistic	*P*-value	*t*-statistic	*P*-value
Between-year				
Spring: 07 vs 08	-1.16	0.25	-1.35	1.00
Fall/Early: 07 vs 08	-4.86	< 0.0001	-4.99	< 0.0001
Fall/Late: 07 vs 08	-1.35	0.18	-1.37	1.00
Among-season - 2007				
Spring vs Fall/Early	2.51	0.01	1.84	1.00
Spring vs Fall/Late	-1.19	0.24	-2.62	0.14
Fall/Early vs Fall/Late	-3.67	0.0003	-4.52	0.0001
Among-season - 2008				
Spring vs Fall/Early	-1.00	0.32	-1.64	1.00
Spring vs Fall/Late	-1.59	0.11	-2.93	0.06
Fall/Early vs Fall/Late	-0.67	0.50	-1.42	1.00

Table 11. *Post hoc* pairwise comparisons of the proportion (arcsin transformed) and number (log transformed) of targets recorded in the 0-100 m stratum. Pairwise comparisons were pre-planned and represent ones believed to be relevant for assessing between-year differences within for specific seasons and among-season differences with a specific year.

Comparisons	Proportion targets detected ≤100 m		Number of targets detected ≤100 m*	
	t-statistic	*P*-value	*t*-statistic	*P*-value
Between-year				
Spring: 07 vs 08	-3.07	0.0023	-2.71	0.11
Fall/Early: 07 vs 08	3.23	0.0014	-3.29	0.0167
Fall/Late: 07 vs 08	2.09	0.037	-0.17	1.00
Among-season - 2007				
Spring vs Fall/Early	-5.72	<.0001	-0.04	1.00
Spring vs Fall/Late	-2.42	0.0161	-2.46	0.22
Fall/Early vs Fall/Late	2.99	0.003	-2.53	0.18
Among-season - 2008				
Spring vs Fall/Early	0.42	0.6723	-0.49	1.00
Spring vs Fall/Late	2.69	0.0076	-0.15	1.00
Fall/Early vs Fall/Late	2.29	0.0226	0.30	1.00

*Note that the SEASON*YEAR interaction was not statistically significant

Table 12. *Post hoc* pairwise comparisons of the proportion (arcsin transformed) and number (log transformed) of targets recorded in the 101-200 m stratum. Pairwise comparisons were pre-planned and represent ones believed to be relevant for assessing between-year differences within for specific seasons and among-season differences with a specific year.

Comparisons	Proportion targets detected 101-200 m		Number of targets detected 101-200 m*	
	t-statistic	*P*-value	*t*-statistic	*P*-value
Between-year				
Spring: 07 vs 08	-3.69	0.0003	-2.46	0.21
Fall/Early: 07 vs 08	2.76	0.006	-3.97	0.001
Fall/Late: 07 vs 08	3.31	0.001	-0.30	1.00
Among-season - 2007				
Spring vs Fall/Early	-4.89	<.0001	0.98	1.00
Spring vs Fall/Late	-5.21	<.0001	-3.11	0.03
Fall/Early vs Fall/Late	-0.73	0.47	-4.20	0.0005
Among-season - 2008				
Spring vs Fall/Early	1.49	0.14	-0.35	1.00
Spring vs Fall/Late	1.67	0.10	-1.22	1.00
Fall/Early vs Fall/Late	0.31	0.76	-0.90	1.00

*Note that the SEASON*YEAR interaction was not statistically significant

Table 13. Results from General Linear Model procedures investigating relationships between the proportion of targets detected in the two lowest altitudinal strata (i.e., 0-100, 101-200 m [arcsine transformed]) and total targets detected in all strata (i.e., sum of the 10-minute sample averages [log transformed]).

Season	0-100			101-200		
Period	Coefficient	*F*	*P*	Coefficient	*F*	*P*
2007						
Spring	-0.2765	78.27	<0.0001	-0.057	3.91	0.05
Fall/Early	-0.0289	3.91	0.05	-0.0452	4.64	0.04
Fall/Late	-0.1141	11.81	0.001	-0.0056	0.10	0.76
2008						
Spring	-0.1465	24.39	<0.0001	-0.0941	11.41	0.001
Fall/Early	-0.0524	11.12	0.002	-0.0787	23.96	<0.0001
Fall/Late	-0.0802	8.72	0.005	-0.0255	0.59	0.45

Table 14. Results from multiple model inference procedures used to evaluate the effects of local meteorological conditions on response variables derived from data collected at the Maple Ridge Wind Power Faciltiy, Spring 2007. Candidate models with the lowest AIC values (corrected for small sample sizes [AIC_c]) and that are at least two units smaller (ΔAIC_c) than the model with the next lowest AIC_c value are considered to have the strongest support (bold).

Response Variable	Model[a]	# of model parameters	(-)2 Log Likelihood	AIC_c	Δ AIC_c	w_i	R^2
Targets recorded (TR, sum of 10-min sample means, log-transformed)	**Expanded-4**	**8**	**-126.10**	**-106.59**	**0.00**	**0.82**	**0.72**
	Expanded-1	8	-123.05	-103.54	3.05	0.18	0.70
	Temp/Barometric Pres.	4	-103.48	-94.59	12.00	0.00	0.56
	Expanded-5	8	-96.50	-76.99	29.60	0.00	0.50
	Expanded-6	8	-96.48	-76.97	29.62	0.00	0.50
	Expanded-3	8	-95.43	-75.92	30.67	0.00	0.49
	Expanded-2	8	-95.41	-75.89	30.70	0.00	0.49
	Ceiling	3	-76.99	-70.46	36.13	0.00	0.26
	Cloud Cover/Visibiltiy	4	-78.60	-69.71	36.88	0.00	0.28
	Julian day	3	-75.78	-69.26	37.33	0.00	0.24
	Julian day (quadratic)	4	-75.78	-66.89	39.70	0.00	0.24
	Dew Point	3	-66.74	-60.22	46.37	0.00	0.09
	THV(360)[c]	3	-64.81	-58.29	48.30	0.00	0.05
	Precipitation	3	-62.18	-55.66	50.93	0.00	0.00
	SWV(360)[c]	3	-61.97	-55.45	51.14	0.00	0.00
	THV (44)/SWV(44)[b]	4	-63.77	-54.88	51.71	0.00	0.03
Targets recorded/hr (log-transformed)	**Expanded-4**	**8**	**-124.41**	**-104.90**	**0.00**	**0.82**	**0.73**
	Expanded-1	8	-121.35	-101.84	3.07	0.18	0.71
	Temp/Barometric Pres.	4	-101.60	-92.71	12.20	0.00	0.57
	Expanded-5	8	-96.32	-76.80	28.10	0.00	0.52
	Expanded-6	8	-96.27	-76.75	28.15	0.00	0.52
	Expanded-3	8	-95.23	-75.72	29.18	0.00	0.51
	Expanded-2	8	-95.23	-75.72	29.18	0.00	0.51
	Julian day	3	-75.39	-68.87	36.04	0.00	0.27
	Ceiling	3	-74.05	-67.52	37.38	0.00	0.25
	Cloud Cover/Visibiltiy	4	-76.38	-67.49	37.41	0.00	0.29
	Julian day (quadratic)	4	-75.39	-66.50	38.40	0.00	0.27
	Dew Point	3	-64.83	-58.31	46.60	0.00	0.10
	THV(360)[c]	3	-62.14	-55.62	49.28	0.00	0.05
	Precipitation	3	-59.65	-53.13	51.77	0.00	0.00
	SWV(360)[c]	3	-59.59	-53.07	51.83	0.00	0.00
	THV (44)/SWV(44)[b]	4	-61.18	-52.29	52.61	0.00	0.03
Proportion <=100 m (PROP100, arcsine transformed)	**Temp/Barometric Pres.**	**4**	**-190.96**	**-182.07**	**0.00**	**0.86**	**0.38**
	Expanded-4	8	-197.18	-177.67	4.40	0.10	0.46
	Expanded-1	8	-195.63	-176.12	5.96	0.04	0.44
	Ceiling	3	-175.54	-169.02	13.05	0.00	0.16
	Julian day	3	-174.87	-168.35	13.72	0.00	0.15
	Julian day (quadratic)	4	-175.30	-166.41	15.66	0.00	0.16
	Cloud Cover/Visibiltiy	4	-172.91	-164.02	18.05	0.00	0.12
	Dew Point	3	-169.83	-163.31	18.76	0.00	0.06
	Expanded-5	8	-182.25	-162.74	19.33	0.00	0.27
	Expanded-6	8	-182.09	-162.58	19.50	0.00	0.26
	Expanded-2	8	-181.35	-161.84	20.23	0.00	0.25
	THV(360)[c]	3	-168.25	-161.73	20.34	0.00	0.03
	Expanded-3	8	-181.21	-161.69	20.38	0.00	0.25
	Precipitation	3	-167.63	-161.11	20.96	0.00	0.02
	SWV(360)[c]	3	-166.73	-160.20	21.87	0.00	0.00
	THV (44)/SWV(44)[b]	4	-168.27	-159.38	22.70	0.00	0.03

Table 14 (continued)

Proportion 100 > <=200 m (PROP 200, arcsine transformed)	**Dew Point**	**3**	**-225.17**	**-218.65**	**0.00**	**0.37**	**0.11**
	Temp/Barometric Pres.	**4**	**-225.82**	**-216.94**	**1.71**	**0.16**	**0.12**
	Precipitation	3	-221.98	-215.46	3.19	0.07	0.05
	Ceiling	3	-221.77	-215.25	3.40	0.07	0.05
	THV (44)/SWV(44)[b]	4	-224.02	-215.14	3.51	0.06	0.09
	THV(360)[c]	3	-220.79	-214.27	4.38	0.04	0.03
	Expanded-4	8	-233.78	-214.26	4.38	0.04	0.25
	Julian day	3	-220.67	-214.15	4.49	0.04	0.03
	Cloud Cover/Visibiltiy	4	-222.88	-213.99	4.65	0.04	0.07
	SWV(360)[c]	3	-220.00	-213.48	5.17	0.03	0.02
	Expanded-1	8	-232.98	-213.47	5.17	0.03	0.24
	Julian day (quadratic)	4	-221.64	-212.75	5.90	0.02	0.05
	Expanded-6	8	-231.44	-211.92	6.72	0.01	0.22
	Expanded-5	8	-231.40	-211.88	6.76	0.01	0.22
	Expanded-3	8	-230.73	-211.22	7.43	0.01	0.21
	Expanded-2	8	-230.68	-211.17	7.48	0.01	0.21
Targets recorded <=100 m (TR100, sum of 10-min sample means, log-transformed)	**Expanded-1**	**8**	**-144.94**	**-125.42**	**0.00**	**0.64**	**0.55**
	Expanded-4	**8**	**-143.36**	**-123.85**	**1.57**	**0.29**	**0.54**
	Temp/Barometric Pres.	4	-128.05	-119.16	6.27	0.03	0.37
	Expanded-3	8	-137.14	-117.62	7.80	0.01	0.48
	Expanded-2	8	-136.78	-117.27	8.16	0.01	0.47
	Expanded-6	8	-135.21	-115.70	9.73	0.00	0.46
	Expanded-5	8	-134.91	-115.39	10.03	0.00	0.45
	Cloud Cover/Visibiltiy	4	-120.20	-111.31	14.11	0.00	0.27
	Ceiling	3	-117.72	-111.20	14.23	0.00	0.23
	Julian day	3	-113.60	-107.08	18.35	0.00	0.16
	Julian day (quadratic)	4	-113.84	-104.95	20.47	0.00	0.17
	Dew Point	3	-106.84	-100.32	25.11	0.00	0.04
	THV(360)[c]	3	-105.76	-99.54	25.88	0.00	0.02
	SWV(360)[c]	3	-105.65	-99.43	25.99	0.00	0.02
	Precipitation	3	-104.93	-98.41	27.02	0.00	0.00
	THV (44)/SWV(44)[b]	4	-106.09	-97.20	28.22	0.00	0.03
Targets recorded 100> <=200 m (TR200, sum of 10-min sample means, log-transformed)	**Expanded-4**	**8**	**-126.10**	**-106.59**	**0.00**	**0.86**	**0.72**
	Expanded-1	8	-122.46	-102.95	3.65	0.14	0.71
	Temp/Barometric Pres.	4	-100.62	-91.73	14.86	0.00	0.56
	Expanded-2	8	-100.39	-80.87	25.72	0.00	0.55
	Expanded-3	8	-100.22	-80.71	25.88	0.00	0.55
	Expanded-5	8	-96.50	-76.99	29.60	0.00	0.50
	Expanded-6	8	-96.48	-76.97	29.62	0.00	0.50
	Ceiling	3	-82.96	-76.44	30.15	0.00	0.37
	Cloud Cover/Visibiltiy	4	-79.39	-70.50	36.09	0.00	0.32
	Julian day	3	-71.05	-64.53	42.06	0.00	0.20
	Julian day (quadratic)	3	-71.42	-62.53	44.06	0.00	0.20
	Dew Point	3	-61.71	-55.18	51.41	0.00	0.03
	THV(360)[c]	3	-60.89	-54.37	52.22	0.00	0.02
	SWV(360)[c]	3	-60.53	-54.01	52.58	0.00	0.01
	Precipitation	3	-60.17	-53.65	52.94	0.00	0.00
	THV (44)/SWV(44)[b]	4	-60.65	-51.76	54.83	0.00	0.01

[a] See Appendix 12 for variables included in Global models

[b] THV=Tailwind/Headwind Vector. SWV=Sidewind Vector. Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees). Based on analysis of data collected with horizontally-oriented radar (see Fig. 43, upper)

[c] Number in parentheses represents generalized and seasonally appropriate directional goal (e.g., spring [South-360°])

Table 15. Parameter estimates of predictor variables in best performing models for flight dynamics response variables: (1) targets recorded (TR), (2) targets recorded/hr (TR/hr), (3) proportion of targets recorded <= 100 m (PROP100), (4) proportion of targets recorded between 101 and 200 m (PROP200), (5) number of targets recorded <= 100 m (TR100) and (6) number of targets recorded between 101 and 200 m (TR200). Data from Spring 2007 (i.e., sunrise - sunset the same day) data collection period. R^2 values are provided to suggest what estimates may be contributing most to model perfromance. Only estimates where $R^2 \geq 0.01$ are shown. Model comparisons for this Season/Year are shown in Table 14.

Model	TR			TR/hr			PROP100			PROP200			TR100*			TR200		
Variable	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2
Expanded-1																		
Cloud cover													-0.1939	0.0682	0.26			
Visibility													----	----	----			
Temperature													0.0406	0.0088	0.16			
Barometric pressure													0.0148	0.0063	0.07			
THV(44)[a]													0.0237	0.0164	0.04			
SWV(44)[b]													-0.0372	0.0309	0.02			
Expanded-4																		
Cloud cover	-0.2260	0.0829	0.28	-0.2376	0.0843	0.28										-0.2260	0.0829	0.28
Visibility	----	----	----	----	----	----										----	----	----
Temperature	0.0804	0.0106	0.30	0.0828	0.0108	0.30										0.0804	0.0106	0.30
Barometric pressure	0.0308	0.0077	0.08	0.0311	0.0078	0.08										0.0308	0.0077	0.08
THV(360)[c]	0.0747	0.0268	0.06	0.0758	0.0272	0.06										0.0747	0.0268	0.06
SWV(360)[c]	----	----	----	----	----	----										----	----	----
Temperature/Pressure																		
Temperature							-0.0243	0.0047	0.27	-0.0058	0.0033	0.09						
Barometric pressure							-0.0101	0.0034	0.12	-0.0101	0.0034	0.04						
Dew point																		
Dew point										-0.0055	0.0022	0.11						

*Multiple Expanded models supported (see Table 14). Parameter signs (i.e., positive, negative) are the same and R^2 values similar in all supported models.

[a] THV=Tailwind/Headwind Vector. Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees). Based on analysis of data collected with horizontally-oriented radar (see Fig. 43, upper)

[b] SWV=Sidewind Vector. Number in parentheses is the assumed directional goal of movement (i.e., in degrees) for nocturnal period. Based on analysis of data collected during the nocturnal data collection period with horizontally-oriented radar (see Fig. 43, upper).

[c] Number in parentheses represents generalized and seasonally appropriate directional goal (e.g., spring [North-360°])

Table 16. Results from multiple model inference procedures used to evaluate the effects of local meteorological conditions on response variables derived from data collected at the Maple Ridge Wind Power Faciltiy, Fall/Early 2007. Candidate models with the lowest AIC values (corrected for small sample sizes [AIC_c]) and that are at least two units smaller (AIC_c) than the model with the next lowest AIC_c value are considered to have the strongest support (bold).

Response Variable	Model[a]	# of model parameters	(-)2 Log Likelihood	AIC_c	AIC_c	w_i	R^2
Targets recorded	**Expanded-4**	**7**	**-126.91**	**-110.80**	**0.00**	**0.37**	**0.27**
(TR, sum of 10-min sample	**Expanded-5**	**8**	**-127.88**	**-109.11**	**1.69**	**0.16**	**0.29**
means, log-transformed)	**Expanded-6**	**8**	**-127.82**	**-109.05**	**1.75**	**0.15**	**0.28**
	Julian day	3	-113.96	-107.54	3.26	0.07	0.10
	Expanded-1	7	-123.51	-107.39	3.41	0.07	0.23
	Cloud Cover/Visibiltiy	4	-115.74	-107.02	3.78	0.06	0.13
	Expanded-2	8	-125.04	-106.27	4.53	0.04	0.25
	Expanded-3	8	-124.98	-106.21	4.60	0.04	0.25
	Julian day (quadratic)	4	-114.33	-105.61	5.19	0.03	0.11
	THV/SWV(180)[c]	4	-112.23	-103.52	7.28	0.01	0.08
	Barometric pressure	3	-107.95	-101.53	9.27	0.00	0.01
	THV/SWV(197)[b]	4	-109.75	-101.04	9.77	0.00	0.04
	Dew point	3	-107.44	-101.02	9.78	0.00	0.00
	Temperature	3	-107.43	-101.01	9.79	0.00	0.00
	Ceiling/Precipiation	4	-107.77	-99.06	11.74	0.00	0.01
Targets recorded/hr	**Expanded-5**	**8**	**-127.96**	**-109.19**	**0.00**	**0.24**	**0.33**
(log-transformed)	**Expanded-6**	**8**	**-127.84**	**-109.07**	**0.12**	**0.23**	**0.33**
	Expanded-4	**7**	**-125.02**	**-108.90**	**0.28**	**0.21**	**0.30**
	Julian day	**3**	**-114.01**	**-107.59**	**1.60**	**0.11**	**0.16**
	Expanded-2	8	-125.17	-106.40	2.79	0.06	0.30
	Expanded-3	8	-125.04	-106.27	2.92	0.06	0.30
	Julian day (quadratic)	4	-114.54	-105.83	3.36	0.05	0.17
	Expanded-1	7	-121.33	-105.21	3.97	0.03	0.26
	Cloud Cover/Visibiltiy	4	-111.95	-103.24	5.95	0.01	0.13
	THV/SWV(180)[c]	4	-108.18	-99.47	9.72	0.00	0.08
	Barometric pressure	4	-104.25	-97.82	11.36	0.00	0.02
	Dew point	3	-103.57	-97.15	12.04	0.00	0.00
	Temperature	3	-103.53	-97.11	12.08	0.00	0.00
	THV/SWV(197)[b]	4	-105.67	-96.96	12.23	0.00	0.04
	Ceiling/Precipiation	4	-103.73	-95.01	14.17	0.00	0.01
Proportion <=100 m	**Julian day (quadratic)**	**4**	**-385.16**	**-376.44**	**0.00**	**0.50**	**0.11**
(PROP100, arcsine	Julian day	3	-380.21	-373.79	2.65	0.13	0.03
transformed)	THV/SWV(197)[b]	4	-382.38	-373.67	2.77	0.12	0.07
	Dew point	3	-378.61	-372.18	4.26	0.06	0.01
	Barometric pressure	3	-378.13	-371.71	4.73	0.05	0.00
	Temperature	3	-378.08	-371.66	4.78	0.05	0.00
	THV/SWV(180)[c]	4	-379.92	-371.20	5.24	0.04	0.03
	Cloud Cover/Visibiltiy	4	-379.08	-370.37	6.07	0.02	0.02
	Ceiling/Precipiation	4	-378.12	-369.41	7.03	0.01	0.00
	Expanded-2	8	-386.24	-367.47	8.97	0.01	0.13
	Expanded-5	8	-385.89	-367.12	9.32	0.00	0.12
	Expanded-3	8	-385.87	-367.10	9.34	0.00	0.12
	Expanded-1	7	-382.85	-366.74	9.70	0.00	0.08
	Expanded-6	8	-385.51	-366.74	9.70	0.00	0.11
	Expanded-4	7	-381.12	-365.01	11.43	0.00	0.05

Table 16 (continued)

Proportion 100 > <=200 m (PROP 200, arcsine transformed)	**Julian day (quadratic)**	**4**	**-373.71**	**-365.00**	**0.00**	**0.52**	**0.12**
	Ceiling/Precipiation	4	-370.19	-361.48	3.52	0.09	0.07
	Barometric pressure	3	-367.90	-361.48	3.52	0.09	0.03
	THV/SWV(180)[c]	4	-369.70	-360.99	4.01	0.07	0.06
	Julian day	3	-367.16	-360.73	4.26	0.06	0.02
	Temperature	3	-366.54	-360.12	4.88	0.05	0.01
	THV/SWV(197)[b]	4	-368.69	-359.98	5.02	0.04	0.04
	Dew point	3	-366.25	-359.83	5.17	0.04	0.00
	Cloud Cover/Visibiltiy	4	-368.16	-359.44	5.55	0.03	0.03
	Expanded-4	7	-371.42	-355.31	9.69	0.00	0.08
	Expanded-1	7	-370.93	-354.82	10.18	0.00	0.08
	Expanded-5	8	-372.89	-354.12	10.88	0.00	0.11
	Expanded-6	8	-372.66	-353.89	11.11	0.00	0.10
	Expanded-2	8	-372.03	-353.26	11.73	0.00	0.09
	Expanded-3	8	-371.81	-353.04	11.95	0.00	0.09
Targets recorded <=100 m (TR100, sum of 10-min sample means, log-transformed)	**Expanded-4**	**7**	**-135.66**	**-119.55**	**0.00**	**0.60**	**0.31**
	Expanded-5	8	-135.66	-116.89	2.66	0.16	0.31
	Expanded-6	8	-135.66	-116.89	2.66	0.16	0.31
	Expanded-1	7	-129.87	-113.76	5.79	0.03	0.24
	THV/SWV(180)[c]	4	-120.16	-111.44	8.11	0.01	0.11
	Expanded-3	8	-130.08	-111.31	8.23	0.01	0.25
	Expanded-2	8	-130.07	-111.30	8.25	0.01	0.25
	Cloud Cover/Visibiltiy	4	-119.79	-111.07	8.47	0.01	0.11
	Julian day	3	-116.90	-110.47	9.07	0.01	0.06
	Julian day (quadratic)	4	-116.94	-108.22	11.32	0.00	0.07
	Barometric pressure	3	-113.51	-107.08	12.46	0.00	0.01
	THV/SWV(197)[b]	4	-115.74	-107.03	12.52	0.00	0.05
	Dew point	3	-113.03	-106.61	12.94	0.00	0.00
	Temperature	3	-112.86	-106.44	13.11	0.00	0.00
	Ceiling/Precipiation	7	-113.51	-104.80	14.75	0.00	0.01
Targets recorded 100> <=200 m (TR200, sum of 10-min sample means, log-transformed)	**Expanded-4**	**7**	**-143.59**	**-127.47**	**0.00**	**0.56**	**0.36**
	Expanded-6	8	-144.05	-125.28	2.19	0.19	0.36
	Expanded-5	8	-144.04	-125.28	2.20	0.19	0.36
	Expanded-1	7	-137.49	-121.37	6.10	0.03	0.29
	Expanded-3	8	-138.53	-119.77	7.71	0.01	0.30
	Expanded-2	8	-138.52	-119.75	7.72	0.01	0.30
	Cloud Cover/Visibiltiy	4	-127.09	-118.38	9.09	0.01	0.16
	THV/SWV(180)[c]	4	-125.62	-116.90	10.57	0.00	0.14
	Julian day	3	-122.56	-116.14	11.34	0.00	0.09
	Julian day (quadratic)	4	-122.58	-113.86	13.61	0.00	0.09
	THV/SWV(197)[b]	4	-120.59	-111.88	15.60	0.00	0.06
	Temperature	3	-116.86	-110.44	17.03	0.00	0.00
	Barometric pressure	3	-116.83	-110.41	17.06	0.00	0.00
	Dew point	3	-116.68	-110.26	17.22	0.00	0.00
	Ceiling/Precipiation	4	-118.27	-109.56	17.92	0.00	0.03

[a] See Appendix 12 for variables included in Global models

[b] THV=Tailwind/Headwind Vector. SWV=Sidewind Vector. Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees). Based on analysis of data collected with horizontally-oriented radar (see Fig. 44, upper)

[c] Number in parentheses represents generalized and seasonally appropriate directional goal (e.g., fall [South-180°])

Table 17. Parameter estimates of predictor variables in best performing models for flight dynamics response variables: (1) targets recorded (TR), (2) targets recorded/hr (TR/hr), (3) proportion of targets recorded <= 100 m (PROP100), (4) proportion of targets recorded between 101 and 200 m (PROP200), (5) number of targets recorded <= 100 m (TR100) and (6) number of targets recorded between 101 and 200 m (TR200). Data from Fall/Early 2007 (i.e., sunrise - sunset the same day) data collection period. R^2 values are provided to suggest what estimates may be contributing most to model perfromance. Only estimates where $R^2 \geq 0.01$ are shown. Model comparisons for this Season/Year are shown in Table 16.

Model	TR*			TR/hr*			PROP100			PROP200			TR100			TR200		
Variable	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2
Expanded-4																		
Cloud cover	-0.1196	0.1326	0.01										----	----	----	-0.1593	0.1156	0.03
Visibility	0.0001	0.0000	0.12										0.0001	0.0000	0.10	0.0001	0.0000	0.13
Barometric pressure	-0.0220	0.0096	0.03										-0.0236	0.0090	0.03	-0.0204	0.0084	0.02
THV(180)[a]	0.0724	0.0248	0.12										0.0834	0.0231	0.17	0.0834	0.0216	0.18
SWV(180)[b]	----	----	----										----	----	----	----	----	----
Expanded-5																		
Julian day				-0.0052	0.0032	0.16												
Cloud cover				-0.0052	0.0032	0.01												
Visibility				0.0001	0.0000	0.08												
Barometric pressure				----	----	----												
THV(180)[a]				0.0639	0.0262	0.07												
SWV(180)[b]				----	----	----												
Julian day (linear)																		
Julian day				-0.0096	0.0029	0.16												
Julian day (quadtratic)																		
Julian day							0.0213	0.0094	0.03	0.0268	0.0103	0.02						
Julian day*Julian day							0.0000	0.0000	0.08	-0.0001	0.0000	0.10						

*Multiple Expanded models supported (see Table 16). Parameter signs (i.e., positive, negative) are the same and R^2 values similar in all supported models.

[a] THV=Tailwind/Headwind Vector. Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees). Based on generalized and seasonally appropriate migration goals (e.g., fall [South-180°])

[b] SWV=Sidewind Vector. Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees. Based on generalized and seasonally appropriate migration goals (e.g., fall [South-180°])

Table 18. Results from multiple model inference procedures used to evaluate the effects of local meteorological conditions on response variables derived from data collected at the Maple Ridge Wind Power Faciltiy, Fall/Late 2007. Candidate models with the lowest AIC values (corrected for small sample sizes [AIC_c]) and that are at least two units smaller (AIC_c) than the model with the next lowest AIC_c value are considered to have the strongest support (bold).

Response Variable	Model[a]	# of model parameters	(-)2 Log Likelihood	AIC_c	AIC_c	w_i	R^2
Targets recorded (TR, sum of 10-min sample means, log-transformed)	**Expanded-5**	**8**	**-81.78**	**-61.66**	**0.00**	**0.34**	**0.49**
	Expanded-6	**8**	**-81.47**	**-61.36**	**0.31**	**0.29**	**0.49**
	Julian day	**3**	**-67.50**	**-60.90**	**0.77**	**0.23**	**0.29**
	Julian day (quadratic)	4	-68.19	-59.16	2.50	0.10	0.30
	Expanded-2	8	-75.17	-55.05	6.61	0.01	0.41
	Expanded-3	8	-74.95	-54.83	6.83	0.01	0.40
	THV/SWV(180)[c]	4	-63.05	-54.02	7.65	0.01	0.22
	THV/SWV(212)[b]	4	-57.42	-48.39	13.28	0.00	0.11
	Expanded-4	8	-67.58	-47.46	14.20	0.00	0.29
	Dew Point	3	-53.91	-47.31	14.35	0.00	0.04
	Cloud Cover/Visibiltiy	4	-54.62	-45.59	16.08	0.00	0.05
	Ceiling/Precipiation	4	-54.08	-45.05	16.62	0.00	0.04
	Temp/Barometric Pres.	4	-52.72	-43.70	17.97	0.00	0.01
	Expanded-1	8	-60.71	-40.60	21.07	0.00	0.18
Targets recorded/hr (log-transformed)	**Expanded-5**	**8**	**-81.21**	**-61.10**	**0.00**	**0.34**	**0.50**
	Expanded-6	**8**	**-80.88**	**-60.76**	**0.34**	**0.29**	**0.50**
	Julian day	**3**	**-67.03**	**-60.43**	**0.67**	**0.24**	**0.31**
	Julian day (quadratic)	4	-67.80	-58.77	2.33	0.11	0.33
	Expanded-2	8	-74.69	-54.57	6.53	0.01	0.42
	Expanded-3	8	-74.45	-54.33	6.77	0.01	0.42
	THV/SWV(180)[c]	4	-61.16	-52.13	8.96	0.00	0.22
	THV/SWV(212)[b]	4	-55.58	-46.55	14.55	0.00	0.11
	Expanded-4	8	-65.99	-45.87	15.23	0.00	0.30
	Dew Point	3	-52.38	-45.78	15.32	0.00	0.04
	Cloud Cover/Visibiltiy	4	-52.91	-43.88	17.22	0.00	0.06
	Ceiling/Precipiation	4	-52.26	-43.24	17.86	0.00	0.04
	Temp/Barometric Pres.	4	-51.04	-42.02	19.08	0.00	0.01
	Expanded-1	8	-59.19	-39.07	22.02	0.00	0.18
Proportion <=100 m (PROP100, arcsine transformed)	**Julian day**	**3**	**-184.09**	**-177.49**	**0.00**	**0.54**	**0.14**
	Julian day (quadratic)	**4**	**-184.97**	**-175.95**	**1.54**	**0.25**	**0.15**
	Ceiling/Precipiation	4	-182.11	-173.08	4.41	0.06	0.10
	Dew Point	3	-179.10	-172.50	4.98	0.04	0.03
	Temp/Barometric Pres.	4	-181.49	-172.46	5.02	0.04	0.08
	THV/SWV(212)[b]	4	-179.78	-170.75	6.73	0.02	0.05
	THV/SWV(180)[c]	4	-179.64	-170.61	6.87	0.02	0.04
	Cloud Cover/Visibiltiy	4	-178.34	-169.31	8.17	0.01	0.01
	Expanded-2	8	-187.17	-167.06	10.43	0.00	0.19
	Expanded-3	8	-187.08	-166.97	10.52	0.00	0.19
	Expanded-5	8	-186.60	-166.49	11.00	0.00	0.18
	Expanded-6	8	-186.50	-166.38	11.10	0.00	0.18
	Expanded-1	8	-183.78	-163.66	13.82	0.00	0.13
	Expanded-4	8	-183.53	-163.41	14.07	0.00	0.12

Table 18 (continued)

Proportion 100 > <=200 m (PROP 200, arcsine transformed)	**Julian day**	**3**	**-223.03**	**-216.43**	**0.00**	**0.33**	**0.04**
	Ceiling/Precipiation	**4**	**-224.42**	**-215.39**	**1.04**	**0.20**	**0.07**
	Dew Point	**3**	**-221.35**	**-214.75**	**1.68**	**0.14**	**0.00**
	Julian day (quadratic)	4	-223.03	-214.00	2.43	0.10	0.04
	THV/SWV(180)[c]	4	-222.75	-213.72	2.71	0.09	0.04
	THV/SWV(212)[b]	4	-221.66	-212.63	3.80	0.05	0.01
	Cloud Cover/Visibiltiy	4	-221.40	-212.37	4.06	0.04	0.01
	Temp/Barometric Pres.	4	-221.39	-212.36	4.07	0.04	0.01
	Expanded-6	8	-225.33	-205.22	11.21	0.00	0.09
	Expanded-5	8	-225.33	-205.21	11.22	0.00	0.09
	Expanded-3	8	-223.94	-203.82	12.61	0.00	0.06
	Expanded-2	8	-223.94	-203.82	12.61	0.00	0.06
	Expanded-4	8	-223.58	-203.46	12.97	0.00	0.05
	Expanded-1	8	-222.34	-202.23	14.20	0.00	0.03
Targets recorded <=100 m (TR100, sum of 10-min sample means, log-transformed)	**Expanded-5**	**8**	**-76.95**	**-56.84**	**0.00**	**0.27**	**0.38**
	Expanded-6	**8**	**-76.91**	**-56.80**	**0.04**	**0.26**	**0.38**
	THV/SWV(180)[c]	**4**	**-65.08**	**-56.06**	**0.78**	**0.18**	**0.18**
	Julian day	**3**	**-62.41**	**-55.81**	**1.03**	**0.16**	**0.13**
	Julian day (quadratic)	4	-62.43	-53.40	3.44	0.05	0.13
	Ceiling/Precipiation	4	-60.45	-51.42	5.42	0.02	0.09
	THV/SWV(212)[b]	4	-60.03	-51.01	5.83	0.01	0.08
	Expanded-2	8	-70.64	-50.52	6.31	0.01	0.28
	Expanded-3	8	-70.64	-50.52	6.32	0.01	0.28
	Dew Point	3	-56.59	-49.99	6.85	0.01	0.01
	Expanded-4	8	-69.95	-49.83	7.00	0.01	0.27
	Cloud Cover/Visibiltiy	4	-57.95	-48.93	7.91	0.01	0.04
	Temp/Barometric Pres.	4	-56.47	-47.44	9.39	0.00	0.01
	Expanded-1	8	-63.04	-42.93	13.91	0.00	0.14
Targets recorded 100> <=200 m (TR200, sum of 10-min sample means, log-transformed)	**Expanded-5**	**8**	**-71.97**	**-51.85**	**0.00**	**0.29**	**0.44**
	Expanded-6	**8**	**-71.76**	**-51.64**	**0.21**	**0.26**	**0.44**
	Julian day	**3**	**-57.88**	**-51.28**	**0.57**	**0.22**	**0.23**
	THV/SWV(180)[c]	**4**	**-59.31**	**-50.28**	**1.57**	**0.13**	**0.25**
	Julian day (quadratic)	4	-58.22	-49.19	2.66	0.08	0.23
	Expanded-2	8	-63.42	-43.31	8.55	0.00	0.32
	Expanded-3	8	-63.29	-43.18	8.67	0.00	0.32
	Expanded-4	8	-63.02	-42.91	8.94	0.00	0.31
	THV/SWV(212)[b]	4	-51.47	-42.44	9.41	0.00	0.10
	Dew Point	3	-48.04	-41.44	10.41	0.00	0.03
	Cloud Cover/Visibiltiy	4	-48.40	-39.37	12.48	0.00	0.04
	Ceiling/Precipiation	4	-47.92	-38.89	12.96	0.00	0.03
	Temp/Barometric Pres.	4	-47.26	-38.24	13.61	0.00	0.01
	Expanded-1	8	-54.01	-33.89	17.96	0.00	0.15

[a] See Appendix 12 for variables included in Global models

[b] THV=Tailwind/Headwind Vector. SWV=Sidewind Vector. Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees). Based on analysis of data collected with horizontally-oriented radar (see Fig. 45, upper)

[c] Number in parentheses represents generalized and seasonally appropriate directional goal (e.g., fall [South-180°])

Table 19. Parameter estimates of predictor variables in best performing models for flight dynamics response variables: (1) targets recorded (TR), (2) targets recorded/hr (TR/hr), (3) proportion of targets recorded <= 100 m (PROP100), (4) proportion of targets recorded between 101 and 200 m (PROP200), (5) number of targets recorded <= 100 m (TR100) and (6) number of targets recorded between 101 and 200 m (TR200). Data from Fall/Late 2007 (i.e., sunrise - sunset the same day) data collection period. R^2 values are provided to suggest what estimates may be contributing most to model perfromance. Only estimates where $R^2 \geq 0.01$ are shown. Model comparisons for this Season/Year are shown in Table 18.

Model	TR*			TR/hr*			PROP100			PROP200			TR100*			TR200*		
Variable	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2
Expanded-5																		
Julian day (linear)	-0.0228	0.0056	0.29	-0.0241	0.0056	0.31							-0.0155	0.0059	0.13	-0.0207	0.0062	0.23
Cloud cover	0.1079	0.1973	0.01	0.1089	0.1986	0.01							0.0965	0.2085	0.01	----	----	----
Visibility	0.0001	0.0000	0.01	0.0001	0.0000	0.01							----	----	----	----	----	----
Barometric pressure	----	----	----	----	----	----							-0.0226	0.0101	0.02	----	----	----
THV(180)[a]	0.0928	0.0257	0.17	0.0930	0.0258	0.16							0.0950	0.0271	0.18	0.1033	0.0287	0.16
SWV(180)[b]	0.0328	0.0353	0.01	0.0336	0.0355	0.01							0.0519	0.0373	0.03	0.0676	0.0395	0.04
Julian day (linear)																		
Julian day	-0.0227	0.0054	0.29	-0.0240	0.0055	0.31	0.0037	0.0014	0.14	0.0013	0.0009	0.04	-0.0146	0.0058	0.13	-0.0212	0.0061	0.23
Julian day (quadratic)																		
Julian day							0.0684	0.0708	0.14									
Julian day*Julian day							-0.0001	0.0001	0.02									
Ceiling/Precipiation																		
Ceiling										0.0000	0.0000	0.02						
Precipitation[c]										0.0000	0.0562	0.05						
Dew point																		
Dew point										----	----	----						
THV/SWV(180)																		
THV(180)[a]													0.0756	0.0254	0.15	0.0986	0.0272	0.20
SWV(180)[b]													0.0546	0.0398	0.04	0.0718	0.0425	0.05

*Multiple Expanded models supported (see Table 18). Parameter signs (i.e., positive, negative) are the same and R^2 values similar in all supported models.

[a] THV=Tailwind/Headwind Vector. Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees). Based on generalized and seasonally appropriate migration goals (e.g., fall [South-180°])

[b] SWV=Sidewind Vector. Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees. Based on generalized and seasonally appropriate migration goals (e.g., fall [South-180°])

[c] Variable assesses "precipitation" vs. "no precipitation." Postiive pararmeter estimate indicates that response variable increased when precipitation was present.

Table 20. Results from multiple model inference procedures used to evaluate the effects of local meteorological conditions on response variables derived from data collected at the Maple Ridge Wind Power Faciltiy, Spring 2008. Candidate models with the lowest AIC values (corrected for small sample sizes [AIC_c]) and that are at least two units smaller (AIC_c) than the model with the next lowest AIC_c value are considered to have the strongest support (bold).

Response Variable	Model[a]	# of model parameters	(-)2 Log Likelihood	AIC_c	AIC_c	w_i	R^2
Targets recorded (TR, sum of 10-min sample means, log-transformed)	**Expanded-3**	**9.00**	**-150.47**	**-129.01**	**0.00**	**0.25**	**0.47**
	Expanded-2	**9.00**	**-150.44**	**-128.98**	**0.03**	**0.24**	**0.47**
	Expanded-6	**9.00**	**-150.12**	**-128.65**	**0.36**	**0.21**	**0.46**
	Expanded-5	**9.00**	**-150.03**	**-128.57**	**0.44**	**0.20**	**0.46**
	Temperature/Pressure	4.00	-133.88	-125.18	3.83	0.04	0.30
	Expanded-4	8.00	-143.74	-125.02	3.99	0.03	0.40
	Expanded-1	8.00	-143.61	-124.89	4.12	0.03	0.40
	Cloud ceiling/Precip	4.00	-120.23	-111.53	17.48	0.00	0.13
	THV/SWV(44)	4.00	-119.39	-110.68	18.32	0.00	0.12
	THV/SWV(360)	4.00	-119.02	-110.32	18.69	0.00	0.11
	Cloud cover/Visibiltiy	4.00	-118.70	-110.00	19.01	0.00	0.11
	Dew point	3.00	-112.84	-106.43	22.58	0.00	0.02
	Julian day	3.00	-111.59	-105.18	23.83	0.00	0.00
	Julian day (quadratic)	3.00	-111.94	-103.24	25.77	0.00	0.01
Targets recorded/hr (log-transformed)	**Expanded-3**	**9**	**-151.25**	**-129.79**	**0.00**	**0.20**	**0.47**
	Expanded-2	**9**	**-151.19**	**-129.73**	**0.06**	**0.20**	**0.47**
	Expanded-6	**9**	**-150.84**	**-129.38**	**0.41**	**0.17**	**0.46**
	Expanded-5	**9**	**-150.74**	**-129.28**	**0.51**	**0.16**	**0.46**
	Expanded-4	**8**	**-147.12**	**-128.40**	**1.39**	**0.10**	**0.43**
	Expanded-1	**8**	**-147.10**	**-128.38**	**1.41**	**0.10**	**0.43**
	Temperature/Pressure	**4**	**-136.59**	**-127.89**	**1.90**	**0.08**	**0.33**
	THV/SWV(41)[b]	4	-120.92	-112.22	17.57	0.00	0.13
	Cloud ceiling/Precip	4	-120.59	-111.89	17.90	0.00	0.13
	THV/SWV(360)[c]	4	-120.33	-111.63	18.16	0.00	0.12
	Cloud cover/Visibiltiy	4	-119.18	-110.48	19.31	0.00	0.11
	Dew point	3	-114.29	-107.87	21.91	0.00	0.03
	Julian day	3	-112.48	-106.07	23.72	0.00	0.00
	Julian day (quadratic)	4	-112.71	-104.01	25.78	0.00	0.01
Proportion <=100 m (PROP100, arcsine transformed)	**Expanded-5**	**9**	**-331.95**	**-310.49**	**0.00**	**0.25**	**0.62**
	Expanded-4	**8**	**-329.08**	**-310.36**	**0.13**	**0.24**	**0.60**
	Expanded-6	**9**	**-331.78**	**-310.32**	**0.17**	**0.23**	**0.62**
	Expanded-2	**9**	**-330.04**	**-308.58**	**1.91**	**0.10**	**0.60**
	Expanded-1	**8**	**-327.26**	**-308.55**	**1.94**	**0.10**	**0.59**
	Expanded-3	9	-329.89	-308.42	2.07	0.09	0.60
	Temperature/Pressure	4	-306.26	-297.56	12.93	0.00	0.42
	THV/SWV(360)[c]	4	-289.32	-280.62	29.88	0.00	0.24
	THV/SWV(41)[b]	4	-287.19	-278.49	32.00	0.00	0.21
	Dew point	3	-280.06	-273.64	36.85	0.00	0.11
	Julian day (quadratic)	4	-276.33	-267.63	42.86	0.00	0.06
	Julian day	3	-272.57	-266.16	44.33	0.00	0.00
	Cloud ceiling/Precip	4	-274.77	-266.07	44.43	0.00	0.03
	Cloud cover/Visibiltiy	4	-274.34	-265.64	44.85	0.00	0.03

Table 20 (continued)

Proportion 100 > <=200 m (PROP 200, arcsine transformed)	**Expanded-5**	**9**	**-341.11**	**-319.65**	**0.00**	**0.41**	**0.56**
	Expanded-6	**9**	**-340.83**	**-319.37**	**0.28**	**0.36**	**0.56**
	Expanded-4	8	-336.03	-317.31	2.33	0.13	0.53
	Expanded-2	9	-336.71	-315.25	4.40	0.05	0.53
	Expanded-3	9	-336.44	-314.98	4.67	0.04	0.53
	Expanded-1	8	-331.74	-313.02	6.63	0.01	0.49
	THV/SWV(360)[c]	4	-316.92	-308.22	11.43	0.00	0.36
	THV/SWV(41)[b]	4	-312.21	-303.50	16.14	0.00	0.30
	Temperature/Pressure	4	-303.79	-295.09	24.55	0.00	0.20
	Cloud ceiling/Precip	4	-298.25	-289.55	30.10	0.00	0.13
	Julian day (quadratic)	4	-295.66	-286.96	32.69	0.00	0.09
	Julian day	3	-291.89	-285.48	34.17	0.00	0.03
	Cloud cover/Visibiltiy	4	-293.02	-284.32	35.33	0.00	0.05
	Dew point	3	-290.71	-284.30	35.35	0.00	0.02
Targets recorded <=100 m (TR100, sum of 10-min sample means, log-transformed)	**Expanded-1**	**8**	**-151.24**	**-132.52**	**0.00**	**0.18**	**0.33**
	Expanded-3	**9**	**-153.55**	**-132.09**	**0.44**	**0.15**	**0.35**
	Expanded-2	**9**	**-153.48**	**-132.02**	**0.50**	**0.14**	**0.35**
	Expanded-4	**8**	**-150.70**	**-131.98**	**0.54**	**0.14**	**0.32**
	Expanded-6	**9**	**-152.67**	**-131.21**	**1.32**	**0.09**	**0.34**
	Expanded-5	**9**	**-152.57**	**-131.10**	**1.42**	**0.09**	**0.34**
	Cloud ceiling/Precip	4	-139.50	-130.80	1.72	0.08	0.19
	Cloud cover/Visibiltiy	4	-139.43	-130.73	1.80	0.07	0.18
	THV/SWV(41)[b]	4	-138.07	-129.37	3.16	0.04	0.17
	THV/SWV(360)[c]	4	-136.97	-128.27	4.26	0.02	0.15
	Dew point	3	-127.16	-120.74	11.78	0.00	0.01
	Julian day	3	-126.83	-120.41	12.11	0.00	0.00
	Temperature/Pressure	4	-128.01	-119.30	13.22	0.00	0.02
	Julian day (quadratic)	4	-127.20	-118.50	14.02	0.00	0.01
Targets recorded 100> <=200 m (TR200, sum of 10-min sample means, log-transformed)	**Expanded-1**	**8**	**-146.78**	**-128.06**	**0.00**	**0.23**	**0.38**
	Expanded-4	**8**	**-146.50**	**-127.79**	**0.27**	**0.20**	**0.38**
	Expanded-3	**9**	**-148.76**	**-127.29**	**0.77**	**0.16**	**0.40**
	Expanded-2	**9**	**-148.67**	**-127.21**	**0.85**	**0.15**	**0.40**
	Expanded-6	**9**	**-148.29**	**-126.83**	**1.23**	**0.12**	**0.40**
	Expanded-5	**9**	**-148.18**	**-126.72**	**1.34**	**0.12**	**0.40**
	Cloud cover/Visibiltiy	4	-130.25	-121.54	6.52	0.01	0.20
	Cloud ceiling/Precip	4	-129.63	-120.93	7.13	0.01	0.19
	Temperature/Pressure	4	-126.00	-117.30	10.76	0.00	0.14
	THV/SWV(41)[b]	4	-125.37	-116.67	11.39	0.00	0.13
	THV/SWV(360)[c]	4	-124.02	-115.32	12.74	0.00	0.11
	Julian day	3	-117.62	-111.21	16.85	0.00	0.01
	Dew point	3	-117.17	-110.75	17.31	0.00	0.01
	Julian day (quadratic)	4	-117.65	-108.95	19.11	0.00	0.01

[a] See Appendix 12 for variables included in Global models

[b] THV=Tailwind/Headwind Vector. SWV=Sidewind Vector. Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees). Based on analysis of data collected with horizontally-oriented radar (see Fig. 43, lower)

[c] Number in parentheses represents generalized and seasonally appropriate directional goal (e.g., spring [South-360°])

Table 21. Parameter estimates of predictor variables in best performing models for flight dynamics response variables: (1) targets recorded (TR), (2) targets recorded/hr (TR/hr), (3) proportion of targets recorded <= 100 m (PROP100), (4) proportion of targets recorded between 101 and 200 m (PROP200), (5) number of targets recorded <= 100 m (TR100) and (6) number of targets recorded between 101 and 200 m (TR200). Data from Spring 2008 (i.e., sunrise - sunset the same day) data collection period. R^2 values are provided to suggest what estimates may be contributing most to model perfromance. Only estimates where $R^2 \geq 0.01$ are shown. Model comparisons for this Season/Year are shown in Table 20.

Model	TR*			TR/hr*			PROP100*			PROP200*			TR100*			TR200*		
Variable	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2
Expanded-1																		
Cloud cover													-0.2309	0.0770	0.15	-0.2638	0.0799	0.17
Visibility													0.0000	0.0000	0.03	0.0000	0.0000	0.03
Temperature													0.0029	0.0083	0.01	0.0224	0.0086	0.11
Barometric pressure													-0.0055	0.0064	0.02	-0.0068	0.0066	0.02
THV(41)[a]													0.0471	0.0158	0.08	0.0378	0.0164	0.05
SWV(41)[b]													0.0425	0.0240	0.04	0.0292	0.0249	0.02
Expanded-3																		
Julian day*Julian day	0.0000	0.0000	0.00	0.0000	0.0000	0.01												
Cloud cover	-0.1958	0.0784	0.11	-0.1960	0.0780	0.11												
Visibility	----	----	----	----	----	----												
Temperature	0.0461	0.0092	0.32	0.0451	0.0092	0.31												
Barometric pressure	-0.0063	0.0066	0.01	-0.0067	0.0066	0.01												
THV(41)[a]	----	----	----	----	----	----												
SWV(41)[b]	0.0422	0.0244	0.03	0.0446	0.0243	0.03												
Expanded-5																		
Julian day							----	----	----	0.0012	0.0005	0.03						
Cloud cover							----	----	----	-0.0262	0.0168	0.01						
Visibility							0.0000	0.0000	0.03	0.0000	0.0000	0.04						
Temperature							-0.0149	0.0021	0.48	-0.0085	0.0020	0.28						
Barometric pressure							-0.0012	0.0015	0.01	-0.0025	0.0014	0.03						
THV(360)[a]							0.0083	0.0046	0.06	0.0042	0.0043	0.05						
SWV(360)[b]							0.0108	0.0043	0.04	0.0154	0.0040	0.12						
Tem/Barometric Pres.																		
Temperature				0.0447	0.0084	0.32												
Barometric pressure				----	----	----												

*Multiple Expanded models supported (see Table 20). Parameter signs (i.e., positive, negative) are the same and R^2 values similar in all supported models.

[a] THV=Tailwind/Headwind Vector. Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees). Based on generalized and seasonally appropriate migration goals (e.g., fall [North-360°])

[b] SWV=Sidewind Vector. Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees. Based on generalized and seasonally appropriate migration goals (e.g., fall [North-360°])

Table 22. Results from multiple model inference procedures used to evaluate the effects of local meteorological conditions on response variables derived from data collected at the Maple Ridge Wind Power Faciltiy, Fall/Early 2008. Candidate models with the lowest AIC values (corrected for small sample sizes [AIC_c]) and that are at least two units smaller (AIC_c) than the model with the next lowest AIC_c value are considered to have the strongest support (bold).

Response Variable	Model[a]	# of model parameters	(-)2 Log Likelihood	AIC_c	AIC_c	w_i	R^2
Targets recorded (TR, sum of 10-min sample means, log-transformed)	**Expanded-2**	**8**	**-87.26**	**-68.49**	**0.00**	**0.28**	**0.32**
	Expanded-5	**8**	**-86.95**	**-68.18**	**0.31**	**0.24**	**0.32**
	Expanded-3	**8**	**-86.57**	**-67.80**	**0.69**	**0.20**	**0.31**
	Expanded-6	**8**	**-86.27**	**-67.50**	**0.99**	**0.17**	**0.31**
	Temperature	3	-70.65	-64.23	4.26	0.03	0.11
	Julian day (quadratic)	4	-72.78	-64.07	4.42	0.03	0.14
	Dew Point	3	-70.10	-63.68	4.80	0.03	0.10
	Cloud Cover/Visibiltiy	4	-69.23	-60.52	7.97	0.01	0.09
	Ceiling/Precipiation	4	-68.71	-59.99	8.49	0.00	0.08
	Expanded-1	7	-75.93	-59.82	8.67	0.00	0.18
	Expanded-4	7	-75.89	-59.78	8.71	0.00	0.18
	Julian day	3	-65.72	-59.29	9.19	0.00	0.04
	THV/SWV(203)[b]	4	-67.47	-58.75	9.74	0.00	0.06
	THV/SWV(180)[c]	4	-67.28	-58.56	9.93	0.00	0.06
	Barometric Pressure	3	-64.92	-58.50	9.99	0.00	0.02
Targets recorded/hr (log-transformed)	**Expanded-2**	**8**	**-87.78**	**-69.01**	**0.00**	**0.31**	**0.34**
	Expanded-5	**8**	**-87.41**	**-68.64**	**0.37**	**0.26**	**0.34**
	Expanded-3	**8**	**-87.00**	**-68.24**	**0.78**	**0.21**	**0.33**
	Expanded-6	**8**	**-86.65**	**-67.88**	**1.13**	**0.17**	**0.33**
	Julian day (quadratic)	4	-72.95	-64.23	4.78	0.03	0.16
	Temperature	3	-68.14	-61.72	7.29	0.01	0.09
	Dew Point	3	-67.94	-61.52	7.49	0.01	0.09
	Julian day	3	-66.14	-59.72	9.29	0.00	0.06
	Ceiling/Precipiation	4	-68.42	-59.71	9.30	0.00	0.09
	Cloud Cover/Visibiltiy	4	-67.68	-58.97	10.04	0.00	0.08
	Expanded-1	7	-73.54	-57.42	11.59	0.00	0.17
	THV/SWV(203)[b]	4	-66.11	-57.40	11.61	0.00	0.06
	Expanded-4	7	-73.50	-57.39	11.63	0.00	0.17
	THV/SWV(203)[c]	4	-66.07	-57.35	11.66	0.00	0.06
	Barometric Pressure	3	-63.20	-56.78	12.24	0.00	0.01
Proportion <=100 m (PROP100, arcsine transformed)	**Cloud Cover/Visibiltiy**	**4**	**-317.08**	**-308.37**	**0.00**	**0.21**	**0.09**
	THV/SWV(203)[b]	**4**	**-316.68**	**-307.96**	**0.41**	**0.17**	**0.09**
	Julian day (quadratic)	**4**	**-316.56**	**-307.84**	**0.53**	**0.16**	**0.08**
	Ceiling/Precipiation	**4**	**-315.85**	**-307.14**	**1.23**	**0.12**	**0.07**
	THV/SWV(203)[c]	4	-314.70	-305.99	2.38	0.06	0.06
	Dew Point	3	-311.99	-305.56	2.81	0.05	0.01
	Julian day	3	-311.81	-305.39	2.98	0.05	0.01
	Temperature	3	-311.76	-305.34	3.03	0.05	0.01
	Barometric Pressure	3	-311.26	-304.84	3.53	0.04	0.00
	Expanded-1	7	-320.83	-304.72	3.65	0.03	0.15
	Expanded-2	8	-321.50	-302.73	5.64	0.01	0.15
	Expanded-4	7	-318.82	-302.71	5.66	0.01	0.12
	Expanded-3	8	-321.38	-302.61	5.76	0.01	0.15
	Expanded-5	8	-319.71	-300.94	7.43	0.01	0.13
	Expanded-6	8	-319.57	-300.80	7.57	0.00	0.13

Table 22 (continued)

Proportion 100 > <=200 m (PROP 200, arcsine transformed)	**Julian day (quadratic)**	**4**	**-309.12**	**-300.41**	**0.00**	**0.60**	**0.17**
	Cloud Cover/Visibiltiy	4	-305.14	-296.42	3.99	0.08	0.11
	THV/SWV(203)[b]	4	-303.68	-294.97	5.44	0.04	0.09
	Expanded-2	8	-313.56	-294.79	5.61	0.04	0.22
	THV/SWV(203)[c]	4	-303.27	-294.56	5.85	0.03	0.08
	Expanded-5	8	-313.20	-294.43	5.98	0.03	0.22
	Expanded-3	8	-313.18	-294.41	5.99	0.03	0.22
	Expanded-1	7	-310.18	-294.06	6.34	0.03	0.18
	Temperature	3	-300.48	-294.06	6.35	0.03	0.04
	Expanded-6	8	-312.76	-293.99	6.42	0.02	0.21
	Dew Point	3	-300.20	-293.78	6.63	0.02	0.03
	Ceiling/Precipiation	4	-302.11	-293.40	7.01	0.02	0.06
	Expanded-4	7	-309.39	-293.28	7.13	0.02	0.17
	Julian day	3	-299.24	-292.82	7.58	0.01	0.02
	Barometric Pressure	3	-298.10	-291.68	8.72	0.01	0.00
Targets recorded <=100 m (TR100, sum of 10-min sample means, log-transformed)	**Expanded-2**	**8**	**-93.23**	**-74.46**	**0.00**	**0.30**	**0.30**
	Expanded-3	**8**	**-92.67**	**-73.90**	**0.56**	**0.23**	**0.30**
	Expanded-5	**8**	**-91.67**	**-72.90**	**1.56**	**0.14**	**0.28**
	Expanded-6	8	-91.15	-72.39	2.08	0.11	0.28
	Temperature	3	-78.61	-72.19	2.27	0.10	0.11
	Dew Point	3	-77.88	-71.46	3.01	0.07	0.10
	Julian day (quadratic)	4	-77.59	-68.87	5.59	0.02	0.10
	Julian day	3	-73.15	-66.73	7.74	0.01	0.03
	THV/SWV(203)[b]	4	-75.39	-66.67	7.79	0.01	0.07
	Barometric Pressure	3	-72.99	-66.57	7.90	0.01	0.03
	Ceiling/Precipiation	4	-75.03	-66.32	8.14	0.01	0.06
	Expanded-1	7	-81.96	-65.84	8.62	0.00	0.16
	Cloud Cover/Visibiltiy	4	-74.10	-65.38	9.08	0.00	0.05
	Expanded-4	7	-81.16	-65.05	9.42	0.00	0.15
	THV/SWV(203)[c]	4	-73.70	-64.99	9.48	0.00	0.04
Targets recorded 100> <=200 m (TR200, sum of 10-min sample means, log-transformed)	**Expanded-2**	**8**	**-97.34**	**-78.57**	**0.00**	**0.22**	**0.28**
	Expanded-3	**8**	**-96.86**	**-78.09**	**0.48**	**0.18**	**0.27**
	Expanded-5	**8**	**-96.35**	**-77.58**	**0.99**	**0.14**	**0.27**
	Temperature	**3**	**-83.98**	**-77.56**	**1.01**	**0.14**	**0.10**
	Dew Point	**3**	**-83.60**	**-77.17**	**1.40**	**0.11**	**0.10**
	Expanded-6	**8**	**-95.90**	**-77.13**	**1.44**	**0.11**	**0.26**
	Julian day (quadratic)	4	-83.03	-74.31	4.26	0.03	0.09
	Ceiling/Precipiation	4	-82.59	-73.87	4.70	0.02	0.08
	Barometric Pressure	3	-79.48	-73.06	5.51	0.01	0.03
	Julian day	3	-79.14	-72.72	5.85	0.01	0.03
	Cloud Cover/Visibiltiy	4	-81.00	-72.29	6.28	0.01	0.06
	THV/SWV(203)[b]	4	-80.68	-71.97	6.60	0.01	0.05
	Expanded-1	7	-87.60	-71.49	7.08	0.01	0.15
	Expanded-4	7	-87.15	-71.04	7.53	0.01	0.15
	THV/SWV(203)[c]	4	-79.75	-71.04	7.53	0.01	0.04

[a] See Appendix 12 for variables included in Global models

[b] THV=Tailwind/Headwind Vector. SWV=Sidewind Vector. Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees). Based on analysis of data collected with horizontally-oriented radar (see Fig. 44, lower)

[c] Number in parentheses represents generalized and seasonally appropriate directional goal (e.g., fall [South-180°])

Table 23. Parameter estimates of predictor variables in best performing models for flight dynamics response variables: (1) targets recorded (TR), (2) targets recorded/hr (TR/hr), (3) proportion of targets recorded <= 100 m (PROP100), (4) proportion of targets recorded between 101 and 200 m (PROP200), (5) number of targets recorded <= 100 m (TR100) and (6) number of targets recorded between 101 and 200 m (TR200). Data from Fall/Early 2008 (i.e., sunrise - sunset the same day) data collection period. R^2 values are provided to suggest what estimates may be contributing most to model perfromance. Only estimates where $R^2 \geq 0.01$ are shown. Model comparisons for this Season/Year are shown in Table 22.

Model	TR*			TR/hr*			PROP100			PROP200			TR100*			TR200*		
Variable	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2
Expanded-2																		
Julian day (linear)	-0.0142	0.0043	0.04	-0.0161	0.0043	0.04							-0.0135	0.0041	0.03	-0.0121	0.0040	0.03
Cloud cover	0.0927	0.1402	0.01	0.0886	0.1396	0.01							0.0626	0.1335	0.01	0.0291	0.1291	0.01
Visibility	0.0001	0.0000	0.07	0.0001	0.0000	0.07							0.0000	0.0000	0.03	0.0000	0.0000	0.04
Temperature	-0.0940	0.0276	0.21	-0.0928	0.0275	0.21							-0.0881	0.0263	0.21	-0.0797	0.0254	0.18
THV(203)[a]	----	----	----	----	----	----							----	----	----	----	----	----
SWV(203)[b]	-0.0525	0.0733	0.01	----	----	----							-0.0905	0.0698	0.02	-0.0695	0.0675	0.01
Julian day (quadratic)																		
Julian day							0.0366	0.0167	0.01	0.0572	0.0177	0.02						
Julian day*Julian day							-0.0001	0.0000	0.07	-0.0001	0.0000	0.15						
Cloud cover/Visibility																		
Cloud cover							0.0002	0.0201	0.01									
Visibility							0.0000	0.0000	0.08									
Ceiling/Precipitation																		
Ceiling							0.0000	0.0000	0.05									
Precipitation							-0.0419	0.0382	0.02									
Temperature																		
Temperature																-0.0543	0.0208	0.10
Dew Point																		
Dew point																-0.0427	0.0169	0.10
THV/SWV(203)																		
THV(203)[a]							-0.0079	0.0043	0.04									
SWV(203)[b]							-0.0163	0.0101	0.04									

*Multiple Expanded models supported (see Table 22). Parameter signs (i.e., positive, negative) are the same and R^2 values similar in all supported models.

[a] THV=Tailwind/Headwind Vector. Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees). Based on analysis of data collected with horizontally-oriented radar (see Fig. 44, lower)

[b] SWV=Sidewind Vector. Number in parentheses is the assumed directional goal of movement (i.e., in degrees) for nocturnal period. Based on analysis of data collected during the nocturnal data collection period with horizontally-oriented radar (see Fig. Fig. 44, lower).

Table 24. Results from multiple model inference procedures used to evaluate the effects of local meteorological conditions on response variables derived from data collected at the Maple Ridge Wind Power Faciltiy, Fall/Late 2008. Candidate models with the lowest AIC values (corrected for small sample sizes [AIC_c]) and that are at least two units smaller (AIC_c) than the model with the next lowest AIC_c value are considered to have the strongest support (bold).

Response Variable	Model	# of model parameters	(-)2 Log Likelihood	AIC_c	AIC_c	w_i	R^2
Targets recorded (TR, sum of 10-min sample means, log-transformed)	**Expanded-5**	**8**	**-83.43**	**-60.14**	**0.00**	**0.52**	**0.68**
	Expanded-6	**8**	**-83.23**	**-59.93**	**0.21**	**0.47**	**0.67**
	Julian day	3	-58.44	-51.84	8.30	0.01	0.43
	Julian day (quadratic)	4	-58.63	-49.60	10.54	0.00	0.43
	Expanded-2	8	-65.99	-45.87	14.26	0.00	0.52
	Expanded-3	8	-65.80	-45.69	14.45	0.00	0.51
	Expanded-4	7	-62.85	-42.73	17.41	0.00	0.48
	Temp/Barometric Pres.	4	-45.28	-36.26	23.88	0.00	0.23
	THV/SWV(180)[c]	4	-41.02	-31.99	28.15	0.00	0.15
	Ceiling/Precipiation	4	-39.44	-30.42	29.72	0.00	0.12
	Cloud Cover/Visibiltiy	4	-38.84	-29.82	30.32	0.00	0.10
	Expanded-1	7	-45.50	-28.39	31.75	0.00	0.23
	Dew Point	3	-34.58	-27.98	32.16	0.00	0.01
	SWV(205)[b]	3	-34.15	-27.55	32.59	0.00	0.00
	THV(205)[b]	3	-34.14	-27.54	32.60	0.00	0.00
Targets recorded/hr (log-transformed)	**Expanded-5**	**8**	**-83.32**	**-60.02**	**0.00**	**0.52**	**0.68**
	Expanded-6	**8**	**-83.09**	**-59.79**	**0.23**	**0.47**	**0.68**
	Julian day	3	-58.35	-51.75	8.28	0.01	0.44
	Julian day (quadratic)	4	-58.50	-49.47	10.55	0.00	0.44
	Expanded-2	8	-65.87	-45.76	14.26	0.00	0.53
	Expanded-3	8	-65.67	-45.55	14.47	0.00	0.53
	Expanded-4	7	-61.67	-41.56	18.47	0.00	0.48
	Temp/Barometric Pres.	4	-44.27	-35.24	24.78	0.00	0.23
	Expanded-1	7	-41.02	-31.99	28.03	0.00	0.23
	THV/SWV(180)[c]	4	-39.78	-30.75	29.27	0.00	0.14
	Ceiling/Precipiation	4	-38.35	-29.32	30.70	0.00	0.12
	Cloud Cover/Visibiltiy	4	-37.82	-28.79	31.23	0.00	0.11
	Dew Point	3	-33.57	-26.97	33.05	0.00	0.01
	SWV(205)[b]	3	-33.08	-26.48	33.54	0.00	0.00
	THV(205)[b]	3	-33.06	-26.46	33.56	0.00	0.00
Proportion <=100 m (PROP100, arcsine transformed)	**Temp/Barometric Pres.**	**4**	**-193.56**	**-184.53**	**0.00**	**0.90**	**0.28**
	Ceiling/Precipiation	4	-186.78	-177.76	6.78	0.03	0.17
	Expanded-1	7	-194.65	-177.54	7.00	0.03	0.30
	Expanded-4	7	-195.08	-174.97	9.56	0.01	0.31
	Expanded-3	8	-194.68	-174.57	9.96	0.01	0.30
	Expanded-2	8	-194.68	-174.57	9.97	0.01	0.30
	THV(205)[b]	3	-180.43	-173.83	10.70	0.00	0.04
	Cloud Cover/Visibiltiy	4	-182.51	-173.48	11.05	0.00	0.08
	Julian day	3	-179.71	-173.11	11.43	0.00	0.02
	THV/SWV(180)[c]	4	-181.54	-172.51	12.02	0.00	0.06
	SWV(205)[b]	3	-179.03	-172.43	12.11	0.00	0.00
	Dew Point	3	-178.88	-172.28	12.25	0.00	0.00
	Expanded-6	8	-195.12	-171.83	12.71	0.00	0.31
	Expanded-5	8	-195.11	-171.82	12.71	0.00	0.31
	Julian day (quadratic)	4	-180.78	-171.76	12.78	0.00	0.04

Table 24 (continued)

Proportion 100 > <=200 m (PROP 200, arcsine transformed)	**Temp/Barometric Pres.**	**4**	**-175.74**	**-166.71**	**0.00**	**0.30**	**0.11**
	Julian day	**3**	**-172.05**	**-165.45**	**1.26**	**0.16**	**0.03**
	Dew Point	**3**	**-171.93**	**-165.33**	**1.38**	**0.15**	**0.03**
	THV(205)[b]	**3**	**-171.52**	**-164.92**	**1.79**	**0.12**	**0.02**
	SWV(205)[b]	3	-170.68	-164.08	2.63	0.08	0.00
	Julian day (quadratic)	4	-172.05	-163.03	3.69	0.05	0.03
	Ceiling/Precipiation	4	-171.93	-162.91	3.81	0.04	0.03
	THV/SWV(180)[c]	4	-171.71	-162.68	4.03	0.04	0.03
	Cloud Cover/Visibiltiy	4	-171.06	-162.04	4.68	0.03	0.01
	Expanded-1	7	-176.17	-159.06	7.66	0.01	0.12
	Expanded-3	8	-178.84	-158.72	7.99	0.01	0.17
	Expanded-2	8	-178.75	-158.64	8.07	0.01	0.17
	Expanded-4	7	-176.40	-156.29	10.42	0.00	0.12
	Expanded-6	8	-178.88	-155.58	11.13	0.00	0.17
	Expanded-5	8	-178.79	-155.50	11.21	0.00	0.17
Targets recorded <=100 m (TR100, sum of 10-min sample means, log-transformed)	**Expanded-5**	**8**	**-91.05**	**-67.76**	**0.00**	**0.51**	**0.68**
	Expanded-6	**8**	**-90.91**	**-67.62**	**0.14**	**0.48**	**0.68**
	Julian day	3	-66.53	-59.93	7.83	0.01	0.45
	Julian day (quadratic)	4	-66.53	-57.50	10.26	0.00	0.45
	Expanded-2	8	-69.01	-48.90	18.86	0.00	0.48
	Expanded-3	8	-68.88	-48.77	18.99	0.00	0.48
	Expanded-4	7	-65.21	-45.09	22.67	0.00	0.43
	THV/SWV(180)[c]	4	-51.48	-42.46	25.30	0.00	0.22
	Temp/Barometric Pres.	4	-44.81	-35.78	31.98	0.00	0.09
	Dew Point	3	-41.00	-34.40	33.36	0.00	0.01
	SWV(205)[b]	3	-40.98	-34.38	33.38	0.00	0.01
	Cloud Cover/Visibiltiy	4	-43.18	-34.15	33.61	0.00	0.06
	THV(205)[b]	3	-40.53	-33.93	33.83	0.00	0.00
	Ceiling/Precipiation	4	-42.70	-33.68	34.08	0.00	0.05
	Expanded-1	7	-45.33	-28.22	39.54	0.00	0.10
Targets recorded 100> <=200 m (TR200, sum of 10-min sample means, log-transformed)	**Expanded-5**	**8**	**-80.93**	**-57.64**	**0.00**	**0.45**	**0.68**
	Expanded-6	**8**	**-80.85**	**-57.56**	**0.08**	**0.44**	**0.68**
	Julian day	3	-60.86	-54.26	3.38	0.08	0.49
	Julian day (quadratic)	4	-60.92	-51.89	5.75	0.03	0.49
	Expanded-2	8	-62.68	-42.56	15.08	0.00	0.51
	Expanded-3	8	-62.59	-42.48	15.16	0.00	0.51
	Expanded-4	7	-54.01	-33.89	23.74	0.00	0.41
	THV/SWV(180)[c]	4	-39.02	-29.99	27.65	0.00	0.17
	Temp/Barometric Pres.	4	-36.72	-27.69	29.95	0.00	0.12
	Dew Point	3	-32.20	-25.60	32.04	0.00	0.03
	Cloud Cover/Visibiltiy	4	-33.91	-24.88	32.76	0.00	0.06
	SWV(205)[b]	3	-31.36	-24.76	32.87	0.00	0.01
	Ceiling/Precipiation	4	-33.61	-24.59	33.05	0.00	0.06
	THV(205)[b]	3	-31.03	-24.43	33.21	0.00	0.00
	Expanded-1	7	-37.05	-19.94	37.70	0.00	0.13

[a] See Appendix 12 for variables included in Global models

[b] THV=Tailwind/Headwind Vector. SWV=Sidewind Vector. Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees). Based on analysis of data collected with horizontally-oriented radar (see Fig. 45, lower)

[c] Number in parentheses represents generalized and seasonally appropriate directional goal (e.g., fall [South-180°])

Table 25. Parameter estimates of predictor variables in best performing models for flight dynamics response variables: (1) targets recorded (TR), (2) targets recorded/hr (TR/hr), (3) proportion of targets recorded <= 100 m (PROP100), (4) proportion of targets recorded between 101 and 200 m (PROP200), (5) number of targets recorded <= 100 m (TR100) and (6) number of targets recorded between 101 and 200 m (TR200). Data from Fall/Late 2008 (i.e., sunrise - sunset the same day) data collection period. R^2 values are provided to suggest what estimates may be contributing most to model perfromance. Only estimates where $R^2 \geq 0.01$ are shown. Model comparisons for this Season/Year are shown in Table 24.

Model	TR*			TR/hr*			PROP100			PROP200			TR100*			TR200*		
Variable	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2	Estimate	SE	R^2
Expanded-5																		
Julian day (linear)	-0.0250	0.0054	0.43	-0.0259	0.0054	0.44							-0.0266	0.0050	0.45	-0.0306	0.0056	0.49
Cloud cover	-0.0748	0.1431	0.03	-0.0751	0.1433	0.03							-0.1281	0.1312	0.01	0.0000	0.0000	0.01
Visibility	----	----	----	----	----	----							----	----	----	-0.1020	0.1472	----
Temperature	0.0338	0.0182	0.00	----	----	----							0.0187	0.0167	0.01	----	----	----
Barometric pressure	0.0264	0.0095	0.06	0.0264	0.0095	0.05							0.0117	0.0087	0.01	0.0000	0.0000	0.01
THV(180)[a]	0.0692	0.0296	0.02	0.0691	0.0296	0.02							0.0669	0.0272	0.01	0.0130	0.0098	0.02
SWV(180)[b]	0.1309	0.0330	0.14	0.1311	0.0330	0.14							0.1415	0.0303	0.19	0.1382	0.0340	0.15
Julian day (linear)																		
Julian day										-0.0019	0.0016	0.03						
Temp/Barometric pres.																		
Temperature							----	----	----	0.0027	0.0050	0.03						
Barometric pressure							-0.0074	0.0018	0.2809	-0.0044	0.0023	0.08						
Dew Point																		
Dew Point										0.0048	0.0042	0.03						
THV/SWV(205)																		
THV(205)[c]										-0.0070	0.0073	0.02						

*Multiple Expanded models supported (see Table 24). Parameter signs (i.e., positive, negative) are the same and R^2 values similar in all supported models.

[a] THV=Tailwind/Headwind Vector. Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees). Based on generalized and seasonally appropriate migration goals (e.g., fall [South-180°])

[b] SWV=Sidewind Vector. Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees. Based on generalized and seasonally appropriate migration goals (e.g., fall [South-180°])

[c] Numbers in parentheses assumed to be the directional goal of movement (i.e., in degrees). Based on analysis of data collected with horizontally-oriented radar (see Fig. 45, lower)

Table 26. Circular-circular correlation coefficients and *P*- values for relationships between wind directions recorded at Watetown International Airport, Watertown, NY and nightly mean vectors of target movement. Wind directions are those recorded at or as close to sunset as data were available. Mean vectors for target directions recorded with the horizontally-oriented radar.

Season/Year	Correlation coefficient (r)*	*P***
Spring 2007	-0.209	< 0.05
Fall/Early 2007	0.163	< 0.05
Fall/Late 2007	0.218	< 0.05
Spring 2008	-0.009	< 0.05
Fall/Early 2008	0.302	< 0.05
Fall/Late 2008	0.359	< 0.05

* Coefficient ranges from -1 to +1, with the former indicating a perfect negative correlation, the latter a perfect positive correlation, and 0 indicating no correlation.

** The significance of the correlation is tested by using the jackknife method described in Zar (2003)

Table 27. Circular-linear correlation coefficients and *P*- values for relationships between Tailwind/Headwind vectors (see Table 2 for description) and mean vectors for target directions recorded with the horizontally-oriented radar.

Season/Period	Correlation coefficient (r)*	*P***
Spring 2007		
THV(44)[a]	0.309	0.01
THV(360)[b]	0.299	0.02
Fall/Early 2007		
THV(197)[a]	0.572	<0.0001
THV(180)[b]	0.564	<0.0001
Fall/Late 2007		
THV(212)[a]	0.546	<0.0001
THV(180)[b]	0.575	<0.0001
Spring 2008		
THV(41)[a]	0.583	<0.0001
THV(360)[b]	0.357	<0.0008
Fall/Early 2008		
THV(205)[a]	0.532	<0.0001
THV(180)[b]	0.541	<0.0001
Fall/Late 2008		
THV(203)[a]	0.429	<0.0007
THV(360)[b]	0.504	<0.0001

[a] Number in parentheses assumed to be the directional goal of movement (i.e., in degrees). Based on analysis of data collected with horizontally-oriented radar (see Figures 43, 44, 45)

[b] Number in parentheses represents generalized and seasonally appropriate directional goal (e.g., spring [North-360°], fall [South-180°])

* Correlation coefficient ranges from 0 to 1, so there is no negative correlation.

** The calculation of the significance of the correlation follows Mardia & Jupp (2000) and is an approximation of the *F* distribution

Table 28. *F* statistics and *P*- vaules for comparisons between Season/Year-specific wind vectors and corresponding mean vectors of bird/bat movement.

Season/Year	Vectors		Degree of freedom	Watson-Williams *F* statistic*	*P*
	Wind	Bird/Bat			
Spring 2007	324°	44°	1, 98	26.33	< 0.0001
Fall/Early 2007	197°	243°	1, 118	75.64	< 0.0001
Fall/Late 2007	212°	327°	1, 78	24.02	< 0.0001
Spring 2008	44°	237°	1, 116	72.83	< 0.0001
Fall/Early 2008	204°	341°	1, 86	58.26	< 0.0001
Fall/Late 2008	204°	290°	1, 82	18.92	< 0.0001

* Compares two or more samples to determine if their mean angles differ significantly by comparing the lengths of the mean vectors for each sample with that for the pooled data of the two or more samples. The resulting *F* statistic is the same as Fisher's variance ratio statistic, which is commonly used in linear statistics

Figure 1. Dual radar system with horizontally and vertically oriented antennas that operate simultaneously. The system allows for data collection on passage magnitude (vertically-oriented radar), altitude (vertically-oriented radar) and flight direction (horizontally-oriented radar).

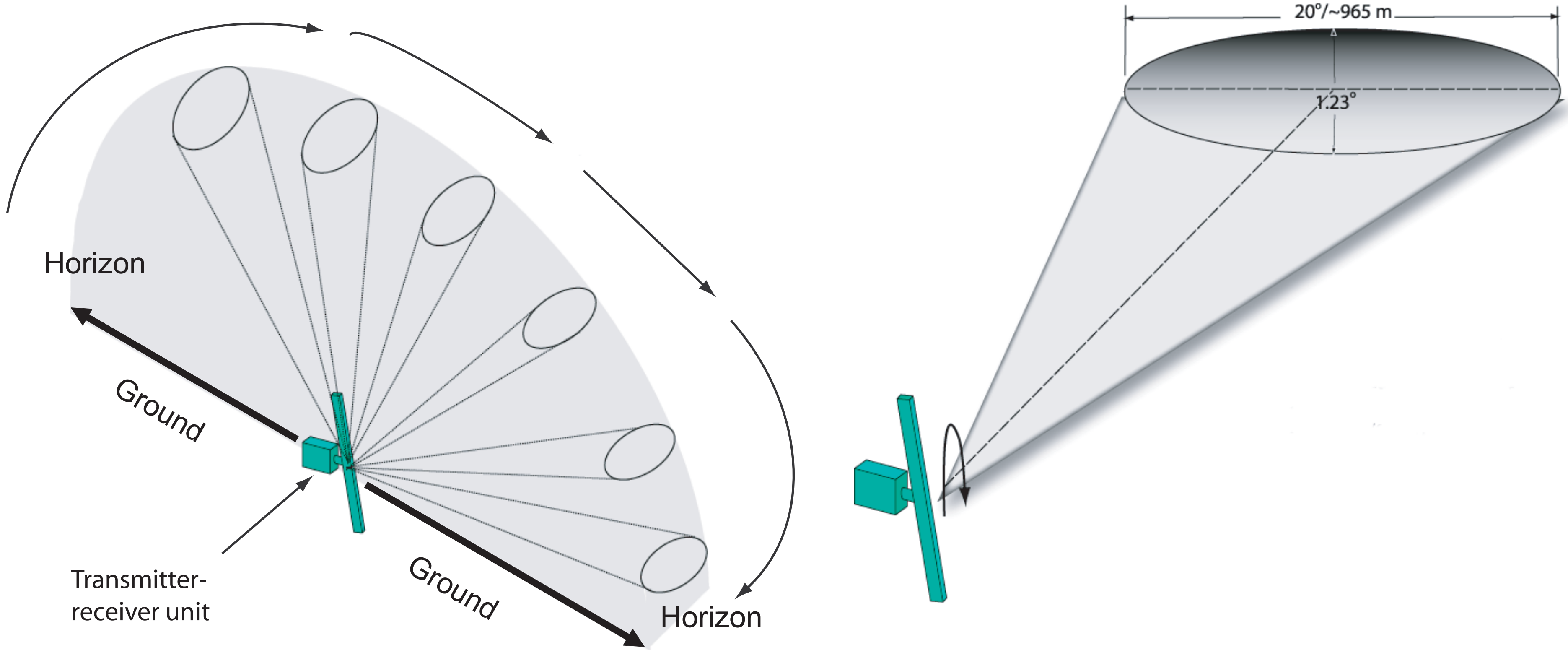


Figure 2. Graphic representation of scanning operation of vertically-oriented radar. In this orientation, the transmitter-receiver unit is mounted perpendicular to the ground so that the radar antenna's rotation results in a 180°, horizon-to-horizon scan (radar does not transmit when antenna is oriented groundward). When the radar's range is set to 0.75 nm (1.4 km, 4557 ft) it samples ~0.98 km^3 of air space. Data collected in "vertical" scanning mode can be used to estimate (1) target passage magnitude and (2) target altitude.

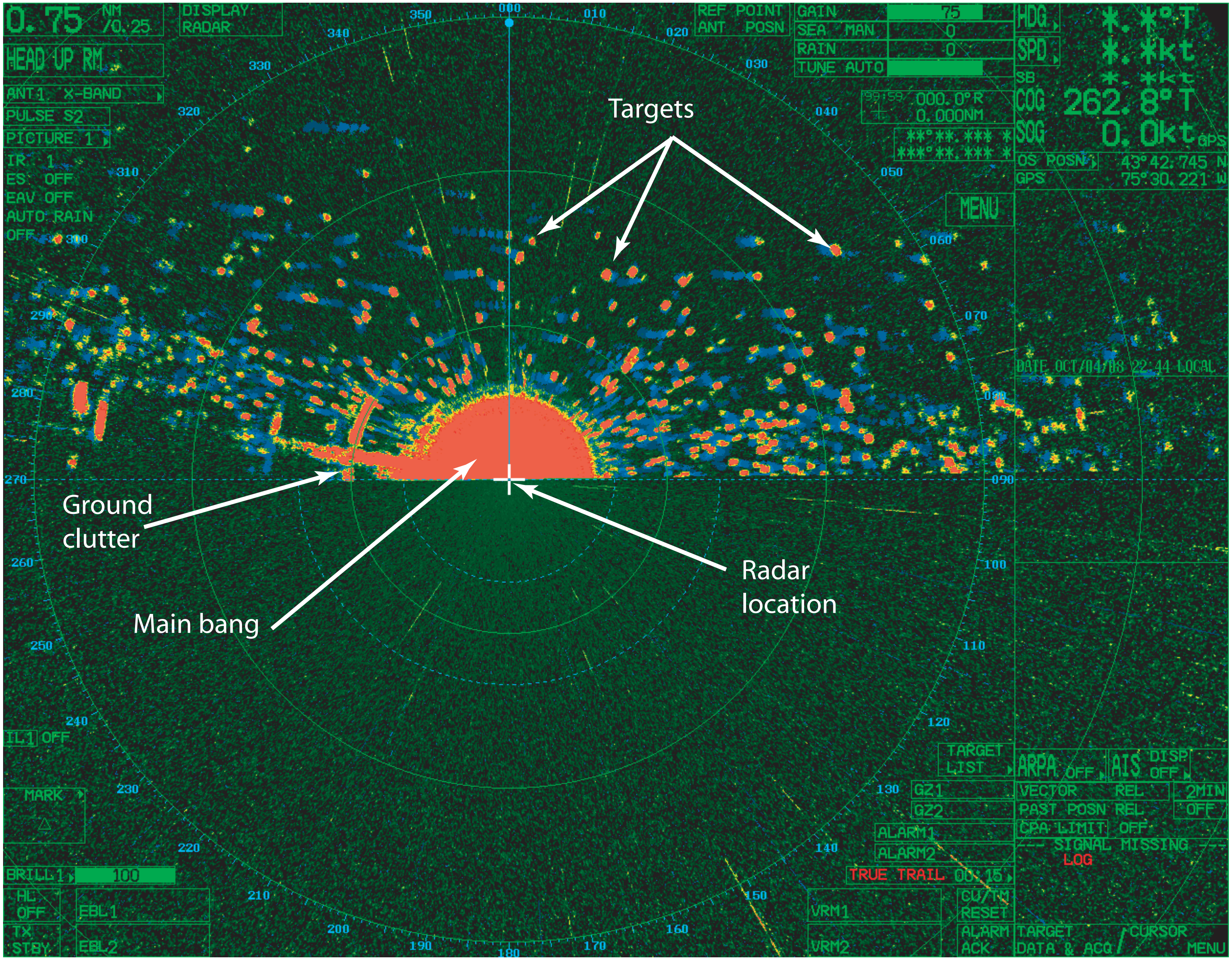


Figure. 3. Data image from the "vertical" radar collected on 4 October 2008 at 2244 EDT (10:44 PM). The small red ellipses with blue tails are bird or bats, or "targets" flying through the radar's sample space. The height above the blue dotted line splitting the image indicates each target's altitude. The large, circular red area in the center of the image is the "main bang," an area of interference generated by and inherent to marine radars. Note that the radar in the vertical orientation does not transmit or receive electromagnetic energy when the antenna scans toward the ground so no targets are shown below the blue dotted line.

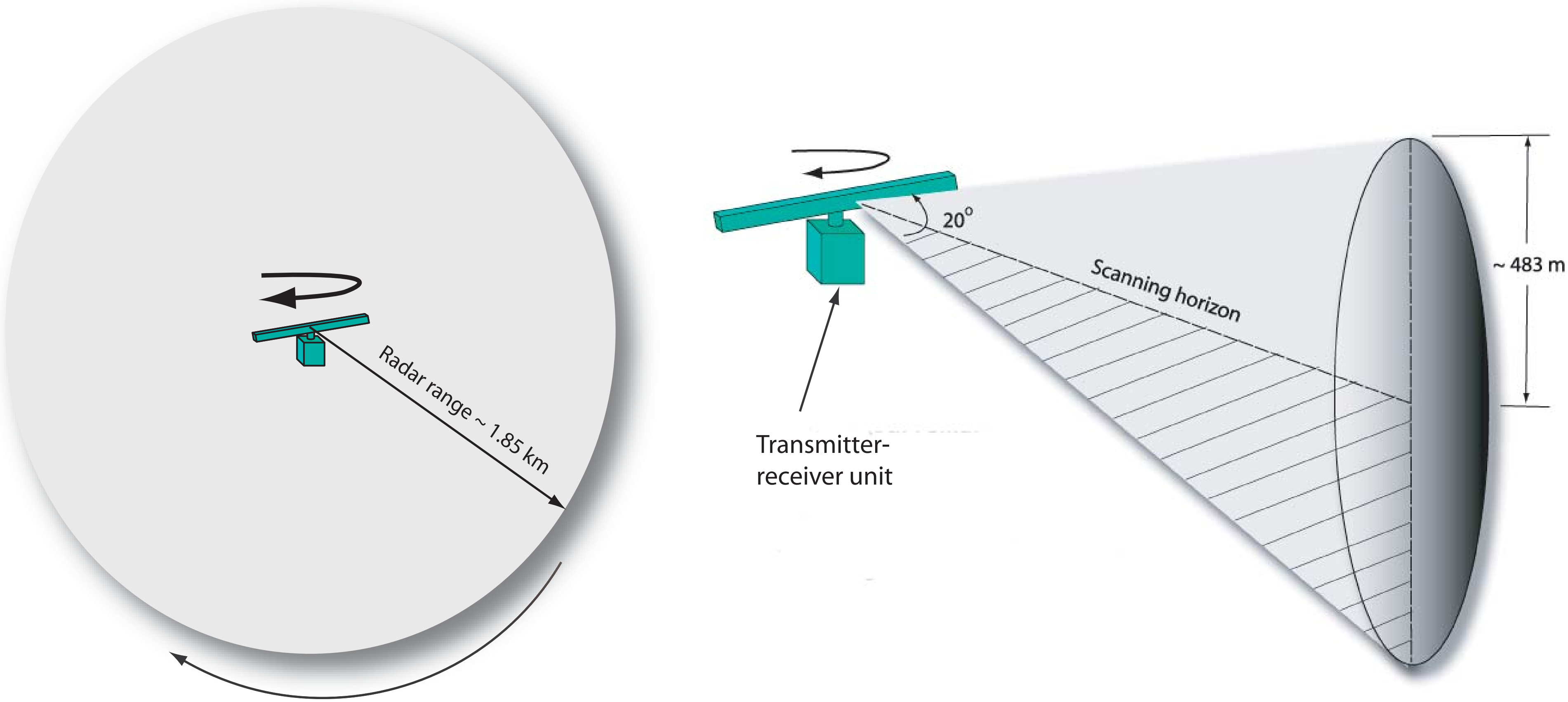


Figure 4. Graphic representation of scanning operation of horizontally-oriented radar. In this orientation, the antenna rotates in a plane parallel to the ground resulting in a 360° scan with a that samples 10° above and below the scanning horizon. With the radar's range set to 1 nautical mile (1.85 km, 6076 ft) which is the effective detection range for small passerines with 25 kW radar) it samples up to 483 m arl (above radar level) and ~4.0 km^3 of air space. Data collected in "horizontal" scanning mode can be used to estimate target flight direction.

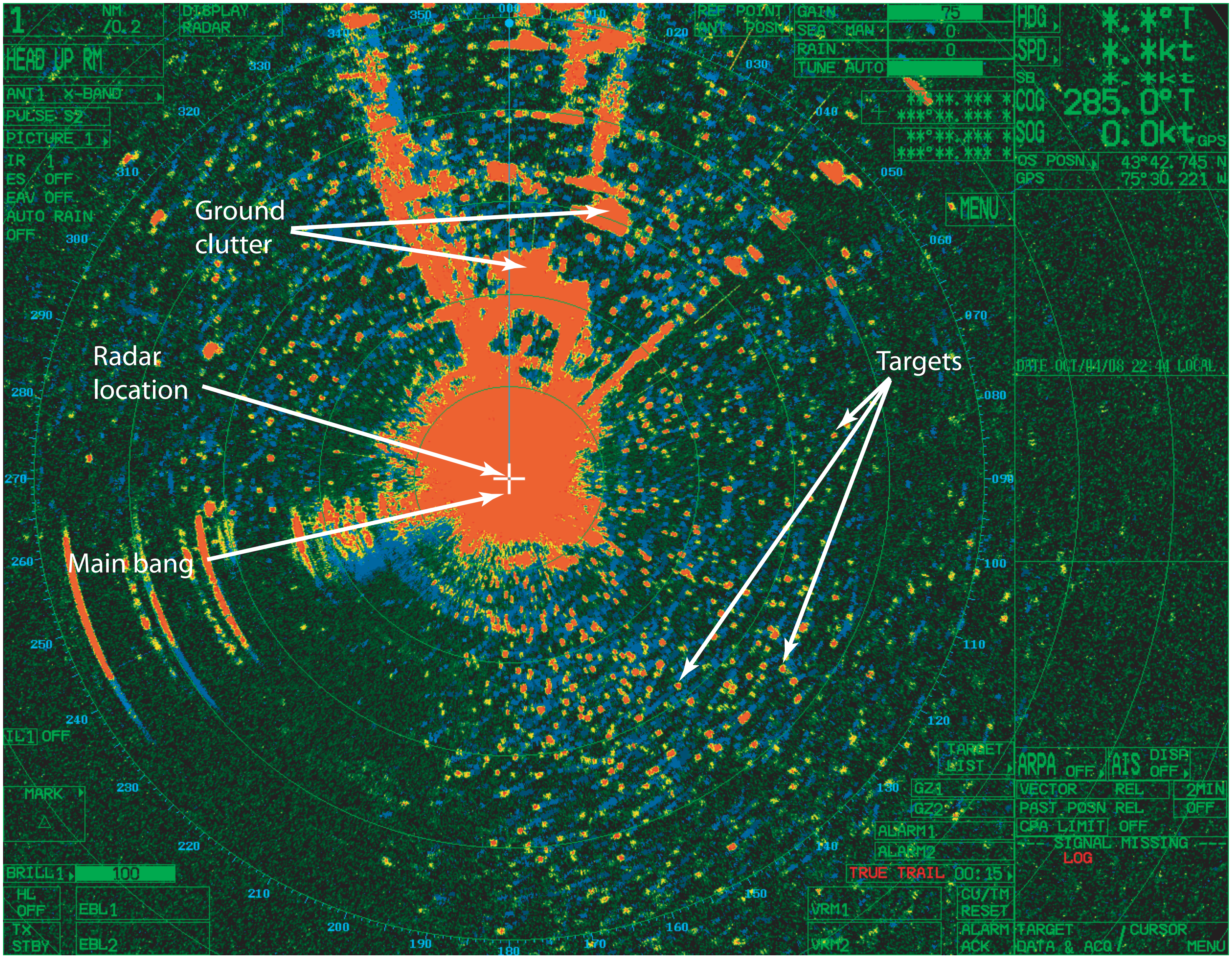


Figure 5. Data image from the horizontally-oriented radar collected on 4 October 2008 at 2244 EDT (10:44 PM). The small red ellipses with the blue trails are bird or bats, or "targets" flying through the radar's sample space. A blue trail shows the 15 second track history of its associated target, so represents its general flight direction. The large, cirucular red area in the center of the image is the "main bang," an area of interference or "ground clutter" generated by and inherent to marine radars. The large, irregularly-shaped areas primarily to the east of radar's location is electromagnetic energy being reflected from the surrounding landform.

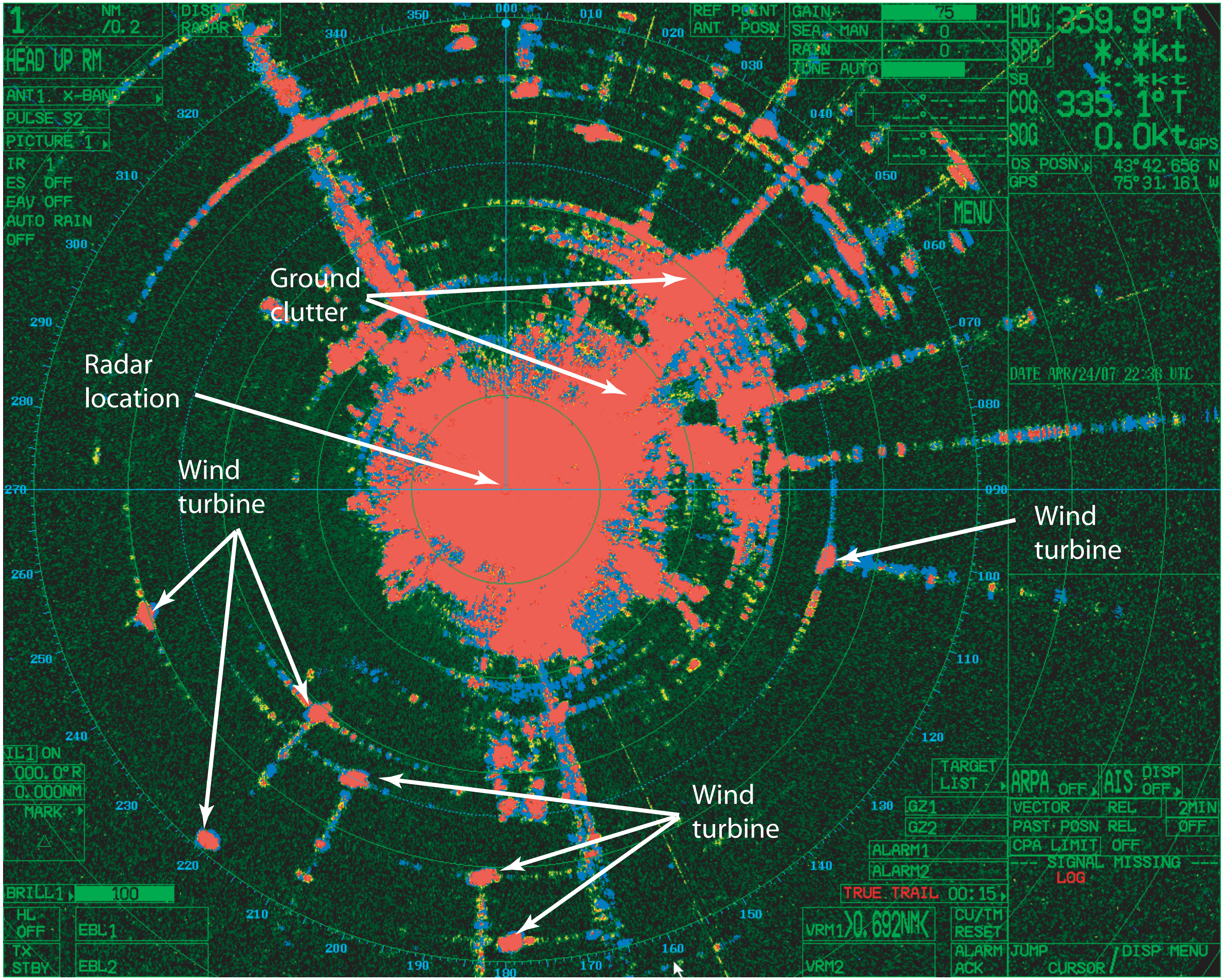


Figure 6. Image from horizontally-oriented radar showing backscatter of radar energy, or "ground clutter," within 1 nm of radar system on the Maple Ridge Wind Power Facility. Image shows ground clutter from the surrounding landforms (large red patches) and wind turbines (red ellipses) at wind turbine (WTG) #105, one of the sites considered for deploying the radar system. Note that the ground clutter at WTG 105 is widespread across the radar's field of view.

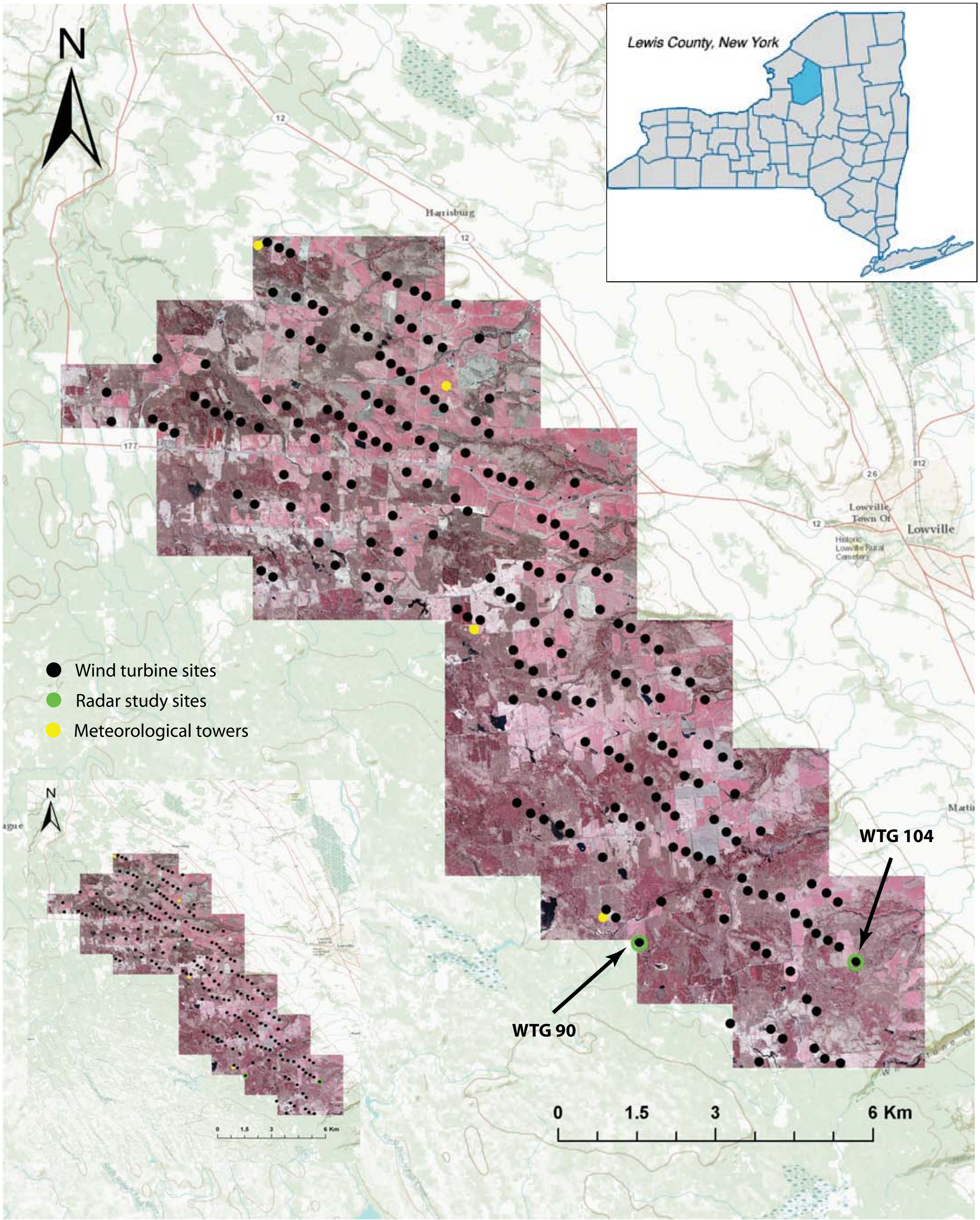


Figure 7. Map showing wind turbine sites, radar study sites and meteorlogical towers at the Maple Ridge Wind Power Facility.

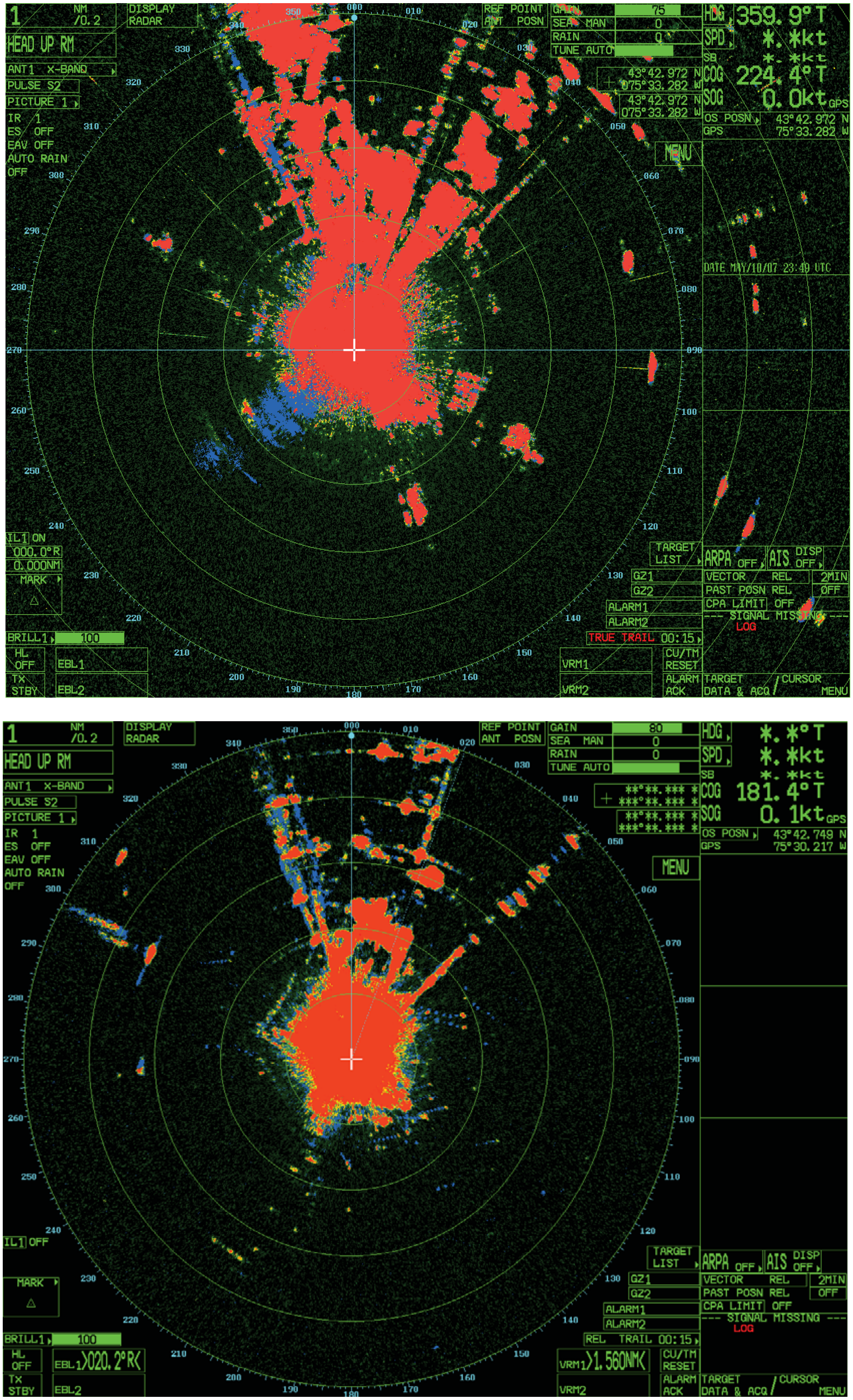


Figure 8. Image from horizontally-oriented radar showing backscatter of radar energy, or "ground clutter," within 1 nm of radar system on the Maple Ridge Wind Power Facility. (Upper) Radar's view of ground clutter at WTG 90, spring data collection site. (Lower) Radar's view of ground clutter at WTG 104, fall data collection site.

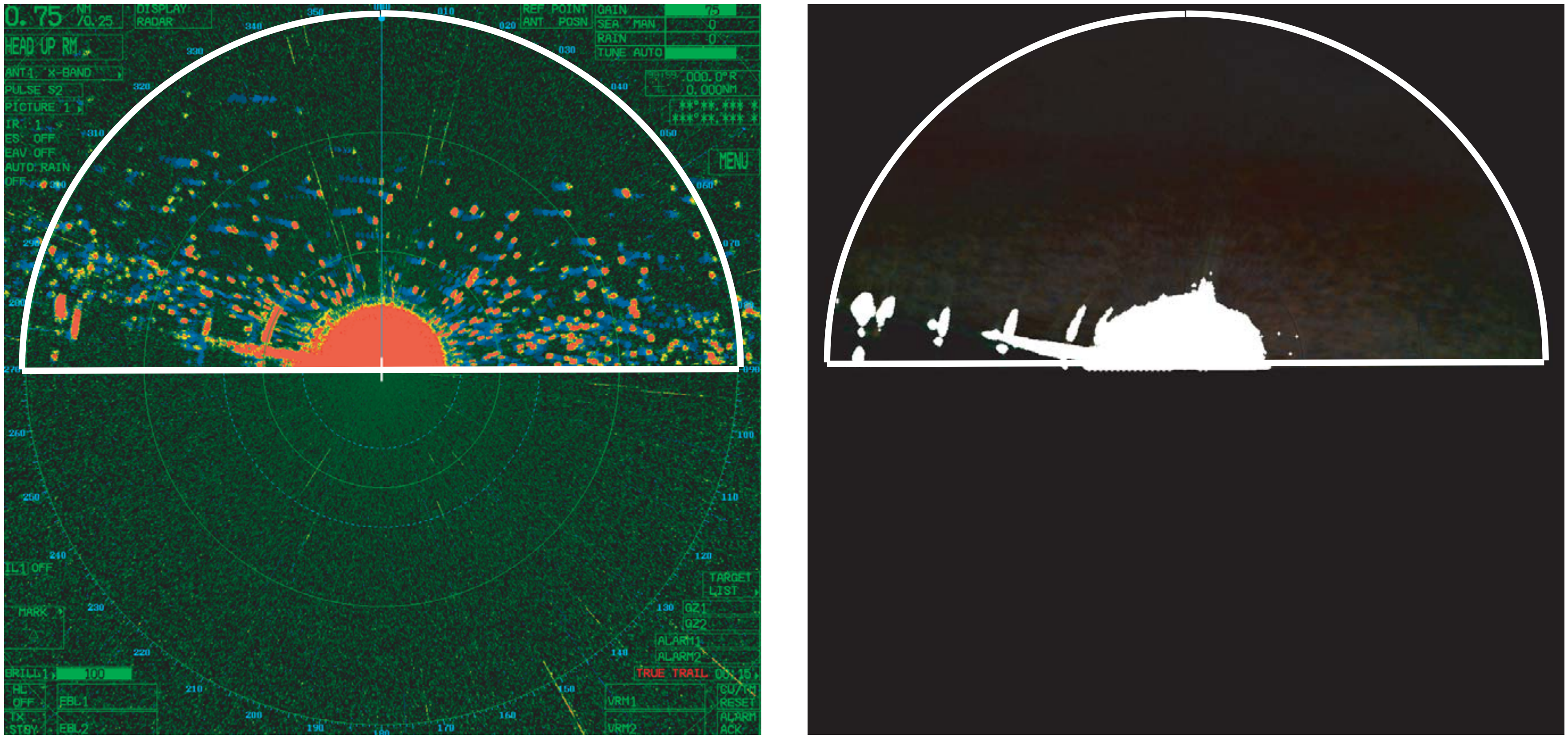


Figure 9. (Left) Data image from vertically oriented radar collected on 4 October 2008, 2244 EDT 10:44 PM). The thick white line graphically represents how NJAS's image processing software defines the sample area. (Right) Template generated by NJAS's image processing software for data collected on the same date as data image on the left. The template is used as a mask to remove stationary reflectors (i.e., main bang, ground clutter, see Figs. 3, 5, 6 for reference) from data images.

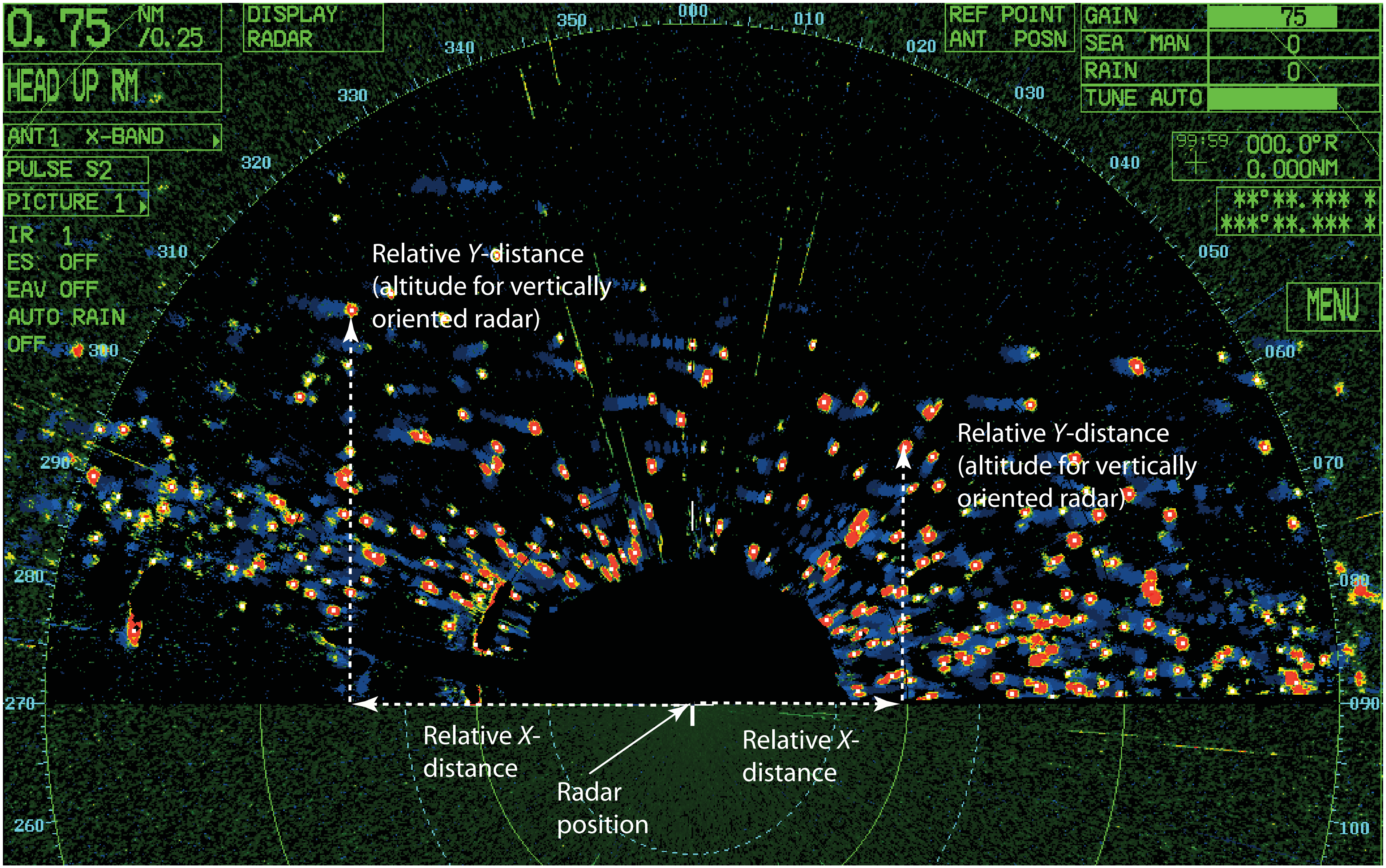


Figure 10. Data image collected on 4 October 2008 at 2244 EDT (10:44 PM), with the vertically-oriented radar. Based on color spectrum, NJAS image proces--sing software removes targets with low reflectivity, smooths the data and locates and marks the centroid of each discrete target that remains. In this representation, target centroids are marked with white dots. Because coordinates of the scan center (i.e., radar position, GPS) and the image's pixel dimensions are known, a target's distance from the radar in the *X*-, *Y*-planeswe can calculated. This allows us to calculate any target's altitude (vertical radar) or *X*-, *Y*-coordinates (horizontal radar). Note that the main bang and ground clutter have been removed in a prior processing step.

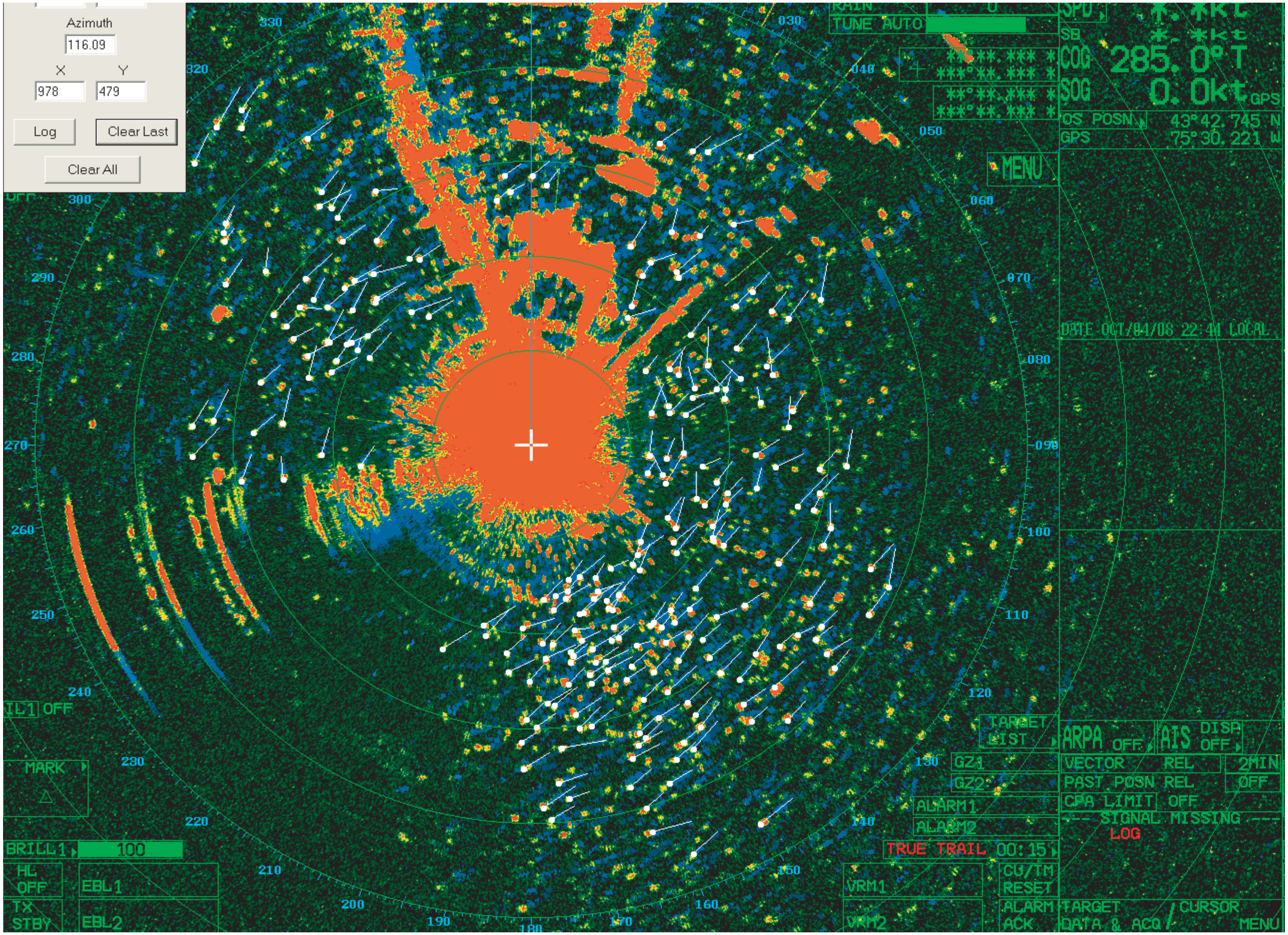


Figure 11. Data image collected on 4 October 2008 at 2244 EDT (10:44 PM) with the horizontally-oriented radar. The image shows target tracks (white circles with white tails) created using NJAS image analysis software to calculate target directions. The end of a target's trail (blue dotted line, see Fig. 5 for reference) and the target (red ellipses) are marked (in that order) using the computer's mouse and cursor. The program outputs the position of the trail's tail and the target and from these calculates the target's direction of movement.

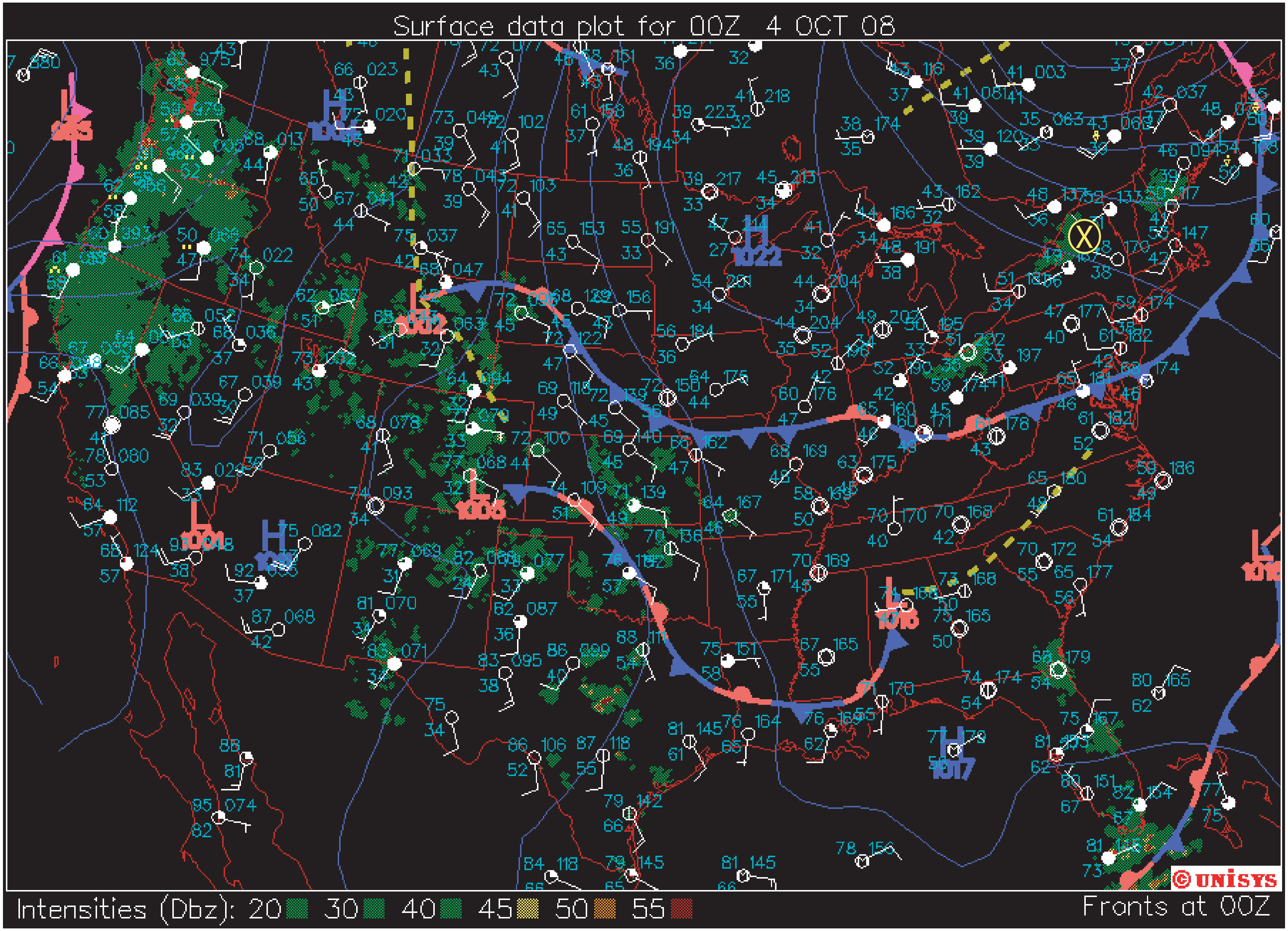


Figure 12. Surface weather map from 4 October 2008, 00Z Greenwich Mean Time (Z, equivalent to 13 October, 2000 EST). Note the yellow "X" within the yellow circle, indicating the general location of the study area. Surface weather maps were used to determine the position of synoptic weather systems (i.e., large scale atmospheric conditions) such as high or low pressure systems or frontal boundaries relative to the study area. On this day, a cold front (indicated by the blue line with blue triangles) passed through the study area on a NW to SE trajectory, primarily producing westerly and northwesterly winds.

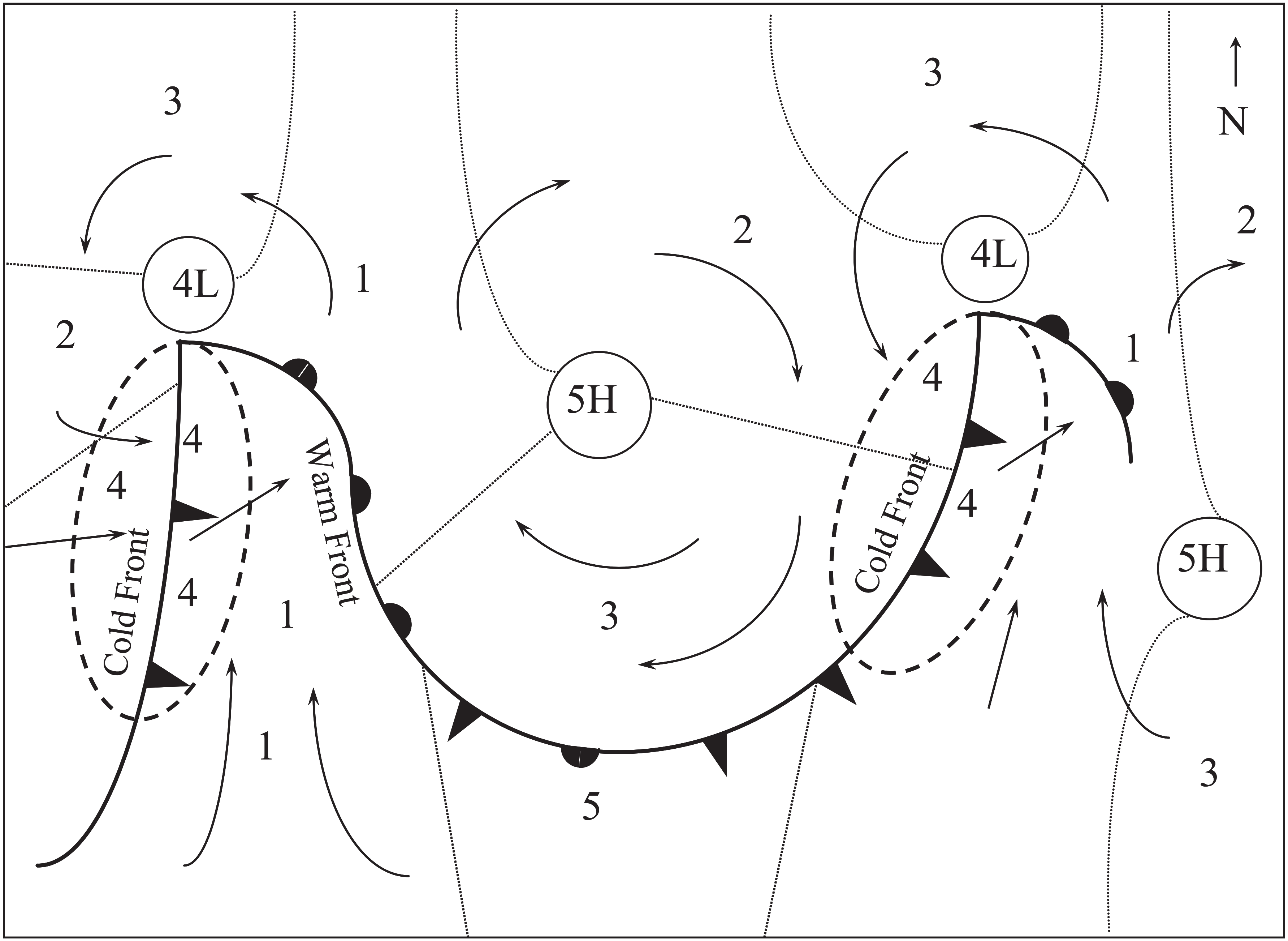


Figure 13. Generalized synoptic weather map with five synoptic regions: (1) southerly winds except after cold fronts, (2) northwesterly winds, (3) northeasterly winds, (4) the center of low pressure systems and (5) calm weather at the center of high pressure systems (after Richardson 1976, Lank 1983).

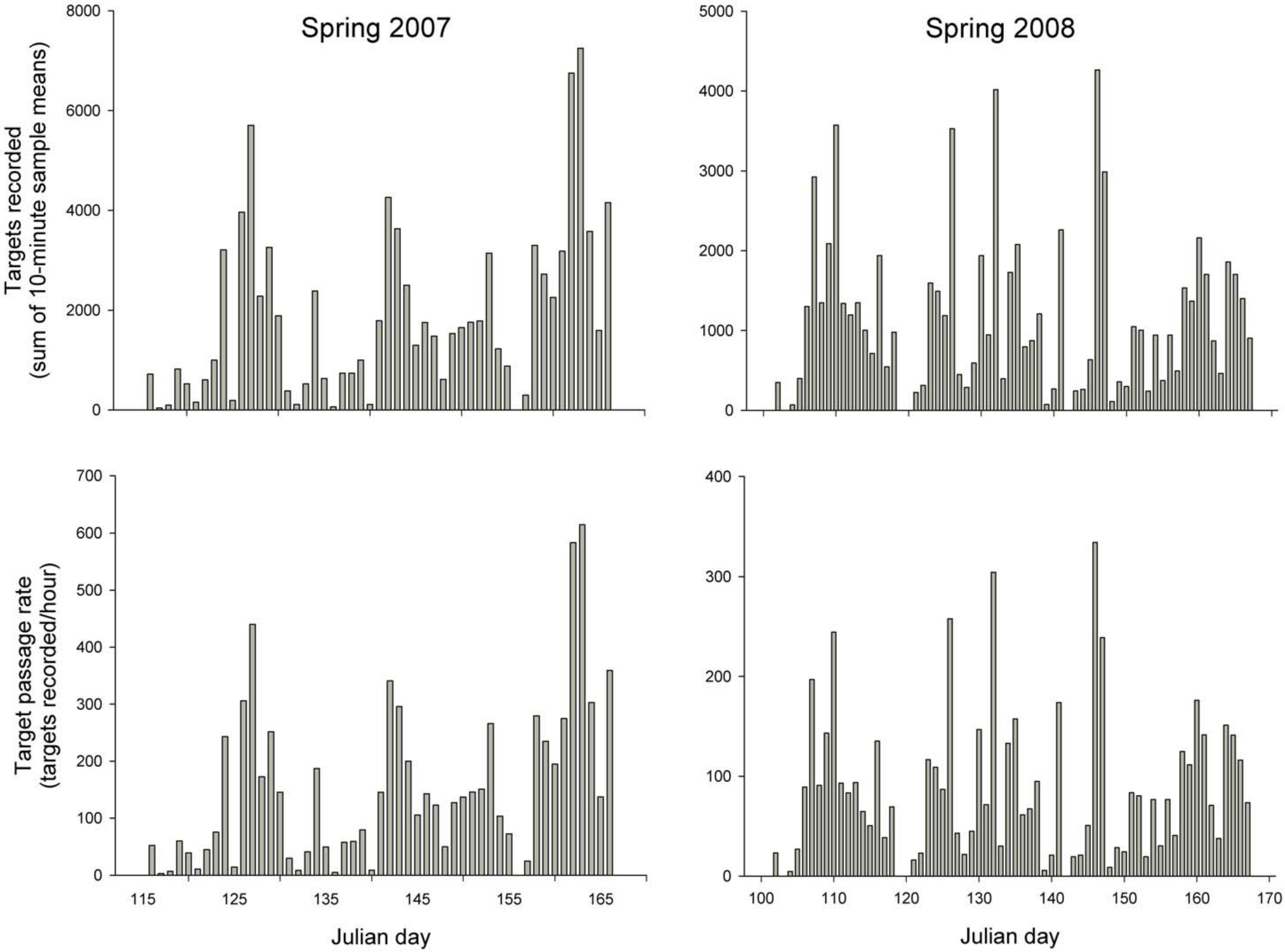


Figure 14. Seasonal temporal pattern in targets recorded (sum of 10-minute sample means) and target passage rates during nocturnal data collection periods (sunset to sunrise the following morning) in Spring 2007 (26 April - 15 June) and 2008 (11 April - 15 June).

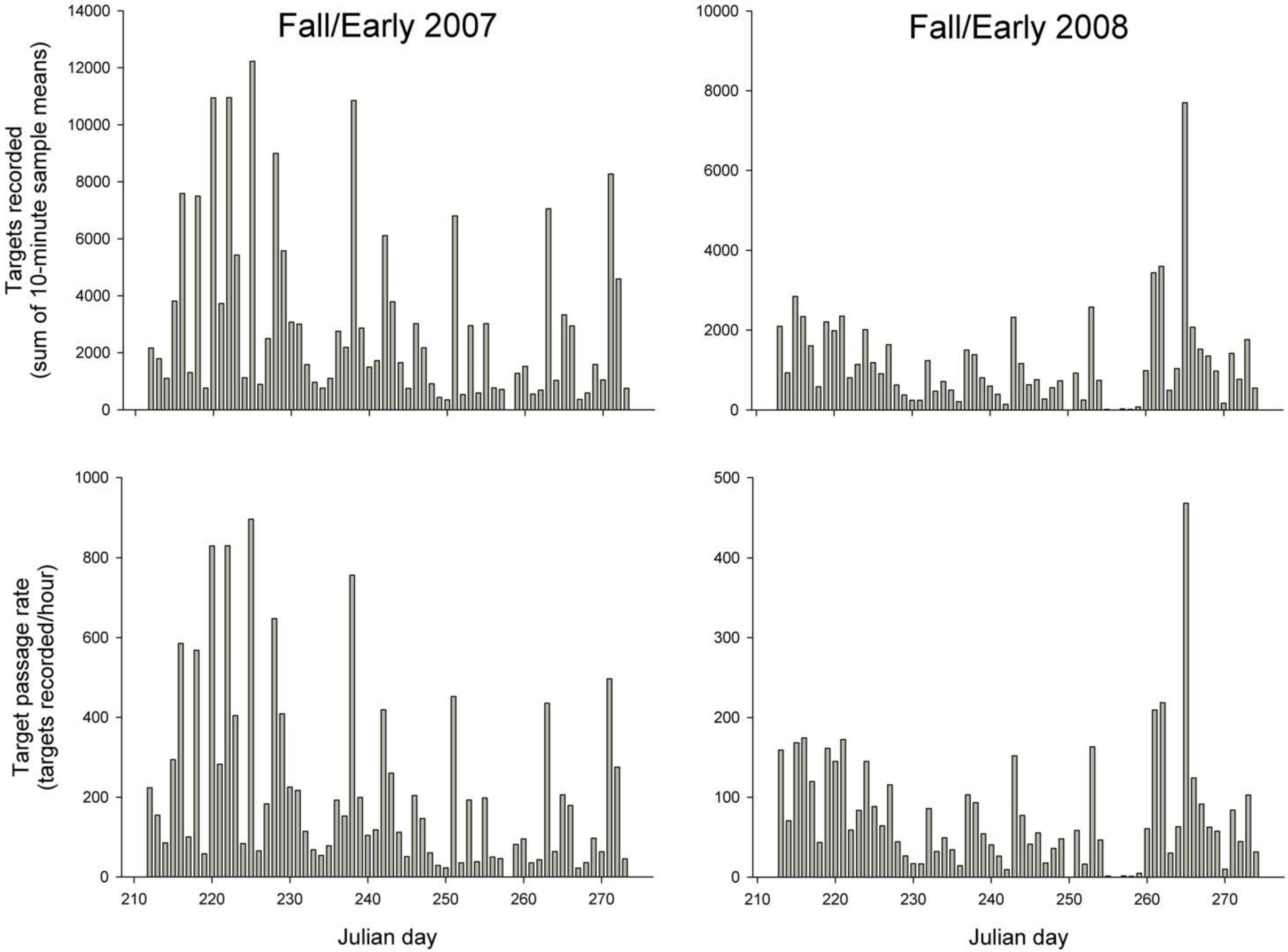


Figure 15. Seasonal temporal pattern in targets recorded (sum of 10-minute sample means) and target passage rates during nocturnal data collection periods (sunset to sunrise the following morning) in Fall/Early 2007and 2008 (31 Jul - 30 September).

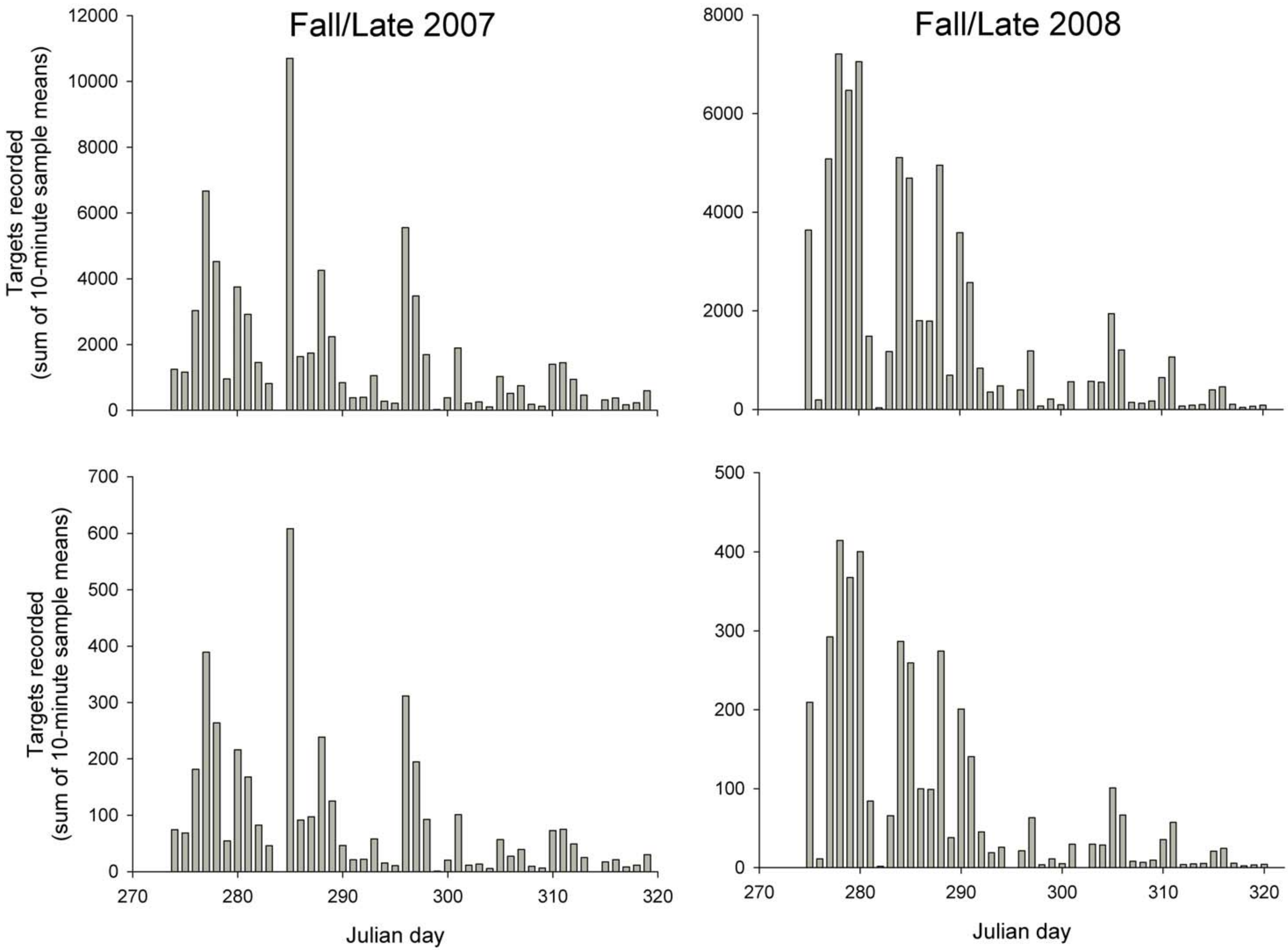


Figure 16. Seasonal temporal pattern in targets recorded (sum of 10-minute sample means) and target passage rates during nocturnal data collection periods (sunset to sunrise the following morning) in Fall/Late 2007 and 2008 (1 Oct - 15 November).

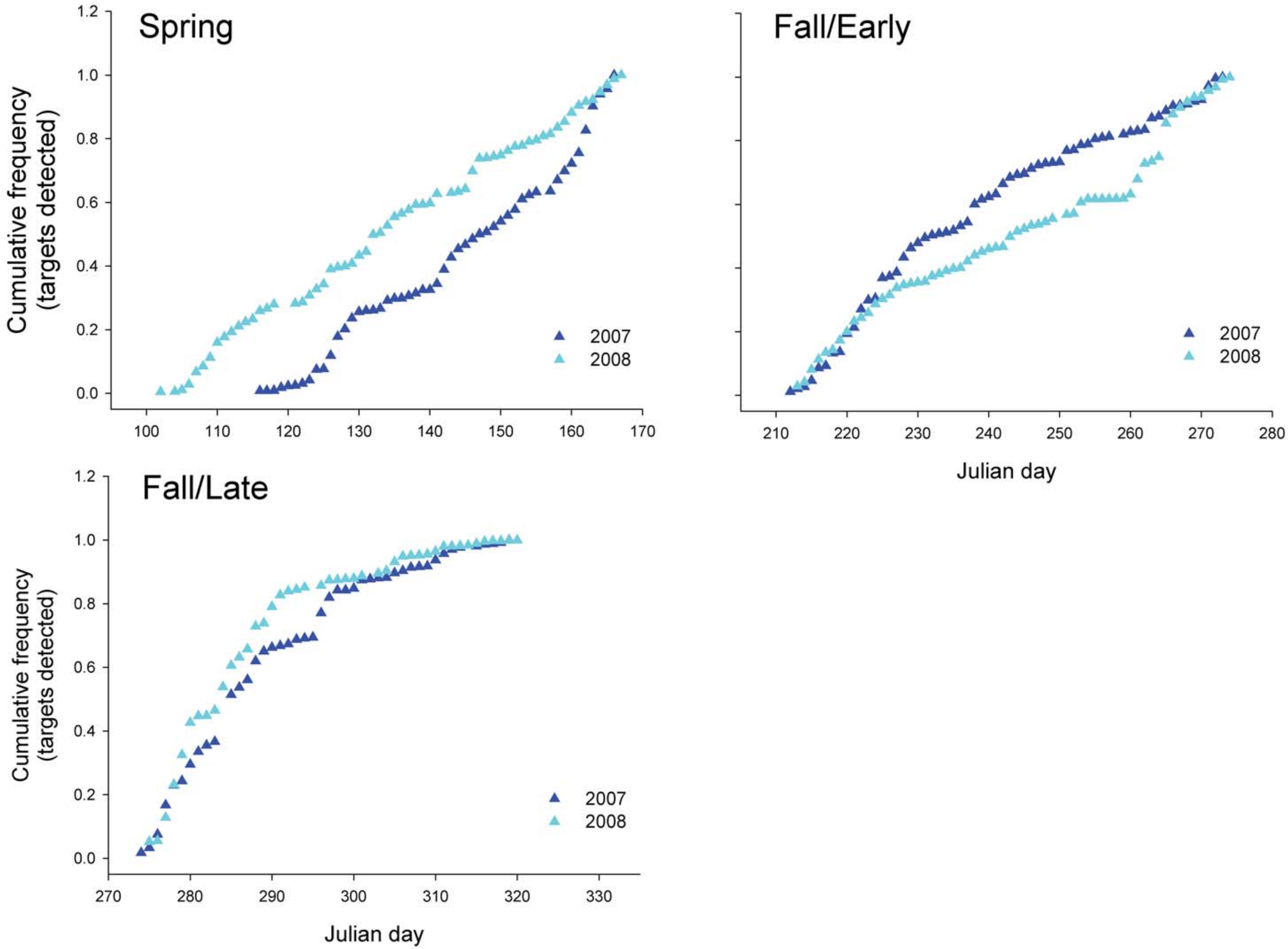


Figure 17. Cumulative frequency distributions for total targets detected (sum of 10-minute sample means) during for nocturnal sampling periods (sunset to sunrise the next morning) during Spring, Fall/Early and Fall/Late 2007 and 2008 seasons.

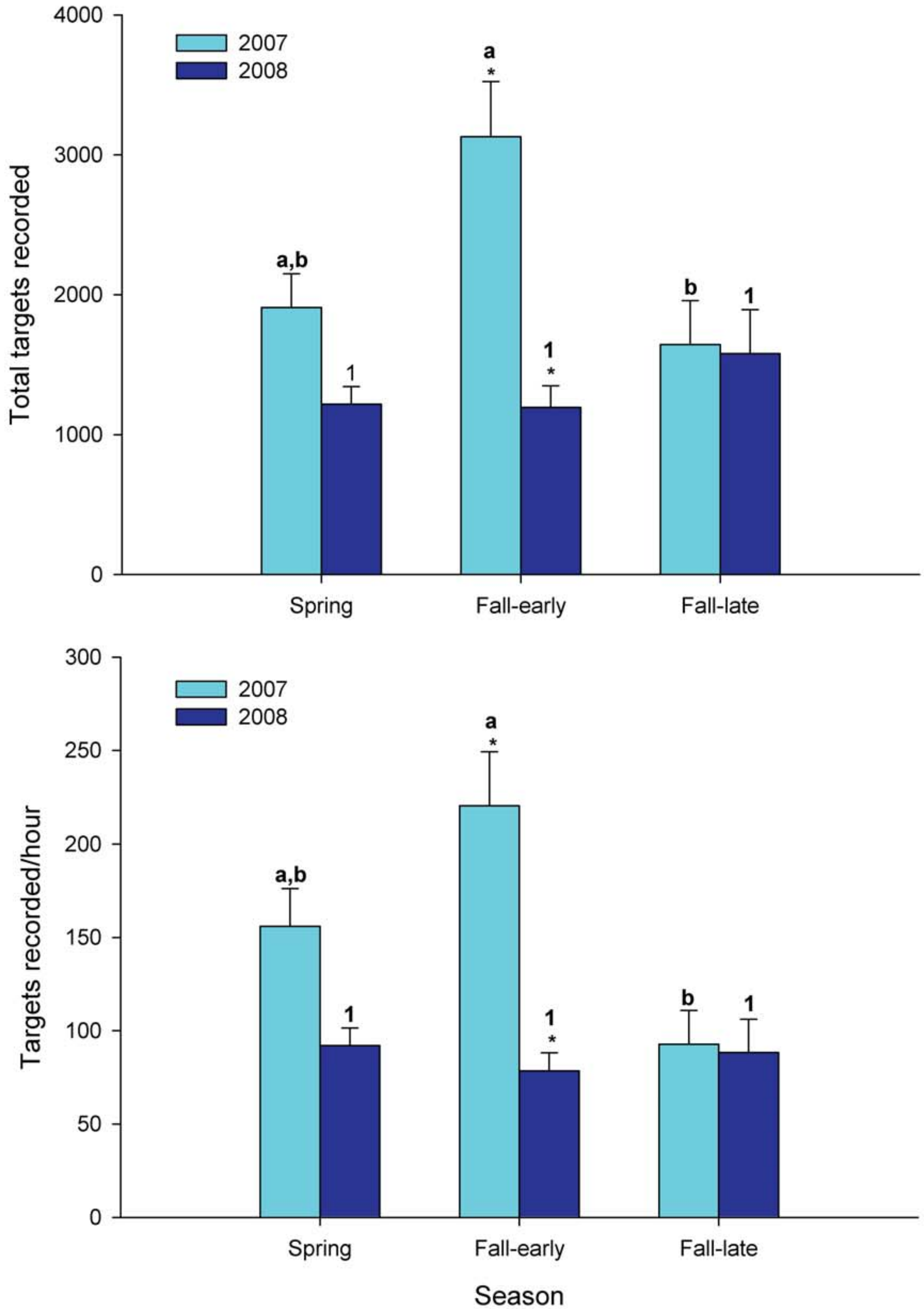


Figure 18. Comparison of mean targets (top) and target detection rate (bottom) recorded during the MRWPF radar study. Error bars represent SE of the means. Bars with asterisks indicate differences between years for a given season (e.g., Spring '07 vs '08). Bars with the same letter ('07) or same number ('08) are not statistically different. Analyses used log-transformed data, and Bonferroni adjustment for multiple comparisons. Data in plots are not transformed.

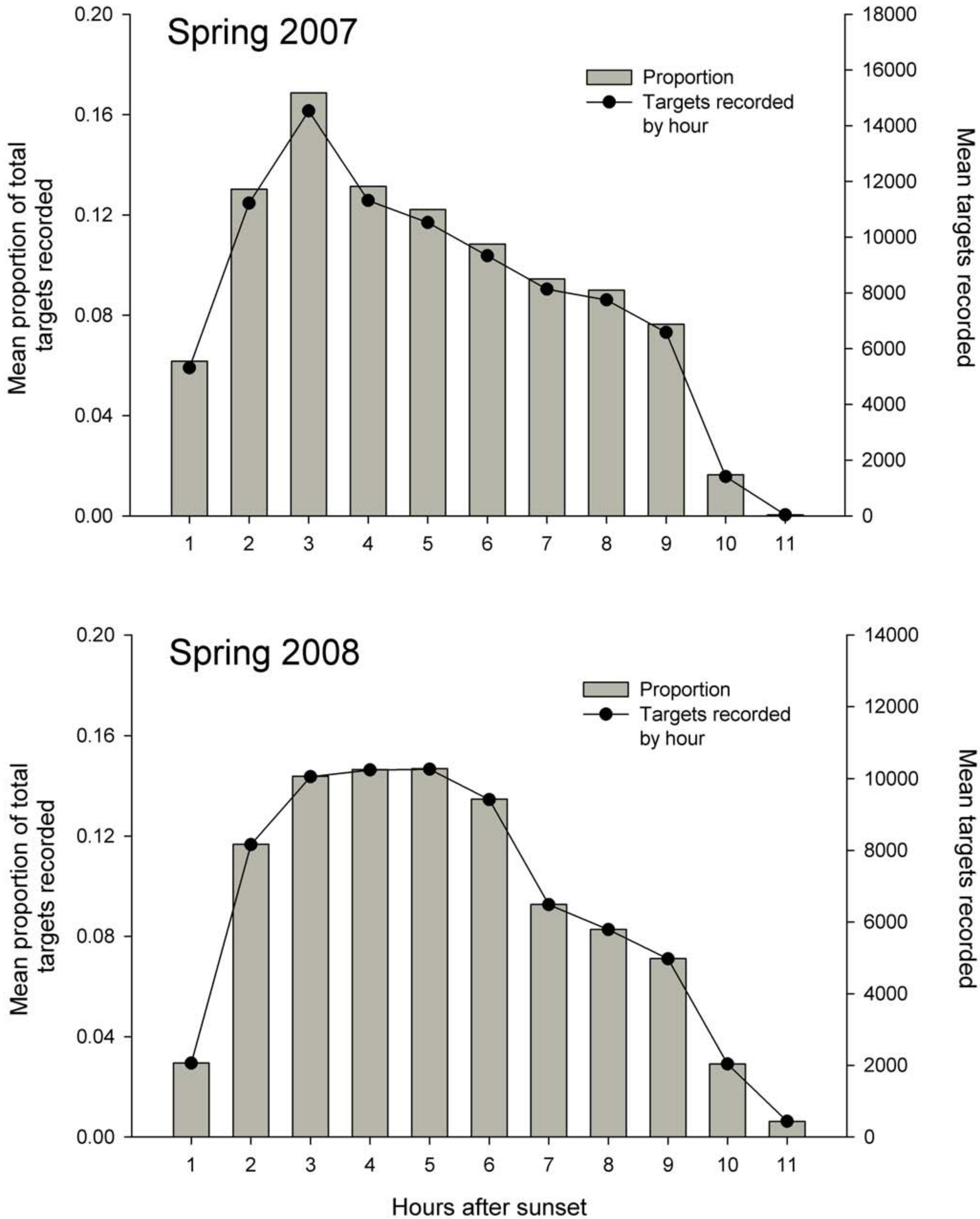


Figure 19. Mean targets and proportion of total targets recorded by hour during Spring nocturnal data collection period (sunset to sunrise the following morning) in 2007 (26 April - 15 June) and 2008 (11 April - 15 June).

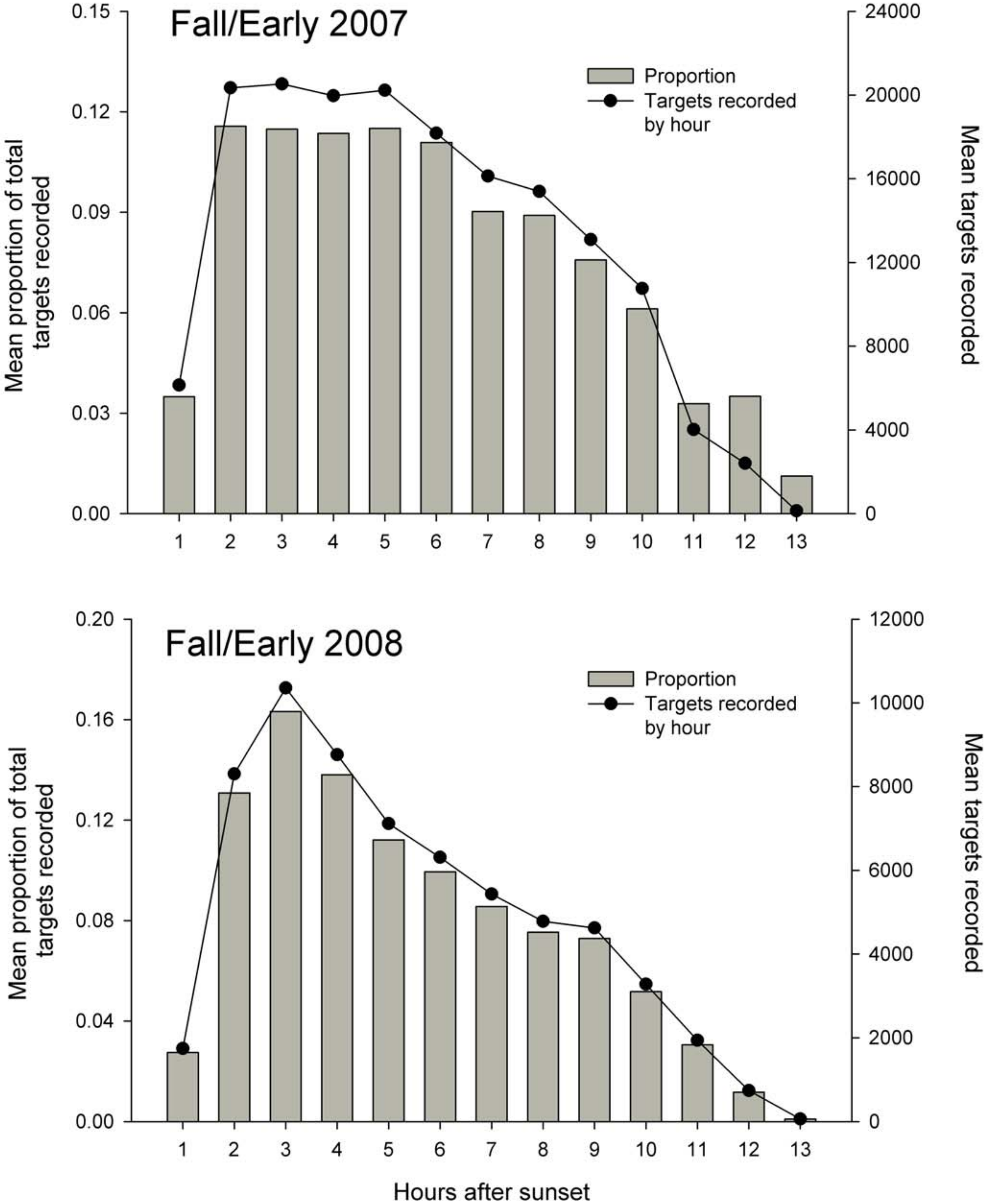


Figure 20. Mean targets and proportion of total targets recorded by hour during Fall/ Early nocturnal data collection period (sunset to sunrise the following morning) for 2007 and 2008 (31 July - 30 September).

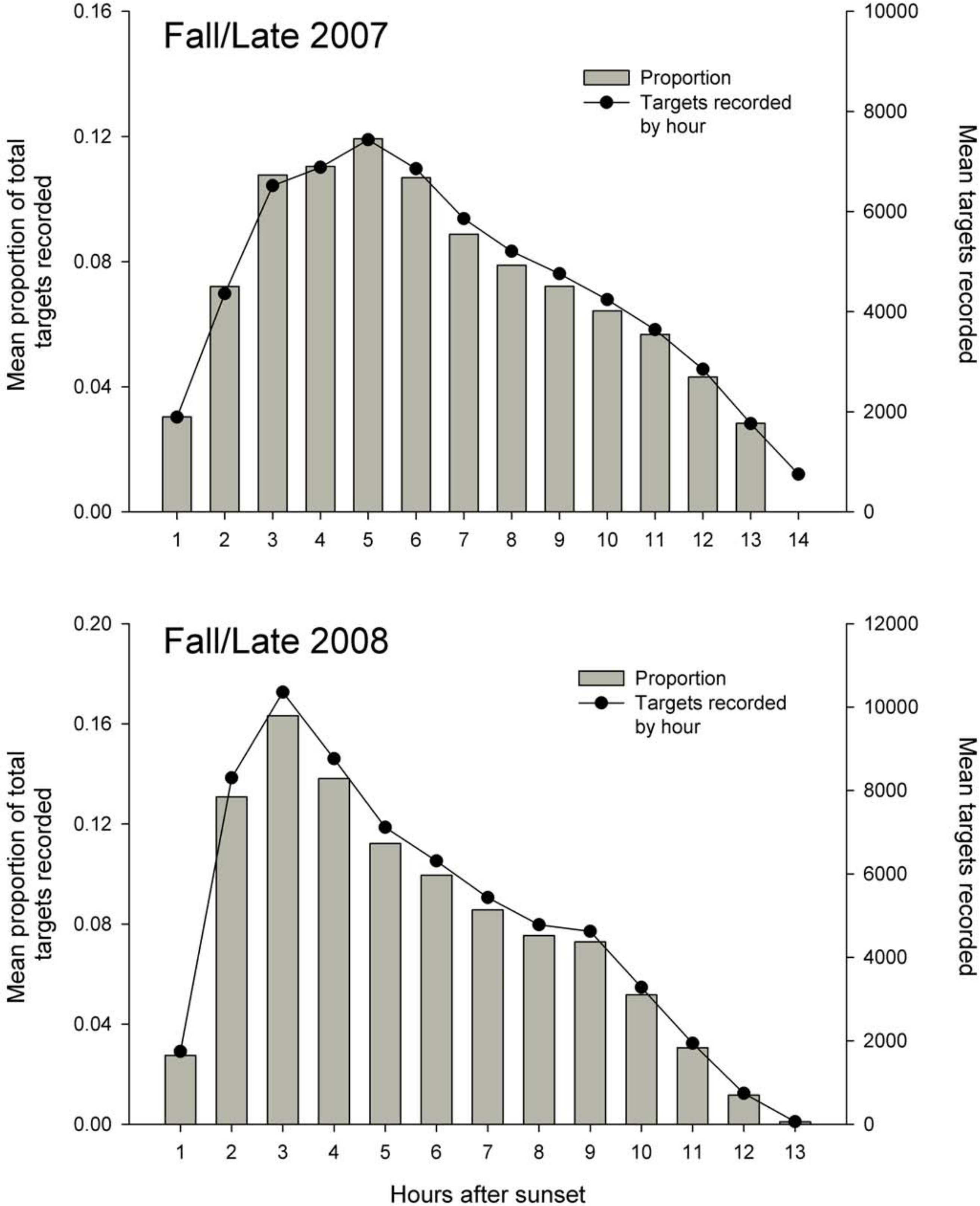


Figure 21. Mean targets and proportion of total targets recorded by hour during Fall/Late nocturnal data collection period (sunset to sunrise the following morning) for 2007 and 2008 (1 October - 15 November).

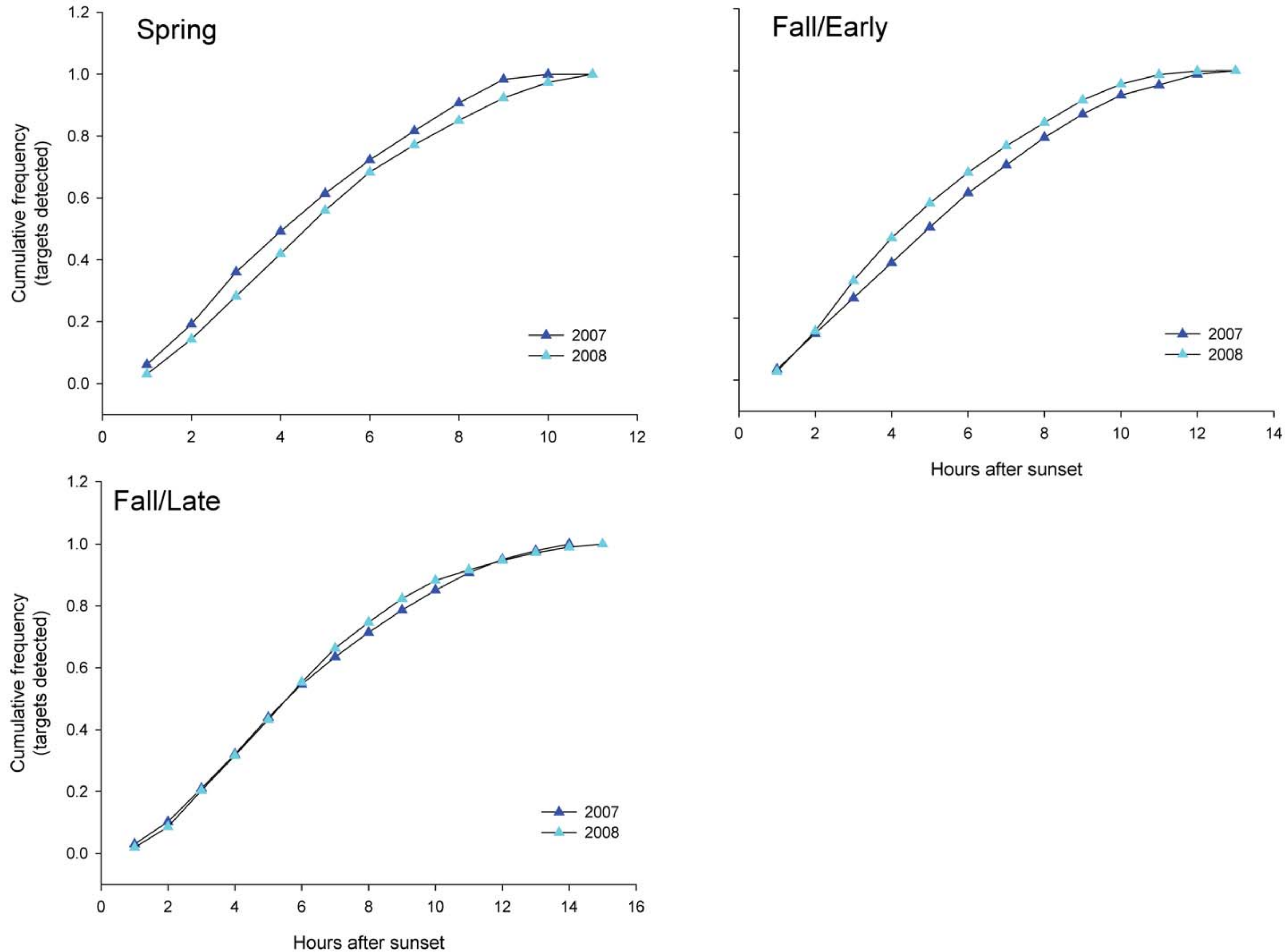


Figure 22. Hourly cumulative frequency distributions relative to sunset for mean targets detected (i.e., sum of 10-minute sample means for each hour, averaged over entire season) during Spring, Fall/Early and Fall/Late seasons, 2007 and 2008.

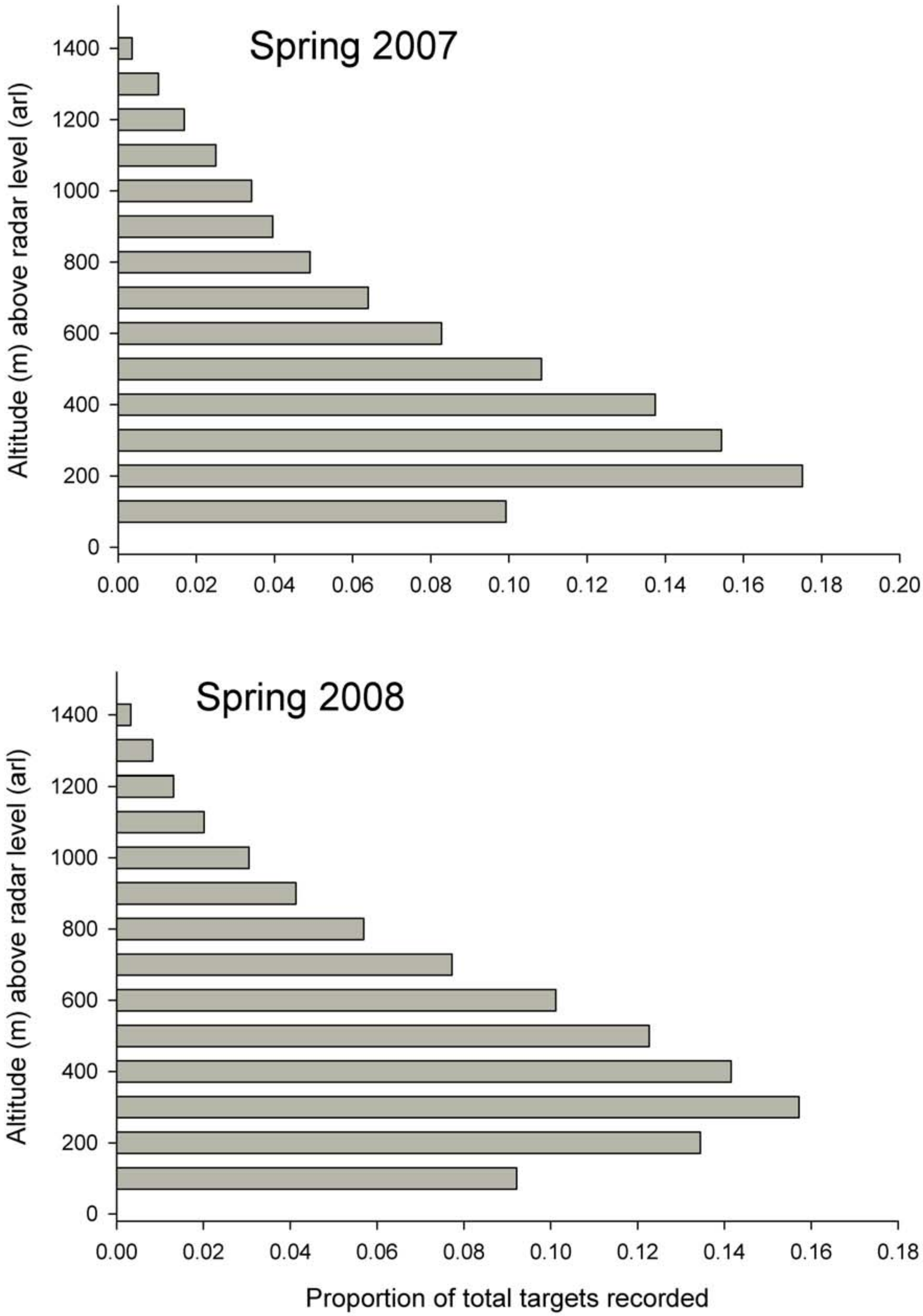


Fig. 23. Altitudinal distribution of targets recorded during the nocturnal data collection period (sunset to sunrise the next day) during Spring 2007 (26 April - 15 June) and 2008 (11 April - 15 June).

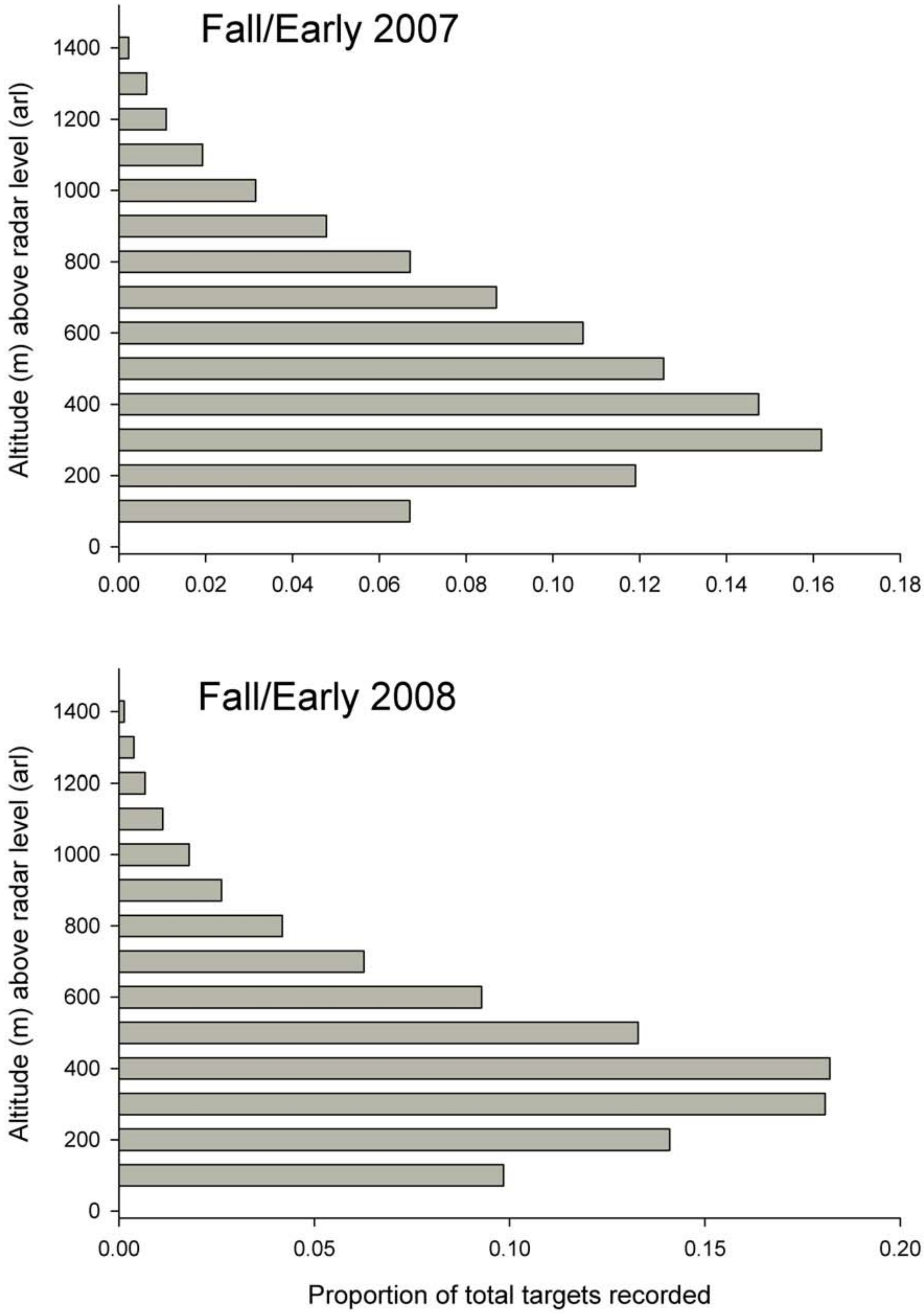


Fig. 24. Altitudinal distribution of targets recorded during the nocturnal data collection period (sunset to sunrise the next day) during Fall/Early 2007 and 2008 (31 July - 30 September).

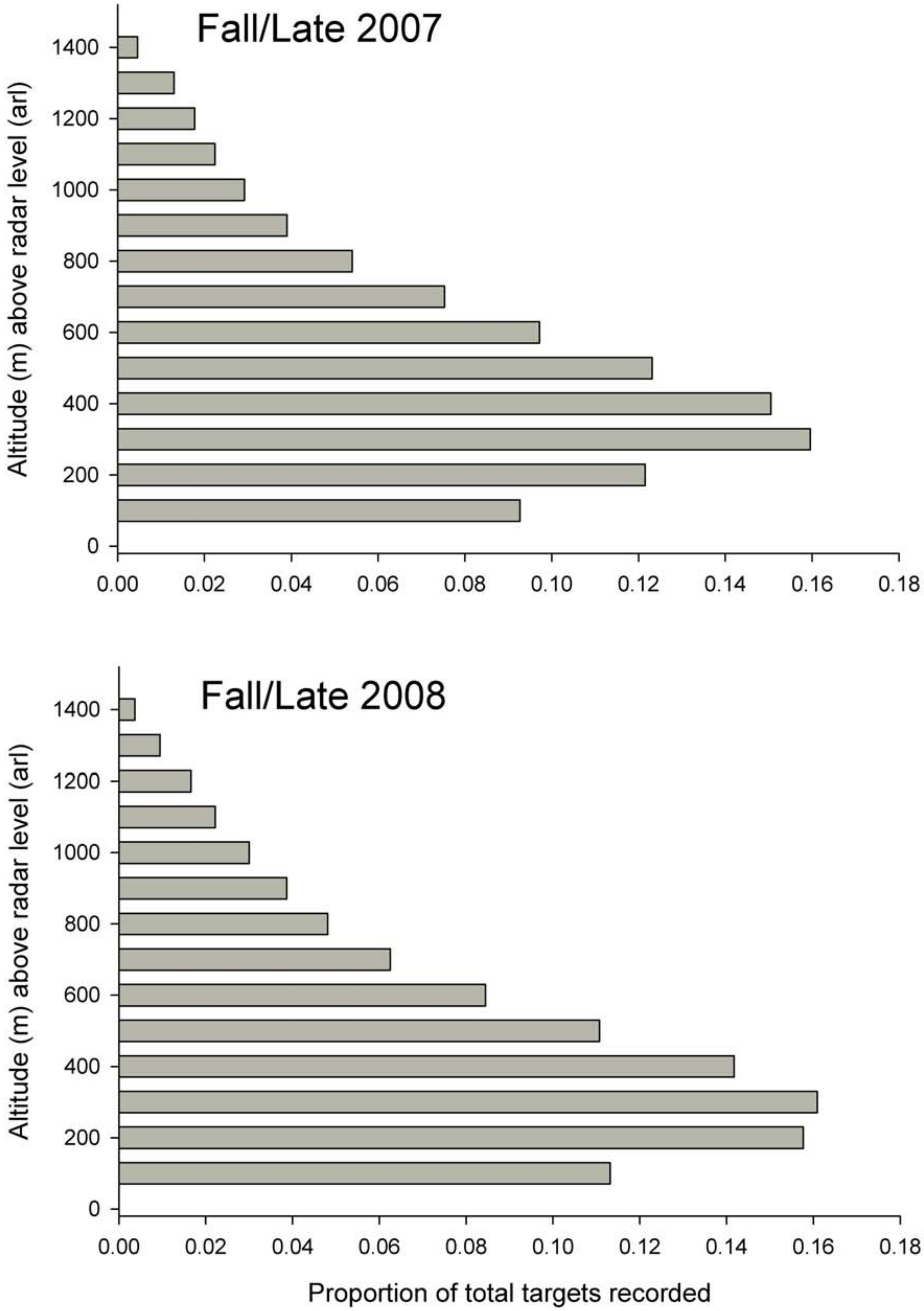


Fig. 25. Altitudinal distribution of targets recorded during the nocturnal data collection period (sunset to sunrise the next day) during Fall/Late 2007 and 2008 (1 October - 15 November).

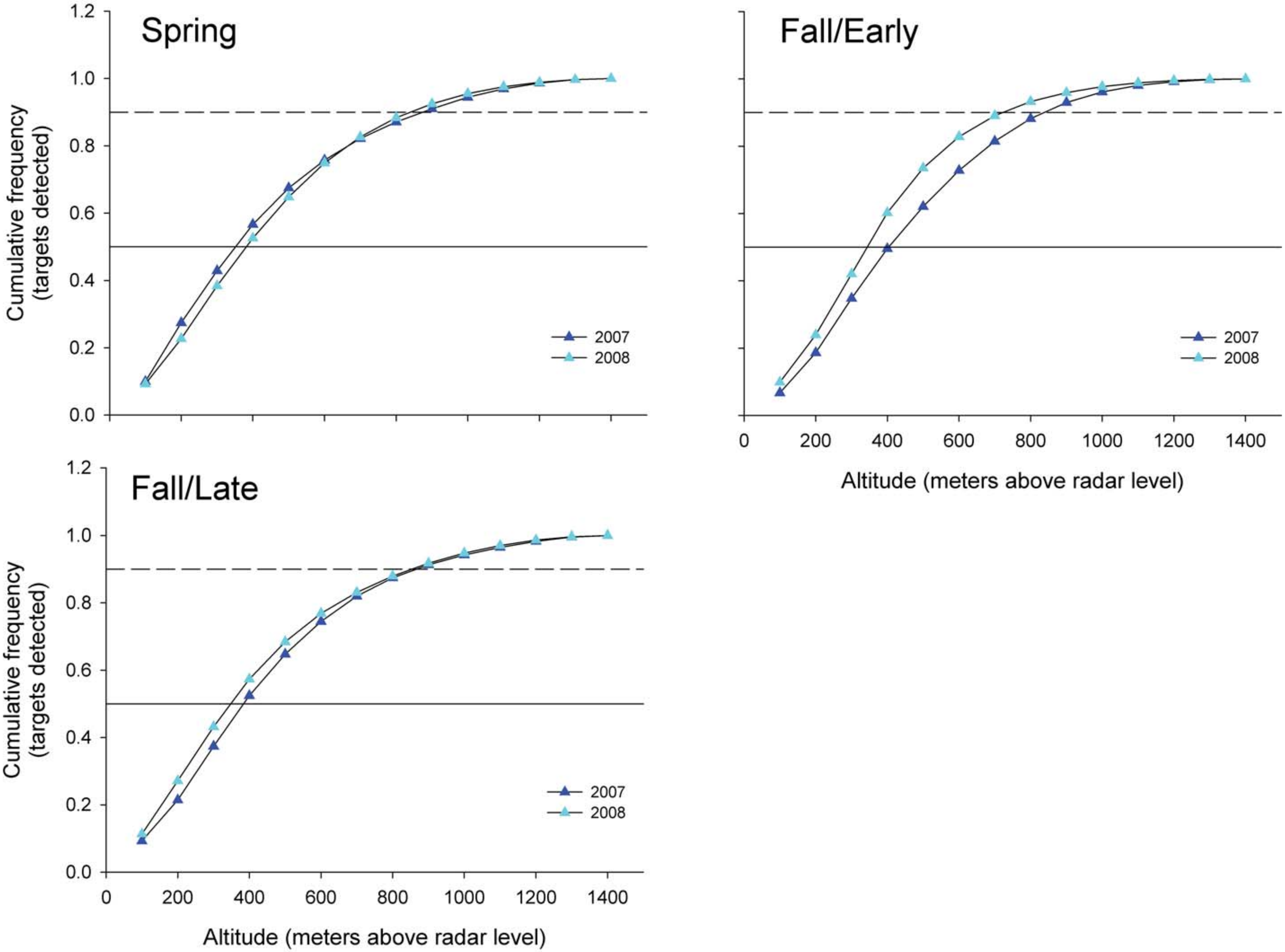


Figure 26. Cumulative frequency distributions for targets recorded in each of 14, 100 m altitudinal strata (i.e., 1400 meters = ~0.75 nautical mile, the range setting for the vertical radar) for nocturnal sampling periods (sunset to sunrise the next morning) during Spring, Fall/Early and Fall/Late seasons, 2007 and 2008. Solid and dashed reference lines represent the 50th and 90th percentiles of targets recorded, respectively.

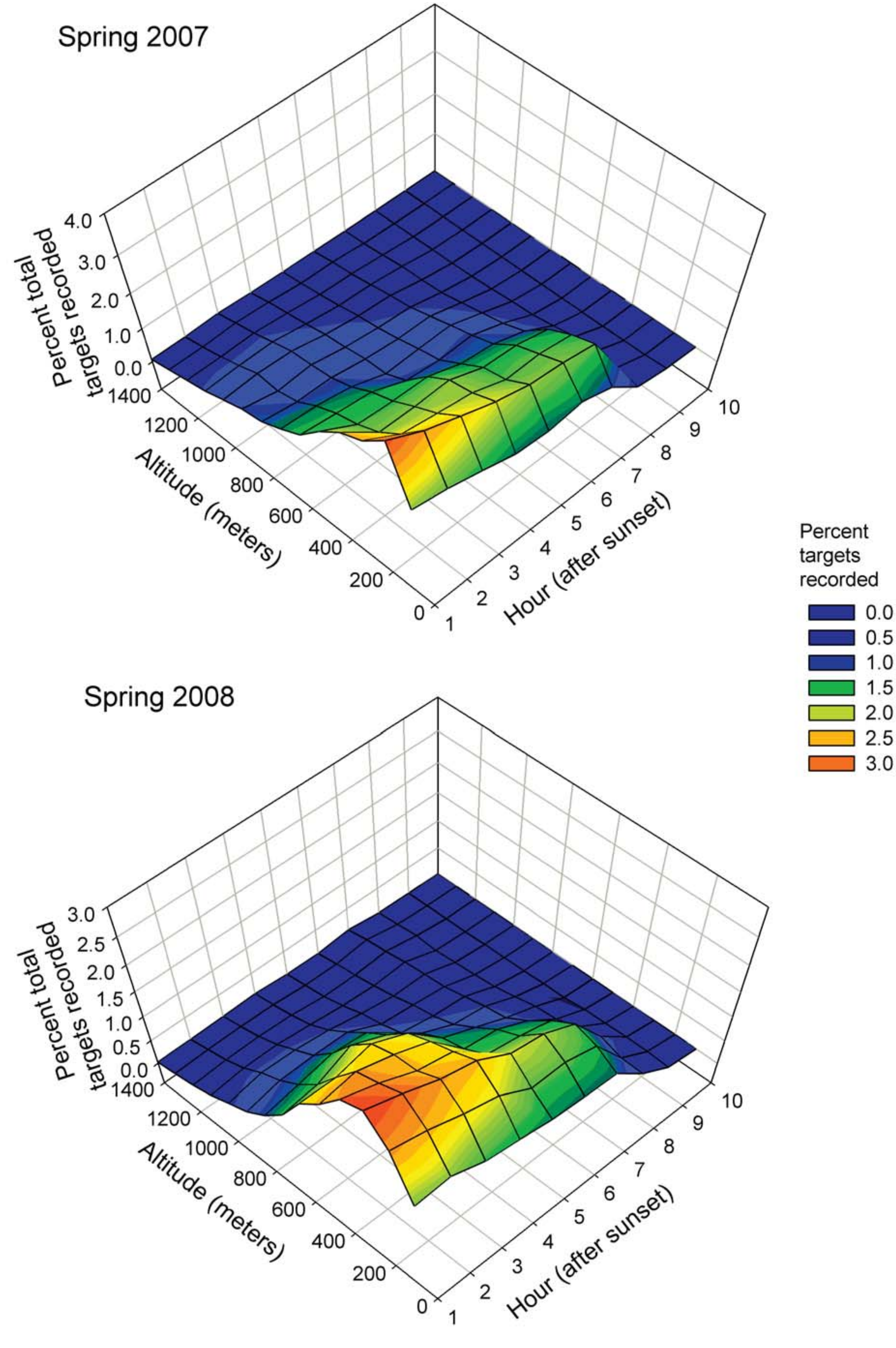


Fig. 27. Altitudinal distribution of targets recorded during nocturnal data collection (sunset to sunrise the following day) during Spring 2007 (26 Apr - 15 June) and 2008 (11 April - 15 June) at the MRWPF, Lewis County, NY. Data are presented by hour after sunset .

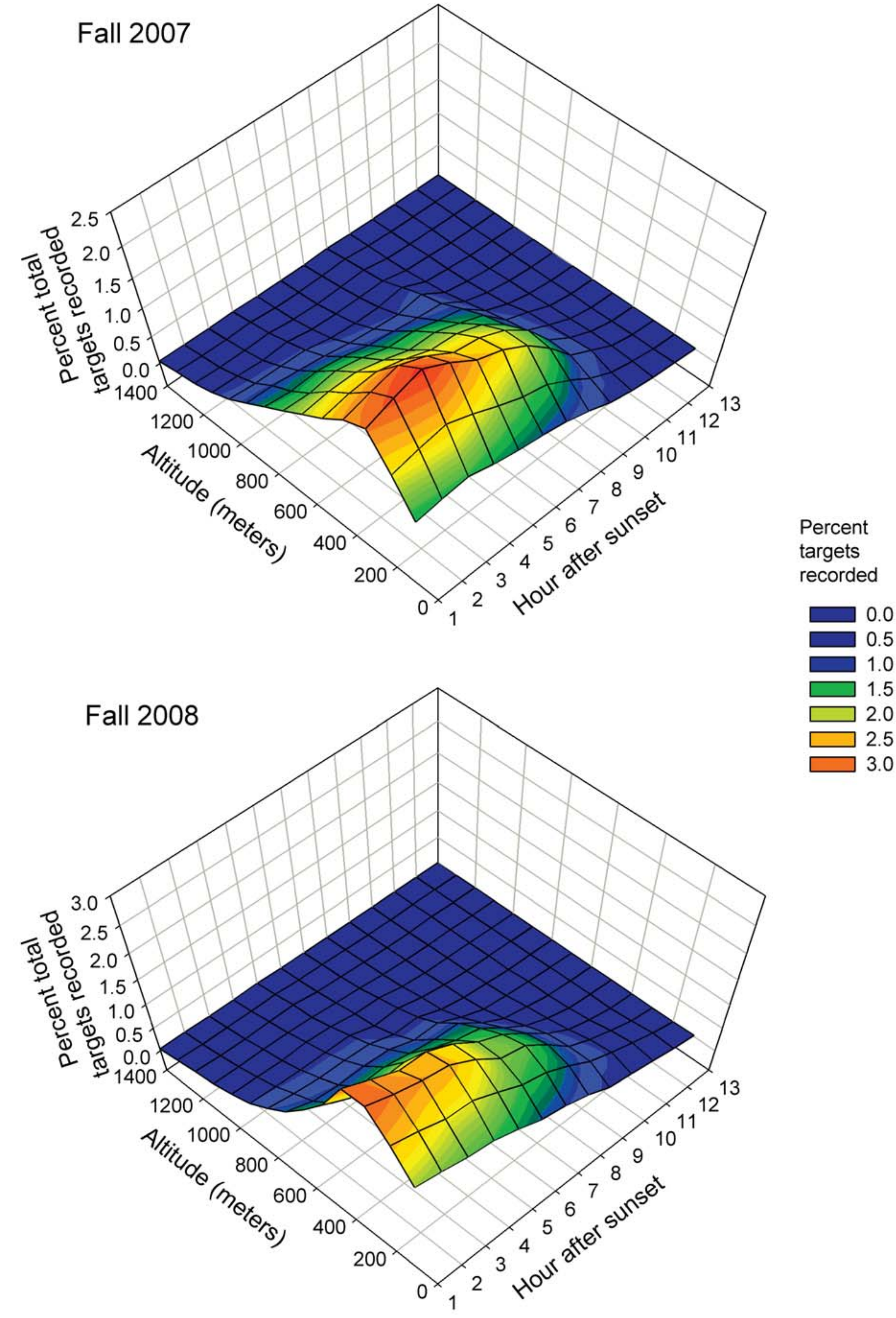


Fig. 28. Altitudinal distribution of targets recorded during nocturnal data collection (sunset to sunrise the following day) during Fall 2007 and 2008 (31 July - 15 November) at the MRWPF, Lewis County, NY. Data are presented by hour after sunset .

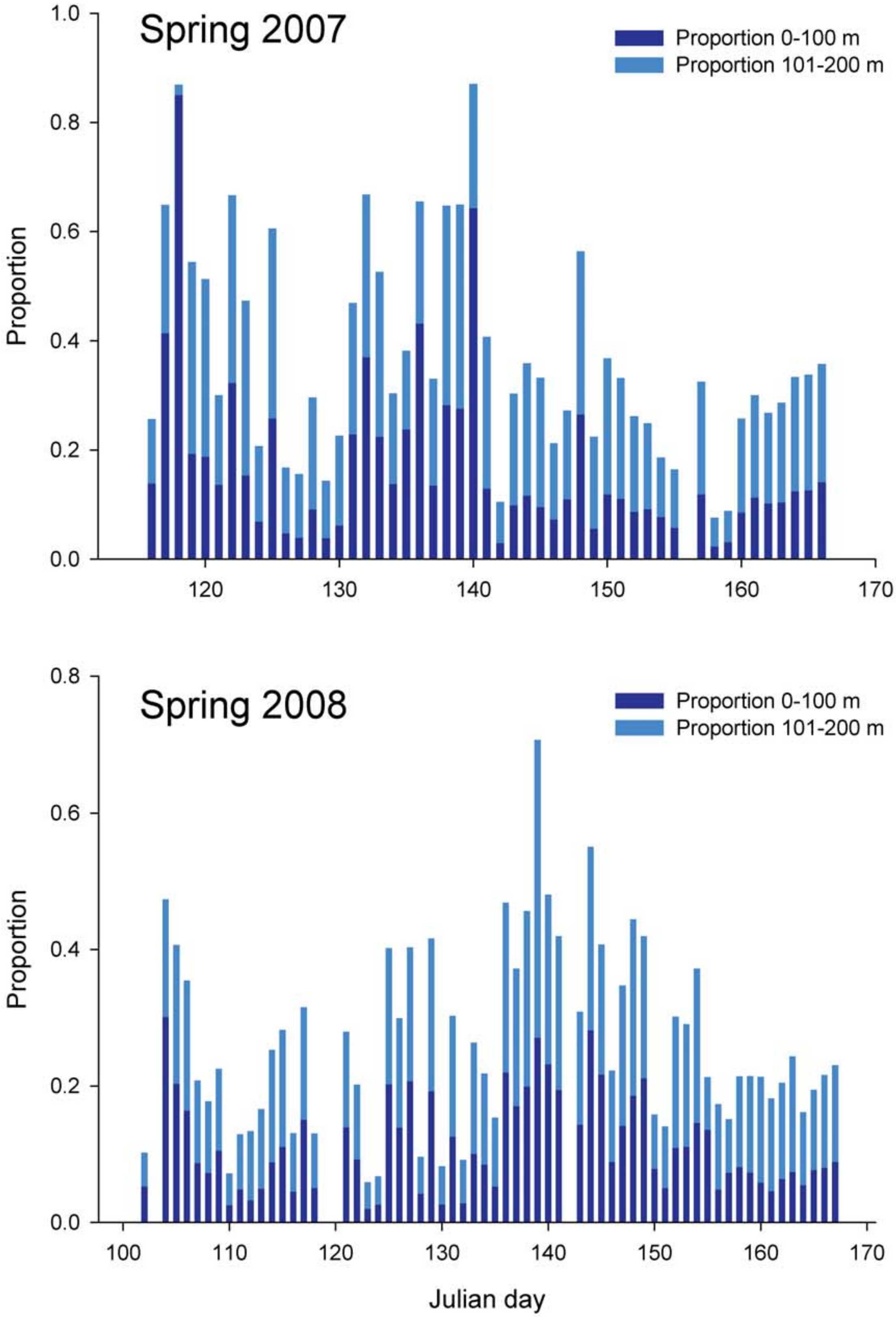


Figure 29. Seasonal temporal pattern in the proportion of targets recorded <= 100 m and between 101 - 200 m during nocturnal data collection periods (sunset to sunrise the following morning) in Spring 2007 (26 April - 15 June) and 2008 (11 April - 15 June).

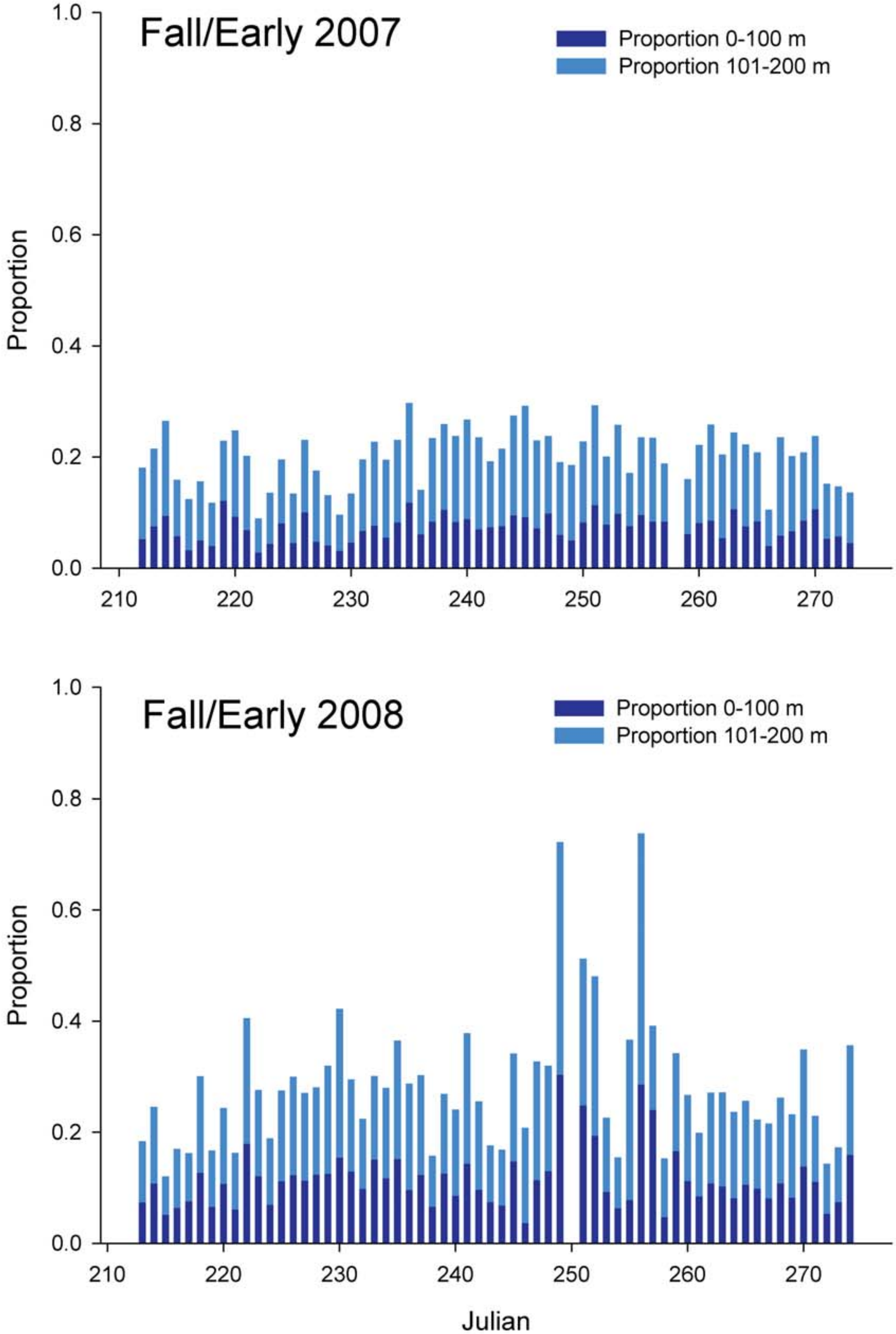
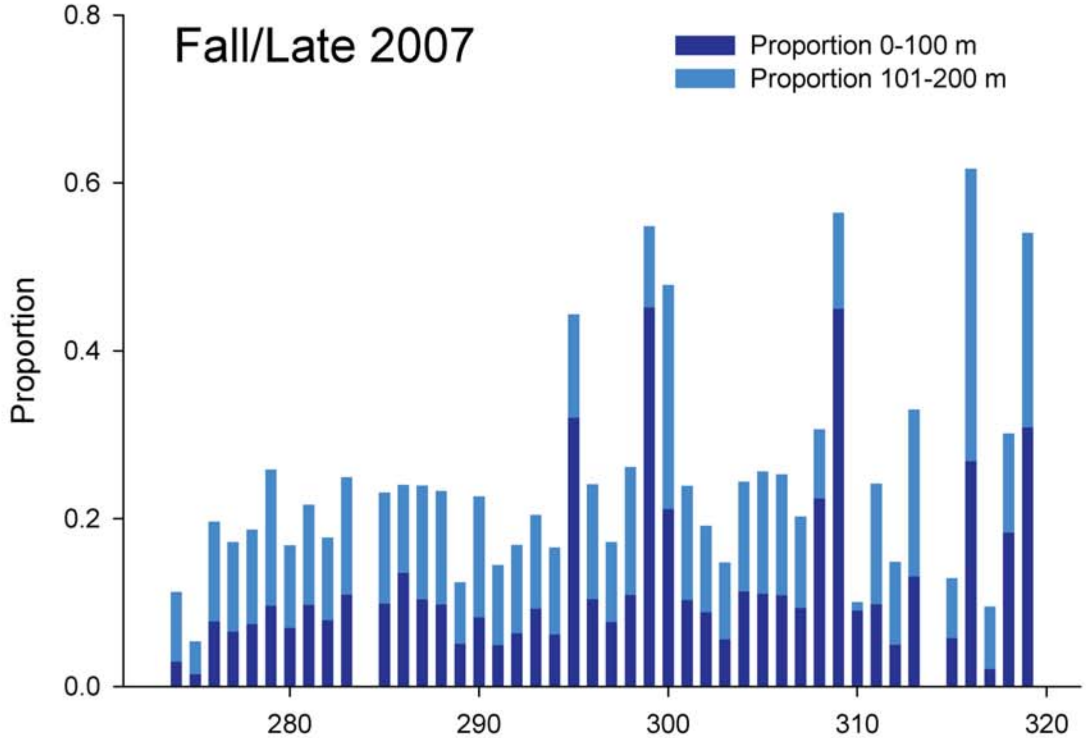


Figure 30. Seasonal temporal pattern in the proportion of targets recorded <= 100 m and between 101 - 200 m during nocturnal data collection periods (sunset to sunrise the following morning) in Fall/Early 2007 and 2008 (31 July - 30 September).



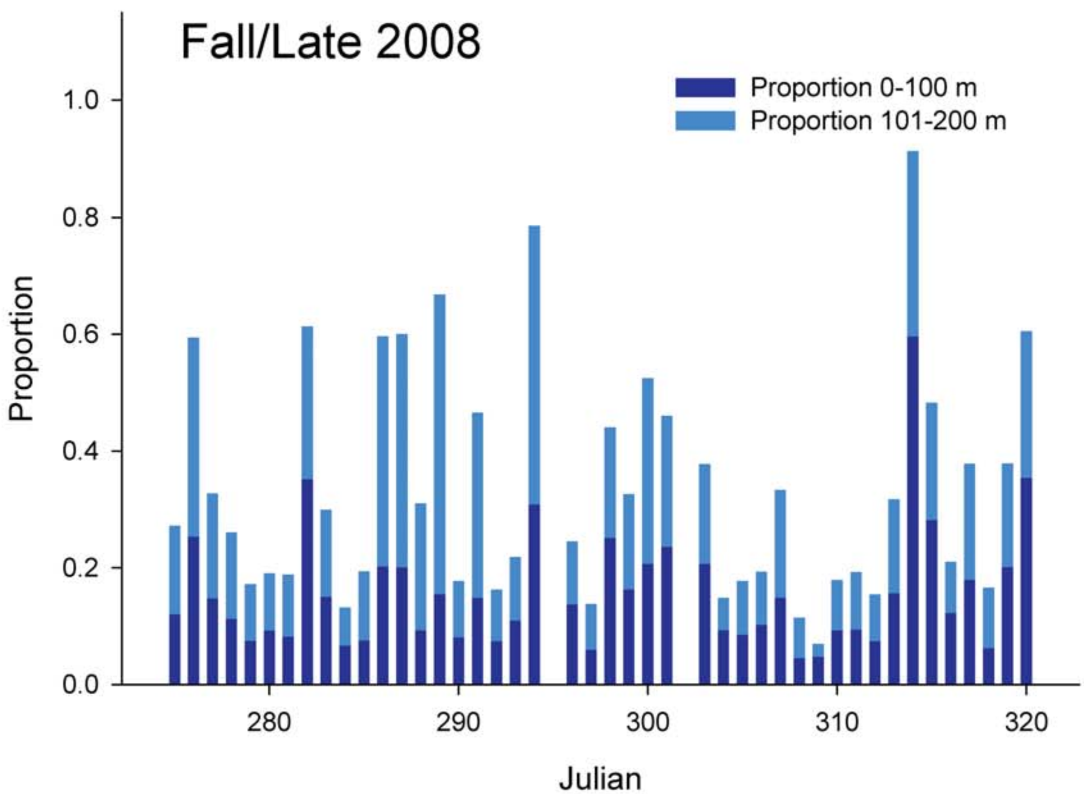


Figure 31. Seasonal temporal pattern in the proportion of targets recorded <= 100 m and between 101 - 200 m during nocturnal data collection periods (sunset to sunrise the following morning) in Fall/Late 2007 and 2008 (1 October - 15 November).

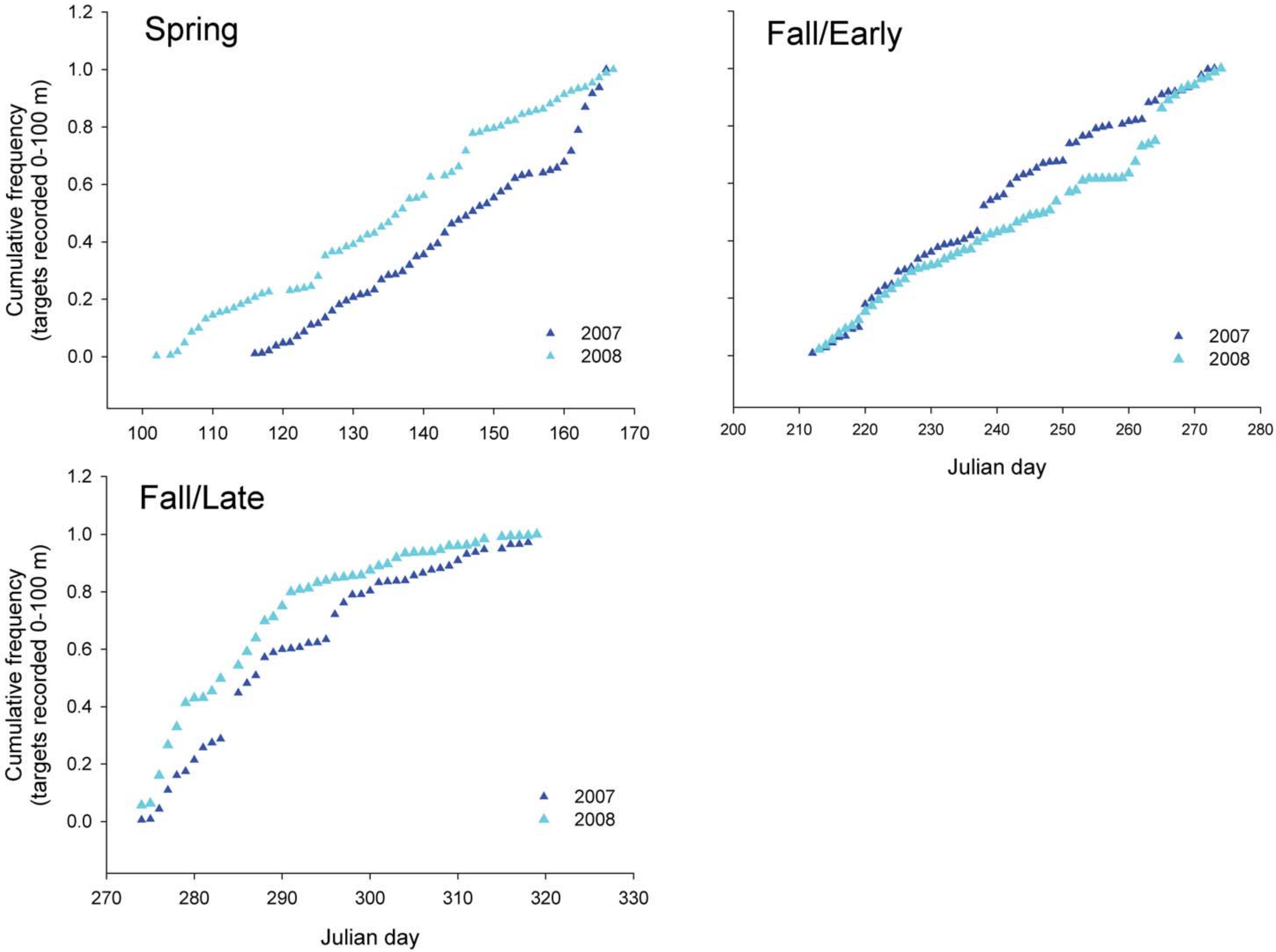


Figure 32. Cumulative frequency distributions for the proportion of targets recorded in the 0-100 m strata) during nocturnal data collection periods (sunset to sunrise the following morning) in Spring, Fall/Early and Fall/Late seasons, 2007 and 2008.

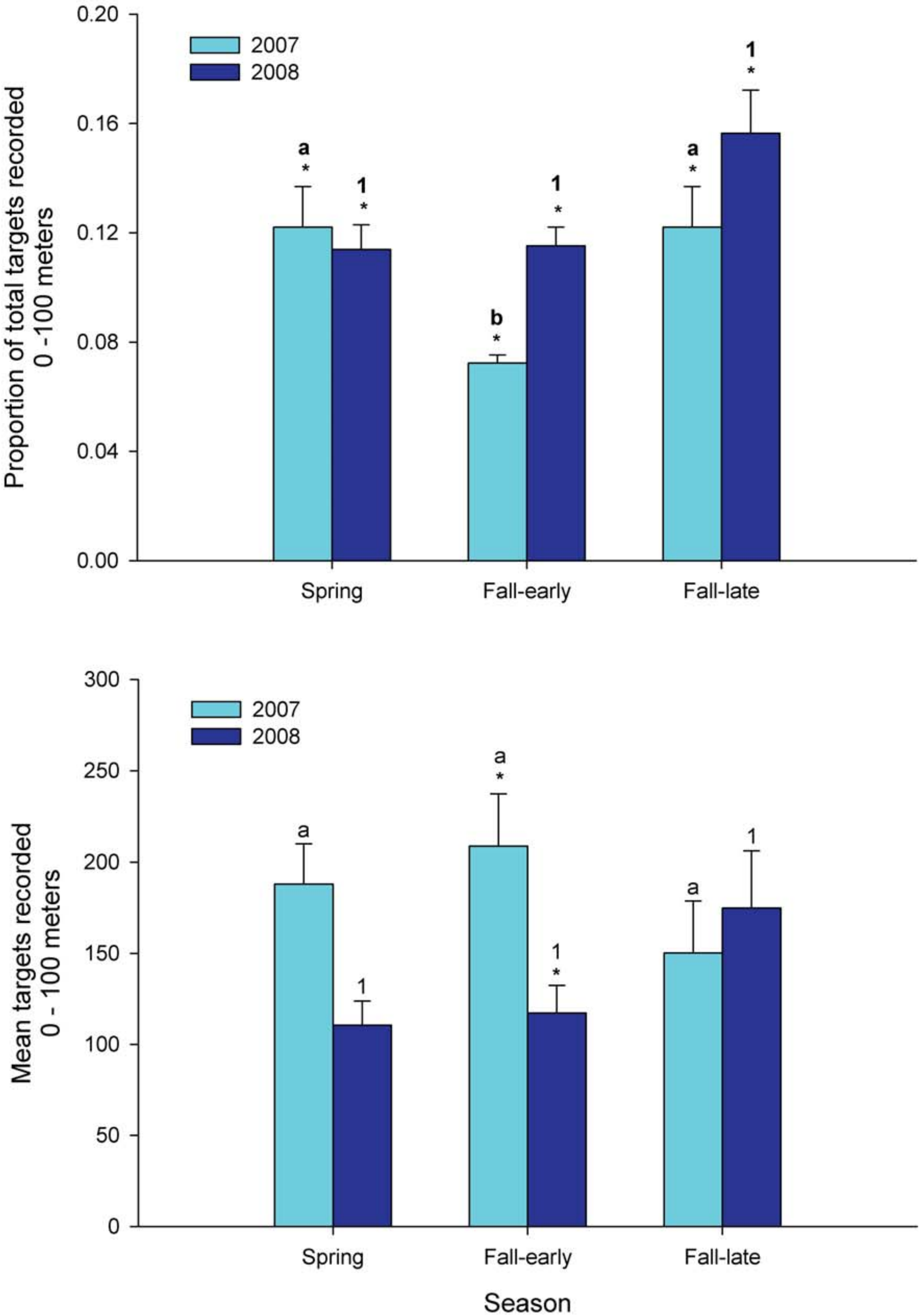


Figure 33. Comparison of the proportion (top) and mean targets recorded (bottom) in the 0-100 m stratum during the MRWPF radar study. Bars with the same letter ('07) or number ('08) are not statistically different. Asterisks indicate differences between years for a given season (e.g., Spring '07, '08). Analyses used arcsin (upper) or log-transformed (lower) data, and Bonferroni adjustment for multiple comparisons. Data in plots are not transformed. Error bars represent SE of the means.

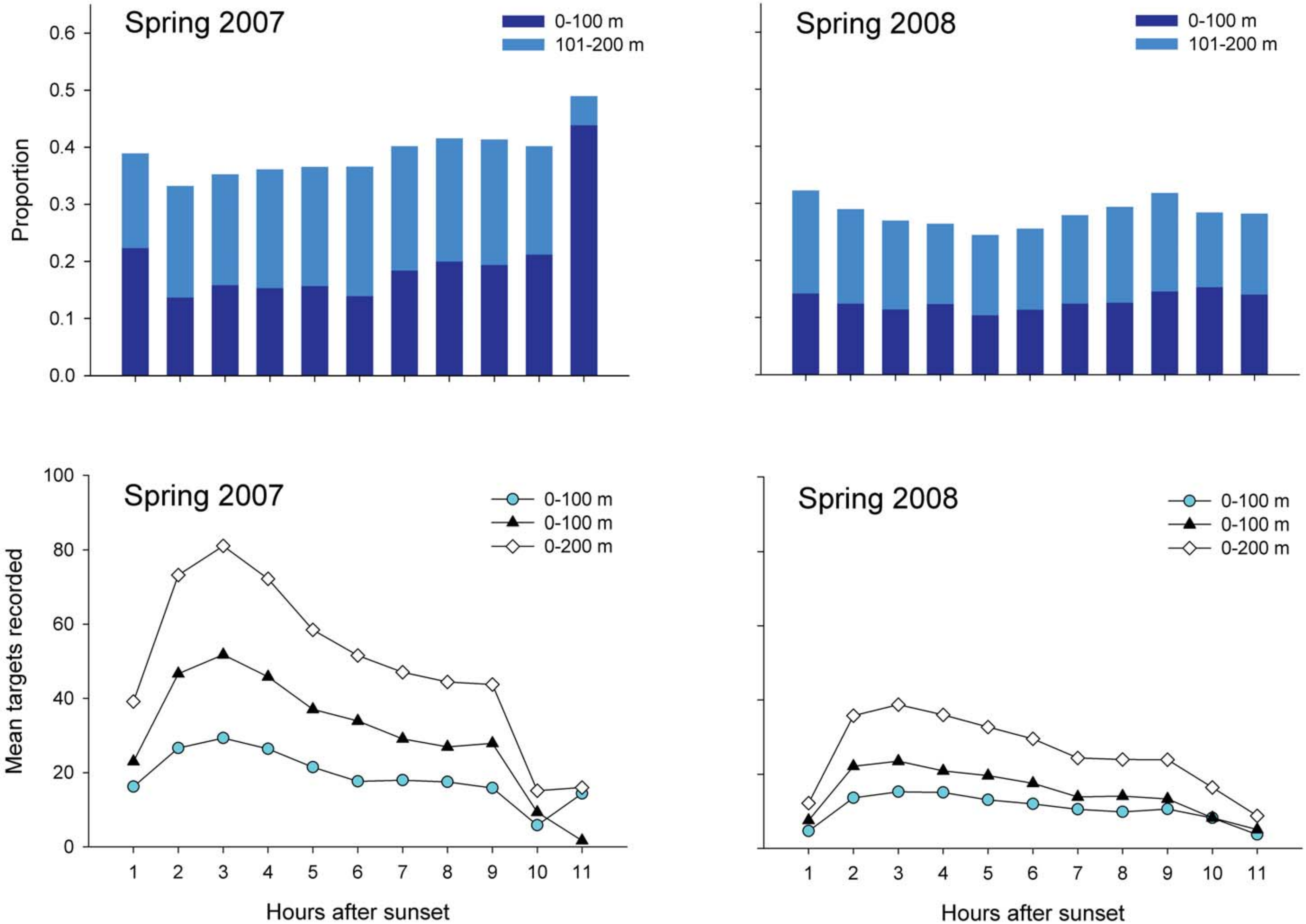


Figure 34. (Upper panels) Mean proportion of targets recorded by hour 0-100 m and 101-200 m above radar level (arl) in Spring 2007 (25 April-15 June) and 2008 (11 April - 15 June). (Lower panels) Mean number of targets recorded by hour at 0-100 m, 101-200 m and 0-200 m arl during Spring 2007 and 2008. Proportions and counts in each bar represent means calculated over the entire season.

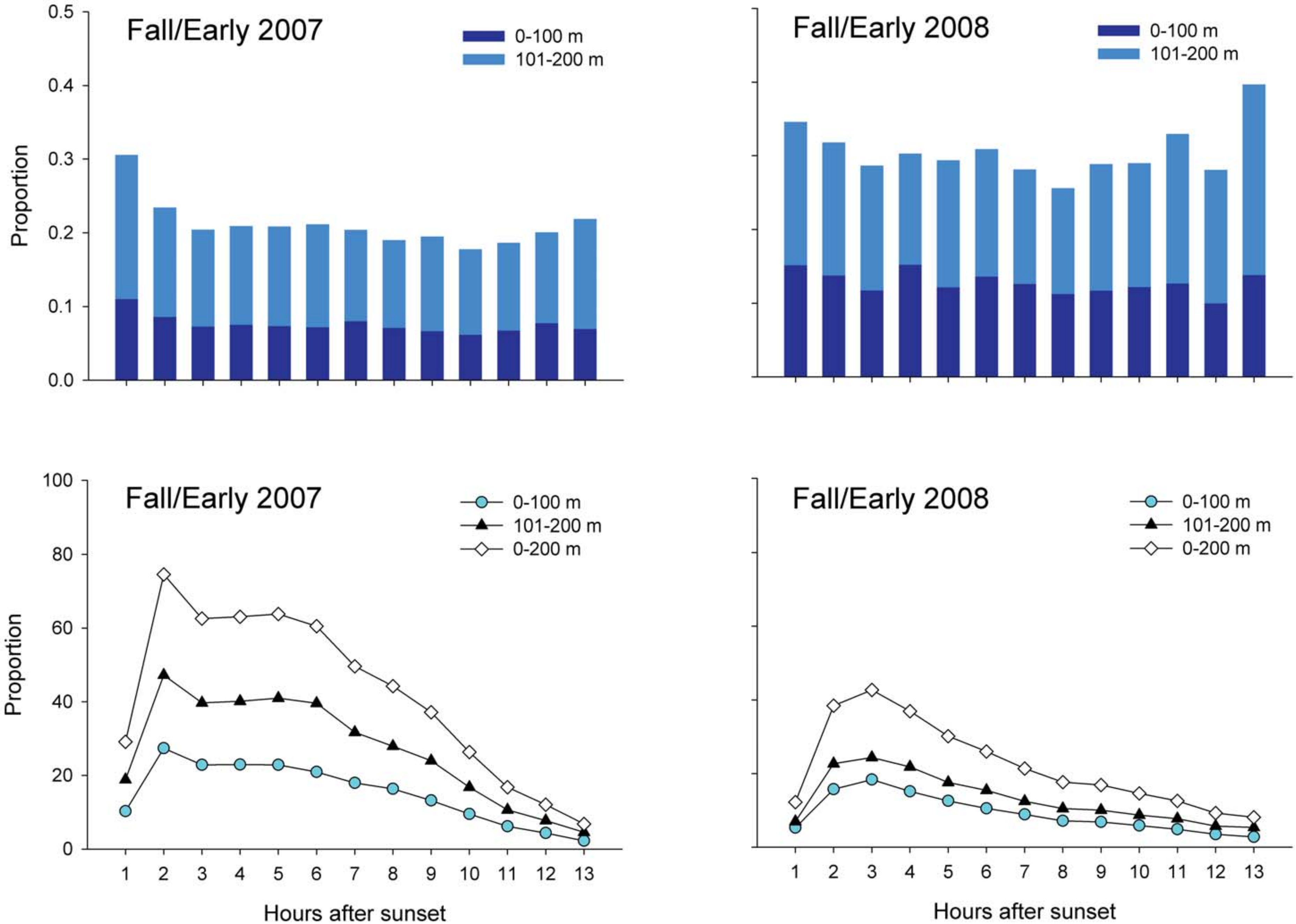


Figure 35. (Upper panels) Mean proportion of targets recorded by hour 0-100 m and 101-200 m above radar level (arl) in Fall/Early 2007 and 2008 (31 July-30 September). (Lower panels) Mean number of targets recorded by hour at 0-100 m, 101-200 m and 0-200 m arl, Fall/Early 2007 and 2008. Proportions and counts in each bar represent means calculated over the entire season.

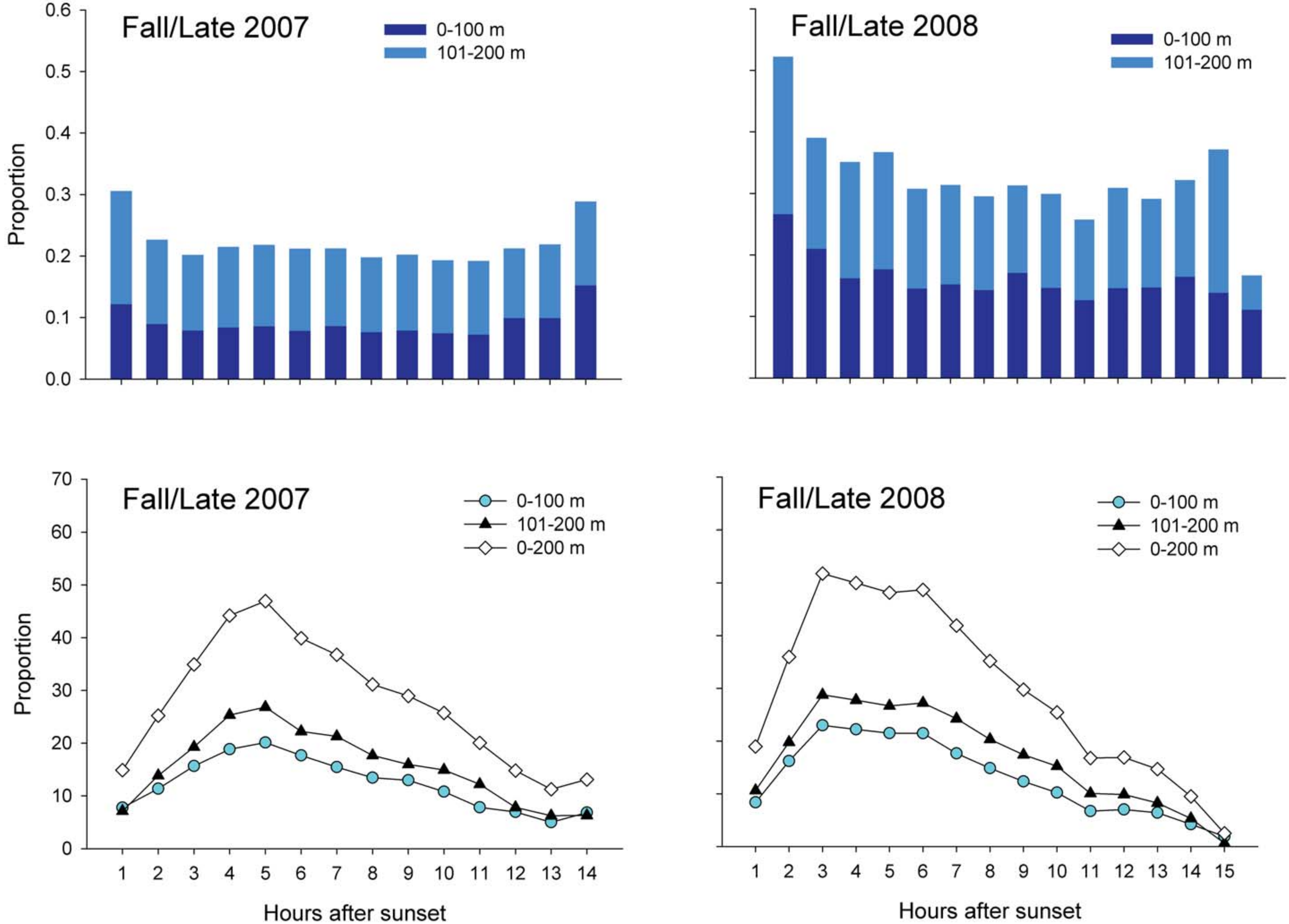


Figure 36. (Upper panels) Mean proportion of targets recorded by hour 0-100 m and 101-200 m above radar level (arl) in Fall/Late 2007 and 2008 (1 October-15 November). (Lower panels) Mean number of targets recorded by hour at 0-100 m, 101-200 m and 0-200 m arl, Fall/Late 2007 and 2008. Proportions and counts in each bar represent means calculated over the entire season.

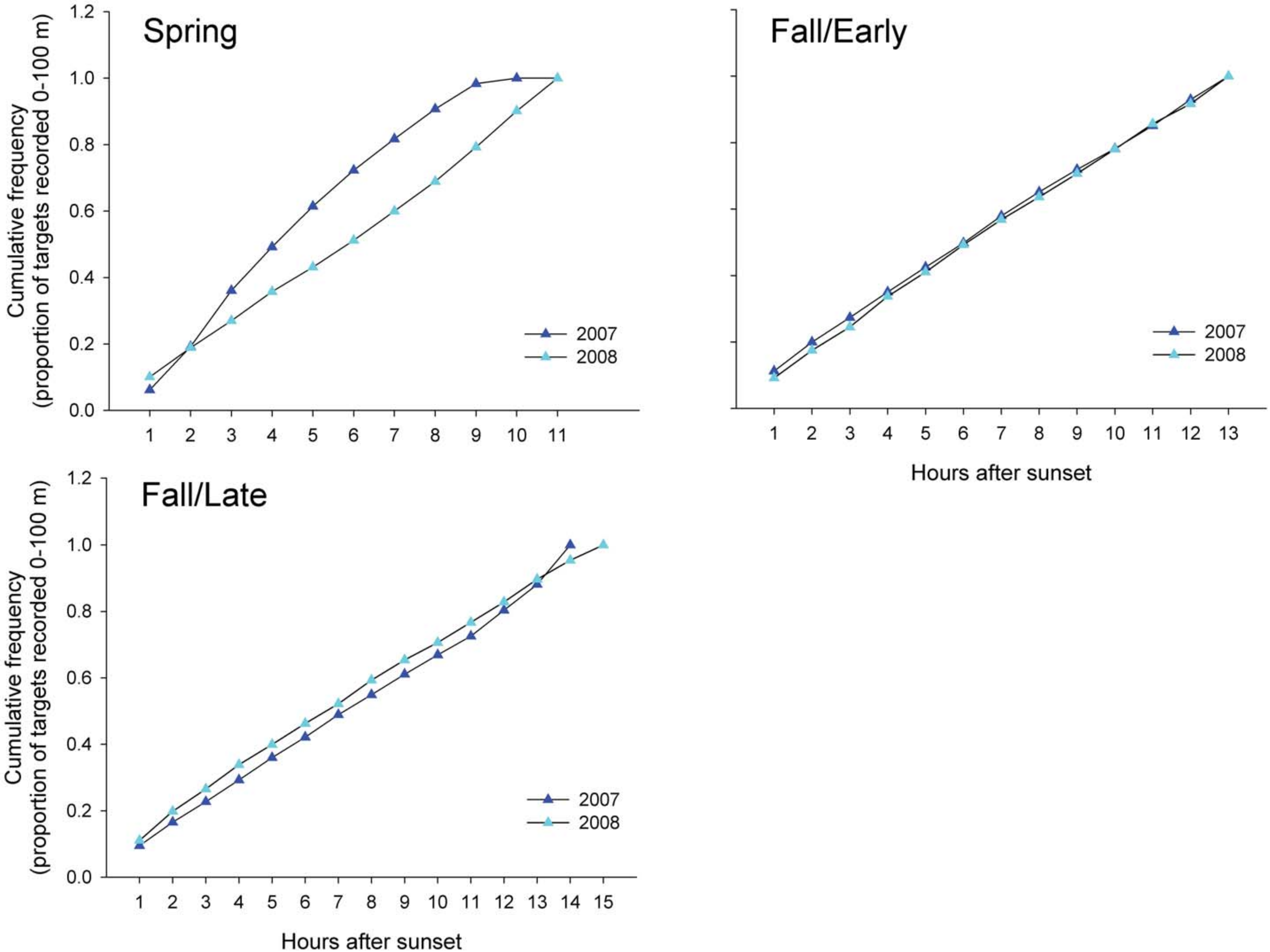


Figure 37. Hourly cumulative frequency distributions relative to sunset for the proportion of targets recorded at or below 100 m during Spring, Fall/Early and Fall/Late data collection periods in 2007 and 2008.

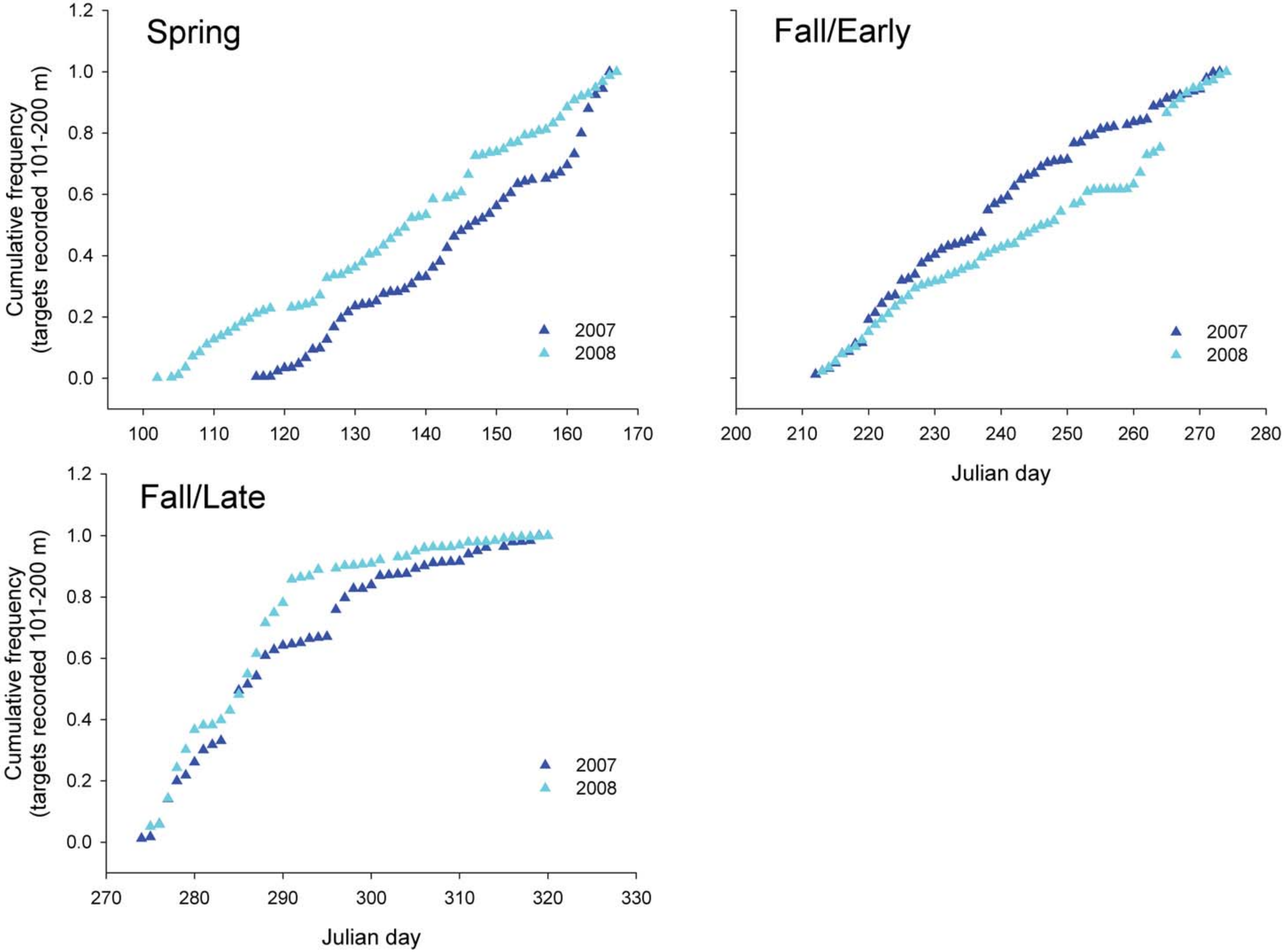


Figure 38. Cumulative frequency distributions for the proportion of targets recorded in the 101-200 m strata during nocturnal data collection periods (sunset to sunrise the following morning) in Spring, Fall/Early and Fall/Late seasons, 2007 and 2008.

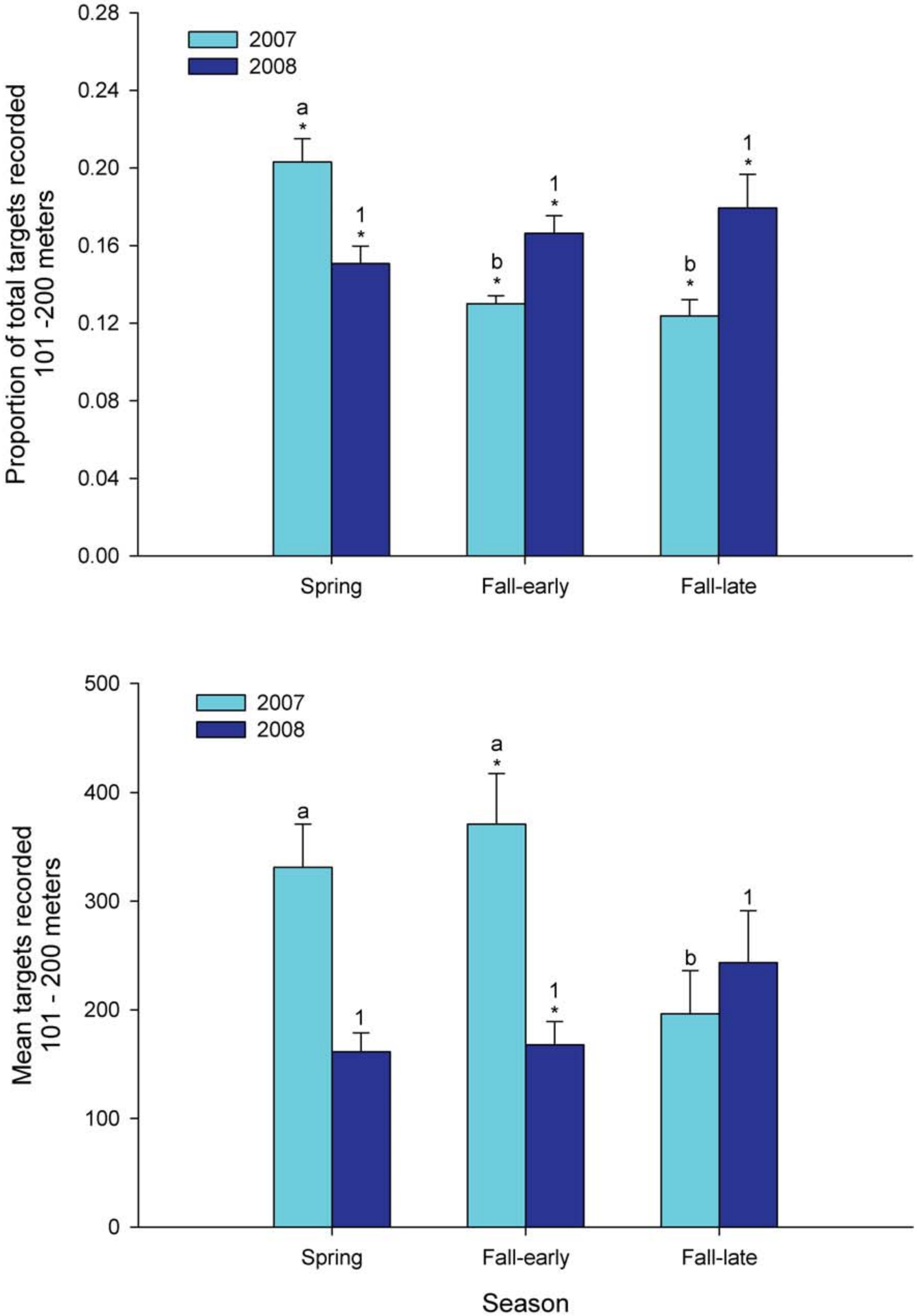


Figure 39. Comparison of the proportion (top) and mean targets recorded (bottom) in the 101-200 m stratum during the MRWPF radar study. Bars with the same letter ('07) or number ('08) are not statistically different. Asterisks indicate differences between years for a given season (e.g., Spring '07 vs '08). Analyses used arcsin (upper) or log-transformed (lower) data, and Bonferroni adjustment for multiple comparisons. Data in plots are not transformed. Error bars represent SE of the means.

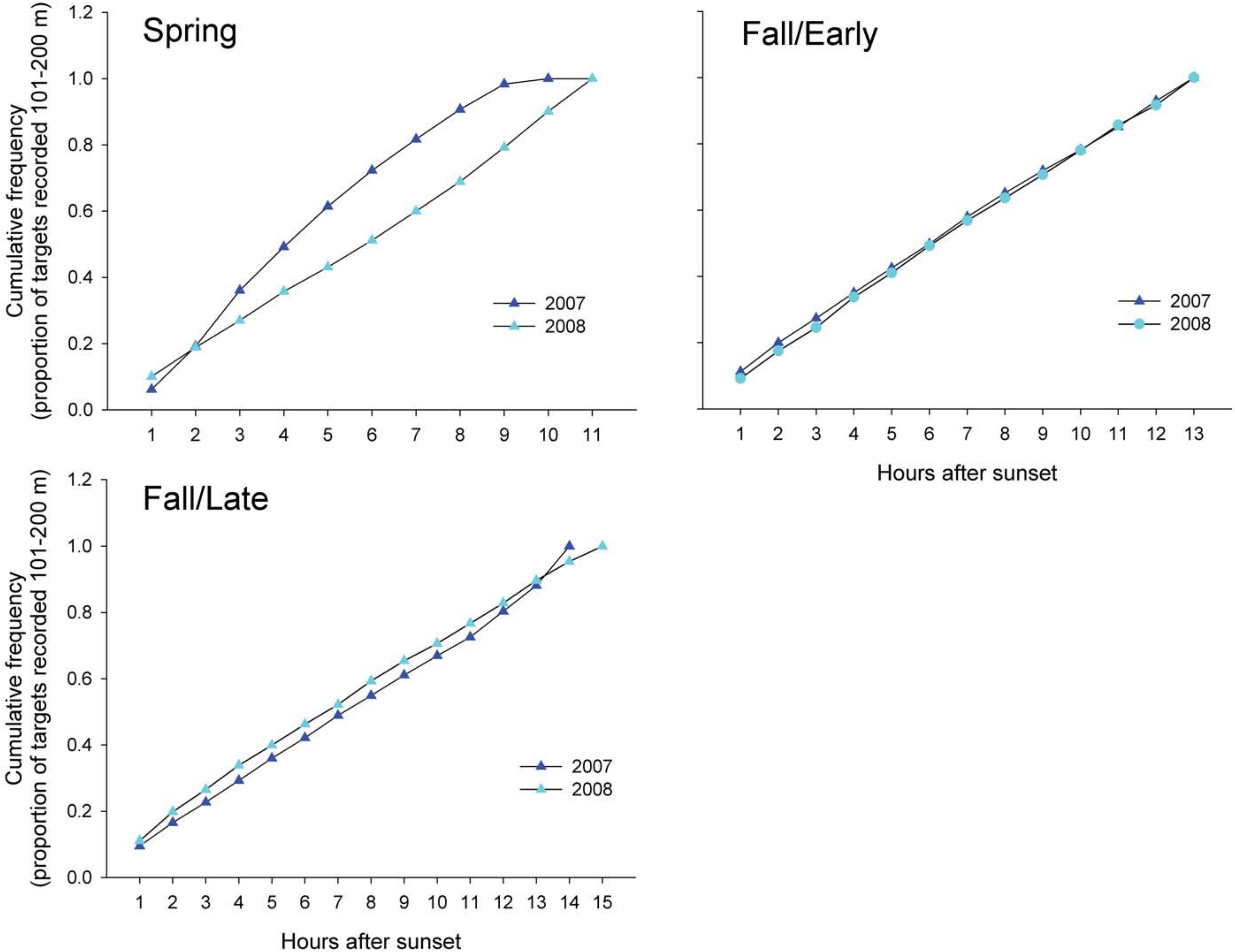


Figure 40. Hourly cumulative frequency distributions relative to sunset for the proportion of targets recorded 101-200 m above radar level (arl) during Spring, Fall/Early and Fall/Late data collection periods in 2007 and 2008.

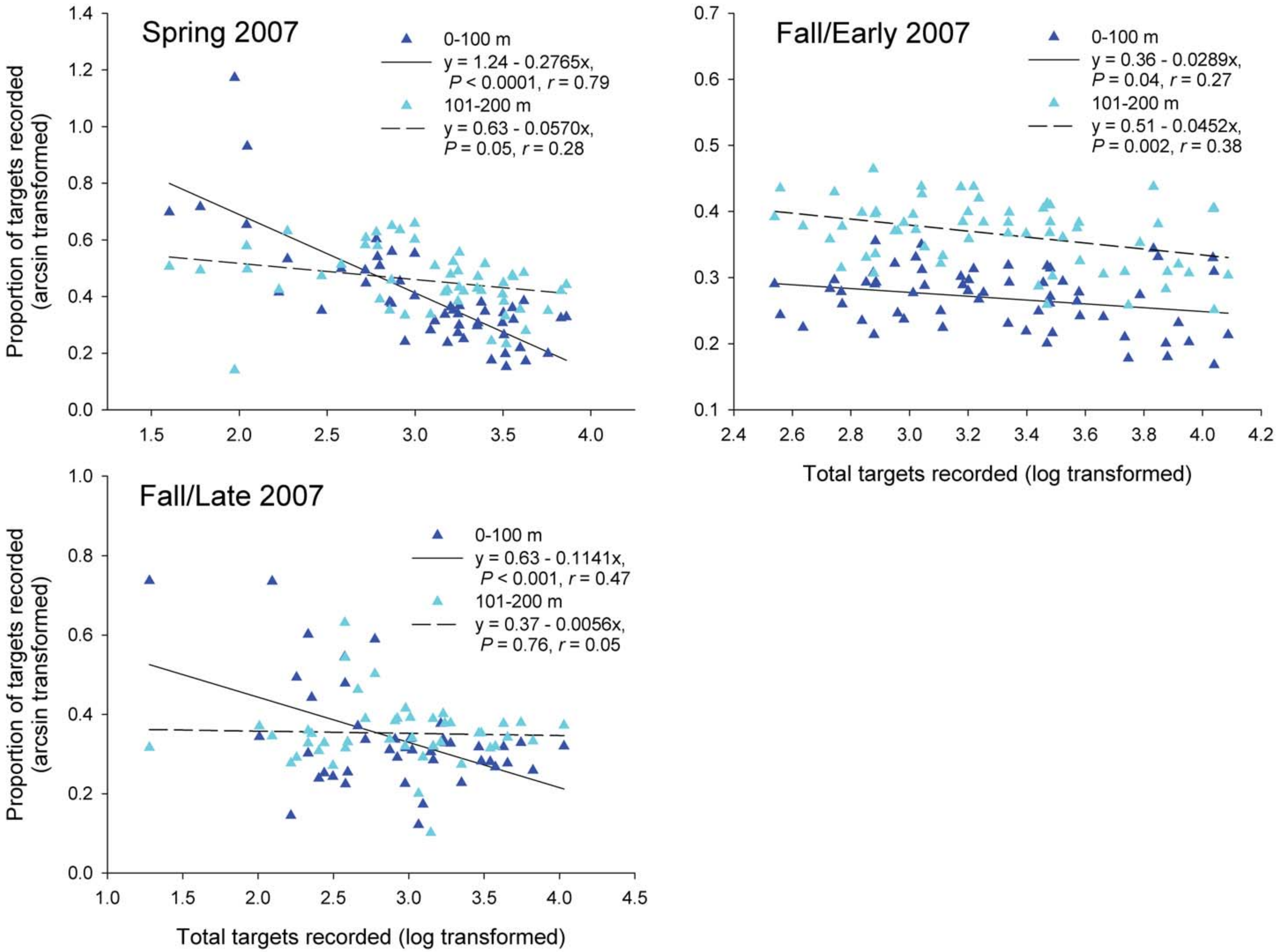


Figure 41. Correlations between the proportion of targets recorded in the two lowest altitudinal strata (i.e.,0 - 100 m, 101 - 200 m) and total targets recorded (i.e., sum of the 10-minute sample averages) during 2007 .

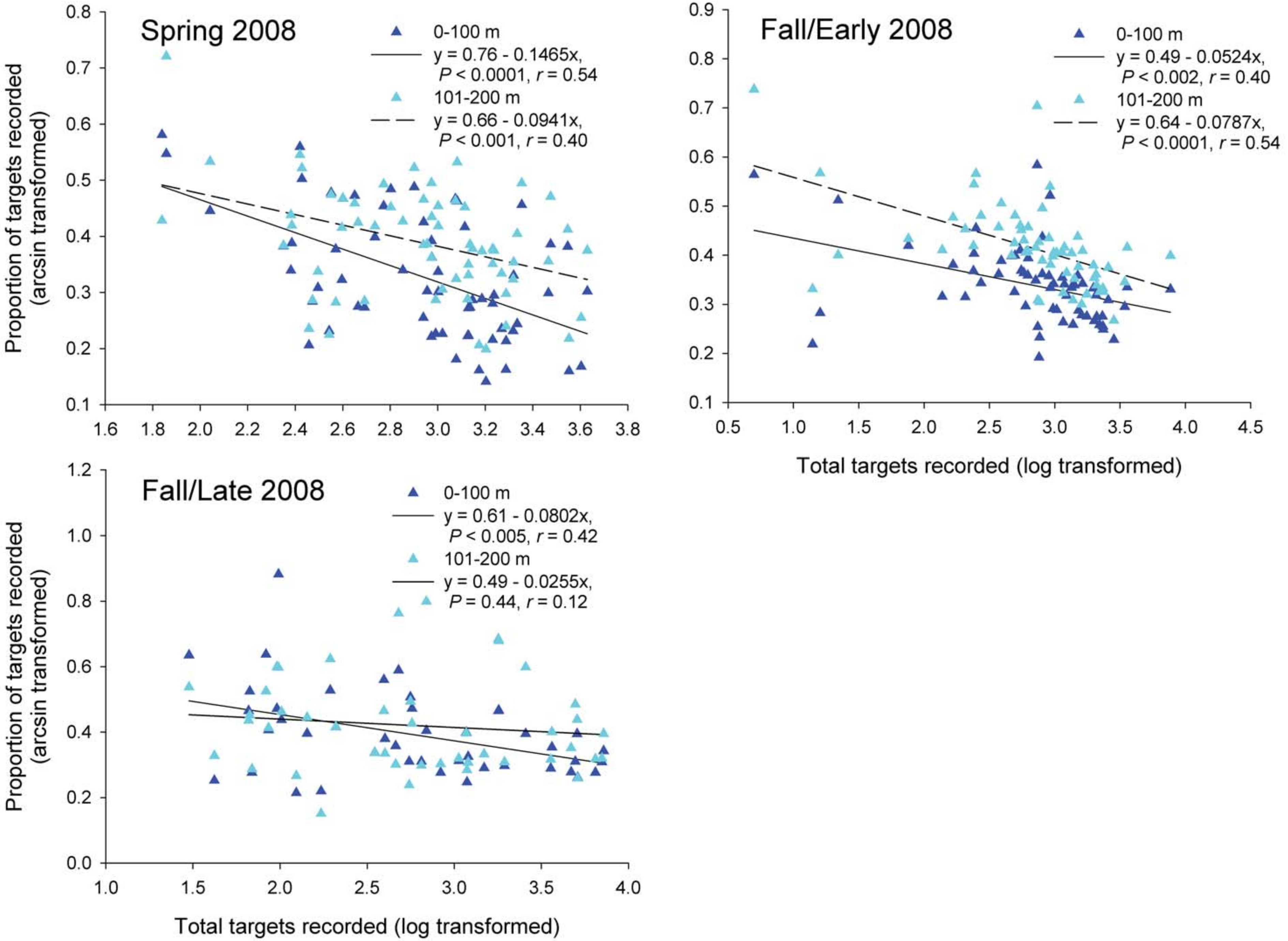


Figure 42. Relationships between the proportion of targets recorded in the two lowest altitudinal strata (i.e.,0 - 100 m, 101 - 200 m) and total targets recorded (i.e., sum of the 10-minute sample averages) during 2008 .

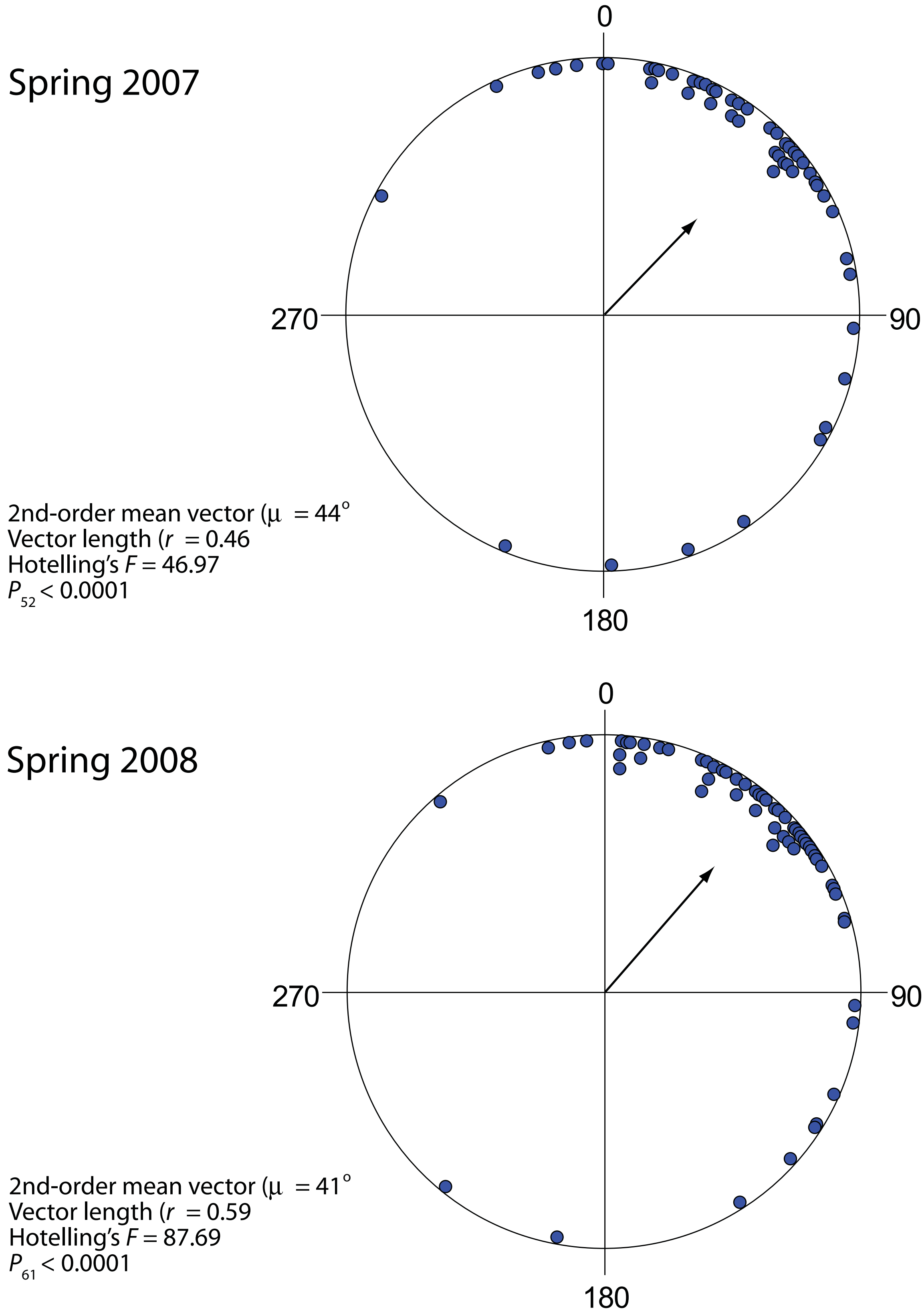


Fig. 43. Second-order mean vectors (i.e., Grand Means) of targets recorded during Spring 2007 (25 April - 15 June) and 2008 (11 April - 15 June) data collection periods. Blue circles around the perimeter of plot represent first-order mean vectors for each night. Arrows point in the direction of the second-order mean vector and their length represents the vector length. Vector length is an index or circular variance with values ranging between 0 and 1. The higher the value, the lower the variance in the mean vector.

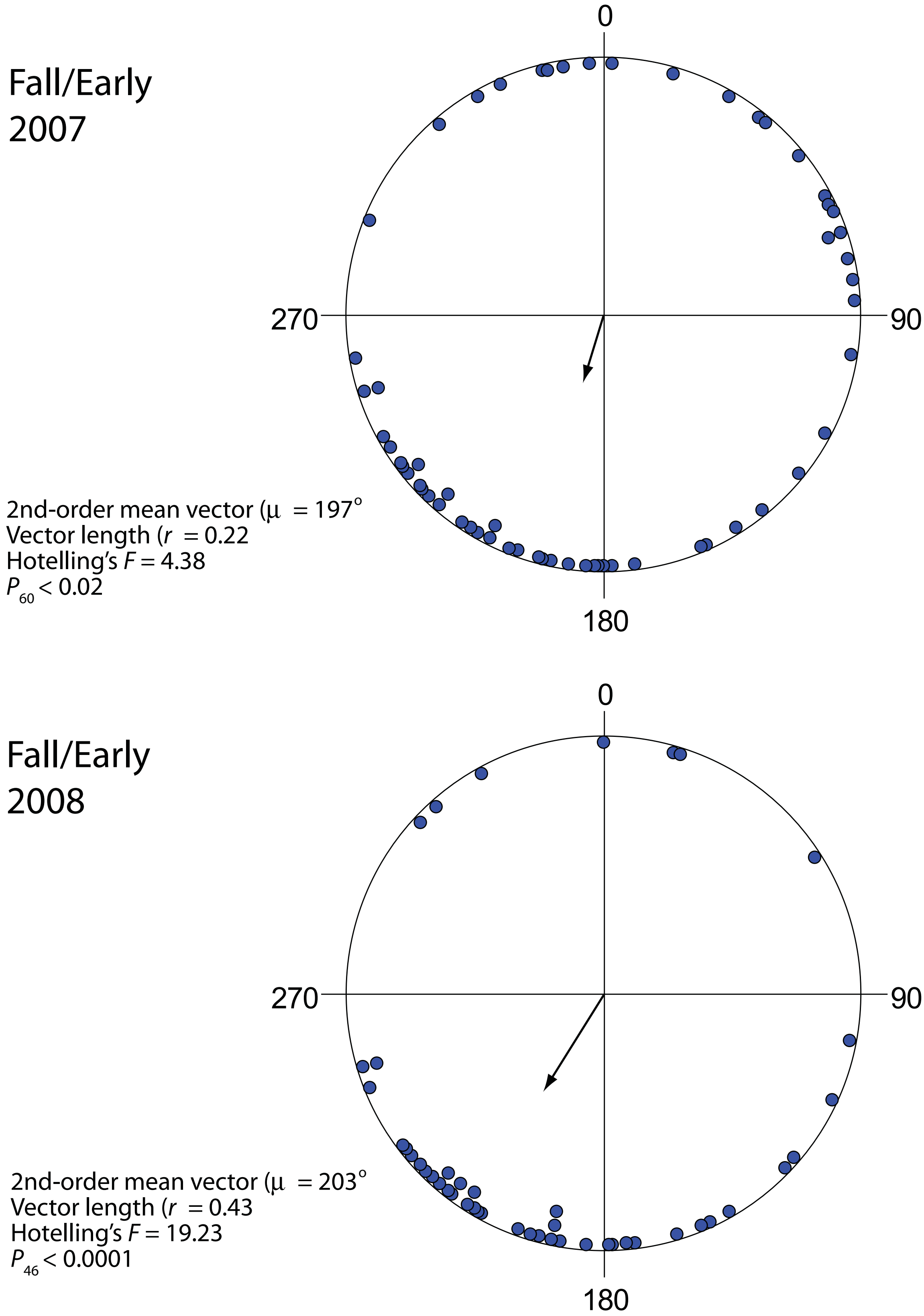


Fig. 44. Second-order mean vectors (i.e., Grand Means) of targets recorded during Fall/Early (31 July - 30 September) 2007 and 2008 data collection periods. Blue circles around the perimeter of plot represent first-order mean vectors for each night. Arrows point in the direction of the second-order mean vector and their length represents the vector length. Vector length is an index or circular variance with values ranging between 0 and 1. The higher the value, the lower the variance in the mean vector.

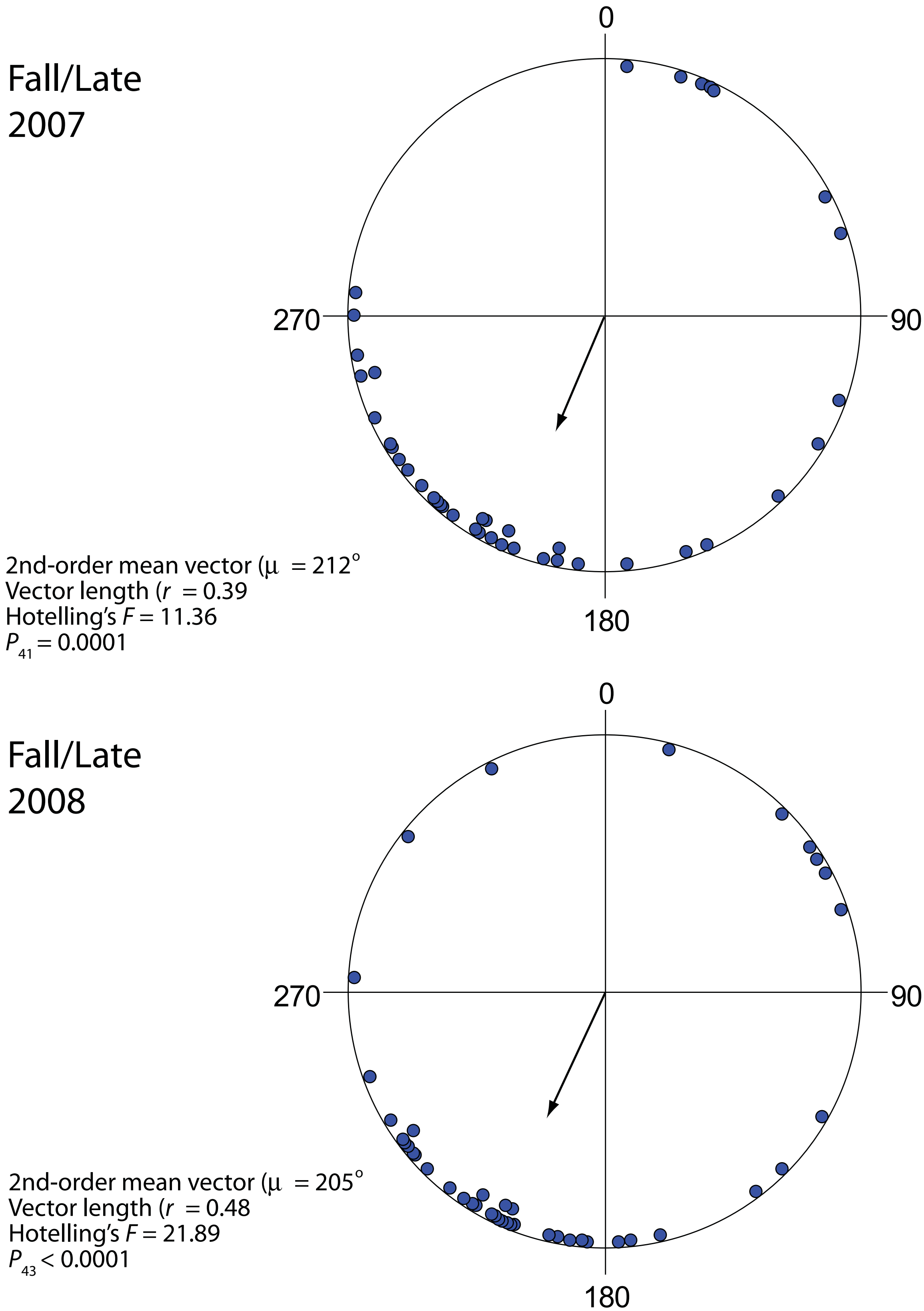


Fig. 45. Second-order mean vectors (i.e., Grand Means) of targets recorded during Fall/Late (1 October - 15 November) 2007 and 2008 data collection periods. Blue circles around the perimeter of plot represent first-order mean vectors for each night. Arrows point in the direction of the second-order mean vector and their length represents the vector length. Vector length is an index or circular variance with values ranging between 0 and 1. The higher the value, the lower the variance in the mean vector.

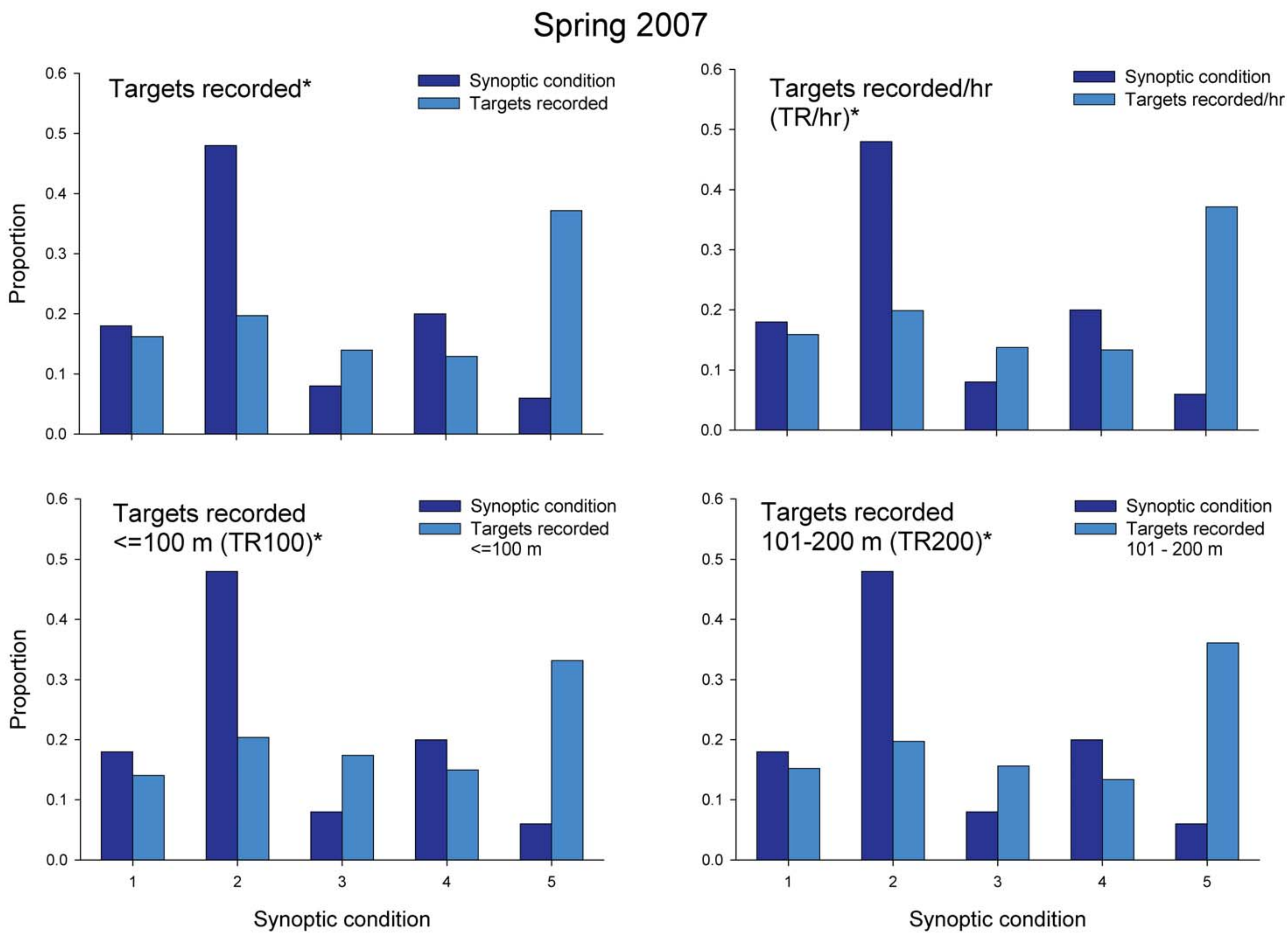


Figure 46. Proportional occurrence of synoptic conditions and response variables (i.e., TR, TR/hr, TR100, TR200) under each condition for Spring 2007 (25 April - 15 June). Asterisk indicates that proportional occurence of synoptic conditions and response variables were significantly different.

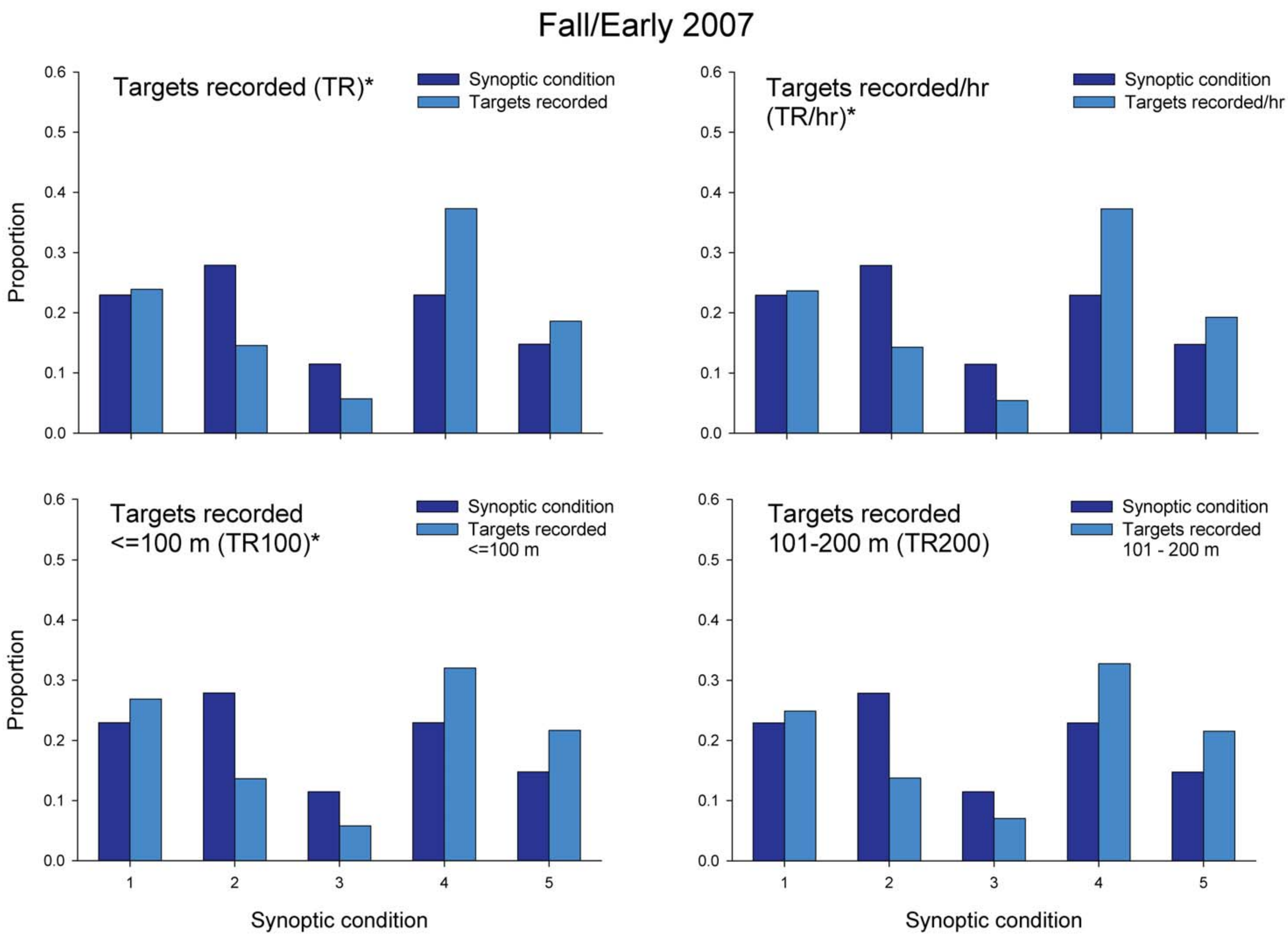


Figure 47. Proportional occurrence of synoptic conditions and response variables (i.e., TR, TR/hr, TR100, TR200) under each condition for Fall/Early 2007 (31 July - 30 September) during the nocturnal data collection period. Asterisk indicates that proportional occurence of synoptic conditions and response variables were significantly different.

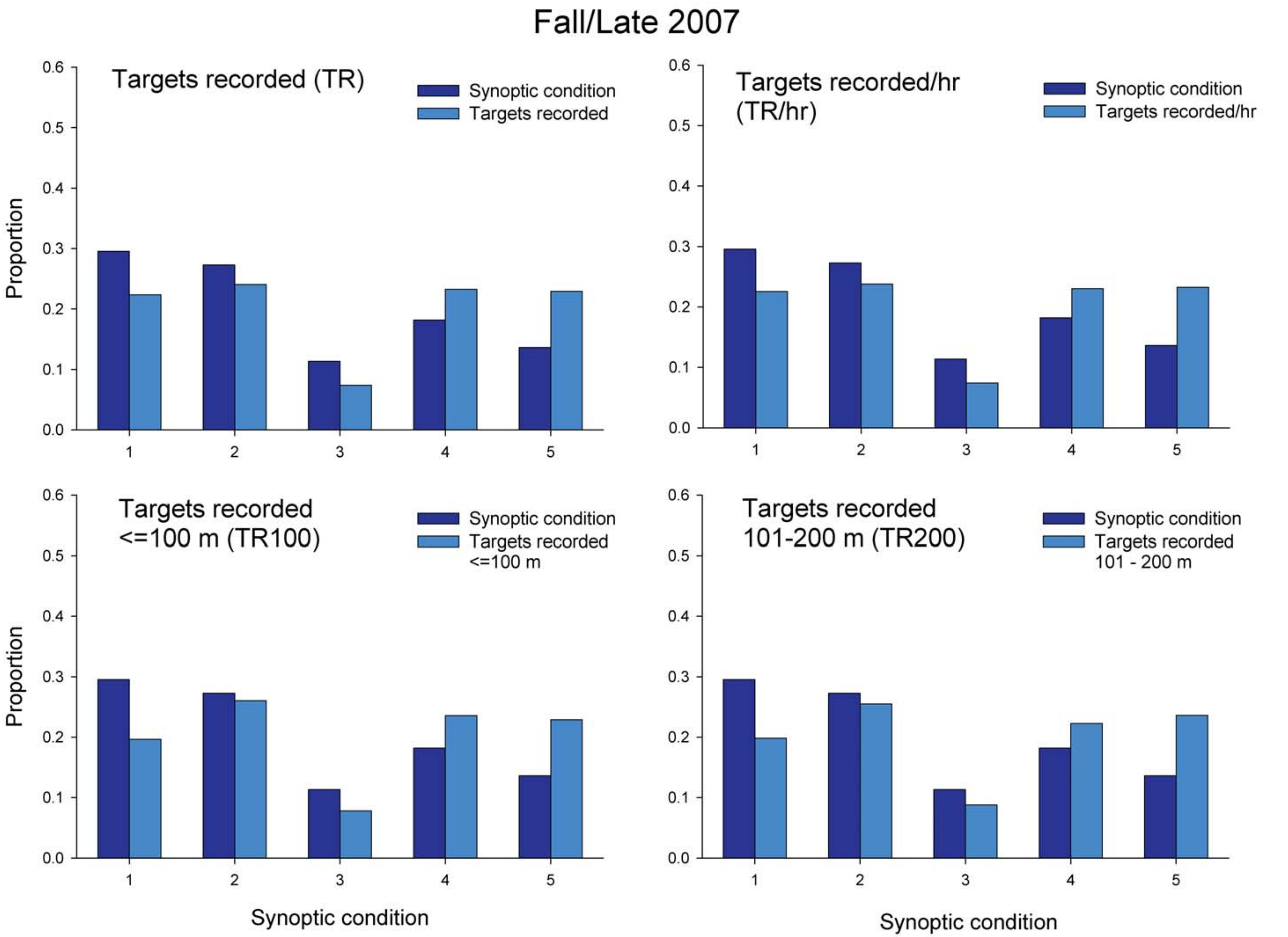


Figure 48. Proportional occurrence of synoptic conditions and response variables (i.e., TR, TR/hr, TR100, TR200) under each condition for Fall/Late 2007 (1 October - 15 November) during the diurnal data collection period. Asterisk indicates that proportional occurence of synoptic conditions and response variables were significantly different.

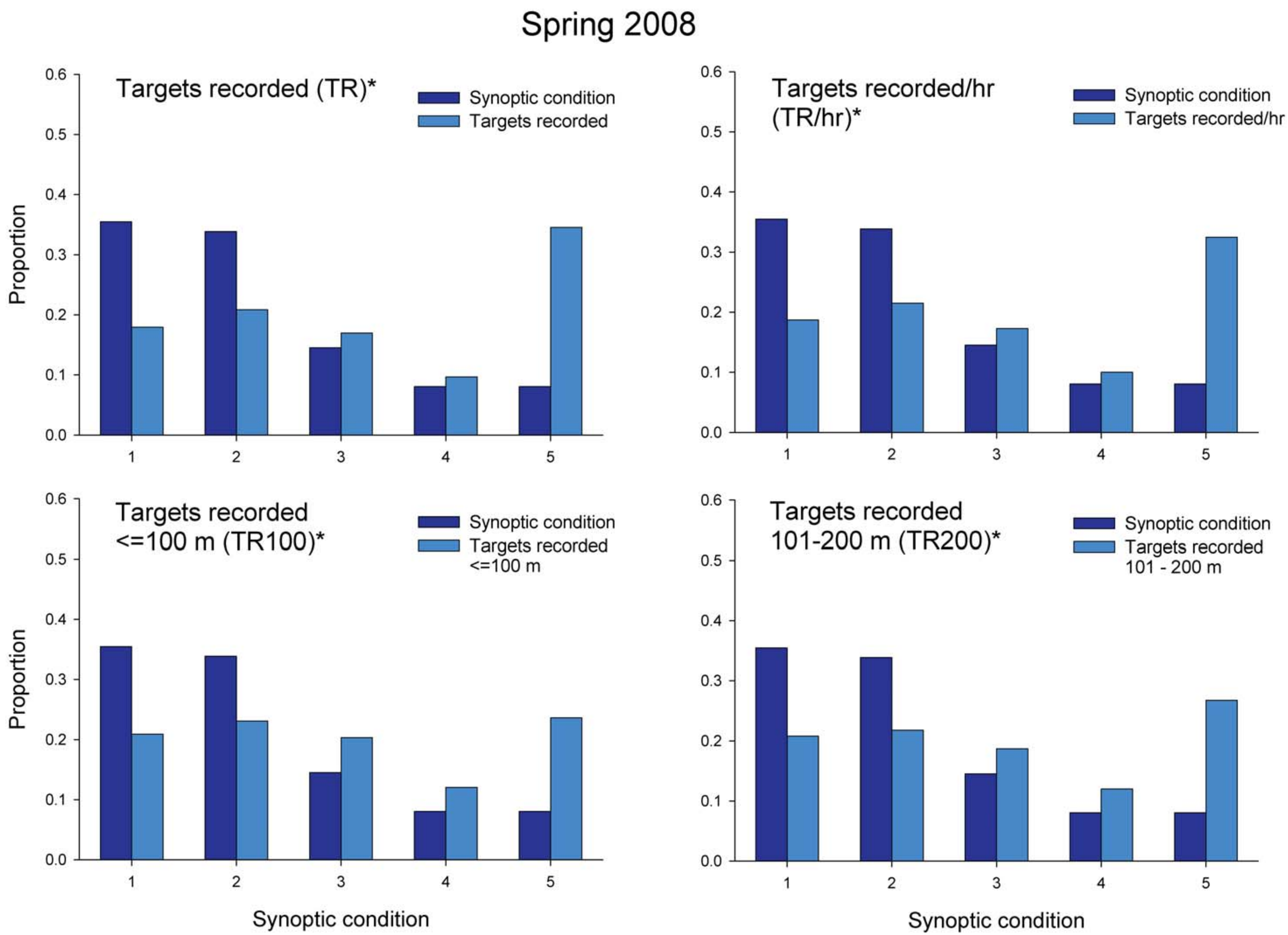


Figure 49. Proportional occurrence of synoptic conditions and response variables (i.e., TR, TR/hr, TR100, TR200) under each condition for Spring 2008 (11 April - 15 June) during the nocturnal data collection period. Asterisk indicates that proportional occurence of synoptic conditions and response variables were significantly different.

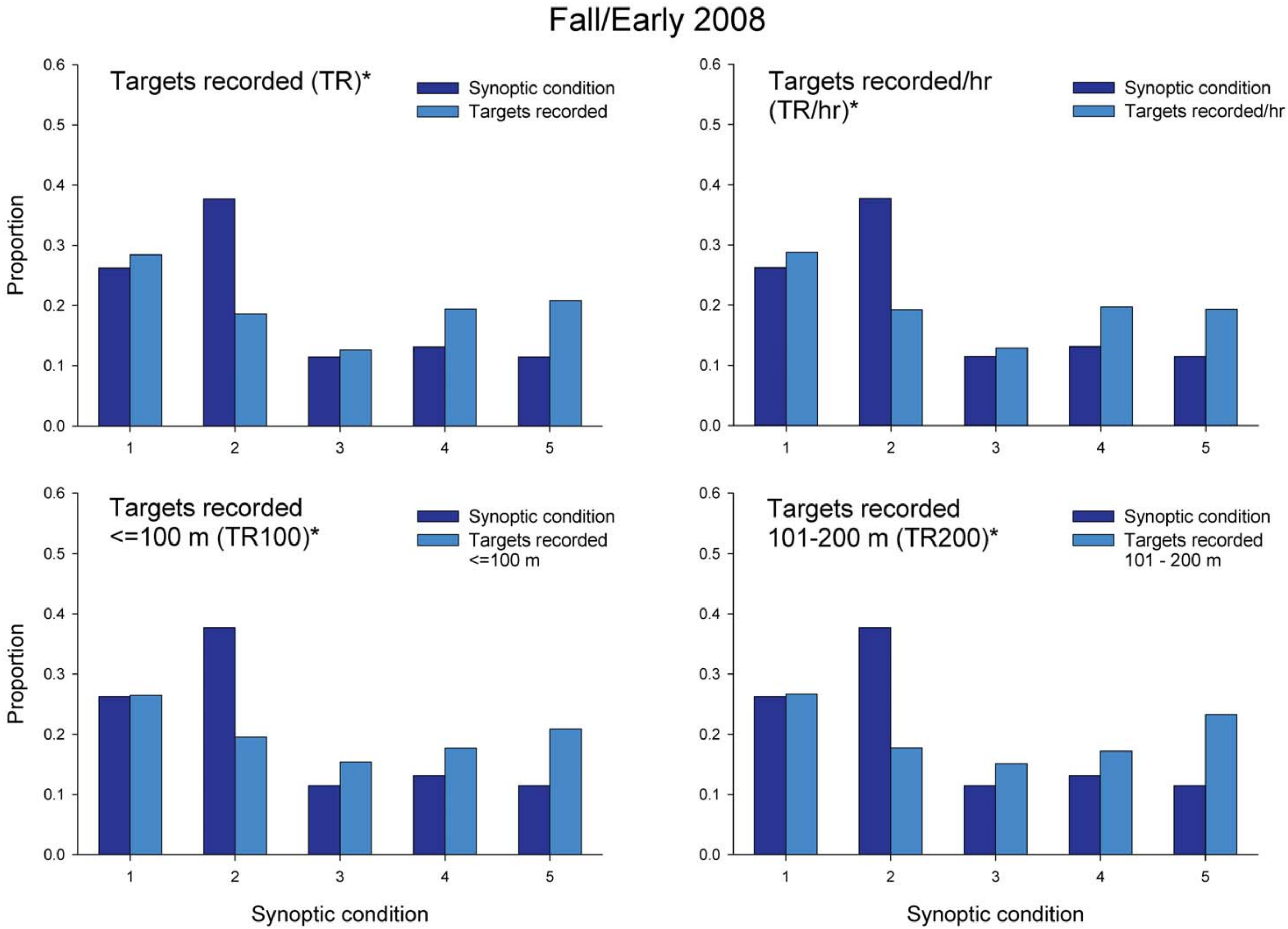


Figure 50. Proportional occurrence of synoptic conditions and response variables (i.e., TR, TR/hr, TR100, TR200) under each condition for Fall/Early 2008 (31 July - 30 September) during the diurnal data collection period. Asterisk indicates that proportional occurence of synoptic conditions and response variables were significantly different.

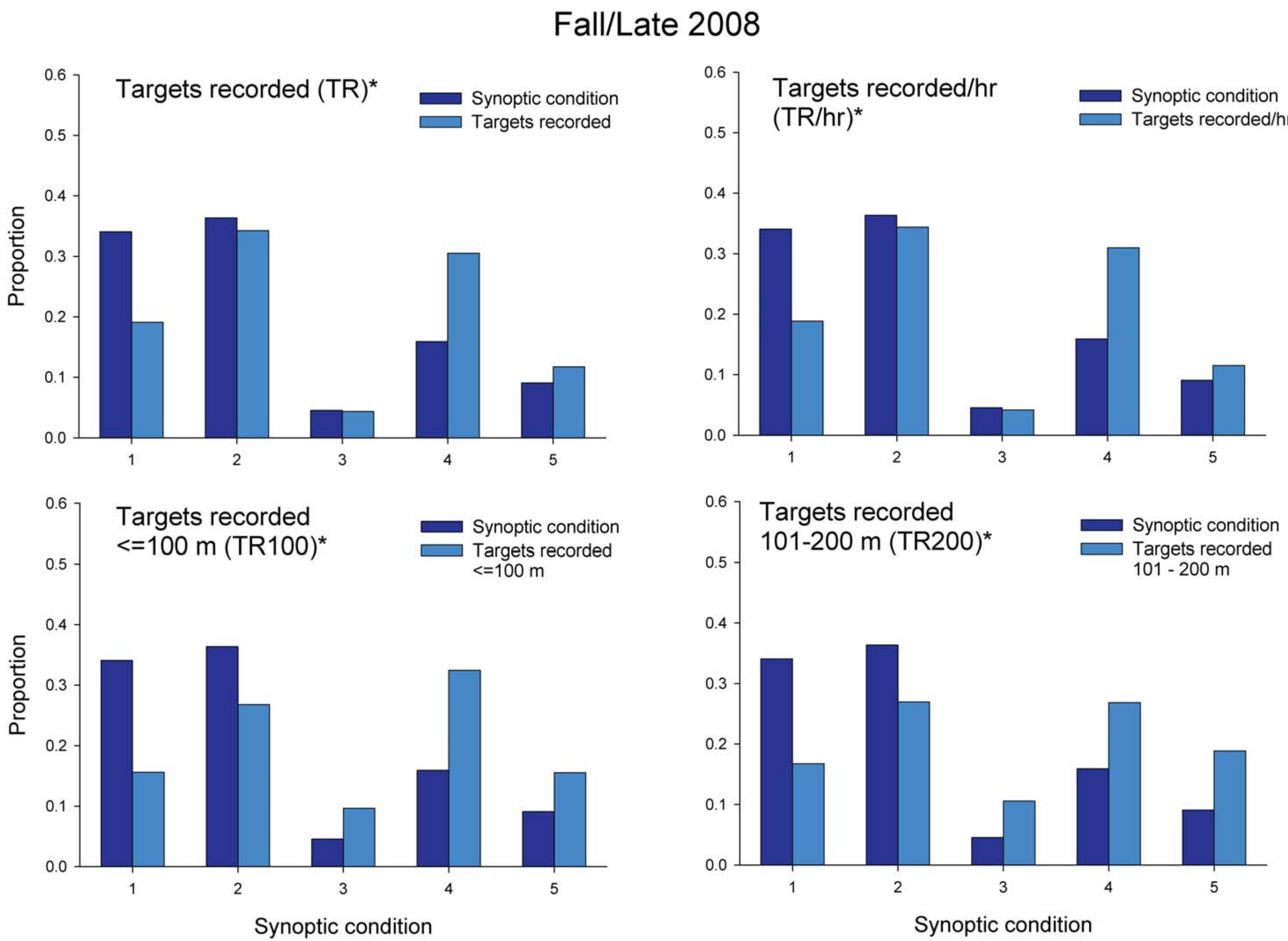


Figure 51. Proportional occurrence of synoptic conditions and response variables (i.e., TR, TR/hr, TR100, TR200) under each condition for Fall/Late 2008 (1 October - 15 November) during the nocturnal data collection period. Asterisk indicates that proportional occurence of synoptic conditions and response variables were significantly different.

Appendix 1. Data collection dates, start/end times, sunset/sunrise times and survey hours for marine radar study conducted on 51 nights during spring 2007 at the Maple Ridge wind power facility, Lewis County, NY. Sunrise and sunset times are given in Eastern Daylight Time. Data were collected for a total of 458.83 hours (mean = 9.00 hours/night).

Date	Sunset time	Sunrise time	Data collection start time	Data collection end time	Data collection hours	Additional details
04/26/07	18:59	05:02	19:05	04:55	9.83	
04/27/07	19:00	05:00	19:02	04:52	9.83	
04/28/07	19:01	04:59	19:02	04:52	9.83	
04/29/07	19:02	04:57	19:03	04:53	9.83	
04/30/07	19:03	04:56	19:07	04:47	9.67	
05/01/07	19:05	04:54	18:48	04:48	10.00	
05/02/07	19:06	04:53	19:12	04:52	9.67	
05/03/07	19:07	04:52	19:15	04:45	9.50	
05/04/07	19:08	04:50	19:16	04:46	9.50	
05/05/07	19:09	04:49	19:18	04:48	9.50	
05/06/07	19:11	04:47	19:20	04:40	9.33	
05/07/07	19:12	04:46	19:20	04:40	9.33	
05/08/07	19:13	04:45	19:13	04:43	9.50	
05/09/07	19:14	04:44	19:18	04:38	9.33	
05/10/07	19:15	04:42	19:20	04:40	9.33	
05/11/07	19:16	04:41	19:21	04:31	9.17	
05/12/07	19:17	04:40	19:17	04:37	9.33	
05/13/07	19:19	04:39	19:24	04:34	9.17	
05/14/07	19:20	04:38	19:26	04:36	9.17	
05/15/07	19:21	04:37	19:27	04:37	9.17	
05/16/07	19:22	04:36	19:25	04:35	9.17	
05/17/07	19:23	04:34	19:24	04:34	9.17	
05/18/07	19:24	04:33	19:26	04:26	9.00	
05/19/07	19:25	04:32	19:28	04:28	9.00	
05/20/07	19:26	04:32	19:32	04:22	8.83	
05/21/07	19:27	04:31	19:34	04:24	8.83	
05/22/07	19:28	04:30	19:30	04:30	9.00	
05/23/07	19:29	04:29	19:37	04:27	8.83	
05/24/07	19:30	04:28	19:33	04:33	9.00	
05/25/07	19:31	04:27	19:33	04:23	8.83	
05/26/07	19:32	04:27	19:34	04:24	8.83	
05/27/07	19:33	04:26	19:42	04:22	8.67	
05/28/07	19:34	04:25	19:34	04:24	8.83	
05/29/07	19:35	04:24	19:42	04:22	8.67	
05/30/07	19:36	04:24	19:39	04:19	8.67	
05/31/07	19:37	04:23	19:42	04:22	8.67	
06/01/07	19:37	04:23	19:45	04:15	8.50	
06/02/07	19:38	04:22	19:47	04:17	8.50	
06/03/07	19:39	04:22	19:45	04:15	8.50	
06/04/07	19:40	04:21	19:41	04:21	8.67	
06/05/07	19:40	04:21	19:41	04:21	8.67	
06/06/07	19:41	04:20	19:42	04:12	8.50	
06/07/07	19:42	04:20	19:42	04:12	8.50	
06/08/07	19:42	04:20	19:51	04:11	8.33	
06/09/07	19:43	04:20	19:51	04:11	8.33	
06/10/07	19:44	04:19	19:50	04:10	8.33	
06/11/07	19:44	04:19	19:49	04:09	8.33	
06/12/07	19:45	04:19	19:46	04:16	8.50	
06/13/07	19:45	04:19	19:45	04:15	8.50	
06/14/07	19:46	04:19	19:52	04:12	8.33	
06/15/07	19:46	04:19	19:52	04:12	8.33	

Appendix 2. Data collection dates, start/end times, sunset/sunrise times and survey hours for marine radar study conducted on 61 nights during the 2007 Fall/Early period at the Maple Ridge wind power facility, Lewis County, NY. Sunrise and sunset times are given in Eastern Daylight Time. Data were collected for a total of 641.17 hours (mean = 10.51 hours/night).

Date	Sunset time	Sunrise time	Data collection start time	Data collection end time	Data collection hours	Additional details
07/31/07	19:27	4:49	21:45	4:45	7.00	
08/01/07	19:26	4:50	20:22	4:42	8.33	
08/02/07	19:25	4:51	19:31	4:51	9.33	
08/03/07	19:23	4:52	19:23	4:43	9.33	
08/04/07	19:22	4:53	19:24	4:44	9.33	
08/05/07	19:21	4:54	19:26	4:46	9.33	
08/06/07	19:19	4:56	19:22	4:52	9.50	
08/07/07	19:18	4:57	19:28	4:58	9.50	
08/08/07	19:17	4:58	19:25	4:55	9.50	
08/09/07	19:15	4:59	19:20	4:50	9.50	
08/10/07	19:14	5:00	19:23	4:53	9.50	
08/11/07	19:12	5:01	19:16	4:56	9.67	
08/12/07	19:11	5:02	19:17	4:57	9.67	
08/13/07	19:10	5:03	19:12	5:02	9.83	
08/14/07	19:08	5:05	19:11	5:01	9.83	
08/15/07	19:07	5:06	19:14	5:04	9.83	
08/16/07	19:05	5:07	19:06	5:06	10.00	Surveillance data corrupt
08/17/07	19:03	5:08	19:10	5:00	9.83	
08/18/07	19:02	5:09	19:10	5:00	9.83	
08/19/07	19:00	5:10	19:09	5:09	10.00	
08/20/07	18:59	5:11	19:08	5:08	10.00	
08/21/07	18:57	5:13	19:00	5:10	10.17	
08/22/07	18:55	5:14	18:55	5:05	10.17	
08/23/07	18:54	5:15	18:58	5:08	10.17	
08/24/07	18:52	5:16	18:52	5:12	10.33	
08/25/07	18:50	5:17	18:53	5:13	10.33	
08/26/07	18:49	5:18	18:56	5:16	10.33	
08/27/07	18:47	5:19	18:56	5:16	10.33	
08/28/07	18:45	5:20	18:54	5:14	10.33	
08/29/07	18:44	5:22	18:44	5:14	10.50	
08/30/07	18:42	5:23	18:50	5:20	10.50	
08/31/07	18:40	5:24	18:49	5:19	10.50	
09/01/07	18:38	5:25	18:42	5:22	10.67	
09/02/07	18:37	5:26	18:38	5:18	10.67	
09/03/07	18:35	5:27	18:42	5:22	10.67	
09/04/07	18:33	5:28	18:42	5:22	10.67	
09/05/07	18:31	5:30	18:32	5:22	10.83	
09/06/07	18:29	5:31	18:30	5:30	11.00	
09/07/07	18:28	5:32	18:31	5:31	11.00	
09/08/07	18:26	5:33	18:34	5:24	10.83	
09/09/07	18:24	5:34	18:25	5:25	11.00	
09/10/07	18:22	5:35	18:30	5:30	11.00	
09/11/07	18:20	5:36	18:23	5:33	11.17	
09/12/07	18:18	5:37	18:27	5:27	11.00	
09/13/07	18:17	5:39	18:26	5:36	11.17	
09/14/07	18:15	5:40	18:20	5:30	11.17	
09/15/07						No data collection, generator problem
09/16/07	18:11	5:42	18:18	5:38	11.33	
09/17/07	18:09	5:43	18:13	5:43	11.50	
09/18/07	18:07	5:44	18:16	5:36	11.33	
09/19/07	18:06	5:45	18:06	5:36	11.50	
09/20/07	18:04	5:47	18:07	5:47	11.67	
09/21/07	18:02	5:48	18:08	5:48	11.67	
09/22/07	18:00	5:49	18:07	5:47	11.67	
09/23/07	17:58	5:50	17:58	5:48	11.83	
09/24/07	17:56	5:51	18:00	5:50	11.83	
09/25/07	17:54	5:52	17:55	5:45	11.83	
09/26/07	17:53	5:53	18:01	5:51	11.83	
09/27/07	17:51	5:55	17:53	5:53	12.00	
09/28/07	17:49	5:56	17:54	5:54	12.00	
09/29/07	17:47	5:57	17:48	5:48	12.00	
09/30/07	17:45	5:58	17:51	5:51	12.00	

Appendix 3. Data collection dates, start/end times, sunset/sunrise times and survey hours for marine radar study conducted on 45 nights during the 2007 Fall/Late period at the Maple Ridge wind power facility, Lewis County, NY. Sunrise and sunset times are given in Eastern Daylight Time. Data were collected for a total of 577.55 hours (mean = 12.83 hours/night).

Date	Sunset time	Sunrise time	Data collection start time	Data collection end time	Data collection hours	Additional details
10/01/07	17:43	5:59	17:50	5:50	12.00	
10/02/07	17:42	6:00	17:47	5:57	12.17	
10/03/07	17:40	6:02	17:54	5:54	12.00	
10/04/07	17:38	6:03	17:39	5:59	12.33	
10/05/07	17:36	6:04	17:43	6:03	12.33	
10/06/07	17:34	6:05	17:34	6:04	12.50	
10/07/07	17:33	6:06	17:36	6:06	12.50	
10/08/07	17:31	6:08	17:37	6:07	12.50	
10/09/07	17:29	6:09	17:29	6:09	12.67	
10/10/07	17:27	6:10	17:28	6:08	12.67	
10/11/07	17:26	6:11	17:26	6:06	12.67	
10/12/07	17:24	6:12	17:31	6:11	12.67	
10/13/07	17:22	6:14	17:22	6:12	12.83	
10/14/07	17:21	6:15	17:24	6:14	12.83	
10/15/07	17:19	6:16	17:19	6:09	12.83	
10/16/07	17:17	6:17	17:25	6:15	12.83	
10/17/07	17:16	6:19	17:17	6:17	13.00	
10/18/07	17:14	6:20	17:16	6:16	13.00	
10/19/07	17:12	6:21	17:14	6:04	12.83	
10/20/07	17:11	6:22	17:16	6:16	13.00	
10/21/07	17:09	6:24	17:17	6:17	13.00	
10/22/07	15:28	6:09	15:28	6:08	14.67	
10/23/07	17:06	6:26	17:07	5:57	12.83	
10/24/07	17:04	6:27	17:06	5:56	12.83	
10/25/07	17:03	6:29	17:10	6:20	13.17	
10/26/07	17:01	6:30	17:08	6:28	13.33	
10/27/07	17:00	6:31	17:09	6:29	13.33	
10/28/07	16:58	6:33	17:00	6:30	13.50	
10/29/07	16:57	6:34	17:05	6:25	13.33	
10/30/07	16:56	6:35	17:04	6:34	13.50	
10/31/07	16:54	6:37	17:03	6:33	13.50	
11/01/07	16:53	6:38	16:54	5:54	13.00	
11/02/07	16:51	6:39	16:58	6:38	13.67	
11/03/07	16:50	6:41	16:51	6:31	13.67	
11/04/07	16:49	6:42	16:57	6:27	13.50	
11/05/07	16:48	6:43	16:48	6:28	13.67	
11/06/07	16:46	6:44	16:46	6:36	13.83	
11/07/07	16:45	6:46	16:51	6:41	13.83	
11/08/07	16:44	6:47	16:51	6:41	13.83	
11/09/07	16:43	6:48	16:48	5:58	13.17	
11/10/07						No data. Radar malfunction
11/11/07	16:40	6:51	16:41	5:41	13.00	
11/12/07	16:39	6:52	16:42	5:32	12.83	
11/13/07	16:38	6:54	16:39	6:29	13.83	
11/14/07	16:37	6:55	16:37	6:47	14.17	
11/15/07	16:36	6:56	16:40	6:50	14.17	

Appendix 4. Data collection dates, start/end times, sunset/sunrise times and survey hours for marine radar study conducted on 62 nights during spring 2008 at the Maple Ridge wind power facility, Lewis County, NY. Sunrise and sunset times are given in Eastern Daylight Time. Data were collected for a total of 588.35 hrs (mean = 9.49 hours/night).

Date	Sunset time	Sunrise time	Data collection start time	Data collection end time	Data collection hours	Additional details
04/11/08	18:42	5:25	18:41	5:31	10.83	
04/12/08						Radar problems, no data collected
04/13/08	18:44	5:22	18:42	5:22	10.67	
04/14/08	18:45	5:20	18:43	5:23	10.67	
04/15/08	18:46	5:18	18:54	5:24	10.50	
04/16/08	18:48	5:17	18:43	5:24	10.68	
04/17/08	18:49	5:15	18:42	5:22	10.67	
04/18/08	18:50	5:13	18:50	5:20	10.50	
04/19/08	18:51	5:12	18:48	5:19	10.52	
04/20/08	18:52	5:11	18:47	5:08	10.35	
04/21/08	18:53	5:10	18:54	5:14	10.33	
04/22/08	18:54	5:08	18:49	5:09	10.33	
04/23/08	18:55	5:06	18:30	5:40	11.17	
04/24/08	18:56	5:05	18:52	5:02	10.17	
04/25/08	18:58	5:03	18:47	5:07	10.33	
04/26/08	18:59	5:02	18:55	5:05	10.17	
04/27/08	19:01	4:59	18:54	5:04	10.17	
04/28/08						No power. MRWPF had a problem at substation
04/29/08						No power. MRWPF had a problem at substation
04/30/08	19:04	4:55	19:00	5:01	10.02	
05/01/08	19:06	4:53	19:04	4:54	9.83	
05/02/08	19:07	4:52	19:05	4:56	9.85	
05/03/08	19:08	4:50	19:06	4:57	9.85	
05/04/08	19:09	4:49	19:04	4:54	9.83	
05/05/08	19:10	4:48	19:02	4:53	9.85	
05/06/08	19:11	4:46	19:10	2:40	7.50	
05/07/08	19:13	4:45	19:13	4:44	9.52	
05/08/08	19:14	4:44	19:16	4:46	9.50	
05/09/08	19:15	4:43	19:15	4:45	9.50	
05/10/08	19:16	4:41	19:16	4:46	9.50	
05/11/08	19:17	4:40	19:10	4:40	9.50	
05/12/08	19:18	4:39	19:17	4:47	9.50	
05/13/08	19:17	4:38	19:17	4:38	9.35	
05/14/08	19:21	4:37	19:15	4:45	9.50	
05/15/08	19:22	4:36	19:16	4:36	9.33	
05/16/08	19:23	4:35	19:17	4:37	9.33	
05/17/08	19:24	4:34	19:28	4:38	9.17	
05/18/08	19:25	4:33	19:25	4:35	9.17	
05/19/08	19:26	4:32	19:24	4:35	9.18	
05/20/08	19:27	4:31	19:25	4:46	9.35	
05/21/08	19:28	4:30	19:27	4:46	9.32	
05/22/08	19:29	4:29	19:28	4:28	9.00	
05/23/08	19:30	4:28	19:27	4:28	9.02	
05/24/08	19:31	4:27	19:28	4:29	9.02	
05/25/08	19:32	4:27	19:24	4:35	9.18	
05/26/08	19:33	4:26	19:27	4:27	9.00	
05/27/08	19:34	4:25	19:25	4:25	9.00	
05/28/08	19:35	4:25	19:26	4:27	9.02	
05/29/08	19:35	4:24	19:34	4:24	8.83	
05/30/08	19:36	4:23	19:27	4:28	9.02	
05/31/08	19:37	4:23	19:29	4:29	9.00	
06/01/08	19:38	4:22	19:30	4:30	9.00	
06/02/08	19:39	4:22	19:35	4:25	8.83	
06/03/08	19:40	4:21	19:31	4:21	8.83	
06/04/08	19:40	4:21	19:39	4:29	8.83	
06/05/08	19:41	4:21	19:40	4:21	8.68	
06/06/08	19:42	4:20	19:37	4:28	8.85	
06/07/08	19:42	4:20	19:39	4:29	8.83	
06/08/08	19:43	4:20	19:38	4:28	8.83	

Appendix 4 (continued)

06/09/08	19:44	4:19	19:41	4:21	8.67
06/10/08	19:44	4:19	19:36	4:26	8.83
06/11/08	19:45	4:19	19:36	4:26	8.83
06/12/08	19:45	4:19	19:36	4:27	8.85
06/13/08	19:46	4:19	19:42	4:23	8.68
06/14/08	19:46	4:19	19:43	4:24	8.68
06/15/08	19:46	4:19	19:37	4:27	8.83

Appendix 5. Data collection dates, start/end times, sunset/sunrise times and survey hours for marine radar study conducted on 61 nights during the 2008 Fall/Early period at the Maple Ridge wind power facility, Lewis County, NY. Sunrise and sunset times are given in Eastern Daylight Time. Data were collected for a total of 670.48 hours (mean = 11.00 hours/night).

Date	Sunset time	Sunrise time	Data collection start time	Data collection end time	Data collection hours	Additional details
07/31/08	19:26	4:50	19:24	4:54	9.50	
08/01/08	19:25	4:51	19:25	4:56	9.52	
08/02/08	19:24	4:52	19:15	7:25	12.17	
08/03/08	19:22	4:53	19:21	5:01	9.67	
08/04/08	19:21	4:54	19:17	4:58	9.68	
08/05/08	19:20	4:55	19:17	4:58	9.68	
08/06/08	19:18	4:56	19:11	5:02	9.85	
08/07/08	19:17	4:58	19:13	5:04	9.85	
08/08/08	19:16	4:59	19:13	5:03	9.83	
08/09/08	19:14	5:00	19:14	5:05	9.85	
08/10/08	19:13	5:01	19:10	5:01	9.85	
08/11/08	19:11	5:11	19:11	5:11	10.00	
08/12/08	19:10	5:03	19:23	5:03	9.67	
08/13/08	19:08	5:04	19:03	5:13	10.17	
08/14/08	19:07	5:05	18:59	5:10	10.18	
08/15/08	19:05	5:07	19:03	5:14	10.18	
08/16/08	19:04	5:08	19:04	5:15	10.18	
08/17/08	19:02	5:09	18:55	5:16	10.35	
08/18/08	19:01	5:10	18:58	5:28	10.50	
08/19/08	18:59	5:11	18:57	5:18	10.35	
08/20/08	18:57	5:12	18:50	5:20	10.50	
08/21/08	18:56	5:13	18:52	5:22	10.50	
08/22/08	18:54	5:14	18:47	5:17	10.50	
08/23/08	18:52	5:16	18:48	5:19	10.52	
08/24/08	18:51	5:17	18:47	5:17	10.50	
08/25/08	18:49	5:18	18:42	5:22	10.67	
08/26/08	18:47	5:19	18:40	5:21	10.68	
08/27/08	18:46	5:20	18:44	5:25	10.68	
08/28/08	18:44	5:21	18:43	5:24	10.68	
08/29/08	18:42	5:22	18:40	5:30	10.83	
08/30/08	18:40	5:24	18:31	5:31	11.00	
08/31/08	18:39	5:25	18:37	5:28	10.85	
09/01/08	18:37	5:26	18:38	5:39	11.02	
09/02/08	18:35	5:27	19:34	5:28	9.90	
09/03/08	18:33	5:28	18:29	5:39	11.17	
09/04/08	18:32	5:29	18:28	5:38	11.17	
09/05/08	18:30	5:30	18:35	5:35	11.00	
09/06/08						Power outage soon after data collection started
09/07/08	18:26	5:33	18:18	5:39	11.35	
09/08/08	18:24	5:34	18:27	5:38	11.18	
09/09/08	18:23	5:35	18:14	5:35	11.35	
09/10/08	18:21	5:36	18:12	5:43	11.52	
09/11/08	18:19	5:37	18:17	5:46	11.48	
09/12/08	18:17	5:38	18:08	5:39	11.52	
09/13/08	18:10	5:40	18:10	5:40	11.50	
09/14/08	18:13	5:41	18:16	5:47	11.52	
09/15/08	18:11	5:42	18:03	5:44	11.68	
09/16/08	18:10	5:43	18:07	5:48	11.68	
09/17/08	18:08	5:44	18:02	5:52	11.83	
09/18/08	18:06	5:45	17:58	5:49	11.85	
09/19/08	18:04	5:46	17:57	5:48	11.85	
09/20/08	18:02	5:47	17:59	5:49	11.83	
09/21/08	18:00	5:49	17:59	5:50	11.85	
09/22/08	17:59	5:50	17:52	5:53	12.02	
09/23/08	17:57	5:51	17:55	5:55	12.00	
09/24/08	17:55	5:52	17:27	8:58	15.52	
09/25/08	17:53	5:53	17:48	5:59	12.18	

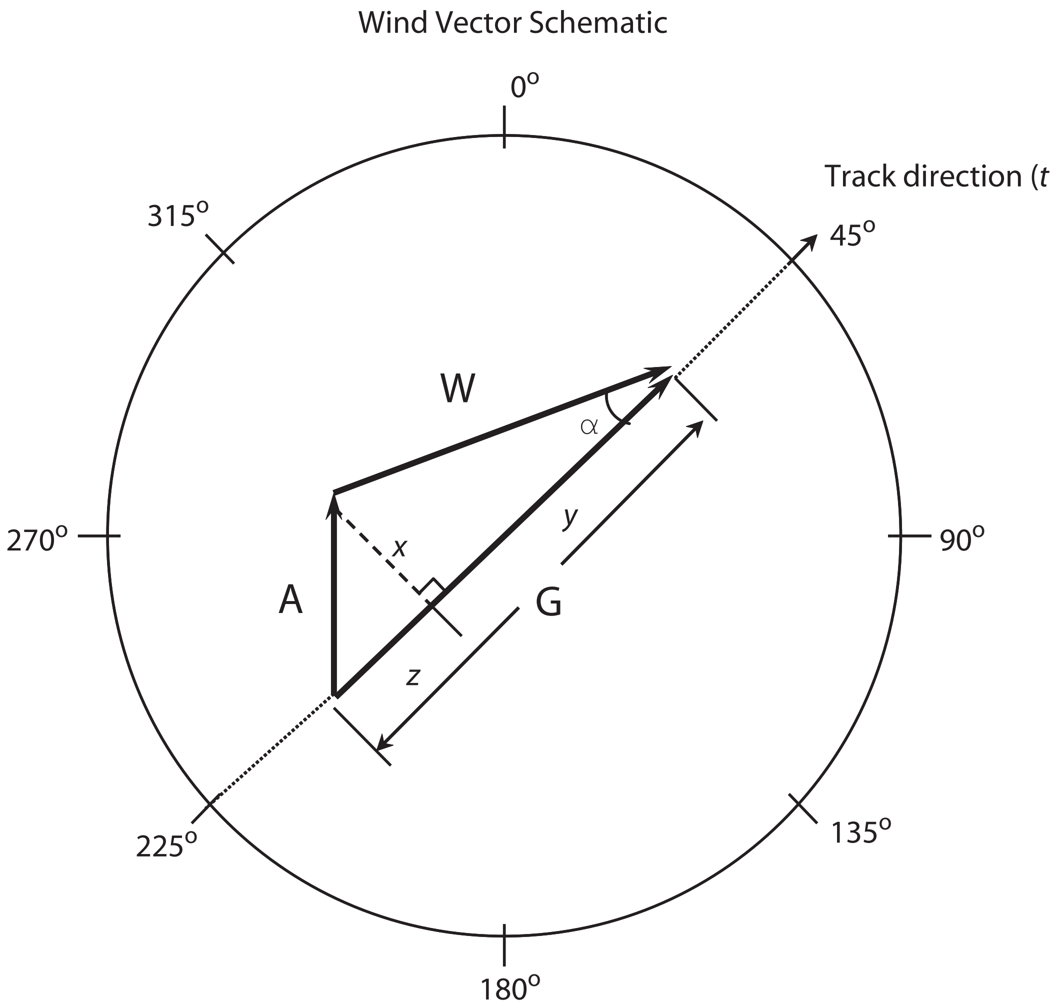
Appendix 5 (continued)

09/26/08	17:51	5:54	17:45	5:56	12.18
09/27/08	17:49	5:55	17:46	5:57	12.18
09/28/08	17:44	6:05	17:44	6:05	12.35
09/29/08	17:46	5:58	17:38	5:59	12.35
09/30/08	17:44	5:59	17:35	6:05	12.50

Appendix 6. Data collection dates, start/end times, sunset/sunrise times and survey hours for marine radar study conducted on 61 nights during the 2008 Fall/Late period at the Maple Ridge wind power facility, Lewis County, NY. Sunrise and sunset times are given in Eastern Daylight Time. Data were collected for a total of 595.778 hours (mean = 13.24 hours/night).

Date	Sunset time	Sunrise time	Data collection start time	Data collection end time	Data collection hours	Additional details
10/01/08	17:42	6:00	17:34	6:04	12.50	
10/02/08	17:40	6:01	17:32	6:03	12.52	
10/03/08	17:38	6:02	17:34	6:05	12.52	
10/04/08	17:37	6:04	17:35	6:06	12.52	
10/05/08	17:35	6:05	17:27	6:07	12.67	
10/06/08	17:33	6:06	17:28	6:09	12.68	
10/07/08	17:31	6:07	17:28	6:09	12.68	
10/08/08	17:25	6:16	17:25	6:16	12.85	
10/09/08	17:28	6:10	17:26	6:16	12.83	
10/10/08	17:26	6:11	17:24	6:14	12.83	
10/11/08	17:24	6:12	17:15	6:16	13.02	
10/12/08	17:23	6:13	17:16	6:17	13.02	
10/13/08	17:21	6:15	17:15	6:16	13.02	
10/14/08	17:19	6:16	17:19	6:19	13.00	
10/15/08	17:18	6:17	17:09	6:19	13.17	
10/16/08	17:16	6:18	17:32	6:23	12.85	
10/17/08	17:14	6:20	17:14	6:25	13.18	
10/18/08	17:13	6:21	17:05	6:26	13.35	
10/19/08	17:11	6:22	17:06	6:27	13.35	
10/20/08	17:09	6:23	17:07	6:28	13.35	
10/21/08	17:07	6:24	17:07	6:30	13.38	
10/22/08	17:06	6:26	17:04	6:35	13.52	
10/23/08	17:05	6:27	17:00	6:31	13.52	
10/24/08	17:01	6:31	17:01	6:31	13.50	
10/25/08	17:02	6:30	17:02	6:33	13.52	
10/26/08	17:00	6:31	16:53	6:34	13.68	
10/27/08	16:59	6:32	16:55	6:35	13.67	
10/28/08						Power outage soon after data collection started
10/29/08	16:56	6:35	16:51	6:42	13.85	
10/30/08	16:54	6:36	16:49	6:40	13.85	
10/31/08	16:53	6:38	16:47	6:38	13.85	
11/01/08	16:52	6:39	17:38	6:39	13.02	
11/02/08	16:50	6:40	17:40	6:40	13.00	
11/03/08	16:49	6:42	17:33	6:44	13.18	
11/04/08	16:48	6:43	17:34	6:45	13.18	
11/05/08	16:47	6:44	17:34	6:45	13.18	
11/06/08	16:45	6:45	17:33	6:54	13.35	
11/07/08	17:30	6:51	17:30	6:51	13.35	
11/08/08	16:44	6:47	17:21	6:52	13.52	
11/09/08	16:42	6:49	17:23	6:53	13.50	
11/10/08	16:41	6:51	17:20	7:00	13.67	
11/11/08	16:40	6:52	17:18	6:59	13.68	
11/12/08	16:39	6:53	17:17	6:58	13.68	
11/13/08	16:38	6:55	17:18	6:59	13.68	
11/14/08	16:37	6:56	17:16	6:57	13.68	
11/15/08	16:36	6:57	17:11	7:02	13.85	

Appendix 7



A schematic representation used to calculate head or tailwind vectors (THV) for birds flying in a fixed track direction (t) and with a constant air speed (after Piersma and Jukema 1990). If α is the angular difference between t and the wind direction (w), then $\alpha = w \pm 180^{o} - t$. If W is wind velocity, A is the bird's air velocity, and G is its ground velocity, then the 'wind effect,' ΔW (THV) = G - A. If birds try to remain on course then the heading of G is always along t. Following the schematic and rules of trigonometry, THV can be calculated as follows: $\sin\alpha = x/W$, therefore $x = W\sin\alpha$. Also, $z = \sqrt{(A^2 - x^2)}$, and so $z = \sqrt{\{A^2 - (W\sin\alpha)^2\}}$. Additionally, $\cos\alpha = y/W$, and therefore $y = W\cos\alpha$. Because $G = y + z$, it follows that:

$$G = W\cos\alpha + \sqrt{\{A^2 - (W\sin\alpha)^2\}}.$$

Similarly, because $\Delta W(\text{THV}) = G - A$, it follows that:

$$\Delta W = W\cos\alpha + \sqrt{\{A^2 - (W\sin\alpha)^2\}} - A.$$

Appendix 8. Results of Pearson's product moment correlation analyses evaluating National Weather Service local climatological data for Watertown, NY, Spring 2007 (25 April - 15 June) at or near sunset. Matrix values represent pairwise correlation coefficients (upper) and their corresponding P-values (lower). Bolded values are correlation coefficients that exceed the 0.50. We use this threshhold to determine what variables cannot occur together in General Linear Model procedures and multiple model inference analyses that investigate relationships between bird/bat flight behavior (e.g., passage magnitude and rate, altitude) and local weather variables.

	Julian	AsinCC	Ceil	Vis	Precip	Temp	DP	BP	THV42	THV360	SWV42	SWV360
Julian	1											
AsinCC	-0.28752 0.0429	1										
Ceil	0.14654 0.3099	**-0.66578** <.0001	1									
Vis	-0.19409 0.1768	-0.07469 0.6062	0.4272 0.002	1								
Precip	0.16541 0.251	0.08627 0.5514	**-0.50035** 0.0002	**-0.69117** <.0001	1							
Temp	**0.55374** <.0001	-0.16232 0.2601	0.11905 0.4103	-0.42115 0.0023	0.25555 0.0733	1						
DP	**0.61671** <.0001	0.07567 0.6015	-0.26681 0.0611	**-0.55028** <.0001	0.40542 0.0035	**0.72538** <.0001	1					
BP	-0.09028 0.533	-0.30489 0.0313	**0.51846** 0.0001	0.36232 0.0097	-0.28798 0.0426	-0.25509 0.0738	**-0.54612** <.0001	1				
THV(42)[a]	-0.09483 0.5124	-0.05569 0.7009	-0.03088 0.8314	-0.27453 0.0537	0.20876 0.1457	0.01016 0.9441	0.17439 0.2258	-0.08465 0.5589	1			
THV(360)[b]	0.04038 0.7807	-0.13033 0.367	0.00234 0.9871	-0.20676 0.1497	0.17146 0.2338	0.05237 0.7179	0.23333 0.1029	-0.14163 0.3265	**0.8879** <.0001	1		
SWV(42)[c]	0.22377 0.1183	-0.1068 0.4604	0.06821 0.6379	0.17553 0.2227	-0.0789 0.586	0.01858 0.8981	-0.03684 0.7995	-0.05485 0.7052	-0.39635 0.0044	0.03007 0.8358	1	
SWV(360)[b]	-0.18985 0.1867	0.02042 0.8881	-0.02745 0.8499	-0.26375 0.0642	0.17059 0.2362	0.00064 0.9965	0.10402 0.4722	-0.01206 0.9337	**0.87657** <.0001	**0.56502** <.0001	**-0.7219** <.0001	1

[a] THV=Tailwind/Headwind Vector. Numbers in parentheses assumed to be the directional goal of movement based on analysis of data collected with horizontally-oriented radar (see Fig. 43, upper)

[b] Number in parentheses represents generalized and seasonally appropriate directional goal (e.g., spring [North-360°])

[c] SWV=Sidewind Vector. Numbers in parentheses assumed to be the directional goal of movement. Based on analysis of data collected with horizontally-oriented radar (see Fig. 43, upper)

Appendix 9. Results of Pearson's product moment correlation analyses evaluating National Weather Service local climatological data for Watertown, NY, Fall/Early 2007 (31 July - 30 September) at or near sunset. Matrix values represent pairwise correlation coefficients (upper) and their corresponding P-values (lower). Bolded values are correlation coefficients that exceed the 0.50. We use this threshhold to determine what variables cannot occur together in General Linear Model procedures and multiple model inference analyses that investigate relationships between bird/bat flight behavior (e.g., passage magnitude and rate, altitude) and local weather variables.

	Julian	AsinCC	Ceil	Vis	Precip	Temp	DP	BP	THV42	THV360	SWV42	SWV360
Julian	1											
AsinCC	-0.00793	1										
	0.9516											
Ceil	0.04292	**-0.77479**	1									
	0.7426	<.0001										
Vis	-0.1616	-0.12327	0.36846	1								
	0.2134	0.3439	0.0035									
Precip	0.10258	0.29687	**-0.51267**	**-0.5035**	1							
	0.4315	0.0202	<.0001	<.0001								
Temp	-0.40185	0.00329	0.0747	0.02272	-0.34882	1						
	0.0013	0.9799	0.5672	0.862	0.0059							
DP	-0.40544	0.30624	-0.28498	-0.24194	-0.00146	**0.70852**	1					
	0.0012	0.0164	0.026	0.0603	0.9911	<.0001						
BP	0.3973	-0.35771	0.21934	0.11624	-0.10697	**-0.58118**	**-0.65216**	1				
	0.0015	0.0047	0.0894	0.3723	0.4119	<.0001	<.0001					
THV(197)[a]	-0.0928	-0.13767	-0.0453	-0.13289	0.1092	-0.24871	-0.23754	0.31506	1			
	0.4769	0.29	0.7289	0.3073	0.4022	0.0533	0.0653	0.0134				
THV(360)[b]	-0.13398	-0.14221	-0.06478	-0.06466	0.13932	-0.2109	-0.22709	0.3294	**0.85165**	1		
	0.3033	0.2743	0.6199	0.6205	0.2842	0.1028	0.0784	0.0095	<.0001			
SWV(197)[c]	-0.0101	-0.10436	0.10904	0.17155	-0.03069	-0.0732	-0.1545	-0.05325	-0.3999	-0.24323	1	
	0.9384	0.4235	0.4029	0.1862	0.8143	0.5751	0.2345	0.6836	0.0014	0.0589		
SWV(360)[b]	0.00922	-0.04055	0.11301	0.14629	-0.01498	0.07823	-0.06549	-0.19062	-0.34357	-0.29169	**0.75956**	1
	0.9438	0.7564	0.3858	0.2606	0.9088	0.549	0.6161	0.1411	0.0067	0.0226	<.0001	

[a] THV=Tailwind/Headwind Vector. Numbers in parentheses assumed to be the directional goal of movement based on analysis of data collected with horizontally-oriented radar (see Fig. 44, upper)

[b] Number in parentheses represents generalized and seasonally appropriate directional goal (e.g., fall [South-180°])

[c] SWV=Sidewind Vector. Numbers in parentheses assumed to be the directional goal of movement. Based on analysis of data collected with horizontally-oriented radar (see Fig. 44, upper)

Appendix 10. Results of Pearson's product moment correlation analyses evaluating National Weather Service local climatological data for Watertown, NY, Fall/Late 2007 (1 October - 15 November) at or near sunset. Matrix values represent pairwise correlation coefficients (upper) and their corresponding P-values (lower). Bolded values are correlation coefficients that exceed the 0.50. We use this threshhold to determine what variables cannot occur together in General Linear Model procedures and multiple model inference analyses that investigate relationships between bird/bat flight behavior (e.g., passage magnitude and rate, altitude) and local weather variables.

	Julian	AsinCC	Ceil	Vis	Precip	Temp	DP	BP	THV42	THV360	SWV42	SWV360
Julian	1											
AsinCC	-0.26288	1										
	0.0847											
Ceil	0.05137	**-0.61732**	1									
	0.7405	<.0001										
Vis	0.35009	-0.21331	0.3702	1								
	0.0198	0.1644	0.0134									
Precip	-0.24846	0.18489	-0.40985	**-0.87481**	1							
	0.1039	0.2296	0.0057	<.0001								
Temp	**-0.72621**	-0.00522	0.08539	-0.28271	0.15562	1						
	<.0001	0.9732	0.5815	0.063	0.3131							
DP	-0.70941	0.16668	-0.24151	-0.48619	0.40644	**0.82629**	1					
	<.0001	0.2795	0.1143	0.0008	0.0062	<.0001						
BP	-0.11138	-0.09888	0.4265	0.29504	-0.37377	-0.12313	-0.29174	1				
	0.4716	0.5231	0.0039	0.0519	0.0124	0.4259	0.0547					
THV(212)[a]	-0.18599	0.03449	-0.05356	-0.35233	0.28935	-0.12491	-0.0672	0.23488	1			
	0.2267	0.8241	0.7299	0.019	0.0568	0.4191	0.6647	0.1248				
THV(360)[b]	-0.22466	0.07598	-0.09898	-0.35157	0.286	-0.16465	-0.08298	0.24046	**0.9168**	1		
	0.1426	0.624	0.5227	0.0193	0.0598	0.2855	0.5923	0.1159	<.0001			
SWV(212)[c]	0.1405	0.19392	-0.18758	0.1889	-0.13157	-0.30994	-0.29333	0.0613	-0.22753	-0.00097	1	
	0.363	0.2072	0.2227	0.2194	0.3946	0.0406	0.0533	0.6926	0.1374	0.995		
SWV(360)[b]	0.01039	0.15814	-0.05573	0.0572	-0.20427	0.01688	0.03668	-0.04044	-0.49141	-0.27064	0.47466	1
	0.9466	0.3052	0.7194	0.7123	0.1835	0.9134	0.8131	0.7944	0.0007	0.0756	0.0011	

[a] THV=Tailwind/Headwind Vector. Numbers in parentheses assumed to be the directional goal of movement based on analysis of data collected with horizontally-oriented radar (see Fig. 45, upper)

[b] Number in parentheses represents generalized and seasonally appropriate directional goal (e.g., fall [South-180°])

[c] SWV=Sidewind Vector. Numbers in parentheses assumed to be the directional goal of movement. Based on analysis of data collected with horizontally-oriented radar (see Fig. 45, upper)

Appendix 11. Results of Pearson's product moment correlation analyses evaluating National Weather Service local climatological data for Watertown, NY, Spring 2008 (11 April - 15 June) at or near sunset. Matrix values represent pairwise correlation coefficients (upper) and their corresponding P-values (lower). Bolded values are correlation coefficients that exceed the 0.50. We use this threshhold to determine what variables cannot occur together in General Linear Model procedures and multiple model inference analyses that investigate relationships between bird/bat flight behavior (e.g., passage magnitude and rate, altitude) and local weather variables.

	Julian	AsinCC	Ceil	Vis	Precip	Temp	DP	BP	THV42	THV360	SWV42	SWV360
Julian	1											
AsinCC	0.04032 0.7557	1										
Ceil	-0.12394 0.3372	**-0.70542** <.0001	1									
Vis	0.1241 0.3365	-0.07333 0.5711	0.3573 0.0044	1								
Precip	0.00796 0.951	0.2663 0.0364	-0.40806 0.001	**-0.65659** <.0001	1							
Temp	0.40485 0.0011	-0.09802 0.4485	0.07684 0.5528	0.02962 0.8192	0.09449 0.4651	1						
DP	**0.67599** <.0001	0.14148 0.2727	-0.33519 0.0077	-0.1845 0.1511	0.28952 0.0225	**0.73538** <.0001	1					
BP	-0.21991 0.0859	-0.33005 0.0088	0.42006 0.0007	0.05449 0.674	-0.04351 0.737	0.0058 0.9643	-0.2226 0.082	1				
THV(44)[a]	0.27659 0.0295	-0.09355 0.4695	0.04043 0.755	0.07675 0.5532	-0.16527 0.1992	-0.03694 0.7756	0.12405 0.3368	-0.09723 0.4522	1			
THV(360)[b]	0.28745 0.0235	-0.11969 0.3541	0.07616 0.5563	-0.01582 0.9029	0.00198 0.9878	0.18071 0.1599	0.26759 0.0355	-0.0053 0.9674	**0.75004** <.0001	1		
SWV(44)[c]	0.06266 0.6285	-0.05415 0.6759	0.07997 0.5367	-0.12166 0.3462	0.23074 0.0712	0.32129 0.0109	0.19083 0.1374	0.07812 0.5462	-0.39374 0.0015	0.27845 0.0284	1	
SWV(360)[b]	0.15064 0.2425	-0.04469 0.7302	0.01322 0.9188	0.12694 0.3255	-0.23343 0.0679	-0.20331 0.113	-0.04038 0.7553	-0.08296 0.5215	**0.85917** <.0001	0.32917 0.009	**-0.7651** <.0001	1

[a] THV=Tailwind/Headwind Vector. Numbers in parentheses assumed to be the directional goal of movement based on analysis of data collected with horizontally-oriented radar (see Fig. 43, lower)

[b] Number in parentheses represents generalized and seasonally appropriate directional goal (e.g., spring [North-360°])

[c] SWV=Sidewind Vector. Numbers in parentheses assumed to be the directional goal of movement. Based on analysis of data collected with horizontally-oriented radar (see Fig. 43, lower)

Appendix 12. Results of Pearson's product moment correlation analyses evaluating National Weather Service local climatological data for Watertown, NY, Fall/Early 2008 (31 July - 30 September) at or near sunset. Matrix values represent pairwise correlation coefficients (upper) and their corresponding P-values (lower). Bolded values are correlation coefficients that exceed the 0.50. We use this threshhold to determine what variables cannot occur together in General Linear Model procedures and multiple model inference analyses that investigate relationships between bird/bat flight behavior (e.g., passage magnitude and rate, altitude) and local weather variables.

	Julian	AsinCC	Ceil	Vis	Precip	Temp	DP	BP	THV42	THV360	SWV42	SWV360
Julian	1											
AsinCC	0.05327 0.6835	1										
Ceil	-0.23592 0.0672	**-0.80513** <.0001	1									
Vis	-0.06367 0.6259	-0.323 0.0111	0.42175 0.0007	1								
Precip	0.01669 0.8984	0.23276 0.071	-0.33961 0.0074	**-0.87675** <.0001	1							
Temp	-0.4677 0.0001	0.16889 0.1932	-0.06673 0.6094	-0.07655 0.5576	0.04081 0.7548	1						
DP	-0.39179 0.0018	0.26773 0.037	-0.24561 0.0564	-0.22891 0.076	0.21132 0.1021	**0.87098** <.0001	1					
BP	**0.54832** <.0001	-0.27917 0.0293	0.21017 0.104	0.22467 0.0817	-0.27054 0.035	**-0.60707** <.0001	**-0.62894** <.0001	1				
THV(203)[a]	0.07173 0.5827	-0.15811 0.2236	0.03747 0.7744	0.23738 0.0655	-0.19083 0.1407	-0.40127 0.0014	-0.29259 0.0221	0.23932 0.0632	1			
THV(360)[b]	0.05138 0.6941	-0.19388 0.1344	0.09927 0.4466	0.28305 0.0271	-0.20559 0.1119	-0.39571 0.0016	-0.2933 0.0218	0.27513 0.0319	**0.95792** <.0001	1		
SWV(203)[c]	-0.25859 0.0442	-0.05921 0.6503	0.0699 0.5924	0.11623 0.3724	-0.02371 0.856	0.32336 0.011	0.35262 0.0053	-0.09078 0.4866	-0.10189 0.4346	0.07759 0.5523	1	
SWV(360)[b]	-0.16523 0.2032	-0.10282 0.4304	0.02558 0.8448	0.14538 0.2636	-0.14037 0.2806	0.23978 0.0627	0.20008 0.1221	0.00962 0.9414	-0.22624 0.0796	-0.15504 0.2328	**0.68796** <.0001	1

[a] THV=Tailwind/Headwind Vector. Numbers in parentheses assumed to be the directional goal of movement based on analysis of data collected with horizontally-oriented radar (see Fig. 44, upper)

[b] Number in parentheses represents generalized and seasonally appropriate directional goal (e.g., fall [South-180°])

[c] SWV=Sidewind Vector. Numbers in parentheses assumed to be the directional goal of movement. Based on analysis of data collected with horizontally-oriented radar (see Fig. 44, upper)

Appendix 13. Results of Pearson's product moment correlation analyses evaluating National Weather Service local climatological data for Watertown, NY, Fall/Late 2008 (1 October - 15 November) at or near sunset. Matrix values represent pairwise correlation coefficients (upper) and their corresponding P-values (lower). Bolded values are correlation coefficients that exceed the 0.50. We use this threshhold to determine what variables cannot occur together in General Linear Model procedures and multiple model inference analyses that investigate relationships between bird/bat flight behavior (e.g., passage magnitude and rate, altitude) and local weather variables.

	Julian	AsinCC	Ceil	Vis	Precip	Temp	DP	BP	THV42	THV360	SWV42	SWV360
Julian	1											
AsinCC	0.14128 0.3603	1										
Ceil	-0.20106 0.1906	**-0.73081** <.0001	1									
Vis	-0.24167 0.114	-0.06725 0.6645	0.37739 0.0116	1								
Precip	-0.08061 0.603	0.15141 0.3265	-0.43885 0.0029	**-0.6658** <.0001	1							
Temp	-0.28788 0.0581	-0.08037 0.604	0.05278 0.7336	-0.06848 0.6587	0.18659 0.2252	1						
DP	-0.27115 0.075	0.01657 0.915	-0.13789 0.3721	-0.24033 0.1161	0.37038 0.0133	**0.87704** <.0001	1					
BP	-0.18867 0.22	-0.43009 0.0036	0.66684 <.0001	0.43547 0.0031	-0.49533 0.0006	-0.27374 0.0722	-0.39561 0.0079	1				
THV(205)[a]	0.09508 0.5393	-0.2766 0.0691	0.31156 0.0395	-0.22488 0.1422	0.09601 0.5353	-0.23004 0.133	-0.23048 0.1323	0.33188 0.0277	1			
THV(360)[b]	0.02626 0.8657	-0.17749 0.2491	0.25509 0.0947	-0.20977 0.1717	0.0693 0.6549	-0.29477 0.0521	-0.28807 0.0579	0.29022 0.056	**0.93799** <.0001	1		
SWV(205)[c]	0.02194 0.8876	0.40447 0.0065	-0.24064 0.1156	0.26635 0.0805	-0.15638 0.3107	-0.08491 0.5837	-0.10249 0.508	-0.23043 0.1324	**-0.63533** <.0001	-0.40995 0.0057	1	
SWV(360)[b]	-0.07207 0.642	0.22052 0.1503	-0.20291 0.1865	0.10423 0.5007	-0.12281 0.4271	-0.13936 0.367	-0.10459 0.4993	-0.20535 0.1811	**-0.54306** 0.0001	-0.29492 0.052	**0.80733** <.0001	1

[a] THV=Tailwind/Headwind Vector. Numbers in parentheses assumed to be the directional goal of movement based on analysis of data collected with horizontally-oriented radar (see Fig. 45, upper)

[b] Number in parentheses represents generalized and seasonally appropriate directional goal (e.g., fall [South-180°])

[c] SWV=Sidewind Vector. Numbers in parentheses assumed to be the directional goal of movement. Based on analysis of data collected with horizontally-oriented radar (see Fig. 45, upper)

Appendix 14. Weather variables used in "expanded" models to investigate relationships between flight dynamics response variables (movement magnitude, rate and altitude), date within season and local-scale meteorological condition. Expanded-1 and -4 models consist of uncorrelated weather variables (i.e., determined using Peason product-moment analysis, see Appendices 8-13). Expanded-2 and -5 models include Julian day, all uncorrelated weather variables except if they were correlated with Julian day. Expanded-3 and -6 models are the same as Expanded-2 and -5 models but the quadratic term of Julian day was used instead of the linear term.

	Expanded-1	Expanded-2	Expanded-3	Expanded-4	Expanded-5	Expanded-6
Spring 2007						
	Cloud cover	Julian day (linear)	Julian day (quadratic)	Cloud cover	Julian day (linear)	Julian day (quadratic)
	Visibility	Cloud cover	Cloud cover	Visibility	Cloud cover	Cloud cover
	Temperature	Visibility	Visibility	Dry Bulb Temperature	Visibility	Visibility
	Barometric Pressure	Barometric Pressure	Barometric Pressure	Barometric Pressure	Barometric Pressure	Barometric Pressure
	THV (44)[a]	THV (44)[a]	THV (44)[a]	THV (360)[c]	THV (360)[c]	THV (360)[c]
	SWV (44)[b]	SWV (44)[b]	SWV (44)[b]	SWV (360)[c]	SWV (360)[c]	SWV (360)[c]
Fall/Early 2007	Cloud cover	Julian day (linear)	Julian day (quadratic)	Cloud cover	Julian day (linear)	Julian day (quadratic)
	Visibility	Cloud cover	Cloud cover	Visibility	Cloud cover	Cloud cover
	Barometric Pressure	Visibility	Visibility	Barometric Pressure	Visibility	Visibility
	THV (197)[a]	Barometric Pressure	Barometric Pressure	THV (180)[c]	Barometric Pressure	Barometric Pressure
	SWV (197)[b]	THV (197)[a]	THV (197)[a]	SWV (180)[c]	THV (180)[c]	THV (180)[c]
		SWV (197)[b]	SWV (197)[b]		SWV (180)[c]	SWV (180)[c]
Fall/Late 2007	Cloud cover	Julian day (linear)	Julian day (quadratic)	Cloud cover	Julian day (linear)	Julian day (quadratic)
	Visibility	Cloud cover	Cloud cover	Visibility	Cloud cover	Cloud cover
	Temperature	Visibility	Visibility	Temperature	Visibility	Visibility
	Barometric Pressure	Barometric Pressure	Barometric Pressure	Barometric Pressure	Barometric Pressure	Barometric Pressure
	THV (212)[a]	THV (212)[a]	THV (212)[a]	THV (180)[c]	THV (180)[c]	THV (180)[c]
	SWV (212)[b]	SWV (212)[b]	SWV (212)[b]	SWV (180)[c]	SWV (180)[c]	SWV (180)[c]
Spring 2008	Cloud cover	Julian day (linear)	Julian day (quadratic)	Cloud cover	Julian day (linear)	Julian day (quadratic)
	Visibility	Cloud cover	Cloud cover	Visibility	Cloud cover	Cloud cover
	Temperature	Visibility	Visibility	Temperature	Visibility	Visibility
	Barometric Pressure	Temperature	Temperature	Barometric Pressure	Temperature	Temperature
	THV (41)[a]	Barometric Pressure	Barometric Pressure	THV (360)[c]	Barometric Pressure	Barometric Pressure
	SWV (41)[b]	THV (41)[a]	THV (41)[a]	SWV (360)[c]	THV (360)[c]	THV (360)[c]
		SWV (41)[b]	SWV (41)[b]		SWV (360)[c]	SWV (360)[c]
Fall/Early 2008	Cloud cover	Julian day (linear)	Julian day (quadratic)	Cloud cover	Julian day (linear)	Julian day (quadratic)
	Visibility	Cloud cover	Cloud cover	Visibility	Cloud cover	Cloud cover
	Temperature	Visibility	Visibility	Temperature	Visibility	Visibility
	THV (203)[a]	Temperature	Temperature	THV (180)[c]	Temperature	Temperature
	SWV (203)[b]	THV (203)[a]	THV (203)[a]	SWV (180)[c]	THV (180)[c]	THV (180)[c]
		SWV (203)[b]	SWV (203)[b]		SWV (180)[c]	SWV (180)[c]

Appendix 14 (continued)

Fall/Late 2008	Cloud cover Visibility Temperature Barometric Pressure THV (205)[a]	Julian day (linear) Cloud cover Visibility Temperature Barometric Pressure THV (205)[a]	Julian day (quadratic) Cloud cover Visibility Temperature Barometric Pressure THV (205)[a]	Cloud cover Visibility Temperature Barometric Pressure THV (180)[c] SWV (180)[c]	Julian day (linear) Cloud cover Visibility Temperature Barometric Pressure THV (180)[c] SWV (180)[c]	Julian day (quadratic) Cloud cover Visibility Temperature Barometric Pressure THV (180)[c] SWV (180)[c]

[a] Tailwind/Headwind Vector. Numbers in parentheses assumed to be the directional goal (i.e., in degrees) of movement based on analysis of data collected with horizontally-oriented radar (see Figs. 43-45)

[b] Side Wind Vector. Numbers in parentheses assumed to be the directional goal (i.e., in degrees) of movement based on analysis of data collected with horizontally-oriented radar (see Figs. 43-45)

[c] Number in parentheses represent generalized and seasonally appropriate directional goal (e.g., spring [North-360°], fall [South-180°])

Appendix 15. Summary statistics for each Season/Period of data collection. Data collected during radar study conducted at the Maple Ridge Wind Power Facility to monitor bird and bat movement patterns and flight dynamics

Season/Period	Variable	N	Mean	Standard error	Standard deviation	Lower95%	Upper95%	Minimum	Maximum
Spring 2007									
	Targets recorded (TR)	50	1908.78	241.56	1708.12	1423.34	2394.22	40.00	7246.00
	Log-transformedTR	50	3.05	0.08	0.54	2.89	3.20	1.60	3.86
	Targets recorded/hr (TR/hr)	50	156.06	20.16	142.53	115.55	196.56	2.93	613.73
	Log-transformed TR/hr	50	1.95	0.08	0.56	1.79	2.11	0.47	2.79
	Proportion of targets recorded ≤ 100 m (PROP100)	50	0.17	0.02	0.15	0.13	0.21	0.02	0.85
	Arcsine-transformed PROP100	50	0.40	0.03	0.19	0.35	0.45	0.15	1.17
	Proportion of targets recorded > 100 m or ≤ 200 m (PROP200)	50	187.89	22.14	156.57	143.40	232.39	16.54	753.31
	Arcsine-transformed PROP200	50	2.14	0.05	0.36	2.04	2.24	1.22	2.88
	Targets recorded ≤ 100 m (TR100)	50	0.20	0.01	0.09	0.18	0.23	0.02	0.37
	Log-transformed TR100	50	0.46	0.02	0.11	0.42	0.49	0.14	0.66
	Targets recorded 100 m or ≤ 200 m (TR200)	50	331.10	39.89	282.06	250.94	411.27	1.85	1326.69
	Log-transformed TR200	50	2.30	0.08	0.56	2.14	2.46	0.27	3.12
Fall/Early 2007									
	Targets recorded (TR)	61	3129.89	393.78	3075.54	2342.20	3917.57	346.00	12225.00
	Log-transformedTR	61	3.30	0.05	0.42	3.20	3.41	2.54	4.09
	Targets recorded/hr (TR/hr)	61	220.69	28.57	223.14	163.55	277.84	22.02	895.05
	Log-transformed TR/hr	61	2.14	0.06	0.43	2.03	2.25	1.34	2.95
	Proportion of targets recorded ≤ 100 m (PROP100)	61	0.07	0.00	0.02	0.07	0.08	0.03	0.12
	Arcsine-transformed PROP100	61	0.27	0.01	0.05	0.26	0.28	0.17	0.36
	Proportion of targets recorded > 100 m or ≤ 200 m (PROP200)	61	208.80	28.73	224.39	151.33	266.27	21.05	1139.34
	Arcsinetransformed PROP200	61	2.14	0.05	0.40	2.04	2.24	1.32	3.06
	Targets recorded ≤ 100 m (TR100)	61	0.13	0.00	0.03	0.12	0.14	0.06	0.20
	Log-transformed TR100	61	0.37	0.01	0.05	0.35	0.38	0.25	0.46
	Targets recorded 100 m or ≤ 200 m (TR200)	61	370.78	46.26	361.26	278.26	463.30	50.45	1702.04
	Log-transformed TR200	61	2.40	0.05	0.39	2.30	2.50	1.70	3.23
Fall/Late 2007									
	Targets recorded (TR)	44	1643.66	314.64	2087.06	1009.14	2278.18	19.00	10703.00
	Log-transformedTR	44	2.91	0.08	0.56	2.74	3.08	1.28	4.03
	Targets recorded/hr (TR/hr)	44	92.80	18.04	119.69	56.41	129.19	1.03	608.33
	Log-transformed TR/hr	44	1.65	0.09	0.57	1.48	1.83	0.01	2.78
	Proportion of targets recorded ≤ 100 m (PROP100)	44	0.12	0.01	0.10	0.09	0.15	0.01	0.45
	Arcsine-transformed PROP100	44	0.34	0.02	0.13	0.30	0.38	0.12	0.74
	Proportion of targets recorded > 100 m or ≤ 200 m (PROP200)	44	150.13	28.64	189.98	92.38	207.89	3.43	1056.96
	Arcsinetransformed PROP200	44	1.90	0.08	0.53	1.74	2.06	0.54	3.02
	Targets recorded ≤ 100 m (TR100)	44	0.12	0.01	0.06	0.11	0.14	0.01	0.35
	Log-transformed TR100	44	0.35	0.01	0.08	0.33	0.38	0.10	0.63
	Targets recorded 100 m or ≤ 200 m (TR200)	44	196.37	39.71	263.38	116.29	276.44	1.84	1418.61
	Log-transformed TR200	44	1.96	0.09	0.60	1.78	2.14	0.26	3.15

Appendix 15. (continued)

Spring 2008									
	Targets recorded (TR)	62	1217.65	124.71	981.98	968.27	1467.02	69.00	4264.00
	Log-transformedTR	62	2.93	0.05	0.41	2.82	3.03	1.84	3.63
	Targets recorded/hr (TR/hr)	62	92.12	9.35	73.60	73.43	110.81	4.66	334.28
	Log-transformed TR/hr	62	1.81	0.05	0.41	1.71	1.91	0.67	2.52
	Proportion of targets recorded ≤ 100 m (PROP100)	62	0.11	0.01	0.07	0.10	0.13	0.02	0.30
	Arcsine-transformed PROP100	62	0.33	0.01	0.11	0.30	0.36	0.14	0.58
	Proportion of targets recorded 100 m or ≤ 200 m (PROP200)	62	110.57	13.14	103.43	84.31	136.84	12.01	489.91
	Arcsinetransformed PROP200	62	1.89	0.05	0.36	1.80	1.99	1.08	2.69
	Targets recorded 100 m (TR100)	62	0.15	0.01	0.07	0.13	0.17	0.04	0.44
	Log-transformed TR100	62	0.39	0.01	0.10	0.36	0.41	0.20	0.72
	Targets recorded 100 m or 200 m (TR200)	62	161.37	17.21	135.53	126.95	195.79	11.90	614.47
	Log-transformed TR200	62	2.06	0.05	0.39	1.96	2.16	1.08	2.79
Fall/Early 2008									
	Targets recorded (TR)	61	1195.21	153.98	1202.61	887.21	1503.22	5.00	7698.00
	Log-transformedTR	61	2.83	0.08	0.60	2.68	2.98	0.70	3.89
	Targets recorded/hr (TR/hr)	61	78.51	9.68	75.60	59.15	97.87	0.31	467.69
	Log-transformed TR/hr	61	1.65	0.08	0.60	1.49	1.80	-0.51	2.67
	Proportion of targets recorded ≤ 100 m (PROP100)	61	0.12	0.01	0.05	0.10	0.13	0.04	0.30
	Arcsine-transformed PROP100	61	0.34	0.01	0.08	0.32	0.36	0.19	0.58
	Proportion of targets recorded 100 m or ≤ 200 m (PROP200)	61	117.18	15.08	117.81	87.01	147.36	0.66	810.89
	Arcsinetransformed PROP200	61	1.85	0.07	0.56	1.71	2.00	-0.18	2.91
	Targets recorded 100 m (TR100)	61	0.17	0.01	0.07	0.15	0.18	0.07	0.45
	Log-transformed TR100	61	0.41	0.01	0.09	0.39	0.44	0.27	0.74
	Targets recorded 100 m or 200 m (TR200)	61	167.75	21.39	167.09	124.96	210.54	1.48	1162.85
	Log-transformed TR200	61	2.02	0.07	0.53	1.89	2.16	0.17	3.07
Fall/Late 2008									
	Targets recorded (TR)	44	297.45	2.07	13.71	293.29	301.62	275.00	320.00
	Log-transformedTR	44	1579.98	313.70	2080.84	947.34	2212.61	30.00	7208.00
	Targets recorded/hr (TR/hr)	44	2.76	0.10	0.69	2.55	2.97	1.48	3.86
	Log-transformed TR/hr	44	88.30	17.83	118.28	52.34	124.26	1.68	414.59
	Proportion of targets recorded ≤ 100 m (PROP100)	44	1.50	0.10	0.70	1.28	1.71	0.23	2.62
	Arcsine-transformed PROP100	44	0.16	0.02	0.10	0.12	0.19	0.05	0.60
	Proportion of targets recorded 100 m or ≤ 200 m (PROP200)	44	0.39	0.02	0.13	0.35	0.43	0.21	0.88
	Arcsinetransformed PROP200	44	174.77	31.54	209.19	111.17	238.37	2.61	813.49
	Targets recorded 100 m (TR100)	44	1.88	0.10	0.64	1.69	2.07	0.42	2.91
	Log-transformed TR100	44	0.18	0.02	0.12	0.14	0.21	0.02	0.51
	Targets recorded 100 m or 200 m (TR200)	44	0.42	0.02	0.15	0.38	0.47	0.15	0.80
	Log-transformed TR200	44	243.49	47.68	316.29	147.33	339.65	3.90	1076.89
		44	1.93	0.11	0.71	1.71	2.15	0.59	3.03

Appendix 16. Mean vectors, vector lengths and results of first-order circular statistics for data collected with the horizontally-oriented radar at the Maple Ridge Wind Power Facility, Spring 2007.

Date	N	Mean vector (μ, in degress)	Standard error mean vector (μ, in degress)	Mean vector length (r)	Rayleigh's Z	*P*
04/25/07	81	12.94	12.86	0.34	9.33	<0.0001
04/26/07	36	345.92	14.25	0.45	7.23	0.0005
04/27/07	19	120.35	93.02	0.10	0.19	0.83
04/28/07	3	203.68	32.30	0.68	1.39	0.27
04/29/07	151	31.40	3.88	0.71	75.31	<0.0001
04/30/07	108	51.94	6.57	0.54	31.80	<0.0001
05/01/07	34	298.56	23.91	0.29	2.75	0.063
05/02/07	243	56.15	2.30	0.82	163.21	<0.0001
05/03/07	263	47.17	1.75	0.88	205.55	<0.0001
05/04/07	273	50.77	1.54	0.91	224.15	<0.0001
05/05/07	60	23.17	10.40	0.47	13.41	<0.0001
05/06/07	212	24.51	2.32	0.84	148.92	<0.0001
05/07/07	154	33.37	2.59	0.85	112.27	<0.0001
05/08/07	269	48.13	2.50	0.77	159.46	<0.0001
05/09/07	160	335.11	7.62	0.40	25.87	<0.0001
05/10/07	142	27.36	5.44	0.57	45.60	<0.0001
05/11/07	75	50.27	7.79	0.55	22.58	<0.0001
05/12/07	56	12.35	10.55	0.48	12.96	<0.0001
05/13/07	142	53.45	3.10	0.81	92.99	<0.0001
05/14/07	139	13.68	2.75	0.85	100.60	<0.0001
05/15/07	103	21.16	9.42	0.41	16.91	<0.0001
05/16/07	18	105.47	26.56	0.35	2.18	0.11
05/17/07	136	349.07	11.42	0.30	12.02	<0.0001
05/18/07	280	50.15	2.01	0.84	197.61	<0.0001
05/19/07	432	53.94	1.24	0.90	352.87	<0.0001
05/20/07	7	77.71	169.67	0.27	0.52	0.61
05/21/07	237	42.12	1.71	0.90	191.57	<0.0001
05/22/07	159	16.37	6.03	0.50	39.32	<0.0001
05/23/07	328	33.46	3.05	0.64	134.47	<0.0001
05/24/07	252	51.43	2.67	0.76	143.96	<0.0001
05/25/07	133	81.56	6.82	0.48	30.98	<0.0001
05/26/07	149	1.93	14.88	0.22	7.23	0.0007
05/27/07	114	48.20	6.75	0.52	30.89	<0.0001
05/28/07	188	59.55	4.36	0.60	68.38	<0.0001
05/29/07	165	26.45	4.80	0.59	57.36	<0.0001
05/30/07	230	62.04	2.73	0.77	134.96	<0.0001
05/31/07	256	58.63	2.52	0.78	154.07	<0.0001
06/01/07	175	47.76	2.75	0.82	116.20	<0.0001
06/02/07	246	0.76	2.96	0.72	126.92	<0.0001
06/03/07	76	354.17	7.85	0.54	22.36	<0.0001
06/04/07	74	35.22	9.18	0.48	17.11	<0.0001
06/05/07	8	35.66	27.95	0.52	2.17	0.11
06/06/07	38	66.69	9.35	0.62	14.62	<0.0001
06/07/07	117	11.42	2.87	0.86	87.08	<0.0001
06/08/07	96	93.92	4.44	0.75	53.39	<0.0001
06/09/07	324	178.62	2.05	0.81	212.00	<0.0001
06/10/07	397	146.28	2.40	0.71	197.18	<0.0001
06/11/07	295	160.68	4.24	0.52	78.40	<0.0001
06/12/07	934	27.53	1.29	0.79	576.99	<0.0001
06/13/07	165	21.27	7.00	0.43	30.31	<0.0001
06/14/07	290	44.83	5.26	0.43	53.62	<0.0001
06/15/07	289	117.48	3.40	0.62	110.87	<0.0001

Appendix 17. Mean vectors, vector lengths and results of first-order circular statistics for data collectfed with the horizontally-oriented radar at the Maple Ridge Wind Power Facility, Fall/Early 2007.

Date	N	Mean vector (μ, in degress)	Standard error mean vector (μ, in degress)	Mean vector length (r)	Rayleigh's Z	*P*
07/31/07	845	194.08	1.19	0.83	585.74	<0.0001
08/01/07	600	129.63	1.58	0.79	377.13	<0.0001
08/02/07	551	87.46	2.23	0.67	243.48	<0.0001
08/03/07	663	141.32	2.26	0.62	251.62	<0.0001
08/04/07	773	234.94	0.79	0.93	666.85	<0.0001
08/05/07	411	16.76	1.31	0.90	331.09	<0.0001
08/06/07	1341	182.58	0.96	0.82	911.55	<0.0001
08/07/07	201	347.73	2.65	0.80	129.59	<0.0001
08/08/07	706	231.94	0.88	0.92	597.45	<0.0001
08/09/07	901	319.12	1.41	0.76	516.18	<0.0001
08/10/07	848	180.60	1.36	0.78	521.07	<0.0001
08/11/07	1329	178.68	0.92	0.84	942.08	<0.0001
08/12/07	413	173.66	2.56	0.67	183.79	<0.0001
08/13/07	924	212.95	0.95	0.88	714.72	<0.0001
08/14/07	449	40.40	2.19	0.72	231.90	<0.0001
08/15/07	516	156.20	2.56	0.62	196.32	<0.0001
08/17/07	371	202.46	2.03	0.79	230.74	<0.0001
08/18/07	981	214.76	2.05	0.57	320.81	<0.0001
08/19/07	800	252.05	1.36	0.80	505.21	<0.0001
08/20/07	496	330.45	2.14	0.71	247.79	<0.0001
08/21/07	211	351.97	3.93	0.63	82.42	<0.0001
08/22/07	208	2.40	3.03	0.74	115.01	<0.0001
08/23/07	358	30.94	1.43	0.90	286.59	<0.0001
08/24/07	759	82.07	2.44	0.55	229.59	<0.0001
08/25/07	635	148.03	1.60	0.78	382.49	<0.0001
08/26/07	1289	227.46	0.74	0.90	1036.30	<0.0001
08/27/07	1435	241.39	0.94	0.82	966.00	<0.0001
08/28/07	122	64.54	3.42	0.80	78.36	<0.0001
08/29/07	426	71.26	3.27	0.55	127.97	<0.0001
08/30/07	964	226.59	0.62	0.95	862.53	<0.0001
08/31/07	823	221.29	0.87	0.91	680.73	<0.0001
09/01/07	474	233.31	1.68	0.81	313.08	<0.0001
09/02/07	340	66.41	1.99	0.81	223.74	<0.0001
09/03/07	517	192.95	1.65	0.80	332.89	<0.0001
09/04/07	575	221.24	1.47	0.82	390.36	<0.0001
09/05/07	242	38.18	3.34	0.67	107.97	<0.0001
09/06/07	146	51.60	2.70	0.85	105.18	<0.0001
09/07/07	112	71.76	3.52	0.81	72.77	<0.0001
09/08/07	1163	224.19	0.84	0.88	903.64	<0.0001
09/09/07	259	200.70	4.45	0.52	70.96	<0.0001
09/10/07	1001	252.29	1.55	0.70	483.79	<0.0001
09/11/07	197	157.95	2.15	0.87	149.06	<0.0001
09/12/07	953	207.77	1.29	0.78	581.22	<0.0001
09/13/07	316	336.88	4.96°	0.44	60.11	<0.0001
09/14/07	87	62.20	8.53	0.48	19.86	<0.0001
09/16/07	314	210.15	2.93	0.67	140.42	<0.0001
09/17/07	472	260.52	2.93	0.58	156.26	<0.0001
09/18/07	316	346.27	6.63	0.33	35.24	<0.0001
09/19/07	306	99.66	6.29	0.36	38.83	<0.0001
09/20/07	1834	238.32	0.71	0.87	1382.95	<0.0001
09/21/07	529	292.68	12.99	0.14	9.63	<0.0001
09/22/07	876	195.15	0.86	0.91	720.39	<0.0001
09/23/07	376	181.68	1.89	0.81	247.23	<0.0001
09/24/07	216	77.83	4.71	0.54	62.28	<0.0001
09/25/07	188	118.93	3.47	0.71	93.87	<0.0001
09/26/07	289	184.47	3.14	0.66	124.30	<0.0001
09/27/07	233	188.03	2.99	0.73	122.36	<0.0001
09/28/07	541	207.54	1.26	0.88	416.00	<0.0001
09/29/07	715	231.97	1.54	0.77	421.14	<0.0001
09/30/07	169	357.32	3.10	0.78	101.87	<0.0001

Appendix 18. Mean vectors, vector lengths and results of first-order circular statistics for data collectfed with the horizontally-oriented radar at the Maple Ridge Wind Power Facility, Fall/Late 2007.

Date	N	Mean vector (μ, in degress)	Standard error mean vector (μ, in degress)	Mean vector length (r)	Rayleigh's Z	*P*
10/01/07	244	5.19	3.86	0.60	87.85	<0.0001
10/02/07	149	23.48	2.91	0.82	100.80	<0.0001
10/03/07	785	191.97	1.34	0.80	505.63	<0.0001
10/04/07	1518	227.72	1.33	0.67	676.77	<0.0001
10/05/07	1169	207.42	1.51	0.67	525.68	<0.0001
10/06/07	223	186.19	4.79	0.52	61.26	<0.0001
10/07/07	784	210.10	2.09	0.61	293.80	<0.0001
10/09/07	189	204.94	3.45	0.71	94.95	<0.0001
10/10/07	176	194.46	3.41	0.73	93.58	<0.0001
10/11/07	16	191.13	9.57	0.80	10.14	<0.0001
10/12/07	1612	217.27	0.53	0.93	1405.30	<0.0001
10/13/07	181	201.90	2.08	0.89	142.29	<0.0001
10/14/07	485	211.04	1.73	0.80	309.26	<0.0001
10/15/07	834	223.53	0.94	0.89	664.44	<0.0001
10/16/07	537	261.54	2.15	0.69	253.77	<0.0001
10/17/07	469	246.70	3.33	0.52	127.14	<0.0001
10/18/07	124	18.47	3.55	0.78	76.17	<0.0001
10/19/07	99	136.40	4.92	0.69	47.70	<0.0001
10/20/07	553	175.78	1.40	0.85	395.46	<0.0001
10/21/07	138	62.56	6.56	0.49	33.33	<0.0001
10/22/07	79	26.13	7.42	0.56	24.68	<0.0001
10/23/07	1213	232.36	0.87	0.87	916.32	<0.0001
10/24/07	938	235.21	0.83	0.91	768.32	<0.0001
10/25/07	496	238.06	2.21	0.69	238.14	<0.0001
10/29/07	51	121.11	8.28	0.61	18.87	<0.0001
10/30/07	56	275.99	18.46	0.29	4.61	0.01
10/31/07	20	71.42	12.95	0.62	7.63	0.0002
11/01/07	380	211.76	1.54	0.87	287.99	<0.0001
11/02/07	167	270.91	3.89	0.68	77.87	<0.0001
11/03/07	177	220.65	1.83	0.91	147.66	<0.0001
11/04/07	9	161.67	48.54	0.35	1.09	0.35
11/05/07	4	25.06	51.34	0.48	0.93	0.42
11/07/07	185	221.94	2.65	0.82	123.44	<0.0001
11/08/07	116	256.85	4.18	0.73	61.97	<0.0001
11/09/07	145	239.39	2.76	0.84	103.17	<0.0001
11/10/07	151	222.33	2.40	0.88	115.65	<0.0001
11/11/07	28	256.44	53.23	0.14	0.57	0.57
11/12/07	4	210.52	38.51	0.56	1.26	0.31
11/13/07	16	156.12	14.96	0.60	5.82	0.002
11/14/07	15	110.23	16.75	0.58	5.07	0.005
11/15/07	68	204.59	4.15	0.84	47.38	<0.0001

Appendix 19. Mean vectors, vector lengths and results of first-order circular statistics for data collectfed with the horizontally-oriented radar at the Maple Ridge Wind Power Facility, Spring 2008.

Date	N	Mean vector (μ, in degress)	Standard error mean vector (μ, in degress)	Mean vector length (r)	Rayleigh's Z	*P*
04/13/08	69	53.07	7.29	0.60	24.62	<0.0001
04/14/08	204	57.08	3.13	0.73	109.80	<0.0001
04/15/08	407	40.15	1.24	0.91	336.19	<0.0001
04/16/08	319	23.68	1.69	0.87	241.23	<0.0001
04/17/08	234	123.69	9.72	0.27	16.75	<0.0001
04/18/08	376	356.61	4.26	0.46	80.29	<0.0001
04/19/08	110	9.50	3.04	0.86	80.59	<0.0001
04/20/08	112	15.00	6.37	0.55	33.71	<0.0001
04/21/08	131	24.25	4.18	0.71	65.02	<0.0001
04/22/08	173	46.20	4.80	0.58	57.80	<0.0001
04/23/08	182	97.84	5.48	0.51	47.18	<0.0001
04/24/08	179	191.54	42.48	0.07	0.91	0.404
04/25/08	152	4.58	2.71	0.84	107.77	<0.0001
04/26/08	136	38.03	3.80	0.74	74.15	<0.0001
04/28/08	2	219.49	32.53	0.97	1.88	0.162
04/30/08	59	49.90	7.16	0.64	24.30	<0.0001
05/01/08	35	122.69	51.98	0.13	0.60	0.551
05/02/08	49	6.07	9.57	0.55	14.91	<0.0001
05/03/08	57	13.72	6.83	0.67	25.66	<0.0001
05/04/08	356	46.21	2.00	0.80	228.45	<0.0001
05/05/08	826	34.01	0.76	0.93	714.57	<0.0001
05/06/08	305	54.30	2.44	0.76	173.89	<0.0001
05/07/08	36	28.45	7.20	0.75	20.17	<0.0001
05/08/08	228	49.61	2.45	0.81	149.07	<0.0001
05/09/08	146	352.76	8.56	0.38	20.76	<0.0001
05/10/08	304	67.63	2.71	0.71	153.58	<0.0001
05/11/08	272	9.89	2.53	0.76	158.47	<0.0001
05/12/08	166	4.41	10.43	0.30	14.42	<0.0001
05/13/08	396	147.51	7.60	0.26	27.41	<0.0001
05/14/08	124	40.51	5.99	0.55	38.05	<0.0001
05/15/08	317	51.36	2.80	0.69	149.55	<0.0001
05/16/08	379	65.53	1.55	0.87	286.68	<0.0001
05/17/08	454	49.54	1.06	0.93	388.79	<0.0001
05/18/08	11	32.78	15.10	0.70	5.31	0.003
05/19/08	152	53.39	2.65	0.85	109.46	<0.0001
05/20/08	541	44.03	0.88	0.94	476.09	<0.0001
05/21/08	14	26.27	13.99	0.72	7.16	0.0003
05/22/08	100	93.63	7.21	0.52	27.07	<0.0001
05/23/08	364	60.50	1.60	0.87	273.17	<0.0001
05/24/08	388	50.80	1.76	0.83	267.52	<0.0001
05/25/08	620	26.62	1.05	0.90	503.00	<0.0001
05/26/08	547	39.95	1.53	0.82	368.15	<0.0001
05/27/08	66	114.30	19.45	0.25	4.20	0.015
05/28/08	200	56.71	2.11	0.87	152.23	<0.0001
05/29/08	378	66.82	1.68	0.85	272.05	<0.0001
05/30/08	199	4.59	2.47	0.83	136.77	<0.0001
05/31/08	309	55.58	1.74	0.87	232.36	<0.0001
06/01/08	102	73.59	5.24	0.66	44.35	<0.0001
06/02/08	374	52.70	1.43	0.89	295.62	<0.0001
06/03/08	38	5.48	6.74	0.76	22.20	<0.0001
06/04/08	132	347.95	3.14	0.82	88.08	<0.0001
06/05/08	11	26.06	7.69	0.93	9.49	<0.0001
06/06/08	630	34.02	0.88	0.93	543.75	<0.0001
06/07/08	347	58.82	1.47	0.89	275.61	<0.0001
06/08/08	397	51.06	1.37	0.89	316.30	<0.0001
06/09/08	361	43.32	1.60	0.87	272.17	<0.0001
06/10/08	172	74.69	3.16	0.77	100.68	<0.0001
06/11/08	141	132.29	6.13	0.52	37.57	<0.0001
06/12/08	259	319.18	4.59	0.51	67.34	<0.0001
06/13/08	219	29.67	1.77	0.90	177.62	<0.0001
06/15/08	162	37.38	4.46	0.63	63.81	<0.0001

Appendix 20. Mean vectors, vector lengths and results of first-order circular statistics for data collectfed with the horizontally-oriented radar at the Maple Ridge Wind Power Facility, Fall/Early 2008.

Date	N	Mean vector (μ, in degress)	Standard error mean vector (μ, in degress)	Mean vector length (r)	Rayleigh's Z	*P*
07/31/08	323	155.64	1.65	0.87	246.64	<0.0001
08/01/08	253	131.05	2.73	0.75	140.87	<0.0001
08/02/08	186	195.49	2.86	0.79	115.92	<0.0001
08/03/08	307	192.74	2.12	0.81	200.28	<0.0001
08/04/08	317	173.67	2.54	0.73	168.89	<0.0001
08/05/08	254	16.45	2.75	0.74	140.24	<0.0001
08/06/08	316	150.97	4.42	0.48	73.70	<0.0001
08/07/08	285	192.82	2.50	0.76	163.75	<0.0001
08/08/08	273	192.99	1.85	0.87	205.31	<0.0001
08/09/08	412	331.54	2.23	0.73	218.32	<0.0001
08/10/08	225	313.51	3.51	0.66	98.49	<0.0001
08/11/08	284	225.30	2.50	0.76	163.73	<0.0001
08/12/08	357	211.90	2.47	0.72	183.11	<0.0001
08/13/08	491	217.01	2.15°	0.71	245.14	<0.0001
08/14/08	613	221.93	1.62	0.78	370.37	<0.0001
08/15/08	322	179.59	5.24	0.41	54.49	<0.0001
08/16/08	233	134.62	2.97	0.73	123.41	<0.0001
08/17/08	208	101.28	4.40	0.58	69.01	<0.0001
08/18/08	46	163.61	12.09	0.47	9.95	<0.0001
08/19/08	334	213.06	1.72	0.86	247.02	<0.0001
08/25/08	293	210.01	1.79	0.87	219.58	<0.0001
09/06/08	8	190.31	7.37	0.96	7.33	<0.0001
09/07/08	381	184.70	1.72	0.84	269.34	<0.0001
09/08/08	236	230.35	7.18	0.36	29.74	<0.0001
09/09/08	680	213.51	0.88	0.92	580.17	<0.0001
09/10/08	487	253.21	1.73	0.80	308.64	<0.0001
09/11/08	169	0.38	4.83	0.58	57.02	<0.0001
09/12/08	112	200.60	4.30	0.73	59.11	<0.0001
09/13/08	380	217.56	2.92	0.63	148.77	<0.0001
09/14/08	102	57.43	4.25	0.75	57.53	<0.0001
09/15/08	939	218.22	0.85	0.90	761.99	<0.0001
09/16/08	404	178.25	2.16	0.75	224.82	<0.0001
09/17/08	707	175.25	2.33	0.59	243.39	<0.0001
09/18/08	693	233.17	1.32	0.83	478.17	<0.0001
09/19/08	273	18.76	3.87	0.57	89.59	<0.0001
09/20/08	466	115.40	3.08	0.56	143.80	<0.0001
09/21/08	969	227.03	0.77	0.92	814.67	<0.0001
09/22/08	476	223.51	1.55	0.84	334.45	<0.0001
09/23/08	381	221.17	2.79	0.65	158.87	<0.0001
09/24/08	316	248.15	6.67	0.33	34.85	<0.0001
09/25/08	240	318.14	5.49	0.45	48.69	<0.0001
09/26/08	70	253.16	8.63	0.52	18.90	<0.0001
09/27/08	368	232.22	3.19	0.59	129.40	<0.0001
09/28/08	25	197.51	5.68	0.88	19.53	<0.0001
09/29/08	276	209.87	3.44	0.62	107.32	<0.0001
09/30/08	164	157.00	11.97	0.26	11.05	<0.0001

Appendix 21. Mean vectors, vector lengths and results of first-order circular statistics for data collectfed with the horizontally-oriented radar at the Maple Ridge Wind Power Facility, Fall/Late 2008.

Date	N	Mean vector (μ, in degress)	Standard error mean vector (μ, in degress)	Mean vector length (r)	Rayleigh's Z	*P*
10/01/08	914	204.63	1.03	0.86	680.28	<0.0001
10/02/08	95	167.29	4.30	0.76	55.02	<0.0001
10/03/08	1069	205.38	0.64	0.94	934.13	<0.0001
10/04/08	1257	218.24	0.86	0.87	944.53	<0.0001
10/05/08	1051	214.47	1.08	0.83	719.86	<0.0001
10/06/08	4	202.87	5.17	0.99	3.95	0.008
10/07/08	382	234.83	2.04	0.78	232.37	<0.0001
10/08/08	2	58.67	18.22	0.99	1.96	0.145
10/09/08	475	174.27	1.36	0.88	363.58	<0.0001
10/10/08	587	193.09	1.08	0.90	477.12	<0.0001
10/11/08	639	232.15	1.27	0.85	464.73	<0.0001
10/12/08	190	191.82	5.98	0.46	40.76	<0.0001
10/13/08	78	120.05	9.12	0.47	17.42	<0.0001
10/14/08	457	206.19	1.74	0.81	297.72	<0.0001
10/15/08	56	308.42	42.96	0.13	0.88	0.414
10/16/08	521	211.70	1.43	0.85	375.68	<0.0001
10/17/08	207	229.49	1.88	0.90	165.69	<0.0001
10/18/08	139	230.67	2.54	0.87	105.60	<0.0001
10/19/08	83	233.38	7.60	0.54	23.92	<0.0001
10/20/08	5	45.76	24.39	0.80	3.17	0.033
10/21/08	5	188.39	19.73	0.86	3.73	0.015
10/22/08	109	203.75	5.79	0.60	39.02	<0.0001
10/23/08	175	239.87	3.87	0.67	79.50	<0.0001
10/24/08	11	15.03	* *	0.21	0.48	0.629
10/25/08	51	185.09	6.19	0.74	27.86	<0.0001
10/26/08	16	177.72	16.64	0.55	4.92	0.006
10/27/08	180	211.96	2.48	0.84	127.86	<0.0001
10/29/08	285	205.41	1.19	0.94	251.98	<0.0001
10/30/08	153	184.98	2.69	0.84	108.95	<0.0001
10/31/08	291	207.92	1.80	0.87	218.01	<0.0001
11/01/08	262	225.72	1.37	0.93	225.32	<0.0001
11/02/08	6	333.77	41.19	0.46	1.26	0.297
11/03/08	11	62.94	33.27	0.40	1.78	0.171
11/05/08	138	250.89	3.35	0.79	85.20	<0.0001
11/06/08	363	234.32	1.47	0.89	285.84	<0.0001
11/07/08	17	143.65	24.38	0.39	2.55	0.077
11/08/08	21	201.58	8.78	0.78	12.68	<0.0001
11/09/08	2	135.73	* *	0.31	0.19	0.86
11/10/08	100	203.13	2.09	0.94	87.53	<0.0001
11/11/08	108	212.40	2.52	0.90	87.59	<0.0001
11/12/08	11	273.70	20.66	0.56	3.50	0.026
11/13/08	6	55.59	16.81	0.86	4.48	0.005
11/14/08	17	71.70	14.99	0.59	5.88	0.002

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Radar Monitoring of Bird and Bat Movement Patterns at the Maple Ridge Wind Power Facility, Lewis County, New York

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