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A VISUAL STUDY OF MIGRATING OWLS AT CAPE MAY POINT, NEW JERSEY[1]

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Abstract. We studied the autumn migration of owls at Cape May Point, New Jersey, on 25 nights (178.5 hr) between 12 October and 11 November 1982 using visual and auditory techniques. We detected and observed migrating owls using an AN/PVS-3A night vision scope and 10X binoculars aided by moonlight, sky glow from a town, and the beam from a lighthouse.

Barn (*Tyto alba,* 72.9%), Saw-whet (*Aegolius acadicus,* 8.6%) and Long-eared (*Asio otus,* 8.1%) Owls accounted for a majority of the 210 individuals counted. A comparison of the numbers of owls counted with those banded at Cape May Point during the same time period revealed a larger number and percentage of Barn Owls counted than banded, and a larger number and percentage of Saw-whet Owls banded than counted. Approximately one third of all owls were counted during the first two hours following sunset and disproportionately more owls were counted with light (<3 m sec^{-1}) northerly winds than with other wind conditions.

Mean flight directions of these species were to the west-southwest. Most Barn Owls were observed at altitudes > 10 m, which may account for their lower representation in the banding sample. Our observations show that visual and auditory techniques may be usefully employed in studying the nocturnal migration of owls, but also suggest that observational/count studies of migrating owls may be subject to biases similar to those affecting diurnal count studies of migrating hawks.

Key words: Migration; owls; flight behavior; Cape May; nocturnal field observations.

INTRODUCTION

During more than 15 years of banding operations Duffy (1985) and Duffy and Kerlinger (MS) found that large numbers of migratory owls occur each autumn near the terminus of the Cape May Peninsula at the confluence of the Atlantic Ocean and Delaware Bay. This aggregation of owls at the coast is reminiscent of the migration of falconiforms, passerines, and other diurnal migrants. Whereas the migrations of hawks (Allen and Peterson 1936, Kerlinger and Gauthreaux 1984), shorebirds (Richardson 1979), and passerines (Stone 1937, Swinebroad 1964) have been studied, virtually nothing is known about the behavior of migrating owls. Here, we report the seasonal occurrence, diel timing, and flight behavior of migrating owls studied by visual and auditory methods. In addition, we compare counts of migrating owls to numbers captured by banders during the same time periods.

STUDY AREA AND METHODS

We conducted observations in the Cape May Point State Park, New Jersey (ca. 38°56′N, 74°58′W; Fig. 1), beginning on the evening of 12 October and ending on the morning of 11 November 1982. Observations were made primarily from the parking lot and hawkwatch platform (1.5 m height). The parking lot is surrounded by shrubby vegetation, a sand dune, and park buildings, all <3–5 m in height. Visibility in all directions is relatively unimpeded.

Observations by a single observer (mostly RWR) commenced at sunset and, when possible, continued until dawn, averaging 7.2 (± 2.6 SD, n = 25 nights) hours per night. On several occasions extra observers assisted the primary observer, usually for periods <1 hr. Observations were interspersed with occasional rest periods, and rain or illness halted operations on five nights.

Migrating owls were located and identified by visual and auditory means. Barn Owls (*Tyto alba*) are extremely vocal during migration, making them easy to locate and identify. Visual observations were made with unaided eye and 10 power Zeiss binoculars, facilitated by moonlight, sky glow from the city of Cape May about 2 km

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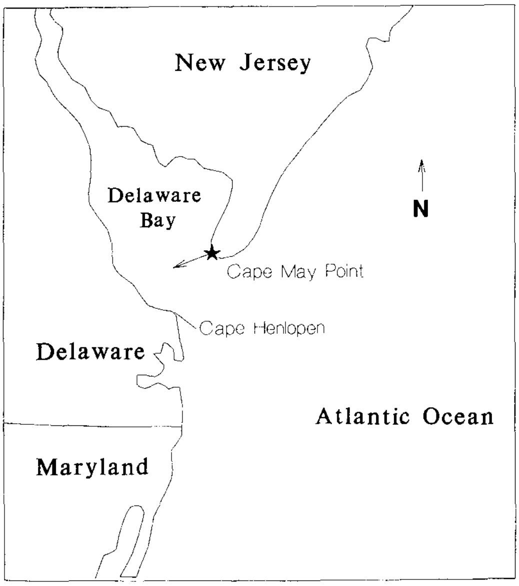

FIGURE 1. Map showing geographical context of the study. Location of the study site is indicated by a star. The arrow indicates the mean flight direction of migrating Barn Owls observed at Cape May Point.

distant, streetlights, the revolving beam of a lighthouse, and a 3 power AN/PVS-3A night vision scope mounted on a rifle stock. Also called a starlight scope or image intensifier, the AN/PVS-3A was designed to be mounted on a military automatic rifle. The night scope intensifies available light several thousand times so that nearby owls could be identified to species even on the darkest nights. Most visual identifications were made on the basis of body proportions and flight characteristics (e.g., Davis and Prytherch 1976), but the pale coloration of Barn Owls was often evident at surprisingly great distances through the Zeiss binoculars. Species identity, time of sighting, direction of flight (i.e., realized flight path or track, as opposed to heading), and altitude were noted for as many migrants as possible. Altitude was estimated in relation to the height of the lighthouse (47.7 m) and surrounding vegetation. Weather data, particularly wind speed and direction, were recorded at hourly intervals.

Banding data were provided by K. Duffy (methods in Duffy 1985, Duffy and Kerlinger MS).

Count data are analyzed using log-likelihood ratio and Kolmogorov-Smirnov tests and the Spearman rank correlation coefficient. Sample size of the orientation data reflects number of observations, which was lower than the total number of individuals involved since owls frequently flew in groups; analysis of these data follows Batschelet (1981).

RESULTS

Two hundred and ten owls of five species were counted during the study (Table 1). Barn Owls were most numerous, accounting for nearly three quarters of all owls observed. Saw-whet Owls (*Aegolius acadicus*) and Long-eared Owls (*Asio otus*) together accounted for most of the remaining owls. On average, 1.18 owls were counted per hour throughout the study.

TEMPORAL PATTERNS OF MIGRATION

The numbers of owls observed were not uniform throughout autumn (Fig. 2). Barn Owls peaked in abundance earlier in the season, with one half observed before 22 October. In contrast, median dates of occurrence of Saw-whet and Long-eared Owls (determined from the banding data) were 7 November and 4 November, respectively. In addition to these differences in seasonal timing of migration among species, a distinct diel pattern of migration emerged from the count data. Comparing the numbers of owls seen during two-hour intervals throughout the night to a uniform pattern showed that more owls were observed during the first two hours following sunset than expected by chance (Kolmogorov-Smirnov one-sample test, $d_{max} = 50.24$, $k = 7$ two-hour periods, $n = 210$ owls, $P < 0.001$). Nearly four times as many owls were observed during the first two hours after sunset as in any other two-hour period during the night (Fig. 3). After the first two hours following sunset the numbers of owls per hour ranged between 0.4 and 1.1 as opposed to 3.9 owls per hour during the first two hours of the night. One third of all owls were observed in this early evening period (72 of 210, 34%).

EFFECTS OF WIND ON VISUAL COUNTS

The numbers of owls seen were also related to ambient wind conditions. Nearly three times as many owls per hour were observed with winds <3 m sec^{-1} than with greater wind speeds, and more than twice as many owls per hour were seen when winds were northerly than southerly

TABLE 1. Summary of owls counted and banded at Cape May Point, New Jersey, 12 October–11 November 1982.

Species	Number seen	Percent of total	Season peak and largest flight	Adjusted number counted[a]	Adjusted number banded[b]	Median altitude of flight in meters (range)
Barn Owl						
Tyto alba	153	72.9	22 Oct–61	147	16	23 (3–92) $n = 38$
Saw-whet Owl						
Aegolius acadicus	18	8.6	22 Oct–7	14	26	3 (<1–8) $n = 5$
Long-eared Owl						
Asio otus	17	8.1	17 Oct, 22 Oct–6	17	9	5 (3–52) $n = 9$
Short-eared Owl						
Asio flammeus	2	1.0	–	2	0	–
Screech Owl						
Otus asio	2	1.0	–	2	1	–
Unidentified[c]	18	8.6	8 Nov–17	18	0	–
Totals[d]	210			200	52	

Total nights = 25
Total hours = 178.5
Number of nights when owls were seen = 16 (64% of nights)
Owls observed per hour = 210/178.5

[a] Adjusted for comparison with banding effort.
[b] Adjusted for comparison with counting effort.
[c] Includes a loose flock of 17 owls (almost certainly Long-eareds) observed on 8 Nov.
[d] Great Horned Owls (*Bubo virginianus*) were resident in the Park and not included in analyses.

during all hours of the night (Table 2). Overall, more than two times more owls per hour were seen than expected when winds were light and northerly, and fewer were seen than expected under all other conditions ($G = 101.4$, df = 3, $P < 0.001$). Similar findings emerged from an analysis of the data when only the two hours following sunset were considered.

COMPARISONS OF VISUAL COUNTS TO BANDING DATA

Nearly four times as many owls were counted as were banded during the same time period (Table 1). The nightly numbers of owls observed during the study were correlated with the numbers banded on the same night ($r = 0.52$, $n = 24$ nights, $P < 0.01$); however, the correlation was not significant when nights during which no owls were observed are excluded from consideration ($r = 0.40$, $n = 15$ nights, $P = 0.134$). Furthermore, the species composition differed ($G = 52.89$, df = 2, $P < 0.001$). Whereas Barn Owls accounted for 82.6% of the three most numerous owls observed, they accounted for only 31.4% of those individuals banded. A similar difference (but in the opposite direction) was evident for Saw-whet (7.9% of those seen vs. 51.0% of those banded), but possibly not for Long-eared Owls (9.6% vs. 17.6%). These differences raise serious questions regarding the comparability of banding and observational data.

FLIGHT BEHAVIOR OF MIGRATING OWLS

Because of darkness, flight behavior of nocturnally migrating owls is difficult to observe. Altitude and flight direction were noted for some individuals, though the sample is undoubtedly not random. Mean altitude of migrants was less than 50 m with maximum altitudes (heard but not seen) estimated at close to 100 m (Table 1). Barn Owls migrated higher than either of the other species and Saw-whet Owls migrated the lowest. Some Saw-whets were observed skimming vegetation contours or the parking lot surface at less than 1–2 m. No statistical tests for altitudinal differences were performed because of small and probably biased samples.

Flight direction of a majority of birds was toward the west-southwest and seemed to be similar among species. The mean flight direction of Barn Owls with straight tracks was oriented toward 257° with relatively little variation ($r = 0.82$ [r is the length of the mean vector], $n = 45$). We tested the hypothesis that the flight of migrating Barn Owls was oriented toward Cape Henlopen, Delaware (the expected destination of migrants following the Atlantic coastline; see Fig. 1), by constructing a 99% confidence interval for the

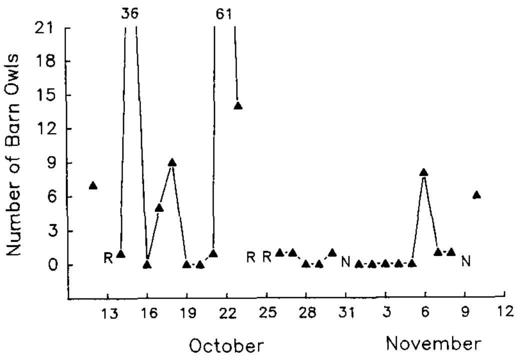

FIGURE 2. Seasonal timing of Barn Owl migration at Cape May Point. Symbols: ▲ = observed number; R = rain; N = No count.

mean flight direction (Batschelet 1981). Because the direction from Cape May Point to Cape Henlopen (230°) does not lie within the 99% CI ($\bar{x}$ = 257° ± 15°), we must reject the hypothesis that Barn Owls were oriented specifically toward Cape Henlopen. Although darkness precluded extended observations of most individual migrants, substantial numbers of Barn Owls appeared to head out over Delaware Bay. Because of the strongly oriented flight of the migrants it is likely that some continued to migrate across the bay to Delaware, perhaps making landfall on the Delaware Bay shore to the north and west of Cape Henlopen.

A spectacular sight was that of 17 owls, thought to be Long-eareds, observed initiating migration from various sites within the State Park shortly after sunset on 8 November. After taking off, the migrants coalesced into a loose group and were last seen at an altitude of about 45 m proceeding out over Delaware Bay to the southwest.

DISCUSSION

OWL MIGRATION AT CAPE MAY POINT

Our study documents a major concentration of migrating owls at Cape May Point, NJ. This has been suggested previously by Duffy (1985) for Barn Owls and Duffy and Kerlinger (MS) for the other species we observed. Stone (1937) mentions that Barn, Saw-whet, and Long-eared Owls are either "regular autumn transients" or winter residents in Cape May, but he says little about the migration of these species through the peninsula. Judging from the numbers of actively migrating owls counted during this one-season study, together with the undoubtedly low efficiency with

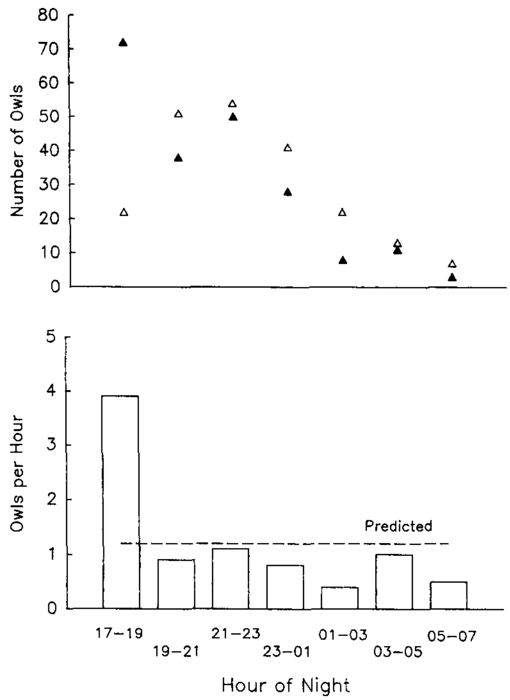

FIGURE 3. Numbers of owls counted (▲) and predicted (△) for each two-hour period of the night (top). Observed migration rates (owls per hour) throughout the night (bottom). Predicted values are from a null model assuming a uniform diel (nocturnal) distribution of owls. Variation in predicted numbers reflects uneven distribution of observational effort throughout the night.

which the less vocal species were detected, it seems probable that several thousand owls move through the Cape May Peninsula each autumn.

METHODOLOGY AND DATA INTERPRETATION

The quantitative description of flight behavior presented in this paper raises several questions. Because of the methods used in this study, alternate explanations of the data are possible. Counts of migrating owls were used to infer migratory behavior as has been done with hawk migration count data. Kerlinger (1989) suggested that count data cannot be used to refute alternate explanations because of sampling bias problems and, consequently, may lead to erroneous conclusions. In addition, nocturnal observations can generate biased data. The night vision scope was inadequate for detecting distant owls because of its low magnification and rather poor resolution. Because the observer could not see birds at great distances at night, it is impossible to determine

TABLE 2. Numbers of owls seen and expected with different wind conditions.[a]

Wind direction	Wind speed (m sec^{-1}) ≤ 3	> 3	Totals
North	109 owls/37.5 hr 2.9 owls/hr (1.2 owls/hr)	30 owls/46.25 hr 0.6 owls/hr (1.2 owls/hr)	139 owls/83.75 hr 1.6 owls/hr
South	65 owls/79.25 hr 0.8 owls/hr (1.2 owls/hr)	6 owls/15.5 hr 0.4 owls/hr (1.2 owls/hr)	71 owls/94.75 hr 0.7 owls/hr
Totals	174 owls/116.75 hr 1.5 owls/hr	36 owls/61.75 hr 0.6 owls/hr	210 owls/178.5 hr 1.2 owls/hr

[a] Expected values (in parentheses) reflect the null hypothesis that the numbers of owls observed under different wind conditions are proportional to the relative frequency of these conditions; observed values are without parentheses. Statistics are given in text.

whether large numbers of owls, especially Barn Owls, passed unnoticed at altitudes greater than those reported above. Furthermore, small or less vocal species and those that tend to fly along woodland edges or near dense cover may pass unseen in large numbers. Such may be the case for Saw-whet and Long-eared Owls.

Important issues and questions raised by the results from the present study include:

DIEL PATTERN OF VISIBLE MIGRATION

Does the peak migratory activity of owls really occur during the first two hours after sunset? Several alternate explanations exist for the disproportionately large numbers of owls counted just after sunset as opposed to later in the night. The lack of sky glow and increasing eyestrain and general fatigue associated with use of the night vision scope were potential sources of bias favoring decreased detectability of owls during the latter part of the night. Flight at high altitudes later in the evening would generate a similar pattern; however, the banding data show that more individual owls of all three species were banded during the latter four hours of the night, suggesting that more owls fly at lower altitudes as the night progresses. Diel changes in vocalization frequency may account for this apparent discrepancy between the observational and banding results. Low-flying individuals may be hunting locally, and so would likely be silent and therefore almost undetectable to an observer. Why should the number of low-flying foragers increase throughout the night? It is plausible that owls suspend their migration and land near the end of the Cape May Peninsula to forage before proceeding across Delaware Bay, and are not counted until they depart early on subsequent evenings. Thus, even if the actual passage rate of migrants *into* Cape May does not vary throughout the night, one would expect a priori to find large numbers of actively migrating (and therefore more readily observable) individuals during the early part of the night, together with a gradually increasing number of low-flying (and potentially undetectable) foraging birds as the night progresses.

INFLUENCE OF AMBIENT WIND CONDITIONS ON OWL MIGRATION

Do more owls migrate when winds are weak than when winds are strong as suggested by our results? Although owls are not especially powerful fliers and, like many other birds, probably prefer to avoid strong winds, two factors could bias our findings. First, owls that are detected frequently by auditory cues might not be heard (or they might not vocalize as frequently) when strong winds obliterate auditory cues. Second, they may be easier to see when winds are weak because flight at higher altitudes may be easier to detect visually (i.e., viewed against the sky versus against a more heterogeneous terrestrial landscape).

Why were more owls seen when winds were northerly? This result could be an artifact, since the increased ground speed of southward-moving birds would be expected to inflate the count at a fixed point per unit time, even if wind conditions did not influence the tendency for owl migration to occur. However, the observed negative correlation between wind speed and owl counts when winds were northerly indicates that this explanation is not correct.

Previous workers (Weir et al. 1980) have suggested that conditions of northwesterly winds "stimulate" owls to initiate migration. In addition, it has been dogma in the migration literature that large coastal concentrations of migrant raptors after periods of northwesterly winds are a consequence of wind drift (Allen and Peterson 1936, Mueller and Berger 1967). It is possible, however, that high-flying owls simply descend in altitude when winds are from the north, especially with a westerly component that could potentially drift birds out over the Atlantic Ocean; other birds such as Sharp-shinned Hawks (*Accipiter striatus*) are known to descend in altitude upon reaching the coast when winds are from the north or west (Kerlinger and Gauthreaux 1984). If Barn Owls respond differentially to the coast in this manner, then the apparent influence of wind direction on numbers of owls observed migrating at the Point would represent a sampling bias. Alternatively, owls may actively select favorable tail winds (i.e., winds with a northerly component in the autumn). More data will be required before it is possible to determine whether the patterns documented here represent counting biases or preferential selection of flight conditions by migrant owls.

SPECIES COMPOSITION OF COASTAL OWL FLIGHTS

Are the proportions of owl species reported in this study representative of the actual proportions of owls migrating through the Cape May Peninsula? The comparison of the count data with banding data suggested that small, less vocal species such as Saw-whet Owls may actually be more abundant than Barn Owls, despite their low representation in the observational sample. Altitudinal data showing that Saw-whet Owls migrate at lower altitudes than Barn Owls are supported by the abundance of Saw-whet Owls and dearth of Barn Owls in banding samples and suggest, again, that sampling biases in both observational and banding studies may be significant. Visual observations and banding studies thus appear to be necessary complements to each other for a thorough study of owl migration.

WATER-CROSSING BEHAVIOR OF MIGRATING OWLS

Do migrating owls cross the Delaware Bay? The unidirectional flight reported here suggests that they do. Barn Owls are often reported far at sea (e.g., Mueller and Berger 1979, Soucy 1985); documentation of successful overwater flights of >1,000 km suggests that the 18 km distance to the Delaware coast should not pose a problem. This tentative conclusion is further strengthened by our direct observations of owls flying out over the Delaware Bay, and by the lack of reports of migrant owls moving north along the western edge of the Cape May Peninsula.

It is not clear, however, why the mean flight direction was to the west of the Delaware Atlantic coast (see Fig. 1). Birds following the Atlantic coastline may reorient upon reaching the end of the Cape and fly to the west until the extreme southwestern tip of New Jersey is reached, whereupon they again reorient in the "appropriate" direction. The techniques used in this study did not allow for such temporally extended measurements of orientation. Alternatively, the flight direction we observed may represent a strategy of overcompensation for wind drift, because many owls were observed when winds were from the northwest. Simultaneous nocturnal observations along the Delaware coast and the Delaware Bay shore to the north of Cape Henlopen might shed some light on the destination of these birds. Furthermore, more work is needed to ascertain that owls do not in fact turn north along the western edge of the peninsula at a location to the west of the site used in the present study, as many diurnally migrating raptors are known to do.

SOCIAL ASPECTS OF BARN OWL MIGRATION

Migrant Barn Owls frequently emit loud call notes while en route. On numerous occasions, vocalizing individuals were subsequently joined by other calling birds, indicating that social interactions may be implicated. Many observations of birds heading out over water were of loose "flocks" formed in this manner. Birds in these flocks were sometimes seen circling with set wings, and on occasion seemed to be gaining altitude, though darkness precluded extended observations. It is known that, under certain conditions, convective structure can develop nocturnally over and adjacent to the sea as a consequence of the different thermal properties of air and water (Woodcock 1975). Migrant Barn Owls have occasionally been observed to use thermal convection for soaring during the day (Russell, pers. obs.), and our observations suggest that some birds may do the same during the night. We hypothesize that the frequent vocalizations of migrant Barn Owls serve to facilitate flocking behavior, which should improve an individual's probability of detecting and exploiting localized pockets of nocturnal thermal convection for bouts of energetically efficient soaring flight.

Until future researchers devise and use techniques that measure the flight behaviors of migrating owls in a wide array of situations, the results presented in this paper should be considered tentative. Banding data and radiotelemetry studies will allow field tests of some of the alternate explanations given above. Our results are a starting point for posing and testing hypotheses about the migratory flight behavior of owls.

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