A STUDY OF HAWK MIGRATION AT GREEN MOUNTAIN POWER CORPORATION'S SEARSBURG, VERMONT, WIND POWER SITE:

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Executive Summary

A study of autumn hawk migration at Green Mountain Power Corporation's Searsburg, Vermont, windpower site was undertaken between 11 September and 3 November 1996. The purpose of the study was to evaluate interactions between migrating hawks and wind turbines. During the study, a few turbines were being erected, though none were operational. In addition to a standard hawk migration count, behavioral observations were made including altitude of flight, flocking behavior, type of flight, direction of flight, and sector over which the migrant was flying. A total of 430 migrating hawks of 12 species was noted during 80 hours of observations on 20 days. Sharp-shinned Hawks were most numerous followed by Red-tailed Hawks and Broad-winged Hawks. Together these species accounted for 81% of all hawks counted. Two Bald Eagles were seen during the study. The altitude of migration was mostly at altitudes greater than 200 feet, the height to which turbines extend above the ground. Sharp-shinned Hawks tended to fly at lower altitudes than other species, although only about one-third of these hawks flew within the turbine sector at altitudes below 200 feet. About one-half of all migrants flew in the sector where turbines will be placed. Flight was primarily to the south and southwest, with some variation in directions. Hawk migration at Searsburg is part of a diffuse, broad-front migration across New England and the counts there do not indicate that it is an important route to hawks or that it is a migration concentration location. The numbers of hawks were an order of magnitude lower than at well known migration concentration sites like Cape May, New Jersey or Hawk Mountain, Pennsylvania. The data collected during the 1996 migration season will serve as a baseline for comparison with a similar data set that will be acquired during 1997 after the turbines have all be erected and are operating. Thus, the data set from this study represents a before (and partially during) construction data set that will increase in significance after the 1997 data set is taken after all the turbines are erected and operating.

The rate of windpower development around the world has increased dramatically during the past decade. With that growth has come an increased concern for possible impacts and interactions between birds and the turbines. Because turbines extend upward to about 200 feet above the ground and because turbine blades move, they pose a potential threat to birds that are making local flights within an area, as well as to birds migrating through an area. Studies are now being done in several places in North America to evaluate whether or not wind turbines influence birds. Such studies are examining various types of birds including birds that breed near wind turbine fields, birds that winter around turbines, and birds that migrate through an area where turbines are operating.

Because migrating hawks sometimes concentrate in large numbers during autumn and spring along ridges and coastlines, and because these areas often have the potential for windpower development, the potential for mortality is evident. Very few studies have examined interactions between migrants and wind turbines (Colson & Associates 1995) and almost no studies of the affects of wind turbines on migrating birds have been conducted in the northeastern United States. A review of such work in the eastern United States reveals that the reason for this is because there are so few wind power facilities now operating in this area and because there are few turbines in these facilities (Kerlinger 1996). Most studies of migrants in the northeastern United States have been confined to studies done prior to permitting and construction to determine the probability of interactions between turbines and birds (Cooper et al. 1995, Northrop, Devine, and Tarbell 1995a, 1995b).

As a first attempt to examine interactions between operating wind turbines and migrating hawks, studies are now underway in Searsburg, Vermont, where a six megawatt wind energy station is being constructed by the Green Mountain Power Corporation. This study consists of hawk migration counts as well as before and after behavioral observations of hawks migrating through the wind power facility. The following report documents the behavior of migrating hawks before and during construction of the wind turbines and will serve as a baseline for a followup study scheduled for autumn 1996. Thus, the current research design focuses on documenting the behavior of migrating hawks at a site prior to the installation of an operating wind energy station and comparing that behavior with the behavior observed when migrating hawks are confronted with an operating wind energy station.

Methods

During September, October, and early November, 1996, a study of migrating hawks was conducted at Green Mountain Power Corporation's Searsburg, Vermont, wind energy station. The site is near the boundary between Searsburg and Readsboro at the junction of state Route 8 and Sleepy Hollow Road. Observations were made from the center of the cemetery situated adjacent to the site on 20 days between 11 September and 3 November 1996 by a single observer The observation site provides the best view of the entire area where the turbines are being installed as well as the area surrounding the actual construction site. Observations were made using 8 power binoculars between the hours of 10:00 a.m. and 14:00 p.m. EST. The selection of days and time of day for observation was based on the scientific literature (Kerlinger 1989). Most observations were made under clear skies with winds from a northerly or westerly direction, often shortly after the passage of a cold front. Such conditions are known to be associated with the movement of large numbers of hawks at most migration count sites in the northeastern United States and eastern Canada (Kerlinger 1989). By selecting the optimal days for migration, a maximum number of raptors was seen. Although this might bias the data set, it provides the greatest sample sizes and, potentially, "worst case" scenarios. For example, the best days for migration increase the numbers of birds seen, and therefore, the potential number of interactions between turbines and birds. If the worst days for migration were selected (southerly winds and, or rainy days), the bias would have been toward smaller numbers of birds and a "best case" scenario for interactions (i. e., very few interactions). The methodology used was a conservative means of examining the questions posed regarding interactions between migrating birds and wind turbines.

Data recorded for each individual or flock that passed included: species, altitude, location over the hillside, the type of flight used, and the direction of flight. Altitude was determined by estimating the birds' height above ground to the nearest 50 feet, or for birds lower than 50 feet to the nearest 10 feet. For location over the ground, the landscape was divided into four sectors: sector A was the area from the top of the hill to the west of Route 8 down to Route 8, sector B was the area from Route 8 to the base of the turbine hill, sector C was the west side of the turbine hill up the hillside nearly to the turbines, and sector D was the hilltop where the turbines were located. Flight direction was simply the direction a bird realized (its track) over the ground in one of eight cardinal directions (N, NE, E, SE, S, SW, W, NW). In addition to flight behavior, local weather data were collected each hour. Weather data included wind speed and direction, percentage cloud cover, temperature, and precipitation. Each day, the synoptic weather conditions were noted as well (i.e., passage of cold fronts and location of high pressure areas).

The data were entered into an Excel database and analyzed using that program.

Results

On 20 days of observations (80 hours), a total of 430 individual raptors of 12 species was counted (Table 1). Sharp-shinned Hawks predominated, accounting for almost one-third (31.9%) of all hawks seen. Red-tailed Hawks and Broad-winged Hawks were counted in slightly fewer numbers, accounting for 28.8% and 19.5%, respectively. Together these three species made up 81.2% of the total count. The remaining 18.8% consisted of eight species among which Turkey Vultures and Red-shouldered Hawks comprised another 13%. Two Bald Eagles were observed. Only 2.1% of the 430 hawks seen could not be identified to species. The hourly passage rate equaled about 5.4 hawks per hour.

The altitude of migration averaged between 315 and 644 feet above ground level for the three most numerous species (Sharp-shinned Hawk, Broad-winged Hawk, and Red-tailed Hawk) and for all other hawks combined (Table 2). Some individuals were observed at well above 1,000 and even 2,000 feet above the ground. The variation around these means, however, was large. Standard deviations ranged from 283 to 377 feet. Broad-winged Hawks flew highest of the hawks and averaged nearly 300 feet higher than the other species. Examining only those birds that passed over the sector on which turbines were being erected, the mean altitudes were about the same as over other sectors. Differences between overall means and means for the turbine sector for each species were only in the 30-45 feet range.

The percentage of each species that flew within the first 200 feet of the ground, the stratum that is within the height of turbine towers, ranged from 44.0% for Sharp-shinned Hawks to only 3.6% for Broad-winged Hawks. The percentage for Sharp-shinned Hawks was considerably higher than for the other species. This means that nearly 60% of the Sharp-shinned Hawks flew above the height of turbines and about 96%, 73%, and 68% of all Broad-winged Hawks, Red-tailed Hawks, and other species flew above the height of turbines (Table 2).

Slightly more than one-half of all hawks were observed flying over Sector D, the sector in which turbines will be erected (Table 3). Between 50.0% and 56.7% of all species were seen over this elongated hill. A smaller, though substantial proportion of Sharp-shinned and Broad-winged hawks flew over Sector A, ranging from 14.5% for Red-tailed Hawks to almost one-third of all Broad-winged Hawks. For Red-tailed Hawks and other hawks, Sector C was used by substantial numbers of individuals. Sector B was used least often of all sectors by most species. The percentages in this sector ranged from only 2.1% for Sharp-shinned Hawks to 10.7% for Broad-winged Hawks.

Examining the altitude of those hawks migrating over the turbine sector (D), the percentages that passed below 200 feet were 22.7% for Sharp-shinned Hawks, 2.4% for Broad-winged Hawks, 7.3% for Red-tailed Hawks, and 17.7% for all other species combined. For all hawks combined the percentage was only 13.3%.

Flight direction of migrants varied little with the largest proportion of all species tracking to the southwest (Table 4). This percentage varied among species. Broad-winged Hawks exhibited southwesterly movement (92.9%) more often than other species, whereas less than one-half of all Red-tailed Hawks moved to the southwest. Movement to the south was infrequent with Red-tails and other hawks moving in this direction more than other species. Very few individuals (<5%) of any species were observed moving to the southeast (Table 4).

Discussion

Hawk migration at Searsburg is similar to hawk migration throughout much of the northeastern United States. Also, it is quite different from migration at sites where hawks concentrate in large numbers. Flight behavior at Searsburg is characterized by small numbers of birds, spread over a broad front at relatively high altitudes. This has been termed "broad front" migration, as opposed to migration that is funneled along ridges or along a coastline (Kerlinger 1989). At Searsburg, where hawks depend on thermals and wind generated updrafts off hills for lift, they fly at several hundred feet above the ground and they are spread over the landscape. At concentration points vast numbers of hawks migrate at very low altitudes, often below 100 feet, and use ridge lift (wind deflected upwards of ridges) or wind deflected off trees and dunes. This type of migration is very concentrated and not broad front. Also, at Searsburg there are no major topographic leading lines as there are at concentration sites. At Searsburg, hawks move over most of the landscape and do not have long leading lines to follow. Behavioral information generated in this study is consistent with broad-front migration.

The numbers of hawks counted during the autumn 1996 migration study at Searsburg, Vermont, was similar to the numbers reported in two previous autumn studies (Martin 1993, 1994) conducted at that site (Table 5). The slightly greater observation time in 1996 over 1993 and 1994 realized a slightly greater number of migrating hawks. However, when the number of hawks seen was standardized for the number of hours of observations (divided by the number of hours of observations), the number of hawks seen in 1996 was between the numbers reported for 1993 and 1994 (Table 5).

When the numbers of hawks seen at Searsburg, Vermont, is compared with the numbers counted at well known observation sites (Table 5) it is obvious that the numbers at Searsburg do not represent a significant concentration. Searsburg counts are only about 1% of the counts from Cape May, New Jersey, and only about 2% of those from Hawk Mountain, Pennsylvania. These latter sites are the premier autumn hawk migration observation sites in the eastern United States. The former is located along a coastline at the end of a peninsula and the latter is situated on a long, linear ridge. Both of these topographic situations act to "funnel" hawks to the hawk migration count sites. At Cape May the number of hawks, when corrected for hours of observation, is more than 50 hawks per hour and at Hawk Mountain the number is more than 30 birds per hour. These per hour counts are 6 to 10 times greater than those found at Searsburg in this and previous studies.

It should be remembered that if a full season of observation were made at Searsburg (longer season, every day, and more hours on each day), as is done at most large hawk migration sites, the per hour count would be considerably less than reported here. The rationale for this statement is that the hours and dates chosen for this study coincide with the best times for migration. More observations would have added to the total number of hawks, but also would have added days with poor conditions for migration, as well as days that are earlier and later in the season when fewer birds are migrating, and hours earlier and later in the day when fewer birds migrate. Thus, the Searsburg counts are but a small fraction of the counts at recognized locations and, thus, Searsburg is insignificant in the larger picture of hawk migration.

It is likely that more birds pass over the Searsburg site than was indicated by the counts reported in this and previous studies (Martin 1993, 1994). Ground based counts have frequently been shown to miss a significant portion of migrants passing over a site because direct visual observations simply cannot monitor high altitude migration (Kerlinger 1989, 1995). Using radar, Kerlinger (see review and ferences in Kerlinger 1989) and others have shown that migrants in the northeastern United States and elsewhere regularly pass at thousands of feet above the ground. At these times they are often almost invisible to all but the most diligent and gifted counter using naked eyes and binoculars. However, these birds are irrelevant to this study because they will in no way be influenced by wind turbines. They are too high to be influenced or to be impacted by turbines. For completeness, this fact is included in this report.

The altitude of hawks migrating through the Searsburg windpower facility shows that a majority of individuals passes at altitudes well above the turbines' blades. Few individuals flew below the 200 foot height of turbines and a small percentage of all migrants flew below 200 feet within Sector D, in which wind turbines will be erected. What this means is that the risk for impacting individuals of all species is low, with Sharp-shinned Hawks being at greatest risk. The maximum number of individuals that could be impacted is a function of the percentage that fly through Sector D at altitudes below 200 feet. However, it remains to be seen how migrating hawks react and behave when they are confronted with operating turbines. The altitude and number of individuals passing through sector D during 1996 will serve as a standard for comparison in 1997, when the turbines are operating.

The baseline data reported herein will provide an important basis for determining whether birds change their behavior when confronted by operating turbines. The type of data to be collected in 1997 will be virtually identical to those collected in 1996, as reported in this study, and reported earlier by Martin (1993, 1994). The data from the tables and analyses in this report will be useful for comparing various aspects of the flight behavior of migrating hawks including flight direction, flight altitude, and sectors used. Even the overall numbers of migrating hawks counted may be influenced by the presence of turbines.

In addition to collecting the same data as collected in this and previous studies, the 1997 study will also provide observations of moment to moment changes in flight direction, flight altitude, and flight type used by migrants as they approach the turbines. In addition, these changes in flight behavior can be compared to migrants flying through sectors A, B, and C, where turbines do not exist. Differences in behavior between sectors can be attributed to the presence of operating turbines because spatial and temporal comparisons can be made and evaluated statistically. It is imperative that these data be collected meticulously and analyzed properly.

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