

Nocturnal Migration of Songbirds at the Searsburg,
Vermont, Proposed Wind Energy Facility: Spring 1995

A Report Prepared for the Green Mountain Power Corporation

Executive Summary

A study of nocturnal songbird migration at the Searsburg, Vermont, was conducted between 4 and 26 May 1995 to determine the potential impact of a proposed 6 megawatt wind energy facility. Migration was observed for 60 minutes per evening on 14 nights using a modification of the ceilometer technique. A 400,000 candle power spotlight/ceilometer was directed vertically and birds were observed as they passed through the beam. Observations commenced 45-60 minutes after sunset. A total of only 26 migrants was observed, an average passage rate of 1.89 birds per hour (maximum of 14 birds per hour, minimum of 0 birds per hour). The direction of migration averaged to the north of east (toward 80°), which is almost downwind of prevailing westerly winds.

The rate of passage as determined by ceilometer in this study for southern Vermont is much lower than reported for most other migration studies including studies in central New York, South Carolina, Louisiana, and coastal Massachusetts. Passage rates were about the same as a study conducted in northwestern Maine. Because of the small number of birds observed passing through the ceilometer during the study, it is likely that migration passage rate over the hilltops of southern Vermont in spring is small. For this reason and because birds generally migrate higher than 200-300 feet at night, it is unlikely that wind turbines placed on these hills will cause undue adverse impact on populations of songbirds migrating through this area during spring.

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Introduction

The impact of wind turbines on birds has been debated for about a decade. On one side are those who feel that wind turbines could pose a risk to birds and on the other are those who feel that wind power development does not constitute an undue adverse impact. The actual impact of wind turbines on birds is not well known. However, because of perceived problems and because mortality has been documented at a few existing wind power facilities, research projects have been conducted recently or are now being conducted to clarify whether wind turbines impact birds.

What has been found regarding wind turbine impact on birds has been summarized by Colson and Associates (1995). It seems that significant or undue impacts to populations of birds by wind power facilities occur at only a very few sites, if at all. It also seems that the impact is both site and seasonally specific. That is, the degree of risk to birds is dependent upon where the facility is located and if birds migrate through a site or breed on the site. A review of the literature reveals that even within a large wind power field of thousands of turbines, there is variability, with some areas (and even individual turbines) having an impact while others do not.

A summary of the studies reveals that, to date, no negative impacts on bird populations have been documented. Turbines do impact occasionally on individual birds, but these impacts do not contribute to a decline in a defined population. Definitive studies of population impacts are ongoing at several sites (Colson and Associates 1995), primarily to provide the information necessary to make intelligent decisions about future wind power development.

Birds are most vulnerable to potential impacts from turbines, towers, lighthouses, and other tall structures when they are flying in the same altitudinal strata as these objects. This occurs primarily when birds make foraging flights or when they are migrating. It can also happen during display flights, during which birds fly at 100 feet or more advertising their territory and attracting a mate.

During spring and autumn in North America, millions of songbirds undertake migrations between their breeding and wintering sites. Most, migrate during the night (Kerlinger and Moore 1989), along with other nocturnal migrants including waterfowl, herons and egrets, swifts and swallows, owls, and shorebirds (Kerlinger 1989, 1995). Birds that use soaring flight during migration such as hawks, gulls, pelicans, and others migrate during daytime (Kerlinger 1989). Soaring flight is

flight without flapping in which birds use updrafts to stay aloft. Nocturnal migrants like songbirds takeoff shortly after sunset, climb to their cruising altitude, fly for one to 12 hours, descend, and land. During this process migrants climb and descend through the first 200 feet above the ground. This occurs for only a small portion of their nightly flights. Most of the night is spent cruising at between 300 and 2,000 feet. Scientists who study migration are in agreement that a majority of migrants fly within this altitudinal band (Kerlinger 1995).

To determine whether a given wind power project will impact upon migrants, planners need to know more about the numbers of migrants that pass through the project area and at what altitude they pass. In addition, the numbers collected at a proposed site must be compared with migration at other sites, particularly known migration hotspots. If large numbers of birds migrate at low altitudes in an area, the potential for adverse impacts to occur is greater than if small numbers of birds occur there.

A small wind energy project of 6 megawatts (up to 12 wind turbines) has been proposed by Green Mountain Power Corporation for the hills near Searsburg, Vermont, a few miles west of Wilmington, Vermont. The wind turbines proposed will extend upwards to about 190+ feet above the ground. Because there is concern regarding the impact of wind turbines on birds, Green Mountain Power has commissioned breeding bird surveys (Capen and Coker 1994), surveys of endangered and threatened birds (Capen and Coker 1994), and hawk migration studies (Martin 1993, Martin 1994). To date, none of the studies has documented a scenario which would indicate undue adverse impact on birds.

The focus of the present study was to determine the amount of migration that occurs during nighttime over the Searsburg site. The birds that migrate over Searsburg at night are primarily songbirds, with some shorebirds, waterfowl, and other species mixed in. A large proportion of those songbirds are Neotropical migrants that fly to and from the Neotropics (Central and South America and the Caribbean Basin). These birds are now of particular interest because the populations of some are declining. The types of Neotropical and non-Neotropical songbird migrants that fly over southern Vermont are summarized in Table 1. The numbers of birds migrating over the proposed wind power site will provide an indication as to the potential impact of the project on migrating songbirds.

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Methods

The songbird migration study was conducted near Searsburg, Vermont in May 1995, at the site of the proposed wind power project. The actual study location was situated where turbine number 4 is expected to be situated at an elevation of about 2,800 feet asl (see Green Mountain Power Corporation Petition of Public Good, Vermont Public Service Board, 1995, for map of wind turbine locations). Dates of the study correspond to the peak of spring migration for Neotropical songbird migrants. At this time, songbirds are returning to New England from Central America, South America, and the Caribbean basin. In addition, some migrants are also returning from the southern and central United States.

To measure the numbers of migrants aloft and their flight direction, a standard ceilometer was used. A ceilometer is simply a very bright, narrow beamed spotlight. For the present study a 12 volt, 400,000 candlepower spotlight (Brinkman Q-Beam, "Black Max") was used. Power was supplied by a gas generator. The ceilometer is aligned vertically with the aid of a bubble level. An observer reclines on his/her back and looks through a 20 power spotting scope that is also aligned vertically. By separating the spotting scope and the ceilometer by about 50 feet, insects that often fly in the lowest portion of the beam are not evident.

The ceilometer illuminates the underside of a migrant as it flies through the beam. Birds flying through a ceilometer beam are easily spotted. Their wings, tails, heads, and even breast spots at times are clearly visible. With the 400,000 candlepower ceilometer used in this study, birds the size of thrushes are visible to more than 600 feet and sometimes to more than 1,200 feet.

Flight direction is determined by recording clockface coordinates of the bird as it flies through the ceilometer beam. For example, with the observer looking upward in the prone position with head aligned to the north (12 o'clock), a bird seen flying from 6 o'clock to 12 o'clock is flying north. A bird seen flying from 3 o'clock to 9 o'clock is flying to the east and one flying from 9 to 3 is flying west.

When the moon was too bright for the Q-beam to be effective (one-half and three quarter moon in this study), moonwatching was substituted for ceilometer observations. Moonwatching for migrants is done by focusing a 20x spotting scope on the moon's disk. Birds can be seen crossing the moon in a fashion similar to the ceilometer. Directions are read off a clockface that the viewer superimposes over the moon's disk. These clockface coordinates are translated into actual directions (0-360o) via a

table that compensates for the moon's changing azimuth and angle above the horizon. This occurred on only two evenings during the study.

At about 45-60 minutes after sunset, ceilometer observations commenced. This period corresponds to the takeoff time and peak timing of migration for most night migrating songbirds. In addition, because it is so close to takeoff time, these birds would be flying at their lowest altitude and be readily visible. Four 15 minute periods of observation per night were used, separated by up to 10 minutes of rest period between them. For the purpose of this study all four 15 minute observation periods per night were pooled. Thus, unless adverse weather curtailed operations, observations occurred over one hour each evening. Operations were completed by a few minutes after 10:00 p.m. EDT.

Rudimentary weather data were gathered at the beginning of observations each evening and were noted if weather changed during an evenings work. Wind direction and speed, approximate temperature, and cloud cover were noted. In addition, precipitation was noted. Operations were terminated on the one evening when rain commenced during field work.

Results and Discussion

Observations at Searsburg were conducted on 14 nights between 4 and 26 May, 1995 (Table 2). A total of 13.75 hours (825 minutes) of observations was logged. During the study, rain precluded observations on eight nights and curtailed observations on one other after about 45 minutes of observations.

During the 14 nights of observations a small number of birds was observed. Migrants were noted on only about one-third of the nights of observation (5 of 14 nights). During 13.75 hours 26 migrants were seen, averaging 1.89 birds per hour. Despite the low overall rate of passage, on two nights rates there were 8 birds per hour and 14 birds per hour. These nights, May 7 and May 8, account for about 85% of all birds seen during the study. This is similar to wavelike events reported in the ornithological literature that occur during migration season, where major migration occurs on only a very few evenings during the season. The flight of May 7-8 constitutes such a wave. It is interesting to note that on the evening of May 8, the night with the largest numbers of birds observed, the wind was light from the northwest. On May 7, winds were strong from the west, when another good flight occurred. With few nights of truly favorable winds (from the south), migrants were compelled to migrate when winds were unfavorable, from the west and northwest.

Direction of migrants was primarily to the east, with the mean direction being toward 80° (Table 3). This is slightly to the north of east. Two birds (7.7% of the sample) were observed flying to the west. The remaining 92.3% were distributed within a narrow band between 45° and 105°. The axis of migration (straight line direction between wintering ground and breeding ground) for spring migrating songbirds in the eastern United States is to the northeast. The mean direction of 80° may be a bit to the east of the presumed axis of migration.

Prevailing west winds explain the fact that so many of the migrants observed were flying to the east-eastnortheast. Birds like songbirds, capable of flying at airspeeds of only 15-25 mph cannot fly into or across winds in the 30+ mile per hour range as was the case on the evening of May 7. All birds on this evening flew directly downwind. Even with light winds from the northwest, migrants primarily flew with the wind in an easterly direction. On this night however, migrants flew in more diverse directions than on any other evening. This was possible because winds were not stronger than the birds' airspeeds.

A comparison of the passage rate observed for spring migration at Searsburg with passage rates observed at other localities is instructive. Passage rates at Searsburg were about

the same as those reported in a study conducted on hilltops in northwestern Maine. The Maine study reported an average of 2.15 birds per hour, which is only slightly greater than the passage rate (1.80 birds per hour) found in the present study.

Studies conducted in North Dakota (Avery et al. 1973) reported rates of about 1 to 18 birds per hour for an average of 5.3 birds per hour. This is about twice the rate found in the present study. Farther south in Georgia, Able and Gauthreaux (1975) reported passage rates averaging more than 50 birds per hour, which is more than 25 times greater than found in southern Vermont. Even the highest hourly passage rates in southern Vermont were less than the lowest passage rates from Georgia. A range of 18-130 birds per hour was observed in Georgia, while during autumn the range was 21 to 503 birds per hour (Able and Gauthreaux 1975). In Louisiana, Gauthreaux (1969) and Able and Gauthreaux (1975) have reported autumn passage rates of more than 800 birds per hour. These migration passage rates are one to two orders of magnitude larger than the 1.89 birds per hour found in the present study. Thus, the numbers of birds seen in Vermont were far fewer than reported farther south using the same methodology. This means that compared to these locations, the probability of wind turbines striking migrants is much lower than at almost any other location where migration has been studied.

Topographic features such as coastlines, rivers, and long, linear ridges are known to concentrate songbird migrants. There are few topographic features near the Searsburg site that act to concentrate migrants. A study in central New York near Albany showed that the Hudson River was a "leading line" for migrants when winds were strong from the west during autumn migration (Bingman et al. 1982). Ceilometer passage rates in this study (and unpublished data from these authors) were much greater than those reported from southern Vermont (this study). Passage rates of greater than 10 birds per hour are normal from the Hudson Valley near Albany and the surrounding area. Greater rates of passage, often exceeding 30-40 birds per hour were not uncommon.

Although no ceilometer data are available, it is likely that the passage rates are much lower than those in coastal areas of New England. This assessment is based on personal observations in coastal New York and Cape May, New Jersey. It is also based on radar studies conducted along the coast of Massachusetts (Nisbet 1963) and the Canadian maritime provinces (Richardson 1971). A regression technique developed by Able and Gauthreaux (1975) describing the relationship between numbers seen on radar and ceilometer yields insight as to how many birds would be seen on radar in Vermont. This compared with coastal radar studies of migration by Nisbet and his colleagues shows that the density of migrants over Vermont is much lower than along the Massachusetts coast. The reason for this is because inland migration occurs over a very wide area and is diffuse, whereas birds concentrate

along the coast because they are reluctant to fly out over the Atlantic Ocean.

At the Searsburg site, there are no rivers, lakes, or ocean coastlines, or ridges to act as leading lines, concentrating large numbers of birds into a small area. Instead, the landscape is dominated by hills and valleys that meander in directions that are seldom appropriate for migration. The data collected in this study do not document any concentrating effect at the study site. The migration passage rate from this study of just less than 2 birds observed per hour indicates that there is a diffuse, broad-front migration that is most likely similar to the rate over hundreds or thousands of square miles of this portion of New England.

Before closing this section it is important to explore what is known about the altitude of nocturnal migration and bias inherent in the method used in this study. Ceilometers are biased to low altitude migrants. They are most effective for detecting birds below 1,500 feet so that birds above 2,000 or 2,500 feet are rarely seen. The reason for this is because the ceilometer beam cannot illuminate sufficiently birds that are more than 2,500 feet or more above the ground. Also, small birds are difficult to see at altitudes of more than 1,000 feet. It is possible that the actual passage rate of migrants over the Searsburg site is greater than the rate found in this study because of ceilometer bias. However, if birds are flying at altitudes beyond the range of the ceilometer they will not be impacted by turbines.

It should be remembered that ceilometer bias is inherent in all studies using this method. Therefore, the results of studies conducted in different parts of the world remain comparable, giving a relative estimation of the amount of migration that occurs at low altitudes. Because songbird migration at night proceeds mostly between 300 and 2,000 feet (Able 1970), ceilometers detect a goodly proportion of those migrants that are aloft.

Conclusions

Although we do not know a great deal about the impacts of wind turbines on songbirds migrating at night at specific sites, we have lots of general information about migratory behavior that will help us determine the potential for impacts. In addition, we are quickly gaining site specific information, as gathered in this study, that will help us make informed decisions as to potential impacts at proposed wind energy sites. Studies like the present study are important not only for the project proposed for Searsburg, but are useful for sighting of wind projects in other portions of Vermont or New England.

It is unlikely that the Green Mountain Power wind energy project proposed for Searsburg, Vermont, will cause undue impact on populations of nocturnally migrating songbirds. This statement is based on the fact that the migration passage rate found in this study is very low and it is based on what has been established regarding the altitude of migration.

Simply put, the density of night migrating songbirds over the Searsburg site is lower than reported in virtually all previous ceilometer studies. Migrants flying over southern Vermont, and probably over most of inland New England, are dispersed over a very wide area. They are not concentrated, at least at Searsburg, where they could be impacted adversely by towers.

Just as important, except during takeoff and landing, migrants usually fly at altitudes that are well above the height of the wind turbines proposed for Searsburg. Considered in light of the scarcity of migrants observed at Searsburg, this means that only a small number of birds could potentially be impacted and only during a small portion of a night's flight. Together, these facts should discount fears that the Searsburg wind energy facility will unduly impact populations of night migrating birds.

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Table 1. Representative samples of Neotropical and non-Neotropical songbirds that migrate at night through the Searsburg, Vermont, area during spring and autumn.

Neotropical Species	Non-Neotropical Species*
Least Flycatcher	Brown Creeper
Chimney Swift	Winter Wren
Blue-gray Gnatcatcher	Ruby-crowned Kinglet
Veery	Hermit Thrush
Red-eyed Vireo	Pine Warbler
Northern Parula Warbler	Palm Warbler
Bobolink	Northern Junco
Northern Oriole	Rufous-sided Towhee
Scarlet Tanager	White-throated Sparrow
Rose-breasted Grosbeak	Song Sparrow

Some individuals of these species, especially those with western populations, migrate to and from the Neotropics and some, migrate at times during daylight hours.

Table 2. Summary of Spring 1995 Nocturnal Songbird Migration Observations at the Proposed Searsburg Wind Power Facility.

Date	Weather	Number of Birds Observed
May 4	Mild, Clear, Thin Cloud Cover, Wind W 5-10 mph, Mild (45o F)	2
May 5	Rain	
May 6	Clear, Cool (30o F), Wind W 35+ mph	0
May 7	Clear, 1/2 moon, Wind W 35-40 mph Cool (ca. 30o+ F)	8
May 8	Clear, Bright Sky, 40o F, Wind NW 10-15 mph	14
May 9	Clear, Bright Sky, 3/4 Moon, Wind calm, 45o F	0
May 10	Rain	
May 11	Rain	
May 12	Rain	
May 13	High clouds, Calm wind, 40o F	1
May 14	Rain	
May 15	Low heavy overcast, wind NW 25-30 mph, 35o F	0
May 16	Cloud cover 100%, Wind SE 5 mph, 50o F	1
May 17	Rain	
May 18	100% cloud cover (low), Wind NW 20-25 mph, rain at 9:40, cold (ca, 35o F)	0
May 19	Rain	
May 20	Clear, 45-50+o F, Wind SW 5-10	0
May 21	Low scattered thunder clouds, Wind SW 10-15 mph, 45-50o F	0
May 22	Clear, Wind W 10-15 mph, 40-45o F	0
May 23	Thin cloud cover, Wind SW 15-20, 50o F	0
May 24	Rain	
May 25	Low overcast clouds, no wind, 45-50+o F	0
May 26	Lite rain	
Total		26

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Table 3. Summary of flight and wind direction of night migrating songbirds at the Searsburg, Vermont, proposed windpower facility during May 1995.

Date	Bird Direction (toward)	Wind Direction and Speed (toward)
May 4	90o (E) 90o "	West 5-10 mph (90o) " " "
May 7	90o (E) 90o " 90o " 90o " 90o " 90o " 90o " 90o "	West 30+ mph (90o) "
May 8	90o (E) 90o " 90o " 90o " 60o (ENE-NE) 90o (E) 75o (E-ENE) 105o (E-ESE) 270o (W) 90o (E) 45o (NE) 75o (E-ENE) 270o (W) 75o (E-ENE)	Northwest 10-15 mph (135o) "
May 13	60o (ENE-NE)	Calm
May 16	75o (E-ENE)	Southeast 5+ mph 315o

Mean Flight Direction - Just North of East - 80o*

Calculated arithmetically from a sample of 24 birds based on range of directions (45-105o), without two west bound birds.