

## **APPENDIX D AVIAN WHITE PAPER**

The presence of existing studies from the nearby Searsburg Wind Facility represents a unique opportunity to evaluate and build upon multi-year, site-specific data, which spans pre- and post-construction of an existing wind energy project (see the Project Record). A summary of avian studies conducted for the Searsburg Wind Facility from 1993 to 2002 follows.

### **EXISTING STUDIES**

Eleven Zond Z-40 turbines were erected at the Searsburg Wind Facility site in 1996. Each turbine is situated on a cylindrical tower. The height above the ground to the tip of the blades (12 o'clock position) is roughly 60 meters (197 feet). Approximately 12 acres (about 5 hectares) were cleared for the Searsburg Wind Facility. Of this area, 75% was deciduous forest and the remainder was coniferous or coniferous and deciduous mixed forest. The coniferous patches were small, consisting of less than one acre (0.47 hectare). The following 14 studies were used to describe avian resources and potential impacts at the Searsburg Wind Facility.

- Martin, Nancy. 1993. Hawk Migration at Searsburg, Vermont—20 September to 28 October 1993. December 1993.
- Capen, David and Danial Coker. 1994. Avian studies—Proposed GMP Wind Turbine Project, Searsburg and Readsboro, Vermont. Summer 1994.
- Martin, Nancy. 1994. Hawk Migration at Searsburg, Vermont—1 to 20 September 1994. September 1994.
- Kerlinger, Paul. 1995. Nocturnal Migration of Songbirds at the Searsburg, Vermont, Proposed Wind Energy Facility. Spring 1995.
- Kerlinger, Paul. 1996a. Potential and Realized Impacts of Operating Wind Turbines on Migrating and Breeding Birds at the Green Mountain Power Wind Turbine Project, Searsburg, Vermont—Study Plan. July 1996.
- Kerlinger, Paul. 1996b. A Literature Survey of Tower and Wind Turbine Impacts on Birds in the Northeastern United States and the Influence of Ceilometers on Bird Flight. July 1996.
- Kerlinger, Paul. 1996c. A Study of Hawk Migration at Green Mountain Power Corporation's Searsburg, Vermont, Wind Power Site. Autumn 1996
- Kerlinger, Paul. 1996d. Nocturnal Migration of Songbirds During Autumn at GMP's Searsburg, Vermont, Windpower Facility—1997 Interim Report. December 1996.
- Kerlinger, Paul. 1997a. A Study of the Nocturnal Migration of Songbirds at the Searsburg, Vermont, Wind Energy Facility—Spring 1997. Spring 1997.

- Kerlinger, Paul. 1997b. A Study of the Impact of the GMP Wind Turbine Development on Breeding Songbirds at Searsburg and Readsboro, Vermont, 1994-1997— Interim Report No. 2. August 1997.
- Kerlinger, Paul. 1997c. A Study of Hawk Migration at Green Mountain Power Corporation's Searsburg, Vermont, Wind Power Site—Autumn 1997.
- Kerlinger, Paul. 1997d. A Study of Avian Fatalities at Green Mountain Power Corporation's Searsburg, Vermont, Windpower Facility – 1997. November 1997.
- Kerlinger, Paul. 1997e. Nocturnal Migration of Songbirds During Autumn at GMP's Searsburg, Vermont, Windpower Facility. December 1997.
- Kerlinger, Paul. 2002. An Assessment of the Impacts of GMP's Wind Power Facility on Breeding and Migrating Birds in Searsburg, Vermont by Curry & Kerlinger LLC, March 2002.

As indicated above, avian studies prepared for the original Searsburg Wind Facility covered the time frame of 1993 to 2002, and included hawk migration surveys, nocturnal migration studies, goshawk surveys, breeding bird surveys, and collision mortality surveys. Detailed descriptions are presented below.

## **PRE-CONSTRUCTION STUDIES**

### **Hawk Migration Studies 1993 and 1994**

In the 1990s, concerns regarding wind turbines' potential impacts to birds focused on raptors (birds of prey, i.e. hawks and eagles). This is likely due to the highly publicized and significant impacts to raptors at the Altamont Pass Wind Farm in Altamont California. In 1993 and 1994 Martin examined Hawk migration at the Searsburg Wind Facility site. The two year study focused on the fall migration. Vermont does not experience very large or concentrated hawk flights as in more southerly locations. The largest hawk movements have been observed at locations in the Lake Champlain and Connecticut River valleys (Martin 1993). These larger valleys are favored in part because thermal activity tends to be stronger over open agricultural land than forested land (Oke 1987 in Martin 1993). Fifteen species of diurnal raptors have been observed during autumn migration in Vermont (Martin 1993).

Two sites were selected for monitoring hawk migration at the Searsburg Wind Facility in 1993 and 1994—Fairington Cemetery, along Route 8, and a clear-cut at the northern edge of the ridge that the existing turbines are on. The fieldwork consisted of scanning the sky and adjacent ridges, with and without binoculars and spotting scope, for migrating raptors. Each bird seen was identified to species, if possible, and its estimated flight altitude, direction, and behavior were noted. Twenty watches were conducted between September 20 and October 28, 1993. Three hundred eighty migrating raptors of 12 identified species were counted during 63.5 hours of observations. Hawk flights were converted to number of hawks per hour of observation to compare with other nearby sites. The Searsburg Wind Facility site had

numbers (5.98 hawks per hour) comparable to several sites in the northern Green Mountains, but less than most hawk watch locations in major valleys in Vermont (Martin 1993).

The altitude of birds flying above the two sites was assessed to determine if birds, including migrating hawks, would be at risk from the proposed turbines. Martin estimated that 14% of the birds observed during the hawk migration survey would be within the height (100 feet) and path of the rotor swept zone.

The hawk migration study was conducted again in 1994; however, only the first part of the fall migration period (September 1–20) was assessed. Nine watches were conducted over the study period. One hundred forty-five migrating raptors consisting of 10 species were counted during 31.3 observation hours (4.6 hawks per hour). As in 1993, the survey showed that the Searsburg Wind Facility site has raptor migration characteristics similar to other sites in the northern Green Mountains, but fewer species and lower overall numbers than most hawk watch locations in major valleys in Vermont. The number of low-flying birds was less during the early September survey in 1994 versus the late September/October survey in 1993. Approximately 25% of all birds, including about a quarter of all raptors, spent some time at heights less than 100 feet; however, only 6–7% remained at that height during the entire observation of a passing bird (Martin 1994).

#### **Northern Goshawk and Breeding Bird Survey 1994**

In 1994, Capen and Coker surveyed the proposed Searsburg Wind Facility site for the presence of nesting northern goshawks (*Accipiter gentiles*) and to document the diversity of songbirds. Transects were established across the two ridges where the turbines are currently located. The total length of the transects surveyed was 48.4 kilometers (30 miles). Biologists stopped along the transects at every 300 meters and played goshawk calls.

Breeding songbirds were also surveyed along the proposed service roads and two ridge lines where the turbines are now located. Twenty-one songbird survey points were located on a zigzag pattern from the center line of the ridge lines and proposed roadway. Birds were identified by sound (species and number) during a five-minute sample period. Birds within a 50-meter radius of the sampling point were noted so that density estimates could be made. Birds outside the 50-meter radius were noted, but were not used for density estimates.

No goshawk was seen or heard during the 16 person/days on the site. The only raptor recorded was a red-tailed hawk. Thirty-eight species of birds were detected along the songbird survey points. None of the 38 species was listed as rare, threatened, or endangered at the time of the survey in 1994. The researchers noted two Bicknell's thrush, which is now listed as a Vermont Species of Special Concern. In Vermont, Bicknell's thrush is typically found in high mountains and ridges in dense coniferous forest above 915 meters (3,000 feet). The diversity of songbirds and the relative abundance of the 38 species detected by point counts were expected by the researchers. The habitat and birds detected in the study area were characterized as common and predictable for the Green Mountain physiographic region (Capen and Coker 1994).

### **Nocturnal Songbird Migration Survey 1995**

A nocturnal songbird migration survey was conducted by Kerlinger between May 4 and May 26, 1995. Migration was observed for 60 minutes per evening on 14 nights using a modification of the ceilometer technique. Kerlinger used a 400,000-candlepower spotlight/ceilometer to observe birds flying overhead. A ceilometer illuminates the underside of a migrant as it flies through the beam. A 400,000 candle-power ceilometer can illuminate a bird the size of a thrush (approximately 7.5–8.5 inches in length) at more than 600 feet and sometimes at more than 1,200 feet. Observations commenced 45 to 60 minutes after sunset. Twenty-six migrants were observed at an average rate of 1.89 birds per hour during the survey. The direction of migration averaged to the north of east (toward 80°), which was almost downwind of the prevailing winds (Kerlinger 1995).

Kerlinger reported that the rate of passage was much lower than that reported for most other migration studies in central New York, South Carolina, Louisiana, and coastal Massachusetts. Passage rates were about the same when compared to a study performed in northwestern Maine. Kerlinger concluded that because of the small number of migrants observed, the migration passage rate over hilltops of southern Vermont in spring is small (Kerlinger 1995).

### **Conclusion of the Pre-construction Studies**

Green Mountain Power (GMP) Corporation sponsored the previously described studies covering breeding songbirds, migrating and resident hawks, and migrating songbirds prior to the erection of the Searsburg Wind Facility turbines. The authors of the studies concluded that no large concentrations of migrating hawks or songbirds used the study area and there were no rare, threatened, or endangered breeding birds at the site (Bicknell's thrush has subsequently been listed as a Vermont Species of Special Concern). Based on these conclusions, it was predicted that the turbines would have little or no impact on migrating or breeding birds in the area. To determine if these conclusions were correct, the Vermont Public Service Board, GMP, and the National Renewable Energy Laboratory sponsored subsequent studies following project construction.

### **POST-CONSTRUCTION STUDIES**

After construction of the 11 Searsburg Wind Facility turbines, studies were performed that centered on direct and indirect impacts to birds. Direct impacts occur when a bird strikes a turbine, whereas an indirect impact is an effect that may not be immediately evident, but is occurring none-the-less, over time (i.e., habitat loss, edge effect, cowbird parasitism, and increased predation of nests facilitated by fragmentation). Kerlinger built upon the earlier studies and repeated the breeding bird survey, diurnal hawk migration study, and nocturnal migration study. The following summarizes the methodologies and results of the post-construction studies. A full description of the methodologies and results is presented in *An Assessment of Impacts of Green Mountain Power Corporation's Wind Power Facility on Breeding and Migrating Birds in Searsburg, Vermont July 1996—July 1998* located in the Project Record.

### **Breeding Bird Studies, 1996 and 1997**

Capen and Coker designed and conducted the first Searsburg Wind Facility pre-construction songbird survey in 1994. The study design consisted of making observations at 21 points situated along and

slightly off an old timber skidding trail on the site from the foot of the hills to the top of the hills. The trail corresponded closely to the roads that have been constructed to service the existing turbines. Kerlinger collected data in 1996 and 1997 using the same methodology as Capen and Coker (1994). Sampling at each point consisted of five minutes of looking and listening for singing birds. All birds heard or seen were recorded as being within or outside of a 50-meter radius. Recording birds within the 50-meter radius allows for the determination of relative and absolute abundances. Both were used to assess any changes in the avian community during and after construction.

Songbird surveys were conducted in June and early July in 1996 and 1997. The survey conducted in 1996 was performed during construction of the Searsburg Wind Facility. Road and turbine areas were cleared, but turbines were not installed and roads were not completed. The survey in 1997 was performed after construction.

Forty-two species were observed at the 21 sampling points in 1994, 1996, and 1997 (see tables in Kerlinger 2002 and Capen and Coker 1994 in Project Record). Species richness (number of species represented) was 31 in 1994, 26 in 1996, and 24 in 1997. Species richness decreased following construction (see tables in Kerlinger 1997b and 2002 in Project Record). Kerlinger hypothesized that pre- and post-construction differences in species richness may be the result of construction disturbance and operational disturbance (sound) of the operating turbines after construction. Construction and subsequent operation of the turbines may have made it more difficult to locate birds "by ear" (identifying birds by their calls) in 1996 and 1997. However, when the numbers of species observed at each of the 21 point count sites before construction (1994) was compared with the numbers after construction (1997), no significant statistical difference was detected in birds identified within and beyond the 50-meter sampling circle (Kerlinger 2002).

The five most common species in descending order of abundance in the 1994 surveys were slate-colored junco, Swainson's thrush, white-throated sparrow, ovenbird, and red-eyed vireo. Following construction in 1997, yellow-rumped warbler was the most numerous followed by slate-colored junco, white-throated sparrow, blackpoll warbler, and magnolia warbler. Three species increased in abundance following construction—American robin, blue jay, and yellow-rumped warbler. The American robin and blue jay are considered edge species and their increase was likely the result of clearing associated with the project (Kerlinger 2002).

Decreases in abundance and frequency occurred for some forest interior nesting birds such as Swainson's thrush, ovenbird, black-throated blue warbler, Canada warbler, red-eyed vireo, and white-throated sparrow. The creation of openings in the forest for the Searsburg Wind Facility turbines was the likely cause for the local decline in abundance for these species (Kerlinger 2002). Despite the opening of canopy around the turbines and along the road, American crows and brown-headed cowbirds did not increase in abundance or frequency (Kerlinger 2002). Both species are implicated as one of several factors causing the decline in forest interior nesting birds.

The Bicknell's thrush, a Vermont listed Special Concern Species, was found in all three (pre, during, and post-construction) years of the 1994, 1996, and 1997 studies. Disturbance, alteration, and clearing of the forest resulting from the construction of the Searsburg Wind Facility appeared to have reduced overall

species richness and the abundance of several forest nesting birds. Kerlinger indicates that the most likely cause was from forest fragmentation created for the Searsburg Wind Facility. However, it is not known if forest interior nesting birds returned near the Searsburg Wind Facility after vegetation was allowed to regrow near the turbines and facility roads.

### **Nocturnal Songbird Migration 1996 and 1997**

A ceilometer was used to examine the spring nocturnal migration in May 1997 at the Searsburg Wind Facility. Autumn flights were observed in late August through early November in 1996 and 1997. Dates of the surveys corresponded with the peak spring and autumn migration for Neotropical and North American songbird migrants. Number of birds and flight direction were recorded as birds crossed the beam. In cases where the moon was too bright for the ceilometer to be effective, the moon was substituted as a light source. The location of the ceilometer survey corresponds to where Turbine 6 at the Searsburg Wind Facility is located today.

Observations were conducted on 14 nights in each of the migration seasons. For a detailed list of the results see Tables 5.1 through 5.6 in *An Assessment of the Impacts of Green Mountain Power Corporation's Wind Power Facility on Breeding Birds and Migrating Birds in Searsburg, Vermont July 1996–1998* located in the Project Record. The number of birds seen on individual nights varied, however, on the majority of nights, no migrants were observed. The maximum number of birds seen on a single evening (14) was observed during spring of 1995, prior to construction. However, during the May 1995 study, only a small number of birds (26) were observed over the entire 14 night study period.

During the autumn migration in 1996, only a few turbines were erected and none was operating. A total of 77 migrants were observed for a total of 4.55 birds per hour. The maximum number of birds counted was eight and nine birds per hour for ceilometer observation and 10 birds per hour using the moon. After construction of the turbines, passage rates dropped to 0.14 birds per hour representing only two birds observed in the ceilometer beam during the entire autumn migration survey (Kerlinger 2002).

After construction of the turbines, fewer migrants were also observed during spring migration. In spring 1997, only five migrants were observed for a passage rate of 0.36 birds per hour. This is about one-fifth the numbers seen in the migrating season prior to construction. The maximum number seen during a single night was two birds (Kerlinger 2002).

The direction of spring migrants during 1995 was primarily to the east, with a mean direction being toward 80°. No mean direction of migration could be calculated for 1997 (post-construction) because of the small sample size. During the fall migration, variation in flight direction was wider than observed during the spring. The mean direction of migration during 1996, and prior to construction in 1994, was nearly due south. A mean direction of migration for birds passing during autumn 1997 was not computed because of the small sample size (Kerlinger 2002).

The difference in numbers between the spring and fall migrants in the pre-construction survey reflects the differences between the seasons. Southbound flights in the fall include adults and recently fledged immature birds. In the spring, the northbound birds include the survivors of both groups after two

migration seasons and a winter season. The difference is generally attributed to the natural mortality of the birds (Kerlinger 2002).

Passage rates observed at the Searsburg Wind Facility are about the same as those reported in studies conducted at most other sites. At Searsburg, there are no rivers, lakes, or ocean coastlines which would concentrate large number of birds. The lower passage rates following construction suggest that migrants avoided the turbines (Kerlinger 2002).

### **Hawk Migration Study 1996 and 1997**

Hawk migration counts and behavioral observations were made at the Searsburg Wind Facility site in 1996 and 1997. Observations were made from the cemetery at the corner of Vermont Route 8 and Sleepy Hollow Road. Dates of observation were from September 10 through October 30, which is consistent with the 1993 and 1994 pre-construction studies, and is the peak hawk migration season in southern Vermont. Twenty days of field observation were made each year in 1996 and 1997. Field methods used were a modification of the Hawk Migration Association of North America (HMANA) standard hawk counting method. The sky was scanned with the naked eye and binoculars on a regular basis. All hawks, falcons, vultures, and harriers were counted and recorded on a data sheet. Additional data collected included altitude of each migrant (to the nearest 100 feet), flight direction, type of flight observed (circle soaring, gliding, straight, holding over the hillside, and power flight), sector of the turbine string they passed over, whether they were within 50 feet of a turbine (between or above), and observed reactions to turbines. The data was analyzed to determine if the turbines had an impact on the hawks that migrate through the turbine area.

Hawks observation rates (birds per hour) during the autumn of 1996 were similar to those documented during the autumns of 1993 and 1994. The number of hawks seen in autumn 1997, after the turbines were in operation, decreased considerably (90%). Twelve hawk species were recorded in the fall of 1993, 1994, and 1996. Following construction of the turbines, only six species were observed in the fall 1997 count. During the four seasons, 986 hawks were observed during 255 hours of observations. This represents approximately four hawks per hour. During the observations, five bald eagles and one peregrine falcon were observed. In pre-construction surveys, Kerlinger observed hawks flying over the hilltop where the current Searsburg Wind Facility is located. After construction of the Searsburg Wind Facility, hawks did not come near the turbines (Kerlinger 2002).

### **Mortality Rate Study 1997**

A mortality study was conducted from early June to the middle of October 1997. The search area was composed of the clear-cut areas under and around the turbines. Searches at each turbine lasted 30 to 60 minutes depending on the type of vegetation. The area searched varied slightly from turbine to turbine, but was typically a circle approximately 50 meters (164 feet) in diameter.

The mortality study included two scavenger efficiency studies, and a carcass detectability study to determine how well different observers located carcasses. The results of the mortality searches and scavenger/observer efficiency tests were analyzed to calculate a mortality rate.

In 21 search periods (one search equals four turbines searched) no dead birds were discovered at the Searsburg Wind Facility. These observations were conducted on 15 different days over four months and consisted of about 41 hours of search time. In addition, workers at the wind power plant had not observed any significant avian mortality since the facility went on-line (Kerlinger 2002). One brown creeper was found dead near the junction of an existing tower and the access road. It is unknown if the cause of death was natural or caused by collision with a vehicle or wind turbine (Torres pers. comm. 2008).

Mortality survey results do not mean that mortality is not occurring at the Searsburg Wind Facility. However, it does indicate that large-scale mortality events did not occur during the survey period (Kerlinger 1997d and 2002).

### **SUMMARY OF EXISTING STUDIES**

Searches for nesting raptors, particularly northern goshawk, conducted in spring 1994 revealed no raptors nesting on or adjacent to the Searsburg Wind Facility project site. No evidence of raptors nesting on the site was found during breeding bird surveys in 1996 and 1997, although two sightings of sharp-shinned hawks within four kilometers (2.5 miles) of the site suggest that this species nests nearby.

Hawk migration counts taken in 1993, 1994, 1996, and 1997 revealed small numbers of migrants. Numbers of hawks counted were lower than or similar to most sites in New England; and two orders of magnitude lower than the counts taken at concentration locations such as Cape May, New Jersey; Lighthouse Point Connecticut; and Hawk Mountain, Pennsylvania (Kerlinger 2002). After the construction of the turbines, fewer hawks and songbirds flew over the site. This suggests that the turbines may have altered the migratory behavior of birds that previously flew over the site. This deviation in flight pattern was considered unlikely to result in a significant increase in the amount of energy required, navigational confusion, or any other adverse effect (Kerlinger 2002).

Nocturnal migration of songbirds through the wind power facility during spring 1994 and 1997 and autumn 1996 and 1997 suggested that the site is not a migratory pathway. The numbers of birds flying over the site were the same as or less than the numbers reported from other inland locations in New England and many fewer than reported in studies conducted farther south. Fewer migrants were counted after construction of the turbines, perhaps indicating avoidance of the immediate turbine area by migrants (Kerlinger 2002).

No carcasses were found on the site during the carcass searches in 1997. This suggests that large-scale mortality has not occurred at the Searsburg Wind Facility. This is further supported by the fact that scavenger rates were relatively low (Kerlinger 2002). The breeding bird surveys did show a change in the numbers of forest interior birds. Concurrently, with the reduction of forest interior nesting birds, there was an increase of several edge species (blue jay, American robin, and yellow-rumped warbler) that normally do not reside in the forest interior. Kerlinger postulated that fragmentation due to the construction of the project could have moved breeding birds away from access roads and turbines.

Approximately 12 acres of land were cleared for the construction of the Searsburg Wind Facility. Following construction, four to five acres (1.6–2.0 hectares) of the 12 acres cleared for the turbines were

allowed to revert to forest/brushland, leaving a total of about seven acres (2.8 hectares) as the actual loss of forested habitat. Whether forest interior birds have returned to the site as revegetation occurred is not known. There may have been an immediate impact to forest interior birds that may have decreased as revegetation occurred.

Kerlinger (2002) examined all of the pre- and post-construction studies conducted at the Searsburg Wind Facility and concluded that overall impacts were minor, and were not likely to significantly affect bird populations on a regional scale.

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