Spring 2006 Survey of Bird and Bat Migration at the Proposed Kibby Wind Power Project in Kibby and Skinner Townships, Maine

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Executive Summary

During spring 2006, Woodlot Alternatives, Inc., conducted nighttime radar surveys of migration activity at the proposed Kibby Wind Power Project site. In addition, nighttime surveys of bat activity were conducted using acoustic monitoring devices. The surveys are part of the planning process by TransCanada Maine Wind Development, Inc., for the Kibby Wind Power Project, which would include the erection of wind turbines on ridgelines in Kibby and Skinner Townships, Maine.

Radar Surveys

The results of the field surveys provide useful information about site-specific migration activity through and above the project area. In a total of 25 nights of radar data collected between May 1 and June 4, 2006, four were simultaneous sampling with two radars. Radar sampling occurred at three locations on the two ridgelines proposed for wind turbine development and at three locations in the valleys between the development ridges.

The mean nightly passage rate was variable between nights, typical of bird migration. Variation between sites is attributable the fact that different sites were sampled on different nights, with differing weather conditions. The season mean passage rate of the three ridgeline sites varied from 197 targets/kilometer/hour (t/km/hr) (Kibby Range 1) to 512 t/km/hr (Kibby Range 2). Nightly passage rates at the valley sites ranged from 45 t/km/hr to 1,242 t/km/hr, both of which were at the Mile 4 Road site.

When pooled by landscape position, the overall seasonal mean passage rate over the three ridgeline sites (360 t/km/hr) was very similar to that of the pooled valley sites (443 t/km/hr). These rates are generally within the range of passage rates documented at other radar survey sites in the Northeast.

The mean flight height of targets documented over the ridgelines was 412 meters (m) (1,351 feet [ft]) above the radar elevation at Kibby Range 1; 378 m (1,240 ft) at Kibby Range 2; and 368 m (1,207 ft) above the radar at Kibby Mountain. The mean flight height of the valley sites, when combined, was 334 m (1,096 ft). There was more variation among the valley sites, with mean nightly flight heights at the these sites ranging from 200 m (656 ft) at the Mile 4 Road to 480 m (1,574 ft) at Wahl Road (Table 2-2 and Appendix B, Table 3).

Seasonal mean flight directions through and over the project area were also similar among the survey sites and ranged from 50º to 86º (relative to true north) overall. Migration was generally in a south to north direction on most nights, particularly on the nights with the most suitable weather conditions (i.e., clear skies with southerly breezes).

Nights with the most suitable weather for nocturnal migration (i.e., clear skies with strong winds from the east, southeast, and south) were generally associated with larger mean nightly passage rates and higher flight heights. This relationship, however, was not consistent throughout the study.

The radar data indicate that migration through the project area, an area of varied topography, is complex. Radar data from the valley sites indicate that some migration takes place within the confines of the valleys, with mean flight heights that are below the altitudes of the surrounding ridgelines. Flight direction and flight height data from the ridgeline survey sites, however, indicate a broad front type of night migration, with mean flight heights largely well above typical turbine heights.

Bat Detector Survey

Four bat detectors were deployed in the project area: one on a meteorological measurement tower (met tower) at Kibby Range North, two at different heights on a met tower at Kibby Range South, and one on a met tower at the southern end of the Kibby Mountain ridgeline. Detectors were deployed on May 4 and will continue to operate in the project area through the fall migration season. For the purposes of describing spring migration, data until the night of June 7 is included in this report.

A total of 108 detector-nights of data were recorded during the sampling period, during which only 31 call sequences were recorded. The overall detection rate was 0.3 call sequences per detector-night, which is generally similar to other spring bat surveys at other sites in the region. All calls were recorded from only one detector. That detector was located at a height of approximately 15-20 m (50-66 ft). The other three detectors were all located at heights that would be within the rotor swept zone of 45-50 m (148-164 ft) but yielded no recorded bat call sequences.

Of the call sequences that were of sufficient length and recording quality for species identification, four were identified as within the big brown bat guild, which includes the big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*), and hoary bat (*Lasiurus cinereus*). One call was identified as myotid. No calls were identified as eastern red bat (*Lasiurus borealis*) or eastern pipistrelle (*Pipistrellus subflavus*).

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1.0 Introduction

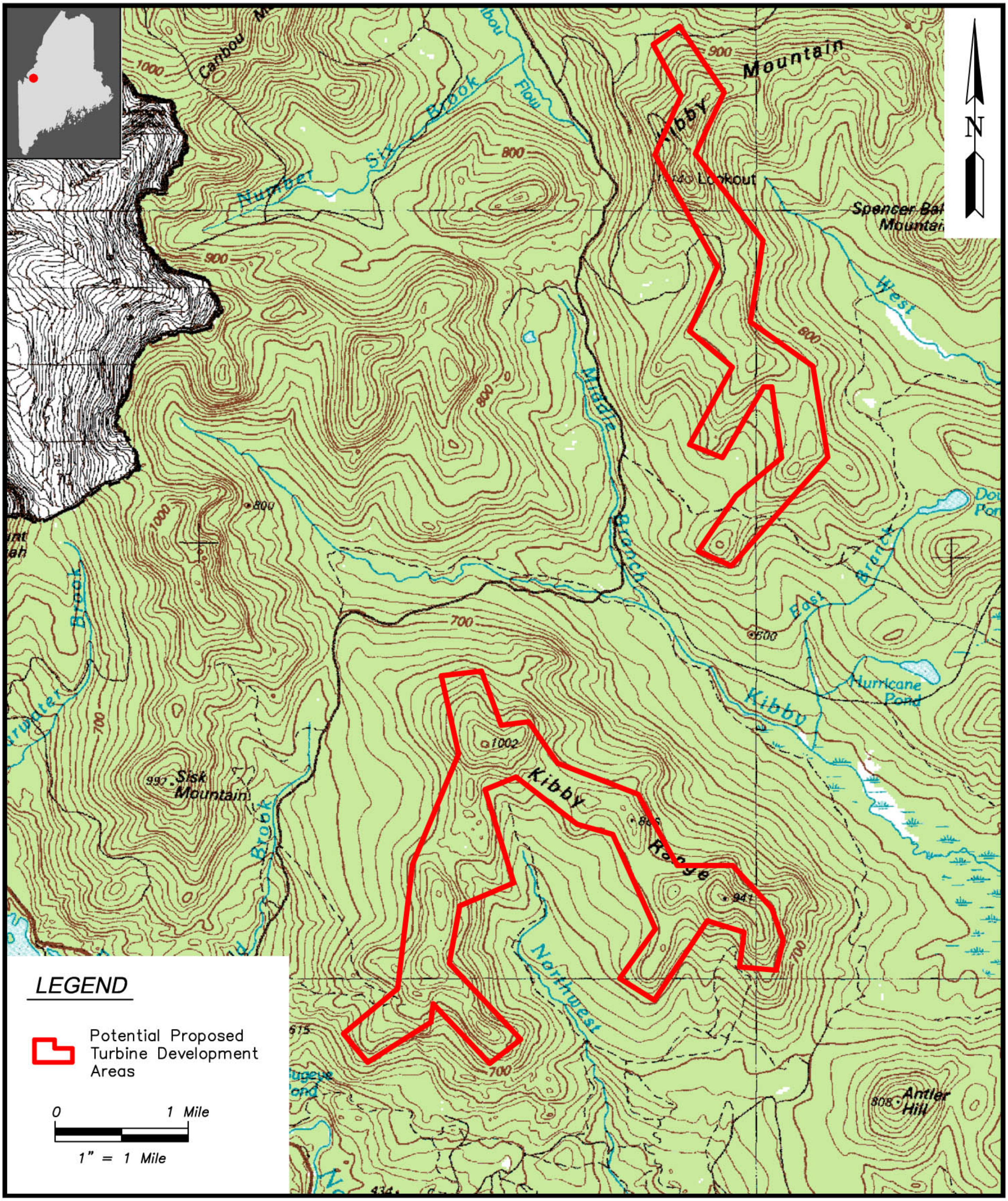
1.1 Project Context

TransCanada Maine Wind Development, Inc., is proposing to develop, own, and operate a 100–200 megawatt wind power generating facility in the Boundary Mountains of Western Maine known as the Kibby Wind Power Project. The project is in a location for which a similar project proposal by U.S. Windpower was previously approved by the Land Use Regulation Commission.

The project will be located in Kibby and Skinner Townships, an unincorporated area of Franklin County, Maine. At the time the study was conducted, up to four ridgelines were under consideration for turbine locations, as shown in Figure 1. The property is owned by Plum Creek, and the surrounding areas are currently actively managed for forest products. The Kibby Wind Power Project can take advantage of existing logging roads and cleared areas to access the ridgelines, and forestry activities can continue in a complementary fashion with the project in place. The project will utilize the superior wind resource found in this vicinity to create clean, renewable power generation.

The predominant peaks in the project vicinity include Smart, Caribou, Kibby, Tumbledown, Spencer Bale and Sisk mountains, all of which are over 975 meters (m) (3,199 feet [ft]) high. Caribou and Kibby mountains are the tallest of these mountains, at 1,051 m (3,448 ft) and 1,115 m (3,658 ft), respectively. Kibby Mountain is included as a potential wind turbine development area for the project, although turbines are currently proposed only at lower elevations of the southern end of the mountain. Kibby Range, also a potential wind turbine development area, is the largest of the mountain ranges in the project area in terms of area and number of peaks included within ridgelines. It has several peaks that are approximately 915 m to 1,000 m (3,002 ft to 3,281 ft) high. The valley bottoms in the study area average between 650 m and 750 m (2,133 ft and 2,461 ft) in elevation

The surveys for this project were conducted to provide data that will help characterize nighttime bird migration and bat activity in the project area. This information, along with other data, is intended to be used to assess the potential risk to birds and bats from this proposed project as a result of potential collisions.



PREPARED BY:

WOODLOT ALTERNATIVES, INC.
ENVIRONMENTAL CONSULTANTS
105112-F101-Location.dwg

SHEET TITLE:
Project Location Map

PROJECT:
Kibby Wind Power Project
TransCanada Energy, Ltd.
Kibby, Maine

DATE: August 2006
SCALE: 1"=1 Mile
PROJ. NO.: 105112
FIGURE:
1-1

1.2 Survey Overview

Woodlot Alternatives, Inc. (Woodlot) conducted field investigations for bird and bat migration during the spring of 2006. The overall goals of the investigations were to:

- document nocturnal migration in the vicinity the project area, including the number of migrants, their flight direction, and their flight height; and
- document the presence of bats in the area, including the rate of occurrence, and when possible, species present during the spring migration period.

The survey protocol was developed through consultation with state and federal natural resource agencies. The design of the spring studies was based on a work plan developed in August 2005, and modified based on the results of fall 2005 surveys and discussions with natural resource agencies (i.e., meeting with Maine Department of Inland Fisheries and Wildlife [MDIFW] and U.S. Fish and Wildlife Service held at the MDIFW Bangor office on February 23, 2006).

Three ridgeline locations were selected for sampling to provide information on nighttime flights over the project area ridgelines. In addition, three valley locations were surveyed to provide additional insight on the flight habits of migrants in the project area. This survey design was the result of consultations with MDIFW to address their concerns regarding nighttime migration not only over the development area ridgelines but across the larger landscape, as well. In total, 21 nights were sampled during the spring migration season. However, on three of those nights, two of the three ridgeline sites were sampled simultaneously and on one night, one of the ridgeline sites and the valley sites were sampled simultaneously. Consequently, a total of 25 “radar-nights” of data were collected from May 1 to June 4, 2006.

Bat surveys included the use of Anabat II (Titley Electronics Pty Ltd) bat detectors to record the location and timing of bat activity. The surveys consisted of deploying four bat detectors on three separate meteorological measurement towers (met towers): two on the southernmost Kibby Range met tower, one on the northernmost Kibby Range met tower, and one on the Kibby Mountain met tower (off Spencer Bale Road).

Details with regard to the radar survey are provided in Section 2.0 of this report, while details regarding the bat surveys are provided in Section 3.0.

2.0 Radar Survey

2.1 Methods

Field Surveys

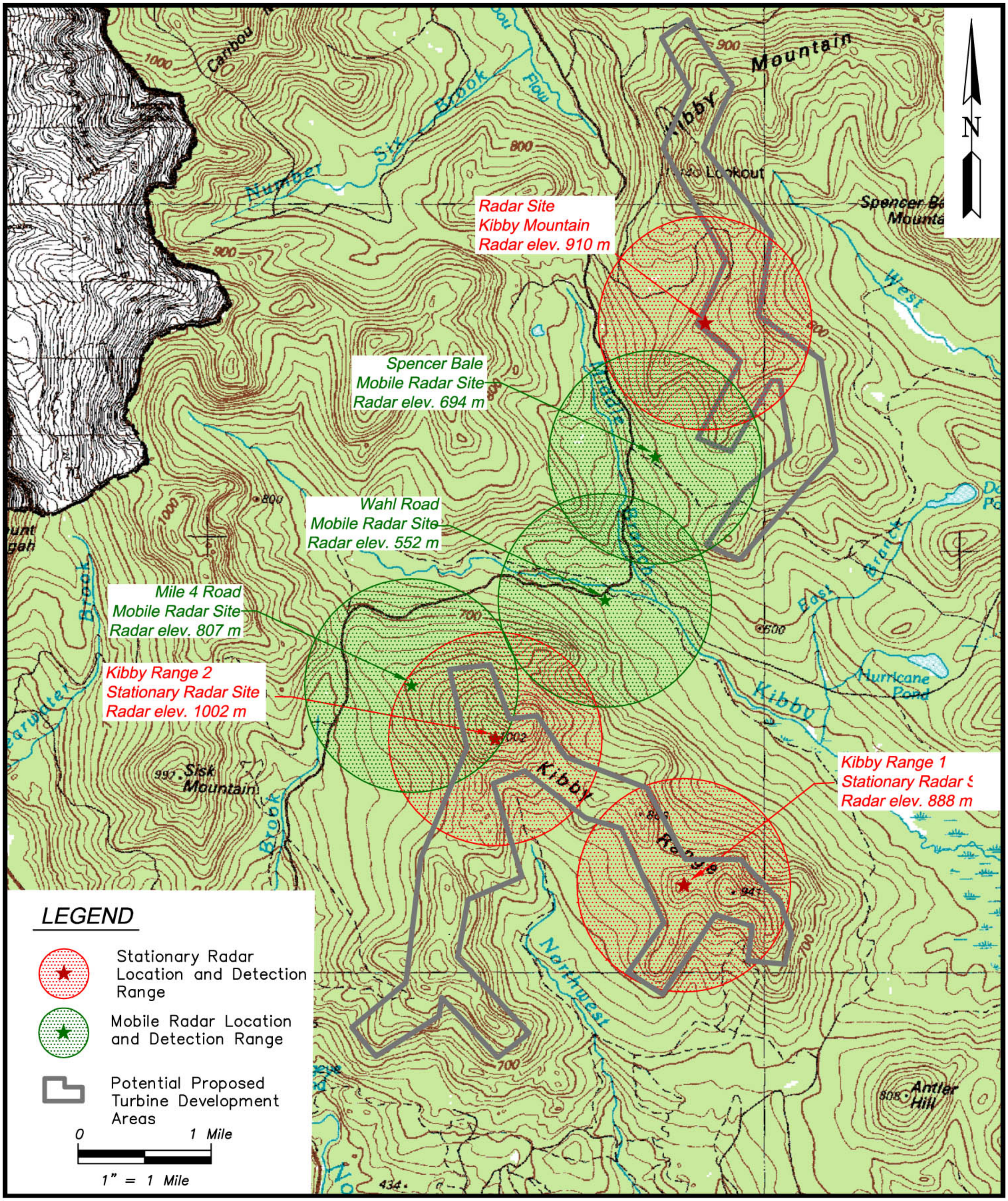
Radar surveys were conducted from six locations in the project area (Figure 2-1). These included three ridgeline locations: one on Kibby Mountain, one on a peak near the southeastern end of Kibby Range (Kibby Range 1), and one on a peak near the northern end of Kibby Range (Kibby Range 2). Three valley locations were selected for mobile sampling. These were located along the existing logging roads in the project area and are referred to in this report as Mile 4 Road, Wahl Road, and Spencer Bale Road sites. The sites were chosen based on several criteria, including location within the overall project area, proximity to road or trail systems for relatively easy access, and the potential radar visibility (i.e., the view that the radar had of the surrounding airspace).

A marine surveillance radar unit similar to that described by Cooper *et al.* (1991) was used during field data collection. The radar has a peak power output of 12 kilowatts and has the ability to track small animals, including birds, bats, and even insects, based on settings selected for the radar functions. It cannot, however, readily distinguish between different types of animals being detected. Additionally, the radar can have difficulty differentiating small flocks of birds flying in close proximity to one another. Consequently, all animals observed on the radar screen are called targets.[1] The radar has an echo trail function that maintains echoes of past migrants. During all operations, the radar's echo trail was set to 30 seconds. The radar was equipped with a 2-m (6.5-ft) waveguide antenna. The antenna has a vertical beam height of 20º (10º above and below horizontal) and the front end was inclined approximately 5º to increase the proportion of the beam directed into the sky.

Objects on the ground detected by the radar cause returns (echoes) on the radar screen that appear as blotches called ground clutter (Figure 2-2). Large amounts of ground clutter reduce the ability of the radar to track birds and bats flying over those areas. However, vegetation near the radar can be used to reduce or eliminate ground clutter by 'hiding' clutter-causing objects from the radar (Figure 2-3). The presence of ground clutter and objects, such as treeline edges, that could reduce clutter were important factors considered during the survey site selection process. Due to the rugged terrain in the project area, ground clutter was unavoidable at the sites surveyed, and the success of reducing clutter was variable from site to site. A description and images of the ground clutter that occurred at each survey site are provided in Appendix A.

Radar surveys were conducted from sunset to sunrise. Twenty-one nights of surveys were conducted for sampling between May 1 and June 4, 2006. Surveys were targeted largely for nights without rain because the anti-rain function of the radar interferes with the detection of small songbirds and bats. However, to characterize migration patterns during nights without optimal conditions, sampling was conducted on nights with weather forecasts that included occasional showers. On those nights, data were not collected during periods of rain, and data collection resumed after the showers passed.

[1] Avian migrants make up the majority of targets documented using this method, but the facts that bats are detected and small groups of birds can occasionally appear as one blip necessitates reporting results as targets and not individual birds.



PREPARED BY: WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS	SHEET TITLE: Radar Location Map	DATE: June 2006
		SCALE: 1"=1 Mile
		PROJ. NO.: 105112
105112-F201-Radar.dwg	PROJECT: Kibby Wind Power Project, TransCanada Energy, Ltd., Kibby, Maine	FIGURE: 2-1

The radar equipment was operated in two modes throughout the night. In the first mode, surveillance, the antenna spins horizontally to survey the airspace around the radar and detect targets moving through the area. The flight direction of targets can be determined by analyzing the echo trail. In the second mode, vertical, the antenna is rotated 90º to vertically survey the airspace above the radar (Harmata *et al.* 1999). In vertical mode, target echoes do not provide directional data but do provide information on the altitude of targets passing through the vertical, 20º radar beam. Both modes of operation were used during each hour of sampling.

The radar was operated at a range of 1.4 kilometers (km) (0.75 nautical miles). At this range, the echoes of small birds can be easily detected, observed, and tracked. At greater ranges, larger birds can be detected but the echoes of small birds are reduced in size and restricted to a smaller portion of the radar screen, reducing the ability to observe the movement pattern of individual targets. The limits of the range setting used are depicted for each of the survey sites in Figure 2-1.

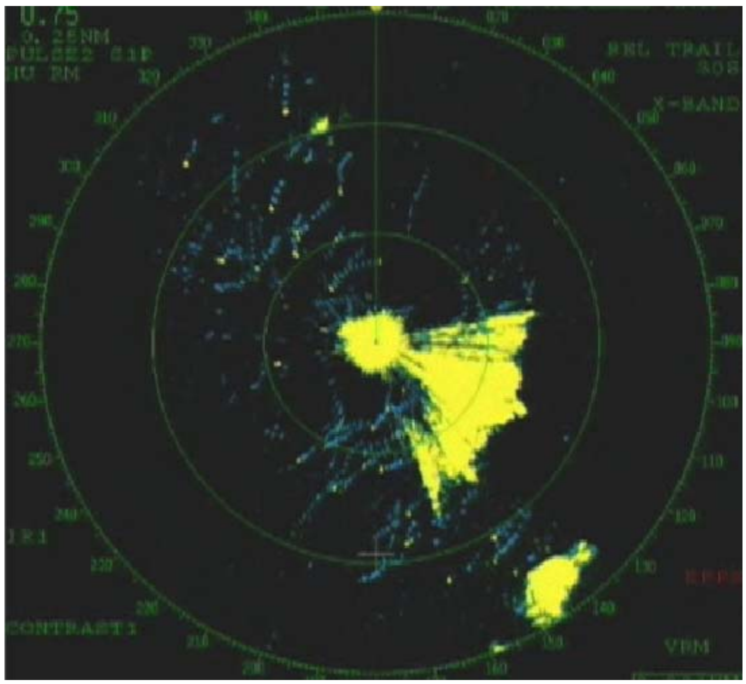


Figure 2-2. Example of ground clutter in project area (Kibby Range 1 site, from fall 2005 survey).

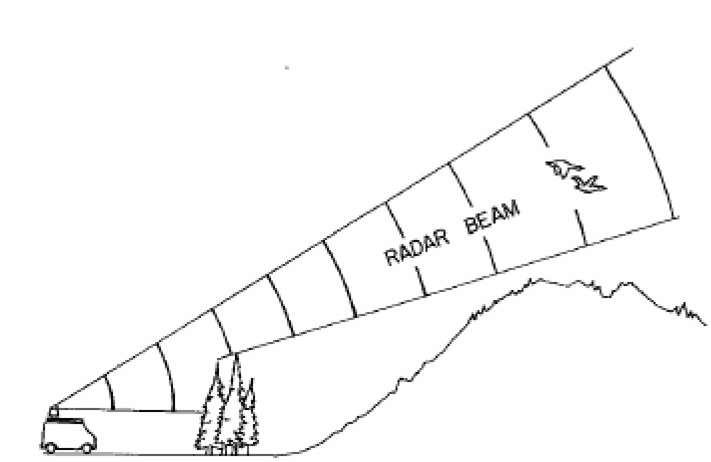


Figure 2-3. Example of how vegetation is used to screen out clutter-causing objects (taken from Sielman *et al.* 1981).

Data Collection

The radar display was connected to computer video recording software. One-minute samples of the radar video display were recorded for data analysis. Depending on the type of sampling (i.e., stationary from the ridgelines or mobile in the valleys), different strategies for recording was employed.

During stationary sampling, 15 one-minute horizontal samples and 10 one-minute vertical samples were recorded during each survey hour. The timing and sequence of the horizontal and vertical samples were based on a random selection for each night. The randomly selected sequence was developed for a one-hour increment and was repeated once for each hour, throughout the entire night.

During mobile sampling, fewer samples were collected at each location to maximize both the number of sites that could be sampled each night and the number of times each site was sampled. Sampling at each site typically occurred for approximately 20 to 30 minutes, after which the radar station was driven to the next site. Because the amount of time spent at each site was brief, a sample of five to six video recordings of the radar display were collected in rapid succession during both horizontal and vertical operation. The exact number of samples in each operating mode varied from site-to-site and night-to-night due to differences in accessibility, site configuration, and the number of sites sampled on a given night.

Ceilometer Observations

Some visual observations were collected during stationary sampling by directing a one-million-candlepower light (commonly called a ceilometer) into the sky and documenting the movement of animals passing through the beam. During each hour of radar sampling, one 5-minute ceilometer survey was conducted. Every bird, bat, or insect was documented per five minute observation period. This data helped provide information on the types of targets that are being detected by the radar, which further assists in the radar data analysis.

Weather data, including wind speed and direction, temperature, cloud cover/visibility, and precipitation, were also recorded during this time period.

Data Analysis

Video samples were analyzed using a digital video analysis software tool developed by Woodlot. For horizontal samples, which provided passage rate estimates and flight directions, targets were identified as birds and bats rather than insects based on true flight speed. To do this, the speed and direction of targets on the radar screen were corrected using the wind speed and direction collected during the nightly sampling. Targets calculated as traveling faster than 6 m (19.7 ft) per second were identified as a bird or bat target, while targets traveling slower than this were identified as insects (Larkin 1991, Bruderer and Boldt 2001) and were not counted.

The software tool recorded the time, location, and flight vector for each target traveling fast enough to be a bird or bat. The results for each sample were output to a spreadsheet. For vertical samples, the software tool recorded the entry point of targets passing through the vertical radar beam, the time, and flight altitude relative to the radar location. The results for each sample were output to a spreadsheet for the calculation of passage rate, flight direction, and flight height of targets.

Passage rate was calculated for each hour of radar operation. Hourly passage rates (in 1-hour increments post-sunset) were calculated for the ridgeline sites by tallying the total number of targets in the one-minute samples for each hour and correcting for the number of samples collected in that hour. That estimate was then corrected for the radar range setting used in the field by dividing the calculated number of targets per hour by the diameter of the radar display range (2.8 km) and was expressed as targets/km/hour (t/km/hr) ± 1 standard error (SE). The hourly rates were used to calculate passage rates for each night. Nightly mean passage rates were then used to calculate the mean passage rates for the entire season.

Mobile sampling included sampling at each valley site several times throughout the night, rather than one or all sites throughout the entire night. Consequently, hourly passage rates for each hour of the night could not be calculated for each of these sites. Instead, hourly passage rate was calculated for only those hours of the night that were sampled at each site. These hourly samples were then used to calculate the nightly mean passage rate for each site.

Mean target flight directions (± 1 circular standard deviation) were summarized in a similar manner by hour, night, and for the entire season. Flight direction analysis and statistical analyses were conducted using software designed specifically to analyze directional data (Oriana2© Kovach Computing Services). The statistics used for this are based on Batschelet (1965), which take into account the circular nature of the data. This software also performs a variety of statistical tests on the data sets to test whether the observed flight directions are uniformly distributed, such as the Rao's test for uniformity. Mean wind speed was calculated using linear statistics (i.e., normal means and averages were calculated that did not have to account for circular [directional] data) and the on-site observations made during each hour of radar operation (Zar 1999).

Flight height data were summarized using linear statistics. Mean flight heights (± 1 SE) were calculated by hour, night, and overall season. The final selection of turbines has not yet been made. Consequently, for the calculation of the percentage of targets assumed to be flying below the height of the proposed turbines, both 100 m (328 ft) and 125 m (410 ft) were used in the calculation, as these are the approximate maximum heights of most modern wind turbines.

2.2 Results

Radar surveys were conducted on 21 nights during the spring 2006 migration season. Field surveys were attempted on additional nights during May, but inclement weather prevented collection of suitable migration data. Weather conditions during each night of sampling are provided in Table 2-1.

The six different radar survey sites sampled varied with respect to their landscape position and surrounding vegetation. Consequently, the views that the radar had of the surrounding airspace in both horizontal and vertical operation modes varied from site to site. Appendix A provides site descriptions and images of the radar display screen depicting the amount of ground clutter at each site. The coverage from the three ridgeline sites represents approximately one-half of the entire proposed development area (Figure 2-1).

Table 2-1. Survey dates, level of effort, and weather

Night of	Sunset	Sunrise	Site	Hours of Survey	Wind Direction	Wind Speed (km/hr)	Temperature (ºC)	Barometric Pressure (cm)
5/1	19:48	5:29	Kibby Range 2	6	18°	10	8	77
5/4	19:52	5:25	Kibby Range 2	10	207°	11	12	75
5/5	19:53	5:23	Kibby Range 2	5	315°	6	5	76
5/7	19:56	5:20	Kibby Range 2	10	n/a	Calm	-1	77
5/8	19:57	5:19	Kibby Mountain	10	334°	9	10	76
5/9	19:58	5:18	Kibby Mountain	8	1°	15	13	76
5/14	20:04	5:12	Kibby Range 1	6	68°	19	11	76
5/15	20:05	5:10	Kibby Range 1	10	69°	10	11	76
5/17	20:08	5:08	Kibby Range 1 / Kibby Mountain	10	158°	6	9	75
5/18	20:09	5:07	Kibby Range 1 / Kibby Mountain	5	137°	7	10	75
5/19	20:10	5:06	Kibby Range 1 / Kibby Mountain	4	184°	11	9	75
5/22	20:13	5:03	Kibby Range 1	9	297°	7	5	76
5/23	20:14	5:02	Kibby Range 1	6	310°	8	8	76
5/24	20:15	5:02	Kibby Mountain / Valley locations	9	n/a	Calm	3	76
5/25	20:16	5:01	Kibby Range 2	9	n/a	Calm	7	76
5/26	20:17	5:00	Kibby Range 2	9	225°	6	16	75
5/27	20:18	4:59	Kibby Range 2	9	135°	6	7	76
5/30	20:21	4:57	Kibby Range 1	9	158°	8	14	77
6/1	20:23	4:56	Kibby Range 1	9	338°	6	16	76
6/2	20:25	4:56	Kibby Range 1	7	34°	7	15	76
6/4	20:25	4:55	Valley locations	6	0°	6	11	76

Passage Rates

Passage rate was variable between sites and among sample periods (Table 2-2; Figure 2-4, Appendix B Tables 1-3). The highest mean seasonal passage rate for the ridgeline sites was 512 ± 113 t/km/hr at Kibby Range 2 site. The lowest observed mean seasonal passage rate of the ridgeline sites was 197 ± 54 t/km/hr at the Kibby Range 1 site, which also had the lowest single night mean passage rate of 6 ± 1 t/km/hr on May 14. The highest single-night passage rate recorded at the ridgeline sites was 1,500 ± 254 t/km/hr at the Kibby Mountain site on May 24.

Nightly passage rates at the individual mobile sites ranged from 45 t/km/hr ± 21 at Mile 4 Road (June 4) to 1,242 t/km/hr ± 45 at Mile 4 Road (May 24) (Appendix B Table 3). The mean passage rate for the mobile site data, when pooled, was 443 ± 100 t/km/hr. Overall, approximately 3 percent of radar targets were identified as insects and not included within the data set used to calculate target passage rates.

Table 2-2. Summary of radar survey results for the entire spring 2006 season

Landscape Position/ Survey Site	Passage Rate (t/km/hr)		Flight height (m)		Direction (º)
	Range	Mean	Range	Mean	Mean
Kibby Mountain	88 - 1500	456	254 - 624	368	67
Kibby Range 1	6 - 471	197	158 - 656	412	50
Kibby Range 2	18 - 757	512	88 - 787	378	86
Pooled Ridgeline Sites	**6 - 1500**	**360**	**88 - 787**	**386**	**76**
Mile 4 Road	45 - 1242	643	200 - 235	218	69
Spencer Bale Road	98 - 604	351	350 - 355	353	46
Wahl Road	195 - 474	334	380 - 480	430	68
Pooled Valley Sites	**45 - 1242**	**443**	**200 - 480**	**334**	**61**
* Insects were not included in calculation of passage rate					

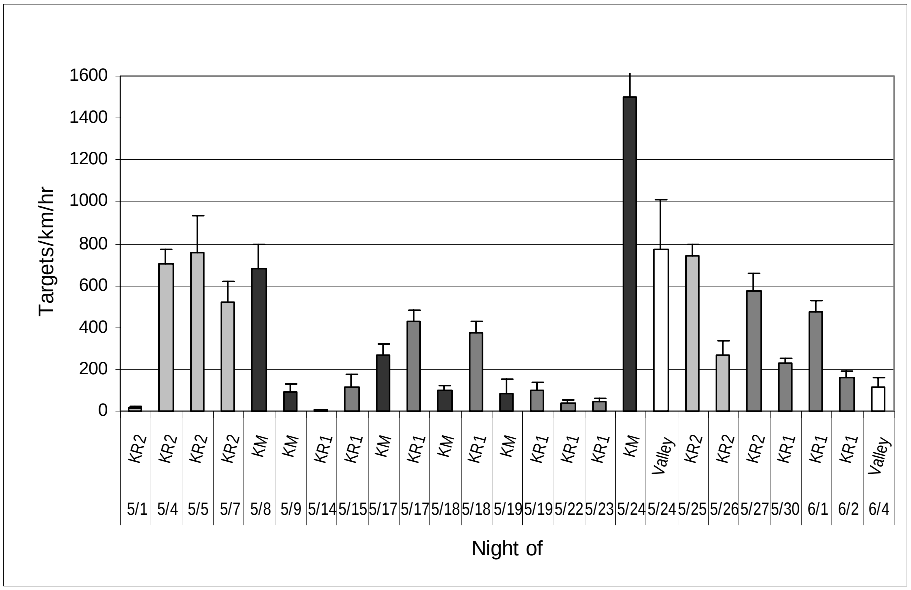


Figure 2-4. Nightly passage rates observed at the three ridgeline and mobile valley (pooled) sites
Key to Site Codes: KM = Kibby Mountain; KR1 = Kibby Range 1; KR2 = Kibby Range 2; and Valley = pooled Mobile Sites in Valley

When pooled by landscape position, the mean seasonal passage rate obtained at the ridgeline sites (360 ± 74 t/km/hr) was less than the mean seasonal passage rate at the pooled valley sites (443 ± 100 t/km/hr). Appendix B Tables 1-4 provide nightly passage rates for each survey site. Passage rates were typically highest on calm, clear nights. Proportionally more of these nights occurred while sampling at the Kibby Range 2 site than at any other site.

At Kibby Mountain and Kibby Range 2, hourly passage rates generally increased rapidly during the first hour after sunset, peaked six to seven hours after sunset, and were followed by a rapid decline. In contrast, at Kibby Range 1, passage rates remained relatively consistent throughout the night (Figure 2-5).

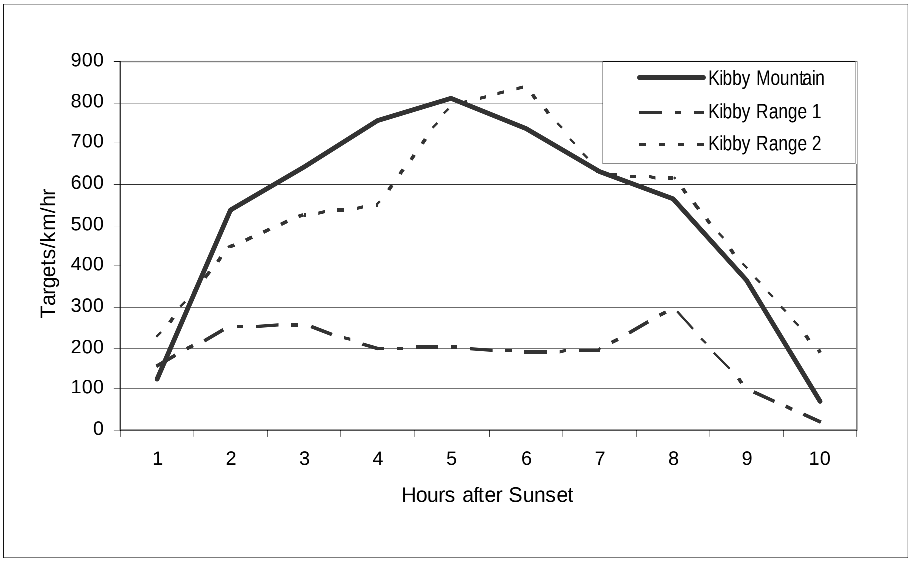


Figure 2-5. Hourly passage rates at the ridgeline survey sites

Flight Height

The mean target flight height over the ridgeline sites ranged from 368 m (1,207 ft) above the radar at the Kibby Mountain site to 412 m (1,351 ft) at the Kibby Range 1 site. The mean target flight height was 378 m (1,240 ft) at the Kibby Range 2 site and 334 m (1,096 ft) for the mobile (pooled data) sites (Appendix B Table 4).[2] Among the mobile sites, the lowest mean nightly flight height was 200 m (656 ft) above the radar at Mile 4 Road on June 4 and the highest mean nightly flight height was 480 m (1,574 ft) at Wahl Road on May 24 (Appendix B Tables 3 and 4).

Flight heights between nights were variable (Figure 2-6), though variation within individual nights was not as pronounced. No obvious relationship between flight height and weather (e.g., cloud cover, precipitation, fog) was observed at any individual survey site; there appeared to be equal variation in flight heights between nights with clear weather or poor weather.

Hourly flight height stayed generally consistent throughout the night at all sites (Figure 2-7). At Kibby Range 1, flight height peaked during the hour before sunrise, while at Kibby Mountain, flight height decreased during this same hour.

[2] The approximate elevation of each radar site is depicted on Figure 2-1.

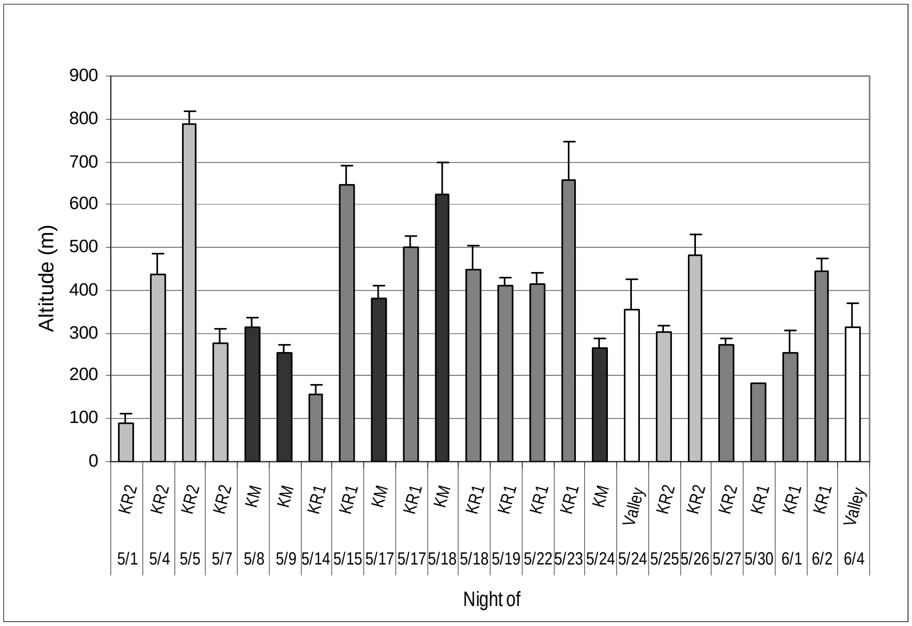


Figure 2-6. Mean nightly flight heights documented at the ridgeline and mobile valley (pooled) sites
Key to Site Codes: KM = Kibby Mountain; KR1 = Kibby Range 1; KR2 = Kibby Range 2; and Valley = pooled Mobile Sites in Valley

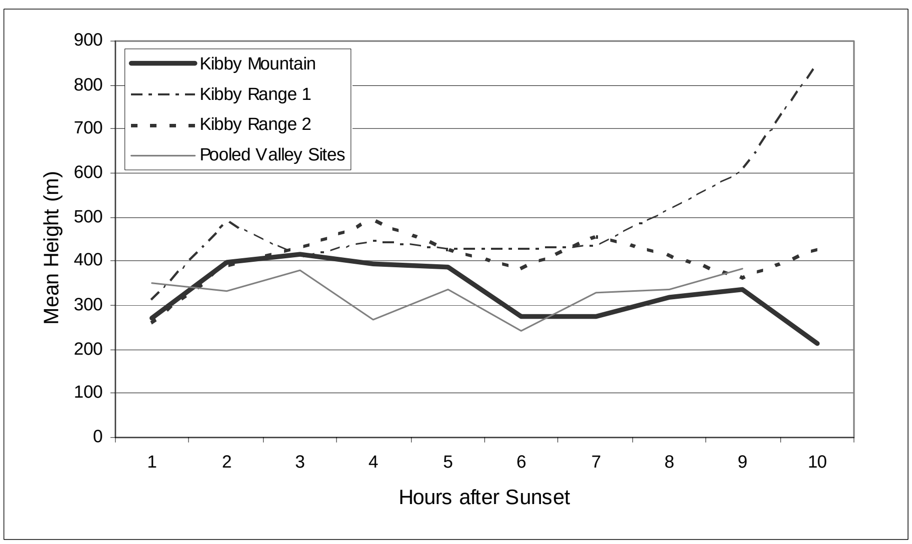


Figure 2-7. Mean hourly flight heights documented at the ridgeline and mobile valley (pooled) sites

The percent of targets flying less than the maximum height of most modern turbines above the survey sites each night was variable (Table 2-3; Appendix B Table 4). The overall mean percent of targets below 100 m (328 ft) was 9 percent at Kibby Mountain, 11 percent at Kibby Range 1, and 21 percent at Kibby Range 2. The overall mean percent of targets below 125 m (410 ft) was 14 percent at Kibby Mountain, 22 percent at Kibby Range 1, and 25 percent at Kibby Range 2.

Table 2-3. Summary of flight heights below proposed maximum turbine height

Landscape Position/ Survey Site	% below 100 m		% below 125 m	
	Range	Mean	Range	Mean
Kibby Mountain	1 - 13	9	2 - 21	14
Kibby Range 1	0 - 50	11	1 – 53	22
Kibby Range 2	2 - 64	21	3 - 71	25

Flight Direction

Mean nightly flight directions[3] were generally similar between the three ridgeline sites (67º at Kibby Mountain, 50º at Kibby Range 1, and 86º at Kibby Range 2) and the pooled mobile sites (61º) (Appendix B Table 1). Nightly flight direction histograms for each of the sites sampled are provided in Appendix C, and the statistics summaries of the nightly direction data are provided in Appendix D. In general, flight was in a northeastern to eastern direction across the entire project area (Figure 2-8).[4] There was night-to-night variation, particularly at Kibby Range 1. Overall, the nights with the highest passage rates were associated with flights to the northeast, while those with lower passage rates sometimes included a majority of flights in directions contrary to typical spring migration patterns.

A notable exception to this was the night of June 1 at the Kibby Range 1 site. The passage rate for that night was more than twice the season mean for the site, and flight direction was to the west-southwest despite relatively light winds from the north (Appendix C Figure 2 of 5). These flight characteristics on this one night created the somewhat bimodal distribution of flight directions at the site that is visually depicted on Figure 2-8; however, it is uncertain why migration was in a direction contrary to typical spring movements on that night.

On the nights of mobile sampling, similar flight directions were observed at the three survey sites (Appendix B Table 3). In general, flight direction was oriented towards the north and northeast at all three sites, which is also generally similar to the ridgeline sites.

Simultaneous Sampling

Simultaneous sampling occurred on four nights. From May 17-19, two of the ridgeline sites (Kibby Range 1 and Kibby Mountain) were sampled, and on May 24 the Kibby Mountain was sampled, along with the mobile sites.

Passage rates were higher at the Kibby Range 1 site than the Kibby Mountain site during all three nights of simultaneous sampling (three-night mean of 300 ± 101 t/km/hr versus 153 ± 59 t/km/hr). The mean flight heights between sites for these nights[5] were similar, ranging from 474 m (1,555 ft) to 503 m (1,650 ft). The flight direction for the two sites were also similar, with a mean flight direction of 66º ± 53º at the Kibby Range 1 site and 63º ± 74º at the Kibby Mountain site.

[3] All flight directions provided are relative to true north.
[4] Note that the flight direction histograms depicted represent the distribution of flight directions documented across the entire radar detection area of the radar at each site and not flight directions of targets flying only directly over the radar location itself.
[5] Flight heights were recorded from both sites only on the first two nights of simultaneous sampling due to weather conditions.

During the night of May 24, the Kibby Mountain site was sampled simultaneously with the mobile sites in the valley. During that night, passage rate was greater at Kibby Mountain (1,500 ± 254 t/km/hr) than at the mobile sites (773 ± 237 t/km/hr), while flight heights were higher at the mobile sites (355 ± 71 m [1,164 ± 233 ft]) than at the Kibby Mountain site (266 ± 19 m [872 ± 62 ft]). Flight direction was fairly similar between the sites sampled, to the east-northeast, with a mean direction of 80° ± 43° at the Kibby Mountain site and 63° ± 48° at the mobile sites.

Simple correlations were calculated for between some of the documented flight characteristics and other variables, such as weather patterns (e.g., passage rate versus flight height or passage rate versus wind speed). No significant correlations were documented (all r and r^2 values were less than 0.4), but some general trends were observed and are discussed in Section 2.3, below.

Ceilometer Surveys

Ceilometer surveys resulted in no observations of birds or bats on any of the nights sampled. This is not uncommon during spring radar surveys. Some insect data were documented, however, which were used during the analysis of the recorded radar video samples.

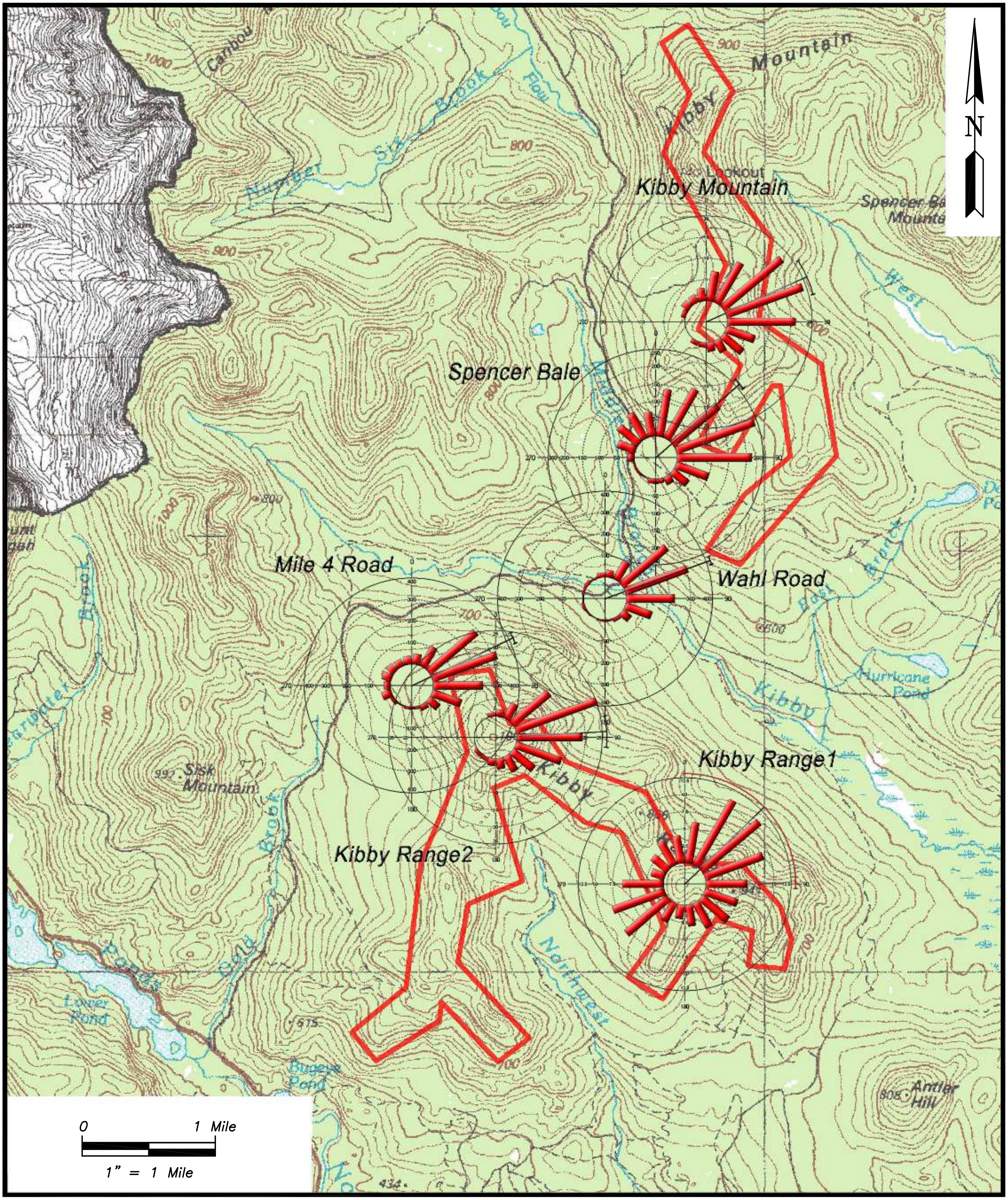
2.3 Discussion

This study was conducted to characterize night migration activity in the vicinity of the Kibby Wind Power Project. This work expanded upon radar surveys previously conducted at the site in 1994, as well as surveys conducted in fall 2005. The original surveys were conducted in May, June, August, September, and October 1994 (ND&T 1995a, b) using a marine surveillance radar similar to the radar used in this study, but did not remove insect data during data analysis. The spring 1994 study was conducted on 17 nights at 2 locations; the fall 1995 study was conducted on 14 nights from 1 of those 2 locations. Fall 2005 surveys were conducted on 29 nights in September and October and included several of the sites that were sampled during the spring 2006 surveys. Additionally, one site sampled during both the fall 2005 and spring 2006 efforts was nearly identical to one of the sites sampled in 1994. The results of those surveys are provided in Table 2-4. Care should be taken when comparing the studies, as the 1994 work did not remove insects during the data analysis and only represents low elevation areas.

Table 2-4. Summary of historic and recent radar surveys at Kibby

Site/Season	Passage Rate*			Flight Direction
	Mean	Min	Max	
Spring 1994	99	n/a	n/a	34° to 53°
Fall 1994	547	48	1,195	200°
Fall 2005	383	201	565	167° to 196°
Spring 2006	360	6	1,500	16° to 84°

* Passage rates for Spring and Fall 1994 were originally reported as total targets. Those results have been converted to t/km/hr, using the range limit used at that time to provide results that are more compatible with more recent studies. These data from 2005 and 2006 include only the ridgeline data.



PREPARED BY:

WOODLOT ALTERNATIVES, INC.
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105112–F208–Results.dwg

SHEET TITLE: Spring 2006 Target Flight Direction

PROJECT: Kibby Wind Power Project
TransCanada Energy, Ltd.
Kibby, Maine

DATE: August 2006
SCALE: 1" = 1 Mile
PROJ. NO.: 105112
FIGURE: 2-8

Passage Rates

Variation in mean nightly passage rate from 6 to 1,500 t/km/hr at the ridgeline sites and 45 to 1,242 t/km/hr at the valley sites was observed during Spring 2006 radar surveys. This is typical of nighttime migration activities as nightly and seasonal weather patterns affect the magnitude of avian migration (Able 1970, Richardson 1971). On nights with optimal conditions for migration (i.e., clear skies and favorable wind speed and direction), more birds would be expected to migrate.

Correlations between passage rate (and other survey result metrics) and weather yielded no significant results, but trends were observed. These trends showed that the magnitude of migration was higher during optimal wind directions and speeds. An example of weather having an important role in nighttime migration can be seen in Figure 2-5. At Kibby Mountain and Kibby Range 2, hourly passage rates generally increased rapidly during the first hour after sunset, peaked six to seven hours after sunset, and were followed by a rapid decline. In contrast, at Kibby Range 1, passage rates remained relatively consistent throughout the night. This was probably due to the fact that these three sites were sampled during different time periods and during nights with different weather. Surveys at Kibby Range 1 occurred more frequently on nights with suboptimal migration weather (i.e., strong winds from a northerly direction or periods of rain) than those at Kibby Mountain and Kibby Range 2 (Table 2-1). Consequently, the overall passage rates at Kibby Range 1 were consistently low compared to the other ridgeline sites (Appendix B Table 2) so such definitive trends in the timing of peak activity could not develop.

Relatively few surveys using the same methods and equipment are available for comparison with the results from the fall 2005 and spring 2006 Kibby Wind Power Project surveys, though more and more studies are rapidly becoming available (Table 2-5). The seasonal mean passage rates documented at the proposed Kibby Wind Power Project during 2005 and 2006 are generally within the range of those other studies. This is true for the mean passage rate and for the observed variation in nightly passage rates among studies (commonly from the teens to mid-thousands).

The passage rates provided in Table 2-5 are from surveys using identical techniques and equipment but from a number of different landscape settings and different years. Direct comparisons between surveys conducted during different years probably yield inherent differences because year to year variation in continental bird populations and weather patterns occur. Additionally, vegetation characteristics (i.e., the vegetation used to help block ground clutter) vary from site to site. This plays a very important role in the volume of airspace sampled by a radar and, consequently, the capability of the radar to accurately document migrants. Because of this latter difference, comparisons of passage rates between any two radar surveys should always be made with caution.

Flight Height

The altitude at which nocturnal migrants fly has been one of the least understood aspects of bird migration. Bellrose (1971) found the majority of birds observed were between 150 and 450 m (492 and 1,475 ft) above the ground level, but on some nights the majority of birds observed were from 450 to 762 m (1,475 to 2,500 ft) above the ground. Radar studies have largely confirmed those visual observations, with the majority of nocturnal migration appearing to occur less than 500 m to 700 m (1,640 ft to 2,300 ft) above the ground (Able 1970, Alerstam 1990, Gauthreaux 1991, Cooper and Ritchie 1995).

Table 2-5. Summary of available spring radar survey results

Project Site	Landscape	Average Passage Rate (t/km/hr)	Range in Nightly Passage Rates	Average Flight Direction	Average Flight Height (m)	Percent Targets Below Turbine Height	Reference
2003							
Chautauqua, NY	Great Lakes shore	395	15-1702	29	528	(125 m) 4%	Cooper *et al.* 2004
2005							
Top Notch, NY	Agric. plateau/ADK foothills	509	80-1175	44	419	(125 m) 20%	Woodlot 2005a
Jordanville, NY	Agric. plateau	409	26-1410	40	371	(125 m) 21%	Woodlot 2005b
Marble River, NY	Grt Lks plain/ADK foothills	254	3-728	40	422	(120 m) 11%	Woodlot 2005c
Clinton Co., NY	Grt Lks plain/ADK foothills	110	n/a	30	338	(n/a) 20%	Young 2006
Dairy Hills, NY	Great Lakes shore	117	n/a	14	397	(n/a) 15%	Young 2006
Cohocton, NY	Agric. plateau	371	133-773	28	609	(125 m) 12%	Woodlot 2006a
Prattsburgh, NY	Agric. plateau	277	70-621	22	370	(125 m) 16%	Woodlot 2005d
Prattsburgh, NY	Agric. plateau	170	3-844	18	319	(125 m) 18%	Mabee *et al.* 2005
Deerfield, VT	Forested ridge	404	74-973	69	523	(125 m) 4%	Woodlot 2005e
Sheffield, VT	Forested ridge	208	11-439	40	522	(125 m) 6%	Woodlot 2006b
Liberty Gap, WV	Forested ridge	457	34-240	53	492	(125 m) 11%	Woodlot 2005f
2006							
Kibby, ME	Forested ridge (no valley data)	360	6-1500	66	391	(125 m) 18%	this report

Recent studies at other proposed wind facilities in the Northeast and Mid-Atlantic states are consistent with this study as well (Table 2-5). The flight height data from available studies show an interesting, consistent trend in nighttime flight height in the Northeast. That trend is that flight height is relatively high regardless of the landscape setting of a project. The mean flight heights documented at the Kibby Wind Power Project site are within the range documented at other sites and consistent with this regional trend in documented flight heights. Of particular importance is the fact that the majority of migration over the ridgelines at the Kibby Wind Power Project site occurs well above the height of modern wind turbines.

Flight Direction

The studies conducted in the study area in 1994 suggested that night migrants may be affected by topography. That study did not document the flight height of the targets that were observed during the studies nor did it document flight activity from the ridgelines proposed for wind turbine development. In areas of varied topography, flight height may be the most important factor determining if topography could affect the movement of migrants, and flight direction would be the most obvious visual clue that topographic-related effects are occurring. Essentially, when migrants fly below the elevation of a ridgeline and are disinclined to gain altitude to cross the ridge (i.e., affected by a topographic feature), flight direction would be expected to be parallel to the ridge rather than perpendicular to it. It is interesting to note that sampling in 2005, near the site where the 1994 surveys were conducted, showed that targets were flying generally at or below the elevation of the surrounding ridgelines (235 ± 6 m on May 24 and 200 ± 32 m on June 4). Flight directions in this area varied but indicated that some form of valley-following, rather than ridge-crossing, movement was occurring.

Consequently, the valley sampling corroborates conclusions drawn from the 1994 data: night migrants in the project area can be affected by the topography of the area. However, the 2005 sampling indicates that this is true only for some of the migrants in the project area, particularly those migrants that fly low and within the confines of valleys. The flight directions documented at the ridgeline sites shows that night migrants at higher altitudes move in directions parallel and perpendicular to the high ridgelines of the project area. This, combined with the documented flight heights of targets at those ridgeline sites, indicates that some migrants fly well above the varied topography.

Simultaneous Sampling

The simultaneous sampling documented variation in migration activity at different sites in the project area on individual nights. For instance, during the three nights of simultaneous ridgeline sampling, the passage rate documented at the Kibby Range 1 site was twice that of the Kibby Mountain site, even though the seasonal mean passage rate for the Kibby Mountain site was more than twice that of Kibby Range 1. Similarly, the passage rate at the Kibby Mountain site on the night it was sampled simultaneously with the mobile valley sites was twice that of the valley sites, even though the overall mean passage rates for these sites were nearly identical. Less variation between the nightly and seasonal flight heights and flight directions at these sites was observed during the simultaneous sampling.

These differences in passage rates on a per night basis compared to the seasonal mean for the sites is most likely due to differences in the overall sampling effort and allocation at the individual sites. Sites sampled during more nights probably reflect a more accurate mean seasonal passage rate, while sites sampled relatively infrequently could provide skewed results if only nights of exceptionally good or exceptionally bad migration weather condition occur on those few nights. The fact that flight height and direction was less variable between these sites on those nights and for the full season indicates that these flight characteristics are inherently less variable than the number of migrants aloft on a particular night.

2.4 Conclusions

Radar surveys conducted during the spring 2006 migration period have provided important information on nocturnal migration patterns at the Kibby Wind Power Project site. The results of the surveys indicate that migration patterns in the area are complex, which is likely attributable to the varied topography and natural variation in migration activity. Where other studies have demonstrated broad-front movement of night migrants over flat and rolling topography, results of this study indicate that some migrants are following valleys and flying below the project area ridgelines while others are flying at heights well above those same ridgelines, in a broad-front type of movement pattern.

The variable nightly passage rates documented at each survey site and at different landscape positions is typical of pulsed migration activity associated with weather systems, and not necessarily due to the concentration of migrants in any one specific area. No pattern in the flight trajectories over the ridgeline sites was observed, and migrants were generally observed throughout the radar display screen at each site. Movements were generally to the northeast, although this varied by night. The flight directions documented migrants moving both parallel and perpendicular to the ridgelines. The high mean flight altitude of migrants over the ridgelines indicates that the ridges generally do not impede the movements of birds passing over the ridgelines, and that most of the migrants crossing the ridgelines do so at heights well above the height of modern wind turbines.

3.0 Bat Detector Survey

3.1 Introduction

The project area is within the published range of seven bat species, including silver-haired bat (*Lasionycteris noctivagans*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), northern long-eared bat (*Myotis septentrionalis*), eastern pipistrelle (*Pipistrellus subflavus*), big brown bat (*Eptesicus fuscus*), and little brown bat (*M. lucifugus*), although an eighth species, the eastern small-footed bat (*M. leibii*) may also occur (DeGraaf and Yamasaki 2001). To document bat activity in the proposed project area, acoustic monitoring surveys were conducted during spring 2006. The survey was designed to document bat passages near the rotor zone of the proposed turbines[6] and, in one location, a lower monitor was also installed for comparative purposes.

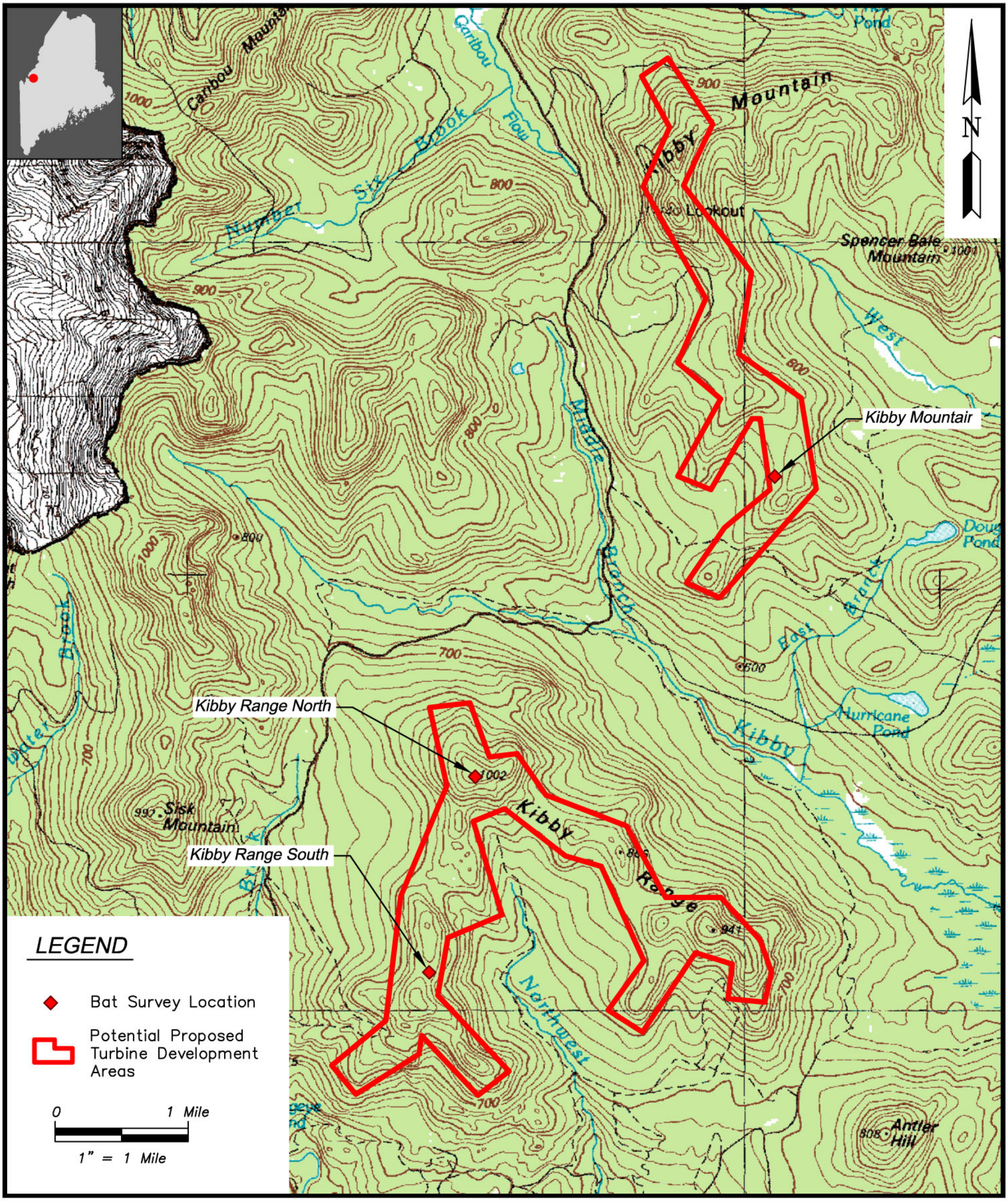
3.2 Methods

Field Surveys

Four Anabat II detectors were deployed in the project area on two met towers on Kibby Range (identified as Kibby Range North and Kibby Range South) and one met tower on Kibby Mountain (Figure 3-1). These were passive surveys, as the detectors were placed at the site and left there for the duration of the study. Each site had a detector deployed at a height of approximately 45-50 m (148-164 ft) to document bat passage at heights consistent with the rotor-swept zone. At the Kibby Range South met tower, an additional detector was deployed at a height of 15-20 m (49-66 ft). Detectors were deployed on May 4, 2006, and are continuing to operate in the project area through the fall 2006 migration season. For the purposes of describing spring migration, data up until the night of June 7, 2006, are included in this report. Detectors were programmed to record nightly from 7:00 p.m. to 7:00 a.m.

Anabat detectors are frequency-division detectors, dividing the frequency of ultrasonic calls made by bats so that they are audible to humans. A factor of 16 was used in this study, as this is the most appropriate division ratio for the frequency at which Northeastern United States bats echolocate. Frequency division detectors were selected based upon their widespread use for this type of survey, their ability to be deployed for long periods of time, and their ability to detect a broad frequency range, which allows detection of all species of bats that could occur in Maine.

[6] The final selection of wind turbine locations has not been made. However, met towers are in place along the ridgelines proposed for wind turbine placement. These towers, which extend into the heights of the rotor-swept zone of modern wind turbines, were used to collect data from those heights.



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105112-F301-BatSurvey.dwg

SHEET TITLE:

Bat Survey Location Map

PROJECT:

Kibby Wind Power Project
TransCanada Energy, Ltd.
Kibby, Maine

DATE: August 2006
SCALE: 1"=1 Mile
PROJ. NO.: 105112
FIGURE:

3-1

Data Analysis

Bat call sequences detected by the deployed Anabat detectors were logged onto compact flash media using a CF ZCAIM (Titley Electronics Pty Ltd.) and downloaded to a computer for analysis. The call files were extracted from the media cards using CFCread© software. The default settings for CFCread© were used during this file extraction process, as these settings are recommended for the calls that are characteristic of northeastern bats. This software screens all data recorded by the bat detector and extracts call files using a filter. The filter simply removes files created by noises other than bat calls based on the characteristics of the call file and the established characteristics of northeastern bat calls. Using the default settings for this initial screen also ensures comparability between data sets. Settings used by the filter include a maximum time between calls of 5 seconds, a minimum line length of 5 milliseconds, and a smoothing factor of 50. The smoothing factor refers to whether or not adjacent pixels can be connected with a smooth line. The higher the smoothing factor, the less restrictive the filter is and the more noise files and poor quality call sequences are retained within the data set. A call is a single pulse of sound produced by a bat. A call sequences is a combination of two or more pulses recorded in a call file.

Following the initial screening, each file was visually inspected to ensure that files created by static or some other form of interference that were still within the frequency range of northeastern bats were not included in the data set. Call sequences were identified based on visual comparison of call sequences with reference libraries of known calls recorded by Woodlot during mist netting surveys in 2006 in New York and Pennsylvania. Supplemental reference calls that were also used were provided by nationally recognized bat experts Lynn Robbins and Chris Corben, who is also the developer of the Anabat software. Bat calls typically include a series of pulses characteristic of normal flight or prey location and capture periods (feeding 'buzzes') and visually look very different than static, which typically forms a solid line at either a constant frequency or with great frequency variation. Using these characteristics, bat call files are easily distinguished from non-bat files.

Qualitative visual comparison of recorded call sequences of sufficient length to reference libraries of bat calls allows for relatively accurate identification of bat species (O'Farrell *et al*. 1999, O'Farrell and Gannon 1999). A call sequence was considered of suitable quality and duration if the individual call pulses were 'clean' (i.e., consisting of sharp, distinct lines) and at least seven pulses were included within the sequence. Call sequences were classified to species whenever possible, using the reference calls described above. However, due to similarity of call signatures between several species, all classified calls have been categorized into four guilds for presentation in this report. This classification scheme follows that of Gannon *et al.* (2003) and is as follows.

- Unknown (UNKN) – all call sequences with too few pulses (less than seven) or of poor quality (such as indistinct pulse characteristics or background static).
- Myotid (MYSP) – All bats of the genus *Myotis*. While there are some general characteristics believed to be distinctive for several of the species in this genus, these characteristics do not occur consistently enough for any one species to be relied upon at all times when using Anabat recordings.
- Red bat/pipistrelle (RBEP) – Eastern red bats and eastern pipistrelles. Like so many of the other northeastern bats, these two species can produce calls distinctive only to each species. However, significant overlap in the call pulse shape, frequency range, and slope can also occur.
- Big brown/silver-haired/hoary bat (BBSHHB) – This guild will also be referred to as the big brown bat guild. These species' call signatures commonly overlap and have, therefore, been included as one guild in this report.

This guilding represents the most conservative approach to bat call identification. Since some species do sometimes produce calls unique only to that species, and as mentioned above, all calls were identified to the lowest possible taxonomic level before being grouped into the listed guilds. Tables and figures in the body of this report reflect those guilds. However, since species-specific identification did occur in some cases, each guild will also be briefly discussed with respect to potential species composition of recorded call sequences.

Once all of the call files were identified and placed into the appropriate guilds, nightly tallies of detected calls were compiled. Mean detection rates (number of calls/detector-night) for the entire sampling period were calculated for each detector and for all detectors combined. It is important to note that detection rates indicate only the number of calls detected and do not necessarily reflect the number of individual bats in an area. For example, a single individual can produce one or many call files recorded by the bat detector, but the bat detector cannot differentiate between individuals of the same species producing those calls. Consequently, detections recorded by the bat detector system likely over-represents the actual number of animals that produced the recorded calls.

Ceilometer Data

Nocturnal radar surveys included ceilometer surveys during each night of radar sampling to document low level flights of birds, bats, and insects. Any bats observed during the ceilometer surveys were recorded.

3.3 Results

Detector Survey

Detectors were deployed on May 4 and operated in the area through the fall 2006 migration season (October 15). For the purposes of characterizing spring migration, results were presented in this report use data up until the night of June 7, for a total survey period of 35 nights. Occasional periods occurred when the individual detectors powered down or malfunctioned. This was attributable to 26 nights of the 35-night period having periods of light to heavy rain and or animal damage the detector equipment deployed at the base of the met towers. Combined, 108 detector-nights of bat echolocation data were recorded during the spring deployment period (32 detector-nights were lost due to these inherent problems).

A total of 31 bat call sequences were recorded during the sampling period (Table 3-1). All calls were detected from the low detector in the Kibby Range South met tower. The mean detection rate for all 4 detectors was 0.3 calls/detector night.

Table 3-1. Summary of bat detector field survey effort and results						
Location	**Dates**	**# Nights**	**# Detector-Nights***	**# Recorded sequences**	**Detection Rate ****	**Maximum # calls recorded *****
Kibby Range North (45-50 m)	May 4 - June 19	50	14	0	0.0	0
Kibby Range South High (45-50 m)	May 4 - June 19	50	24	0	0.0	0
Kibby Range South Low (15-20 m)	May 4 - June 19	50	35	31	0.7	11
Kibby Mountain (45-50 m)	May 4 - June 19	50	35	0	0.0	0
Overall Results	***May 4 - June 19***	***200***	***108***	***31***	***0.3***	--
* Detector-night is a sampling unit during which a single detector is deployed overnight. On nights when two detectors are deployed, the sampling effort equals two detector-nights.						
** Number of bat passes recorded per detector-night.						
*** Maximum number of bat passes recorded from any **single** detector for a 12-hour sampling period.						

Appendix E provide two tables with more specific information on the nightly timing, number, and species composition of recorded bat call sequences. Included is information on the number of call sequences by guild and suspected species recorded (Appendix E Table 1). Appendix E Table 2 provides the actual data file information for each of the detectors, including the file name. Included on this latter table is the Analook file name for all 31 recorded call sequences, the night during which the call sequence was recorded, the time of night of the recording, and the species code that the call was given during analysis. The timing of recording of calls is particularly useful in identifying if some recorded call files could have been created by the same individual bat.

The nightly call volume at the Kibby Range South low detector, when calls were actually recorded, was typically one to three calls. Two nights with higher call volume did occur, however, including the nights of May 5 (6 calls) and May 25 (11 calls) and nights with recorded call sequences were generally spaced throughout the survey period (Figure 3-2).

The majority of the recorded call sequences (84%) were labeled as unknown due to very short call sequences (less than 7 pulses), poor call signature formation (probably due to a bat flying at the edge of the detection zone of the detector or flying away from the microphone), or static interference (Table 3-2). Of the calls that were identified to species or guild, species within the big brown bat guild were most common (13% of all call sequences). Only one call identified as *Myotis* was recorded, and no red bat/eastern pipistrelle call sequences were identified.

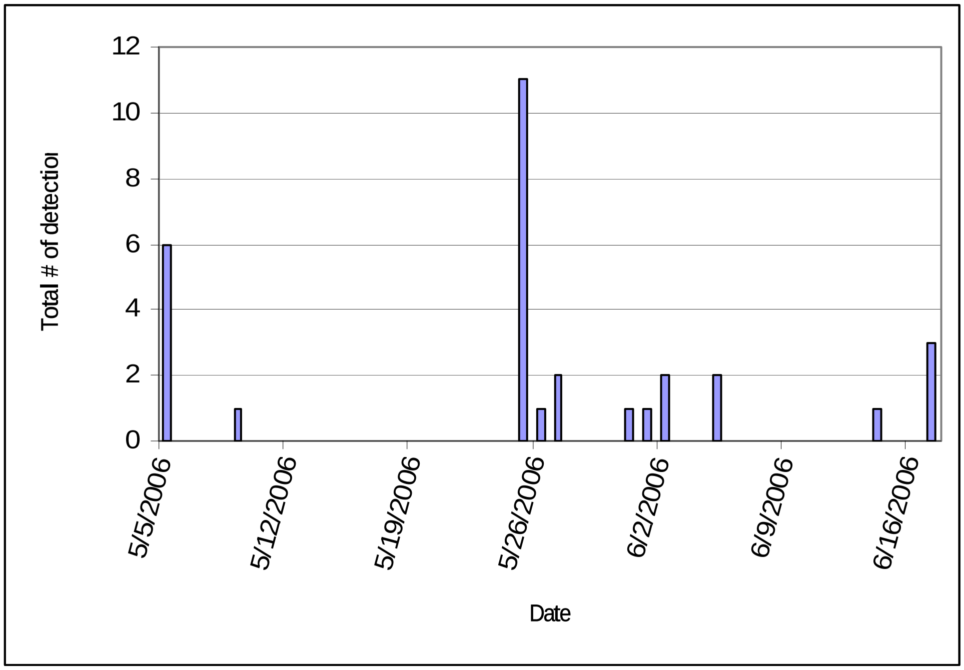

Figure 3-2. Nightly bat call sequence detections

Table 3-2. Summary of the composition of recorded bat call sequences

Detector	Guild				Total
	Big brown guild	Red bat/ E. pipistrelle	Myotis	Unknown	
Kibby Range North (45-50 m)	0	0	0	0	0
Kibby Range South High (45-50 m)	0	0	0	0	0
Kibby Range South Low (15-20 m)	4	0	1	26	31
Kibby Mountain (45-50 m)	0	0	0	0	0
Total	***4***	***0***	***1***	***26***	***31***

Within the big brown bat guild, some individual call sequences were identified to species (Appendix E Table 1). One call was likely that of a hoary bat while the remaining three were either a silver-haired bat or big brown bat. Call sequences within the guild of unknown bat calls were identified as such primarily due to too few pulses being included within the recorded call sequence. A vast majority of these call sequences, however, had pulses that were steep and above 35 to 40 kilohertz, indicating that they are most likely to be myotid calls. However, the characteristic of the upper portions of feeding buzzes for several other species extending above this frequency precludes making definitive identification of those call sequences to guild.

Ceilometer Surveys

Ceilometer surveys resulted in no observations of bats on any of the nights sampled with radar.

3.4 Discussion

Bat echolocation surveys in 2006 at the proposed Kibby project provide some insight into activity patterns, possible species composition, and timing of movements of bats in the project area. The overall mean detection rate at the proposed Kibby Wind Power Project during the spring 2006 survey period was 0.3 calls/detector-night. This is generally similar to other spring bat detector surveys conducted recently using the same technique (Table 3-3).

While some opportunities for data collection were lost due to equipment problems, patterns in the weather conditions probably also played an important role in the overall activity of bats and survey results and activity of bats. As mentioned previously, 26 of the 35 survey nights included some amount of precipitation, as recorded in Eustis. Locally, weather conditions are typically worse in the project area than in Eustis, despite its relative proximity to the project area. Additionally, bats are typically not very active when temperatures drop below 50º Fahrenheit. A total of 18 of the 35 nights sampled included mean nightly temperatures (again, in Eustis) below 50 degrees.

Table 3-3. Summary of other available bat detector survey results

Project	Location	Season	Calls per detector night	Reference
Sheffield	Sheffield, VT	Spring 2005	0.17	Woodlot 2006c
Deerfield	Searsburg, VT	Spring 2005	0.07	Woodlot 2005e
Marble River	Churubusco, NY	Spring 2005	0.26	Woodlot 2005c
Jordanville	Warren, NY	Spring 2005	0.5	Woodlot 2005b
Cohocton	Cohocton, NY	Spring 2005	0.72	Woodlot 2006b
Prattsburgh	Prattsburgh, NY	Spring 2005	0.28	Woodlot 2005d
Liberty Gap	Franklin, WV	Spring 2005	0.50	Woodlot 2005f
Kibby	Skinner Township, ME	Spring 2006	0.3	this report

Calls of the big brown bat guild were the most abundant of the calls that could be identified to species or guild. However, the majority of the calls identified as unknown were likely to be myotids. This preponderance of potential myotid call sequences within the data set is very common among detector surveys, particularly from detectors deployed at relatively low heights over the ground (such as tree-top height).

Results of acoustic surveys must be interpreted with caution. Room for error exists in identification of bats based upon acoustic calls alone, especially if a site- or regionally-specific library of recorded reference calls is not available. Also, detection rates are not necessarily correlated with the actual numbers of bats in an area because it is not possible to differentiate between individual bats. A review of the timing of individual recorded call sequences on each night provides some insight into the actual number of bats that may be represented by those calls. For instance, call sequences recorded within seconds of each other may have been produced by one individual bat, rather than two bats traveling or foraging together.

While this type of assessment is somewhat speculative, it can provide some evidence on which to base assessments of overall use of an area by bats. Since so few bat call sequences were recorded during the spring survey, little qualifying information is needed to conclude that bat activity in the area appears to be low. However, on the night of May 25, three bat call sequences, all of which were identified as unknown but had similar pulse characteristics, were recorded over a 55-second period (see files G5252035.22#, G5252035.33#, and G5252036.17# on Appendix E Table 2). These three call sequences could very well have been produced by just one bat and would indicate that fewer individual bats were in the area relative to the actual number of recorded calls on that night.

3.5 Conclusions

Detector surveys during spring 2006 have provided information on bat activity in the vicinity of the proposed Kibby Wind Power Project. The surveys documented species that would be expected in the area based on the species' range and abundance, as well as the habitats in the project area. Overall, the level of activity recorded during the detector survey was low, which is typical of spring migration surveys in the northeast.

Of the relatively few calls recorded during the spring survey period, all were recorded by the only detector that was deployed low over the ridge (15-20 m [50-66 ft]) and none were recorded by the three detectors deployed at heights (45-50 m [148-164 ft]), consistent with the rotor zone of the proposed wind turbines. This could indicate that more bat activity occurs closer to the ground and below the rotor zone, and that the risk of bats colliding with wind turbines could be low within the rotor zone.

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Appendix A

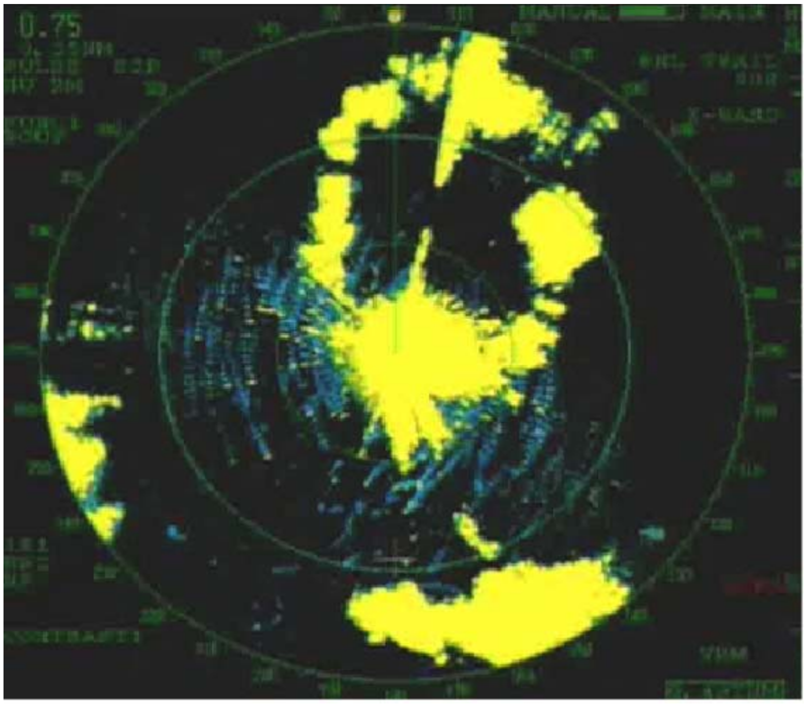
Radar Survey Site Descriptions

Key to Radar Survey Site Descriptions

Following are site descriptions for each of the six radar sites used during the Spring 2006 survey. Provided in each description is a picture of the radar screen, followed by a description of the site location and radar visibility while in horizontal and vertical modes of operation.

The radar screen pictures show the ground clutter that was observed at each site. Ground clutter is yellow and may be very limited to the center of the screen or may be widespread across the screen, depending on the complexity of the vegetation and landscape at each site. Figure 2-3 of the report provides an example of how nearby vegetation was used to try to mask out large areas of ground clutter and should be referred to when interpreting the site descriptions. All radar sites were established with true north oriented to the top of the radar screen

Spencer Bale Road – Mobile Site

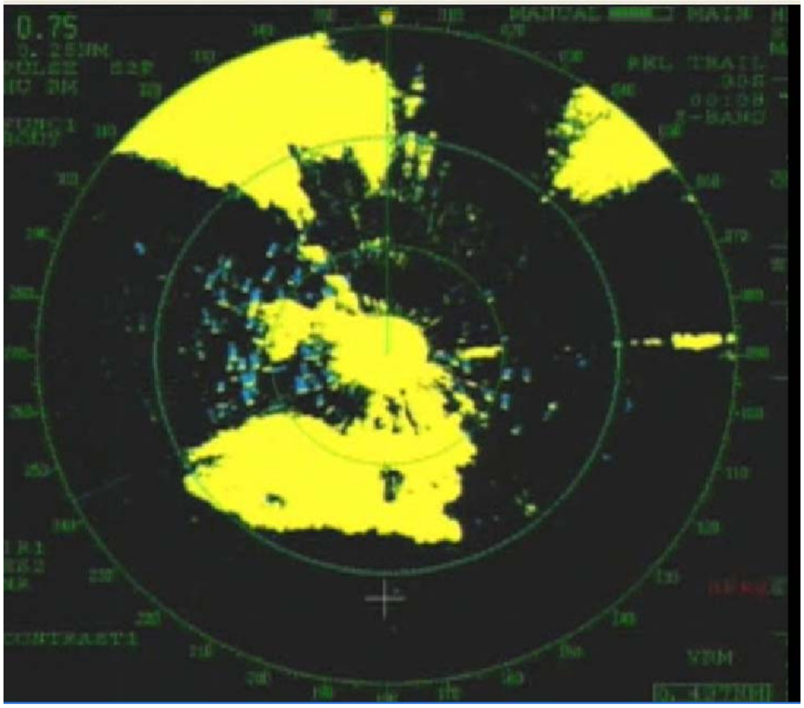


This survey site was located on a small spur road that extends off of Spencer Bale Road. The radar site was located within a large clearcut approximately 12 years old. Tree height surrounding the radar was uniform and provided a relatively level canopy nearly equal in elevation to the radar antenna. One small grove of more mature trees occurred approximately 200 meters north of the site.

During horizontal operation, the surrounding topography created some areas of ground clutter. Parts of a ridgeline extending down from the Kibby Mountain ridge were visible to the north. The crest of another ridge to the northeast of the site, which is included within one of the potential turbine development areas, was also visible as a fairly small area of ground clutter. The very southern end of the Kibby Mountain project area was visible southeast of the site, near the outer edge of the radar range setting, and a small part of one hillside west of Kibby Stream was visible at the western edge of the radar screen. Clear views over Kibby Stream to the west and over the clearcut areas to the southeast were available at this site.

While in vertical mode, a clear view of the airspace over Kibby Stream was available. The ridgeline to the east created a gradual slope detected by the radar. Due to the nearly equal height of the surrounding regeneration with the antenna, that ridge did not cause ground clutter until approximately 0.75 kilometer away from the radar and targets were visible passing over that slope.

Wahl Road – Mobile Site

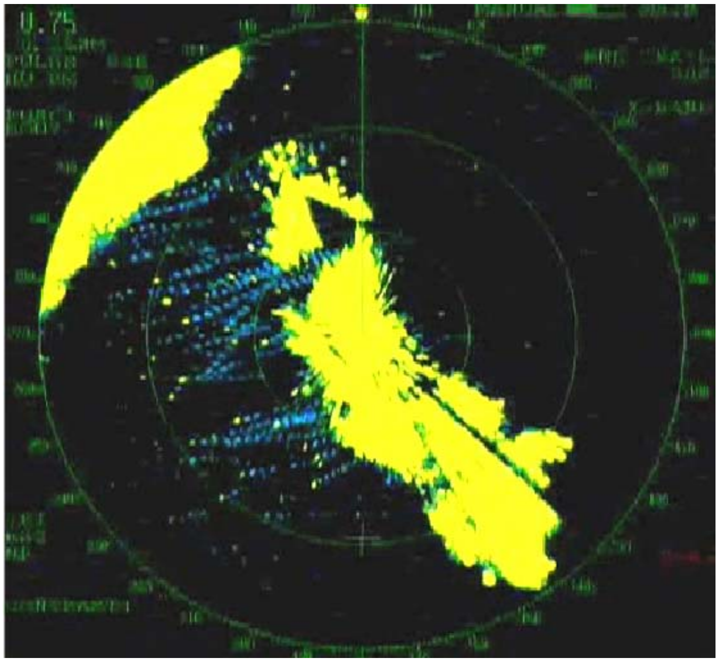


The Wahl Road mobile radar site was located at the junction of three valleys. It was located approximately 50 meters down Wahl Road (also called Kibby Stream Road), off of Beaudry Road. The difficulty at this site was in its presence at the base of several different slopes and some relatively tall trees in the area. Although the radar was placed so that surrounding vegetation did not impair the radar's ability to see targets in the area, the high elevations to the north and south did.

During horizontal operation, the steep slopes on either side of Beaudry Road were detected and created areas of ground clutter. The northern slope of Kibby Range created a large area of ground clutter immediately south of the radar that extended upward, through the full radar beam. Consequently, the airspace south of that ground clutter was not surveyed by the radar. North of Beaudry Road, a steep slope created clutter, as did the slope just southwest of the Kibby Mountain ridge, which was visible at the northeast edge of the radar screen. The clear view to the west was approximately 70 degrees wide, while the view to the north and east was clear.

In vertical operation, the radar antenna was positioned east to west. A clear view nearly to the horizontal was observed without any ground clutter disturbance because of the Kibby Stream valley.

Mile 4 Road - Mobile Site

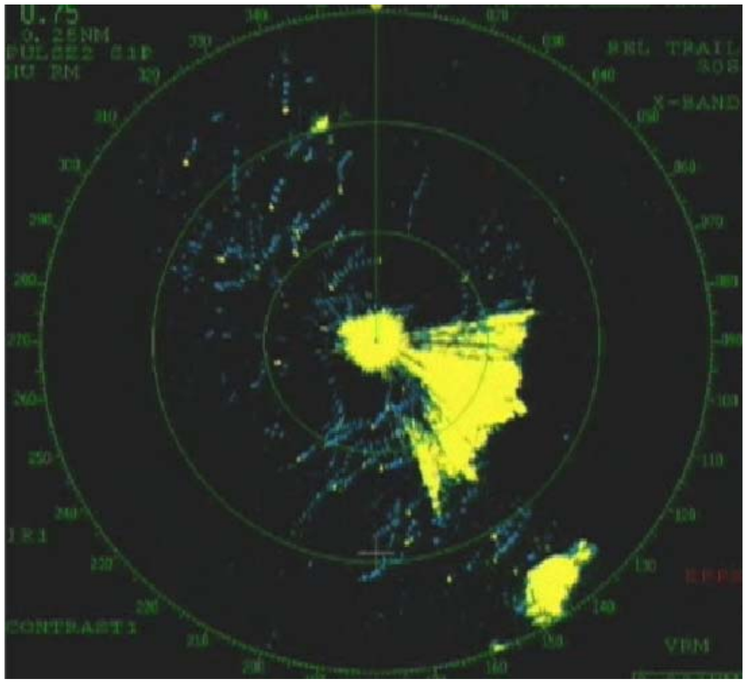


The Mile 4 Road mobile radar site was located within a large, approximately 15-year old clearcut. Tree height was uniform throughout the cut. Since tree height was optimal, vegetation did not impact the radar's ability to see the surrounding airspace. However, the slope to the east did impair the radar detection area.

During horizontal operation, ground clutter to the northwest of the radar was caused by a steep slope west of Beaudry Road that eventually leads to the northern end of Sisk Mountain. To the east and southeast, the slope of Kibby Range rose just enough to increase the canopy height of the regeneration and limit the view of the radar. To the northeast and east-northeast, the radar did still detect targets but they were limited to higher flying targets. The slope was steep enough to the east and southeast to eliminate the detection of targets in those directions.

With the radar in vertical mode, targets were visible east and west of the radar. The view to the west was downward, over Gold Brook. To the east, the tree canopy did raise the view to approximately 6 degrees above the horizontal. Beyond this, however, the slope of Kibby Range was only detected at a distance of approximately 1 kilometer.

Kibby Range 1 – Stationary Site

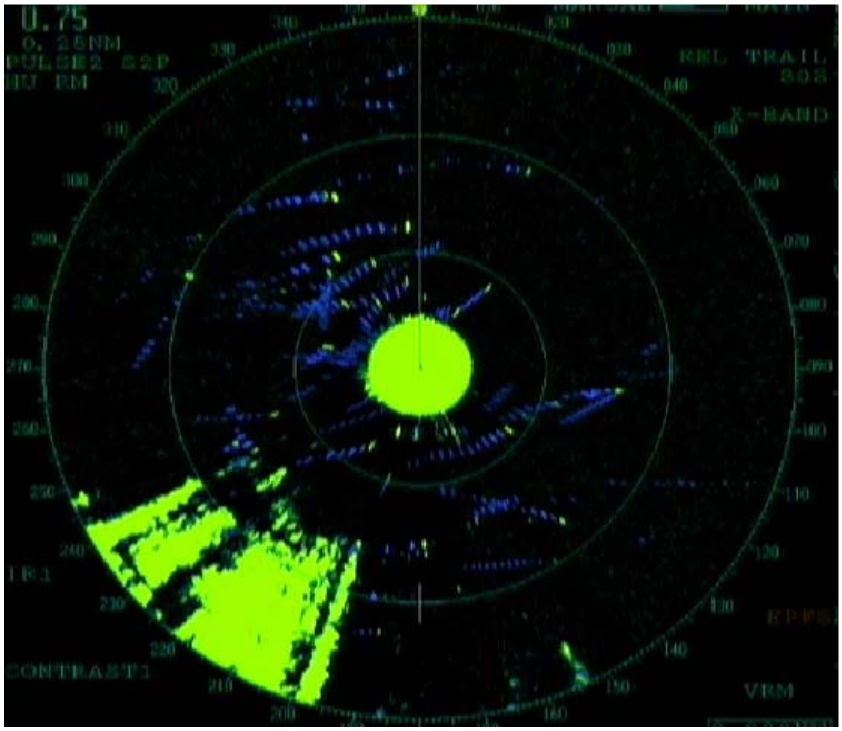


Kibby Range 1, a stationary radar site used during the fall 2005 season, was located within a small opening created around 1994 intended for a meteorological measurement tower. Trees in this area were generally low, as is common in areas along high ridges in western Maine. However, the trees were high enough to limit the view of the radar, so a temporary 6-meter (20-foot) tower for the radar antenna was constructed to raise it to near-canopy height, and the front edge of the antenna was inclined approximately 5 degrees to maximize the airspace sampled by the radar.

During horizontal operation, the surrounding tree line created a mask for ground clutter, limiting the clutter to the center of the radar screen. A small, triangular area of ground clutter occurred to the southeast and was caused by the radar's view of the forest canopy leading to the adjacent peak (941 meters, or 3,086 feet) in that direction. Another small area of ground clutter caused by a slope further to the southeast was detected. A third, very small area of ground clutter was also present north-northeast of the radar and was caused by a small prominence on the Kibby Range ridgeline. This area is marked on U.S. Geological Survey topographic maps as being at an elevation of 866 meters (2,841 feet).

In vertical mode, the radar had a clear view of the airspace above the radar and to the east and west. In both directions, the view was to just below the horizontal, as some targets at this site were observed flying below the height of the radar.

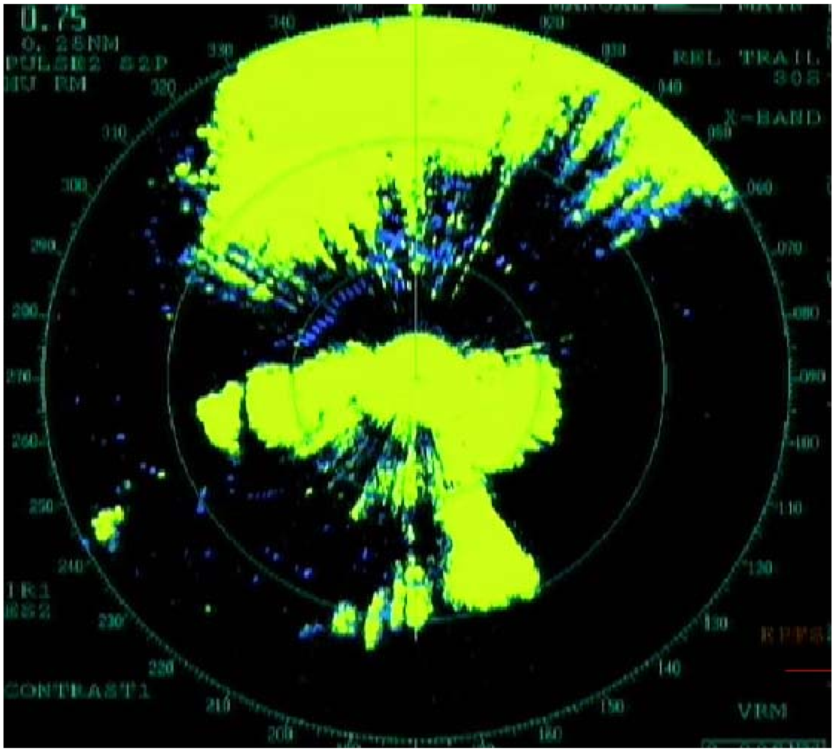
Kibby Range 2 – Stationary Site



Kibby Range 2 was located within another small opening created in 1992 for a meteorological measurement tower. This stationary radar site was positioned adjacent to the new meteorological measurement tower that was installed during the winter of 2006. Trees in this area were also generally low, as is common in areas along high ridges in western Maine. However, the trees were high enough to limit the view of the radar, so a temporary 6-meter (20-foot) tower for the radar antenna was constructed to raise it to near-canopy height and the front edge of the antenna was inclined approximately 5 degrees to maximize the airspace sampled by the radar.

During horizontal operation, the surrounding tree line created a mask for ground clutter, limiting the clutter to the center of the radar screen. A small area of ground clutter occurred to the southwest and was caused by the radar's view of the forest canopy on the flank of the ridgeline in that direction. In vertical mode, clear views above the radar occurred. To the east and west, the radar view was too horizontal, as the surrounding canopy was generally at the same height as the radar antenna.

Kibby Mountain – Stationary Site



The Kibby Mountain radar site was positioned near the crest of the Kibby Mountain ridge, at an elevation of approximately 910 meters (2,985 feet). Trees surrounding the site were relatively tall, but those nearest the radar that could have created visibility problems were dropped.

During horizontal operation, the radar detected side ridges of the Kibby Mountain ridge. These were located both north and south of the radar site, but the view toward the lower saddles of the ridge were visible as targets flying over that saddle were readily detected. Views westward into the Middle Branch Kibby Stream valley were clear, as were views over and beyond the Kibby Mountain ridge to the east.

In vertical mode the radar site provided good views down into the valley west of the radar. The slight rise of the ridge east of the radar was detectable in vertical mode and targets flying over the ridge were observed.

Appendix B

Radar Survey Data Tables

Appendix B Table 1. Summary of radar surveys conducted at the Kibby Wind Power Project by night and by site - Spring 2006

Night of	Passage Rate (t/km/hr)				Flight Height (m)				Flight Direction (compass degrees)			
	Kibby Mountain	Kibby Range 1	Kibby Range 2	Mobile	Kibby Mountain	Kibby Range 1	Kibby Range 2	Mobile	Kibby Mountain	Kibby Range 1	Kibby Range 2	Mobile
5/1	--	--	18 ± 5	--	--	--	88 ± 24	--	--	--	292 ± 51	--
5/4	--	--	704 ± 72	--	--	--	438 ± 48	--	--	--	86 ± 39	--
5/5	--	--	757 ± 175	--	--	--	787 ± 31	--	--	--	100 ± 51	--
5/7	--	--	521 ± 99	--	--	--	276 ± 35	--	--	--	67 ± 24	--
5/8	685 ± 115	--	--	--	313 ± 23	--	--	--	51 ± 35	--	--	--
5/9	95 ± 35	--	--	--	254 ± 19	--	--	--	317 ± 42	--	--	--
5/14	--	6 ± 1	--	--	--	158 ± 21	--	--	--	42 ± 30	--	--
5/15	--	115 ± 59	--	--	--	645 ± 48	--	--	--	75 ± 58	--	--
5/17	271 ± 48	428 ± 55	--	--	382 ± 27	501 ± 26	--	--	72 ± 73	77 ± 53	--	--
5/18	99 ± 21	372 ± 57	--	--	624 ± 74	447 ± 59	--	--	16 ± 60	47 ± 48	--	--
5/19	88 ± 67	101 ± 39	--	--	--	412 ± 17	--	--	48 ± 49	53 ± 34	--	--
5/22	--	35 ± 16	--	--	--	416 ± 25	--	--	--	143 ± 38	--	--
5/23	--	49 ± 16	--	--	--	656 ± 91	--	--	--	192 ± 28	--	--
5/24	1500 ± 254	--	--	773 ± 237	266 ± 19	--	--	355 ± 71	80 ± 43	--	--	63 ± 48
5/25	--	--	744 ± 55	--	--	--	303 ± 14	--	--	--	78 ± 31	--
5/26	--	--	265 ± 69	--	--	--	483 ± 49	--	--	--	92 ± 61	--
5/27	--	--	574 ± 84	--	--	--	272 ± 17	--	--	--	120 ± 39	--
5/30	--	229 ± 26	--	--	--	181	--	--	--	46 ± 34	--	--
6/1	--	471 ± 57	--	--	--	254 ± 52	--	--	--	244 ± 46	--	--
6/2	--	162 ± 30	--	--	--	444 ± 29	--	--	--	354 ± 43	--	--
6/4	--	--	--	113 ± 44	--	--	--	312 ± 56	--	--	--	309 ± 84
Mean	456 ± 229	197 ± 54	512 ± 113	443 ±183	368 ± 68	412 ± 54	378 ± 90	334 ± 42	67 ± 50	50 ± 105	86 ± 42	61 ± 53

-- indicates that no surveys were conducted at this site on this night

Appendix B Table 2. Summary of passage rates by site, hour, night, and for entire season.

Night of	Site	Passage Rate (targets/km/hr) by hour after sunset										Entire Night			% of targets < 125 meters
		1	2	3	4	5	6	7	8	9	10	Mean	Stdev	SE	
8-May	Kibby Mountain	257	534	781	1064	1214	1027	770	670	452	77	685	363	115	21%
9-May	Kibby Mountain	189	181	111	30	47	18	279	0	--	--	95	100	35	18%
17-May	Kibby Mountain	61	346	491	452	369	244	334	207	145	64	271	152	48	9%
18-May	Kibby Mountain	57	84	156	142	56	--	--	--	--	--	99	47	21	2%
19-May	Kibby Mountain	0	43	220	--	--	--	--	--	--	--	88	116	67	--
24-May	Kibby Mountain	188	2046	2106	2094	2375	1657	1141	1385	505	--	1500	763	254	20%
Kibby Mountain Average		**125**	**539**	**644**	**756**	**812**	**736**	**631**	**566**	**367**	**70**	**456**	**560**	**229**	**14%**
14-May	Kibby Range 1	3	4	7	8	9	7	--	--	--	--	6	2	1	48%
15-May	Kibby Range 1	125	72	18	17	0	62	21	614	202	21	115	186	59	2%
17-May	Kibby Range 1	201	624	589	346	318	364	595	390	--	--	428	155	55	1%
18-May	Kibby Range 1	347	213	496	508	297	--	--	--	--	--	372	128	57	6%
19-May	Kibby Range 1	60	43	214	86	--	--	--	--	--	--	101	78	39	1%
22-May	Kibby Range 1	30	162	36	34	28	19	18	21	6	--	35	47	16	2%
23-May	Kibby Range 1	--	--	--	0	91	93	80	59	21	--	49	39	16	1%
30-May	Kibby Range 1	216	328	323	257	250	234	216	165	74	--	229	78	26	0%
1-Jun	Kibby Range 1	229	574	431	554	688	638	403	529	195	--	471	172	57	53%
2-Jun	Kibby Range 1	195	269	208	186	140	105	28	--	--	--	162	78	30	6%
Kibby Range 1 Average		**156**	**254**	**258**	**200**	**202**	**190**	**194**	**296**	**100**	**21**	**197**	**171**	**54**	**12%**
1-May	Kibby Range 2	21	25	8	21	--	--	--	--	32	0	18	12	5	71%
4-May	Kibby Range 2	392	482	696	1053	847	782	934	798	678	373	704	228	72	12%
5-May	Kibby Range 2	--	332	580	651	850	1373	--	--	--	--	757	391	175	3%
7-May	Kibby Range 2	35	243	414	519	721	1049	817	701	521	186	521	312	99	22%
25-May	Kibby Range 2	486	683	683	653	781	1064	768	912	671	--	744	166	55	23%
26-May	Kibby Range 2	270	673	384	116	--	214	43	246	170	--	265	194	69	14%
27-May	Kibby Range 2	163	688	921	827	757	549	551	422	284	--	574	252	84	31%
Kibby Range 2 Average		**228**	**447**	**527**	**549**	**791**	**839**	**623**	**615**	**393**	**186**	**512**	**277**	**105**	**25%**

-- indicates no data for that hour
Insects were not included in calculation of passage rate

Appendix B Table 3. Summary of flight patterns observed at mobile sampling sites - Spring 2006			
Passage Rate (t/km/hour)			
Night of	Spencer Bale Road	Wahl Road	Mile 4 Road
24-May	604 ± 291	474 ± 174	1242 ± 45
4-Jun	98 ± 10	195 ± 19	45 ± 21
Average	**443 ± 100**		
Flight Height (in meters)			
Night of	Spencer Bale Road	Wahl Road	Mile 4 Road
24-May	350 ± 17	480 ± 21	235 ± 7
4-Jun	355 ± 89	380*	200 ± 39
Average	**334 ± 62**		
Flight Direction (Compass Degrees)			
Night of	Spencer Bale Road	Wahl Road	Mile 4 Road
24-May	48 ± 59	69 ± 39	70 ± 39
4-Jun	320 ± 76	300 ± 85	298 ± 97
Average	**61± 53**		
*Flight height was only collected for one hour, therefore standard error could not be calculated			

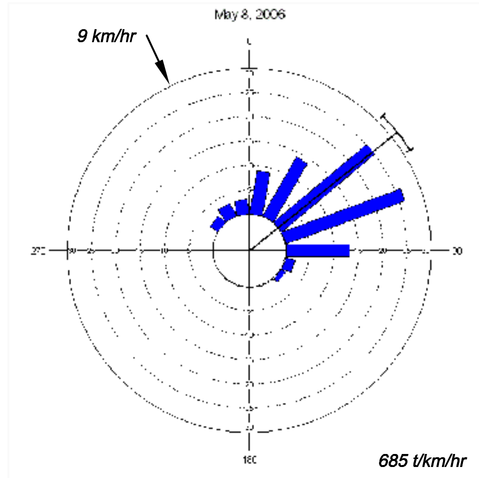
Appendix B Table 4. Summary of mean flight heights by hour, night, and for entire season

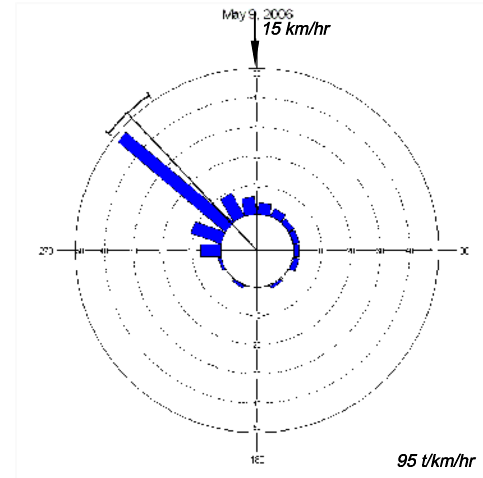
Night of	Site	Mean Flight Height (altitude in meters) by hour after sunset										Entire Night			% of targets < 100 meters	% of targets < 125 meters
		1	2	3	4	5	6	7	8	9	10	Mean	STDV	SE		
5/8	Kibby Mtn	228	306	367	344	380	437	331	286	234	213	313	73	23	13%	21%
5/9	Kibby Mtn	223	315	303	284	307	182	206	213	--	--	254	54	19	12%	18%
5/17	Kibby Mtn	258	373	361	422	355	--	339	519	434	--	382	77	27	6%	9%
5/18	Kibby Mtn	333	655	739	692	702	--	--	--	--	--	624	165	74	1%	2%
5/19	Kibby Mtn	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/24	Kibby Mtn	305	337	309	226	190	206	228	254	344	--	266	58	19	11%	20%
	KM Average	**269**	**397**	**416**	**394**	**387**	**275**	**276**	**318**	**337**	**213**	**368**	**152**	**68**	**9%**	**14%**
5/14	Kibby Range 1	--	--	139	205	177	110	--	--	--	--	158	42	21	46%	48%
5/15	Kibby Range 1	--	444	454	576	579	626	754	748	774	847	645	144	48	1%	2%
5/17	Kibby Range 1	328	562	573	549	516	471	460	486	565	--	501	78	26	0%	1%
5/18	Kibby Range 1	272	486	506	525	--	--	--	--	--	--	447	118	59	3%	6%
5/19	Kibby Range 1	341	448	427	445	462	373	390	--	--	--	412	45	17	0%	1%
5/22	Kibby Range 1	296	431	462	440	302	442	385	520	470	--	416	76	25	1%	2%
5/23	Kibby Range 1	316	762	827	742	636	--	--	--	--	--	656	202	91	0%	1%
5/30	Kibby Range 1	--	--	181	--	--	--	--	--	--	--	181	--	--	0%	100%
6/1	Kibby Range 1	--	287	107	66	337	464	203	313	--	--	254	139	52	50%	53%
6/2	Kibby Range 1	--	--	--	--	418	502	413	--	--	--	444	50	29	3%	6%
	KR1 Average	**311**	**488**	**409**	**443**	**428**	**427**	**434**	**414**	**603**	**847**	**412**	**172**	**54**	**11%**	**22%**
5/1	Kibby Range 2	--	67	136	--	--	--	--	--	61	--	88	42	24	64%	71%
5/4	Kibby Range 2	299	539	689	555	528	394	--	311	263	362	438	145	48	10%	12%
5/5	Kibby Range 2	--	847	815	901	772	798	846	807	713	587	787	92	31	2%	3%
5/7	Kibby Range 2	11	364	278	251	255	204	335	370	366	329	276	109	35	17%	22%
5/25	Kibby Range 2	326	250	319	343	335	297	222	288	342	--	303	43	14	18%	23%
5/26	Kibby Range 2	316	316	487	634	--	--	624	473	530	--	483	130	49	10%	14%
5/27	Kibby Range 2	349	362	287	256	244	219	243	224	261	--	272	52	17	24%	31%
	KR2 Average	**260**	**392**	**430**	**490**	**427**	**382**	**454**	**412**	**362**	**426**	**378**	**221**	**90**	**21%**	**25%**

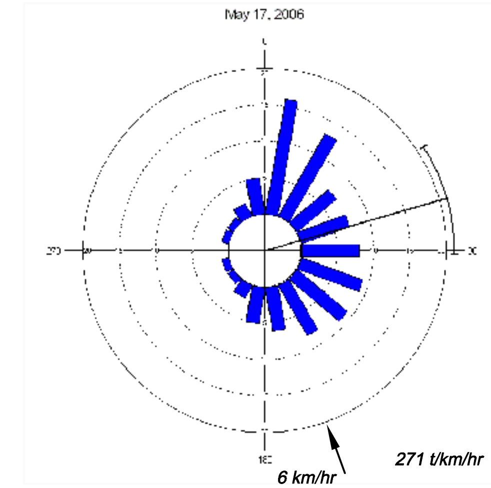
-- indicates no data for that hour

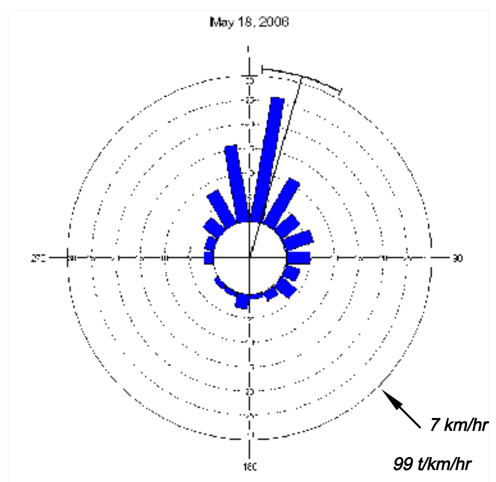
Appendix C

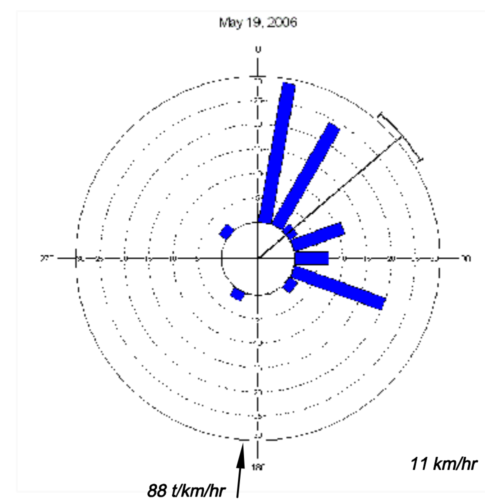
Nightly Flight Direction Histograms

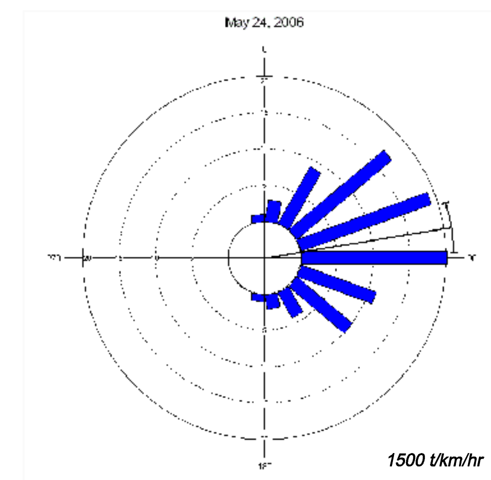


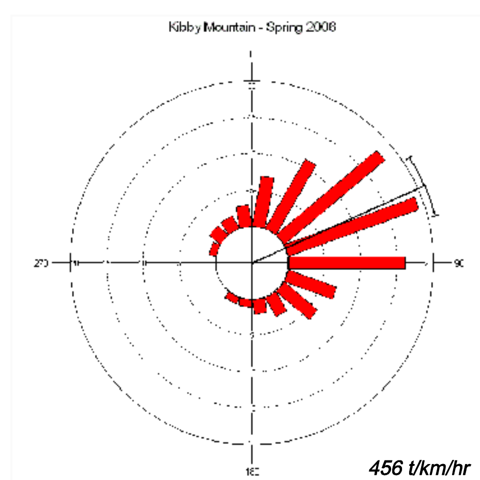






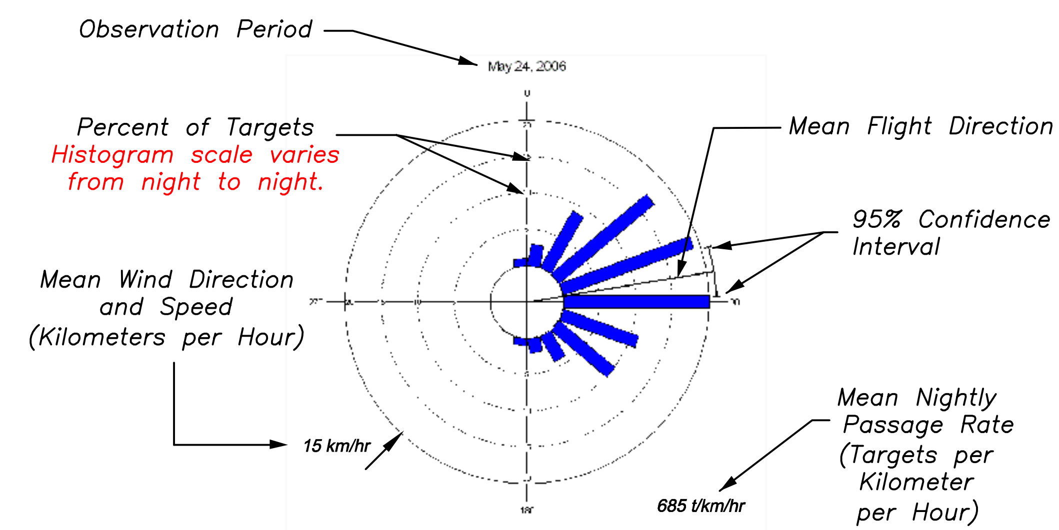






Mean Spring Target Flight Direction

RADAR DATA ROSE LEGEND



Data rose shows bird targets in directions of 20° increments.

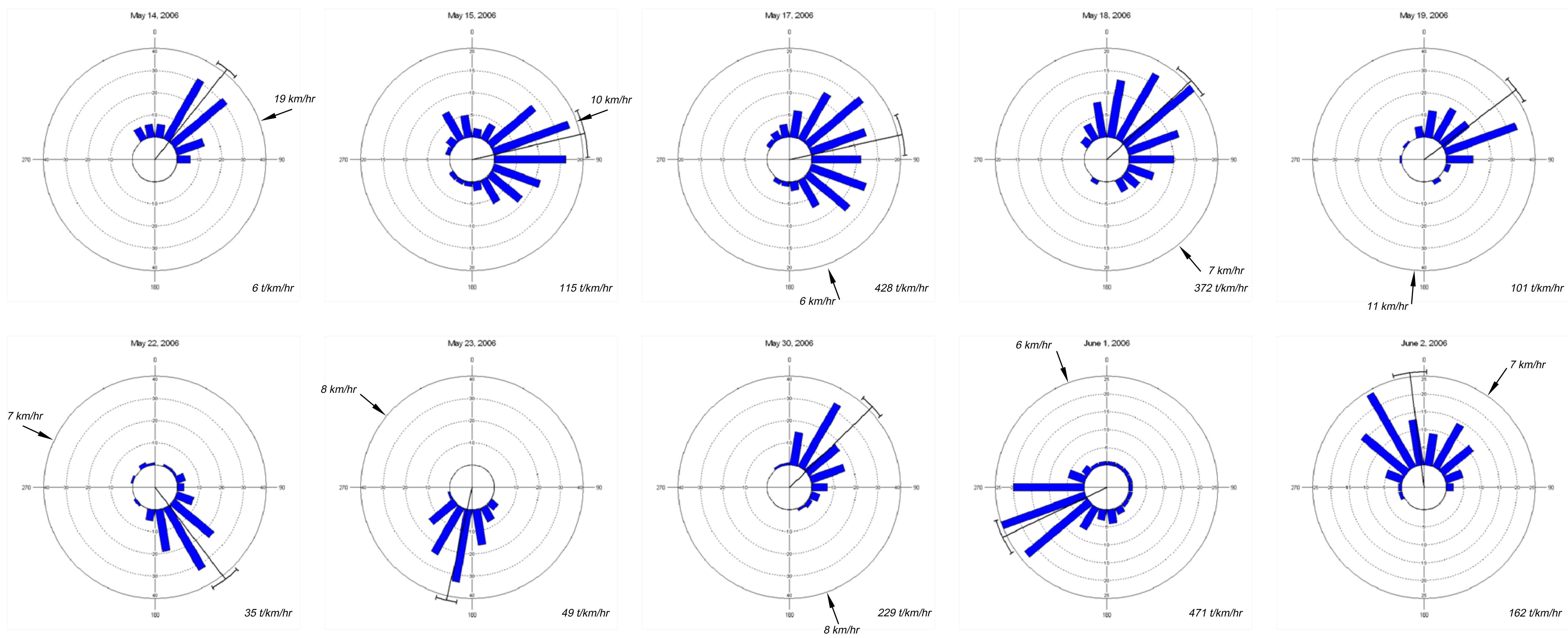
SHEET TITLE: Appendix C – Spring 2006 Kibby Mountain Nightly Mean Flight Direction

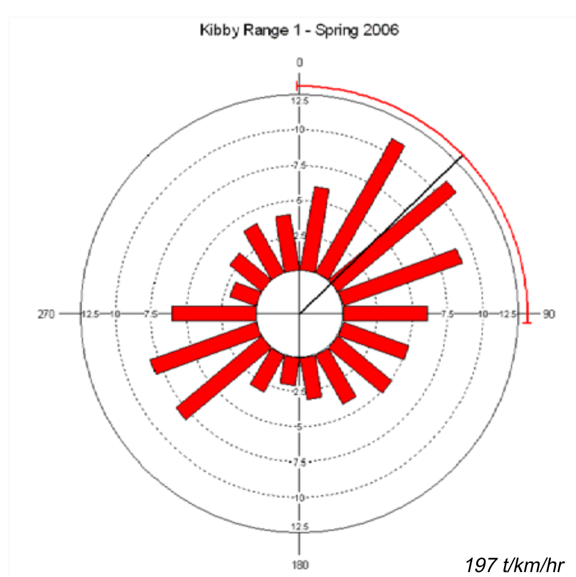
PROJECT: Kibby Wind Power Project
TransCanada Energy, Ltd.
Kibby, Maine

PREPARED BY: WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS

105112-F105-KibbyTraffic.dwg

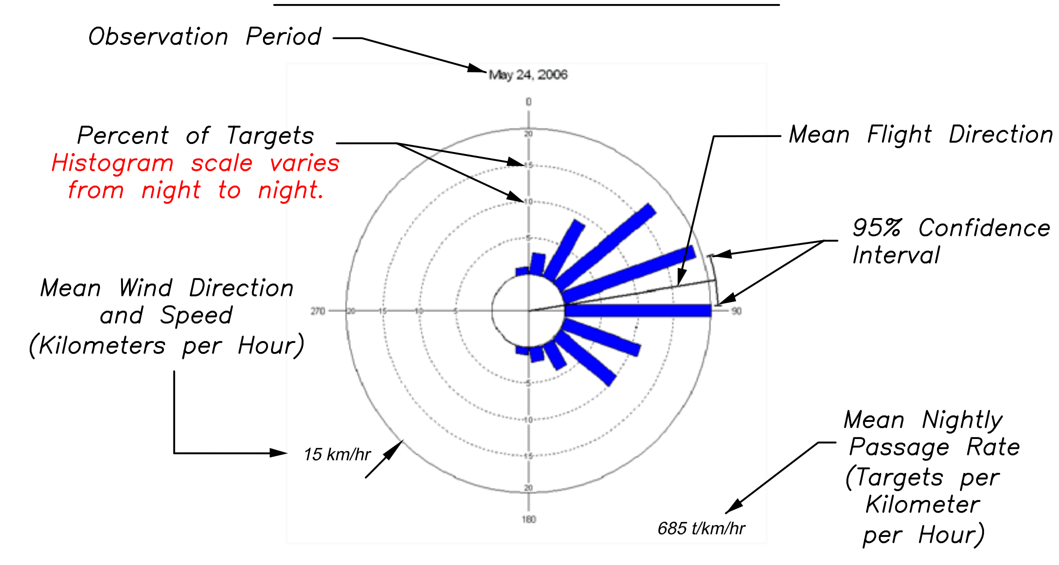
DATE: August 2006
SCALE: N/A
PROJ. NO. 105112
FIGURE: 1 of 5





Mean Spring Target Flight Direction

RADAR DATA ROSE LEGEND



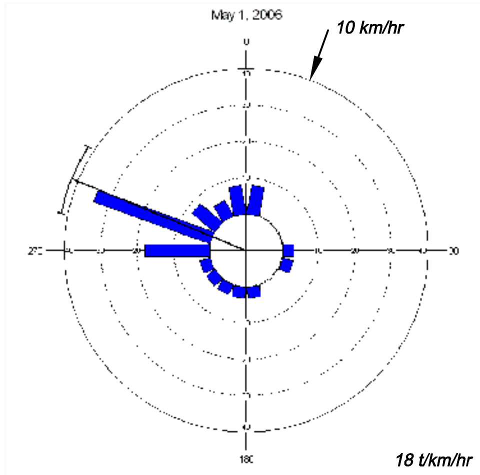
Data rose shows bird targets in directions of 20° increments.

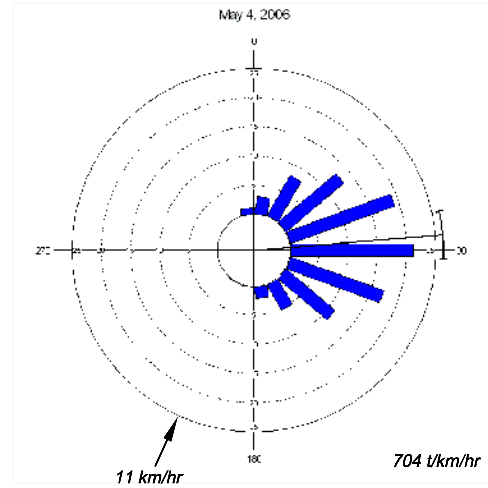
SHEET TITLE: Appendix C – Spring 2006 Kibby Range 1 Nightly Mean Flight Direction

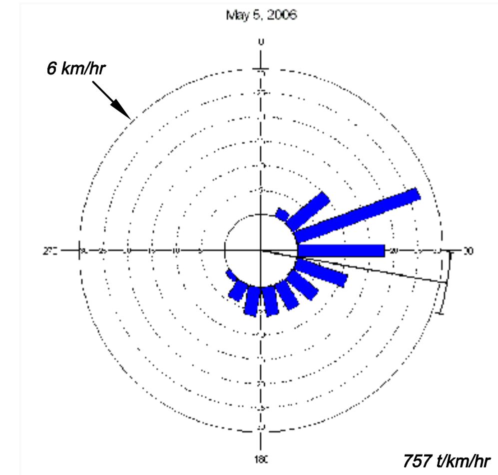
PROJECT: Kibby Wind power Project
TransCanada Energy, Ltd.
Kibby, Maine

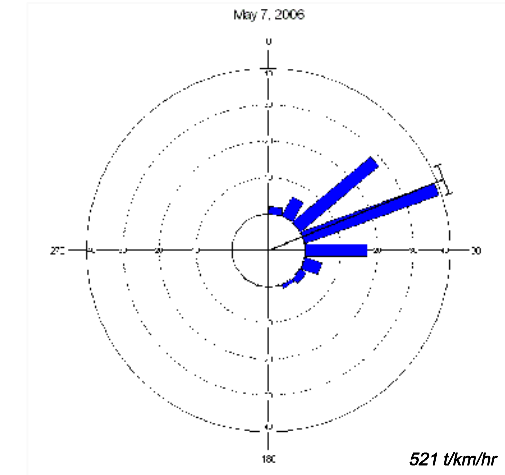
PREPARED BY: WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS

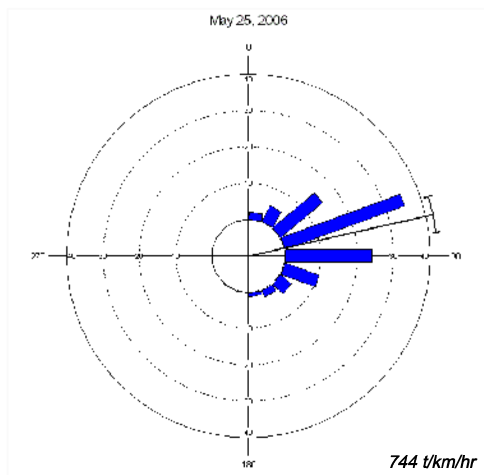
DATE: August 2006
SCALE: N/A
PROJ. NO. 105112
FIGURE: 2 of 5

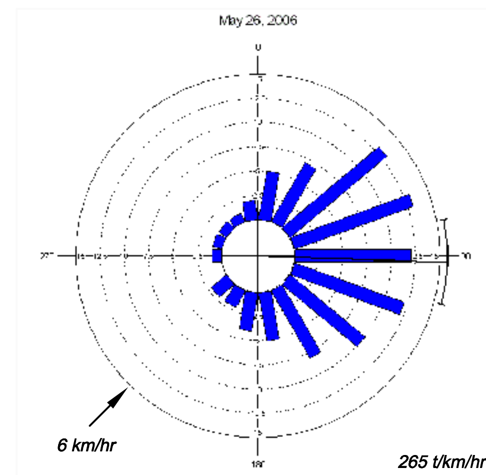


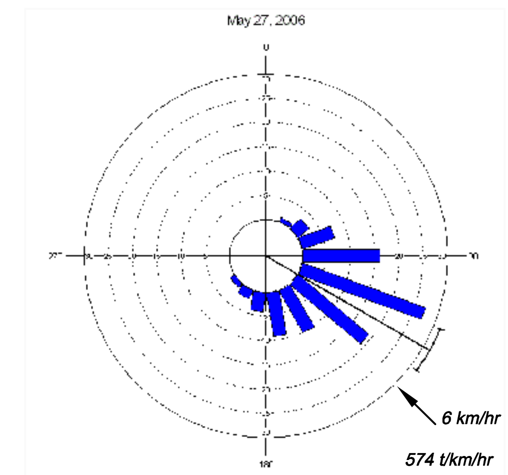


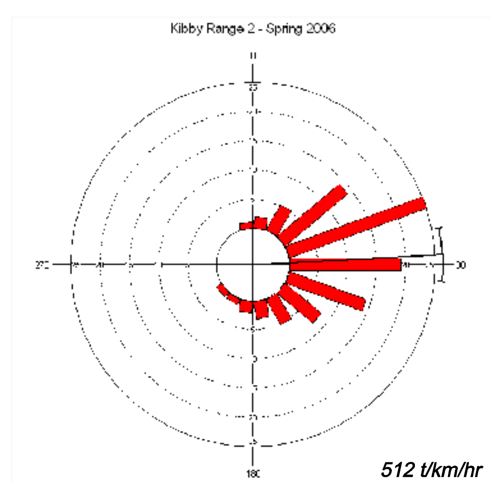






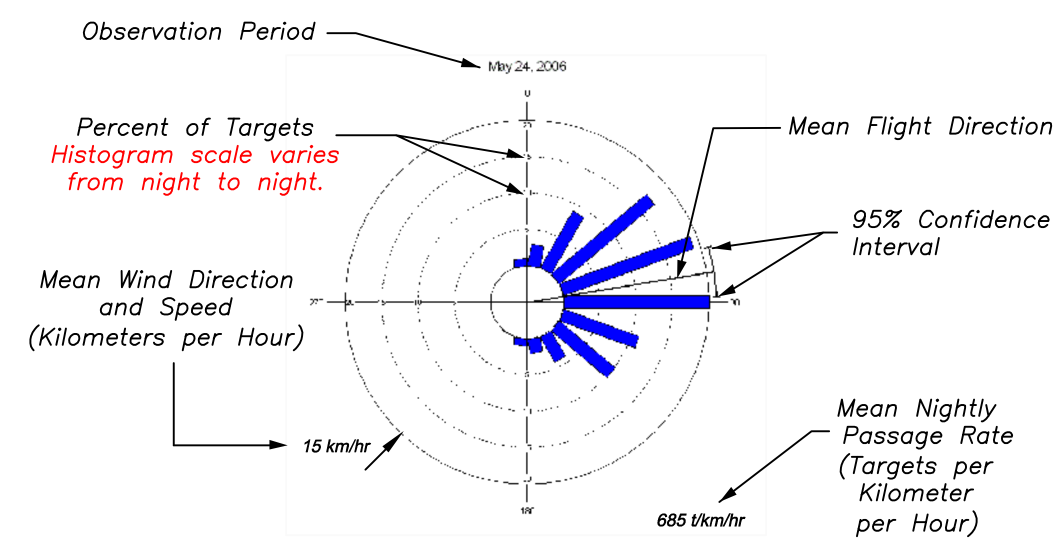






Mean Spring Target Flight Direction

RADAR DATA ROSE LEGEND



Data rose shows bird targets in directions of 20° increments.

SHEET TITLE: Appendix C – Spring 2006 Kibby Range 2 Nightly Mean Flight Direction

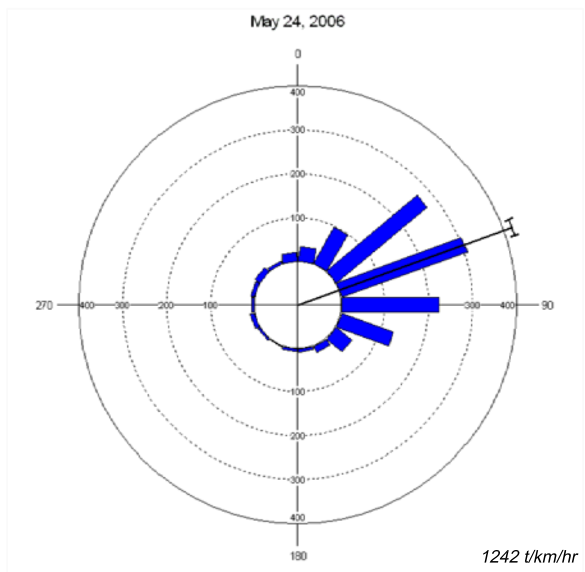
PROJECT: Kibby Wind Power Project TransCanada Energy, Ltd.

PREPARED BY: WOODLOT ALTERNATIVES, INC. ENVIRONMENTAL CONSULTANTS

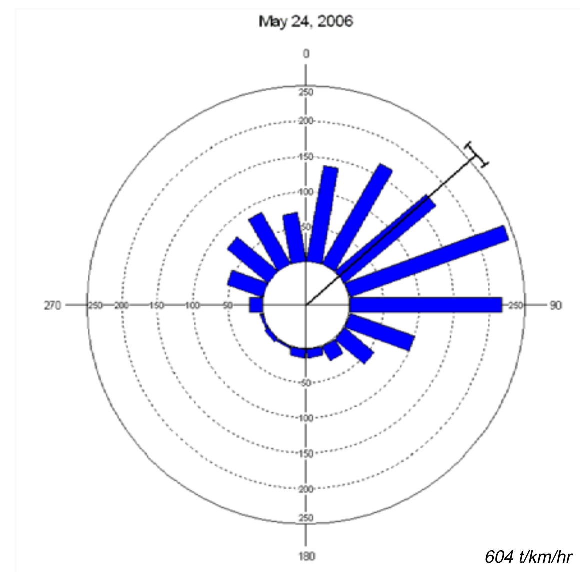
105112–F105–KibbyTraffic.dwg

DATE: August 2006
SCALE: N/A
PROJ. NO. 105112
FIGURE: 3 of 5

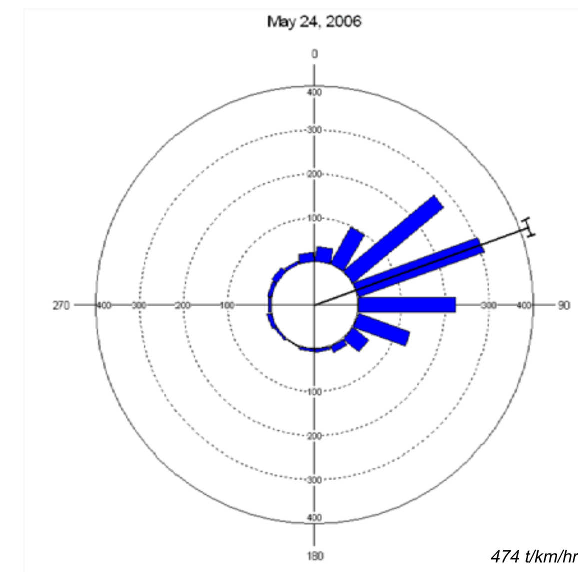
Mile 4 Road
Mobile Radar Site



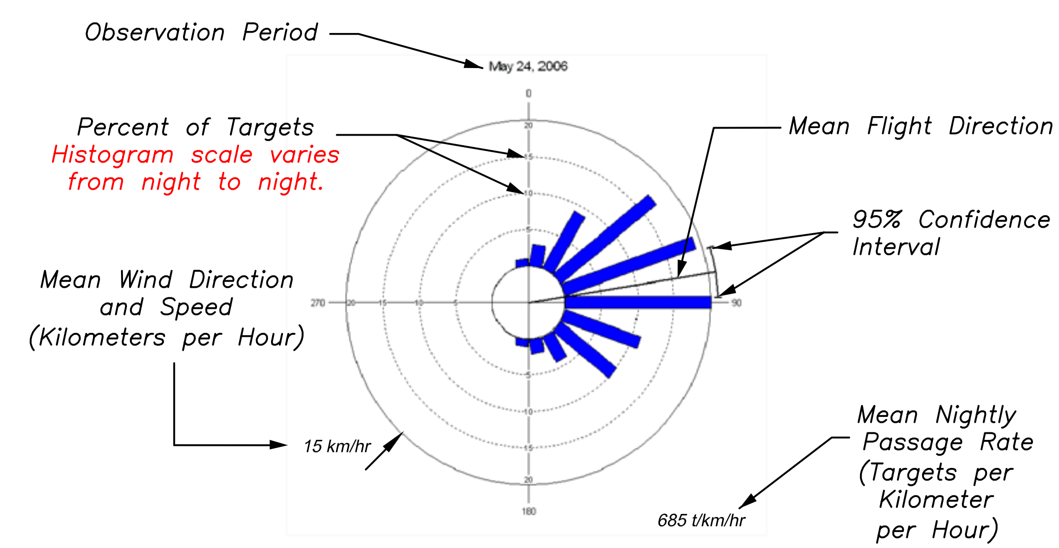
Spencer Bale
Mobile Radar Site



Wahl Road
Mobile Radar Site



RADAR DATA ROSE LEGEND



Data rose shows bird targets in directions of 20° increments.

SHEET TITLE: Appendix C – May 24, 2006 Mobile Radar Sites Nightly Mean Flight Direction

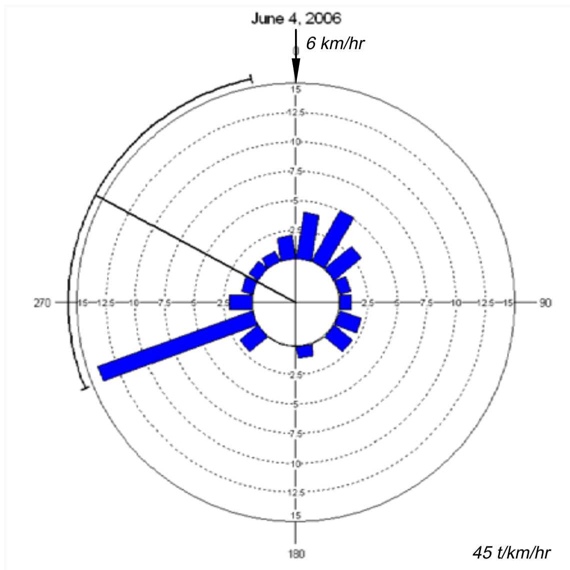
PROJECT: Kibby Wind Power Project
TransCanada Energy, Ltd.

PREPARED BY: WOODLOT ALTERNATIVES, INC.
ENVIRONMENTAL CONSULTANTS

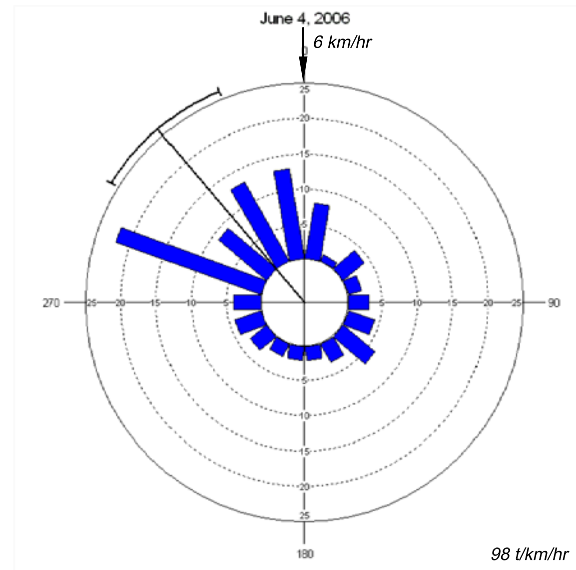
105112–F105–KibbyTraffic.dwg

DATE: August 2006
SCALE: N/A
PROJ. NO. 105112
FIGURE:
4 of 5

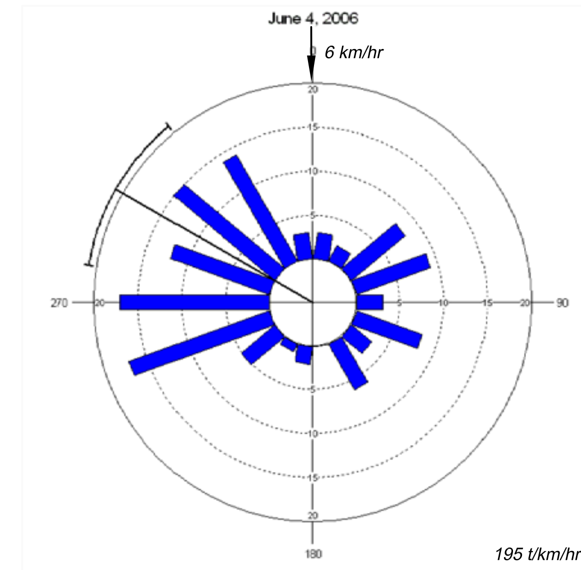
Mile 4 Road
Mobile Radar Site



Spencer Bale
Mobile Radar Site



Wahl Road
Mobile Radar Site



RADAR DATA ROSE LEGEND

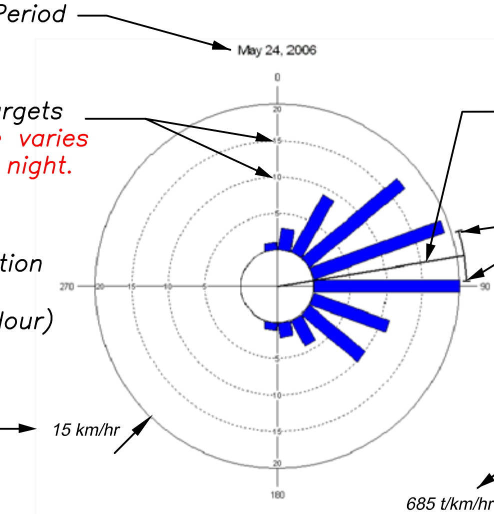
Observation Period

Percent of Targets
Histogram scale varies from night to night.

Mean Wind Direction and Speed (Kilometers per Hour)

Mean Flight Direction

95% Confidence Interval



Mean Nightly Passage Rate (Targets per Kilometer per Hour)

Data rose shows bird targets in directions of 20° increments.

SHEET TITLE: Appendix C – June 4, 2006 Mobile Radar Sites Nightly Mean Flight Direction

PROJECT: Kibby Wind Power Project
TransCanada Energy, Ltd.

PREPARED BY: WOODLOT ALTERNATIVES, INC.
ENVIRONMENTAL CONSULTANTS
105112–F105–Kibbytraffic.dwg

DATE: August 2006
SCALE: N/A
PROJ. NO. 105112
FIGURE: 5 of 5

Appendix D

Direction Data Statistics Summaries by Site

Appendix D Table 1. Nightly Circular Statistics for Kibby Mountain Site - Spring 2006

Variable	Night Of					
	8-May	**9-May**	**17-May**	**18-May**	**19-May**	**24-May**
Data Type	Angles	Angles	Angles	Angles	Angles	Angles
Number of Observations	4461	363	1682	279	45	7315
Data Grouped?	No	No	No	No	No	No
Group Width (& Number of Groups)						
Mean Vector (µ)	51.395°	316.917°	72.235°	15.811°	48.117°	80.408°
Length of Mean Vector (r)	0.825	0.76	0.441	0.574	0.694	0.759
Median	55.601°	311.29°	72.352°	9.732°	35.475°	79.323°
Concentration	3.199	2.45	0.98	1.407	1.968	2.437
Circular Variance	0.175	0.24	0.559	0.426	0.306	0.241
Circular Standard Deviation	35.576°	42.424°	73.361°	60.387°	48.997°	42.581°
Standard Error of Mean	0.528°	2.203°	2.126°	3.818°	7.309°	0.493°
95% Confidence Interval (-/+) for µ	50.36°	312.597°	68.068°	8.326°	33.788°	79.442°
	52.431°	321.236°	76.402°	23.295°	62.445°	81.374°
99% Confidence Interval (-/+) for µ	50.035°	311.24°	66.759°	5.975°	29.287°	79.139°
	52.756°	322.593°	77.711°	25.646°	66.946°	81.677°
Rayleigh Test (Z)	3033.855	209.798	326.464	91.871	21.658	4210.604
Rayleigh Test (p)	0	0	0	0	3.19E-10	0
Rao's Spacing Test (U)	236.979	224.135	185.576	194.923	225.908	222.27
Rao's Spacing Test (p)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Appendix D Table 2. Nightly Circular Statistics for Kibby Range 1 Site - Spring 2006

Variable	**Night Of**									
	14-May	**15-May**	**17-May**	**18-May**	**19-May**	**22-May**	**23-May**	**30-May**	**1-Jun**	**2-Jun**
Data Type	Angles	Angles	Angles	Angles	Angles	Angles	Angles	Angles	Angles	Angles
Number of Observations	16	605	2042	1106	130	167	218	1180	2682	680
Data Grouped?	No	No	No	No	No	No	No	No	No	No
Group Width (& Number of Groups)										
Mean Vector (μ)	41.587°	75.474°	77.022°	47.324°	52.898°	142.652°	192.035°	45.951°	244.253°	353.881°
Length of Mean Vector (r)	0.873	0.604	0.652	0.701	0.839	0.805	0.888	0.838	0.729	0.754
Median	43.677°	75.035°	73.406°	46.078°	58.679°	143.825°	190.902°	39.983°	244.478°	344.518°
Concentration	4.242	1.524	1.74	2.011	3.432	2.929	4.75	3.421	2.199	2.397
Circular Variance	0.127	0.396	0.348	0.299	0.161	0.195	0.112	0.162	0.271	0.246
Circular Standard Deviation	29.857°	57.563°	53.022°	48.312°	33.979°	37.7°	27.963°	34.054°	45.57°	43.046°
Standard Error of Mean	7.443°	2.428°	1.191°	1.451°	2.962°	2.887°	1.89°	0.985°	0.874°	1.634°
95% Confidence Interval (-/+) for μ	26.995°	70.713°	74.688°	44.479°	47.092°	136.993°	188.33°	44.02°	242.54°	350.677°
	56.179°	80.235°	79.356°	50.168°	58.704°	148.312°	195.74°	47.882°	245.966°	357.085°
99% Confidence Interval (-/+) for μ	22.411°	69.218°	73.955°	43.585°	45.268°	135.215°	187.166°	43.413°	242.002°	349.671°
	60.762°	81.73°	80.09°	51.062°	60.528°	150.09°	196.903°	48.489°	246.505°	358.091°
Rayleigh Test (Z)	12.195	220.493	867.221	543.214	91.454	108.314	171.796	828.831	1424.727	386.702
Rayleigh Test (p)	7.58E-07	0	0	0	0	0	0	0	0	0
Rao's Spacing Test (U)	208.716	189.949	197.318	203.259	236.435	235.39	252.339	240.445	221.394	220.098
Rao's Spacing Test (p)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Appendix D Table 3. Nightly Circular Statistics for Kibby Range 2 Site - Spring 2006

Variable	**Night Of**						
	1-May	**4-May**	**5-May**	**7-May**	**26-May**	**25-May**	**27-May**
Data Type	Angles	Angles	Angles	Angles	Angles	Angles	Angles
Number of Observations	38	3490	2043	3283	1143	3741	2535
Data Grouped?	No	No	No	No	No	No	No
Group Width (& Number of Groups)							
Mean Vector (µ)	291.905°	86.385°	100.338°	67.183°	91.683°	77.874°	119.921°
Length of Mean Vector (r)	0.67	0.796	0.677	0.917	0.568	0.864	0.792
Median	289.818°	87.816°	90°	65.462°	90°	75.745°	117.075°
Concentration	1.837	2.819	1.874	6.3	1.384	3.986	2.769
Circular Variance	0.33	0.204	0.323	0.083	0.432	0.136	0.208
Circular Standard Deviation	51.235°	38.663°	50.574°	23.868°	60.97°	30.971°	39.124°
Standard Error of Mean	8.376°	0.647°	1.125°	0.416°	1.912°	0.505°	0.768°
95% Confidence Interval (-/+) for µ	275.486°	85.116°	98.133°	66.367°	87.935°	76.884°	118.414°
	308.325°	87.654°	102.544°	67.999°	95.432°	78.863°	121.427°
99% Confidence Interval (-/+) for µ	270.328°	84.718°	97.44°	66.111°	86.757°	76.573°	117.941°
	313.483°	88.053°	103.237°	68.255°	96.609°	79.174°	121.901°
Rayleigh Test (Z)	17.081	2213.463	937.349	2759.97	368.361	2793.113	1590.299
Rayleigh Test (p)	1.25E-08	0	0	0	0	0	0
Rao's Spacing Test (U)	188.141	226.68	214.207	267.021	182.355	247.59	225.387
Rao's Spacing Test (p)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Appendix D Table 4. Nightly Circular Statistics for Mobile Valley Sites - Spring 2006

Variable	Mile 4 Road			Spencer Bale			Wahl Road			Mobile Pooled
	Night of			Night of			Night Of			
	24-May	4-Jun	Entire Season	24-May	4-Jun	Entire Season	24-May	4-Jun	Entire Season	
Data Type	Angles	Angles		Angles	Angles		Angles	Angles	Angles	Angles
Number of Observations	1196	42	1238	1448	105	1553	1196	128	1324	4115
Data Grouped?	No	No	No	No	No	No	No	No	No	No
Group Width (& Number of Groups)										
Mean Vector (µ)	69.919°	298.256°	69.461°	48.473°	319.763°	45.552°	69.919°	300.061°	67.892°	61.49°
Length of Mean Vector (r)	0.792	0.24	0.759	0.584	0.412	0.546	0.792	0.331	0.695	0.647
Median	69.278°	255.428°	68.749°	54.884°	324.942°	51.84°	69.278°	301.035°	66.979°	63.794°
Concentration	2.764	0.493	2.442	1.447	0.903	1.307	2.764	0.702	1.976	1.716
Circular Variance	0.208	0.76	0.241	0.416	0.588	0.454	0.208	0.669	0.305	0.353
Circular Standard Deviation	39.172°	96.864°	42.513°	59.382°	76.319°	63.006°	39.172°	85.174°	48.878°	53.496°
Standard Error of Mean	1.12°	25.715°	1.196°	1.637°	9.167°	1.721°	1.12°	10.501°	1.344°	0.848°
95% Confidence Interval (-/+) for µ	67.723°	247.845°	67.117°	45.264°	301.792°	42.179°	67.723°	279.474°	65.258°	59.828°
	72.115°	348.667°	71.805°	51.683°	337.734°	48.925°	72.115°	320.648°	70.527°	63.153°
99% Confidence Interval (-/+) for µ	67.034°	232.01°	66.381°	44.255°	296.146°	41.12°	67.034°	273.007°	64.431°	59.306°
	72.805°	4.503°	72.542°	52.691°	343.379°	49.985°	72.805°	327.114°	71.354°	63.675°
Rayleigh Test (Z)	749.436	2.41	713.864	494.613	17.809	463.436	749.436	14.043	639.481	1720.97
Rayleigh Test (p)	0	0.089	0	0	1.84E-08	0.00E+00	0	7.96E-07	0	0
Rao's Spacing Test (U)	225.236	177.936	219.944	184.732	147.621	180.226	225.236	164.916	209.976	218.831
Rao's Spacing Test (p)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Appendix E

Bat Survey Data Tables

Appendix E Table 1. Summary of species and weather during each survey night at the Kibby Range South low detector (15 m) – Spring 2006

Night of	Big Brown Bat Guild				RBEP		MYSP				UNKN	Total
	big brown bat	**hoary bat**	**silver-haired bat**	**silver-haired/big brown**	**eastern pipistrelle**	**eastern red bat**	**little brown bat**	***Myotis* spp.**	**northern myotis**	**small-footed myotis**	**unknown**	
5/1/2006												**0**
5/2/2006												**0**
5/3/2006												**0**
5/4/2006												**0**
5/5/2006											6	**6**
5/6/2006												**0**
5/7/2006												**0**
5/8/2006												**0**
5/9/2006											1	**1**
5/10/2006												**0**
5/11/2006												**0**
5/12/2006												**0**
5/13/2006												**0**
5/14/2006												**0**
5/15/2006												**0**
5/16/2006												**0**
5/17/2006												**0**
5/18/2006												**0**
5/19/2006												**0**
5/20/2006												**0**
5/21/2006												**0**
5/22/2006												**0**
5/23/2006												**0**
5/24/2006												**0**
5/25/2006											11	**11**
5/26/2006											1	**1**
5/27/2006		1						1				**2**
5/28/2006												**0**
5/29/2006												**0**
5/30/2006												**0**
5/31/2006				1								**1**
6/1/2006				1								**1**
6/2/2006											2	**2**
6/3/2006												**0**

(***continued***)

Appendix E Table 1. Summary of species and weather during each survey night at the Kibby Range South low detector (15 m) – Spring 2006 (*continued*)

Night of	**Big Brown Bat Guild**				**RBFP**		**MYSP**				**UNKN**	**Total**
	big brown bat	**hoary bat**	**silver-haired bat**	**silver-haired/big brown**	**eastern pipistrelle**	**eastern red bat**	**little brown bat**	***Myotis* spp.**	**northern myotis**	**small-footed myotis**	**unknown**	
6/4/2006												**0**
6/5/2006				1							1	**2**
6/6/2006												**0**
6/7/2006												**0**
6/8/2006												**0**
6/9/2006												**0**
6/10/2006												**0**
6/11/2006												**0**
6/12/2006												**0**
6/13/2006												**0**
6/14/2006											1	**1**
6/15/2006												**0**
6/16/2006												**0**
6/17/2006											3	**3**
6/18/2006												**0**
6/19/2006												**0**
By Species	**0**	**1**	**0**	**3**	**0**	**0**	**0**	**1**	**0**	**0**	**26**	**31**
By Guild	**4**				**0**		**1**				**26**	
	Big Brown Bat Guild				**RBFP**		**MYSP**				**UNKN**	**Total**
n/o - indicates that detector was not operating on that night												

Appendix E Table 2. Bat detector file name information						
Filename	**Date (night of)**	**Time**	**Species Code**	**Detector**	**Height**	**Common Name/Guild**
G5272036.58#	5/27/06	20:36	LACI	KRS Low	15 m	hoary bat
G6010020.07#	5/31/06	0:20	LE	KRS Low	15 m	silver-haired/big brown
G6012206.51#	6/1/06	22:06	LE	KRS Low	15 m	silver-haired/big brown
G6052320.09#	6/5/06	23:20	LE	KRS Low	15 m	silver-haired/big brown
G5272120.04#	5/27/06	21:20	MY	KRS Low	15 m	Myotis spp.
G5052217.19#	5/5/06	22:17	UNK	KRS Low	15 m	unknown
G5052228.53#	5/5/06	22:28	UNK	KRS Low	15 m	unknown
G5052232.10#	5/5/06	22:32	UNK	KRS Low	15 m	unknown
G5052237.10#	5/5/06	22:37	UNK	KRS Low	15 m	unknown
G5052348.14#	5/5/06	23:48	UNK	KRS Low	15 m	unknown
G5060019.23#	5/5/06	0:19	UNK	KRS Low	15 m	unknown
G5092110.25#	5/9/06	21:10	UNK	KRS Low	15 m	unknown
G5252008.46#	5/25/06	20:08	UNK	KRS Low	15 m	unknown
G5252021.24#	5/25/06	20:21	UNK	KRS Low	15 m	unknown
G5252027.13#	5/25/06	20:27	UNK	KRS Low	15 m	unknown
G5252035.22#	5/25/06	20:35	UNK	KRS Low	15 m	unknown
G5252035.33#	5/25/06	20:35	UNK	KRS Low	15 m	unknown
G5252036.17#	5/25/06	20:36	UNK	KRS Low	15 m	unknown
G5252141.56#	5/25/06	21:41	UNK	KRS Low	15 m	unknown
G5252337.17#	5/25/06	23:37	UNK	KRS Low	15 m	unknown
G5252342.20#	5/25/06	23:42	UNK	KRS Low	15 m	unknown
G5260016.54#	5/25/06	0:16	UNK	KRS Low	15 m	unknown
G5260227.07#	5/25/06	2:27	UNK	KRS Low	15 m	unknown
G5262009.54#	5/26/06	20:09	UNK	KRS Low	15 m	unknown
G6022256.18#	6/2/06	22:56	UNK	KRS Low	15 m	unknown
G6030045.51#	6/2/06	0:45	UNK	KRS Low	15 m	unknown
G6060058.30#	6/5/06	0:58	UNK	KRS Low	15 m	unknown
G6142129.53#	6/14/06	21:29	UNK	KRS Low	15 m	unknown
G6172226.53#	6/17/06	22:26	UNK	KRS Low	15 m	unknown
G6172313.59#	6/17/06	23:13	UNK	KRS Low	15 m	unknown
G6180133.05#	6/17/06	1:33	UNK	KRS Low	15 m	unknown