Appendix E
Bat Study Report

Pre-Construction Bat and Nocturnal Migrant Bird Monitoring Report

Greenwich Wind Project

June, 2008

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PRE-CONSTRUCTION

BAT AND NOCTURNAL MIGRANT BIRD MONITORING REPORT GREENWICH WIND PROJECT

1 EXECUTIVE SUMMARY

This document details the pre-construction monitoring results of the EchoTrack Inc. (EchoTrack) assessment of bats and nocturnal migrant birds during the fall of 2007 at the proposed Greenwich Wind Project site.

Comparison with other sites in Ontario with similar land use or topography that were sampled within the same season and year using the same radar-acoustic technology, suggests that Greenwich Lake has a low concentration of night migrant birds or bats.

Radar and acoustic data were collected simultaneously from sunset to sunrise. The nightly pattern of radar-determined bird and bat flight activity was consistent with other sites; a peak one hour after sunset, decreasing gradually to sunrise. However, the acoustic-determined bat activity peaked almost five hours after sunset, which was not the pattern observed at other proposed or permitted wind sites in Canada.

An average of 78% of the total flights of bats and birds through the proposed development area was outside the sweep area of the blades, leaving an average of 22% of airborne animals potentially exposed to a collision. This exposure is expected to be further reduced by an increase in flight height and avoidance after the installation of turbines. Wind direction apposing the southward direction of migration tended to increase this proportion.

The study results for nocturnal migrant birds and bats suggest that the risk at Greenwich Lake is low compared to studies in New York State. The site of highest activity for all migrants was E2. The habitat of highest activity was forest clearings as determined by both radar and acoustics.

While the proposed wind project area itself carries a low risk to the flying population, some flight concentrations, generally associated with attractants, were identified. Turbines should be placed to avoid locations areas where feeding attractants such as standing water are present.

The pre-construction results should be compared to post-construction results for a measure of collision-avoidance behaviour and disturbance response.

2 INTRODUCTION

Renewable Energy Systems Canada is proposing to development a wind farm northwest of Thunder Bay, Ontario (Fig. 1). The turbine locations are not yet known.

This document details the monitoring results of the EchoTrack Inc. ("EchoTrack") assessment of risk to bats and nocturnal migrant birds during the fall of 2007 at the proposed Greenwich Wind Project site. This assessment has been completed to provide additional numerical and standardized data as pre-construction baseline information for post-construction comparisons.

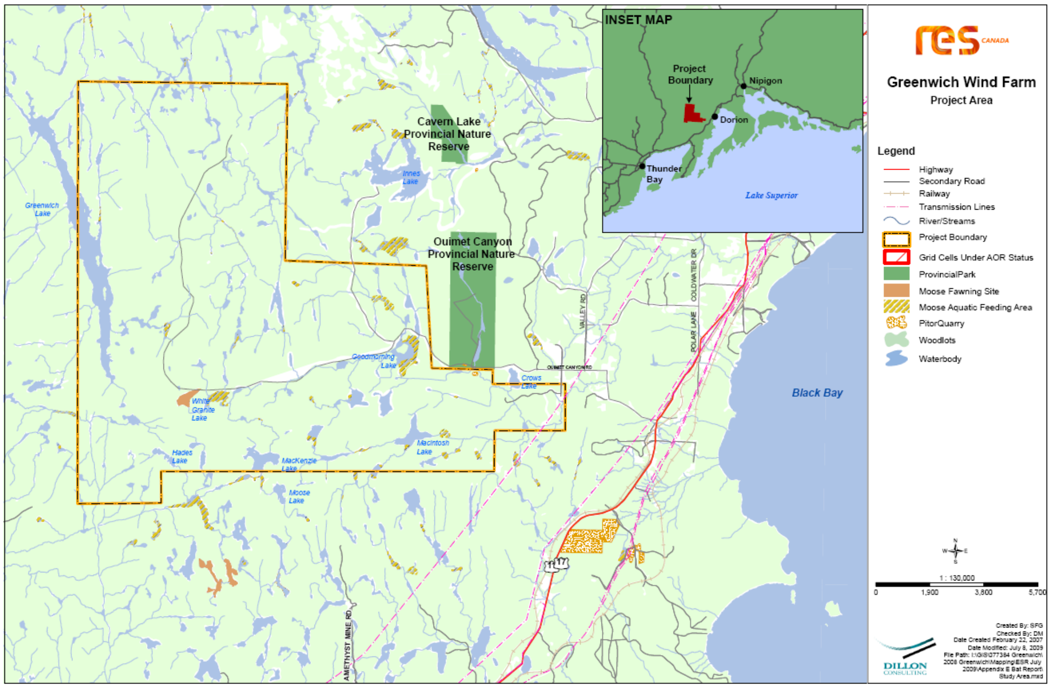

Fig. 1. Location of the Greenwich Wind Farm northeast of Thunder Bay, Ontario.

2.1 Background

The study design for this work adheres to the Ontario Ministry of Natural Resources ("OMNR") draft guidelines (OMNR 2007). EchoTrack prepared the study design outlining the proposed survey methodology to monitor the fall bat and nocturnal migrant bird characteristics, and submitted it to Dillon on 4 June, 2007. This work plan was accepted by MNR staff (Leona Tarini) via letter correspondence (MNR August 24 2007).

A supplemental letter was prepared by EchoTrack, explaining the need to replace E3 due to bear baiting in the area, with a fourth plot E4 and mobile sampling on three nights. This was sent to Dillon and RES on 26 September, 2007. The letter confirmed a sampling design of 24 nights to meet the OMNR draft guidelines (OMNR 2007).

The work focuses on bats, but also provides data on night migrant birds given the proximity of the site to Quimet Canyon Provincial Nature Reserve for Greenwich Lake.

The work includes provisions to evaluate the presence of listed species and to sample in a manner that supports a comparison with data gathered post-construction by including a control or reference plot as well as plots within the wind plant area.

2.2 Terms

The following terms are used throughout the report, and are defined here for clarity. In sampling, a **site** is a geographic location, a **plot** is a sampling area within the site, and a plot is either **evaluation** (proposed to have wind turbines) or **control** (no turbines proposed). Evaluation and control plots are 2 km-radius circles sampled by EchoTrack. A **replicate** is a repeated sample of a plot. A **sample** is an approximately 11-hour time period, depending on the length of night, from sunset to sunrise and includes both radar and acoustic recordings.

A summary of the observations from these samples have been be tabulated and delivered in this final report. These tabulations have included the number of bats and birds per time period (i.e., hour, date, and season) and plot, the species at risk if observed, and the flight behaviour, defined as flight speed, direction, height, speed, and type (bird, bat or unknown). Those data have been **interpreted** using statistical analysis and the author's experience to assess the potential significance of the **collision risk** relative to the total population moving through the site. The collision risk is estimated as the relative flight activity within the proposed sweep area of the blades.

3 APPROACH

3.1 Objective

The objective of this study was to monitor and record the presence and flight behaviours of bats and nocturnal migrant birds at the Greenwich Wind Project site during the fall 2007 migration, and, based on the gathered data, to assess the collision risk that the installation of wind turbines could pose to those populations.

In light of regulatory guidelines from OMNR (2007) and Environment Canada "EC" (2005) special consideration is given to four specific aspects of airborne wildlife behaviour at the site:

1. The timing of risk (seasonal and within-night hours)
2. The response in flight behaviour to topography-habitat features within the project area
3. The influence of the Lake Superior shore on bat and bird night migrant populations
4. Weather influences on flight behaviour.

Care was also taken in the study design to ensure that the gathered data could effectively serve as a basis of comparison should post installation monitoring be pursued.

This study has been completed to provide additional numerical data as pre-construction baseline information, for post-construction comparison. This study is also intended to augment the visual data collected during field surveys of diurnal activity of birds by Dillon Consulting.

3.2 Context

State of knowledge and field practice

OMNR (2007) provides an excellent summary of the state of knowledge and field practice related to bats. However, data gaps remain in the timing of risk and response to topography-habitat features. Data gaps also remain in the significance of observed or potential effects relative to the overall population of migrants that pass through an area, and the determination of movements of species at risk.

The data gathered as part of this study will help fill these gaps by using automated equipment to eliminate observer biases, as well as providing height estimates in 360° in relation to habitat and landscape features.

The influence of Lake Superior and the Quimet Canyon Nature Reserve on Flight Behaviour

Environment Canada and OMNR identify the presence of Great Lakes shore and a protected area as a consideration when assessing the risk of a site to birds and bats. The survey plots were selected to be varying distances from the shore and protected natural area (e.g., Quimet Canyon Nature Reserve).

Weather

It has been hypothesized that reduced visibility could increase the collision risk to night migrants (EC 2005). To test for this, meteorological data (i.e., wind speed, wind direction, temperature and barometric pressure) from an on-site meteorological tower were correlated with heights and activity patterns of night migrants (birds and bats).

3.3 Methods

3.3.1 Surveillance Tools and Techniques

The primary tool for data gathering in this study was EchoTrack's patented Radar-Acoustic surveillance system. The system is based on a combination of two technologies:

1. 25 kW X-band Radar is used to monitor airborne movement within a 2 km radius (i.e., surveillance area four kilometres in diameter) and up to 870 m in altitude; and
2. Acoustics waveform analysis is employed to recognize and locate species. Acoustic sampling is conducted for two distinct frequency ranges. Audible frequencies (i.e., sounds audible to the human ear; between 2-10 kHz) are used to monitor bird calls and ultra-frequencies (i.e., 20-140 kHz) are used to monitor bat calls.

Specialized analysis programs involving signal detection, tracking analysis and signal recognition, are then utilized to identify recorded flight-paths in three dimensions (both northing and easting location and altitude) and to associate the recognized species with them.

The species expected to be most likely at risk based on collision of night migrant birds with communication towers are those flying in low visibility conditions (EC 2005), within the height of the wind turbine blades; which is 35-125 m above ground. This includes nocturnal migrant birds (mainly passerines but also rails, some waterfowl and shorebirds), and resident owls, snipe, woodcock, and nighthawks. The species of bats most likely at risk based on mortality searches at operating wind turbines are longer-distance bats.

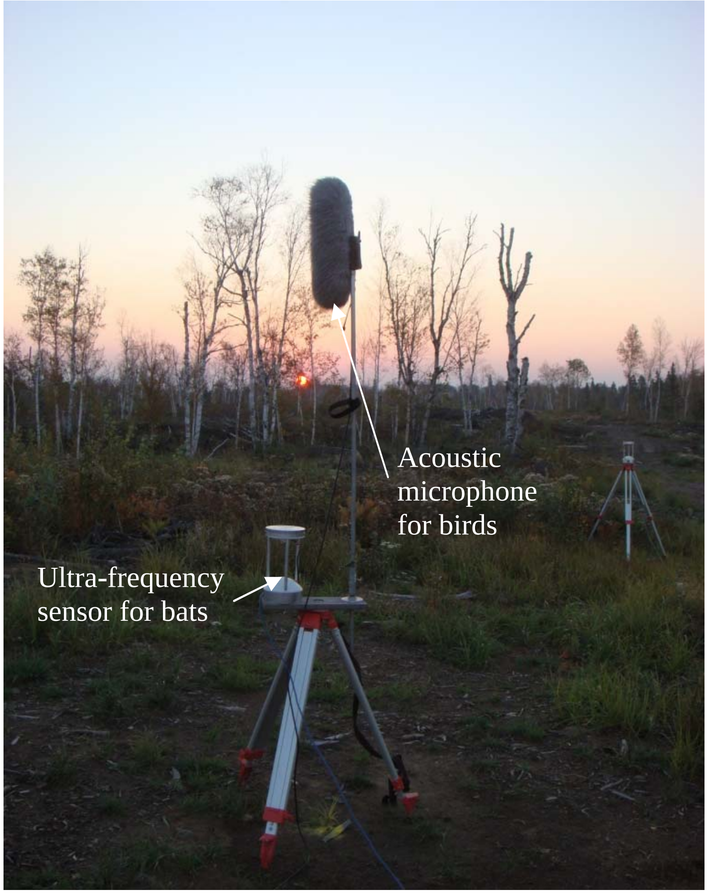

Fig. 2. Acoustic sampling using ultra-frequency sensors bats and acoustic microphones for birds.

Analysis of the recorded flight paths was conducted to measure for the effects of:

1. Time of night and seasonal influences on flight concentrations (temporal effects);
2. Topography and habitat associated with the concentrations (spatial effects);
3. The distance from open water of Lake Superior; and
4. Weather conditions associated with the concentrations.

The intensive sampling at stationary plots using Radar-Acoustic fusion was supplemented with extensive acoustic-only sampling using Avisoft® CM16 for bats along road transects. This acoustic-only sampling was completed using road transects orientated west to east and north to south over the full extent of the proposed wind plant area (Fig. 2). The observer started at dusk and sampled every one kilometre for five minutes per stop for a comparison of acoustic activity and species complex between habitats and areas. The order of sampling was reversed for each replicate.

3.3.2 Sampling Locations

The Greenwich Wind Project site and surrounding area is shown in Fig. 2. The predominant land use at the site and in the vicinity is forest with clearings either due to harvesting or wetlands. The project area is bordered by land with Lake Superior to the south and east.

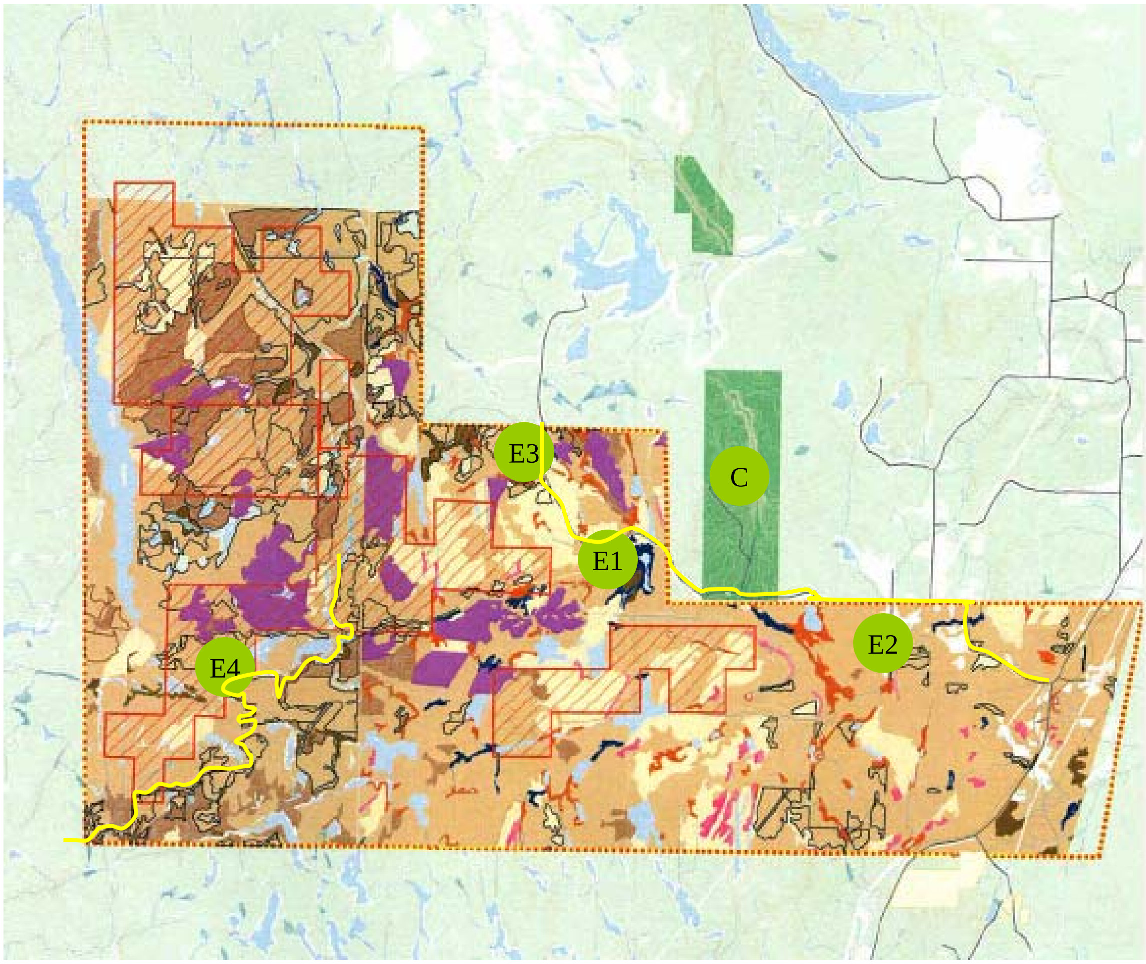

Fig. 2. Aerial view of the Greenwich Wind Project site with EchoTrack Radar-Acoustic plots (evaluation plots E1, E2, E3 and E4; green 2-km circles) and acoustic-only transects (to be represented with yellow lines; roads bisecting the project area).

Criteria for the selection of sampling locations included the following considerations:

1. Geographic Representation - They should be representative of the wind project area as a whole and, taken together, should include a good representation of the site habitat likely to influence the presence and behaviour of night flying birds and bats (Fig. 2 and 3). Appendix I lists the bats of interest and their preferred habitat
2. Data Consistency - They should facilitate comparisons within the region and for subsequent monitoring by incorporating standardized automated sampling that can remove human bias
3. Topographic Influences - In light of the objective to assess the importance of the lakeshore, chosen plots should provide some indication of distance from the lakeshore and from the provincial nature reserve.

4. Access and Landowners Issues - The EchoTrack system is trailer based. Appropriate access needs to be available (dirt track) and appropriate regard given to trespass. The selected sites also need to be able to accommodate the trailer and the placement of a microphone array perpendicular to it.

The final sampling locations conform to these considerations in the manner identified below.

- Geographic Representation

  Three evaluation plots (E1, E2 and E3) were initially established within the project area and sampled for one replicate each. Due to safety issues (bear baiting and hunting), E3 was replaced with E4. The 2-km radius circles at E1, E2, E3 and E4 sample all representative topographic features and preferred habitat of the species of interest. A fifth plot, C, was established to monitor activity in the protected area where turbines are not planned.

- Data Consistency – subsequent studies

  The plots have a consistent sampling volume so they can be compared spatially and temporally, before and after installation of the turbines as necessary.

- Topographic Influences

  The plots were located west to east (E4, E3, E1, C and E2), which is also in diminishing distance from the Lake Superior shore, providing an opportunity to assess how flight behaviour changes with distance from the Great Lakes shore.

- Access and Land Owner Issues

  This site is MNR Crown land, primarily forested with some access by logging roads. Access to certain portions of the site was constrained. Bear baiting and hunting required some change in sampling location such that E3 had to be dropped and replaced by E4.

Fig. 3. The radar-acoustic plot E1 showing the microphones ready to set in the foreground clearing bordered by forest. This layout is repeated at other plots in the wind project site.

3.3.3 Sampling Regime

The EchoTrack system was moved each day such that each plot was sampled once per replicate and the replicates were spread over the bat migration season to cover the diversity of migrants; longer-distance northern populations followed by the shorter-distance, more local populations. The timeframe chosen for sampling was based on the expected migration period of the bat species of concern (Bat Conservation International 2004; van Zyll de Jong 1985; OMNR 2007).

The environmental attributes included in the sampling regime were those expected to concentrate flights of birds and bats within the sweep area of the proposed turbines and thereby, increase the risk of a collision and/or disturbance. The environmental attributes included within-site habitat elements such as roosting sites for bats (e.g., buildings), migration stopover habitat for night migrants (e.g., woodlots), and feeding sites for bats (e.g., lights and riparian corridors). The resultant sampling regime is presented in Table 1.

Table 1. Initial sampling plan in 2007

Four evaluation plots were paired with a control plot to be sampled a total of 24 nights. An additional three nights of acoustic-only sampling was conducted mid and late migration (September to October).

Site	Plot	Topographic Feature	Within-site Habitat	#Nights	Dates (dd/mm)	#Hrs /Night
Greenwich Lake	E2	Shore	field, forest	7	27/07, 29/07, 15/08, 08/09, 11/09, 22/09; 04/10	10-11
	E1	Plateau	lake, ridge, riparian, forest	7	25/07, 28/07, 30/07, 16/08, 09/09, 12/09, 26/09	10-11
	E3	Plateau	clearing, forest	1	26/07	10-11
	E4	Plateau	clearing, forest	4	23/09, 25/09, 05/10, 07/10	10-11
	C	Plateau	clearing, logged forest	6	31/07, 17/08, 10/09,13/09, 24/09, 06/10	10-11
Acoustic-only: route 1) and 2)		1) Shore, Plateau 2) Plateau	1) field, forest, lake, riparian, wetland, ridge 2) logged forest, forest, riparian, lake	4	1) 22/09, 24/09, 2) 23/09, 07/10	4-8

The five radar-acoustic plots were sampled in stratified random order; the exact order varied to accommodate hunting.

Fifty acoustic-only samples were taken along the north and south road into the project area (Fig. 2). The north road was sampled on 22 September east to west and then east to west on 24 September. The south road was sampled on 23 September south to north and then north to south on 07 October. The last two sites could not be reached on 07 October due to road conditions. The observer stopped every one kilometre and recorded for a five minute period using an Avisoft® sensor mounted on a tripod and pointed 30 degrees above the horizon.Habitat for Survey 2 consisted of recently logged forest, forest, shrubs, and lakes.

3.3.4 Measurement Endpoints

The measurement endpoints (i.e., the variables to be measured and delivered), were selected to compare the evaluation and control plots over different spatiotemporal scales. They include:

- Total numbers of flights (all migrants, birds and bats)
- Height (in meters above ground)
- Speed (in meters per second)
- Direction (in degrees)

- Response to environmental attributes (i.e., attraction as indicated by an increase in activity or an increase in the proportion of flights within the blade sweep area and therefore, at risk to a collision)

The results include spatial and temporal scale analyses. The spatial scale increases from a habitat feature (e.g. forest edge) to the 2 kilometre plot, the Greenwich Wind Project site, and the northern Ontario region. The temporal scale increases from hourly to daily and seasonal effects.

The nightly sampling pattern involved collection of four samples at dusk, two per hour through the night, and then a similar series of four final samples at dawn. All samples were 14 minutes in duration to allow for one minute of recording of data to file during each 15-minute period. In aggregate, over four sites and five nights of sampling, this yields:

- 88 Dusk samples (4 samples x 3 locations x 6 nights at each plus 4 x 1 x 4 nights)
- 88 Dawn samples (4 samples x 3 locations x 6 nights at each plus 4 x 1 x 4 nights)
- 484 Hourly samples (2 samples x 3 locations x 6 nights x 11 hours between sunset and sunrise plus 2 x 1 x 4 x 11).

Analysis

Consistent with the study objective, the data gathered within this sampling framework was analysed under four topics:

1. Timing of risk, measured by flight activity

   For every 14-minute radar sample, the number of flight paths are counted and expressed as a number per minute per sampling volume (6.7 km^3). The data are presented for all night migrants (bats, birds and unclassified), birds and bats; where 'unclassified' are migrants that are not clearly a bat or a bird (approximately 30% of the total number of flights). The temporal pattern of activity was then compared in two ways:

   - Over the night based on the time relative to sunset; and
   - Over the season.

2. The influence of Lake Superior, measured by changes in activity with increasing distance from the open water.

3. Response in flight behaviour for bat populations

   Each 14-minute ultra-frequency sample recorded was searched for the presence of bat signals. Bat activity was measured and expressed as the number of seconds of calling relative to the total number of seconds sampled. Each section that was determined to have bat calls was then re-analyzed for the particular waveforms of selected species (Fig. 4). All waveforms were identified using spectrogram analysis for minimum frequency, duration, and shape (van Zyll de Jong 2004). The species investigated included all eight species expected to be present in the area: the Big brown bat, *Eptesicus fuscus,* Little brown bat, *Myotis lucifugus,* Northern long-eared bat, *Myotis septentrionalis*, Eastern small-footed bat, *Myotis leibii*, Silver-haired bat, *Lasionycteris noctivagans,* Hoary bat, *Lasiurus cinereus* , Red bat, *Lasiurus borealis* and Eastern pipistrelle, *Pipistrellus subflavus.*

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Start times of time segments (segment length 1.00000 s) containing signal
in range 15000-99000 Hz of at least -20 dB
Sampling rate 200000, 4 channels, 4 byte floating-point samples, total file 835.19407 second
FFT frame width 256, time grid width 100

Time       Channels
366.000000        0 Lasiurus cinereus(14ms, 24.5kHz)
367.000000        0 1Lasiurus cinereus
368.000000        0 1Lasiurus cinereus
369.000000        0Lasiurus cinereus
370.000000        0Lasiurus cinereus
786.000000        0 Lasiurus cinereus(16ms, 23.5kHz)
787.000000        0 1Lasiurus cinereus
788.000000        0 1Lasiurus cinereus
789.000000        0 1Lasiurus cinereus
790.000000        0 1Lasiurus cinereus
791.000000        1Lasiurus cinereus
792.000000        1Lasiurus cinereus
804.000000        1 Eptesicus fuscus or Lasionycterus noctovagans(10ms, 25.3kHz)
805.000000        1Eptesicus fuscus or Lasionycterus noctovagans
806.000000        0 1Eptesicus fuscus or Lasionycterus noctovagans
End of log
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Fig 4. An example 14 minute segment at 02:12 hrs on 24 July 2007. Activity is expressed two ways: a) the proportion of time with calling = 15/835 seconds = 0.02; b) the number of bat passes = 3 (366-370; 786-702; and 804-806). Two species were identified (*Lasiurus cinereus* and *Eptesicus fuscus* or *Lasionycterus noctovagans*, which can't be separated by call).

4. Bird species at risk

   Incidental visual observations were conducted for bird species at risk.

5. Weather influence on collision risk

   A daily record was kept of weather in the area including moon phase, cloud cover, fog, temperature (average, minimum, maximum), rain, and wind (hourly average and direction). The weather conditions most likely to effect exposure of flying animals, daily maximum wind and accumulated rain, were analyzed for their effect on flight activity (#/6.7 km^3) and flight height (meters above ground).

   Weather data was also obtained from the meteorological tower within the wind farm (temperature, wind speed, wind direction and barometric pressure).

3.3.5 Risk Factors

The risk of an impact is defined as a concentration of flights of bats/birds within the blade sweep area of the proposed turbines, a high proportion of overall flights that pass through the experimental plot within the blade sweep area, or the presence of species at risk within the proposed blade sweep area.

To test for the effect of spatial attributes (spatial scale from previous page), the number of flights and flight behaviours were analyzed by distance from: the nearest day roost habitat for bats (e.g., forest edge), distance from feeding site (e.g. standing water) and distance from open water of Lake Superior. Depending on the species of bat, night roosts could include buildings, bridges, tree crevices, and caves.

The level of risk to migrating birds and bats will vary between plots based on the number of proposed turbines in that location as well as the number of birds and bats flying through the area and their flying height. This risk can be influenced by other independent variables that may help the birds/bats avoid the towers such as light level (i.e., visual cues), time of night (i.e., height of migration), and day in season (i.e., predominance of young of the year versus experienced adults).

The sample sizes are too small to establish causal relationships between these "extraneous" independent variables, but the observed trends are discussed (Section 5).

The dependent variables of interest in assessing the actual risk include the number of flights, the presence/absence of species at risk, and pre-construction collision-avoidance behaviours such as change in speed, direction and height, relative to the proposed locations of turbines (Millikin, in press). These variables were measured to permit comparison of pre-construction baseline data to post-construction monitoring.

The recorded flight paths were separated into two groups: flights within the blade sweep area (35-125 m above ground) and therefore possibly at risk of collision, and those above or below this range in heights and, therefore not at risk. This provides a measure against which post-construction data can be compared. When the wind turbines are introduced, a change in height can indicate avoidance of the turbines and any observed mortality can be compared to the level of risk that was predicted.

Sampling included measurement of the variables expected to change after construction such as the collision-avoidance behaviours like changes in flight speed, direction, and height. These measurements were also recorded at the control site which is not expected to differ post-construction. The variables measured were:

- Acoustic and ultra-frequency sampling was conducted at all plots on all nights where sampling occurred
- A visual check for bird species at risk was conducted regularly and records kept of incidental mortality from cars or predation in the area, to supplement the radar-acoustic sampling activities
- Flight path analysis was conducted on all radar data collected at all sites
- Ultra-frequency wave form analysis was conducted for bat species identification for both stationary and mobile acoustic samples.

4 RESULTS

4.1 Timing of Risk

4.1.1 Seasonal

Using radar, EchoTrack recorded 185,100 individual flights of night migrants on 24 nights of radar-and stationary-acoustic sampling from sunset to sunrise on four plots. Three additional nights were conducted of acoustic-only sampling.

Radar-determined flight activity of night migrants fluctuated over the migration season. For example, flight activity of birds was greatest between 22 to 25 September (Fig. 5). Bats plus unclassified individuals peaked in activity 28 to 31 July and 22 to 25 September. For each sampling period, the data are averaged over all plots, dates and time of night and expressed as the number of flights per minute per 6.7 km^3. The dates overlap in some cases due to the need to adjust sampling order to fit landowner needs and road conditions.

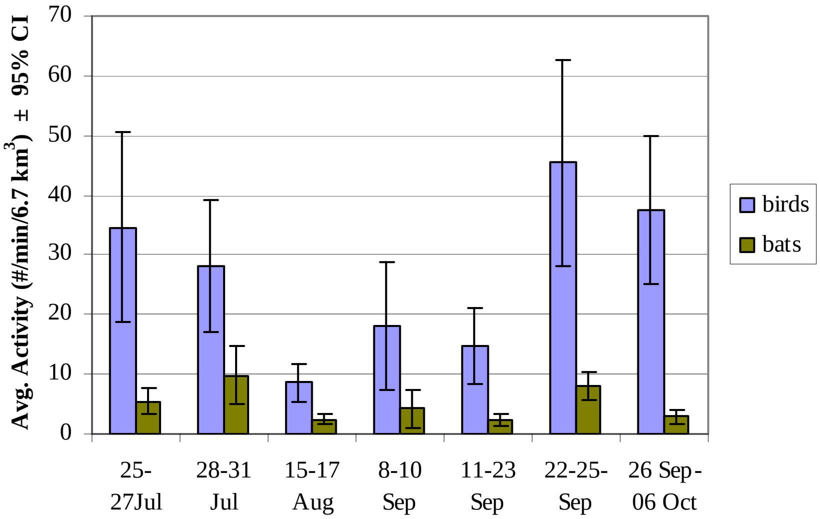

Fig. 5. Seasonal radar-determined flight activity averaged over all radar plots, dates and times and expressed as the average ± 95% CI per minute per sampling volume which is 6.7 km^3, for birds (blue bars) and bats plus unclassified individuals (brown bars).

The periods of maximum activity of all migrants (birds and bats) at Greenwich Lake are of a similar magnitude to another forested wind development site in northern Ontario (Fig. 6). However, activity between 15 August and 23 September was much lower at Greenwich Lake (Fig. 6).

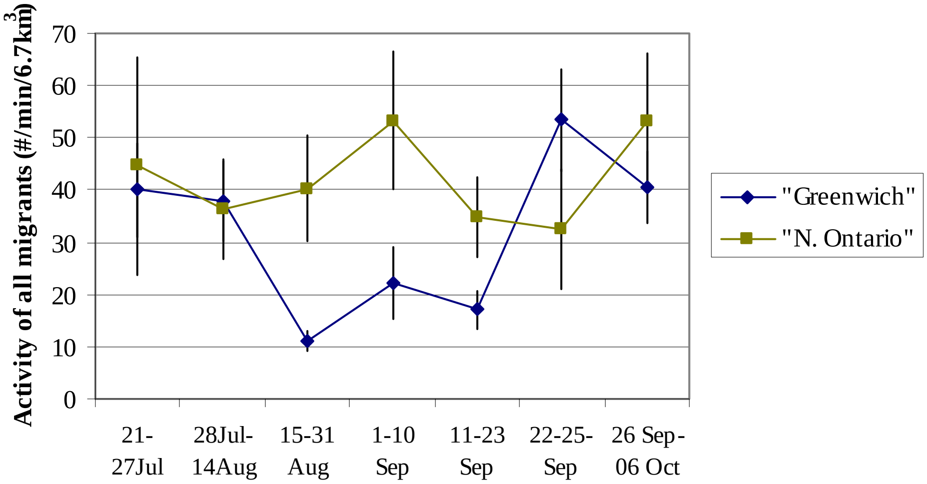

Fig. 6. Comparison of seasonal activity of all migrants at Greenwich Lake to another wind development site in Northern Ontario. The vertical lines are 95% CI of the average.

4.1.2 Within night hours

Combining all sampling dates and plots, nocturnal flights through the study area peaked in activity one hour after sunset, tapering towards dawn (Fig. 7). This pattern is generally consistent with observations at another wind project area in northern Ontario (confidential information; blue line in Fig. 7). The night flight activity over the fall migration in 2007 at Greenwich Lake was lower than at the site in northern Ontario (average of 25.5 ± 5.7 versus 41.1 ± 5.4).

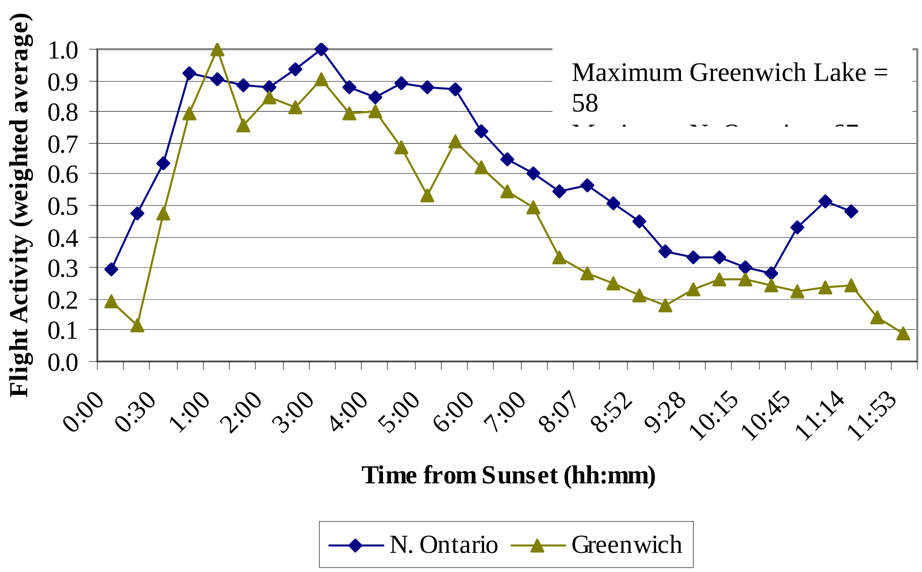

Fig. 7. Nightly pattern determined from radar-acoustic plots of flight activity of night migrants (all) on all plots combined over all dates for each project. The data are presented as the average number per minute per sampling volume (6.7 km^3). The peak activity was lower at Greenwich Lake (58 versus 67).

Stationary acoustic records of bat calling over the course of the night show a peak in activity in the middle of the night and just before sunrise (Fig. 8).

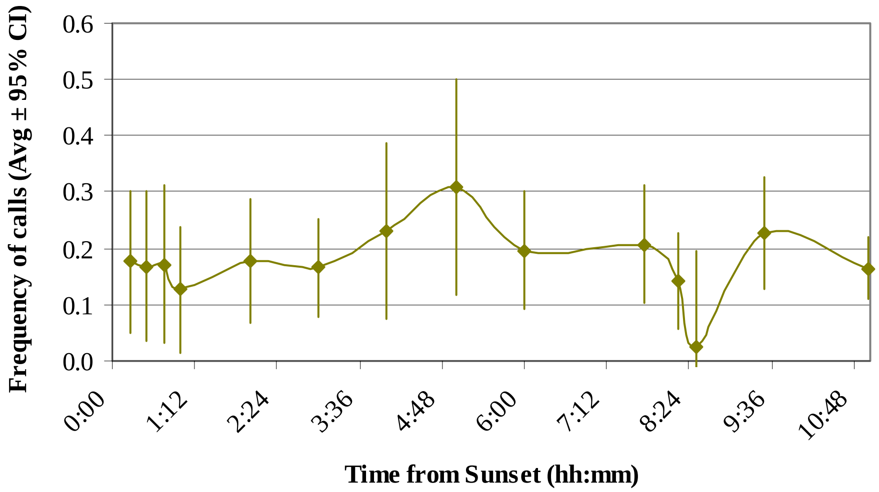

Fig. 8. Nightly pattern determined from stationary acoustic sampling of bat calls (#seconds calling per total sampling time) averaged over the season for all plots. The y axis is seconds/total seconds and therefore has no units.

4.2 Response in Flight Behaviour to the Topography-Habitat

4.2.1 Regional topography

The activity at Greenwich Lake can be compared to other sites sampled with the same equipment and in the same season in southern and northern Ontario (Fig. 9), or similar equipment in the Great Lakes region of northern Ontario and upper New York State (Appendix V).

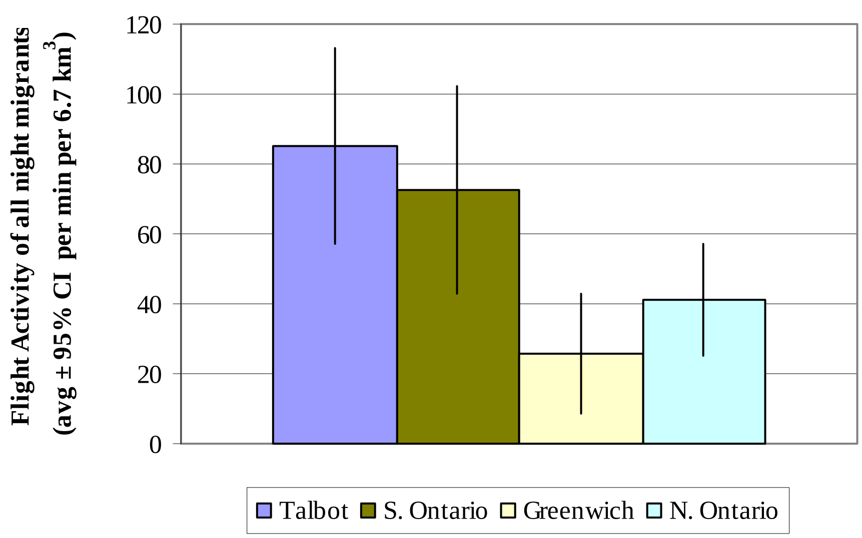

Fig. 9. Comparison of the average flight activity at Greenwich Lake, to activity in southern Ontario (Talbot and other combined sites) and northern Ontario. All sites were sampled with EchoTrack equipment in fall of 2007.

The overall radar-determined flight density (birds and bats) in the proposed Greenwich Wind Project is 14% of the density (#/km/hr) of other published data for wind farm sites in the Great lakes area (New York State) (Appendix V). At Greenwich Lake sampling plots, an average of 42 ± 12 (95% CI) night migrants (birds and bats) were recorded per kilometre per hour. This translates to 26 per minute per radar sampling volume (6.7 km^3).

The range in flight density at Greenwich Lake (1 to 174 /km/hr) is low compared to the New York sites in forested plateau (Appendix V).

Bats are 17% ± 5% (95%CI) of the overall radar-determined night migrant population in the Greenwich Wind Project area.

The average passage rate based on mobile acoustics (all sites) is 16.3 ± 8.6 (95% CI) passes per minute which is comparable to other sites monitored with the same equipment in the same season and year, along the Great Lakes in northern Ontario (16.3 ± 14.0).

4.2.2 Local topography and habitat

Bat calling activity is greater at Greenwich Lake in areas of intact forest (Fig. 10). The presence of trees is apparently associated with increased bat activity and increased diversity of species. Surprisingly, the presence of water did not seem to concentrate bats; the lowest activity is in stream (bridge) habitat. The Big brown/Silver-haired bat (EP/LA) was only recorded near forest. The Northern long-eared bat (MYSE) was found in open habitat (stream and 30 m clearing). The Little brown bat is more of a habitat generalist.

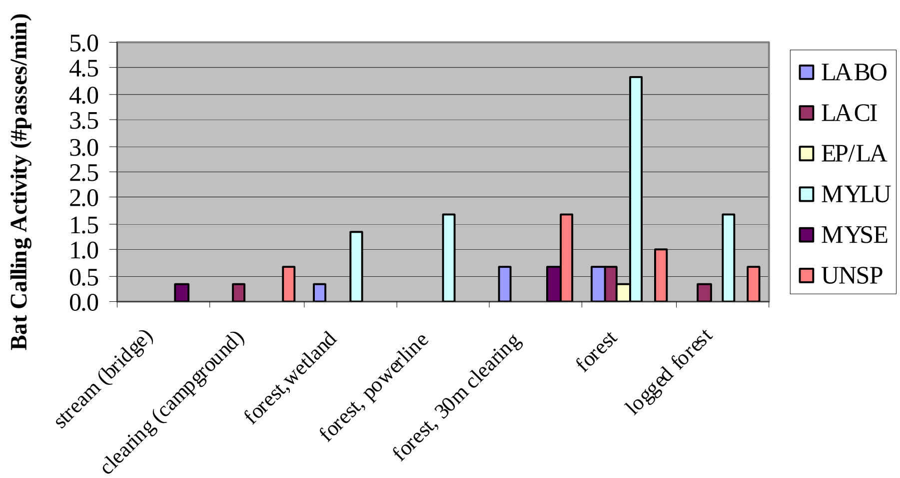

Fig. 10. Effect of habitat on bat activity monitored by acoustics and expressed as the number of passes per minute. Comparisons are made between ten habitats (stream, clearing etc.). LABO = red bat, LACI = Hoary bat, EP/LA = Big brown/Silver-haired bat, MYLU = Little brown bat, MYSE = Northern long-eared bat. The campground is a non-official hunt camp.

Longer-distance migrant bats which are more at risk to collisions with wind turbine blades are less active at the observed habitats than shorter-distance migrants (Fig. 11). Forest is particularly selected by short-distance migrants. Both short and long-distance migrants were less active in the logged forest.

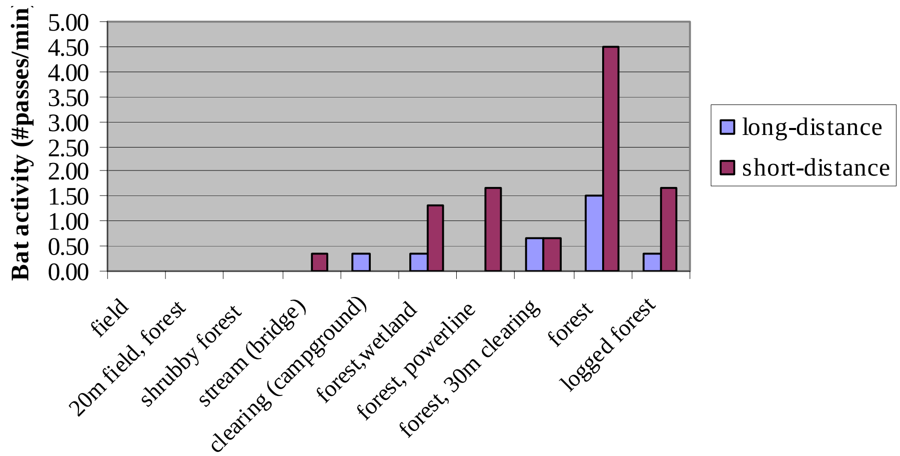

Fig. 11. The effect of habitat on long and short-distance bat species. Long distance bat species have a longer distance of migration and appear to be more at risk to collisions. They include Silver-haired bat, Hoary bat and Red bat. Short distance bats include Little bat, Big Brown bat and Northern long-eared.

The radar data were analyzed for levels of activity at increasing distances from two habitat features that are important for bats and night migrant birds; lake and forest habitat. The relative abundance (#flight paths of birds and bats) was compared at blade height and beyond; either above or below the blade sweep area.

The E1 plot was selected to sample for flight activity associated with lake habitat aligned NE to SW 500 m east of the radar centre (Fig. 2). To analyze for concentrations of flights potentially exposed to the turbine blades, flight paths were analyzed with respect to the lake (0 m in Fig. 12) and with respect to imaginary lines at 10, 50, 100, 300, 500, 1000 and 1500 m W (negative distances) and E (positive distances) from the lake; lines perpendicular to the expected direction of the fall migration (Fig. 13). The maximum proportion of flights at blade height is 50m west of the lake, though the abundance of bats and birds at blade height increases at 100m west. This is 50-100% of 15 or fewer individual birds or bats.

A second feature of interest for mitigation at E1 is a cliff face 50m to the east of the radar plot centre. The relative abundance of birds increases at the cliff face (+50 in Fig. 12), at heights beyond the blade height and therefore not at heights of collision risk.

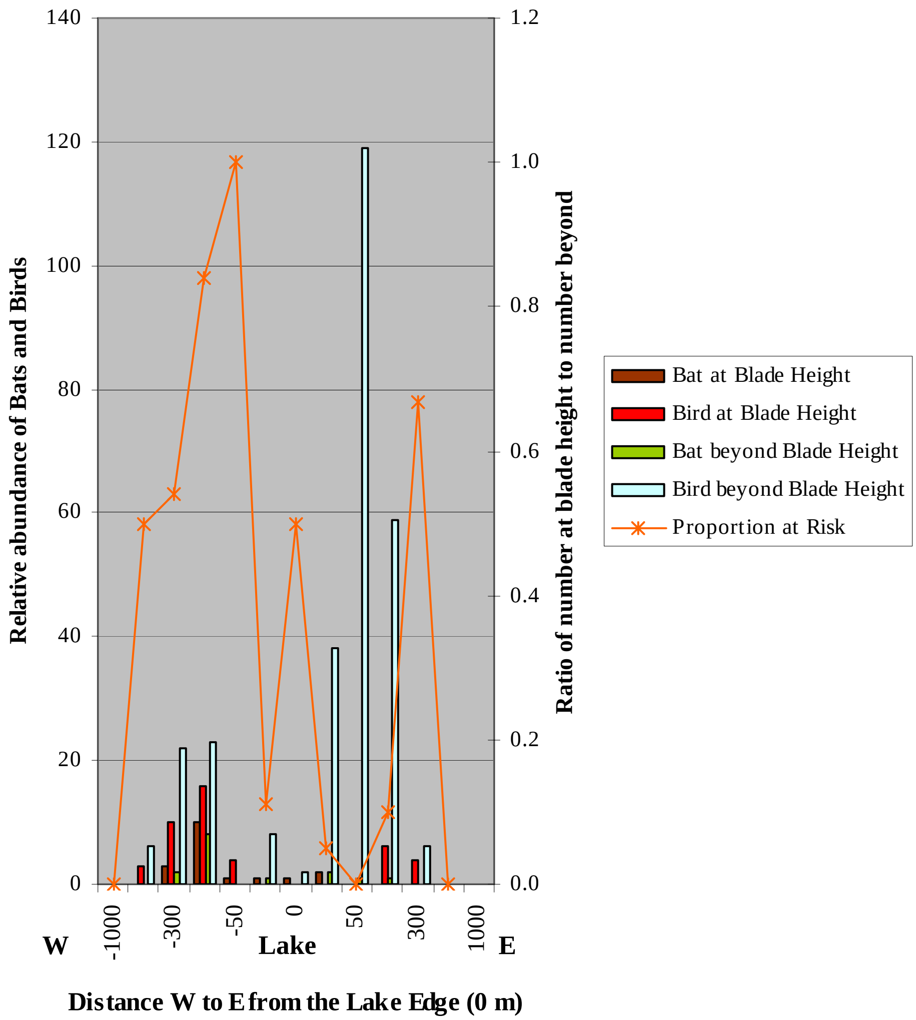

Fig. 12. Radar –determined relative abundance of night migrant birds and bats with respect to a lake edge at the E1 radar-acoustic plot. Flights were grouped as at blade height or beyond (above or below), and counted at increasing distances perpendicular to the expected direction of flight in fall migration (SE). The edge is positioned at 0 m. The maximum proportion of flights at blade height is 50m west of the lake.

Plot E2 was selected to sample the forest to the west of the radar or plot centre (Fig. 2). The border of the forest was defined as 0 m (Fig. 13) and the flights were analyzed with respect to artificial lines drawn west (negative) and east (positive) of the border. No increase in the number of birds and bats at blade height was observed and a very low proportion of the flights were at blade height, suggesting no attraction to this habitat feature.

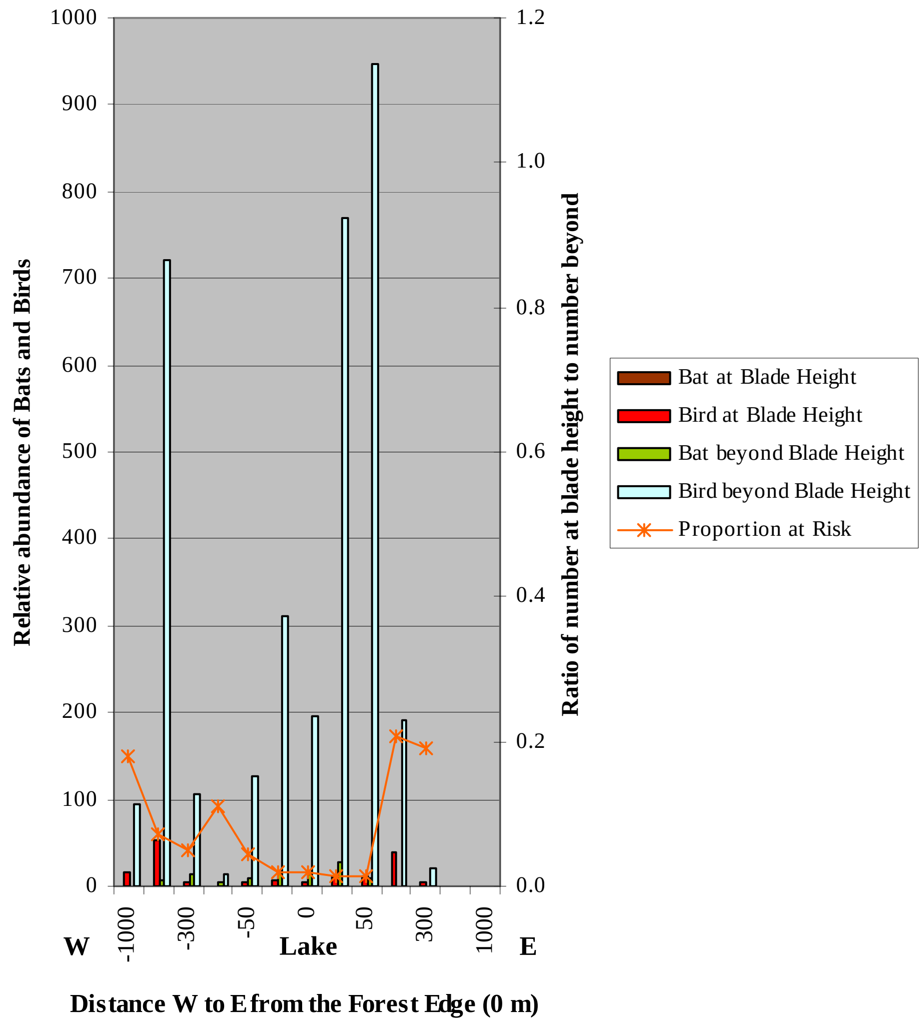

Fig. 13. Radar –determined relative abundance of night migrant birds and bats with respect to a forest edge at plot E2. Flights were grouped as at blade height or beyond (above or below), and counted at increasing distances perpendicular to the expected direction of flight in fall migration (SE). The boundary of the trees is positioned at 0 m. The proportion of flights at blade height was very low suggesting no attraction.

The clear cut forest at E4 (Fig. 2) was associated with high activity (birds and bats) across the opening in the forest (Fig. 14). The proportion of birds and bats at risk did not increase at the edge. An increase in the proportion of flights at blade height was observed at 300 m to the northwest. There is no attraction to the forest edge. Most flights were beyond blade height.

Bats were observed to use linear clearings (roads) in particular. This suggests that roads developed for the project will provide transit opportunities for bats. However, these linear clearings are not the same as clearings for turbines.

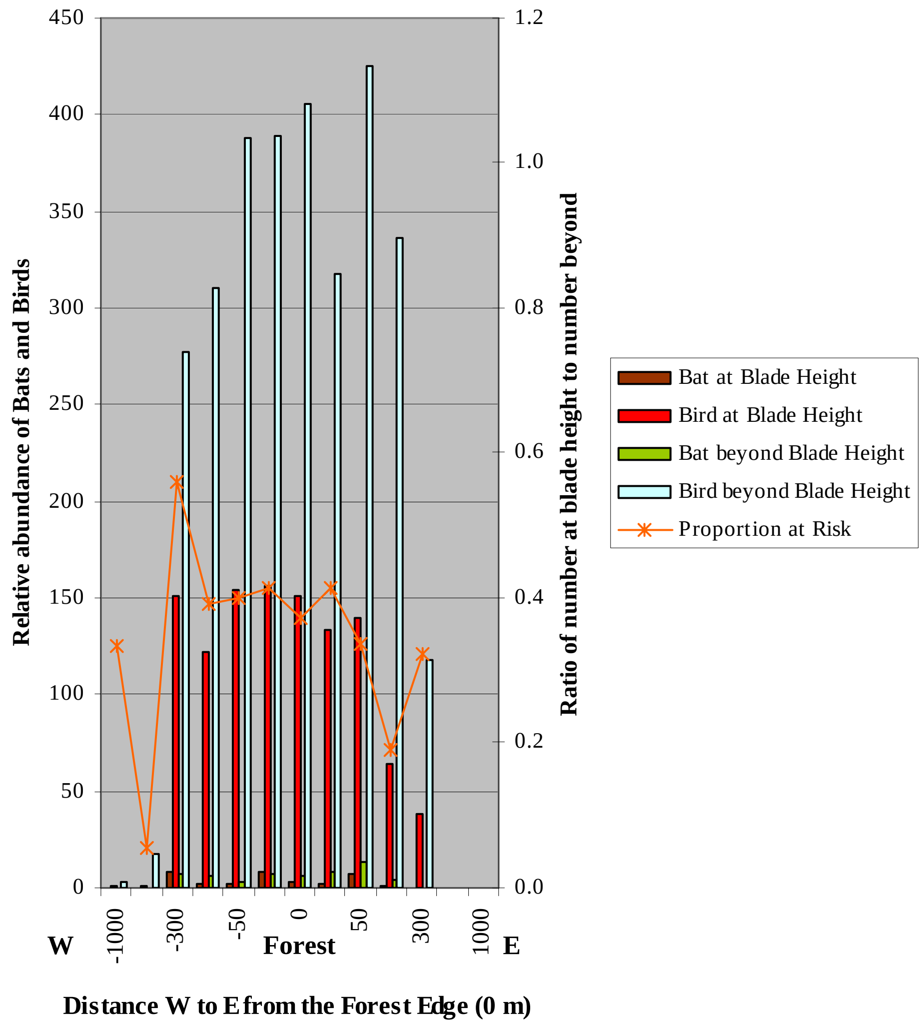

Fig. 14. Radar –determined relative abundance of night migrant birds and bats with respect to a forest clearing. Flights were grouped as at blade height or beyond (above or below), and counted at increasing distances perpendicular to the expected direction of flight in fall migration (SE). The boundary of the forest is at 0 m. Activity in the blade sweep area was high for birds. The proportion of flights at blade height increased at 300 m W of the forest.

This analysis was repeated for C (Appendix III).

4.2.3 Population Characterization

Of the eight species of bats potentially present in the study area, five were recorded, including: the Hoary bat, the Big Brown or Silver-haired bat, which are not distinguishable by voice, the Red bat, the Northern long-eared and the Little brown bat. No species classified as "at risk" were found.

Bat diversity was low compared to Talbot in southern Ontario; a Simpson index of 0.56 at Greenwich Lake versus an average of 0.66 at Talbot. The most common species on all plots is the Little brown bat and then the Red bat (Table 2).

Table 2. Bat species diversity at Greenwich Lake. The Little brown bat is the most common based on the proportion of all recordings which were this species.

Species	Proportion
Little brown bat	0.490
Red bat	0.102
Hoary bat	0.082
Northern long-eared bat	0.061
Big brown/Silver-haired bat	0.020
Unknown	0.414

4.2.4 Risk Assessment

An average of 21% of the total population (all night migrants) flying at night through the area planned for turbines (E-plots) fly within the proposed height of the blades (Fig. 15). The lowest proportion at risk is those on E2.

A larger proportion of the animals flying within the collision risk zone (i.e., the planned height of the blades of the E-plots) are bats; an average of 25% of bats flying through are potentially at risk (Fig. 15). The collision risk to bats is lowest on E2 and highest on E1 for bats. The proportion is of a lower number of bats at risk on E-plots; an average of 3.1 per min per 6.7 km^3 (± 0.7) on E-plots versus 8.5 for C, the control plot which will not have turbines. The proportion of bats and birds at risk tend to increase with increased distance from the Lake Superior shore.

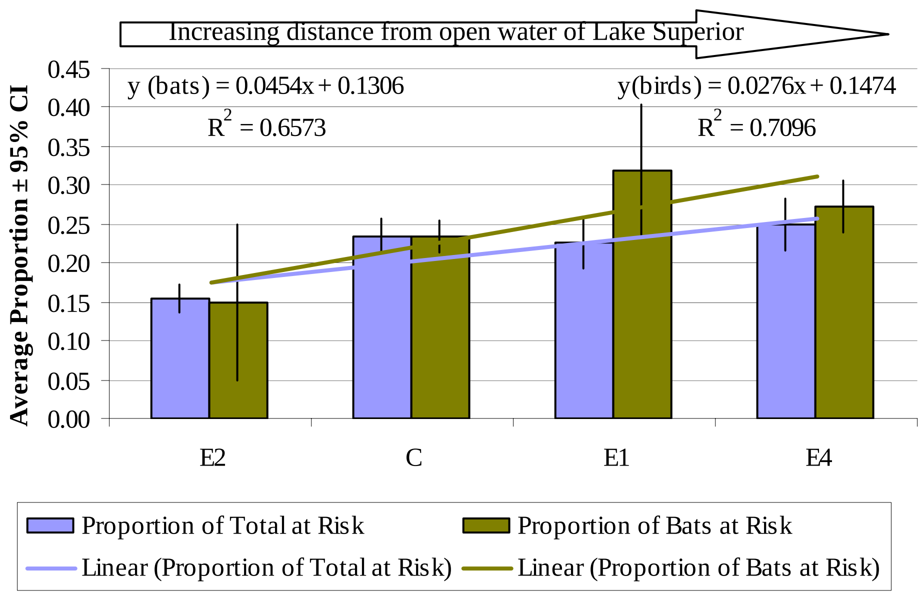

Fig. 15. Relative proportion of night migrants flying through that is within a proposed blade height (35 to 125 m above ground). The plots are presented in increasing distance from the open water of Lake Superior. The collision risk to bats is lowest on E2, the closest to shore.

Only flights within the sweep area of the blades were included in the flight activity graphs above (Figs. 12-14 and Appendix III), because turbines will only represent a risk to those flying within their operational envelope (the swept area of their blades). Only a small proportion of the night flights (birds and bats) are within the sweep area of the blades based on the proposed blades being 35 to 125 m above ground; ranging less than 35% of the population flying through (Fig. 15). The maximum average proportion of bats flying in the blade sweep area (32%) was observed at E1, which had the second lowest level of bat flight activity as determined through radar analysis (Fig. 17).

4.2.5 Influence of Lake Superior

There is no correlation between distance from Lake Superior and acoustic-determined calling activity of bats (Fig. 16) or radar-determined flight activity (Fig. 17).

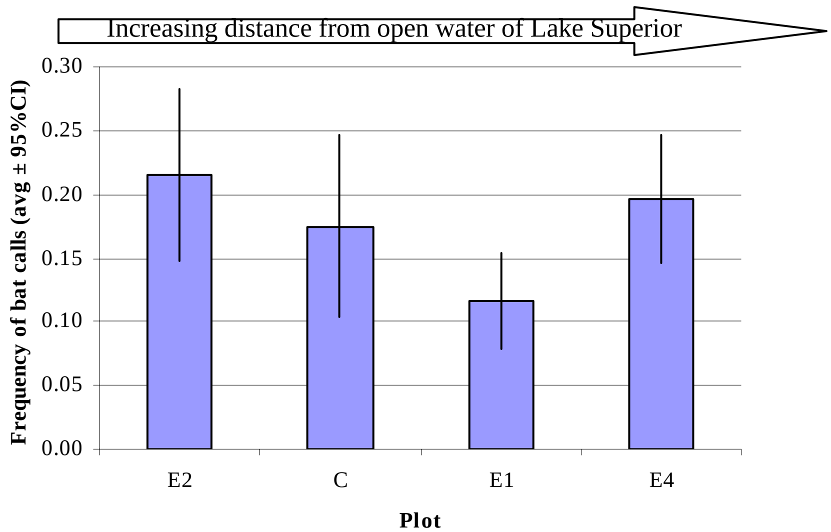

Fig. 16. Acoustic-determined bat calling activity averaged over the migration period for each plot. The plots are presented increasing distance from open water of Lake Superior.

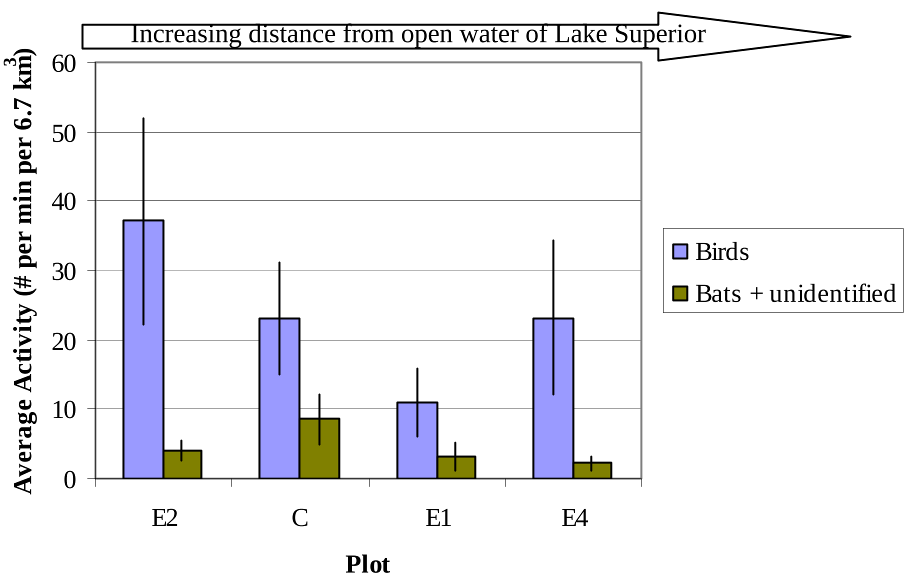

Fig. 17. Radar-determined flight activity averaged over the migration period for each plot. The plots are presented in increasing distance from the shore of Lake Superior.

4.2.6 Weather

Based on a comparison of weather data downloaded from an on-site meteorological station and radar data collected during this study, wind direction had more of an effect on flight behaviour during night migration than did wind speed (Fig. 18 and 19, respectively). Winds in the direction of the fall migration (from the north to northeast; 350-75) were associated with a higher flight activity of birds than were winds in a direction that apposed the direction of migration (i.e., winds from the southeast, southwest and from the west) (Fig. 18). The proportion of bats at risk (i.e., in the area of the blades) was 10% to 20% higher in winds from the east-southeast (Fig. 18; proportion at risk).

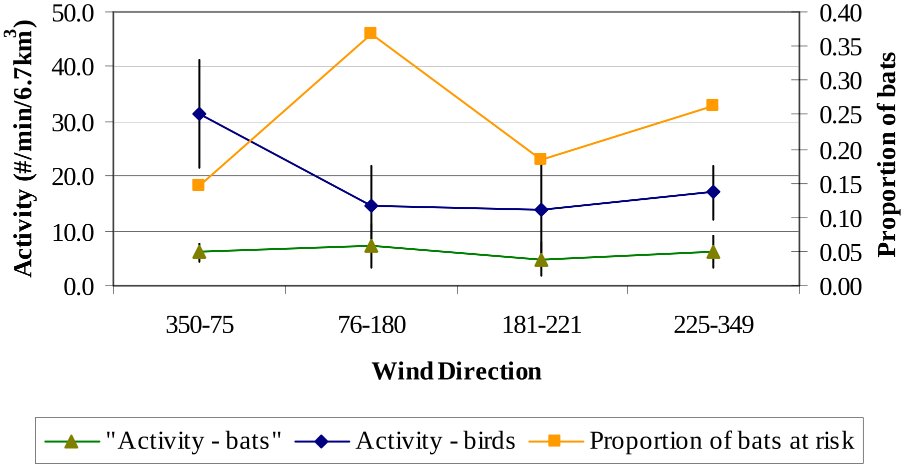

Fig 18. The relationship between wind direction and the flight activity (birds and bats; #/min/6.7 km^3) (y-axis on the left), and the radar-determined proportion of bats flying within the blade sweep area (y-axis on the right). Wind directions are in the direction of migration (from 350-75) or against (from 76-180, 181-221 and 225-349). The data are averaged across plots and dates. The vertical lines are the 95% CI of the average.

Ignoring wind direction, stronger winds had a tendency (not significant) to decrease the number of birds flying (Fig. 19). The other weather parameters such as temperature and barometric pressure did not appear to effect flight behaviour.

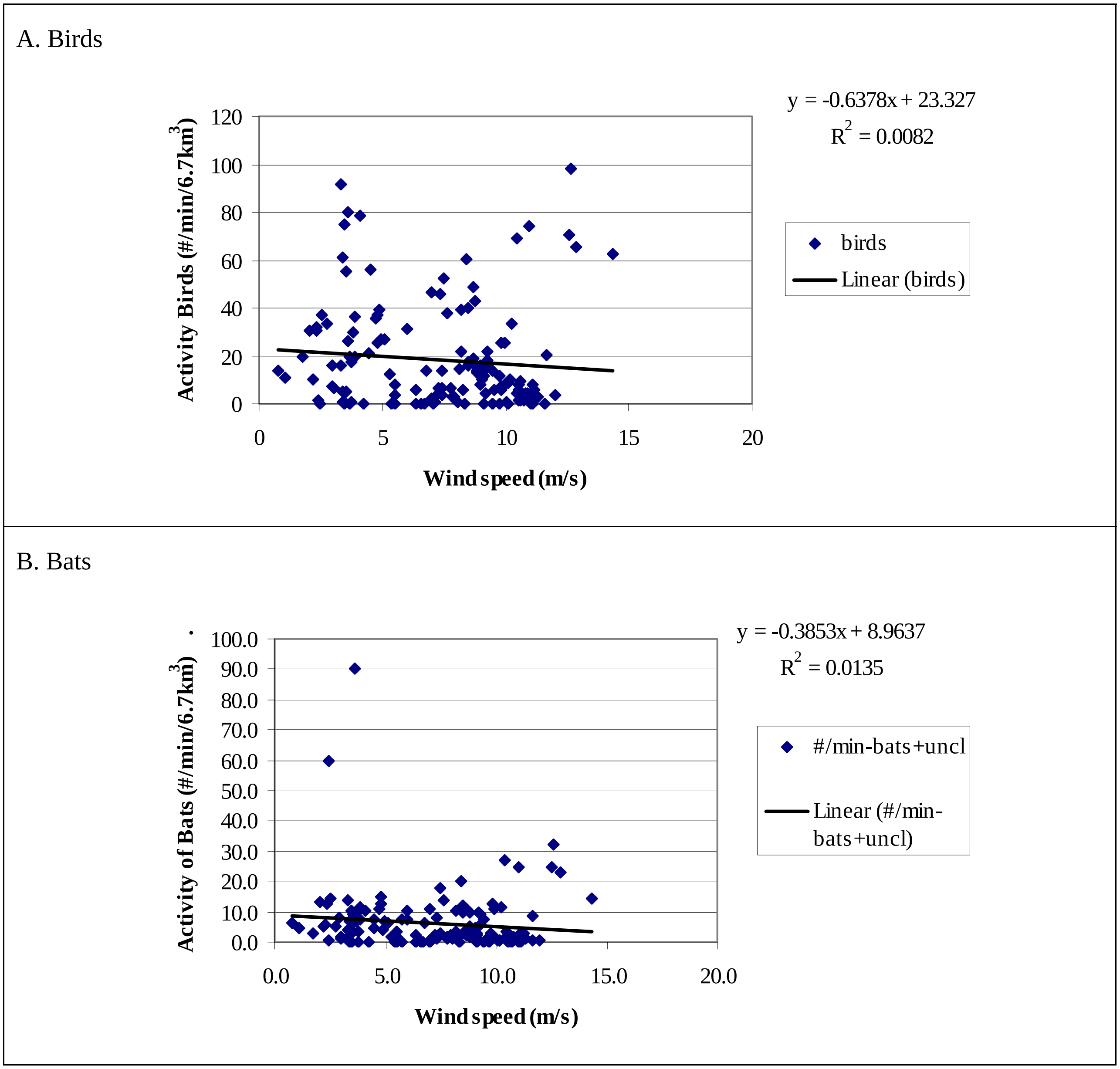

Fig 19. The relationship between wind speed and activity of birds (A) and bats (B); expressed as the number per minute per 6.7 km^3

5 DISCUSSION

5.1 Temporal Factors in Risk

There were two seasonal periods of maximum activity of night migrants; the third week of July and the third week of September (Fig. 6). These peaks in activity at Greenwich Lake are comparable to a site already developed for wind. However, the activity between 15 August and 23 September is much lower at Greenwich Lake than the already developed site.

The time of night of highest flight activity for all migrants is one hour after sunset. Bat calling did not peak until almost five hours after sunset. This is likely due to the different range of detection for radar versus acoustics. The radar detects individuals up to 870 m in height where the microphones detect to a maximum of 100 m in height. The individuals flying higher than 100 m would not be detected by acoustic sampling. The objective of the acoustic sampling is to provide species identification, not to provide the three-dimensional abundance that the EchoTrack radar provides.

5.2 Spatial Factors in Risk

EchoTrack did not find evidence for hibernacula at Greenwich Lake. There were no swarming events observed in August or September as would be expected if bats were making nocturnal visits to the site they intended to use for hibernation.

The sampling plots were situated at increasing distance from the open water of Lake Superior to investigate if bats (and birds) used the lakeshore in navigation; this would be visible as a decreased activity further inland. Neither the acoustic nor radar results support this hypothesis. There was a trend to increased proportion of bat and bird flights at risk (i.e., at blade height) with increased distance from the lakeshore. Though the lakeshore (E1) had the highest proportion of bats in the blade sweep area, this was of a smaller number of animals flying; it was the second lowest flight activity for bats and lowest bat calling. This result is contrary to the expected concentration of migrants at that the water and ridge.

In order of importance, the habitat most likely to attract bats to within the blade sweep area at Greenwich Lake is forest and logged forest (Figs. 10 and 11). The forest edge was not an attraction (line 0, Figs. 13 and 14). The logged forest plot E4 had a larger diversity and larger relative abundance of birds and bats at blade height, suggesting an enhanced use of this manipulated habitat. The clearing at C, the control plot where no turbines will be built also had high activity at blade height. A clearing seems to provide foraging habitat.

The average proportion of flights potentially exposed to the turbine blades at Greenwich Lake in general, was higher than the average recorded in radar studies in similar landscapes in New York State (24% of 180 flights versus 12% of 304 flights; Appendix V, Table 1). Some of the difference in the proportion of flights exposed could be due to the different configuration of the radar sampling beam used in the New York studies. EchoTrack uses one antenna for a torroid-shaped sampling of height in 360° as apposed to a second antenna which is pointed vertically to sample heights within a 20-25° beam at one location in the sampling plot. The EchoTrack radar samples a larger area of the landscape at maximum turbine height and below. The range of passage rates at Greenwich Lake falls within the New York State published results.

5.3 Species and Risk

All bat species observed are considered 'secure' in Ontario. Longer distance bats found previously by EchoTrack to be more at risk to collisions (Red bat, Hoary bat, Big brown bat), were less common (26% of the recorded bat passes) in the acoustic recordings than were the shorter distance migrants Only the Little brown bat was present on all plots; Appendix I. Some avoidance of the turbines using increased flying height, reduced flying speed, and directional changes are expected for all species.

5.4 Confounding Factors

5.4.1 Weather

In this study, wind direction had the most effect on flight behaviour of the weather variables measured. Winds in the direction of the fall migration (from the N) were associated with higher passage rates. Whereas, winds apposing the direction of migration had a lower passage rate and specifically east to southeast winds, were associated with a higher tendency to be within the height of the blades (assuming a blade sweep area 35-125 m above ground). This implies that bats flew lower in apposing winds.

5.4.2 Geographic Influences

It has been proposed by Environment Canada and OMNR that the presence of a Great Lakes shore may influence flight behaviour by resulting in an increase in activity by funneling or concentrating nocturnal flight activity, some within the blade sweep area of the turbines. These data suggest there was no effect of the shore on the passage rate (acoustic or radar). The trend to a lower proportion of bats and birds at risk closer to the Lake Superior shore was not significant.

The observed activity associated with forest clearings, suggest that forest clearings can provide feeding habitat for bats.

5.4.3 Specific Species

Acoustic analysis showed the most common bat species to be the Little brown bat. Based on observations during this investigation, the Hoary bat was most active in open areas. The Big brown/Silver-haired bat was only observed associated with forest. The Red bat was active near wetland and forest.

No species at risk were recorded during the field sampling. All bat species observed are considered 'secure' in the province.

6 CONCLUSIONS

6.1 Validity

The confidence interval and standard error calculations indicate that the volume of gathered data and its distribution is adequate to support the analysis with a reasonable level of certainty. The internal consistency of independent findings (e.g. maximum radar-determined activity at E4 and mobile acoustic activity at clearings in forest) and the conformance of the results to known behaviours and preferences (e.g. higher bat flight densities at locations where trees are present), also support this conclusion.

Comparison with independently gathered data from another lakeshore location of wind power development in northern Ontario confirms that sampling is comparable and therefore a good indication of the presence and behaviour of the migratory population in fall. Migration patterns in spring would be different and fall 2007 may not represent future weather patterns.

6.2 Characterization

The following provides a summary of key observations and interpretations of data collected during the fall 2007 Bat and Nocturnal Migrant Bird investigation at the Greenwich Wind Project site.

1. EchoTrack recorded 185,100 individual flights of night migrants during 24 nights of sampling from sunset to sunrise using radar-acoustic technology. Sampling was completed for four evaluation plots (E1, E2, E4 and C). Bats comprised 17% of the overall night migrant population sampled by radar.
2. The observed overall flight density (birds and bats) was 14% of the abundance recorded in shore and forested ridge topography in the Great Lakes region (New York) and 70% of the activity observed in the same season at a permitted wind farm site in northern Ontario.
3. Habitats most associated with concentrations of bats were intact and logged forest. A setback from the forest edge wasn't relevant in this study. However, based on this study a setback of 100 m from the lake would be sufficient to mitigate for potential collisions.
4. Comparable radar results suggest Greenwich Lake has low activity compared to other wind farm sites in northern and southern Ontario.
5. Plot C (the control which would not have turbines) had the highest diversity of bat species and Plot E2 the least.
6. Eight species of bats are potentially present in the study area. Six of these were recorded. All species are considered secure in Ontario.
7. Nocturnal flights (birds and bats) in the study area peaked in activity 1.0 hour after sunset, tapering towards dawn. The peak in bat calling activity five hours after sunset was not typical of other sites monitored in the same season and sites monitored in other years but with the same equipment.
8. Night migrant radar-determined activity (birds and bats) was greatest at E2, and then E4 and C. E1 had the lowest overall (bird and bat) activity level and the second lowest bat activity level of all plots sampled.

9. Bat calling activity as determined by acoustic analysis, was greatest at E2 and E4, followed by C and E1.
10. An average of 22% of the total population (all night migrants) was observed flying through the area proposed for turbines at blade sweep height. This proportion is higher than the average recorded by radar observations in similar landscapes in New York State (10%), but of a lower observed migration activity. This proportion is expected to be reduced once the turbines are operational due to increased flying heights, reduced flying speeds and changes in flying direction. The lowest proportion of those at risk was observed at E2.
11. 24% of the total number of bats was recorded flying at heights within the blade sweep volume. Plot E1 had the highest proportion (32%), followed by plot E4 (27%), plot C (24%) and E2 (15%).
12. The average flying height of all animals at plot E1 is 257 m; plot E2 = 395 m, plot E4 = 159 m; plot C = 166 m. All average flying heights for both birds and bats was above the proposed blade sweep volume for all plots.
13. Based on the relatively lower flying height of bats, trees in the vicinity of plots E1 and E4 likely provide some diurnal roosting habitat.
14. No evidence of hibernacula was found at Greenwich Lake. No swarming events were observed.
15. Winds apposing the direction of migration had a tendency to decrease activity and those from the east-southeast, to increase the proportion of airborne wildlife in the blade sweep volume, although in both cases, not significantly. Other weather parameters, such as temperature and barometric pressure did not appear to affect flight behaviour.
16. Some potential attractants associated with flight concentrations were identified in the project area. These include treed clearings and a lake within the forest.

Based on consideration of the above information, EchoTrack characterizes the Greenwich Lake Wind Project as posing a low risk to bats and nocturnal migrant birds. This pre-construction baseline information should be compared to post-construction data to determine collision avoidance behaviour and disturbance response.

6.3 Risk

An average of 78% of flights through the proposed development area was outside the blade sweep area, leaving an average of 22% of airborne animals potentially exposed to a collision. This exposure is expected to be further reduced by over-flight and avoidance after the installation of turbines (Millikin in press).

Due to the lower flying height by bats, they are more at risk to a collision than birds; this agrees with the literature (Bat conservation international 2004). Plots E4 and E1 have lower flight heights and a higher proportion of bats at risk but E1, as determined through radar analysis, has the lowest bird and bat activity, thus reducing the collision risk. Bat calling activity, as determined through acoustic analysis, was highest at E2 and lowest at E1.

The observed concentration of flights at some forest clearings is based on pre-construction flight behaviour. It is expected that birds and bats would adapt their flight behaviour post-construction to avoid the turbine blades.

7 RECOMMENDATIONS

The study results suggest that the risk to night migrant birds and bats is low and the site of highest combined activity and proportion of flights in the blade area is the control site, outside the area where wind turbines will be erected.

While the area of Greenwich Lake that will receive wind turbines carries a low risk to the flying population, some flight concentrations, generally associated with attractants, were identified. Turbines should be placed to minimize and/or avoid the use of locations where feeding attractants such as standing water or a clearing in potential roost trees are present.

The pre-construction results should be compared to post-construction results for a measure of collision-avoidance behaviour and disturbance response.

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APPENDIX I - BAT SPECIES DIVERSITY

None of the species potentially present in the proposed wind plant area are listed federally as species at risk on Schedule 1 of the Species at Risk Act or provincially under the Endangered Species Act. However, one species is considered sensitive or potentially at risk by the Ministry of Natural Resources Natural Heritage Information Centre was observed at control.

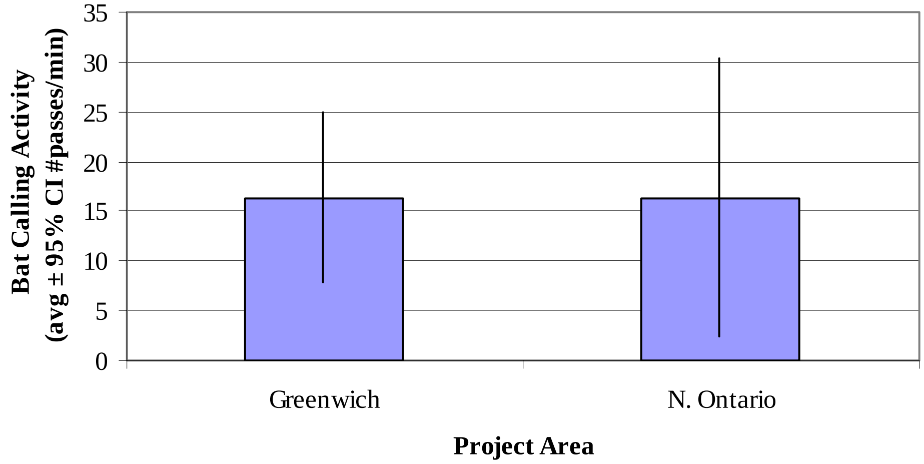
Longer distance migrants (Hoary bat and Red bat) were present at E4 and control.

Bat Species	Common Name	Ontario General Status	Observed on Plots[1]	Preferred Habitat
Myotis lucifugus	Little brown bat	Secure	E1,E2,E3, E4,C	buildings, trees, water
Myotis septentrionalis	Northern long-eared bat	Sensitive	C	trees
Lasiurus borealis	Eastern red bat	Secure	E4,C	trees, streams
Lasiurus cinereus	Hoary bat	Secure	E4,C	open, lights
Lasionycteris noctivagans	Silver-haired bat	Secure	E1,E4,C	trees, water
Eptesicus fuscus	Big brown bat	Secure	E4,C	open, trees, buildings
#observed / #possible			6/8	

[1] Where a plot is specified, these results are from the stationary or mobile acoustics. The following species were also recorded in the general area using mobile acoustics: Little brown bat, Northern long-eared, Eastern Red bat, Hoary bat, Silver-haired bat and Big brown bat.

APPENDIX II - MOBILE ACOUSTIC DATA - COMPARING GREENWICH LAKE TO ANOTHER NEARBY SITE SAMPLED DURING THE FALL OF 2007

Mobile acoustic sampling on Greenwich Lake 22, 23 and 24 September, 2007, compared to other sites in northern Ontario sampled with the same equipment and method, between 29 August and 6 September, 2007. The average bat calling rate at Greenwich Lake is within the range of the calling rate at another nearby permitted wind development site.



APPENDIX III - FLIGHT RESPONSE TO HABITAT FEATURES

Plot C was selected to sample flights associated with a clearing in forest habitat. To analyze for concentrations of flights potentially exposed to the turbine blades, flight paths were analyzed with respect to the habitat edge (0 m) and with respect to imaginary lines at 10, 50, 100, 300, 500, 1000and 1500 m NW (negative distances) and SE (positive distances) from the forest edge, which was perpendicular to the expected flight direction of SE for fall migration. The proportion of flights at blade height increased markedly at 100 m SE of the forest habitat at C but the abundance were so small that this does not suggest attraction. No turbines will be built at C.

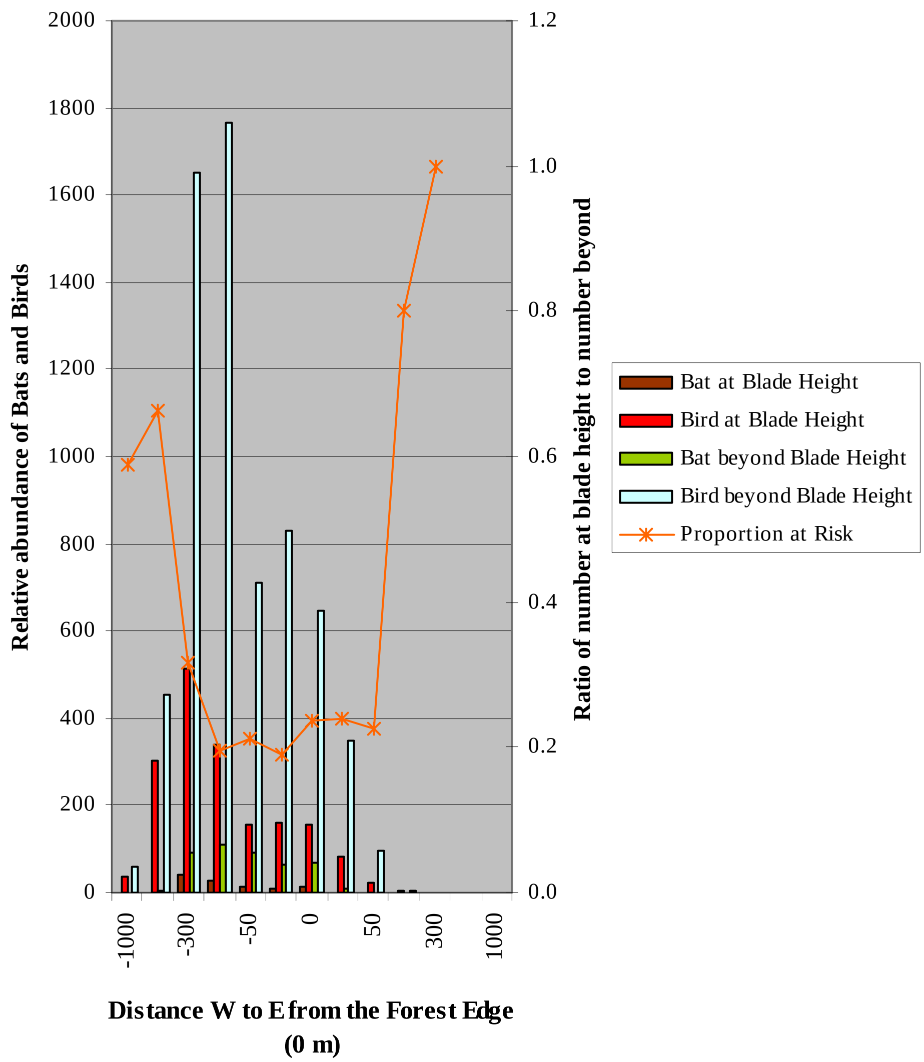


Fig. 1. Radar –determined relative abundance of night migrant birds and bats with respect to a forest edge at C, the control radar-acoustic plot. Flights were grouped at blade height and beyond (above or below), at increasing distances perpendicular to the expected direction of flight in fall migration (SE). The forest edge is positioned at 0 m. There was no concentration of flights within blade height at the forest edge.

APPENDIX IV - DISTANCE FROM OPEN WATER

To test for an effect of the lakeshore on night bat and bird flight activity and thus collision risk, the distance of each plot from the open water of Lake Superior was calculated using the distances below.

Plot	Distance from Lake Superior shore (m)	#/6.7 km^3/min
E2	6,000	37.1
C	9,000	23.1
E1	12,000	10.9
E4	20,000	23.2

APPENDIX V – COMPARISON OF COLLISION RISK DURING FALL MIGRATION

Table 1. Radar-determined passage rate, and the percent of targets (flight paths) below turbine height and therefore at risk to a collision with the blades; a comparison of the Greenwich Lake results to other radar studies in similar landscape in New York State. The percent potentially exposed is greater than the average of these other studies (10%). Though, this is 21% of a much lower average passage rate (42 versus an average of 304).

Project Site	Number of Survey Nights	Number of Survey Hours	Landscape	Average Passage Rate (t/km/hr)	Range in Nightly Passage Rates	Average Flight Direction	Average Flight Height (m)	% Targets Below Turbine Height	Citation
Greenwich	24	693	Great Lakes, forest	42 ± 12	1-174	144	159	21	this report
Great Lakes									
Harrisburg, NY	35	n/a	Great Lakes	122	n/a	181	182	45	Cooper and Mabee 2000
Churubusco, Clinton	38	414	Great Lakes	152	9-429	193	438	5	Woodlot 2005l
Ellenberg, Clinton Cty,	n/a	n/a	Great Lakes	197	n/a	162	333	12	Mabee *et al.* 2006a
Flat Rock, Lewis Cty,	n/a	n/a	Great Lakes	158	n/a	184	415	8	ED&R 2006a
Westfield Chautauqua	30	180	Great Lakes shore	238	10-905	199	532	4	Cooper *et al.* 2004c
Forested Ridge									
Mt. Storm, Grant Cty,	45	270	Forested ridge	241	8-852	184	410	n/a	Cooper *et al.* 2004b
Franklin, Pendleton Cty,	34	349	Forested ridge	229	18-643	175	583	8	Woodlot 2005a
Deerfield, Bennington	28	300	Forested ridge	175	7-519	194	438	1	Woodlot 2005c
Deerfield, Bennington	14	159	Forested ridge	193	8-1121	223	624	5	Woodlot 2005c
Deerfield, Bennington (Valley Site)	13	136	Forested ridge	150	58-404	214	503	1	Woodlot 2005c
Deerfield, Bennington (3 sites combined)	28	595	Forested ridge	178	7-1121	212	611	3	Woodlot 2005c
Sheffield, Caledonia	18	176	Forested ridge	114	19-320	200	566	1	Woodlot 2006a
Deerfield, Bennington	32	324	Forested ridge	559	3-1736	221	395	13	Woodlot 2005s
Kibby, Franklin Cty,	12	115	Forested ridge	565	109-1107	167	370	16	Woodlot 2006d
Kibby, Franklin Cty,	12	101	Forested ridge	201	12-783	196	352	12	Woodlot 2006d
Kibby, Franklin Cty,	5	13	Forested valley	452	52-995	193	391	16	Woodlot 2006d
Mars Hill, Aroostook	18	117	Forested ridge	512	60-1092	228	424	8	Woodlot 2005t
Lempster, Sullivan Cty,	32	290	Forested ridge	620	133-1609	206	387	8	Woodlot 2007a
Stetson, Penobscot Cty,	12	77	Forested ridge	476	131-1192	227	378	13	Woodlot 2007b
Average	23.9	226.0		291.2		197.8	438.5	9.9	

From: Rhonda Millikin [mailto:rmillikin@echotrack.com]
Sent: Tuesday, December 02, 2008 10:45 AM
To: Nicolas Muszynski
Subject: report on bats sent to Ontario Parks

Nick,

Please find below the details of the report that I sent to Ontario Parks (Steve). The work was in association with another project so I have taken out any reference to their project and any data that they paid for and is not yet released to the public or Ontario Parks.

The report that I sent Steve and the details below, were OK'd by the client.

Cavern Lake bats

Thank you again for facilitating our visit to Cavern Lake Provincial Nature Reserve (i.e. the Cavern Lake bat cave). I hope the results I have attached will contribute to information on the cave and knowledge of bats in the region.

Monday 15 September at sunset (20:09 hrs EDT), the temperature was 15.2°C.

We entered the cave one hour before sunset and captured all the bats we could reach from the main chamber (4 bats) and the side chamber to the northeast (9 bats); a total of 13 bats, 85% from the side chamber (Table 1). We saw six bats in the cave prior to sunset that we could not capture. All bats were released at 22:40 hrs.

A 12 m mist net was strung across the entrance to the cave for 2.5 hrs from sunset to 22:30 hrs EDT. We caught 5 bats (Table 1) and saw one bat flying that eluded our capture attempts.

All bats were held in capture bags until the end of sampling. We recorded species, age (A = adult or S = subadult; based on the fusion of the phalangeal epiphysis), sex (M = male or F = female), reproductive state (BP = bare patch around nipple, indicating the female nursed a young this year, or TD = testes distended, indicating the male is in breeding condition), forearm length (mm), weight (g) and health of each individual (presence of parasites). All were adult little brown bats, *Myotis lucifugus*, and in good condition (average weight 11.2 g and 22% with parasites). Most were males (83%).

We are confident that we can account for the majority of the population of bats using Cavern Lake cave on 15 September (Table 1). A population of 19 bats of one species suggests this is not a significant cave for bats in Ontario.

Table 1. Capture results for the known hibernacula, outside the Gilead development area, on 15 September at Cavern Lake cave by hand in the cave and by mist net at the cave entrance, from sunset (20:09 hrs) to 20:30 hrs EDT. M = male, F = female; BP = Brood patch, TD = testes distended; A = adult; FA = forearm

Species	Sex	Rep	Age	FA (mm)	Mass (g)	Capture method	Comments
Myotis lucifugus	F	BP	A	40.0	9.0	mist net	2020 hrs
Myotis lucifugus	M	TD	A	37.8	9.5	in cave (side room)	
Myotis lucifugus	M	TD	A	38.9	10.5	in cave (side room)	ticks on back
Myotis lucifugus	M	TD	A	39.8	11.5	in cave (side room)	
Myotis lucifugus	M	TD	A	38.3	12.0	in cave (side room)	
Myotis lucifugus	F	BP	A	37.3	11.5	mist net	2115 hrs
Myotis lucifugus	M	TD	A	37.3	11.5	mist net	2115 hrs
Myotis lucifugus	F	BP	A	40.7	12.0	mist net	2115 hrs; orange ear mites
Myotis lucifugus	M	TD	A	38.0	12.0	mist net	2115 hrs
Myotis lucifugus	M	TD	A	37.9	11.0	in cave (main area)	orange ear mites; short tragus
Myotis lucifugus	M	TD	A	39.8	12.5	in cave (side room)	
Myotis lucifugus	M	TD	A	36.7	11.0	in cave (side room)	
Myotis lucifugus	M	TD	A	38.9	11.0	in cave (side room)	
Myotis lucifugus	M	TD	A	37.3	11.5	in cave (side room)	
Myotis lucifugus	M	TD	A	39.8	10.5	in cave (main area)	
Myotis lucifugus	M	TD	A	39.8	10.5	in cave (side room)	orange ear mites
Myotis lucifugus	M	TD	A	36.9	12.0	in cave (side room)	
Myotis lucifugus	M	TD	A	39.3	11.5	in cave (side room)	
Total = 18							

With Regards,:R

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Response to MNR Comments on Draft ESR

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RE: Comments from MNR

10 July, 2009

Dear Andrea,

This letter is in response to MNR comments on the "Pre-Construction Bat and Nocturnal Bird Monitoring Report for Greenwich Lake Wind Project". MNR comments are given in italics and the response in regular font.

"*The conclusion of low risk is mainly supported by comparison to other sites sampled with radar. The comparisons between Ontario sites sampled with the same equipment are presented as total activity (bats plus birds). We think that a comparison of bats plus unknown to other sites would be more appropriate in assessing the relative risk to bats. Comparison to sites in New York should include a discussion of the potential effect of a different antenna configuration on total activity, not just on proportion in the blade sweep area*."

- The results are re-analyzed for bats plus unknown (unclassified) and presented in Figure 1 and Table 1. The bat plus unknown night migrant activity at Greenwich is 39% of other proposed wind development sites monitored with the same radar system in the same year and season (Fig. 1). This difference is significantly different on treatment sites (sites proposed for wind development) but not control (Table 1; paired t-test).
- Based on these results, the risk to bats is predicted to be low in comparison to these other proposed development sites in the forested landscape of Northern Ontario. However, this prediction should be verified with direct comparison of predicted activity pre-construction to observed mortality post-construction.
- The comparison to radar results from studies conducted in New York State also suggests a low comparative activity of night migrants at Greenwich (an average of 42 versus 291 targets per kilometre per hour). These other studies do not separate birds from bats and unknown night migrants and therefore, the comparison made between New York studies and Greenwich is of all night migrants. Also, the comparison of 42 to 291 is of activity in the blade sweep area and beyond.
- To compare the EchoTrack results to New York results where they express the radar-determined activity as a number per kilometre front per hour, EchoTrack analysis is repeated (the first analysis being of the full 6.7 km^3 scan volume) using a computer-generated line drawn through the 2 km radius 360° scan volume,

perpendicular to the average direction of migration, and all flight paths crossing this line are counted. This includes flight paths at all heights, which is how other radars "see" the flight paths (i.e., there is no separation into height). Therefore, the difference in antenna configuration should have little effect on total activity for this analysis.

- The configuration difference will affect the calculation of the proportion of flights within the blades sweep area. This is because the EchoTrack system scans height over a 2 km radius circle (360°) where the other radars calculate the proportion of flights at different heights using a vertical beam at one point in space. Because height is calculated over a different scan volume for other radars, a comparison of the proportion of flights at risk of a collision can be made using the percent of the scan volume that is sampled.

"*The location of the sampling sites and timing of the sample collection also adds some uncertainty to the conclusion that the proposed development poses a low risk to bats. Almost all of the sampling was to the east of the area where turbines are proposed and the lack of observed swarming events can not be generalized to the entire study area. Clustering of sampling nights and a very low sampling intensity during August increases the likelihood that significant migratory events could have been missed. Additionally, while the importance of forested ridges is highlighted in the ESR, the study did not appear to sample this important habitat. There are some areas of high relief which should be a high priority for sampling. Additional sampling in the area to be developed for turbines should be undertaken prior to construction of the towers in order to confirm that the study results are applicable to the development area.*"

- The sampling sites were selected to include a measure of the potential effect of distance from Lake Superior on bat migration (E2 to E4). They were also selected to include within site habitat features that were predicted to influence bat activity but potentially attracting bats into the blade sweep volume (artificial lights, standing water and forest edge). Plot E1 included a cliff face and forested ridge adjacent to a wetland and therefore is expected to represent maximum activity of migrant bats. However, the post-construction monitoring could include additional sites of high relief.
- Taking the two sites most closely matched in time and representing the within-site habitats predicted to maximize bat activity (E1 and E2), variability between the sites was not significant (Table 2). This suggests that the sites selected for pre-construction sampling could represent the larger project area. However, post-construction monitoring could also include a site further to the west.
- Given the northern latitude of the Greenwich sites, migration was expected to start earlier than sites in southern Ontario and swarming was expected in July. For this reason, sampling was initiated before August. To determine if significant migratory events could have been missed, radar-determined activity of bats plus unknown night migrants was graphed for the fall migration of 2007 combining data from Greenwich and other sites in Northern Ontario. To control for differences in development areas, daily activity was expressed as a proportion of the maximum activity for the development area (i.e., the weighted average).

Activity at Greenwich peaked end of July as expected. A second peak in activity was observed late September at Greenwich. However, a peak in activity early September, observed at other sites in northern Ontario, may have been missed at Greenwich (Fig. 2).

"Two years of post construction monitoring will be required for this site. A post construction monitoring protocol should be developed and included as an appendix to the document."

The pre-construction monitoring results suggest that a correlation between radar-determined flight activity and mortality could help in the interpretation of pre-construction results in future studies. For this reason, the protocol for post-construction monitoring could include paired sampling for radar activity and carcass search. Post-construction monitoring could also include a plot further west in higher elevation forested ridge habitat and some shifting in plot locations to maximize the overlap with turbine locations. Post-construction sampling could include more replicates in early September.

A separate letter from Ontario Parks dated July 6, commenting on the Environmental Screening Report, references the bat hibernacula at Cavern Lake Provincial Park.
I would like to confirm that the reference to the independent work on 15 September 2008 is valid. The significant difference in species complex and abundance between early fall and the middle of winter is important information suggesting bats had not committed to their winter hibernacula by 15 September. Cavern Lake is an important bat hibernacula deserving protection.

The work by the University of Calgary showed the mortality of bats exposed to wind turbines could include barotrauma (due to a change in air pressure on the leeward side of the blades) and therefore, does not require a direct collision with the blades or tower. Mitigation for barotrauma would be consistent with mitigation for collision risk, where the important factor is to minimize exposure of bats to wind turbine blades (the air behind them or the blade itself). This is consistent with the approach we have taken to monitor spatial and temporal patterns of activity so turbines can be locations to minimize the interaction of bats with wind turbine blades (and the air behind them).

With Regards,

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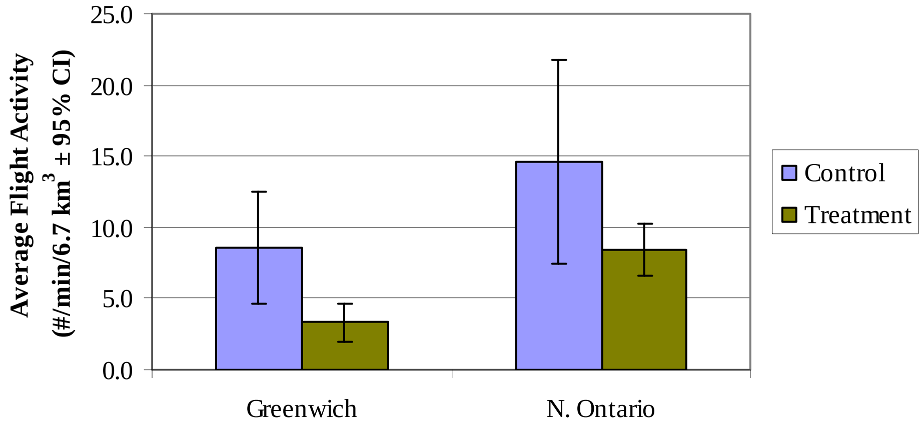

Fig. 1. Comparison of radar-determine activity of bats plus unknown night migrants at control and treatment sites at Greenwich versus other proposed wind development sites in northern Ontario, sampled with the same radar system in fall of 2007. Treatment sites are proposed for wind development where control sites are not. The Greenwich treatment sites have 39% of the bat plus unknown flight activity at other wind development sites in northern Ontario.

Table 1. Statistical comparison of radar-determine activity of bats plus unknown night migrants. Sites were paired by date. Control sites did not differ significantly in activity, but treatment sites at Greenwich had significantly lower activity that those in northern Ontario ($p < 0.05$, paired t-test).

t-Test: Two-Sample Assuming Equal Variances
Control

	Greenwich	*N. Ontario*
Mean	8.59	14.64
Variance	20.08	66.99
Observations	5.00	5.00
Pooled Variance	43.53	
df	8.00	
t Stat	-1.45	
P(T<=t) one-tail	0.09	
t Critical one-tail	1.86	
P(T<=t) two-tail	0.19	
t Critical two-tail	2.31	

t-Test: Two-Sample Assuming Equal Variances
Treatment

	Greenwich	*N. Ontario*
Mean	3.32	8.84
Variance	6.64	25.65
Observations	14.00	14.00
Pooled Variance	16.14	
df	26.00	
t Stat	-3.64	
P(T<=t) one-tail	0.00	
t Critical one-tail	1.71	
P(T<=t) two-tail	0.00	
t Critical two-tail	2.06	

Table 2. Variation in bat activity between two sites representative of the range of within-site habitat expected to maximize bat activity. Sites were paired by date and then compared using paired t-test assuming equal variance. There is no significant difference in activity between sites.

t-Test: Two-Sample Assuming Equal Variances
area differences

	E1	*E2*
Mean	3.14	3.76
Variance	10.34	7.70
Observations	5.00	5.00
Pooled Variance	9.02	
df	8.00	
t Stat	-0.32	
P(T<=t) one-tail	0.38	
t Critical one-tail	1.86	
P(T<=t) two-tail	0.75	
t Critical two-tail	2.31	

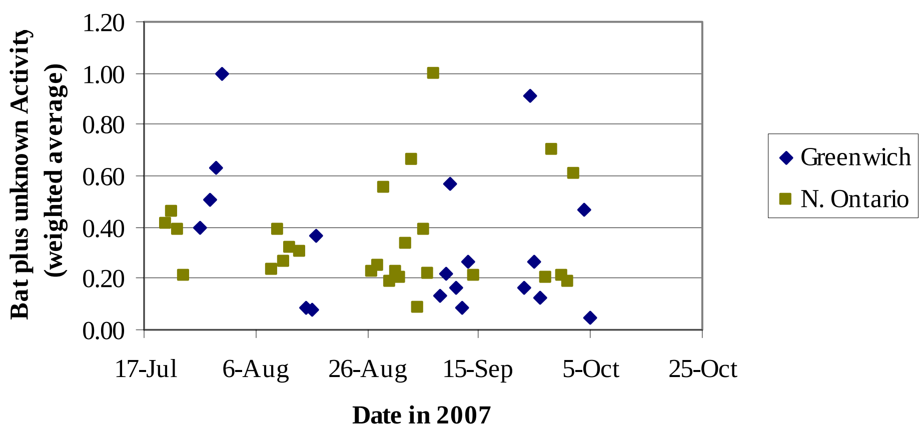

Fig 2. Fall migration activity of bats and unknown night migrants in 2007. The activity is expressed relative to the maximum activity in the area, Greenwich separate from N. Ontario.