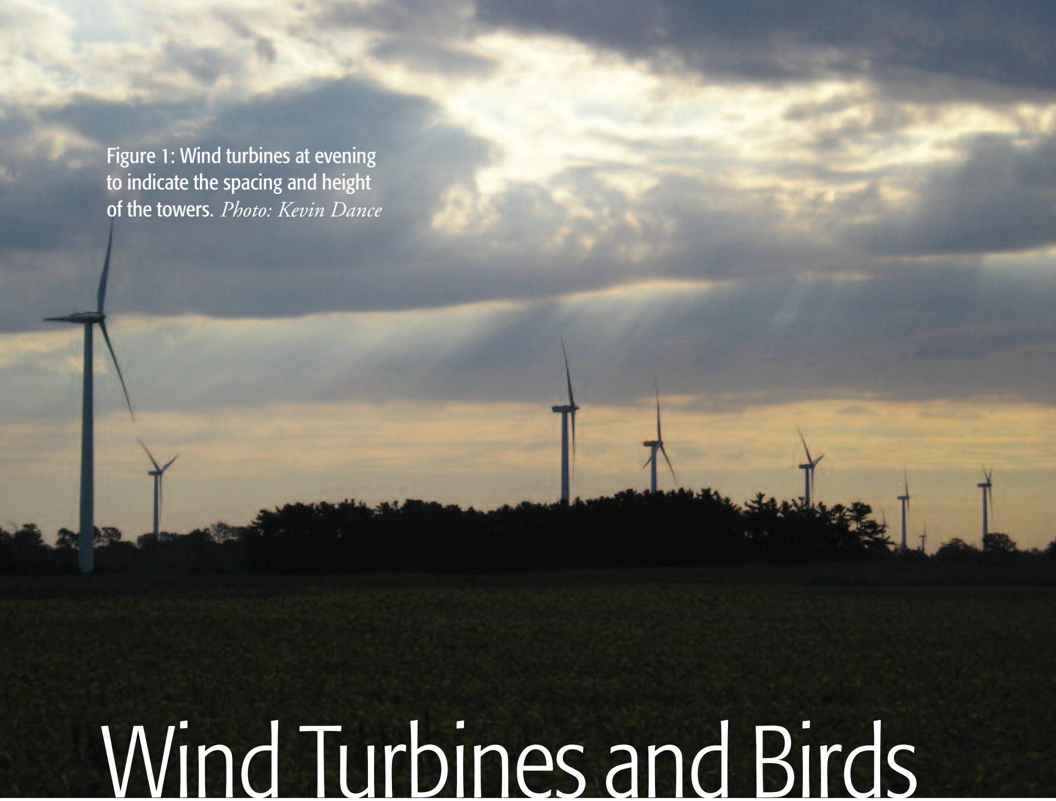

Figure 1: Wind turbines at evening to indicate the spacing and height of the towers. *Photo: Kevin Dance*

Wind Turbines and Birds

The Erie Shores Wind Farm Experience: Avian Mortality

Ross D. James

THE ERIE SHORES Wind Farm (ESWF) is located on the north shore of Lake Erie, extending about 29 km east and west of Port Burwell. In this area, large numbers of migrant birds are expected. Thousands of Tundra Swans (*Cygnus columbianus*) and other waterfowl are known to congregate in the Long Point marshes about 20 km to the east of ESWF (Ridout 2010). In some years at least, large groups flew inland in spring to forage in fields as far west as ESWF (pers. obs.). Large concentrations of diurnal raptors move west along the Lake Erie shore in autumn (Field 2004), thousands flying through ESWF (pers. obs.). Bald Eagles (*Haliaeetus leucocephalus*) are present all year, and one pair nested within the wind farm area (James 2008). Concentrations of diurnal migrants pass along the Lake Erie shores in autumn (James 2010, pers. obs.). Nocturnal migrants pass over the area in spring and autumn in huge numbers (Black 2000) and may occasionally concentrate in the shoreline areas, where they could be vulnerable to wind turbines when taking off and landing (Black 1988, Richardson 2000).

If there is a mortality problem for birds from modern wind turbines, it should be apparent at ESWF. Environment Canada requires mortality monitoring at all new wind turbine installations in Ontario, regardless of perceived threat. When I began monitoring at ESWF in 2006 only interim guidelines were available, with the "final" version available by July (Environment Canada 2006). But, as I tried to follow procedures outlined in this document, I became aware of problems that would affect the calculation of mortality. The main problem, that would affect a mortality estimate, was that an area searched was needed. This is readily calculated in grassland habitats, similar to the United States studies from which the monitoring procedures were adopted. But at ESWF, where crops were planted close around the turbine towers, a very different situation is observed. Another problem was related to scavenger removal studies, where bird carcasses were checked only once after a week, also a procedure that had been followed in the U.S.

This paper presents the results of efforts to try to find an alternative way of arriving at a reasonable estimate of mortality at ESWF, regardless of the numbers and types of migrants expected in the area, and to provide a mortality estimate at ESWF. It is an analysis of findings from more than 1400 hours of fieldwork, during 2006 and 2007, largely devoted to assessing mortality at ESWF.

Methods

ESWF consisted of 66 turbines placed in farm fields along the north shore of Lake Erie for a distance of about 2.5 km inland. They were spaced at least 300m apart, usually considerably more, at varying distances from the shore; woodlots, roads and crops were variable around them (Figure 1).They were 1.5 MW turbines on tubular towers, rising 80m at hub height, with blades spanning 77m. Thus, the lowest sweep of the blades was more than 40m above ground, 15-20m above taller tree heights. Maximum rotation was about 22 rpm in stronger winds. Direct visual searches were used to look for dead birds. When any remains were found, they were noted along with distance and direction from the base of the turbine. The identity of the item and, for carcasses, the nature of any visible injuries or possible cause of death, and an estimate of the length of time since death, were recorded.

Search Schedule: In March, over a three week period, a fairly quick scan of bare fields was made, at a variable number of turbines, anywhere swans were seen nearby in fields or flying past. In addition, in 2007, all turbines were searched carefully once to look for the remains of anything that might have been killed since the previous November.

Searching then extended for six weeks in spring, through May and the first couple weeks of June. In autumn, searching lasted over at least 12 weeks, from about mid-August into early November. Through late June and early July 2006, eight turbines nearest a Bald Eagle nest, on the north side of the wind farm, were searched once a week.

During the spring of 2006, all operating turbines were searched once a week.

In the autumn, half were searched at least once a week and the rest once every two weeks; five to seven near-shore turbines were monitored two or three times a week following days of heavy migration. In spring of 2007, 30 were searched twice a week and 36 once a week; in autumn all were searched at least once a week. In addition, another researcher independently made at least weekly searches of a subset of 12 turbines.

Search area: Before planting and after harvest, fields were searched to 40m from the tower and visually beyond that distance. Fields were walked in parallel transects, about 4-6m apart in grass and 6-10m apart in fields. Once planted, searching was restricted to laneways and around the tower base, or any smaller unplanted places. However, fields were carefully visually scanned as far as crop growth allowed.

Search time: Search times varied from 5 minutes in mid-summer when only a laneway and turbine base could be searched in a dense field of soybeans, to 45 minutes when an entire field could be searched carefully. Searching was as long as necessary to do a thorough search of any area available within 40m or the turbine tower.

Limitations and complications: A few turbines were located in orchards where grass was mowed regularly and all, or almost all, of the 40m radius could be searched throughout the year. But, at most turbines the area that could be searched varied weekly depending on planting and harvest schedules and on crop growth and die back. These varied from farm to farm, and even from turbine to turbine, week to week. Different layouts of laneways permitted differing lengths of field that could be scanned. Variable crop growth and soil type (sandy and smooth vs. clay and rough) affected the extent of visual searches for different sized or coloured birds, making it impossible to calculate any effective area searched each week.

Furthermore, the distance and direction at which carcasses were found seemed of no value in trying to assess a number per unit area. The location of specimens defied the expected. For example, after two days of strong winds in the same direction, a bird was found 16m up wind; or two fresh kills found the same morning, one 29m west and one 25m south of the same turbine. Winds varied locally depending on topography and location, and wind often varied hour by hour. The direction a bird went once hit would depend on many other factors: the direction and height it was flying and hence at what height and on what side of a turbine it may have struck the blade and the speed of blade rotation at that point.

In addition, the distribution of kills around turbines was not uniform. About 46% were found within 10m of the tower (searchable all year at almost all turbines). But, the area which could potentially be searched increases greatly with increasing distance from the tower. If the number found within 10m really did represent the density of kills, and if one assumed an equal distribution of carcasses, the mortality estimate would be quite large.

Also, birds were not distributed uniformly around a turbine with respect to compass direction. In 2007, some 45% of birds found were in the western quarter (where 34% of roads were) and only 11% were in the eastern quarter (also with about 34% of roads there); the remaining birds were distributed as follows: 23% to the north and 21% to the south. But, in 2006, it was 33% to the west, 20% east, 13% north and 33% south. The dispersion will vary year to year depending on many factors, and cannot be assumed to be uniform.

Furthermore, in 2006, birds thrown out for scavenger removal studies (see below) were only being checked once a week. It should be obvious that scavenger removal rate is a variable, with more birds disappearing through the week the longer they have been out (until about a week old when they are so well rotted as to be of little further interest) (Figure 2). Just checking birds once a week, as initial guidelines recommended, provided only one removal rate. Yet at the same time there is a higher probability of finding fresh kills because of scavenger removal. Applying a week long removal rate to mainly fresh kills would also inflate mortality rate. Through the spring of 2007, it was becoming clear to me that the procedures being followed were not going to provide an accurate estimate of mortality.

Figure 2: A well rotted dead passerine bird that would not likely be of much further interest to a scavenger. *Photo: Kevin Dance*

Revised Sampling: Visual searching can never account for everything. Effective sampling is necessary. But, trying to guess the area searched, and considering an even distribution of mortality around turbines was proving to be impossible. In the autumn of 2007, I followed a different procedure, building on what was already being done, but paying more specific attention to scavenger removal and search timing. It was anticipated that these procedures might permit the estimation of mortality by several different methods.

I considered six turbines (in 2007; five in 2006) as control areas. At these turbines it was possible to search grassy areas around these turbines throughout the year as they were in orchards where grass was routinely mowed throughout the year. Using these controls, it was possible to get a measure of the proportion of mortality found on laneways compared to surrounding fields.

I also carefully selected four sets of eight turbines to sample over four days each week. These 32 were chosen because they represented turbines across the entire wind farm in proportion to the numbers found in eastern and western sectors. Half were closer to trees; half were more than 50m from trees to the base of the tower, half had lights; they encompassed those close to the Lake Erie shore as well as those further inland; they included some with the highest mortality in 2006, and included four of the six controls. I started searches at these sets as soon as light permitted (shortly before sunrise) and searched as quickly as possible, while taking as much time as needed for a careful search of available area, visually or actually accessible.

Since most mortality is nocturnal, early surveying allowed the most accurate assessment of daily mortality at a sample of turbines each day (considering fresh specimens only), while minimizing scavenger removal. The two other control turbines, not part of these 32 early morning sets, were given priority for searching as soon as possible in the morning. The order of the set searched varied week to week as did the scavenger removal trials. At these 32, the search on laneways was extended to 80m to assess what proportion of mortality might be found beyond the usual 40m search radius. All other turbines were searched once a week as time permitted.

It is difficult to know exactly how long a turbine kill has been lying on the ground. However, it is possible to tell if the carcass is fresh or nearly fresh, has been there only a few days (fly eggs and with a distinct odour) or is more nearly a week old or older (maggoty, rotted, ripe or already dehydrated). In this way birds found could be divided into three time periods. This was always done conservatively, assigning birds to an older time period when uncertain. These three categories were used because not only specimens from the autumn of 2007 could reasonably be assigned to a time group, but also it was possible to go back through the record of all carcasses from 2006, and the spring of 2007, and similarly assign them to one of the three age groups.

Scavenger Removal Trials: To estimate how quickly scavengers removed carcasses before they could be found, birds of various sizes were deliberately thrown out and monitored for removal. In the autumn of 2007, six birds were thrown out every week (and four fresh birds were left in place) for a total of 64 birds. No turbine ever got more than one bird per month and birds were widely scattered across the wind farm. This avoided attracting predators to any one place, and accounted for any potential change in predators throughout the season. Specimens were thrown out roughly as expected of kill distribution — most within 10m of the tower, some on laneways and relatively few beyond 20m. Most were medium to small birds corresponding to what is typically found as mortality. They were thrown out on Monday afternoons, prior to one hour before sunset. They were checked again the following day to provide a one-day removal rate. Any remaining carcasses were checked again on Friday to provide a mid week removal rate, and again on the following Monday to provide a week-long removal rate. In calculating mortality, the three removal rates were then applied to the three time periods in which the carcasses found could readily be assigned.

Observer Efficiency Trials: Several methods were tried, but the most comprehensive and effective involved two people simultaneously throwing out birds for each other at different turbines out of sight of each other, and then switching turbines, and doing our regular searches. First we threw out a variable number on grassy, but cut fields. Then we threw out from 0 to 2 birds on laneways and switched to do our regular searches. A total of 28 birds was used — 20 on grassy fields and eight on laneways. All birds used were thrush size or smaller, assuming any large birds would be readily apparent. While such searches were not conducted in secret, there were many reasons for not even trying to do so — impractical if not impossible, unduly complicating a study, and, to some, interfering with a study and even dishonesty. The method outlined avoided potential scavenger removal or movement, trespassing, scheduling problems, and carcass durability study, plus provided immediately useful results on different substrates and did not entangle the studies.

Estimating Mortality: To estimate avian mortality at the wind farm, several different data sets (from different groups of turbines) were considered, and several different calculations were made with some data sets where possible (for varying areas and time periods). In all calculations, adjustments were made for scavenger removal and for observer efficiency. Where only birds found in autumn were used, adjustment was made for those potentially missed in spring. Where only those found within 40m were used, adjustment was made for those potentially found beyond that distance. For all calculations, correction factors were applied to arrive at a mortality estimate of the number of native birds per turbine per year (hereafter nb/t/y).

Method 1 – Controls, using numbers of native birds found at turbines searchable all around, first using only the six from the autumn of 2007, and then combining with the five from 2006. Calculations were made using only birds found on laneways, then using all birds found.

Method 2 – 32 Sampled Turbines, One Day Mortality, using only the number of fresh native birds found on laneways, as a proportion of those expected had it been possible to search all turbines every day each week.

Method 3 – 32 Sampled Turbines, All Carcasses on Laneways, using the number of native birds of any age found on laneways as a proportion of those expected had it been possible to search all turbines every day each week.

Method 4 – All Turbines, using numbers of native birds found at all turbines, first birds found only on laneways, then anywhere around turbines, for 2007 alone and then combined for 2006 and 2007. Additional calculations were done to allow mortality rates for all birds including non-native birds.

Results

Carcass Durability: Some carcasses will disappear after a week, even after two, but if not removed within a week, particularly in warm weather, most are no longer of interest to scavengers. Some older carcasses may be moved, even over several metres, as if just being played with. However, a Red-eyed Vireo (*Vireo olivaceus*) was visible for more than two months. A Ruby-throated Hummingbird (*Archilochus colubris*), in grass, was still visible after 3.5 weeks. A couple of kinglets remained visible for four and 4.5 weeks each (Figure 3). Hermit Thrushes (*Catharus guttatus*) remained visible for 11 and 12 weeks. Birds as small as Brown Creeper (*Certhia americana*), Hermit Thrush and Cedar Waxwing (*Bombycilla cedrorum*), thrown out for scavenger removal in October 2006, were still visible after 5 months, in March 2007.

Figure 3: Kinglet that has been dead for some time. Such a carcass would likely remain untouched and visible for several weeks even in a grassy area. *Photo: Kevin Dance*

Search Results: It was readily possible to find even small feathers, either on grass or bare soil. These were molted feathers and had nothing to do with mortality. Damage to birds was typically minimal, many showing no visible external sign of injury. For a number of birds no cause of death could be established, however, birds were generally considered turbine kills if found near turbines, even when cause of death was uncertain. During 2006, from 7 May to 15 June (6 weeks) and 16 August to 15 November (14 weeks), the number of native bird species found was 29 (plus one found by K. Dance) and in 2007, from 1 May to 15 June (8 weeks) and 21 August to 8 November (12 weeks) there were 29 found also, as follows:

In 2006

Turkey Vulture (*Cathartes aura*)	1
Sharp-shinned Hawk (*Accipiter striatus*)	1
Virginia Rail (*Rallus limicola*)	1
Mourning Dove (*Zenaida macroura*)	1
Yellow-bellied Sapsucker (*Sphyrapicus varius*)	1
Warbling Vireo (*Vireo gilvus*)	2
Red-eyed Vireo(*Vireo olivaceus*)	4
Bank Swallow (*Riparia riparia*)	3
Golden-crowned Kinglet (*Regulus satrapa*)	6
Ruby-crowned Kinglet (*Regulus calendula*)	2
Hermit Thrush (*Catharus guttatus*)	1
Cedar Waxwing (*Bombycillia cedrorum*)	2
Magnolia Warbler (*Setophaga magnolia*)	2
Yellow-rumped Warbler (*S. coronata*)	1
Black-and-white Warbler (*Mniotilta varia*)	1
Indigo Bunting (*Passerina cyanea*)	1

In 2007

Cooper's Hawk (*Accipiter cooperii*)	1
Red-tailed Hawk (*Buteo jamaicensis)*	1
Ring-billed Gull (*Larus delewarensis*)	1
Mourning Dove	1
Ruby-throated Hummingbird	2
Downy Woodpecker (*Picoides pubescens*)	1
Least Flycatcher (*Empidonax minimus*)	1
Philadelphia Vireo (*Vireo philadelphicus*)	2
Red-eyed Vireo	7
Blue Jay (*Cyanocitta cristata*)	2
Horned Lark (*Eremophila alpestris*)	1
Bank Swallow	3
Barn Swallow (*Hirundo rustica*)	1
Golden-crowned Kinglet	1
Ruby-crowned Kinglet	1
American Robin (*Turdus migratorius*)	1
Magnolia Warbler	1
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	1

Figure 4: Dead bat, a fresh carcass, and showing no visible sign of injury. Bats were more frequent victims than birds, but both were often found showing no sign of injury outwardly, and very few had a severed part. *Photo: Kevin Dance*

The majority of turbine-related mortalities was passerine birds as expected (79%) of which nocturnal migrants made up about half the passerines (48.9%). Although there were hundreds of diurnal raptor migrants observed, and thousands more unseen diurnal migrants that would have passed low enough to be at blade height, we found only one migrant each year over 12 weeks of searching in autumn (Figures 4 and 5). It is likely that few if any more were missed. Larger birds are readily visible if present, and even where scavenged, numbers of feathers are typically left behind, feathers that would last over many weeks, and visible in fields even after crops were harvested. Despite thousands of diurnal passerine migrants observed in autumn, only five casualties were found in the migration season, and two or three may not have been migrating yet. Of all casualties, only six species were found both years, all very common species, and for most, numbers fluctuated from year to year.

Towers Involved: Native bird species were found at 19 turbines in each of the two years of study, extending over the extent of the wind farm. Only four of 66 turbines (6%) had bird kills in both years, and at 33 turbines (50%) no mortality was ever found. In 2006, a disproportionate number was found in the eastern sector. In 2007, this trend was reversed.

Figure 5: A larger bird readily visible. Note the wing apparently severed. One of a very few instances of such an injury and one of a very few raptors killed despite thousands in the area each autumn. *Photo: Kevin Dance*

Over the two years, the distribution of mortality was close to the proportion of turbines in each sector (30% of mortality at 36% of turbines in the western sector). Usually, only 1 or 2 birds were found at any one turbine; one had three in 2006, and one had five in the western sector in 2006; one in the eastern sector had five in 2007. Any of the higher numbers observed at one turbine in 2006 were not repeated the following year. Again, the distribution of mortality was not found to be uniform or predictable.

Scavenger Removal Rates: Removal rates for the 64 birds in the autumn of 2007 were: One day – 17.2%; at mid week – 43.7%; after one week – 54.7%. These rates were used in all calculations of mortality.

Observer Efficiency: On first searches, in the autumn of 2007, with the usual search times, 21.4% of carcasses were missed. This rate was used in correcting mortality calculations. More of the birds thrown out, but missed on the first search, were found on subsequent searches at a later date, as would be expected for any searches for turbine mortality. But, the additional birds were not considered in adjusting rates. The higher rate from the first search was used in all calculations.

When using a different method to assess observer efficiency in spring, a higher proportion was found when there was less plant growth. If anything, the observer efficiency rate used in mortality calculations tended to maximize the mortality estimates.

On Versus Off Laneways: In determining a correction factor for use in adjusting mortality found on laneways only, to account for the proportion found in fields, the proportions found on and off laneways were considered at: the controls, the selected 32, and all towers, in spring, in autumn, and all year, in 2007; at controls only, and at all towers in 2006; at controls, and at all towers in 2006 and 2007 combined. The highest proportion of off-laneway mortality was found at the control turbines, whether in 2006 (83.3%), in 2007 (85.7%), or for both years combined (84.6%). The controls were considered to provide probably the most accurate proportion, given the unpredictable scatter of birds around turbines. The results at the controls were also relatively similar each year or when combined. In all calculations of mortality of native birds, the highest proportion (85.7%) was used for the proportion expected off laneways. This also tended to maximize the mortality estimates.

Distance from Turbine Towers: Carcasses were found from the base of towers up to 46m away (average 17.7m). More than 80% were within 30m, and only about 5% were beyond 40m (8.7% of those found on laneways). The proportion found on laneways only, beyond 40m, was highest for the 32 selected turbines specifically searched for them in the autumn of 2007 (at 20%). This proportion was used in corrections for the proportion beyond 40m, although it may not have been the most accurate, as it represented only one bird of only five found.

Proportion Found in Spring: As with the previous adjustment, many different possibilities were considered. However, because of the unpredictable distribution in time and space, and nothing found in several instances, most were unusable. The highest sample sizes and most consistent proportions came from the use of all mortality found at all turbines. In any calculations involving a correction for a proportion found in spring, the proportion for the appropriate year(s) was used: for 2007 – 26.1%, for 2006 – 25%, and for the combined years 25.5%.

Mortality Estimates

Method 1 – Control Towers

Calculations using native birds found only on laneways gave mortality estimates of 0.54 (2007) and 0.53 (2006) nb/t/y. However, using all carcasses found gave estimates of 2.38 (2007) and 2.4 (2006 and 2007) nb/t/y.

Method 2 – 32 Sampled Turbines, One Day Mortality

Only one native bird was found, yielding a mortality estimate of 0.87 nb/t/y.

Method 3 – 32 Sampled Turbines, All Carcasses on Laneways

Only three native birds were found, giving a mortality estimate of 0.6 nb/t/y.

Method 4 – All Turbines

Mortality estimates using birds found only on laneways at all turbines combined ranged from 0.41 to 0.66 nb/t/y with data from either 2006 or 2007 or both years combined. Mortality estimates using birds found anywhere around all turbines combined ranged from 0.72 to 0.75 nb/t/y with data from each year.

Discussion

Mortality estimates calculated from birds found only on laneways and extrapolated to the total area, gave estimates that were always below one. While laneways are the only areas that are always searchable, using only numbers found on laneways to estimate mortality provided low estimates compared to other North American installations (Erickson *et al.* 2001, National Wind Coordinating Committee 2010). The relatively small sample sizes, combined with the variable and uneven distribution of carcasses around turbines could readily skew results. Using laneway carcasses is undoubtedly an inaccurate method of estimating mortality. It would also be reasonable to rule out any method that relied on only one or two specimens, where estimates were also very low (*e.g.* Methods 2 and 3).

Mortality estimates calculated from all birds found around all turbines also tended to be lower than elsewhere in North America. In these estimates, there was a variable area searchable through the year, with much if not all of the off-laneway fields unavailable at times. At the control towers, the average distance from the turbine tower at which birds were found was 23.3m (versus 17.7m at all turbines) and only 15.4% were within 10m of the tower (versus 46.4% at all turbines). This further indicates that a significant proportion of carcasses are being missed where fields around a turbine cannot be searched during much of the year. Despite most carcasses being found closer to the turbines, an unknown proportion are going to be missed, giving inaccurate results.

At the control turbines, the mortality estimates were close to two, and with a correction factor for a proportion missed beyond 40m (obtained from laneways of other turbines), the estimate was about 2.4 birds/turbine/year — closer to what might be expected from other studies. This would suggest that estimates from areas that can be searched all year are the only ones that are going to provide reasonable estimates of mortality. However, the correction factor used for a proportion beyond 40m (20%) could be high, as it was based on a very small sample size. In all of the searches conducted at all turbines over two years, the proportion found on laneways beyond 40m was only 8.7%. Birds on laneways are typically readily visible, many seen before even getting out of a vehicle to start searching. The true value is probably somewhere between 20 and 8.7 percent.

Also, two of six control turbines in 2007, and two of five in 2006, were nearshore turbines, where average mortality was apparently slightly higher (unpublished data). In the control sample, nearshore turbines made up 33% and 40% of turbines sampled in two different years, whereas in the wind farm they comprised only 13.6% of the total. This, in conjunction with all correction factors tending to maximize estimates, may have elevated the mortality estimates.

Overall, the most accurate estimates of mortality, as might be expected, probably came from areas that could be searched all year and for which the fewest correction factors were used. However, all results are compromised to an unknown extent by small sample sizes, and the varying random scatter of carcasses from year to year. Given: that correction factors used to calculate mortality tended to maximize mortality; that no more native birds were found in 2007 than 2006 when turbines were not operating for a full year; that mortality of any native birds was found at only 19 of 66 turbines (<30%) each year; that at only four turbines (6%) was any mortality of native birds found in both 2006 and 2007; that after two years of searching no carcasses of native birds were found at half the turbines; that no birds were found at all on 30% of weeks spent searching; that even when fields cannot be walked on (except carefully to retrieve a carcass), they can be scanned to some extent from laneways well beyond 10m, even to 40m for large birds; a mortality estimate of native birds of between 2 and 2.5 birds/turbine/year seems reasonable and in line with estimates from other North American installations (Friesen 2011). The estimates would have been somewhat higher (e.g. 2.58 b/t/y) had non-native Rock Pigeons (*Columba livia*) been included, or had my searches continued later in 2007 (one other casualty known).

Considering that, on average, for residential areas, from 1-10 birds per year are expected to be killed at every building, and that numbers can be considerably higher (20-30) (Klem 1990, Dunn 1993), the mortality estimates for the Erie Shores Wind Farm are about what one could expect at most any home on average. By contrast, with no attempt at systematic surveys, where scavenger removal must have been at least as high, and where vehicle traffic would quickly obliterate many, over the same search period in 2007 as for turbines, 81 native bird species were readily found dead on roads, within the wind farm, while traveling between turbines. The road kills involved more species than found under turbines each year (at least 23 species); more Bank Swallows and Mourning Doves than recorded in 2 years at turbines; 14 species never found at turbines (Killdeer (*Charadrius vociferus*), Eastern Screech-Owl (*Megascops asio*), Eastern Kingbird (*Tyrannus tyrannus*), Gray Catbird (*Dumetella carolinensis*), Brown Thrasher (*Toxostoma rufum*), Yellow Warbler (*Setophaga petechia*), Song Sparrow (*Melospiza melodia*), Lincoln's Sparrow (*M. lincolnii*), White-crowned Sparrow (*Zonotrichia leucophrys*), Common Grackle (*Quiscalus quiscula*), Brown-headed Cowbird (*Molothrus ater*), Orchard Oriole (*Icterus spurius*), Baltimore Oriole (*I. galbula*) and American Goldfinch (*Spinus tristis*)); more passerine migrants in one year than recorded in two years at turbines, and as many or more nocturnal migrants than found under all turbines in either 2006 or 2007. Undoubtedly many more could have been found by regular searches and by searching roadsides more carefully.

Despite being close to the shores of Lake Erie, where thousands of birds are known to pass in autumn, mortality was relatively low, and not out of line with mortality estimates from other wind turbine installations in Ontario (Friesen 2011). What is notable is that there was no waterfowl mortality observed, despite large numbers in the area during migration and some nesting there. Notable also is very low raptor mortality (separately estimated at 0.004 nb/t/y) despite thousands migrating through the facility every year and some summering. ESWF is not comparable to other wind farms where high raptor mortality has been recorded (*i.e.* Altamont Pass, California, and Tarifa, Spain). ESWF turbines are not lined up to winds coming from one direction, are widely spaced to deal with variable wind, and blades turn at relatively low speeds with blades visible to birds. Most mortality involved common nocturnal migrants, as is consistent with most other installations (Erickson *et al.* 2001, National Wind Coordinating Committee 2010). Given the variety of species involved, the estimated rate of mortality could not be considered significant to bird populations, particularly when compared to other sources of avian mortality (see Erickson *et al.* 2001). Diurnal birds were very lightly impacted; they were obviously unafraid of the turbines (James 2010, unpublished observations), and could readily see and avoid them.

Acknowledgements

I have benefited from, and greatly appreciated the tolerance of landowners in permitting access to their farms to carry out the study. I thank them for their support. Conversations with several landowners were also of benefit.

Various people at International Power Canada (formerly AIM PowerGen) supported my endeavours. In particular, Ansar Gafur fielded most of my queries, and along with Mike Crawley, Jay Wilgar, Jim Wilgar, and Roy Kahn, I thank them. Pud Hunter of the Ontario Ministry of Natural Resources, Aylmer, took several days each year to join me in the field. For our many conversations and discussions, and for comments on methodology, I am very appreciative. He, along with Dan Elliott, were also instrumental in providing the necessary permits. A number of people at Environment Canada played a role in guiding the project, in particular, Lyle Friesen, who made several site visits.

I am indebted to David Price, along with Dennis Hagarty and Herman Kolk at Erie Shores Wind Farm, for their support through the project. Kevin Dance (and an assistant) worked independently in searching some turbines, in making observations of diurnal migrants and in providing observations that paralleled my own. I appreciate their support in field trials and with observations. Glenn Murphy and Mark Peck at the Royal Ontario Museum also contributed to fieldwork.

And, to those who contributed opposition and negativity, I also offer recognition. They provided incentive to carry on over many tedious weeks of searching for a problem that, for birds at least, remains elusive. I would invite them, and anyone else, to go and stand near a turbine during the autumn migration, to see what I have seen — thousands of birds moving as usual through the wind farm along the shores where they have gone before.

Literature Cited

Black, J.E. 1998. Ontario spring bird migration on weather radar. Birders Journal 7:310-315.

Black, J.E. 2000. The Ontario spring bird migration on weather radar: an update. Birders Journal 9:37-39.

Dunn, E.H. 1993. Bird mortality from striking residential windows in winter. Journal Field Ornithology 64:302-309.

Environment Canada. 2006. Recommended protocols for monitoring impacts of wind turbines on birds. Environment Canada, Canadian Wildlife Service. (For updated versions seewww.cws-scf.ec.gc.ca/publications/eval/index_e.cfm)

Erickson, W.P., **G.D. Johnson**, **M.D. Strickland**, **D.P. Young, Jr**., **K.J. Sernka** and **R.E. Good**. 2001. Avian collisions with wind turbines: a summary of existing studies and comparisons of other sources of avian collision mortality in the United States. National Wind Coordinating Committee, Washington, D.C. (www.nationalwind.org)

Field, M. 2004. The Hawk Cliff Raptor Banding Station 1969-2002. in Birds of Elgin County. Elgin County Naturalists, St. Thomas.

Friesen, L.E. 2011. No evidence of large-scale fatality events at Ontario wind power projects. Ontario Birds 29:149-156.

James, R.D. 2008. Wind turbines and birds: the Erie Shores Wind Farm experience: nesting birds. Ontario Birds 26:119-126.

James, R.D. 2010. Wind turbines and birds: behaviour of migrant Blue Jays in relation to tree cover and wind turbines. Ontario Birds 28:87-92.

Klem, D. Jr. 1990. Collisions between birds and windows: mortality and prevention. Journal Field Ornithology 61:120-128.

National Wind Coordinating Committee. 2010. Wind turbine interactions with birds, bats and their habitats: a summary of research results and priority questions. http://www.nationalwind.org/

Richardson, W.J. 2000. Bird migration and wind turbines: migration timing, flight behavior, and collision risk. Proceedings National Avian-Wind Power Planning Meetings 3:132-140.

Ridout, R. 2010. A birding guide to the Long Point area. Bird Studies Canada, Port Rowan.

Ross D. James
S1480 Conc. 7
Sunderland, ON L0C 1H0
E-mail: rossjoann.james@sympatico.ca