

Pickering Wind Turbine
Bird Monitoring Program in 2002

Ross D. James, Ph.D.

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Pickering Wind Turbine Report on Bird Monitoring in 2002

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Executive Summary

A 1.8 MW wind turbine was installed at the western end of the Pickering Nuclear Generating Station, and began operation in the autumn of 2001. It was placed in an area with a rich bird life throughout the year; a river and marsh border on the west, Lake Ontario on the south, and parkland to the north. To estimate bird mortality associated with the wind turbine, ground searches were made from late January to early December 2002, covering a radius of at least 50 m around the tower. Searches were made as often as three times a week during the main migration seasons, and once per week most of the rest of the year. A predator removal study was also conducted, and observations of bird behaviour were noted during each visit.

Local bird populations quickly adapted to the presence of the turbine. They continued to live around it in places they normally occupied, even nesting in close proximity. Birds flying at rotor height largely passed more than 100 m from the turbine, but some came much closer, and there was no indication that the birds were afraid to be in the area. Marsh nesting species and migrants continued to use the available habitats as would normally have been expected. Dogs and other predators proved to be inefficient at finding dead birds that were placed out, and remains were left behind for half of the few that were found. It is unlikely that turbine kills were missed in searchable areas.

Two common small nocturnal migrants were fairly obvious turbine casualties, and one common local nocturnal forager was probably also a casualty. Migrating birds of prey were unaffected. Overall, I would estimate that probably no more than four birds were killed by the turbine through the year. This level of mortality is absolutely insignificant when compared to tall buildings and communications towers that each regularly kill hundreds of birds each year. The level of mortality at the wind turbine is comparable to that of an individual house. Clearly the turbine is having no significant impact on bird populations.

Other wildlife, likewise, did not appear to be significantly affected by the turbine. Bats apparently suffered about twice the mortality of birds, but the species involved are also widespread and relatively common species. Neither monarch butterflies or large dragonflies suffered any detectable mortality.

Introduction

This report presents the results of a monitoring program at the Pickering Wind Turbine, installed by Ontario Power Generation (OPG) at the western end of the Pickering Nuclear Generating Station (PNGS) in 2001. The purpose of the monitoring program was to estimate bird mortality associated with the installation of this turbine. The program ran through 2002, sampling all seasons of the year, with emphasis on bird migration times, when there was the greatest possibility of mortality.

The Study Site

The wind turbine was placed in the west landfill area at the west end of the Pickering Nuclear Generating Station (Figure 1). To the north of the west landfill is Alex Robertson Park, an area of open lawns and number of deciduous and coniferous trees placed about the area. To the west is Hydro Marsh, which has open water areas, cattail stands, and is bordered by shrubs and more trees. To the north end of Alex Robertson Park, along Kronso Creek that flows into Hydro Marsh, there is a small wooded area. To the south of the landfill is Lake Ontario. Between Hydro Marsh and the lake is a barrier beach. The Waterfront Trail passes through the south end of the park, around the turbine site and along the barrier beach. Other paths circle most of the park. A parking lot near the northeast corner of the park provides access to visitors to the park.

The turbine site, then, surrounded on three sides as it is by lake, marsh, and open parkland, is in a unique situation with respect to wildlife. Compilations of the wildlife have been made in connection with environmental assessment reports (Marshall, Macklin, Monaghan 2000, LGL 1992) and wildlife atlases (Cadman, Eagles and Helleiner 1987, Dobbin 1994). These compilations indicate that the area is frequented by numerous species, often in considerable numbers.

The marsh and adjacent creek provide foraging, nesting, roosting, and shelter for cormorants, herons, waterfowl, rails, shorebirds, gulls, terns, and songbirds of many kinds. Common species in 2002 included Double-crested Cormorant, Black-crowned Night-Heron, Canada Goose, Mallard, Ring-billed Gull, Common Tern, Song Sparrow, Swamp Sparrow, Red-winged Blackbird, and Common Grackle. The Park provides foraging, nesting, and roosting for a variety of species, most notably Canada Goose, Killdeer, Ring-billed Gull, Mourning Dove, European Starling, Common Crow, House Finch, and American Goldfinch. Numerous migrant songbirds also stopped temporarily in the park both spring and autumn. The waters of Lake Ontario provide foraging and loafing areas for a wide variety of waterfowl, plus cormorants, gulls, and terns. Herons are also frequent along the shores. A warm water discharge to the lake (from the generating station) maintains open water conditions all winter that is particularly attractive to waterfowl. Overall more than 100 bird species could be expected over the course of the year, with another 100 or more species as possible visitors. It is an area rich in bird life.

The west landfill area itself is fenced off from the park, with access through the PNGS. The area monitored included areas inside and outside of the fence, within a 50 m radius of the tower, for the most part. The ground cover in the surrounding areas of the tower is presented in Figure 2. Within a 50 m radius, mowed lawn and paved trail covered about 24 % of the area; bare gravel and roadway covered about 29 %. Together 53 % of the area could be searched thoroughly throughout the year. The uncut grassy areas, and the open shrubs on the west side of the landfill, covered about 23 % of the area. These could be searched at least for any medium or large sized bird throughout the year. The shrubbery and weedy areas around the marsh to the southeast of the turbine, and along the Hydro Marsh to the west (12 %) could be searched for large birds at least until early June, and to varying degrees late in the year. The marshy areas (12 %) were basically not searched, although I certainly scanned the edges as best I could, particularly until early June, for anything large that might have been there.

The Turbine

The wind turbine is a Vestas V80, 1.8 MW, constant speed model, with a tower standing about 78 m high. The variable pitch blades are 39 m long. The rotation is a constant 15.3 rpm. The generator is very quiet. The main audible sound, which was minimal, resulted from the sweeping of the blades through the air. The noise was not sufficient that I noticed anyone in the park reacting negatively to it. The sound would, however, be audible to any birds approaching the turbine, and could warn them of its presence.

Procedures

Monitoring

Direct visual searches were mainly concentrated within 50 m of the turbine tower. However, I regularly scanned beyond that distance for anything obvious farther away, and I often extended the search for 20 or 30 m downwind, where possible, following days when strong winds might have carried something farther away. Searches lasted about an hour each time. I walked a pattern that covered all searched area at intervals of about 5 m or less. I varied the approach and specific path somewhat in order to see things from a different perspective, or to be closer to somewhat different parts of the area. But, I was to a large extent guided by the layout of the area being searched.

Searches were usually made on the same day or days of the week, in order to get fairly even coverage. The weather was random with respect to searches, and weather did not inhibit any search; all weather conditions were encountered. Searches were made about every 2 weeks between 1 January and 9 March, and between 27 October and 12 December. From 10 March to 4 May, 2 June to 17 August, and 22 September and 26 October, searches were made once per week. Search frequency increased to 3 times a week from 5 May to 1 June and from 18 August to 21 September.

Predator Removal Study

This study was conducted to assess the potential for removal of dead birds by predators prior to being found on searches. I placed dead birds within 50 m of the turbine tower on a variety of ground covers. While I tried to avoid putting birds where they might be found by park users, I did place a number close to areas regularly used by people.

Results

Bird Behaviour

Canada Geese were numerous in the area throughout the year. They foraged regularly in the park, and loafed/roosted along the lakeshore. They flew back and forth past the turbine virtually every day. Typically they flew wide of the turbine, moving north and south over Hydro Marsh or to the east end of the landfill and the west end of the generating station. They were obviously aware of the turbine, and simply avoided it most of the time. But obviously they were not afraid of it. A few birds were seen to fly past very close to the turbine even when it was in operation. And when flying close past the tower did not make sudden panic manoeuvres to avoid it, but continued directly on their flight, even when it brought them within a few metres of the turning blades. They also landed on the landfill and walked all about, even right beside the tower when the blades were turning above them.

Other waterfowl were present in varying numbers throughout the year, more so in migration and nonbreeding season. Most were in Hydro Marsh or on the lake, and regularly flew back and forth over the barrier beach between, although not necessarily near the turbine. A few ducks, principally Mallards, did fly over the landfill area within 50 m of the turbine, and regularly flew into the small marsh southeast of the turbine, landing within 30 m of the tower. A pair of mallards nested in the small marsh about 35 m from the tower, below the turning blades. Swans were present in Hydro Marsh throughout the year, and were out on the lake sometimes. They flew about the area, and I saw 5 fly over the east end of the landfill one day when the turbine was in operation. Again, these waterfowl seemed to be aware of the potential hazard, but were not inhibited from living in close proximity.

Ring-billed Gulls were common in the area throughout the year, and regularly flew back and forth from the lake to inland areas. They also landed on the grass of the park on numerous occasions, flying in and out as they wished. As with geese, they were obviously aware of the turbine and typically flew wide of it, over Hydro Marsh or to the east end of the landfill area. On occasion, however, they flew much closer to the operating turbine blades without showing any alarm.

Small numbers of Black-crowned Night-Herons were seen foraging in Hydro Marsh much of the summer and autumn, and regularly flying back and forth from the marsh to the outflow area of the PNGS. They usually also stayed well clear of the turbine, but occasionally were seen flying within 50 m of the tower below the operating blades, and certainly visited the small marsh to the southeast of the turbine. They were not unduly disturbed by the turbine. Great Blue Herons were in Hydro Marsh on many

occasions, flying over the park and the marsh. None were seen close to the turbine, but their usual activities did not seem to be interrupted in the least.

Common Terns remained in Hydro Marsh through the summer, nesting on a raft there. As many as 70 birds could be seen at one time. They often flew above the marsh, and out over the lake, but seldom came over land near the turbine. I rarely saw one over the landfill, or as close as 50 m from the tower. The turbine did not interfere with their normal feeding or nesting activity.

Killdeers were regular users of the gravel areas of the landfill, and flew in and out to the park every day through the summer. One pair nested within 60 m of the tower. They regularly walked all about the turbine area, even within a few metres of it when in operation. Several Spotted Sandpipers visited puddles on the landfill. Migrant shorebirds of many species foraged in Hydro Marsh on migration spring and autumn. Although I did not see any of the other shorebirds close to the turbine, they could easily have come that way. The wind turbine did not interfere with the regular shorebird activities.

Double-crested Cormorants were regular users of Hydro Marsh and the adjacent lake through most of the year. When the turbine was in operation, they ordinarily stayed well clear. I did see one fly right under a blade close to the nacelle one day when the blades were not turning.

A flock of Rock Doves lived in the generating station and regularly flew about the park and toward Hydro Marsh. I regularly saw them fly over the landfill area, usually well clear of the blades. On one occasion four flew between stationary turbine blades. Some foraged on the ground near the turbine with no concern about its operation.

Considering that hawk migration in the autumn brings hundreds of hawks relatively close to Lake Ontario, I saw very few close to the turbine. They apparently moved along the shore in a more inland location this year. I did see a Merlin in the park, and several Sharp-shinned Hawks. When the turbine was not operating I watched one Sharp-shinned Hawk soar up right past the nacelle within a few metres of it. One flew across the landfill very close to the tower when the turbine was operating, but well below the blades. I watched another chase a bird within 25 m of the turbine when in operation, but again well below the blades. As with other birds, there was no apparent fear of coming close, while remaining clear of potential danger as necessary.

Summer resident songbirds of several types were regularly encountered near the turbine. Red-winged Blackbirds, Common Grackles, American Robins, Mourning Doves, Song Sparrows, European Starlings, American Goldfinches, House Finches, Barn Swallows, and Yellow Warblers were the most numerous. All were seen close to the tower, whether operating or not, and seemed to pay no particular attention to the turbine above. Their activities were largely close to the ground below the blades, but not exclusively so for some. Several nested near the turbine: Red-winged Blackbirds within 30 m, Song Sparrow within 50 m, Common Grackle within 50 m, and American Robin within 30 m. There were broken eggs of Mourning Dove and Cedar Waxwing on the

ground within 50 m, suggesting they may have nested close also. A goldfinch or warbler nest (depredated and torn up) was within 50 m of the tower.

Several other species such as Gray Catbird, Warbling Vireo, Northern Cardinal, and Downy Woodpecker frequented the trees and shrubs of the landfill near the turbine. Swallows of several species foraged over the landfill area. Numerous migrant songbirds were seen in the trees of the park, marsh and landfill. Several times when the turbine was not operating, I observed small birds within a few metres of and between the turbine blades. Overall these small birds seemed well aware of the turbine, but were not inhibited from normal daily activities right below and around the turbine.

Other Wildlife

From mid August until early October, at least a few monarch butterflies were regularly seen in the landfill and park area. In mid September as many as 20 per hour were seen drifting past on migration. They roosted in trees below the operating turbine and fed on flowers there also. Typically they were close to the ground well below the operating blades. Only when they drifted up and out over the lake did they go high enough to have come into contact with the turbine blades.

Likewise, large dragonflies migrated through the area in late summer, and 20 to 30 per hour were seen one day. All that I observed were close to the ground well below the turbine blades.

Predators and the Predator Removal Study

I typically arrived and searched outside the fence starting before sunrise. I occasionally came at other times. Most days, however, I arrived prior to any people or dogs that may have removed birds. Some dogs and people usually passed while I was there, but they were on or close to the paved trail to the west of the tower.

Although most dogs were running loose, many stayed close to the trail. Some, however, ranged widely and some people and dogs traveled over grassy areas. It was obvious that through the day and particularly on weekends, people and dogs could be anywhere outside the fence.

There were numerous borrow dens in the landfill area. Some were woodchuck burrows, but others were used by other species. There were a few fox tracks, and one den appeared to be large enough to have been used by foxes. Digging in the landfill area indicated skunks were present. There were raccoon tracks regularly seen after each rain. There were at least two feral cats roaming the area. Several times half eaten mice and snakes were found attesting to the presence of these predators.

Common Crows were fairly regularly seen about the park and landfill areas from winter to early summer. However, when they came close to the turbine they were usually distracted by attacks from Red-winged Blackbirds and/or Common Grackles, and were quickly chased away. In summer and early autumn they were virtually absent (west Nile

virus). More were seen again after the end of September as migrants began to move through.

Gulls were present every day through the year, but they generally avoided close approach to the turbine area. Although these also were potential removers of any dead birds, they were seldom within the area most likely to have had any avian casualties.

I found fresh remains of a muskrat on top of the hill south of the turbine. While they may have been carried a short distance, it is probable that it wandered into the landfill area where a predator found it. Old desiccated bones were found several times on the west side of the hill, and along the edges of the small marsh to the southeast of the turbine. A bird sternum turned up in mid April. It was also an old bleached bone, yet had not been at that place the week previously. Another bleached sternum was found near there in October. These, with a couple of raccoon skulls, were in an area of several active burrows. These were all obviously not the result of the wind turbine, but indicate the activity of mammalian predators active in the area.

Predator Efficiency

I placed out 42 dead birds, but am excluding 7 from consideration. One was placed directly on the entrance to an active burrow, in far too obvious a place to indicate predator efficiency. The six placed in the last week of the study all disappeared, suggesting that a predator, perhaps a feral cat, suddenly began searching for placed birds. But, even then, four of the six were not found for two to three days at least.

Of the remaining 35 birds, most were small (20 – warbler/sparrow sized), that were the size of those most likely to have been turbine casualties, and most likely to have been removed completely by a predator, leaving no trace of their presence. Nine medium sized birds (thrushes), and six large birds (woodcock, Rock Dove, gull) were also placed out. Fourteen were placed outside the fence and 21 inside.

Birds were placed in a variety of situations, including on areas of short grass, longer grass, bare gravel, and among shrubbery or under trees. However, I made no attempt to conceal birds. When placed on longer grass they were clearly visible from above and from one or more directions. When among shrubs I chose a spot where there was no overhead cover. When under trees, the branches were well above them so that they were easily seen from beside the tree. Thus, they were placed as if they had fallen dead on the ground. Most were placed with the lighter coloured lower surface upward, making them all the more visible.

Of the 14 birds placed outside the fence only one was removed by a predator. This is despite having placed one just into sparse weeds at the edge of a well-trodden path along the edge of the marsh, and another within 30 cm of the waterfront trail where dozens of people and dogs passed every day. The numerous dogs running loose in the park were certainly not adept at finding motionless birds. The one bird that disappeared was placed on an area of long grass. None of those on closely mowed grass disappeared.

Of the 21 birds placed inside the fence where there were no dogs, five were found. Four of these were placed on bare gravel clearly visible from all directions. Two of six large birds were eaten, and one of those was on the roadway where predators could be expected to travel. The visibility of birds on bare gravel would seem to have been a factor in their being found, as proportionately more were taken there.

Overall, 29 of 35 birds (83%) were removed by me, when no longer of interest to a predator because of the state of decay. Of the six birds found by predators, three were eaten in place and remains were clearly visible indicating they had been there. Also, of the six removed, four were removed within the first 48 hours, and two remained more than two days before being found. Only three of 35 vanished without leaving a trace (8.6%), and two of those were not found by predators for at least three days. Had I not left birds in such visible places, I doubt as many would have been found.

Avian Mortality

Over the course of the year, a total of three dead birds or their remains was found that I had to consider as probable turbine kills (Appendix 1). There were two nocturnal migrants, a Wood Thrush and a Philadelphia Vireo. Given the habitat requirements and breeding distribution of these species, they were migrants only in the area, and injuries are consistent with those expected of a bird hitting a structure in flight. They probably died as a result of flying into a tall structure in darkness, but not because they were hit by rotating blades.

There is some uncertainty about the third bird, a Black-crowned Night-Heron. They were common summer visitors to the marsh and generating station. They are also somewhat nocturnal in foraging habits. Although predators may have moved the remains, I am inclined to think it was also a casualty at the turbine. The remains found were consistent with what would be expected if the bird hit the turbine and fell dead into the grass below where it was largely consumed by a predator at that location. A smaller part of the remains probably then were removed to a second location.

I also found one recently dead European Starling that I do not think had anything to do with the turbine. There were no broken bones or any indication of hemorrhaging in the skull. It was 50 m from the tower and under a pine tree. It probably died of natural, but unknown, causes and fell out of the tree in which it sought refuge.

Projected Total Avian Mortality

The search pattern that I followed, and the ground conditions, allowed me to find even single small feathers in many places, including long grass. Dozens of feathers were removed over the course of the year. These were not the result of any interaction with the turbine, but the normal loss of feathers from passing birds. Most were found in late summer when many birds were molting. Thousands of feathers were scattered through

the park at that time. But, I do not think I missed seeing any dead birds, if they were there, in the areas that could be searched.

Searches were most frequent at the times of year when casualties were most likely to have been encountered. At other times of the year, the most likely casualties would have been large birds. If large birds had died, even if found by predators, it is highly probable that remains would have been seen since the area was checked regularly. Smaller birds were less likely to be found by predators before rotting, in which case I would almost certainly have found them. I was also able to find individual bones and feathers in areas of long grass, open shrubbery, and weeds until early June at least. And in areas of uncut grass and open shrubbery I could have found any large birds, and probably even medium-sized birds throughout the year. About 75% of the area was likely to have received thorough searching, for all but small animals, at times when casualties were more likely, and additional area was searched beyond the 50 m radius.

Predators proved to be rather inefficient at finding dead birds. When they did find birds, remains were left in half the instances. Small birds were least likely to be found, and most likely to have been found by me before any predators found them at times of frequent searching. With these considerations, and a predator removal efficiency of less than 10% of highly visible birds, it is unlikely that more than one additional bird casualty might be expected. Overall avian mortality at this location was probably no more than four birds during 2002.

Impact of the Pickering Wind Turbine on Bird Populations

This study clearly indicates that the wind turbine at PNGS has no significant impact on bird populations. The local birds soon learned of the presence of the tower and readily avoided it. There is no indication that the turbine disrupted the normal activity of local bird populations, except that some species may have flown less frequently over the area close to the tower. This redirection probably had no effect on their ability to forage and live in a typical way in this area. There is no evidence that migrants avoided the area because of the turbine. Given the many species and thousands of individuals found in the area through the year, the mortality is a tiny fraction of the numbers that lived near and migrated past the wind turbine. Only one immature locally foraging bird was an apparent casualty. Migrant birds suffered two known casualties, and if an additional bird were killed, it would likely have been a small nocturnal migrant. However, this level of mortality is absolutely insignificant when compared to tall buildings and communications towers that each regularly kill hundreds of birds each year. The level of mortality at the wind turbine is comparable to that of an individual house.

Other Wildlife

Bats

Over the course of the year a total of eight dead bats was found, and evidence suggests they were all hit by rotating turbine blades (Appendix 2). This is a surprising and unexpected result, as bats have a rather marvelous echolocation ability, allowing them to navigate in darkness, and to catch moving (flying) prey. Why they would not be able to avoid moving turbine blades in not entirely clear. There are probably several factors involved. The bats may be less efficient at avoiding a rotating object than a stationary one. They may not expect anything in their environment where they are hunting to be moving in the way turbine blades do – a very unfamiliar thing they had not had to deal with before. They may be temporarily distracted by their feeding activity. As they close in on prey, they may briefly forget about the fact that the turbine blades they know are there are moving toward them. Temporary distraction during hunting was suggested as a reason why birds of prey in California were hit more frequently than other species. And the foraging behaviour of bats, of flying about in the same area for a prolonged period (Davis 1960) may repeatedly bring them within the range of the blades increasing the chances of being hit. Perhaps all of the above contribute to an increased danger.

Most of the bats were also Red Bats, and it has been suggested that when first emerging for the night to forage, they tend to fly higher (above the trees) and that their flight is at this time slower, erratic, and fluttering (Barbour and Davis 1969). However, they are capable of being one of the fastest and manoeuvrable of flying bats (Farney and Fleharty 1969). If this initial flight pattern is involved, and there is some doubt about that (M.B. Fenton, pers. comm.) then it could increase the danger to this species.

However, none of the species found are rare. They are widespread and common over wide areas of North and Central America, and even South America (Shump and Shump 1982a, 1982b, Van Zyll de Jong 1985, Peterson 1966, M.B. Fenton, pers. comm.). The Red Bat is known to have one of the highest reproductive potentials of any bat, and is more capable of replacing losses than other species (Birney and Rising 1968, Jones et al. 1967, Van Zyll de Jong 1985).

The dates on which the first three bats were found suggested summering in the area by the three species involved. The habitat near the turbine with an open marsh and parkland for foraging, and with trees, shrubs, and buildings in which to roost during the day, would probably provide appropriate conditions for a few to summer at this site. However, the fact that only one of each of three common species was hit before late August, suggested that summering populations were not at high risk. There may be relatively few of them, or the local bats may quickly learn of the presence of the turbine as the birds did, and stay away from it.

The majority were hit in late August and early September during migration season for Red Bats (Van Zyll de Jong 1985, M.B. Fenton, pers. comm.). These bats then would be unfamiliar with and less wary of a wind turbine. Mortality among migrant birds at

least, and probably also among migrant bats, is high, and consists mainly of immature and inexperienced animals. Such losses are not necessarily of serious concern from the standpoint of population biology. Loss of habitat is a far more serious concern. As long as species have unpolluted habitat in which to live and reproduce, they can replace their losses from things such as migration mortality. This would be particularly true of the Red Bat with its high reproductive rate. The destruction of habitat by such things as pollutants like acid rain will be a far more serious problem in the long term for all wildlife than some direct mortality of migrant individuals.

The losses experienced by the bats, while regrettable, are not likely a significant impact on any of the species involved. The situation at Pickering may also be unique with respect to bats. Similar mortality may not occur at any other turbine sites. And the events of 2002 at Pickering may not be repeated in subsequent years. Movements of birds will certainly change from year to year, and I would expect the numbers of migrant bats would also vary yearly.

Monarch Butterflies

Despite large numbers migrating through the area, I only once found a dead one, and there was no clear indication that the turbine was the cause of its death (Appendix 2). Except when moving out over the lake, the butterflies were close to the ground and well below the turbine blades. The wind turbine had no affect on monarch butterflies.

Large Dragonflies

Again, despite heavy migration through the area, they were not at risk. They were close to the ground and not likely to have experienced any mortality. Only one was found and the cause of death cannot be clearly tied to the turbine (Appendix 2).

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Appendix 1 Birds casualties near the Pickering Wind Turbine in 2002, that may be attributable to the turbine.

Wood Thrush, *Hylocichla mustelina*, 15 May, 40 m to the east.

Turbine had not been operating for several days.

Nocturnal migrant species, not resident in this specific area.

Common Ontario breeding species.

Hemorrhaging on head, typical of collision injury.

Broken wing, may be the result of a long fall onto bare gravel, or strike in flight.

Probably hit turbine blade when flying in darkness.

Philadelphia Vireo, *Vireo philadelphicus*, 23 August, 1.5 m northeast.

Nocturnal migrant species at this locality.

Common Ontario breeding species.

Hemorrhaging on head, typical of collision injury.

No broken bones.

Probably hit tower when flying in darkness.

Black-crowned Night-Heron, *Nycticorax nycticorax*, 10 Oct., 20 m south and 30 m north.

Main part in long grass south of tower on landfill hill. Small part outside fence also in long grass.

Mostly eaten, feathers and a few bones left behind.

Local summer/autumn resident (non breeding), feeding in Hydro Marsh and around PNGS outflow.

Immature bird.

Nocturnal species to some extent, often flying at night.

Species regularly observed flying between Hydro Marsh and PNGS, often over south end of landfill area.

Scatter of remains consistent with what was seen with other scavenged large birds placed near the tower.

Probably hit flying in darkness, possibly in combination with poor weather, and fell to ground where main part of remains were found; smaller part subsequently dragged outside the fence by predator.

Appendix 2. Other wildlife casualties found near the Pickering wind turbine.

Hoary Bat, *Lasiurus cinereus*, 4 July, 15 m northeast.

Back broken and separated. Apparently also hit in corresponding place on left wing, with skin broken there.

Probably hit by rotating blade.

Red Bat, *Lasiurus borealis*, 19 July, 5 m east.

Left wing broken near elbow. Back badly scraped right across in line with the direction of the injury on the wing.

Probably hit by rotating blade.

Big Brown Bat, *Eptesicus fuscus*, 2 August, 50 m east.

Left wing membrane in tatters. Left leg and surrounding part of body torn out.

Probably hit by rotating blade tip.

Red Bat, 23 August, 20 m west.

Skin on both wings loosened or scraped off over bones as if hit a glancing blow from above right across the body and wings.

Probably hit by rotating blade.

Red Bat, 29 August, 20 m northeast.

Left wing broken near body. Head missing.

Probably hit hard by rotating blade. Head could have fallen in nearby bushes – predator would be expected to have eaten the body.

Red Bat, 2 September, 25 m southwest.

Hit hard across lower abdomen; skin broken, hemorrhaging there.

Probably hit by rotating blade.

Red Bat, 6 September, 25 m northeast.

Hit hard across right shoulder, tearing skin off upper arm and back.

Probably hit by rotating blade.

Red Bat, 16 September, 15 m northeast.

Top of right forearm with skin torn back toward body. Bloody spot on lower back.

Probably hit by rotating blade.

Green Darner Dragonfly, *Anax junius*, 27 August, 55 m southwest.

Head loose, thorax cleaned out (ants), otherwise basically intact. Activity of ants may have loosened head.

Cause of death uncertain.

Monarch Butterfly, *Danaus plexippus*, 3 October, 40 m northwest.

Dessicated, but otherwise intact except for ants eating out the thorax.

Cause of death uncertain.

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