# Avian window strikes at a Toronto office building, with regular opportunistic scavenging by American Crows (*Corvus brachyrhynchos*)

*Emily Giles, Peter J. Ewins and Sarah Zachariah*

## Introduction

Bird mortalities caused by collisions with buildings is now known to be a leading cause of direct human-induced avian mortality in North America, second only to predation by domestic cats (Dunn 1993, Klem *et al.* 2004, Blancher 2013, Loss *et al.* 2014). In Canada alone, it is estimated that between 16 and 42 million birds die annually from collisions with buildings (Machtans *et al.* 2013). Large cities like Toronto, Ontario, pose a particular problem for migratory birds. Toronto contains over 950,000 registered buildings that have the potential to kill an estimated 1 to 9 million birds annually (FLAP 2015).

Although window strikes can occur during any time of day or night, many studies show that the majority of collisions occur during daylight hours (Gelb and Delacretaz 2006). Many migratory birds die in head-on collisions with glass during the day due to the reflective and/or transparent qualities of glass windows (Hager *et al.* 2008). Birds cannot detect glass, but instead see the reflection of vegetation in the window, mistaking the deadly glass window as habitat or a safe passageway (Klem *et al.* 2004).

Although substantial anecdotal evidence suggests that daytime window collisions are a significant issue in Toronto, very few published scientific studies in peer-reviewed journals exist. Bird collisions have been noted by staff working at

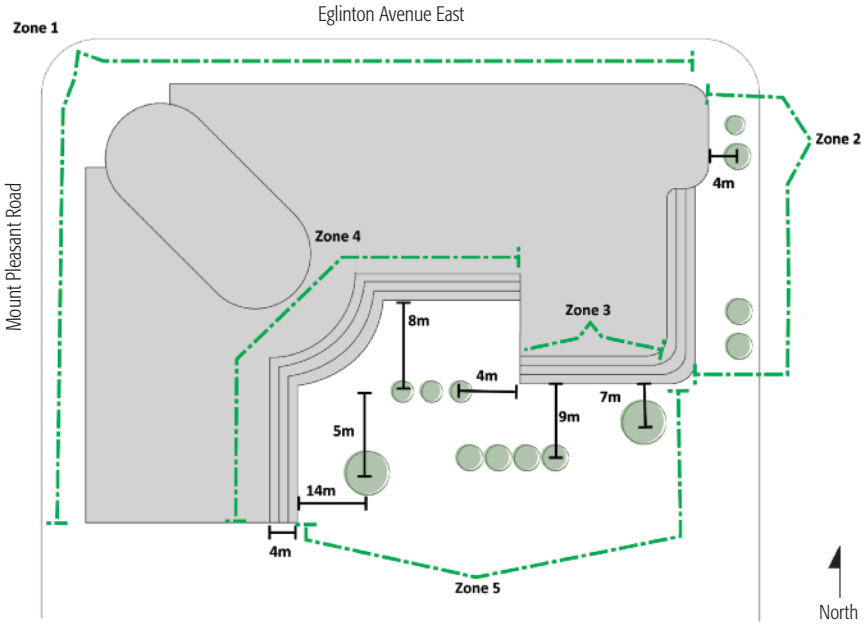


Figure 1. Plan of the WWF office building at 245 Eglinton Avenue East, Toronto, with location of the main nearby trees. Zones for the surveys conducted refer to those detailed in Table 2. Overall dimensions of the building are not drawn to scale.

the World Wildlife Fund Canada (WWF) head office in mid-town Toronto for a number of years. Staff at Fatal Light Awareness Program Canada (FLAP) — a non-profit, Toronto-based organization that works to safeguard migratory birds in urban environments — confirmed that their research indicated that this neighbourhood appeared to be a particular hotspot for bird collisions in Toronto (FLAP 2015). As a conservation-driven organization, WWF staff wanted to actively find a solution to this issue. Other initiatives that had been previously tested by WWF staff at the office, such as lowering blinds over the windows during both day and night time, were not demonstrating successful results (FLAP 2015).

The purpose of our study was to quantify the bird collisions that are occurring at the WWF office building during peak fall migration and to determine whether or not specific façades of the building or time of day were of particular concern. We also wanted to determine what species of birds were hitting the windows to see whether or not it was primarily fall migrants that were being affected. We wanted to investigate the possibility that more collisions were occurring where vegetation was reflected in the glass windows. It is hoped that the results of this study can be used to suggest solutions to building management to help mitigate this problem during subsequent migration seasons.

## Methods

We conducted our study over a six-week period during fall migration season, from 18 September – 23 October 2014 at the WWF head office. The office is located in mid-town Toronto, in a four story building (Figure 1). We recognize that for some bird species significant fall migration is already underway in Ontario in August. The building is approximately 20 m high and has a flat roof. It is bordered by two busy streets — Eglinton Avenue to the north of the building and Mount Pleasant Road to the west. The WWF offices are located on the 4th floor of the building along the east and south sides of the building. A 1.2 m ledge extends beyond the windows along the 2nd, 3rd and 4th floors along parts of the south and east sides of the building (Figure 2). Most of the window panes on the building are 1.8 m in height and 1.4 m wide (area = 2.52 $m^2$) and are all double-glazed, tinted and highly reflective. All the windows of this building are of the same reflective type. Apart from four panes of glass that have micro-dot film attached to the exterior, from a past attempt to reduce bird collisions, there are no bird-scaring silhouettes or other modifications to any of these highly reflective windows. The south side of the building is enclosed by a garden, which contains both flower gardens as well as large deciduous trees, providing substantial cover and feeding grounds for birds

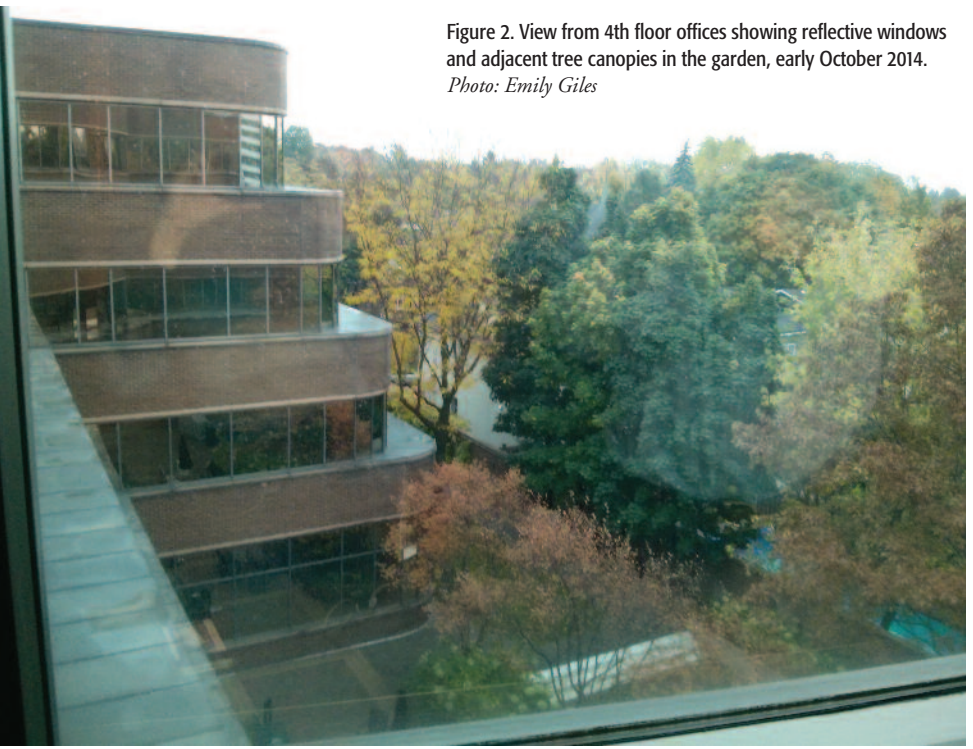

Figure 2. View from 4th floor offices showing reflective windows and adjacent tree canopies in the garden, early October 2014. *Photo: Emily Giles*

and other wildlife species. Approximately 55% of the southern face of the building is made up of uninterrupted horizontal glass panels (see Figure 2). The north and west sides of the building are on busy streets and have no adjacent trees or vegetation.

During the study period, the entire building perimeter was surveyed by a volunteer team of WWF staff members once to twice daily, depending on staff availability. The time of day for these surveys also varied slightly depending on volunteer availability, with the goal of surveying once early in the morning at first light (0700h - 0800h) and once again in late afternoon before nightfall (1630h-1730h). One or two staff per survey searched for evidence of bird window strikes from both inside the building from the 4th floor looking down along all three levels of the building's ledges, as well as outside the building around the perimeter and in the back gardens. On each survey the entire area of the ledges was surveyed from different vantage points in the 4th floor WWF offices.

Evidence of a window strike was determined by the presence of a bird body or the presence of a pile of bird feathers which likely indicated that a bird death had occurred and was consumed by a scavenger (following approaches taken by Klem *et al.* 2004). Dead birds found along the window ledges or on the ground in close proximity to the building (≤ 10m away) were recorded as window strikes. Live birds found with visible trauma, such as those found fluffed up along the ledges close to windows, sometimes with their heads tilted back or wings outstretched, were also documented and counted as a window strike. The type of evidence, as well as the location in relation to the building, were recorded and identified to species when possible. Feathers and carcasses were removed (where accessible to the surveyor) in order to prevent double counting. If they could not be removed, the precise location was recorded on the observation sheets in order to prevent double counting by the next volunteer. Weather conditions were also recorded.

Observed strikes that occurred at other times of day outside of the survey times were reported to the volunteer team and documented. The time to which the bird either recovered and flew off, was scavenged, or succumbed to its injuries was recorded whenever possible.

We divided the building into five different segments (Figure 1), to investigate whether or not there were any 'hot spots' with high incidence of bird window strikes.

## Results

### Overall results and temporal variations

During the six week period, we conducted 37 systematic surveys around the office building and documented evidence indicating that a total of 93 window strikes had occurred. A total of 11 species was identified, involving 19 individual birds, with the remainder being classed simply as passerine spp., warbler spp. or kinglet spp. (Table 1). The majority of bird remains we detected were from smaller migratory passerine species, with the largest being a Swainson's Thrush (*Catharus ustulatus*). The only species

Table 1. Breakdown of species and categories of bird collisions at 245 Eglinton Avenue East, Toronto, 18 September – 23 October 2014. Scientific names can be found in AOU (2015).

| | WEEKLY SURVEY DATES | | | | | | |
|---|---|---|---|---|---|---|---|
| SPECIES | 18-19 Sept | 22-26 Sept | 29 Sept – 3 Oct | 6-10 Oct | 14-17 Oct | 20-23 Oct | TOTAL |
| **# surveys** | **2** | **8** | **7** | **7** | **8** | **5** | **37** |
| Passerine sp. | 3 | 12 | 13 | 11 | 9 | 15 | 63 |
| Warbler sp. | | 3 | 3 | | | | 6 |
| Golden-crowned Kinglet | | | | 1 | 2 | 2 | 5 |
| Kinglet sp. | | | 1 | 2 | 1 | 1 | 5 |
| Yellow-rumped Warbler | | | 1 | 1 | 1 | | 3 |
| Red-eyed Vireo | | 1 | 1 | | | | 2 |
| Dark-eyed Junco | | | | | 1 | 1 | 2 |
| Black-throated Blue Warbler | | | 1 | | | | 1 |
| American Redstart | | | 1 | | | | 1 |
| Orange-crowned Warbler | | | | 1 | | | 1 |
| Ruby-crowned Kinglet | | | 1 | | | | 1 |
| Swainson's Thrush | 1 | | | | | | 1 |
| Red-breasted Nuthatch | | | 1 | | | | 1 |
| American Goldfinch | | 1 | | | | | 1 |
| | | | | | | | |
| **TOTAL #** | **4** | **17** | **23** | **16** | **14** | **19** | **93** |
| **%** | **4.3** | **18.3** | **24.7** | **17.2** | **15.1** | **20.4** | |

identified which we knew to be nesting in the neighbourhood was one American Goldfinch (*Spinus tristis*).

Although we were not able to maintain systematic daily surveys and removal of carcasses and piles of feathers, our observations indicated a fairly even distribution of new window collisions across the September-October migration period (Table 1).

Of our 37 surveys, 22 (60%) were in the morning — most within one hour of sunrise, and 15 (40%) were in the late afternoon. On the morning surveys, we recorded evidence of 77 strikes (85%), whereas on the afternoon surveys we noted only 14 new strikes (15%).

We examined daily and overnight local weather conditions in relation to our recorded numbers of new window collisions, but could not detect any obvious relationships. The four highest numbers of recorded new collisions were all on our morning surveys, and all but one of these

Table 2. Location of bird collisions in different sections around the office building at 245 Eglinton Avenue East, Toronto, 18 September – 23 October 2014.

| | WEEKLY SURVEY DATES | | | | | | |
|---|---|---|---|---|---|---|---|
| ZONE | 18-19 Sept | 22-26 Sept | 29 Sept –3 Oct | 6-10 Oct | 14-17 Oct | 20-23 Oct | TOTAL |
| **# surveys** | **2** | **8** | **7** | **7** | **8** | **5** | **37** |
| 1 (N+W street) | | | 1 | | | 2 | 3 |
| 2 (East) | 1 | | 2 | | | 2 | 5 |
| 3 (SE ledges) | | 4 | 2 | | | | 6 |
| 4 (main ledges) | 1 | 8 | 5 | 11 | 7 | 10 | 42 |
| 5 (ground) | 2 | 5 | 13 | 5 | 7 | 5 | 37 |
| | | | | | | | |
| **TOTAL** | **4** | **17** | **23** | **16** | **14** | **19** | **93** |
| | | | | | | | |
| **Within Zone 4:** | | | | | | | |
| Ledge 4th | 1 | 4 | 3 | 6 | 3 | 9 | 26 (65%) |
| Ledge 3rd | | 1 | 2 | 2 | 4 | 1 | 10 (25%) |
| Ledge 2nd | | 1 | | 3 | | | 4 (10%) |
| | **1** | **6** | **5** | **11** | **7** | **10** | **40** |

days were dry and mild (8-17$^{o}$C) with little cloud cover and no precipitation: ten new strikes on 3 October; eight on 9 October; nine on 14 October; eight on 23 October. We recorded no new evidence of a strike on four of the morning surveys and on six of the afternoon surveys.

**Window collisions around the building**

The location of strikes was linked closely to the presence of trees near to the building's reflective windows (Table 2, Figure 1). Of the 93 passerine remains we found, only three were noted along the street sides of the building. Remains of 48 birds (52%) were noted on the main south-southeast facing three ledges with the large reflective windows, immediately adjacent to the trees within the garden. Remains of 37 (40%) were recorded on the ground in the garden area (Zone 5 in Table 2 and Figure 1).

Among strikes recorded on the three ledges on the southerly aspect of the building (Zone 4 in Figure 1), the majority (65%) were on the 4th floor ledge (Table 2, see example at Figures 2 and 3).

**Behavioural observations**

On eight occasions (all in the mid-late mornings), we observed birds colliding with the 2nd-4th floor windows, and then timed to either recovery, death, or removal by a scavenger. Two died instantly, one

(a Golden-crowned Kinglet, *Regulus satrapa*) lay stunned and gyrating for about 5 minutes and then removed to another location to be eaten by an American Crow (*Corvus brachyrhynchos*). The remaining five recovered (63%) and the mean time to recovery was 14 minutes (range 0-30 minutes). Observations of post-collision birds on the ledges revealed the main pattern of standing motionless often with a drooping wing (or often lying on one side and sometimes shaking rapidly), then eventually righting themselves and, if successful, flying off towards the garden trees (see Figure 3).

Among the eight observed window strikes, three were different Golden-crowned Kinglets flying from the canopy of the 19 m high tree in the adjacent garden and striking the 4th floor windows that were about 18m from the peak of the tree. Of these three strikes, only one kinglet survived. On another occasion, a Red-breasted Nuthatch (*Sitta canadensis*) was observed flying from the canopy of the same tree about 18m from the 4th floor windows, but it appeared to bounce and then fly uninjured back to the tree canopy.

In the gardens at the south side of the building, we found feces of both Raccoons (*Procyon lotor*), and Norway Rats (*Rattus norvegicus*), although none were seen in daylight hours and we assume that their activity was mainly nocturnal. Up to four domestic cats (*Felis catus*) regularly frequented the garden area in daylight hours, and presumably also at night, and on one occasion a cat surveyed the entire first floor ledge and sniffed the feathers still present (see Figure 1).

**Figure 3. Dark-eyed Junco stunned after collision with East-facing windows on 4th floor of study building, October 2014.** *Photo: Pete Ewins.*

On one occasion, at around 0830h we witnessed two American Crows chasing a kinglet spp. out of the crown of the adjacent 19 m-high tree, which appeared to have caused the kinglet to fly straight into the south-east facing window approximately 18 m from the tree. The kinglet fell to the ledge partly stunned after striking the window and then continued to be pursued by the two crows. Within 10 seconds the kinglet was captured and then plucked until the bird was eaten with only feathers remaining.

## Discussion

Our findings are consistent with other studies of office building collisions, as the majority of strikes that occurred were migratory passerine species (Gelb and Delacretaz 2006, Borden *et al.* 2010). Our systematic surveys support the FLAP observations that the Yonge and Eglinton neighbourhood in Toronto constitutes a hotspot for bird-building collisions. However, we accept that our surveys were not started until part-way through the migration season and that we did not complete surveys every day. For these reasons, and in consideration of other biases outlined below, we feel it is premature to attempt any roll-up estimation of the total numbers of bird strikes that may have occurred at this building in the fall 2014 migration season.

The large number of collisions that we observed in the morning hours (85%) are consistent with the daily activity patterns of migratory birds passing through a treed urban neighbourhood. During the study period, we noted fairly regular large numbers and daily activity of different migrant passerines in the trees of nearby gardens. On some days before and just after sunrise, we noted up to ten passerines calling and foraging in trees adjacent to the building, consistent with general increased numbers of staging birds in the Toronto area on those days. We have no evidence to suggest that a significant number of strikes are occurring during the nighttime at our building. These findings are similar to studies on other low rise buildings that are dark during the night (Gelb and Delacretaz 2009).

Although we were surprised by the high number of collisions that occurred during the time period, overall we believe that the recorded evidence of 93 collisions likely represents a substantial underestimate of the actual number of window strikes that occurred. We think this is due to a number of biases, notably: 1) complete removal of a stunned or dead bird by a scavenger with no evidence left behind; and 2) birds that may have struck the window then recovered and flew off without being observed directly by office staff would leave no evidence of the strike behind.

We found 40% of the collision evidence located on the ground in the back garden of the building (Zone 5). These mortalities may not have all been related to window strikes, although for the purposes of this paper we assumed that all of them were. The majority of the bird remains found in Zone 5 were in the garden, either beneath or adjacent to shrub vegetation which had been planted for landscaping purposes. We often found fresh piles of feathers on the patio stones adjacent to these herbaceous beds, but there was usually no sign of any bones or

other body parts. We presume that all of these feather piles were from bird window strikes that fell to the ground and were scavenged overnight by mammals. However, this could be a potential source of overestimation as the birds may have died from other causes in this region, whereas bird carcasses found along the ledges of the building in Zone 3 and 4, were almost certainly victims of window strikes.

Although 63% of the observed strikes were documented as recoveries, we acknowledge that some of these birds may have recovered only temporarily. A proportion of these birds could have sustained an injury which weakened them and caused them to die shortly after our observation period, or to be more vulnerable to predation in the immediate time period that followed. This could result in an underestimation in the number of window collisions that resulted in mortalities.

The significant number of collisions that we recorded in Zones 4 and 5 (85%) supports our initial theory that more collisions occur in areas of high vegetation and is likely related to the tree canopy being reflected in large windows (Gelb and Delacretaz 2009). This hypothesis is further supported by the low number of collisions that were documented along Zone 1 (3%) and Zone 2 (5%), which contain little to no adjacent vegetation. We suspect that the configuration of large tree canopies close to the large facades of south and east facing windows represents a dead-end for migratory birds. Once birds entered the garden, the apparent next tree is often in fact a reflection of the tree canopy in a window. We believe that the garden area and adjacent windows formed a kind of 'dead-end' or 'cul-de-sac' for migrant passerines moving through this area. Of the collisions that occurred within Zone 4, 65% were recorded from the 4th floor windows and ledge. These 4th floor highly reflective windows were at a similar elevation (15-20 m above ground) to the crown of the six main trees in the garden (estimated tree heights = 18-19m). The trunks of these six largest

Figure 4. American Crows plucking a fresh victim (kinglet spp.) of a window collision, on a 4th floor ledge, October 2014. *Photo: Pete Ewins*

trees in the adjacent garden were a distance of from 11m – 18 m from the 4th floor windows (see Figure 1). Overall we believe that these windows within 20 m of significant tree canopies provide a very high risk of fatal collisions for migratory passerine species.

The ledges encompassing the windows provided a unique opportunity to observe post-collision response of the affected bird, as well as scavenger behaviour. Throughout the study period, three American Crows clearly scavenged large numbers of passerines that had struck the building's windows (see Figure 4). Our observations indicated that this was a pair of adults with one first-year auxiliary family member. On numerous occasions

(particularly in the first 4-5 hours of daylight), we noted these crows flying along the ledges and then quickly swooping down if a new bird carcass was present. Although we did not conduct any continuous watches over the area, incidental observations suggest that in the mornings especially, these crows scanned the ledge area and garden trees every 5 minutes or so, either by flying over, or simply by perching on the edge of the roof to the building.

Upon spotting a new carcass, the crows would either pick it up and fly off to the rooftop or a nearby large tree to pluck and eat, or they would kill and partially pluck and then consume on the ledge. On two occasions where a passerine had just struck a window, we observed a crow fly down to the ledge and then remove the whole carcass — leaving no feathers or body remains at all from the window collision.

The observation of crows appearing to chase the kinglet into the window could potentially be the first documented evidence of crows showing a learned killing technique, utilizing the windows as a stun agent. We found no mention of this behavior in the Birds of North America account for this crow species (Verbeek and Caffrey 2002). At this stage, we cannot discount the possibility that these intelligent creatures were doing this more frequently than we recorded.

Currently there is a growing realization that building design and regulatory codes must address the issue of bird collisions. For example, in Toronto, FLAP has developed the BirdSafe™ Building Standards and Risk Assessment and provide consulting to anyone looking to make their building BirdSafe™ in a more cost-effective way by zeroing in on the façades where the majority of collisions occur at a structure (FLAP 2015). In addition, a recent legal precedent has been set in Toronto, by Ontario Nature and Ecojustice, requiring building owners to adhere to the provisions under Ontario's Environmental Protection Act. It is now an offense to harm migratory birds with light reflected from building windows (Ecojustice 2015).

New types of windows can be made which break up the reflection in the window so that birds do not mistake the reflection for a tree (FLAP, pers. comm.). New informed guidance for landscape design could also help address the issue.


## Acknowledgements

We thank FLAP staff members Paloma Plant and Michael Mesure, Chris Wedeles of ArborVitae Environmental Services and York University graduate student Sean Chin, for ongoing discussions and reviews of previous draft manuscripts. We are grateful to the WWF volunteer bird survey team (Olivia Fernandez, Robert Badley, Maya Ahmad, and Jessica Park), and to the building management team for help with recording and recovering bird carcasses. We also thank Alana Young who helped prepare Figure 1.


## Literature Cited


**American Ornithologists' Union (AOU)**. 2015. Checklist of North and Middle American Birds. http://checklist.aou.org/

**Blancher, P.J.** 2013. Estimated number of birds killed by house cats (*Felis catus*) in Canada. Avian Conservation and Ecology 8(2):3.

**Borden, W.C.**, **O.M. Lockhart**, **A.W. Jones**, and **J.S. Lyons**. 2010. Seasonal, taxonomic, and local habitat components bird-window collisions on an urban university campus in Cleveland, OH. Ohio Journal of Science 110 (3):44-52.

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

**Ecojustice**. 2015. http://www.ecojustice.ca/case/migratory-birds-building-collision/

**FLAP**. 2015. Fatal Light Awareness Program Canada. http://www.flap.org/faqs.php

**Gelb, Y.** and **N. Delacretaz**. 2006. Avian window strike mortality at an urban office building. Kingbird 56(3):190-198.

**Gelb, Y.** and **N. Delacretaz**. 2009. Windows and vegetation: primary factors in Manhattan bird collisions. Northeastern Naturalist 16(3):455-470.

**Hager, S.B.**, **H. Trudell**, **K.J. McKay**, **S.M. Crandall** and **L. Mayer**. 2008. Bird density and mortality at windows. Wilson Journal of Ornithology 120(3):550-564.

**Klem, D., Jr.**, **D.C. Keck**, **K.L. Marty**, **A.J. Miller Ball**, **E.E. Niciu**, and **C.T. Platt**. 2004. Effects of window angling, feeder placement, and scavengers on avian mortality at plate glass. Wilson Bulletin 116:69–73.

**Loss, S.R.**, **T. Will**, **S.S. Loss** and **P.P. Marra**. 2014. Bird-building collisions in the United States: Estimates of annual mortality and species vulnerability. Condor: Ornithological Applications 116:8-23.

**Machtans, C.S.**, **C.H.R. Wedeles** and **E.M. Bayne**. 2013. A first estimate for Canada of the number of birds killed by colliding with building windows. Avian Conservation and Ecology 8(2):6. http://www.ace-eco.org/vol8/iss2/art6/

**Verbeek, N.A.M.** and **C. Caffrey**. 2002. American Crow (*Corvus brachyrhynchos*). *In:* The Birds of North America, No. 647 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

---

*Emily Giles*, *Pete Ewins*
and *Sarah Zachariah*
WWF-Canada
Suite 410, 245 Eglinton Avenue East
Toronto, Ontario M4P 3J1
E-mail: egiles@wwfcanada.org.