City of Markham

Part 2 Appendices

A Best Practices Summary

Best Practice Implementation Strategies

Several major municipalities and agencies have taken steps to reduce bird-window collisions, including York Region, Toronto, FLAP Canada, the American Bird Conservancy (ABC) Chicago, New York City, San Francisco, Portland, Calgary, and United States green Building Council (USGBC).

Standards from Toronto, Chicago, American Bird Conservancy, New York Audubon, and USGBC are widely adopted by regulation agencies across North America.

Toronto's mandatory bird-friendly requirement and light out policies are based on known risk factors. The Canadian Standards Association's Bird-friendly Building Design standard is the National Standard of Canada for reducing bird collisions with buildings by providing design guidelines for glazing, building-integrated structures, and site design. The National Capital Commission Bird-Safe Design Guidelines offer best practices for building, lighting, and landscape design on federal lands in the National Capital Region. Government of Canada Greening Government Strategy incorporates bird collision prevention through its commitment to minimize impacts of federal operations on species, including measures to reduce bird strikes on buildings on federal lands.

What are the best practices?

Federal

Canadian Standards Association (CSA): Bird-Friendly Building Design Guidelines, Policies and Standards that Infection Prevention and Control professionals may use to support their own documentation and best practices.

Treasury Board of Canada Secretariat: protects migratory birds and nests.

US Congress (Proposed): Bird-Friendly public buildings, adopted Toronto, Chicago, ABC, and New York Audubon standards.

Regional

Province of Ontario: protects non-game birds, regulates the design of build environments, protects species at risk.

State of New York: Bird-Friendly public buildings, adopted Toronto, Chicago, ABC, and New York Audubon standards.

State of Minnesota: Bird-Friendly public buildings, public buildings mandatory light off during migratory period, and sustainability development standards for new and renovated buildings.

Cook County, Illinois: Bird-Friendly new and major renovated buildings, energy conservation requirement.

Municipal

City of Toronto: Two tiers standards (mandatory tier 1 and optional tier 2), identify effective measures, public building evening and weekend light-out, tier acknowledgement program, public campaign.

City of Calgary: Bird-Friendly design and operation of public buildings and affordable housing, downtown bird-window collisions analysis, site design criteria, schedule cleaning during daytime.

City of San Francisco: zoning standards, maximum unbroken glazed area, and voluntary bird-strict hotline.

Several other Canadian municipalities and agencies have also adopted bird-friendly design guidelines to help reduce bird-window collisions. These include the City of Mississauga, the City of Ottawa, the City of Richmond Hill, and the National Capital Commission. The full set of guidelines and standards can be found on each organization's official website.

Non-Governmental Organizations

New York City Audubon: nighttime & inclement weather at-risk elevation level, nighttime migration path at-risk elevation level, minimize building footprint, district wide light-out strategies.

American Bird Conservancy: windowed courtyards & open-topped atria as at-risk area, minimum treated glazing for lower and upper levels, evaluate effectiveness of mitigation measures, rank light colours.

United States Green Building Council LEED: mandatory criteria comprise of building façade, interior & exterior lighting, and post construction monitoring program compliance, specify light angle, light-off period.

FLAP Canada: recommends that individual developers, municipalities, and other levels of government use the Canadian Standards Association's (CSA) Bird-Friendly Building Design Standard for consistent and effective guidance on making buildings safer for birds.

Bird-Window Collisions

This section describes what is currently known about bird-window collisions in Markham, drawing on FLAP Canada's documentation. It elaborates on the primary causes of bird-window collisions based on documentation in other parts of the GTA and North America, as well as specific observations in Markham.

Bird-Window Collisions in Markham

Over 5,000 bird-window collisions were recorded in Markham between 2000 and 2024 (FLAP Canada 2022), though the number is suspected to be higher as less effort is spent in Markham than in other parts of the GTA and volunteers recover only a small fraction of the victims (Mesure 2023 pers. comm.). Bird-window collisions were concentrated in areas shown in **Figure D-3**. The distribution shown on **Figure D-3** indicates that bird-window collisions are not localized near natural areas in Markham, but tend to occur in areas where glass buildings are concentrated.

Most bird-window collisions in Markham occurred during the day (Mesure 2013 pers. comm.). Fall migrating birds are more susceptible, such as a substantial increase in populations from the most recent breeding season, inexperienced young unfamiliar with the built environment, and a higher concentration of birds residing in areas with less urgency to continue migrating to their wintering grounds. In the spring, they would travel far greater distances over a shorter period to arrive at and establish their breeding territories. According to the new data (2000-2022), forty-two percent (42%) of collisions were detected in September, and forty-one percent (41%) were detected in October, indicating that, as in the rest of the GTA, fall migrating birds are by far the most often involved in bird-window collisions. Three percent (3%) of collisions occurred in April, and ten percent (10%) occurred in May, showing that spring migrants are also affected. Collisions during all other months make up less than one percent (1%) of the total number, indicating that resident and breeding birds are less often involved in bird-window collisions. However, it is known that there are undocumented collisions, for example those related to bird feeders outside residential windows.

Figure A-1: Planted trees near windows are an amenity of urban life

Figure A-2: Glass buildings are a feature of modern cities

Dr. Daniel Klem Jr. (2013 pers, comm.), who has researched bird-window collisions for decades, noted that any building could attract bird-window collisions if it had large amounts of glass facing areas of vegetation, even if that vegetation consisted of manicured trees and shrubs. This is borne out by the areas in which bird-window collisions are observed outside the Greenway System.

Markham Development Structure

Markham has been mandated by the Province to intensify for future growth. The Official Plan (2014) introduces a proposed urban structure which focuses intensification in nodes and corridors. Intensification may result in the development of more tall glass buildings with a resulting increase in night lighting.

Figure A-3: World on Yonge Development, Markham

Factors: Glazing and other transparent or reflective surfaces

Reflectivity

Surfaces that reflect habitat are seen as habitat by birds, resulting in bird-window collisions. Reflective surfaces can include glass, polished marble (especially dark colours as it is more reflective), or polished stainless steel. Birds may fly into glass that reflects vegetation, sky, or water. Birds may even attack their own reflection in reflective surfaces.

Figure A-4: Birds may fly into glass that reflects vegetation

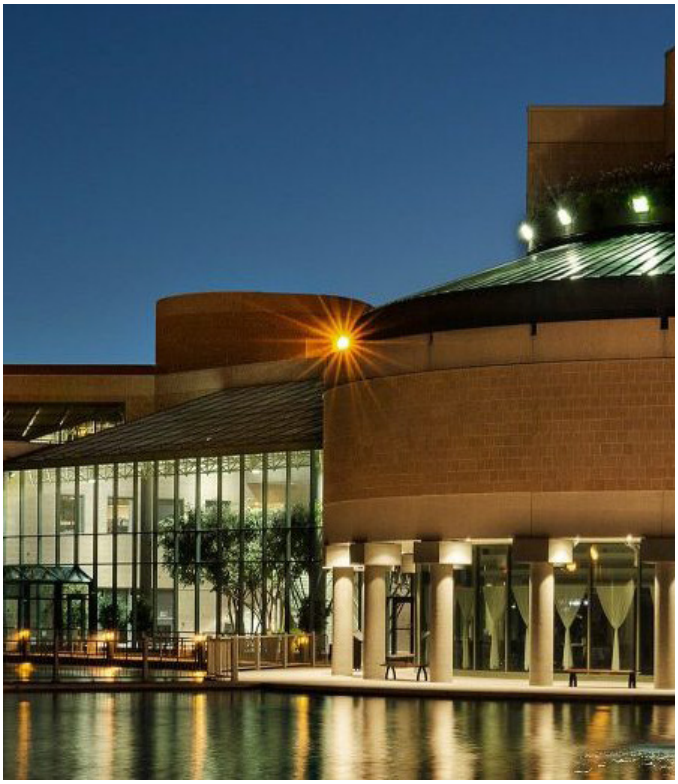

Figure A-5: A bird that see habitat through the glass may fly into the glass

Transparency

Both research and anecdotal evidence indicate that birds do not see glass as a barrier (Klem and Mesure 2013, pers. comm.). A bird that sees habitat through glass may fly into the glass as if it were not there. Habitat can include trees, flowers, water, sky, etc. Birds may fly into glass if they can see what they perceive as habitat inside the glass (e.g. house plants), or if they can see habitat on the other side of the glass (for example vegetation, sky or water through link ways, courtyards, bus shelters, plexiglass barriers on verandas, etc.).

Fly-Through Conditions and Black Hole Passage Effect

Birds may fly into what they perceive as a “gap” in an obstacle. For example a dark, reflective spot in an otherwise impermeable building may appear to be a way through the building. The size of the bird is an important determinant of the size of the glass that may be a problem: e.g. hummingbirds may collide with smaller perceived passages (Mesure 2013, pers. comm.).

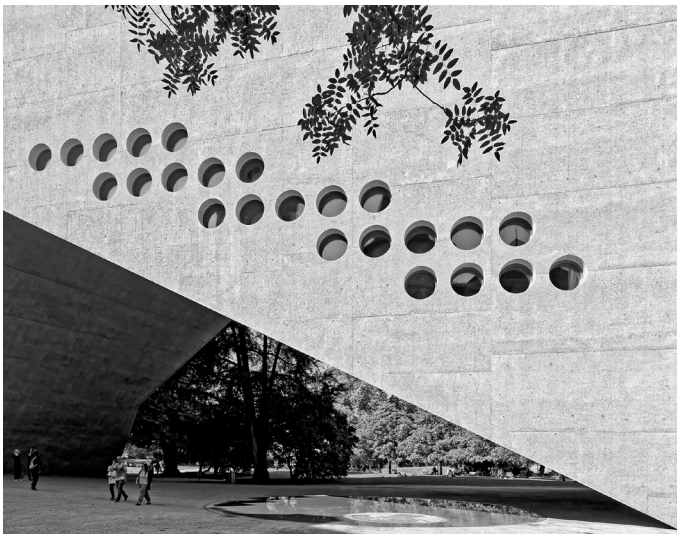

Figure A-6: Birds may fly into what they perceive as a gap in an obstacle

Figure A-7: Birds may fly into clear galss corners that is no clear line of sight

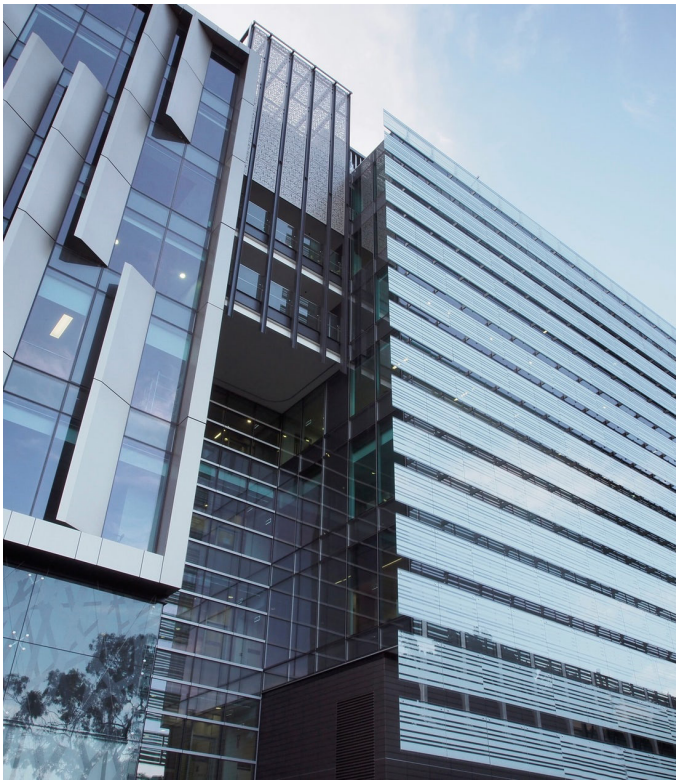

Figure A-8: Buildings largely composed of glass significantly increase the risk of bird-window collisions

Overall Design

The highest numbers of bird-window collisions in Markham are associated with buildings that are largely composed of glass (Mesure 2013, pers. comm.). However, the threshold percentage of glass associated with increased collision risk is not well understood. Most monitoring has been conducted in known “high-collision” areas, which are typically glass-dominated buildings. As a result, research has not consistently identified building types that are free from bird collisions. It is also recognized that, under certain circumstances, even small areas of glass can pose collision risks.

Types of Glass

Almost any type of surface associated with buildings largely composed of glass significantly increase the risk of bird-window collisions. If the glass is transparent, it can be perceived as leading to habitat. If it is reflective, it generally reflects elements perceived as habitat such as sky, vegetation or water.

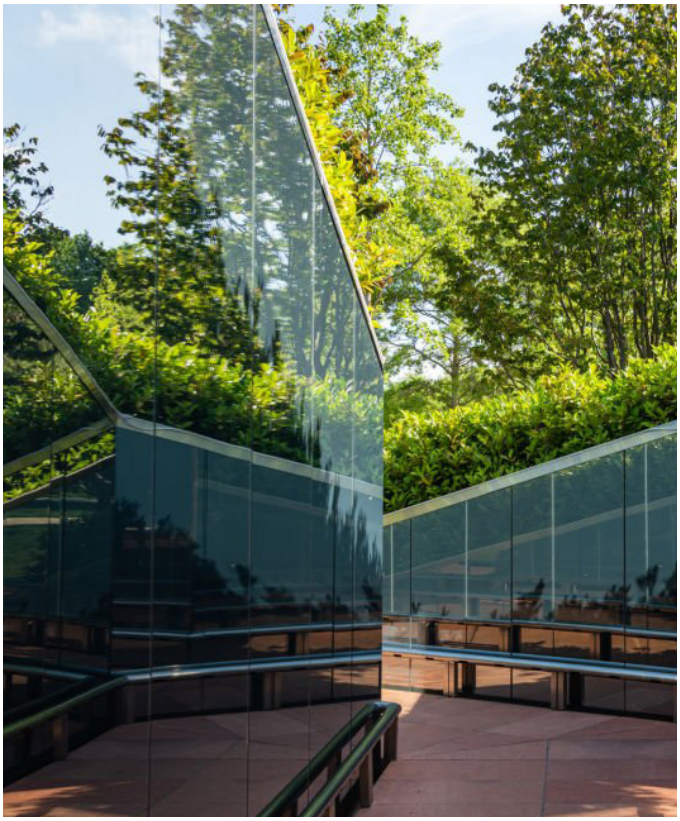

Figure A-9: Glass reflects elements perceived as habitat such as sky

Orientation

Though each façade of a building tends to have a unique “signature” when it comes to bird-window collisions, there is little information on the effect of orientation. For example, there is no evidence that south-facing façades are more likely to have bird-window collisions than north-facing façades.

Figure A-10: Size of a building is not necessarily associated with numbers of collisions

Building Size

The size of a building is not necessarily associated with numbers of collisions: except in the case where the amount of glass is proportionally high in relation to the size of the building. The surface area of glass is one of the most important factors in predicting the number of bird-window collisions. The larger the glass surface, the higher the bird-window collisions (Hager et al. 2013).

Figure A-11: Building orientation is not necessarily associated with numbers of collisions

Proximity to Natural Features

The proximity of development and the relationship to the surrounding landscape (along with the area of glass) has been noted as one of the most important factors associated with bird-window collisions. The closer the glass building is to natural features, generally the higher the bird-window collisions, except in some circumstances where vegetation is in very close proximity. There are two reasons for this:

- First, birds are attracted to natural habitat to rest and feed during migration and thus if the vegetation is closer to the building, birds have a higher probability of colliding with the building.

- Second, the larger the area of vegetation, the more birds are likely to be attracted to it. However, some buildings have high numbers of bird-window collisions even though they are not immediately adjacent to large areas of natural habitat. The birds may be just as attracted by lush landscaping.

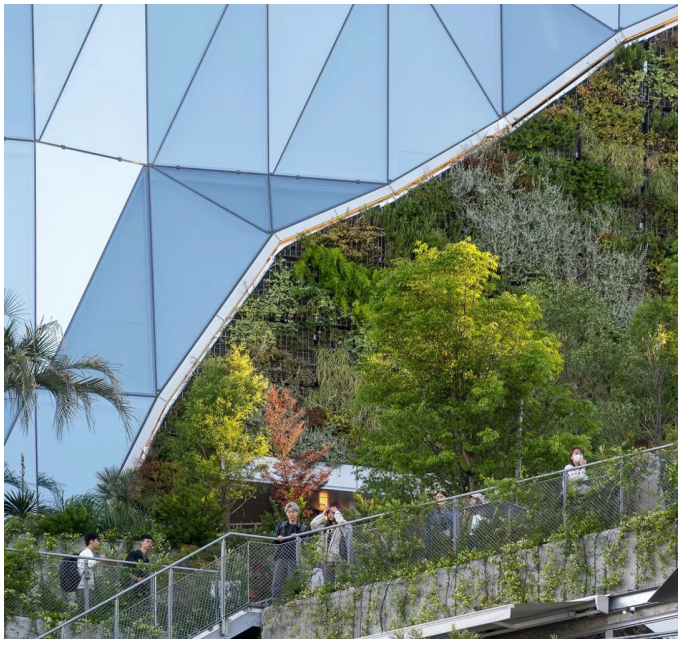

Figure A-12: Proximity of development and relationship to surrounding landscape is one of the most important factors associated with bird-window collisions

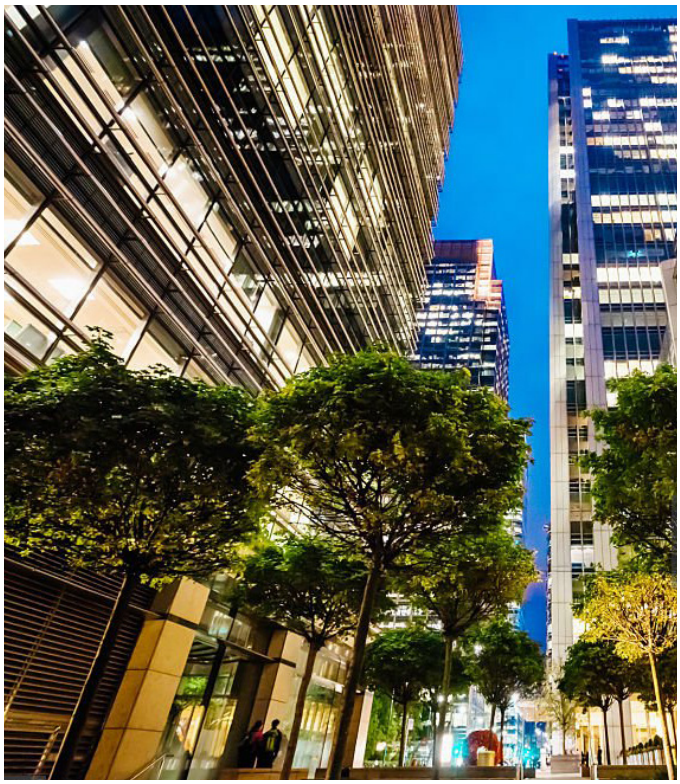

Figure A-13: Building siting can deter potential bird-window collisions

Siting

Siting of the building is very important, mainly because the building's relationship to the surrounding vegetation is so important. Building siting can deter potential bird-window collisions to some extent. For example, it is noted that buildings sited in areas where there is a higher concentration of development (i.e. buildings and other impervious surfaces) are less likely to be involved in bird-window collisions. This is probably because birds are more attracted to areas that appear to contain suitable habitat. However, birds tend to seek out smaller areas of habitat during migration, which can include landscaped gardens even in highly developed areas. If landscaped gardens are reflected in the glass, this may be more important than the siting of the building.

Design Traps

Enclosed features such as window-lined courtyards can “trap” birds, especially if the courtyard is highly vegetated, and/or contains a water feature (Mesure 2013, pers. comm.). Birds are attracted to the vegetation within the courtyard and then fly into the surrounding windows.

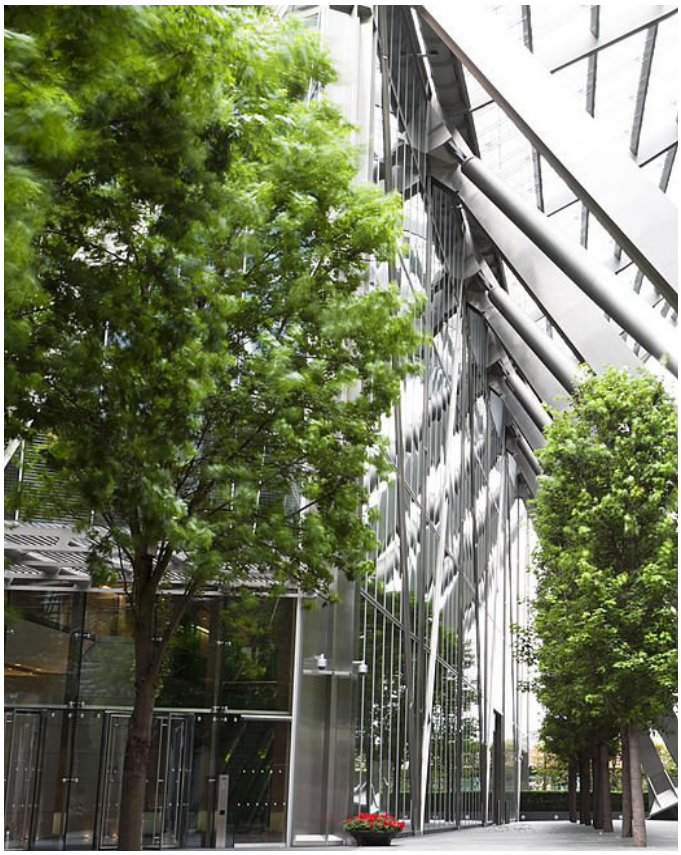

Figure A-14: Bird are attracted to vegetation in courtyards

Figure A-15: Bird-Window collisions are most often assocatted with glass that reflects vegation

Reflected Vegetation

Bird-window collisions are most often associated with glass that reflects vegetation. The reflections can be associated with a natural feature, or can be associated with planted gardens. Both features seem to attract birds and are associated with bird-window collisions. The height of the vegetation is the most important factor in dictating the height at which bird-window collisions will occur. Generally, collisions occur from the ground to the top of the reflected trees (approximately 16m from finished grade is considered to be the height). However, if a building is next to a slope, the height of the reflected vegetation may be greater than when the building is on flatter ground. Moreover, the height of mature trees in a natural area can reach 25m or more. In this case, bird-window collisions will occur at higher levels of the building. Where there is glazing adjacent to green roofs and/or other rooftop vegetation, the bird collision mitigation strategy should be applied to a height of 16m from the surface of the green roof.

Green Roofs/Rooftop Vegetation, Gardens, and Walls

Green roofs adjacent to glass may attract birds and these birds may become involved in bird-window collisions. As with vegetation on the ground, it is the height of the vegetation that dictates the height of bird-window collisions. Vegetation on green roofs is generally adapted to shallow soils so is usually composed of grasses and herbaceous plants, possibly with a few shrubs. These generally do not reach the height that trees can reach, so reflections in the glass may potentially only reach few metres above the roof. However, some roof gardens have planted trees or other design feature (e.g. transparent glass railings) which can make them especially high-risk for bird-window collisions.

Figure A-16: Green roof, living walls, and gardens could attact birds and associate with numbers of collisions

Figure A-17: Migrating birds are attracted to artificial urban light

Factor: Lighting

Fatal Light Attraction

Migrating birds are attracted to artificial urban light at night under specific circumstances. The attraction is not well understood, as songbirds migrate well above cities at night, and may use brightly lit objects such as the moon and stars as navigational cues. Different colours may differ in their attractiveness to birds. Light may be particularly attractive to birds during bad weather when birds descend to rest until the weather improves and becomes more conducive to navigation.

Beacon Effect and Urban Glow

Birds attracted by urban lights that form a “cone” or beacon of light in fog may be reluctant to leave the light and fly into the darkness beyond. Under these circumstances they become disoriented and panicky, flying into anything that they cannot see clearly such as windows, tall communication towers, wires, and even structures that they would normally be able to see such as smokestacks, the ground, and even each other. Some mortality events at tall buildings have involved extensive numbers of birds (Erickson et al. 2005).

Factor: Building Height and High Risk Areas

The science of bird-window collisions is evolving. While it used to be thought that night lighting was primarily responsible for collisions, it is now known that most collisions occur in the daytime potentially within Markham (Mesure 2013, pers. comm.). There may be an interaction between night lighting and daytime bird collisions, which is poorly understood (Sheppard 2013, pers. comm.). Lighting may draw birds to seek habitat in cities where they are at risk of collisions. It is possible that the majority of nighttime bird collisions occur only in bad weather, where rain and fog cause birds to come down to the height of buildings (Gelb & Delacretaz 2009); and predicting locations and numbers of these collisions may be very difficult. Night collisions are much more prevalent in Toronto near the waterfront (Mesure 2013, pers. comm.). It is worth considering flight patterns of birds in relation to buildings of various heights, especially relative to night lighting within cities.

Nighttime Migration Path Threat

Songbirds generally migrate from approximately mid-March to late May in spring, and mid-August to late October in the fall. As shown in **Figure B-18**, in good weather most songbirds migrate over the height of most buildings, but may rarely reach the height of the tallest in some cities. Over land, they usually fly at 640 - 730 m (2,100 to 2,400 feet) but sometimes much lower (Cornell Laboratory of Ornithology 2007). Over water, migration takes place at a much higher altitude, from 1829 - 3658 m (6,000 to 12,000 feet). Weather conditions often affect the migratory altitude as birds may fly higher or lower to avoid or take advantage of prevailing winds. **Figure B-18** illustrates the height at which birds migrate in relation to buildings in the GTA.

What does this mean in relation to the height of buildings in the GTA, and in Markham in particular? The height of the CN Tower, the tallest free-standing structure in the GTA, is 553 m. First Canadian Place in Toronto, the tallest building in Canada, is 298 m (72 stories). Several tall buildings have been built and approved in Markham, ranging up to (80) storeys. Buildings that reach the height of migrating songbirds are rare in the world, and in North America. For example, One World Trade Centre in New York is the tallest building in North America and the fourth tallest building in the world (Emporis 2013b) but reaches only 541 m (104 floors): below the height of the CN Tower. Even these buildings are below the height at which songbirds normally migrate. However, the degree to which birds are drawn down to lighted buildings at night in good weather is still unknown. What is known is that turning lights out on a building where high collisions have been documented can reduce the number of collisions dramatically (ABC 2011).

Seasonal Migratory Threat / Bad Weather Threat

The greatest potential threat to migratory songbirds from tall buildings is thought to occur in bad weather. During bad weather, when navigational cues may be impeded by rain, low cloud and fog, birds descend to much lower heights, as needed, to improve visibility. In the most extreme conditions they stop wherever they can to rest until the weather improves. As noted above, they may be trapped by light and become disoriented, and are especially likely to collide with structures at this time. Bad weather does not appear to contribute to a greater likelihood of bird-window collisions in resident or breeding birds.

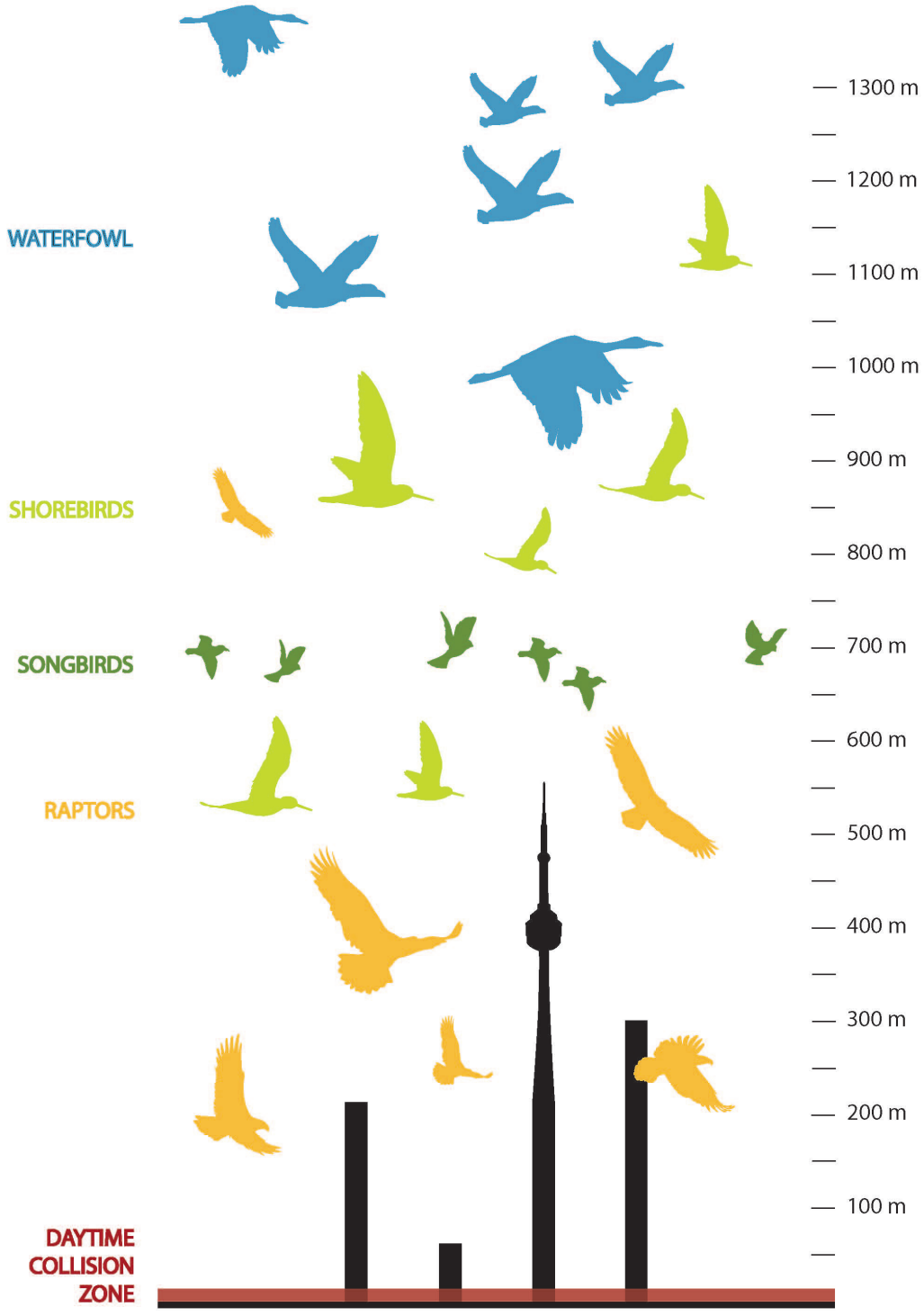

Figure A-18: Approximate range of bird migration heights over land, in good conditions

B Markham Retrofit Projects

Markham Treatments: Retrofit Case Studies

Markham has shown leadership in the implementation of bird-friendly measures on several public buildings including:

- 8100 Warden Ave,
- Milliken Mills Community Centre (7600 Kennedy Road),
- Markham Public Library (6031 Highway 7),
- Markham Museum (9350 Markham Road),
- Markham Pan Am Centre (16 Main Street Unionville),
- Centennial Community Centre (8600 McCowan Road), and
- Angus Glen Community Centre (3990 Major Mackenzie Drive East).

It was documented that these buildings were experiencing bird-window collisions and as a result Markham sought the advice of FLAP Canada. Through extensive consultation the certain high risk façades have been retrofitted and enhanced to incorporate bird-friendly treatments to avoid bird-window collisions. For new buildings such as the Cornell Community Centre and the Aaniin Community Centre, bird-friendly design has been incorporated into the design process.

1. Fred Varley Art Gallery

The Fred Varley Art Gallery in Unionville is adjacent to the Bruce Creek valley, in an area that likely provides habitat for migrating birds. The treatment, an applied film with a dot pattern called Symmetry Duo, was installed in October 2012 as a leadership initiative for bird-friendly design.

2. Markham Civic Centre

This building was retrofitted in September 2012, as a result of concerns regarding the number of bird-window collisions. The pattern used was Exterior 70 with custom print created for the City of Markham. Since the installation of the film, there have been no bird-window collisions at this building. However, definitive data regarding the effectiveness of retrofitting this building has not been obtained as the amount of time since retrofitting has not been sufficient.

3. 8100 Warden Avenue

A pattern of horizontal dotted stripes printed onto transparent film was applied to the Fire and Emergency Services building at 8100 Warden Avenue in 2009 and 2010. The treated areas included a large transparent glass atrium at the entrance as well as two storeys of narrow, mirrored office windows, located on both sides of the atrium, where reflected vegetation were responsible for numerous bird-window collisions. Though the treatment proved to be effective at reducing collisions, the initial treatment had degraded and was thereby replaced with a white die-cut dotted pattern.

Figure B-1: Markham Pan Am Centre

Figure B-2: Implementation of bird-friendly measures on public buildings in Markham

Images

A. Fred Varley Art Gallery
B. Markham Civic Centre
C. 8100 Warden Avenue

Figure C-1: FLAP Canada's annual bird layout educates about the dangers birds face in our built environment in a moving display of the dead birds collected by FLAP rescue volunteers. This layout includes roughly 5000 birds collected between 2019 and 2020

C Existing Conditions Summary

Bird-Window Collisions in the Greater Toronto Area

FLAP Canada volunteers have documented approximately 90,000 bird-window collisions in the GTA since record keeping began in 2000. These represent the results of monitoring approximately 50 buildings, mainly towers with an abundance of glass. Klem (2006) has estimated that the number of bird casualties at urban office buildings in North America is between 1 and 10 per year. Thus, with approximately 950,000 buildings in Toronto, there is the potential for between 1 and 9.5 million birds to be killed in the City of Toronto per year (FLAP Canada, 2013).

Two particular species are frequently involved in bird-window collisions in the GTA: White-throated Sparrow and Golden-crowned Kinglet, with over 5000 bird-window collisions each since record-keeping began. **Table C-1** provides a list of the birds most frequently involved in bird-window collisions in the GTA, with their preferred habitat.

Species	Number of bird-window collisions	Habitat	Status in Most Urban Portions of GTA
Golden-crowned Kinglet	7739	Forest	Migrant
White-throated Sparrow	7663	Forest	Migrant
Nashville Warbler	3454	Forest	Migrant
Ovenbird	3252	Forest	Migrant
Ruby-crowned Kinglet	3246	Forest	Migrant
Dark-eyed Junco	3188	Forest	Migrant
Brown Creeper	2698	Forest	Migrant
Hermit Thrush	2078	Forest	Migrant
Black-capped Chickadee	1980	Forest	Migrant, resident
Common Yellowthroat	1609	Various Habitats	Migrant, breeding
Ruby-throated Hummingbird	1565	Forest, urban gardens	Migrant, breeding
Magnolia Warbler	1336	Forest	Migrant
Tennessee Warbler	1220	Forest	Migrant
Yellow-bellied Sapsucker	1026	Forest	Migrant
Swainson's Thrush	1001	Forest	Migrant
Black-throated Blue Warbler	940	Forest	Migrant
Black-and-white Warbler	893	Forest	Migrant
Fox Sparrow	743	Forest, riparian areas	Migrant
American Woodcock	724	Forest	Migrant
Black-throated Green Warbler	721	Forest	Migrant

Table C-1: Top 20 birds most frequently involved in bird-window collisions in the GTA from 2000 to 2023

Though the numbers of aerial foragers and birds of other habitat guilds involved in bird-window collisions are much fewer, they are still found. For example, 48 Eastern whip-poor-wills have been catalogued by FLAP Canada over the period data has been collected. This species is exclusively an aerial forager, and is also a diurnal migrant. It is also a Species at Risk in Canada and Ontario.

Among the species with the lowest bird-window collisions (i.e. those where only 1 to 5 have been involved in collisions since 2000), there are also similarities. Very few large birds are involved in bird-window collisions (e.g. ducks, herons, hawks, owls). There are almost no waterfowl, and very few swallows are involved in bird-window collisions. Many of these species are diurnal migrants (they migrate during the day). It is possible that these species are not drawn to habitat in urban areas because buildings are more visible during the day.

Very few open country birds (e.g., Eastern Meadowlark, Bobolink, and Vesper Sparrow) are involved in bird window collisions, despite being small, ground foraging songbirds. This is notable given that some of these species, such as the Bobolink, which is designated as Threatened in Canada and Ontario due to significant population declines, still have relatively large populations, estimated at approximately 800,000 individuals in Ontario. However, as pointed out by Klem (2013, pers. comm.), there are very few large glass towers surrounded by open grassland habitats, so it is not known whether these species are less likely to be involved in bird-window collisions because the habitat is not common, or if they are innately less likely to fly into glass.

Bird-Window Collisions in Markham

Two thousand six hundred eighty-three (2,683) birds were catalogued as bird-window collisions in Markham from 2000 to 2023 (2% of the total in the GTA). **Table C-2** provides a listing of the top 20 species involved in bird-window collisions in Markham, with the numbers of each species involved. There are two likely reasons for the lower number of birds involved in bird-window collisions in Markham: there are fewer glass buildings than in Toronto, and there is a much lower search effort in Markham (Mesure 2013, pers. comm.).

The bird species involved in bird-window collisions in Markham are similar to those in the GTA as a whole and mainly inculde small forest songbirds that do not usually nest in Markham, with rare exceptions where some species nest in large natural areas such as the Rouge Valley. However, two species known to collide with windows in Markham, Black-capped Chickadee and Mourning Dove, are both residents and migrants. Black-capped Chickadees may not migrate, but during the fall they may range more widely in search of habitat or food, and their numbers are likely inflated in the fall. As a result, the species distribution associated with bird window collisions in Markham likely represents a smaller subset of that observed across the GTA.

The two resident species are likely higher up on the list in Markham (in the GTA, Mourning Dove is 46th and Black-capped Chickadee is 12th on the list) because the total numbers of birds are smaller, so there are fewer migrants. As in the GTA, there are very few bird-window collisions involving larger birds, waterfowl, raptors, shorebirds, open-country birds, and aerial foraging species. A reason for these resident species being higher up the list in Markham is mainly due to a greater abundance of natural habitat being found on commercial properties which these species rely on for food, breeding, nesting, and shelter.

As the presence of adjacent vegetation can play a significant role in the potential for collisions to occur, certain families of birds tend to be less frequent colliders. For example, waterfowl and shorebirds rely of large bodies of aquatic habitat for breeding, feeding, and resting. These habitats rarely surround glazed structures, thereby reducing the likelihood for collisions to occur. Raptors tend to have much smaller populations and defend a much larger breeding area than that of songbirds. This lower concentration of raptors around buildings results in its lower collision rates.

Rank	Species	Number of bird-window collisions	Habitat	Status in Markham
1	Nashville Warbler	454	Forest	Migrant
2	White-throated Sparrow	336	Forest	Migrant
3	Dark-eyed Junco	219	Forest	Migrant
4	Tennessee Warbler	214	Forest	Migrant
5	Ruby-crowned Kinglet	171	Forest	Migrant
6	Black-capped Chickadee	168	Forest	Migrant, resident
7	Golden-crowned Kinglet	129	Forest	Migrant
8	Ovenbird	127	Forest	Migrant
9	Hermit Thrush	107	Forest	Migrant
10	Ruby-throated Hummingbird	102	Forest, Urban Gardens	Migrant
11	Yellow-bellied Sapsucker	97	Forest	Migrant
12	Yellow-rumped Warbler	76	Forest	Migrant
13	Common Yellowthroat	75	Variety of Habitats	Migrant
14	Magnolia Warbler	70	Forest	Migrant
15	Black-throated Green Warbler	61	Forest	Migrant
16	Brown Creeper	60	Forest	Migrant
17	Blackpoll Warbler	58	Forest	Migrant
18	Bay-breasted Warbler	55	Forest	Resident
19	Blackburnian Warbler	52	Forest	Migrant
20	Swainson’s Thrush	52	Forest	Migrant

Table C-2: Top 20 bird species involved in bird-window collisions in Markham from 2000 to 2023

Timing of Bird-Window Collisions in Markham

There is overwhelming evidence that bird-window collisions in Markham almost always involve migrants, rather than residents or breeding species. Resident species collide less frequently than migrating species because resident species are more familiar with the built environment. Furthermore, resident species that do collide with windows tend to be inexperienced young.

As noted above, most of the species involved in bird-window collisions do not nest in the Markham area. Secondly, as shown by **Table C-3**, almost all bird-window collisions occur during the period when birds are migrating, with most occurring during the fall in September and October, but another peak occurring during the spring migration primarily in April and May. This is consistent with information on bird-window collisions from other jurisdictions (e.g. Chicago and New York).

Species at Risk Involved in Bird-Window Collisions

A total of 776 individuals of twenty-four Species at Risk have been involved in bird-window collisions in the GTA from 2000 to 2023, as shown in **Table C-4**. The table shows numbers of bird-window collisions/ estimated numbers of adults in Ontario according to Cadman et al. 2007. In addition, Little Brown Bat, an Endangered mammal species, has been catalogued among bird-window collisions. The number of Species at Risk involved in collisions in Markham is low (only 6 have been found) but this is likely because of the lower search effort. Almost all bird Species at Risk in Ontario (listed as of 2013) are represented in bird-window collisions within the GTA. In some cases, it could be said that bird-window collisions have the potential to impact Species at Risk at the population level in Ontario. For example, some with very low populations such as Yellow-breasted Chat and Acadian Flycatcher (both of which are estimated at fewer than 100 adults). All species listed in **Table C-4** could potentially collide with windows in Markham.

In Canada, there are enforceable provincial and federal laws designed to protect birds from these collisions, including Species at Risk, making building owners and operators responsible to exercise due diligence to avoid the killing or harming of birds. For more information, visit: https://flap.org/property-managers-face-new-risks/

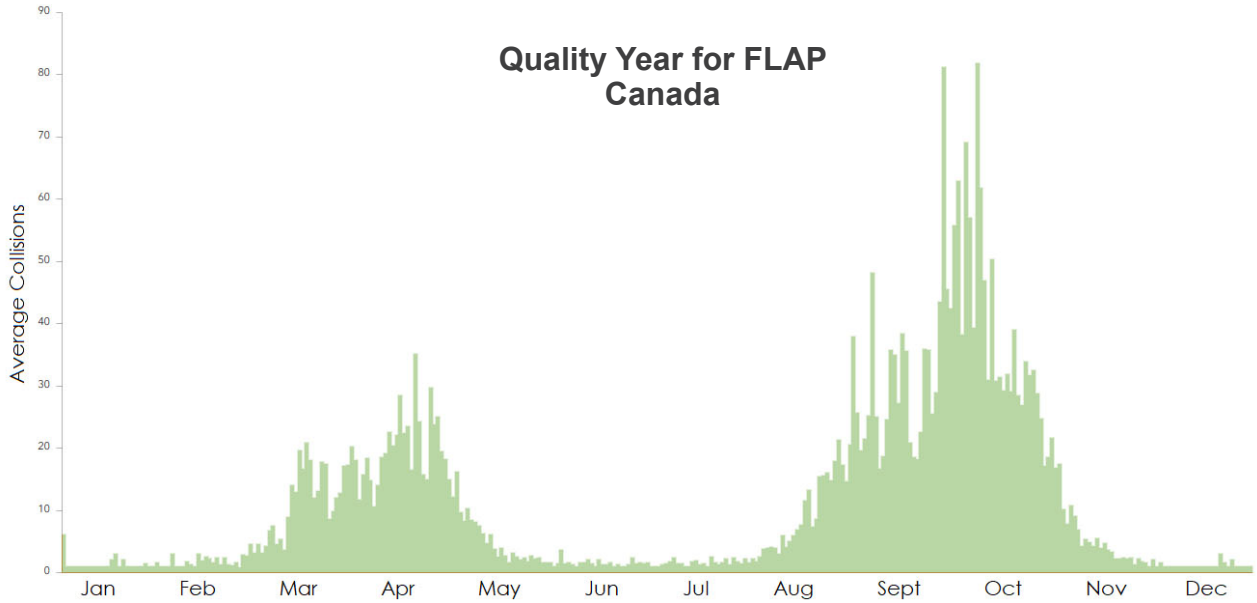

Table C-3: Seasonal Distribution of bird-window collisions in GTA up to and incldng 2023 data

Species	Federal Status	Provincial Status	Number involved in bird-window collisions in the GTA	Number involved in bird-window collisions in Markham	Number of Adults in Ontario (Estimate)
Wood Thrush	Threatened	Special Concern	348	6	200,000
Canada Warbler	Threatened	Special Concern	217	2	900,000
Eastern Whip-poor-will	Threatened	Threatened	69		?
Eastern Wood-pewee	Special Concern	Special Concern	39	4	300,000
Rusty Blackbird	Special Concern	Special Concern	14	1	Uncertain: 500,000 to 5 million
Chimney Swift	Threatened	Threatened	13		8,000
Grasshopper Sparrow	Special Concern	Special Concern	13	1	?
Acadian Flycatcher	Endangered	Endangered	11		50-70
Common Nighthawk	Special Concern	Special Concern	6		?
Golden-winged Warbler	Threatened	Special Concern	6		25,000
Louisiana Waterthrush	Threatened	Threatened	6		200-400
Olive-sided Flycatcher	Special Concern	Special Concern	4		100,000
Eastern Meadowlark	Threatened	Threatened	4		150,000
Bobolink	Threatened	Threatened	2		800,000
Yellow Rail	Special Concern	Special Concern	2		?
Peregrine Falcon	Not at Risk	Special Concern	2		78 Pairs
Red-headed Woodpecker	Endangered	Endangered	2		?
Yellow-breasted Chat	Endangered	Endangered	1		80-100
Cerulean Warbler	Endangered	Threatened	1		?
Evening Grosbeak	Special Concern	Special Concern	1		250,000
Henslow's Sparrow	Endangered	Endangered	1		?
Prothonotary Warbler	Endangered	Endangered	1		?
Short-eared Owl	Threatened	Threatened	1		?

Table C-4: Species at Risk involved in bird-window collisions in the GTA and Markham, status (in 2023) and estimates of total populations of each species (from Cadman et al. 2007, and Atlas of the Breeding Birds of Ontario 2001-2005). A question mark (?) indicates that the population is unknown

Areas with Highest Bird-Window Collisions in the Greater Toronto Area and Markham

Figure C-2 provides an aerial photograph showing the areas with the highest bird-window collisions in the GTA. All of the top sites for bird-window collisions are in Toronto. These sites include the Toronto Dominion bank towers (approximately 5000 bird-window collisions), the buildings centred around 4025 to 4120 Yonge Street, with approximately 4500 bird-window collisions, and Consilium Place in Scarborough (including two buildings and a glass linkway) with nearly 4000 bird-window collisions.

The high number of bird-window collisions at many of these locations are influenced by each building's proximity to large natural features. For example, various buildings along Yonge Street south of Highway 401 are in close proximity to lush vegetation of the Don River corridor (e.g. Yonge Corporate Centre). Buildings along King Street West between Yonge Street and John Street are close to both the Don River corridor and the vegetated shoreline of Lake Ontario (e.g. the Toronto Dominion Centre). Buildings in this area also experience a much higher number of nighttime collisions due close access to the waterfront. In Scarborough, some buildings are in close proximity to green space associated with Highland Creek (e.g. Consilium Place). Collision rates at many buildings within these regions are further intensified by the presence of adjacent ornamental plantings.

The building with the highest number of collisions in Markham (8500 Warden Ave) is included for reference; however, the number of bird-window collisions is much lower (1,069) at this building than at buildings in Toronto. As noted above, the numbers of bird-window collisions in Markham are likely less than in Toronto because of the lower search effort in Markham.

Location	Number of bird-window collisions
8500 Warden Avenue	1069
675 Cochrane Drive	680
8200 Warden Avenue	511
55 Commerce Valley Drive W	372
100 Allstate Parkway	328
131 McNabb Street	294
625 Cochrane Drive	267
75 Tiverton Court	166
7495 Birchmount Road	148
260 Town Centre Boulevard	145
1350 Rodick Road	127
4175 14th Avenue	102
90 Allstate Parkway	80
260 Town Centre Boulevard (Unit 101)	65
88 McNabb Street	56
303 Allstate Parkway	53
1351 Rodick Road	44
605-15 Allstate Parkway	30
191 McNabb Street	28
60 Columbia Way	24
101 McNabb Street	23
115 Apple Creek Boulevard	23
185 Clegg Road	20
600 Cochrane Drive	18
11 Allstate Parkway	18
1300 Rodick Road	15
80 Tiverton Court	14
8 The Seneca Way	13
20 Valleywood Drive	13
19 Allstate Parkway	11
25 Royal Crest Court	10
8133 Warden Avenue	10

Table C-5: Locations of buildings in Markham where there were 10 or more collisions from 2000 to 2023

Table C-5 provides the numbers associated with the 32 sites in Markham with 10 or more bird-window collisions. The site with the highest number is 8500 Warden Avenue, with 1,069 bird-window collisions (22% of the total 4,777 bird-window collisions documented in Markham). Bird-window collisions have been noted at 19 other buildings, but the numbers are much lower at these buildings: fewer than 10 collisions at each site since recording began in 2000. For some properties, fewer collisions are recorded due to a lack of data collected by volunteers.

The lower number of bird-window collisions is at least partly due to the fact that information on bird-window collisions in Markham is not nearly as extensive as in Toronto due to the much smaller number of volunteers patrolling for birds under the buildings. This is especially true on days when there are numerous bird-window collisions occurring in the region, forcing volunteers to focus more on rescuing as many birds as possible rather than gathering their associated collision records (Mesure 2013 pers. comm.). Therefore, it is not possible to determine whether there are significantly fewer migrants in Markham. There are, at least at present, fewer glass buildings.

As in the rest of the GTA, most bird-window collisions in Markham occur during the day (Mesure 2013 pers. comm.). 47% of collisions occur in September, and 35% occur in October, indicating that, as in the rest of the GTA, fall migrating birds are by far the most often involved in bird-window collisions. 3% of collisions occur in April, and 10% occur in May. Collisions during all other months make up less than 1% of the total number. There are several reasons why there are fewer collisions in spring compared to fall; birds migrate longer distances in springtime, majority of birds migrating are experienced adults, and there are fewer birds migrating in spring.

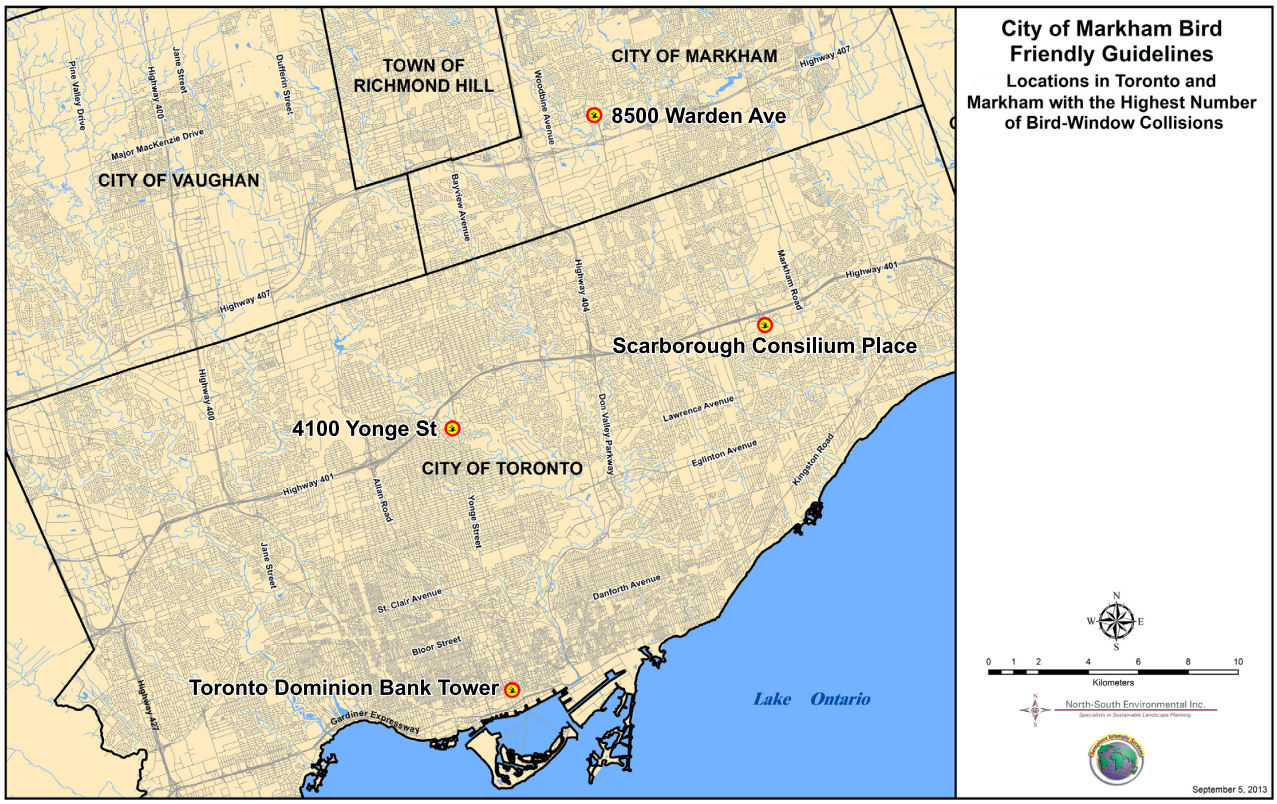

Figure C-2: Aerial photograph indicating highest bird-window collisions in the GTA (September 2013)

Results of Analysis to Determine whether Concentrations of Birds affects Bird-window Collisions

The possibility was examined that there could be factors that lead to concentrations of birds, and could predict locations most likely for bird-window collisions. Two factors were examined: whether there are documented areas where migrants, breeding birds or resident birds concentrate, which might be associated with higher numbers of bird-window collisions, and whether there were obvious landscape factors (such as the presence of a natural corridor) that might be associated with large numbers of bird-window collisions.

Areas of Bird Concentration Migrant Bird Concentration in Markham

Information on areas of migrant bird concentration was sought in order to determine if bird-window collisions were associated with areas where migrants were concentrated. Section 2 provides sight records of migrants have been recorded within the City of Markham. Records were obtained through consultation with three birders knowledgeable about Markham (Stan Long, Barrie Kent-McKay, and Roy Smith), and through scanning through any available archives of three websites most frequently used by birders in southern Ontario: Ontbirds from 1999 to 2013 (the website of the Ontario Federation of Ornithologists) and the Toronto and Southern Ontario Bird Forum website from 2006 to 2013. Records were also obtained from E-bird, a website used throughout the world to record bird observations; however, this website is of relatively recent origin and there were few records available. It was hoped that records could be obtained from the Toronto Ornithological Club database but Smith (2013 pers. Comm.) noted that there were very few records for Markham in that database.

There were few records of migrant bird concentrations in Markham; most records involved only small numbers of birds. Long (2013 pers. comm.) explained that this is likely because birds are spread out among many small woodlots in Markham, as opposed to the situation in Toronto where birds are very concentrated along the waterfront.

Hotspots represent areas where a high number of bird-window collisions occur, based on the E-bird website. Hotspots receive this designation based on birders' perceptions. The most popular birding sites in Markham are generally those where people go to see shorebirds and waterfowl, and hotspots are therefore biased towards ponds in Markham where these species are most often seen, though records indicate that songbirds are noted here as well. Since waterfowl and shorebirds are among the least numerous birds to be involved in bird-window collisions these locations do not represent concentrations of birds that would be most susceptible to bird-window collisions. Blue spots represent areas that are mentioned by birders without any reference to unusual numbers.

It is evident that locations of bird-window collisions are related to the abundance of glass buildings, the quantity and quality of reflective or transparent polished materials, and the proximity and abundance of nearby vegetation. Collisions are worsened when buildings are situated in areas where birds are know to congregate in high numbers during migrations.

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D Birds in Markham

Birds in Markham

Birds in Markham Consist of:

- Those that generally move through Markham on migration on their way to breeding grounds further north, which may stop to rest and feed on the way (migrant birds);
- Those that live all year round in Markham (resident birds);
- Those that breed in Markham but migrate south in the winter (breeding birds); and,
- Those that breed up north but come down to winter in southern Ontario, like snow buntings and evening grosbeaks (wintering birds).

The following provides a brief description of habitat use of each of those groups and explains why each group may be vulnerable to collisions with glass. **Appendix C** provides an existing conditions summary on bird-window collisions in the GTA and Markham, and **Appendix D** provides a brief description of how to identify the "top 10" birds that are involved in collisions in Markham.

Migrant Birds

As can be seen in the radar image of migrating birds in **Figure D-1**, migrants depart stopover areas in high densities and move north around the Great Lakes, staying close to the north edge of Lake Erie, along the Niagara Peninsula and the north shore of Lake Ontario in very large numbers. They move north along the north shore of Lake Ontario in a dense band which is densest within approximately 1km of the lake shore (as shown by the colour purple and dark red) but is still very dense (shown by lighter red) as it passes through Markham. Birds appear to become more dispersed as they move north of Markham, as is shown by the yellow colour band. In the fall, the opposite occurs, as they migrate southward and encounter the northern shoreline of Lake Ontario. As a result, the concentration of birds in southern Ontario region increases exponentially. This dramatically increases the potential for bird-window collisions.

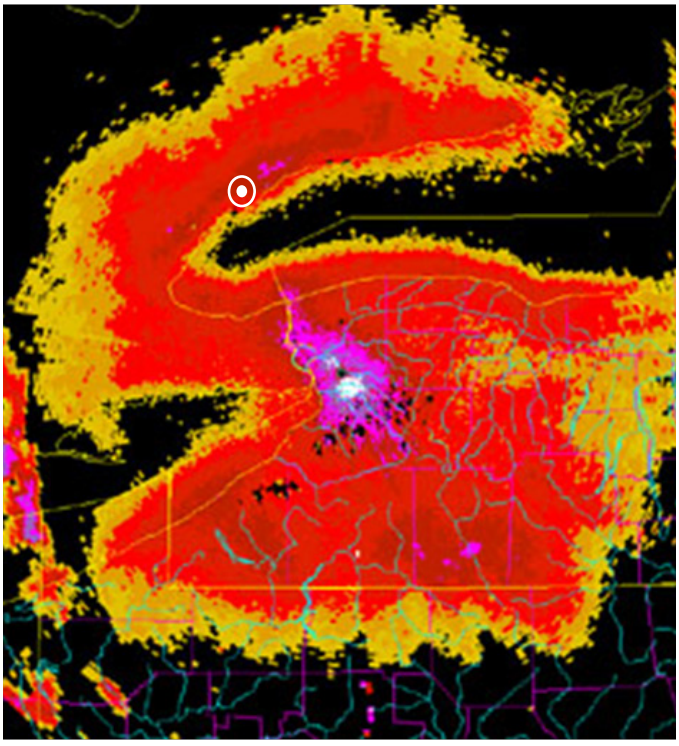

Figure D-1: Radar image night of migration route around Lake Ontario

Select groups of birds, such as hawks, falcons, waterfowl, swallows, and nightjars, migrate during the day while most songbirds migrate at night. **Table D-1** shows the top 10 species involved in collisions in Markham.

Birds are vulnerable to collisions with buildings not because they hit them during migratory flight, as they migrate well above the height of buildings, but because they drop out of migration at dawn to rest and feed. As shown in **Figure D-3**, migrants have been observed stopping to rest and feed in many locations around Markham. There are few reports of areas where songbirds consistently stop in large numbers. Instead, migrants appear to be widely distributed and use a variety of habitats.

Nocturnal migrants tend to depart stopover areas at dusk. Their departure is governed by a combination of weather factors, but generally birds prefer to migrate in good weather with southerly winds as they move north and with northerly winds as they move south. In good weather, birds may fly through the night until they land before dawn, and then feed at first light. In bad weather, or at times when birds' fat stores are depleted (for example in unusually cold weather or strong winds) birds may make an emergency stop well before dawn, landing wherever they can. These emergency stops are often influenced by sudden changes in weather conditions such as adverse winds, rain, and fog where visibility is poor.

Resident Birds

Resident birds are those that reside in Markham year-round. These consist of species that do not migrate, with the most common including Northern Cardinal, Black-capped Chickadee, American Crow, Blue Jay, Downy and Hairy Woodpecker, Mourning Dove, and American Goldfinch. These species do not appear to be commonly involved in bird-window collisions in the GTA, though the resident Mourning Dove and Black-capped Chickadee are two of the top 10 in Markham with regard to collisions. However, even these resident species are mainly involved in bird-window collisions during the migration periods (spring and fall). It is known that some Mourning Doves are short distance migrants, though some are residents, and that young Black-capped Chickadees move around extensively in the fall as they search for winter habitat, so it is likely that the bird-window collisions involving these species also reflect birds that do not stay in the area for long periods.

Bird	Number of Bird-window Collisions	Status
Nashville Warbler	454	Migrant
White-throated Sparrow	336	Migrant
Dark-eyed Junco	219	Migrant
Tennessee Warbler	214	Migrant
Ruby-crowned Kinglet	171	Migrant
Blacked-capped Chickadee	168	Resident
Golden-crowned Kinglet	129	Migrant
Ovenbird	127	Migrant
Hermit Thrush	107	Migrant
Ruby-throated Hummingbird	102	Migrant

Table D-1: Bird-window collisions recorded in Markham from 2000-2023

Breeding Birds

Breeding birds are those that nest and raise their young to fledge in Markham. Locations of habitat-sensitive breeding birds surveyed by the Toronto & Region Conservation Authority (TRCA) are shown in **Figure D-3**. Adults and young then fly south in the fall. Again, these species are less likely to be involved in collisions in Markham than are migrant birds, though Nashville Warblers, some of which breed in Markham while others fly through Markham on their way north to breed, are one of the top 10 species involved in collisions. Markham breeding birds include the Yellow Warbler, Chestnut-sided Warbler, American Redstart, Baltimore Oriole, Rose-breasted Grosbeak, White-throated Sparrow, and the Chipping Sparrow.

Markham's Greenway System

Threading through both the urban and rural landscapes of Markham are several major river valleys: the Rouge and the Don being the largest, as well as the smaller Petticoat and Duffins Creek in the east. Each river and creek is surrounded by varying widths of riparian vegetation that provides habitat for migrating and breeding birds. Tributaries of each of these rivers also thread through the urban and rural fabric of the City. **Figure D-3** provides an aerial photo view of the City overlaid with the Greenway System that protects, enhances and connects the significant natural heritage of the City. Breeding birds are well-documented within the Greenway System (**Figure D-4**). They are also known to breed in smaller patches of habitat outside the Greenway System; bird surveys shown in the figure (conducted by the TRCA) included mainly public property. Other areas may not necessarily receive the same level of effort. There is evidence that many migrants are found throughout the City in smaller patches of vegetation outside the Greenway System so breeding birds would inhabit these areas as well.

Figure D-2: Nashville Warbler

Figure D-3: Markham's proposed Greenway System in relationship to areas where migrants have been observed and bird-window collisions

Figure D-4: Markham's proposed Greenway System and locations of breeding birds classified according to their susceptibility to bird-window collisions

Areas of Bird Concentration: Breeding Bird Concentrations in Markham

The birds involved in bird-window collisions are primarily migrants, but concentrations of breeding birds were used to suggest where concentrations of migrants might also occur, since there were so few records of migrants. Breeding bird records of birds with a Conservation Concern score of L1 to L4 (as determined by bird surveys conducted by the Toronto and Region Concentration Authority (TRCA)) were plotted to determine if there were concentrations of breeding birds in the City. As illustrated in **Appendix D**, it is evident that areas of concentration of breeding birds are not related to areas where most bird-window collisions occur.

There are two caveats associated with the use of this data. The first is that most of the species that have the highest susceptibility to bird-window collisions do not generally breed in the GTA: this includes for example Ruby-crowned Kinglet, Golden-crowned Kinglet, Dark-eyed Junco, and Nashville Warbler. Collision rates by individual species can be defined by the concentration of its species within a region. High populations (common species) tend to have higher collision rates, where lower populations (less common species) tend to have fewer collisions. It is these less common species, particularly Species at Risk, that are currently most threatened by window collisions.

The second caveat is that these records only include L1 to L4 species (i.e. those that have more conservative habitat requirements such as dependence on larger areas of habitat). Therefore, some of the birds that do breed in Markham, and have a high susceptibility to bird-window collisions (for example Black-capped Chickadee) are not recorded. The birds that were recorded breeding in Markham are thus used as a surrogate to indicate where birds with different rates of bird-window collisions were concentrated.

It appears that birds that occur in high, moderate and low numbers of bird-window collisions breed throughout natural areas in Markham, with a few areas of concentration in larger patches of natural habitat near water bodies. Areas of breeding bird concentration are not always immediately adjacent to areas of bird-window collisions concentration. Breeding birds are found along a wide variety of natural corridors, in a variety of habitats, in large and small patches of habitat. This is likely true of migrants as well. As with migrant species, the points noted here relate to areas that have been studied by TRCA: there has been no random sampling of all natural habitat to determine relative abundance in different areas.

Areas of Concentration: Resident Bird Concentrations

Resident birds are those that reside in Markham year-round. These consist of species that are not long-distance migrants, with the most common including Northern Cardinal, Black-capped Chickadee, American Crow, Blue Jay, Downy and Hairy Woodpecker, Mourning Dove, and American Goldfinch.

With the exception of Black-capped Chickadee and Mourning Dove, resident species do not appear to be commonly involved in bird-window collisions. As noted in **Appendix D,** the birds killed in bird-window collisions are primarily migrants. This is in part due to adult resident species having adapted to the built environment making them less likely to collide with windows. However, resident species are known to collide with windows when being chased by aerial predators or as inexperienced fledglings.

In addition, resident birds are likely to be more widely distributed than breeding birds, as like migrants they are relatively mobile (they are not tied to breeding territories, for example) and their distribution corresponds to areas where they can find food, particularly bird feeders, during the winter. Resident birds include several that are highly susceptible to bird-window collisions, but there are very few bird-window collisions during the winter (fewer than 1% of total bird-window collisions), and predicting the areas where bird-window collisions would be most likely to occur in winter would be problematic. This is in part due to adult resident species having adapted to the built environment making them less likely to collide with windows. However, resident species are known to collide with windows when being chased by aerial predators or as inexperienced fledglings.

Landscape Setting of Towers with High Bird-Window Collisions in the GTA and Markham

There are few similarities between the landscape settings of sites in the GTA with the highest numbers of bird-window collisions. In some cases, buildings are adjacent to a large natural corridor while in other cases there is no substantial natural corridor nearby.

The site with the highest number of bird-window collisions in Markham is 8500 Warden Avenue. As with 4025 to 4200 Yonge Street, which are located close to the Don River, the reason for the high number of bird-window collisions is related to the building's close proximity to the Rouge River and its abundant surrounding vegetation (close to a tributary which may channel migrating birds from larger natural areas).

The 8100 Warden Avenue building is similar to Toronto's glass towers in that it reflects the surrounding planted vegetation to a high degree. Mesure (2013 pers. comm.) and Klem (2013 pers. comm.) both stated that it is the reflective and transparent qualities of glass, which is not perceived as a barrier by birds, that is primarily responsible for bird-window collisions. Birds are attracted to a wide variety of natural vegetation as they migrate, and even if they travel to Markham along a larger corridor, could conceivably cross the space between a natural corridor and a well-vegetated garden around a glass building in seconds.

Bird Identification

The following table provides a brief guide to the top 10 birds involved in bird-window collisions in Markham, as well as the two Species at Risk involved in bird-window collisions. Note that the photos show birds in breeding plumage only. Females, many migrants, and juvenile birds encountered in the fall have drab plumage that may not resemble breeding plumage.

Figure D-5: Nashville Warbler

Species: Nashville Warbler

Breeding/Migrant/Resident: Migrant

Species At Risk Status: None

Habitat: Forest

Figure D-6: White-throated Sparrow

Species: White-throated Sparrow

Breeding/Migrant/Resident: Migrant

Species At Risk Status: None

Habitat: Forest, swamp

Figure D-7: Dark-eyed Junco

Species: Dark-eyed Junco

Breeding/Migrant/Resident: Migrant

Species At Risk Status: None

Habitat: Forest, swamp

Figure D-8: Tennessee Warbler

Species: Tennessee Warbler

Breeding/Migrant/Resident: Migrant

Species At Risk Status: None

Habitat: Forest

Figure D-9: Ruby-crowned Kinglet

Species: Ruby-crowned Kinglet

Breeding/Migrant/Resident: Migrant

Species At Risk Status: None

Habitat: Forest

Figure D-10: Black-capped Chickadee

Species: Black-capped Chickadee

Breeding/Migrant/Resident: Resident

Species At Risk Status: None

Habitat: Forest

Figure D-11: Golden-crowned Kinglet

Species: Golden-crowned Kinglet

Breeding/Migrant/Resident: Migrant

Species At Risk Status: None

Habitat: Forest

Figure D-12: Ovenbird

Species: Ovenbird

Breeding/Migrant/Resident: Migrant

Species At Risk Status: None

Habitat: Forest

Figure D-13: Hermit Trush

Species: Hermit Trush

Breeding/Migrant/Resident: Migrant

Species At Risk Status: None

Habitat: Forest

Figure D-14: Ruby-throated Hummingbird

Species: Ruby-throated Hummingbird

Breeding/Migrant/Resident: Migrant, Breeding

Species At Risk Status: None

Habitat: Forest, Urban Gardens

Figure D-15: Wood Thrush

Species: Wood Thrush

Breeding/Migrant/Resident: Migrant

Species At Risk Status:
Federal (Threatened), Provincial (Special Concern)

Habitat: Forest

Figure D-16: Canada Warbler

Species: Canada Warbler

Breeding/Migrant/Resident: Migrant

Species At Risk Status:
Federal: Threatened, Provincial: Special Concern

Habitat: Forest, Swamp

Figure D-17: Eastern Wood-Pewee

Species: Eastern Wood-Pewee

Breeding/Migrant/Resident: Migrant

Species At Risk Status:
Federal (Special Concern), Provincial (Special Concern)

Habitat: Forest

Figure D-18: Rusty Blackbird

Species: Rusty Blackbird

Breeding/Migrant/Resident: Migrant

Species At Risk Status:
Federal (Special Concern), Provincial (Special Concern)

Habitat: Forest

Figure D-19: Grasshopper Sparrow

Species: Grasshopper Sparrow

Breeding/Migrant/Resident: Breeding

Species At Risk Status:
Federal (Special Concern), Provincial (Special Concern)

Habitat: Grasslands

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E Glossary

Building Industry and Land Development Association (BILD): was formed through the merger of the Greater Toronto Home Builders' Association (GTHBA) and the Urban Development Institute/Ontario. BILD is the voice of the land development, home building and professional renovation industry in the Greater GTA. BILD represents more than 1,400 member companies. Their membership includes: home builders; land developers; professional RenoMarkTM renovators; land use and environmental planners; sub-contractors; manufacturers; lawyers; surveyors; architects; suppliers; and representatives of service, professional and financial institutions. For more information, visit (http://www.bildgta.ca).

Bird-Window Collisions (BWCs)/Strike: any occurrence, whether fatal or not, of a bird colliding with a building which are most often associated with glass that reflects vegetation or provides see-through conditions to vegetation on the adjacent side of a building. The reflections can be associated with a natural feature, or can be associated with planted gardens.

Black Hole Effect: a condition in which, in some lights, glass can appear black, creating the appearance of a cavity or passage through which birds can fly.

Building Owners and Managers Association (BOMA): is the voice of the Canadian commercial real estate industry with over 3,200 members in regional associations across Canada. On behalf of the building owners, managers, developers, facilities managers, asset managers, leasing agents, brokers, and the product and service providers to over 2.1 billion square feet of commercial real estate in Canada, BOMA Canada addresses issues of national concern, and promotes excellence in the industry through information, education advocacy and recognition. BOMA has a local Toronto office, for more information, visit (http://www.bomatoronto.org).

Canadian Standards Associataion (CSA), now known as CSA Group, is a not-for-profit organization that develops standards to ensure safety, sustainability, performance, and quality across various industries in Canada and internationally, visit (https://ipac-canada.org/canadian-standards-association-csa)

Contiguous Glass Areas: is defined as a continuous window construction, including frames or mullions, glazing units, and muntin bars, within a façade and separated in all directions by an opaque façade component. A contiguous glass area can be a glazing panel used for decorative or life-safety purposes and can include, but not be limited to, balcony guards, balcony dividers, louvers or projections made of glass installed in any position other than horizontal, guards, and balustrades. For the purposes of determining areas to be treated, it can also include spandrels: decorative glass that does not provide a window, and which reflects adjacent vegetation. It could also include areas of highly polished marble or stainless steel. For the purpose of these Guidelines, a maximum of 10% of the glass area on a façade can be left without treatment. The 10% would generally be applied primarily to retail window surfaces or building areas where the internal building function requires unimpeded views.

Endangered Species: means a species that is listed or categorized as an "Endangered Species" on the Ministry of Natural Resources and Forestry official Species At Risk in Ontario List, as updated and amended from time to time.

Fatal Light Attraction: the consequence of the increase in artificial lighting by streetlights and buildings, whereby nocturnal migratory bird species are attracted to and disoriented by our cities' glowing night skies. The effects of fatal light attraction are exacerbated in poor weather such as rain or fog.

Fatal Light Awareness Program Canada (FLAP): a registered Canadian charity widely recognized as the pre-eminent authority on the bird-building collision issue. Since 1993, FLAP Canada has worked tirelessly to safeguard birds in the built environment through advocacy, education, policy development, research, and bird rescue. FLAP Canada works with industry professionals, researchers, wildlife conservation groups, government agencies and members of the public to protect migrating birds from collisions with buildings.

Film: a material applied to the exterior surface of glass. Perforated or non-perforated film can be used without alteration (raw) or be printed with decorative patterning.

Fly-Through Condition: a condition created when architectural elements provide birds with a clear line of sight to sky or vegetation on the other side. Glass corners, parallel glass, building-integrated or free-standing glass, at-grade glass guards/ guardrails, and glass parapets are examples of fly-through conditions.

Frit Patterns: glass that is manufactured with a visible embedded pattern within the glass.

Fenestration: the arrangement of glass panels and/or windows in a wall.

Glass Surface: the surface of glazing on which visual markers are applied.

Glazing and other transparent or reflective Surfaces: Surfaces made of materials, typically glazing and other transparent or reflective surfaces that either reflect the surrounding environment or are see-through, and are commonly used in architectural façades, windows, and building envelopes.

LEED® Canada for New Construction and Major Renovations (2009): is the Canada Green Building Council's nationally accepted standard of sustainability for the commercial, residential, and institutional building industries. Credits are awarded in six categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation In Design and Regional Priority. For more information, visit (http://www.cagbc.org).

Light Pollution: the unnaturally increased illumination and temporary fluctuations in lighting produced from man-made sources such as building lights, street lamps and vehicles.

Light Spill: a form of light pollution resulting from excess artificial light (i.e., lighting fixtures) from a focused source being cast where it is not useful or desired.

Light Trespass: a form of light pollution, where potentially unwanted light crosses a property line.

Migration: animal species' long distance movement from one habitat to another, according to the seasons and on an annual cycle.

Mullions: the bars between panes of glass in a window.

Muntins: a bar or sash bar is a strip of wood or metal separating and holding panes of glass in a window.

Natural Area: means features and areas which are important for their environmental and social values as a legacy of the natural landscapes of an area.

Non-Film Adhesive Marker: a product applied to the exterior surface of glass at a specified spacing or decal with custom-cut graphic designs.

Opaque Façade Component: defined as a solid façade construction that is neither reflective nor transparent. Examples can include, but not be limited to, masonry, precast concrete, metal panel, EIFS, or wood façade and rainscreen constructions; spandrel panels with an infill panel of a material other than glass, back-painted or otherwise; or a screen, scrim, or continuous louvers applied over glazing or other construction with openings or spaces no larger than 50 mm in at least one direction.

Treatments: modifications to windows, window coverings, buildings and landscaping to reduce the potential for bird-window collisions.

Public Building: a building that belongs to a town, city or regional office, and is used by the public.

Treatment: is defined as a standard based on a minimum visual markers/cues. In order to minimize bird collisions visual marker spacing on clear or reflective surfaces on a structure should not exceed 50 mm (2 inches) on the horizontal plane or 50 mm (2 inches) on the vertical plane. Primary treatments for new buildings and site plan design may include applying external semitransparent stripes, dots or other patterns.

Spandrel Glass: the opaque portion of a building's exterior between the top of a window and the sill of the window above.

Species at Risk: refers to native plants and animals assessed as Extirpated, Endangered, Threatened, or Special Concern, meaning they are at risk of disappearing from the province due to threats like habitat loss, pollution, and invasive species.

Threatened Species: is a species vulnerable to extinction in the near future that is listed or categorized as a "Threatened Species" on the Ministry of Natural Resources and Foresty official Species At Risk in Ontario List, as updated and amended from time to time.

Up-lighting: light that is projected directly upward by inefficient lighting fixtures. Direct upward light contributes greatly to artificial sky glow.

Visual Markers/Cues: a term used to describe birds' visual perception created by spolid/opaque surfaces or solid physical design cues on the exterior surface of glazing and other transparent or reflective surfaces material which helps its surface appear different from reflected sky or habitat that makes it visible to birds.

Visual Noise: the effect of the application of visual markers on the appearance of a building. A building with high visual noise will be more visually distinct from reflected habitat or sky, and more easily distinguished and avoided by birds.

Window-to-Wall Ratio (WWR): is defined as the area of fenestration, including frame or mullion and glazing, relative to the total area of the façade. Treatment is required on each façade, and as such, the WWR of each façade should be evaluated independently. WWR = Area Glazing – including frames (m^2) / total façade area **(m^2)**

Ultraviolet (UV): the electromagnetic radiation that falls on the electromagnetic spectrum between visible light and X-rays, with a wavelength from 10 nm to 400 nm. Birds have the ability to perceive wavelnghts between 200 nm and 400 nm.

UV Marker: an ultraviolet pattern on the exterior surface of glass (the first surface; see definition of Glass Surface) and consisting of absorbing and reflecting elements that create a visible barrier that can be seen by birds.

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