An Analysis of Collision Mitigation Effectiveness

Pre- and Post-Installation of Bird Collision Deterrents at Four Toronto Buildings

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Background

It is estimated that one billion birds die in North America from the impact of colliding with windows. As one of the leading causes of bird death, this issue has become an escalating concern among bird conservationist and government agencies.

In 2017, FLAP Canada was approached by the Canadian Wildlife Services (CWS) to analyze pre-installation and post-installation data at four Toronto buildings monitored by FLAP Canada volunteers where bird collision deterrents were applied. This analysis aims to identify the effectiveness of these bird collision deterrents. The results of this analysis will help assist CWS as they explore the potential for mitigating bird-window collisions at their portfolio of buildings across the country.

The City of Toronto is situated beneath the Mississippi and Atlantic Flyways. Millions of migratory birds fly through the City on their way north during the spring migration (March through May) and south during the fall migration (August through mid-November). Though the Greater Toronto Area (GTA) is increasingly more urbanized, there are numerous watersheds and Lake Ontario within its boundaries that provide ideal corridors, stopovers, foraging and breeding habitats for birds. These attraction factors create the perfect storm for bird-building collisions across the GTA.

In preparing the findings for this analysis, approximately 6,000 collision records were reviewed by FLAP staff. This data was collected by a network of FLAP volunteers who routinely patrol a select group of buildings across the GTA for bird-building collisions. Along with the monitoring records by volunteers, supporting information on the location, surrounding land use and building materials of the four buildings were also briefly reviewed using orthoimagery.

A number of factors influence the availability and success of volunteers who monitor these sites including employment priorities, lack of transportation, building construction, security restrictions, sickness and inclement weather. More important to the data collection is for volunteers to quickly respond to any injured bird(s) they encounter in the hopes they can be rehabilitated and released back into the wild.

Further to this matter, the following list offers vulnerabilities of individual volunteer collection methods that could affect the nuances of this document's data analysis:

- varying consistency in individual volunteer data collection practices,
- varying consistency between different volunteers' data collection practices,
- varying accessibility across one site and between sites,
- varying structural features (e.g., inaccessible overhangs, floor staging)
- varying patrolling pattern/frequency.

FLAP CANADA

FLAP Canada is a national charitable organization (Canada Revenue Agency #14074 6736 RR0001) celebrating 25 years of advocating for the protection of migratory bird species from bird-building collisions across North America and abroad. FLAP was the first organization to address this bird conservation issue and has contributed directly or indirectly to the creation of similar groups around the world. FLAP has been highly successful at educating key audiences on the issue and has made outstanding strides toward creating change to mitigate this threat. Some of FLAP's accomplishments have been in partnering with key audiences in the commercial, manufacturing and scientific communities, as well as various levels of government, to develop programs and provide expert comment on innumerable documents on the issue including:

- Contributing expertise and data to WWF Canada's 1996 report titled *'Collision Course: The Hazards of Lighted Structures and Windows'***.**
- Initiating the first "Lights Out" campaign in 1997 with WWF Canada called the Bird-Friendly Building Program.
- Offering instrumental expertise to City of Toronto staff which informed the development of the original *Bird-Friendly Development Guidelines* (2007), now under the *Toronto Green Standard* (2010-present).
- Developing the FLAP Mapper (see References) in 2012 which allows for citizen scientists to track bird-window collisions globally and has over 9,000 entries to date. With financial support from Environment Canada, this mapping tool will soon have the capability to provide groups with the option to access and track their combined data.
- Providing precise and one-of-a-kind data to the authors of Environment Canada's 2013 paper '*A First Estimate for Canada of the Number of Birds Killed by Colliding with Building Windows*'.
- Recording over 74,000 bird-window collisions between 1993 and 2017 in the Greater Toronto Area (GTA). Of the 170-species recorded, 23 were Species at Risk, listed under the provincial *Endangered Species Act* (2007) and/or the federal *Species at Risk Act* (2002).

BirdSafe® Building Risk Assessment

By 2009, as concerns surrounding the bird-window collision issue escalated and the demand for effective solutions grew, FLAP recognized the need for a methodology that would provide scientific information to building owners and operators on the level of risk each of their building façades pose to birds.

In the years that followed, FLAP developed BirdSafe®; a building standard to objectively assess design features of a building and surrounding topography for any risk(s) for bird-building collisions. BirdSafe was developed collaboratively with subject expertise in the science, biology, ornithology, architecture, engineering, computer programing and bird conservation fields.

An accompanying online building risk assessment system follows the BirdSafe standard, assesses each building façade on its own merit based on regional, local and building factors to identify those that pose the greatest risk to birds. In this way, building owners can choose to address the risk of collisions on a select priority basis. Since its launch, FLAP Canada has undertaken numerous assessments in 7 different cities across North America.

Data Collection and Use

At its inception in 1993, one of the primary activities of FLAP Canada was to monitor buildings for bird collisions, salvage and document the birds found, and release healthy birds back into the wild. This practice continues to this day primarily by trained volunteers. Buildings are monitored all days of the week during spring and fall migration which accounts for approximately seven and a half months of the year. Birds that are found alive are treated with homeopathic remedies and, if healthy enough, are released into natural areas away from the built environment. Birds that require rehabilitation are transported to a rehabilitation centre (e.g. Toronto Wildlife Centre) where they are treated, monitored and released if possible.

All dead birds recovered by FLAP volunteers are individually tagged with a unique number and frozen for later storage at the Royal Ontario Museum (ROM). Volunteers enter detailed data into the FLAP online database for each bird-window collision they encounter. This database is quality controlled by FLAP Canada staff on a regular basis. This pertinent data includes the bird species, its status (dead or alive), date, time, name and side of structure where found (cardinal direction). Currently, there are 206 buildings in this database being monitored by over 60 trained volunteers compared with 65 buildings in 2000. These collisions were initially recorded on paper, but in 2001, a new volunteer database was created to:

- Store and manage records (including location and date) for each bird-window collision.
- Provide the Royal Ontario Museum (ROM) with essential data to accompany the bird specimens provided by FLAP for education, scientific and research use.
- Yield a better understanding of the intricacies of the bird-window collision issue by storing data that is easy to review and deploy.

- Provide building operators with both the history of bird collisions at their facility and where collisions are recorded.

- Measure and identify differences between daytime and nighttime collisions; this has helped to demonstrate that the issue of nighttime collisions is mainly a localized phenomenon.

- Provide data for scientific research outside of the bird-window collision issue, including studies that monitor bird population trends and to research projects that estimate bird deaths caused by anthropomorphic issues.

As a testament to the quality and accuracy of FLAP Canada's data, it was thoroughly scrutinized and recognized as evidence by the Ontario Court of Justice in the *Podolsky v. Cadillac Fairview, 2012* trial. The data provided to the court included collision observations for 4100, 4110, and 4120 Yonge Street collectively known as Yonge Corporate Centre (YCC) in the City of Toronto. The data was instrumental in establishing a comprehensive understanding of the bird-window collision issue at this site and was reflected highly upon by Judge Melvyn Green who presided over the trial:

> *"The evidence before me makes clear that there were occasions of on-site recording error or confusion. I recognize, as well, that some mistakes occurred through data transfer. Nonetheless I am more than satisfied of the chain of continuity of the vast majority of the recovered birds and the general integrity, accuracy and reliability of the 2010 bird strike data collected and collated by FLAP. More precisely, I have no doubt that many hundreds of birds lost their lives or were injured as a result of colliding with the reflective windows and spandrels at the YCC during the time frames set out in the three counts and that, among the killed birds, were the one Olive-sided Flycatcher and three Canada Warblers whose field identification as such were positively confirmed by Peck during his examination of them at the ROM."*
>
> - Judge Melvyn Green (see Dianne Saxe reference, February 25, 2013).

FLAP Canada data has also been used in a number of scientific papers including:

- Cusa, M., Jackson, D and Mesure, M. (2015). Window Collisions by Migratory Bird Species: Urban Geographical Patterns and Habitat Associations. Urban Ecosystems, 18(4), 1427-1446.

- Bayne, E., Machtans, C., and Wedeles, C. (2013). A First Estimate for Canada of the Number of Birds Killed by Colliding with Building Windows. The Journal of Avian Conservation and Ecology, 8(2).

The data for the pre- and post-installation of bird collision deterrents at the four Toronto buildings in this paper has not been analyzed or published in any form.

Analysis of Data at Four Buildings in the City of Toronto

The following sections analyze the pre- and post-deterrent data at four Toronto buildings and the effectiveness of these collision mitigation measures. The data used was retrieved from FLAP Canada's volunteer database. These buildings were chosen because of the access to collision data and they have been known to be particularly lethal to birds due to their mirrored façades reflecting neighboring vegetated landscapes.

The window film bird collision deterrents that were applied to the façades of all four buildings were manufactured by the same company. The bird collision deterrents are vinyl exterior film made up of light grey dots that are distributed evenly across select façades. For each application described below, the film was applied to the first (exterior) surface of glass. These particular mitigation measures are applied by sizing each windows on each façade and then applying, by hand, a custom-sized film over the entire pane of glass.

33 Yonge Street (Building 1)

Situated between the Financial District and the historic St. Lawrence neighbourhood in the City of Toronto, the building at 33 Yonge Street is a 13-storey office tower in a densely urbanized environment (**Figure 1**). The shoreline of Lake Ontario, which acts as a stopover for migratory birds, is less than 1 kilometre from the building. Due to the location immediately inland from the lake and the heavy use of highly reflective building material **(Figure 2**), 33 Yonge Street and many other buildings in the area are known for bird-window collisions. As a result, FLAP Canada has been monitoring 33 Yonge Street for the past 12 years.

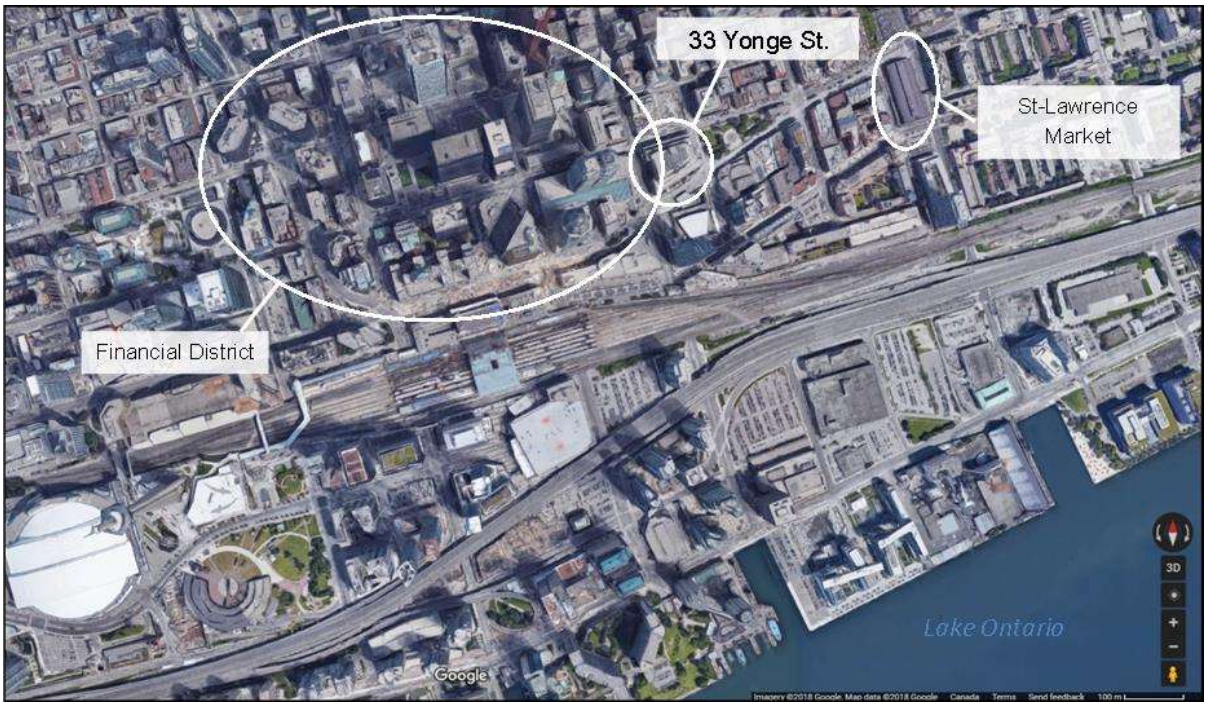

Figure 1. Location of 33 Yonge St. in downtown Toronto. *Source: Google Maps, 2018.*

Figure 2. Mirrored exterior surface of 33 Yonge Street, south side. *Source: FLAP Canada, 2018.*

One of the few greenspaces in the area is Berczy Park which has an abundance of trees, manicured grass, and a large, central water feature. It also provides migratory birds with food and shelter as they travel to areas beyond the city. Berczy Park is located immediately east of 33 Yonge Street. (**Figure 3**).

Figure 3. Location of Berczy Park east of 33 Yonge Street, looking north. Source: Google Maps, 2018.

In October of 2013, Great West Life Realty (GWL), the owners and operators of 33 Yonge Street, contacted FLAP Canada to conduct a building assessment using the *BirdSafe® Building Risk Assessment* software. The results of the assessment revealed that the east-facing façade at 33 Yonge Street was the most lethal to birds and bird collision deterrents were recommended to be installed on this façade only.

In 2014, the atrium (**Figure 4**) was the first section of the east façade to have installed a dot-patterned bird collision deterrent window film (**Figure 5**). The property owners chose to start with this inset entranceway due to the abundance of dead birds seen by building occupants accessing the building.

Figure 4. The location of the atrium at 33 Yonge Street, view from Berczy Park. *Source: FLAP Canada, 2018.*

Figure 5. Example of a dot-patterned bird collision deterrent. Source: FLAP Canada.

In 2015, GWL then installed a venetian blind-patterned bird collision deterrent (**Figure 6**) to the remaining east-facing façades, on either side of the previously treated atrium to a height of approximately 12 metres.

Figure 6. Example of a venetian patterned bird collision deterrent marker. *Source: FLAP Canada.*

33 Yonge Street – Data Analysis and Results

The results of the monitoring data and comparison of the pre- and post-installation bird collision deterrent marker data is shown in **Table 1**. Both styles of the bird collision deterrents resulted in a dramatic drop in the number of collisions at the east façade from an average of 25 per year over an eight-year period to under one per year for a five-year period.

These numbers represent a decrease in bird-window collisions of 86% pre-installation over an eight-year period to a complete reduction in 2016 and 2017 on the east side.

Table 1. Pre- and post-installation data from 33 Yonge Street. Source: FLAP Canada.

Year	Total Collisions	Birds Found Alive	Birds Found Dead	Total Collisions On East Side	Birds Live Vs. Total (%)	East Side Collisions Vs. Total Building Collisions (%)	Average No. Of Collisions Per Time Period	Average No. Of Collisions Per Time Period – East Side
2006	14	4	10	10	28.6%	71.4%		
2007	36	0	36	31	0.0%	86.1%		
2008	28	7	21	21	25.0%	75.0%		
2009	37	7	30	16	18.9%	43.2%		
2010	54	14	40	35	25.9%	64.8%		
2011	15	0	15	3	0.0%	20.0%		
2012	73	1	72	66	1.4%	90.4%		
2013	28	8	20	13	28.6%	46.4%		
Totals for 2006 - 2013	285	41	244	195		68.4%	35	25
Window Deterrents installed 2014								
2014	23	7	16	6	30.4%	26.1%		
Additional Deterrents installed 2015								
2015	10	3	7	1	30.0%	10.0%		
2016	3	0	3	0	0.0%	0.0%		
2017	4	1	3	0	25.0%	0.0%		
TOTALS	**325****	**52**	**273**	**202**	**17.8%**	**3.3%**	**4**	**0.33**

*In 2012 there was an increase in collisions primarily due to a localized irruption in the population of Black-capped Chickadees in Ontario accounting for 52 out of 73 birds that collided with the building. Of the 52 Black-capped Chickadees, 98% of them collided with the east side.

** A recorded total of 52 different species of birds were either killed or injured at this building.

4120 Yonge Street (Building 2)

The building at 4120 Yonge Street in the City of Toronto is one of three office towers that make up the Yonge Corporate Centre (YCC) located near the intersection of Yonge Street and Wilson Avenue to the south (**Figure 7**).

Figure 7. Location of 4120 Yonge Street in the City of Toronto. *Source: Google Maps, 2018.*

4120 Yonge Street and the other office towers of YCC have been constructed mid-way of the eastern valley slope of the Don River. This north-south corridor is frequently traveled by migratory birds due to the abundant vegetation and watercourse (**Figure 8**).

Figure 8. Don River valley systems. *Source: Google Maps, 2018.*

The neighbouring valley lands, water courses, shrubs and grasses attract a high concentration of bird species resulting in a higher risk of exposure to collisions. The majority of 4120 Yonge Street is surrounded by this lush vegetation, which include mature trees exceeding 16 metres in height. These landscape features are situated as close as 3 metres to the building's mirrored façades. The exteriors of all three YCC buildings are clad in predominantly mirrored glass (**Figure 9** and **Figure 10**).

Figure 9. Mirrored exterior of east-facing façade at 4120 Yonge Street. *Source: Google Maps, 2018.*

Figure 10. Mirrored exteriors of YYC building complex. *Source: Google Maps, 2018.*

Another feature of 4120 Yonge Street and YCC that contributes to bird-window collisions is the irregular shape of the buildings. As shown in **Figure 11**, the staggered glass creates an alcove effect which channels birds towards the center, enclosing them in mirrored glass and making it difficult for them to differentiate between real and reflected images in order to escape.

Figure 11. Irregular shape of the north façade of 4120 Yonge Street. Source: FLAP Canada, 2018.

As with most locations of this magnitude, FLAP Canada had been notifying Cadillac Fairview, the property owner, of the bird-window collision issue at Yonge Corporate Centre. The north-facing façade of 4120 Yonge Street was particularly lethal to birds with 704 collisions of the building's 771 recorded at this location between 2006 and 2010. In addition to FLAP Canada's efforts to mitigate the number of bird-window collisions at this site, the property owners were taken to court by Ecojustice in 2012 for the large number of birds dying at the site each year.

One year prior to these court proceedings, YCC applied a dot-patterned bird collision deterrent window film to the north façade of 4120 Yonge Street (**Figure 12**). The bird collision deterrent covered 13 vertical, mirrored glass corners up to 5 of its 6 storeys.

Figure 12. Bird collision deterrents (dot-pattern) applied on the north façade of 4120 Yonge St. Source: FLAP Canada, 2018.

4120 Yonge Street – Data Analysis and Results

Though there was a noted reduction in collisions after the initial deterrent installation (see **Table 2**), birds continued to collide with the untreated 6th storey windows. In 2012, a second application of the same bird collision deterrent was applied to the remaining 6th storey windows. This second application resulted in a further reduction in the number of collisions at the north façade. **Table 2** shows the results of the data collected by FLAP Canada prior to and after the first installation of bird collision deterrents in 2011 and again after the second installation in 2012.

Table 2. Pre- and post-installation data from 4120 Yonge Street. *Source: FLAP Canada.*

Year	Total Collisions	Birds Found Alive	Birds Found Dead	Total Collisions On North Side	Birds Live Vs. Total (%)	North Side Collisions Vs. Total Building Collisions (%)	Average No. Of Collisions Per Time Period	Average No. Of Collisions Per Time Period – North Side
2006	217	57	160	206	26%	95%		
2007	141	22	119	129	17%	91%		
2008	70	16	54	64	23%	91%		
2009	102	22	80	92	21%	90%		
2010	241	68	173	213	28%	88%		
Totals for 2006 - 2010	771	185	586	704		91%	**154**	**140**
Window Deterrents installed August								
2011	134	20	114	125	15%	93%		
Additional Deterrents installed March								
2012*	81	18	63	51	22%	63%		
2013*	N/D**	N/D**	N/D**	N/D**	N/D**	N/D**		
2014*	N/D**	N/D**	N/D**	N/D**	N/D**	N/D**		
2015*	2	0	2	1	0%	50%		
2016*	2	0	2	2	0%	100%		
2017*	9	2	7	8	22%	89%	45	12
Totals for 2011 - 2017	94	20	74	26		28%		
TOTALS	**999*** **	**225**	**774**	**891**	**23%**	**89%**		

*The data for 2012 to 2017 is badly skewed due to the fact that FLAP volunteers were banned from the property. However, anecdotal evidence from people at the building indicates that there was a dramatic drop in bird collisions.
**N/D = no data available.
***A recorded total of 93 different species of birds were either killed or injured at this building.

As can be seen from the **Table 2**, after the initial installation of bird collision deterrents in 2011, the amount of bird-window collisions dropped marginally from a 5-year average of 154 collisions between 2006 and 2010 to an average of 125 collisions. It is believed that two factors influenced the marginal reduction in collisions:

1. The initial marker installation was not applied to the full extent of the building and the untreated surfaces continued to reflect the adjacent vegetation.
2. Several corners of the building had only one side of the corner treated with bird collision deterrents.

Following the second installation of bird collision deterrents in 2012 to the remaining untreated surfaces on the north side, there was an additional 30% decrease in the number of bird-window collisions.

Subsequent to the final application of bird collision deterrents and the court case against YCC, the property owners banned FLAP Canada volunteers from monitoring the buildings in the YCC complex. As a result, no monitoring data was collected for 2013 and 2014 and only very limited data was available for 2015 to 2017.

Consilium Place

The office complex known collectively as Consilium Place contains three office towers located at 100, 200 and 300 Consilium Place in the City of Toronto (**Figure 13**).

Figure 13. Location of 100, 200 and 300 Consilium Place. *Source: Google Maps, 2018.*

Consilium Place is situated a few kilometres away from two major ravine corridors of Highland Creek at Morningside Park and Thomson Memorial Park (**Figure 14**) and just 10 kilometres from the Rouge National Urban Park. These vegetated north-south corridors are integral to the passage of birds and wildlife within the densely built environment. There is also two hectares of undeveloped land south of Progress Avenue that currently offers some habitat for meadow species. The manicured land surrounding the three buildings of Consilium Place consists of an open-ended courtyard with a large,

central water feature, mature trees, and manicured grass and shrubs. The close proximity to these natural systems and the manicured property significantly increases the concentration of birds in the vicinity.

Figure 14. Location of two Highland Creek ravine corridors to Consilium Place. *Source: Google Maps, 2018.*

100 and 200 Consilium Place (Buildings 3 and 4)

Both 100 and 200 Consilium Place share identical building profiles and are enclosed by some of the most highly-reflective mirrored glass on the market. Over a period of twelve years (2006 to 2017), FLAP Canada documented a total of 3,525 collisions with 2,334 representing bird fatalities at 100 and 200 Consilium Place. These two buildings at Consilium Place are surrounded by vegetation and fully covered in mirrored glass. The exterior of 300 Consilium Place has some stone cladding. An all-glass linkway (**Figure 15**) bridges the pedestrian corridor between 100 and 300 Consilium Place while the pedestrian corridor constructed between 100 and 200 Consilium is a transparent glass atrium (**Figure 16**).

Figure 15. Glass linkway between 200 and 300 Consilium Place. *Source: Consilium Place, 2018.*

Figure 16. The atrium between 100 and 200 Consilium Place. *Source: Consilium Place, 2018.*

The building at 100 Consilium Place (**Figure 17**) is located in the southwest quadrant of the complex. The majority of bird-window collision reports for this building were on the northwest, southwest and southeast façades as the majority of bird bodies on the northeast façade fall onto the lobby rooftop, which is inaccessible to FLAP volunteers.

Figure 17. View of the mirrored exterior at 100 Consilium Place, looking south. Source: FLAP Canada.

To the east of 100 Consilium Place and joined by the all-glass atrium is 200 Consilium Place (**Figure 18**). It replicates the profile and aesthetic of 100 Consilium with its mirrored exterior. The majority of bird-window collision records for 200 Consilium Place were for the northeast and southwest façades. Data was not readily available for the northwest façade because the same lobby rooftop as 100 Consilium Place was likely preventing birds from reaching the ground. The southeast façade has lower collisions records than the other sides as there is minimal vegetation surrounding the facade.

Figure 18. Mirrored exterior and trees at 200 Consilium Place, looking northwest. Source: FLAP Canada.

During the trial, *Shultz v. Menkes Developments, 2012*, in an effort to demonstrate due diligence to the courts, while at the same time prepare the property for sale, the building owners collaborated with FLAP Canada and a window film contractor to develop a first-of-its-kind test application of a bird collision deterrent for a commercial structure. This test application used an adhesive film with a pattern of 4 mm grey dots spaced 5 cm vertical X 5 cm horizontal to cover the first surface of the windows on the southwest façade of 100 Consilium Place (**Figure 19**) to a height of 16 metres above grade.

Figure 19: Southwest Façade of 100 Consilium Place**,** *Source: FLAP Canada.*

Following the 2012 spring migration trial period, there was a significant drop in the number of collisions observed; however, this did not meet the desired target for collision reduction set by the building owner

and the contractor. Therefore, a second test marker pattern that had larger 5 mm light grey dots were applied on the northeast façade of 100 Consilium. This slight enhancement to the dot helped reach the desired target for collision mitigation and was then applied to the remaining façades of 100 and 200 Consilium Place as well as to the south side of the atrium and both sides of the all-glass linkway.

100 and 200 Consilium Place – Data Analysis and Results

The monitoring data of the bird-window collisions prior to and after both installations at 100 Consilium Place and 200 Consilium Place can be found in **Table 3** and **Table 4** below. In 2006, a total of 316 bird-window collisions were recorded at 100 Consilium Place and another 604 were recorded at 200 Consilium Place. Over the course of seven years, the yearly average of collisions was 155 for 100 Consilium and 291 for 200 Consilium. Following the completion of the second installation of bird collision deterrents in August 2012, the average number of bird-window collisions a year was reduced to 27 and 54, respectively, over a four-year period between 2013 and 2017.

These numbers represent a decrease in bird-window collisions of 88% at 100 Consilium Place and 87% for 200 Consilium Place after the installation of bird collision deterrents.

Table 3. Pre- and post-installation data from 100 Consilium Place. Source: FLAP Canada.

Year	Total Collisions	Birds Found Alive	Birds Found Dead	Birds Live Vs. Total (%)	Average No. Of Collisions Per Time Period
2006	316	153	163	48.4%	
2007	103	40	63	38.8%	
2008	149	38	111	25.5%	
2009	137	52	85	38.0%	
2010	234	102	132	43.6%	
2011	94	30	64	31.9%	
2012	50	6	44	12.0%	
Totals for 2006 - 2012	1,083	421	662	40.5%	155
Window Markers installed August 2012					
2013	27	4	23	14.8%	
2014	35	4	31	11.4%	
***2015**	3	1	2	33.3%	31 (between 2013 and 2014)
2016	28	4	24	14.2%	
2017	41	6	35	14.6%	34 (between 2016 and 2017)
Totals for 2013 - 2017	134	**19**	**115**	**14.1%**	**27**
TOTALS	**1217****	**440**	**777**	**27.2**	**101**

*In 2015, the freezer at Consilium Place in which the dead birds were being stored malfunctioned and resulted in the loss of all the specimens.

**A recorded total of 98 different species of birds were either killed or injured at this building.

Table 4. Pre- and post-installation data from 200 Consilium Place. *Source: FLAP Canada.*

Year	Total Collisions	Birds Found Alive	Birds Found Dead	Birds Live Vs. Total (%)	Average No. Of Collisions Per Time Period
2006	632	235	397	37.2%	
2007	173	66	107	38.2%	
2008	211	57	154	27.0%	
2009	338	109	229	32.2%	
2010	410	202	208	49.3%	
2011	131	47	84	35.9%	
2012	144	19	125	13.2%	
Totals for 2006 - 2012	2039	735	1304	36%	291
Window Markers installed August 2012					
2013	45	6	39	13.3%	
2014	52	0	52	0.0%	
***2015**	10	1	9	10.0%	
2016	72	9	63	12.5%	
2017	90	5	85	5.6%	
Totals for 2013 - 2017	269	21	248	7.8%	54
TOTALS	**2308**	**756**	**1552**	**22.9%**	**192**

**A recorded total of 98 different species of birds were either killed or injured at this building.

It is important to note that as a result of the court case against Menkes Developments -- the owner and operator of Consilium Place at the time -- strict restrictions were imposed on FLAP Canada volunteers. These restrictions included volunteers to sign in and out during property visits, a security escort while on the property and to surrender all data and dead birds with building management before leaving the property. As a consequence of these restrictions, the abundance of monitoring data leading up to and during the trial is not as robust as was prior to 2011. In 2012, Kevric Real Estate Corporation purchased the property from Menkes Development and dropped the monitoring restrictions. Typical monitoring efforts by FLAP Canada volunteers resumed shortly thereafter and continue to this day.

Conclusions

Reflective and transparent surfaces of buildings, whether commercial, industrial, recreational or private dwellings, are a threat to bird species across the world. Buildings become an even greater threat to birds when vegetation reflects in its windows. In the case of the four Toronto buildings, they all have reflective, mirrored surfaces and vegetation adjacent to all or some of their façades.

FLAP Canada has over 74,000 entries in its database from over 200 buildings across the GTA that are monitored by volunteers on a regular basis during spring and fall migration periods. This paper only addresses a small sampling of the data to show the efficacy of bird collision deterrents at the four buildings: 33 Yonge Street, 4120 Yonge Street, 100 Consilium Place and 200 Consilium Place. Though FLAP Canada was aware of these four buildings and the threat they pose to birds, convincing the property owners to apply bird collision deterrents took years of education, encouragement and, in a couple of examples, legal action by Ontario Nature and Ecojustice.

Following the completion of the window film installation, it was evident that the application of bird collision deterrents significantly reduced bird-window collisions at all four buildings. **Table 5** summarizes the findings for pre- and post-installation of bird collision deterrents.

Table 5. Summary of the pre- and post-installation of bird collision deterrents. *Source: FLAP Canada, 2018.*

Building	No. of Collisions Pre-Installation	No. of Collisions Post-Installation	Reduction in Bird-Window Collisions (%)
33 Yonge Street	308	17	94%
4120 Yonge Street	905	94*	89%
100 Consilium Place	1083	134	88%
200 Consilium Place	2039	269	87%

*Data is skewed due to no collection by FLAP volunteers after markers were installed.

From this research, bird collision markers as high contrast dots, spaced 5 cm vertical X 5 cm horizontal with a dot size of 5 mm installed to 16 metres above grade or to the top of the mature tree canopy are significantly effective at mitigating bird-window collisions on highly reflective surfaces. However, due to some of the vulnerabilities of individual volunteer collection methods itemized on page 3, combined with what controlled studies suggest in assessing similar bird collision deterrents, more rigorous studies would ideally be conducted at private property sites for pre- and post-deterrent application results.

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