UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Recommendations for the UBC Bird Friendly Buildings Guideline

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UBC SEEDs Project

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Abstract

Collisions with windows are one of the largest known sources of direct anthropogenic mortality of birds in North America. Previous studies indicate that factors such as the amount of glazing area on a building, the extent of vegetation surrounding a building, and proximity to natural areas can increase the risk of bird collisions. A growing number of municipalities have adopted bird-friendly building guidelines. To evaluate the extent of the problem at UBC and options for improvement, bird-window collisions have been monitored for more than 16 buildings across UBC Vancouver Campus in past 4 years. Based on the results of these studies and the peer reviewed literature, three recommendations are made to update bird-friendly building guidelines. Firstly, a “reason” section to illuminate the reasons of bird strikes, including what features could cause or reduce bird strikes. Second, the current "strategy" section is suggested to be separated into three parts: additions to current buildings, new constructions suggestions and vegetation regulations. An explanation follows each strategy. The third recommendation is to add UBC bird friendly buildings’ introductions as examples of the strategies.

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Introduction

UBC is well-known as a community that values sustainability. In 2015, UBC developed a 20-year Sustainability Strategy intended to aid in the development of a regeneratively sustainable campus, where sustainability is intended to mean simultaneous enhancements to human and environmental wellbeing. The Strategy denotes a specific change to the institutional approach to sustainability: the goal is no longer solely to reduce emissions and waste but also to provide a sustainable environment for all UBC inhabitants (human and otherwise). The sustainability mandate of UBC's campus is not limited to greenhouse gas emission control, new energy use and waste management protocols, but includes the maintenance of plant and animal populations within their current, historical, and potential range of habitats (Harder, et al., 2017).

UBC is populated by both year-round resident and migratory birds. Bird distribution is showed in table 1. The UBC environment includes temperate rainforest and coastline and well as the managed landscape, making it a complex and appealing habitat for birds. Over half of the identified bird species in UBC are migratory (Porter and Huang, 2015). The Fraser River Estuary, where Vancouver and UBC are located, is a major stop along the Pacific Migratory Flyway. Billions of migratory birds fly along this route every year, temporarily residing at UBC. Migratory birds tend to stop on campus in winter, nesting between mid-March and late-August (Government of Canada, 2017).

UBC Building Operations is aware that collisions with building windows are one of the major causes of direct anthropogenic mortality of birds in North America. An estimated 16-42 million birds are killed annually in collisions with buildings in Canada (Machtans et al., 2013) and 365-988 million in the U.S. (Loss et al., 2014). Birds are not able to recognize the presence of reflective glass and interpret reflections of trees and sky on glass windows as real. Consequently, most collision-related deaths occur during the daytime with glazing on residential and low-rise buildings (Machtans et al. 2013; Loss et al. 2014).

The UBC SEEDs[1] program, UBC Building Operations, and Environmental Canada have been collaborating to study on campus bird strikes since 2014. The studies have quantified the bird strike rates for individual buildings on the UBC point Grey campus, identified some factors that cause or influence bird strikes, and tested potential strategies to mitigate bird – building collisions[2].

At UBC, bird mortality on campus caused by window collisions rises between January - May (Alison and Andrew, 2015). However, data after May is spare. The majority of students are present on UBC campus, and active in course and extra-curricular projects, between September and April. Therefore, more bird strike data has been collected between September and April than during the summer. Additional of Spring and Summer data is needed to provide a more holistic understanding of the challenges facing resident and migratory bird populations throughout the year.

This report provides UBC-specific recommendations for Bird-Friendly Building Guidelines that can incorporate during the design phase of new buildings. Specifically, this report

[1] The UBC SEEDS program creates partnership between students, operational staff, and faculty on innovative and impactful research projects to advance sustainability and contribute to international commitments.

[2] For further details of individual researches, a 'UBC Pilot Project to Assess Bird Collision Rates in Western North America' brochure is provided in UBC campus

summarizes the reasons for bird strikes on campus implied from local studies and the peer reviewed literature. Retrofit solutions, that can be implemented in existing building, are also discussed.

Recommendations

Recommendation 1:

I suggest adding a "reason" section to explain the why bird strikes happen, including what features could cause or reduce bird strikes.

How a Bird "Sees"

The visual system of a bird is different from a human's in four fundamental ways: color, acuity, distance measurement and field of view (Martin, 2011):

- Birds have a color vision which extends to UV light, which means that they are able to capture more light and color than human.
- Birds also have higher acuity than humans so they could see objects more clearly (Martin, 2011). Humans have one region in the brain that has one relatively higher acuity area in their visual region, but birds have two. The difference means that human will see one area in their visual region clearer so that they could focus on the it and birds could focus on two. But the two high acuity areas are on the side of bird's head, but not the front. So, it causes a problem of birds to do distance measurement of the object in front of it. The distance measurements include the relative depth, distance and time to contact.

- Birds, except for some owl species, do not have binocular vision to help them do the determination of position of an object and them because they have their eyes on side. So, the determination of the position of an object to oneself is different for a bird and a human (Bruce et al, 2003). This causes that they may not recognize the distance between themselves and a close object, and the “time to contact” when an object is in close range (Martin, 2009). So, when they are close to a glass, they may not able to determine the distance between themselves and glasses.
- Birds have a narrow field of view compared with human. Because birds have narrow views and the detection of food is primarily for them, they usually make the food has high acuity, which may cause the birds not to see the glasses then strike on it (Martin, 2011).

Reflective Glass

Bird collisions with clear and reflective glass have the highest death rate among all the human-related avian mortality factor (Klem Jr, 2009). Reflective glass has three times the bird strike rates than the non-reflective or less reflective glass (Klem Jr, 2009). Because birds have no natural perception of clear glass as a solid object (Martin, 2011) and no perception of the difference between a real object and a reflected image, birds collide with glass in pursuit of reflected objects: birds, looking for trees or sky, fly into windows that reflect trees and sky (City of Toronto, 2007).

Features that influence bird collision:

Type of glass: Different types of glass have different reflectivity. Mirrored glass often reflects its surroundings. Low-reflection glass is available and may decrease bird strikes. We currently have little local data on the effects of using low reflecting glass. The color of glass also influences the visibility of the glass. Further study is needed on the relationship between glass color and bird strikes.

Building size: More glass is correlated with more bird strikes (Klem et al., 2009). On UBC campus, larger buildings, with more gazing, have a higher probability of the bird strikes. The critical zone, which presents the highest collision probability, is considered to be up to the fourth floor of a building (Vancouver City Council, 2015). Though birds commonly strike windows on the lower floors of building, in the height range of the local, bird-attracting vegetation, recent monitoring of setbacks and roofs heights shows that birds also collide with windows on higher floors especially during poor weather at night (Erickson, *et, al*, 2015).

Reflected Vegetation: Vegetation attracts birds by providing food and habitat. Glass that reflects shrubs and trees causes more collisions than glass that reflects pavement or grass (Barton, 2017). The combination of vegetation near buildings with reflective glass is likely to result in higher strikes in that area. Studies with bird feeders have shown that fatal collisions occur when birds fly towards glass from more than a few feet away (Klem et al., 1991).

Façades: At UBC*,* western facing building façades have been identified as having the highest strike rates (Cavers G., et, al, 2015), possibly relating to sunlight direction and angles. However, the data supporting this conclusion is limited and counter examples exist: the ESB building has similar bird strike rates on both East and West façades and the Beaty Museum has the highest bird strike rate on the south façade (Chien, et al., 2015). More data is needed to definitively conclude that façade is important in relations to bird strike rate.

UBC Example: Reflective Glass

The Museum of Anthropology (MOA) which has the highest bird strike rate of all studied buildings on campus, provides an example of a highly reflective, large glass façade (Figure 2). Birds strike the north wall of the MOA where the15m high glass window reflect the local water and trees.

Figure 1. MOA building in UBC. 15m high windows present on the north end of the Museum of Anthropology, facing the water and trees.

Transparent glass

Birds will also strike clear glass while attempting to reach habitat and sky seen through corridors. This occurs when windows are positioned opposite each other in a room or ground floor lobby, on glass balconies, or where glass walls meet at corners. Research shows that birds begin to perceive buildings as objects to be avoided when the distance between building features or patterns on the glass is approximately 28 cm (City of Toronto, 2007). Building features or patterns on glass are most effective in reducing bird strikes when placed every 10 cm or less (REF). Essentially, the denser the pattern, the more likely a bird will perceive it as a solid object.

Features that Influence Bird Collision:

Type of Glass: The type of glass used for windows influences bird strike rate by influencing visibility. Birds do not perceive clear, bright glass as a barrier. Colored and patterned glass has a lower rate of birds strikes than clear transparent glass (REF).

Surrounding Vegetation: Visible vegetation attracts birds. If there are trees and attractive vegetation on the other side of the glass, birds will strike the glass while trying to fly through it. A research also shows that birds strike rate is relatively high when the building is constructed near a vegetation cover that has both high areas and high height (Porter and Huang, 2015). But the reason is still unknown.

Vegetation inside Buildings: The location of interior plants, both large and small, on the ground floor levels of a building can attract birds, increasing strike rates (Porter and Huang, 2015).

UBC Example: Transparent Glass

The Liu Centre at UBC has a large transparent glass corridor that is difficult for birds to see. Vegetation on both exterior walls invites birds to fly through, resulting in collision.

Figure 2. A transparent ground floor corridor at the Liu Centre, UBC.

Light Pollution

Light pollution influences the migratory birds more than the local birds. Many species of migratory birds travel at night (Cabrera-Cruuz, 2018). Light pollution creates an “artificial sky glow” that obscures the light from the moon and stars and disorients migrating birds. Disoriented birds will often fly around until exhausted and drop to the ground (Davie, et al., 2014). They will also fly towards the “artificial sky glow”, which often leads to their collision with a building (REF). Poor weather and rain obscure the night sky, possibly exacerbating this problem.

Features that influence bird collision:

Light Intensity: The hazards of light pollution increase with light intensity. Lights disrupt birds' orientation. Birds may cluster around lights circling upward, increasing the likelihood of collisions with structures or each other.

Weather Hazards: The combination of fog and light doubly affects birds' navigation and orientation (Ogden 2006). In Vancouver, rain is common is winter.

The color of Light: Red light could disturb birds' orientation more than any other color because red light interferes with bird's ability to track geomagnetic cues (Watson, 2016). Songbirds, in particular, seem to be guided by light and appear more susceptible to collisions with light (Wiltschko, et al., 1993).

Figure 3. The Irving library in UBC night light. Copyright: UBC logos

Recommendation 2:

The strategies in the current guideline are classified by application. Since the guideline is for the building designer, I recommend separating the current "strategy" section into three parts: additions to current buildings, new constructions suggestions and vegetation regulations. An explanation follows each strategy, especially the new strategies that are added.

Recommendation Strategies

Additions to Current Buildings

Minimize reflection and increase the visibility of glass.

Apply visual markers to glass surfaces in the critical zone: up to the fourth floor of a building or mature tree height, whichever is greater. Visual markers should be located on the exterior surfaces of glass and be high in contrast. They should also be based on the 2x4 rule in which gaps are no more than 50mm wide and 100 mm high (2 in x 4 in). Possible strategies include fenestration patterns, adhesives, etching, fritting, sunshades, louvers, screens, blinds, and netting. To effectively reduce reflection, patterning must be applied to the exterior surface of the window (City of Toronto, 2007).

Avoid interior vegetation near windows.

Interior vegetation can attract birds. Decorative indoor plants are commonly placed in ground floor lobbies near windows. However, bright glazed lobbies with attractive vegetation are dangerous for migratory birds drawn into the city by light pollution.

Pay special attention of the buildings near Wreck Beach.

On UBC Vancouver campus, Wreck Beach has the highest bird biomass and richness (Linnea Harder, et al., 2017). Therefore, buildings near Wreck Beach should be considered high risk. With a higher abundance of birds living in the area, the total deaths will be higher even though the death rate is as same as another areas om campus.

Ensure enclosed spaces with large openings, such as courtyards, are generous enough for birds to engage in flight and escape.

Birds that collided on window may get injured and fall or become hard to fly. Then, they may be trapped in enclosed spaces, such as one-end pipe, or courtyards. Considering this situation, enclosed spaces or courtyard should be designed carefully to make sure injured birds will not be trapped. But there is no reference that has regulation on the size of bird-friendly spaces.

Reduce Night Light in Building.

Building operations can be managed to eliminate or reduce night lighting from activities near windows. Minimize perimeter and vanity lighting and consider filters or special bulbs to reduce red wavelengths where lighting is necessary. Cleaning during daytime is another strategy to reduce night interior light and reduce night light pollution.

For example, Irving K. Barber Library is designed with a transparent glass frontage and balconies. Throughout the regular term, the Irving K. Barber Library closes at 1 am and it remains opens all night for studying during the exam periods. At night, the bright glass wall generates light pollution and likely attracts birds, especially when someone put greens or green things near the glass (City of San Francisco, 2011).

Adjust inefficient external lighting.

Inefficient external lighting is a significant source of light pollution. Minimizing inefficient external lighting would reduce light pollution. Specifically, lighting should be chosen to minimize spill light and upward light while maximizing useful light (Figure 4).

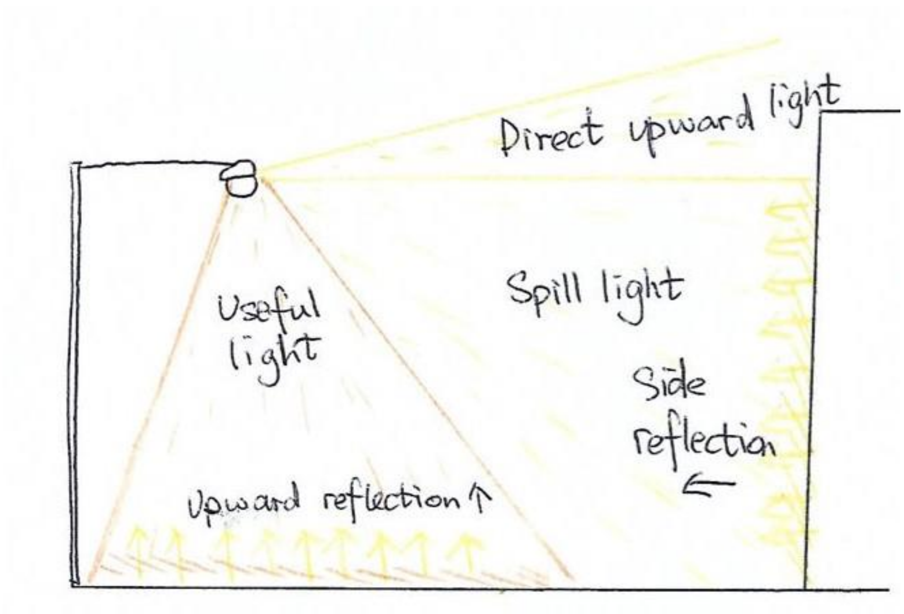

Figure 4. Useful light, spill light, and upward light.

Suggestions for new Construction on Campus

Reduce the quantity of large, unpatterned panes of glass.

Large clear panes of reflective glass are the most likely to cause bird collisions glass. A reduction in the quantity of clear glass panes will reduce the reflection of trees, sky, and sunlight.

Install Motion-sensitive Lighting in Lobbies, Walkways, and Corridors.

To reduce interior night lighting, implement a program to turn off all unnecessary lights after hours or install an operational system to automatically turn lights off. If the building will frequently be used after hours, ensure lighting levels are appropriately adjusted during all nighttime hours.

Minimize the appearance of clear passages to the sky.

Glass corridors or windows opposite one another visually form a clear passage to sky. While designing buildings with this kind of feature, bird-friendly strategies, such a patterned glass, should be applied.

Use small site ventilation.

Ventilation grates should have a porosity no larger than 2 cm x 2 cm or should be covered with netting to prevent birds from entering. Also, ventilation grates should never be up-lit for this produces light pollution.

Avoid open pipes.

Cap the ends of all open pipes, large and small, so that birds do not become entrapped when investigating these openings for nesting opportunities. (Vancouver City Council, 2015)

Suggestions for Vegetations near the Building

Avoid high percentage of vegetation cover and high trees near buildings.

If the building has high percentages of vegetation cover or high height of the vegetation, it could be in bird strike risk (Porter and Huang, 2015). However, when the surrounding vegetations are both in high height and in large area. The bird strike rate will be especially higher.

Place vegetation at least 10 meters away from the buildings.

A safe distance between vegetation and buildings could lower the rates of a bird flying near the building and reduce the reflection on the glass windows of the building. It is recommended to reduce the vegetation within 10 meters of glazed walls (Vancouver City Council, 2015)

Avoid mirror or glass in the garden.

Glass and mirrors are sometimes used in the garden for some purposes, such as to create a reflection, or to create an illusion of a larger space. Glass and mirrors should be avoided in landscape design.

Recommendation 3:

I suggest adding current UBC Bird-friendly building's introduction to show the past bird-friendly project.

Bird-friendly buildings in UBC

This section consists some samples of UBC bird-friendly building projects. The types of bird-friendly markers are explained with the samples.

UBC building management group is applying visual markers on large glass panes to help birds detect and avoid the glass. Although the visual markers applied on campus are patterned for aesthetics, all of applications are white. White colored marker on window creates a contrast against the background or reflections and increases the visibility of the glass barrier.

Some of the following UBC bird-friendly buildings were not intentionally designed to be bird friendly. The patterns and special designs, which originally were added for appearance, also increases the visibility of the windows to birds.

Robert H. Lee Alumni Centre

The Robert H. Lee Alumni Centre has vertical white stripes on the large window. The stripes, placed 10 cm apart are effective for preventing strikes of birds since the building is large.

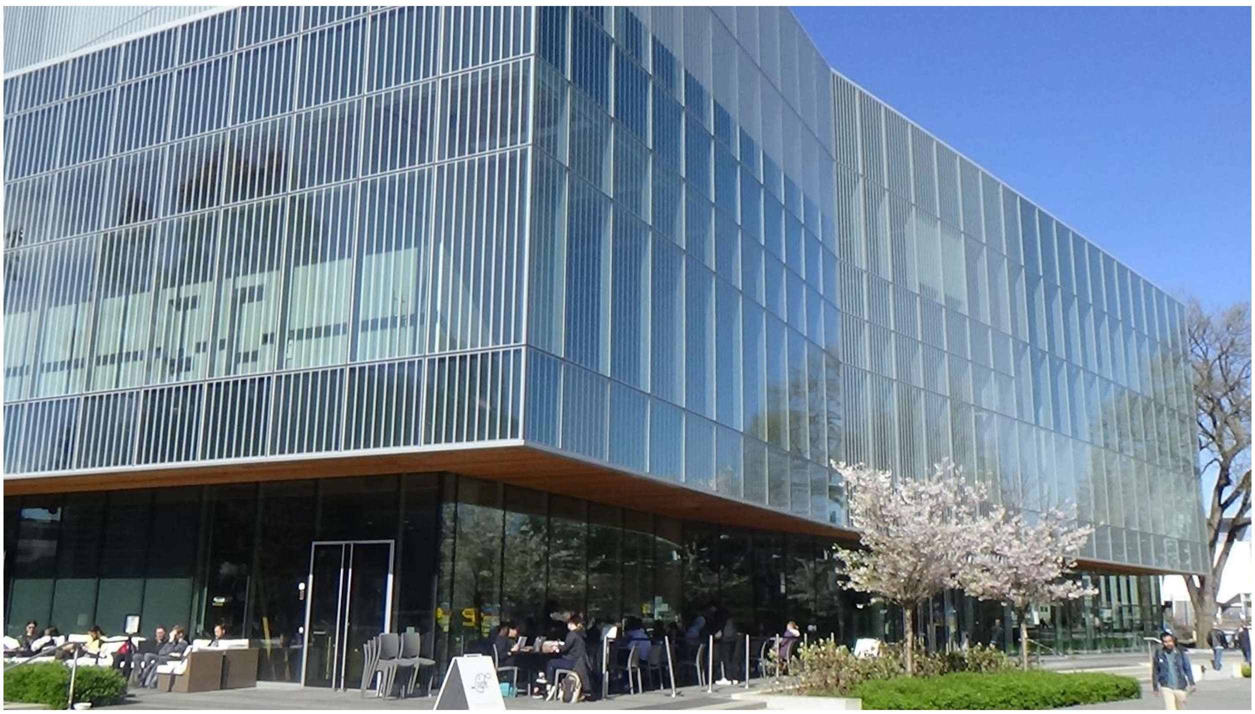

Figure 5. Robert H Lee Alumni Centre. The center has vertical white stripes on the large window, which is effective preventing strikes of birds.

AMS Student Nest

AMS Student Nest has a grass hill and trees directly in front of the building. The building has light shields outside of the window. When birds see the light shields, they could realize that the metals and glass on the wall of the building are solid and not transitable. One potential trouble of the shields is that they are hard to be seen from the front because it is vertical to the window. The white markers on the windows help to make the glass panes visibility. The white window markers in the Nest are on the left half of the window. Though the markers do not follow the 2 x4 rule, in combination with the shields, the Nest windows can be considered bird-friendly.

Figure 6. AMS Student Nest. Metal shields and white stickers on the window.

The Centre for Interactive Research on Sustainability (CIRS) Building

The CIRS building is a green building that showcases a number of sustainability features (CIRS, 2016). There is a large Living Laboratory inside of the building. The green walls and green roofs provide an energy savings, as well as habitat for animals, including birds. The combination of glass windows and bird habitat could increase the bird strike rates of a building. To counter this problem, a designed pattern has been applied on the window of CIRS. The stickers follow the 2x4 rule and are bright white in color. The bird and flower pattern increases the beauty.

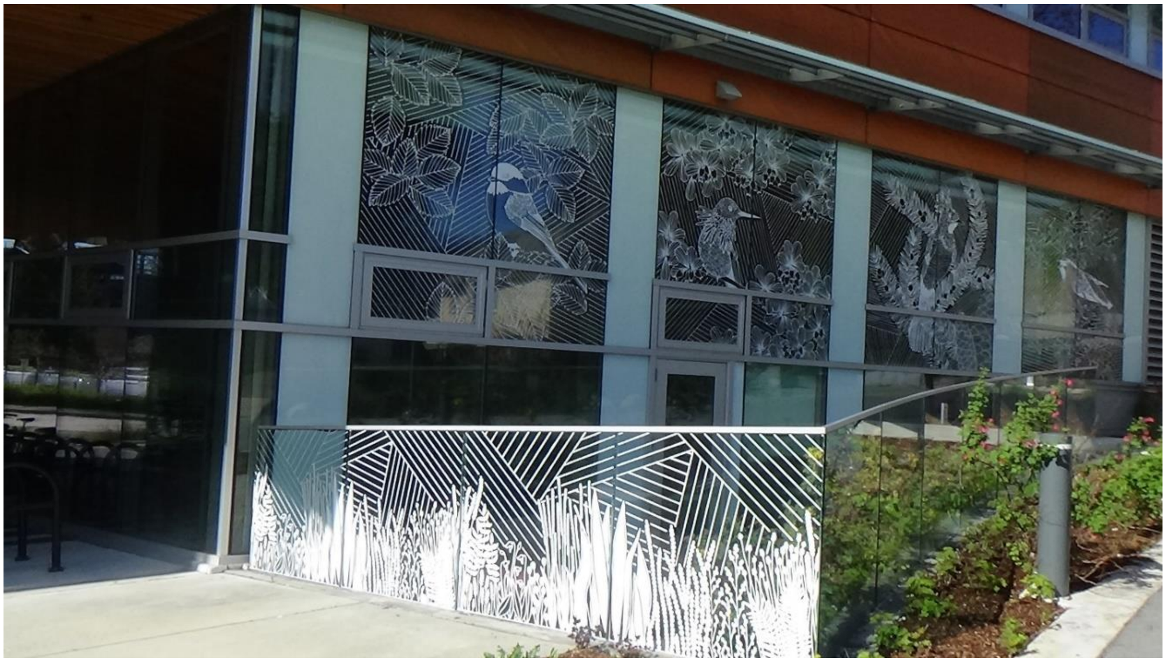

Figure 7. CIRS Building. Bird-friendly patterns also increase the beauty.

The Beaty Biodiversity Museum

The Beaty Biodiversity Museum uses the most common bird-friendly stickers: dots. Dots are unlike the stripes. Dots need to be spaced more closely than stripes as dots do not visually break up the glass as much as stripes do (CIRS, 2016). The dots on the windows of Beaty Museum are small and intensive, following the 2x4 rule. Though the dots effectively prevent bird strikes (Klem et al., 2009), dots are hard for humans to see at a distance and therefore do not visually detract from the aesthetic impact of the glazing.

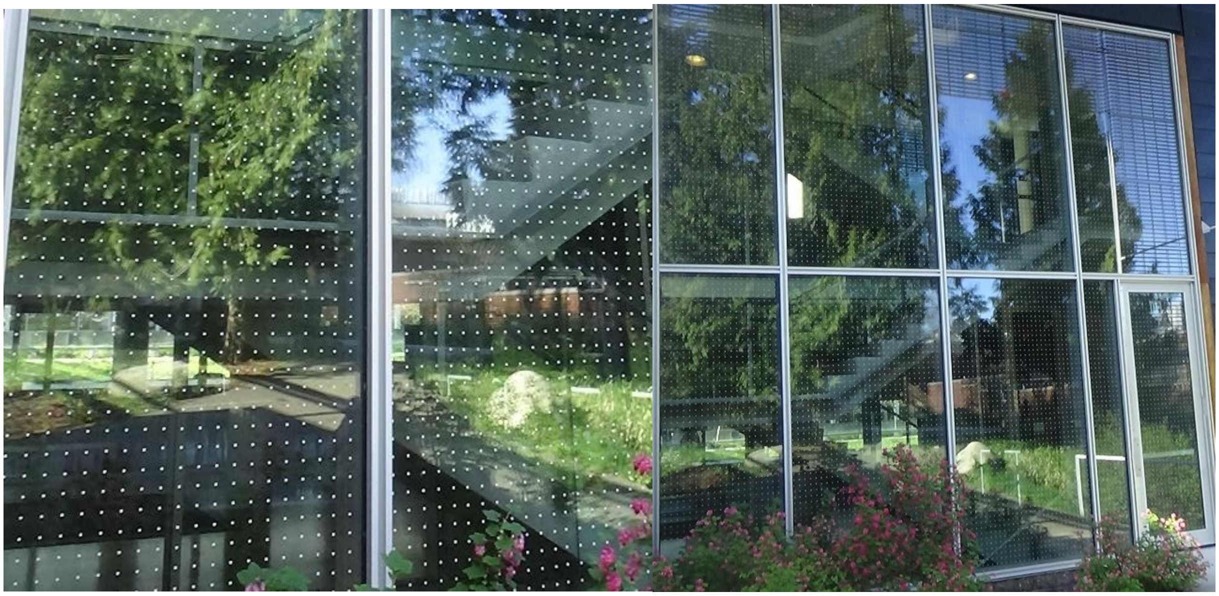

Figure 8. The Biodiversity Beaty Museum. The dots can efficiently reduce bird strike. The dots are not easy to notice by people, as shown in right picture. The left picture shows a closer view of the dots.

The UBC Hospital

The UBC hospital has a metallic pattern on a large glass window. But the unique pattern does not follow the 2x4 rule. The gaps between the pattern images are large enough for birds to fly through. The efficacy of the UBC hospital window patterns as a bird deterrent is not yet known.

Figure 9. UBC Hospital. The metallic pattern could help increase the visibility of the glass wall. But the efficiency is unknown since it is not following the 2 x 4 rule.

Recommendations on further studies

The relationship between glass color and bird strike rate

Birds can perceive color differently than humans (Martin, 2011). Data shows that glass color could influence the visibility of a glass to birds (Martin, 2011). This is an area for further study.

The study on migratory birds and local birds

Vancouver is located in the Pacific migratory bird pathway. The lack of summer bird strike data on campus makes it hard to determine if the migration of birds is influenced by the light pollution at UBC.

What is the rule for stripes

Window dots need to be spaced more closely than stripes, since dots do not break up the glass as much as stripes do (CIRS, 2016). The 2 x 4 rule is especially for dots. We do not know what is an appropriate rule for stripes.

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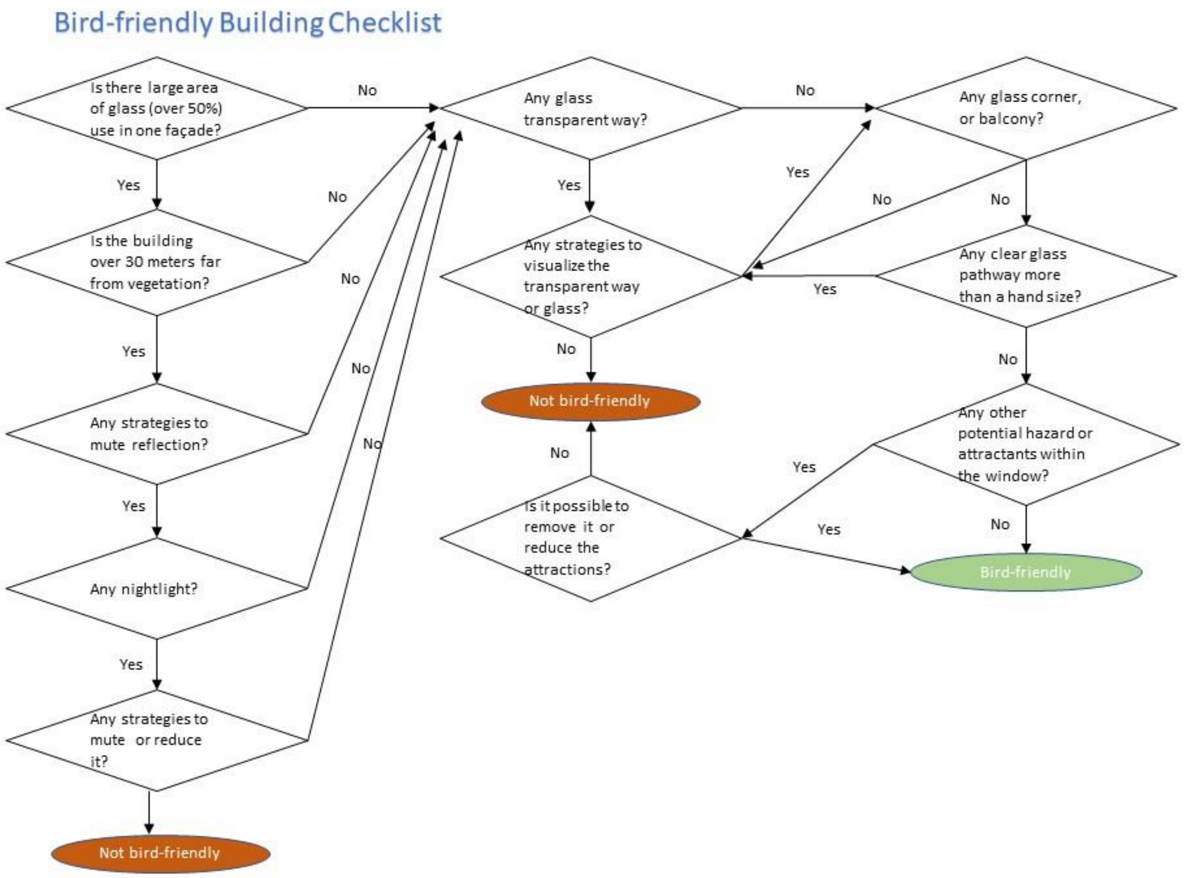
Appendix


Bird-friendly Building Checklist
Is there large area of glass (over 50%) use in one façade?
No
Yes
Is the building over 30 meters far from vegetation?
No
Yes
Any strategies to mute reflection?
No
Yes
Any nightlight?
No
Yes
Any strategies to mute or reduce it?
No
Not bird-friendly
Any glass transparent way?
No
Yes
Any strategies to visualize the transparent way or glass?
No
Not bird-friendly
Any glass corner, or balcony?
Yes
No
No
Any clear glass pathway more than a hand size?
Yes
No
Any other potential hazard or attractants within the window?
Yes
No
Is it possible to remove it or reduce the attractions?
No
Yes
Bird-friendly

Species	Asian Centre	Robert Osborne	Irving K. Barber	Marine Drive	Wesbrook	Interna. House	Vanier Okanagan	FP Innovation
American Robin	rare	low	low	moderate	0	0	0	low
Black-capped Chickadee	high	moderate	high	moderate	high	moderate	moderate	high
Chestnut-backed Chickadee	low	0	0	0	0	0	0	rare
Cedar Waxwing	0	0	low	0	low	0	rare	0
Dark-eyed Junco	moderate	0	low	low	moderate	rare	rare	moderate
Downy Woodpecker	0	0	0	rare	0	rare	0	0
European Starling	rare	low	moderate	moderate	0	0	0	low
House Sparrow	0	0	0	0	rare	0	0	0
Anna's Hummingbird	low	0	0	0	0	0	0	0
Kinglet spp.	high	0	low	0	rare	moderate	rare	low
Northwestern Crow	low	low	moderate	moderate	moderate	rare	rare	moderate
Northern Flicker	rare	0	rare	low	rare	rare	0	0
Pacific Wren	moderate	0	0	low	rare	0	0	0
Pine Siskin	low	0	0	0	0	0	rare	moderate
Red-breasted Nuthatch	low	0	0	0	0	0	0	rare
Sora	0	0	0	rare	0	0	0	0
Song Sparrow	low	moderate	high	moderate	moderate	0	low	0
Spotted Towhee	low	0	moderate	low	rare	0	0	0
Varied Thrush	rare	0	0	low	0	rare	0	low

Table 1. Bird distribution at eight buildings on UBC (Porter and Huang, 2015). Rare means that the species is detected less than 5% of the survey days. Low means that the species is detected less than 5-20% of the survey days. Moderate means that the species is detected less than 20-55% of the survey days. High means the birds is detected on more than 55% of the survey days.

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