UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

UBC Bird Collisions with Windows Phase 4.0

Vanessa Cheung and Alessandra Gentile

University of British Columbia

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I. Abstract

Bird-strikes with urban structures are a major source of bird mortality in North America, having a significant effect on bird biodiversity. Three projects documenting bird strikes on the University of British Columbia Vancouver Campus have been conducted so far. Research has shown that glazing and bird strikes are positively correlated, and many of the species that have been documented to strike buildings at UBC are already in steep decline. This study aims to investigate whether there is a correlation between vegetation reflection on windows and bird collision rates at UBC. Methods include surveying eight stratified buildings at UBC for evidence of bird strikes every day for three weeks, then every other day for two weeks. Two methods of window image analysis were used to increase power. There was a trend that facades of buildings with bird-strikes may have more vegetation reflected in windows than facades with no bird-strikes, but the trend was not significant. This research supports the development of the UBC Bird Friendly Guidelines strategy. More broadly, this research promotes bird biodiversity by identifying a factor that may contribute bird friendly environments.

II. Introduction

Bird-strikes with buildings have become an increasing area of concern, with studies showing that up to 42 million birds die from bird-strikes annually in Canada (Machtans et al., 2013). In the United States, building collisions have been estimated to cause between 100 million and 1 billion deaths annually (Loss et al,. 2014). To put these numbers in perspective, bird populations in North America from 1970 to 2016 have dropped from 11.5 billion to 10 billion (Gee, 2016). Thus, collisions with urban structures are said to be one of the leading anthropogenic causes of bird deaths in North America (Martin, 2015).

Poor frontal vision due to binocular vision is likely a contributing factor to collisions in songbirds (Martin, 2015). Binocular vision generates lower quality images, resulting in birds having difficulties interpreting transparent glass as a solid and having poor depth perception (Martin, 2015). Birds also have a limited range of flight speeds due to aerodynamics, thus flying at a higher speed is more optimal, increasing the probability of collisions (Nudds et al., 2004). Therefore, they cannot recognize the glass soon enough to maneuver around it. This may result in them dying instantly upon impact, dying post collision due to brain hemorrhaging or becoming susceptible to predation due to concussion symptoms (Parkins et al., 2015).

Bird-strikes occur when birds are deceived by the reflection of nearby vegetation, causing collisions with the reflective panes when they attempt to fly through them (Cusa et al., 2015). Studies have also shown that areas with high collisions often have trees with high ground cover and large areas of reflective windows (Cusa et al., 2015). Therefore, eliminating vegetation around buildings may reduce bird-strikes (Klem et al., 2009). Some studies have shown that increasing the height of ground and tree cover by 10% near buildings increases the risk of strikes by 13% and 30%, respectively (Klem et al., 2009). In contrast, increased tree cover and decreased urbanization has been shown to increase bird-strike rates (Gelb and Delacretaz, 2009).

Previous studies at UBC have shown that increasing vegetation 0-20 m from the facade, and increasing glazing has a positive effect on bird-strikes, yet the combination of high glazing and vegetation 0-2m from the facade has a protective effect against bird-strikes (DeGroot and Porter, 2017). Methods included looking at the number of trees per area in order to look at coverage from an aerial view (DeGroot and Porter, 2017). Other studies have also used the height of adjacent buildings to measure tree height (Klem et al., 2009). Also, looking at the number of facades reflecting vegetation was a proxy for vegetation height, as vegetation was frequently at different grades from the building foundations (DeGroot and Porter, 2017).

Many cities have already implemented Bird Friendly Building guidelines, making steps in the right direction to help decrease bird-strikes (City of Toronto 2007, City of Vancouver 2015, City of Calgary 2011). By 2020, Vancouver aims to be a world leader in supporting their native birds year round by making the city more accessible and usable by birds, thus making Vancouver a tourist hot spot for the avid birder (City of Vancouver, 2015). This proposition acts alongside the Greenest City Action Plan that lays out ten goals to make Vancouver the most green city in the world by 2020 (City of Vancouver, 2015).

This study is one small part of a larger project which aims to: investigate bird collision frequencies for each season, identify factors that influence collision frequency, and identify species that are most vulnerable to collisions at the University of British Columbia Vancouver Campus (DeGroot and Porter, 2017). This study investigates the relationship between the amount of reflected vegetation in windows to bird-strikes. If more bird-strikes occur when there is more vegetation around a building, then facades with bird-strikes should have more vegetation reflectance than facades without bird-strikes. This study aims to strengthen and refine the UBC Bird Friendly Design Guidelines (2016) and other policies.

III. Methodology

A. Buildings

Eight buildings on the UBC Campus were randomly stratified by categorical building heights and vegetation by Huang and Porter (2015) using methods from Hager and Cosentino (2014), previously; International House, Okanagan House, Marine Drive Building Six, Osborne Gym Unit 1, FP Innovations, Asian Centre, Wesbrook, and Irving K. Barber Learning Center. Each facade of the buildings was given a number. Facade number one faced North, then counted clockwise (Fig.1).

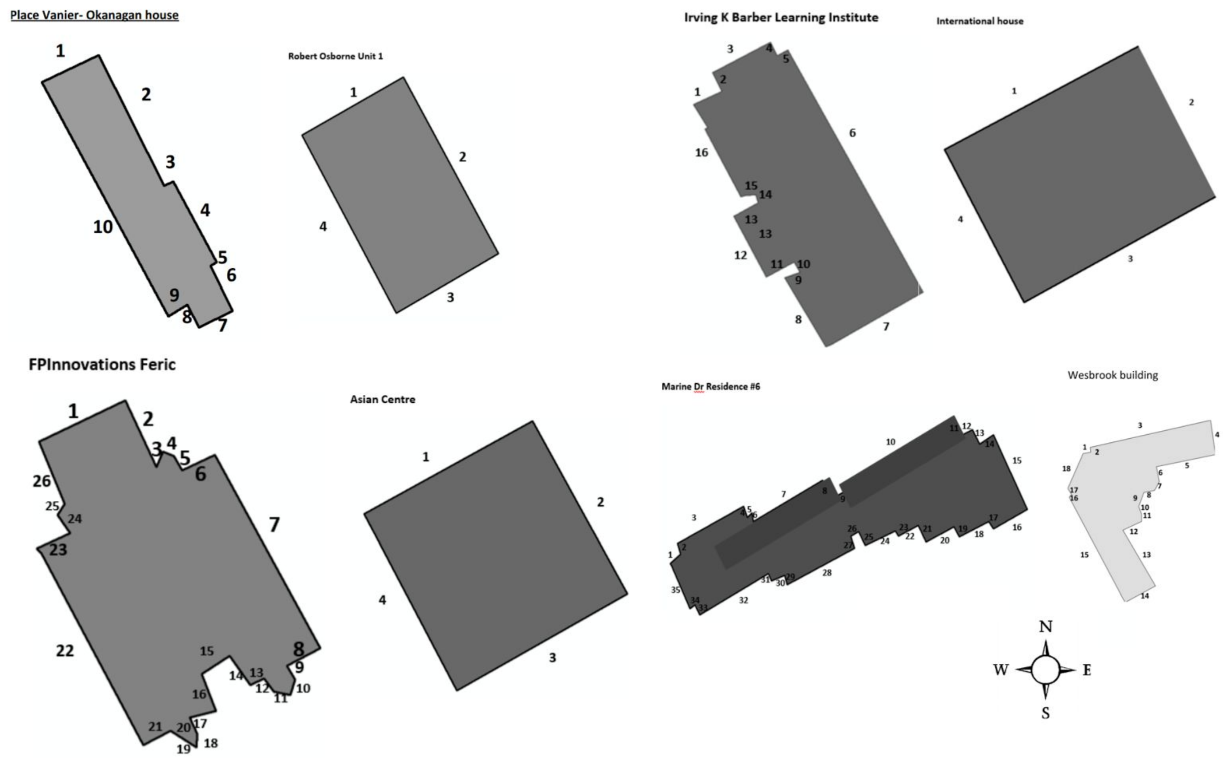

Fig. 1. Silhouettes of all eight survey buildings, with numbered facades. Number 1 facade is facing North, then numbers increase clockwise (Porter, 2017).

B. Bird-strike surveys

Bird-strike data collection methods followed these of Hager and Cosentino (2014). First, a clean up day was performed to collect all evidence of bird-strikes at all the buildings (Hager and Cosentino, 2014). Evidence included: window smears, carcasses, partial carcass, and piles of 10 or more feathers within 2 m from the facade (Hager and Cosentino, 2014). Surveys to look for bird-strike evidence were performed early afternoon everyday by two people from January 23, 2017 - March 12, 2017: surveying daily for 21 days, and then every other day for 14 days, for a total of 33 surveys over 46 days (Hager and Cosentino, 2014). Surveyors started at the same point and went around the building in opposite directions, one clockwise and one counterclockwise, to ensure coverage (Hager and Cosentino, 2014). Each survey, a starting building was randomly chosen to eliminate fatigue as a biasing factor in search efficiency (Hager and Cosentino, 2014).

When the weather was too poor to conduct surveys efficiently (i.e.,snow), surveys were stopped (Hager and Cosentino, 2014). Afterwards, a clean up days was performed to remove any past evidence of bird-strikes that occurred, and then the clock would restart the next day (Hager and Cosentino, 2014).

Bird-strike evidence will be identified to the species level if possible by Krista DeGroot from Environment Canada to estimate what species are at risk on the UBC Campus.

C. Window Reflectance Data Collection

Facades on the buildings were split into two groups: facades with bird strikes (treatment), and facades with no bird strikes (control) up until March 8, 2017. As a result, any collisions or modifications that were made to the main datasheet or recorded bird-strikes post March 8, 2017 were not considered in the following.

Windows on each facade were numbered left to right. Three ground level windows in each group, at each building were randomly selected using excel to have a photo taken. If the windows were continuous, they were divided by the window panes. The photos were taken on a DSLR camera, 2 m away from the window with the bottom of the window being captured by the bottom of the photo frame. This allowed us to control for consistency. A distance of 2 m from the window was chosen because it would be enough distance for the bird to hopefully recognize the window as a solid object and maneuver around it. The photos were taken on the same day from 11:00-13:00 on March 8, 2017 to control for weather and light conditions.

D. Window Reflectance Data Analysis

Images were analyzed in two different ways: Image J and by volunteers via Google Forms to obtain measurements for total reflectance and vegetation reflectance. Total reflectance included any solid object reflected in the window, and vegetation reflectance only included vegetation reflected in the window.

Image J is a java based image processing program that can be used to measure the surface area on images. Using Image J the area of the window, reflected vegetation and total reflectance were traced manually to obtain percent coverages.

To strengthen the Image J estimates, Google Forms was used to create an online survey to have people estimate percent coverage. The Google Form consisted of all 28 photos of the windows, with two questions attached to each photo:

1) Estimate the percentage of reflected image in the window.
2) In cases where your answer was greater than 0% to the previous question, estimate the percentage of the area of the window that reflects vegetation.

The estimations were done using 10% increments. The Google Form also included a question about demographic: UBC Student, UBC Postgraduate, Professor or other. The Google Form was sent out to prospective volunteers via email and personal correspondence.

E. Statistical Analysis

To combine the Image J and Google Form results, z-scores were performed to normalize the global mean of each measure to zero (similar results were obtained without normalization, considering each measure separately:data not shown). For each type of image analysis, the global mean and global standard deviation were calculated treating each facade as an independent. The z-scores were then averaged between Image J and Google Form, and a two sample t-test was performed between facades with no strikes and strikes to test statistical significance. This was done for total reflectance and vegetation reflectance.

IV. Results

The total number of strikes recorded from all eight buildings was 46 during January 23, 2017 to March 19, 2017. Of the eight buildings surveyed, Marine Drive Building 6 had the most bird-strikes with 13 bird-strikes. International House and Okanagan House had the least amount with 2 bird-strikes recorded each.

Total reflectance between facades with strikes and no strikes appeared to be fairly similar (Fig. 3.). Total reflectance z-scores for facades with strikes versus no strikes both had total reflectance very close to the mean total reflectance, as they were 0.01 standard deviations from the mean in each direction (Fig. 3.). The probability of these results assuming the null hypothesis was 0.97, which was not statistically significant (Fig. 3.)

Vegetation reflectance displayed a trend that facades with strikes had more vegetation reflected than facades with no strikes (Fig. 4.). Vegetation reflectance z-scores for facades with strikes were 0.26 standard deviations above the mean, and facades with no strikes were 0.26 standard deviation below the mean (Fig. 4.). The probability of these results assuming the null hypothesis was 0.43, which was not statistically significant (Fig. 4.).

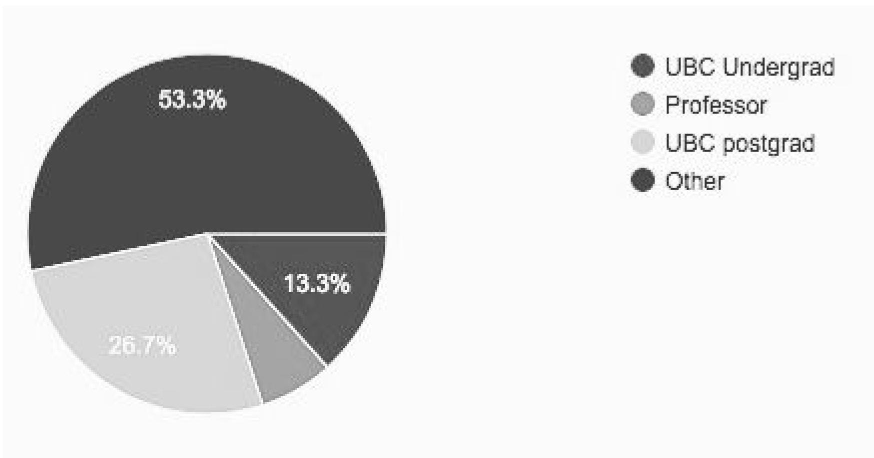

Fig. 2. Google Form participation Distribution [N=15]. 53.3% Demographic consisted of: [n=8] other, 26.7% [n=4] UBC PostGrads, 13.3% [n=2] UBC Undergrads, and 6.7% [n=1] UBC Professors.

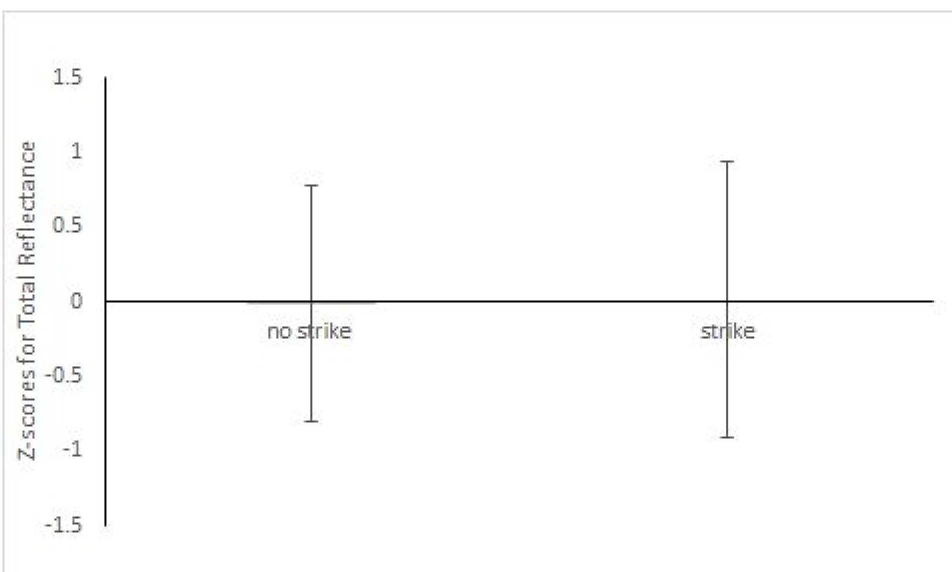

Fig. 3. Mean Total Reflectance z-scores for facades with strikes [z-score=+0.01] vs. no strikes [z-score=-0.01]. [Two sample t-test: df=8, sdev= 0.98, t=0.05, p=0.97,]. Error bars represents 95% CI: strike [-0.91, 0.94] , no strike [-0.81, 0.78].

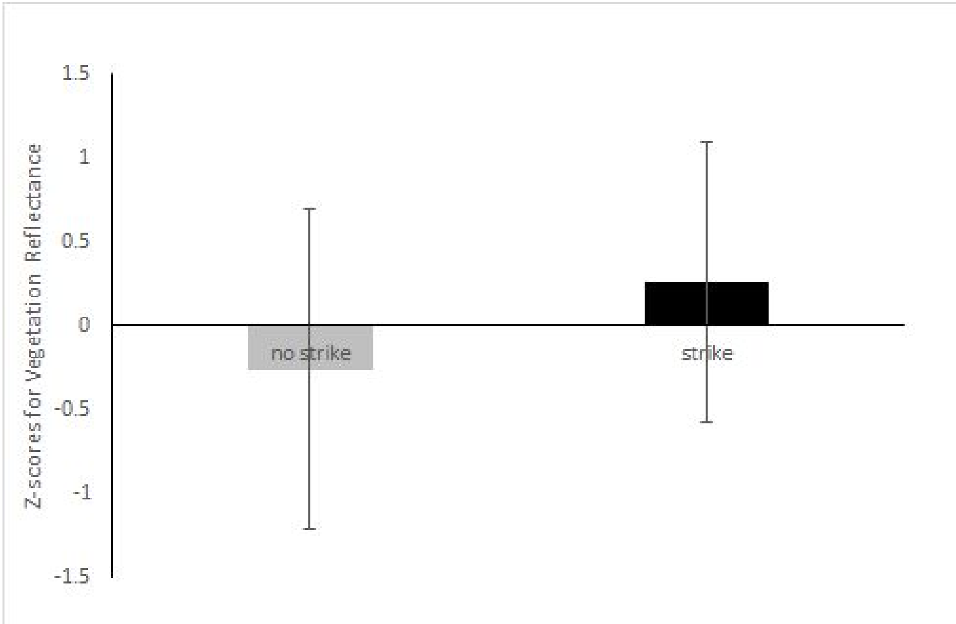

Fig. 4. Mean Vegetation Reflectance z-scores for facades with strikes [z-score=+0.26] vs. no strikes [z-score=-0.26]. [two sample t-test: df=8, sdev=0.98, t=0.84, p=0.43]. Error bars represent 95% CI: strike [-0.68, 1.20], no strike [-1.04, 0.52].

V. Discussion

The z-scores for total reflectance were closer to zero than vegetation reflectance between strikes and no strikes (Fig.3,Fig.4.) This suggest that vegetation reflectance may have a greater effect on bird-strikes than total reflectance, although the results were not significant (Fig. 3, Fig.4.). Facades with bird-strikes may have increased vegetation reflectance as the z-scores were positive, indicating that the vegetation reflected was above the mean (Fig. 4). This suggests that it may matter what is reflected in the window. The p-values resulting from both total reflectance and vegetation reflected were higher than 0.05 (Fig. 3, Fig. 4), making us unable to reject the null hypothesis that vegetation reflectance does not have an effect on bird-strikes.

The trends indicate that increasing the amount of vegetation reflectance in a window may increase the amount of bird-strikes (Fig.4). This is congruent with DeGroot and Porter (2017) that increased vegetation 0-20 m from the facade leads to an increase in bird-strikes. They also found high glazing and high vegetation 0-2m from the facade decelerated the positive effect generally seen for high vegetation, resulting in a protective effect (DeGroot and Porter, 2017). This may be why our results were statistically insignificant as we were unable to determine the distance of vegetation in the reflected image on the window. Therefore the positive effects of vegetation 2-20 m away and the negative effect of high glazing and vegetation 0-2 m away (DeGroot and Porter, 2017) may have cancelled each other out.

Vegetation may have the potential to attract birds, leading to a higher bird density, and resulting in more bird-strikes. Previous studies have recorded that window exteriors that incorporated vegetation had the most collisions, finding strong evidence to support that vegetation may have bird attracting properties (Gelb and Delacretaz, 2009). However, it is still unclear whether an increase in bird strikes is due to birds being attracted to the vegetation itself, the deceptive effects of vegetation reflected in windows or a combination of both. Many studies have looked if the presence of vegetation increased the amount of bird-strikes (Loss *et al*. 2014), yet they have not pinpointed the precise mechanism. Therefore, future studies focusing on the amount of vegetation reflected may allow for stronger conclusions.

This particular winter season in Vancouver had an abundance of snowfall, therefore the troubleshooting methods by Hager and Consentino were followed (2014). Surveys were not completed for 6 days, Feb 3, 2017 to Feb 8, 2017, along with a clean up day on Feb 9, 2017, because of the snow. This resulted in the surveys finishing on March 19, 2017 instead of on March 12, 2017 as planned. As a result, the exact consecutive day procedure suggested by Hager and Consentino (2014) was not followed.

Windows and facades were randomized on March 8, 2017 before the bird-surveys were completed on March 19, 2017. This was partially due to the delay caused by the snow, and due to the time crunch of getting the Google Form out in time for people to analyze. After March 8, 2017, only 6 bird surveys were conducted, and 6 bird-strikes were recorded. Thankfully, none of the strikes occurred on any of the facades that had already been randomized for analysis. However, it could have affected the random choice of strike versus no strike facade, as four facades that had no bird-strikes before were subsequently struck; Irving facade 16, 11, 13, and Wesbrook facade 4.

Some facades of the buildings were eliminated from randomizations because they had no windows at eye level to photograph. FP Innovations had the most facades eliminated. Also, most of the facades that were eliminated had no bird-strikes throughout the whole survey period. In addition, the west side of facade 6 at Irving was unable to be accessed until February 1, 2017 due to construction. Therefore, the decreased number of facades used may have resulted in a lower number of bird-strikes recorded.

Osborne Gym Unit 1 was eliminated as there were no windows at eye level. Okanagan House was eliminated from the reflectance data as none of the facades had strikes before March 8, 2017 recorded on the data sheet, therefore it had no contrast in strike rate(treatment). Okanagan House had strikes on facade 10 on January 24, 2017 and Facade 2 February 21, 2017. However, the building was not included in the randomization as these additions were finalized in the data sheet after the randomization of facades on March 8 ,2017. Therefore the building was eliminated from the reflectance data. Lastly, Asian Centre had strikes on all four facades, therefore there was no control and was eliminated from the reflectance data. Therefore, only five of the eight buildings were included in this component of the study decreasing the power.

There were also obstacles that prevented pictures from being taken 2 m away from windows. During the window randomization, re-randomizations had to be conducted upon realization that certain windows had gates or other obstacles that limited our ability to photograph. Lastly, the strike facade at Marine only had one window, resulting in an imperfect number of 28 total windows, instead of the 30 that was originally planned for. Future studies should increase by significant sample size of the buildings, windows and facades in hopes to achieve statistical differences.

Since facades were grouped into strikes and no strikes, the amount of strikes recorded on each facade were not taken into account to simplify analysis. Nevertheless, it was a rare for facades to have multiple strikes. From the buildings we randomized on March 19, 2017, facade 10 at Marine had two strikes, and facade 13 at Wesbrook had 3 strikes. When randomizing, facades that had more than one bird-strike were only inputted once.

Bird surveys were unable to be conducted at the exact same time every day due to scheduling conflicts between surveyors as suggested by Hager and Cosentino (2014). Bird strikes most likely occur between sunrise and early afternoon (Klem, 1989). Therefore the optimal time to look for evidence of bird-strikes would be late afternoon to limit the effects of scavenging, at the same time every day to limit variation.

In this study, the specific window on the facade that the bird struck was not determined. This was because when a bird impacts a window, the carcass (or partial carcass) is rarely found directly underneath the window it struck. This may be due to scavengers moving the carcass, the fact that some birds do not die immediately upon impact, or that the wind blows feathers around. This rises another caveat, there were so few strikes, there was uncertainty whether the struck window really had a higher risk of being struck. By randomizing the windows on the main level for each facade for image analysis, an estimated average vegetation reflectance was obtained for that facade. This may have added more noise to the results as vegetation reflection in the windows is not the same across the whole facade and can change quite drastically depending on the angle of sight. To decrease this uncertainty, a video camera could be used to monitor which precise windows are being struck. This would also allow the researcher to determine what specific time, and at what angle to take the optimal photo to obtain the most accurate vegetation reflectance that the bird saw moments before impact.

The bird-strike surveys were conducted during the winter. The deciduous vegetation did not have foliage, making it difficult to estimate the amount of vegetation reflected. Image J is great for tracing large objects, but not ideal to trace fine details as it needs to be done manually with a mouse. Therefore when using Image J, the projected area of potential foliage was traced. This free-hand method of estimation may have caused an overestimate in the amount of reflectance. Also, it was not indicated clearly on the Google Form that participants should estimate the projected area of vegetation with all its foliage, which may have caused variability in the answers provided. Therefore, taking photos of windows throughout all seasons with different levels of foliage, could help diminish this limitation.

In addition, a software that is able to better estimate the amount of reflectance and vegetation reflectance could help decrease any uncertainty from the free-hand estimates on Image J and eye-balled estimates of our volunteers on Google Forms. On Google Forms, participants could only estimate in 10% increments, increasing noise. This was a limitation of using Google Forms as a platform for the surveys. Trust was placed on the participants to answer the questions to the best of their abilities. A recorded total of 15 people completed the survey (Fig. 2), but during analysis, we eliminated person #11 because they stopped answering part b of the questions part way through. Therefore their answers were not valid, decreasing our sample size to 14. To increase the power of the survey future studies could: increase the number of participants, include a more accurate method to report estimations (i.e., a sliding bar to estimate percentages using a different online survey program) , and recruit a wider demographic to avoid bias (Fig.2).

46 bird-strikes were recorded during this study, which was astoundingly similar to the previous study at UBC with 45 bird-strikes in the winter of 2015 (DeGroot and Porter, 2017) that surveyed the same buildings. This was surprising that the snow this winter did not appear to have an effect on the number of bird-strikes recorded. Species were unable to be identified in this study due to time constraints with Krista DeGroot from Environment Canada. However, many of the species that have been documented to strike buildings at UBC in previous studies are already in steep decline (DeGroot and Porter, 2017, Huang and Porter, 2015). Therefore, a balance between vegetation and window reflectance must be obtained to continue promoting biodiversity on campus.

The goal of this project was to update and refine the UBC Bird Friendly design guidelines. This study suggests that a decrease in vegetation reflectance in windows may lead to a decrease in bird-strikes. However, the solution is not to decrease the amount of vegetation around buildings, but to instead decrease the amount of vegetation reflected in the window. The main problem is the windows, not the surrounding vegetation. Vegetation on campus is aesthetically pleasing, provides clean air, and serves as habitats for many local bird species, but it also has the potential to be detrimental to birds by promoting bird-strikes. Even something as simple as closing the blinds when you are not in the room can decrease the amount of bird-strikes by muting the reflection of vegetation (Fatal Light Awareness Program, 2017).

To decrease the amount of vegetation reflected in the windows, this study supports UBC's suggested Glazing Design Considerations; to increase the visibility of glass by applying visual markers with gaps no more than 50 mm wide and 100 mm high (The University of British Columbia, 2016, Fatal Light Awareness Program, 2017). These markers will make the glass more visible by creating visual noise and will decrease the amount of vegetation reflected in the window hopefully leading to a decrease in bird-strikes. Ultimately, this study supports that a more sustainable way to decrease the amount of bird-strikes without decreasing the amount of vegetation near windows is to implement bird-strike preventative alterations to existing and new windows.

VI. Acknowledgements

Thanks to Alison Porter for organizing the bird-surveys. Thanks to Sally Otto (UBC) for her amazing and insightful feedback on this project. Thanks to Hannah Brash (UBC SEEDS) for organizing all the parties involved with this project. Thanks to Krista Degroot (Environment Canada) for giving us so many resources to use for our project. Thanks to Penny Martyn (UBC Community Planning) for the information about UBC Buildings.

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VIII. Appendix

Raw Data:
https://docs.google.com/spreadsheets/d/10iAjopmO0Au-5tW_1nne3bYgCqdt2PDDVY5baHXAns8/edit?usp=sharing