

UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

**Bird-Friendly Art: A Social-Ecological Evaluation of the Prevention
of Bird Collisions with Campus Windows**

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University of British Columbia

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Bird-Friendly Art: A Social-Ecological Evaluation of the Prevention of Bird Collisions with Campus Windows

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Executive Summary

Collisions with windows are one of the main causes of human-induced bird deaths (Klem et al. 2014). Indeed, University of British Columbia (UBC) Sustainability estimates that more than 10,000 birds are killed on the UBC campus annually. These collisions occur as a result of birds attempting to fly through transparent glass, or mistaking reflections in windows as a part of their environment (Martin 2011).

UBC shares its campus with various species of wildlife, including birds. The campus is situated on the Pacific Flyway, the route that migratory birds use during their bi-annual migrations from Alaska to Central and South America (City of Vancouver 2015). Birds provide important ecosystem services, such as pest management, nutrient cycling, and promotion of feelings of well-being in nearby humans. UBC Sustainability has therefore identified the need to promote a campus that is inclusive to non-human organisms. With this in mind, various buildings on UBC's campus have added art to their windows to prevent bird collisions. However, launching such an initiative requires several significant considerations.

The purpose of this project is to identify successful strategies for creating community-engaged window art that reduces bird collisions, and to provide recommendations for how other buildings on campus can similarly be retrofitted. Hummingbird Daycare, a childcare centre located on the south-west side of UBC campus, has been identified by UBC's SEEDS (Social Ecological Economic Development Studies) Sustainability Program as a hotspot for bird collisions. Therefore, we have tailored recommendations for this particular case.

This project includes an examination of social-ecological frameworks that can conceptualize the multifaceted nature of the problem. More specifically, our analysis draws on literature that explores human-wildlife conflict, ecosystem services, and community-building in a social-ecological problem setting. We also present a review of previous strategies adopted for creating retrofit window solutions to reduce bird collisions, including a broad search of strategies and policies employed globally. Further, we review relevant case studies of bird-friendly art that has been established on UBC campus, including the Centre for Interactive Research on Sustainability (CIRS) and the Biodiversity Research Centre (BRC).

We also present a case-specific discussion of the Hummingbird Daycare hotspot window. UBC's SEEDS Sustainability Program has developed a bird collision monitoring protocol that can be applied to investigate bird strikes at locations of interest. Hummingbird Daycare, the focal location for this social-ecological evaluation, shares its window of concern with Vantage College, located upstairs of the daycare. Therefore, in order to contribute quantitative data that may help to inform the severity of the problem, and potentially the efficacy of the solution efforts, we have employed this collision monitoring protocol between the months of March and April 2020 at the location of interest. This data serves as baseline data specific to Hummingbird Daycare and Vantage College. We also present the perspectives of relevant community members who have been involved in this particular initiative.

The final element of this report is a set of recommendations for interventions that highlight specific examples from the focal location of interest of this project. This toolkit reviews conceptual principles and significant considerations for the process of implementing bird-friendly retrofits on campus buildings. Materials include considerations for selecting artist(s), designing

artwork, and designing informative materials, including preliminary text for an educational sign at Hummingbird Daycare. This toolkit may serve as a conceptual guide that can assist other groups on campus that wish to retrofit their buildings to be more bird-friendly, or for new buildings to implement these strategies. The toolkit excludes bureaucratic elements, as well as specific design elements. Ultimately, this element of the project uses the anticipated retrofit at Hummingbird Daycare as a case study to outline considerations that are significant to the social-ecological problem of bird collisions with glass features in the built environment.

1. Social-Ecological Characterization of Problem

Bird collisions with glass features are a source of major concern for conservation worldwide (Klem et al. 2014; Winton et al. 2018). Millions of annual bird strikes in North America alone represent the second highest cause of anthropogenic avian mortality, after predation by feral cats (Loss et al. 2015). The built environment has experienced continued development since the industrial period, and urban land is predicted to expand by 185% by 2030 from a circa 2000 baseline (Seto et al. 2012). Therefore, developing sustainable practices that address this conservation issue of concern is a pressing initiative. In order to convey the significance of this problem, it is helpful to examine it through a social-ecological system lens. In this section, we will review literature that describe concepts of interest that may aid in characterizing this challenge. Specifically, we will discuss human-wildlife conflict, human relationships with nature and ecosystem services, as well as community-building in a social-ecological problem setting.

1.1 Human-Wildlife Conflict

Complex negative encounters between humans and other organisms in nature are widespread and frequently described in literature (Treves et al. 2006; Peterson et al. 2010). These encounters are traditionally termed human-wildlife conflicts, and defined as “situations occurring when an action by either humans or wildlife has an adverse effect on the other” (Conover 2002). From rodents that consume grain in crop fields, to disease transmission from wildlife to humans, there are many cases where wildlife creates inconveniences for human livelihoods that range from mild to quite severe (Perez & Pacheco 2006; Thirgood et al. 2013). On the other hand, humans have had a destructive impact on wildlife throughout the last 500 years, during which we have been implicated in the extinction of hundreds of species worldwide (Dirzo et al. 2014). The case of bird collisions with human-made windows is no exception to this trend. However, it is a unique situation because built environments are causing unnecessary deaths in a taxon that is commonly perceived as pleasant (Sekercioglu 2006; Whelan et al. 2015). Human reactions to bird deaths caused by window collisions can range from feelings of sadness, guilt, or apathy, but both parties can be seen as “losers” regardless. Therefore, framing this situation as a human-wildlife conflict may be deceptive. This is also exemplary of a broader issue in the human-wildlife conflict literature.

The term human-wildlife conflict has been criticized because its traditional definition implies that wildlife is actively antagonizing humans (Conover 2002; Graham et al. 2005; Peterson et al. 2010). In reality, there are many interactions between humans and wildlife that range from animal damage to human goods, to conflict between two human groups with opposing views on conservation issues, that are deceptively categorized as human-wildlife conflict in the literature (Peterson et al. 2010; Redpath et al. 2014). Indeed, in a systematic review of 422 human-wildlife conflict publications, only one described direct conflict between humans and wildlife (Peterson et al. 2010). Framing is instrumental to the appropriate perception of conservation issues by the broader public (McComas 2006). Therefore, we are cautious to categorize the bird collision issue as a human-wildlife conflict.

Regardless of the framework employed, addressing challenges between humans and nature is often complex (Chan et al. 2007; Dickman 2010). For one, human attitudes toward wildlife are themselves inherently complex as many social factors can influence perception, including cultural beliefs, values, and previous experiences (Dingwall 2002; Dickman 2010). The consideration of social factors is therefore essential for addressing human-wildlife conflict issues (Dickman 2010). Further, both the best interests of the people and nature involved must be considered when addressing these problems (Chan et al. 2007). Because bird collisions can be described as a “lose-lose” situation for both humans and nature, there is an interesting opportunity to address the issue in a way that can promote a “win-win” situation. The human-wildlife conflict framework provides an interesting perspective of the problem in that sense. However, the very extraction of humans from the natural environment is indicative of another general perception issue, which is that rather than framing humans as being in conflict with nature, understanding humans as being a part of the natural environment is vital (Chan et al. 2007; Chan et al. 2016).

1.2 Ecosystem Services and Human Relationships with Nature

Ecosystem services are the many goods and benefits that nature provides to humans (Daily et al. 1997). They can be classified into four broad categories: provisioning, regulating, supporting, and cultural services (Daily et al. 1997). Bird species provide a wide range of services, including seed dispersion, pest control, and even floral pollination (Sekercioglu 2006; Caves et al. 2013; Whelan et al. 2015). The ecosystem service framework can be useful for putting a market value on nature, when economists might otherwise describe healthy ecosystems as externalities (Heal 1999). However, this is also an imperfect framework, because as soon as the service cannot be quantified, such as the cultural services provided by birds, they no longer have worth, leading to a market failure (Heal 1991; Jaffe et al. 2005). Perhaps the most evident ecosystem service that birds provide to people is a cultural one (Whelan et al. 2015). Birds are the subject of many cultural stories, sing pleasant songs, and attract people around the world to observe them in the wild so much so that birdwatching has become a major driver of ecotourism (Sekercioglu 2006; Callaghan et al. 2018). Birds, and nature in general, also provide a sense of place, in what are known as relational values to nature, which involve the promotion of feelings of cultural identity, social cohesion, social responsibility and moral responsibility to non-humans by the environment (Chan et al. 2016).

The ecosystem service framework also implies that if a species does not provide services directly to humans, they are worthless. However, this concept neglects the fact that ecosystems rely on the many interactions between their many biotic and abiotic factors that support one another, such that if one aspect were to be removed, the system could collapse through what is known as a trophic cascade (Spencer et al. 1991; Pace et al. 1999). Actor network theory is a social-ecological approach that is supportive of this concept, advocating that social and natural systems exist as shifting networks of vital relationships (Dwiartama & Rosin 2014). Ultimately, it is highly human-centric to purport that nature is only valuable for the goods it provides to humans (Chan et al. 2007). However, the ecosystem service framework does offer a tangible valuation of biodiversity that is easily understood when it comes to conservation policies. It also leads to the conclusion that social drivers are necessary to promote the resilient provision of ecosystem services (Robards et al. 2011), which may be achieved through the support of conservation initiatives, such as bird-friendly art projects.

To conclude this section, we will point to the opportunity for community building that this problem setting brings. The nature of social-ecological problems is that they often implicate whole communities in their scales. Indeed, an issue such as bird collisions with glass features on buildings will have impacts on more than just the birds themselves. For instance, passersby may experience discomfort in seeing injured or deceased birds that have collided with windows, users of the space within a window that is a hotspot for collisions may experience distraction, and communities overall may experience a loss of biodiversity that leads to decreased associated ecosystem benefits. This situation is particular in that it is a conservation issue that has a clear and relatively simplistic solution. The circumstance can be viewed as an opportunity to engage the community in a creative manner, which may allow for many members to reap benefits, such as feelings of wellbeing, belonging, and achievement (Ostrom et al. 1999).

2. Case Studies of Implemented Strategies

In this section we present information on global and local perspectives of best bird-friendly art practices. For the global perspectives, we conducted a literature search of past experiences at other campuses across North America. We were particularly interested in the strategies they have implemented to mitigate bird collisions on windows, and their recommendations for best practices. For the local perspectives, we conducted interviews with stakeholders involved in the process of implementation of bird-friendly art on the University of British Columbia (UBC) campus. Several stakeholder perspectives are also discussed more generally throughout the report as their insights were relevant for multiple aspects of bird-friendly art initiatives.

2.1 Methodologies

The literature search for global perspectives of best bird-friendly practice was scoped to North America, and specifically focused on university campuses. Nonetheless, it is important to mention that the bird collision problem has also been identified and addressed through guidelines in major cities, such as the Greater Toronto Area, the City of Vancouver, the City of Chicago, and others. However, since our focal case takes place on a university campus, we opted to draw from reports with similar contexts. We also draw from published studies by other universities to assess the risk level of the focal building for our case of interest, and discuss some of the contributions of bird-friendly art to the mitigation of this social-ecological problem.

The interviews that we conducted to include local perspectives at the UBC campus took place between the last week of March 2020 and the second week of April 2020. The majority of the stakeholders that we contacted were introduced to us by the SEEDS team, who had previously identified these individuals from their prior experiences of developing bird-friendly guidelines, art and monitoring protocols. We conducted a total of 6 interviews, during which we asked individuals about their roles relevant to the problem in question, their level of awareness and involvement with bird-friendly initiatives, and their general knowledge on the procedural

steps required to develop successful bird-friendly art projects. The interview instrument can be found in Appendix 2. Table 1 below presents the name of the stakeholder interviewed, along with their job position and department at UBC.

Table 1. Interviewed stakeholders¹ from UBC.

Name	Department/Unit	Job Position
David Gill	Campus & Community Planning	Program & Policy Planner for SEEDS Sustainability Program
Penny Martyn	Campus and Community Planning	Green Building Manager
Shiloh Bouvette	Campus and Community Planning	Manager, Community Programs and Outreach
Karen Russell	Campus & Community Planning	Manager Development Services
Susanne Schmiesing	UBC Vantage College	Director, Business Development & Operations
Derek Tan	Beaty Biodiversity Museum	Digital Media Specialist

2.2 Global Perspectives of Best Practices

To date, several mitigation implementations have shown reduced collisions: from spandrel panels and mullions, to strategies such as external blinds, sunshades, and artwork (City of Vancouver 2015). No matter the strategy, any intervention that involves patterns or visual markers that divide clear window space should allow an empty space of more than 5 centimeters (Klem 2009b).

The UBC campus is located within the Pacific Flyway, the route that migratory birds use during their bi-annual migrations from Alaska to Central and South America (City of Vancouver 2015). This indicates that birds may experience more frequent collisions than if it were not located on a migratory path. However, North America is located under several other migratory flyways, which explains why bird collisions are a ubiquitous problem throughout the continent (Arctic National Wildlife Refuge 2013).

¹ We have received consent from the interviewed people to use their names and positions for this report.

At the university campus level, students and local communities have taken the initiative to quantify the magnitude of the problem using their campus buildings as living laboratories to address the problem. From York University in Canada, to Duke University in the United States, bird-friendly windows have been promoted mainly by students, and concerned community members that have witnessed birds colliding against windows throughout their campuses (Ocampo-Peñuela et al. 2016). Students have played an important role in this community-based initiative, as they have collected data that has been used as evidence to convince decision-makers that solutions must be explored (see Figure 1 below) . For instance, at Northwestern University, students volunteered to survey several buildings during the spring (Western News 2019). They documented and mapped a total of 137 collisions on campus. With this data they were able to convince the university to invest in window treatments. Decision-makers opted for a safety film that is characterized for having a low visual impact for humans. However, part of their constraints to treat all windows on campus is that for one building alone, this could cost up to \$90,000 USD (Van Brenk 2019).

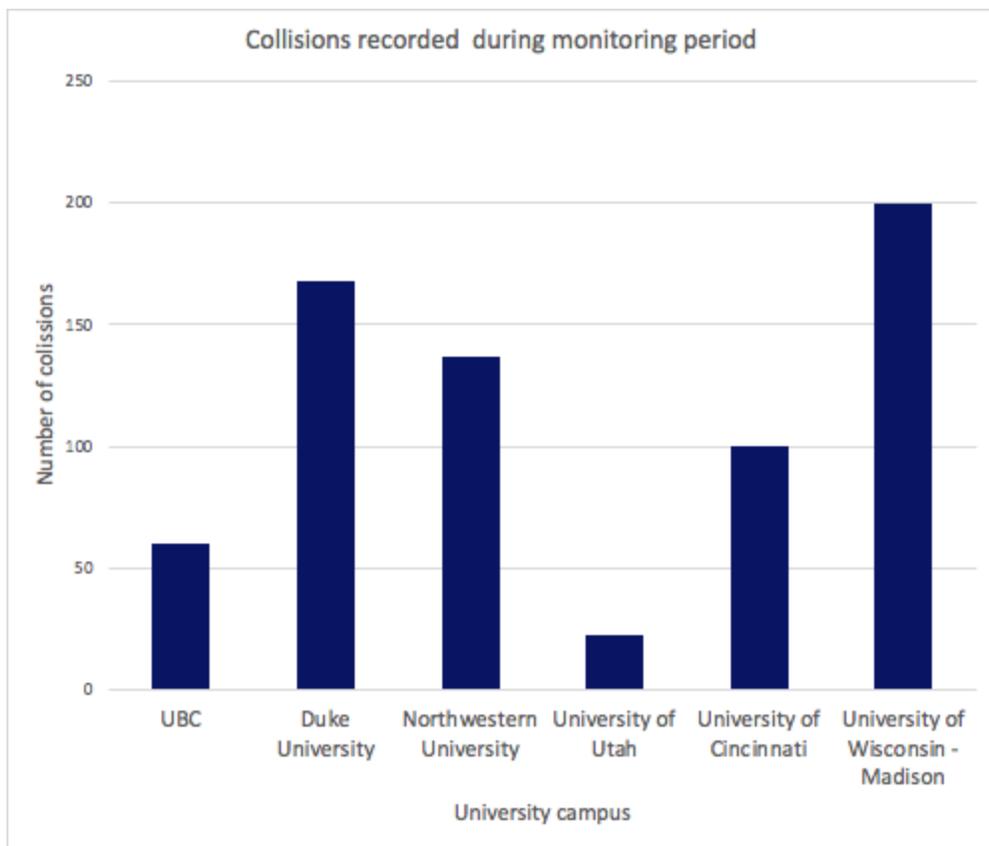


Figure 1. Number of bird collisions recorded at different universities’ campuses across North America. The data comes from actual monitoring, not estimates. Not all buildings within the campuses were monitored (Chien et al. 2015; Ocampo-Peñuela et al. 2016; Western News, 2019; Brown et al. 2019; Bentley 2019; Kim 2019).

A report on bird-window collision at UBC was conducted in 2015 by students partnered with SEEDS. They monitored a total of 10 buildings and recorded a total of 60 collisions (Chien et al. 2015). Another study from Duke University documented a total of 168 bird deaths during migration, where 72% occurred at the tallest building (Ocampo-Peñuela et al. 2016). Researchers from this study concluded that “preventing collisions can be easy and inexpensive. If buildings were made bird friendly from the beginning, the additional cost would be very minor” (Ocampo-Peñuela et al. 2016). However, according to the manager of Development Services at the Campus & Community Planning Unit at UBC, despite efforts to encourage architectural firms and designers to incorporate the university’s bird-friendly guidelines, these projects often have a limited budget and any changes, even at the design stage, can be expensive. Moreover, since the bird-friendly guidelines are not mandatory, their implementation becomes particularly difficult with tall and residential buildings, where many concerns orbit around the visibility issue, which involves the fact that designers prioritize clear windows so that users of the building can enjoy pleasing views. Although the design stage may be the most convenient to introduce bird-friendly guidelines, managers can also opt for bird-friendly practices when windows of already constructed buildings go through the process of glazing, which is the repairing or replacing of old windows.

Most cases, including the ones at UBC, have highlighted cost and visual impact as constraints when implementing bird-friendly strategies. Bird-friendly artwork may represent an inexpensive and attractive solution. UBC stands out from other universities’ initiatives reviewed for this report as the only university that has used bird-friendly art as a strategy to decrease bird collisions. Other universities have opted for patterned glass and UV-reflective films, which despite having proven to prevent collisions, they may not have the same positive community impact. Using bird-friendly art as a strategy can address this problem through a social-ecological approach that engages the community and increases the awareness of the problem among users of buildings and the general public. While bird-friendly art might not be suitable for all windows due to design or installation constraints, the ones that already exist on campus have proven to be an effective and relatively low cost tool.

2.3 Design Competition for the Centre for Interactive Research on Sustainability

The Centre for Interactive Research on Sustainability (CIRS) building, which is dedicated to research collaboration and outreach on urban sustainability, was inaugurated back in 2011. The building holds the highest sustainable building certification under the LEED (Leadership in Energy and Environmental Design) Green Building Rating System (UBC Sustainability Initiative, 2019). Indeed, this green building has obtained numerous awards and international recognition for being a leader in accelerating the adoption of sustainable building and urban practices. Nevertheless, the building is subject to the bird collision problem.

When the UBC Sustainability team identified the risk that the building posed for birds, they decided to take action through a community involvement initiative. They created an art contest with the goal of finding a design that not only complied with bird-friendly guidelines, but would also “tell a story about biodiversity, be beautiful, and be applied to a window on campus

to reduce bird collisions and raise the profile of this issue, because most people are not [aware of it].” -- Program & Policy Planner for SEEDS Sustainability Program².

The process at CIRS involved not only the art contest, but also a period of bird collision monitoring, and a process of window selection. One of the barriers they experienced was that the window they initially identified as the highest risk window for bird collision could not easily incorporate an art installation, and they therefore selected a different window on which to implement bird art. It is clear that bird art is only one potential solution, and not all windows are good candidates for bird-friendly art. However, one of the advantages of creating an art project on a window is the opportunity to involve the broader community and stakeholders, from ornithologists and designers, to building managers, students and faculty members. As the SEEDS representative stated, “the creation and installation of bird art is an opportunity to achieve so many more goals than just reducing bird collisions. Reducing bird collisions might be the initial goal, but because you’re talking about art and bringing people together, you can achieve so much more”.



Figure 2. Installation of bird-friendly art on a window at the CIRS building.

2.4 Community-Engaged Initiative for the Biodiversity Research Centre

The Biodiversity Research Centre (BRC) hosts researchers from the Botany and Zoology departments. The main goal of this centre is to “investigate the ecology, evolution, and conservation of biological diversity through research at all levels, from genes to ecosystems

² SEEDS is within the Campus & Community Planning unit and UBC Sustainability.

through to interactions with society” (Biodiversity Research Centre 2020). The complex was built back in 2009, two years before CIRS. The building does not hold any sustainability certification but since 2017, it is considered to be bird-friendly. After users of the building identified the risk one of its windows poses on bird survival, they decided to take action through the implementation of an artistic design (see Figure 3 below). In contrast to the process that CIRS followed, the BRC process, from identification of the problem to the installation of the bird art, occurred at the community level within the building. Users of the building, guided by the Digital Media Specialist and supported by the director and administrator of the building, volunteered to install the design using a low cost tool: oil pens³. The Digital Media Specialist declared that the fact that the design came from the users of the building created a sense of ownership, which could appeal to more individuals to participate in such a project. As part of the monitoring process at the BRC, researchers reached out to the broader community through the use of a bird strike database. The database can be found on the webpage of the research centre. In this database, people entered information about strikes they witnessed at the surroundings of the BRC, including the Beaty Biodiversity Museum, which is characterized by its large glass windows surrounding the iconic blue whale skeleton.

Bird-friendly art initiatives at UBC have emerged mainly from units and departments whose research is already related to biodiversity and sustainability. Therefore, there is a need to increase awareness throughout the broader campus community. The case study that we use for this matter is described in the following section.



Figure 3. Bird-friendly art at the BRC building.

³ For more information on the tools, cost and implementation see Appendix 1.

3. Case-Specific Discussion: Hummingbird Daycare and Vantage College

The windows of interest for this project are located above the Hummingbird Daycare at the Orchard Commons Vantage College building. Even though the windows are not part of the daycare, birds colliding against it have landed on the daycare's playground, where toddlers have found the dead birds. This issue became a concern to the daycare teachers, who then contacted Campus & Community Planning and SEEDS to find a solution.

The window of concern faces east, towards an arbutus tree located at the center of the playground. Based on previous studies that have focused on the different elements that classify a building as high bird collision risk (Brown et al. 2019; Ocampo-Peñuela et al. 2016; Klem Jr. 2014), we conclude that the Orchard Commons building represents a high risk for birds, due to the nearness of the arbutus tree, the east-facing direction of the window, and the large surface area of glass. Despite the fact that the building poses a high risk to birds, the Orchard Commons Vantage College has been publicized as a sustainable building. Built in 2016, this relatively new complex is also one out of the 31 LEED certified⁴ buildings on campus. Green buildings have become icons of sustainability in the built environment, but they may have unintended consequences for birds and other non-human species (Ogden 2014). When interviewing the director of the Business Development & Operations unit at Vantage College, she emphasized the LEED certification; however, she also recognized that the sustainability of the buildings refers particularly to its energy efficiency. Therefore, in order to comply both with the bird friendly guidelines and the UBC Green Building Action Plan⁵, the Orchard Commons building requires an intervention.

It is worth noting that although this project focuses solely on one window face (because of the rising concern from daycare staff), the building may be subject for more interventions in the future. The building does comply with bird-friendly guidelines in other parts of its facade; for instance, there are exterior sun shades blinds that reduce the bird collision risk. Nevertheless, not all windows were equipped with these sunshades, as is the case of the window above the daycare (see Figure 4 below).

⁴ According to the Canada Green Building Council, a LEED certification “provides independent, third-party verification that a building, home or community was designed and built using strategies aimed at achieving high performance in key areas of human and environmental health: location and transportation, sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality”.

⁵ This plan was approved by the UBC Board Director of Governors in 2018. The plan outlines “a holistic pathway for academic and residential buildings at the UBC Vancouver campus to advance towards making net positive contributions to human and natural systems by 2035”. Biodiversity is incorporated into the plan as a component area of priority.

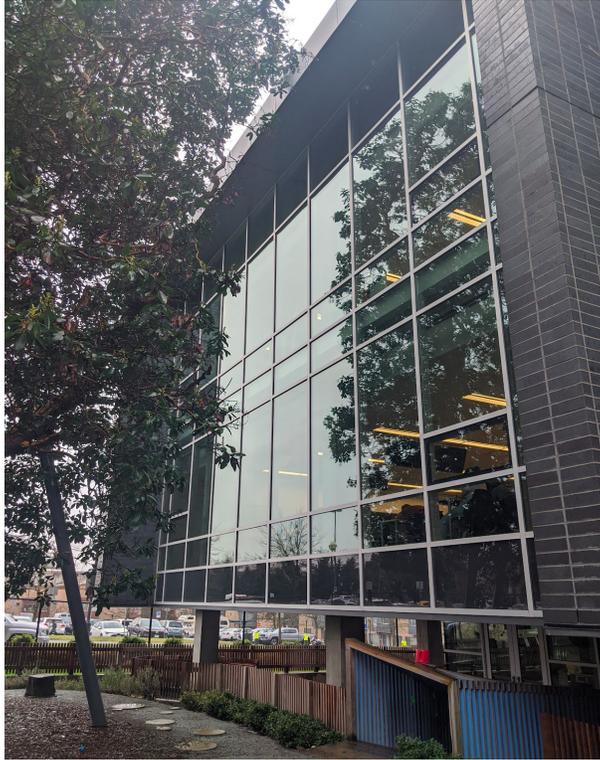


Figure 4. Orchard Commons Vantage College windows and Hummingbird Daycare playground.

3.1 Methodologies

We employed a mixed methods approach for our case-specific investigation of the Hummingbird Daycare/Vantage College site. In order to provide quantitative data on the extent of the bird collision problem at the site, we monitored bird collisions with the eastern facade windows from March 3 through April 5, 2020. We conducted this monitoring to provide baseline data, describing the number of bird collisions with the Vantage College windows at this particular time of year. After the recommended bird art is installed onsite, a future study can follow similar methods and compare the number of collisions before and after bird art installation. For the qualitative element, we utilized our previously described interviews (see Section 2) to garner expert perspectives on bird collisions, bird art, stakeholder and community engagement, and more with respect to this location. We utilized the same interview instrument aforementioned (see Appendix 2). Furthermore, we have included perspectives from informal stakeholder engagement and materials produced by Hummingbird Daycare.

Our bird collision monitoring study primarily drew from the methods described in a previous SEEDS project, titled *Bird-Window Collision: A Problem at UBC Buildings* (Chien et al. 2015). We first acquired permission to enter the properties daily from Hummingbird Daycare and Vantage College (February 25th, 2020). Subsequently, we established a monitoring schedule of 7:45 AM, every day, from March 3rd through April 5th. The time, 7:45 AM, was selected because of its close proximity to sunrise throughout the study period. Monitoring shortly after sunrise is important, because at sunrise, birds awaken and immediately begin frantically

searching for food. During this period, many collisions occur. Scavengers tend to retrieve the bodies of dead or injured birds quickly, so it is important to document collisions soon after they occur, before they are scavenged and the evidence is potentially lost (Campus and Community Planning staff, personal correspondence). We monitored every day, in order to get the most robust sample size possible within the weeks allotted. The larger time frame, March 3rd through April 5th, was selected because of the availability of group members and the due date of the project. Each day, we monitored for bird collision evidence by examining the Hummingbird Daycare playground area beneath the Vantage College windows, looking for injured or dead birds. We then entered the Vantage College classrooms (classrooms #3074 and #4074) to search for evidence of bird collisions on the windows from the inside. Evidence typically presents as feathers attached to the window, bird-shaped imprints, smudges, or sometimes bodily fluids. We photographed and recorded all incidents and pieces of evidence.

3.2 Collision Monitoring Results

Over the monitoring period, we recorded five or six total collisions: one from a bird carcass found on Hummingbird Daycare's playground on March 3rd, and five incidents of collision against windows. We could not establish whether one of the collections of feathers on windows was attributable to the collision that caused the death of the bird found on March 3rd, hence we cannot be certain whether we documented five or six total collisions. The data is described and plotted below (see Figures 3 and 4), please see [this link](#) for the raw data, notes and details on location and evidence, and pictures of each incident. The limitations of this study are described in Section 5.



Figure 1. Deceased bird found at Hummingbird Daycare.



Figure 2: Collision on window found at Vantage College.

Figure 3. Recorded bird collisions during monitoring period with type of evidence found.

Date	Number of bird collisions	Type of evidence
March 3	1 collision	1 dead bird on ground (Figure 1)
March 7	2 separate bird collisions	2 separate collections of feathers on windows (one of these collections is pictured in Figure 2)
March 14	1 collision	Feathers on window
March 18	1 collision	Feathers on window
March 20	1 collision	Feathers on window

Counts of bird collision evidence over monitoring period

March 3 - April 5, 2020

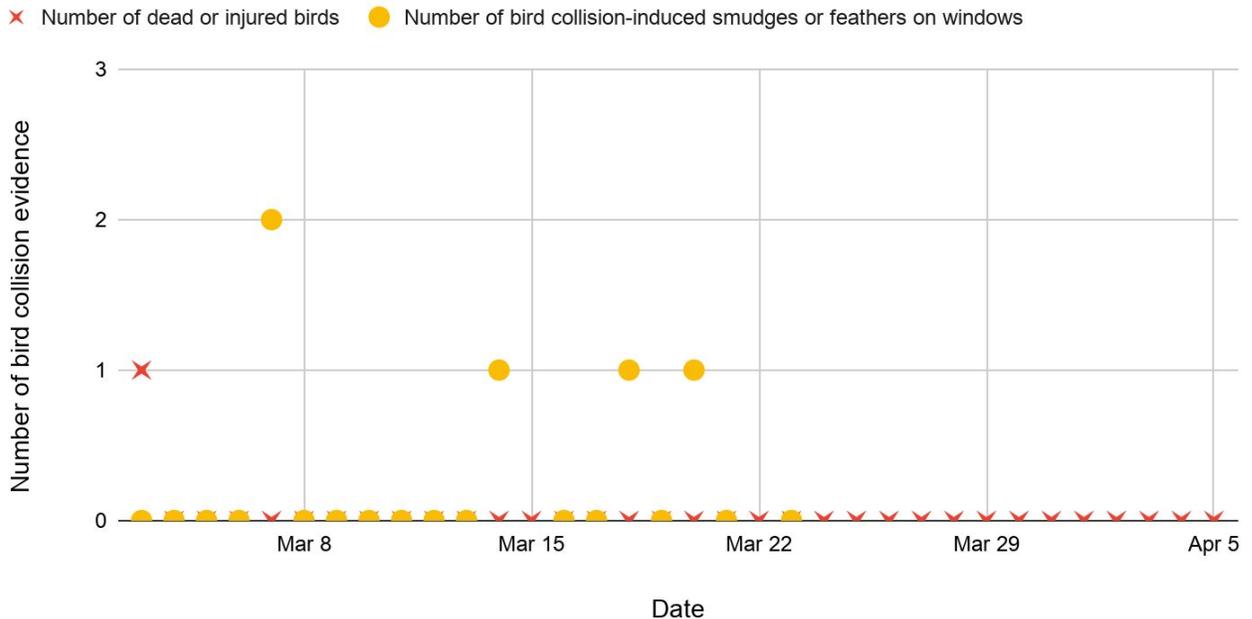


Figure 4. Counts of bird collision evidence over monitoring period according to date found.

3.3 Expert and Stakeholder Perspectives

One of the most significant dimensions of this community-engaged initiative is the community that first raised the issue to the SEEDS staff: Hummingbird Daycare. The director of Hummingbird came to SEEDS because the children under their care - stakeholders themselves - repeatedly found dead birds on the playground, particularly in autumn. According to the director, kids would ask questions about the birds and talk about them. The daycare documented some of the collisions and children's responses to them in a scrapbook (see Figures 5 and 6). Particularly because it was the Hummingbird Daycare community that first documented the bird collision problem at this site and subsequently brought the issue to SEEDS, they are a vital stakeholder to engage early and often. Although we were unable to interview staff formally, we recommend that Hummingbird community members remain a part of the bird art implementation process.

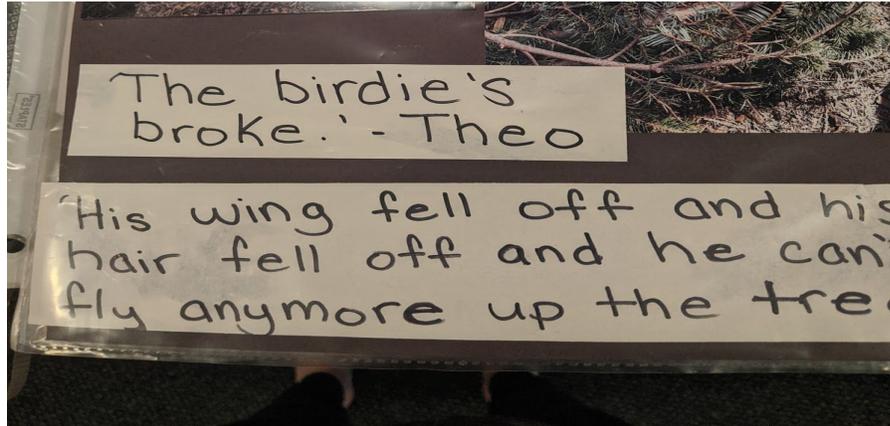


Figure 5. Excerpt from scrapbook, children's response to finding deceased birds.

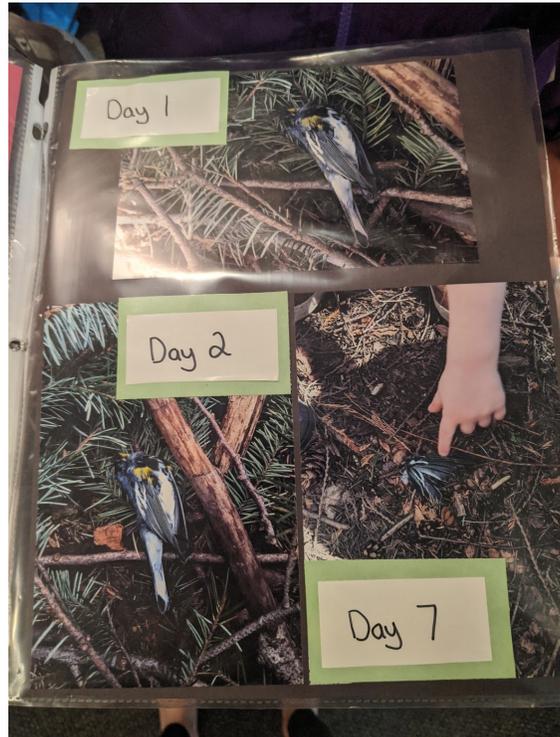


Figure 6. Excerpt from scrapbook, deceased birds found by children.

We also formally interviewed a variety of experts and stakeholders using the instrument described in Appendix 2. We engaged an array of departments across UBC, including Vantage College, Beaty Biodiversity Museum, and various roles within Campus and Community Planning. Across these interviews, common themes emerged.

The preeminent common thread among interviews was the capacity of bird art to be simultaneously educational, aesthetically pleasing, and sustainable. Furthermore, interviewees

highlighted the ways that each of these three dimensions can reinforce and contribute to the success of the others. Three interviewees discussed the lack of awareness of the bird collision problem at UBC, despite the especially high frequency of collisions that occur on campus. They explained the need to ameliorate this lack of awareness via educational measures, but interviewees had different suggestions for how exactly that education should be brought forward, in the Hummingbird Daycare/Vantage College case. In addition to educating people about bird collisions themselves, Shiloh Bouvette, Manager of Community Programs and Outreach in Campus and Community Planning, suggested that education on this topic can prompt more engagement with “our responsibilities around the built environment and its interaction with the natural world”.

Another commonality between interviews was the emphasis on engaging stakeholders early in the process, although the sets of stakeholders depend on the project, location, and opportunity in question. Susanne Schmiesing, Director of Business Development and Operations at Vantage College, stated that finding partnerships within the building where the bird art will be placed is critical. Penny Martyn, Green Building Manager in Campus and Community Planning, echoed this point. The building partnerships at this case study site are Hummingbird Daycare and Vantage College, but various interviewees underscored the fact that other students and members of the public will engage with this art as well, and their perspectives and needs should be considered.

On the bureaucratic side, Penny Martyn and Susanne Schmiesing both shared that when it comes to sustainability in buildings, energy efficiency is prioritized, and biodiversity conservation issues are not necessarily a part of the conversation. There is an opportunity to introduce bird-friendly qualifications into building standards on campus. As for barriers to implementing this bird-friendly art, multiple interviewees pointed out the long and delayed timelines that community-led initiatives can take, as well as specific weather requirements during the installation period. Another potential barrier for implementation is cost, with longer-lasting strategies typically being more expensive. Karen Russell, Manager of Development Services in Campus and Community Planning, mentioned some of the challenges with taller buildings, because of accessibility, which was echoed by Derek Tan, Digital Media Specialist at the Beaty Biodiversity Museum.

While there were minor differences in some interviewees’ responses (their suggestions for educational measures or their assessments of the magnitude of barriers, for example), there was mostly agreement on the following considerations for implementing bird art at the Hummingbird Daycare/Vantage College site and beyond:

1. The multidimensional aspects of bird art
2. The lack of awareness of bird collisions at UBC and subsequent opportunity for education through art projects (and otherwise)
3. The importance of engaging stakeholders early
4. The importance of engaging local stakeholders/building occupants, but also considering the public
5. The sustainability emphasis in buildings is on energy efficiency, not human-wildlife conflict, but this could change to include bird-oriented policy
6. Interviewees with experience in bird art projects and/or technical expertise discussed similar barriers to bird art implementation, including cost, weather, height of buildings, and the long timelines of community-led initiatives.

4. Social-Ecological Analysis and Recommendations for Intervention

In this section, we delve into the social dimensions of implementing bird-friendly art retrofits on UBC campus. It includes an analysis of the elements of UBC's governance structure that enable such adaptive ecosystem-based management and highlights leverage points in the system that were targeted in past projects. We then discuss current challenges for implementing bird-friendly art retrofits on UBC campus and recommendations for how to overcome these barriers that are informed by the SES literature. Finally, we provide specific recommendations for Hummingbird Daycare that follow the form of the bird art toolkit in Appendix 1.

4.1 Adaptive Governance at UBC

There are certain aspects of UBC's governance structure that make it amenable to adaptive management plans. Bird-friendly art is an example of such a plan because these initiatives identify a social-ecological problem, implement an evidence-based intervention, and perform monitoring before and after the intervention to allow for learning and adaptation.

Management of ecosystem resilience to maintain ecosystem services provided by on-campus bird populations requires the social capacity to respond to and shape ecosystem dynamics (Folke et al. 2005). One component of UBC's social capacity is the polycentric governance structure it shares with municipal, provincial, and federal governments. This structure supports flexible institutions and multi-level governance. For instance, UBC has the authority to conduct its own bird-friendly art research, and as a quasi-municipality it has the authority to make policies that can reduce collisions without consultation with a municipal government. It also allows UBC to build ecological knowledge through collision monitoring on-campus and identification of hotspots for bird collisions on-campus (Park & Lai 2017).

There is also a polycentric governance structure within UBC itself, with multiple departments and faculties that have their own policies and decision-making authority. It is important to acknowledge that these different organizations all exist within UBC and can therefore be considered part of a nested institutional structure. This structure is what enables bottom-up community-based initiatives such as bird-friendly art projects. For example, the initiative at BRC began with several concerned occupants of the building who self-organized and reached out to other groups at UBC, such as the Beaty Biodiversity Museum and the SEEDS program. The initiative did not require large regulatory oversight and was not overly complicated.

Social sources of resilience are another important component of social-ecological resilience (Leslie & McCabe 2013). Through bird-friendly art initiatives, UBC has demonstrated social resilience by building social networks that facilitate knowledge transfer, learning, and social memory. Such networks include those created through the CIRS and BRC bird-friendly art initiatives. These networks can be considered informal bird-friendly knowledge sharing networks and include collaborations between UBC Sustainability, UBC SEEDS, and Campus and Community Planning, and other universities across North America. Such collaborations have resulted in not only successful bird-friendly art projects, but also impact UBC policy. For instance, UBC's Green Building Action Plan includes a bird-friendly target and UBC has

released official Bird-Friendly Design Guidelines (UBC Campus and Community Planning 2019a; 2019b).

Adaptive governance also requires dealing with the broader governance environment beyond UBC (Folke et al. 2005). This includes cross-institutional collaboration and bridging organizations that facilitate such collaborations. The CIRS project included knowledge sharing between an ornithologist with expertise in bird collisions at the federal Ministry for Environment and Climate Change. The bird-friendly design generated during the BRC project included input from FLAP Canada, a Non-Governmental Organization specializing in bird collisions. Case study interviews revealed that the SEEDS program acts as a bridging organization and facilitator between UBC departments, students, staff, faculty, and other organizations.

4.2 Leverage Points at UBC

The social-ecological system literature has long grappled with how to effectively generate system change (John et al. 2009; Shove 2010). In the case of UBC, the desired change is transforming the campus from a system in which 10,000 birds are killed annually by collisions with windows into a more bird-friendly system (Martin 2011). Thus far, the informal bird-friendly knowledge-sharing network of actors at UBC has used several strategies to generate such system change. These can be described using Meadows' typology of leverage points and Heath & Heath's analogy of the Rider and the Elephant (Meadows 2009; Heath and Heath 2010). Meadows' typology is a list of points in a system which can be leveraged to generate change. The Rider and the Elephant is an analogy that is used to describe how to generate change in a system and proposes that both the emotional and rational sides of an actor need to be engaged to do so.

There are four leverage points from Meadows' typology that the bird-friendly knowledge-sharing network have employed in UBC's system. The first is changes to the stock and flow structures, which entails altering the physical structure of a system. This was achieved through a bird-friendly design target for new buildings in the Green Building Action Plan, which states that all new UBC buildings must comply with UBC Bird-Friendly Guidelines for Buildings by 2030 (UBC Campus and Community Planning 2019b; 2019a). The second leverage point is information flows, which describes how information is being shared and with whom. This was leveraged by creating the knowledge-sharing network itself and through educational signs in front of the bird-friendly designs. The third leverage point is altering the rules of the system through changes to policies and action plans. UBC's Green Building Action Plan includes a target for biodiversity, and the Bird-Friendly Guidelines for buildings will soon be compulsory for new buildings. The final leverage point is changing the self-organization of the system by creating new structures and behaviours. New structures and behaviours were created through the bird-friendly knowledge-sharing network and community-building opportunities that the bird-friendly art installations created. Meadows (2009) points out that accessing this leverage point requires social diversity, and the advice is heeded by the bird-friendly knowledge-sharing network, which is formed of an interdisciplinary group of actors and purposefully employs an interdisciplinary lens to solving the bird collision problem.

The bird-friendly art initiatives have thus far appealed to two of the three actions that Heath & Heath (2010) recommend when trying to implement change. Firstly, the bird-friendly designs and educational signs used in the CIRS and BRC case studies Motivate the Elephant,

which is an analogy that expresses the need to engage actors' emotional sides. This was achieved by beautifully depicting biodiversity in the designs and appealing to the sadness that bird collisions can generate in the educational signage. Secondly, the Bird Friendly Design Guidelines Direct the Rider, that is provide a clear direction for change, by providing standardized guidelines that are clear and simple.

4.3 Current Challenges of Implementing Bird-Friendly Art on UBC Campus

Although UBC's governance structure is such that bird-friendly art can be implemented and the bird-friendly knowledge-sharing network has taken advantage of various leverage points for achieving system change, some barriers to implementing bird-friendly art campus-wide remain. These challenges include competing sustainability goals, as resources are often allocated to projects associated with energy efficiency and reducing greenhouse gas emissions. The projects were also time-consuming and incurred delays. Finally, interviewees expressed that the process of initiating and implementing bird-friendly art was opaque and difficult to navigate.

These barriers can be readily understood using social-ecological system concepts. Although the bird-friendly knowledge-sharing network is an excellent start, it is currently limited to a select group of actors. Indeed, interviewees repeatedly stated that few people know about the bird collision problem on campus and that there are solutions. Meadows (2009) argues that a lack of information flow can reinforce a bad feedback loop, such as the bird collision problem.

The problem of bird collisions also extends to the social-ecological system critique of the management of human and natural systems as separate entities (Berkes et al. 2003). In its sustainability policies, UBC seems to maintain the dichotomy. The UBC Green Building Action Plan emphasizes the separation between human and natural systems; indeed, the vision statement itself treats human and natural systems differently by stating, "By 2035, UBC's buildings will make net positive contributions to human *and* natural systems" (emphasis added). Additionally, the Action Plan shows that UBC's progress towards its biodiversity goals have seen little progress, while there has been significant progress towards classic "human" systems goals, such as materials and resources. This point is further emphasized in the following quote from an interview:

"We're talking about a specific issue, which is bird collisions, that reflects a much larger issue which is our lack of connection to place and non-human communities we are embedded in and with which we share these environments. And there's a deep societal need to bring attention to this interconnectedness"

- Sustainability Professional

It is therefore evident that UBC remains in the traditional mindset that human and natural systems remain in disciplinary silos.

These barriers to implementing bird-friendly art can be addressed using several SES concepts. Firstly, the informal bird-friendly art knowledge-sharing network should be formalized to enhance further network-building and knowledge-sharing with other groups on-campus. This could be done by setting up a dedicated unit within UBC Sustainability, or through a student-led club. The network can share that there are potential co-benefits to bird-friendly art initiatives,

including energy-saving (UBC Campus and Community Planning 2019b). The Bird-Friendly Art Toolkit (Appendix 1) addresses the issue of the opacity of the process by shedding some light on social, ecological, and technical considerations for implementing bird-friendly art. Formalizing the network would also help with learning and social memory, for example, an important lesson from the CIRS project was that it took longer than anticipated due to challenges in finding a skilled contractor and weather delays. Finally, the formalized network can be used to share information about where to get funding for these projects. For instance, UBC Food Services funded the CIRS project.

Another option to address the barriers to the bird problem would be to opt for a top-down regulatory approach in which UBC mandates that all buildings on campus need to follow bird-friendly guidelines. This would be in line with Heath & Heath (2010)'s analogy of Shape the Path, in which the environment is changed to make it easy for actors to follow. However, Ostrom et al. 1999 argue that top-down regulatory approaches can be limiting and exclusionary. In this sense, it would eliminate the community-building and educational components of the bird-friendly art initiatives. The bottom-up bird-friendly art initiatives at UBC were executed by a small group of committed individuals, which Ostrom et al. 1999 also argue is a more effective way to manage the commons.

Ultimately, as the quote from the Sustainability Professional suggests, there ought to be a paradigm shift from conceptualizing UBC as an institution for humans to acknowledging the coupled nature of the social-ecological system that makes up the campus environment. Meadows (2009) argues that this is one of the more effective levers to generate system change. It requires an appeal to the people in power to shift to a bird-friendly paradigm; it would be worthwhile to reach out to UBC's leadership to promote the management of the campus as a coupled system.

4.4 Recommendations for Hummingbird Daycare

Here, we present concrete recommendations for the various dimensions that should be considered for implementing bird-friendly art at Hummingbird Daycare in the format of the Bird-Friendly Art Toolkit (Appendix 1).

Social Considerations

Stakeholder Identification

An important first step in the bird-friendly art generation process is the identification of stakeholders. Figure 7 depicts some stakeholder groups and specific examples identified in interviews.

Stakeholder Engagement

The stakeholders should be engaged at various stages of the process. The early group of stakeholders should include technical and regulatory groups, a bridging organization, senior personnel, and Musqueam. These stakeholders should decide how the art will be generated, how to fund the project, and should have a vision for the project. Other stakeholders can be

engaged later in the process. For instance, it would be worthwhile to elicit design ideas from building occupants. A bird collision expert could be contacted to determine what materials should be used. The public and art community may be engaged later in the process through producing the art and education, respectively.

Tech and Regulatory*	<ul style="list-style-type: none"> • Site Building Manager • UBC Green Building Manager
Bridging Organization*	<ul style="list-style-type: none"> • Manager, Community Programs and Outreach • SEEDS Program
Bird Collision Expert	<ul style="list-style-type: none"> • FLAP Canada
Building Occupants	<ul style="list-style-type: none"> • Vantage College Staff and Students • Daycare Staff, Children, Parents
Public	<ul style="list-style-type: none"> • UBC Visitors
Art Community	<ul style="list-style-type: none"> • Engage an artist in UBC community
Senior Personnel*	<ul style="list-style-type: none"> • Daycare Manager • Principal of Vantage College
Musqueam*	<ul style="list-style-type: none"> • Consult Musqueam-UBC Collaboration Document

Figure 7: Stakeholders identified for Hummingbird Daycare bird-friendly art. * indicates that the stakeholder group should be involved early in the process.

Educational Component

The desired art generation strategy was chosen by a few key stakeholders, and will likely be to commission an artist.

Educational Component

UBC Sustainability seeks to educate students, staff, faculty, and the public about the prevalence of bird collisions on campus. Therefore, we present preliminary text for an educational sign at Hummingbird Daycare that will introduce passersby to the concept behind the window art, along with a brief description of the problem of bird collisions (see Appendix 2).

Ecological Considerations

Bird-Friendly Design

We recommend that the project manager of the Hummingbird bird-friendly art project refer to UBC's Bird-Friendly Guidelines for choosing a bird-friendly design that will reduce collisions at the site (UBC Campus and Community Planning 2019b).

Collision Monitoring

Collision monitoring was completed in March 2020. Due to a limited number of reported collisions, we recommend that the collision monitoring be repeated in the fall, when bird collisions are more common, prior to the installation. A collision monitoring protocol was developed for UBC campus (Park & Lai 2017). Collision monitoring should then be repeated after the installation at the same time of year.

Sustainability of Art Materials

We recommend that before choosing a material for the art installation, the project manager should compare the environmental impacts of the options presented in the Bird-Friendly Guidelines. It could also be beneficial to consult a bird collision expert.

Technical and Regulatory Considerations

Building Permit	Height of Chosen Window	Window Cleaning	Weather	Union Environment
<ul style="list-style-type: none">• Contact Green Building Manager for assistance once design is completed	<ul style="list-style-type: none">• Reach out to Building Operations and private contractors for costs	<ul style="list-style-type: none">• Contact Building Operations once design is completed	<ul style="list-style-type: none">• Make an installation timeline that includes considerations for when materials can be installed	<ul style="list-style-type: none">• Contact Building Operations once design is completed to see if they can install it themselves

Figure 8. Technical and regulatory considerations for Hummingbird Daycare bird-friendly art.

5. Limitations and Recommendations for Future Research

There were a number of limitations and errors encountered in our bird collision monitoring study. First, it was a source of error throughout the monitoring period that observers could not see the top row of windows in Vantage College classroom #4074. As a result, we were not able to document any collision evidence that may be present on those windows, potentially leading to an underrepresentation of collisions. Second, all classrooms were closed on Sundays for cleaning, so we were not able to document window collision evidence from the inside on these days throughout the monitoring period. Third, this study took place during the COVID-19 pandemic, and several errors resulted. As of March 13th, UBC transitioned to online classes. To protect the safety of group members, our group made the decision for only one member to conduct the monitoring, due to their easy access to the Hummingbird Daycare/Vantage College building. As a result, the period from March 13th through April 5th is subject to observation bias, because the study had only one observer. Next, as of March 17th, Vantage College classroom #4074 became an Active Emergency Operations Center, and therefore was unable to be accessed for the rest of the monitoring period. Finally, on March 24th, classroom #3074 closed as well, leaving both classrooms inaccessible, and only the outdoor monitoring portion (examining the Hummingbird Daycare playground area for dead and injured birds) could occur. Both classrooms remained closed for the rest of the monitoring period. In summary, only the March 3rd through 13th period had multiple observers with access to all classrooms (with the exception of Sundays).

A few improvements can be made for future bird collision monitoring studies at Hummingbird Daycare/Vantage College. First and foremost, we suggest a monitoring study should be conducted during the fall migration, when Hummingbird staff and children have observed the most collisions. This will better capture the magnitude of the problem. Next, a longer monitoring period should be employed, such as two months in length. Not only will this result in a more robust sample size of days monitored, but more seasonal variability might be captured as well. Finally, especially if conducted in the fall, the monitoring study should consider using citizen science, as compiled by the Hummingbird staff and children. The staff and children already notice and collect information on bird collisions; adding counts and dates to those observations is a feasible contribution. Doing so could further bolster their engagement as stakeholders and also the children's education on birds and bird collisions.

Regarding the set of interviews we conducted, we would recommend interviewing more community perspectives. Gaining the perspective of community members such as users of the spaces within buildings that receive many bird collisions might yield interesting considerations for bird-friendly art guidelines as well as design strategies. Finally, as UBC is constantly under construction, bird collision monitoring and the associated research should also remain constant. Researchers might consider qualifying the risk factor of new buildings by characterizing the number of windows, the size of the building, and the number and size of trees surrounding them. Furthermore, our research was conducted at the university campus level, but drawing from and contributing to experiences at the city/municipality level could also represent an opportunity to address the problem at a larger scale.

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Appendix 1: Bird-Friendly Art Toolkit

This toolkit is intended to be a how-to for any group on UBC campus that wants to start their own bird-friendly art initiative. It includes important social, ecological, and technical considerations for the scoping and implementation of a bird art project. It also identifies key resources and personnel that are helpful in getting bird-friendly art projects off the ground.

Social Considerations

Stakeholder Identification

Stakeholders will differ depending on the site; however, they can be distilled into certain groups. The table below shows groups of stakeholders you may want to consider in your project.

Stakeholder Group	Examples
Technical and Regulatory Actors	Building Manager UBC Building Operations UBC Green Building Manager UBC Sustainability Initiative
Bridging Organization or Actor	UBC SEEDS Program
Bird Collision Expert	FLAP Canada Krista De Groot, Environment and Climate Change Canada Penny Martin, Green Building Manager
Building Occupants and Users of the Space	UBC students, staff, faculty Other community members
Public	Other UBC students UBC visitors
Art Community	UBC Fine Arts students Vancouver Art Community
Senior Personnel in the Faculty or Department in the Building	Dean of the Faculty in the building Head of Department in the building
Musqueam Indian Band	Contact People may vary – please consult the Musqueam-UBC Collaboration document (UBC Sustainability Scholars 2015)

The purpose of a Bridging Organization or Actor is to facilitate the collaboration between different departments, academic disciplines, and on-campus communities. This role is important because UBC is a large institution with many different actors.

It is important to consider whose voice may not be heard in the stakeholder identification process. One group that was identified to have been left out of past projects was the Musqueam Indian Band, who have previously expressed concerns about bird collisions on UBC campus. It is important to note that Musqueam receives many requests from UBC, so it may be best to work with existing relationships if possible. It is also recommended to engage Musqueam early on in the process and ask if and how they would like to be involved.

Stakeholder Engagement

After identifying stakeholders, you may want to consider how and when they should be engaged. Successful bird art projects have included a key group of stakeholders that connect early on. These stakeholders should be champions of the project who have the authority, the funding, and the expertise to implement a bird art project. Some examples might include the site's building manager, a bird collision expert, committed occupants of the building, and the SEEDS program. This group should meet and discuss the scope and goals of the project.

Once the scope and goals of the project are determined, other stakeholders can be engaged at various subsequent stages. In the case of the Centre for Interactive Sustainability (CIRS), UBC students were engaged during the art competition stage. Beaty Biodiversity Museum engages the public with the art at the Biodiversity Research Centre (BRC) during their tours.

Art Generation Strategies

An important aspect of any bird-friendly art project is the process through which the art is generated. Case study analyses identified three distinct art generation strategies that have been successful on UBC campus. Which strategy you choose will depend partly on the goal for the project beyond reducing bird collisions. You may also want to consider your budget and desired timeline.

Additional goals for bird art projects can include:

- Community-building
- Education about biodiversity and the bird collision problem
- Telling a story about what goes on inside the building
- Engaging UBC students, staff, and faculty in their campus environment
- Educational Component

Art Strategy #1: Art Contest

Example: “For the Love of Birds” SEEDS Bird Art Competition at CIRS

Description: This strategy included an art competition for UBC students. The window was identified as a high-risk location by a bird collision expert. The art was selected by a panel of judges, depicts birds and plants commonly found on campus, and is made of adhesive film. There was a \$400 prize for the winning artist. See <https://sustain.ubc.ca/stories/bird-friendly-art-saves-feathered-lives> for more details.

Goal: Education, community-building, student engagement

Cost: ~\$7000 for installation and contest prize

Time: 12+ months, delay in finding a contractor with the expertise to install adhesive film

Special Considerations: An art competition should include a competition brief that will be sent out to potential applicants. The brief should include a picture of the window the art will be on, window dimensions, a rubric of how the art will be evaluated, bird-friendly design directives, and requirements for entry. You may want to consider a prize and convening a panel of judges. Selecting a diverse panel of judges is another way to increase stakeholder engagement.

Art Strategy #2: Occupant Engagement

Example: BRC

Description: A series of windows was identified as a hotspot by building occupants. An existing drawing commemorating the research organisms of the BRC was adapted to the windows. The design was projected onto the windows, paper was placed behind the windows, and volunteers from the building traced the design on the outside of the windows. See the report compiled by Tan 2018 for more details.

Goal: Community-building, telling a story

Cost: ~\$1200, probably the lowest-cost option

Time: A few weeks for preparation and organization, 42.5 person-hours for installation

Special Considerations: It is worthwhile to create a design that is relevant to the research or activities that occur in the building. These kinds of initiatives can create a sense of ownership by the community and help build social networks. The installation work should be celebratory and include food and drinks.

Art Strategy #3: Commission an Artist

Example: Hummingbird Daycare

Description: Hummingbird Daycare was identified by its inhabitants as a hotspot for bird collisions. As of April 2020, the initiative has not been completed. It is anticipated that an artist will be commissioned to complete the art, and that the design will be inspired by the occupants of the building, namely Vantage College and Hummingbird Daycare, and include children's drawings and writing, the Arbutus tree in front of the daycare, and writing in different languages.

Goal: Community-building, education

Cost: unknown (project has not yet been completed)

Time: unknown (project has not yet been completed)

Special Considerations: If an outside artist is hired, it is important to elicit design ideas from the community to create a sense of ownership. To enhance community-building, it would be beneficial to host an event to celebrate the installation of the art upon its completion.

Educational Component

In addition to reducing bird collisions and other goals, bird-friendly art can provide an opportunity to educate the users and visitors of the space about the problem of bird collisions on UBC campus. This is especially important, given that it is a way to engage people in a socio-ecological problem for which there is a solution.

The CIRS installation is accompanied by an educational sign, which explains the bird collision problem on campus and highlights the importance of bird-friendly design in maintaining biodiversity. It is also part of the building tour. The installation at the BRC is now included in the Beaty Biodiversity Museum tour. The Hummingbird project will include a sign outside of the installation similar to the one at CIRS and will also include translations into other languages and a kid-friendly explanation of the bird collision problem.

Ecological Considerations

Bird-Friendly Design

There are various ecological aspects of the bird collision problem that should be considered when implementing bird art. UBC's best resource for bird-friendly design is the Bird Friendly Design Guide prepared by UBC Campus and Community Planning. It includes evidence-based recommendations about which windows are most effective, what colour the design should be, and what surface it should be placed on. If there are any additional questions about the

effectiveness of a potential bird-friendly design, a bird collision expert should be consulted. The guide also includes potential co-benefits and costs.

Collision Monitoring

Collision monitoring is a valuable addition to a bird art project. It adds to the North American university and UBC knowledge networks of the bird collision problem. Collision monitoring involves collecting monitoring data before and after the bird-friendly art is installed. A detailed methodology was developed for bird collision monitoring on UBC campus (Park and Lai 2017). Collision monitoring should be done in the fall, as that is when collisions are most common. Both Hummingbird Daycare and the BRC bird art initiatives included a collision monitoring component.

Sustainability of Art Materials

It is also important to consider the environmental and ecological impacts of the materials that are used for the bird-friendly art. There are often sustainability issues associated with manufacturing materials like vinyl, and other less permanent materials like oil-based sharpie have the potential to enter the environment.

Technical and Regulatory Considerations

From conceptualizing the bird art design to getting it installed on a window, there are various technical and regulatory considerations that ought to be made. These include are shown in Figure 9.

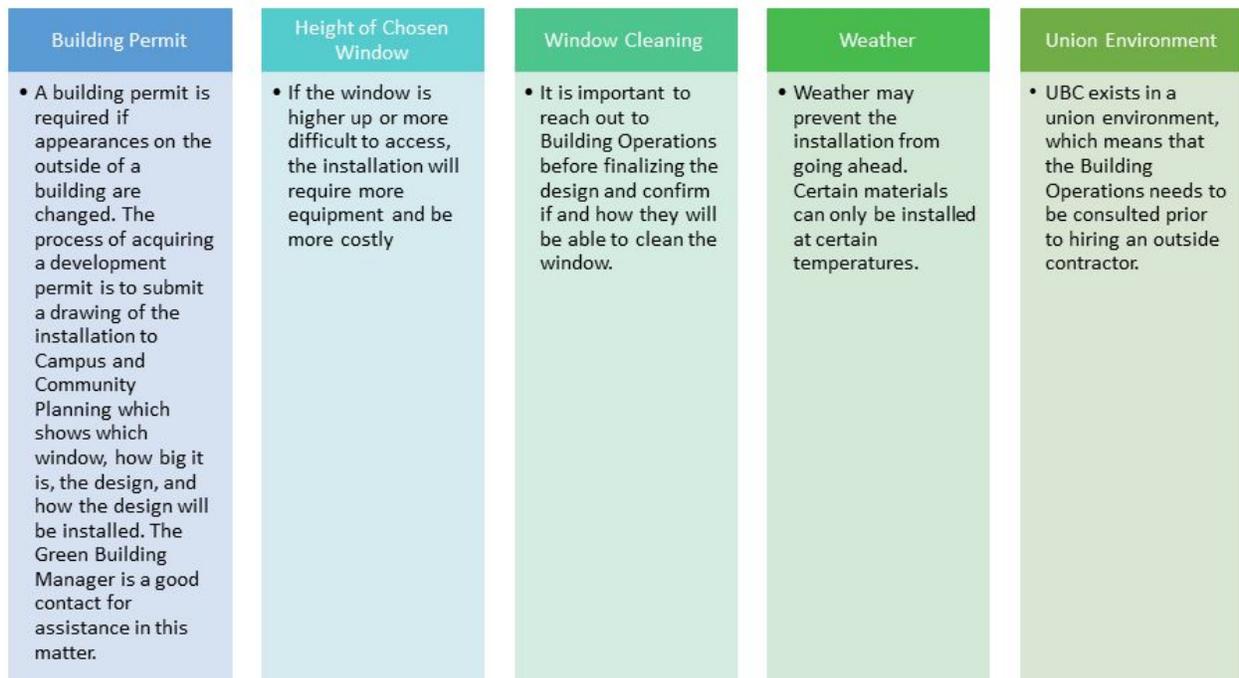


Figure 9. Technical and regulatory considerations for implementing bird-friendly art.

Appendix 2: Interview Instrument

Research Question:

- What are the social-ecological considerations of implementing bird art to reduce bird collisions with windows on UBC campus?

Themes we want to discuss:

- Stakeholder engagement
- Participatory methods for SES management
- Governance structures available for SES management
- Perceived barriers to integrated SES management
- Ecosystem services provided by birds
- Perception of the bird collision problem
- Past place-based bird art initiatives
- Bird collision education

Interview questions and rationale for asking these questions:

1. Just to start off, can you tell us a bit about your position at UBC?
 - Just starting off, opening with an easy question
2. I want to first ask you about how you perceive bird collisions on campus in your professional capacity. How did you become aware of the bird collision problem at UBC or the site where you work?
 - Perception of bird collision problem
3. Why is/was it important for you to become involved in reducing bird collisions?
 - Ecosystem services provided by birds
4. **(if involved in a past project)** I now want to talk a bit about your previous experience in bird art initiatives. Can you describe your past involvement in on-campus bird art initiatives?
 - Past place-based bird art initiatives
 - What partners?
 - How was the rubric decided?
 - How to pick the window? .
5. **(if involved in a past project)** Which stakeholders were engaged during the process of implementing the bird art? How were they identified?
 - Stakeholder engagement (past)
6. Now I want to talk a bit about how you think these initiatives *should* be done. Which stakeholders should be involved in community-led bird art initiatives?
 - Stakeholder engagement (future)
7. How should stakeholders be engaged in bird art initiatives?
 - Outreach, daycare, support.
 - Participatory methods for SES management

8. **(for those with technical and procedural knowledge)** What kind of technical and procedural considerations should people make when starting a bird art initiative?
 - Governance structures available for SES management
9. Are there any specific barriers that you perceive to implementing bird art on campus? These can be social, regulatory, ecological...
 - Perceived barriers to integrated SES management
10. For the last part of the interview, I want to direct my line of questioning to the educational aspect of bird collisions at UBC. What is important for people to know about the bird art you were/will be involved in implementing?
 - Educational aspect of bird art

Appendix 2: Hummingbird Daycare Educational Signage Text

Skeleton of text for consideration for educational signage near the retrofitted window.

Why is there art on the window?

Birds collide with windows when they fly into them, which can stun, injure, or kill them. Birds run into windows because they can't recognize them as hard glass - they see it as an extension of the landscape. This art helps them to see the window and avoid running into it.

Why is there art on THIS window?

UBC has a BIG bird collision problem. On UBC's campus alone, 10,000 birds die every year from window-collisions! This is likely because UBC is located on an important migratory path for birds, called the Pacific Flyway, so we get extra bird traffic, especially in the fall. Also, UBC uses lots of glass in its buildings. By putting bird art on this window, we're preventing bird injuries and deaths by collision. We can do the same for many other windows on campus!

What's the story of this art?

(Insert details of the design, who ended up designing it, etc.)

I'm concerned about bird collisions with another building at UBC, what can I do?

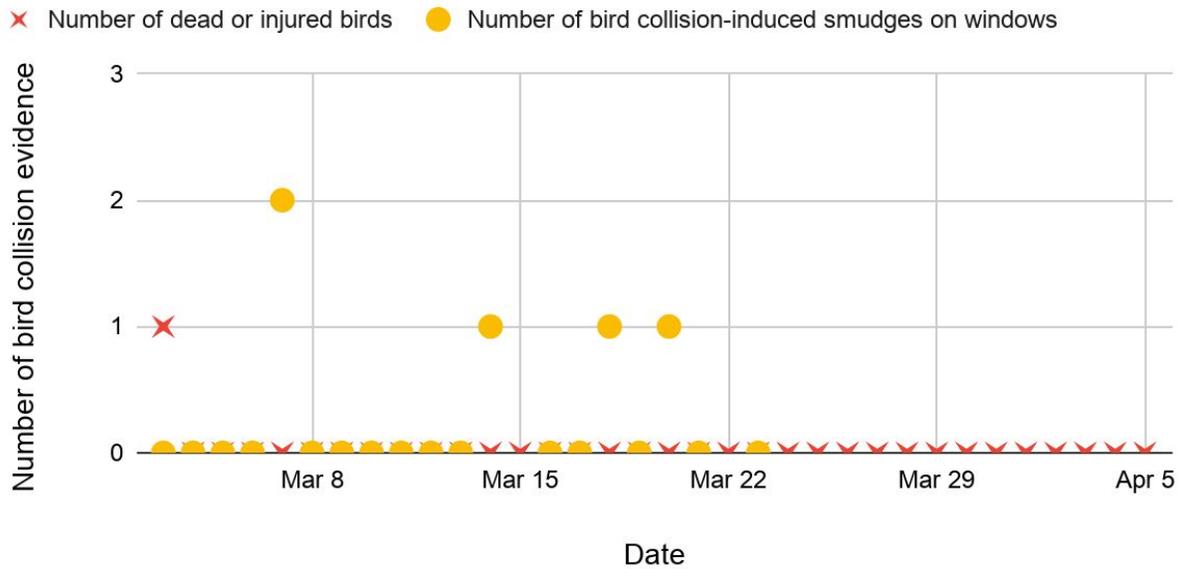
UBC's SEEDS Sustainability Program has a toolkit that includes information about how to get a bird art project started on your building! Scan the QR code for details.

- QR Code that takes them to the toolkit

Appendix 3: Bird Collision Monitoring Data

Counts of bird collision evidence over monitoring period

March 3 - April 5, 2020



Full spreadsheet of data, notes, and pictures can be found [here](#).