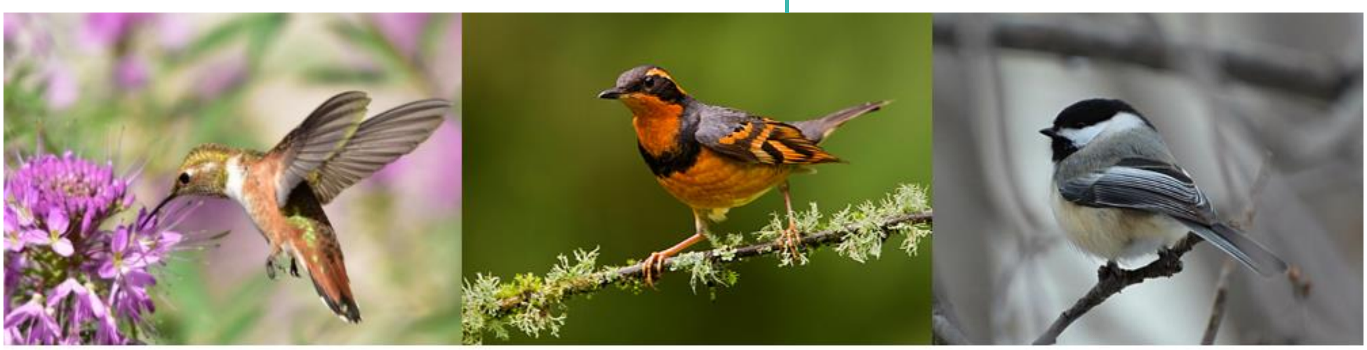
UBC BIRD BACKGROUNDER

May 2024

Compiled by SEEDS Sustainability Program Student Researchers



Left to right: Rufous Hummingbird, photo by USFWS Mountain-Prairie, CC BY 2.0 DEED. Varied Thrush, photo by Eleanor Briccetti, CC BY-SA 2.0 DEED. Black-capped Chickadee, photo by DaPuglet, CC BY-SA 2.0 DEED

SEEDS Sustainability Program

Acknowledgements

Land Acknowledgement

The authors and contributors of this report are fortunate to work and learn on the traditional, ancestral, and unceded territory of the xʷməθkʷəy̓əm (Musqueam) people. We respectfully acknowledge that the student research compiled in this background report was also carried out in xʷməθkʷəy̓əm (Musqueam) territory.

Contributions

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This document includes a literature review and summarizes research on bird collisions carried out on the UBC Vancouver campus. Research carried out by: Krista De Groot (and team at Environment and Climate Change Canada) and UBC SEEDS Sustainability Program student researchers*

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SEEDS Sustainability Program

Practitioner Summary

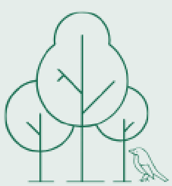
WHY BIRD-FRIENDLY BUILDINGS?

An estimated 10,000 birds die annually from building collisions on UBC Vancouver campus. Birds are important because they contribute to human mental health and well-being; they also help regulate insect and rodent populations, and contribute to pollination and seed dispersal.

100% OF NEW BUILDINGS & MAJOR RETROFITS MUST BE BIRD-FRIENDLY

All new buildings and major retrofits should comply with UBC's Bird-Friendly Design Guidelines for Buildings (BFDGB).

SPECIES VULNERABILITY



Forest-dwelling birds are more likely to collide with windows. UBC is located along a major migratory route and campus proximity to Pacific Spirit Park may increase collision risk for many birds.

Research found that Varied Thrush are particularly vulnerable to bird strikes on UBC campus (over 75 times more likely than other birds to collide with windows).

MINIMUM REQUIREMENTS

There is a tiered approach to BFDGB compliance. Tier 1 (Recommended) aligns with the CSA Bird-Friendly Standard. Tier 4 (minimum) includes the following:

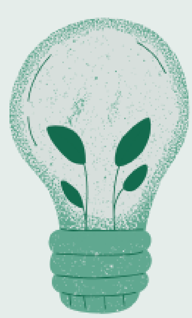
- Eliminate fly-through conditions (up to 16 m or 4 m above highest vegetation).
- Exterior light features should be Dark Sky compliant.
- Treat or cover glazing near existing bird habitat (eg. ravine, natural area) or known migratory paths

There are additional glazing treatments to comply with higher tiers.

Tier 1 Glazing Treatments
(**complies with CSA standards**)

90% of glazing treated up to 16m or 4m above tallest vegetation - whichever is greatest **and** Treat or cover all glazing adjacent to vegetation and/or water features

WHY BIRDS COLLIDE WITH WINDOWS



- It is hard for birds to see directly in front of them.
- Lighting can both attract and disorient birds.
- Windows can reflect vegetation and appear as open space.

Executive Summary

The University of British Columbia (UBC) Vancouver campus is located within the Pacific Flyway, a north-south migratory route utilized by several migrating species in North America. The surrounding Pacific Spirit Park helps to create habitat for birds year-round. At the same time, an estimated 10,000 birds die annually as a result of building collisions with academic and residential buildings on campus. Since forest-dwelling birds are found to be more susceptible to bird collisions, the proximity of Pacific Spirit to the densely-constructed campus may contribute to higher risks for birds.

Birds provide important ecosystem services including the regulation of insect and rodent populations and they contribute to pollination and seed dispersal. The presence of birds also contributes to overall mental and wellbeing of campus residents. At the same time, birds face threats from ongoing urbanization because of increased risk of building collisions and from loss of habitat.

There are many factors that influence collision risk for birds. Their visual system makes it difficult to perceive objects directly in front of them, and glass may sometimes appear to them as clear and open space. Windows can also reflect vegetation, making it more difficult for birds to perceive the window as a solid surface. At night, lights can attract and disorient birds, which can also contribute to bird strikes.

In response to the number of bird collisions, UBC Campus and Community Planning (C+CP) has released Bird-Friendly Design Guidelines for Buildings (BFDGB). The BFDGB is aligned with UBC's Green Building Action Plan, UBC's Climate Action Plan 2030, Campus Vision 2050, and the emerging Biodiversity Strategy. As part of an implementation strategy, C+CP have developed a tiered approach to bird-friendly buildings. Tier 1 (recommended) is aligned with the Canadian Standards Association bird-friendly standards. Achieving Tier 1 requires: eliminating all fly-through conditions; restricting grade level ventilation grates to a maximum porosity of 20mm x 20mm or 40mm by 10mm; ensuring all exterior lighting is Dark Sky compliant; and treating 90% of glazing up to 16m or 4m above the tallest vegetation (whichever is greatest), and treating all glazing adjacent to bird habitat. Tier 4 (meeting minimum requirements) is considered a precondition for achieving the minimum required Gold Standard according to REAP 3.3 for residential buildings on campus.

Glazing treatment refers to making windows more visible to birds. Potential window treatment strategies include architectural mesh and solar shading; UV-treated glass; and fritted glass, among others. Designs on fritted glass must follow specific spacing requirements to ensure visibility: marks must be at least 0.32mm in size and should be spaced no more than 5cm x 5cm apart.

Making UBC a bird-friendly campus goes beyond addressing window strikes. Bird-friendly landscapes support and maintain bird habitat. In urban spaces, maintaining large parks and varied vegetation can support avian biodiversity. In particular, meadows with native species that attract pollinators can provide both habitat and food sources to a variety of birds. Maintaining a mature urban tree canopy is also important to support bird populations on campus.

To identify existing biodiversity and measure impacts to biodiversity on campus, SEEDS (Social Ecological Economic Development Studies) Sustainability Program has supported and facilitated several applied student research projects. Since 2014, students have monitored bird strikes, assessed species richness, evaluated the effectiveness of mitigation strategies, and made recommendations for bird-friendly policies.

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Why Are Birds Important?

The University of British Columbia (UBC) Vancouver campus is located within the Pacific Flyway, a north-south migratory route utilized by several migrating species in North America. The surrounding Pacific Spirit Park helps to create habitat for birds year-round. At the same time, an estimated 10,000 birds die annually as a result of building collisions with academic and residential buildings on campus (De Groot et al., 2021). Since forest-dwelling birds are found to be more susceptible to bird collisions, the proximity of Pacific Spirit to the densely-constructed campus may contribute to higher risks for birds.

Some of the many migrating birds that have their habitat needs met on campus include the Olive-sided flycatcher (*Contopus cooperinus*), Purple Martin (*Progne subis*), Cliff Swallow (*Petrochelidon pyrrhonota*), Band-tailed Pigeon (some live year-round; *Patagioenas fasciata*), and Rufous Hummingbird (*Selasphorus rufus*) (Edwards et al., 2021). Many other birds spend all year on UBC campus, including the American Crow (*Corvus brachyrhynchos*), Glaucous-winged Gull (*Laurus glaucescens*), Black-capped Chickadee (*Poecile atricapillus),* Chestnut-backed Chickadee (*Poecile rufescens),* American Robin (*Turdus migratorius),* Varied Thrush (*Ixoreus naevius),* Golden-crowned Kinglet (*Regulus satrapa),* Northern Flicker (*Colaptes auratus),* Anna's Hummingbird (*Calypte anna)*, and many others (De Groot et al., 2021).

Figure 1 Rufous Hummingbird (Selasphorus rufus). Photo by USFWS Mountain-Prairie. CC BY 2.0 DEED

Figure 2 Black-capped Chickadee (Poecile atricapillus). Photo by DaPuglet. CC BY-SA 2.0 DEED

Birds are crucial to the health and functioning of many ecosystems. Their ecological roles include insect and rodent regulation, carrion scavenging, pollination, and seed dispersal (Sekercioglu, 2006; Viswanathan et al., 2015; Whelan et al., 2015; Freeman et al., 2021). Seed dispersal positively correlates with plant diversity and forest regeneration; this in turn results in a greater abundance of ecosystem services (Carlo & Morales, 2016; Freeman et al., 2021). Some birds, such as woodpeckers (*Picidae*), provide habitat and nesting sites for other cavity-dwelling species. The health of these ecosystem engineers often reflects the health of the entire ecosystem (Catalina-Allueva & Martín, 2021).

Several studies have found that specific bird species can be indicators of wider avian biodiversity, ecological health and habitat degradation (Smits & Fernie, 2013; Hatfield et al., 2018; Virkkala et al., 2021; Terrigeol et al., 2022). However, these studies are specific to their contexts and are not able to identify indicator species for the Lower Mainland.

Birds are also important for human health and wellbeing. People value birds for aesthetics (e.g., aesthetic appreciation of birdsong) and for their contributions to ecological health. Auditory and visual presence of birds in neighbourhoods can contribute to increased wellbeing and improved mental health (Cox et al., 2017; Chen et al., 2022). Higher human density correlates with higher density of bird species associated with disturbances, which refers to urban-adapted species that may spread garbage and cause other inconveniences. While there are sometimes inconveniences associated with birds (e.g., bird droppings), studies show that most residents positively value birds in North America (Belaire et al., 2015). In one study in the UK, authors found a greater abundance of songbirds at medium human density; the authors propose that this is because songbirds are able to visit birdfeeders and find food in people's yards (Cox et al., 2018). This suggests that there are opportunities to support the continued presence of birds and their associated positive mental health benefits.

Birds in Urban Landscapes

Increasing development and urbanization affects bird habitat. Species richness at the landscape level declines with greater built environments (Suárez-Castro et al., 2022). Different guilds of birds (grouped according to dietary traits) are affected differently. In general, maintaining larger urban parks that contain varied vegetation will continue to support functional and taxonomic diversity in urban landscapes (Morelli et al., 2017; Schütz & Schulze, 2015; Callaghan et al., 2018). Varied vegetation will support the different habitat and dietary needs of a variety of bird species. Chong and colleagues found that cultivated cover (tree cover and ground cover) leads to more homogeneous bird and butterfly populations; they stress the importance of natural vegetation to support diversity (Chong, 2014). Maintaining large trees and having scattered urban trees can also continue to support avian biodiversity (as well as supporting insects and bats) (Le Roux et al., 2018). Urban parks and urban areas with habitat features play an important role in maintaining functional avian diversity, and can even be comparable to that of protected natural areas (Muvengwi et al., 2022).[1]

Figure 3 Urban varied landscape. Vector by vectorportal.com

Urbanization and the increased level of anthropogenic noise also affects bird populations. Larger areas of impervious surfaces can reflect and distort bird songs, while high levels of low-frequency traffic and building noise can mask birdsong (Dowling et al., 2011). To adapt to the intensity of low-frequency traffic noise, some bird species adopt higher-frequencies in their birdsong (Dowling et al., 2011; Halfwerk et al., 2011; Neweth et al., 2013). Birds changing the frequency of their song is also associated with being able to sing louder, facilitating communication in loud environments (Neweth et al., 2013). Changing song frequency has some negative implications for reproduction mating success in some birds (Halfwerk et al., 2011; Derryberry & Luther, 2021). There is some evidence that birds will avoid particularly noisy spaces, although this may be restricted to the specific time of noise (Carral-Murrieta et al., 2020). Beyond an individual level, Marín-Gómez and colleagues found that bird choruses (where three or more birds of the same or different species sing at a similar time, often at dawn) were also diminished in urban spaces (Marín-Gómez et al., 2020). Despite noise impacts on avian (and other) populations, acoustic features of a landscape are not often considered in land use planning guidelines.

[1] Please note that the study found species richness was still greater within the protected area.

Bird Collisions

Building collisions are a major threat to bird populations in North America. Bird strikes are often fatal, mostly as a result of head and neck trauma (Veltri & Klem, 2005). Collisions are one of the leading causes of anthropogenic bird mortality, with up to an estimated 42 million avian deaths in Canada and 1 billion in the United States occurring every year (Machtans et al., 2013; Loss et al., 2014). The true number of collisions is likely much higher as scavenger removal bias makes it difficult to account for every collision before all evidence is removed (Hager et al., 2012; Riding & Loss, 2018). The collision risk for birds in Vancouver is potentially higher because of increased abundance of birds along the migratory Pacific Flyway (Cusa et al., 2015; Toews et al., 2017; Loss et al., 2019).

Causes of Collisions

Bird collisions are a result of bird biology (specifically their visual system – but also influenced by migratory patterns and other life history strategies) and by building and landscape features (number and style of windows, distance from vegetation).

Vision

The avian visual system differs from humans in important ways. Birds' visual fields are laterally projected which allows them to easily forage and detect predators but simultaneously reduces their ability to perceive what lies directly ahead (Martin, 2011). A bird's frontal vision often has poor acuity and is used for the detection of movement and perception of speed rather than for the recognition of fixed buildings or obstructions (Martin, 2011). Ultimately, their lateral visual system makes it easy for them to collide with unexpected objects, such as buildings, located in the frontal flight path.

In terms of perception, clear reflective surfaces such as glass windows often appear as either invisible or as black passageways for the birds to fly through. This is referred to as the passage or black hole effect (City of Toronto, 2016). When sunlight, sky, and nearby vegetation are reflected onto the glass surface, it can appear as though the window is a continuation of the environment rather than an obstacle (Klem et al., 2009).

Birds perceive light differently than humans. For example, birds are capable of seeing ultraviolet (UV) light (Martin, 2011), which is important when considering potential mitigation strategies to reduce bird strikes. At night, birds rely on several environmental cues to migrate, such as the Earth's magnetic field, starlight, and landmarks (Ogden, 1996; McLaren et al., 2018; Lao et al., 2020). Artificial light at night can disrupt a bird's spatial-visual senses, disorienting them. This interferes with their ability to perceive static obstacles such as buildings. Birds can also be attracted to the light, increasing the risk of colliding with well-lit buildings after dark (Muheim et al., 2016; Lao et al., 2020; Loss et al., 2019). Red and white light was found to be more disorienting than green or blue lights (Poot et al., 2008). There is some evidence that the disorienting effects of lights do not affect long-term behavioural patterns, suggesting that lights can be removed at times of high migration (Van Doren et al., 2017).

Seasonality

Temporal factors such as season and time of day also influence collision frequency. The risk of collision appears to be highest during the fall followed by spring and winter, respectively (Drewitt & Langston, 2008; Hager et al., 2013;

Loss et al., 2014; Schneider et al., 2018). However, other studies have found collision rates to be similar year-round, except for winter having significantly less mortality (Hager et al., 2013). The majority of bird-strike research has been carried out during the fall and spring migratory periods in eastern and central North America with a lack of investigation during the remainder of the year and in other regions of the continent (Hager et al., 2013; Loss et al., 2014). To address this gap, research conducted on UBC Vancouver campus found that collision frequency increased during the fall migratory period (Zulian et al., 2023).

Time of day is also an influential factor. The majority of collisions occur between dawn and 4:00 pm, with peak mortality occurring in the early morning hours when activity levels increase in terms of feeding and migration (McNamara et al., 1987; Hager & Craig, 2014). Nighttime collisions are also abundant in areas with a large presence of artificial lighting (Lao et al., 2020). Importantly, bird collision frequency may differ on the west coast of North America due to the ecology and climate makeup in the coastal regions (De Groot et al., 2021).

Species Vulnerability

Specific species may be more vulnerable to bird strikes than others. The least vulnerable birds appear to be urban-adapted species such as American Crows (*Corvus brachyrhynchos*), gulls (*Laridae*), ducks (*Anitidae*) and European Starlings (*Sturnus vulgaris*) due to their familiarity with the anthropogenic environment (Loss et al., 2014; Wittig et al., 2017; De Groot et al., 2021). Traits such as migratory behavior, woodland habitat, and insectivory positively correlate with collision frequency (Arnold & Zink, 2011; Wittig et al., 2017; Elmore et al., 2020). Forest-dwelling species that occupy open woodland habitats and feed on the ground are often at the highest risk of collision (Cusa et al., 2015). However, there is an apparent lack of research specific to North American species susceptibility to bird strikes (De Groot et al., 2021; Elmore et al., 2020). There are important differences in species-specific collision rates that can provide valuable information about the impact of collisions on the population level (Loss et al., 2012; Cusa et al., 2015; Elmore et al., 2020; De Groot et al., 2021).

Figure 4 Varied Thrush (Ixoreus naevius), found to be very vulnerable to window collisions. Photo by Eleanor Briccetti.

The most vulnerable species on UBC-Vancouver campus, according to a study by De Groot and colleagues, are forest-dwellers (De Groot et al., 2021). Researchers conducted a point count of birds present around the sampled buildings to assess species richness and abundance; this was used to determine whether individual species were more susceptible to window collisions. They found that the Varied Thrush (*Ixoreus naevius*) was disproportionately vulnerable to collisions (76.9 times more likely than other species to be affected by bird collisions). Grouped by family and averaging the winter counts, "38% of 98 carcasses… were thrushes (*Turdidae*), 32% were sparrows (*Passerellidae*), and 15% were kinglets (*Regulidae*)" (De Groot et al., 2021, p. 8). Kinglets were most likely to collide in the fall migratory season. During migratory periods the species found most frequently were Golden-crowned Kinglet (*Regulus satrapa*), Fox Sparrow (*Passerella iliaca*), and American Robin.

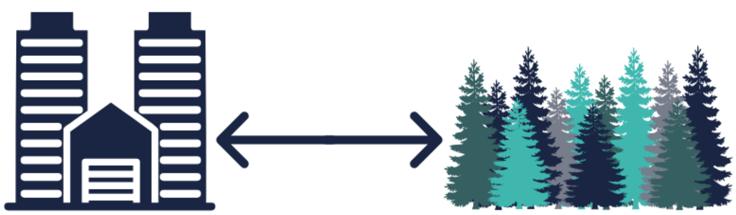
Building Features

According to Machtans and colleagues, building type influences collisions (2013). Detached houses are estimated to be responsible for around 90% of all building collisions; at the same time, they are also one of the more frequent building types. Larger office buildings and skyscrapers have a much higher per-building collision rate due to their greater height and glass cover (Elmore et al., 2020).

The presence and surface area of glass is a significant feature in determining the collision risk of a building. Several studies have demonstrated a positive correlation between the glass cover and collision severity (Klem et al., 2009; Borden et al., 2010; Hager et al., 2013; Cusa et al., 2015; Parkins et al., 2015; Kahle et al., 2016; Ocampo-Peñuela et al., 2016; Riding et al., 2020; Elmore et al., 2020).

Another important structural element in determining collision severity is called a fly-through condition. Fly-through conditions are illusions that occur when glass reflections on parallel panes or glass corners create an apparent void that a bird perceives it can fly through to get to the habitat on the other side (City of Toronto, 2016). Buildings that incorporate fly-through conditions in their design will have a higher number of collision-related fatalities.

Other risk factors include lighting, bird feeders, and specific architectural effects. Bird feeders should be within 1 meter of a building to reduce the momentum of birds taking off from the feeder by limiting the amount of speed they can achieve and ultimately reducing the risk of injury upon collision (Klem et al., 2014; Kummer & Bayne, 2015).



The amount and proximity of vegetation to buildings can also influence collision risk (Cusa et al., 2015). Forests, trees, and open woodlands are vital bird habitats, and the closer they are to buildings the more birds will be drawn to the area in search of shelter and resources. Further, the type and height of vegetation may play a role. For example, taller vegetation can increase collision frequency by 3.6 times compared to dwellings with shorter or no surrounding greenery (Kummer et al., 2016). One study found that tall reflected vegetation primarily increased collisions during the fall migratory period (Zulian et al., 2023). This may be partially due to the vegetation obstructing the bird’s view of oncoming buildings or that they perceive reflections of greenery as an extension of their environment (Klem et al., 2009; Martin, 2011). Similarly, indoor vegetation visible from the exterior of the window also heightens collision risk (Gelb & Delacretaz, 2009).

Bird-Friendly Best Practices

In response to bird strikes, the Provincial Government of Ontario sponsored the National Canadian Standards Association (CSA) to develop bird-friendly building design standards in 2019. FLAP Canada (Fatal Light Awareness Program) – a Canadian charity focused on protecting birds from building collisions – supported the development of the CSA Bird-Friendly standard (CSA A460-2019). At a minimum, buildings should avoid the construction of and/or treat all high-risk areas including fly-through conditions, parallel glass, glass corners, and reflective surfaces next to important bird habitats (Canadian Standards Association, 2019). There are additional measures that should be taken to ensure bird safety, including potential strategies for adaptations to existing buildings.

Building on these strategies, several municipalities across North America have adopted bird-friendly building policies. Some of these resources are included as Appendix A.

SEEDS Sustainability Program staff compiled a spreadsheet to compare various mitigation strategies and products, drawing from effective strategies detailed by the American Bird Conservancy.[2] This spreadsheet is available on the Campus and Community Planning Bird-Friendly webpage; it is meant to provide an approximate comparison of costs and effectiveness of different products and may not reflect the most up-to-date pricing.

Collision Risk: Window Perception

Exterior fixtures such as shutters, grilles, awnings, mesh, netting, and wire can be incorporated into new building designs or added to existing structures and are very effective at preventing collisions when they are properly installed following the correct spacing requirements. Similarly, the shading that building overhangs provide can also count as treated area up to a 1:1 ratio, but this is less effective than other mitigation measures (Canadian Standards Association, 2019).

Reducing the glass surface area or incorporating bird-friendly glass in a building is an effective way to prevent collisions during the design stages (Piselli, 2020). Decals, markers, paint, and UV film can be highly effective if appropriately spaced (Klem, 2014; Klem, 2015; Brown et al., 2019; Sheppard, 2019; Brown et al., 2020). All individual decal/marker treatments must be spaced no further than 5 cm apart to present a visual obstacle to birds (Klem, 2014; Klem, 2015; Sheppard, 2019). For linear elements, horizontal lines should be 5 cm apart and vertical should be no more than 10 cm apart (and ideally only 5 cm apart to align with FLAP Canada's guidelines [Klem, 2014; Klem, 2015; Sheppard, 2019]).

Collision Risk: Artificial Light

One relatively simple way to reduce collisions is to turn off artificial lights, especially at night (Lao et al., 2020). Further, streetlights should be shielded and directed downward to prevent light trespass and reduce the likelihood of disorientation (Loss et al., 2019; Lao et al., 2020). Blue and green lights should be used over red and white ones as the latter attract birds (Poot et al., 2008). Task lighting should also be used to reduce unnecessary light trespass.

[2] You can access a database of products and their effectiveness on the American Bird Conservancy website: https://abcbirds.org/glass-collisions/products-database/

Collision Risk: Reflected Vegetation

Further prevention measures include removing attractants such as bird baths and feeders or ensuring that they are within 1 m of the building to reduce the momentum birds can achieve and thus reduce the risk of injury (Klem, 2015). Untreated glass facades should not be built within 2-20 m of vegetation (Cusa et al., 2015). Building users should not place plants directly next to windows inside buildings.

Ineffective Strategies

Many mitigation strategies are ineffective at reducing bird strikes (Brisque et al., 2017; City of Toronto Bird Friendly Guidelines; UBC Bird Friendly Design Guidelines for Buildings). Some popular methods that do not mitigate collisions are single bird of prey decals, interior blinds, and angled or tinted glass.

Bird-Friendly Landscapes

Reducing bird strikes is only one aspect of mitigating impacts to bird populations in a built environment. Urban landscapes alter bird habitat and can affect food availability. In order to benefit from the ecosystem services that birds provide (see above), municipalities are also adopting bird-friendly landscape policies. For example, the City of Vancouver's Bird-Friendly Design Guidelines identify habitat loss due to urbanization as a key problem; the guidelines aim to "protect, enhance and create bird habitat" (City of Vancouver, 2017). Recommendations for bird-friendly habitats include: planting native vegetation, increasing vertical vegetation structure, incorporating a mix of habitat types and reducing light pollution (City of Vancouver, 2015; Campbell, 2013).

Birds on UBC-Vancouver Campus

At the UBC Vancouver campus, an estimated 10,000 birds die annually as a result of building collisions (De Groot et al., 2021). Due to the alarming quantity of collisions, UBC has initiated several student-led research projects to better understand the issue and how to prevent it. The majority of this research has been done in collaboration with SEEDS (Social Ecological Economic Development Studies) Sustainability Program. SEEDS creates applied student research and maintains interdisciplinary partnerships between students, faculty, staff, and community partners to advance sustainability ideas, policies, and practices.

To date, there have been 13 published SEEDS projects focused on the problem of bird collisions on UBC Vancouver campus. There have been an additional 5 SEEDS projects which assess human impacts on bird-friendly landscapes (specifically evaluating species richness, habitat connectivity, human impacts on bird song, and impacts to birds from trash as an unintentional food source). These student-led projects supplement other research conducted at UBC (See Appendix B for a detailed list of SEEDS bird-related projects).

Bird Collisions at UBC

To understand the impact of UBC's built environment on avian diversity, students and researchers have monitored bird collisions at sample locations on UBC Vancouver campus in varying intervals since 2014 (see Figure 1 for an overview of which buildings have been monitored). The primary study was led by Krista De Groot (Environment and Climate Change Canada); this larger project was supported by several student-led SEEDS projects.

From 2014 to 2017, several student groups monitored bird collisions on campus institutional buildings. Fourth-year students monitored 10 buildings across campus, for a total of 27 days of observation between November 2014 and February 2015, finding evidence of 60 total bird strikes with windows (Chien et al., 2015). Simultaneously, two graduate students monitored a random selection of 8 buildings across campus in winter 2015 (Porter & Huang, 2015). They documented 45 bird strikes with windows. From January to March 2017, a group of fourth-year students monitored the same 8 buildings for bird collisions, finding evidence of 46 bird strikes (Cheung & Gentile, 2017). Evidence collected included: "window smears, carcasses, partial carcass, and piles of 10 or more feathers within 2 m from the façade" (Cheung & Gentile, 2017, p. 5, citing Hager & Consentino, 2014).

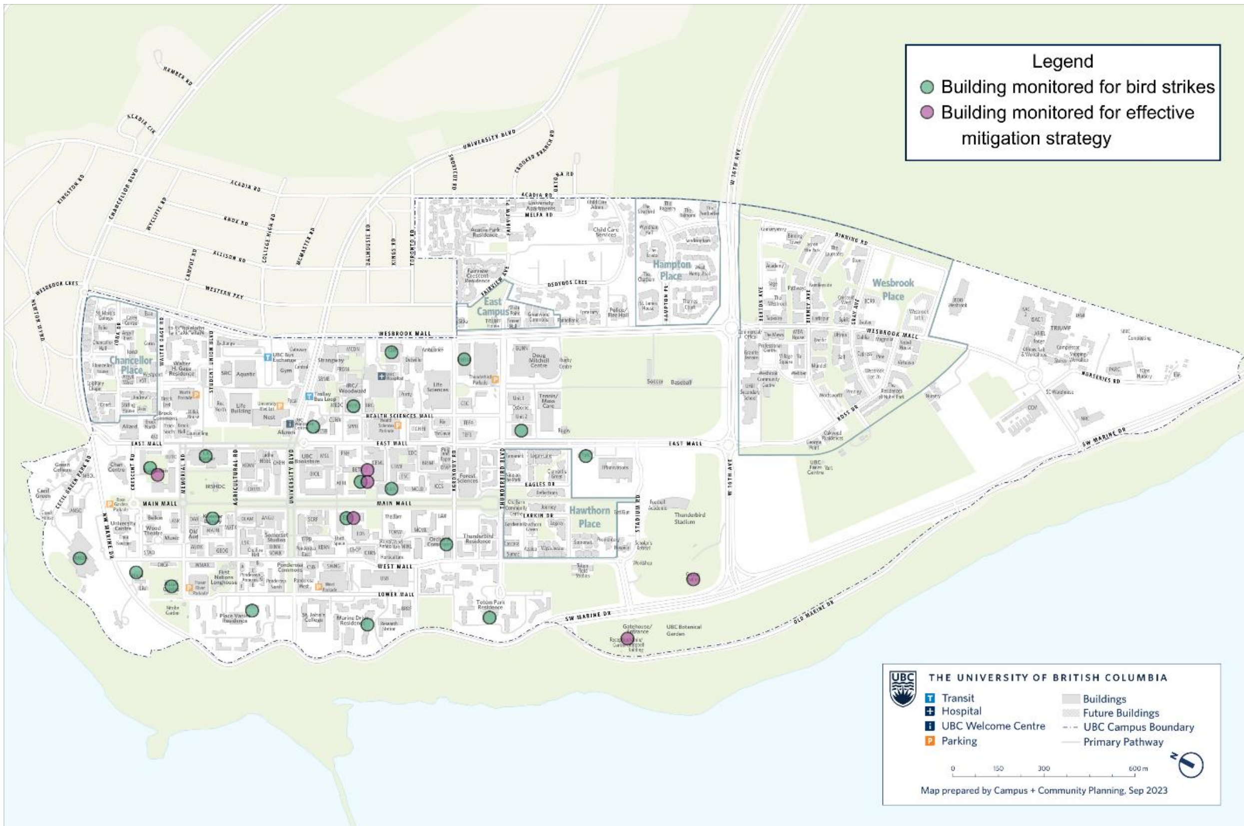


Figure 4. Map of UBC Vancouver campus, identifying which buildings have been monitored for bird strikes and for effective mitigation strategies.

In 2021, De Groot and colleagues (including the two graduate student SEEDS authors Porter and Huang) published their analysis of bird impacts with 8 buildings on UBC Vancouver campus.[3] De Groot and colleagues further outline their analysis methods, including how they account for carcass persistence (whether scavengers remove evidence of bird collisions prior to researchers documenting the impact), and for searcher efficiency (2021). While the number of documented carcasses totalled 152 over 225 sampling days, authors estimate that this represents 360 collision fatalities for the 8 observed buildings (the 95% confidence interval is between 281 and 486 fatal impacts). There is a peak in the number of collisions in the fall season, although the number of documented impacts remained at an intermediate level in both winter and spring.

UBC SEEDS research has also explored the impact of vegetation reflections on bird collisions. For example, Chien and colleagues (2015) and Cheung and Gentile (2017) measured the distance of vegetation from windows. Cheung and Gentile further tried to estimate the amount of percentage of reflected vegetation in windows; since the amount of reflected vegetation may change throughout the day and season (depending on weather and position of the sun), the results were not conclusive. Based on other research, high glazing (a large proportion of windowed surfaces) combined with increasing vegetation up to 20 m from the building leads to increased bird strikes.

In addition to the survey-monitoring methods outlined above, SEEDS projects have explored alternative methods to be able to document and assess bird collisions. One such project attempted to develop a reporting app for

[3] You can find the open access peer-reviewed article assessing bird collisions at UBC here (De Groot et al., 2021).

mobile devices, as a strategy to employ community science to monitor bird collisions (Crombie, 2016); developing an app was ultimately not feasible, and there has not been further evaluation into whether its adoption would be successful if launched in the future. In 2019, a group of engineering students designed and built a Bird Impact Monitor that accurately detects 95% of bird collisions (Chen et al., 2019). This device addresses the limitations of bird collision surveys (mainly, carcass persistence and searcher efficiency). In 2023, another group of engineering students undertook a SEEDS project and built upon on the initial model. They designed and built a functioning prototype that can sense bird collisions and record additional details including indoor and outdoor temperature (Li et al., 2023). By monitoring temperatures in addition to bird strikes, the device can record data for other sustainability measures (specifically thermal insulation). The updated bird strike monitoring device was calibrated to detect the impact for the 5 bird species identified by De Groot and colleagues to be the most common in bird collisions on UBC Vancouver campus. While the prototype sensor remains installed on a window in the CIRS building, there needs to be ongoing monitoring and analysis of the collected data. Additional devices are needed to effectively monitor bird strikes across campus.

Effectiveness of Mitigation Strategies on UBC

Research conducted at UBC Vancouver informs the development of bird-friendly building guidelines. Following the preliminary baseline studies to estimate rates of bird collisions with UBC buildings, SEEDS projects evaluated the effectiveness of mitigation strategies at several locations across UBC-Vancouver campus. Prior to the extensive update of the Bird Friendly Building Design Guidelines released in 2019, a SEEDS project reviewed existing research and provided recommendations for effective strategies to reduce bird collisions (Li, 2018). Many of these recommendations were adopted in the Guidelines (including introductions to causes and consequences of collisions; differentiating between strategies for new and current buildings; vegetation regulations; and examples of existing bird-friendly buildings). SEEDS projects also support the implementation of the guidelines by summarizing and outlining social, technical and regulatory considerations of installing bird-friendly art, for example (McGregor et al., 2020).

One potential window treatment for existing buildings is to apply film with markings, with a maximum distance of 5cm between each marking (as recommended in the guidelines). Park and Li monitored three buildings over winter 2016-2017; two of these buildings had also been monitored by Chien and colleagues in 2014-2015. When comparing the number of bird strikes per day before and after applying Feather Friendly® window dots, Park and Li found a reduction in the number of bird strikes; however, the results were not statistically significant nor were they conclusive, as windows without treatment also saw reduced bird strikes. A study conducted by De Groot and colleagues in the Lower Mainland using two years of monitoring data pre- and post-treatment conclusively found that Feather Friendly® window treatments reduced collisions by 95% (De Groot et al., 2022). Using survey data, Park and Li found that UBC building residents and users consider reducing bird strikes an important issue. Importantly, building users do not feel the Feather Friendly window treatment detracts from building aesthetics (Park & Li, 2017).

De Groot and colleagues also assessed the effectiveness of UV-treated glass. Although this aspect of the study has more limitations, they were able to show that UV-treated glass also reduces bird strikes but is less effective than visible markers (De Groot et al., 2022).

In winter 2022 (January to March 2022), three groups of students monitored three different areas across campus for bird strikes. All of the buildings monitored had previous bird strike data prior to being treated with a recommended bird-friendly method. At the UBC Botanical Gardens, two SEEDS studies analyzed the effectiveness of bird-friendly window art and dirty windows on reducing bird collisions. Using data from 2021, they found that both dirty windows and bird-friendly art dramatically reduced collisions (up to 100%) (Crews, 2022; Leung, 2022). Another SEEDS group monitored all five Buchanan buildings (A, B, C, D, and E). Over 32 survey dates, they found evidence of 33 bird collisions; they compared this with data collected in 2021 and found similar results. After the 2021 study, Feather Friendly® decals were placed on the window facade with the highest number of bird strikes; in 2022, the authors found evidence of only one collision (which occurred between that facade and the neighbouring window) (Hardy, 2022; Harter, 2022). This shows a significant reduction of bird strikes after adding decals to the window at Buchanan. The third group monitored Ponderosa and the Indian Residential School History and Dialogue Centre; however, they had limitations and inconsistencies in data collection and the results are not available.

Bird-Friendly Landscapes

Building a bird-friendly campus goes beyond buildings and bird strikes; research at UBC Vancouver has also worked to baseline bird populations and habitat to be able to measure impacts to bird biodiversity. The first SEEDS student baseline project was done in 2017 (Harder et al., 2017). They surveyed the four most common habitat types on campus (coniferous forest, urban old field, urban park, and mixed forest) and identified 29 bird species in total. They were not surveying for bird abundance, but rather for species richness. They found the highest number of species around the Museum of Anthropology (19 ssp.), and the lowest number of species by the UBC Hospital (9 spp.). All species identified are considered stable (of least concern). Since more species richness was found in locations with varied vegetation, Harder and colleagues recommend avoiding habitat simplification.

A graduate student SEEDS report analyzed and modeled habitat connectivity for brown creepers (*Certhia americana*), a bird species which prefers mature forest habitat. Nduna found that brown creepers had a well-connected habitat across campus (Nduna, 2023). Key habitat areas were found to be in the south of campus, where there are currently less buildings. This suggests that connectivity may be affected in the future, depending on development plans.

In 2021, a graduate student SEEDS project sought to provide “species-level habitat and planting guidelines for high priority species at UBC Vancouver” (Edwards et al., 2021, p. 3). They established a priority list of 10 species present on campus, based on factors including: global and provincial conservation status; trophic level (diet and ecosystem function); social perceptions and stated priorities; and within the realm of campus control and/or influence. A full list of the species, along with their habitat and planting recommendations, is included as Appendix C. This should be incorporated into future landscape and planting guidelines developed by UBC.

Another study aimed to baseline bird biodiversity on campus by analyzing the soundscape at UBC Botanical Gardens (Newman et al., 2018). Bird song is a communication device among birds, and can also be used to determine population health. Although the study does not include the full list of species identified, nor were they able to analyze the density of bird song at the recording locations, the authors suggest that smaller species are more affected by anthropogenic noise because their birdsong is not identifiable when there is competing noise sources (unlike larger birds).

An additional SEEDS project by a group of graduate students observed the frequency of birds (primarily crows and gulls) feeding on trash across campus from October to December 2022 (Eronen et al., 2022). They also observed birds contributing to food waste being spread on campus because of how birds interacted with waste. Their results suggest that further research should be done to understand the territorial behaviours of crows and gulls and whether their increased feeding on trash interferes with other species' abilities to access nesting habitats.

This wide variety of SEEDS-supported research continues to inform the development of UBC policies and guidelines.

UBC Policy

In response to the number of bird strike fatalities, UBC developed the Bird-Friendly Design Guidelines for Buildings (BFDGB) in 2016, with a significant update released in 2019. The BFDGB summarizes glazing and design considerations as well as effective and ineffective mitigation strategies for reducing collision frequency. The BFDGB intersects with other UBC policies, plans, strategies and building guidelines, as outlined in Table 2. The BFDGB is aligned with the CSA Bird-Friendly Standard mentioned above.

The strategies for treating glazing in the BFDGB include effective methods for new buildings, retrofits strategies, and occupant strategies (Figure 2).

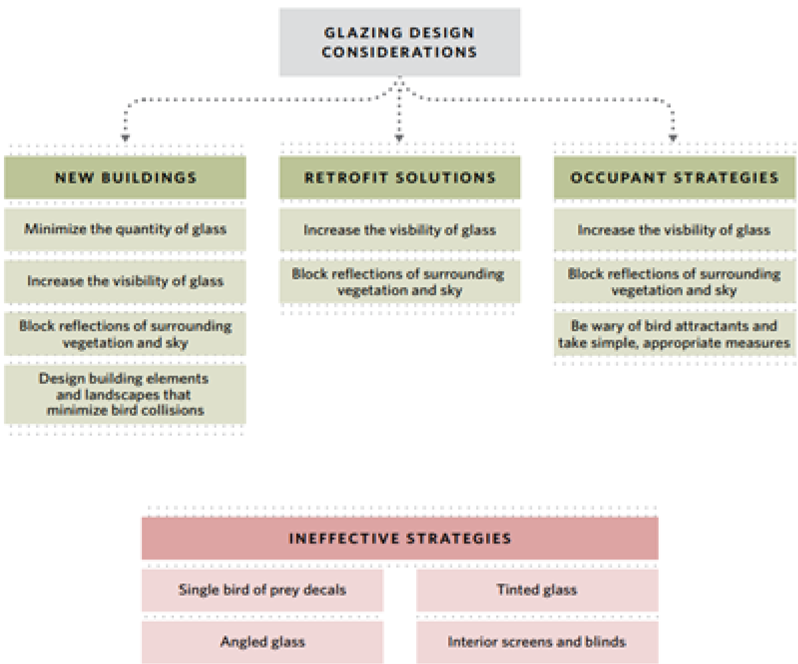


Figure 5. A visual summary of glazing design considerations from UBC's Bird-Friendly Design Guidelines for Buildings.

The BFDGF also includes recommendations to address other threats to birds in built environments. Specifically, it includes recommendations for lighting and to prevent bird traps. Birds may become unintentionally trapped when exploring buildings. Utilizing specialized screens to block access to mechanical ducts, pipes, and intake/exhaust vents can prevent this. In terms of lighting, the BFDGB recommends using low-wattage bulbs to reduce glare, turning off lights at night or if not possible, drawing blinds, and using task lighting after hours. Street lighting should be shielded and angled downward. Blue and green hues should be used over white or red as birds are attracted to the latter.

To facilitate and encourage compliance with the BFDGB, Campus and Community Planning have developed a new tiered approach to bird friendly policy. Common to all four tiers is a requirement to eliminate fly-through conditions (up to 16 m or 4 m above tallest vegetation, and treating glass corners 5 m each direction) and size specifications for grade level ventilation grates (porosity no greater than 20mm x 20mm or 40mm x 10mm). There are additional bird-friendly lighting specifications (including providing interior blinds and educating occupants). Higher tiers (Tier 1 and Tier 2) prioritize occupancy sensors and task lighting. All tiers must have exterior light features that are Dark Sky compliant. Differences between the tiers are primarily in the percentage of treated or covered glazing (see Table 1). This tiered approach is reflected in the most current Residential Environmental Assessment Program (REAP) implementation guide (see Table 2 below).

The BFBDG align with other existing UBC policies as outlined in Table 2.

Table 1. Comparing Bird-Friendly Tiers

Bird-Friendly Tier	Minimum Glazing Percentage	Additional glazing requirements
Tier 1 (Recommended, in line with CSA Standards)	**90%** of glazing treated up to 16m or 4m above tallest vegetation - whichever is greatest	Treat or cover all glazing adjacent to vegetation and/or water features
Tier 2	**85%** of glazing treated up to 16m or 4m above tallest vegetation - whichever is greatest	Treat or cover all glazing adjacent to vegetation and/or water features
Tier 3	**55%** of glazing treated up to 16m or 4m above tallest vegetation - whichever is greatest	Treat or cover all glazing adjacent to large areas of vegetation and/or water features
Tier 4	N/A	Treat or cover glazing near existing bird habitat (e.g., ravine, natural area) or known migratory paths

Table 2. UBC Bird-Friendly Policy Alignment

UBC Policy, Plans and Strategies	Overview of Policy / Plan / Strategy	Bird-Friendly Specific Details
Green Building Action Plan (2018)	Outlines pathways to meet UBC's sustainability goals.	**Target:** 100% compliance to the UBC BFDGB for new institutional buildings by 2020 and for new residential buildings by 2025; **Indicator:** Increase opportunities to provide habitat for birds, pollinators and other species **Priority actions:** Baseline biodiversity
Climate Action Plan 2030 (2021)	Plan to reduce greenhouse gas emissions and address climate emergency	**Actions:** Understanding campus biodiversity (and climate adaptation benefits); Incorporating and enhancing campus biodiversity to reach GHG targets

Campus Vision 2050	Emerging plan to guide the future development of UBC Vancouver campus	**Guiding Principle:** Enhance climate ecology Also encourages resilient and naturalized landscapes
Integrated Sustainability Process	Supports an integrated design process for major projects, and includes workshops and meetings with key stakeholders	Step 2 (Schematic Design) – Workshop 2 includes the identification of bird-friendly design strategies as a deliverable
Residential Environmental Assessment Program 3.3 (2023)	UBC's Green building rating system for multi-family residential buildings; it is used to mandate sustainable building practices. Construction must meet all minimum preconditions as well as additional points to achieve the minimum required Gold standard.	**BIO P1** – Ecological Planting (Precondition): encourages habitat and food source creation **BIO P2** – Light pollution reduction (Precondition) **BIO P3** - Bird-Friendly Design-Basic (Precondition): eliminate fly-through conditions and cover windows facing habitat **BIO Credit 3.1** – Bird-Friendly Design-Enhanced (3 points): cover 55% (2 pts) or 85% (3 pts) of all windows up to 16m or 4m above highest vegetation
UBC LEED 4.0 Implementation Guide / UBC LEED 4.1 Implementation Guide	Facilitates LEED certification process, identifying mandatory credits and recommending additional credits that align with UBC priorities	Recommends the Bird Collision Deterrence credit (1 point) as one of the required Innovation credits (total of 5 credits for LEED 4.0 and 6 credits for LEED 4.1) for certification

Bird-Friendly Approaches on Campus

Bird-Friendly Buildings on UBC Vancouver Campus

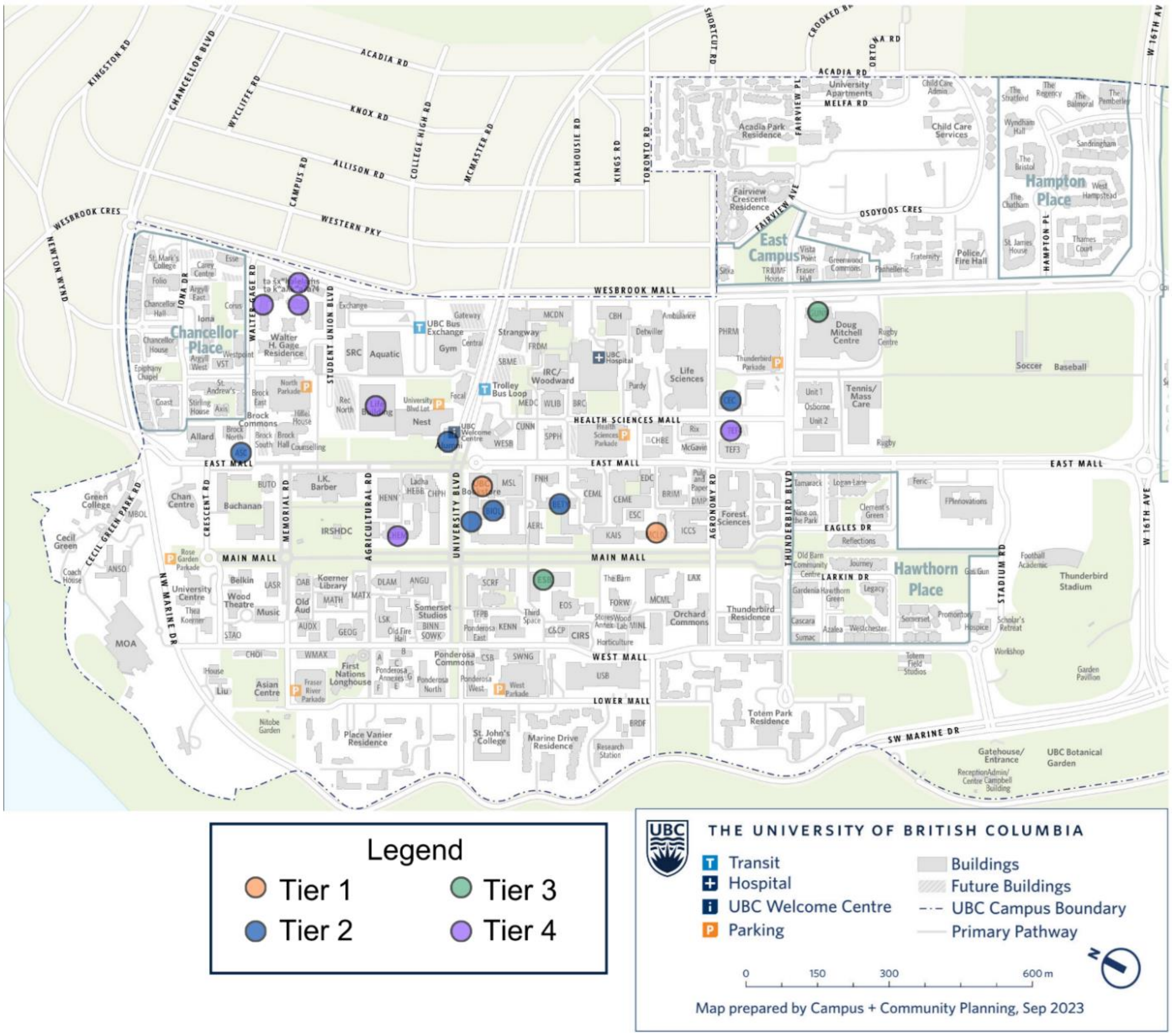


Figure 6. Map of Bird-Friendly buildings on UBC Vancouver campus.

While many UBC-Vancouver campus buildings still need to become more bird-friendly, significant progress has been made towards minimizing bird collisions. For example, as of 2023 all new residential buildings will need to, at minimum, meet Tier 4 Bird-Friendly requirements (outlined above). Institutional buildings and residential buildings are also taking steps to treating glass facades to reduce the risk of bird collisions. Some of the more popular treatment strategies include using architectural mesh and solar shading; these strategies have the additional benefit of reducing solar heating (adhering to Climate Ready Requirements). Four of the thirteen buildings that currently meet minimum Bird-Friendly requirements are retrofits.

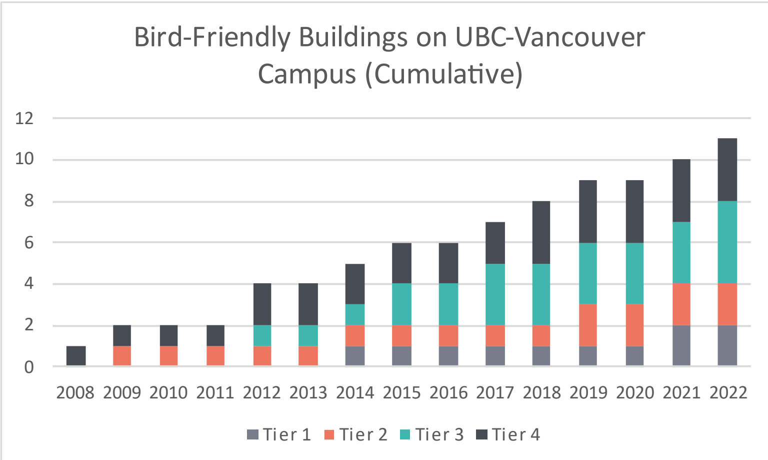


Figure 7. Table showing the cumulative number of Tier 1, Tier 2, Tier 3 and Tier 4 Bird-Friendly Buildings on UBC Vancouver campus over time.

The buildings represented in Figure 6 do not include those that have incorporated semi-permanent or temporary strategies (decals, etc.) to make at least some of their glass facades bird-friendly. For example, the Buchanan complex is slowly becoming bird-friendly by applying Feather Friendly® window treatments. Another strategy to become bird-friendly is through bird-friendly art. Three notable examples of campus buildings that have incorporated art onto glass facades include the Beaty Biodiversity Centre (BRC; also, a Tier 2 Bird-Friendly Building), the Centre for Interactive Research on Sustainability (CIRS) and the Garden Pavilion at UBC Botanical Gardens.

Centre for Interactive Research on Sustainability

In 2018, CIRS held an art competition to create a bird-friendly window installation, following bird-friendly visual guidelines. The purpose was to use the artwork to raise awareness of the bird collision issue, promote biodiversity, and reduce strikes at the building. The competition also served to engage the UBC community. The winning design, by Ph.D. candidate Lora Zosia Moon, highlighted local species while drawing viewers into the natural world and the relationship between science and art. The winning design was installed as a decal on a high-collision area of the CIRS building (identified through strike monitoring). The design followed UBC's bird-friendly design guidelines for buildings at the time (note that the guidelines have since been updated to have smaller spacing between marks).

Biodiversity Research Centre

Users of the BRC, including the Director, noticed that there was a problem with bird collisions at the atrium windows of the building. Derek Tan, a digital media specialist, designed artwork which reflected the research expertise of the faculty and students who use the BRC building. He created the drawing using Adobe Illustrator following FLAP Canada's 5 cm and 10 cm vertical and horizontal space requirements. Users of the building installed the design using oil pens. Five volunteers covered 177 square feet in 4 hours. The installation did not wear and zero bird collisions were documented after one-year post-application. The following year, an additional glass facade was treated by 4 volunteers who covered 287 square feet in 8 hours. In November 2023, the design was updated with the help of community volunteers. Building users helped to trace the original design, clean off the exterior windows, and then re-apply the oil paint.

UBC Botanical Garden Pavilion

After students identified several bird strikes at the Garden Pavilion, UBC Botanical Garden staff decided to install bird-friendly artwork to mitigate collisions. Derek Tan (from the BRC) designed artwork that incorporated the bird species found most vulnerable to collisions by De Groot and colleagues. In February 2021, with the financial support from a donation, a local printing company created and applied the decals to the Pavilion (Moreno-García, 2022). UBC now has a Botanical Garden Bird-Collision Retrofitting Fund to further retrofit other buildings.

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Appendices

Appendix A: Bird-Friendly Guidelines in other jurisdictions

Appendix B: Bird-Friendly SEEDS projects

Appendix C: Planting recommendations for prioritized bird species

Appendix A: Bird-Friendly Guidelines in Other Jurisdictions

Table A1 Bird-Friendly Guidelines and resources from other jurisdictions

Bird-Friendly Guidelines and Resources		
City of Toronto	Bird-Friendly Development Guidelines	2007
	Best Practices for Effective Lighting	2017
	Bird-Friendly Best Practices Glass	2016
City of Vancouver	Vancouver Bird Strategy	2020
	Bird Friendly Landscape Operational Guidelines	2015
	Bird Friendly Design Guidelines Explanatory Note	2015
	Bird Friendly Landscape Design Guidelines - Executive Summary	2013
City of Calgary	Bird Friendly Urban Design Guidelines	2011
	Bird Friendly Calgary	
City of Ottawa	Bird-Safe Design Guidelines	2022
	Ottawa Bird Strategy (Safe Wings Ottawa)	2020
San Francisco	Design Guide: Standards for Bird-Safe Buildings	
	Standards for Bird-Safe Buildings	2011
New York City	Bird Friendly Building Design & Construction Requirements: Guidance document	2020
Portland	Resource Guide for Bird-Friendly Building Design	2012
	Bird-Safe Building Design Toolkit (Audubon Portland)	
Minnesota	Bird-Safe Building Guidelines (Audubon Minnesota)	2010
FLAP Canada	Bird-Safe Campus	

Appendix B: Bird-Friendly SEEDS projects

Table A2 Bird-friendly SEEDS projects to date.

Bird-friendly Student SEEDS projects

	year	course	Library Title [Report Title]	Authors	*Link*	Theme
1	Mar-15	VOL 500	Bird Collisions: UBC Bird Strike Monitoring Phase 2 [Bird Collisions with Glass: UBC pilot project to assess bird collision rates in Western North America (Phase 2)]	Alison Porter, Andrew Huang	Report not publicly available	Bird Strike Monitoring
2	Apr-15	ENVR 400	Bird Collisions: UBC Bird Strike Monitoring Phase 1 [Bird-Window Collision: A Problem at UBC Buildings (Phase 1)]	Andy Chien, Carmen Leung, Gordon Cavers, Tiffany Nam	Access the report here	Bird Strike Monitoring
3	May-16	VOL 500	Bird Collisions: Mobile Reporting Application [Bird Collision Reporting Mobile App A Partner Project Between FLAP Canada and UBC SEEDS Program]	Merle Crombie	Access the report here	Bird Strike Monitoring
4	Apr-17	ENVR 400	UBC Wildlife Biodiversity Baseline: How can UBC campus grow with minimal or positive impacts on bird populations?	Linnea Harder, Kathy Miao, Michael Oh, Erin Pippus	Access the report here	Biodiversity Baseline
5	Apr-17	BIOL 448	Bird Collisions: UBC Bird Strike Monitoring Phase 4 [UBC Bird Collisions with Windows Phase 4.0]	Vanessa Cheung, Alessandra Gentile	Access the report here	Bird Strike Monitoring

6	May-17	BIOL 448 / ISCI 448	Bird Collisions: Feather-Friendly Glass Monitoring & Perception [Birds & Buildings: Feather-Friendly Glass Bird Strike Monitoring & Perception]	Sarah Park, Jasmine Lai	Access the report here	Bird Strike Monitoring
7	Jan-18	EOSC 448	Mobilizing Knowledge to Action for Bird Friendly Guidelines on Campus [Recommendations for the UBC Bird Friendly Buildings Guideline]	Ruiyao Li	Access the report here	Bird-Friendly Policies + Practices
8	Apr-18	GEOG 371	How Does Human Activity Impact Bird Song in the UBC Botanical Gardens?	Lia Newman, Robbie Lockyer, Shea McConkey, Severine Renard, Savannah Gladstone	Access report here	Biodiversity Impacts
9	May-19	EECE 4XX	Bird Window Collision Impact Detection System	Susanna Chen, David He, Kieran Morton, Emily Xiong, Stevan Vicentijevic	Access report here	Bird Strike Monitoring
10	Apr-20	RES 510	Bird-Friendly Art: A Social-Ecological Evaluation of the Prevention of Bird Collisions with Campus Windows	Carly McGregor, Claire Ewing, Erika Luna Perez, Hannah Barnard-Chumik	Access report here	Bird-Friendly Policies + Practices
11	Dec-21	RES 510	Birds on UBC's Campus: A Mixed-Method Approach to Prioritize Bird Species and Assess Habitat Needs to Inform Policy & Campus Design	Emily Edwards, Dan Forrest, Marika Laird, and Alina Zeng	Access report here	Bird-Friendly Landscapes
12	Apr-22	APBI 495	Invisible to visible: A field study investigating dirty windows and bird-friendly artwork as mitigation strategies against bird-window collisions	Kelsey Leung	Access report here	Bird Strike Monitoring

13	Apr-22	APBI 495	Reducing bird-window collisions at a botanical garden: The effect of bird-friendly artwork and dirty windows	Christie Crews	Access report here	Bird Strike Monitoring
14	Apr-22	APBI 495	Longitudinal Bird strike monitoring- UBC Buchanan Building	Emily Hardy	Access report here	Bird Strike Monitoring
15	Apr-22	APBI 495	Final Research Report: Buchanan Birds	Linda Clarke Harter	Access report here	Bird Strike Monitoring
16	Dec-22	RES 510	Birds on Campus: Assessing Sources of Unintentional Feeding to Inform Policy and Campus Design Understanding Trash Foraging Practices in Bird Populations on the UBC Vancouver Campus	Eline Eronen, Dana Johnson, Kah Mun Wan	Access report here	Human-Wildlife Conflict
17	Apr-23	ELEC 491	Designing Window Sensors to Advance Bird-Friendly and Energy Saving Building Design Strategies on UBC Vancouver Campus	Huawen Li, Gengran Li, Ryotaro Hokao, Benjamin Powell, Mohamed Salah	Access report here	Bird Strike Monitoring
18	Apr-23	FCOR 599	Ecological Connectivity in Coastal British Columbia: How can we enhance habitat connectivity on the UBC campus and its adjacent ecosystems for the improvement of urban biodiversity?	Norman Nduna	Access report here	Biodiversity

Appendix C: Planting Recommendations for Prioritized Bird Species

Table A3 Habitat planting recommendations for prioritized bird species. Adapted from Edwards et al., 2021.

Habitat Planting Recommendations for Prioritized Bird Species. Data from Edwards et al., 2021.				
Species	**General Habitat**	**Feeding**	**Nesting**	**Presence**
Olive-sided flycatcher *Contopus cooperi*	Open meadows with native grasses: e.g., plant Western Wheatgrass (*Pascopyrum smithii*), Green Needlegrass (*Nassella viridula*), Blue Grama (*Bouteloua gracilis*), and Sagebrush (*Artemisia tridentata*)	Provide habitat for a diversity of insects, upon which this species feeds: e.g., plant Showy Milkweed (*Asclepias speciosa*) to attract butterflies and moths.	Nest in coniferous trees: e.g., support Sitka Spruce (*Picea sitchensis*), Western Redcedar (*Thuja plicata*), Douglas-fir (*Pseudotsuga menziesii*), Ponderosa Pine (*Pinus ponderosa*), Western Hemlock (*Tsuga heterophylla*) on campus	breeding season
Purple Martin *Progne subis*	n/a	Provide habitat for a diversity of insects, upon which this species feeds: e.g., plant Showy Milkweed (*Asclepias speciosa*) to attract butterflies and moths.	Nest in small cavities: e.g., provide small bird houses around campus (may also make use of sides of buildings, downed trees, etc.)	breeding season
Cliff Swallow *Petrochelidon pyrrhonota*	n/a	n/a	Nest on the side of buildings under horizontal overhangs: e.g., could provide this infrastructure under window ledges or roof overhangs on new and existing buildings	breeding season

Western Meadowlark *Sturnella neglecta*	Open meadows with native grasses: e.g., plant Western Wheatgrass (*Pascopyrum smithii*), green needlegrass (*Nassella viridula*), blue grama (*Bouteloua gracilis*) and sagebrush (*Artemisia tridentata*).	Will eat from feeders: e.g., eats cracked corn, millet and black-oil sunflower seeds in feeders.	n/a	year-round, sensitive to humans when nesting
Band-tailed Pigeon *Patagioenas fasciata*	n/a	Feeds on berry bushes: e.g., plant Black Elderberry (*Sambucus nigra*), Chokecherry (*Prunus virginiana*), Red Huckleberry (*Vaccinium parvifolium*), Salmonberry (*Rubus spectabilis*) and Trailing Blackberry (*Rubus ursinus*); Feeds on acorns: e.g., support Garry oak (*Quercus garryana*) on campus; Feeds on pine nuts: e.g., support ponderosa pine (*Pinus ponderosa*), and western white pine (*Pinus monticola*) on campus	n/a	In the BC coastal area for breeding. Declining conservation status (8% breeding pop in Canada) mostly because of hunting
Common Redpoll *Acanthis flammea*	n/a	Feeds on birch seeds: e.g., support Paper Birch (*Betula papyrifera*) on campus	n/a	Non-breeding (winter) in BC

Mourning Dove *Zenaida macroura*	n/a	Feeds on seeds from wild grasses: e.g., plant Western Wheatgrass (*Pascopyrum smithii*), Green Needlegrass (*Nassella viridula*), and Blue Grama (*Bouteloua gracilis*); Will eat from feeders: e.g., eats cracked corn, millet and black-oil sunflower seeds in feeders.	Nests in crotches of trees: e.g., put "nesting cones" (wide-based, fabric cones) in forks of trees, or hang empty baskets from trees	year-round
Rufous Hummingbird *Selasphorus rufus*	n/a	Brightly colored, tubular flowers: e.g., plant Red Columbine (*Aquilegia formosa*), Red Flowering Currant (*Ribes sanguineum*), Snowberry (*Symphoricarpos albus*), and Indian paintbrush (*Castilleja spp.*)	Nest in coniferous and hardwood trees: e.g., support Sitka spruce (*Picea sitchensis*), Western Redcedar (*Thuja plicata*), Douglas-fir (*Pseudotsuga menziesii*), Ponderosa Pine (*Pinus ponderosa*), western hemlock (*Tsuga heterophylla*), paper birch (*Betula papyrifera*), bigleaf maple (*Acer macrophyllum*) on campus	In western BC for the breeding season (summer)

Townsend's Solitaire *Myadestes townsendi*	n/a	Feeds on seeds and berries: e.g., plant/support Rocky Mountain Juniper (*Juniperus scopulorum*), Winterberry (*Ilex verticillata*), Buckthorn (*Rhamnus spp.*), Currant (*Ribes spp.*), Shadbush (*Amelanchier spp.*), hackberry (*Celtis occidentalis*), and elderberry (*Sambucus spp.*).	n/a	year-round
Lincoln's Sparrow *Melospiza lincolnii*	Meadows with native grasses: e.g., plant Western wheatgrass (*Pascopyrum smithii*), green needlegrass (*Nassella viridula*), blue grama (*Bouteloua gracilis*) and sagebrush (*Artemisia tridentata*) and dense patches of trees: e.g., support Red Alder (*Alnus rubra*), willow (*Salix spp.*), Bigtooth Aspen (*Populus grandidentata*), Black Cottonwood (*Populus trichocarpa*), and Soft Rush (*Juncus effusus*) on campus.	Will eat from feeders: e.g., eats cracked corn, millet and black-oil sunflower seeds in feeders.	Nest in thick covering of plants: e.g., plant Buttercup (*Ranunculus bulbosus*) and Sedge Grass (*Carex spp.*)	