City of Vancouver

BIRD FRIENDLY DESIGN GUIDELINES
EXPLANATORY NOTE

September 2014

CITY OF VANCOUVER | GREENEST CITY 2020

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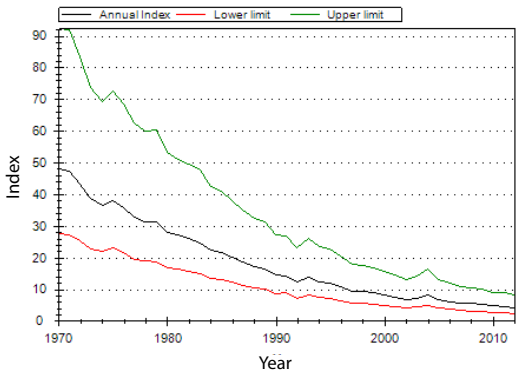
Habitat loss has caused a
35% decline
in characteristic bird species in the Pacific Coast region of Canada since 1970.

Monitoring by the Canadian Wildlife Service and thousands of volunteers has found clear trends in bird populations in Canada. Barn Swallows, previously a common bird in Canada, have declined by over 70% across the country and by over 90% in our Pacific Coast region since the early 1970s.

Annual Index



The *Bird Friendly Design Guidelines* are intended for use by developers, planners, designers and public and private landowners. These guidelines are divided into *Landscape Design Guidelines and Building Design Guidelines* and should be used in conjunction with other regulations, policies and guidelines. The document is not intended to be a comprehensive maintenance guideline, however, operations and maintenance staff, stewardship groups and landscape industry personnel may find it a useful reference. Prior to design and installation of any development, applicants should ensure that they are in compliance with current municipal, provincial and federal regulations that protect birds, including the BC Wildlife Act, the Species at Risk Act, and the Migratory Birds Convention Act, 1994.

These guidelines are intended to support the design and implementation of bird friendly development throughout the city. The document assembles existing best management practices and guidelines based upon scientific research for easy reference. Due to the complex interactions between birds, their environment and people, these guidelines are not comprehensive and do not address all possible management actions. It may be necessary to consult a qualified environmental professional on a site-by-site basis to ensure birds, their nests, and their eggs are protected.

The *Bird Friendly Design Guidelines* are part of the *Vancouver Bird Strategy.* In keeping with Vancouver's Greenest City Action Plan, Vancouver recognizes the role it has to play in creating the conditions for native birds to thrive in the city. Birds provide valuable ecosystem services in the form of pest control, pollination, and seed dispersal. Birds also form a dynamic link between people and nature that can inspire stewardship and enrich people's lives.

In Canada's Pacific Coast region, habitat loss due to human settlement, industry and forestry has caused a 35% decline in characteristic bird species since 1970.[1] It is imperative that action be taken to reduce the impact of urbanization on birds by protecting the variety of habitat types that birds depend upon. By enhancing bird habitat on public and private lands, Vancouver can become a safer place for birds and a greener, more livable city for people.

2. BENEFITS OF BIRDS IN THE CITY

Birds contribute to human health, quality of life and benefit the economy, both directly and indirectly. Birds perform important ecosystem services; they disperse seeds, consume vast numbers of insects, reduce the transmission of disease, and provide pest control and pollination services for agriculture and forestry.[2] Birds are also beautiful and accessible forms of nature that bring the city to life with their songs and flight. Bird watching is one of the fastest growing leisure activities in North America, estimated to generate billions of dollars in tourism and recreation industries. According to a 2006 study, more than 1.8 million Canadians participated in a multi-day bird watching activity within the past two years.[3] The Vancouver area is recognized internationally as a year-round hotspot for birds and a desirable destination for bird watchers, making consideration of bird friendly design a priority that has economic, social, and environmental benefits as we move towards the goal of becoming the greenest city by 2020.

People care deeply about birds, an important component of urban biodiversity.

3. GUIDELINES OBJECTIVES

The *Bird Friendly Design Guidelines*, if properly applied, should meet the following objectives outlined in the *Vancouver Bird Strategy*.

Support Habitat:
Protect, enhance and create habitats for a diversity of native birds.

Reduce Threats:
Reduce threats to birds in the urban environment.

Enhance Access:
Enhance access to nature for Vancouver residents and visitors to the city.

Enhance Awareness:
Increase awareness of the importance of birds and their needs.

In the U.S. in 2011, bird watchers spent **$15 billion** on trip expenditures.

4. BIRDS IN VANCOUVER

Resident Birds
live in the area year-round
e.g. Steller's Jay

Migratory Birds
live in the area in the summer
e.g. Wilson's Warbler

Over-wintering Birds
live in the area in the winter
e.g. Barrow's Goldeneye

Vancouver is located in a region rich in avian diversity; over 250 species of resident, migratory and over-wintering birds are regularly observed in Metro Vancouver. Resident species are non-migratory and live in the region year-round, thriving in the diversity of habitats found in the area: forest, shrub, freshwater and marine. Examples of resident birds include Steller's Jay, Black-capped Chickadee and Northern Flicker. Metro Vancouver also provides important habitat for weary migratory birds that spend the winters in Central and South America but breed here, such as Wilson's Warbler, Barn Swallow and Warbling Vireo. Finally, over-wintering birds such as songbirds, shorebirds, birds of prey and waterbirds may pass by on their migratory routes or migrate further north in the spring.

While there is a diversity of native bird species that live in Vancouver, there are also many non-native bird species. Non-native bird species are well adapted to the urban environment and can become invasive. These include Rock Pigeon, European Starling and House Sparrow. Therefore, these guidelines focus on creating the conditions for native birds to thrive in the city.

5. THE VANCOUVER CONTEXT

The City of Vancouver has more than 220 parks, constituting 11% of Vancouver's land mass, including Stanley Park, Queen Elizabeth Park, and Everett Crowley Park. Vancouver is surrounded by adjacent provincial and federally protected natural and semi-natural areas that support bird populations, such as Burns Bog, George C. Reifel Migratory Bird Sanctuary (part of the Alaksen National Wildlife Area on Westham Island), Maplewood Flats, and the provincial parks of the North Shore Mountains (Seymour and Cypress). To the south of the city, Boundary Bay in the Fraser Delta is one of the four Important Bird Areas (IBAs) in Metro Vancouver. It was designated a Western Hemisphere Shorebird Reserve Network site in 2005 in recognition of its importance for the over half million shorebirds that visit the Fraser Delta during spring migration.[4 5] The Fraser River Delta is also now recognized as a Ramsar wetland of international significance for migrating birds.[6]

The routes that migratory birds use during their northward and southward bi-annual migrations have been named "flyways." Vancouver is situated on the Pacific Flyway, which extends from Alaska in the north to Central and South America. The geography and topography of the region is such that funneling of birds through Vancouver's downtown core is unlikely. The mountainous habitat north of the City of Vancouver is an important migratory stopover habitat for hundreds of species. [7 8 9] Research indicates that these high elevation habitats are good refueling sites for migrant birds in autumn. At high elevations, birds can take advantage of later pulses of insects and fruits to eat that may be less available during the fall in valley bottoms and low-lying areas. These high altitude habitats are not as valuable as refueling habitats in spring, when they are still covered by heavy snow, therefore, there may be more birds using lower elevation urban areas during spring migration.

Important Bird Areas

1. Greater Vancouver Watershed
2. English Bay and Burrard Inlet
3. Pacific Spirit Park
4. Fraser River Estuary

Approximately
87% of forest cover
in Vancouver has been replace with urban development since the 1850s.

Stanley Park, a forest remnant, attracts the highest diversity of birds in the city.

Habitat loss is the leading cause of bird population declines in British Columbia.[10] According to the *State of Canada's Birds, 2012,* report, habitat loss due to human settlement, industry and forestry has caused a 35% decline in a representative sample of bird species in Canada's Pacific Coast region since 1970.[11] As urban development increases, habitat loss is expected to become the single largest driver of bird extinction in this century.[12] Interest in how birds respond to changes in land use along a gradient from rural to urban areas has grown and research shows that urbanization is associated with the loss of avian species, especially ground-nesting species, habitat specialists (species with very specific habitat needs) and birds that require large habitat patches.[13]

Vancouver was once covered in towering Western Hemlock, Western Red Cedar, and Douglas Fir; prior to the 1850's Vancouver was completely covered by Coastal Western Hemlock forest. Based on analysis of Landsat imagery of Vancouver, researchers estimate that approximately 87% of the forest cover has been replaced with urban development.[14] Habitat loss due to urbanization is particularly damaging because vegetation is replaced with impervious surfaces and structures and the negative effect is nearly always permanent.[15] Vancouver's loss of forest cover and the resulting decline of bird species associated with these lowland forests emphasizes the need to protect and enhance the remaining urban forest fragments.[16]

The effect of urbanization on birds is quite complex. A study conducted in Vancouver in 1979, found that total bird density is actually higher in urban areas than rural areas, but species richness is lower, due to the dominance of a few, introduced species.[17] Although urbanization is associated with the loss of diversity of avian species, total avian density peaks in developed areas due to high numbers of birds that have adapted to live in proximity with humans (synanthropic species).[18]

Another study performed in Vancouver in 2003 found that species richness declined in relation to increasing urbanization.[19] The same study found that habitat features, like mature trees and fruit bearing plants, are correlated with increased bird diversity. These results suggest that the incorporation of habitat features throughout the city can significantly contribute to the creation of bird habitat in Vancouver, to support a greater diversity of native birds.

7. THE PROBLEM: Collisions with Buildings

Windows are considered to be one of the largest sources of direct human-caused mortality for birds in North America.[20] [21] [22] Glass, whether reflective or clear, is effectively invisible to birds. Bird visual systems have not evolved to recognize windows as a barrier. Birds collide with windows because they are trying to fly into the habitats they see beyond or reflected by the glass. If windows reflect sky or vegetation, birds perceive only the sky or vegetation, failing to perceive the window itself. Birds perceive windows as unobstructed airspace.

In Canada, an estimated **16-42 million birds** collide with glass on buildings every year.

It is estimated that across Canada, 16-42 million birds are killed annually by collisions with buildings.[23] Most collision deaths occur at residential buildings because they are the most common and widespread building types.[24] Nevertheless, because many high-rise office buildings are clad in large expanses of reflective glass, they can cause a highly disproportionately number of collisions annually, particularly if they are adjacent to natural areas that attract high densities of birds. Mitigating collisions at all building types is an important step in reducing fatal collisions in Vancouver and elsewhere in Canada.

Glass, whether reflective or clear, is effectively invisible to birds.

Estimates vary, but studies suggest that about 50% of birds that collide with windows are killed instantly.[25] An unknown number of the birds that survive their initial collision and fly away will subsequently succumb to their injuries. Experiments suggest that bird collisions with windows are indiscriminate. They can occur anywhere, at any time, day and night, year-round, across urban and rural landscapes, affecting migratory, resident, young, old, large, small, male and female birds. The problem of nocturnal collisions is compounded by the presence of artificial light in the built environment, which can impede bird's navigational systems.

The extent to which bird collisions are a serious concern in Vancouver has not yet been scientifically assessed or monitored. However, because downtown Vancouver is host to an abundance of potential scavengers, including gulls, crows, raccoons, squirrels and other rodents, nocturnal collisions may be a hidden and underestimated problem in our city.[26] Window collisions occur everywhere that birds and buildings coincide, therefore collisions are certainly an issue year–round in Vancouver. It is prudent to take measures to increase the visibility of windows and decrease the upward spill of artificial light at night. If Vancouver is to become a more bird friendly city, these design guidelines should be followed to enhance the safety of buildings and homes for our winged cohabitants.

8. DESIGN PROCESS

a. SURVEY the site for birds and existing bird habitat features. Developers should consider hiring a qualified environmental professional to survey and document nesting sites and any bird supportive habitat, in order to inform design choices such as building location and vegetation retention.

b. REDUCE THREATS to manage the impact of urbanization on birds. Aim for a net zero reduction in bird habitat, mimic hydrological systems through storm water management, restore riparian habitat through daylighting streams and pursue traffic calming to reduce noise pollution and bird deaths due to vehicle collisions.

c. CREATE bird habitat to increase bird diversity and abundance. Providing opportunities for food, shelter, nesting sites and water, creates or restores habitat for birds throughout Vancouver.

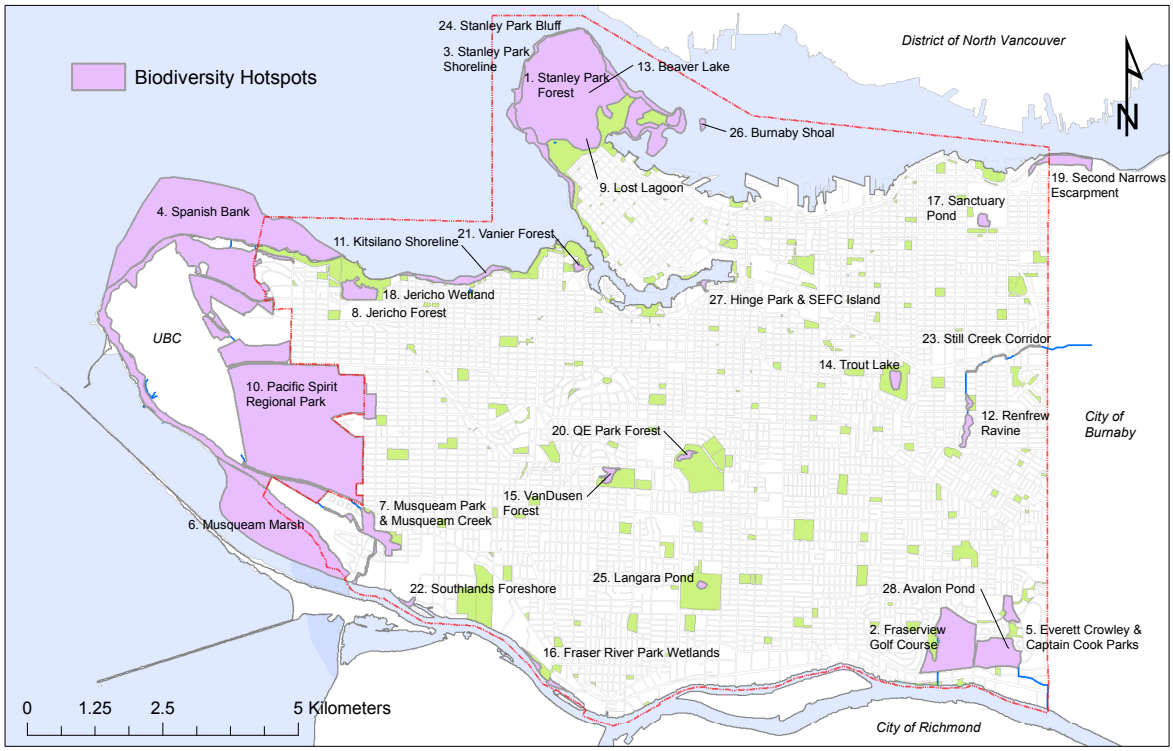
d. MAINTAIN new and existing bird habitat to increase bird diversity and abundance. Create a long-term management guide that informs maintenance staff and landowners with strategies and best practices for their new bird friendly landscape.

e. MONITOR changes in bird populations and adapt site design. For large public sites such as parks and other government lands, monitoring programs should be established to identify problems and allow for adjustments. For private lands, property owners are encouraged to seek the help of a qualified environmental professional and local birders to assess the success of their landscape installations.

a. Protect and enhance large patches of habitat.

Vancouver is a refuge for resident and migratory birds that currently breed and feed in our larger parks, like Stanley, Queen Elizabeth and Everett Crowley Parks. These large parks form the hubs in a network of connected natural areas called an "ecological network".[27] Hubs are natural areas greater than 10 hectares in size and support large concentrations of urban biodiversity. These hubs form the foundation for biodiversity and are key to protecting bird diversity in the city.

Vancouver's Biodiversity Hotspots



Multiple studies have shown that large forest fragments support greater bird species richness and densities than small fragments because of greater diversity and/or abundance of habitat resources.[28] A review of 72 studies of habitat influences on urban avian assemblages found that large habitat patches support larger and more stable bird populations.[29] It is recommended that nature reserves and parks be as large as possible to maintain bird diversity.[30] Creating new large parks within Vancouver is virtually impossible, so protecting and enhancing identified biodiversity zones is key to increasing bird diversity in the city. Developments adjacent to these large patches of habitat can incorporate habitat features to increase the size and function of biodiversity zones.

i. Eliminate non-natural breaks or gaps in habitat patches to increase the quantity and quality of interior habitat.
ii. Increase interior habitat by reducing the interior-to-edge ratio of habitat patches.
iii. Prioritize habitat enhancement and tree planting on areas adjacent to large natural areas away from areas of high traffic volume and speed and increase the overall size of biodiversity zones.
iv. Enhance Vancouver's existing ecological network through habitat restoration and private land stewardship.

b. Green the urban landscape by planting native trees and shrubs for birds.

Since it is unlikely that new large parks will be created in Vancouver, an alternative strategy is to make the urban landscape resemble native habitat.[31] These areas, when taken as a whole, can support biodiversity and provide essential habitat for many birds. Greening the urban landscape means incorporating habitat features throughout the city wherever possible, from streets and rail corridors, to small municipal parks and residential back yards. A study conducted in Vancouver found that species richness declined in relation to increasing urbanization and habitat features were important in determining the distribution of birds in urban areas.[32] The results suggest that habitat features within the city, like mature trees and fruit bearing plants, can increase bird diversity. When the effect of habitat features is multiplied across the city, the result is a greener bird friendly city.

i. Incorporate bird habitat features on public and private land including: parks and public gardens, residential gardens, green streets, green roofs and walls, community gardens, communal gardens, golf courses, school grounds and cemeteries (See 9.1 Opportunities for Bird Friendly Development on Public and Private Land).
ii. Establish habitat features like mature trees, native fruit bearing shrubs and freshwater ponds and wetlands throughout the urban landscape.
iii. Use street and park trees to create a continuous forest canopy for birds.
iv. Prioritize greening along quiet streets with low traffic volumes and speeds, and avoid planting shrubs adjacent to highways and other high volume thoroughfares, due to the risk of increasing bird mortality due to vehicle collisions.

c. Incorporate a mix of habitat types including: coniferous forest, deciduous/mixed forest, shrubland, meadow, freshwater wetland, riparian and coastal shoreline.

Birds require a diversity of habitat types. One of the first studies to pursue this idea revealed a strong correlation between bird species diversity and the presence of a mosaic of habitat patches.[33] Subsequent studies have led to similar results, including a local study that recommends providing birds with a range of habitat types.[34] Combining habitat types maximizes opportunities for foraging, perching and nesting.[35] Priority should be placed on incorporating a mix of deciduous and coniferous forest, complemented by more open habitat like shrub or meadow. The most productive and complementary habitat types are shorezone and deciduous forest, therefore, emphasizing protection and creation of deciduous forests on backshores is a priority.[36]

i. Protect rare habitat types throughout the city to ensure the presence of a mix of habitat types and prioritize the conservation of riparian, wetland and shoreline habitat.
ii. On larger sites (at least 4 hectares) establish a minimum of three distinct habitat types, for example: forest, shrub and meadow.
iii. On sites where it is feasible to construct a wetland, incorporate shrub and forest habitat along the wetland riparian zone.
iv. On backshores, the area behind high-tide, prioritize the creation of deciduous forest.

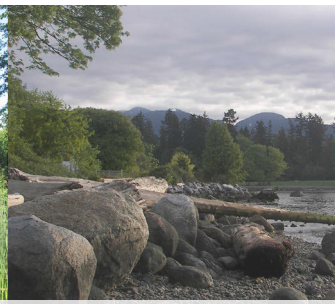
The chart on the next page illustrates a range of key habitat types and their defining features as well as examples of the habitat found in Vancouver and an example of birds that use each habitat type. The visualizations on page 20 and 21 illustrate how existing urban landscapes can be transformed by application of these guidelines.

Forest
e.g. Stanley Park

Shrub
e.g. Jericho Park

Meadow
e.g. Oak Meadows Park

Wetland
e.g. Hastings Park



Backshore
e.g. Stanley Park

FEATURES	HABITAT TYPES				
	FOREST	SHRUB	MEADOW	FRESHWATER WETLAND	SHORELINE/ BACKSHORE
Minimum Area	3 - 8.5 ha	0.5 - 3.0 ha	0.5 - 1.0 ha	0.05 - 0.25 ha	15 - 30 m setback from high water mark
Canopy Coverage	60 - 80%	20 - 40%	10 - 20% along edges	10 - 20% within 15 - 30m setback	60 - 80%
Understorey Coverage	70%	60 - 80%	10 - 20% along edges	10 - 20% within 15 - 30m setback	70%
Herbaceous Coverage	10 - 20%	20 - 40%	80%	25%	10 - 20%
Coniferous to Deciduous Ratio in the Canopy	Conifer Forest >75% Conifer Deciduous Forest <75% Conifer	50:50	30:70	30:70	50:50
Examples of Birds found in Habitat Type	CONIFEROUS: Pacific Wren, Brown Creeper, Golden-crowned Kinglet DECIDUOUS: Wilson's Warbler, Bushtit, Purple Finch, Warbling Vireo	Spotted Towhee, Song Sparrow, Black-headed Grosbeak	Savannah Sparrow, Horned Lark, Violet-green Swallow	Barn Swallow, Marsh Wren, Red-winged Blackbird, Willow Flycatcher	Great Blue Heron, Bald Eagle, ducks, shorebirds

Wilson's Warbler

Spotted Towhee

Savannah Sparrow

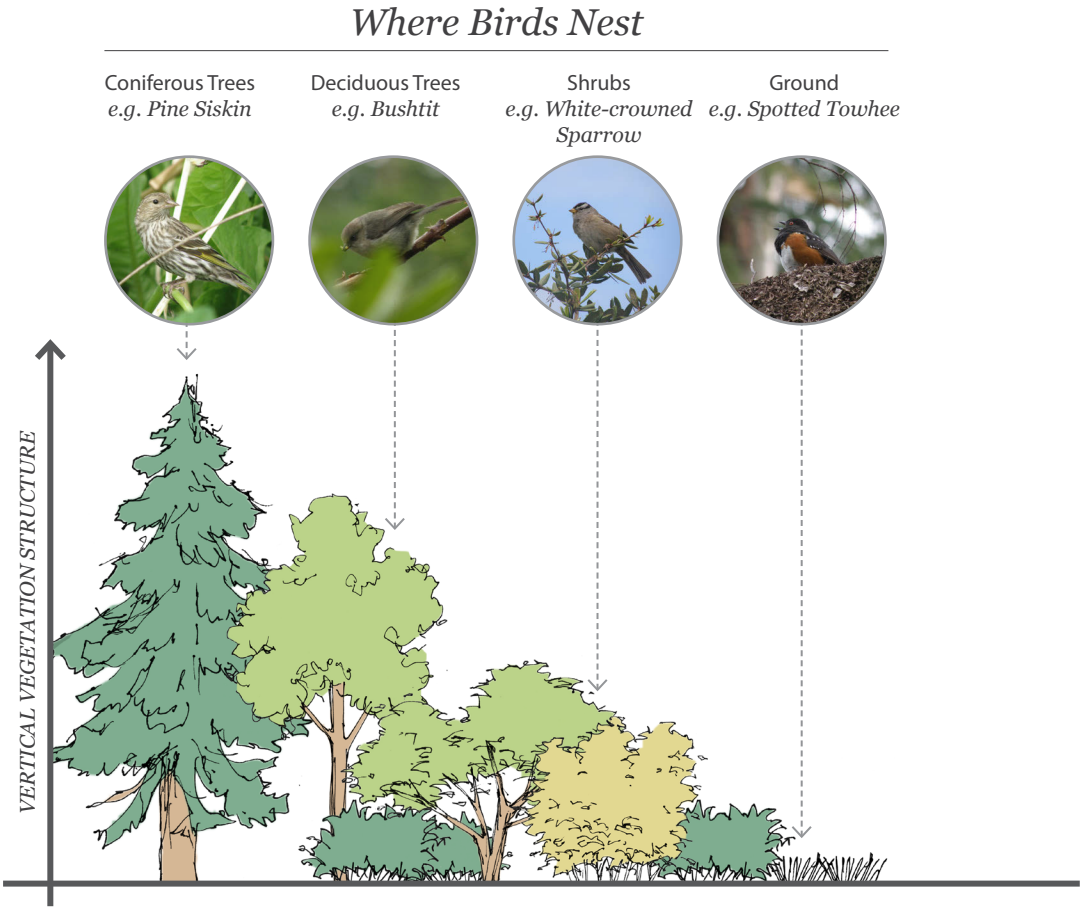
Barn Swallow

Great Blue Heron

d. Increase vertical vegetation structure by planting and maintaining native trees and shrubs.

Researchers have found that an effective way to enhance bird species richness and diversity in the urban landscape is by increasing vertical vegetation structure, or in other words, creating layers of vegetation.[37 38 39 40 41] Forests with many vegetation layers create more foraging, breeding, and nesting opportunities for birds. Researchers in Vancouver found that bird species diversity, evenness of species abundances, and number of species increase with foliage height diversity and total vegetation.[42] Large mature trees have more vertical vegetation structure than young trees, so it is essential to protect mature trees. Individual trees have less structural complexity than groups of trees and shrubs, so planting new trees and shrubs together, where appropriate, will increase vegetation structure throughout the city. There can be up to six distinct foliage heights or layers including a ground cover, shrub, understorey, and canopy layer to maximize the amount of available bird habitat.

i. Increase vertical vegetation structure by creating layers: ground cover, shrub, understorey and canopy layers. Tall shrubs and subcanopy trees are particularly important.
ii. Conserve and replant large trees and shrubs where space permits.
iii. Plant shade-tolerant native ground cover and shrub plants within forest fragments to increase foraging and nesting opportunities for birds.
iv. Plant native ground cover and shrub plants at the base of isolated trees to create islands of layered vegetation.
v. Plant vegetation in a stepped pattern, with large trees in the back, shrubs in the middle, and ground cover plants in the front.



e. Select a diversity of native and non-invasive plants.

The urban environment can be enhanced to attract birds through the cultivation of a diverse mix of trees and shrubs. Diversity in the tree canopy tends to be positively correlated with avian species richness in urban areas.[43] A diversity of native plants, which have evolved to thrive in local conditions, are recommended.[44] Studies show that a balanced mixture of coniferous and deciduous plants maximizes bird species richness.[45] Since birds that prefer conifers will use the forest differently than birds that prefer deciduous trees, a mix of deciduous and coniferous trees will enhance bird species richness. A study in Vancouver found that large coniferous trees and berry-producing shrubs were habitat features consistently linked to the presence of a variety of bird species.[46] Selecting a diversity of plants that produce seeds, fruit, nuts and nectar can provide a diverse food supply for birds throughout the year.

Red Alder is a native deciduous tree that provides nesting and foraging habitat and attracts insects for birds to feed on.

Salmonberry provides nesting and foraging habitat and is a native alternative to invasive Himalayan Blackberry.

Sword Fern provides nesting habitat for ground nesting birds like the Spotted Towhee.

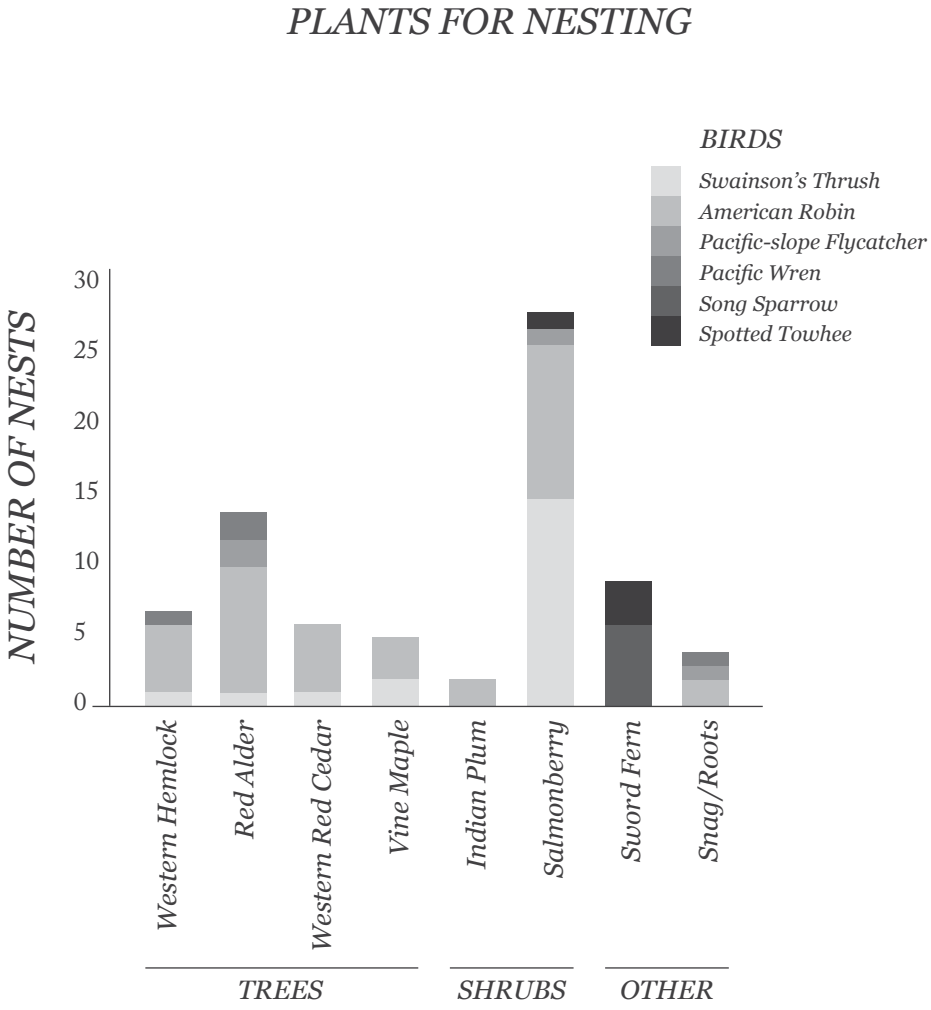


Chart adapted from Maintain Native Plants for Wild Birds.

i. Use a diversity of native plants that are appropriate for the soil and site-specific conditions.
ii. Incorporate a mix of coniferous and deciduous vegetation (unless the intent is to create a specific habitat type).
iii. Select a mix of native plants that provide a variety of foraging options for birds including: seeds, fruit, nuts and nectar
iv. Incorporate plants with persistent fruits, plants that hold their fruit into the winter, for example, Pacific Crabapple, Evergreen Huckleberry and Highbush Cranberry.
v. Incorporate plants that attract insects for birds to feed on, for example, Red Alder, Pacific Willow and Scouler's Willow
vi. Incorporate plants with early flowering to ensure a reliable supply of nectar when migratory hummingbirds arrive in spring, for example, Salmonberry, Flowering Currant and Oregon Grape.

PLANTS FOR FORAGING

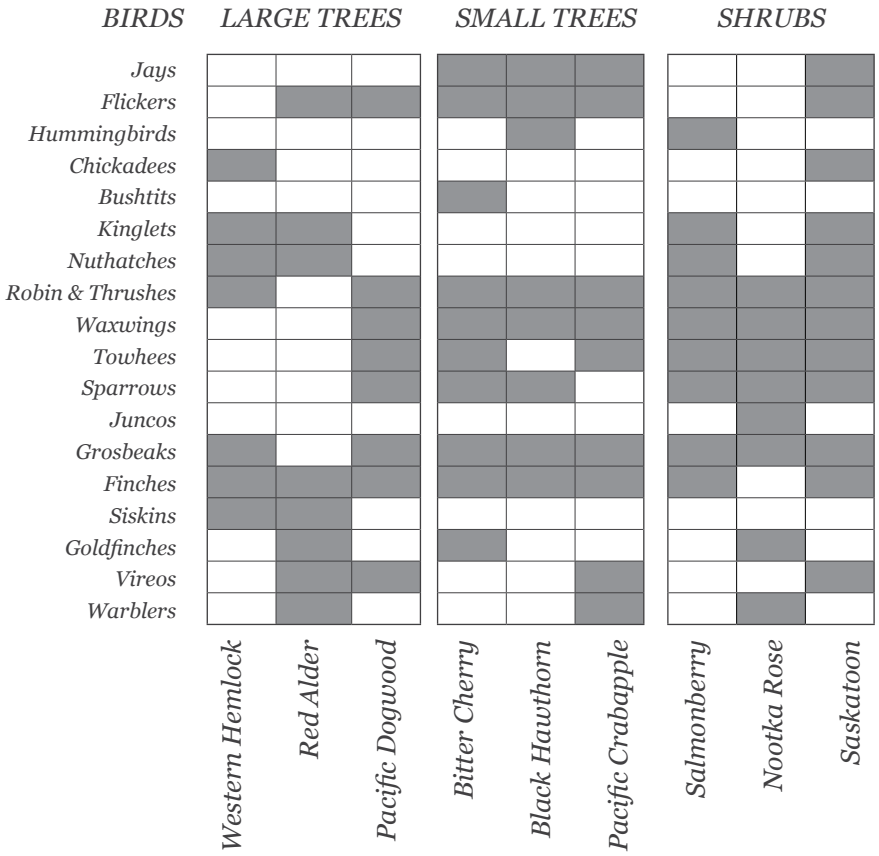


Chart adapted from Birds and Berries by Al Grass, Kevin Bell and June Ryder.

Seeds from the Western Hemlock tree are eaten by birds like Pine Siskin, American Goldfinch and Common Redpoll.

Pacific Crapapple is a great habitat tree with persistent fruit that attracts birds, like Purple Finch, from July to October.

Many bird species forage on Saskatoon berries when they appear in August to September.

f. Control invasive plants without disturbing breeding birds.

A House Finch eating invasive blackberries. Invasive plants must be managed with care as some birds will use them for nesting and foraging habitat.

Management of invasive plants can pose a threat to birds. Invasive plants are introduced, non-native plants that spread quickly and pose a threat to local ecosystems and species.[47] Invasive plants often out-compete native plants on disturbed sites that are common in cities. Native bird species are least abundant within urban landscapes where non-native understorey vegetation is most common.[48] Invasive plants must be actively managed if native vegetation is to be maintained and native birds are to thrive in our urban forests.[49] Some invasive plants, like Himalayan Blackberry, create habitat for birds by providing food and shelter. However, Himalayan Blackberry forms a monoculture that replaces high quality habitat and has been shown to support fewer birds when compared to a greater diversity of native vegetation.[50] It is therefore important to manage Himalayan Blackberry carefully; avoid removal of invasive plants during the breeding season in accordance with the federal Migratory Birds Convention Act (1994), remove small patches at a time and replace with a diversity of native plants to ensure habitat is not lost.

i. Avoid removing invasive plants during the bird-breeding season, specifically plants that are known to create nesting habitat for birds like Himalayan Blackberry.
ii. Follow best management practices for invasive species removal: *Stanley Park Ecology Society Guide to Invasive Plant Management in Stanley Park.*

g. Minimize direct disturbance from humans.

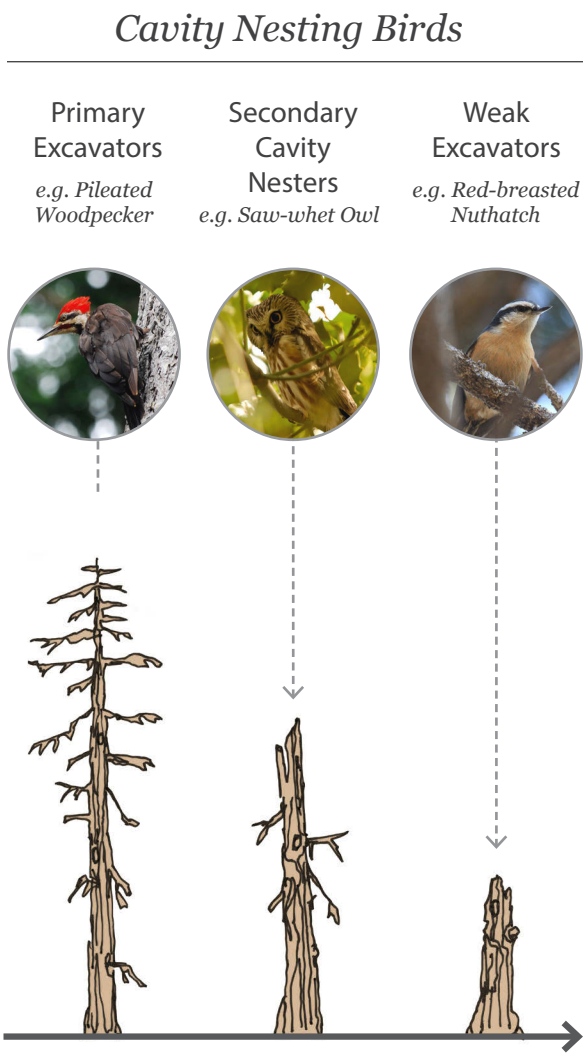
Bird watching is an excellent way to experience nature in the city, however a balance should be found between promoting human access to nature and protecting birds from disturbance. Although some birds have adapted to live in proximity with humans (synanthropic species), disturbance effects have been observed even in urban-adapted birds.[51] For example, one study found that the density of breeding House Sparrows in urban parks initially increased with the presence of human visitors, likely due to food availability, however, sparrow densities declined when the number of human visitors was high, indicating a balance between attraction to and avoidance of humans.[52] Research suggests that as pedestrian rates increase within habitat fragments, avian species richness and abundance decline.[53] Designated habitat areas should keep human recreation use to a minimum, especially off-trail hiking, biking and dog walking. These areas can still have aesthetic value for people if sightlines are maintained and well-marked trails avoid sensitive habitat.

i. Designate habitat areas where human and dog access is limited and create peripheral paths rather than paths that fragment habitat patches.
ii. Provide sidewalks, boardwalks or trails to direct human circulation around sensitive habitat areas.
iii. Incorporate trail signage to educate the public on human-induced threats to birds.
iv. Use barriers like dense shrub thickets or fences to protect designated habitat areas while retaining sightlines.
v. Where areas adjacent to sensitive habitat areas are designated for passive human recreation, such as bird watching, fishing or enjoying nature, ensure they are designed to limit access into or disturbance of the habitat areas, possibly reinforced with signage indicating out-of-bound sensitive areas.
vi. Follow established guidelines and regulations for working near important nest areas.

h. Reduce light pollution.

Light pollution impedes the navigational system of birds as they migrate at night; migrating birds appear reluctant to leave artificially lighted areas once they enter them during nocturnal migration. Efforts should be made to reduce light pollution from outdoor lighting. Outdoor lighting is required in cities due to safety concerns but International Dark-Sky Association Approved light fixtures help reduce light pollution while lighting our streets and parks. See “reduce light pollution” under building guidelines.

i. Install outdoor lighting only where it is necessary, for example along trails and streets, but not within important habitat patches.
ii. Use International Dark-Sky Association Approved lighting fixtures for outdoor applications.



Stages of Deterioration

i. Minimize lawn area.

Areas of lawn reduce potential biodiversity, require large amounts of water and fertilizer,and typically require the use of fossil fuels for maintenance.[54] Removal of ground cover, shrub, understorey, and canopy layers in favour of lawn reduces the habitat value of parks, gardens and forest fragments for birds. Keep lawn areas to a minimum and replace with a diversity of native trees and shrubs. Although it is not always practical to eliminate all open lawn, while it provides space for passive recreation, adding or expanding native flower and shrub beds adjacent to lawn can attract birds. Where lawn is required, management strategies like eliminating chemicals and reducing mowing are beneficial for birds.

i. Keep lawn areas to a minimum and replace with a diversity of native trees and shrubs

j. Incorporate snags and downed wood.

Birds that nest in tree cavities or use cavities depend upon snags for nesting, roosting, foraging and other life functions. Snags are dead or decaying trees at least 25cm in diameter and a height of 1.8m.[55] In interior British Columbia, about 25% of forest birds and mammals depend on tree cavities for their life activities.[56] There are three cavity-nesting bird guilds: primary excavators, like woodpeckers that make cavities; secondary cavity nesters, birds that use cavities but do not make them; and weak excavators that can only make cavities in decayed wood, like Red-breasted Nuthatches.[57] In addition to nesting, deadfall and snags create habitat for decomposers, invertebrates, and small mammals that in turn create a food source for birds.[58] Allowing trees to mature, lose branches, and die naturally is ideal but can be difficult to manage. An alternative management strategy is topping large, dying trees (but avoid topping healthy trees). By cutting the tops of dying trees that pose a threat to people to a safe height, bird habitat can be created while ensuring public safety.

i. Avoid turning healthy trees into deadfall or snags.
ii. Leave naturally occurring deadfall and snags in place, unless they pose a risk to human safety.
iii. Turn dying trees into snags by cutting the tops to a safe height of 2-10m.

iv. Snags must have a diameter greater than 40cm to accommodate cavity-nesting birds. Large snags are more valuable than small snags for nesting, however, snags smaller that 40cm in diameter can provide foraging habitat.
v. Where dying trees are not present, cut tree stems can be installed, away from direct human access but within sightlines.
vi. Incorporate deadfall and snags at different stages of decay to accommodate different cavity-nesting guilds.
vii. Aim for a density of five snags per hectare.

k. Provide water for birds to drink and bathe.

All life on earth needs water to survive; urban forests support a higher density of birds when a source of water is present.[59] The Vancouver Avian Research Centre's number one recommendation for attracting winter birds is to provide copious amounts of clean, fresh water for drinking and bathing.[60] A study in Vancouver found that several species were three times more likely to be present if a water source was nearby.[61] If a natural source of water exists on the site, enhancing its habitat value by planting the water's edge with vegetation can attract birds.[62] If a water source does not already exist on the site, shallow ponds with gently sloped edges can be created. On residential sites, incorporating a birdbath can also be effective if cleaned regularly.[63] Creating artificial water sources needs to be done in a way that is safe for humans; small sources of water away from direct human access but within sightlines are recommended.

i. Construct wetlands, especially on sites where streams or wetlands existed historically and water collects naturally.

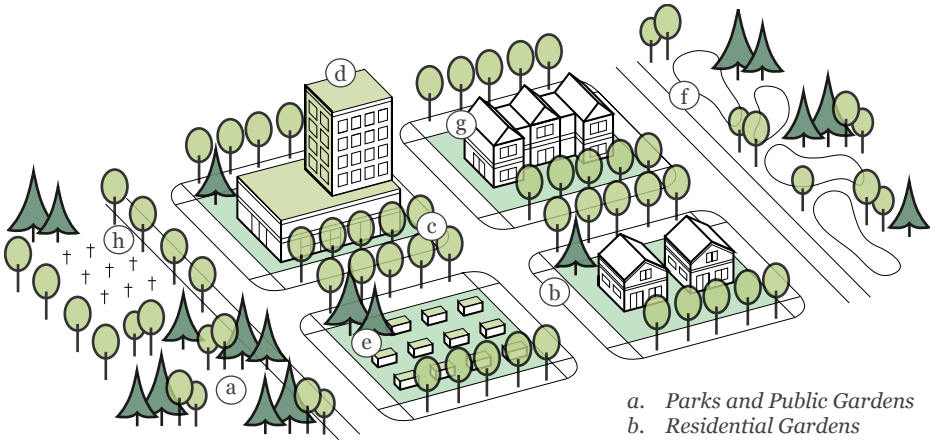
1. Visualizations of Bird Friendly Habitat in Vancouver.

CALLISTER PARK - Now and Potential

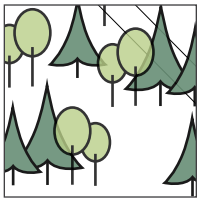
Landscape improvements in parks can increase habitat value and enhance access to nature.

VANIER PARK - Now and Potential

Enhanced wetlands improve bird habitat
and increase overall biodiversity.

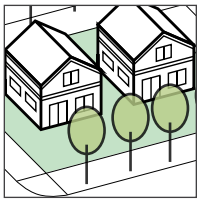


a. Parks and Public Gardens
b. Residential Gardens
c. Green Streets
d. Green Roofs and Walls
e. Community Gardens
f. Golf Courses
g. School Grounds
h. Cemeteries



a. Parks and Public Gardens

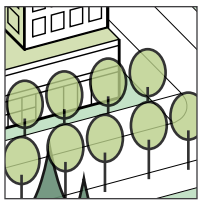
Vancouver's 220 parks total 11% of Vancouver's land area, and represent the best opportunity to transform existing green space into attractive habitat for birds. Many birds already prefer Vancouver's parks and gardens over more urbanized areas; bird species richness declines as urbanization increases.[64] However, more can be done to attract birds to Vancouver's parks and gardens. For example, our parks are characterized by large areas of mown grass around trees. Incorporating a shrub layer into underutilized locations in parks can create bird habitat without reducing human access to parks.



b. Residential Gardens

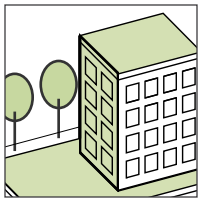
Residential gardens can be turned into attractive habitat for birds, by providing food, shelter, and water. Gardens made to attract birds also make beautiful green places for people, animated by the exciting sounds and movement of birds. Residential gardens and adjacent habitat, when added together, can create interconnected networks of habitat within the urban fabric.[65] Birds are very mobile and can forage across the landscape, moving between individual gardens in search of food.[66] In addition, residential development adjacent to Vancouver's parks and gardens should add bird supportive habitat to the existing ecological network. Many residential backyard guidelines and books are widely available. An excellent resource, written for local ecology, is NatureScape British Columbia, *Caring for Wildlife Habitat at Home*, which is available for free online.

c. Green Streets



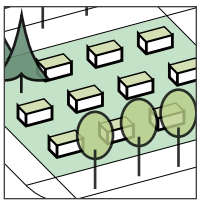
In order to make the urban landscape more attractive to birds our streets should be made to more resemble the forest fragments that birds occupy. Treed streets provide better habitat than streets without vegetation; avian diversity increases from the least suitable (streets without vegetation) to the most suitable habitats (urban parks), with treed streets being of intermediate landscape value.[67] Streets can best be used by birds if a continuous canopy of trees is present. A concern with attracting birds to streets is that avian mortality from vehicular collision is a serious concern; approximately 1,167 birds are killed per 100 km of road, during the breeding season, in Canada.[68] Street trees provide bird habitat above the height of cars, but planting of low shrubs, adjacent to highways and other high volume throughfares should be avoided, to reduce the risk of increasing bird mortality due to vehicle collisions.

d. Green Roofs and Walls



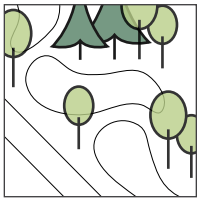
Green roofs increase the availability of green space for people and wildlife in the urban environment. A green roof is a green space created on top of a traditional roof system using a growing medium, plants and a waterproof membrane. Green roofs are used frequently by birds for foraging, especially within urban centers where green space and food is usually sparse.[69] If birds are able to find food, shelter, and water on a green roof they are more likely to use it as habitat. Bird species that are able to find food will frequent the green roof but those whose food supply is not present will not visit the green roof.[70] Researchers from Switzerland have found that varying the substrate thickness, to create different microhabitats and using natural soils from nearby can increase biodiversity.[71]

Green walls use self-adhering climbing plants to colonise vertical surfaces. Although scientific data to support the habitat benefits of green walls is sparse, one study from the United Kingdom found that avian abundance was far greater on green walls compared to bare walls.[72] The study examined 27 green walls and 27 bare walls and found 68 birds associated with green walls compared to 15 birds found on the roofs associated with bare walls. [73] The potential risk of green roofs and walls is that they may draw birds into areas where the risk of collisions with windows is higher; it is imperative that glass in the vicinity of green roofs and walls be treated to manage this risk. More research is needed to understand the capacity of green roofs and walls to support specific bird species.



e. Community Gardens

Vancouver has over 75 community gardens, located in city parks, in school grounds, and on private property, all managed by local community groups. Community gardens present an opportunity for wildlife gardening and to engage citizens in this effort. Many people enjoy the aesthetic of community gardens, overgrown with a rich diversity of plants, and this aesthetic bears some resemblance to the tangled understorey that grows naturally in forests. Incorporating native plants into and around community gardens makes sense aesthetically and is beneficial for birds. The diversity of plant life in community gardens already attracts insects that supply food for birds. Information about community gardens is available on the City of Vancouver's website.



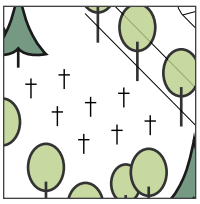
f. Golf Courses

Vancouver's three major municipal golf courses, Fraserview, Langara, and McCleery, total 186 hectares, almost 15% of Vancouver's parkland. These golf courses provide valuable bird habitat in the city and are designated through Audubon International as Certified Audubon Cooperative Sanctuaries. They were initially certified in 2003 and 2004 and have been recertified every two years since, demonstrating their ongoing environmental efforts. The Audubon Certification addresses six key environmental components, including wildlife and habitat management. Some of their guidelines include, for example, maintain or plant varying heights and types of plants and leave dead trees standing when they do not pose a safety hazard. For the complete list of guidelines, refer to the Audubon International's Fact Sheet.

g. School Grounds

School grounds create exciting opportunities to bring together habitat restoration and education. With schools and their attached green space spread throughout the city, incorporating habitat for birds into school grounds is an excellent way to green the urban landscape and increase access to nature for students. In 1999, "Mainly for the Birds," an art project designed to raise awareness of urban birds, led to the planting of bird supportive habitat at Riley Park and Mount Pleasant Community Centres, and the greening of Simon Fraser School.[74] Development adjacent to school grounds should consider similar collaborations with neighbouring schools to increase awareness and develop bird friendly urban environments.

h. Cemeteries



Urban cemeteries offer opportunities to incorporate nature into the city and become sanctuaries for birds. Vancouver's only cemetery, Mountain View Cemetery, is 46 hectares of land owned and operated by the City of Vancouver. This tranquil, large green space of lawn and mature trees offers a place where visitors can remember loved ones and engage with nature. A study from Chicago found that urban cemeteries larger than 25 ha support more bird species than the surrounding city because of features like ponds, vegetation, and undeveloped land.[75] Development of cemeteries or development adjacent to cemeteries should consider potential habitat enhancement opportunities.

Examples of effective visual markers to make windows more visible to birds.

Scientific research to better understand bird collisions is still in progress with many promising solutions that can already be incorporated into urban planning and architectural design. By thinking about both feature-related and location-related hazards, many bird collisions can be prevented. Feature–related hazards are those that are linked to a specific component of the architecture that creates a hazard for birds in flight unrelated to the location of the building. Examples include free–standing clear glass walls, glass corners, linkways, skywalks, greenhouses, balconies or patios with unbroken glazed segments, and bus shelters made of glass. Location–related hazards are linked to the habitat that occurs in the immediate vicinity of the building or structure. For example, buildings adjacent to open spaces, vegetation, forest, lawns, parks, water features, birdfeeders, green roofs and walls, waterfront and wetlands, are likely to be at increased probability of sustaining bird collisions.

a. Increase visibility of glass.

On buildings, walkways, bus shelters, balconies, guardrails, and patios, glass presents two hazards to birds. Reflective glass, including both mirrored glass and non-mirrored glass, may reflect inviting habitat such as trees or sky, while transparent glass appears as open air to birds.

The height that presents the highest collision probability is at or below mature tree height, or up to the fourth floor of a building, approximately 12 meters, whichever is highest.

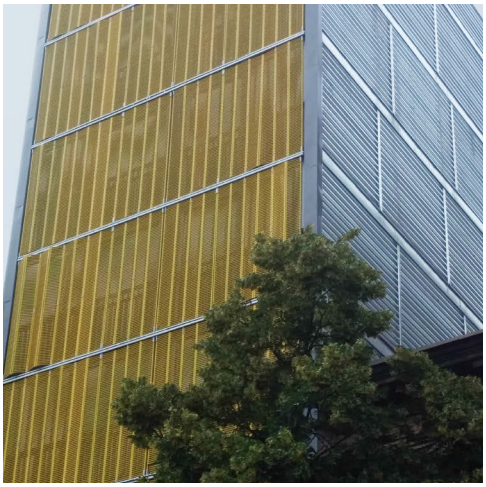
Commonly used bird of prey silhouettes have been tested experimentally and found to be largely ineffective.[76] Birds will avoid hitting the decal if it is applied on the exterior surface of the window, but may still hit glass beside the decal if it reflects suitable vegetation or sky.

i. Apply visual markers to the exterior of glass surfaces (markers on the interior surface of glass are less effective). Ensure gaps between markers are no greater than 5 cm vertically or 10 cm horizontally.

Visual markers such as window films, stick-on patterns, decals, and fritted or frosted glass, applied to the exterior-facing surfaces of glass can be used to add visual noise and make windows more visible to birds. Treatment of interior-facing surfaces of glass will still allow reflectivity on the exterior-facing surfaces, reducing effectiveness in collision prevention. Markers must cover full extent of glass. Commercially available window treatments can be an attractive building feature. There is also an opportunity to design unique architectural works of art, rethinking the traditional window and its framing.

Optimal density of vertically placed visual markers (lines or designs) is a minimum of 5 mm wide placed no more than 10 cm - approximately a hand's width - apart. Optimal density of horizontally placed visual markers is a minimum of 3 cm wide spaced at a maximum of 3 cm, or a minimum of 5 mm wide spaced at a maximum of 5 cm apart. This spacing reduces the possibility that birds will try to fly between markers.

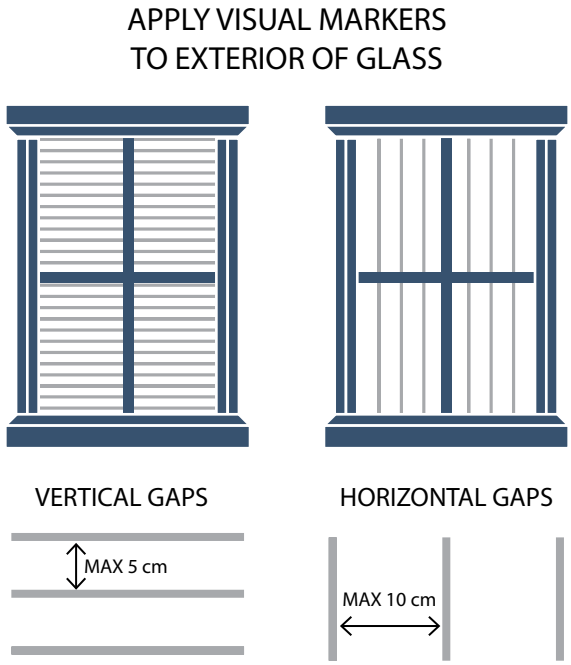
Applied visual markers are not an optimal solution for all building types; visibility may be better improved with greater use of ii and iii.



Examples of creative bird friendly buildings in Vancouver.

ii. Interrupt reflective glass by increasing the density of external visual markers including spandrel panels and mullions.

Horizontal spandrels and vertical mullions increase the opacity of a building's exterior, reducing the number of bird collisions. A spandrel refers to the space between the top of the window in one storey and the sill of the window in the storey above. Mullions are vertical elements (usually opaque or translucent) that divide units of a window, door, or screen.



iii. Other strategies can include adapted fenestration patterns, external blinds, shutters, sunshades, grilles, louvers, or artwork.

Other exterior visual markers that can more easily demarcate hazardous glass areas for birds include exterior decorative grilles and fenestration patterns (stylistic arrangement of windows in a building) that help to better define for birds that building exterior surfaces are solid. Sunshades, louvers, external blinds, and other fixed or retractable/movable-shading devices on the outside, as well as window screens, can help to better define wide areas as solid and obscure reflections in the glass behind them. These features contribute to better articulating the building façade as something more than an uninterrupted, reflective surface.

iv. Design corner windows, glass walkways, glass railings, and other similar features to reduce the appearance of clear passage to sky or vegetation.

Walkways, pedestrian skywalks (glassed corridors linking buildings above-ground), glass noise barriers, bus shelters, glass patio railings etc. should be treated so they are not misinterpreted by birds as open flyways. Recessed areas and courtyards may be easy for birds to enter but confusing and more difficult to exit. These areas, especially if heavily planted with vegetation, can become traps for birds. These areas should have clearly defined edges, in either opaque materials or non-reflective glass.

b. Dampen reflections

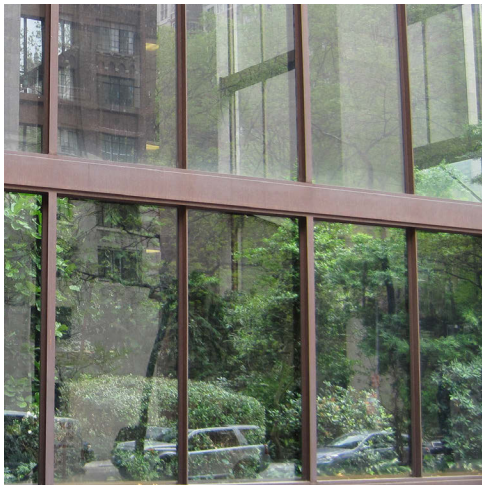
i. Use canopies or sunshades to cover windows at ground level.

Overhangs and awnings may reduce collisions but they do not eliminate reflections from glass; they only block it from being visible to birds flying above. Therefore this strategy will not be effective at reducing collisions from birds using low vegetation, e.g., shrubs and small trees, surrounding buildings.

ii. Use screens, drapes, or blinds to increase the opacity of clear glass.

Treatments of the inside of windows are not nearly as effective as those applied to the exterior, since under some lighting conditions, windows will continue to reflect the outdoors. Internal blinds and curtains are therefore only partially effective, and are not the best solution but can reduce some of the window reflectivity at certain times of the day. Drawing curtains or blinds when offices or homes are temporarily unoccupied, such as when workers go home for the evening or weekend, may reduce bird collisions.

Canopies, sunshades, screens, drapes and blinds can dampen reflections.



Interior landscaping attracts birds to habitat that is visible through glass.

c. Reduce the dangers of attractants and landscape reflections.

i. Ensure outdoor landscaping is at an appropriate distance from glass.

Landscaping (especially shrubs and trees) should be located far enough away from the building that there are no reflections of vegetation in its glazed surfaces. If this is not possible, landscaping should occur directly (0-1m) adjacent to glass. A bird perched further than 1 m from vertical glass can achieve enough momentum to fatally collide. If the above condition is not possible, then other measures should be taken to make glass visible. This may be particularly applicable for buildings near natural areas, where bird densities tend to be higher.

ii. Avoid interior landscaping near windows.

Interior landscaping should not present inviting habitat visible to birds from the outside of the building. Birds may fly towards greenery seen through transparent glass, assuming it to be desirable habitat. If it is not possible to site greenery away from windows, particularly in the lower floors of a building, glass should be treated with visual markers as described in the guidelines above.

iii. Locate birdfeeders 0-1 m from windows.

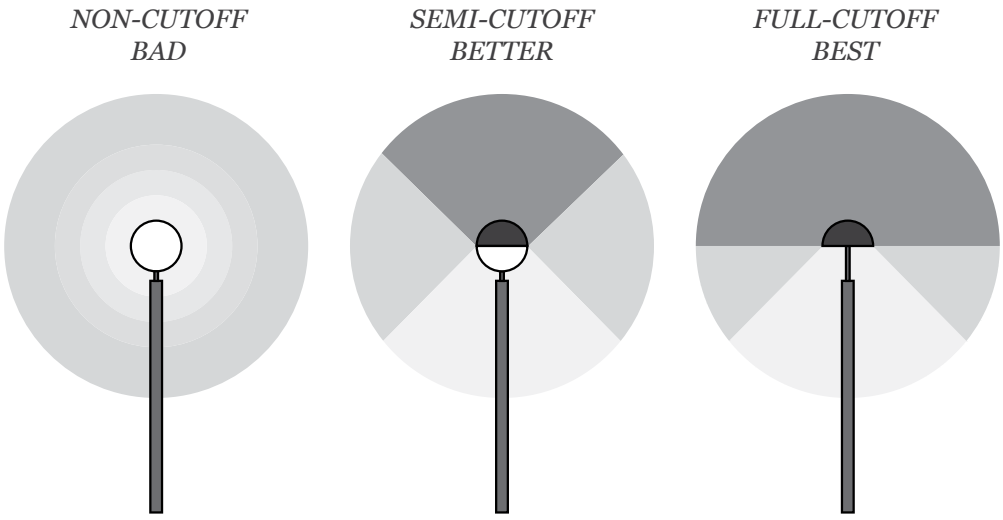
While this recommendation may seem counter-intuitive, experiments have shown that when birdfeeders are located very close to windows, birds that are startled and initiate a "panic flight" cannot generate enough speed to injure themselves if birdfeeders are located very close to windows.[77] The opposite is true when birdfeeders are located further from windows. The optimal location for birdfeeders to prevent collisions is placement within 1 m of the window. When feeders are located further away from windows, panic flight can result in sufficient acceleration to cause mortality or severe injury.

d. Reduce light pollution

Most long-distance migratory songbirds and shorebirds, as well as some waterfowl, migrate at night when the air is cooler and calmer and predators are less active.[78] At night, the navigational systems of birds can be impeded by the presence of artificial light, especially during inclement weather conditions involving heavy cloud, when birds tend to fly at lower altitudes.[79] Birds are known to use celestial cues like the moon and stars as part of their "on board" navigation, in addition to being guided by local topography, so it is possible that artificial light sources are confusing to birds.[80] Like humans, birds' eyes require time for dark adaptation, and light pollution can interfere with this dark adaptation. The interference of artificial light with the suite of systems that birds use for navigation makes them more vulnerable to colliding with structures such as buildings, towers and various forms of infrastructure. In addition, birds appear to be reluctant to leave any artificially lighted areas they enter during their nocturnal migration. Large numbers of birds may circle a light source over a number of hours, depleting their energy reserves and making them more vulnerable to collisions during the night and following day as described above.

i. Reduce unnecessary light-spill through shielding, targeted lighting and reduction of vanity lighting.
ii. Down lighting should be selected over up lighting and floodlighting should be avoided.
iii. Use the minimum wattage fixtures.

REDUCE LIGHT POLLUTION:
Use down-lighting and avoid uplighting



e. Reduce the dangers of open pipes, ventilation grates and drains.

Open, uncapped pipes, particularly hollow plastic PVC and metal pipes and posts, used for a variety of purposes such as exhaust and venting, can be lethal to birds.[81] Once birds enter these open pipes, they are unable to escape because the smooth surface within the pipe prevents them from getting sufficient traction to change direction. The narrow interior of the pipe also prevents them from opening their wings to fly out. Ventilation grates and drains can also be a hazard, as birds that collide with windows and become stunned can fall through, become trapped, and are unable to fly out.

i. Ventilation grates and drains should have openings no larger than 2 by 2 cm or 1 by 4 cm to ensure that birds cannot be trapped within.
ii. Cap or screen the ends of all open pipes, large and small, so that birds do not become entrapped when investigating these openings for nesting opportunities.

Thank you!

The City of Vancouver would like to thank the organizations, scientists and municipalities whose work on urban birds and bird friendly design guidelines made this document possible. Special thanks goes to Leslie Evans-Ogden for her work compiling bird friendly building design guidelines and developing text specific to the City of Vancouver, from which this document borrowed extensively. The City would also like to thank the UBC Greenest City Scholar, Michele Campbell, for her work on bird friendly landscape design guidelines.

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Appendix A – Additional Resources

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