BIRD-FRIENDLY URBAN DESIGN GUIDELINES

Integrating Natural Systems with Human Activities

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THE CITY OF CALGARY

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Acknowledgements

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CBBS (Calgary Bird Banding Society)

FLAP Toronto (Fatal Light Awareness Program)

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City of Calgary Land Use Planning and Policy

City of Calgary Law Department

1.0 Introduction

Image 1: Chipping Sparrow

The City of Calgary Bird-friendly Urban Design Guidelines (the "Guideline") offers bird-friendly urban design strategies and guidelines which address the direction of Calgary Planning Commission, the Centre City Plan policies (2007, Section 7.9, Urban Ecology), and the environmental objectives outlined in the City of Calgary's Environmental Policy and the Municipal Development Plan (MDP).

Based on local data collected by Calgary Bird Banding Society (CBBS) and on research collected from global sources on bird mortality in relation to the built environment, the Guideline provides a collection of urban design-based strategies for the creation of bird-friendly developments, buildings, and structures. It also offers suggestions for bird-friendly building operations which align with accepted sustainable design objectives.

2.0 Role of the Guideline

2.1 Policy Alignment

The City of Calgary Bird-friendly Urban Design Guidelines (the "Guideline") provides a variety of bird-friendly urban design suggestions that can be considered to achieve the environmental objectives as outlined in the following high-level policy documents approved by Council:

The City of Calgary's Environmental Policy

The City of Calgary's Environmental Policy states:

The City will lead and inspire actions to reduce Calgary's ecological footprint and conserve, protect and enhance the environment for all Calgarians and the regional community. The City will integrate social, economic and environmental principles and performance objectives into all decision-making processes to maintain a high quality of life for present and future generations.

The policy further states:

The City of Calgary will integrate environmental considerations into all decisions and approvals relating to growth, planning, infrastructure, transportation and development.

The City of Calgary Municipal Development Plan (MDP)

The City of Calgary Municipal Development Plan incorporates the following specific environmental objectives and policies into land use, urban form and transportation planning to help to reduce impacts on the environment:

- *Protecting environmentally-sensitive areas that conserve biodiversity and contribute to people's quality of life, the quality of communities and the quality of ecological systems.*
- *Creating a more compact urban form that uses less land and, therefore, reduces habitat loss and fragmentation and adverse impacts on wildlife, vegetation and water quality and quantity.*
- *Maintain biodiversity and landscape diversity, integrating and connecting ecological networks throughout the city.*
- *Give the highest priority to the protection of environmentally-significant areas in the allocation of land use.*
- *Protect biodiversity within river valleys, ravines, coulees and wetlands.*
- *Ensure that the protection of significant habitats (sensitive ecological areas/unique environmental features) within the city's parks and open space system takes precedence over other uses.*
- *Protect riparian areas to meet habitat, water quality and public access through environmental reserve dedications and design alternatives.*
- *All land use and transportation planning and development should seek to conserve and protect ecosystems by:*
  - *i. Recognizing the interconnectedness of air, land, water, climate, ecosystems habitat and people;*
  - *ii. Considering and managing the cumulative impacts of development;*
  - *iii. Establishing, protecting and restoring native habitat and areas of biodiversity locally and regionally.*

2.0 Role of the Guideline

The Centre City Plan

The Guideline responses to the Centre City Plan (2007, Section 7.9, Urban Ecology) regarding setting a high standard of sustainable design practice for both new buildings and renovation projects. The specific action item is:

Investigate and report back to Council on the impact of built form on the migration of birds within the specific Calgary context. The report should propose specific mitigation techniques if warranted and achievable.

2.2 Status of the Guideline

The Guideline is a non-statutory document. It aligns with and elaborates upon specific environmental considerations as outlined in the City of Calgary's Environmental Policy, the Municipal Development Plan, and the Centre City Plan.

As a supplement to other policy documents, the Guideline provides urban design guidance and examples of means by which to balance aesthetics and bird-friendliness.

The Guideline will be considered by the development authority during the review of planning applications to assist in reducing adverse impacts of our built environment on bird population.

Situations may arise where direction given in the Guideline is at apparent conflict with other applicable policies and guidelines. For example, the development of a pedestrian-friendly, fully transparent building façade or +15 bridge may address other policies and guidelines, but be less desirable in terms of bird-friendliness. Tree planting is another example, where landscaping is desirable, but its placement could have negative consequences for bird populations. The careful placement of trees could eliminate bird-vulnerable facades with inviting habitat reflected in glazing. A mutually compatible solution in both scenarios could be the treatment or modification of the glass façade to reduce glass reflectivity. It is the intent of the Guideline to raise awareness of bird-sensitive development and suggest alternative or comprehensive design considerations that would be mutually beneficial in addressing the urban design objectives of the pedestrian realm while being bird-friendly.

The dangers a particular building might pose to birds can be significantly mitigated or exacerbated specifically by the design and operation of building's lighting. The Guideline provides an additional and specific layer of information complementary to the Centre City Illumination Guidelines (Proposed, March 2011).

In addition, it is the intention of this Guideline to raise public awareness regarding bird-building collisions, and to offer a catalogue of potential urban design-related solutions.

2.3 Audience

Planners, architects, designers, builders and owners can use the Guideline to understand the principles underlying bird-friendly design and look to them as a resource where appropriate to new projects under consideration. Building operators also play a part in maintaining and operating their facilities in a bird-friendly fashion.

3.0 Stakeholder Engagement

The DRAFT version of the Guideline was reviewed and commented on by a number of relevant organizations and individuals, including CBBS (Calgary Bird Banding Society) and FLAP Toronto (Fatal Light Awareness Program), City of Toronto, and Dr. Daniel Klem, a renowned researcher studying bird-window collisions. As part of the engagement process, the draft version of the Guideline was also circulated to selected internal and external stakeholders representing the audience of the document including planners, architects, designers, builders and owners. The comments received from those stakeholder groups who responded were largely incorporated into the Guideline.

4.0 Background Information

4.1 Bird Collisions with Buildings

Approximately 1,400 bird species are found in North America, 250 of which are migratory. Canada is home to over 600 species. [1] These populations are considered to be increasingly threatened: The World Conservation Monitoring Center lists 71 bird species on the continent as threatened.

The Commission for Environmental Cooperation cites loss of natural habitat as the primary cause of bird population declines, but also lists collisions with buildings - known as strikes - as one of several other principal threats to the birds of North America. [2]

Estimates of bird mortality vary greatly, owing to the general lack of awareness and reporting of the problem, and to the large variance in estimates of general bird populations. The United States Fish and Wildlife service estimates that of a North American population guessed at between 10 and 20 billion birds, building strikes may account for at least 97 million deaths each year. The estimates suggested could be much higher. [3] The increased incidence of bird collisions with buildings is particularly apparent during Spring and Fall migration seasons, when the population of migratory birds in a city increases. Bird mortality from window strikes is very high. An estimate of between 50–90% of birds die after a strike, usually from internal hemorrhaging. [4]

In comparison to building strikes, the United States National Wind Coordinating Committee estimates that nation wide there are 60 million to 80 million annual bird deaths caused by automobiles, 4 million to 50 million annual fatal encounters with communications towers, and 7,000 wind turbine bird fatalities annually (or about 1-2.5 bird fatalities per tower per year). Cat predation is another major challenge for birds. To put this into perspective, among several major causes of bird death related to human impacts, building and window strike is one of the most significant causes.

This is a modern irony that as sustainability has become an important objective for buildings, increased glazing has become the fashion. These very buildings have become more of a threat, and therefore less sustainable to our migratory bird populations.

Image 2: Orange-crowned warbler

Image 3: A photo of birds collected by FLAP volunteers in Greater Toronto Area in 2009

Image 4: Building as sky

Image 5 A complete reflection of sky

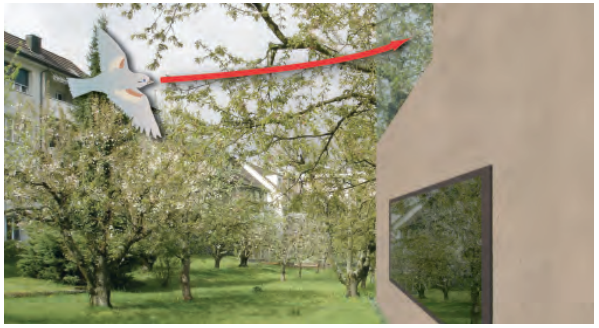


Image 6: A reflection of habitat

4.2 Causes of Collisions

Built Environment

Birds cannot see clear or reflective glass. Collisions are caused when they attempt to fly toward inviting habitat or sky reflected in or seen through building glass. The colour and size of a window does not affect whether a bird might strike it. Simply, where birds and windows coexist, collisions can happen.

Specific landscape features (planting, building orientation) can further explain the degree of peril at a particular site. Research has demonstrated that the threat from reflective glass persists for any time of day, season of the year, or weather condition. [5]

During the day, birds are at risk because they are unable to perceive clear or reflective glass as a solid. Particularly dangerous are buildings which through construction or location reflect habitat and sky. Specific perils include see-through view corridors where a bird can observe internal or external greenery through building corners or walkways. [7]

During the night, disoriented birds are effectively trapped by lighted and densely-built downtowns. In attempting to remove themselves to safety, birds may fly into reflective glass or clear glass through which they can see interior landscaping. A migratory bird which is not a year-round city resident (such as a pigeon or a magpie) can easily fall prey to the perils inherent in reflective and transparent glass surfaces.

Image 7: Bird collisions with buildings

4.0 Background Information

Light Pollution

During the spring and fall migrations, the population of birds over and in cities increases, where migratory birds are ill-suited to cope with the physical obstructions and other obstacles our cities present. Night-migratory birds flying over a city can become confused by the effects of light pollution, which draws them toward dense urban centres. Light pollution competes with the light of the moon and stars, which provide one of the natural instinctive clues by which birds navigate.

Birds are hesitant to fly from a well-lit area to a dark one. This behaviour is exacerbated in poor weather, when their natural navigational cues are obscured by low cloud cover. Birds then tend to circle within lighted areas, increasing the risk of collision and exhaustion. [6]

Specific recommendations relative to the light pollution issues of spill light and light trespass are outside of the scope of this document. Reference the City of Calgary Land Use Bylaw and the Centre City Illumination Guidelines for these lighting recommendations.

Image 8: Night-time city lights

4.3 Calgary Context

Image 9: White-throated sparrow

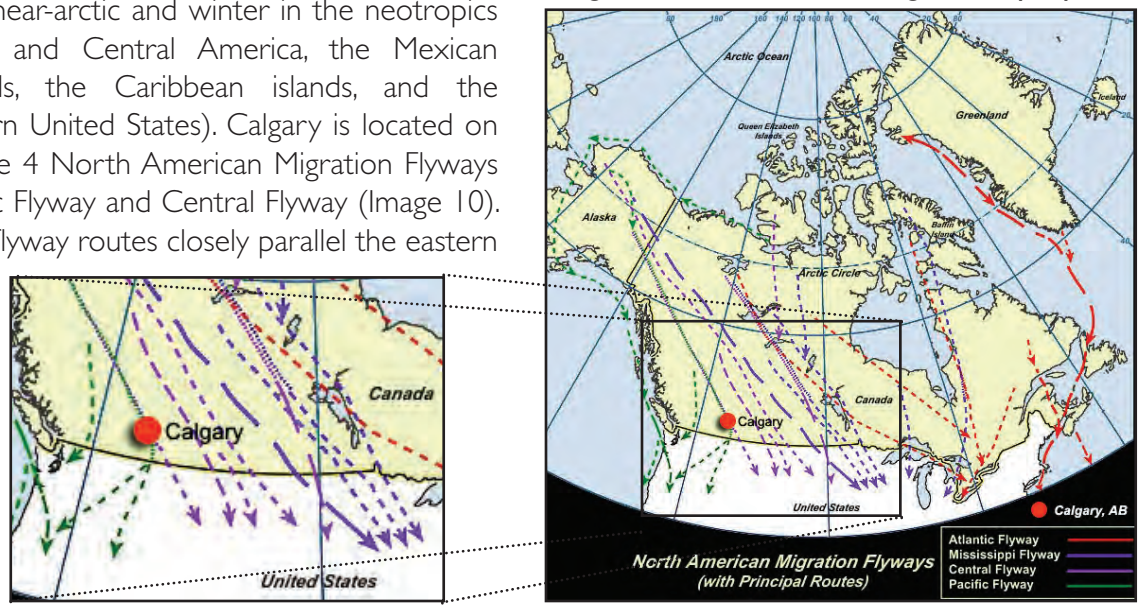
This section provides research and data specific to bird mortality in Calgary. While the collection data for Calgary's bird population may be in question in terms of quality and timeliness, the research and data from other sources such as New York, Toronto, and Switzerland are extensive, and provide sound evidence of bird mortality in relation to built environment as a serious worldwide environmental issue.

Migratory Birds

A major portion of the migratory population of birds traveling past Calgary are known as neotropical migrants, which are birds that breed in the near-arctic and winter in the neotropics (South and Central America, the Mexican lowlands, the Caribbean islands, and the southern United States). Calgary is located on 2 of the 4 North American Migration Flyways - Pacific Flyway and Central Flyway (Image 10). These flyway routes closely parallel the eastern foothills of the Rocky Mountains. [8] Although not identified as one of the "Principle Routes", involving large numbers of migratory birds, estimates put this population at 5-10 billion birds and over 150 species.

Some research indicates that the numbers of neotropical migrants in North America may be decreasing. A primary cause may be the destruction of their wintering grounds in tropical forests, but there is increasing awareness and concern for the impacts of urbanization on these birds' breeding grounds. [9]

Image 10: North American Migration Flyways



4.0 Background Information

Bird Mortality In Downtown Calgary

It is important to recognize the assembled facts of bird mortality as directly observed in the Calgary region. In a study running from 1995 through 1997, the Calgary Bird Banding Society (CBBS) collected and recorded the number of strikes for buildings in the downtown core during the spring-fall migration periods. The intent of the project was to determine the number of avian mortalities occurring in the downtown core, especially during the migration periods; and if weather conditions and building lighting has an effect on birds in the downtown area. More current collection data is not available.

In the three years of monitoring strikes, CBBS collected 411 birds, an average of 137 birds per year. There is a great likelihood that these gathered statistics far underestimate actual numbers of strikes considering limited number of volunteers participating in the program, limited number of Downtown buildings being monitored, lack of report of bird strikes for those unstudied buildings, and potential predators (e.g. domestic cats, crows, other scavengers) preying on dead and injured birds before they were found by the participating building owners.

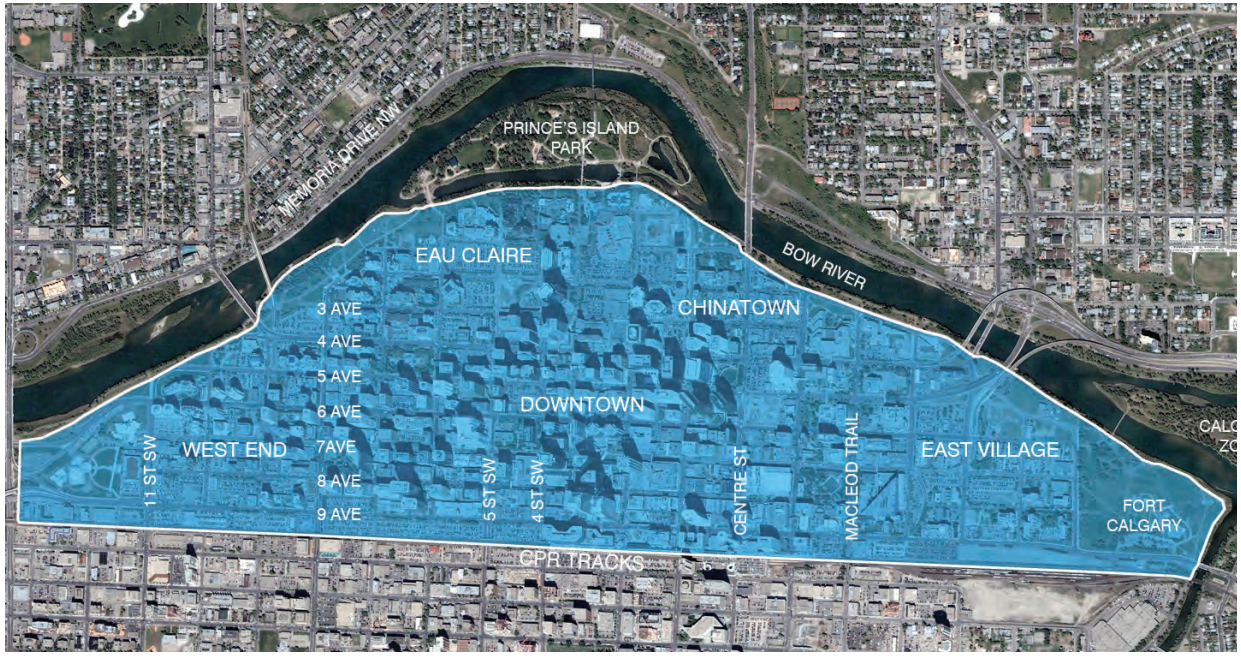


Image 11: Critical downtown area

Critical Downtown Area

In Calgary, preferred bird habitat is concentrated along the river systems, in locations such as the Inglewood Bird Sanctuary in the mature riparian forest on the Bow River east of downtown.

CBBS attributed the low number of strikes in one year of their study to the occurrence of clear nights during which birds fly at higher altitudes and have easier access to natural navigational cues such as the moon and stars. They also speculated that the popular habitat of the Bow River makes a more attractive bird refuge than the downtown core. [10] It is because of this proximity to the river and its high density that downtown Calgary is a critical area in which bird-friendly designs should be considered.

Downtown Bird Strikes Statistical Breakdown

The data was recorded based on the following categories: date, time, species, building, facing direction, and weather condition. As illustrated in Image 12, of the 411 collisions recorded between 1995 and 1997, 319 (78%) were with mirrored-glass buildings, indicating that a significant share of strikes occur during the day, when the building façade can be seen and mistaken for open sky or habitat.

Observations by building managers in Calgary suggest that buildings further from the river are struck less often, even if they are mirrored-glass buildings. This emphasizes the riparian corridor of the Bow as desirable bird habitat, and underscores the importance of bird-friendly design strategies for the nearby downtown area.

In Toronto, the last 15 years of data from the birds collected by the FLAP (Fatal Light Awareness Program) show that between 80 and 90% of known strikes are by migratory species. [11] Similarly, in Calgary, collected data indicates that between 70 and 90% of strikes are by known migratory species.

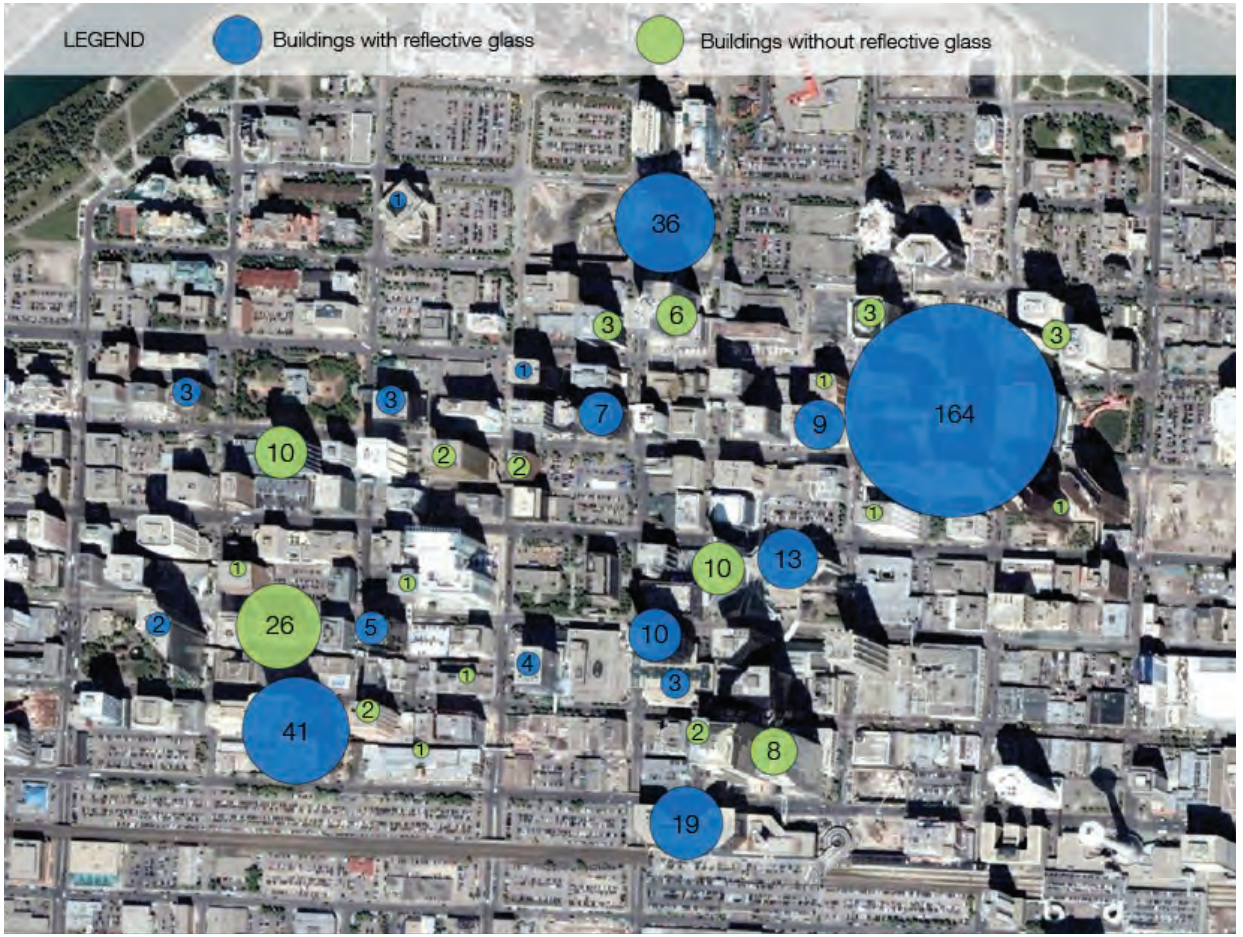


Image 12: Downtown bird strikes

4.0 Background Information

Without diminishing the statistical findings, it should be noted that of the 411 strikes recorded in Calgary between 1995 and 1997, only one of the birds recovered was from a threatened species. A Rusty Blackbird—which was rehabilitated and released—has a SARA (Species at Risk Act) status of "Schedule 1, Special Concern". Schedule 1 lists species in Canada that are extirpated, endangered, threatened and of special concern. In addition, one Olive-sided Flycatcher was found, which has a SARA status of "Schedule 1, threatened".

Image 13: Olive-sided flycatcher

5.0 Bird-Friendly Urban Design Guidelines

5.1 Goals

The goals of the Guideline include:

- Provide effective locally-appropriate design guidance that can be applied to new development;
- Illustrate modifications that can be made to improve an existing building's bird-friendliness; and
- Demonstrate how, with the judicious application of appropriate design strategies, both goals of design aesthetics and bird-friendliness can be achieved.

5.2 Guideline Area

This Guideline is intended to be relevant to citywide, and applied particularly where developments interface with environmentally significant areas including the patches, corridors and matrixes as defined by Section 2.6.4 Ecological Networks of The Municipal Development Plan (e.g. the Bow River and the Elbow River valleys, ravines, creeks, coulees, wetlands). Care should be taken with buildings and structures in the Centre City area, where the immediate adjacency to the Bow River and predominant concentration of the city's largest built structures are located, and the incidence of bird strikes has been observed to be highest.

Specific consideration should be given to building facades facing directly onto open spaces in urban areas (such as urban parks, pocket parks, green roofs, street-tree corridors, etc.) and onto natural landscapes in suburban areas. The following table lists the Areas of Particular Concern for applying bird-friendly urban design strategies and guidelines. Image 14 illustrates those areas, and Calgary's natural parks which have been identified as preferred natural habitats for local and migratory birds in Calgary.

Areas of Particular Concern

Areas of Particular Concern	**Descriptions**
Development/Building/Structure Locations	• Within the Centre City area (Centre City Plan, 2007) • Adjacent to Bow River and Elbow River valleys and open space, Weaselhead and Glenmore Park, and Fish Creek Provincial park (Within a distance of 1/4 mile or 400 metres from the edge of the open space) • Adjacent to Calgary's natural parks and associated open spaces as identified on Image 14 (Within a distance of 1/4 mile or 400 metres from the edge of the open space)
Window or Glass Façade Locations	• Abutting attractive bird habitat areas (trees, shrubs, meadows, water features, etc.) • At the first 4 levels of a building or up to 16 metres(especially the atriums, lobbies, linkways and +15 bridges) • Abutting a rooftop garden • Abutting a landscaped courtyard • At building corners

5.0 Bird-Friendly Urban Design Guidelines

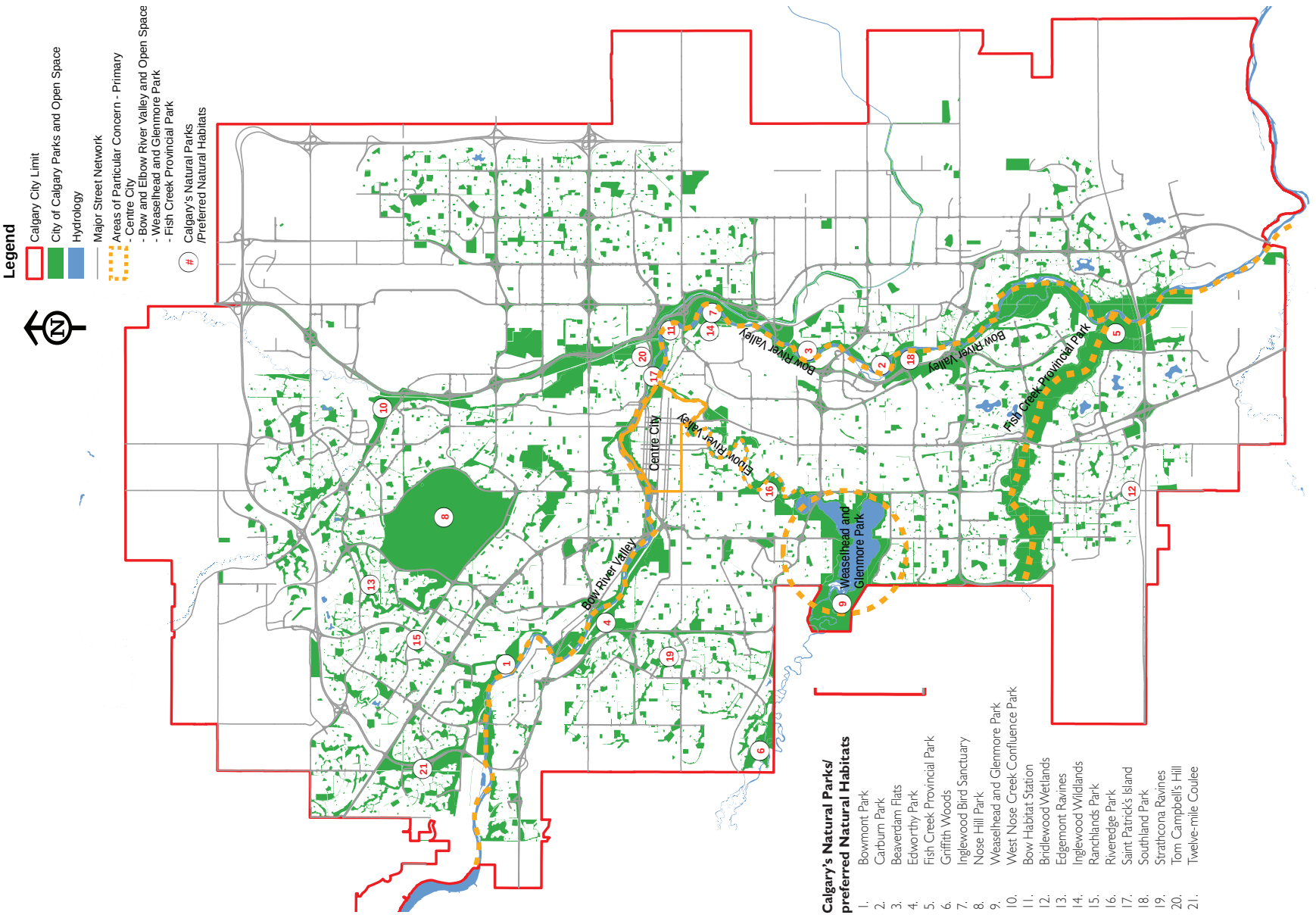


Image 14: Areas of Particular Concern / Calgary's Natural Parks

5.0 Bird-Friendly Urban Design Guidelines

5.3 Guideline Applications

Developments, Buildings and Structures

The Guideline is relevant to developments, buildings, and structures of any use or type which may present a peril to birds: high- or low-rise buildings, residential, commercial or industrial uses, bridges including road bridges and pedestrian bridges, +15 bridges and passageways, noise barriers, bus shelters, kiosks, etc.

Interior, Exterior and Lower Levels

Special design attention should be paid to ensure that linkways, interior lobbies, sky gardens, and building facades at or up to 16 metres above grade (or the typical mature tree heights in the area) are well-treated for bird friendliness.

Site Layout and Landscaping Features

Site layout and landscaping features should also be carefully considered to ensure bird friendliness. This applies to both at-grade and rooftop gardens, especially those adjacent to a building facade with transparent or reflective windows.

New Structures and Renovation of Old Structures

The Guideline should be applicable to both new structures and renovations of old structures.

Building Operations

Recommendations for bird-friendly building operation are also included as part of the Guideline.

City-owned Properties/Facilities

In response to the Centre City Plan, Section 7.9, Urban Ecology, ensure that City-owned facilities, as part of the objective to set a high civic standard of sustainable design practice, address Bird Friendly design considerations in both new buildings and renovation projects.

Image 15: Residential Building

Image 17: Bus Shelter

Comprehensive Considerations

The Guideline encourages the use of comprehensive bird-friendly strategies and guidelines which include both site/building/structure design and operational solutions.

Image 16: Linkway

Image 18: Museum Rietberg

5.0 Bird-Friendly Urban Design Guidelines

5.4 Strategies and Guidelines

This section of the Guideline outlines several strategies which may be used in order to reduce the risk of bird strikes on any new or existing development, building and structure. The guidelines under each strategy provide design guidance and potential design solutions available for planners, architects, designers, builders and owners to consider. To supplement a bird-friendly urban design, or to improve the sustainability of any development, building, or structure, there are additional operational practices that building owners, managers and tenants can implement that will positively impact bird populations.

Strategy 1: Clearly distinguish building/structure volumes with visual markers

Reflective and transparent glass on buildings and structures present two different hazards to birds: the first reflects inviting habitat (trees) or sky, while the second appears as open flyways. Image 19 and Image 20 show potential urban design solutions.

Image 19: A window film applied to the solarium entrance of a town building in Markham, Ontario to prevent bird-window collisions

Image 20: Translucent visual marker treatment on a bridge guardrail

5.0 Bird-Friendly Urban Design Guidelines

Guideline 1 Increase the density of mullions or other visual markers

One of the solutions to the problems presented by glass is to increase the density of mullions or other visual markers (e.g. exterior decorative grilles, fenestration patterns/multiple paned glass) that can help birds discern the building volume as something other than sky or reflected landscape. Image 21 and Image 22 show examples of how decreasing mullion spacing and using spandrels of non-reflective material helps to define a building volume as a solid.

The optimal density for visual markers is 10 cm—a hand's width—although spacing of 28 cm is considered satisfactory. This spacing is small enough that a bird will not attempt to fly between the markers. The greatest density should be located at the height which presents the highest risk.

When birds are trapped in urban areas, they can easily get confused, and even a ventilation grate could be dangerous for them. A porosity of 2 by 2 centimetres is recommended to ensure the grate is fine enough that a bird will not be trapped.

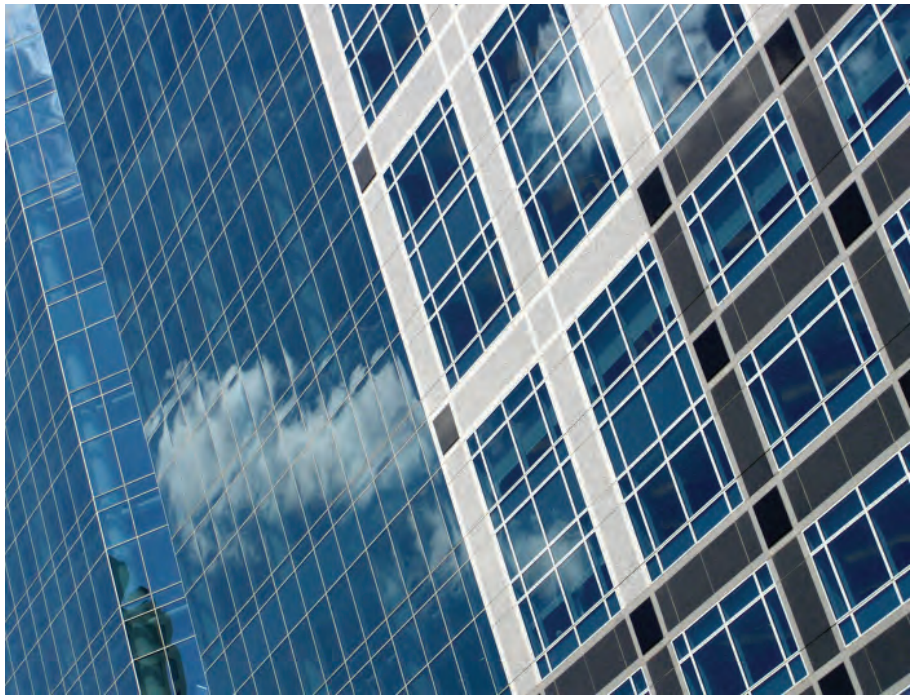


Image 21: Dense mullions and visual markers

Image 22: The use of both transparent and opaque building surface materials combined with dense mullions.

Guideline 2 Add visual noise with films, decals or frits

The optimal density of mullions would often not be desirable or practical, so other solutions can be sought: commercially available films (Image 24), decals, and fritted or frosted glass (Image 23) can be employed to effect a high degree of visual noise that will positively mark the glass and building as a solid object in the landscape.

Research has shown that some graphic patterns, such as vertical stripe patterns or spiderweb patterns, are more effective than others.

Image 24: An image of CollidEscape (one-way viewing perforated external window film) that has been successfully applied and used to prevent bird strikes at windows at commercial and residential dwellings. Thousands of small perforations allow ample light to pass through the window to the interior, while substantially reducing the window's exterior reflectivity and transparency. Graphic patterns can be printed on the exterior film to make it more aesthetically appealing. The film can be applied to windows of certain heights or locations without contradicting pedestrian-friendly interfaces that other policies require.

Image 23: Frosted glass appearing as a solid

Guideline 3 Interrupt reflective glass with spandrel panels, sunshades or louvres

Image 25: Spandrels interrupting a reflective facade

Image 26 Louvres defining areas as solid

The experience of Calgary Bird Banding Society(CBBS) is that any interruption in a reflective façade, such as a horizontal spandrel at each storey as shown in Image 25, is beneficial in reducing the number of strikes.

A solution does not have to be uniform for any one building. An improvement in the visibility to one area of a building's glass will help with the adjoining areas, by increasing the overall articulation of the building's volumes.

Sunshades, louvres and other passive shading devices fastened to the exterior of the building help by defining wide areas as solid and obscuring reflections in the glass behind them, as can be seen in Image 26. They contribute to the overall articulation of the building façade as something more than an uninterrupted, reflective surface. Where installed, they prevent birds from seeing reflective glass as either open sky or inviting habitat.

5.0 Bird-Friendly Urban Design Guidelines

Guideline 4 Treat the glass on the first 4 storeys to render it visible to birds

Ideally, all building glass should be treated to make it bird-friendly. For those instances where this is neither desirable nor possible, the 4 storeys above grade (16 metres)—those portions of the building that are at or below tree-canopy height—are the most critical, and should be treated in order for the building to be considered bird-friendly.

The practice of adhering silhouettes of predatory birds to windows is generally considered ineffective. These single images only succeed in marking a small portion of the glass as a solid. In order to be effective, visual markers should cover a large extent of the windows.

Application of this guideline need not conflict with policy objectives and urban design guidelines requiring transparency at grade to promote retail and pedestrian street animation. There are many design solutions to explore in order to meet both objectives of pedestrian and bird friendliness.

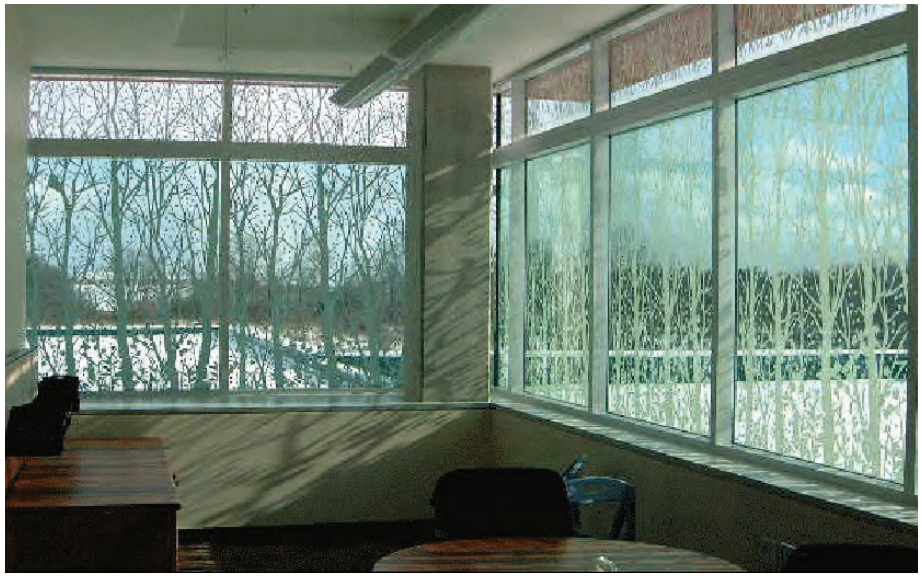


Image 27: The window film is patterned in the shape of trees and attached to the windows of the Earth Rangers Centre in Woodbridge, Ontario. FLAP Toronto collaborated with Earth Rangers to help make their new LEED building safe for birds. The design received an "innovation" LEED credit for addressing bird-building collision issue in the design.

5.0 Bird-Friendly Urban Design Guidelines

Guideline 5 Ensure building volumes such as courtyards, walkways and Plus 15s are clearly defined

Recessed areas and courtyards—areas where it is easy for a bird to enter and become confused—should have clearly defined edges, in either opaque materials or non-reflective glass. [12] Walkways and Plus 15s should be treated (based on Guidelines 1, 2, 3, 4, 8, 9 and 10) so that they are not misinterpreted by birds to be open flyways. [13]

Image 28: Clearly defined courtyard volumes

Strategy 2: Mute reflections

Collisions are caused when birds attempt to fly toward inviting habitat or sky reflected in building glass. Image 29 shows one of the many design solutions which can be considered.

Image 29: A window film applied to the solarium entrance of a town building in Markham, Ontario to prevent bird-window collisions

5.0 Bird-Friendly Urban Design Guidelines

Guideline 6 Use awnings to cover ground-storey glass

Awnings at the ground level become opaque visual markers that have the effect of obscuring reflections of sky or trees in ground-storey glass. Awnings can also serve to reduce visual connections with internal landscaping.

Image 30: Awnings covering glass

Guideline 7 Use internal screens, curtains or blinds to make clear glass more opaque

Visual markers on the inside of transparent glass can serve to make the building volume more opaque. Objects such as screens should be placed in close proximity to the inside of the glass in order to be effective.

Lighter colours work better at muting reflections. To maximize their usefulness, building users must remember to close curtains or blinds during the evening if the interior lights are on. [14]

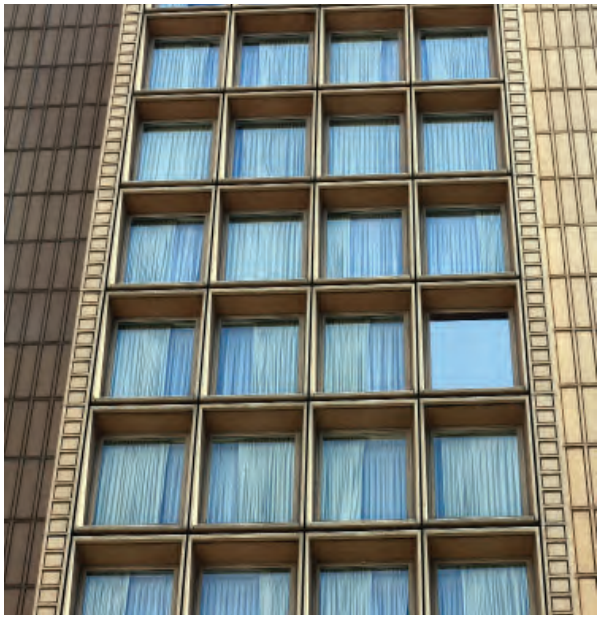


Image 31: Curtains drawn to increase opacity

Guideline 8 Angle glass downward to reduce reflections of sky and surrounding landscaping

Glass that is angled between 20 and 40 degrees so that it reflects the ground instead of the sky has been demonstrated to substantially reduce the hazard of reflections. The angling of the glass also theoretically serves to reduce the force of a strike's impact. [15]

Image 32: Canted windows

Strategy 3: Reduce reflections of landscape

Landscape attractive to birds, such as watering areas and vegetation next to windows will increase the potential for bird strikes. [16] Care should be taken to minimize the risk of strikes by locating site vegetation appropriately, and adding visual markers to glazing as necessary.

Image 33: Reduce reflections of landscape - before

Image 34: Reduce reflections of landscape - after

5.0 Bird-Friendly Urban Design Guidelines

Guideline 9 Locate site landscaping away from untreated building glazing

A bird-friendly building will be situated and oriented on its site in such a way as to reduce the reflections of vegetation or water on its glazed surfaces. [17] If it is not possible to site the building away from existing vegetation which is inviting to birds, strategies such as those discussed in the previous guidelines should be employed.

New landscaping that may be attractive to birds should be located far enough from the building to reduce reflections in its glazed surfaces. Alternately, trees can be planted close to a building façade if they are sufficiently close to the building—within a metre—that their reflections will be obscured, and the velocity of departing birds will be slow enough to limit the fatality of any strikes. [18]

Guideline 10 Locate interior landscaping away from windows

Interior landscape elements should not have the effect of presenting desirable habitat to birds on the outside of the building. Upon seeing greenery through transparent glass, birds may fly toward it as a place of refuge. The peril is increased if interior light levels are equal to or greater than exterior light levels.

Lobby greenery should be located well away from exterior windows. In those existing cases where this is either not possible or desirable, glass treated with visual markers such as frits, decals or films will make the lobby more bird-friendly.

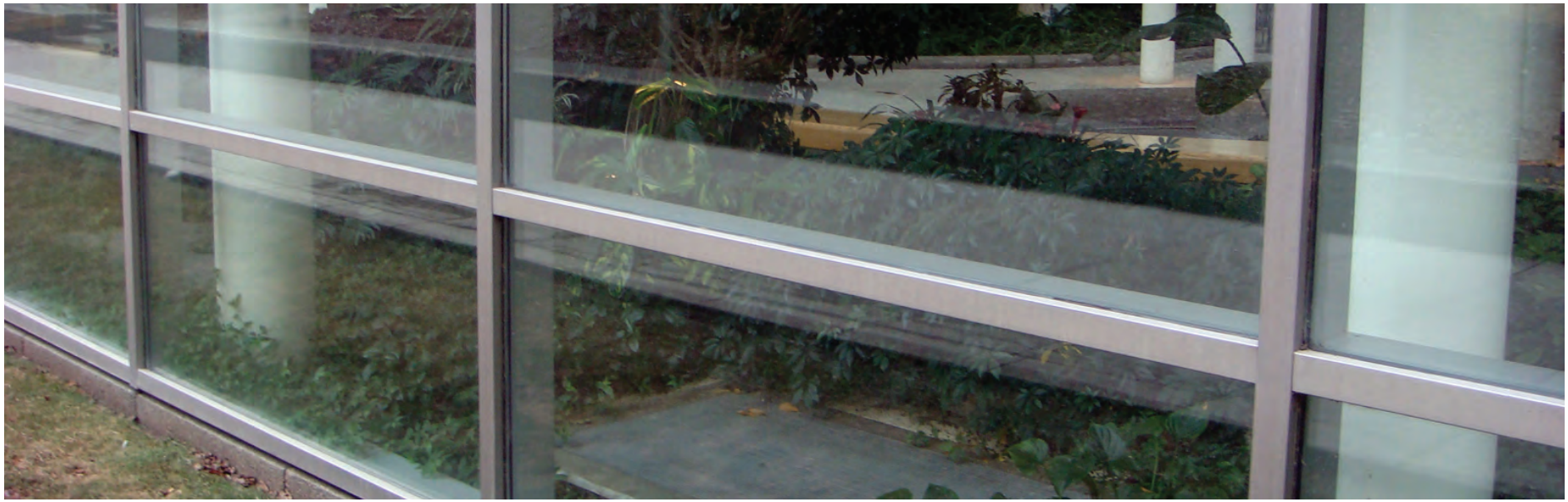


Image 35: Lobby landscaping visible from the exterior

Strategy: 4 Reduce site and building light pollution

During the night, disoriented birds are effectively trapped by lighted and densely-built downtowns.

Image 36 shows some design sensitivity to spill light in urban areas.

Guideline 11 Select appropriate site and area lighting fixtures

Refer to the City of Calgary Land Use Bylaw and the Centre City Illumination Guidelines for exterior lighting requirements and recommendations.

Guideline 12 Consider migratory seasons when implementing festival lighting and advertisement lighting effects

In this Guideline, Spring migration is considered to be mid-March to early June, and Fall migration is mid-August to early November. Reference Centre City Illumination Guidelines and Calgary Land Use Bylaw for lighting recommendations.

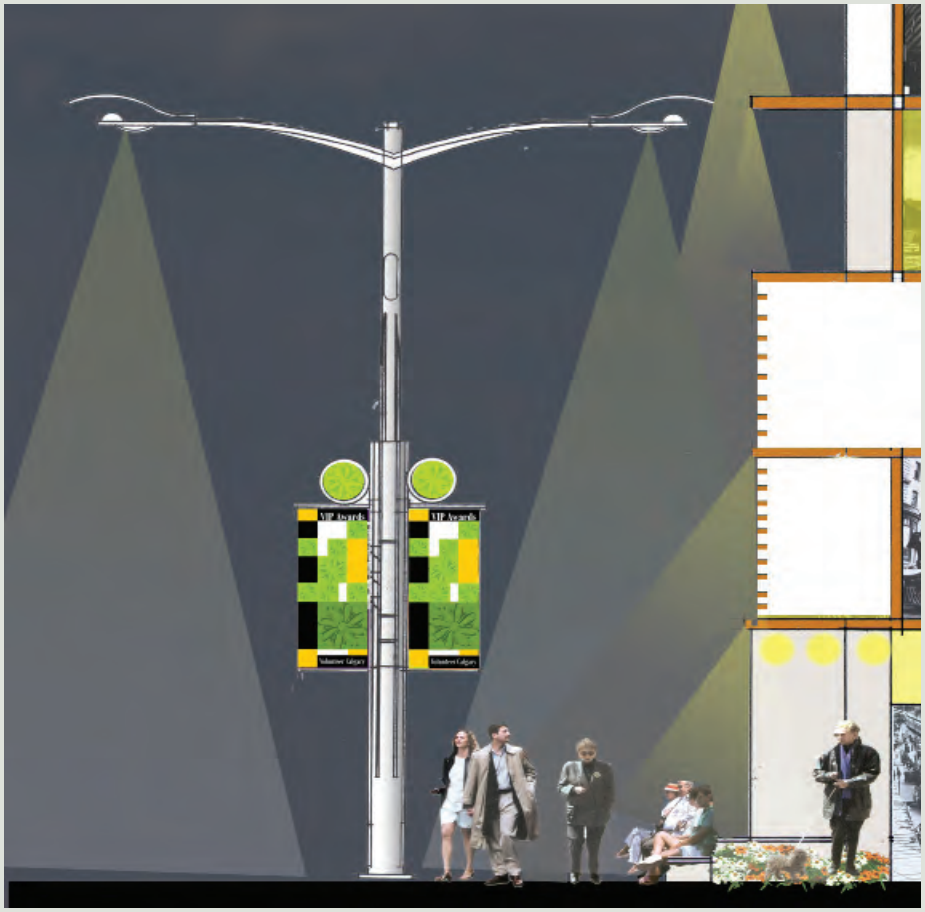


Image 36: An illustration showing design to constrain light to the features being lit..

Strategy 5: Extinguish or Manage the Effect of Interior Lights

Turn off interior lights at every opportunity. This is particularly important during the migratory seasons of about 6 months a year (mid-March to early June for Spring migration and mid-August to early November for Fall migration), or during periods of inclement weather, when low-flying birds will be more susceptible to becoming lured and trapped by city lights. This also provides financial benefit for building owners through savings on energy cost.

Image 37: An illustration of a street scene at night with reduced spill lights and interior lights turned off. The lighting at street level is sufficient for pedestrian safety as well as urban vitality.

Guideline 13 Use task lighting and draw office curtains or blinds

Interior lights should be turned off whenever possible.

Nighttime building occupants should make use of task lighting whenever possible, to reduce the amount of time that building lights are on. When internal lights are on, curtains or blinds should be drawn in order to reduce the amount of light cast to the exterior.

Guideline 14 Use timers and motion sensors to limit unnecessary lighting

Building lighting systems on timers help to make efficient use of energy, and ensure the timely reduction of excess building light and the possibility of fatal light attraction for birds. Motion sensing devices can minimize excess building lighting, without sacrificing security or convenience. [19]

Guideline 15 Schedule building cleaning during the day

One potential operational strategy to reduce exterior light pollution from a building is to have cleaning staff move through the building during daylight hours, rather than in the evening when interior building lights will be required. A net benefit can be achieved in terms of energy, personal work schedules and security.

5.5 Sustainability Integration

The City is a strong supporter of sustainable building practices. The City of Calgary Sustainable Building Policy (2008) defines a sustainable building as follows:

"A sustainable building integrates building materials and methods that promote environmental quality, economic vitality, and social benefit through the design, construction and operation of the built environment. Sustainable building merges sound environmentally responsible practices into one discipline that looks at the environmental, economic and social effects of a building or built project as a whole. Sustainable design encompasses the following broad topics: appropriate management of land, efficient management of energy and water resources, management of material resources and waste, protection of the environment, protection of indoor and outdoor air quality and reinforcement of natural systems through an integrated design approach."

This section identifies the potential benefits of applying bird-friendly urban design strategies and guidelines, and explains how adopting bird-friendly guidelines has corollary benefits towards other sustainability goals. It also highlights potential cost-saving benefits for building owners who consider the guidelines and put them into practice.

The City strongly promotes the use of energy design and management systems to encourage energy efficiency in buildings. The bird-friendly design features and elements included in this document may help in securing credits under one of the many Green Rating Systems such as LEED® Canada, Built Green Canada, BOMA BESt, Green Globes (or an equivalent rating system).

5.0 Bird-Friendly Urban Design Guidelines

Strategies	Guidelines		Benefits
Strategy 1: Clearly distinguish building volumes with visual markers	1	Increase the density of mullions or other visual markers	• Stimulation of innovative aesthetic approaches to façade treatment in addition to increased bird friendliness. • Stimulation of research and development in the glass industry - The aesthetic and cost related issues associated with increasing the density of mullions for curtain walls may help to stimulate research and development in the glass industry to develop an integral glass technology, which may resolve the conflicts between glass building-related bird mortality and imposing major aesthetic modifications to glass building designs.
	2	Add visual noise with films, decals or fritted glass	• A cost-effective, bird-friendly design solution with increasing levels of energy performance through application of exterior or interior window films - The window films help to control interior building climate passively by greatly reducing solar heat gain in a building thus substantially reducing cooling loads on a building.
	3	Interrupt reflective glass with spandrel panels, sunshades or louvres	• A cost-saving, bird-friendly solution - Opaque building elements (such as spandrel panels in curtain wall) that comply to bird-friendly design guidelines typically reduce capital costs (i.e. spandrel is less expensive than clear glazing) while providing higher insulation values and subsequently reducing operating costs. • Better energy performance - shading devices can help to control interior building climate passively in addition to increasing bird friendliness by greatly reducing solar heat gain thus substantially reducing cooling loads. • Contribution to good design and aesthetics – Combination of opaque and transparent materials contributes to the overall articulation of the building façade with variations.
	4	Treat the glass on the first 4 storeys to render it visible to birds	• Contribution to both bird and pedestrian friendliness when aesthetically appealing graphic patterns are applied to transparent or reflective glass surface, especially at the lower levels of the buildings. • Glare control. • Addressing privacy issue at lower levels of a residential building. • Increasing the visibility of retail businesses through applying colourful and unique graphic patterns on transparent or reflective glass at the lower levels of the buildings. This should not conflict with retail visibility as detailed in the Centre City Plan and other City policies and bylaws..
	5	Clearly define building courtyards, walkways and Plus 15s	• Clearly-defined, legible site plan and building layout contributing to both pedestrian and bird safety.
Strategy 2: Mute Reflections	6	Use awnings to cover ground-storey glass	• Functioning as shading devices and contributing to glare control, reduction of solar heat gain. • Contribution to overall articulation of the building façade. • Contribution to human scale and pedestrian orientation of the streets.
	7	Use internal screens, curtains or blinds to make clear glass more opaque	• Reduces solar heat gain in a building during the day, resulting in energy savings. • Reducing light pollution (including urban sky glow, light trespass, glare) from the building during the night. • Addressing privacy issue especially for a residential building.
	8	Angle glass downward to reduce reflections of sky and surrounding landscaping	• Daylight effectiveness - Angled glass, when used appropriately, can substantially reduce building cooling loads, while reducing internal reflections for better glare control and greater transparency to occupants. • Contribution to overall articulation of the building façade with unique variations.

5.0 Bird-Friendly Urban Design Guidelines

Strategies	Guidelines		Benefits
Strategy 3: Reduce reflections of landscape	9	Locate site landscaping away from untreated building glazing	• A simple and cost-effective solution - Locating bird attractive habitat away from glass is a simple and cost-effective solution for reducing bird-building collisions. • Less site disruption and reflection of existing landscape - For sites with existing landscaping, site disruption is minimized by reducing the size of the building footprint, and the reflections can be avoided by locating the glass facades far away from existing landscaping. • Contribution to maximizing vegetated open space on a new development site - For a new development, the smaller the size of the building footprint, the greater the opportunity to expand the vegetated open space on the site. When landscaping techniques (e.g. 1m close to the glass building façade) are employed to reduce reflections of landscape on glass façades, the vegetated open space can be maximized without compromising bird-friendliness. • When 1 metre close to the glass building facades, the landscape provides beneficial summertime shading and reduces cooling loads. This also applies to rooftop gardens which help to reduce heat absorption through adjacent glass facades while reducing heat islands and minimizing impact on microclimates.
	10	Locate interior landscaping away from windows	• When practical, this is a quick and easy solution to reduce the incidents of bird-window collision.
Strategy 4: Reduce site and building light pollution	11	Select appropriate site and area lighting fixtures	• Reduction of operating costs through energy efficient building operation and maintenance practices. • Reduction of light pollution and light trespass. • Reduction of sky-glow and improved night-time visibility through glare control. • Reduction of visual clutter, which refers to bright, confusing, and excessive groupings of light sources commonly found in over-lit urban areas. • Reduction of energy consumption and carbon dioxide emissions. • Highly effective solutions in reducing night-time bird-building collisions, especially during migratory season.
	12	Consider migratory seasons when implementing festival lighting and advertisement lighting effects	
Strategy 5: Extinguish or manage the effects of interior lights	13	Use task lighting and draw office curtains or blinds	
	14	Use timers and motion sensors to limit unnecessary lighting	
	15	Schedule building cleaning during the day	

5.6 Reference Guide

Development Review Process

(For Development Planners to consider during the review of planning applications)

Step 1: Check the project location based on the proximity of development to flyways and habitats (as described in the following table).

Step 2: Check the locations of the window or glass façades included in the proposed development to identify all bird vulnerable facades (a-e as described in the following table)

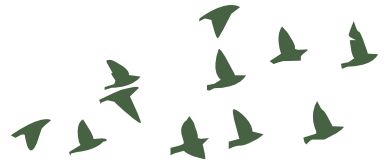
Step 3: Identify the level of importance for the application of the guidelines (low, medium and high as shown in the following table)

Step 4: Discuss with and encourage applicants to consider applying bird-friendly urban design guidelines based on the level of importance identified in Step 3. The higher the level of importance, the more design intervention being applied to those bird-vulnerable facades as identified in Step 2. Refer to Section 5.5 for potential benefits of applying the guidelines.

The Hierarchy/Level of Importance for the Application of the Guidelines

Hierarchy/ Level of Importance / **Window or Glass Façade Locations** / **Project Location/ Proximity of Development to Flyways and Habitats**	**Bird-vulnerable Windows or Glass Facades** a. Abutting attractive bird habitat areas (trees, shrubs, meadows, water features, etc.) b. At the first 4 levels of a building or up to 16 metres (especially the atriums, lobbies, linkways and +15 bridges) c. Abutting a rooftop garden d. Abutting a landscaped courtyard e. At building corners	**Other Locations** (excluding a-e)
Areas of Particular Concern (Image 14) • Within the Centre City area (Centre City Plan, 2007) • Adjacent to Bow River and Elbow River valleys and open space, Weaselhead and Glenmore Park, and Fish Creek Provincial park (Within a distance of 1/4 mile or 400 metres from the edge of the open space) • Adjacent to Calgary's natural parks and associated open spaces as identified on Image 14 (Within a distance of 1/4 mile or 400 metres from the edge of the open space)	High	Medium
Other Locations (Adjacent to other scattered Parks and Open Spaces throughout the city as shown on Image 14)	Medium	Low

5.0 Bird-Friendly Urban Design Guidelines



Strategies and Guidelines

The following table is a summary of strategies and guidelines for planners, designers and architects when considering bird-friendliness of a development, building or structure. It provides a quick reference guide for development planners to review a development application for bird friendliness. It also provides a checklist for building owners to consider the operational aspects.

Checklist: Strategies and Guidelines

Strategies	Guidelines		New Developments/ Buildings/Structures	Retrofits	Operation
Strategy 1: Clearly distinguish building volumes with visual markers	1	Increase the density of mullions or other visual markers	✓	✓	
	2	Add visual noise with films, decals or fritted glass	✓	✓	
	3	Interrupt reflective glass with spandrel panels, sunshades or louvres	✓	✓	
	4	Treat the glass on the first 4 storeys to render it visible to birds	✓	✓	
	5	Clearly define building courtyards, walkways and Plus 15s	✓		
Strategy 2: Mute reflections	6	Use awnings to cover ground-storey glass	✓	✓	
	7	Use internal screens, curtains or blinds to make clear glass more opaque		✓	✓
	8	Angle glass downward to reduce reflections of sky and surrounding landscaping	✓	✓	
Strategy 3: Reduce reflections of landscape	9	Locate site landscaping away from untreated building glazing	✓	✓	
	10	Locate interior landscaping away from windows	✓	✓	✓
Strategy 4: Reduce site and building light pollution	11	Select appropriate site and area lighting fixtures	✓	✓	
	12	Consider migratory seasons when implementing festival lighting and advertisement lighting effects			✓
Strategy 5: Extinguish or manage the effect of interior lights	13	Use task lighting and draw office curtains or blinds		✓	✓
	14	Use timers and motion sensors to limit unnecessary lighting	✓	✓	✓
	15	Schedule building cleaning during the day			✓

Glossary

BOMA BESt - BOMA BESt (Building Environmental Standards) is a national program launched in 2005 by BOMA Canada to address an industry need for realistic standards for energy and environmental performance of existing buildings based on accurate, independently verified information.

Today, BOMA BESt has evolved from simply identifying key best practices to providing common standards; an array of educational and on-line assessment tools; independent data audits; and a four-level performance certification program.

For more information, visit http://www.bomabest.com

Built Green Canada -The Built Green name adds value to new home construction by promoting and recognizing the use of practices and products that represents resource-efficient and environmentally friendly construction. The primary purpose of Built Green Canada is to encourage home builders to use technologies, products and practices that will:

- Provide greater energy efficiency and reduce pollution
- Provide healthier indoor air
- Reduce water usage
- Preserve natural resources
- Improve durability and reduce maintenance

For more information, visit http://www.builtgreencanada.ca

CBBS – The Calgary Bird Banding Society (CBBS) was incorporated on 22 March 1995 with the following objectives:
- Quantify long-term population trends of Neotropical migratory birds using constant effort mist-netting;
- Promote involvement and expertise in bird banding; and
- Promote conservation of Neotropical migratory birds by fostering public awareness and understanding of Neotropical migratory birds.

CBBS is an active local bird organization in Calgary whose primary project is monitoring of birds at Inglewood Bird Sanctuary, a federal Migratory Bird Sanctuary.

FLAP – Fatal Light Awareness Program (FLAP) was founded in 1993. It has played the pinnacle role for raising awareness of the bird collision phenomenon across the globe. As the first organization of its kind in the world, FLAP has mobilized the NGO (Non-government Organization), business, educational, and government sectors to seek out progressive ways of protecting birds from the hazards of our built environment. FLAP has provided the template for educational and rescue initiatives in cities like Calgary, Montreal, Chicago, New York City, and Minneapolis & St. Paul.

Fatal Light Attraction – The consequence of the increase in artificial lighting by streetlights and buildings, whereby nocturnal migratory bird species are attracted to and disoriented by our cities' glowing night skies. The effects of fatal light attraction are exacerbated in poor weather such as rain or fog. [20]

Fritted Glass - Glass with a ceramic-based paint fused to its surface.

Glass Treatment - In the context of this document, any of a number of methods used to render glass opaque and non-reflective to birds. Possible glass treatments include the use of closely spaced mullions and other solid objects, as well as the application of commercial films, ceramic frits and decals.

Green Globes - The Green Globes system is a revolutionary building environmental design and management tool. It delivers an online assessment protocol, rating system and guidance for green building design, operation and management. It is interactive, flexible and affordable, and provides market recognition of a building's environmental attributes through third-party verification.

For more information, visit www.greenglobes.com

Glossary

LEED® Canada - LEED® Canada for New Construction and Major Renovations (2009) is the Canada Green Building Council's nationally accepted standard of sustainability for the commercial, residential, and institutional building industries. Credits are awarded in six categories:

1. Sustainable Sites
2. Water Efficiency
3. Energy and Atmosphere
4. Materials and Resources
5. Indoor Environmental Quality
6. Innovation In Design
7. Regional Priority

For more information, visit http://www.cagbc.org

Light Pollution - The unnaturally increased illumination and temporary fluctuations in lighting produced from man-made sources such as building lights, street lamps and vehicles. [21]

Light Trespass - A form of light pollution, where potentially unwanted light crosses a property line.

Migratory Route/Flyway - The terms "migration route" and "flyway" are to some extent theoretical concepts, while the latter has, in addition, come to have an administrative meaning. Migration routes may be defined as the lanes of individual travel from any particular breeding ground to the winter quarters of the birds that use them. Flyways, on the other hand, may well be conceived as those broader areas in which related migration routes are associated or blended in a definite geographic region. They are wide arterial highways to which the routes are tributary. [22]

Migratory Seasons - According to CBBS, there are birds migrating through Calgary area at all times between March and November, not to mention there are irruptive species that are moving even during winter months in search of food resources. Specific groups of birds migrate and move at different times. In this Guideline, Spring migration is considered to be mid-March to early June, and Fall migration is mid-August to early November.

Spandrel Panel - The opaque portion of a building's exterior between the top a window and the sill of the window above.

Spill Light - A form of light pollution resulting from excess light from a focused source being cast where it is not useful or desired.

Strike - Any occurrence, whether fatal or not, of a bird colliding with a building.

Visual Markers - Physical cues on the exterior of a building which help its surface appear different than reflected sky or habitat.

Visual Noise - The effect of the application of visual markers on the appearance of a building. A building with high visual noise will be more visually distinct from reflected habitat or sky, and more easily distinguished and avoided by birds.

References

1 Secretariat of the Commission for Environmental Cooperation. "North American Important Bird Areas." Publications and Information Resources. 25 Oct. 1999. 5 Feb. 2009. <cec.org/pubs_info_resources/publications/pdfs/english/iba-ang.pdf>. Pp. v.

2 Ibid. Pp. vi.

3 U.S. Fish & Wildlife Service. "Migratory Bird Mortality." Division of Migratory Bird Management. 31 Jan. 2002. 5 Feb. 2009. <fws.gov/birds/mortality-fact-sheet.pdf>. Pp. 2.

4 American Bird Conservancy. "Mortality Threat to Birds – Building Strikes." 2007. 5 Feb. 2009. <abcbirds.org/conservationissues/threats/buildings.html>.

Klem, Daniel Jr. "Bird Injuries, Cause of Death, and Recuperation from Collisions with Windows." Journal of Field Ornithology. Vol. 61, No. 1. 1990. 10 Aug. 2010. <http://aco.muhlenberg.edu/documents/JFO19906l115-119.pdf>. Pp.115.

Veltri, Carl J. and Daniel Klem, Jr. "Comparison of Fatal Bird Injuries from Collisions with Towers and Windows." Journal of Field Ornithology, Vol. 76, No. 2. 2005. 10 Aug 2010. <http://aco.muhlenberg.edu/documents/FieldJournaltowers-windows2005.pdf>. Pp.127.

5 Klem, Daniel Jr. "Glass: A Deadly Conservation Issue for Birds." Bird Observer. Vol. 34, No. 2. 2006. 5 Feb. 2009. <birdscreen.com/PDF/Bird-Observer2006.pdf>. Pp. 74.

6 American Bird Conservancy. "Mortality Threat to Birds – Building Strikes." 2007. 5 Feb. 2009. <abcbirds.org/conservationissues/threats/buildings.html>.

7 American Bird Conservancy. "Mortality Threat to Birds – Building Strikes." 2007. 5 Feb. 2009. <abcbirds.org/conservationissues/threats/buildings.html>.

8 Birdnature.com. "North American Migration Flyways". Published 1998-2009. <http://www.birdnature.com/flyways.html> (visited August 2010)

9 Collister, Douglas M. and Gwen Smiley. "2006 Annual Technical Report." Calgary Bird Banding Society. Aug. 2007. 5 Feb. 2009. <calgarybirdbandingsociety.org/documents/06cbbsatr.pdf>. Pp. 11.

Klem, Daniel Jr. "Avian Mortality at Windows: the Second Largest Human Source of Bird Mortality on Earth." Proceedings of the Fourth International Partners in Flight Conference: Tundra to Tropics; McAllen, Texas, USA. USDA, Forest Service Technical Report. 2009. 10 Aug. 2010. <http://aco.muhlenberg.edu/documents/Klem_PIF09-Final-rec-1-XII-09.pdf>. Pp.244.

10 Calgary Bird Banding Society. "Fatal Light Awareness Program (FLAP) Calgary 1995." Completed Projects. 5 Feb. 2009.<http://www.calgarybirdbandingsociety.org/completed.php#flap>.

11 Fatal Light Awareness Program. "93 Through 98." Flap Resource Centre - Bird Collision Data - Recovery Data. 09 Jan. 2009. <http://www.flap.org/data.htm>.

12 "Bird-Safe Building Design Guide for New Construction and Renovation." City of Chicago. 2006. 5 Feb 2009. <cityofchicago.org/Environment/BirdMigration/pdf/SafeBuildingDesignGuide.pdf>. Pp. 2.

13 Ibid.

14 Brown, Hillary and Steven Caputo. "Bird-Safe Building Guidelines." New York City Audubon Society. May 2007. 5 Feb 2009. <nycaudubon.org/home/BirdSafeBuildingGuidelines.pdf> Pp. 35.

References

15 Klem, Daniel Jr., et al. "Effects of Window Angling, Feeder Placement, and Scavengers on Avian Mortality at Plate Glass." Wilson Bulletin. 116 (1), 2004. 5 Feb 2009. <birdscreen.com/PDF/Klem_WB_WindowAngling2004.pdf>. Pp. 72.

16 Klem, Daniel Jr. "Glass and Bird Kills: An Overview and Suggested Planning and Design Methods of Preventing a Fatal Hazard." 1991. 5 Feb 2009. <birdscreen.com/PDF/NIUWSymp1991.pdf>. Pp. 102.

Klem, Daniel Jr., Christopher J. Farmer, Nicole Delacretaz, Yibal Gelb, and Peter G. Saenger. "Architectural and Landscape Risk Factors Associated with Bird-Glass Collisions in an Urban Environment." Wilson Journal of Ornithology, Vol. 121, No. 1. 2009. 10 Aug 2010. <http://aco.muhlenberg.edu/documents/Klem-Et-al-2009-A-L-Risk-Factors-WJO-121-01-126-134-l.pdf>. Pp. 126.

Klem, Daniel Jr. "Preventing Bird-Window Collisions." Wilson Journal of Ornithology, Vol. 121, No. 2. 2009. 10 Aug 2010. <http://aco.muhlenberg.edu/documents/Klem-2009-Prev-wils-121-02-314-321-e.pdf>. Pp.314.

17 Brown, Hillary and Steven Caputo. Pp. 25.

18 "City of Toronto Green Development Standard – Bird-Friendly Development Guidelines." Pp. 26.

19 Ibid. Pp.29

20 Deda, P., I. Elbertzhagen, and M. Klussman . "Light Pollution and the Impacts on Biodiversity, Species and Their Habitat." Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals (UNEP-CMS). 2007. 5 Feb. 2009. <starlight2007.net/pdf/proceedings/P_Deda.pdf>. Pp. 134.

21 Ibid. Pp. 133.

22 Birdnature.com. "North American Migration Flyways". Published 1998-2009. <http://www.birdnature.com/flyways.html> (visited August 2010)

Image Credits

Image	Description	Source or Credit
Cover	A window film used on the government building in Markham, Ontario to prevent bird-window collisions	FLAP Toronto collaborated with the Convenience Group, Inc., Toronto, Ontario
1	Chipping Sparrow	naturepicsonline.com, released to public domain. (commons.wikimedia.org/wiki/File:Chipping_Sparrow.jpg)
2	Orange-crowned warbler	U.S. Fish and Wildlife Service, public domain. (commons.wikimedia.org/wiki/File:Orangecrownedwarbler27.jpg)
3	A photo of birds FLAP Toronto volunteers picked up in Greater Toronto Area in 2009	Kenneth Herdy/FLAP
4	Building as sky	HF Ng, licenced (bigstockphoto.com/photo/view/3365229)
5	A complete reflection of sky	Sky, licenced. (bigstockphoto.com/photo/view/3607148)
6	A reflection of habitat	Swiss Ornithological Institute
7	Bird collisions with buildings	Swiss Ornithological Institute
8	Night-time city lights	Gorgo, released to public domain. (commons.wikimedia.org/wiki/File:PengrowthSaddledomeNight.jpg)
9	White-throated sparrow	Steve Listengart, released to public domain. (commons.wikimedia.org/wiki/File:Sparrow,_White_throated.jpg)
10	North American Migration Flyways	Adapted from Birdnature.com. (http://www.birdnature.com/flyways.html)
11	Critical downtown area	Evan Spence, Zeidler Partnership Architects
12	Downtown bird strikes	Evan Spence, Zeidler Partnership Architects
13	Olive-sided flycatcher	Birds of New York (New York State Museum. Memoir 12), Albany: University of the State of New York. Plates by Fuertes later reproduced in Birds of America (1917) by Thomas Gilbert Pearson (1873-1943) et al., public domain. (en.wikipedia.org/wiki/File:Contopus_cooperiAAP067B.jpg)

Image Credits

Image	Description	Source or Credit
14	Areas of particular concern/Calgary's natural parks	Foley, Jim. "Calgary's Natural Parks." Calgary Field Naturalists' Society. 2006.
15	Residential Building	Swiss Ornithological Institute
16	Linkway	Wilfried Doppler, Vienna
17	Bus Shelter	Wilfried Doppler, Vienna
18	Museum Rietberg	Swiss Ornithological Institute
19	A window film applied to the solarium entrance of a town building in Markham, Ontario to prevent bird-window collisions	FLAP Toronto collaborated with the Convenience Group, Inc., Toronto, Ontario.
20	Translucent visual maker treatment on a bridge railing structure	Swiss Ornithological Institute
21	Dense mullions and visual markers	Melissa Dockstader (bigstockphoto.com/photo/view/1542815)
22	The use of both transparent and opaque building surface materials combined with dense mullions.	Urban Design & Heritage, City of Calgary
23	Frosted glass appearing as a solid	Urban Design & Heritage, City of Calgary
24	An image of CollidEscape (one-way viewing perforated external window film) that has been successfully applied and used to prevent bird strikes at windows at commercial and residential human dwellings.	FLAP Toronto
25	Spandrels interrupting a reflective facade	Alexander Fediachov: (bigstockphoto.com/photo/view/1540797)
26	Louvres defining areas as solid	Wolfgang Amri (bigstockphoto.com/photo/view/1618453)
27	The window film is patterned in the shape of trees and attached to the windows of the Earth Rangers Centre in Woodbridge, Ontario.	FLAP Toronto
28	Clearly defined courtyard volumes	Evan Spence, Zeidler Partnership Architects

Image Credits

Image	Description	Source or Credit
29	A window film applied to the solarium entrance of a town building in Markham, Ontario to prevent bird-window collisions	FLAP Toronto
30	Awnings covering glass	Evan Spence, Zeidler Partnership Architects
31	Curtains drawn to increase opacity	Gloria Meyerle: (bigstockphoto.com/photo/view/3367735)
32	Canted windows	Evan Spence, Zeidler Partnership Architects
33	Reduce reflections of landscape - before	Swiss Ornithological Institute
34	Reduce reflections of landscape - after	Adapted from Swiss Ornithological Institute
35	Lobby landscaping visible from the exterior	Evan Spence, Zeidler Partnership Architects
36	An illustration showing design to constrain light to the features being lit	Urban Design & Heritage, City of Calgary
37	An illustration of a street scene at night with reduced spill lights and interior lights turned off.	Urban Design & Heritage, City of Calgary