Expert Series:
Bird-Friendly Glazing

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Bird Basics

Up to one billion bird deaths in the United States are attributed to collisions with buildings and other structures each year[1]. This document provides information on the problem, its relation to building glass and glazing, and offers potential solutions for architects, contractors, and fabricators.

The highly social Bohemian wax wing almost always forages in flocks. This "flocking" behavior potentially makes collision occurrences more devastating.

The American Bird Conservancy partnered with the U.S. Green Building Council to incorporate solutions for bird-friendly architecture into USBGC LEED® (Leadership in Energy and Environmental Design) green building certification guidelines. The resulting USGBC Pilot Credit 55 is available for projects that develop a building façade and site design strategy that makes the building visible as a physical barrier to birds. Demand for bird-friendly glass is also driven by municipal and regional government requirements in a growing number of areas. As the architectural community and glass industry work to address this issue, it is critical for audiences to understand collision causes, product testing, bird behavior, and solution options.

Collison Causes

Cities with a density of building structures, including high-rise, can be the site of nighttime bird collisions due to interior and exterior lighting. Flocks of migrating birds can collide with large buildings and this generates headlines and attention. However, suburban, low-rise buildings account for a much higher percentage of collisions; individual collisions may not be as evident but can happen more frequently[2]. In general, there are four ways buildings and building environments contribute to bird collisions:

The Blackpoll Warbler is an intercontinental migrator in the Americas. With a 12,000-mile annual round trip migration, they are at risk for collision with low-rise buildings.

- **Reflection:** Birds cannot differentiate between actual and reflections of tree, sky, or habitat. Even lower reflecting glass can act like a mirror when it is bright outside and dark inside. When coupled with certain façade designs, the reflections can create areas that are visually confusing to birds. Reflective materials that provide adequate image formation, pose a danger to birds.

Reflections can deceive birds into thinking that the glass is an extension of the environment. Trees and sky are replicated on the surface of the glass.

- **Transmission:** When there is a direct line of sight from one window to another (e.g. walkways, corners, bus stops, or transparent wind/sound barriers), birds do not perceive the glass as a barrier, and may attempt to fly through, causing a collision. Also, birds can see wooded atriums or indoor plants as an inviting habitat.

High light transmission of certain glass can also be a problem because birds can clearly see the environment on the opposite side of the glass; they may be drawn to pass through this structure making collisions more likely.

- **Design:** The design of the building and its location can have a significant impact on the collision risk as well as the maximum effectiveness of deterrents. Building shape, location, and landscaping (especially the anticipated height of the tree canopy once mature) all have considerable impact on the collision risk profile of the facility.

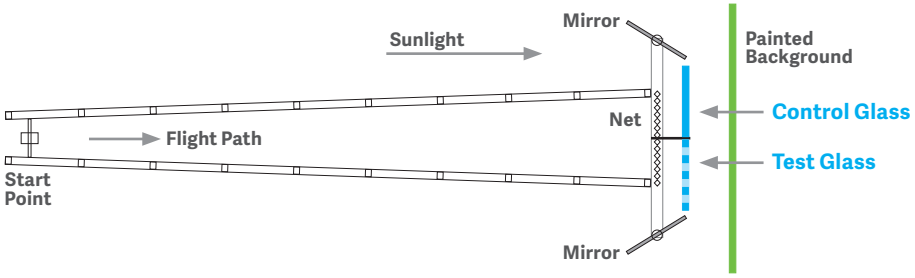
The design of the building can increase the likelihood of birds colliding with the facade by creating a funnel effect where birds fly into a space between the building and then find themselves surrounded by glass and unable to determine how to safely leave the area.

- **Lighting:** Birds use the night sky and ambient light levels to aid their migration navigation. This causes nighttime collisions as lighting inside buildings, especially those buildings with potential habitat, attracts birds. Artificial lights, particularly those that point upward, can lure and trap birds in their haze, where they potentially fly to the point of exhaustion.

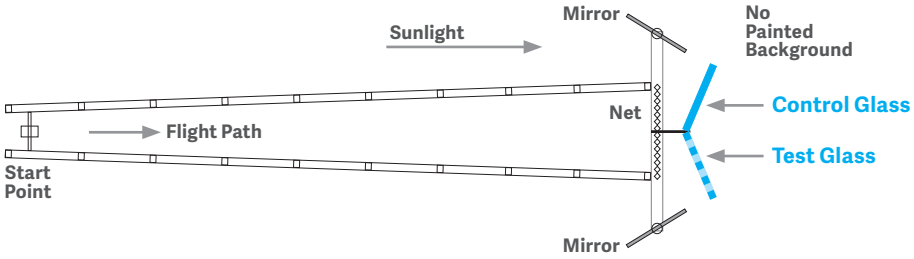
The interior and exterior lighting of this building could attract birds toward the building and increase the chances of collisions with the glass.

Product Testing and Bird Behavior

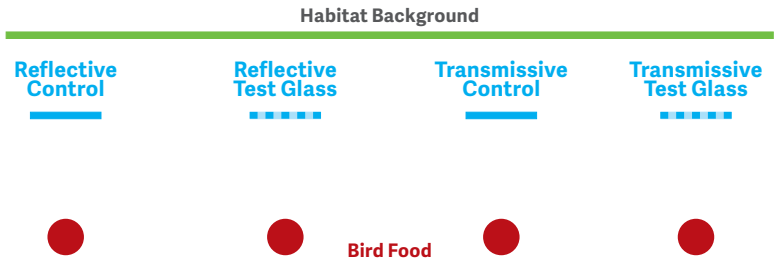
Products intended to reduce or eliminate bird collisions can be tested for effectiveness. Evaluation takes time given they take place during seasonal migration, resulting in a limited number of tests and product configurations. The following tests use different methodologies to evaluate glass products:



American Bird Conservancy Tunnel Testing: *Birds fly through a tunnel toward either a product for testing or a control in this non-lethal methodology. Products tested effective by ABC can help projects earn the LEED pilot credit.*



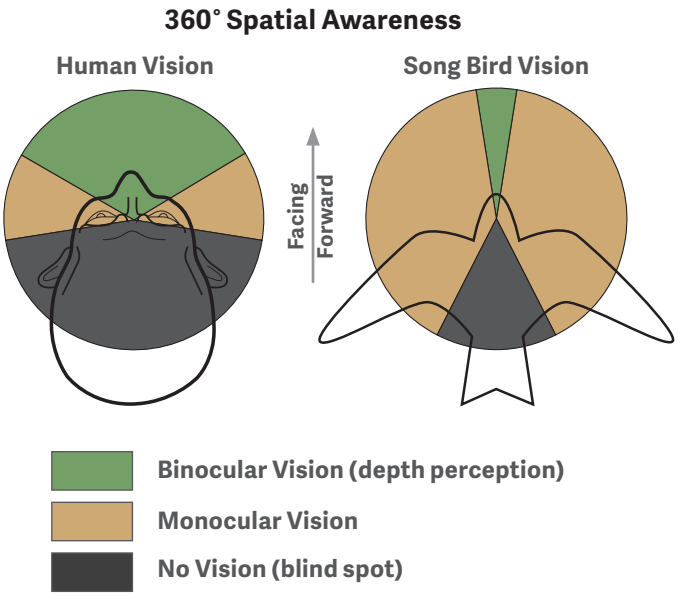
Austrian Tunnel Testing[4]: *The Austrian tunnel test is similar to ABC tunnel testing, while adding the ability to test samples in a reflective mode.*



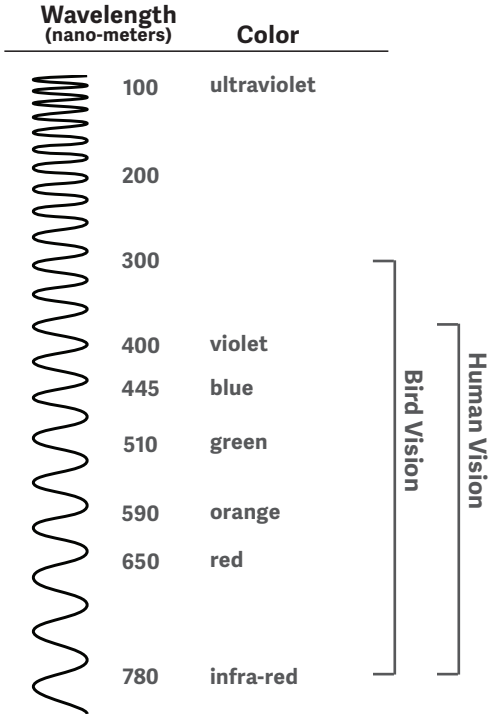
Muhlenberg College Field Testing[5]: *This test places glass in a natural habitat to avoid modifying bird natural behavior during testing and is capable of testing outside of migration and nesting periods (Sep-Mar), and avoids stressing birds and modifying their natural behavior during testing. This form of testing, essentially measures collisions that would already be happening on a façade (i.e. lethal).*

Before & After Retrofit Monitoring *is the most definitive way to test a deterrent but also the slowest method in developing data for actual results. Monitoring can take place year-round, but numbers increase starting in spring and peaking in the fall. There are over 100 community and education-based local initiatives to collect this data in North America.*

Biological Considerations



360° Spatial Awareness: Song birds have a nearly 360º field of view, but nearly no binocular vision. In flight, birds are looking more around their environment for food or predators rather than ahead of them at where they are going[6].



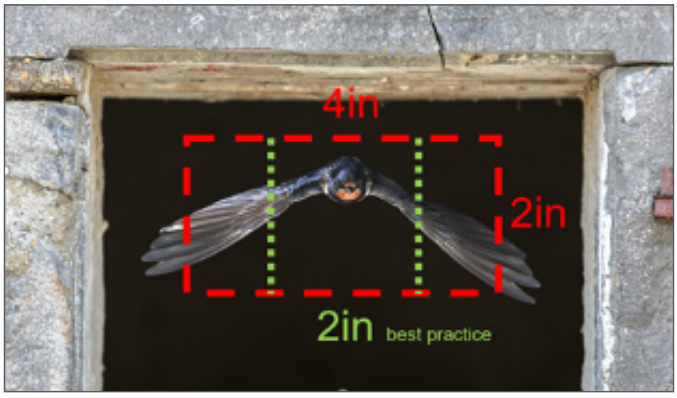
Song birds have vision that extends into the UV. This may be a weaker signal than the visible spectrum but does offer the possibility for solutions that are invisible to humans but are still effective for birds.

Solutions

To mitigate effects of image formation on the façade, strategies for Bird-Friendly building design can be summarized in four categories:

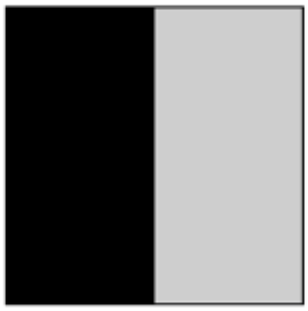
1. **Reduce the glazing area:** However, this can have other benefits and trade-offs related to energy performance and occupant views that should be considered.
2. **Utilize a physical barrier:** Mounting exterior materials such as netting, mesh or decorative grills, and shading systems.
3. **Building shape and site design:** Architects and designers can reduce the risk of bird collisions by addressing the following elements in the design planning phase. Studies show that proximity to undeveloped land, agricultural areas, parks, steep grades, and water often correspond to increased bird populations and therefore increased risk of collisions. Hills that are at the level of glass can increase likelihood that birds will fly into a façade. In addition, areas located in between landscape features desirable to some species of birds may also pose higher risks. Vegetation increases risk both by attracting more birds to an area and by being reflected in glass[3]. Consultants can help architects and designers by evaluating building plans for the impact that shape, layout, and fittings will have on bird populations.
4. **Incorporate glazing surface deterrence:** The most important considerations for any glazing deterrence solution are the implementation of the ***2x2 rule***, maximizing ***visual contrast***, and ***surface one deterrents***.

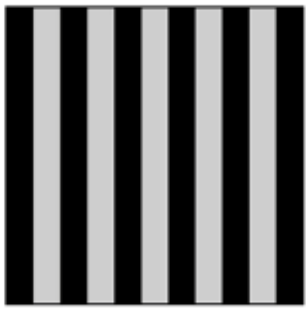
2x2 Rule (formerly 2x4)
Birds are highly aware of their body size (like wingspan) and how they can safely navigate through a complex 3D environment. Hummingbirds are the smallest species that are highly affected by collisions - they will avoid flying through gaps 2" x 2", in turn, coating or frit must meet these dimensions. This smaller spacing will also effectively deter birds with larger wingspans.

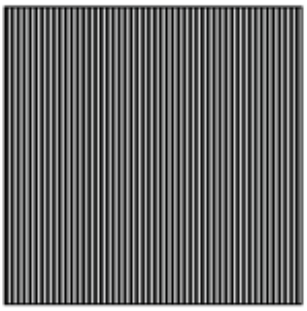


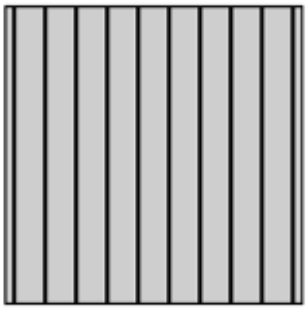
Visual Contrast
A pattern with smaller elements, smaller spacing, and greater coverage will be less visible from a distance than a pattern with larger elements, larger spacing, and smaller coverage.

(Left) Clear No frit. The center glazing with the larger dots provides superior visual contrast as compared to the glazing on the right, with a tighter distribution of smaller dots.


Pattern #1 - 50% Coverage

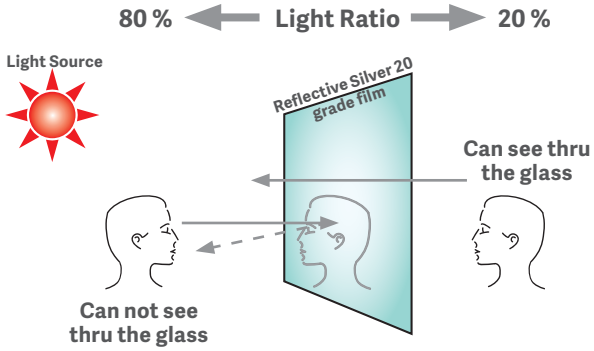

Pattern #2 - 50% Coverage


Pattern #3 - 50% Coverage

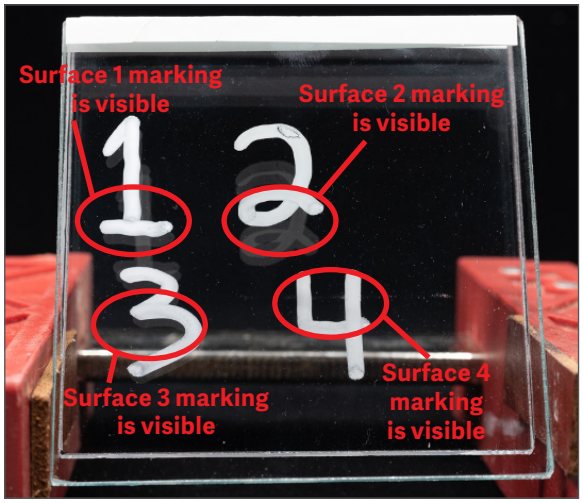

Pattern #4 - 7.5% Coverage

It is important to note that pattern design should be based on visual contrast and NOT simply percentage coverage. As shown above, the first three patterns in the row provide the same percent coverage while pattern #2 is the only one of the three that would be considered more effective by means of superior visual contrast. As shown by pattern #4 (7.5% coverage), precent coverage is not coupled to visual contrast or effectiveness, therefore it is possible to have patterns that are more effective collision deterrents that have a more minimal pattern.

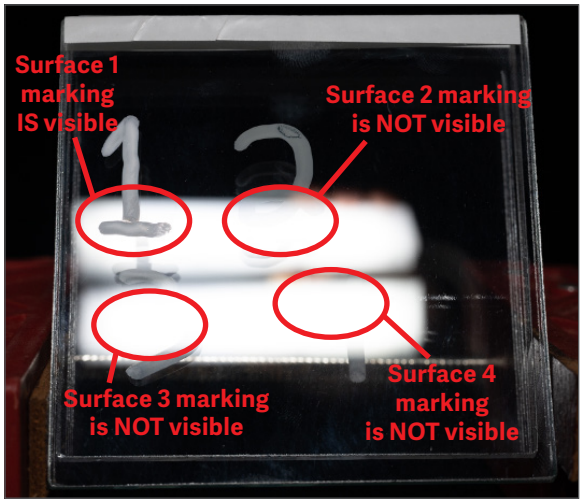
Surface 1 Deterrents
Placement of optimally spaced visual deterrents on surface one of a building's glazing further augments detection by birds by minimizing the dilution of contrast when placed on surfaces two, three or four. NOTE: IGU glass surface numbers are identified by counting from exterior (surface #1) to interior (typically surface #4 for a standard insulating glass unit).



A one-way mirror is a useful analogy when discussing the subject of surface positioning of a deterrent. In bright daylight, surface 1 reflections create a one-way mirror with everything that is behind it (whether inside the building or on other glass surfaces).



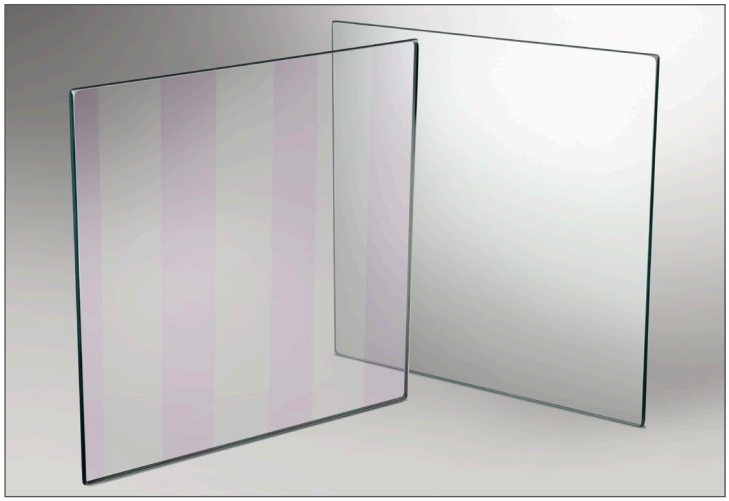
In this photo: Each number was written with a chalk marker on the surface it represents. Pictured is a clear outboard lite and ultra-clear inboard lite. When evenly lit from front and back markings on S1, S2, S3, & S4 are equally visible.



In this photo: The background lighting was dimmed, and foreground specular highlights were cast with LED lamps to simulate daylight conditions. On a building, sunlight is MUCH brighter than the background — can overpower markings on S2, S3, & S4.

Surface 1 Applications
Reflection and Transmission issues can be resolved by adding a visual cue for birds, such as a UV coating or ceramic frit (see below for more information about these solutions). **Applications on surface 1 of an insulating glass unit have had the best results with real world monitoring.**

UV patterned glass
Humans only see in the visible light spectrum. Some birds see in the UV spectrum in addition to the visible spectrum, UV coatings help prevent collisions by visually signaling an impending barrier. UV coatings provide another option for deterring bird strikes. Like frit or etch, UV provides a visual marker that can indicate a potential obstacle to birds. UV trades off some amount of effectiveness for dramatically improved aesthetics for humans.



UV Reflecting coatings visible to some bird species (left) are invisible to the human eye (right).

Coated glass with Ceramic frit or Acid Etch
Ceramic frit is widely available solution for bird friendly glass. Frit patterns can be most economical solution in new projects. However, frit will tend to obstruct more of the occupant view than some other solutions. Fritted glass is most commonly used in new construction and is most effective to deter bird collisions when placed on the #1 surface.

Ceramic Frit is a common and economical method of bird collision deterrence in commercial glazing

An Acid Etched pattern on surface one with a Low-E coating on surface two provides a bird friendly and energy efficient option.

Additional Resources

Bird friendly building design continues to evolve based on continued understanding of bird behavior, testing protocols and evaluation of collision deterrent solutions. Here are additional resources on bird friendly building design:

- American Bird Conservancy: https://abcbirds.org/program/glass-collisions/bird-friendly-design/
- City of Toronto: https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/design-guidelines/bird-friendly-guidelines/

1, 2. Scott R. Loss, Tom Will, Sara S. Loss and Peter P. Marra, "Bird-building collisions in the United States: Estimates of annual mortality and species vulnerability", The Condor: Ornithological Applications (January 2014)
3. Christine Sheppard, "Bird-Friendly Building Design" (Updated April 2019)
4. Operated by Martin Rössler
5. Developed by Professor Daniel Klem Jr.
6. Graham R. Martin, The Sensory Ecology of Birds. Oxford University Press, 2017.

Learn More About Bird-Friendly Glazing

If you need more information, Guardian's Technical Services group is available to assist with questions about color and glazing options. Please contact Guardian at https://www.guardianglass.com/us/en/contact or call 855-58-GLASS (45277).

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