Methods to Reduce Bird Collisions with Glass When Remodeling and Designing New Facilities
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Every year nearly one billion birds fatally collide with glass in the U.S. While most people consider bird collisions with glass to be an urban phenomenon involving tall, mirrored-glass skyscrapers, the reality is that 56% of collision mortality occurs at low-rise buildings (i.e., one to four stories), 44% at urban and rural residences, and <1% at high-rise buildings (Loss et al. 2014). Many government facilities and refuge visitor centers fit the description of the buildings involved in most bird collisions. Fortunately, low-cost, attractive glass treatments are available for existing buildings, while new builds and remodels can incorporate bird-safe building design and specialized glass. Many of bird-safe measures simultaneously reduce energy costs. Recent research quantifying that bird populations in North America have declined by nearly three billion birds over the last 50 years, deserves a strong response from federal agencies and an increased focus on tangible actions that result in measurable conservation outcomes, such as reducing bird collisions with glass.

Minimizing bird collisions with glass is consistent with 116-100 – Department of the Interior, Environment and Related Agencies Appropriations Bill 2020; the Government Services Administration (GSA) P100 Facilities Standards for the Public Buildings Service; and a continuously growing public concern about bird population declines. In June 2020, the House of Representatives passed H.R. 2, the Bird Safe Buildings Act, which mandates all public buildings managed by GSA to be designed or altered in a bird friendly manner. Leadership in Energy and Environmental Design (LEED) acknowledges the importance of bird-friendly design and related measures through associated credits. In addition, taking steps to reduce bird collisions with glass supports the intention of Executive Order 13186: Responsibilities of Federal Agencies to Protect Migratory Birds.

Birds do not see clear or reflective glass as a barrier. Glass creates a lethal illusion of clear airspace. The majority of collisions occur during the day when birds can see landscape reflections in the glass (e.g., clouds, sky, vegetation, or the ground); or birds see through glass to perceived habitats (e.g., potted plants or vegetation inside buildings). When inclement weather occurs during spring and fall bird migrations, birds can be attracted to lighted facilities; resulting in collisions, entrapment, excess energy expenditure, exhaustion, and occasionally large-scale nighttime mortality events.

Daytime collisions are reduced at existing facilities by using glass treatments that allow birds to see glass as a barrier. Some glass treatments increase energy efficiency. For example, bird collision prevention film has a U-factor of 2.61 and Solar Heat Gain Coefficient of 0.46. Specialized glass, building design features (awnings, screens, etc.), and bird-safe building design can reduce bird collisions at new and remodeled facilities. Many of the measures to reduce bird collisions with glass at new and remodeled facilities simultaneously reduce energy costs by reducing heat gain and minimizing lighting costs. Glass treatments and other bird-safe measures should be applied up to the third floor, or up to the height of the adjacent vegetation. However, applying bird-safe practices to just the first story windows or known problem glass can make an important difference. Nighttime collisions and attraction can be reduced by minimizing interior and exterior lighting, especially during bird migration seasons.

Glass Types

A variety of glass and window types are available to create visual barriers for birds thereby reducing mortality from collisions. Vertical stripes that are at least ¼ inch wide with a maximum spacing of 4 inches, or horizontal stripes that are at least ¼ inch wide with a maximum spacing of 2 inches, have been effective at preventing glass strikes of most birds. Because hummingbirds are so much smaller than other birds, closer spacing of the elements of any pattern (striped or otherwise) will be necessary. Also, when using patterns other than stripes, closer spacing of elements is recommended because a series of smaller images like dots will not break up the glass as much as stripes using the 2" X 4" spacing rules. Glass with external patterns are more effective at preventing bird collisions than glass with internal modifications; given that internal patterns may be invisible to birds through reflections in the glass.

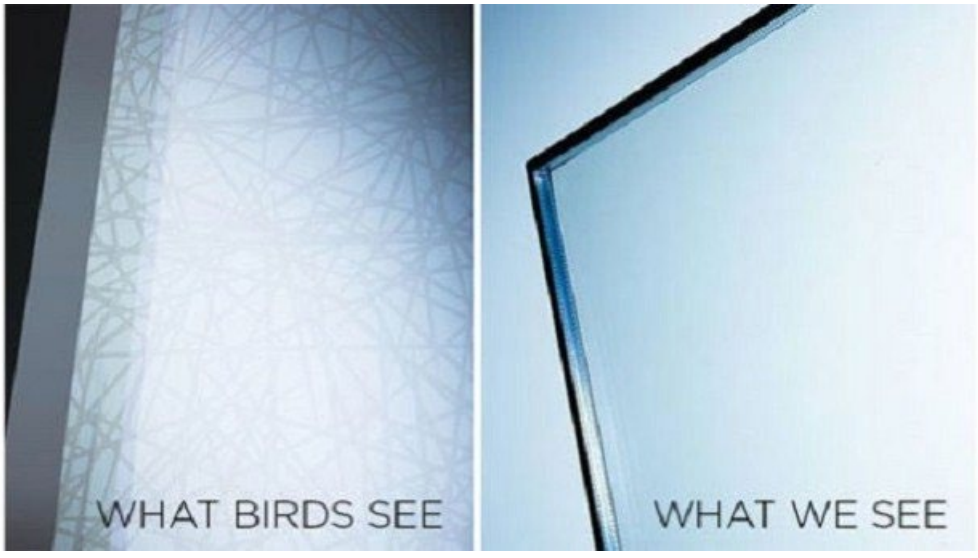
Acid-etched, Fritted or Frosted Glass

Fritting is the use of ceramic lines, dots or other patterns that are most effective when placed on the external glass surface, but which are usually put on the interior surfaces of insulated glass. Etching, fritting, and frosting not only reduces the risk of bird collisions but simultaneously increased energy conservation by reducing solar heat gain (27 SHGC) and glare while simultaneously reducing cooling loads and allowing natural lighting of buildings. These products can slightly reduce the glass transparency. Existing glass also can be frosted by on-site sandblasting during remodeling. To see a list of the latest recommendations in fritted glass products, visit the American Bird Conservancy's webpage (https://abcbirds.org/get-involved/bird-smart-glass/#1).

Etched, patterned glass provides a visual barrier to birds. Photo from https://www.walkerglass.com

Ultraviolet Patterned Glass

Some birds see in the ultraviolet (UV) spectrum. As of 2020, a handful of UV-reflecting glass products were available with UV patterns generally not visible to humans but visible to many bird species. Initially this glass option was more expensive than other treatments, but costs are expected to decrease with higher demand and production. The American Bird Conservancy's webpage (https://abcbirds.org/get-involved/bird-smart-glass/#1) includes a list of recommendations for ultraviolet patterned glass products.



UV patterns on glass are visible to many birds but not to humans. Photo from http://ornilux.com/

Patterns created by channel glass have demonstrated the ability to reduce bird collisions. Materials are up to 60 percent recycled with low-emissivity coatings, high thermal performance u-value (>0.17) and r-values as high as 5.88. The American Bird Conservancy's webpage provides additional information (https://abcbirds.org/get-involved/bird-smart-glass/#1).

Channel glass can create a visual barrier to birds. Photo from https://www.constructioncanada.net

Building Design Features

Building designers can use features such as awnings, lattice-work, louvers, mesh, double-skin façades, shutters, and other creative strategies to reduce glass reflections or reduce visibility into transparent areas. Most bird-safe building design features simultaneously conserve energy while reducing the risk of bird collisions. Screens can both reduce the reflectivity of glass and block bird collisions.

Awnings, Shades, and Shutters

Shaded windows allow building occupants access to outdoor views and light but reduce the glass reflections confusing to birds, especially when glass is shaded on all sides. These design features also reduce glare and overheating of the building interior. Awnings, shades, and shutters can be used on new construction, renovations, and retro-fits.

Shading was applied around the windows on the exterior of the Research Support Facility (RSF) at the National Renewable Energy Laboratory (NREL). Photo by Dennis Schroeder, NREL 19798.

Shutters overhang windows at a facility at the San Diego Zoo. Photo by Christine Sheppard, ABC.

Screens and Netting

External insect screens or netting on windows is an effective and relatively inexpensive treatment to reduce the visual reflection in the glass and might also help prevent some injuries by providing a cushion between the bird and the window. To be effective, the netting must be placed far enough in front of the window that a bird hitting it will not collide with the glass behind the net. The netting should have openings no larger than ½ inch and it must be completely taut so that birds do not get trapped in it. Several companies sell screens or other barriers that can be attached with suction cups or eye hooks. These treatments can be used on new construction, renovations, and retro-fits. https://www.birdscreen.com

Netting installed on slanted wooden beams. Photo by USFWS.

Nighttime Lighting

Not only is the elimination or reduction of unnecessary lighting one of the easiest ways to reduce collisions, it also saves energy and reduces costs. Newer energy codes allow less lighting power than older energy codes for a given facility type and use. Reduced lighting power can be accomplished using lighting control strategies that extinguish or dim interior lighting when it is unneeded, such as after hours (when the building is vacant), during the work day when a space is unoccupied or natural lighting is adequate. Exterior lighting can also employ motion sensors and light down shields resulting in cost savings with only modest initial investment. Light minimization is especially important during the bird migration periods (early April through late

May and mid-August through early November), and periods of inclement weather. Combined with glass treatments, reducing nighttime lighting can save many birds. For more information, see: https://www.audubon.org/conservation/project/lights-out

While bird friendliness has not been a criterion in the development of ASHRAE Standard 90.1 or the IECC, the committee developing ASHRAE Standard 90.1 worked extensively with the International Dark Sky Association in efforts to reduce light pollution. This collaboration resulted in the development of exterior lighting zones found in ASHRAE Standard 90.1-2010 and all subsequent versions of Standard 90.1. Five exterior lighting zones are defined, ranging from "0" for undeveloped land in national parks and other undeveloped areas, such as Yellowstone National Park, to "4" for high activity commercial districts in major metropolitan areas, such as Times Square. The amount of exterior lighting power allowed varies by exterior lighting zone, with lower numbered exterior lighting zones being allowed less exterior lighting power. Interior and exterior lighting power and controls in Standard 90.1 could also lead to energy savings for buildings. Lighting retrofits are reasonably common in buildings; with both interior and exterior lighting and the needed controls easily retrofitted in most buildings. Once installed, it is important to both energy savings and bird safety that lighting controls are properly used to minimize lighting, when possible.

To eliminate and reduce unnecessary nighttime lighting:

1. Extinguish lights or install motion sensors and controls on all lights (both interior and exterior) that activate only when people are present. Motion sensors are inexpensive and save energy;
2. use window coverings to reduce bird attraction to lighted buildings;
3. ensure all exterior lighting is "fully shielded" so that light is prevented from being directed skyward. "Fully shielded" light fixtures are defined as those with an opaque shield so that all light is only emitted downward below the lowest light emitting part of the fixture. "Fully shielded" is the same as "zero up light" and "dark sky compliant;" and
4. comply with current ASHEAE Standards and current Federal Aviation Administration (FAA) marking and lighting guidance on obstructions (i.e., ensure that required obstruction lighting includes only L-864 flashing lights with appropriate flash rates, and non-flashing L-810 lights extinguished or reprogrammed to flash).

Vegetation, Landscaping, and Outdoor Facilities

Where vegetation is adjacent to, seen through, or reflected in glass structures (e.g., windows, bus shelters, noise barriers, walkways, glass walls, etc.), treat existing glass or install a bird-safe glass that is visible to birds such as those previously listed. Avoid creating an effect where landscaping funnels birds toward glass (e.g., walkways, passageways, edges) or where activities

near buildings flush birds towards glass. Move indoor plants, trees or shrubs out of bird view, if possible; otherwise, treat existing glass or install bird-safe glass.

Trees and shrubs can be reflected in glass and create a type of funnel effect near the entrance of a building. Vegetation can also be viewed through glass. Photos by USFWS.

Building Design

Designing a building to be bird-safe may not require higher costs, especially if bird-safe measures are integrated early in the design process. Energy conservation measures often overlap with bird-safe measures, thereby enhancing the cost effectiveness of bird conservation.

Many people find glass buildings aesthetically pleasing but are unaware that glass reduces energy efficiency in many climate zones and causes most bird collisions. New energy codes do not explicitly regulate the amount of window area in a building but do typically require more stringent requirements for windows as the window area increases. The American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) and the International Code Council state that heating and cooling costs increase when more than 30-40% of a building's exterior is glass (ANSI/ASHRAE/IES Standard 90.1 2013). Windows smaller than 2.5 square meters can simultaneously reduce energy costs and reduce bird collisions. Reducing the window to wall ratio (WWR) is expected to have three distinct but interactive effects on building energy usage because:

1. there is less glazed area and more opaque wall area, the overall U-factor should go down; implying reduced heat transfer through the walls. This lower U-factor should lead to lower heating loads in the winter and lower cooling loads in the summer.
2. Less glazed area typically equates to less solar heat gain. Lower solar heat gain implies higher heating loads in the winter and lower cooling loads in the summer.

3. Because there is less glazed area, there is less natural daylight entering the building. For buildings with daylighting controls, this means that interior lighting loads may increase during the day. For buildings without daylighting controls, the lighting loads may or may not change, depending on how occupants perceive and react to the reduced light from the windows.

If unable to use bird-safe glass then features such as awnings, lattice-work, louvers, mesh, double-skin façades, shutters, and other creative strategies should be integrated into the building or facility design. Avoid building clear glass corridors, skyways, walkways, building connectors, or courtyards without considering the risk of bird collisions. Glass installed in all facilities should be fritted, etched, frosted, or include UV-patterns. Overall, it's important to work toward reducing the amount, reflectivity, and transparency of glass.

For more information consider the design guidelines in New York City's bird-friendly design legislation and LEED Pilot Credit 55: Bird Collision Deterrence recommendations for new construction. In addition, the American Bird Conservancy's offers bird-friendly building design literature and a class for continuing education credits with LEED and the American Institute of Architects.

U.S. Department of Energy's (DOE) Building Technologies Office (BTO) offers several free building energy modeling programs including EnergyPlus™ (https://energyplus.net/). Engineers, architects, and researchers can use EnergyPlus to simulate and model energy consumption while incorporating bird safe building measures in different thermal zone conditions and geographic areas. Models include heating, cooling, ventilation, lighting and plug, and process loads for an entire building; with the opportunity to evaluate lighting control strategies, advanced fenestration models with controllable window blinds, electrochromic glazings, and layer-by-layer heat balances that calculate solar energy absorbed by window panes. EnergyPlus™ is open-source and cross-platform that runs on the Windows, Mac OS X, and Linux operating systems.

Communications

Federal agencies, especially those with visits from the public, such as refuges and fish hatcheries, have an opportunity to share information about effective ways to reduce bird collisions. We encourage you to develop interpretive information to share what measures you take at your facility and why it is important for bird conservation.
https://abcbirds.org/wp-content/uploads/2017/04/Save-birds-2017.pdf

Agencies have an opportunity to address the magnitude of bird losses with tangible actions that result in measurable conservation outcomes. Ensuring facilities glass is bird-safe brings us a step closer to reducing the loss of migratory birds. For more information please contact: Joelle_Gehring@FWS.gov or Eric_Kershner@FWS.gov