

Causes and Solutions for Bird Collisions with Glass Curtain Wall Buildings

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Abstract. In urban areas, bird collisions with glass curtain wall buildings are a major contributing factor to avian mortality. The goal of this paper is to explore how material property, structural design, and artificial lighting of glass curtain walls participate in bird collisions. Among the factors, high reflectivity, concavities in structures, and nighttime lighting are established as the most prominent in increasing the risk of collision and mortality. Suggestions are tailored to using high-transmittance or patterned glass and designing structures flat or more open plus reducing artificial light during migration seasons, which all might work toward bird-friendly architecture and biodiversity conservation.

Keywords: Bird collisions; Glass curtain walls; Reflective glass; urban biodiversity; Bird-friendly architecture.

1. Introduction

With accelerated urbanization, the co-existence of human activities and wildlife is dwindling. One of the salient issues is the effect of glass curtain wall buildings on urban bird populations. Generally, people are very much inclined to such infrastructures for the impeccable reasons that light up inside spaces reflecting their phenomenal beauty and these same people do not realize the extent to which these very structures have turned out to be the fatality sources for birds who are just unable for whatsoever reasons to consider glass as a solid material. They usually detected vegetation or open sky in their passage and transparent material as a clear way through, allowing a fair amount of fatal collisions. According to Loss et al., building collisions account for annual mortality ranging between 365 million and 988 million birds in the United States alone [1], constituting the second most significant cause of avian fatalities on the continent of North America after predation by feral cats.

There has been much less focus on the intrinsic characteristics of glass curtain walls that cause a collision, although several studies have reported on bird vision, migration pathways, and the habitat around the building. This paper attempts to fill this vacuum by reviewing how material properties, structural design, and artificial illumination of glass curtain walls raise the probability of bird collisions. It amalgamates available research on the contribution of highly reflective glass concave structures, and artificial lighting at night to bird collisions. By summing up and integrating these studies, this paper sets the scene for offering actionable ways of minimizing bird mortality through bird-friendly materials, safer building designs, and the reduction of artificial light emissions.

At the end of the day, the onus of reducing bird collisions with glass curtain wall buildings rests upon the collective collaboration of architects, developers, and policymakers to do the tight-rope walking of satisfying urban development and conserving biodiversity. The current paper embodies such a synthesis of existing knowledge for making practical recommendations to create safe environments for birds in urban areas.

2. Literature Review

Bird collisions with glass curtain wall buildings have been a subject of extensive research with various factors related to bird vision and migration patterns, temporal variations of the environment, and structural aspects of the building involved. The intrinsic characteristics of glass curtain walls have

been less comprehensively considered in establishing primary causation. This section combines critical review findings from prior works as a foundation for the present review.

Research gaps are highlighted in the following credits to bird vision. As already noted, Martin has again proved that lateral visions in most bird species and inability to see reflective surfaces are major contributions to the difficulty birds often encounter in discriminating real environments from mirrored images [2]. The works by Loss et al. state that bird collisions cause millions of avian deaths each year in North America, second only to predation by stray cats [1]. They stress that the work highlights urbanization and the increasing use of glass architecture that exacerbate the issue.

The reflective properties of glass are hazards of a challenging nature to settle. For this reason, according to Loss et al., high-reflectivity glass (that mirrors surrounding vegetation and the sky) is noted to dramatically increase collision rates [3]. Even though not so reflective, clear glass still creates the optical illusion of open pathways and thus further misleads birds. Moreover, the vegetation near buildings enhances the risk. Areas with grasslands or trees within 50 meters of glass curtain walls are particularly hazardous.

Structural design certainly matters in bird collisions. According to Riding et al., concave structures like alcoves trap birds due to the creation of a semi-enclosed space and reducing visibility from the other side [4]. Mortality is further increased by surface orientation and no clear path to an exit. Conversely, flatter, or open designs, like porticos, have solutions that are safe.

Artificial lighting is, along with its many other roles, also a huge factor in bird collisions, especially during nocturnal migration. Birds are inherently attracted to light, and well-lit glass buildings increase their traffic in the vicinity of hazardous surfaces. According to Lao et al., turning lights off during migration seasons dramatically reduces collision rates. Initiatives like "Lights Out" have worked well in reducing this source of risk [5].

These studies have to be compiled with what is known about material properties, to fathom structural design and artificial lighting of glass curtain walls and their collision risk to birds. The present review tries to fill this gap and merge the knowledge into one conceptual view about the subject. It attempts to describe the important variables that are discussed from different points of view and offers a set of practical strategies to mitigate mortality.

3. Factors Contributing to Bird Collisions with Glass Curtain Walls

3.1. Material Properties of Glass Curtain Walls

The material properties of glass curtain walls play a paramount role in bird collisions, with reflectivity and transparency as leading factors. High-reflectivity glasses entail a significantly higher collision mortality rate compared to clear glasses. Reflective glasses reflect current vegetation and the sky, among other views, therefore giving an impression of open space. Generally, birds collide at these reflections, mistaking them for natural habitats at the high speeds at which they fly. For instance, in areas with vegetation adjacent to the reflective glass, the rate of bird mortality is very high, especially from grasslands or trees within 50 meters of the building [6]. This also indicates that birds cannot separate the reflected image from reality; hence, they are more likely to hit reflective surfaces.

While reflective glass is highly obvious, a see-through effect can be just as hazardous. Birds perceive what is inside as being somewhat a part of their environment, expecting clear, safe fly-through places. Such misperceptions are likely to be caused by fatal collisions, particularly in urban areas, where glass curtain walls are the dominant features on the faces of buildings. Other research studies have shown that materials composing glass curtain walls with lower reflectivity result in fewer collisions, thereby emphasizing the significance of the choice of material in efforts aimed at reducing bird strikes [7].

Bird-friendly materials, such as fritted glass, or UV-patterned glass are designed to break up the reflection or see-through illusion that can be "read" by birds on glass surfaces, therefore making them more apparent to the birds and thus reducing the likelihood of strikes. Another approach is applying

anti-collision stickers, or anti-collision film or patterns to all existing reflective glass during the bird migration seasons. These work well for buildings where it is not possible to change the material.

3.2. Structural Design of Glass Curtain Walls

Collision probabilities and fatalities tend to be strongly mediated by the structural design of architectural glass curtain walls. Birds are, for example, more likely to collide with concave or convex structural glass than flat glass. Uneven glass, such as when of a concave shape, creates larger reflective areas, reflecting more of either the surrounding vegetation or the sky. An apparent wide-open space in reflections increases the likelihood of bird strikes [8].

Concave structures are the most hazardous types of structures—from alcoves to wall indentations, because they form semi-confined spaces where the bird may get trapped. Birds colliding with the concave wall often fail to detect the path of exit and strike the surrounding glasses in a loop manner; it is much worse for deep alcoves where less lighting makes navigation more difficult. Conclusively done studies reflect a tripled mortality risk of birds flying against concave surfaces compared to flat or convex ones [4]. As such, vertical ways of alteration within the deep set are more dangerous than the horizontal ones because lateral vision predominates during the flight, less likely noticing the vertical escape route.

While convex designs are certainly not as dangerous as concave ones, they still harbor risks because their curved surfaces reflect area. In contrast flat glass curtain walls do not reflect as many illusions and so offer a much safer line in building design.

Architects should, in this regard, design more flat or open structures to minimize bird collisions. For instance, buildings having porticos or buildings with horizontal exit channels offer birds a safer navigation. In the case of pre-existing buildings with concave features and creating clearer exit routes for birds by lowering the height of surrounding walls, it is also feasible to erect visual markers.

3.3. Artificial Lighting and Bird Collisions

Artificial lighting is the other major reason birds collide quite often with glass curtain walls during nighttime migration. Birds are attracted to light of any kind; during migration, in fact, they tend strongly to lights as cues for their orientation in the sky. These behavioral patterns are disturbed by artificial light that overshadows all the rest by driving in birds to lighted buildings. This therefore increases the likelihood of bird-strike occurrence due to the reflected lights from the glass-dominated building structure.

Research has indicated that dimming or turning lights off during migration seasons can markedly cut bird collision rates. For instance, programs like "Lights Out" in a host of cities across North America prove that reducing nighttime lighting in urban areas leads to measurable decreases in bird mortality [9]. Also, the use of motion-activated or shielded lighting can reduce the amount of light that buildings give off while still keeping safety and function for humans.

Artificial lighting sources interact with the type of glass to influence collision risks. When illuminated at night, both clear and reflective types of glass increase collision probabilities. The very reflective type enhances mirrored images of artificial light sources and thereby even more confuses the birds with these reflections. Inside lighting projects through transparent glass and make the interior of the building accessible and birds are drawn to structures this way. Therefore, interior light emissions especially in buildings that are mainly made of glass should be reduced during peak migration periods.

To solve the problem, in the recommendations to the building managers is presenting bird-friendly lighting practices such as changing direction so lights shine down, using window coverings during the night hours, and creating "dark zones" in areas of high bird activity. By doing these, the number of bird collisions can be largely reduced without any human usability of the building.

3.4. Synthesis of Contributing Factors and Practical Solutions

Material properties, structural designs, and artificial lighting of glass curtain walls interact to influence bird collisions in a complex manner [10]. Reflective glass along with concave structural designs increase the illusory effect of free space. They generally work in unison with other aspects to create especially bird-unsafe environments. For instance, a highly reflecting concave glass and night lighting create an exceptionally high collision risk.

To address these risks, solutions have to come in a combination. First, architects should seriously consider bird-friendly materials, such as fritted or patterned glass, which reduce reflectivity and increase visibility. Second, designs should steer away from concavity in the majority of the building and instead look to include flat or open surface types that allow birds to see clear exit routes. Third and finally, reducing artificial light emissions during migration seasons in order to reduce nighttime collisions. These strategies will be effective if only all the related parties, such as the architects, building managers, and policymakers collaborate among themselves.

4. Conclusion

Among urban habitats, one of the most substantial sources of bird fatality that is strongly influenced by material property, structural configuration, and artificial illumination is bird-glass collisions with curtain wall buildings. Open space reflections and see-through glass provide spatial illusion reflexions, concave and convex forms enhance contact probability, while at night, and illumination interferes with bird orientation and draws them into the striking circles of menace. Drawing upon existing studies, the very review below develops feasible mitigating measures for these risks, for instance regarding material fritted or UV patterned, flat, and open structures as well as the reduction in the amount of artificial lighting during the migration season.

It is the challenging work, through the joint efforts of developers and city planners, with coordination from policymakers and conservationists that will bring bird-friendly architecture and lighting practices into place. These efforts require applications not only to save many bird species but also to provide conditions for biodiversity, and ensure sustainable urban development. With these evidence-based strategies, we are able to produce urban environments in which human development coexists with the conservation of wildlife.

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