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Glass traps: Investigating bird mortality at glass-fronted buildings in the Nilgiris

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Abstract Bird-window collisions pose a significant but underexplored threat to the avian biodiversity in India. This study, the first of its kind in the Nilgiris, South India, documents bird collisions with glass surfaces over a year. A total of 35 incidents were recorded across two locations, Forestdale and Coonoor, involving 22 species from 15 families. Among these, 16 birds were found dead, 18 were injured, and one managed to fly away. Migratory species, particularly the Indian Blue Robin, had the highest number of collisions, while among resident birds, the White-cheeked Barbet and Spotted Dove were most affected. Collisions peaked during winter, highlighting seasonal vulnerability. Building architecture, especially reflective glass surfaces, played a crucial role in increasing collision risks. These findings underscore the urgent need for mitigation measures such as UV-reflective films, window modifications, and strategic landscaping. Promoting bird-friendly urban designs and raising awareness are essential to reducing avian mortality in expanding human settlements.

Keywords: bird-glass collision, Nilgiris, Western Ghats, urban bird conservation

Öszefoglalás A madarak ablaknak ütközése India madárvilágára is jelentős hatással bíró, de alulkutatott tényező. Ez a tanulmány, amely az első ilyen jellegű vizsgálat a dél-indiai Nilgiris területén, egy éven át dokumentálja az üvegfelületeken történő madárütközéseket. Két helyszínen, Forestdaleben és Coonoorban összesen 34 esetet rögzítettek, amelyek 15 család 22 faját érintették. Ezek közül 16 madarat elpusztulva találtak, 18 megsérült, és egynek sikerült elrepülnie. Az ütközések jelentős része vonuló fajokra – különösen a narancsszínű fülemülére – vonatkozott, míg az állandó fajok közül a fehérarcú bajszika és a gyöngyösnyakú gerle volt a leginkább érintett. Az ütközések csúcsa télen volt, ami rávilágít a szezonális veszélyeztetettségre. Az épületek építési módja, különösen a fényvisszaverő üvegfelületek jelentősen növelték az ütközés kockázatát. Ezek az eredmények hangsúlyozzák az olyan megelőző intézkedések szükségességét, mint az UV-tükröző fóliák, az ablakok módosítása és a stratégiai tereprendezés. Az egyre inkább terjeszkedő városokban alapvető fontosságú a madárbarát várostervezés és a tudatosság növelése a madárpusztulás csökkentése érdekében.

Kulcsszavak: madár – üveg ütközés, Nilgiris, Nyugati-Ghátok, városi madárvédelem

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Introduction

Bird-window collisions are primarily driven by anthropogenic pressure, with urbanization playing a significant role in wildlife mortality (Loss *et al.* 2015, Adams *et al.* 2021, Riding *et al.* 2021, Żmihorski *et al.* 2022). The transformation of natural habitats into urban areas due to human population growth has profound negative effects on biodiversity (Rebolo-Ifrán 2019). Habitat fragmentation is a major factor contributing to biodiversity decline, as it isolates populations and disrupts ecological balance (Fischer & Lindenmayer 2007, Rodríguez-Loinaz *et al.* 2012). In urban environments, glass reflections deceive birds by creating the illusion of open space or natural habitats, leading to fatal collisions. Globally, an estimated one billion birds die each year due to window collisions (Klem 1989, Klem 2006, Bayne *et al.* 2012). Key habitat factors influencing collision risks include the presence of trees and shrubs near buildings or their reflections in windows, both of which significantly increase the likelihood of bird strikes (Klem 2009, Borden *et al.* 2010, Rosenberg *et al.* 2019, Brown *et al.* 2020). In the United States alone, rough estimates suggest that 100 million to one billion birds perish annually due to window collisions (Kornreich *et al.* 2024). Despite the growing concern over bird-window collisions worldwide, research on this issue in India remains limited (Sekhsaria 2020). This study represents the first-ever investigation of bird-window collisions in South India, specifically in the Nilgiris region. This study analyses seasonal bird-window collisions, the time of day they occur, bird outcomes (dead, injured, or flown away), and the residency status (resident vs. migratory) over a year.

Methods

This study was conducted over a one-year period, from January to December 2024, at two locations in and around Coonoor: Coonoor (11.346, 76.81529) and Forestdale (11.3654, 76.79919) *(Figure 1)*. Bird collision data was collected opportunistically throughout the year, documenting instances where birds sustained fatal injuries upon striking windows. Data were categorised for the seasonal analysis as summer (March to June), monsoon (July to October) and winter (November to February) and for the time period of the collisions morning (06.00 AM to 12.00 PM), afternoon (12.00 PM to 4.00 PM), evening (4.00 PM to 8.00 PM). Mapping was done using QGIS (version 3.40) and data visualization was performed using R Studio (2020), utilizing the “ggplot2”, “patchwork” and “RColorBrewer” packages for analysis and graphical representation.

Both study sites featured commercial buildings surrounded by gardens, with nearby forested areas comprising semi-evergreen forests and shola, while non-forest areas primarily consisted of tea plantations. The architectural characteristics of the buildings varied, potentially influencing the frequency and severity of bird-window collisions. At Coonoor, buildings are in a two-storied structure, with the first and second stories featuring transparent glass panels facing east and measuring 6 × 4 feet, installed uniformly at a two-foot interval. The reflective nature of the second-story glass panels mirrors the sky and the

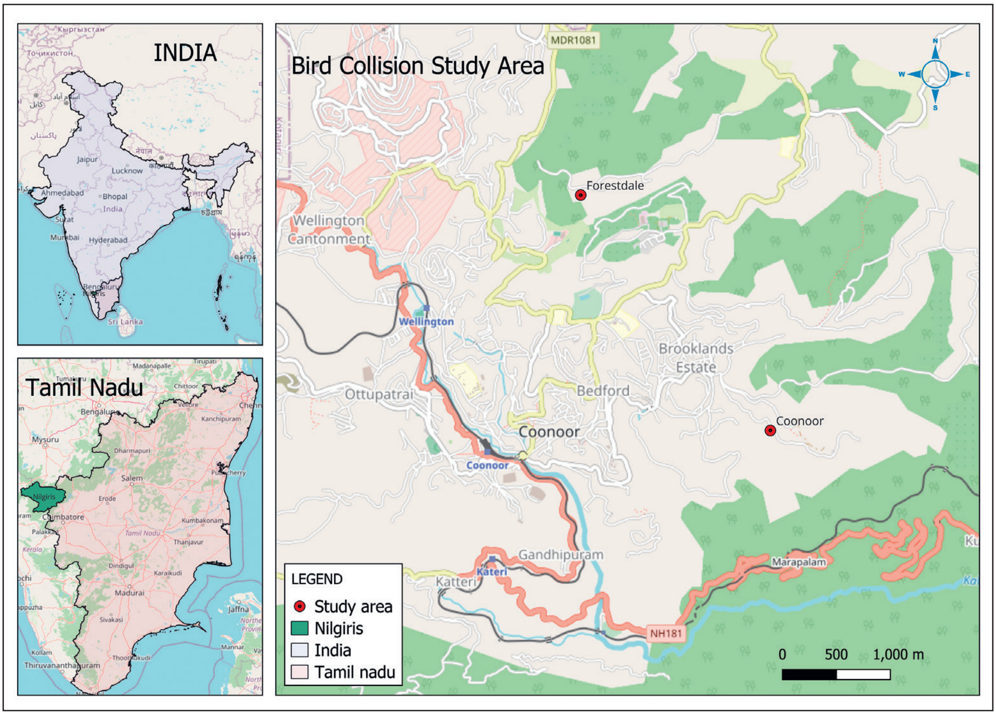

Figure 1. The map of the study area
1. ábra A kutatási terület térképe

garden in front. At Forestdale, the structure is similar but differs in its design: the first floor lacks transparent or reflective glass, while the second floor features a continuous transparent glass panel facing east and measuring 20 × 10 feet, which reflects both the adjacent garden and the sky.

Result

Bird-window collisions were recorded at two locations, Forestdale (n = 19) and Coonoor (n = 16), totalling 35 collisions across 22 bird species *(Table 1, Figure 2)*. These incidents affected 15 families, with Muscicapidae (n = 4) and Columbidae (n = 3) being the most impacted. Of the recorded collisions, 16 birds were found dead, 18 were injured, and one managed to fly away *(Figure 2)*. Monsoon had the highest number of collisions (n = 15), followed by summer (n = 11) and winter (n = 9). Most collisions occurred in the morning (n = 18), followed by the afternoon (n = 12) and evening (n = 5). A total of 18 resident and four migratory bird species were affected. Among migratory species, the Indian Blue Robin *(Luscinia brunnea)* (3 fatalities, 1 injury) had the highest number of collisions, followed by the Greenish Warbler *(Phylloscopus trochiloides)*, Kashmir Flycatcher *(Ficedula subrubra)* (1 male, 1 female), and Grey Wagtail *(Motacilla cinerea)*. Among residents, the White-cheeked Barbet *(Megalaima viridis)* and Spotted Dove *(Spilopelia chinensis)* were most

Table 1. Results of glass collisions including family, scientific name, common name, number of collisions, IUCN status, and residency status of species

1. táblázat Az üvegnek ütközött fajok listája

Family	Scientific Name	Common Name	N	IUCN Status	Residency Status
Tytonidae	*Tyto alba* (Scopoli, 1769)	Barn Owl	2	LC	Resident
Strigidae	*Strix leptogrammica* (Temminck, 1832)	Brown Wood Owl	2	LC	Resident
Columbidae	*Chalcophaps indica* (Linnaeus, 1758)	Common Emerald Dove	1	LC	Resident
	Columba elphinstonii (Sykes, 1832)	Nilgiri Wood Pigeon	1	VU	Resident
	Spilopelia chinensis (Scopoli, 1786)	Spotted Dove	3	LC	Resident
Megalaimidae	*Psilopogon viridis* (Boddaert, 1783)	White-cheeked Barbet	3	LC	Resident
Corvidae	*Corvus macrorhynchos* (Wagler, 1827)	Large-billed Crow	1	LC	Resident
Hirundinidae	*Hirundo domicola* (Jerdon, 1841)	Hill Swallow	2	LC	Resident
	Ptyonoprogne concolor (Sykes, 1832)	Dusky Crag Martin	1	LC	Resident
Motacillidae	*Motacilla cinerea* (Tunstall, 1771)	Grey Wagtail	1	LC	Migratory
Pycnonotidae	*Pycnonotus cafer* (Linnaeus, 1766)	Red-vented Bulbul	1	LC	Resident
	Pycnonotus jocosus (Linnaeus, 1758)	Red-whiskered Bulbul	2	LC	Resident
Phylloscopidae	*Phylloscopus trochiloides* (Sundevall, 1837)	Greenish Warbler	2	LC	Migratory
Paridae	*Parus cinereus* (Vieillot, 1818)	Cinereous Tit	1	LC	Resident
Zosteropidae	*Zosterops palpebrosus* (Temminck, 1824)	Indian White-eye	1	LC	Resident
Sturnidae	*Acridotheres fuscus* (Wagler, 1827)	Jungle Myna	1	LC	Resident
Turdidae	*Turdus simillimus* (Jerdon, 1839)	Indian Blackbird	1	LC	Resident
Muscicapidae	*Copsychus saularis* (Linnaeus, 1758)	Oriental Magpie-robin	1	LC	Resident
	Cyornis tickelliae (Blyth, 1843)	Tickell's Blue Flycatcher	1	LC	Resident
	Ficedula subrubra (Hartert & Steinbacher, 1934)	Kashmir Flycatcher	2	VU	Migratory
	Larvivora brunnea (Hodgson, 1837)	Indian Blue Robin	4	LC	Migratory
Passeridae	*Passer domesticus* (Linnaeus, 1758)	House Sparrow	1	LC	Resident

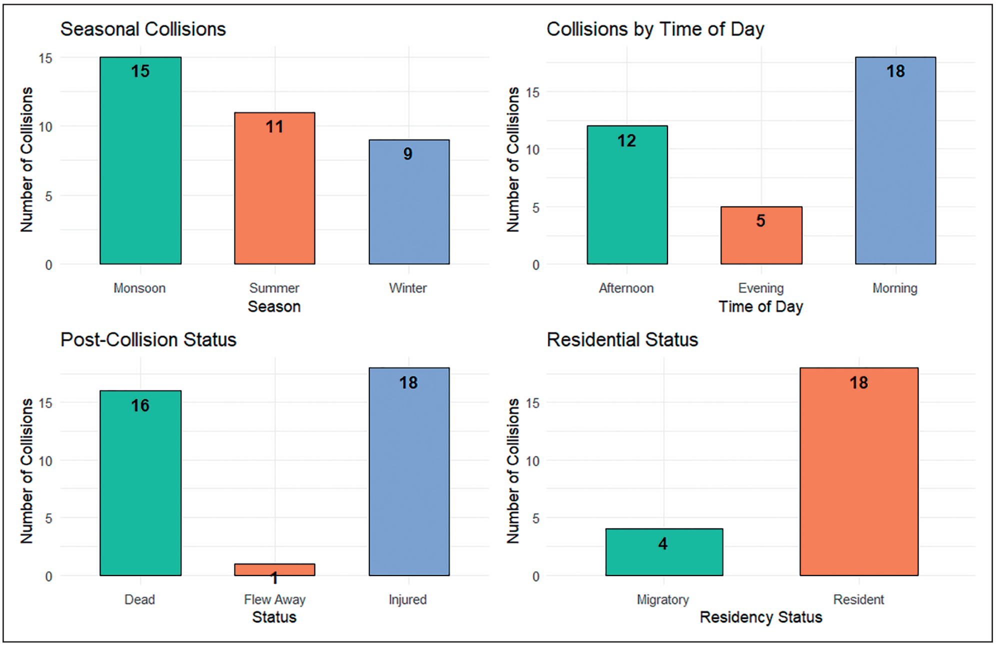

Figure 2. Analysis of bird-window collisions based on season, time of day, post-collision status, and residency status

2. ábra A madarak ablaknak ütközésének elemzése a szezon, a napon belüli időpont, az ütközés utáni státusz és a vonulási típus alapján

affected, followed by the Brown Wood Owl *(Strix leptogrammica)*, Common Barn Owl *(Tyto alba)*, Hill Swallow *(Hirundo domicola),* and Red-whiskered Bulbul *(Pycnonotus jocosus)*, each with two collisions. Additionally, single collisions were observed for 12 species.

Discussion

This study provides valuable insights into bird-window collisions in the Nilgiris, a region where such research has been limited. Our findings highlight that multiple factors including seasonality, species residency status, and building structure significantly influence collision occurrences (Longcore *et al.* 2012, Calvert *et al.* 2013, Loss *et al.* 2015, 2019). With increasing urbanization, habitat fragmentation and glass reflections pose serious risks to birds, making these collisions an emerging conservation concern (Klem 2010, 2014). The data indicate that resident birds, White-cheeked Barbet and Spotted Dove, experience more collisions than other migratory species, likely due to their year-round presence and frequent interactions with human-altered environments. The Indian Blue Robin, an important winter migratory bird in the Nilgiris, was involved in three collisions, resulting in two fatalities and one injury. Notably, this study also recorded fatalities of the Nilgiri Wood Pigeon a Near Threatened (NT) species endemic to the Western Ghats (BirdLife International 2025). We also observed a male and female Kashmir Flycatcher *(Ficedula subrubra)*, a vulnerable winter migrant in the Nilgiris (Moinudheen & Samson 2021, BirdLife International 2025), collided in Forestdale but were able to recover and fly away. While migratory species are also vulnerable, their collision rates are lower due to their seasonal presence. Seasonality played a crucial role in collision rates, with monsoon recording the highest number of incidents. This trend may be attributed to reduced visibility, increased bird activity, and possibly higher food availability near human settlements during rainy seasons. The relatively lower number of collisions in summer suggests that birds may either adapt to their surroundings or avoid high-risk areas during this period. The architectural design of buildings significantly influenced collision frequency. Forestdale recorded a higher number of collisions compared to Coonoor, likely due to its continuous transparent glass panel on the second floor, which reflects the surrounding garden and sky.

The findings from this study highlight the urgent need for mitigation measures in urban and peri-urban areas. Simple interventions, such as window films, external screens, and modifications to glass transparency, can significantly reduce bird mortality. Additionally, altering landscape features such as relocating vegetation away from reflective surfaces can help minimize collision risks. Birds possess a broader visual spectrum than humans, extending into the ultraviolet range (Jacobs 1992, Hart 2001, Lind *et al.* 2013). Research indicates that UV-reflective films, such as BirdShades, can effectively reduce collisions by enhancing glass visibility to birds while remaining mostly unnoticed by humans (Goldsmith & Butler 2005, Aidala *et al.* 2012, Swaddle *et al.* 2020). Our findings align with previous studies suggesting that UV-reflective treatments and circular-shaped decals serve as effective deterrents against bird-window collisions (Ribeiro *et al.* 2020). This underscores the importance of incorporating bird-friendly glass solutions in urban planning and conservation efforts to mitigate avian mortality from glass-pane collisions. Despite being the first study of its kind in South India, this research serves as an essential starting point for further investigation. Expanding studies across different landscapes and building types can help refine mitigation strategies tailored to Indian urban environments. Long-term monitoring, public awareness campaigns, and policy-level interventions are crucial steps toward addressing this growing conservation issue.

References

Adams, C. A., Fernández-Juricic, E., Bayne, E. M. & St. Clair, C. C. 2021. Effects of artificial light on bird movement and distribution: A systematic map. – Environmental Evidence 10: 37. DOI: 10.1186/s13750-021-00246-8

Aidala, Z., Huynen, L., Brennan, P. L. R., Musser, J., Fidler, A., Chong, N., Machovsky Capuska, G. E., Anderson, M. G., Talaba, A., Lambert, D. & Hauber, M. E. 2012. Ultraviolet visual sensitivity in three avian lineages: paleognaths, parrots, and passerines. – Journal of Comparative Physiology A 198: 495–510. DOI: 10.1007/s00359-012-0724-3

Bayne, E. M., Scobie, C. A. & Rawson-Clark, M. 2012. Factors influencing the annual risk of bird–window collisions at residential structures in Alberta, Canada. – Wildlife Research 39(7): 583–592. DOI: 10.1071/WR11179

BirdLife International 2025. IUCN Red List for Birds. – https://datazone.birdlife.org 15/03/2025

Borden, W. C., Lockhart, O. M., Jones, A. W. & Lyons, M. S. 2010. Seasonal, taxonomic, and local habitat components of bird-window collisions on an urban university campus in Cleveland, OH. – Ohio Journal of Science 110(3): 44–52.

Brown, B. B., Hunter, L. & Santos, S. 2020. Bird-window collisions: different fall and winter risk and protective factors. – PeerJ 8: e9401. DOI: 10.7717/peerj.9401

Calvert, A., Bishop, C., Elliot, R., Krebs, E., Kydd, T., Machtans, C. & Robertson, G. J. 2013. A synthesis of human-related avian mortality in Canada. – Avian Conservation and Ecology 8(2): 11. DOI: 10.5751/ACE-00581-080211

De Groot, K. L., Wilson, A. G., McKibbin, R., Hudson, S. A., Dohms, K. M., Norris, A. R., Huang, A. C., Whitehorne, I. B. J., Fort, K. T., Roy, C., Bourque, J. & Wilson, S. 2022. Bird protection treatments reduce bird-window collision risk at low-rise buildings within a Pacific coastal protected area. – PeerJ 10: e13142. DOI: 10.7717/peerj.13142

Diefenbach, D. R., Brauning, D. W. & Mattice, J. A. 2003. Variability in grassland bird counts related to observer differences and species detection rates. – Auk 120(4): 1168–1179. DOI: 10.1093/auk/120.4.1168

Fischer, J. & Lindenmayer, D. B. 2007. Landscape modification and habitat fragmentation: a synthesis. – Global Ecology and Biogeography 16(3): 265–280. DOI: 10.1111/j.1466-8238.2007.00287.x

Fontúrbel, F. E., Rodríguez-Gómez, G. B., Fernández, N., García, B., Orellana, J. I. & Castaño-Villa, G. J. 2020. Sampling understory birds in different habitat types using point counts and camera traps. – Ecological Indicators 119: 106863. DOI: 10.1016/j.ecolind.2020.106863

Goldsmith, T. H. & Butler, B. K. 2005. Color vision of the Budgerigar *(Melopsittacus undulatus)*: hue matches, tetrachromacy, and intensity discrimination. – Journal of Comparative Physiology A: Neuroethology, Sensory, Neural, and Behavioral Physiology 191: 933–951. DOI: 10.1007/s00359-005-0024-2

Hart, N. S. 2001. The visual ecology of avian photoreceptors. – Progress in Retinal and Eye Research 20(5): 675–703. DOI: 10.1016/S1350-9462(01)00009-X

Jacobs, G. H. 1992. Ultraviolet vision in vertebrates. – American Zoologist 32: 544–554.

Klem, D. 1989. Bird-window collisions. – Wilson Bulletin 101(4): 606–620.

Klem, D. 2009. Preventing bird–window collisions. – The Wilson Journal of Ornithology 121: 314–321. DOI: 10.1676/08-118.1

Klem, D. Jr. 2010. Sheet glass as a principal human-associated avian mortality factor. – In: Majumdar, S. K., Master, T. L., Brittingham, M., Ross, R. M., Mulvihill, R. & Huffman, J. (eds.) Avian Ecology and Conservation: A Pennsylvania Focus with National Implications, pp. 276–289.

Klem, D. Jr. 2014. Landscape, legal, and biodiversity threats that windows pose to birds: A review of an important conservation issue. – Land 3(1): 351–361. DOI: 10.3390/land3010351

Klem, D. Jr. 2006. Glass: A deadly conservation issue for birds. – Bird Observer 34(2): Article 11.

Kornreich, A., Partridge, D., Youngblood, M. & Parkins, K. 2024. Rehabilitation outcomes of bird-building collision victims in the Northeastern United States. – PLoS One 19(8): e0306362. DOI: 10.1371/journal.pone.0306362

Lind, O., Mitkus, M., Olsson, P. & Kelber, A. 2013. Ultraviolet sensitivity and colour vision in raptor foraging. – Journal of Experimental Biology 216(10): 1819–1826.

Longcore, T., Rich, C., Mineau, P., MacDonald, B., Bert, D. G., Sullivan, L. M., Mutrie, E., Gauthreaux, S.A. Jr., Avery, M. L., Crawford, R. L., Manwille, A. M., Travis, E. R. & Drake, D. 2012. An estimate of avian mortality at communication towers in the United States and Canada. – PLoS One 7(4): e34025. DOI: 10.1371/journal.pone.0034025

Loss, S. R., Lao, S., Eckles, J. W., Anderson, A. W., Blair, R. B. & Turner, R. J. 2019. Factors influencing bird-building collisions in the downtown area of a major North American city. – PLoS One 14(11): e0224164. DOI: 10.1371/journal.pone.0224164

Loss, S. R., Will, T. & Marra, P. P. 2015. Direct mortality of birds from anthropogenic causes. – Annual Review of Ecology, Evolution, and Systematics 46: 99–125. DOI: 10.1146/annurev-ecolsys-112414-054133

Moinudheen, N. & Samson, A. 2021. Migratory sites of Kashmir Flycatcher Ficedula subrubra in Nilgiris and its migratory status in India. – Podoces 16(1–2): 13–17.

Sekhsaria, P. 2020. Are buildings the new killing fields for birds? – Bird Count India, October 5. https://birdcount.in/gbr-story2/

Rebolo-Ifrán, N., di Virgilio, A. & Lambertucci, S. A. 2019. Drivers of bird-window collisions in southern South America: A two-scale assessment applying citizen science. – Scientific Reports 9: 18148. DOI: 10.1038/s41598-019-54351-3

Ribeiro, B. C. & Piratelli, A. J. 2020. Circular-shaped decals prevent bird-window collisions. – Ornithology Research 28: 69–73. DOI: 10.1007/s43388-020-00007-0

Riding, C. S., O'Connell, T. J. & Loss, S. R. 2021. Multi-scale temporal variation in bird-window collisions in the central United States. – Scientific Reports 11: 11062. DOI: 10.1038/s41598-021-89875-0

Rodríguez-Loinaz, G., Amezaga, I. & Onaindia, M. 2012. Does forest fragmentation affect the same way all growth-forms? – Journal of Environmental Management 94(1): 125–131. DOI: 10.1016/j.jenvman.2011.06.024

Rosenberg, K. V., Dokter, A. M., Blancher, P. J., Sauer, J. R., Smith, A. C., Smith, P. A., Stanton, J. C., Panjabi, A., Helft, L., Parr, M. & Marra, P. P. 2019. Decline of the North American avifauna. – Science 366: 120–124. DOI: 10.1126/science.aaw1313

Swaddle, J. P., Emerson, L. C., Thady, R. G. & Boycott, T. J. 2020. Ultraviolet-reflective film applied to windows reduces the likelihood of collisions for two species of songbird. – PeerJ 8: e9926. DOI: 10.7717/peerj.9926

Team RStudio 2020. RStudio: Integrated development environment for R. – RStudio, PBC. https://posit.co/

Żmihorski, M., Kotowska, D. & Zyśk-Gorczyńska, E. 2022. Using citizen science to identify environmental correlates of bird-window collisions in Poland. – Science of the Total Environment 811: 152358. DOI: 10.1016/j.scitotenv.2021.152358