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ABSTRACT

Collisions with windows are the second leading cause of bird mortality worldwide. Since its identification as a major threat to avian biodiversity, bird-window collisions (BWCs) have been the focus of numerous studies attempting to determine what factors contribute to the susceptibility of birds to collisions. Migratory status, ecological niche, and local abundance have all emerged as possible contributors to species-specific collision risk. Our study models the relationship between species-specific local abundance and collision vulnerability from standardized collision surveys and eBird records. Collision surveys were conducted over approximately 3 years (30 Sept. 2018 - 23 Dec. 2021), covering 21 target buildings on the Louisiana State University main campus. A total of 3,118 surveys yielded 363 collisions, with the 5 most represented target buildings having a collision rate per survey of at least 10%. The collision dataset included 76 total species from 28 families, with passerines representing 80.17% of all collisions and Common Yellowthroats (*Geothlypis trichas*) being the top collider overall. We generated a hierarchical generalized additive model (HGAM) relating collision probability to local abundance for 21 species based on the fall 2020 and spring 2021 collision data and local eBird records. Our eBird dataset was particularly thorough, and included 34,484 unique observations from 1,358 checklists, accounting for 301 total species. Results of the modelling reveal four broad categories of species based on how their collision susceptibility relates to their local abundance, including species whose collisions appear dependent on their local abundance (e.g. Yellow-rumped Warbler, *Setophaga coronata*), those whose risk is independent of abundance (Common Yellowthroat and Ruby-throated Hummingbird, *Archilochus colubris*), those that are secretive yet highly vulnerable (e.g. Ovenbird, *Seiurus aurocapilla*), and those that are collision-avoidant (most residents). Our results also indicate that local abundance is overall a poor predictor of collision vulnerability and confirm previous studies' conclusions identifying migrant species as more susceptible than residents, as well as the importance of localized assessments of collision vulnerability for determining collision risk factors and effective mitigation strategies on a local scale.

INTRODUCTION

Collisions with windows are the second leading cause of bird mortality worldwide, second only to predation by cats. In the United States alone, it is estimated that an average of 599 million birds die annually due to window collisions (Loss et al. 2014).

A variety of factors are thought to contribute to the occurrence of bird-window collisions (BWCs). Among these, behavioral factors and relative window area are considered to be the primary determinants of window collisions. Birds cannot perceive glass as a physical barrier and are more likely to collide with windows as a result of behaviors that place them at or near ground-level (Klem 1990). Other factors known to contribute to the occurrence of BWCs include architectural features of buildings such as alcoves which effectively “trap” birds in an area of high collision risk, as well as environmental features such as high levels of vegetation or feeding stations located near high-risk windows (Klem et al. 2009, Riding et al. 2019).

Window collision risk has also been shown to vary on a taxonomic basis. While some taxonomic groups, such as warblers (Parulidae), appear to exhibit high levels of collision vulnerability across species, other species’ vulnerability does not appear to be connected to a broader taxonomic trend (Loss et al. 2014). Migratory passerine species, including several classified as threatened or endangered, are especially vulnerable to window strikes, ultimately exacerbating the overall trends of decline observed in these species due to habitat loss and invasive species introduction (Loss et al. 2014, Basilio et al. 2020).

Since its identification as a major contributor to bird mortality, various efforts have been conducted to better understand the occurrence and contributing factors of BWCs. Early studies primarily focused on establishing estimates and patterns of total mortality due to BWCs on a large scale, typically within the continental United States (Klem et al. 2009, Arnold and Zink 2011, Loss et al. 2014). Some early studies also began evaluating mitigation methods based on small-scale standardized collision surveys (Klem 1990, Klem et al. 2009, Loss et al. 2014). Later studies began to establish patterns of species-specific collision risk, in particular heightened collision risk among migrant species, as well as early looks into what factors may contribute to collision occurrence, such as seasonality, architectural features, and environmental factors (Hager et al. 2013, Loss et al. 2014, Hager et al. 2017). More recent BWC studies have focused on identifying specific contributing factors to BWCs on a more local scale as a means of providing tailored collision mitigation proposals as well as serving as a targeted compliment to previously established national estimates (Nichols et al. 2018). Several factors have been identified as potential contributors to BWCs and provide insight into where to focus efforts for effective mitigation, such as through modification of windows to increase visibility, removal of bird attractants near collision sites, and preventative architectural planning (Klem 1990). Among these are season, architectural features such as window area and reflectivity, and environmental conditions immediately surrounding a collision site (Martin and Bonier 2018, Nichols et al. 2018, Loss et al. 2019, Menacho-Odio et al. 2019, Riding et al. 2019). Other biological factors, including phylogenetic or ecological characteristics and local abundance have also been identified as contributing to collision risk (Hager et al. 2008, Sabo et al. 2016, Wittig et al. 2017, Elmore et al. 2020). The relationship between local abundance and collision risk is of particular importance as it can distinguish between species that suffer collisions as a result of high densities near high-risk areas and those with other more complex contributing factors at play. If abundance is a primary contributing factor to collision risk, we would anticipate that species with relatively high abundances would exhibit the greatest collision vulnerability. In the absence of this relationship, consideration of alternative contributing factors becomes necessary.

Here we incorporate both standardized survey and citizen science data to analyze the relationship between species-specific collision probability, season, and local detections. BWC data from standardized surveys was collected on the Louisiana State University (LSU) main campus in Baton Rouge, Louisiana, and were analyzed alongside temporally and spatially matched citizen science observation records collected through the Cornell Lab of Ornithology’s eBird program. The objectives of this study are as follows:

- Determine collision rates and species composition during the fall and spring seasons from 2018 to 2021
- Estimate local species-specific abundance via eBird detections during fall 2020 and spring 2021
- Determine both generalized and species-specific collision probability with a generalized model combining BWC and abundance data

METHODS

Collision Surveys

The protocols developed for the collision survey portion of this project were adapted from similar efforts conducted previously by Oklahoma State University and the Ecological Research as Education Network (EREN) (Hager et al. 2017, Riding and Loss 2018). Surveys were conducted at 21 target buildings on the LSU main campus (*Figure 1, Table 1*), determined as potentially high-risk for collisions based on relative window area compared to surrounding structures. Surveys were conducted by 10 trained volunteers from 30 Sept. 2018 until 23 Dec. 2021.

A set of standardized protocols for conducting on-campus surveys were developed to ensure proper handling of collision evidence and thorough data collection. Surveys were conducted via a single complete systematic pass within a 2-meter-wide perimeter around building exteriors. Surveyors were instructed to look thoroughly for collision evidence within this perimeter, including within and under obstacles such as shrubs, trashcans, benches, etc. All survey data including instances of no detected collisions were recorded via the Google Forms software, which took record of the surveyor, date and time of survey, target building, presence/absence and type of collision evidence, as well as an optional evidence description for ID confirmation and descriptions of nearby bird and scavenger sightings. Instances in which collision evidence was found (carcasses, feather piles, or live birds), were also uploaded to an iNaturalist project (https://www.inaturalist.org/projects/lsu-bird-window-collision-monitoring-project) for peer-reviewed species identification. All species taxonomy listed in this survey are derived from the American Ornithological Society Checklist of Middle and North American Birds (Chesser 2021). Incidental collision evidence not found during standardized surveys or at non-target buildings was also occasionally collected and submitted to the project iNaturalist. Fresh carcasses recovered in good condition were appropriately labelled with location and date found, then submitted to the LSU Museum of Natural Science for preservation.

Citizen Science Data

Local species abundance was estimated using citizen science observation data collected through the Cornell Lab of Ornithology's eBird project (eBird 2022). Data were obtained via an eBird data request corresponding to the fall 2020 and spring 2021 survey periods (31 Aug. – 17 Dec. and 11 Jan. – 1 June, respectively). The dataset used in the final analysis was limited to a circle centered at the LSU Renewable Natural Resources Building and extending to a radius of 4.41 km in all directions (*Figure 2*). This area was chosen to include eBird observation hotspots in the area with consistent and reliable observation data.

The dataset was filtered to include only those eBird checklists determined to be complete, research-grade, compiled during the daytime as either a stationary or travelling survey (non-incidental), and lasting between 30-250 minutes. Observations present across shared checklists or those able to be identified as multiple sightings of the same individual bird were also excluded from all but one checklist to prevent recurrent datapoints in the final dataset. The eBird observation data was ultimately used as a proxy of local abundance based on the occurrence of each species observed per eBird checklist per season.

Data Modelling and Analysis

A subset of the survey data totaling 165 collisions recorded during the fall survey season of 2020 and spring season of 2021 was selected for analysis alongside corresponding eBird observation data. This timeframe was selected due to its consistent BWC survey coverage and eBird contributions. We selected 21 migratory species commonly represented in observation and/or window-collision data (marked with * in *Appendix*) for modelling and further analysis. The species selected to inform the model were chosen to provide broad coverage of taxonomic groups and collision occurrence to better inform the global model.

We used hierarchical generalized additive models (HGAM) to model the non-linear relationship between eBird detections, collisions, and time among migratory species and evaluate the probability of window collisions for the fall and spring season for each species. HGAMs estimate “smooth” functional relationships of predictor variables (time, eBird detections) and their responses (window collisions) between each group-level (species), while also pooling these functions towards a common shape, resulting in a powerful yet flexible model (Pedersen et al. 2019). We implemented the mgcv package (Wood 2011) in the program R (R Core Team 2021) to generate these models. Models for fall and spring migration were generated separately, as these are ecologically separate events with different phenologies, diversity, and abundances. We compared 4 different models: A global model that uses an interaction term between detections and week but does not allow for individual species variation (G), two separate models with group-level smoothers (GI) to allow individual variation of species predicted by only detections or only week, and a model with global smoothers (GS) and interaction terms of both predictor variables (Table 3). For each model, we calculated the total weight (Wt), the number of basis functions (K) which sets the number of coefficients to be estimated in the models, and Akaike’s information criterion (AIC).

RESULTS

Survey and eBird Results

From 30 Sept. 2018 to 23 Dec. 2021, a total of 3,118 surveys were conducted across the LSU main campus. A total of 245 instances of positive collision evidence as either a carcass, feather pile, or live bird was recorded via our standardized survey method at target buildings (*Table 1*).

Only 3 target buildings (LSU03 – Lockett Hall, LSU12 – Acadian Hall, LSU13 – Herget Hall, and LSU14 – Miller Hall) showed no evidence of collisions during the total survey period. A grand total of 363 collisions, accounting for both survey and incidental data, were recorded on the project iNaturalist page since fall 2018. Of these, 113 were recorded during the spring survey season and 250 during the fall (*Appendix*). This data represents 76 total species from 28 families.

Passerines represented the vast majority of window collisions (80.17%) collected during the survey period, with warblers (Parulidae) accounting for 151 of the total collisions recorded. Overall, the 10 most prevalent species recorded represent 6 families and are all, with the exception of Mourning Dove, migrants within our region (*Table 2*).

Following filtering protocols, the eBird dataset for the modelling timeframe included a total of 34,484 unique observations representing 301 species from 1358 complete checklists.

The top 10 most-observed species present among eBird checklists represent 9 families and all are residents in this region.

Data Modelling Results

We selected the interaction-term model with global smoothers (GS) to predict window collision probabilities over time based on total weight and AIC values, and because it was the most informative model (*Table* 3). K values were reduced for this model for computational power, and thus generated a "smoother," more generalized model. Binomial predictions were generated from the model, thus providing species-specific probabilities of window collisions (0 – 1) throughout the fall and spring migration seasons. Each species exhibits a unique probability curve based on their recorded collisions and observations, as well as the generalized trends predicted by the global model. The area under the curve represents the probability of a species colliding with windows at a given point during the migration season. A total of 66 collisions informed the model, with 23 recorded during spring and 43 during fall. For less-represented species in the collision dataset, as well as residents included in the model, the slight increase in predicted collision vulnerability during the spring and fall seasons represents the influence of the generalized global model.

Species represented in the model can be grouped into 4 distinct categories based on the relationship between their observed abundance and collision risk.

- *Abundance-dependent* species exhibit higher levels of collision vulnerability with an increase in abundance, such as Cedar Waxwings and Yellow-rumped Warblers
- *Collision-vulnerable* species exhibit high collision vulnerability independent of local abundance, as appears to be the case for Common Yellowthroats and Ruby-throated Hummingbirds.
- *Secretive-vulnerable* species have high collision vulnerability even at low detected abundance, as with Ovenbirds.
- *Avoidant* species show very low or no apparent collision risk despite relatively high local abundance, including Eastern Phoebes and Barn Swallows

DISCUSSION

Collision Surveys

Our window collision surveys yielded 363 collisions over the course of approximately 4 years, representing 76 total species. The proportion of surveys with positive collision evidence varied between target buildings, with 5 buildings having collisions recorded during at least 10% of surveys (LSU UREC, Patrick F. Taylor Hall, LSU Library, Tureaud

Hall, and Tiger Stadium). Previous studies have established an average collision rate of 1-10 birds killed per building annually (Klem 1990). Based on the survey timeframe, the 10 buildings with the highest collision proportions all exhibit collisions rates within this estimate. The taxonomic composition of our collisions also aligns with that of broader studies quantifying species-specific collision risk and identifying some of our most prominently represented species as particularly window-strike susceptible, including Ruby-throated Hummingbirds, Ovenbirds, Black-and-white Warblers, and Common Yellowthroats (Loss et al. 2014).

eBird Data

Our project leveraged a unique opportunity to utilize a comprehensive citizen science dataset as an index for local species abundance that is rarely afforded to similar studies. The Baton Rouge area—and particularly the area surrounding LSU campus—contains a large number of experienced birders, including multiple professional ornithologists, birding guides, and eBird editors who, in the midst of initial lockdowns during the COVID-19 pandemic, were able to engage in local birding surveys more often and consistently than in previous years. This, combined with the consistency of our campus collision surveys during the same timeframe, offers us comprehensive datasets for both collision and local abundance data for our analysis.

The filtered eBird dataset containing 34,484 total observations taken during the modelling timeframe (31 Aug. – 17 Dec. and 11 Jan. – 1 June) also serves as a basis of comparison for determining what species are most susceptible to collisions. There is little overlap in the list of top 10 window strike versus observed species (*Table 2*). This discrepancy provides an initial indication that abundance may not be the sole factor contributing to collision risk. Similarly, the prominence of migrant species among window-strike species when compared to more-observed residents confirms previous studies' conclusions that migrant species are relatively more susceptible to window collisions compared to residents (Hager et al. 2017).

Data Modelling and Analysis

Modelling the relationship between species detections and collision probability over the course of spring and fall involved the generation of a hierarchical generalized additive model (HGAM) in R. A subset of 21 species were chosen to inform the model based on their prominence within the collision and/or eBird observation datasets.

Several patterns emerged with our data analysis. Between the spring and fall models, collision probability is highest among long-distance migrants compared to residents and other migrant species. Several species (Common Yellowthroat, Black-and-white Warbler, Cedar Waxwing) exhibit a higher risk of collisions earlier during their migration or only during a single season, indicating that it is also possible that phenological differences in migration timing and intensity may factor into species' vulnerability to collisions. This has been hinted at in earlier studies but has not been the subject of intensive research (Klem et al. 2009, Basilio et al. 2020). Further research will be necessary to fully determine the relationship between phenological characteristics of species and their susceptibility to window collisions; it is possible that improvements in the capacity to forecast species migration in real-time will allow for future projects to shed light on species-specific migration patterns and their contribution to window collision risk (Van Doren and Horton 2018).

Our model also reveals that vulnerability to collisions is independent of local detections. The four categories that emerged from of our analysis relating species collision probability to detections provide a basis for understanding what factors contribute to vulnerability on a species-specific basis. Abundance-dependent species exhibit the simple relationship in which increased collision risk appears to result primarily from increased local abundance. From our modelling, these species include migrants which occur in relatively high abundances in the area including Gray Catbird, Orange-crowned Warbler, Yellow-rumped Warbler, and Indigo Bunting. Other species, including Ruby-throated Hummingbird, Yellow-bellied Sapsucker, Northern Waterthrush, Black-and-white Warbler, Tennessee Warbler, Common Yellowthroat, and Magnolia Warbler exhibit a disproportionate level of collision risk relative to their detections. Other than Ruby-throated Hummingbird, all species in this category are insectivorous migrants, and among them warblers appear particularly vulnerable. The disproportionate vulnerability of warblers has been previously connected to aspects of their biology, specifically their tendency to forage near the ground (Klem 1979)**.** Species with relatively low collision vulnerability include Chimney Swift, Eastern Phoebe, Barn Swallow, Ruby-crowned Kinglet, Blue-gray Gnatcatcher, White-throated Sparrow, and American Redstart. Among our modelled species, collision avoidance seems to occur among aerial insectivores and a subset of migratory species that winter in our region. Several of these species have been previously identified as having relatively low risk of collision, but the exact mechanism by which this avoidance occurs is unknown (Arnold and Zink 2011, Loss et al. 2014) Lastly, two species have been categorized as secretive-vulnerable: Wood Thrush and Ovenbird. These species are unique in that, despite having very low eBird detection values, they exhibit high levels of collision vulnerability. Ovenbirds are perhaps the best example of this specific phenomenon, as they are relatively secretive and underrepresented in observation data despite being one of the most prevalent species in our collision dataset. This may be due to low detection probability or can possibly be attributed to nighttime collisions (Arnold and Zink 2011, Wittig et al. 2017). In any case, the categories proposed here classifying collision vulnerability based on local detections provide a new dimension to understanding species-specific collision risk. Previous studies have developed their own classification systems based on factors such as migratory status or ecological niche (Wittig et al. 2017). The development and refinement of these "group-specific" approaches to understanding BWCs is ultimately necessary as our understanding of its contributing factors become more complex (Cusa et al. 2015, Nichols et al. 2018). There is potential for using these classification systems alongside one another to develop more targeted approaches to understanding contributing factors to collision risk as well as what mitigation methods may be most effective, as we do not necessarily know if the same factors contribute equally to each species' collision vulnerability.

Limitations to our model primarily stem from incomplete or unrepresentative datasets for species known to be susceptible to window collisions. Scavenger removal is a known limiting factor in window-collision surveys, and it is likely that scavenger removal of collision evidence occurred during the survey timeframe, as feral cats and other wildlife are present on LSU campus, contributing to an underestimate of total collision mortality during the survey timeframe (Powers et al. 2021). Similarly, surveys were conducted during a limited timeframe between which campus facility services and students would frequent the area surrounding target buildings, as well as employees of the LSU Museum of Natural Science, who would occasionally collect collision evidence without conducting a full building survey. Due to this, it is possible that our records of campus collisions represent overall an underestimate due to human interference with collision evidence.

Our project sheds further light onto the factors contributing to species-specific vulnerability to BWCs. Our results indicate that local abundance is not the sole contributor to vulnerability to collisions on a species-by-species basis, emphasizing the need for further study into what factors come into play for each identified high-risk group or species. The prioritization of studies similar to our own, occurring on a localized scale and focusing on assessing specific factors contributing to collision risk, would be valuable for informing future efforts to mitigate BWCs on a local scale, rather than attempting to apply a "catch-all" solution that may leave some species unprotected (Riding et al. 2019).

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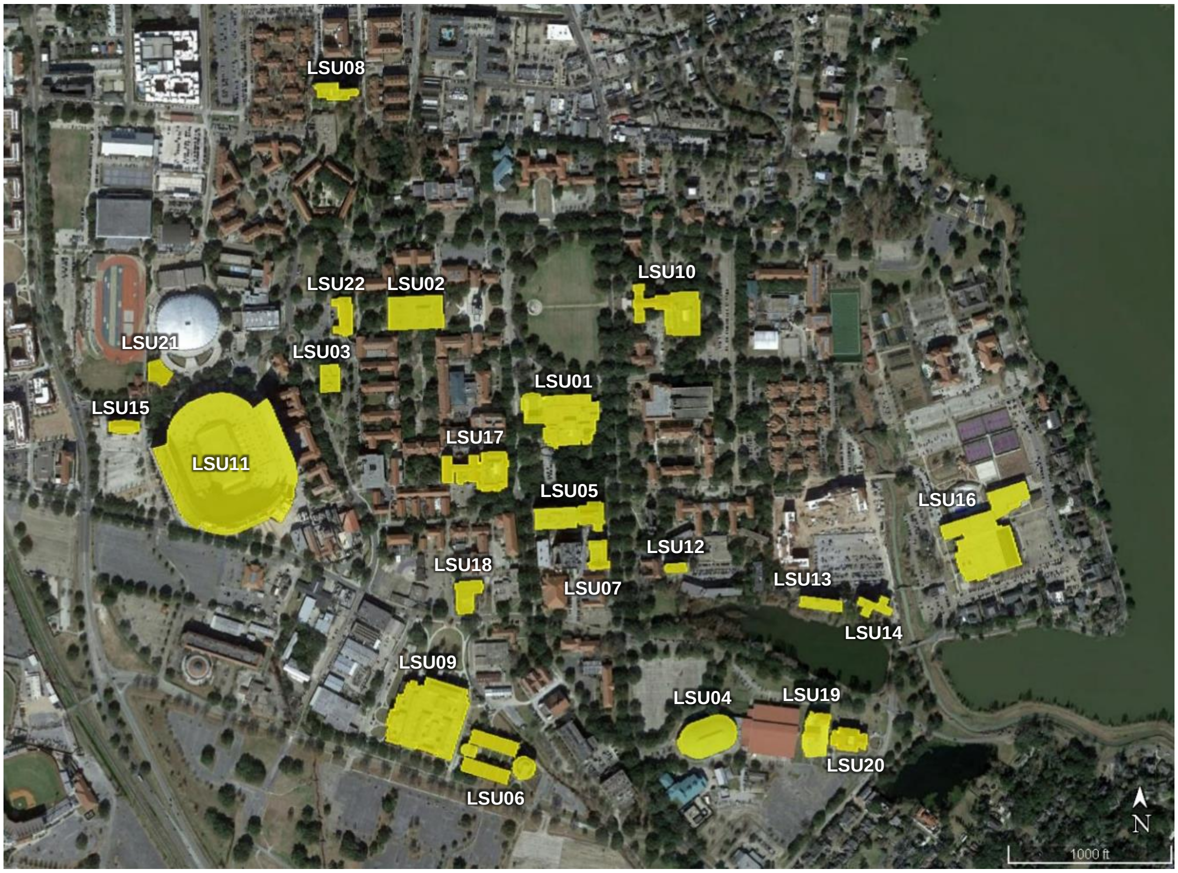

Figure 1: LSU main campus buildings targeted for bird-window collision surveys (highlighted yellow).

Figure 2: Circular area used to filter eBird observation data for the area immediately surrounding the LSU main campus. The area is centered at the LSU School of Renewable Natural Resources Building, extending to a radius of 4.41 km. This specific area was chosen as it encompasses eBird observation hotspots in the area, particularly to the south and east of campus.

Table 1: LSU campus target buildings surveyed during the total project period. Data is organized from largest to smallest value of the proportion of total surveys conducted at a building that yielded positive collision evidence.

Target Building	**Recorded Collisions**	**Total Surveys**	**Survey Proportion with Collisions**
LSU16 - UREC	12	39	0.31
LSU09 - Patrick F. Taylor Hall	54	299	0.18
LSU02 - LSU Library	60	362	0.17
LSU18 - Tureaud Hall	38	292	0.13
LSU11 - Tiger Stadium	9	92	0.10
LSU06 - E. J. Ourso College of Business	25	287	0.09
LSU15 - Ticket Office	7	97	0.07
LSU01 - Student Union	19	305	0.06
LSU17 - Howe-Russel Geoscience Complex	2	60	0.03
LSU10 - Paul M. Hebert Law Center and Law Library	6	210	0.03
LSU04 - John M. Parker Agricultural Center	3	115	0.03
LSU19 - Digital Media Center	3	124	0.02
LSU20 - LSU Emerging Technology Center	2	107	0.02
LSU05 - Department of Biological and Life Sciences	2	133	0.02
LSU22 - Hill Memorial Library	2	180	0.01
LSU21 - Mike the Tiger's Habitat	1	131	0.01
LSU03 - Lockett Hall	0	29	0.00
LSU07 - Chemistry and Materials Building	0	171	0.00
LSU12 - Acadian Hall	0	45	0.00
LSU13 - Herget Hall	0	19	0.00
LSU14 - Miller Hall	0	21	0.00
Total	**245**	**3118**	

Table 2: Top 10 species represented in collision dataset (left) and eBird observation data (right). Top 10 window strike species are organized from greatest to least number of collisions, while the top 10 observed are listed from greatest to least number of checklists present. Species listed include the number of collisions recorded on LSU campus during the project period. Also included are the total number of checklists on which each species appeared in the eBird dataset as well as the proportion of total eBird checklists this value represents.

Top 10 Window Strike Species			
Common Name	**Collisions**	**Checklists Present**	**Checklist Proportion**
Common Yellowthroat	53	179	0.13
Ruby-throated Hummingbird	41	427	0.31
Ovenbird	28	20	0.01
Mourning Dove	18	869	0.64
Indigo Bunting	17	215	0.16
Northern Waterthrush	16	39	0.03
Swamp Sparrow	12	82	0.06
Yellow-bellied Sapsucker	12	190	0.14
Wood Thrush	11	50	0.04
Black-and-white Warbler	10	74	0.05

Top 10 eBird Observed Species			
Common Name	**Collisions**	**Checklists Present**	**Checklist Proportion**
Blue Jay	2	1155	0.85
Northern Cardinal	3	1127	0.83
Northern Mockingbird	0	1059	0.78
Carolina Wren	0	950	0.70
Downy Woodpecker	0	915	0.67
Carolina Chickadee	1	919	0.68
Mourning Dove	18	869	0.64
American Robin	6	852	0.63
House Sparrow	2	771	0.57
European Starling	1	696	0.51

Table 3: Model selection for probability of window collisions, separated by spring and fall migrations. Models are listed in ascending order based on total weight (Wt), and includes the number of basis functions (K), Akaike's information criterion (AIC and Delta AIC).

Model	**K**	**AIC**	**ΔAIC**	**Wt**
Spring Migration				
Collisions ~ Week * Detection (GS)	**4**	**148.29**	**0.00**	**0.54**
Collisions ~ Week (GI)	10	148.61	0.31	0.46
Collisions ~ Detection (GI)	10	159.46	11.17	0.00
Collisions ~ Week * Detection (G)	10	182.98	34.69	0.00
Fall Migration				
Collisions ~ Week * Detection (GS)	**4**	**169.69**	**0.00**	**0.99**
Collisions ~ Week (GI)	10	199.25	29.56	0.00
Collisions ~ Detection (GI)	10	228.29	58.60	0.00
Collisions ~ Week * Detection (G)	10	230.89	61.2	0.00

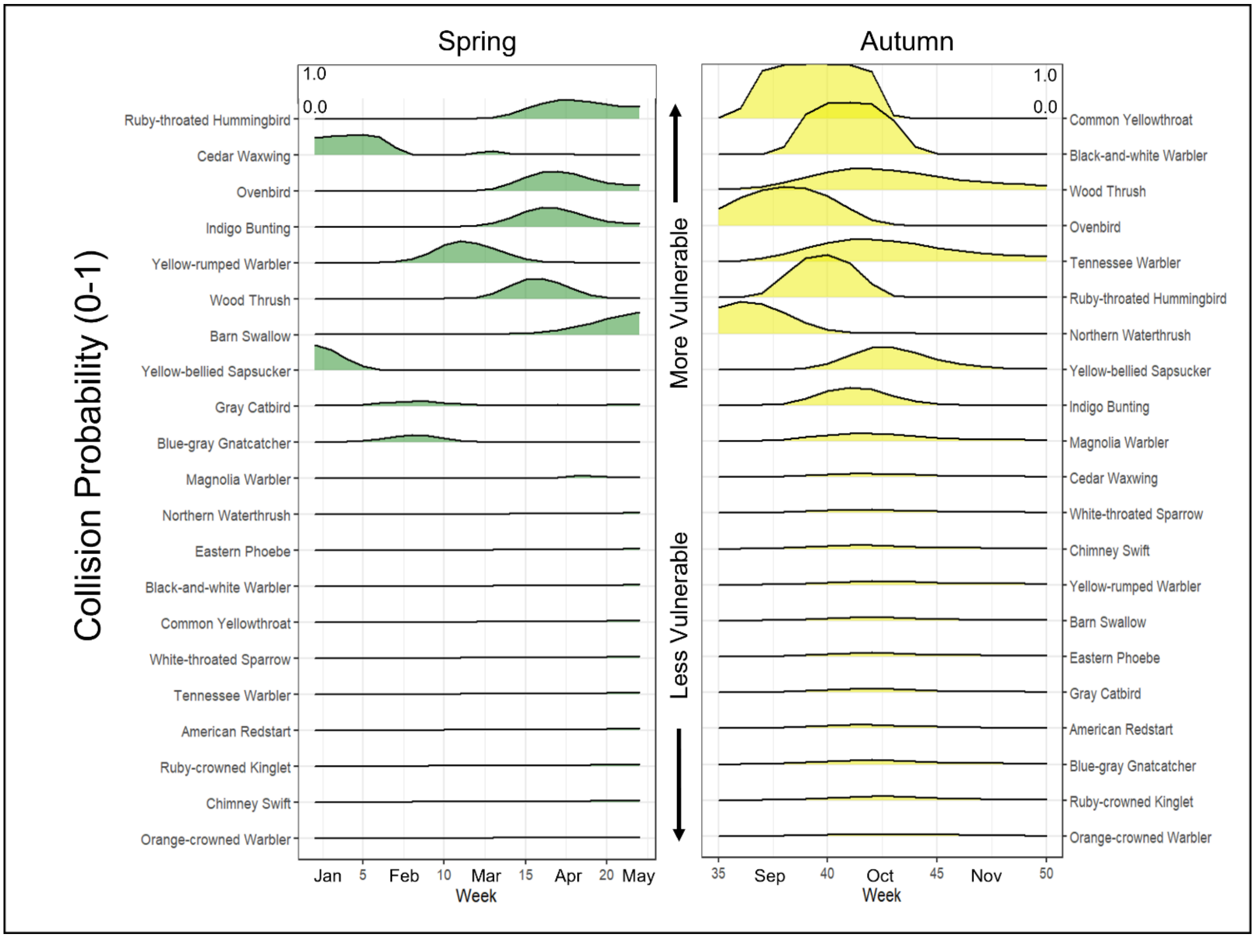

Figure 3: Predictive model of collision vulnerability by season of our 21 selected model species. Collision vulnerability is represented as the probability of a species striking windows during a given week, based on each species' previous collision patterns as well as the global model, scaled from 0 to 1. Species are aligned in descending order of total area under the probability curve, representing overall collision risk of a species throughout the migration season.

Appendix

Summary table of species represented in the total project collision survey dataset (collected 30 Sept. 2018 - 23 Dec. 2021). Species are organized in taxonomic order and include migratory status classifications for the East Baton Rouge Parish area. The number of collisions recorded for each species are subdivided according to what survey season they were found and are totaled on both a family and species level in the rightmost column. Species marked with an * are among the 21 selected as part of the modelling portion of the project. Species taxonomy is sourced from the American Ornithological Society Checklist of Middle and North American Birds (Chesser 2021).

	Common Name	Scientific Name	Migratory Status	Spring	Fall	Total
	Anatidae					**1**
	Wood Duck	*Aix sponsa*	Winter/Resident	1	0	1
	Columbidae					**24**
	Rock Pigeon	*Columba livia*	Resident	1	0	1
	White-winged Dove	*Zenaida asiatica*	Resident	1	0	1
	Mourning Dove	*Zenaida macroura*	Resident	8	10	18
	Cuculidae					**3**
	Yellow-billed Cuckoo	*Coccyzus americanus*	Summer	1	2	3
	Apodidae					**2**
*	Chimney Swift	*Chaetura pelagica*	Summer	0	2	2
	Trochilidae					**41**
*	Ruby-throated Hummingbird	*Archilochus colubris*	Summer/Resident	20	21	41
	Rallidae					**2**
	Sora	*Porzana carolina*	Winter	1	1	2
	Scolopacidae					**5**
	American Woodcock	*Scolopax minor*	Winter	2	3	5
	Accipitridae					**1**
	Cooper's Hawk	*Accipiter cooperii*	Resident	0	1	1
	Picidae					**16**
	Red-bellied Woodpecker	*Melanerpes carolinus*	Resident	0	1	1
*	Yellow-bellied Sapsucker	*Sphyrapicus varius*	Winter	0	12	12
	Downy Woodpecker	*Dryobates pubescens*	Resident	1	0	1
	Tyrannidae					**6**
	Eastern Kingbird	*Tyrannus tyrannus*	Summer	1	1	2
	Eastern Wood-Pewee	*Contopus virens*	Summer	0	1	1
	Acadian Flycatcher	*Empidonax virescens*	Summer	1	1	2
	Alder Flycatcher	*Empidonax alnorum*	Passage	0	1	1
	Vireonidae					**3**
	Red-eyed Vireo	*Vireo olivaceus*	Summer	0	3	3
	Corvidae					**2**
	Blue Jay	*Cyanocitta cristata*	Resident	0	2	2
	Hirundinidae					**1**
*	Barn Swallow	*Hirundo rustica*	Summer	1	0	1
	Regulidae					**4**
*	Ruby-crowned Kinglet	*Regulus calendula*	Winter	0	4	4
	Polioptilidae					**1**
*	Blue-gray Gnatcatcher	*Polioptila caerulea*	Resident	1	0	1
	Troglodytidae					**3**
	Marsh Wren	*Cistothorus palustris*	Winter	0	3	3
	Sturnidae					**1**
	European Starling	*Sturnus vulgaris*	Resident	0	1	1
	Mimidae					**7**
*	Gray Catbird	*Dumetella carolinensis*	Passage	3	4	7

	Turdidae					**33**
	Veery	*Catharus fuscescens*	Passage	1	2	3
	Gray-cheeked Thrush	*Catharus minimus*	Passage	0	1	1
	Swainson's Thrush	*Catharus ustulatus*	Passage	0	2	2
	Hermit Thrush	*Catharus guttatus*	Winter	0	7	7
*	Wood Thrush	*Hylocichla mustelina*	Summer	4	7	11
	American Robin	*Turdus migratorius*	Resident	6	0	6
	Bombycillidae					**7**
*	Cedar Waxwing	*Bombycilla cedrorum*	Winter	7	0	7
	Passeridae					**2**
	House Sparrow	*Passer domesticus*	Resident	1	1	2
	Fringillidae					**2**
	House Finch	*Haemorhous mexicanus*	Resident	1	0	1
	American Goldfinch	*Spinus tristis*	Winter	1	0	1
	Passerellidae					**22**
	Chipping Sparrow	*Spizella passerina*	Winter	0	2	2
*	White-throated Sparrow	*Zonotrichia albicollis*	Winter	0	2	2
	Nelson's Sparrow	*Ammospiza nelsoni*	Passage	0	1	1
	Lincoln's Sparrow	*Melospiza lincolnii*	Winter	0	4	4
	Swamp Sparrow	*Melospiza georgiana*	Winter	0	12	12
	Icteriidae					**3**
	Yellow-breasted Chat	*Icteria virens*	Summer	2	1	3
	Icteridae					**1**
	Brown-headed Cowbird	*Molothrus ater*	Resident	1	0	1
	Parulidae					**151**
*	Ovenbird	*Seiurus aurocapilla*	Passage	9	19	28
*	Northern Waterthrush	*Parkesia noveboracensis*	Passage	3	13	16
*	Black-and-white Warbler	*Mniotilta varia*	Passage	0	10	10
	Prothonotary Warbler	*Protonotaria citrea*	Summer	1	2	3
*	Tennessee Warbler	*Leiothlypis peregrina*	Passage	2	4	6
*	Orange-crowned Warbler	*Leiothlypis celata*	Winter	4	4	8
	Kentucky Warbler	*Geothlypis formosa*	Summer	1	1	2
*	Common Yellowthroat	*Geothlypis trichas*	Winter/Resident	1	52	53
	Hooded Warbler	*Setophaga citrina*	Summer	2	0	2
*	American Redstart	*Setophaga ruticilla*	Summer	0	1	1
*	Magnolia Warbler	*Setophaga magnolia*	Passage	1	5	6
	Yellow Warbler	*Setophaga petechia*	Passage	0	2	2
	Pine Warbler	*Setophaga pinus*	Winter/Resident	0	1	1
*	Yellow-rumped Warbler	*Setophaga coronata*	Winter	5	0	5
	Black-throated Green Warbler	*Setophaga virens*	Passage	0	1	1
	Canada Warbler	*Cardellina canadensis*	Passage	0	2	2
	Cardinalidae					**34**
	Summer Tanager	*Piranga rubra*	Summer	4	5	9
	Northern Cardinal	*Cardinalis cardinalis*	Resident	0	3	3
	Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Passage	2	0	2
	Lazuli Bunting	*Passerina amoena*	Passage	0	1	1
*	Indigo Bunting	*Passerina cyanea*	Passage	10	7	17
	Painted Bunting	*Passerina ciris*	Summer	1	0	1
	Dickcissel	*Spiza americana*	Resident	0	1	1
			Total:	**113**	**250**	**363**