A SURVEY OF BIRD-BUILDING COLLISIONS AND BUILDING CHARACTERISTICS AT THE UNIVERSITY OF NEW MEXICO

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INTRODUCTION

Billions of birds in the United States are annually killed by human influence (Loss et al. 2014, 2015), notably from predation by house cats and collisions with buildings, vehicles, or powerlines (Loss et al. 2015). While certain species of birds are more vulnerable to collisions, particularly migratory birds (Loss et al. 2014), the result is declining avian populations. Buildings across the U.S. are unfortunate examples of the lack of building and landscape planning concerning birds, resulting in frequent deaths (Loss et al. 2014, 2015; Hager et al. 2017).

To combat this issue, researchers have investigated aspects of buildings that make them at risk for collision. Common features that contribute to bird-window collisions are glass area (Klem 2009, Klem et al. 2009, Nichols et al. 2018), surrounding vegetation (Hager et al. 2013, Klem et al. 2009), and building size (Hager et al. 2017). Research has established that birds are unable to see the clear, reflective glass and plastic common in many windows (Klem 2009). The birds are subsequently killed from rupturing blood vessels and impact damage in their brains from colliding with windows (Klem 1990). Researchers across the globe have conducted studies to inform future planning and amending buildings to be more bird-friendly by surveying collisions (Klem et al. 2009, Ocampo-Peñuela et al. 2016, Hager et al. 2017, Low et al. 2017, Nichols et al. 2018).

The University of New Mexico (UNM) is no stranger to human-caused avian fatalities. While the topic is more commonly studied in other parts of the U.S., there is no similar study in the Southwestern U.S. assessing bird-building collisions. In this study, the UNM central campus was surveyed for bird-building collisions by quantifying the number of bird casualties and identifying building characteristics that are known to be correlated with such collisions: building size and glass area. It was hypothesized that larger buildings, buildings with more glass area, and buildings with higher reflectivity increase collision risks and yield more casualties than those with lower risk characteristics.

METHODS

Buildings and Study Area. The study area was UNM's Central Campus (not including the UNM Hospital Campus) in Albuquerque, Bernalillo County, New Mexico (Figure 1). The campus is approximately 800 acres (3.24 km^2) according to their website, sporting

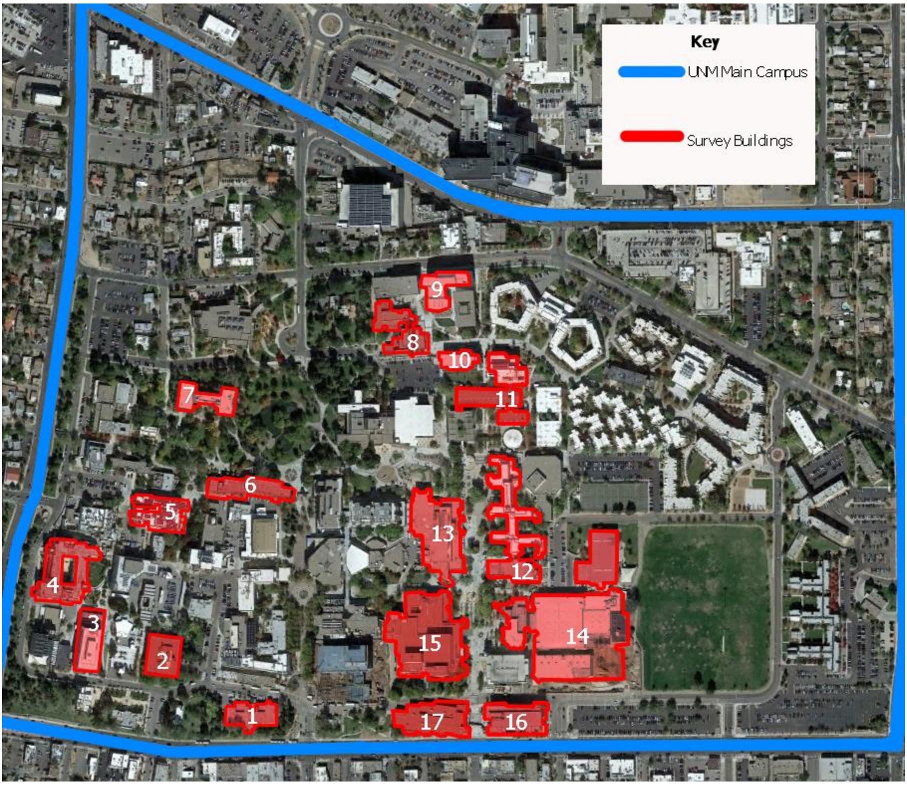

Figure 1. Study area and buildings. The area classified as UNM's Central Campus is contained within the blue line. All study buildings and building complexes are outlined and colored in red and numbered in order in which they were surveyed (Table 1).

a mixture of pueblo revival, modern, and post-modern architecture. UNM has a lush, vivacious environment full of "bird-friendly" landscaping as set out by Leopold (1918). The campus became a designated Arboretum in 1914 providing ample habitat for birds. As a result, the abundant vegetation could contribute to window collisions. After surveying the buildings and structures on campus between May and July 2018 and identifying buildings potentially posing the greatest risk, buildings were narrowed down further when certain buildings consistently yielded no casualties early on in the surveys. The 17 selected buildings (Figure 1, Table S1) were surveyed for 22 days from August 2018 to November 2018, and again for 13 days from March 2019 to May 2019 with a standardized survey path of 5.02 km.

Collision Risk. Buildings were assessed for four identifying factors that contribute to bird collisions as outlined by Klem (2009) and USFWS (2016): glass area, building size, surrounding vegetation, and building features. Since building size is related to risk of collision (Hager et al. 2017), building size was measured using building square feet and number of floors provided by UNM Space Management. Glass area was measured by visual observation, photos, and estimating glass to building area percentage. Risk was also determined by observations of window strike imprints, near-misses, reflectivity of glass, reflection of vegetation, vegetation distance to buildings, and window features such as coverings, decals, and patterns. These factors were descriptive and used to elaborate on risk factors for respective buildings.

Quantifying Casualties. A typical survey day was conducted from 6:30 AM to 9:30 AM walking the entire perimeter of the survey buildings looking for dead birds or other evidence of collision (i.e., stunned birds) (Figure S2, Figure S3). Birds recorded in the list of total casualties were skeletons and other more complete carcasses within 2 m or less of a window and identified to species with the assistance of Museum of Southwestern Biology (MSB) staff. Other birds included in the total casualties were those that were stunned or observed actively colliding with a building, whether the bird flew/hopped away or not, as there is a high chance they would succumb to their injuries from the collision or have a decreased chance of survival due to injuries (Klem 1990).

Birds collected by others during the study's duration and those in the ARCTOS database of birds found in the immediate area were added to the casualty list. The ARCTOS database (arctos.database.museum/) is a multi-university online collection of research data managed and used for natural and cultural history research.

RESULTS

The number of casualties collected and observed across the entire period was 36, with 25 during the fall period and 11 during the spring survey. Casualties from the ARCTOS database totaled 40, resulting in 76 total casualties on the UNM Main Campus. There were 34 species recorded (Table 1), the highest from MacGillivray's Warbler (9) and Rock Pigeon (8). Among survey casualties, the highest species were MacGillivray's Warbler (5), Orange-crowned Warbler (4), and American Robin (4). The number of casualties in the survey was higher in October (11) than any other month and higher in the fall (27) compared spring (12; Figure S4). For all recorded casualties (Figure S5), fall and spring had equal casualties (25), which were higher than either summer (2) or winter (11). The peak months were October (13) and May (12).

Buildings with the highest casualties recorded during the survey (Figure S1, Table S1) were Farris Engineering Center (5), followed by College of Education, George Pearl Hall, McKinnon Center, and Science & Math Learning Center, all with four casualties each. The relationship between casualties and floorspace (Figure 2) was negative (r = -0.437, N = 17, P = 0.079) where casualties were highest at smaller buildings. Buildings with floorspace < 10,000 m² had 28 out of 36 casualties. The relationship between glass area and casualties (Figure 3), was positive (r = 0.588, N = 36, P = 0.013). Most survey casualties were found in buildings with ≥ 50% glass area (30 out of 36 casualties).

Table 1. The 76 total casualties of 34 species recorded during the study.

Scientific Name	Common Name	Found	ARCTOS	Total
Accipiter striatus	Sharp-shinned Hawk	0	1	1
Archilochus alexandri	Black-chinned Hummingbird	2	1	3
Bombycilla cedrorum	Cedar Waxwing	0	3	3
Cardellina pusilla	Wilson's Warbler	2	0	2
Catharus guttatus	Hermit Thrush	3	2	5
Chordeiles minor	Common Nighthawk	0	1	1
Coccyzus americanus	Yellow-billed Cuckoo	0	1	1
Columba livia	Rock Pigeon	2	6	8
Corvus brachyrhynchos	American Crow	0	1	1
Geococcyx californianus	Greater Roadrunner	0	1	1
Geothlypis tolmiei	MacGillivray's Warbler	5	4	9
Geothlypis trichas	Common Yellowthroat	1	0	1
Hirundo rustica	Barn Swallow	0	1	1
Junco hyemalis	Dark-eyed Junco	3	0	3
Megascops asio	Western Screech-Owl	0	1	1
Oreothlypis celata	Orange-crowned Warbler	4	0	4
Passer domesticus	House Sparrow	1	1	2
Peucaea cassinii	Cassin's Sparrow	0	1	1
Passerina caerulea	Blue Grosbeak	1	0	1
Pipilo chlorurus	Green-tailed Towhee	1	2	3
Pipilo maculatus	Spotted Towhee	1	0	1
Psaltriparus minimus	Bushtit	0	3	3
Regulus calendula	Ruby-crowned Kinglet	0	2	2
Seiurus aurocapilla	Ovenbird	0	1	1
Setophaga coronata	Yellow-rumped Warbler	0	1	1
Setophaga petechia	Yellow Warbler	0	1	1
Sphyrapicus varius	Yellow-bellied Sapsucker	0	1	1
Spinus psaltria	Lesser Goldfinch	1	1	2
Spizella passerina	Chipping Sparrow	1	1	2
Sturnella neglecta	Western Meadowlark	0	1	1
Turdus migratorius	American Robin	4	0	4
Vireo gilvus	Warbling Vireo	1	0	1
Zenaida asiatica	White-winged Dove	2	0	2
Zenaida macroura	Mourning Dove	1	1	2

The features of reflection and vegetation combined with glass area increased collision potential. Buildings with a combination of high reflectivity of vegetation, building size, and glass area consistently (with the exception of intervention by groundskeepers) yielded larger amounts of mortalities—most notably the Farris Engineering Center.

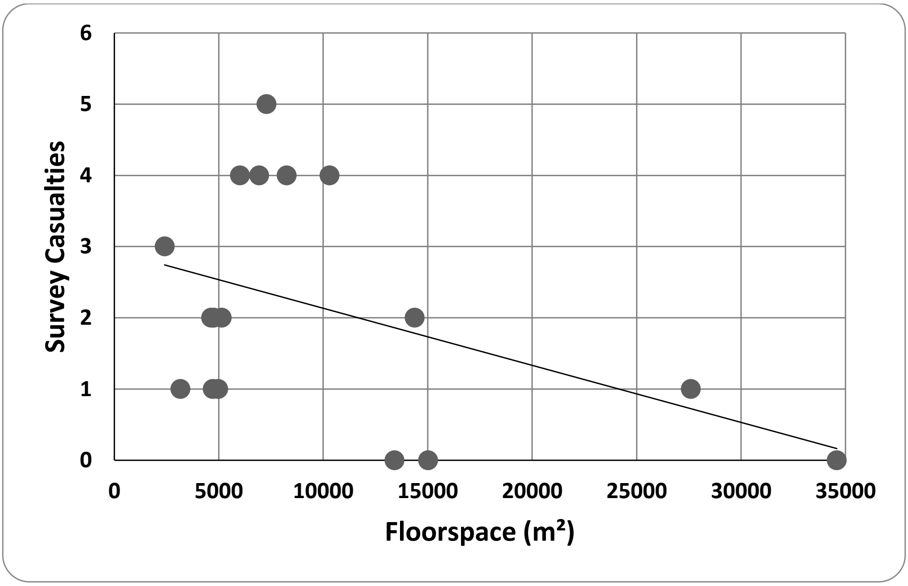

Figure 2. The relationship between survey casualties and the floorspace area of selected buildings.

Discussion

UNM's Central Campus is known to be unsafe to birds with casualties observed each year; this study confirmed that glass area and number of casualties were significantly related. Unfortunately, building height was unavailable in this study due to limited access, showing obvious next steps for more detailed analyses. However, minimal resources severely restricted the amount of data that was collected. The limitations of one surveyor restricted the survey to buildings with medium and high collision risk, therefore eliminating the ability to thoroughly compare each individual building and landscaping characteristic. Because of these constraints, carcasses could not be verifiably determined to have collision as the cause of death unless the event was directly observed or the disposition of the carcass showed obvious signs of collision.

The size of the data set including the ARCTOS specimens was smaller than desired for appropriate statistical tests. The frequency of casualties by month showed similarities with other collision studies, where more collisions occur in the fall than spring and most collisions occur in October (Loss et al. 2014, Low et al. 2017, Nichols et al. 2018). Birds most prone to collisions in this study were regular long-distance fall and spring migrants; the *Parulidae* (Wood-warblers) were heavily represented in both survey (12) and total (19)

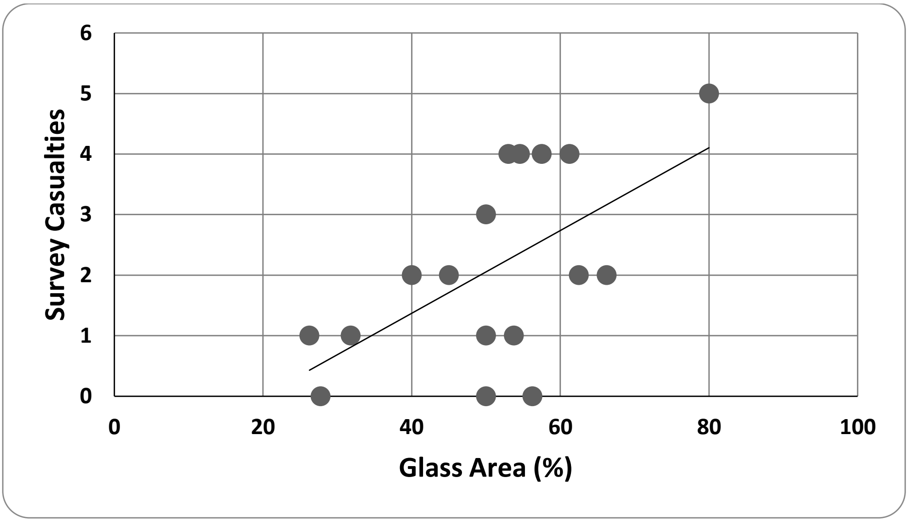

Figure 3. The relationship between survey casualties and the glass area of the survey buildings.

casualties, consistent with other research (Nichols et al. 2018). Resident and seasonal resident species more prevalent in this study were American Robin, Dark-eyed Junco, and Rock Pigeon; their mortality risk was attributed to food sources being closer to buildings (Klem et al. 2004) and higher densities of these birds around windows in general (Hager et al. 2008).

Susceptible buildings with no specimens were likely influenced by facility management and custodial staff removing carcasses earlier than the survey start time. Carcass removal by custodial staff occurred daily in the early morning for the Student Union Building and there were presumably similar practices for the Center for the Arts/Popejoy Hall and Centennial Engineering Center as well. Casualty yield was also likely affected by scavengers, as there are many Cooper's Hawks (*Accipiter cooperii*) and feral cats on campus.

The purpose of this study was to establish a precedent to move forward in informing campus policies and finding ways to reduce bird-building collisions. Future research on UNM Campus bird-building collisions should involve concentrated effort of consistent surveying for each given target building and a greater variety of buildings surveyed, as has been typical in other bird-building collision studies (Klem et al. 2009, Nichols et al. 2018, Ocampo-Peñuela et al. 2016). This should provide a large enough data set to use in petitioning for appropriate bird-safe measures. Future mitigation would involve creating a database for anyone on campus to report and provide bird carcasses for collection and research by MSB. Planning for future research with faculty at UNM began in September 2019 with the School of Architecture and Planning and MSB, informed by this study and the body of research informing mitigations for bird friendly solutions.

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