

2026 Sunfish Lake Park Acoustic Bird Survey

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1.0 Abstract

This report evaluates the bird diversity within Sunfish Lake Park during the summer of 2026. Overall species richness was evaluated with the use of two Wildlife Acoustics Song Meter Mini 2 devices. Acoustic surveys were conducted at seven different locations during the summer months between July and August. All recorded calls were run through BirdNet analyzer, the files were transferred to Raven Lite, and the top calls from a species with the highest confidence level were manually validated through auditory comparison. Following the confirmation of that species call, the following identified calls with lower confidence levels were assumed to be correct. Species identification was checked by information provided on eBird and any bird species reportedly detected by BirdNet that has never been spotted in Minnesota were disregarded and removed from the database. Results indicated the presence of 81 species and a total number of 42,330 bird calls recorded and validated. These findings highlight the value of monitoring native and migratory bird presence within an ecosystem to determine ecological health. Overall, further research is required to find total abundance and see if any comprehensive planning is required to form a balanced environmental restoration plan.

2.0 Introduction and Background

Sunfish Lake Park was established in 1974 on land sold to the City of Lake Elmo by landowners at below market value to avoid the construction of a large housing development. Sunfish Lake was in all likelihood formed due to the melting of a large glacier more than 15,000 years ago. The lake itself is centered at 45.002 north latitude and -92.895 west longitude in Lake Elmo, Minnesota and is a safe haven for many bird species to live year-round, raise their young, and pass through during migration. The area of Lake Elmo is found in East-central Minnesota and is home to a diverse range of habitats including forests, lakes, prairie, and wetlands which creates an ideal overlap for a multitude of species. Minnesota currently has an official list of 444 recorded bird species, though some of them are classified as accidental, introduced, casual, or extinct. A total of 266 species have at least one record of documented nesting in Minnesota and 56 are noted as year-round species. A previous species count in 2019 listed on eBird recorded 176 species observed in Sunfish Park while a Haikubox monitor at the Nature Center detected 213 species between October 2024 and July 2025. Visit the page listed in the references under *bird exhibit* to see these species lists. Some of the most common birds sighted in the Lake Elmo area include Canada geese, mallards, loons, marsh wrens, ospreys, marsh wrens, and migratory visitors such as sandhill cranes, warblers, and herons. Birds are widely known as bioindicators as their presence, absence, or population fluctuations can provide key clues to the overall health of an ecosystem. Birds react quickly to environmental changes as they live in every biome and have a wide distribution. Species presence or absence can provide insight into the health and maturity of a forest, pollution levels of wetlands, overall biodiversity, and are relatively straightforward to count and study as they are loud and often easily visible.

An acoustic bird study was conducted in Sunfish Lake Park through the use of mechanical auditory processes with deployed ARU (Autonomous Recording Unit) devices at multiple locations with different environments. This includes multiple areas around Sunfish Lake, Unnamed Pond, prairie, edge of the forest, and at the Sally Manzara Interpretive Nature Center building; See *Figure 1.* for all ARU

locations around Sunfish Lake Park. Passive acoustic monitoring allows for the collection of detailed data as they can record for long hours over multiple days in remote areas without the influence of human presence. Different species have different hours they typically vocalize and allow for the collection of nocturnal birds. Common nocturnal birds in the Minnesota Lake Elmo area include the nighthawk, barred owl, great horned owl, and eastern screech owl. Additionally, recorded calls provide verifiable data that can be listened to and reviewed by multiple people, eliminating individual listener bias. ARUs do not typically misinterpret data on their own, data misinterpretation typically happens in the processing phase which is why manual confirmation with multiple inputs is important for the highest identification success rate. Visual confirmation was not taken into consideration or recorded during this process.

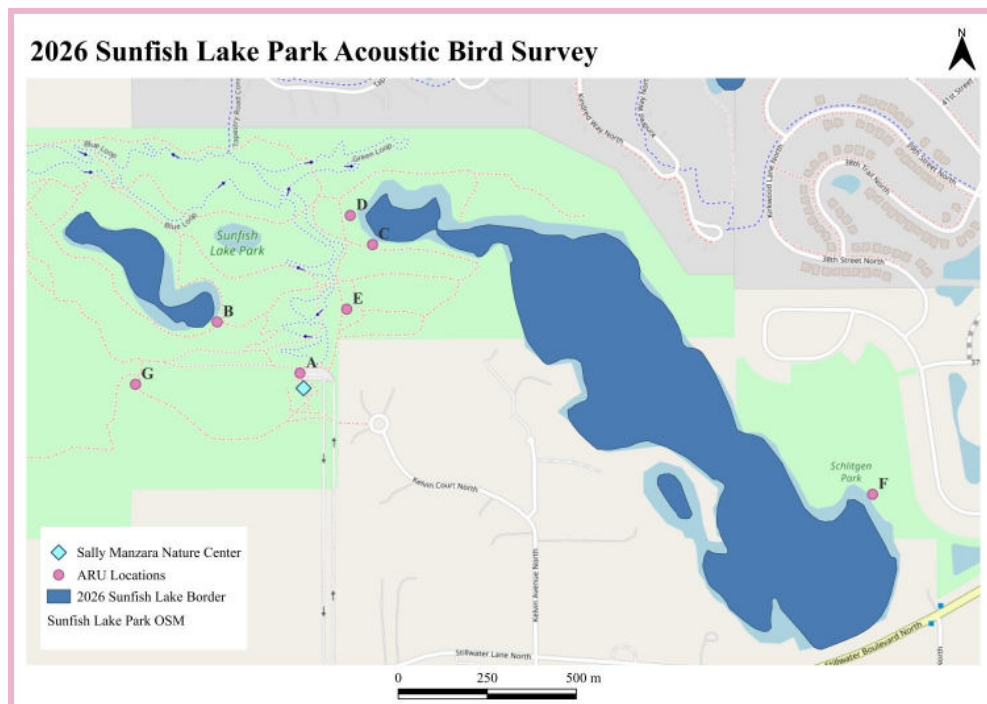


Figure 1. Map of all ARU locations for the 2026 acoustic bird survey in Sunfish Lake Park.

3.0 Methods and Materials

All bird calls were collected with the use of two Wildlife Acoustic Song Meter Mini 2(AA) Acoustic Recorder devices placed in multiple areas around Sunfish Lake Park - see *Figure 1*. Each ARU was secured to a tree with a cable lock at its designated site. Each site utilized the use of one ARU device at a time; while one device recorded at site A, another device recorded calls at site B. At no time were both of the devices present at the same location. At the end of each sampling session, the ARU was removed from the tree and brought back to the center where all data was collected from the SD card and the batteries were changed out with fully charged replacements. See *Figure 3*. for a detailed table on how long each ARU was recording in a certain area and the total number of calls recorded at each site. The ARU devices were set to begin recording at 3:00pm (15:00) and stopped at 3:00am (3:00) for each day they were deployed at their designated location. All bird calls were analyzed with BirdNET set within the parameters: net sensitivity - 1, merge consecutive detections - 1, minimum bandpass frequency (Hz) - 0, minimum confidence - 0.8, overlap - 1, audio speed modification - 1, maximum bandpass frequency (Hz)

- 15000, and species list - all species. Following BirdNET analysis, the files were transferred to Raven Lite where the top calls from a species with the highest confidence level were manually validated through auditory comparison. Following the confirmation of that species call, the following identified calls with lower confidence levels were assumed to be correct. Most calls identified by Bird Net as a species that has never been spotted in Minnesota were disregarded and removed from the database. Species presence was checked by information provided on eBird. However, certain species not present in Minnesota that carry lower frequency calls, such as doves, owls, and bitterns, were listened to as they are commonly misinterpreted by BirdNet for their Minnesota native counterparts. All figures and data were created and analyzed with Rstudio. Each site was analyzed with total species richness, the Shannon index, and Simpson's diversity index, as well as total call count comparisons.

4.0 Results

Across all sampling sites, a total number of 42,330 bird calls were recorded and validated; this number does not include calls from misinterpreted species. Site E recorded the highest number of calls with a total of 11,484 calls, followed by site G with 9,870 calls, and site F at 7,697 calls. Based on total detections, July was regarded with the most total calls collected depicted by a specific spike on around July 24th, see *Figure 5*. A number of detected calls were disregarded during the manual validation process as a multitude of construction noises, crickets, and frog calls were categorized as bird vocalizations.

Survey Area	Map Label	Dates Surveyed	Total # of Calls
Nature Center	A	6/28 - 7/05	5270
Pond	B	6/27 - 7/05	1808
Lake	C	7/06 - 7/15	3962
Lake	D	6/11 - 6/16, 6/22 - 6/26	2239
Prairie	E	7/09 - 7/19	11484
Lake	F	7/22 - 7/29	7697
Forest Edge	G	7/22 - 7/29	9870

Figure 2. Table of dates ARU's collected data, map location, survey area, and total number of bird calls collected. Note: site D has a gap in data collection - It is believed that the batteries died in the device on 6/16 and were not restored until 6/22 when data resumed.

The most notable species with the highest call counts include the Eastern wood-pewee (11,389), house wren (5,339), great crested flycatcher (4,439), and Eastern kingbird (2,985). Certain species only had a total of one call recorded such as a bald eagle, black-crowned night-heron, brown-headed cowbird, least fly-catcher, wild turkey, and carib grackle. Eastern wood-pewee had the highest abundance of calls at site G with a total of 7,720 calls detected. This is followed by house wrens with a total number of 3,770 calls at site A, Eastern bluebird at site F with 2653 calls, and great crested flycatcher at site E with 2182 calls. See additional figures for total call counts detected per species.

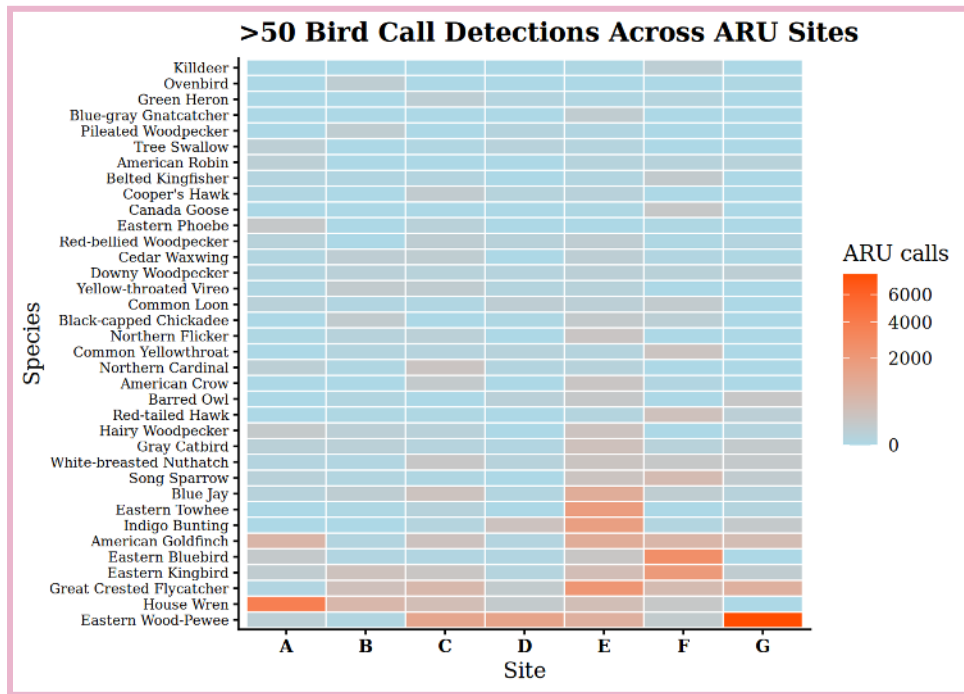


Figure 3. Total calls detected per species at each site above 50 detections.

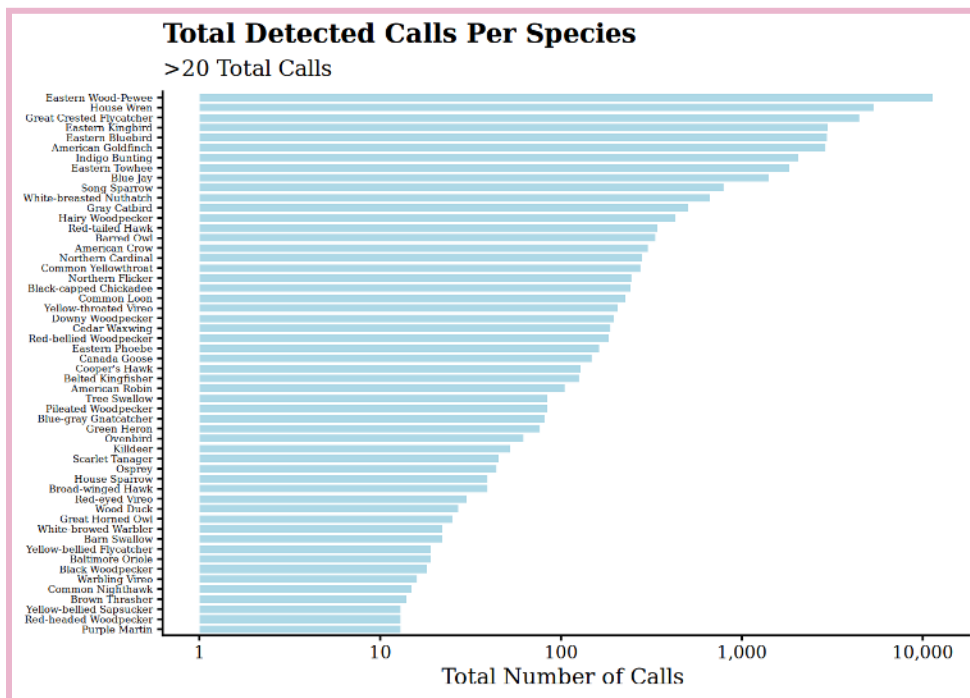


Figure 4. Total calls detected per species above 20 total detections.

Bird species diversity varied among ARU survey sites. Observed species richness ranged from 22 species detected at site G to 48 species detected at site E. Site E had the highest diversity according to

both the Shannon diversity index ($H' = 2.6$) and Simpson's diversity index ($1 - D = 0.893$) followed by site C ($H' = 2.44$; $1 - D = 0.849$) and site B ($H' = 2.30$; $1 - D = 0.839$). Site A had a relatively low diversity ($H' = 1.24$; $1 - D = 0.839$) while site G had the lowest observed diversity and richness ($S=22$, $H' = 0.98$, $1 - D = 0.378$). Overall, site E, C, F, and B supported more diverse bird populations than site A, and G. A comparison of all sites concluded an average Shannon's index score of 1.90, which indicates low to moderate level of biodiversity in an ecosystem. An estimated overall richness of 35 species per site and a Simpson's diversity score of 0.69 which indicates a moderate-to-high level of biodiversity or community diversity. See additional figures for full site specific richness, Shannon index, and Simpson's diversity calculations.

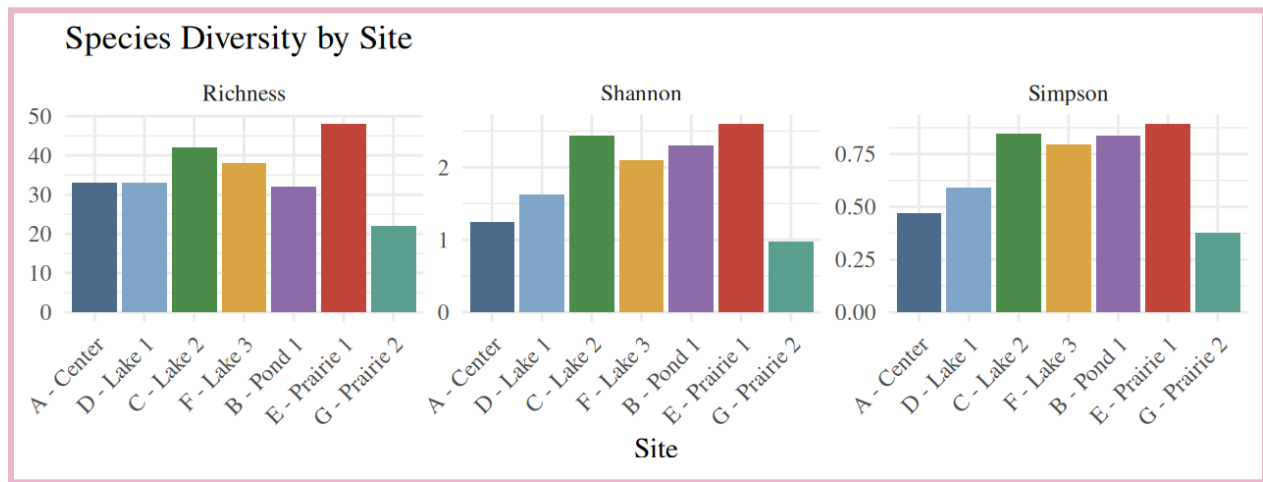


Figure 5. Triple bar graph depicting species diversity by site through comparison of species richness, Shannon index, and Simpson's diversity index comparisons.

Diel bird activity varied among survey sites. Across sites, detections generally increased in abundance during the evening and reached their highest levels between approximately 17:00 and 20:00, followed by a sharp decline between 20:00 and 12:00. Site E exhibited the greatest activity, with a maximum of approximately 3,200 detections at hour 20. Site A and F also showed relatively high activity during the late afternoon and evening, whereas site B had the least overall abundance of detections. Sites C and F displayed more pronounced fluctuations throughout the afternoon, while site D remained relatively stagnant until an increase in detections at 20:00. These patterns suggest that the timing and amount of bird activity differed among sites, with site E showing the strongest evening activity. Note that all detections were recorded during the hours of 3:00 pm (15:00) and 3:00 am and the data does not account for any activity taking place between the hours of 4:00 am and 2:00 pm (14:00).

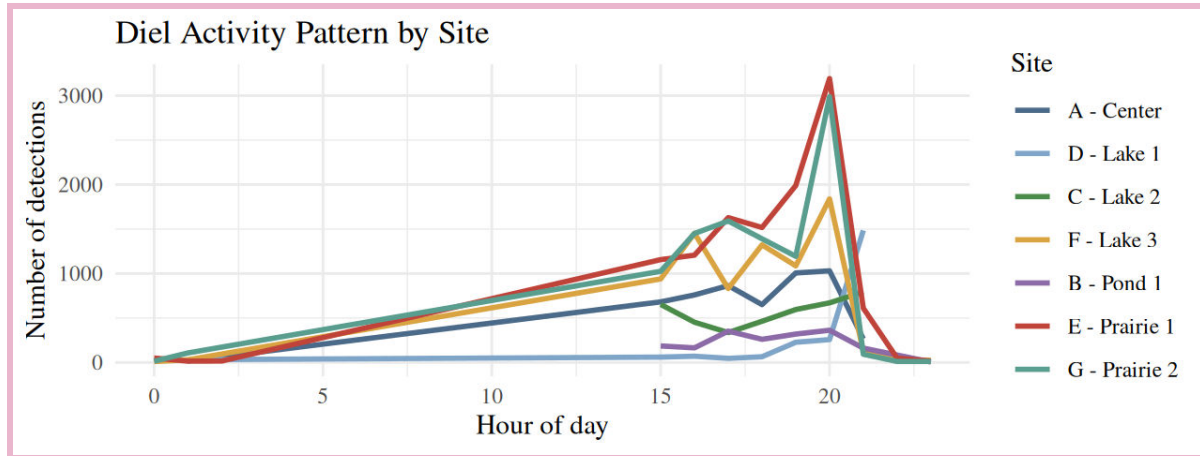


Figure 4. Line graph depicting diel activity throughout the hours of 3:00 pm (15:00) to 3:00 am across all sampling sites. Note: No data between 3:00 and 15:00 as recording did not occur during this time frame. Straight sloping lines are an artifact of software.

The number of detected calls varies substantially among sites and across time, with most sites showing relatively low or moderate activity and a few dates showing pronounced peaks. The highest number of calls were detected on July 22th at site G for a total of 4,164 calls followed by 3081 calls on July 25th at site F, and 2,470 calls on July 28th at site G. Site B remained relatively consistent with total call counts falling below 300 for all collection dates. Site A generally recorded low to moderate numbers of calls, with peaks near late June and early July. Variation among sites may indicate differences in bird abundance, habitat quality, vegetation, or local environmental conditions. Note all sites were surveyed at different times with differing recording lengths and this data does not include comprehensive comparison.

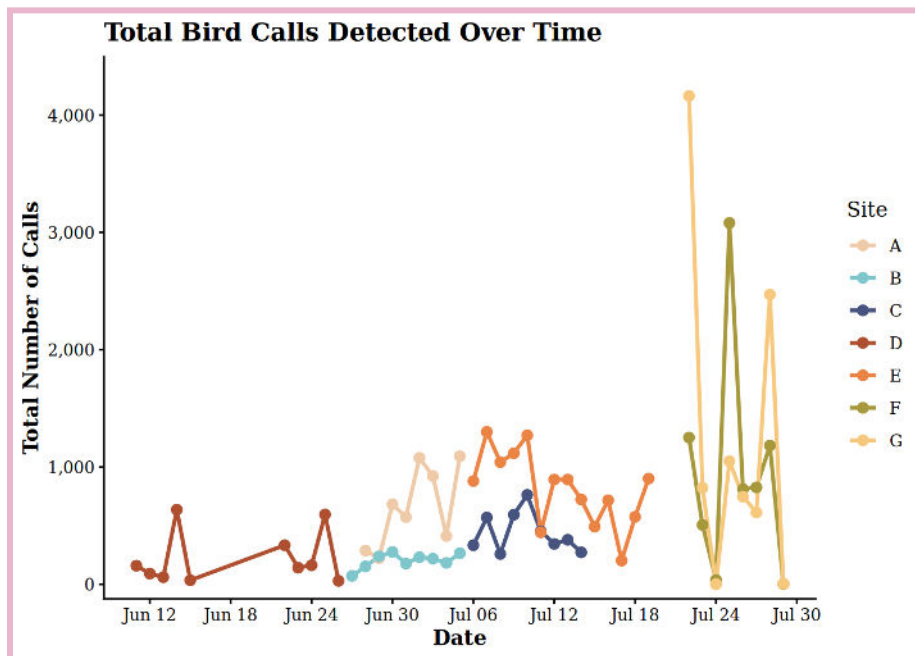


Figure 5. Total bird calls detected by autonomous recording units across all sampling sites from June 11 to July 29.

Discussion

The findings of this study should be interpreted with the restraint of certain limitations. Each ARU was deployed for different lengths of time in different locations which may have caused biased results in data analysis comparison as longer recordings gather more information. Calls were not recorded on a 24-hour schedule as the acoustic devices were originally placed with the sole purpose of recording amphibian calls in the area and this time frame is when frogs are most active vocally. Additionally, Each call recorded with an ARU does not define how many individuals are present in an area; abundance counts require additional analysis with the use of a standard call intensity index. Differences in recording conditions, background noise, weather, ARU placement, and detection performance could influence the number of calls recorded. BirdNet software typically misinterprets data roughly 15% and 28% of the time. While this means they achieve a baseline precision rate of roughly 72% to 85% under typical field conditions, some misinterpreted data may have been included in validated data due to the large amount of recorded calls. Future directions include conducting a standard call intensity index to determine how many individuals of one species are recorded at one site, deploying multiple ARUs at different sites for replicated measures of time, and running all recording devices for a 24-hour period.

References

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5.0 Additional Figures

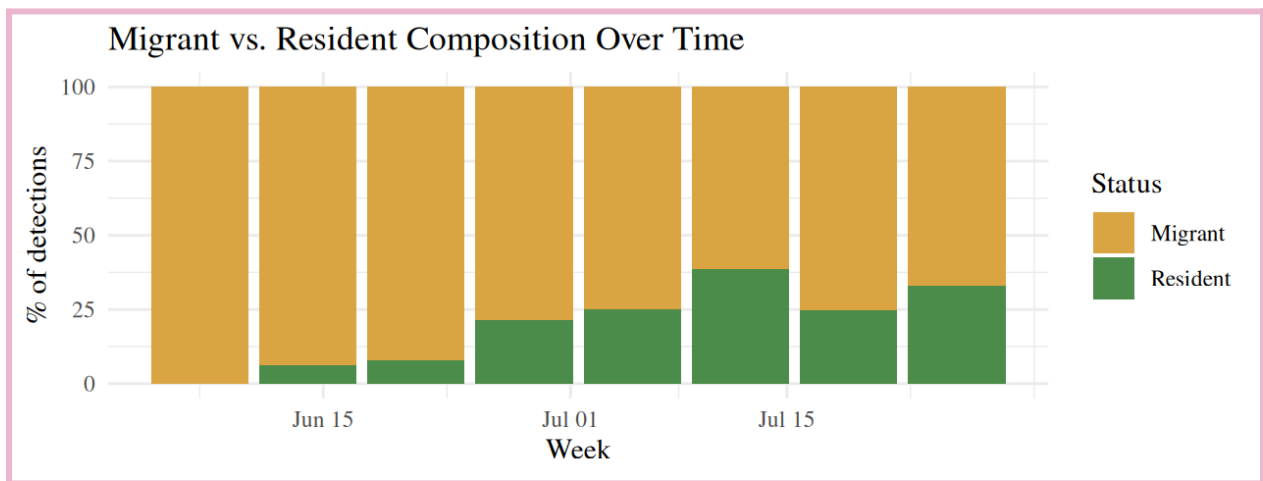


Figure 6. Comparison of migrant and resident bird species detected from June 11 to July 29.

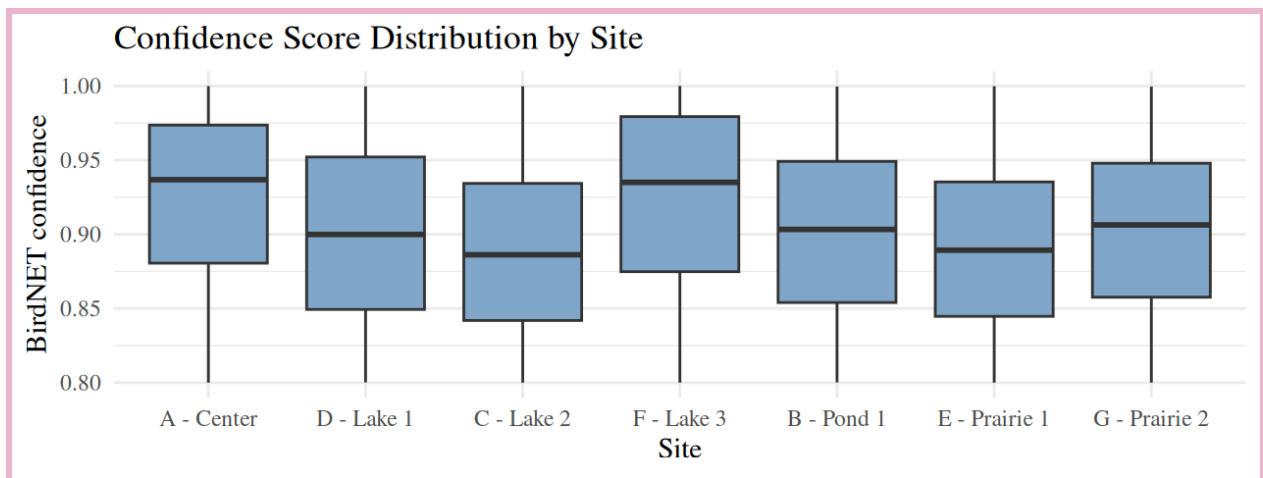


Figure 7. BirdNet confidence score distribution by site.

Site	Richness	Shannon	Simpson
A	33	1.241911631	0.4716784361
B	32	2.29961146	0.8389532266
C	42	2.44007734	0.8490447235
D	33	1.627725679	0.5896011686
E	48	2.598546085	0.8925066171
F	38	2.102215194	0.7976550132
G	22	0.9751168239	0.37834772

Figure 8. Diversity summary of species richness, Shannon index, and Simpson's diversity index across all sites.

Species	Total Call Count
Eastern Wood-Pewee	11389
House Wren	5339
Great Crested Flycatcher	4439
Eastern Kingbird	2985
Eastern Bluebird	2952
American Goldfinch	2889
Indigo Bunting	2056
Eastern Towhee	1831
Blue Jay	1399
Song Sparrow	789
White-breasted Nuthatch	664
Gray Catbird	507
Hairy Woodpecker	430
Red-tailed Hawk	341
Barred Owl	333
American Crow	301
Northern Cardinal	279
Common Yellowthroat	275
Northern Flicker	244
Black-capped Chickadee	243
Common Loon	226
Yellow-throated Vireo	207
Downy Woodpecker	197

Cedar Waxwing	188
Red-bellied Woodpecker	184
Eastern Phoebe	162
Canada Goose	147
Cooper's Hawk	128
Belted Kingfisher	125
American Robin	105
Tree Swallow	84
Pileated Woodpecker	84
Blue-gray Gnatcatcher	81
Green Heron	76
Ovenbird	62
Killdeer	52
Scarlet Tanager	45
Osprey	44
House Sparrow	39
Broad-winged Hawk	39
Red-eyed Vireo	30
Wood Duck	27
Great Horned Owl	25
White-browed Warbler	22
Barn Swallow	22
Yellow-bellied Flycatcher	19
Baltimore Oriole	19
Black Woodpecker	18
Warbling Vireo	16
Common Nighthawk	15
Brown Thrasher	14
Yellow-bellied Sapsucker	13
Red-headed Woodpecker	13
Purple Martin	13
Great Blue Heron	9
Common Grackle	7
Bell's Vireo	7
Mourning Dove	6
Long-eared Owl	6
Greater Yellowlegs	6

Vesper Sparrow	5
Sandhill Crane	5
Rusty Blackbird	5
Ruby-throated Hummingbird	5
House Finch	5
Rose-breasted Grosbeak	4
Mallard	4
Hooded Merganser	4
Green-winged Teal	4
Blue-headed Vireo	4
Solitary Sandpiper	3
Veery	2
Spotted Sandpiper	2
Red-breasted Nuthatch	2
Chipping Sparrow	2
Wild Turkey	1
Least Flycatcher	1
Carib Grackle	1
Brown-headed Cowbird	1
Black-crowned Night-Heron	1
Bald Eagle	1

Figure 9. Master list of all species detections and total call count across all sites.