

Monitoring bird species of greatest conservation need in Michigan grasslands and savannas



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Cover: Grassland at Allegan State Game Area where dickcissel and grasshopper sparrow were detected. Photo by E. Branch.

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EXECUTIVE SUMMARY

The Michigan Department of Natural Resources (DNR) obtained a Competitive State Wildlife Grant (C-SWG) to implement habitat conservation and monitoring activities for imperiled prairie and savanna ecosystems and associated species of greatest conservation need (SGCN). Focal SGCN for the project include rare and declining grassland bird and butterfly species. Project partners are working toward two objectives: 1) restore and enhance 1,000 acres of grassland and savanna habitat in Michigan and Ohio; and 2) develop and implement long-term monitoring programs under an adaptive management framework to better assess population level impacts on SGCN relative to ongoing and historical management activities. As a partner on the C-SWG project, the Michigan Natural Features Inventory (MNFI) is working with the DNR to achieve the second project objective by conducting surveys to evaluate the status of SGCN populations and their response to management actions. Our objective for the second year of monitoring was to design and implement surveys for grassland bird SGCN on managed grasslands and savannas on State of Michigan and private conservation organization lands.

We worked with DNR Lansing and field staff to identify grasslands/savannas with planned management for the three priority SGCN bird species identified for the project, dickcissel (*Spiza americana*), grasshopper sparrow (*Ammodramus savannarum*), Henslow's sparrow (*Ammodramus henslowii*). Survey points were then randomly created within these areas with a minimum separation distance of 250 m. Our goal was to survey each point twice during the breeding season, approximately mid-May to mid-July. We recorded all birds seen or heard during a 10-minute point count consisting of three periods: 2 minutes, 3 minutes, and 5 minutes. During each time period, bird observations were assigned to one of four distance categories at the time of first observation (0-25 m, 26-50 m, 51-100 m, and >100 m) based on the estimated distance of the bird from the observer. Habitat sampling was conducted in early to mid-August at the same points where bird surveys were completed. Three 1-m² quadrats were sampled at random locations within 50 m of the survey points. Ten variables were estimated within each quadrat: 1) % cover bare ground; 2) % cover grass; 3) % cover dead vegetation; 4) % cover forbs; 5) % cover litter; 6) % cover of woody vegetation; 7) index of vegetation density; 8) index of vegetation volume; 9) litter depth; and 10) vegetation height. We conducted exploratory data analyses of bird assemblages and habitat variables using nonmetric multidimensional scaling (NMS).

We completed 247 point counts at 132 stations in 13 management areas, with 114 bird species recorded across all sites and visits combined. Field sparrow, song sparrow, common yellowthroat, and American goldfinch were most common bird species detected. At least one of the three project priority bird species was observed at five management areas: Allegan State Game Area (SGA), Gourdneck SGA, Maple River SGA, Rose Lake State Wildlife Area (SWA), and Verona SGA. Twenty-one of the bird species observed had some kind of special status, such as state listed or special concern, SGCN, DNR featured species, or focal species of the Upper Mississippi / Great Lakes Joint Venture. This project resulted in several bird element occurrences being added to or updated within the Natural Heritage Database. NMS analysis indicated several survey points from Maple River, Verona, Oliver Township, and Allegan SGAs appeared to have greater association with grassland-dependent bird species compared to other management units. Detailed habitat characteristics were gathered at 117 survey points in 12 management areas. NMS ordination of the habitat variables indicated a high amount of variation in the vegetation structure both within and among management areas. We did not find occurrence of several grassland-dependent bird species to be highly correlated with the three NMS axes.

The bird survey and habitat sampling program developed and implemented for this project provide a framework and baseline data to facilitate long-term monitoring of grassland bird use of managed sites, evaluation of vegetation structural variables important to birds, and assessing relationships between bird use and habitat variables. Our survey data highlight the value of the study areas to a myriad of bird species and indicate that grassland/savanna management implemented at several locations is benefiting grassland-dependent bird species. Expanding grassland management around existing areas could increase use by grassland bird SGCN. Brown-headed cowbirds were detected at 50% of the survey points and 12 of the 13 management areas. Reducing the fragmentation of managed grasslands, such as removing or minimizing woody fence lines, could decrease nest parasitism by brown-headed cowbirds on grassland bird species of conservation concern. Finally, we recommend future monitoring efforts include analysis of bird and habitat data sets to address critical information needs hindering management decisions for grassland birds. In addition to the fine-scale habitat variables estimated through our sampling, future analyses should include large-scale variables that are known to influence bird use of grasslands.

INTRODUCTION

Historically, native grasslands such as prairies and savannas were found primarily in the southern Lower Peninsula of Michigan. Estimates based on surveys conducted by the General Land Office in Michigan from 1816 to 1856 suggest these grasslands occupied approximately 7% of the state (Comer et al. 1995). Most of our native grasslands and savannas have been lost or fragmented due to development, conversion to agriculture, and lack of disturbance leading to vegetative succession. Grassland and savannas remaining in the southern Lower Peninsula are considered degraded or highly degraded and are generally disjunct and smaller in size than in the past. Many of these grassland natural communities are ranked as imperiled or critically imperiled within Michigan or globally. Not surprisingly, many species reliant on these grasslands and savannas are now in decline or in danger of extinction. With our remaining grasslands being degraded, fragmented, and more isolated, native animal species requiring these habitats are more vulnerable to an array of threats, such as climate change, invasive species, and human development.

To address the conservation needs of imperiled grassland ecosystems and associated species of greatest conservation need (SGCN), the Michigan Department of Natural Resources (DNR) applied for and obtained a Competitive State Wildlife Grant (C-SWG) to implement habitat conservation and monitoring activities. The project focuses on implementing conservation actions to benefit several SGCN affected by grassland loss and degradation, including dickcissel (*Spiza americana*), grasshopper sparrow (*Ammodramus savannarum*), Henslow's sparrow (*Ammodramus henslowii*), frosted elfin (*Incisalia irus*), Karner blue butterfly (*Lycaeides melissa samuelis*), and monarch butterfly (*Danaus plexippus*). In addition to habitat conservation, monitoring of these SGCN is an important part of the project to facilitate assessment of success and adaptation of management strategies to achieve project goals. Two objectives were identified for the project: 1) restore and enhance 1,000 acres of grassland and savanna habitat in Michigan and Ohio; and 2) develop and implement long-term monitoring programs under an adaptive management framework to better assess population level impacts on SGCN species relative to ongoing and past management activities. The Michigan Natural Features Inventory (MNFI) is a partner on the C-SWG project and working with the DNR to achieve the second project objective by conducting surveys to evaluate the status of SGCN populations and their response to management actions. In 2022, we implemented grassland bird surveys to target the three project priority species, dickcissel, grasshopper sparrow, and Henslow's sparrow, and completed vegetation sampling to estimate several habitat variables known to influence grassland bird use.

METHODS

Sample Design

MNFI staff worked with DNR biologists to identify areas to be managed and monitored for grassland bird SGCN under the current C-SWG project. Managed areas consisted of properties owned by the DNR and private conservation organizations at locations targeted for long-term management of grassland and savanna ecosystems. In addition, we included other nearby grasslands previously monitored by MNFI for other C-SWG projects. Bird surveys occurred in 13 management areas in the southern Lower Peninsula of Michigan (Figure 1). Using recent aerial photography and information provided by local land managers, we digitized polygons within each management area where management and/or monitoring activities would occur. For each polygon, we randomly located the maximum number of bird survey points possible with a minimum separation of 250 m (Figure 2).

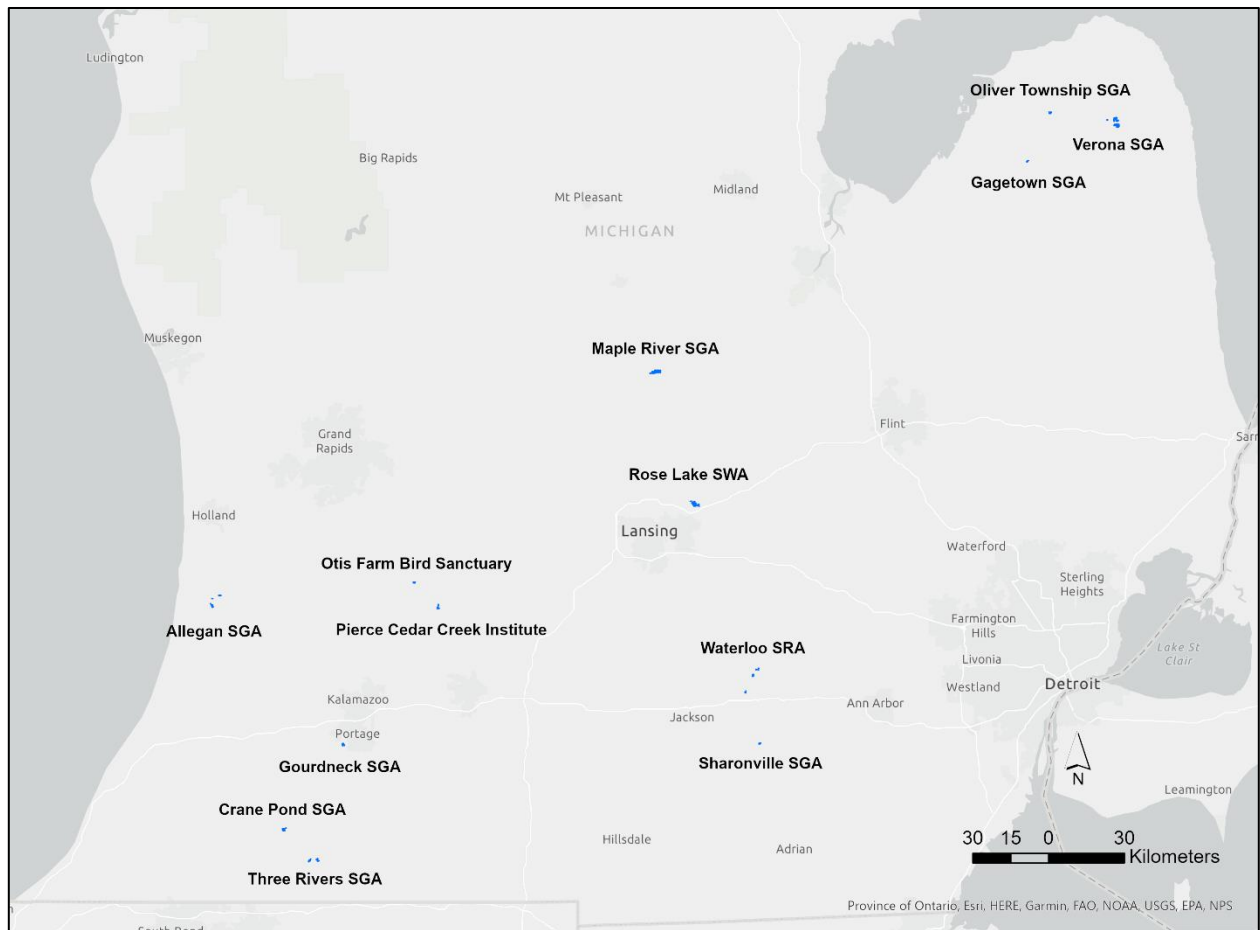


Figure 1. Areas (blue shading) where grassland bird surveys were conducted in southern Lower Michigan in 2022.

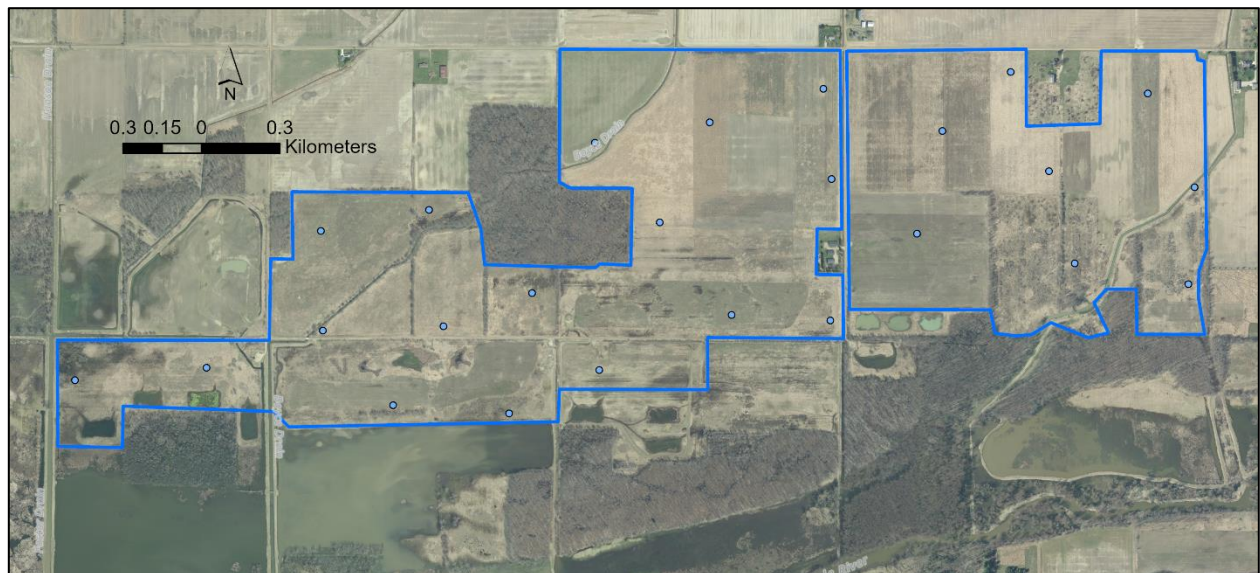


Figure 2. Example of random survey stations (blue points) placed within areas surveyed in 2022 at Maple River State Game Area.

Bird Surveys

Bird survey stations (i.e., points) were surveyed twice from 12 May to 15 July 2022 from sunrise to four hours after sunrise (Ralph et al. 1995). Observers avoided conducting surveys during weather conditions that could reduce bird detectability, such as strong winds (≥ 20 km/hr or 13 mph) and moderate to heavy precipitation. We recorded all birds seen or heard during a 10-minute point count consisting of three periods: 2 minutes, 3 minutes, and 5 minutes (Ralph et al. 1995, Howe et al. 1997). Use of the three survey periods provides flexibility in making comparisons with other surveys and studies of varying time lengths (e.g., North American Breeding Bird Survey). During each time period, bird observations were assigned to one of four distance categories at the time of first observation (0-25 m, 26-50 m, 51-100 m, and >100 m) based on the estimated distance of the bird from the observer. Surveyors used laser rangefinders to assist with distance estimation.

Habitat Characterization

We characterized the habitat near bird survey stations to help evaluate the results of management activities and assess relationships between bird occurrence and habitat variables. Three quadrats were sampled at each bird survey point: one at the survey point (placed immediately northwest of point) and two randomly located within 50 m of the point. Plots were placed by selecting a random cardinal direction and random distance between 1 m and 50 m. Vegetation was sampled once late in the growing season during early to mid-August. Nine variables identified by Fisher and Davis (2010) as important predictors of habitat use by grassland birds were estimated during sampling. Fisher and Davis (2010) conducted a review of grassland bird literature to identify a reduced set of habitat variables important to grassland birds. They also provided standardized definitions for these nine variables to promote consistent data collection and permit better comparisons among studies. Because DNR management activities also aim to control encroachment of woody vegetation in grasslands, we also estimated the percent cover of woody vegetation. The following 10 variables were recorded within 1-m² quadrats (100 cm x 100 cm): 1) % cover bare ground (any land surface not covered by vegetation, rock, or litter); 2) % cover grass (all graminoids combined); 3) % cover dead vegetation (standing dead vegetation that is attached to the soil); 4) % cover forbs (any flowering plants that are not graminoid); 5) % cover of woody vegetation (all shrubs and trees combined); 6) % cover litter (organic debris on the soil surface); 7) index of vegetation density (according to Wiens [1969]); 8) index of vegetation volume (according to Robel et al. [1970]); 9) litter depth; and 10) vegetation height (height at which approximately 80% of vegetation is growing below).

Field staff estimated % cover variables using the six cover class categories developed by Daubenmire (1959): 1 – 0-5%; 2 – 5-25%; 3 – 25-50%; 4 – 50-75%; 5 – 75-95%; and 6 – 95-100%. A technique described by Wiens (1969) was used to estimate an index of vegetation density. Field crews placed a narrow (~5-7 mm diameter) wood rod through the vegetation at the center of each quadrat and counted the number of times a stem or leaf intercepted the rod at 10-cm height increments up from the ground. We used the method described by Robel et al. (1970) to measure visual obstruction to provide an indirect index of vegetation volume. Visual obstruction was estimated at the center of each quadrat using a circular pole (3 x 150 cm) marked in 5-cm intervals; measurements were made at a distance of 4 m and from a height of 1 m above the ground by recording the lowest 5-cm interval visible on the pole (Robel et al. 1970). Litter depth and vegetation height was measured to the nearest cm using a meter stick.

Analysis

We conducted two nonmetric multidimensional scaling (NMS) analyses to explore possible patterns in bird assemblages and habitat variables across the management units. Only those 117 points at which both bird surveys and habitat sampling occurred were included in the analyses. We examined bird assemblage data in the first ordination analysis. Bird species detected at less than 5% of the points were removed, resulting in 67 species total. After completing the NMS, we conducted correlation analyses between the final ordination scores for points and the original bird assemblage matrix to assess if certain bird species were associated with the NMS axes. We also ran correlation analyses between the point scores and habitat variables (e.g., percent grass, vegetation height, etc.) averaged by survey point to determine if any variables were highly associated with the ordination axes.

In the second NMS analysis, we analyzed habitat variables gathered at the 117 survey points. Prior to analysis, we ran a correlation matrix on the habitat variables and removed colinear variables ($r \geq 0.50$), resulting in 15 variables being included in the analysis. Once the NMS was complete, we examined correlations between the final ordination scores for points and the original habitat matrix to evaluate if particular variables were associated with the ordination axes. To evaluate if any of the bird species were strongly correlated with the ordination axes, we conducted correlation analysis between the point ordination scores and occurrences of the following nine grassland bird species: ring-necked pheasant, sedge wren, savannah sparrow, grasshopper sparrow, dickcissel, bobolink, eastern meadowlark, clay-colored sparrow, and Henslow's sparrow.

We performed both NMS analyses using the Bray-Curtis distance measure, 250 runs on the original data matrix, and a maximum of 500 iterations. Final solutions were achieved when an instability value of 0.0000001 was obtained or after 500 iterations. Monte-Carlo permutation procedures (McCune and Grace 2002) were conducted for each analysis with 250 randomized runs to evaluate if axes produced by NMS explained more variation than by chance alone.

RESULTS

Bird Surveys

We completed 247 point counts at 132 stations in 13 management areas, with 86% of the points being surveyed twice. A list of the bird species detected, scientific names, and special designations (e.g., endangered, threatened, etc.) is provided in Appendix A. We recorded 114 bird species across all sites and visits combined (see Appendix B for detection frequency by site). Four species, field sparrow, song sparrow, common yellowthroat, and American goldfinch, were most common, being detected at 81% or more of the points. Ten species were regularly recorded at 50-75% of the points: red-winged blackbird, gray catbird, yellow warbler, northern cardinal, American crow, indigo bunting, American robin, mourning dove, cedar waxwing, and brown-headed cowbird. Thirteen species were detected at 25-50% of the points, and the remaining 87 species were observed sporadically at less than 25% of the points. Twenty-one of the bird species observed had some kind of special status designation, such as being state listed, species of greatest conservation need (SGCN), DNR featured species, or focal species of the Upper Mississippi / Great Lakes Joint Venture (Appendix A).

Surveys were designed to target the three priority bird species identified in the C-SWG grant proposal. Henslow's sparrow is listed as state endangered and dickcissel and grasshopper sparrow are state species of special concern (SC); all three species are SGCN. In addition, Henslow's sparrow is a focal species for the Landbird Habitat Conservation Strategy of the Upper Mississippi / Great Lakes Joint Venture (JV; Soulliere et al. 2020). We observed all three priority bird species in 2022 surveys and recorded one or more of the three species at five management areas: Allegan State Game Area (SGA), Gourdneck SGA, Maple River SGA, Rose Lake State Wildlife Area (SWA), and Verona SGA. Grasshopper sparrow was detected most often of the three, with 15% of the survey points having observations. We observed grasshopper sparrow at Allegan, Maple River, and Verona State Game Areas. We recorded dickcissel at 8% of all survey points, which occurred in Allegan State Game Area (SGA), Maple River SGA, and Rose Lake SWA. Henslow's sparrow was the least often observed of the three priority species, with only 5% of the survey points having detections. We recorded Henslow's sparrows at Allegan, Gourdneck, and Verona SGAs.

In Allegan SGA, we observed dickcissel at seven of the 10 points surveyed, followed by grasshopper sparrow being recorded at four points, and Henslow's sparrow at one point (Figure 3). These observations were used to update existing dickcissel (EO ID 16163) and grasshopper sparrow (EO ID 16154) occurrences and create a new Henslow's sparrow occurrence (EO ID 26223) in the Natural Heritage Database (NHD). Before our observations this year, dickcissels and grasshopper sparrows had not been documented at Allegan in the NHD since 2007.

Henslow's sparrow was the only priority species detected at Gourdneck SGA in 2022 (Figure 4); however, occurrences for dickcissel and grasshopper sparrow are known from the area. Dickcissels were observed in 2013 and grasshopper sparrows in 2013 and 2014 during previous surveys conducted by MNFI. Henslow's sparrow was recorded at three of the five points surveyed in 2022, all of which were located in a single field being managed as prairie and savanna (Figure 5). We used these observations to update an existing element occurrence for Henslow's sparrow (EO ID 20415) in the NHD that was last observed in 2015.

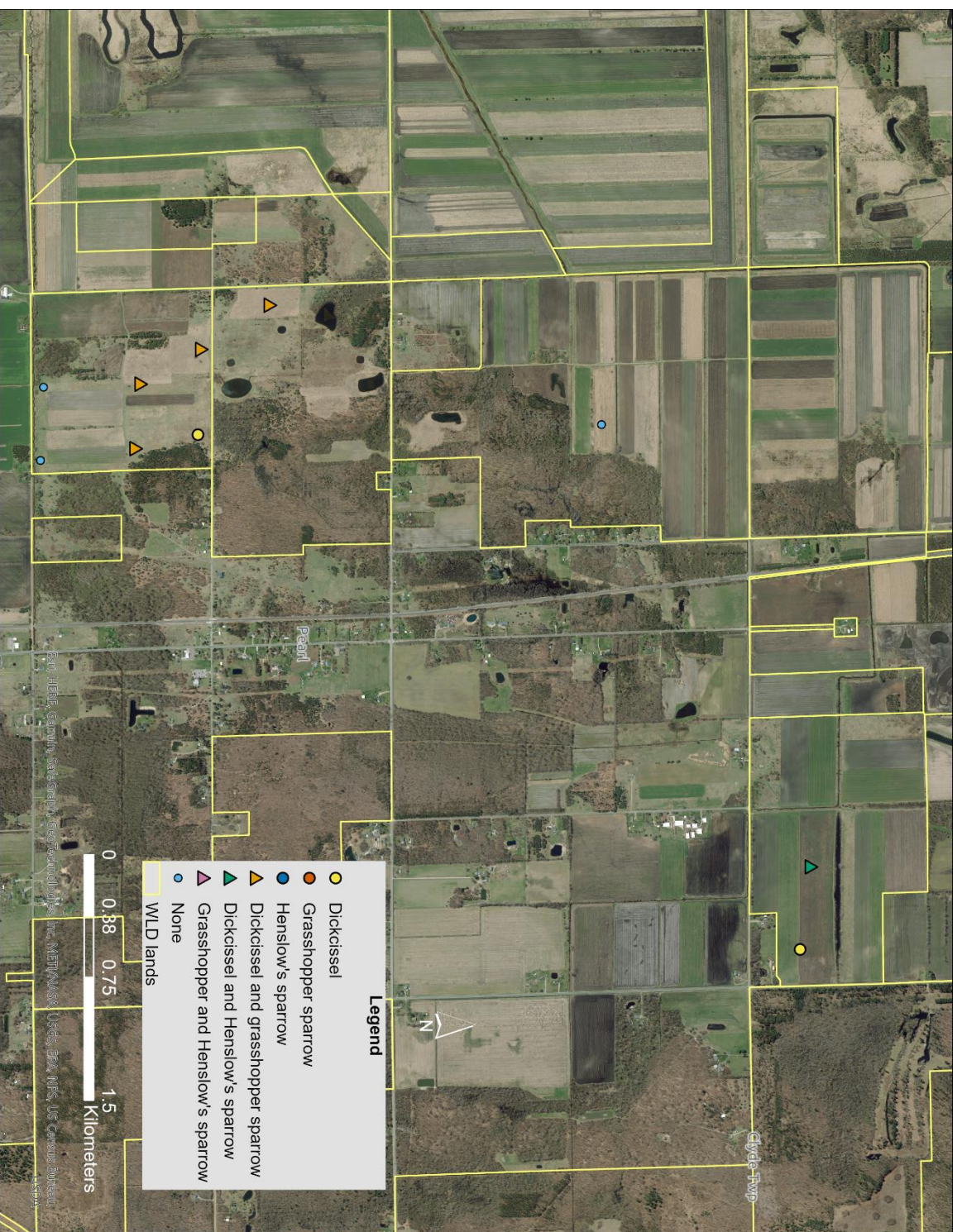


Figure 3. Summary of observations of C-SWG project priority bird species at points surveyed within Alleghen State Game Area in 2022.



Figure 4. Grassland in Gourdneck State Game Area where Henslow's sparrows were observed during bird surveys conducted in 2022. Photo by E. Branch.

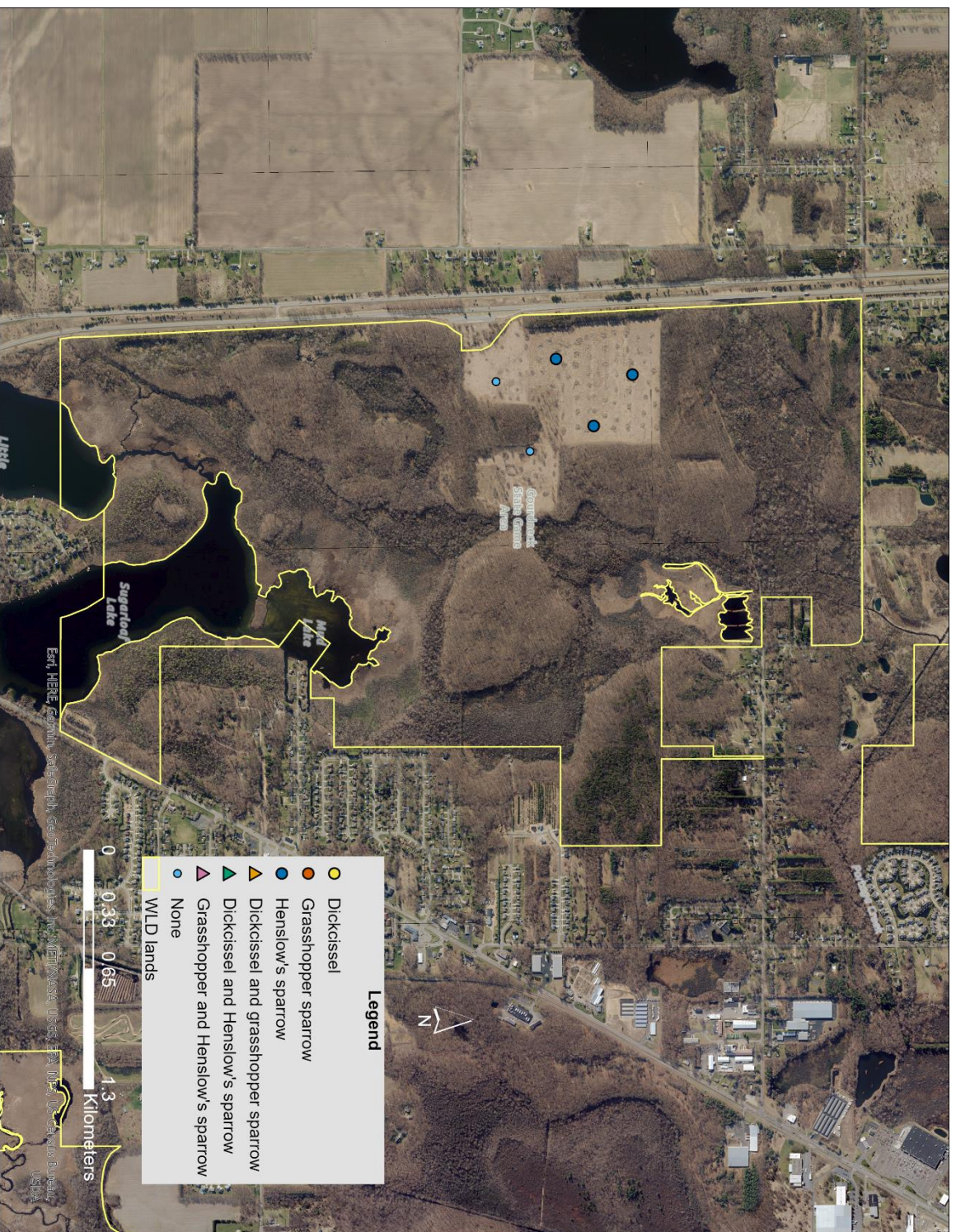


Figure 5. Summary of observations of C-SWG project priority bird species at points surveyed within Gourneck State Game Area in 2022.

Dickcissel and grasshopper sparrow were observed Maple River SGA, with dickcissel being detected at one point and grasshopper sparrow at two (Figure 6). The grasshopper sparrow records were used to update an existing occurrence (EO ID 16610) that was last documented at the site in 2007. The dickcissel observation represented a new element occurrence for the area (EO ID 26227). Although we did not observe Henslow's sparrow at Maple River, it has been recorded at the site previously (EO ID 2776) and was last documented with the NHD in 2001.

We recorded dickcissel at one point in Rose Lake SWA (Figure 7), which is a new element occurrence (EO ID 26225) for the area. A Henslow's sparrow occurrence is known from the area (EO ID 16615), but we did not detect the species during 2022 surveys and it has not been documented in the area since 2007.

Grasshopper sparrow was the most common priority species observed at Verona SGA, being detected at 14 of the 26 points surveyed (Figure 8). We used these observations to update two existing element occurrences (EO ID 17187 and 19881) within the game area that resulted from data gathered during previous MNFI surveys conducted in 2008, 2014, and 2015. We also documented Henslow's sparrow at two points in 2022, which reconfirmed an existing occurrence for the species (EO ID 15798). Henslow's sparrows were first documented at the site by MNFI in 2005 and observed again during surveys in 2014. Dickcissel was recorded at Verona SGA by MNFI during surveys conducted in 2015 (EO ID 20428), but we did not detect the species in 2022.

Several other bird species dependent on grasslands, savannas, or graminoid-dominated wetlands were observed during our 2022 surveys. Most common of these species was eastern meadowlark, which was recorded at 23% of the points and in six of the management areas. Eastern meadowlark is both a DNR featured species and JV focal species. Four species, ring-necked pheasant, sedge wren, clay-colored sparrow, and savanna sparrow, were recorded at about 20% of the survey points. Ring-necked pheasant is a DNR featured species for habitat management. We detected bobolinks at 12% of the points and three of the management areas, with the species being commonly observed at Allegan SGA (50% of points) and Maple River SGA (42% of points). Bobolink is both a DNR featured and JV focal species. Northern harrier, upland sandpiper, vesper sparrow, and red-headed woodpecker were occasionally recorded (< 5% of the points overall). Northern harrier and red-headed woodpecker are both special concern species and SGCN, whereas red-headed woodpecker is also considered a DNR featured and JV focal species (Soulliere et al. 2020). We detected northern harriers at single points in Allegan and Verona SGAs, and in both cases, we observed birds foraging over grasslands. Red-headed woodpeckers were observed at Crane Pond SGA and Ottis Farm Bird Sanctuary; however, they were heard at long distances, so we did not enter them as occurrences in the NHD because we lacked the specific spatial information needed. Upland sandpiper, a JV focal species for regional shorebird conservation (Potter et al. 2007), was only recorded at two points in Allegan SGA.

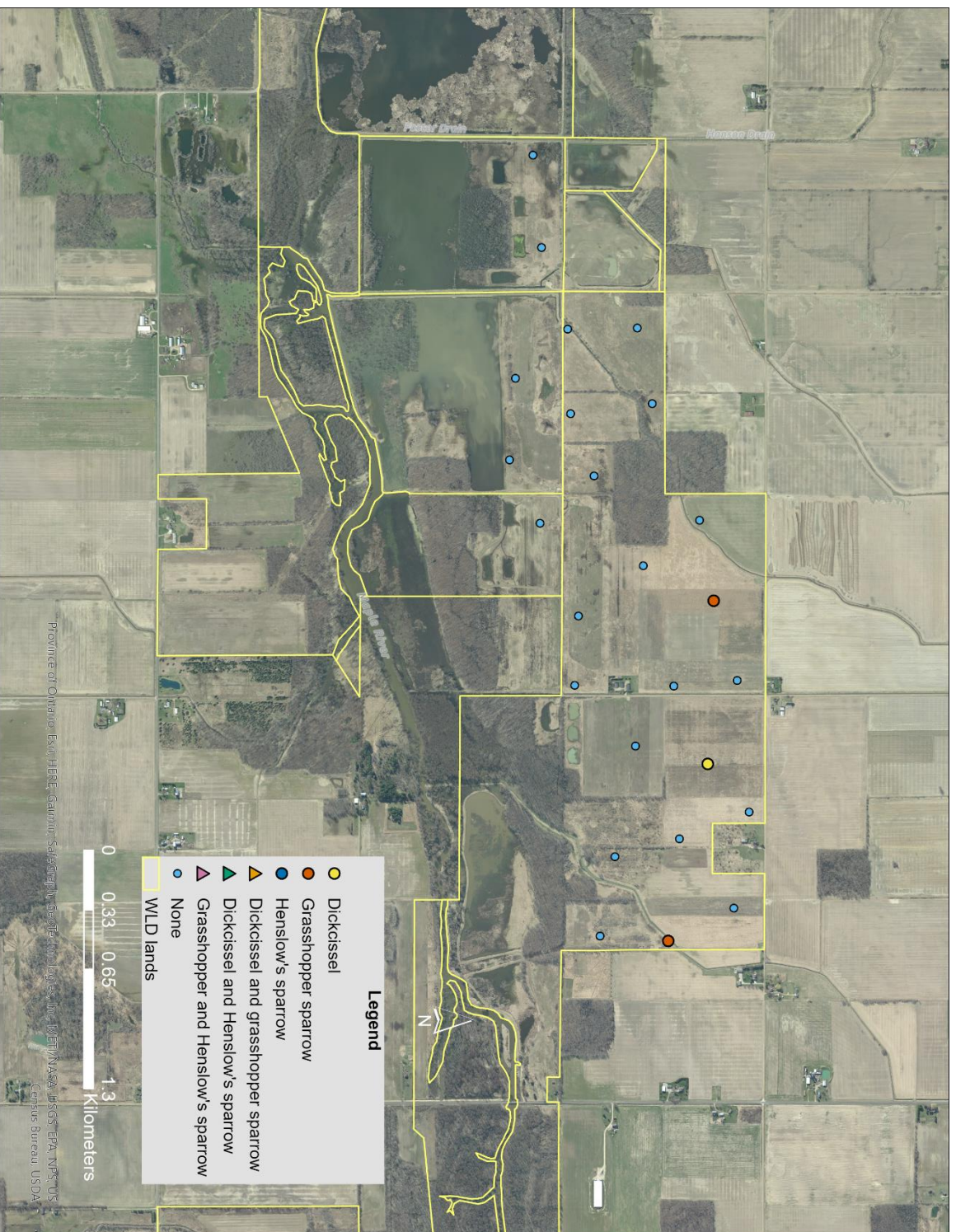


Figure 6. Summary of observations of C-SWG project priority bird species at points surveyed within Maple River State Game Area in 2022.

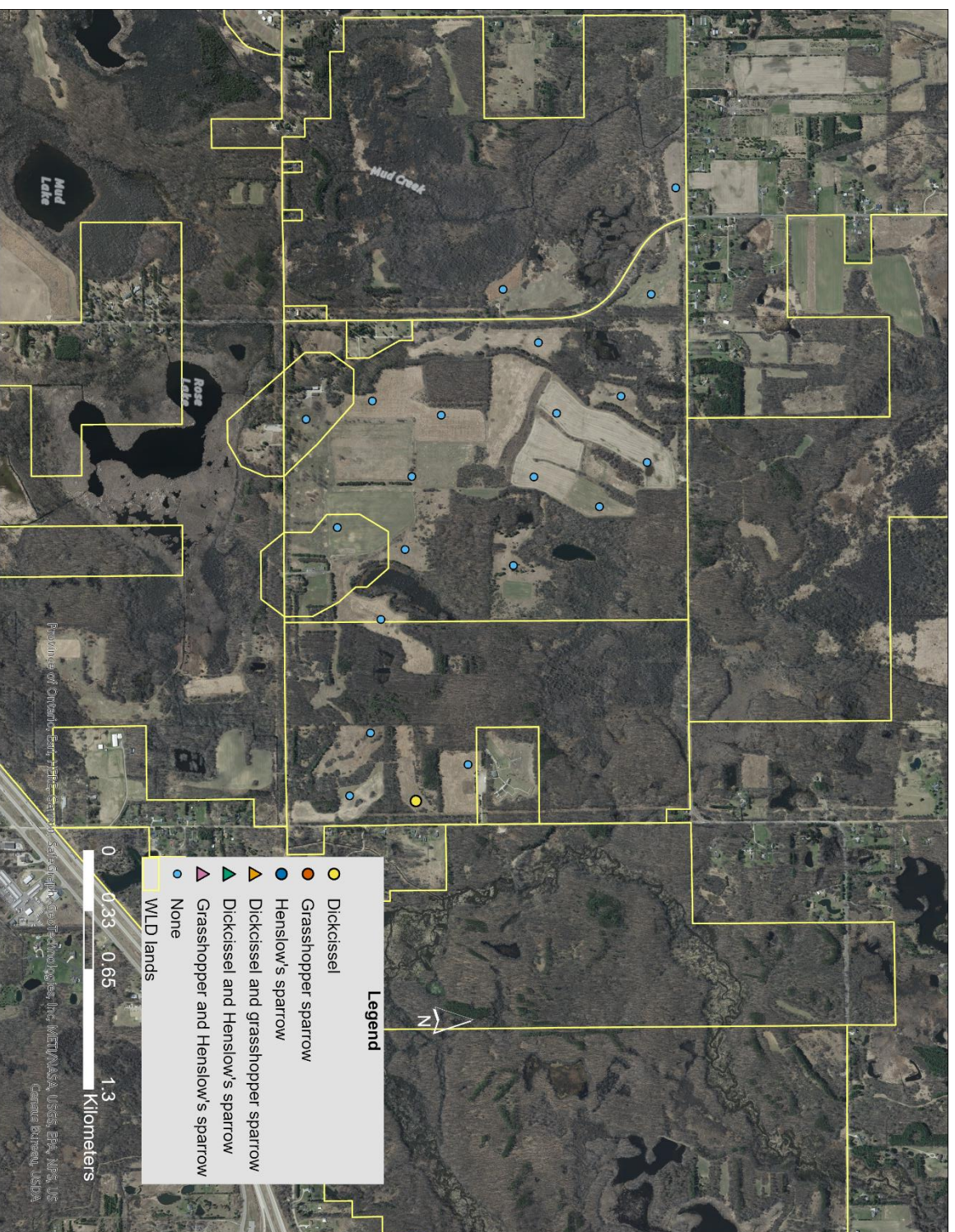
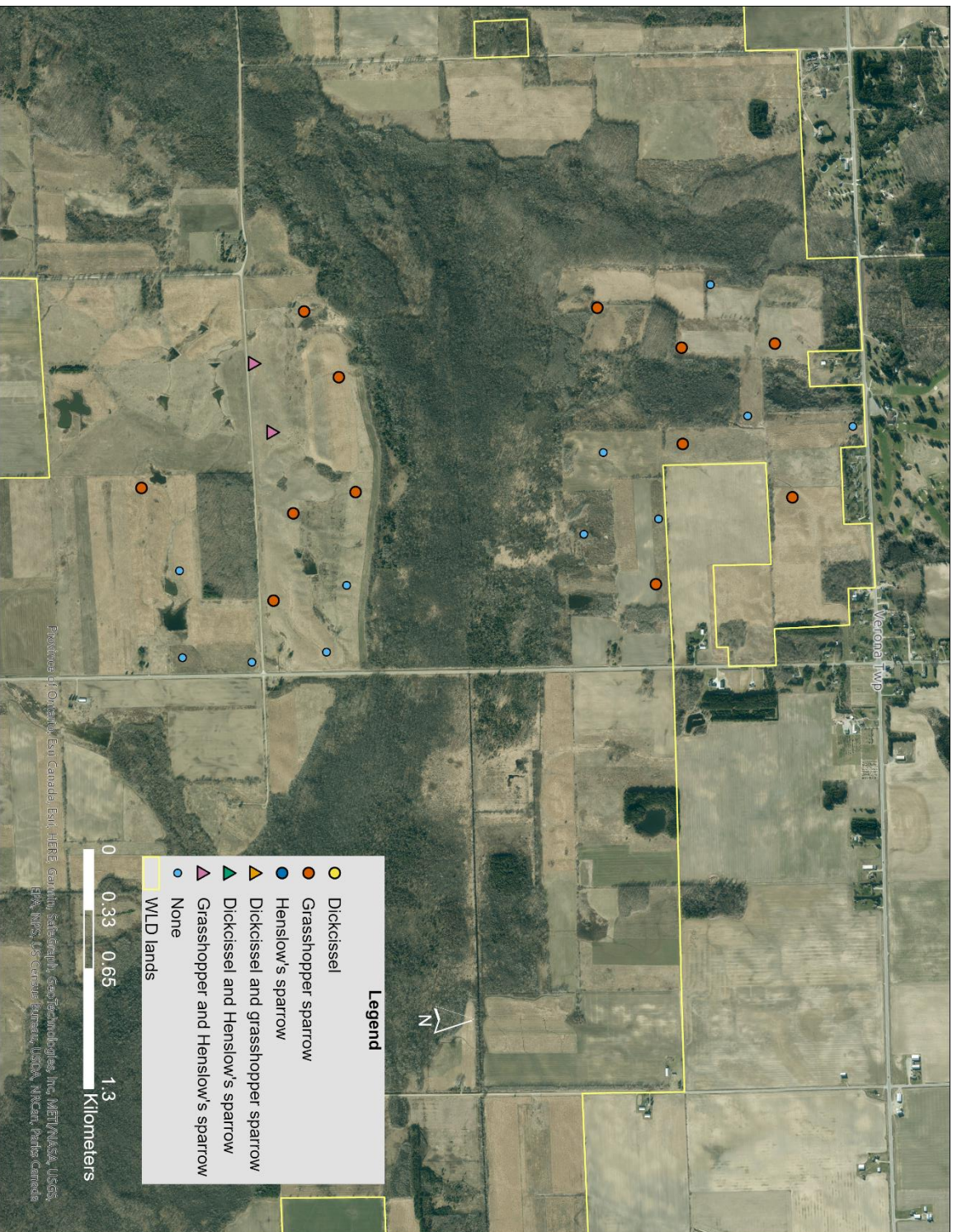


Figure 7. Summary of observations of C-SWG project priority bird species at points surveyed within Rose Lake State Wildlife Area in 2022.



We also observed several other bird species of management interest that are typically associated with habitats other than grasslands and savanna. Although survey points were placed within grassland or savanna habitats, other cover types, such as forests and wetlands were located nearby. Several wetland-dependent species were detected, often at a distance, while conducting the grassland bird surveys. The following waterfowl species were recorded: trumpeter swan (state threatened [T], SGCN), Canada goose (DNR featured), mallard (DNR featured and JV focal species), and wood duck (DNR featured and JV focal species). We regularly observed Canada goose, mallard, and wood duck at several areas, but trumpeter swan was only heard at Pierce Cedar Creek Institute in a nearby lake. We also found a blue-winged teal nest in grassland at Maple River SGA while walking between survey points (Figure 10); blue-winged teal is a JV focal species. Common gallinule (state T, SGCN) was heard at one point in Waterloo State Recreation Area (SRA), and we recorded marsh wren at two points in Waterloo SRA and one point in Gagetown SGA. We used these observations to create a new common gallinule EO in Waterloo SRA (EO ID 26224) and update existing marsh wren occurrences in Waterloo SRA (EO ID 2621) and Gagetown SGA (EO ID 15581). Surveys often occurred near forest edges, and we recorded the following forest bird species of conservation concern: American woodcock (DNR featured), cerulean warbler (state T, SGCN, and JV focal), pileated woodpecker (DNR featured), wild turkey (DNR featured), and wood thrush (DNR featured and JV focal). We used the cerulean warbler observations to update element occurrences at Crane Pond SGA (EO ID 17095) and Three Rivers SGA (EO ID 8787). Chimney swift, a JV focal species for urban habitats (Soulliere et al. 2020), was detected at both Pierce Cedar Creek Institute and Verona SGA.

To examine patterns in bird assemblages across management units, we conducted nonmetric multidimensional scaling. Initial NMS analysis suggested the data were best represented by three dimensions and a solution with equal or less stress was not likely to occur by chance alone ($P = 0.004$). After rerunning NMS with only three dimensions, 71.3% of the variation in the original distance matrix was explained (final stress of 21.5). The first axis explained 48.4% of the variation and was positively associated with bird species that use forested and forest-edge habitats and negatively related to species that occur in grasslands and shrubby wetlands (Figure 9). Sedge wren, savanna sparrow, clay-colored sparrow, swamp sparrow, bobolink, eastern meadowlark, ring-necked pheasant, willow flycatcher, and song sparrow were negatively correlated with axis 1 ($r \leq -0.40$), whereas eastern towhee, indigo bunting, northern cardinal, blue jay, white-breasted nuthatch, blue-winged warbler, eastern wood-pewee, and tufted titmouse were positively correlated with axis 1 ($r \geq 0.42$). Percent cover of woody vegetation was positively related with axis 1 ($r = 0.43$), which was the only habitat variable of those we estimated showing a strong relationship with any of the three axes. The second axis accounted for 15.2% of the variation in the original matrix. Three grassland species, dickcissel, ring-necked pheasant, and bobolink, along with red-winged blackbird and American crow were negatively correlated with axis 2 ($r \leq -0.40$). Alder flycatcher was the only species showing a relatively strong ($r = 0.40$) positive association with axis 2. None of the grassland bird species had strong relationships with axis 3. Points from Maple River, Verona, Oliver Township, and Allegan SGAs appeared to have greater association with grassland-dependent bird species overall compared to other management units (Figure 11).



Figure 10. Blue-winged teal nest found in grassland at Maple River State Game Area while conducting bird surveys in 2022. Photo by M. Monfils.

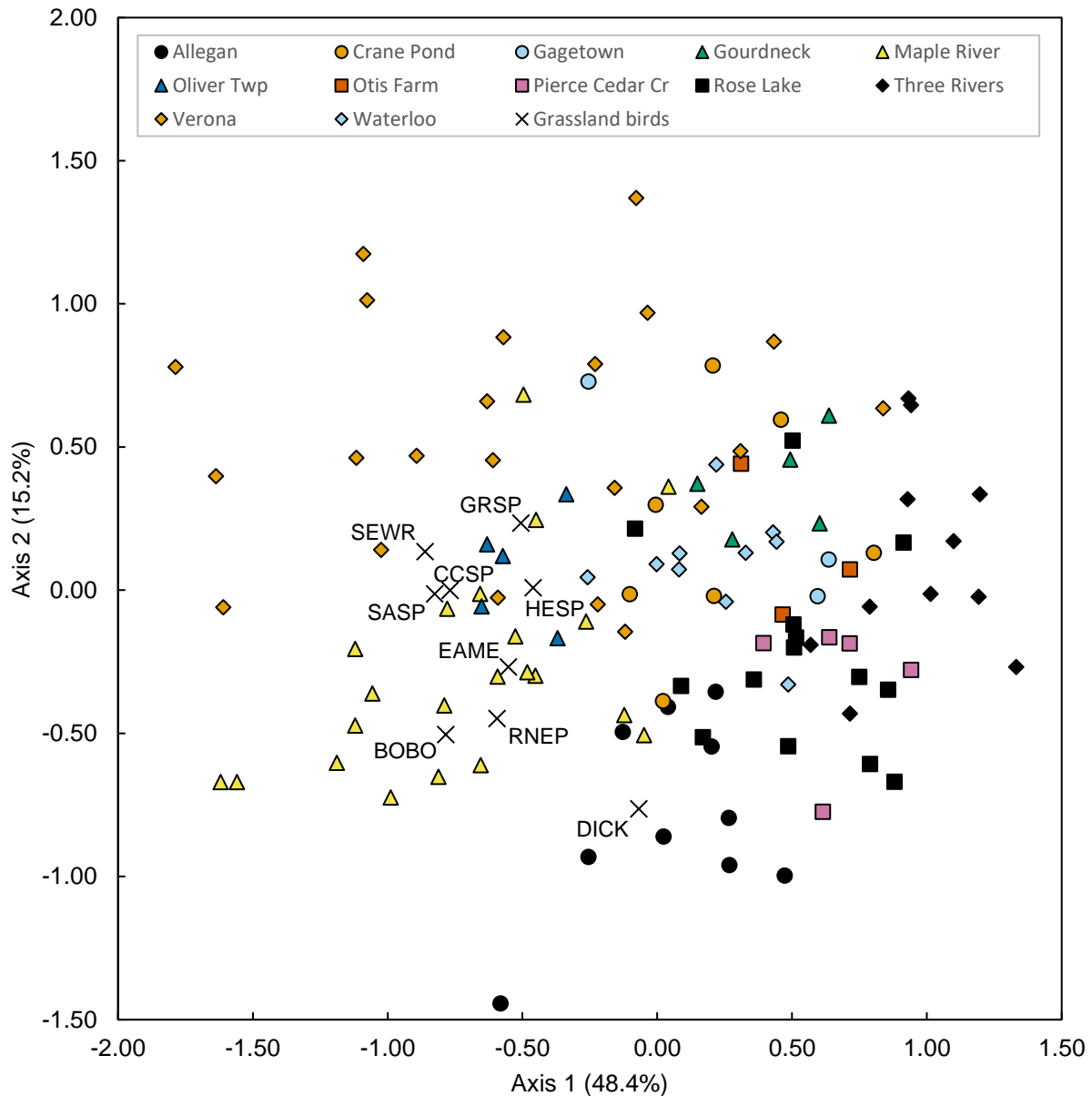


Figure 11. Graph of axes 1 and 2 from non-metric multidimensional scaling performed on bird species assemblages detected at management units surveyed in 2022. Scores for several grassland-dependent bird species are indicated by an “X” and labeled with standard four-letter codes as follows: BOBO = bobolink; CCSP = clay-colored sparrow; DICK = dickcissel; EAME = eastern meadowlark; GRSP = grasshopper sparrow; HESP = Henslow’s sparrow; RNEP = ring-necked pheasant; SASP = savanna sparrow; and SEWR = sedge wren.

Habitat Characterization

We collected detailed habitat information from 117 (89%) of the 132 survey points and 12 of the 13 management areas. Some points were not sampled due to a predominance of wetland vegetation or shrubs/trees. Ten habitat variables were sampled in accordance with recommendations of Fisher and Davis (2010). We observed substantial variation in the habitat variables across the management areas surveyed (Table 1). These data provide baseline information that could be used in assessing the effects of management actions over time and evaluating potential relationships with bird use of the management areas. We followed the method described by Wiens (1969) to provide an index of vegetation density at 10-cm intervals above the ground. Average vegetation density index values by interval and management unit peaked within 10 cm – 60 cm above the ground surface (Figure 12).

Initial NMS analysis suggested the habitat data were best represented by three dimensions and a solution with equal or less stress was not likely to occur by chance ($P = 0.004$). The final NMS ran with three dimensions explained 74.4% of the variation in the original distance matrix with a final stress of 14.2. Ordination of vegetation structural variables highlighted the variation we observed both within and among management areas, with little clustering of points by management area along any of the three dimensions (Figures 13 and 14). Axis 1 accounted for 51.4% of the variation and was positively related to vegetation height ($r = 0.71$) and vegetation density at 120-130 cm ($r = 0.59$), 140-150 cm ($r = 0.56$), and 150-160 cm ($r = 0.55$) above ground. The second axis explained 23.0% of the variation and was positively associated with percent cover of woody vegetation ($r = 0.77$) and vegetation density at 0-10 cm above the ground ($r = 0.53$). Most points at Three Rivers SGA were positively associated with the second dimension (Figure 13), suggesting greater percent cover of woody vegetation and denser vegetation at ground level (0 – 10 cm above ground). Conversely, most of the points in Rose Lake SWA and Verona SGA were negatively related with the second axis. Some management areas tended to separate along the third axis, which explained 12.2% of the variation and was negatively associated with percent cover of dead vegetation and density within 0-10 cm above ground. Points within Otis Farm Bird Sanctuary, Waterloo SRA, and Gourdneck SGA tended to be on the positive side of the Axis 3, indicating lower percent cover of dead vegetation and lower vegetation density 0-10 cm above the ground. Most points within Oliver Township SGA, Maple River SGA, Verona SGA, and Rose Lake SWA negatively associated with the third axis, suggesting greater percent cover of dead plants and greater vegetation density just above the ground surface (Figure 14). We did not find occurrence of any of the grassland-dependent bird species highly correlated with the three NMS axes for the habitat variables.

Table 1. Mean vegetation characteristics by management area from habitat sampling conducted during 2022.

Management Area	Percent Cover						Vegetation Volume (dm)	Litter Depth (cm)	Vegetation Height (cm)
	Bare Ground	Grass	Forbs	Dead Vegetation	Litter	Woody Vegetation			
Alleghan SGA	29.00	47.17	24.87	0.40	37.13	8.67	4.92	1.83	60.20
Crane Pond SGA	11.43	29.33	53.33	0.86	43.57	1.52	8.79	2.05	100.00
Gagetown SGA	0.00	66.11	20.22	1.22	83.33	0.00	6.11	4.78	75.00
Gourdneck SGA	0.87	52.00	13.93	0.33	59.67	10.27	6.90	7.40	89.00
Maple River SGA	8.32	48.78	33.47	2.70	63.94	2.46	5.70	4.06	71.29
Oliver Twp. SGA	6.20	36.13	53.67	4.33	69.33	0.93	5.27	4.07	75.33
Otis Farm Bird Sanctuary	0.00	42.22	21.11	0.11	45.00	10.56	10.78	11.00	103.89
Pierce Cedar Creek Institute	0.00	47.67	23.67	0.53	48.00	4.73	7.93	3.60	102.00
Rose Lake SGA	6.90	58.02	29.81	3.21	71.55	0.12	7.21	7.88	79.88
Three Rivers SGA	9.85	20.91	27.03	1.42	48.18	38.85	5.89	0.94	78.94
Verona SGA	4.23	51.67	15.59	2.20	71.45	0.09	5.39	4.21	66.82
Waterloo SRA	9.77	37.67	30.80	0.07	51.83	4.50	7.20	2.87	89.83
Mean	8.41	45.41	28.29	1.79	59.65	6.28	6.35	4.16	77.67

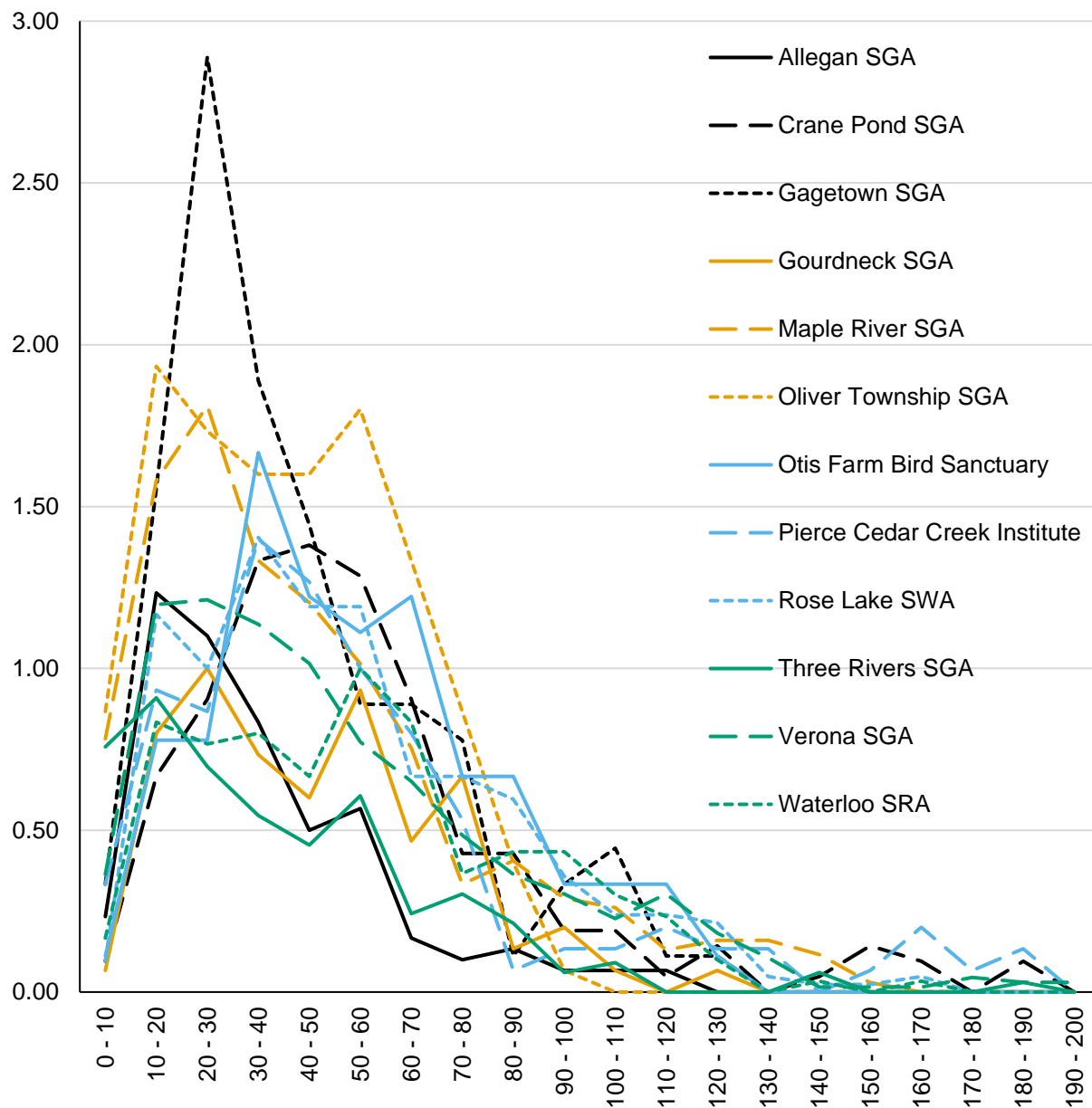


Figure 12. Average vegetation density index values (i.e., mean number of times vegetation touches vertical rod) per 10-centimeter segment (0 to 200 cm above ground) by management area when sampling vegetation density according to Wiens (1969).

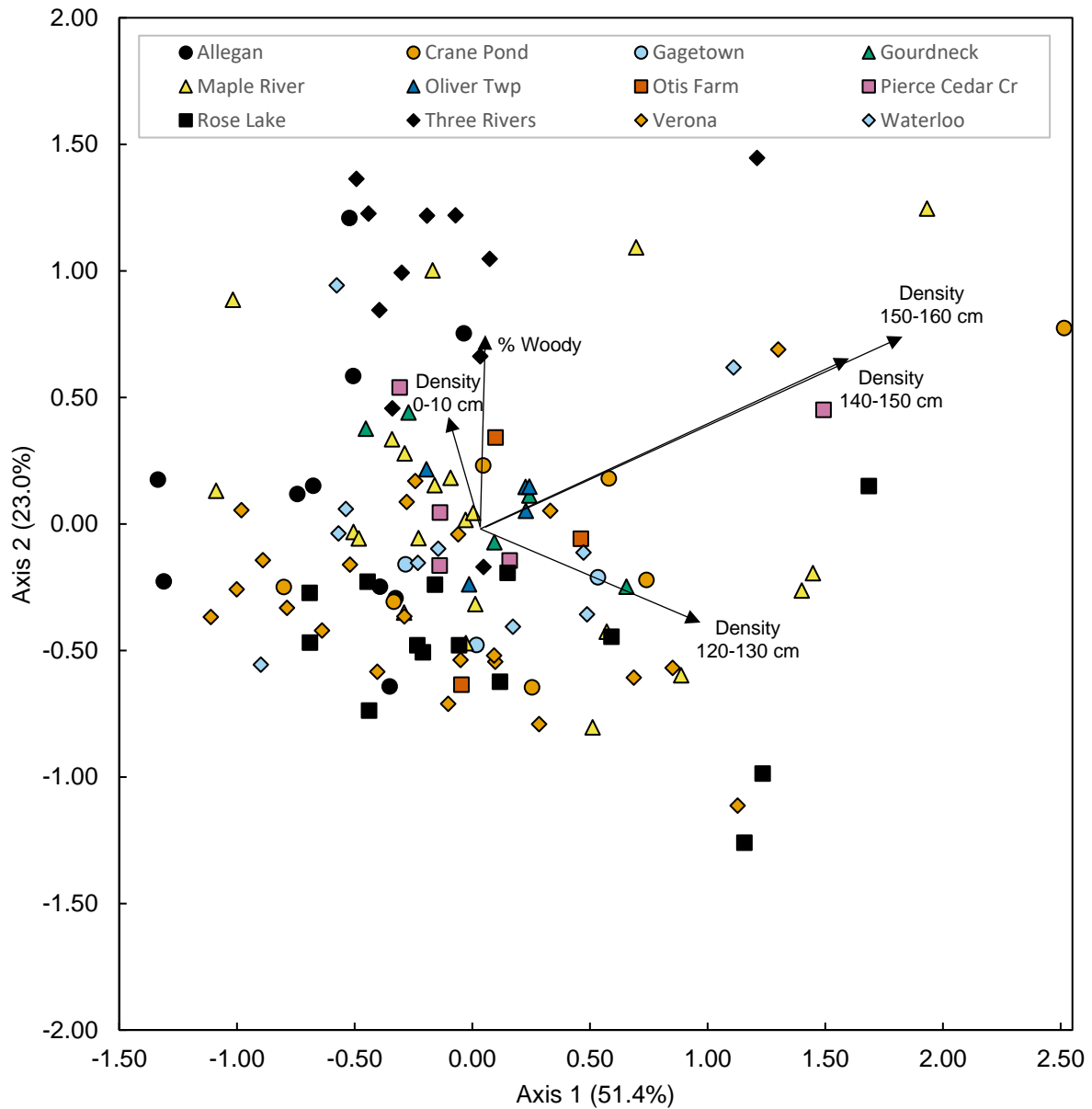


Figure 13. Graph of axes 1 and 2 from nonmetric multidimensional scaling performed on habitat variables collected at management units surveyed in 2022 in southern Lower Michigan. Variables strongly associated with the axes are indicated by an arrow and label.

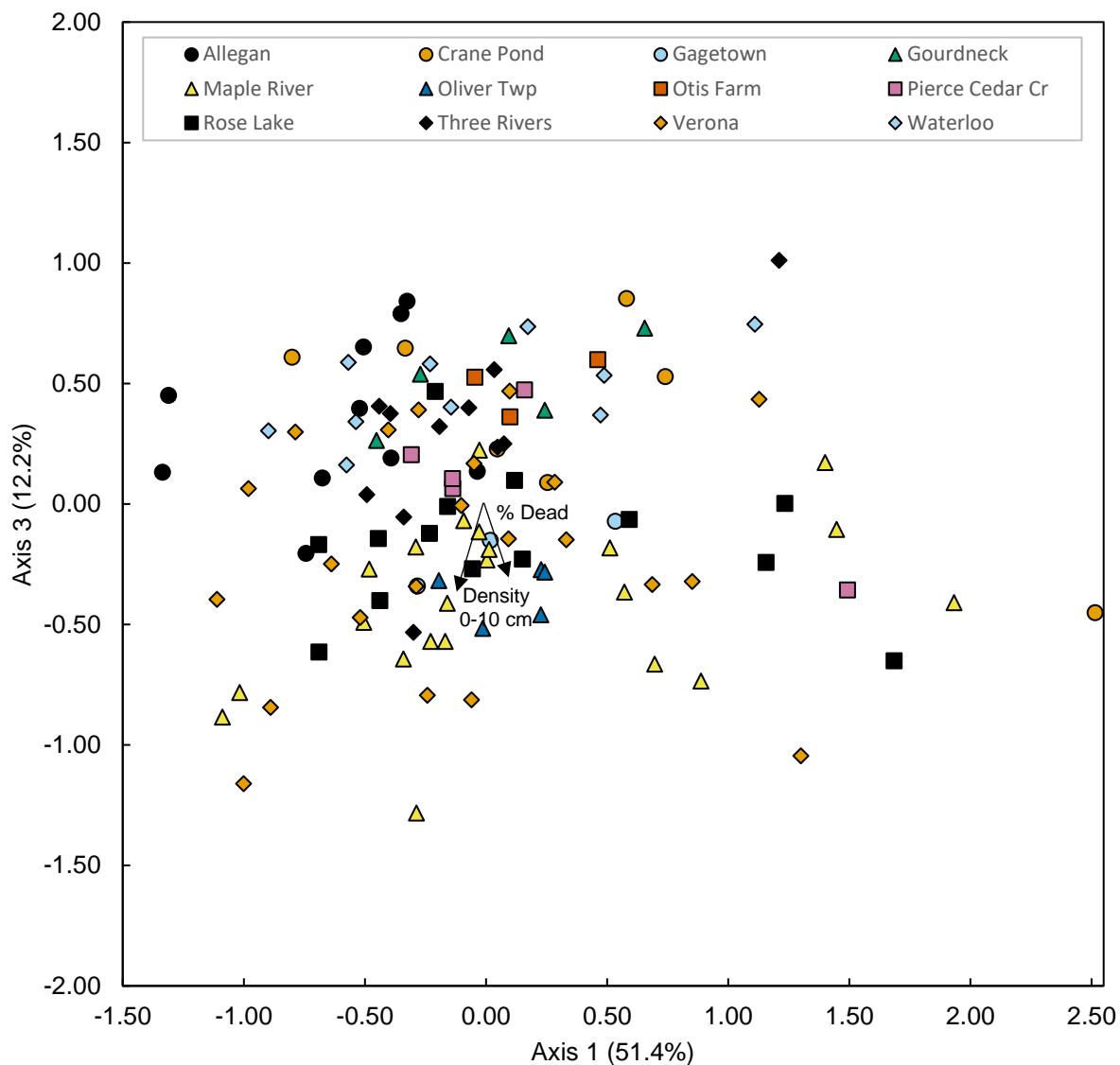


Figure 14. Graph of axes 1 and 3 from nonmetric multidimensional scaling performed on habitat variables collected at management units surveyed in 2022 in southern Lower Michigan. Variables strongly associated with the axis 3 are indicated by an arrow and label.

DISCUSSION

We developed and implemented a grassland bird and habitat survey program for management areas in the southern Lower Peninsula of Michigan, which built upon work conducted for other projects funded by C-SWG and other programs. Our hope is that the sample frame, methods, and baseline data resulting from this project will be used during future surveys to assess the status of grassland birds and effects of management actions. The sample frame is flexible in that points can be easily added or removed as management goals, ownership, priorities, and funding levels change. We recommend continuing the bird and habitat surveys implemented for this project on a periodic basis (e.g., every 2-5 years) over the long term.

Five of the areas surveyed, Allegan SGA, Gourdneck SGA, Maple River SGA, Rose Lake SWA, and Verona SGA, had observations of at least one of the three priority bird species for this project. These and several other management areas supported other grassland-dependent bird species, such as bobolink, eastern meadowlark, ring-necked pheasant, and savanna sparrow. Past and ongoing grassland and savanna management at these areas has no doubt benefited these bird species, and expansion of these efforts could increase use by declining grassland birds. We recorded brown-headed cowbirds at 50% of the survey points and 12 of the 13 management areas visited. Cowbirds thrive in fragmented landscapes and reduce the reproductive success of breeding songbirds through nest parasitism (Robinson et al. 1995). Efforts to reduce the fragmentation of managed grasslands, such as removal or minimization of linear woody edges (e.g., hedgerows, woody fence lines; Sample and Mossman 1997), could decrease nest parasitism by brown-headed cowbirds on the three priority bird species and other bird SGCN.

We conducted some exploratory multivariate analyses using the bird and habitat data gathered for this project as examples of analyses that could be done in the future. The habitat variables included in these analyses were limited to those collected during our quadrat-level habitat sampling; however, we know landscape-scale variables influence habitat selection by grassland birds (e.g., Coppedge et al. 2005, Cunningham and Johnson 2006), so we recommend estimating new variables from larger spatial scales (e.g., proportion of grassland in surrounding landscape, distance to nearest woody vegetation) and including them in similar future analyses. Other analyses could be valuable in tracking the status of bird species over time (e.g., occupancy modeling [MacKenzie et al. 2002, 2003]) and evaluating relationships between bird occurrence and habitat variables (e.g., logistic regression). We suggest that land managers identify the key knowledge gaps or questions limiting management planning/implementation, so analyses can be targeted to inform management and included as part of future monitoring efforts.

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Appendix A. List of bird species detected during surveys conducted in southern Lower Michigan in 2022 and special designations.

Common Name	Scientific Name	State Status ¹	DNR Featured Species ²	JV Focal Species ³
Acadian flycatcher	<i>Empidonax virescens</i>	---	---	---
Alder flycatcher	<i>Empidonax alnorum</i>	---	---	---
American crow	<i>Corvus brachyrhynchos</i>	---	---	---
American goldfinch	<i>Spinus tristis</i>	---	---	---
American kestrel	<i>Falco sparverius</i>	---	---	---
American redstart	<i>Setophaga ruticilla</i>	---	---	---
American robin	<i>Turdus migratorius</i>	---	---	---
American woodcock	<i>Scolopax minor</i>	---	X	X
Baltimore oriole	<i>Icterus galbula</i>	---	---	---
Barn swallow	<i>Hirundo rustica</i>	---	---	---
Barred owl	<i>Strix varia</i>	---	---	---
Belted kingfisher	<i>Megaceryle alcyon</i>	---	---	---
Black-billed cuckoo	<i>Coccyzus erythrophthalmus</i>	---	---	---
Black-capped chickadee	<i>Poecile atricapillus</i>	---	---	---
Blue grosbeak	<i>Passerina caerulea</i>	---	---	---
Blue jay	<i>Cyanocitta cristata</i>	---	---	---
Blue-gray gnatcatcher	<i>Polioptila caerulea</i>	---	---	---
Blue-winged teal	<i>Spatula discors</i>	---	---	X
Blue-winged warbler	<i>Vermivora cyanoptera</i>	---	---	---
Bobolink	<i>Dolichonyx oryzivorus</i>	---	X	X
Brown thrasher	<i>Toxostoma rufum</i>	---	---	---
Brown-headed cowbird	<i>Molothrus ater</i>	---	---	---
Canada goose	<i>Branta canadensis</i>	---	X	---
Carolina wren	<i>Thryothorus ludovicianus</i>	---	---	---
Cedar waxwing	<i>Bombycilla cedrorum</i>	---	---	---
Cerulean warbler	<i>Setophaga cerulea</i>	T, SGCN	---	X
Chestnut-sided warbler	<i>Setophaga pensylvanica</i>	---	---	---
Chimney swift	<i>Chaetura pelagica</i>	---	---	X
Chipping sparrow	<i>Spizella passerina</i>	---	---	---
Clay-colored sparrow	<i>Spizella pallida</i>	---	---	---
Common gallinule	<i>Gallinula galeata</i>	T, SGCN	---	---
Common grackle	<i>Quiscalus quiscula</i>	---	---	---
Common yellowthroat	<i>Geothlypis trichas</i>	---	---	---
Dickcissel	<i>Spiza americana</i>	SC, SGCN	---	---
Downy woodpecker	<i>Dryobates pubescens</i>	---	---	---
Eastern bluebird	<i>Sialia sialis</i>	---	---	---
Eastern kingbird	<i>Tyrannus tyrannus</i>	---	---	---
Eastern meadowlark	<i>Sturnella magna</i>	---	X	X
Eastern phoebe	<i>Sayornis phoebe</i>	---	---	---
Eastern towhee	<i>Pipilo erythrophthalmus</i>	---	---	---
Eastern wood-pewee	<i>Contopus virens</i>	---	---	---

Appendix A. Continued.

Common Name	Scientific Name	State Status¹	DNR Featured Species²	JV Focal Species³
European starling	<i>Sturnus vulgaris</i>	---	---	---
Field sparrow	<i>Spizella pusilla</i>	---	---	---
Grasshopper sparrow	<i>Ammodramus savannarum</i>	SC, SGCN	---	---
Gray catbird	<i>Dumetella carolinensis</i>	---	---	---
Great blue heron	<i>Ardea herodias</i>	---	---	---
Great crested flycatcher	<i>Myiarchus crinitus</i>	---	---	---
Great egret	<i>Ardea alba</i>	---	---	---
Great horned owl	<i>Bubo virginianus</i>	---	---	---
Green heron	<i>Butorides virescens</i>	---	---	---
Hairy woodpecker	<i>Dryobates villosus</i>	---	---	---
Henslow's sparrow	<i>Centronyx henslowii</i>	E, SGCN	---	X
Hermit thrush	<i>Catharus guttatus</i>	---	---	---
Horned lark	<i>Eremophila alpestris</i>	---	---	---
House finch	<i>Haemorhous mexicanus</i>	---	---	---
House sparrow	<i>Passer domesticus</i>	---	---	---
House wren	<i>Troglodytes aedon</i>	---	---	---
Indigo bunting	<i>Passerina cyanea</i>	---	---	---
Killdeer	<i>Charadrius vociferus</i>	---	---	---
Least flycatcher	<i>Empidonax minimus</i>	---	---	---
Magnolia warbler	<i>Setophaga magnolia</i>	---	---	---
Mallard	<i>Anas platyrhynchos</i>	---	X	X
Marsh wren	<i>Cistothorus palustris</i>	SC	---	---
Mourning dove	<i>Zenaida macroura</i>	---	---	---
Mourning warbler	<i>Geothlypis philadelphia</i>	---	---	---
Northern cardinal	<i>Cardinalis cardinalis</i>	---	---	---
Northern flicker	<i>Colaptes auratus</i>	---	---	---
Northern harrier	<i>Circus hudsonius</i>	SC, SGCN	---	---
Northern parula	<i>Setophaga americana</i>	---	---	---
Northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>	---	---	---
Orchard oriole	<i>Icterus spurius</i>	---	---	---
Ovenbird	<i>Seiurus aurocapilla</i>	---	---	---
Pied-billed grebe	<i>Podilymbus podiceps</i>	---	---	---
Pileated woodpecker	<i>Dryocopus pileatus</i>	---	X	---
Pine warbler	<i>Setophaga pinus</i>	---	---	---
Purple finch	<i>Haemorhous purpureus</i>	---	---	---
Purple martin	<i>Progne subis</i>	---	---	---
Red-bellied woodpecker	<i>Melanerpes carolinus</i>	---	---	---
Red-breasted nuthatch	<i>Sitta canadensis</i>	---	---	---
Red-eyed vireo	<i>Vireo olivaceus</i>	---	---	---
Red-headed woodpecker	<i>Melanerpes erythrocephalus</i>	SC, SGCN	X	X
Red-tailed hawk	<i>Buteo jamaicensis</i>	---	---	---
Red-winged blackbird	<i>Agelaius phoeniceus</i>	---	---	---

Appendix A. Continued.

Common Name	Scientific Name	State Status¹	DNR Featured Species²	JV Focal Species³
Ring-necked pheasant	<i>Phasianus colchicus</i>	---	X	---
Rock pigeon	<i>Columba livia</i>	---	---	---
Rose-breasted grosbeak	<i>Pheucticus ludovicianus</i>	---	---	---
Sandhill crane	<i>Antigone canadensis</i>	---	---	---
Savannah sparrow	<i>Passerculus sandwichensis</i>	---	---	---
Scarlet tanager	<i>Piranga olivacea</i>	---	---	---
Sedge wren	<i>Cistothorus platensis</i>	---	---	---
Song sparrow	<i>Melospiza melodia</i>	---	---	---
Swainson's thrush	<i>Catharus ustulatus</i>	---	---	---
Swamp sparrow	<i>Melospiza georgiana</i>	---	---	---
Tennessee warbler	<i>Leiothlypis peregrina</i>	---	---	---
Tree swallow	<i>Tachycineta bicolor</i>	---	---	---
Trumpeter swan	<i>Cygnus buccinator</i>	T, SGCN	---	---
Tufted titmouse	<i>Baeolophus bicolor</i>	---	---	---
Turkey vulture	<i>Cathartes aura</i>	---	---	---
Upland sandpiper	<i>Bartramia longicauda</i>	---	---	X
Veery	<i>Catharus fuscescens</i>	---	---	---
Vesper sparrow	<i>Poocetes gramineus</i>	---	---	---
Warbling vireo	<i>Vireo gilvus</i>	---	---	---
White-breasted nuthatch	<i>Sitta carolinensis</i>	---	---	---
White-crowned sparrow	<i>Zonotrichia leucophrys</i>	---	---	---
White-eyed vireo	<i>Vireo griseus</i>	---	---	---
Wild turkey	<i>Meleagris gallopavo</i>	---	X	---
Willow flycatcher	<i>Empidonax traillii</i>	---	---	---
Wilson's snipe	<i>Gallinago delicata</i>	---	---	---
Wood duck	<i>Aix sponsa</i>	---	X	X
Wood thrush	<i>Hylocichla mustelina</i>	---	X	X
Yellow warbler	<i>Setophaga petechia</i>	---	---	---
Yellow-bellied sapsucker	<i>Sphyrapicus varius</i>	---	---	---
Yellow-billed cuckoo	<i>Coccyzus americanus</i>	---	---	---
Yellow-breasted chat	<i>Icteria virens</i>	---	---	---
Yellow-throated vireo	<i>Vireo flavifrons</i>	---	---	---

¹ State status: E = endangered; T = threatened; SC = special concern; and SGCN = species of greatest conservation need.

²Michigan Department of Natural Resources, Wildlife Division, featured species for habitat management (indicated by an "X").

³Upper Mississippi / Great Lakes Joint Venture, focal species (indicated by an "X").

Appendix B. Proportion of points having bird species detections by management area during surveys conducted in southern Lower Michigan in 2022.

Species	Allegan SGA n = 10	Crane Pond SGA n = 7	Gagetown SGA n = 3	Gourdneck SGA n = 5	Maple River SGA n = 24	Ottis Farm n = 4	Oliver Twp. SGA n = 5	Pierce Cedar Cr. n = 5	Rose Lake SWA n = 19	Sharonville SGA n = 2	Three Rivers SGA n = 11	Verona SGA n = 26	Waterloo SRA n = 11	Sites Combined n = 132
Acadian flycatcher	---	0.14	---	---	---	---	---	---	---	---	0.09	---	---	0.02
Alder flycatcher	---	---	---	---	---	---	0.20	---	---	---	---	0.35	---	0.08
American crow	0.80	0.57	1.00	0.20	0.63	0.50	0.60	1.00	0.84	1.00	0.82	0.35	0.82	0.65
American goldfinch	0.50	1.00	1.00	1.00	0.54	1.00	1.00	1.00	0.95	1.00	0.91	0.81	0.82	0.81
American kestrel	0.10	---	---	---	---	---	---	---	---	---	---	0.08	---	0.02
American redstart	0.10	0.14	0.33	---	---	---	---	---	0.26	---	0.27	0.12	0.09	0.11
American robin	0.90	0.43	0.67	0.40	0.42	0.25	1.00	1.00	0.89	---	0.27	0.58	0.82	0.61
American woodcock	---	---	---	---	---	---	---	---	---	---	---	---	0.09	0.01
Baltimore oriole	0.40	0.14	---	0.20	0.21	---	---	0.40	0.11	0.50	0.18	0.04	0.09	0.15
Barn swallow	0.50	0.57	---	---	0.21	0.25	---	0.20	0.05	---	0.09	0.15	---	0.17
Barred owl	---	---	---	---	0.04	---	---	---	---	---	---	---	---	0.01
Belted kingfisher	0.10	---	---	---	---	---	---	---	---	---	---	---	---	0.01
Black-billed cuckoo	---	---	---	---	0.04	---	---	---	---	---	---	---	0.09	0.02
Black-capped chickadee	0.20	---	---	0.20	---	0.25	---	0.40	0.58	0.50	0.36	0.31	0.55	0.27
Blue grosbeak	---	---	---	---	---	---	---	---	---	---	0.18	---	---	0.02
Blue jay	0.80	0.71	0.33	1.00	0.25	0.50	0.40	0.80	0.74	0.50	0.45	0.15	0.55	0.48
Blue-gray gnatcatcher	---	---	---	---	0.08	---	---	0.20	---	---	0.36	---	0.09	0.06
Blue-winged warbler	0.10	0.29	---	0.40	---	1.00	---	1.00	0.32	---	0.45	---	0.09	0.20
Bobolink	0.50	---	---	---	0.42	---	---	---	---	---	---	0.04	---	0.12
Brown thrasher	0.50	---	0.67	---	0.04	---	---	---	0.11	---	---	0.08	---	0.09
Brown-headed cowbird	0.40	0.29	0.67	0.60	0.96	---	1.00	0.20	0.42	1.00	0.73	0.15	0.36	0.50
Canada goose	0.20	---	---	---	0.46	1.00	---	0.60	0.37	---	0.09	---	---	0.21
Carolina wren	---	---	---	---	---	---	---	0.20	---	---	0.18	---	---	0.02

Appendix B. Continued.

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Appendix B. Continued.

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Appendix B. Continued.

Species	Allegan SGA n = 10	Crane Pond SGA n = 7	Gagetown SGA n = 3	Gourdneck SGA n = 5	Maple River SGA n = 24	Ottis Farm n = 4	Oliver Twp. SGA n = 5	Pierce Cedar Cr. n = 5	Rose Lake SWA n = 19	Sharonville SGA n = 2	Three Rivers SGA n = 11	Verona SGA n = 26	Waterloo SRA n = 11	Sites Combined n = 132
Pied-billed grebe	---	---	---	---	---	0.25	---	---	---	---	---	---	---	0.01
Pileated woodpecker	---	---	---	0.20	---	0.25	---	0.20	0.05	0.50	0.45	0.12	---	0.10
Pine warbler	---	---	0.33	---	---	---	---	---	---	---	---	---	---	0.01
Purple finch	---	---	---	---	---	---	---	---	---	---	---	0.08	---	0.02
Purple martin	---	---	---	---	---	---	---	---	---	---	---	0.04	---	0.01
Red-bellied woodpecker	0.20	0.29	0.33	---	0.17	0.50	---	1.00	0.26	1.00	0.64	0.15	0.27	0.28
Red-breasted nuthatch	0.10	---	---	---	---	---	---	---	---	---	---	---	---	0.01
Red-eyed vireo	0.10	---	0.67	---	---	---	---	0.20	0.21	---	0.27	0.19	0.09	0.13
Red-headed woodpecker	---	0.14	---	---	---	0.25	---	---	---	---	---	---	---	0.02
Red-tailed hawk	0.10	---	---	0.20	---	---	---	---	0.05	0.50	---	---	0.09	0.04
Red-winged blackbird	0.90	0.86	---	0.80	0.96	0.75	1.00	0.60	0.68	1.00	0.27	0.54	1.00	0.73
Ring-necked pheasant	0.60	---	---	---	0.58	---	---	---	---	---	---	0.15	---	0.18
Rock pigeon	---	---	---	---	0.04	---	---	---	---	---	---	---	---	0.01
Rose-breasted grosbeak	0.20	0.14	---	---	0.08	---	---	0.40	0.47	0.50	0.18	0.04	0.27	0.17
Sandhill crane	0.80	0.29	0.33	---	0.54	1.00	---	0.80	0.26	---	0.55	0.19	0.64	0.42
Savannah sparrow	0.20	---	0.33	---	0.38	---	0.80	---	---	---	---	0.35	---	0.19
Scarlet tanager	---	0.14	---	0.40	0.04	---	---	---	0.05	---	0.18	---	---	0.05
Sedge wren	---	---	---	---	0.46	0.25	---	---	---	---	---	0.54	---	0.20
Song sparrow	0.60	1.00	1.00	1.00	1.00	1.00	1.00	0.80	1.00	---	0.09	0.96	1.00	0.86
Swainson's thrush	---	---	---	---	---	---	---	0.20	---	---	---	---	---	0.01
Swamp sparrow	---	---	---	---	0.46	0.25	0.60	---	---	---	---	0.23	0.55	0.20
Tennessee warbler	---	---	---	---	---	---	0.20	---	0.16	---	---	---	---	0.03
Tree swallow	0.10	0.14	---	---	0.50	0.75	---	0.20	0.11	---	---	0.04	0.27	0.18
Trumpeter swan	---	---	---	---	---	---	---	0.20	---	---	---	---	---	0.01

Appendix B. Continued.

Species	Allegan SGA n = 10	Crane Pond SGA n = 7	Gagetown SGA n = 3	Gourdneck SGA n = 5	Maple River SGA n = 24	Ottis Farm n = 4	Oliver Twp. SGA n = 5	Pierce Cedar Cr. n = 5	Rose Lake SWA n = 19	Sharonville SGA n = 2	Three Rivers SGA n = 11	Verona SGA n = 26	Waterloo SRA n = 11	Sites Combined n = 132
Tufted titmouse	0.30	0.14	---	0.20	0.25	---	---	0.40	0.58	1.00	0.64	---	0.36	0.28
Turkey vulture	---	0.29	---	---	---	0.25	---	0.20	0.05	0.50	0.09	0.04	---	0.06
Upland sandpiper	0.20	---	---	---	---	---	---	---	---	---	---	---	---	0.02
Veery	---	---	0.67	---	---	0.25	---	---	---	---	0.36	0.23	0.27	0.12
Vesper sparrow	0.30	---	---	---	---	---	---	---	0.05	---	---	---	---	0.03
Warbling vireo	0.30	0.14	---	---	0.08	---	0.80	---	---	---	---	0.08	---	0.09
White-breasted nuthatch	0.20	0.71	---	0.20	---	0.50	---	0.80	0.37	0.50	0.55	0.12	0.36	0.27
White-crowned sparrow	---	---	---	---	---	---	---	---	0.05	---	---	---	---	0.01
White-eyed vireo	---	---	---	---	---	---	---	---	---	---	0.09	---	---	0.01
Wild turkey	---	0.14	---	---	---	0.75	---	0.20	0.05	---	0.09	0.04	---	0.06
Willow flycatcher	0.40	0.14	0.33	---	0.58	---	0.60	---	---	---	---	0.38	0.18	0.27
Wilson's snipe	---	---	---	---	---	0.25	---	---	---	---	---	---	---	0.01
Wood duck	0.10	0.14	---	---	0.04	---	---	---	0.11	---	---	---	---	0.04
Wood thrush	0.10	---	---	---	---	0.25	---	0.20	0.11	---	0.45	0.04	---	0.08
Yellow warbler	0.70	0.86	1.00	0.20	0.71	1.00	1.00	0.80	0.58	---	0.82	0.62	0.73	0.69
Yellow-bellied sapsucker	---	---	---	---	---	---	---	---	0.05	---	---	0.04	---	0.02
Yellow-billed cuckoo	---	0.57	---	---	0.04	---	---	---	---	0.50	0.27	---	---	0.07
Yellow-breasted chat	---	0.14	---	---	---	---	---	---	---	---	0.09	---	---	0.02
Yellow-throated vireo	---	---	---	0.20	0.25	0.50	---	---	0.21	---	0.18	0.08	0.45	0.17