

# Status, Distribution, and Adaptive Capacity of Rare and Declining Avian Species at Fort Custer Training Center



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We collectively acknowledge that Michigan State University occupies the ancestral, traditional, and contemporary Lands of the Anishinaabeg – Three Fires Confederacy of Ojibwe, Odawa, and Potawatomi peoples. In particular, the University resides on Land ceded in the 1819 Treaty of Saginaw. We recognize, support, and advocate for the sovereignty of Michigan’s twelve federally recognized Indian nations, for historic Indigenous communities in Michigan, for Indigenous individuals and communities who live here now, and for those who were forcibly removed from their Homelands. By offering this Land Acknowledgement, we affirm Indigenous sovereignty and will work to hold Michigan State University more accountable to the needs of American Indian and Indigenous peoples.

**Cover:** Cerulean warbler (*Setophaga cerulea*), a Department of Defense Mission Sensitive Species commonly detected at Fort Custer Training Center. Photo by Aaron Kortenhoven.

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## INTRODUCTION

The Department of Defense (DoD) is tasked with managing diverse ecosystems and their component species in a manner that fulfills environmental stewardship responsibilities while maintaining mission readiness. Military installations are increasingly recognized for their important role in sustaining biodiversity, with intact habitats on military lands providing refugia for both common and at-risk species. Globally, military lands support high levels of biodiversity and provide critical habitat for many threatened and endangered species (Warren et al. 2007). In the United States, DoD installations harbor disproportionately large numbers of imperiled species (Groves et al. 2000), supporting at least three times higher densities of threatened, endangered, and imperiled species than lands managed by any other federal agency (Stein et al. 2008). These installations are important resources for migratory birds, providing critical stopover habitat during migration and nesting habitat during the breeding season (DoD Natural Resources Program 2014).

Migratory bird species from nearly every biome have experienced considerable population declines throughout North America (Rosenberg et al. 2019). These declines are exacerbated by climate change (Mac Nally et al. 2009), and with the current rate and magnitude of climate change many species may be unable to adapt without targeted conservation interventions (Bateman et al. 2020). Population declines and concern regarding the future impacts of climate change has resulted in an increase in the number of bird species considered of high conservation concern. At-risk bird species occurring on DoD lands have a high potential to impede training activities, especially if they become listed under the federal Endangered Species Act (ESA). To reduce conflicts between rare species conservation measures and military operations, it is increasingly important that natural resource managers have accurate information on the status, distribution, and climate vulnerability of at-risk species occurring on their lands. Such information is critical to reinforcing the DoD's commitment to balancing mission readiness with responsible environmental management.

Fort Custer Training Center (FCTC) is a federally owned, active National Guard Training Center operated by the Michigan Department of Military and Veteran Affairs (DMVA). It is located on 7,570 contiguous acres in southwestern Michigan between the cities of Kalamazoo and Battle Creek. Training activities are concentrated in the northern 10% of FCTC, and the remaining proportion is managed for biodiversity conservation in tandem with military training. FCTC is regionally important as a contiguous block of habitat, along with the adjacent Fort Custer Recreation Area (3,033 acres), in the predominantly fragmented landscape of southern Michigan. The facility supports many rare plant and animal species, high-quality natural communities (Cohen et al. 2009, Bassett et al. 2022), and provides a variety of habitats for migratory and breeding birds. The facility also boasts a long history of avian surveys, with near-annual monitoring conducted across the installation by Kalamazoo Nature Center (KNC) staff from 1997-2023. This long-term dataset provides critical information on the bird species using FCTC lands and provides a mechanism for documenting population trends over time.



The aim of this report is to leverage this long-term monitoring dataset to provide FCTC natural resource managers with information and tools to manage for at-risk bird species in the face of climate change. The primary objectives of this project were to use this dataset to: 1) identify focal species using FCTC lands for further assessment and conservation planning; 2) document the distribution of these focal species and assess changes in status throughout the monitoring period; and 3) assess the adaptive capacity of these species using tools developed by Thurman et al. (2020), which assesses the adaptive capacity of species based on life history, ecological, and evolutionary attributes. Results from this tool allow managers to craft conservation actions that target the specific climate vulnerabilities of species.

The results and interpretation we provide in this document can be used to identify at-risk bird species that rely heavily on FCTC lands, areas of the installation that provide critical habitat for these species, and specific attributes that limit their ability to adapt to climate change. Natural resource managers can use this information to strategically prioritize management actions and locations, helping the installation achieve the goals and objectives outlined in the DoD's strategic plan for bird conservation and management (DoD Natural Resources Program 2014). Ultimately, this information can be used to inform FCTC's Integrated Natural Resource Management Plan (INRMP) and Readiness and Environmental Protection Integration (REPI) program, ensuring the installation continues to be a local and national leader in the conservation of biodiversity on DoD lands.



Grasshopper sparrow (*Ammodramus savannarum*), a Department of Defense Tier 2 species commonly detected at Fort Custer Training Center. Photo by Aaron Kortenhoven.



## METHODS

### Sampling Effort

The Kalamazoo Valley Bird Observatory, a program of the Kalamazoo Nature Center (KNC), has been conducting surveys and contributing to collaborative avian research in Southwest Michigan for over 30 years. Kalamazoo Nature Center staff, primarily John Brenneman, Rich Keith, and Brenda Keith, have conducted nearly annual bird surveys at FCTC from 1997-2023. Point count surveys were conducted at 290 survey points distributed across all nine Training Areas (Figure 1). Survey points were separated by at least 200 m and were located at least 50 m into a stand, with a stand defined as a relatively homogenous area of a similar cover type. Surveys occurred during late May through early July and from sunrise to 11 am. All birds seen or heard were recorded during 10-minute point counts.



Hooded warbler (*Setophaga citrina*), an at-risk songbird species commonly detected at Fort Custer Training Center. Photo by Aaron Kortenhoven.

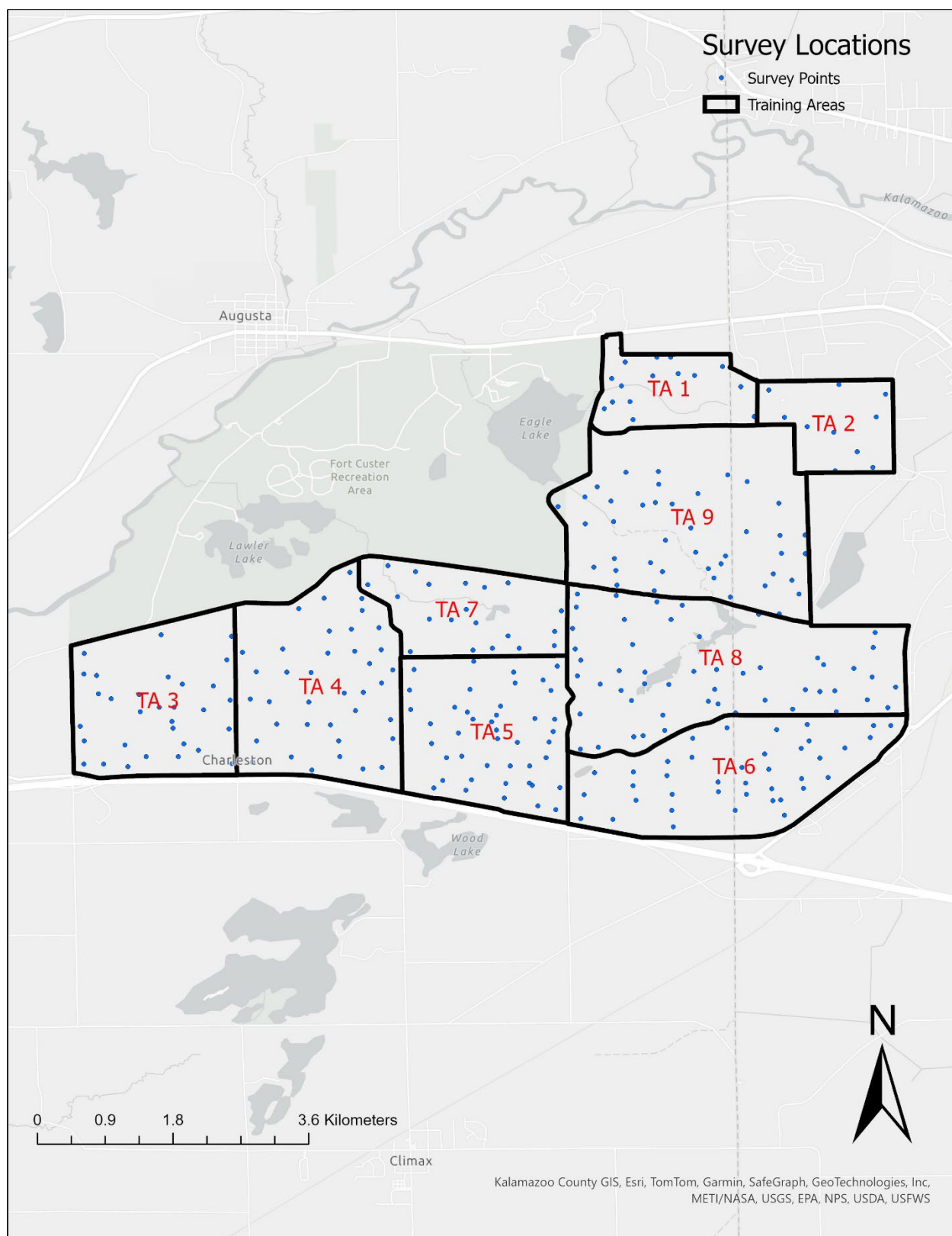


Figure 1. Locations of survey points monitored by Kalamazoo Nature Center staff at Fort Custer Training Center from 1997-2023.

## **Focal Species**

To determine focal species for further assessment, we identified species observed at FCTC during the monitoring period (1997-2023) with one or more of the following special status designations: 1) Department of Defense mission-sensitive species and Tier 2 species (DoD 2021); 2) State listed species (Threatened, Endangered, or Special Concern; MDNR 2024); 3) Michigan Species of Greatest Conservation Need (Derosier et al. 2015); and 4) focal species of the Upper Mississippi/Great Lakes Joint Venture Landbird Habitat Conservation Strategy (Soulliere et al. 2020). We also considered species not previously detected at FCTC that may increase within the installation in future years due to current or projected climate-induced range shifts. We focused on species that are currently increasing in abundance or are projected to increase in abundance in southern Michigan, with a particular focus on at-risk species that have the potential to impact military training activities. We used eBird status and trends maps to determine cumulative changes in relative abundance of species in southern Michigan from 2012-2022 (Fink et al. 2023) and used modeled projections from Audubon's Survival by Degrees report (Wilsey et al. 2019) and the U.S. Forest Service's Climate Change Bird Atlas (Matthews et al. 2011, 2014) to assess projected range shifts.

## **Status and Distribution of Focal Species**

We compiled information on the distribution and status of focal species occurring at the installation to aid land managers in strategically prioritizing management actions and locations. We first assessed the number of focal species detected in each Training Area to determine if certain areas support higher species diversity. After identifying the most diverse Training Areas, we then examined stands to identify which were associated with higher avian diversity by determining the number of focal species detected in each stand. We used Michigan Forest Inventory (MiFI) cover type data to classify habitats. We also looked to see if commonly detected focal species with similar habitat requirements, such as grassland-dependent species, were concentrated in certain areas of the installation.

We used annual survey data to assess trends in relative abundance of focal species across the monitoring period. To increase the relevance and interpretability of the results, we excluded species ( $n = 13$ ) for which fewer than 50 individuals were detected across all surveys. These species contributed less than 2% to the total abundance of focal species, and it is unlikely that they rely heavily on FCTC habitats. To assess trends for the remaining species ( $n = 8$ ), we divided the monitoring period into eight discrete sampling periods. Each sampling period consisted of three full seasons of point count surveys, apart from 2022-2023, which included only two seasons. For each sampling period we calculated the total number of birds observed (i.e., abundance) by species and the total number of surveys conducted. Because survey effort varied considerably between periods, we calculated species abundance per survey for each period, making values more comparable.

To further assess the status of focal species at FCTC and identify changes to the breeding status of species in Kalamazoo and Calhoun counties, we compared data from the first (Brewer et al.

1991) and second Michigan Breeding Bird Atlases (Chartier et al. 2011). We focused on townships covering FCTC to assess if breeding status has changed over time for focal species. We assessed two townships that overlapped with FCTC, S2 8W and S2 9W. A third township, 1S 9W, was excluded from analysis as it encompassed only 11 acres of the northwestern-most portion of the installation.

## Assessing Adaptive Capacity of Focal Species

A species' overall vulnerability to climate change is determined by three core components: exposure, sensitivity, and adaptive capacity (Glick et al. 2011). Of these three components, adaptive capacity (AC), defined as "the ability of species to cope with or adjust to climate change" (Thurman et al. 2020), can most easily be addressed by biologists and wildlife managers. A thorough understanding of a species' AC profile allows managers to craft species-specific conservation plans that target specific climate vulnerabilities. To aid FCTC staff working to manage for at-risk bird species, we completed AC assessments for all focal species.

We completed assessments using a rapid AC tool developed by Thurman et al. The rapid AC assessment tool consists of 37 species- or population-level attributes organized into seven attribute groups: distribution, movement, evolutionary potential, ecological role, abiotic niche, life history, and demography (Table 1). Each avian species was assessed as low, moderately low, moderately high, or high for each attribute (some attributes only contain three levels – low, moderate, high) based on predefined evaluation criteria. The assessment output includes an average AC level (low, moderately low, moderate, moderately high, or high), with an associated score ranging from 0 (lowest AC) to 1 (highest AC) for each of the seven attribute groups, and an overall AC level and score for the species. For a detailed description of the rapid AC tool used to complete assessments please see [Earl et al. 2024](#).

Table 1. The seven adaptive capacity (AC) assessment attribute groups and the 37 traits assessed, with brief descriptions of each group.

| AC attribute group            | Traits assessed                                                                                                                                         | Description                                                                                               |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| <b>Distribution</b>           | Extent of Occurrence, Area of Occupancy, Habitat Specialization, Commensalism with Humans, Geographic Rarity                                            | Where the species is found, how common the species is across the landscape.                               |
| <b>Movement</b>               | Dispersal Syndrome, Dispersal Distance, Dispersal Phase, Site Fidelity, Migration Frequency, Migration Demography, Migration Timing, Migration Distance | How far and how often the species moves, how likely the species is to move and establish in new habitats. |
| <b>Evolutionary Potential</b> | Genetic Diversity, Population Size, Hybridization Potential                                                                                             | How genetically viable the species is, how likely inbreeding is to occur.                                 |
| <b>Ecological Role</b>        | Enemies, Diet Breadth, Diversity of Obligate Species                                                                                                    | What the species eats, how dependent it is on other species, and other biotic                             |

|                      |                                                                                                                                   |                                                                                                                              |
|----------------------|-----------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
|                      |                                                                                                                                   | interactions or relationships that impact the species.                                                                       |
| <b>Abiotic Niche</b> | Seasonal Phenology, Climatic Niche Breadth, Physiological Tolerances, Behavioral Regulation of Physiology, Disturbance Tolerances | What range of climatic conditions the species can tolerate. How sensitive the species is to changes in natural disturbances. |
| <b>Life History</b>  | Reproductive Phenology, Reproductive Mode, Mating System, Fecundity, Parity, Sex Ratio, Sex Determination, Parental Investment    | How the species reproduces. How often, how many offspring, and how offspring are cared for.                                  |
| <b>Demography</b>    | Life Span, Generation Time, Age of Sexual Maturity, Age Structure, Recruitment                                                    | How populations of the species are composed. How old they can live and how likely juveniles are to survive to reproduce.     |

For the evaluated attribute groups, the AC score indicates how that portion of a species' life cycle, ecology, or demography may be able to respond to and adapt to climate change, with a low scoring attribute or group being a limiting factor. For example, the distribution and movement attributes relate to a species' ability to potentially move through a landscape in response to climate change (shift in space), whereas the life history and demography attributes indicate a species' capacity to accommodate changing climates (persist in place) (Thurman et al. 2020). A lower overall AC score/level suggests a species may have reduced ability to adapt and may need targeted management or active intervention to persist with climate change, while species with a higher evaluated AC may be better suited to cope with climate change (Thurman et al. 2020).

## RESULTS

Surveys were conducted in all but four years of the monitoring period (1997-2023), with 4,407 surveys conducted by KNC staff across all 23 years. Survey effort varied considerably from year to year, both in terms of the number of points surveyed and the number of surveys conducted (Figure 2). A total of 138 species were detected at FCTC (Appendix A). Eastern wood-pewee (*Contopus virens*), American robin (*Turdus migratorius*), red-eyed vireo (*Vireo olivaceus*), brown-headed cowbird (*Molothrus ater*), and rose-breasted grosbeak (*Pheucticus ludovicianus*) were the most commonly detected species.

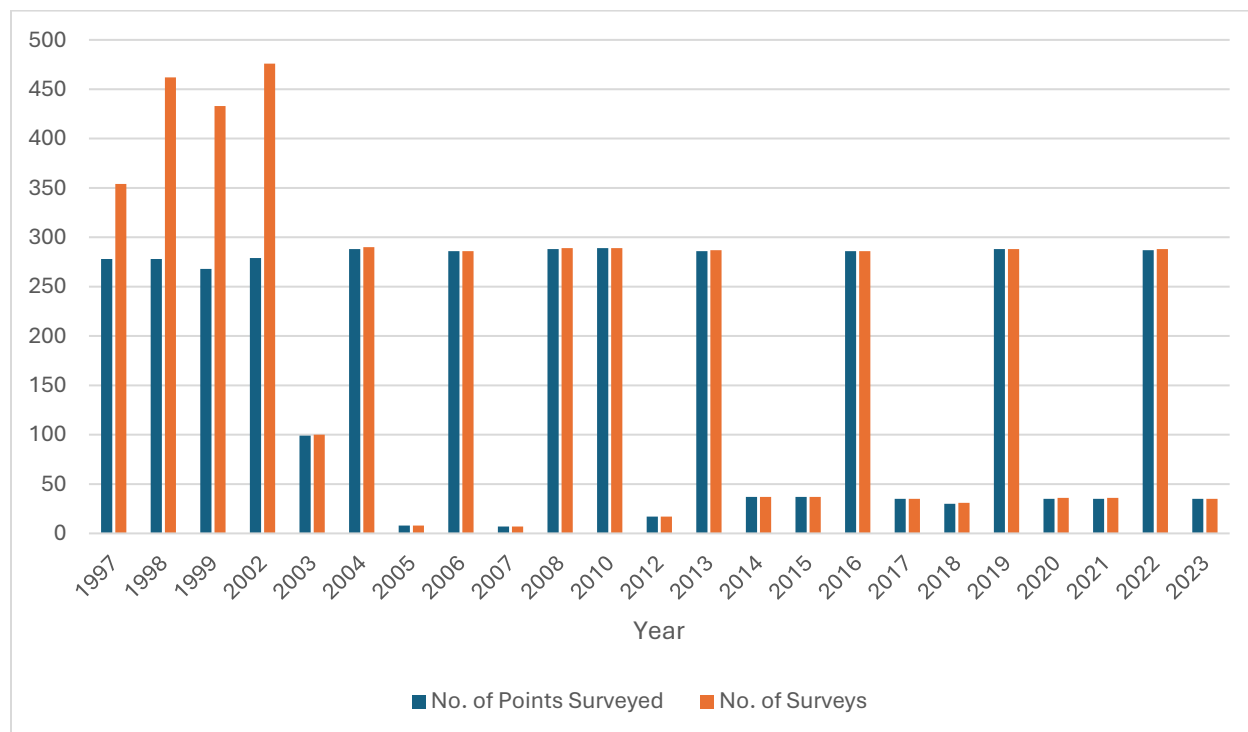


Figure 2. The number of points surveyed and number of surveys conducted by Kalamazoo Nature Center staff between 1997 and 2023. No surveys were conducted in 2000, 2001, 2009, and 2011, and some points were surveyed multiple times per year.

### Focal Species

We identified 22 focal species for further assessment and conservation planning at FCTC (Table 2). Three of these species are classified as DoD mission-sensitive species, meaning they have a high potential to impact DoD missions if federally listed under the Endangered Species Act (DoD 2021). Seven additional species are DoD Tier 2 species. While not the highest priority, many of these species are experiencing long-term declines and have the potential to impact future missions (DoD 2021). Four species are listed as State Threatened or Endangered and 64% of the focal species contain two or more special status designations.



Yellow-throated warbler (*Setophaga dominica*) was the only species not previously documented at FCTC identified to potentially impact future training activities. This species currently reaches the northern limit of its range in southern Michigan, but Audubon and the USFS climate change bird atlas both project the range to expand further north in Michigan, and eBird trend data show an increase in abundance in southern Michigan between 2012-2022. Yellow-throated warbler is currently a Species of Greatest Conservation Need (SGCN) in Michigan and was listed as State Threatened prior to 2023. If detected at FCTC in the future, this species may require further assessment. Several other species are projected to increase in southern Michigan, but the degree to which they will be of conservation concern within the state is currently unclear. It is worth noting that the USFS atlas predicts a range expansion into southern Michigan for Kentucky warbler (*Geothlypis Formosa*), a DoD Tier 2 and Midwest Regional SGCN watchlist species (Terwilliger and MLI 2022) infrequently detected at FCTC during the monitoring period. A future increase in abundance may necessitate further assessment and planning for this species.

Table 2. Focal species and their associated special status designations that we identified for further assessment and conservation planning at Fort Custer Training Center.

| Scientific Name                        | Common Name             | Special Status <sup>1</sup> |
|----------------------------------------|-------------------------|-----------------------------|
| <i>Ammodramus savannarum</i>           | Grasshopper sparrow     | DoD-2, SC, SGCN             |
| <i>Cardellina canadensis</i>           | Canada warbler          | DoD-2, JV                   |
| <i>Centronyx henslowii</i>             | Henslow's sparrow       | DoD-M, E, SGCN              |
| <i>Chaetura pelagica</i>               | Chimney swift           | JV                          |
| <i>Cistothorus palustris</i>           | Marsh wren              | SC                          |
| <i>Cistothorus stellaris</i>           | Sedge wren              | SC                          |
| <i>Coccyzus erythrophthalmus</i>       | Black-billed cuckoo     | DoD-2                       |
| <i>Contopus cooperi</i>                | Olive-sided flycatcher  | DoD-2                       |
| <i>Cygnus buccinator</i>               | Trumpeter swan          | SC, SGCN                    |
| <i>Dolichonyx oryzivorus</i>           | Bobolink                | JV                          |
| <i>Gallinula galeata</i>               | Common gallinule        | T, SGCN                     |
| <i>Geothlypis formosa</i>              | Kentucky warbler        | DoD-2                       |
| <i>Haliaeetus leucocephalus</i>        | Bald eagle              | SC, SGCN                    |
| <i>Hylocichla mustelina</i>            | Wood thrush             | DoD-2, SC, JV               |
| <i>Melanerpes erythrocephalus</i>      | Red-headed woodpecker   | DoD-2, SC, SGCN, JV         |
| <i>Pandion haliaetus</i>               | Osprey                  | SC, SGCN                    |
| <i>Setophaga cerulea</i>               | Cerulean warbler        | DoD-M, T, SGCN, JV          |
| <i>Setophaga citrina</i>               | Hooded warbler          | SC, SGCN                    |
| <i>Setophaga dominica</i> <sup>2</sup> | Yellow-throated warbler | SGCN                        |
| <i>Spiza americana</i>                 | Dickcissel              | SC, SGCN                    |
| <i>Sturnella magna</i>                 | Eastern meadowlark      | SC, JV                      |
| <i>Vermivora chrysoptera</i>           | Golden-winged warbler   | DoD-M, T, SGCN, JV          |

<sup>1</sup>Special status abbreviations: DoD-M = Department of Defense mission-sensitive species; DoD-2 = Department of Defense Tier 2 species; SC = State Special Concern; T = State Threatened; E = State Endangered; SGCN = species of greatest conservation need; and JV = focal species of the Upper Mississippi / Great Lakes Joint Venture.

<sup>2</sup>Species not detected at FCTC during monitoring period but included due to potential impacts to future training activities.

### Status and Distribution of Focal Species

Fort Custer Training Center provides important habitat for several at-risk forest species, with wood thrush (*Hylocichla mustelina*), hooded warbler (*Setophaga citrina*), cerulean warbler (*Setophaga cerulea*), and black-billed cuckoo (*Coccyzus erythrophthalmus*) being the most abundant of the focal species (Table 3). The installation also supports considerable numbers of several at-risk grassland species, including Eastern meadowlark (*Sturnella magna*), grasshopper sparrow (*Ammodramus savannarum*), and dickcissel (*Spiza americana*), as well as the urban associated chimney swift (*Chaetura pelagica*). The remaining focal species documented at the installation occur in much lower abundance and many have not been detected in at least seven years. However, several of these uncommon species, including three DoD Tier 2 species and one State Threatened species, have been documented within the past two years and continued monitoring is needed.

Table 3. Total number of each focal species detected during the monitoring period (1997-2023) and the most recent year that each species was observed at the installation.

| Scientific Name                   | Common Name            | Number Detected | Last Observed |
|-----------------------------------|------------------------|-----------------|---------------|
| <i>Hylocichla mustelina</i>       | Wood thrush            | 2594            | 2023          |
| <i>Setophaga citrina</i>          | Hooded warbler         | 1840            | 2023          |
| <i>Setophaga cerulea</i>          | Cerulean warbler       | 382             | 2023          |
| <i>Coccyzus erythrophthalmus</i>  | Black-billed cuckoo    | 132             | 2022          |
| <i>Chaetura pelagica</i>          | Chimney swift          | 117             | 2019          |
| <i>Sturnella magna</i>            | Eastern meadowlark     | 93              | 2013          |
| <i>Ammodramus savannarum</i>      | Grasshopper sparrow    | 75              | 2022          |
| <i>Spiza americana</i>            | Dickcissel             | 58              | 2013          |
| <i>Melanerpes erythrocephalus</i> | Red-headed woodpecker  | 23              | 2023          |
| <i>Cygnus buccinator</i>          | Trumpeter swan         | 20              | 2022          |
| <i>Dolichonyx oryzivorus</i>      | Bobolink               | 13              | 2008          |
| <i>Cistothorus stellaris</i>      | Sedge wren             | 11              | 2008          |
| <i>Geothlypis formosa</i>         | Kentucky warbler       | 10              | 2022          |
| <i>Centronyx henslowii</i>        | Henslow's sparrow      | 6               | 2016          |
| <i>Gallinula galeata</i>          | Common gallinule       | 5               | 2022          |
| <i>Cistothorus palustris</i>      | Marsh wren             | 4               | 2010          |
| <i>Haliaeetus leucocephalus</i>   | Bald eagle             | 3               | 2019          |
| <i>Cardellina canadensis</i>      | Canada warbler         | 2               | 1999          |
| <i>Contopus cooperi</i>           | Olive-sided flycatcher | 1               | 2022          |
| <i>Pandion haliaetus</i>          | Osprey                 | 1               | 2006          |
| <i>Vermivora chrysoptera</i>      | Golden-winged warbler  | 1               | 1997          |

The highest diversity of focal species was observed in Training Areas 6 and 8 in the southeast portion of the installation, while the lowest diversity was observed in Training Areas 1, 2, and 4 (Figure 3). Within Training Areas 6 and 8, particularly high diversity was observed within 12 stands (Figure 4). Most of these stands are classified as mixed upland deciduous (33.3%), herbaceous open land (33.3%), or low-density tree (25%) habitats, with a single stand containing lowland shrub habitat. Of the locally abundant focal species (i.e., > 50 individuals detected), forest interior species associated with large, contiguous tracts of mature forest (cerulean warbler, hooded warbler, wood thrush) were relatively widespread throughout the installation but were most common in Training Areas 5 and 8, with 39% of all detections occurring in these two areas. The majority of these detections occurred in mixed upland deciduous habitats. Conversely, over 95% of all detections of locally abundant grassland species (dickcissel, Eastern meadowlark, grasshopper sparrow) occurred in Training Areas 1, 2, and 6, with 50% of all detections occurring in Training Area 6 alone. Observations of these species are restricted to 19 stands, with 80% of all detections occurring in just seven stands (Figure 5). These stands are comprised of a mix of urban (57%), low-density tree (29%), and herbaceous open land (14%) habitat. Black-billed cuckoo have been documented throughout the installation and in a variety of cover types, but the highest number of detections have occurred in Training Area 9 and in mixed upland deciduous habitats. Distribution of chimney swift is difficult to assess, as all but one detection consisted of flyover observations.

Of the locally abundant focal species (i.e., > 50 individuals detected), numbers of edge-sensitive, forest interior species (i.e., cerulean warbler, hooded warbler, wood thrush) have remained relatively stable or increased throughout the monitoring period (Figure 6a). Conversely, all three commonly detected grassland species have declined, and neither Eastern meadowlark nor dickcissel have been detected since 2013 (Figure 6b). Numbers of chimney swift have declined considerably since 2015 (Figure 6c), while numbers of black-billed cuckoo have increased steadily since 2018 (Figure 6d).

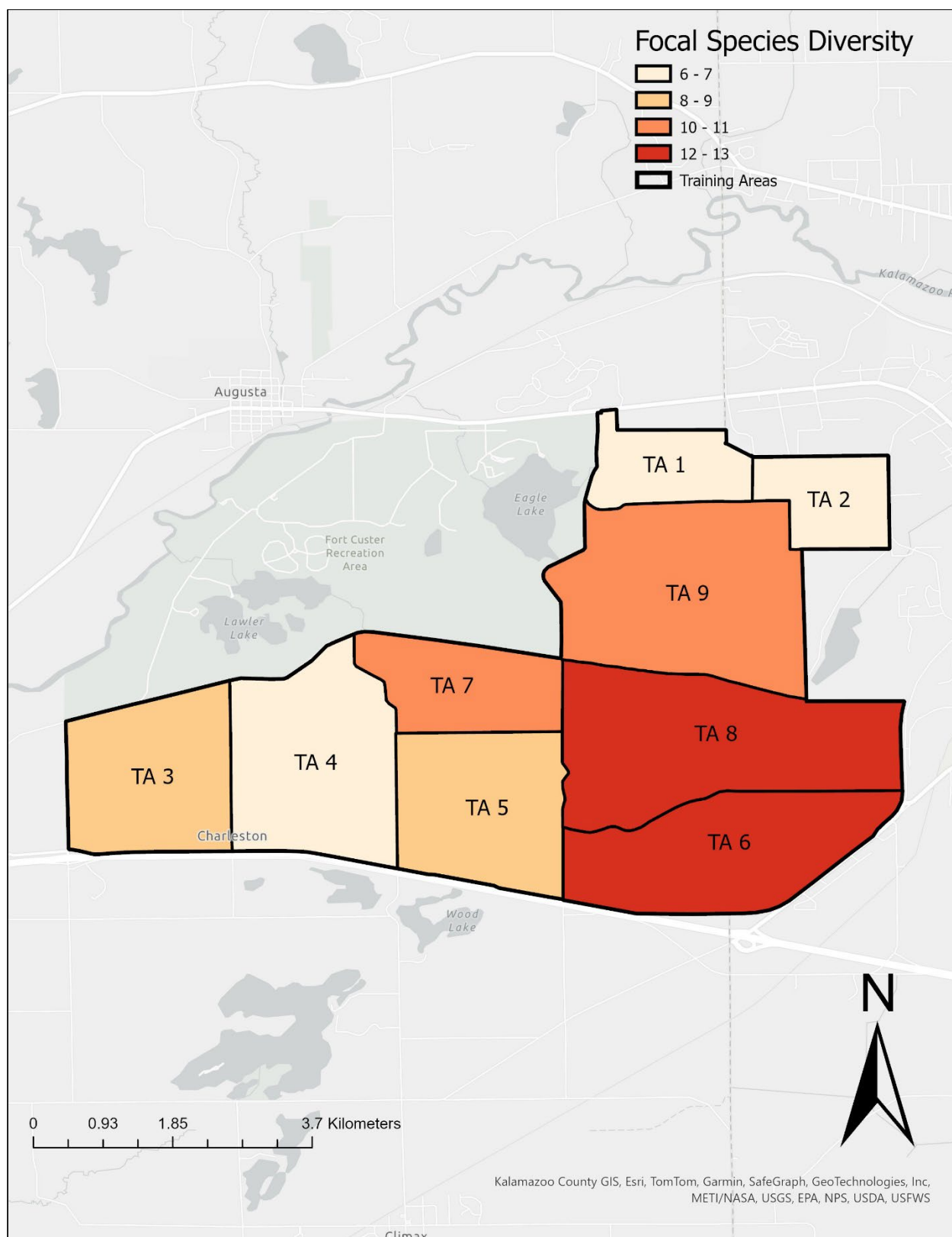


Figure 3. The number of focal species detected within Fort Custer Training Center Training Areas during the monitoring period.

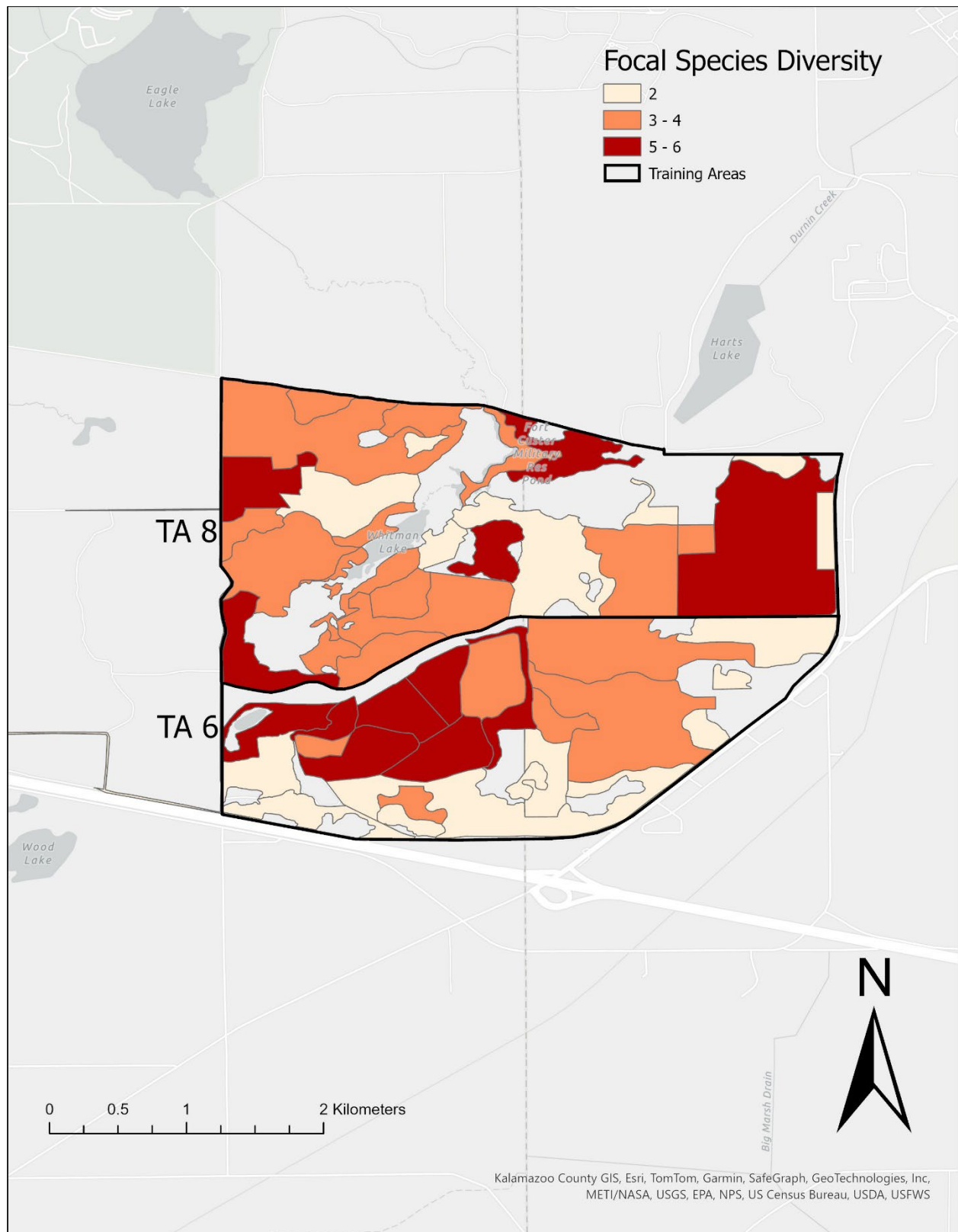


Figure 4. The number of focal species detected within each surveyed stand of Training Area 6 and 8 during the monitoring period.

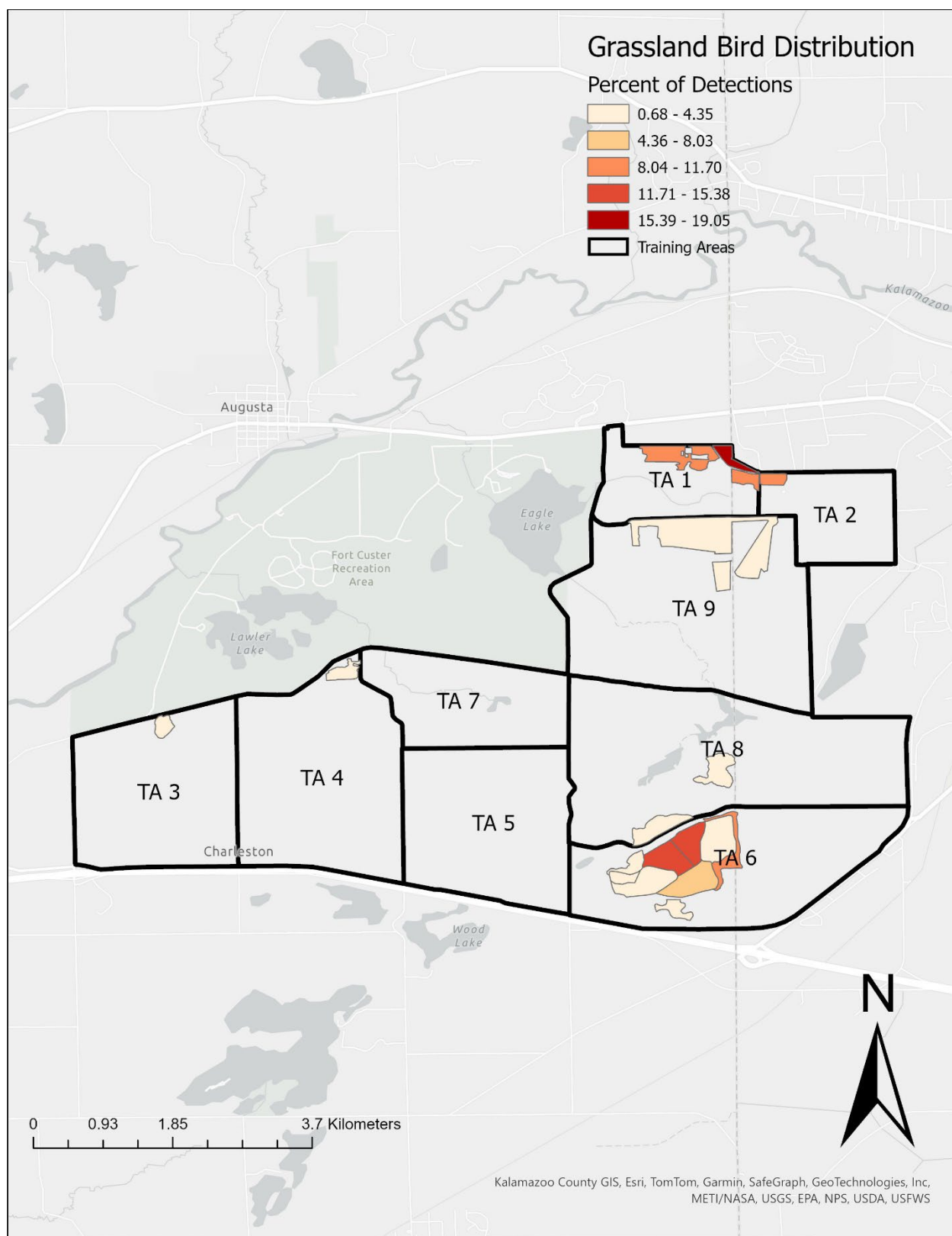


Figure 5. The percent of total detections that occurred within each stand for the three most commonly detected at-risk grassland species.



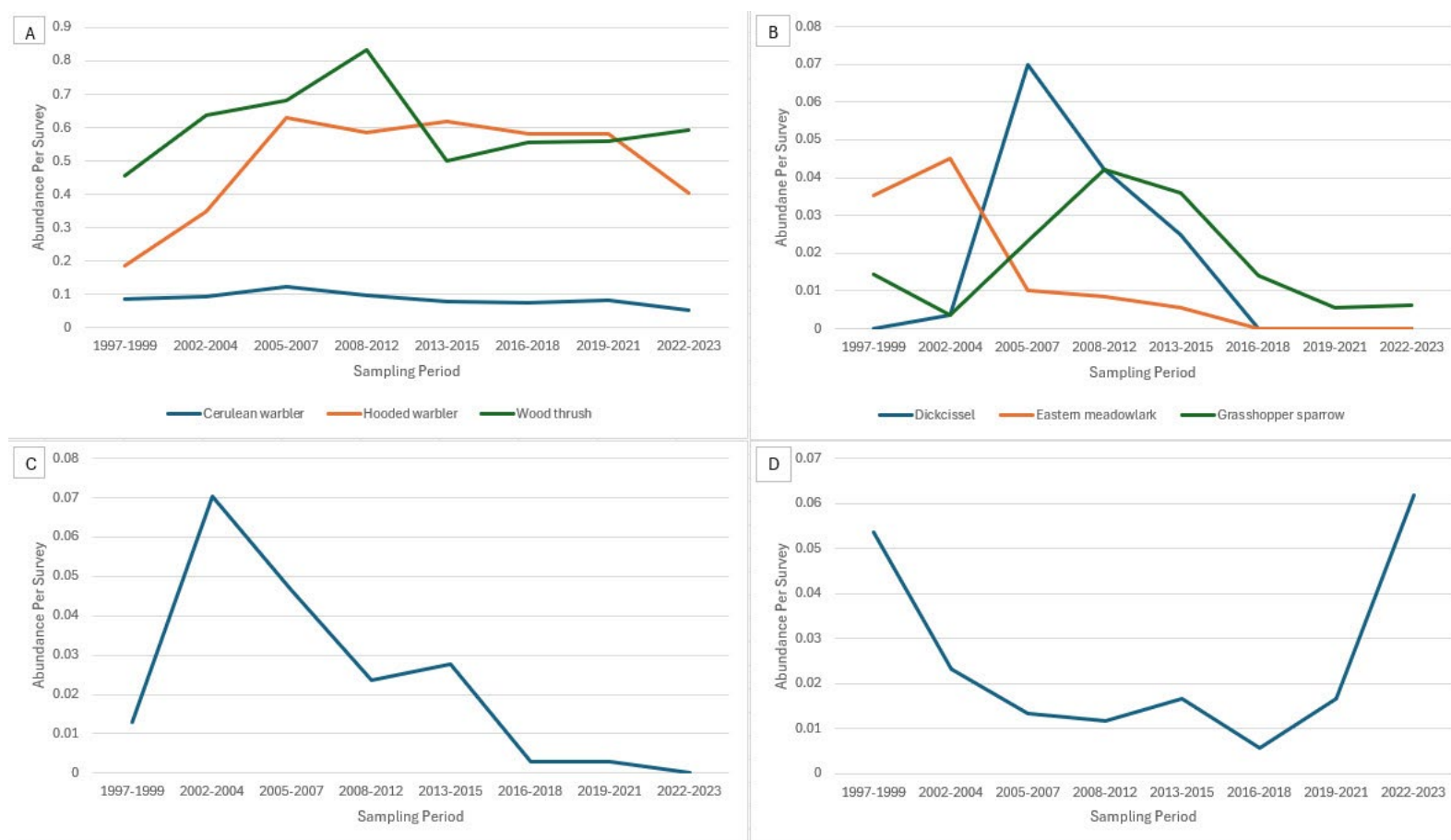


Figure 6. Trends in relative abundance across the monitoring period for common focal species, including (a) forest interior species, (b) grassland species, (c) chimney swift, and (d) black-billed cuckoo.

Thirteen focal species had a documented improvement in breeding status within relevant townships between the first and second Michigan Breeding Bird Atlases, while three species had a documented decrease in status and six species experienced no change or a net neutral change in status (Table 4). Please see Appendix B for details on the specific statuses of species during each Atlas.

Table 4. A comparison of the documented breeding statuses within relevant townships in the first and second Michigan Breeding Bird Atlases. Status change represents the net or cumulative change in breeding status for both townships (+ indicates status improvement; - indicates status decrease; / indicates no change in status.

| Scientific Name              | Common Name         | Status Change |
|------------------------------|---------------------|---------------|
| <i>Ammodramus savannarum</i> | Grasshopper sparrow | -/            |
| <i>Cardellina canadensis</i> | Canada warbler      | ++            |
| <i>Centronyx henslowii</i>   | Henslow's sparrow   | +/            |
| <i>Chaetura pelagica</i>     | Chimney swift       | +/            |
| <i>Cistothorus palustris</i> | Marsh wren          | ++            |

| Scientific Name                   | Common Name             | Status Change  |
|-----------------------------------|-------------------------|----------------|
| <i>Cistothorus stellaris</i>      | Sedge wren              | ± <sup>1</sup> |
| <i>Coccyzus erythrophthalmus</i>  | Black-billed cuckoo     | ±              |
| <i>Contopus cooperi</i>           | Olive-sided flycatcher  | + /            |
| <i>Cygnus buccinator</i>          | Trumpeter swan          | ++             |
| <i>Dolichonyx oryzivorus</i>      | Bobolink                | ±              |
| <i>Gallinula galeata</i>          | Common gallinule        | - /            |
| <i>Geothlypis formosa</i>         | Kentucky warbler        | + /            |
| <i>Haliaeetus leucocephalus</i>   | Bald eagle              | ±              |
| <i>Hylocichla mustelina</i>       | Wood Thrush             | + /            |
| <i>Melanerpes erythrocephalus</i> | Red-headed woodpecker   | + /            |
| <i>Pandion haliaetus</i>          | Osprey                  | ++             |
| <i>Setophaga cerulea</i>          | Cerulean warbler        | ++             |
| <i>Setophaga citrina</i>          | Hooded warbler          | ++             |
| <i>Setophaga dominica</i>         | Yellow-throated warbler | ±              |
| <i>Spiza americana</i>            | Dickcissel              | + /            |
| <i>Sturnella magna</i>            | Eastern meadowlark      | --             |
| <i>Vermivora chrysoptera</i>      | Golden-winged warbler   | ±              |

<sup>1</sup>No change in status in either township or net neutral change in status.

### Adaptive Capacity of Focal Species

We evaluated 22 focal species for Adaptive Capacity (AC). We completed 13 of these as a part of a concurrent effort (Earl et al. 2024) and assessed an additional nine for this effort. All species assessed had moderate or above AC. Most species (77%, n = 17) had moderate AC and five species (23%) had moderately high AC (Table 5). Chimney swift, golden-winged warbler (*Vermivora chrysoptera*), and sedge wren (*Cistothorus stellaris*) had the lowest overall AC scores, while grasshopper sparrow, bald eagle (*Haliaeetus leucocephalus*), and red-headed woodpecker (*Melanerpes erythrocephalus*) had the highest. Across all focal species, abiotic niche and demography attributes were most limiting, as these groups had the lowest average scores. Additionally, attributes related to migration were limiting for nearly all species. For non-migratory attributes that exhibited some interspecific variation outside of these two groups, substantial parental investment (i.e., altricial young), lack of known hybridization potential, and low commensalism with humans were limiting factors for the highest number of focal species.

The AC of all three of the lowest scoring species is primarily constrained by abiotic niche attributes. Sedge wren is sensitive to disturbance and largely restricted to a particular hydrological regime, chimney swift is sensitive to disturbance and has low physiological tolerances, and golden-winged warbler is largely restricted to a particular climatic condition. Chimney swift are additionally limited by evolutionary potential attributes (e.g., small population size and no known hybridization potential), and golden-winged warblers and sedge wren by demographic attributes, such as population age structure.

Of the focal species considered locally abundant at FCTC (i.e., > 50 individuals detected during monitoring period, n = 8), chimney swift and wood thrush have the lowest AC, while grasshopper sparrow and dickcissel have the highest. Forest species (n = 4) have lower average AC (moderate, score = 0.57) than grassland species (n = 3, moderately high, score = 0.63). The largest differences between the forest and grassland species are present in the ecological role and movement attribute groups, with forest species scoring lower in both. In contrast, demography and evolutionary potential attributes vary little between the groups. In general, forest species have higher site fidelity, are more likely to be complete migrants across their range, are more likely to be negatively affected by native or non-native species that may be favored by climate change, and exhibit slightly lower diet flexibility. Regarding uniquely limiting factors for forest interior species, both cerulean warbler and wood thrush (Figure 7) are limited by their low tolerance for natural disturbances, while cerulean warbler and hooded warbler are limited by their intolerance of human interactions and human-dominated landscapes. Cerulean warbler are additionally limited by their high degree of habitat specificity and potential to be negatively affected by native or non-native species as a result of climate change, and wood thrush by low recruitment and lack of known hybridization potential. For the locally abundant grassland species, both dickcissel and Eastern meadowlark are limited by their lack of known hybridization potential. Dickcissel are additionally limited by low recruitment, and eastern meadowlark by low disturbance tolerance.

Table 5. Overall adaptive capacity score and level for each focal species included in our analysis.

| Scientific Name                   | Common Name             | AC Score | AC Level        |
|-----------------------------------|-------------------------|----------|-----------------|
| <i>Ammodramus savannarum</i>      | Grasshopper sparrow     | 0.67     | Moderately high |
| <i>Cardellina canadensis</i>      | Canada warbler          | 0.55     | Moderate        |
| <i>Centronyx henslowii</i>        | Henslow's sparrow       | 0.56     | Moderate        |
| <i>Chaetura pelagica</i>          | Chimney swift           | 0.46     | Moderate        |
| <i>Cistothorus palustris</i>      | Marsh wren              | 0.58     | Moderate        |
| <i>Cistothorus stellaris</i>      | Sedge wren              | 0.52     | Moderate        |
| <i>Coccyzus erythrophthalmus</i>  | Black-billed cuckoo     | 0.58     | Moderate        |
| <i>Contopus cooperi</i>           | Olive-sided flycatcher  | 0.52     | Moderate        |
| <i>Cygnus buccinator</i>          | Trumpeter swan          | 0.59     | Moderate        |
| <i>Dolichonyx oryzivorus</i>      | Bobolink                | 0.56     | Moderate        |
| <i>Gallinula galeata</i>          | Common gallinule        | 0.61     | Moderately high |
| <i>Geothlypis formosa</i>         | Kentucky warbler        | 0.58     | Moderate        |
| <i>Haliaeetus leucocephalus</i>   | Bald eagle              | 0.65     | Moderately high |
| <i>Hylocichla mustelina</i>       | Wood thrush             | 0.54     | Moderate        |
| <i>Melanerpes erythrocephalus</i> | Red-headed woodpecker   | 0.63     | Moderately high |
| <i>Pandion haliaetus</i>          | Osprey                  | 0.57     | Moderate        |
| <i>Setophaga cerulea</i>          | Cerulean warbler        | 0.55     | Moderate        |
| <i>Setophaga citrina</i>          | Hooded warbler          | 0.58     | Moderate        |
| <i>Setophaga dominica</i>         | Yellow-throated warbler | 0.54     | Moderate        |
| <i>Spiza americana</i>            | Dickcissel              | 0.63     | Moderately high |
| <i>Sturnella magna</i>            | Eastern meadowlark      | 0.60     | Moderate        |

| Scientific Name              | Common Name           | AC Score | AC Level |
|------------------------------|-----------------------|----------|----------|
| <i>Vermivora chrysoptera</i> | Golden-winged warbler | 0.51     | Moderate |

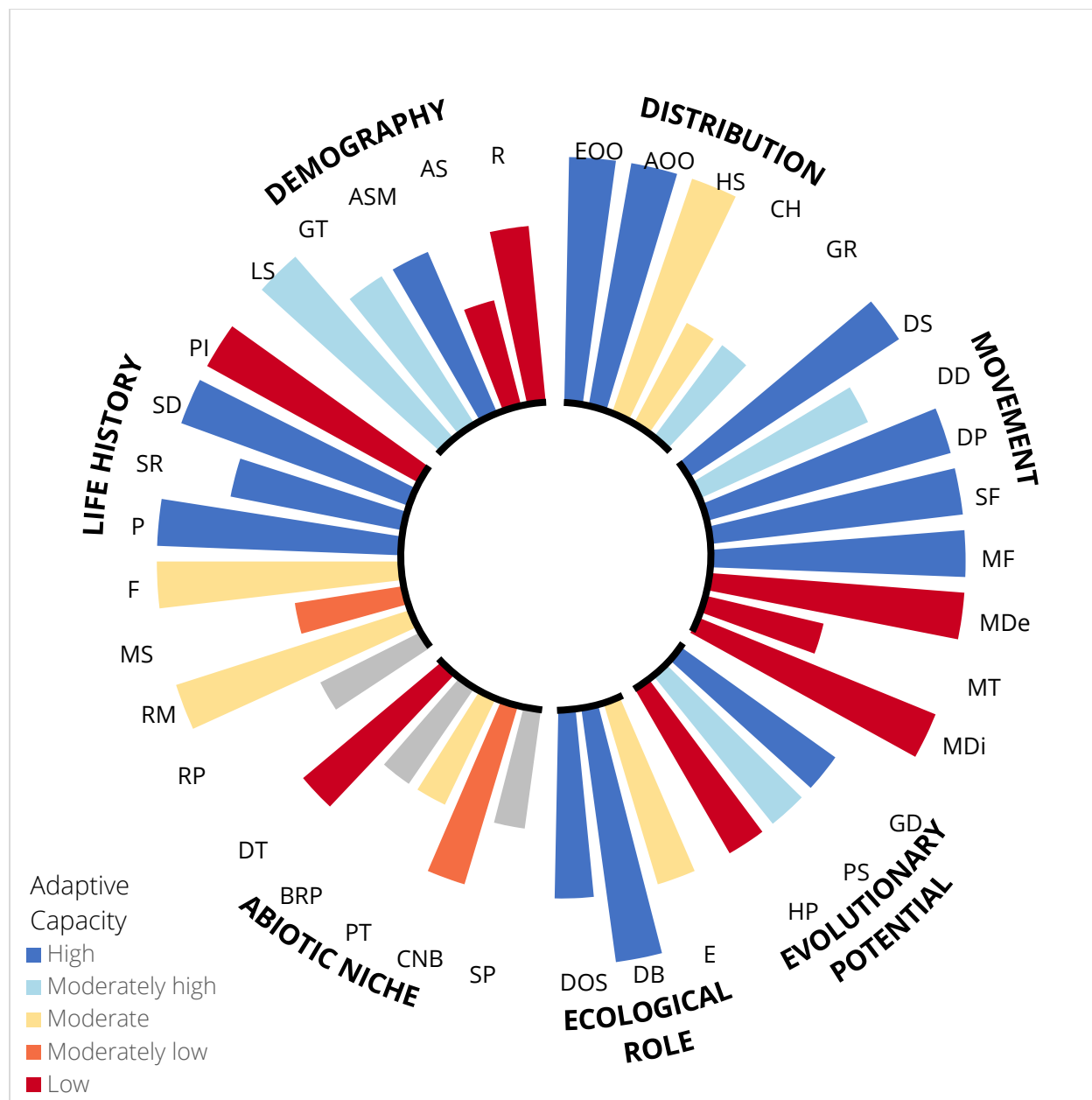


Figure 7. Graph output of the adaptive capacity assessment for wood thrush (*Hylocichla mustelina*). Traits assessed as low (red spokes) represent potentially limiting factors that constrain the species' ability to adapt to climate change.

## DISCUSSION

The FCTC has consistently provided important habitat for both breeding and migratory birds, with 138 species documented over the monitoring period from 1997 to 2023. This remarkable achievement is a testament to the ongoing dedication and collaboration between the Michigan Army National Guard, Department of Defense (DoD), FCTC, and KNC, which has led to the creation of an invaluable long-term monitoring dataset utilized in this report. We recommend that these successful conservation efforts be sustained and expanded in the coming years to continue supporting bird populations and preserving essential habitats.

The FCTC plays a critical role in supporting rare and at-risk bird species in southern Michigan, providing habitat for 21 species that are recognized with at least one special status designation, and one additional species that may use the installation in future years (Table 2). These species rely on the environmental conditions found within the installation for breeding, migration, and survival. The presence of such a diverse array of species with special conservation statuses underscores the significant ecological value of the installation, highlighting its importance as a key refuge for vulnerable bird populations. Protecting and managing this habitat will contribute to the continued survival and recovery of these species, many of which face ongoing threats from habitat loss, climate change, and other environmental pressures.

### **Status and Distribution of Focal Species**

While we identified 22 focal species for further assessment and conservation planning, many of these species were rarely detected at the installation. For the purposes of this report, we focused primarily on species that we deemed locally abundant, but several of these uncommon species require further mention. Detections of red-headed woodpecker (DOD-2, SC, SGCN, JV) have increased slightly within the past few years. The highest annual abundance of the monitoring period was recorded in 2022, and this species also experienced an improvement in breeding status between atlases. Most detections of this species have occurred in Training Areas 6 and 9 and in mixed-upland deciduous or low-density tree cover types. As a DoD Tier 2 species that may be increasing at the installation, continued monitoring is recommended. Similarly, close monitoring of common gallinule (T, SGCN) trends is recommended. While only five individuals have been detected to date, two were observed as recently as 2022. All detections of this species have occurred in Training Area 7. Olive-sided flycatcher (DoD-2) was detected at the installation for the first time in 2022 and had an improvement in breeding status between atlases. Further use of the installation by this species should be documented.

### *Management and Monitoring Recommendations*

While all Training Areas contained detections of multiple focal species, the highest diversity was present in Training Areas 6 and 8. Within these Training Areas, particularly high diversity was observed in 12 stands (Figure 4), and management and protection of these areas should be prioritized. The FCTC appears to be a regional stronghold for several rare and declining area

sensitive, forest interior songbirds - cerulean warbler, hooded warbler, and wood thrush. These were the most commonly detected focal species and all three appeared to have stable to slightly increasing trends across the monitoring period. While fairly widespread throughout the installation, the majority of detections occurred within Training Areas 5 and 8 and within mixed upland deciduous cover types. At a minimum, these areas should be protected from logging activity and habitat fragmentation. However, Training Areas 3, 4, and 6 also appear to provide important habitat for these species.

After declining throughout most of the monitoring period, black-billed cuckoo appear to be increasing in recent years. This increase is likely due to recent Spongy moth (*Lymantria dispar*) outbreaks in Kalamazoo County, which are known to result in localized population increases for this species (J. Brenneman, Kalamazoo Nature Center, personal communication). As a DoD Tier 2 species, trends should be monitored closely in subsequent years. While chimney swift (JV) were frequently detected, all but one of these observations were flyovers, and it's unclear whether the species nests within structures present at FCTC or simply uses it as foraging habitat.

Throughout the monitoring period, the installation also supported high numbers of three at-risk grassland species – grasshopper sparrow, dickcissel, and Eastern meadowlark. All three of these species appear to be declining, and neither Eastern meadowlark nor dickcissel have been detected since 2013. Detections of these species were largely concentrated in just seven stands distributed across Training Areas 1, 2, and 6 (Figure 5), and these areas should be prioritized for management and future monitoring. Given the declining trends, we recommend that grassland birds be a focal point of future conservation planning.

### **Adaptive Capacity of Focal Species**

The ability of a species to cope with or adapt to changing climatic conditions is a vital component of their overall climate vulnerability (Thurman et al. 2020), and the implementation of management actions that enhance adaptive capacity (AC) is greatly needed. Often, AC is difficult to evaluate and is inconsistently applied, which has limited its inclusion in conservation planning efforts (Thurman et al. 2020). This project addresses this issue by providing AC assessments for 21 at-risk bird species that use FCTC habitats, and one species that may use them in the future. When interpreting the results of these assessments, we caution against placing too much emphasis on the overall AC score. Rather, we recommend using these assessments to gain a deeper understanding of how specific factors contribute to a species' overall AC profile (Thurman et al. 2020), with a focus on traits that limit a species' ability to adapt. Such an approach allows managers to craft species-specific conservation plans that target specific climate vulnerabilities.

### ***Management Recommendations***

Most management actions that augment adaptive capacity are fairly intuitive, and many of these strategies will be familiar to practitioners. The AC of cerulean warblers, for example, was primarily limited by their habitat specificity (habitat specialization), intolerance of human influences (commensalism with humans), potential increase in detrimental interactions with species as a result of climate change (enemies), and low tolerance for large-scale natural disturbances (disturbance tolerance). Adaptation actions to address habitat specificity include improving habitat quality and suitability, protecting and enhancing connectivity among habitats, and conserving or restoring local climate microrefugia (Thurman et al. 2021). Similarly, low commensalism with humans may be addressed by restricting human access to occupied areas, particularly during the breeding season, and increasing the size and number of protected areas (Thurman et al. 2021).

Regarding enemies, cerulean warblers are often subordinate members of breeding populations that are routinely displaced by more common species and are common hosts of brood-parasitic brown-headed cowbirds. Potential reductions in suitable habitat and increased fragmentation of forests resulting from climate-related disturbances and pests are likely to exacerbate these threats. Recommended adaptation actions include establishing new areas of suitable habitat to reduce interspecific competition and reducing the competitive ability of less desirable species (Thurman et al. 2021), such as brown-headed cowbirds. Simple ways to reduce the competitive ability of brown-headed cowbirds include reducing forest fragmentation, managing forests to increase interior-to-edge ratios, and feathering or softening forest edges. While cerulean warblers may benefit from small-scale natural disturbances (e.g., windthrow) that create occasional gaps in the canopy, this species is susceptible to large-scale natural disturbances predicted to increase in frequency as a result of climate change. Providing refugia to escape natural disturbances by maintaining multiple patches of suitable habitat and focusing on early detection and rapid response to novel and emerging threats (e.g., tree pests and diseases) will help to augment their AC. Many of these adaptation actions will also benefit hooded warblers and wood thrush, two species with similar habitat requirements and vulnerabilities. If resources are limited, focusing adaptive management within mixed upland deciduous habitats in Training Areas 5 and 8 will maximize benefits for these species.

## **Future Work**

Based on models (Matthews et al. 2011, 2014, Wilsey et al. 2019) and eBird trend data (Fink et al. 2023), yellow-throated warbler (SGCN) was identified as a species not yet documented at FCTC that may increase within the installation as a result of climate change. Similarly, Kentucky warbler (DoD-2), a species infrequently detected at FCTC throughout the monitoring period, may increase in abundance in recent years due to projected range shifts. In 2022, Kentucky warbler was documented at FCTC for the first time since 2007, and this species also experienced an improvement in breeding status between atlases. Detections of this species are infrequent and widespread throughout the installation, but all have occurred within mixed upland deciduous cover types. As a DoD Tier 2 and Midwest Regional SGCN watchlist species,



future trends should be monitored closely. While not yet detected at the installation, yellow-throated warbler would be most likely to occur in the southern hardwood swamp natural communities (lowland deciduous cover type) present in Training Areas 2, 3, and 9. Both of these species have the potential to impact future training activities and should be prioritized in future monitoring efforts.

While not possible under the current sample and survey effort design, we recommend continued exploration of the use of multi-year occupancy models to assess potential changes in estimates of occupancy, extinction, and colonization probabilities over time for high priority species. These models improve inferences of occupancy, defined as the proportion of sites in a landscape where a target species is present (MacKenzie and Royle 2005), by accounting for imperfect detection (MacKenzie et al. 2003), an especially important consideration when dealing with rare species (MacKenzie et al. 2005). Failure to account for imperfect detection can result in biased estimates of occupancy and unreliable inferences (MacKenzie et al. 2003). Furthermore, relevant covariates (e.g., cover type, stand size, management actions) can be incorporated into the models to assess how these factors influence probabilities of occupancy, colonization (probability an unoccupied area becomes occupied), and extinction (probability an occupied area becomes unoccupied) over time (MacKenzie et al. 2003). Occupancy models require that multiple surveys be conducted at sampling units within a single season. If occupancy models are of interest, we recommend that a subset of point count stations be visited twice during each breeding season.

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**APPENDIX A: COMMON AND SCIENTIFIC NAMES OF BIRD SPECIES DETECTED AT FORT CUSTER TRAINING CENTER DURING THE MONITORING PERIOD (1997-2023).**

| Common Name                  | Scientific Name                  |
|------------------------------|----------------------------------|
| 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>            |
| Bald Eagle                   | <i>Haliaeetus leucocephalus</i>  |
| Baltimore Oriole             | <i>Icterus galbula</i>           |
| Bank Swallow                 | <i>Riparia riparia</i>           |
| Barn Swallow                 | <i>Hirundo rustica</i>           |
| Barred Owl                   | <i>Strix varia</i>               |
| Belted Kingfisher            | <i>Megaceryle alcyon</i>         |
| Black-and-white Warbler      | <i>Mniotilta varia</i>           |
| Black-billed Cuckoo          | <i>Coccyzus erythrophthalmus</i> |
| Black-capped Chickadee       | <i>Poecile atricapillus</i>      |
| Blackpoll Warbler            | <i>Setophaga striata</i>         |
| Black-throated Blue Warbler  | <i>Setophaga caerulescens</i>    |
| Black-throated Green Warbler | <i>Setophaga virens</i>          |
| Blue Jay                     | <i>Cyanocitta cristata</i>       |
| Blue-gray Gnatcatcher        | <i>Polioptila caerulea</i>       |
| Blue-headed Vireo            | <i>Vireo solitarius</i>          |
| Blue-winged Teal             | <i>Spatula discors</i>           |
| Blue-winged Warbler          | <i>Vermivora cyanoptera</i>      |
| Bobolink                     | <i>Dolichonyx oryzivorus</i>     |
| Broad-winged Hawk            | <i>Buteo platypterus</i>         |
| Brown Creeper                | <i>Certhia americana</i>         |
| Brown Thrasher               | <i>Toxostoma rufum</i>           |
| Brown-headed Cowbird         | <i>Molothrus ater</i>            |
| Canada Goose                 | <i>Branta canadensis</i>         |
| Canada Warbler               | <i>Cardellina canadensis</i>     |
| Carolina Wren                | <i>Thryothorus ludovicianus</i>  |
| Cedar Waxwing                | <i>Bombycilla cedrorum</i>       |
| Cerulean Warbler             | <i>Setophaga cerulea</i>         |
| Chestnut-sided Warbler       | <i>Setophaga pensylvanica</i>    |
| Chimney Swift                | <i>Chaetura pelagica</i>         |
| Chipping Sparrow             | <i>Spizella passerina</i>        |
| Clay-colored Sparrow         | <i>Spizella pallida</i>          |
| Common Gallinule             | <i>Gallinula galeata</i>         |

| Common Name              | Scientific Name                |
|--------------------------|--------------------------------|
| Common Grackle           | <i>Quiscalus quiscula</i>      |
| Common Yellowthroat      | <i>Geothlypis trichas</i>      |
| Cooper's Hawk            | <i>Accipiter cooperii</i>      |
| Dickcissel               | <i>Spiza americana</i>         |
| Double-crested Cormorant | <i>Nannopterum auritum</i>     |
| Downy Woodpecker         | <i>Dryobates pubescens</i>     |
| Eastern Bluebird         | <i>Sialia sialis</i>           |
| Eastern Kingbird         | <i>Tyrannus tyrannus</i>       |
| Eastern Meadowlark       | <i>Sturnella magna</i>         |
| Eastern Phoebe           | <i>Sayornis phoebe</i>         |
| Eastern Towhee           | <i>Pipilo erythrophthalmus</i> |
| Eastern Wood-Pewee       | <i>Contopus virens</i>         |
| European Starling        | <i>Sturnus vulgaris</i>        |
| Field Sparrow            | <i>Spizella pusilla</i>        |
| Golden-winged Warbler    | <i>Vermivora chrysoptera</i>   |
| Grasshopper Sparrow      | <i>Ammodramus savannarum</i>   |
| Gray Catbird             | <i>Dumetella carolinensis</i>  |
| Great Blue Heron         | <i>Ardea herodias</i>          |
| Great Crested Flycatcher | <i>Myiarchus crinitus</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>     |
| Hermit Thrush            | <i>Catharus guttatus</i>       |
| Hooded Merganser         | <i>Lophodytes cucullatus</i>   |
| Hooded Warbler           | <i>Setophaga citrina</i>       |
| Horned Lark              | <i>Eremophila alpestris</i>    |
| House Finch              | <i>Haemorhous mexicanus</i>    |
| House Sparrow            | <i>Passer domesticus</i>       |
| Indigo Bunting           | <i>Passerina cyanea</i>        |
| Kentucky Warbler         | <i>Geothlypis formosa</i>      |
| Killdeer                 | <i>Charadrius vociferus</i>    |
| Least Flycatcher         | <i>Empidonax minimus</i>       |
| Magnolia Warbler         | <i>Setophaga magnolia</i>      |
| Mallard                  | <i>Anas platyrhynchos</i>      |
| Marsh Wren               | <i>Cistothorus palustris</i>   |
| Mourning Dove            | <i>Zenaida macroura</i>        |
| Mourning Warbler         | <i>Geothlypis philadelphia</i> |
| Mute Swan                | <i>Cygnus olor</i>             |
| Northern Cardinal        | <i>Cardinalis cardinalis</i>   |
| Northern Flicker         | <i>Colaptes auratus</i>        |
| Northern House Wren      | <i>Troglodytes aedon</i>       |
| Northern Mockingbird     | <i>Mimus polyglottos</i>       |

| Common Name                   | Scientific Name                   |
|-------------------------------|-----------------------------------|
| Northern Parula               | <i>Setophaga americana</i>        |
| Northern Rough-winged Swallow | <i>Stelgidopteryx serripennis</i> |
| Northern Waterthrush          | <i>Parkesia noveboracensis</i>    |
| Olive-sided Flycatcher        | <i>Contopus cooperi</i>           |
| Orchard Oriole                | <i>Icterus spurius</i>            |
| Osprey                        | <i>Pandion haliaetus</i>          |
| Ovenbird                      | <i>Seiurus aurocapilla</i>        |
| Pied-billed Grebe             | <i>Podilymbus podiceps</i>        |
| Pileated Woodpecker           | <i>Dryocopus pileatus</i>         |
| Pine Warbler                  | <i>Setophaga pinus</i>            |
| Purple Martin                 | <i>Progne subis</i>               |
| Red-bellied Woodpecker        | <i>Melanerpes carolinus</i>       |
| Red-eyed Vireo                | <i>Vireo olivaceus</i>            |
| Red-headed Woodpecker         | <i>Melanerpes erythrocephalus</i> |
| Red-tailed Hawk               | <i>Buteo jamaicensis</i>          |
| Red-winged Blackbird          | <i>Agelaius phoeniceus</i>        |
| Ring-billed Gull              | <i>Larus delawarensis</i>         |
| Ring-necked Pheasant          | <i>Phasianus colchicus</i>        |
| Rock Pigeon                   | <i>Columba livia</i>              |
| Rose-breasted Grosbeak        | <i>Pheucticus ludovicianus</i>    |
| Ruby-throated Hummingbird     | <i>Archilochus colubris</i>       |
| Ruffed Grouse                 | <i>Bonasa umbellus</i>            |
| Sandhill Crane                | <i>Antigone canadensis</i>        |
| Savannah Sparrow              | <i>Passerculus sandwichensis</i>  |
| Scarlet Tanager               | <i>Piranga olivacea</i>           |
| Sedge Wren                    | <i>Cistothorus stellaris</i>      |
| Song Sparrow                  | <i>Melospiza melodia</i>          |
| Sora                          | <i>Porzana carolina</i>           |
| Spotted Sandpiper             | <i>Actitis macularius</i>         |
| Summer Tanager                | <i>Piranga rubra</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>          |
| Tufted Titmouse               | <i>Baeolophus bicolor</i>         |
| Turkey Vulture                | <i>Cathartes aura</i>             |
| Veery                         | <i>Catharus fuscescens</i>        |
| Vesper Sparrow                | <i>Pooecetes gramineus</i>        |
| Virginia Rail                 | <i>Rallus limicola</i>            |
| Warbling Vireo                | <i>Vireo gilvus</i>               |
| White-breasted Nuthatch       | <i>Sitta carolinensis</i>         |
| White-eyed Vireo              | <i>Vireo griseus</i>              |

| Common Name               | Scientific Name               |
|---------------------------|-------------------------------|
| Wild Turkey               | <i>Meleagris gallopavo</i>    |
| Willow Flycatcher         | <i>Empidonax traillii</i>     |
| Wilson's Snipe            | <i>Gallinago delicata</i>     |
| Winter Wren               | <i>Troglodytes hiemalis</i>   |
| Wood Duck                 | <i>Aix sponsa</i>             |
| Wood Thrush               | <i>Hylocichla mustelina</i>   |
| Worm-eating Warbler       | <i>Helmitheros vermivorum</i> |
| Yellow Warbler            | <i>Setophaga petechia</i>     |
| Yellow-bellied Flycatcher | <i>Empidonax flaviventris</i> |
| Yellow-billed Cuckoo      | <i>Coccyzus americanus</i>    |
| Yellow-breasted Chat      | <i>Icteria virens</i>         |
| Yellow-throated Vireo     | <i>Vireo flavifrons</i>       |



**APPENDIX B: BREEDING STATUS IN REVELANT TOWNSHIPS FOR ALL 22 FOCAL SPECIES DURING THE FIRST (1983-1988) AND SECOND (2001-2008) MICHIGAN BREEDING BIRD ATLASES.**

| Scientific Name                   | Common Name             | S2 9W (Kalamazoo County) |               | S2 8W (Calhoun County) |               |
|-----------------------------------|-------------------------|--------------------------|---------------|------------------------|---------------|
|                                   |                         | MBBAI Status             | MBBAII Status | MBBAI Status           | MBBAII Status |
| <i>Ammodramus savannarum</i>      | Grasshopper sparrow     | Confirmed                | Probable      | Not present            | Not present   |
| <i>Cardellina canadensis</i>      | Canada warbler          | Not present              | Probable      | Not present            | Possible      |
| <i>Centronyx henslowii</i>        | Henslow's sparrow       | Not present              | Possible      | Not present            | Not present   |
| <i>Chaetura pelagica</i>          | Chimney swift           | Probable                 | Probable      | Possible               | Probable      |
| <i>Cistothorus palustris</i>      | Marsh wren              | Not present              | Probable      | Not present            | Possible      |
| <i>Cistothorus stellaris</i>      | Sedge wren              | Not present              | Probable      | Possible               | Not present   |
| <i>Coccyzus erythrophthalmus</i>  | Black-billed cuckoo     | Confirmed                | Confirmed     | Possible               | Possible      |
| <i>Contopus cooperi</i>           | Olive-sided flycatcher  | Probable                 | Probable      | Not present            | Possible      |
| <i>Cygnus buccinator</i>          | Trumpeter swan          | Not present              | Confirmed     | Not present            | Probable      |
| <i>Dolichonyx oryzivorus</i>      | Bobolink                | Probable                 | Probable      | Possible               | Possible      |
| <i>Gallinula galeata</i>          | Common gallinule        | Probable                 | Not present   | Not present            | Not present   |
| <i>Geothlypis formosa</i>         | Kentucky warbler        | Not present              | Probable      | Not present            | Not present   |
| <i>Haliaeetus leucocephalus</i>   | Bald eagle              | Not present              | Not present   | Not present            | Not present   |
| <i>Hylocichla mustelina</i>       | Wood Thrush             | Confirmed                | Confirmed     | Possible               | Confirmed     |
| <i>Melanerpes erythrocephalus</i> | Red-headed woodpecker   | Confirmed                | Confirmed     | Possible               | Probable      |
| <i>Pandion haliaetus</i>          | Osprey                  | Not present              | Confirmed     | Not present            | Possible      |
| <i>Setophaga cerulea</i>          | Cerulean warbler        | Probable                 | Confirmed     | Not present            | Possible      |
| <i>Setophaga citrina</i>          | Hooded warbler          | Possible                 | Confirmed     | Not present            | Confirmed     |
| <i>Setophaga dominica</i>         | Yellow-throated warbler | Not present              | Not present   | Not present            | Not present   |
| <i>Spiza americana</i>            | Dickcissel              | Not present              | Confirmed     | Not present            | Not present   |
| <i>Sturnella magna</i>            | Eastern meadowlark      | Confirmed                | Probable      | Confirmed              | Possible      |
| <i>Vermivora chrysoptera</i>      | Golden-winged warbler   | Not present              | Not present   | Not present            | Not present   |