



**Department of Defense
Legacy Resource Management Program**

PROJECT 14-764

**Migratory connectivity of At-Risk grassland
birds**

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Table of Contents

| | |
|--|----|
| Executive Summary..... | 1 |
| Project Background..... | 2 |
| Military Mission Benefits..... | 3 |
| Survey & Capture Methods..... | 6 |
| Banding, Feather & Blood Sampling..... | 8 |
| Geocator Deployment & Color-banding..... | 10 |
| Post-deployment Observations..... | 13 |
| Nesting Birds..... | 14 |
| eBird Summary..... | 15 |
| Point Count Summary..... | 17 |
| Habitat Management Recommendations..... | 20 |
| Lessons Learned..... | 21 |
| Acknowledgments..... | 22 |
| References..... | 22 |
| Appendix A..... | 23 |
| Appendix B..... | 25 |
| Appendix C..... | 26 |
| Appendix D..... | 30 |
| Appendix E..... | 32 |

Migratory connectivity of At-Risk grassland birds Camp Grafton 2015 Research Report

Executive Summary

In 2015, the Vermont Center for Ecostudies initiated an innovative grassland bird research project at Camp Grafton South and five other military installations. Supported by the DoD Legacy Program, Project 14-764, contract no. W81EWF-4119-9496, this research is designed to elucidate the migratory pathways and wintering grounds of three At-Risk grassland bird species: Grasshopper Sparrows (*Ammodramus savannarum*), Eastern Meadowlarks (*Sturnella magna*), and Upland Sandpipers (*Bartramia longicauda*). Understanding the entire annual cycle of migratory bird species offers DoD installations an avenue for sharing the burden of protecting declining populations. Data collected from across the breeding range will provide insight into regional population connectivity, applicable to other installations that support grassland birds. In 2015, we exclusively focused our research efforts on Grasshopper Sparrows, but we will expand our efforts to Eastern Meadowlarks and Upland Sandpipers in 2016.

We banded and fit light-level geolocators onto male Grasshopper Sparrows from 9 May through 28 May, 2015. We also assessed the avifauna at Camp Grafton South via point count surveys. We focused our efforts working on Camp Grafton South north of North Dakota Highway 15 in an extensive grassland unit (718 ha). In total, we banded 57 male Grasshopper Sparrows, found nests of nine different species, and deployed 30 geolocators on male Grasshopper Sparrows on Camp Grafton South. We conducted 36 point counts at 18 locations, and detected 46 species during those counts. Point counts and geocator deployment occurred in a 248-ha area north of North Dakota Highway 15 on Camp Grafton South. Overall, we detected 46 species during point counts on Camp Grafton South. In addition to our point count surveys we also recorded an additional 54 species that we observed during our daily activities at Camp Grafton South. We contributed all of our birding data to an online ornithological database, eBird.

While Camp Grafton South currently provides substantial grassland bird habitat, several changes to the current management practices would likely tremendously benefit the grassland bird population at Camp Grafton South. Periodic burning every 2-5 years would help to cease the woody vegetation expansion currently underway, and Camp Grafton South contains many savanna-like areas with too much woody vegetation to support grassland bird populations. During point counts and banding efforts, we rarely observed Grasshopper Sparrows and Western Meadowlarks in areas dominated by shrubs. In contrast, Clay-colored Sparrows, an early successional species, were one of the most abundant species at Camp Grafton South.

Project Background

The quantity and quality of grassland bird habitat has declined in North America during the last half century, and concurrently, grassland bird population declines have been among the steepest of all North American landbirds. More than 70% of grassland bird species declined significantly between 1966 and 2012, while only 7% have increased. Upland Sandpiper (*Bartramia longicauda*), Grasshopper Sparrow (*Ammodramus savannarum*), and Eastern Meadowlark (*Sturnella magna*) are three At-Risk migratory grassland bird species that commonly occur on military installations supporting substantial grasslands. Populations of Grasshopper Sparrow, a DoD PIF priority bird species, have dropped by 78% in the last 4 decades. Many states, particularly in the Northeast, have listed Grasshopper Sparrows as Threatened or Endangered. Upland Sandpiper populations have decreased substantially in some regions, including parts of the Midwest (IL, WI, MN, and MI), and in NY and other eastern states. It is Endangered, Threatened, or of Special Concern in five of eight Midwestern states and in most eastern states. The U.S. Fish and Wildlife Service considers Upland Sandpiper to be of national conservation concern due to population declines during the last century, and the U.S. Shorebird Conservation Plan lists Upland Sandpiper as a Species of High Concern. Eastern Meadowlark populations have experienced some of the most dramatic declines of grassland bird species. Their long-term population decline has resulted in a loss of 80% of the population since 1966, and this sharp decline has continued unabated even in recent years.

Until now, the understanding of migration and wintering ecology of most migratory songbirds has been extremely difficult, if not intractable. Managers have necessarily managed breeding populations with sparse, if any, knowledge of the limitations imposed on those populations during the rest of the year. Stable isotopes can provide us with clues for some species, but entail many uncertainties. New, powerful tools have emerged that allow researchers to document the daily movements of birds throughout an entire year. For a bird as small as a Grasshopper Sparrow, light-level geolocators can now provide latitude and longitude estimates for each day of its life through an entire year, and larger birds like Eastern Meadowlark can carry GPS geolocators that provide precise (within 500 m) location fixes for up to 30 programmable dates, downloaded via satellite onto a computer. For a species as large as Upland Sandpiper, we now have the capability of accurately tracking (with 500 m resolution) their every move each day, all year, using battery- and solar-powered GPS technology. With this revolutionary advancement, researchers can accurately track a bird during migration and winter, and they can record fine-scale movements in and around breeding areas. By using the latest state-of-the-art technology available, we will not need to recapture Eastern Meadowlarks or Upland Sandpipers to retrieve data.

These technologies will allow us to record wintering areas and to track the timing and routes of an individual bird's migration. We will be able to determine whether these characteristics differ among breeding populations, with implications for where and how a species may be threatened. The data will provide managers with dramatic new insight into the potential limitations and

threats faced by migratory birds throughout their annual cycle, allowing them to forge new partnerships to address these issues.

Military Mission Benefits

Conservation of natural resources on DoD lands is ultimately necessary to sustain the military training mission by ensuring the long-term availability of training lands (i.e., appropriate habitat conditions). In addition to serving its own mission, conservation fulfills the DoD's obligation, as required by the Migratory Bird Treaty Act, the Readiness Rule, Executive Order 13186, and the Sikes Act, to protect and conserve migratory birds on installations through research, habitat management, partnerships, and education. For all of these reasons, management personnel largely focus on conserving birds and their habitat on installations. Managers can use these resources more efficiently and effectively if there is an understanding of the events that affect migratory birds during their entire life cycle, rather than only during the 3-4 month-long breeding season.

Upland Sandpiper, Grasshopper Sparrow, and Eastern Meadowlark are top DoD priority species in part because they are rare and of high responsibility for DoD. Furthermore, these species are the most likely of grassland bird species to affect or be in conflict with training activities, further underscoring the need to understand their year-round ecology. We know little about the ecology of these species outside of the breeding season, and therefore the weight of responsibility has fallen entirely on land managers on the breeding grounds, such as DoD, for maintaining populations. Knowledge of the non-breeding ecology of these species will help spread the weight of responsibility to partners, present and future, at migration stopovers and wintering grounds. Addressing threats to these species off the breeding grounds will help the DoD maximize efficacy of breeding season management on installations. Additionally, it will provide opportunities to develop partnerships and enhance cross-cultural outreach with organizations responsible for these same species on migratory and wintering grounds.

By building on grassland bird research previously funded by Legacy, this project provides a rare opportunity to conserve At-Risk species using a "full life cycle" approach. We will complement Legacy-funded work that has assessed the breeding distribution, abundance, productivity, and overall demography of the same grassland bird species on some of the same military airfields (Legacy projects #10-381 and #11-408). Models developed from these breeding season studies have provided an essential means for determining best management practices to benefit birds on installations, but they have not been able to incorporate factors outside of the breeding season that contribute to population viability. Our results will discern where and when, outside of the breeding season, other factors may affect grassland bird populations on installations. Combined with information from Legacy-funded projects on breeding parameters, the data we collect will take the initial, essential steps in ultimately determining the extent to which populations are limited on and outside of military installations. For example, we can begin to address whether

populations that are more productive differ in their migration phenology, routes, or wintering grounds compared to less productive populations.

This project will also benefit from research outside of DOD, further extending the limits of our knowledge, and if DOD desires, maximizing the use of data collected. The Principal Investigator for this Legacy proposal is involved with a project at the University of Wisconsin to develop full life cycle models under different climate change scenarios for other grassland bird species; researchers could use these models as a basis for these three grassland bird species in the future. These novel exercises in full life cycle science and stewardship will serve as templates for other migratory bird species on installations and elsewhere.

The proposed research will directly benefit the six installations included in the study: Joint Base Cape Cod (MA), Patuxent River NAS (MD), Fort Riley (KS), Fort McCoy (WI), Camp Grafton Training Site (ND), and Camp Ripley (MN). In addition, our results will be applicable to other installations across the country. Because our study spans much of the breeding range of the focal species, any installations that support breeding populations of these species may infer the connectivity of migration and wintering grounds with populations breeding on their lands, based on patterns we find. For example, we will discern whether populations breeding in the East migrate and winter in different locations compared to populations in the Midwest. Assuming species behave on this scale, installations in the East can infer where “their” populations are most likely to winter. The list of installations to benefit from our results therefore includes all that support breeding populations of the three focal species. This includes but is not limited to: Hanscom AFB (MA), Fort Devens Army Base (MA), Massachusetts Military Reservation (MA), Warren AFB (WY), Fort Drum (NY), Fort Campbell (KY/TN), McConnell AFB (KS), Grand Forks AFB (ND), Minot AFB (ND), Fort Leavenworth (KS), and Fort Indiantown Gap (PA). These are only the installations that we investigated during our site selection process, a mere subsample of those that will benefit from our study.

Installations that serve as migratory stopovers or wintering areas for these grassland birds will also greatly benefit from knowledge of connectivity between breeding, migratory, and wintering populations. By making connections on a coarse scale between the migration routes and wintering areas of birds with their breeding origin, our study will allow managers to coordinate efforts that will support bird populations during different parts of the life cycle. For example, several Navy installations in Texas host wintering populations of Grasshopper Sparrow and meadowlark spp. Knowledge about where these populations hail from will allow managers to understand where management on the breeding grounds would have the greatest impact on “their” birds. Armed with this insight, installations on the breeding and wintering grounds can work in unison to identify and address the needs unique to the populations they share.

Knowledge of breeding origin and connectivity with wintering grounds will also assist managers at installations supporting migrating bird populations (e.g., Patuxent NAS hosts migrating Upland Sandpipers). By revealing migratory paths, the consistency of migratory stopover use,

the length of time spent at stopovers, and the duration and distance of flights before and after a stopover, we will shed light on how and when different stopover regions are used by migrating birds of different breeding origins. Is a particular installation in the path a commonly used migratory route for all breeding populations or only certain ones? Do the birds stop there prior to or just after a long leg of their migratory flight, suggesting that the food resources may be critical to a successful migration? With the technology we will employ, we will be able to address such questions for the first time.

In this second year (2016) of the project, we will be able to analyze location data from any geolocators that we retrieve from recaptured Grasshopper Sparrows. In 2016 we will also deploy four solar-powered GPS tags on Upland Sandpipers, and almost two dozen battery-powered GPS tags on Upland Sandpipers (22 tags) and Eastern Meadowlarks (20 tags). The battery-powered tags have sufficient battery to store location data for 30 pre-programmed dates, while the solar-powered tags have the ability to last up to 3 years. Based on our observations of grassland birds during the 2015 field season we plan to deploy these tags on Upland Sandpipers and Eastern Meadowlarks at Fort Riley, Fort McCoy, and Joint Base Cape Cod. The other three DoD installations (Camp Grafton, Camp Ripley, and Patuxent River NAS) either lack populations or have very low densities of Upland Sandpipers and Eastern Meadowlarks.

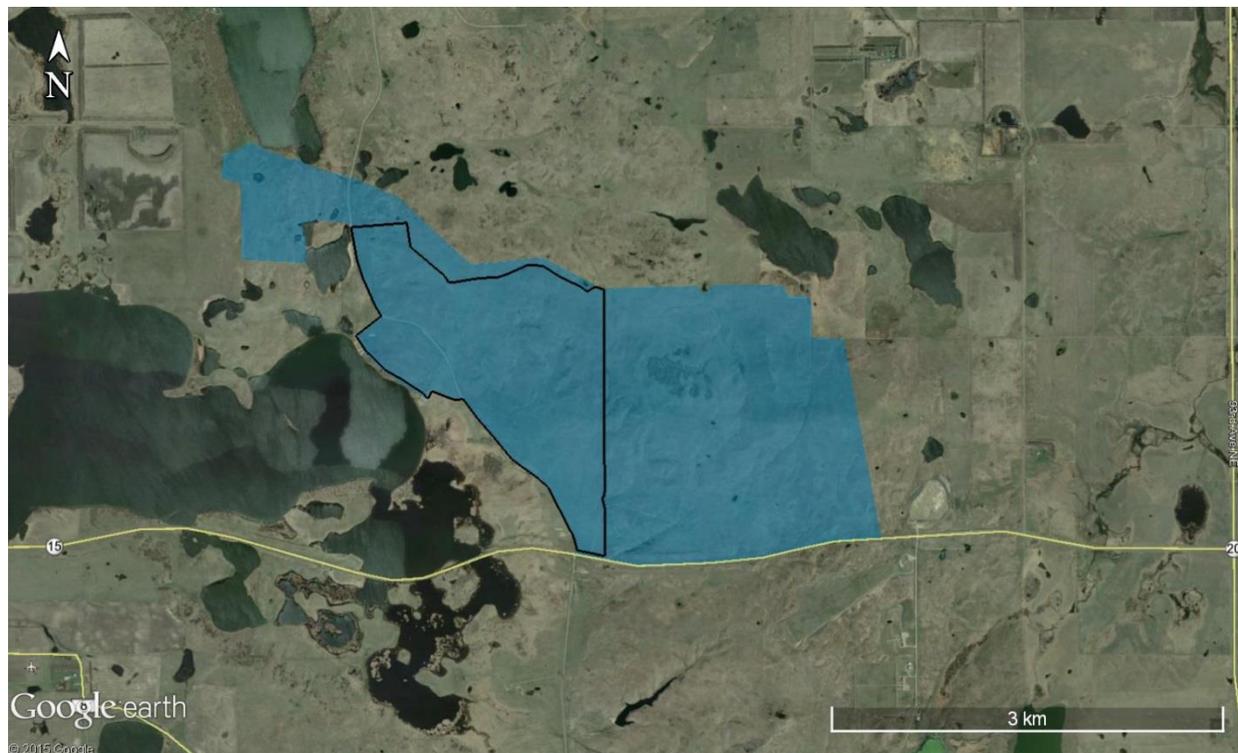
In 2018, we will issue recommendations directly relating to this proposal after we retrieve all data. These recommendations will differ from the typical land use management practices; they will identify where these installation-specific populations may be limited during migration and winter, and thus where land managers may share responsibility. Our recommendations will include a strategy for how and where the DOD, through its alliance with Partners in Flight (PIF), may forge and enhance partnerships on a broad scale in order to maximize positive management impact on grassland bird populations that breed on installations. Installations involved in the project will be advised as to 1) what entities, both military and non-military, they may coordinate with to manage grassland bird populations throughout their life cycle; 2) follow-up research questions or issues that may be helpful for managers; 3) any changes in field protocols that would be advisable or useful for future work using the new technology of geolocators.

Our project will take miniaturized technology to new limits: it will be the first to use light-level geolocators, Argos GPS technology, and PTTs on these grassland bird focal species. We will be able to ask questions that we have never before been able to address, and we will gain insights never before possible. This groundbreaking research will serve as a template for implementing tracking technology for other bird species on military lands throughout the United States. Most importantly, however, the DoD will be involved in a project that will help to transform our way of thinking about how migratory bird species management and partnerships can sustain the military training mission.

Survey & Capture Methods

Male Grasshopper Sparrows are more vocal, visible, and easier to capture, and have lower inter-annual dispersal rates than female Grasshopper Sparrows. Therefore, we exclusively targeted male Grasshopper Sparrows for light-level geolocator deployment. At Camp Grafton South we systematically walked transects across the grounds, on the north side of North Dakota highway 15, during the first week of May 2015. We focused on the north side of highway 15 because this area is open to the public; range personnel sporadically close the south side of highway 15 due to live fire exercises. The north side of highway 15 contains extensive grassland habitat with ubiquitous pockets of short (1-2 m) shrubs. Within this mosaic, suitable grasslands occur in pockets across the landscape. Grasshopper Sparrows prefer areas of extensive grass cover >50 m from woodland edges with little woody vegetation and small areas of exposed ground. There is a well-maintained gravel road that runs north away from highway 15 along the eastside of Lake Coe, and the intersection of this road and highway 15 is located at approximately 525745 E, 5281521 N (UTM Zone 14N). There is extensive Grasshopper Sparrow habitat along the first three kilometers of this road running north away from highway 15 to just past (200 m) the first cattle guard. Most of the Grasshopper Sparrow habitat lies on the eastside of this road (Figure 1). Our goal was to identify areas with high concentrations of Grasshopper Sparrows, so that we could deploy geolocators on males in a relatively small area. Marking males in one small area, as opposed to several scattered areas, will reduce the amount of land that we need to search in 2016 to relocate and recapture males wearing geolocators, because male Grasshopper Sparrows often shift their territories between years.

Figure 1. *Main search area (blue polygon, 718 ha) at Camp Grafton South, ND. We spent the first week of May 2015, extensively searching the area outlined in blue for concentrations of Grasshopper Sparrows. The highest density of Grasshopper Sparrows occurred within the black polygon (248 ha), and we concentrated our capture and banding efforts within this smaller area.*

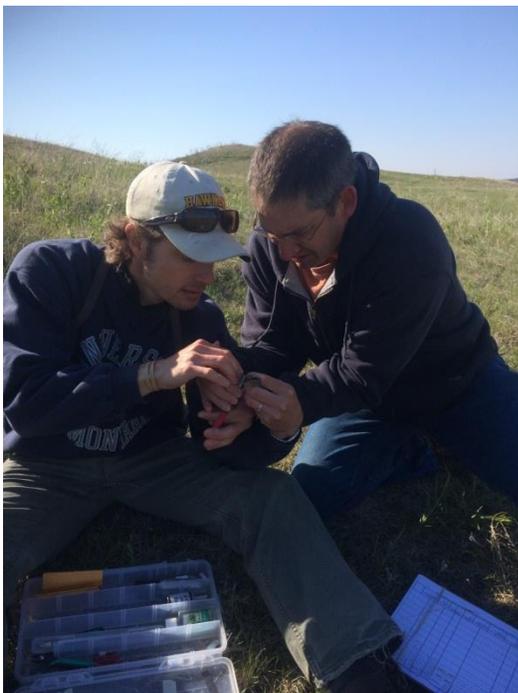


Male Grasshopper Sparrow activity greatly increased during the first two weeks of May, and we began capture efforts on 9 May 2015. The freezing early morning temperatures and the limited singing behavior of males, however, hindered our capture efforts through the middle of May. Once we located a singing male sparrow, we then set up a 6-m 30mm-mesh nylon mist net on 2-m tall poles (Figure 2). We then placed a small speaker, attached to a smartphone, 1-m away from the center of the net and broadcasted a recording of a male Grasshopper Sparrow song. Male Grasshopper Sparrows are territorial and they perceive the recorded song as an intruding male sparrow. Male sparrows generally flew up to the net and landed on the ground near the speaker. We then quickly approached the bird and encouraged the male to fly into the net. Occasionally male sparrows would fly into the net without encouragement from us. We limited the use of recordings to <5 min with any given male sparrow, and we generally targeted males between 0600 and 1030. This 4.5 hr period corresponds with the timing of copulation in this species, and males became noticeably less aggressive to our recorded intruder song after 1000. We also attempted to capture males in the evening hours (1730-2030), but males showed little interest in our playback during these hours.

Figure 2. *Typical mist net set up used to capture male Grasshopper Sparrows at Camp Grafton South, North Dakota. We captured the vast majority of males within 1 m of the ground.*



Banding, Feather & Blood Sampling



We began banding on 9 May 2015 and concluded our efforts on 28 May 2015. For all captured birds, we recorded their age, sex, weight, and basic morphological measurements (Figures 3-4). We typically handled birds for <10 minutes, and we released all birds unharmed at their capture location. During May, we successfully captured and banded 57 Grasshopper Sparrows on Camp Grafton South (Figure 5). Of those 57 birds, 55 were male (96%) and two (4%) were classified as sex unknown due to their

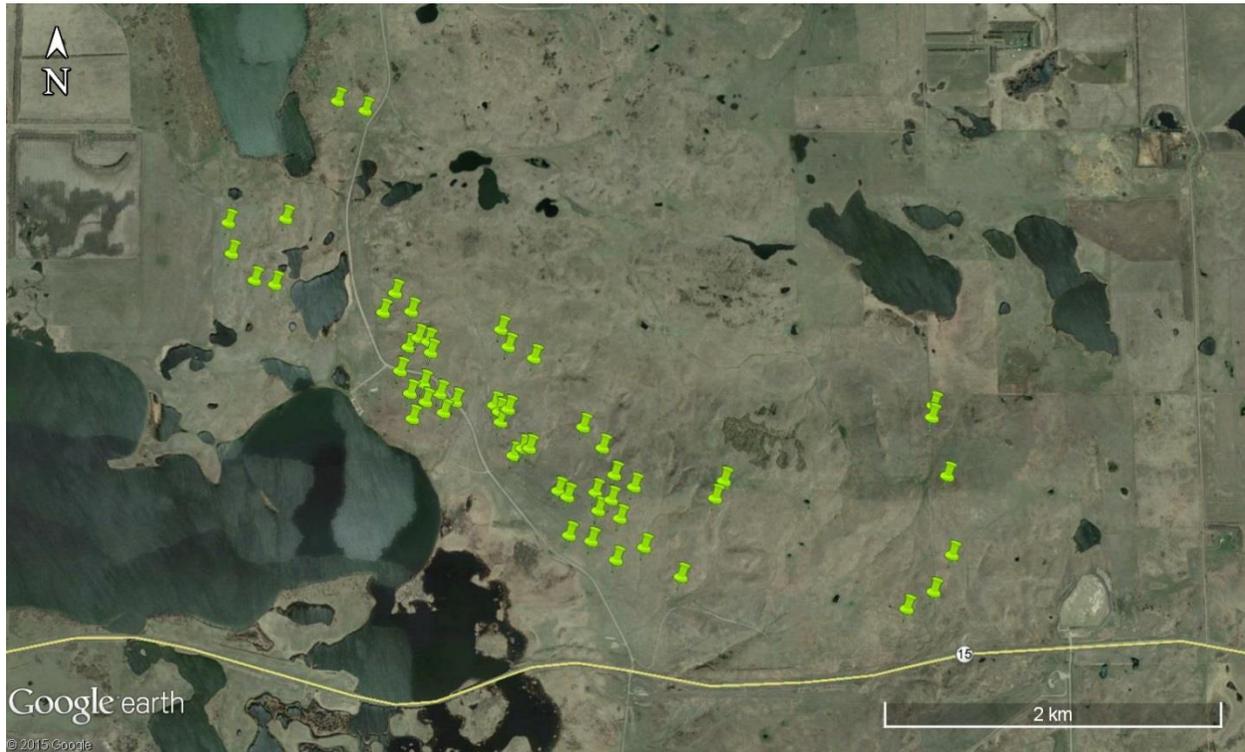
Figure 3. *Steve Miller, Environmental Scientist at Camp Grafton (right), bands his first Grasshopper Sparrow under the watchful eyes of Jason Hill (left) at Camp Grafton South, May 2015.*

nondescript breeding characteristics early in the season (Appendix A). In collaboration with other researchers we also sampled a single primary (i.e., wing) feather and a small amount of blood (<100 μ l) from birds that did not receive a geolocator. Our colleagues will use the feather sample to determine the diet of wintering Grasshopper Sparrows, and the blood samples will provide our colleagues with insight into internal parasite loads. We obtained feather samples from 21 birds, but we did not take any blood samples due to the cold temperatures during banding operations. We did not recapture any previously banded individuals.

Figure 4. *Biological Technician Alex Lehner measures the head size of an adult male Grasshopper Sparrow. We recorded basic morphological measurements from all birds captured at Camp Grafton South during May 2015.*



Figure 5. *Banding locations of all Grasshopper Sparrows captured at Camp Grafton South, ND, during May 2015.*



Geolocator Deployment & Color-banding

We must recapture birds wearing geolocators in 2016 to gain access to geolocator data. To facilitate our future recovery efforts we attached a unique combination of color bands to the legs of a Grasshopper Sparrows fitted with a geolocator. The geolocator units are small (~0.5 g, including the harness) and are difficult to see on a moving bird. Color bands, however, are more visible and in 2016 these color band combos will allow us to quickly key in on birds wearing a geolocator. We made a simple loop harness for the geolocators using an 80.5 mm piece of Stretch Magic bead and jewelry cord (0.7 mm). We passed the material through the geolocator loops, and melted the ends of the cord together using a soldering iron. The resulting fused harnesses are strong, but also flexible to accommodate sparrows of varying body sizes.

We only deployed geolocators on birds that weighed ≥ 17.0 g, so that the geolocator + harness weight did not exceed 3% of body mass. The geolocator harness slipped on over a bird's legs and fit snugly over their hips (Figure 6). Once the geolocator was on the bird we checked the harness fit by measuring the amount of vertical play between the bird's back and the bottom of the geolocator when slight upwards force was applied to the geolocator. We deemed that the harness fit adequately if the play was 1-2 mm. We used a small piece of plastic to smooth the body

feathers underneath the harness. Before releasing the bird we made sure that the harness fit securely, and that the wings and legs were free to move unimpeded.

Figure 6. *Male Grasshopper Sparrow wearing a light-level geolocator at Camp Grafton South, North Dakota, May 2015. The light stalk of the geolocator is visible at the tip of the index finger.*



We color-banded 31 adult male Grasshopper Sparrows at Camp Grafton South (Figure 7), and we deployed 30 geolocators (Appendix A). We removed one geolocator from a very large male, after we color-banded him, because the harnesses did not fit properly. The color band combinations consist of an aluminum band (A) with three color bands of the following colors: red (R), white (W), blue (L), orange (O), green (G), black (K), violet (V), yellow (Y), and hot pink (H). The color band combinations are read in the following order: right leg top, right leg bottom, left leg top, left leg bottom (Figure 8).

Figure 7. Locations of all color-banded adult male Grasshopper Sparrows at Camp Grafton South, May 2015. All of these birds except one (HAHO) were fitted with a geolocator.

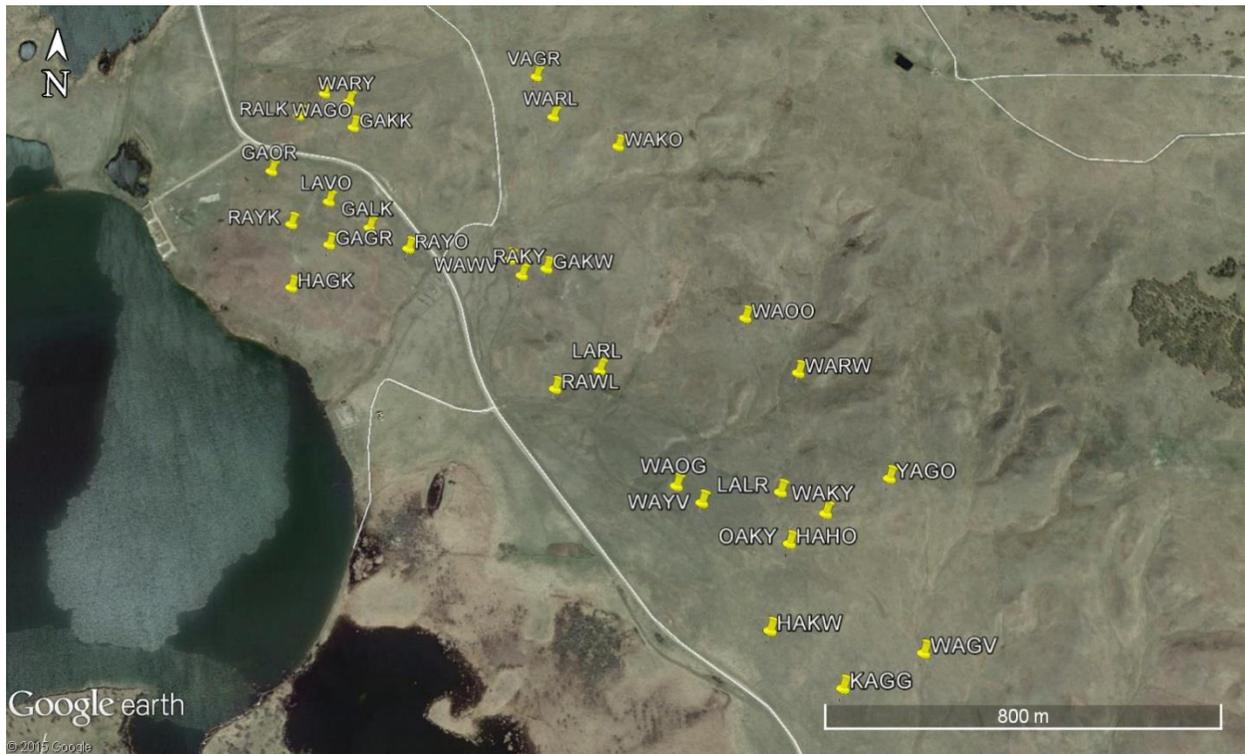


Figure 8. *Adult male Grasshopper Sparrow wearing a geolocator at Camp Grafton South, May 2015. This bird's color band combination is WAYV (white over aluminum on the bird's right leg, and yellow over violet on the bird's left leg).*



Post-deployment Observations

In general, we tried to avoid areas where we had previously banded male Grasshopper Sparrows to avoid accidentally recapturing birds wearing geolocators. We must recapture male Grasshopper Sparrows wearing geolocators in subsequent years to acquire their data. Males may become weary of mist nets if they are captured frequently, which could hinder our recapture efforts in 2016. Nevertheless, we observed approximately one-quarter of our color-banded male Grasshopper Sparrows after initially banding them. All of these color-marked birds behaved naturally, and the geolocators were intact and mounted in the correct position as far as we could determine.

Nesting Birds

Nest searching was not one of our main foci at Camp Grafton, but we did opportunistically discover bird nests. We recorded the location of these nests, but we did not monitor them. We found nests for nine species (Figure 9, Appendix B): Mallard (*Anas platyrhynchos*), Great Blue Heron (*Ardea herodias*), Red-tailed Hawk (*Buteo jamaicensis*), Killdeer (*Charadrius vociferus*; Figure 10), Northern Flicker (*Colaptes auratus*), Horned Lark (*Eremophila alpestris*), Sedge Wren (*Cistothorus platensis*), Savannah Sparrow (*Passerculus sandwichensis*), and European Starling (*Sturnus vulgaris*).

Figure 9. Locations of all nests discovered on Camp Grafton South, May 2015.

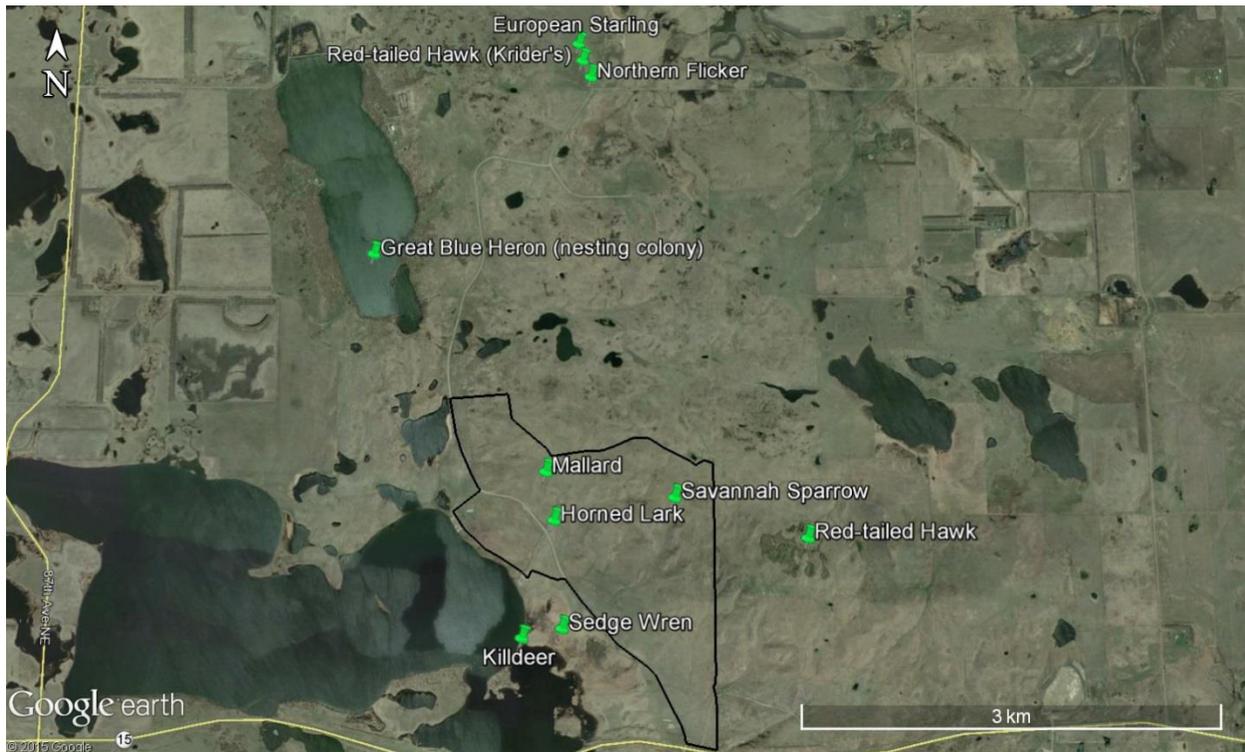


Figure 10. *Killdeer nest opportunistically discovered adjacent to Lake Coe on Camp Grafton South.*



eBird Summary

All of our daily observations of birds were entered into eBird (www.ebird.org), which is an online database managed by Cornell University that has become an important resource about bird distribution and abundance for scientists, researchers, and amateur birders. eBird is entirely free and available to anyone with an internet connection. eBird has dramatically changed the way that the professional and amateur birding communities record and assess information about birds throughout the world. Essentially, an observer enters a checklist of the number of individuals seen of each species that they encounter while birding into eBird. The user plots their location on a map, records information about their effort (e.g., number of hours birded, and distance traveled, if any), and can provide comments about their observations or even upload photos. An expert local reviewer examines each observation to ensure a high level of integrity in the database. In May 2015, for example, users around the world submitted >9.5 million bird observations.

In general, we strived to create a checklist of the bird species that we observed each day on Camp Grafton South (Table 1), but we also recorded the breeding statuses and interesting behaviors of individuals that we observed (Figure 11).

Table 1. Summary of our eBird avian observation data from Camp Grafton South, May 4 through May 31, 2015, which includes the number of checklists, submitted and the number of species and individuals detected.

| | May 1-5 | May 6-10 | May 11-15 | May 16-20 | May 21-25 | May 26-31 |
|--------------------|------------|-------------|--------------|--------------|--------------|--------------|
| No. of species | 33 | 55 | 40 | 50 | 43 | 32 |
| No. of individuals | 160 | 658 | 221 | 252 | 140 | 176 |
| No. of checklists | 4 | 10 | 7 | 5 | 4 | 1 |

Figure 11. A partial example of a typical eBird checklist that we submitted for Camp Grafton South, May 2015.

Checklist S23396623

Location Camp Grafton South (public area), Eddy County, North Dakota, US

Date and Effort Mon May 11, 2015 3:40 PM

Protocol: Traveling
 Party Size: 1
 Duration: 1 hour(s), 10 minute(s)
 Distance: 1.93 mile(s)
 Observers: Jason Hill
 Comments: High winds (>20 mph), drizzle...what a great day for finding birds! (Distance measured with GPS tracks), Vermont Center for Ecostudies Grassland Bird Research

Species 12 species total

- 2 Canada Goose *Branta canadensis*
- 4 Mallard *Anas platyrhynchos*
- 1 Killdeer *Charadrius vociferus*
- 1 Merlin (Prairie) *Falco columbarius richardsonii*
This guy came flying over the hill about 150 m from me chasing a small bird. After several twists and turns it grabbed the bird midair and flew to a snag to snack. Incredible.
- 1 Loggerhead Shrike *Lanius ludovicianus*
So cool! Flushed from the ground as I crested a little hill. Dude was flying into the wind about 1.5 feet off of the ground going strong. He didn't seem to be concerned about me and passed within 15 m of me.

The number of individuals and species presented in Table 1 is a substantial underestimate of the amount of effort that we exerted. Often we simply reported the presence of a species (i.e., “X”) without a count of individuals when we were engaged in banding efforts, because it was too difficult to accurately count individuals while also trying to capture birds. Nonetheless, we contributed an abundance of data to eBird.org (Appendix C)—more than all but one other observer for Eddy County, North Dakota, in the history of eBird. All of our data and bird sighting information is publicly available on

eBird.org and this data is viewable to scientists and the public at any time.

Although our primary focus was on grassland birds, in our free time we spent a considerable amount of time birding on Camp Grafton North (where our housing was located), and we have included that data in an attachment to this report. Through 17 checklists, we detected 86 species at Camp Grafton North, including some rare birds for North Dakota (Appendix D).

Point Count Summary

We conducted point count surveys at 18 locations in the general vicinity where we deployed geolocators on male Grasshopper Sparrows (Figure 12). Camp Grafton South contains thousands of hectares of grasslands and adequately surveying such a large area would likely take a dedicated crew working for the entire summer. Rather than sample the entire grassland complex at Camp Grafton South we chose to sample grassland birds in the 248-ha area (black polygon, Figure 1) where we performed the majority of our research. By focusing on this smaller area we were able to much more effectively sample the avian population, and our point count results are likely informative of the species diversity and relative abundance of grassland bird species across the remainder of Camp Grafton South.

Two observers separately surveyed each point on 26 and 27 May 2015. Point count locations were a minimum of 0.25 km apart. Over the course of five minutes a lone observer counted all individual birds that they detected by either sight or sound within an unlimited distance from the point. In practice, however, observers detected most individual birds within 100 m. Observers did not use audio or visual attractants of any kind to increase the detection of individuals. We made every effort to avoid double-counting individual birds (e.g., a soaring hawk) across multiple point count locations. Each count started immediately as the observer arrived at the point count location, and observers surveyed all points between 0530 and 0900. In total, observers detected 46 bird species during the point counts (Appendix E). Western Meadowlark (*Sturnella neglecta*), Grasshopper Sparrow, and Clay-colored Sparrow (*Spizella pallida*) were the most frequently detected species, and were all detected on >85% of our point counts.

Grasshopper Sparrows were most abundant at point count station 12 (Figure 13), while all grassland birds combined (including Grasshopper Sparrow, Western Meadowlark, Killdeer, Northern Harrier [*Circus cyaneus*], Horned Lark, Chestnut-collared Longspur [*Calcarius ornatus*], Vesper Sparrow [*Pooecetes gramineus*], Savannah Sparrow, and Bobolink [*Dolichonyx oryzivorus*]) were more abundant at point count stations 15 and 16 (Figure 14).

Figure 12. *Point count locations (purple markers) were systematically located within the area of Camp Grafton South where we deployed geolocators (black polygon).*

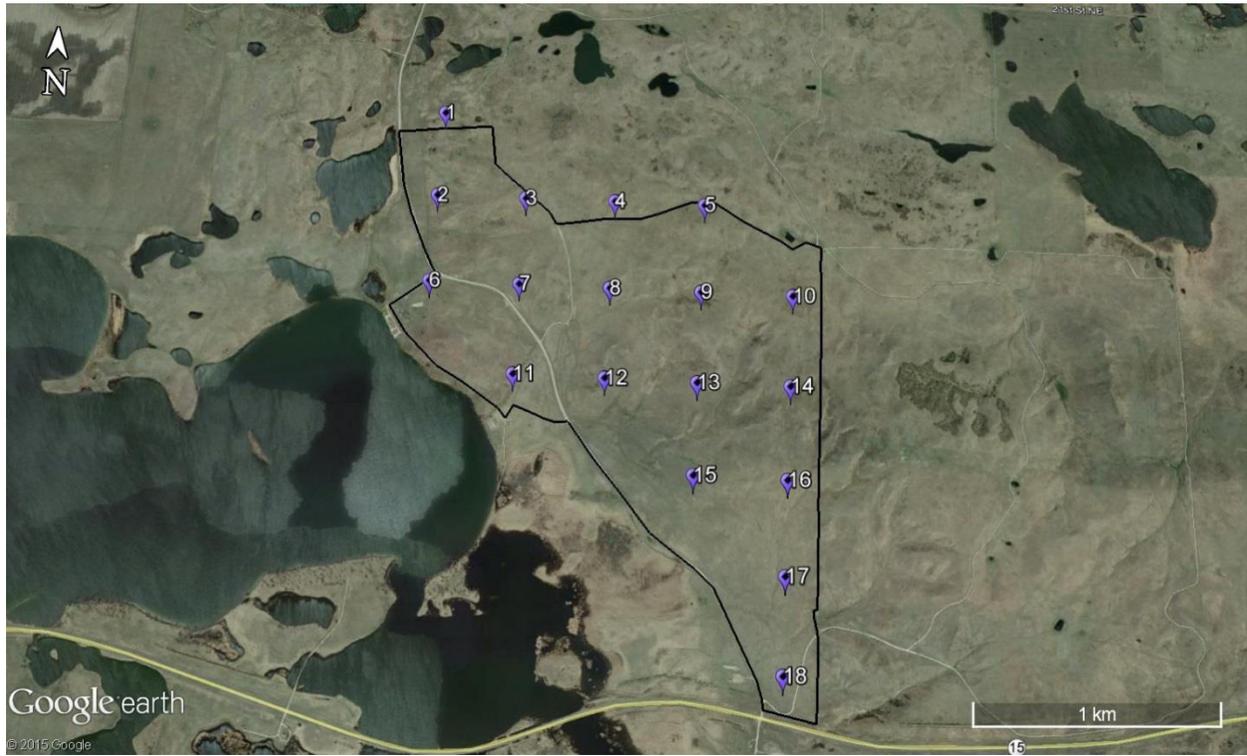


Figure 13. The mean number of Grasshopper Sparrows detected on a point count in the 100-m area surrounding each point count location on Camp Grafton South.

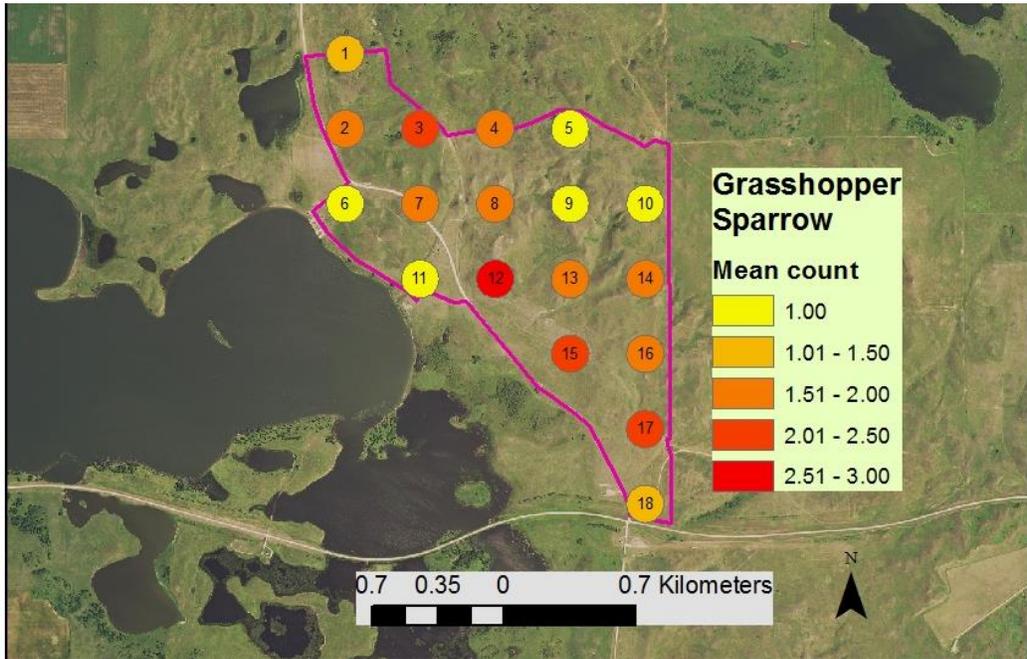
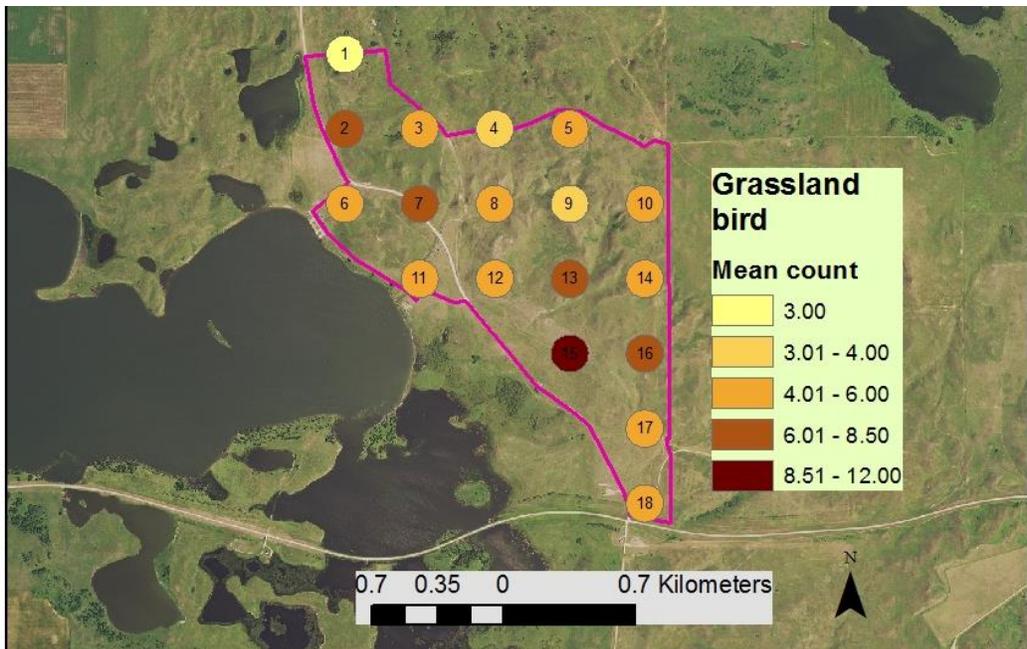


Figure 14. The mean number of individual grassland birds (including Grasshopper Sparrow, Western Meadowlark, Killdeer, Northern Harrier [*Circus cyaneus*], Horned Lark, Chestnut-collared Longspur [*Calcarius ornatus*], Vesper Sparrow [*Poocetes gramineus*], Savannah Sparrow, and Bobolink [*Dolichonyx oryzivorus*]) detected on a point count in the 100-m area surrounding each point count location at Camp Grafton South.



Habitat Management Recommendations

The Camp Grafton South unit is a vast complex of diverse habitats including wetlands, woodlots, shrublands, and rangelands (i.e., grazed grasslands). As explained to us in our multiple meetings with Steve Miller (Environmental Scientist) and Joel Cichos (Weapons Range Technical Coordinator) the South unit is open to public access, including hunting, and hosts a substantial cattle herd for part of each summer. While considerable grassland habitat exists at the South unit, the absence of prescribed fire has allowed substantial amounts of short (1-2 m tall) woody vegetation (Figure 15). Grassland birds, in general, favor grass-dominated areas with little woody vegetation and we encountered very few Grasshopper Sparrows or Western Meadowlarks in these shrub-dominated areas. We also did not detect any bird species at Camp Grafton South that are both DoD priority bird species (Eberly and Fischer 2011) and breeders in scrub-shrub habitat.

Managers at Camp Grafton South do not explicitly manage for shrubby habitat--it is a result of the absence of prescribed fire. There does not appear to be any history of management via prescribed fire at Camp Grafton South. In the absence of fire, these areas dominated by woody vegetation will likely continue to expand in the South unit. Grassland birds and cattle herds would benefit from a 3-4 year prescribed fire regime (Murphy 2008) which would curb woody vegetation growth, remove accumulated dead grass, and encourage new grass growth. Grassland bird species in the Dakotas are well-adapted to frequent fire intervals and such a prescribed fire regime would likely have positive benefits to grassland bird abundance and productivity on Camp Grafton South if conducted in spring (April-May) or late summer through early fall, August-October (Murphy 2008). To the best of our knowledge, a 3-4 year prescribed fire regime would not adversely affect existing management activities. Many of the cattle fences contain wooden fence posts, which would complicate prescribed fire activities, and there are few natural or manmade fire breaks in the South unit. The creation of firebreaks along existing fence lines and/or jeep trails would likely be easiest and would serve to protect the fences and cattle water troughs. Staggering the initiation of prescribed fire over the first four years (burning 25% of the grassland in the first year, 25% in the second year, etc.) would ensure that suitable habitat exists each year for all of the grassland bird species at Camp Grafton South. Due to the existing presence of large shrub islands, which are fire resistant, prescribed fire would not eradicate shrub habitat at Camp Grafton South. These shrub islands are the preferred breeding habitat for Clay-colored Sparrows at Camp Grafton South, and a prescribed fire regime would likely have only a small effect on their presence. Areas with existing grassland bird populations on Camp Grafton South (Figure 5) would be a logical place to initiate a multi-year rotational prescribed fire regime. Any newly implemented fire regime would need to be closely coordinated with the ranchers who currently stock cattle at Camp Grafton South, and such a regime might require managers to implement a rotational grazing system specifically designed to support successful grassland bird nesting. An appropriately timed rotational grazing system would positively affect grassland bird populations at Camp Grafton South, even if managers implemented it without a prescribed fire component (Buskness et al. 2001). The coordination of prescribed fire and

rotational livestock grazing can be challenging, and either hiring or coordinating with someone who is also knowledgeable of grassland bird management would be appropriate.

Figure 15. A *Clay-colored Sparrow (Spizella pallida)* sits in a shrub island on Camp Grafton South. Clay-colored Sparrows nest in pockets of shrubs, and were one of the most numerous species detected during point counts at Camp Grafton South.



Lessons Learned

Unforeseen events will affect any research project of this size and scope, but for the most part we were very fortunate at Camp Grafton in 2015. Compared to some of our other partner installations (e.g., Fort Riley, KS), we did not have access to as thorough bird data from eBird or from Camp Grafton personnel for the Camp Grafton area. This caused us to guess as to the arrival dates of Grasshopper Sparrows, and we arrived approximately 10 days before breeding activity kicked into full gear. During these 10 days, we were largely unsuccessful at capturing Grasshopper Sparrows, so instead we focused on scouting for high-quality sections of grassland during this time. Through the first half of May, the early morning temperatures were often below freezing, which made it more challenging to manipulate the small geolocator harnesses. These

temperatures were not a concern for the birds, but the temperatures simply increased our handling and preparation time for each bird.

During the month of May, we stayed at Camp Grafton North, approximately 45 minutes to the north of our field sites. Staying on the base was very comfortable, but it also resulted in 1.5 hours of travel time each day. As far as we could tell, there was no rental housing available that would have shortened our commute. The distance between our housing and study areas was great enough that it prevented us from making a second late-afternoon trip back to the field plots each day. We broke up the long drive back to our housing each day with frequent birding stops. These group birding outings were an excellent team-building exercise, and an effective means of getting our field techs more practice with their bird identification skills.

We had originally planned to deploy satellite tags on Upland Sandpipers in 2016, but we will not be following through with that plan. We expected to find greater numbers of Upland Sandpipers at Camp Grafton than we did in 2015. The lessons learned are to have backup sites already identified in the event that one site falls through, and to thoroughly check out sites in the year prior to the commencement of research activities. In our case, we already knew that three of our six sites (Fort Riley, Joint Base Cape Cod, and Fort McCoy) had sizable populations of Upland Sandpipers, so removing Camp Grafton from our list of Upland Sandpiper sites will not affect our research.

Acknowledgments

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References

Buskness, N.A., R.K. Murphy, K.F. Higgins, and J. Jenks. 2001. Breeding bird abundance and habitat on two livestock grazing regimes in North Dakota. *Proceedings of the South Dakota Academy of Science* 80:247-258.

Eberly, C., and R. Fischer. 2011. DoD PIF Priority Species. Fact Sheet #11. Department of Defense. Partners in Flight. Available at <file:///C:/Users/jmh656/Downloads/DOD%20priority%20species%202011.pdf>

Murphy, R.K. 2008. Fire is for the birds in northern mixed-grass prairie. *Fire Science Brief* 9:1-6.

Appendix A: Grasshopper Sparrow banding efforts at Camp Grafton South

| Date | UTMS Easting | UTMS Northing | Band Number | Color band combo | Received a geolocator? | Feather collected? | Age | Sex |
|-----------|--------------|---------------|-------------|------------------|------------------------|--------------------|-------|---------|
| 5/6/2015 | 527631 | 5282142 | 160123308 | None | | Yes | Adult | Unknown |
| 5/7/2015 | 527513 | 5281928 | 160123310 | None | | | Adult | Male |
| 5/7/2015 | 527355 | 5281827 | 160123309 | None | | | Adult | Male |
| 5/9/2015 | 527524 | 5282958 | 160123312 | None | | | Adult | Male |
| 5/9/2015 | 527613 | 5282609 | 160123311 | None | | | Adult | Male |
| 5/9/2015 | 527535 | 5283029 | 160123313 | None | | | Adult | Male |
| 5/12/2015 | 525108 | 5282762 | 160123317 | None | | Yes | Adult | Unknown |
| 5/12/2015 | 525066 | 5282761 | 160123315 | None | | Yes | Adult | Male |
| 5/12/2015 | 525524 | 5282392 | 160123322 | HAHO | | | Adult | Male |
| 5/12/2015 | 525506 | 5282501 | 160123320 | LALR | Yes | | Adult | Male |
| 5/12/2015 | 525108 | 5282762 | 160123316 | LARL | Yes | | Adult | Male |
| 5/12/2015 | 525524 | 5282392 | 160123321 | OAKY | Yes | | Adult | Male |
| 5/12/2015 | 525011 | 5282718 | 160123314 | RAWL | Yes | | Adult | Male |
| 5/12/2015 | 525283 | 5282509 | 160123318 | WAOG | Yes | | Adult | Male |
| 5/12/2015 | 525799 | 5282176 | 160123323 | WAGV | Yes | | Adult | Male |
| 5/12/2015 | 525338 | 5282474 | 160123319 | WAYV | Yes | | Adult | Male |
| 5/13/2015 | 524979 | 5282995 | 160123326 | GAKW | Yes | | Adult | Male |
| 5/13/2015 | 524923 | 5282980 | 160123325 | RAKY | Yes | | Adult | Male |
| 5/13/2015 | 524932 | 5283473 | 160123328 | VAGR | Yes | | Adult | Male |
| 5/13/2015 | 525132 | 5283302 | 160123327 | WAKO | Yes | | Adult | Male |
| 5/13/2015 | 524977 | 5283370 | 160123329 | WARL | Yes | | Adult | Male |
| 5/13/2015 | 524893 | 5283018 | 160123324 | WAWV | Yes | | Adult | Male |
| 5/15/2015 | 525654 | 5282348 | 160123331 | None | | Yes | Adult | Male |
| 5/15/2015 | 525350 | 5282245 | 160123330 | None | | Yes | Adult | Male |
| 5/15/2015 | 525619 | 5282605 | 160123334 | None | | Yes | Adult | Male |
| 5/15/2015 | 525430 | 5282890 | 160123336 | WAOO | Yes | | Adult | Male |
| 5/15/2015 | 525547 | 5282766 | 160123335 | WARW | Yes | | Adult | Male |
| 5/15/2015 | 525601 | 5282457 | 160123332 | WAKY | Yes | | Adult | Male |
| 5/15/2015 | 525737 | 5282535 | 160123333 | YAGO | Yes | | Adult | Male |
| 5/16/2015 | 524507 | 5283334 | 160123340 | GAKK | Yes | | Adult | Male |
| 5/16/2015 | 524322 | 5283223 | 160123343 | GAOR | Yes | | Adult | Male |
| 5/16/2015 | 524402 | 5282936 | 160123344 | HAGK | Yes | | Adult | Male |
| 5/16/2015 | 524467 | 5283146 | 160123341 | LAVO | Yes | | Adult | Male |
| 5/16/2015 | 524371 | 5283367 | 160123337 | RALK | Yes | | Adult | Male |
| 5/16/2015 | 524386 | 5283088 | 160123342 | RAYK | Yes | | Adult | Male |
| 5/16/2015 | 524490 | 5283400 | 160123339 | WARY | Yes | | Adult | Male |
| 5/16/2015 | 524429 | 5283422 | 160123338 | WAGO | Yes | | Adult | Male |
| 5/17/2015 | 524566 | 5283086 | 160123347 | GALK | Yes | | Adult | Male |
| 5/17/2015 | 524481 | 5283037 | 160123348 | GAGR | Yes | | Adult | Male |
| 5/17/2015 | 524659 | 5283039 | 160123346 | RAYO | Yes | | Adult | Male |
| 5/19/2015 | 526273 | 5282574 | 160123351 | None | | Yes | Adult | Male |
| 5/19/2015 | 526018 | 5282004 | 160123349 | None | | Yes | Adult | Male |
| 5/19/2015 | 526221 | 5282471 | 160123350 | None | | Yes | Adult | Male |
| 5/20/2015 | 524589 | 5282973 | 160123355 | None | | Yes | Adult | Male |
| 5/20/2015 | 524933 | 5282918 | 160123354 | None | | Yes | Adult | Male |
| 5/20/2015 | 525483 | 5282212 | 160123353 | HAKW | Yes | | Adult | Male |
| 5/20/2015 | 525631 | 5282101 | 160123352 | KAGG | Yes | | Adult | Male |
| 5/22/2015 | 524284 | 5283695 | 160123357 | None | | Yes | Adult | Male |
| 5/22/2015 | 524384 | 5283583 | 160123358 | None | | Yes | Adult | Male |
| 5/22/2015 | 524213 | 5283577 | 160123356 | None | | Yes | Adult | Male |
| 5/24/2015 | 523549 | 5283745 | 160123364 | None | | Yes | Adult | Male |
| 5/24/2015 | 523604 | 5284150 | 160123359 | None | | Yes | Adult | Male |
| 5/24/2015 | 523425 | 5283771 | 160123363 | None | | Yes | Adult | Male |
| 5/24/2015 | 523257 | 5284122 | 160123360 | None | | Yes | Adult | Male |
| 5/24/2015 | 523281 | 5283933 | 160123362 | None | | Yes | Adult | Male |

Appendix A: Grasshopper Sparrow banding efforts at Camp Grafton South

| Date | UTMS Easting | UTMS Northing | Band Number | Color band combo | Received a geolocator? | Feather collected? | Age | Sex |
|-----------|--------------|---------------|-------------|---------------------|---------------------------|-----------------------|-------|------|
| 5/28/2015 | 523907 | 5284879 | 160123366 | None | | Yes | Adult | Male |
| 5/28/2015 | 524079 | 5284819 | 160123365 | None | | Yes | Adult | Male |

Appendix B: Nests discovered at Camp Grafton South

| Species | Date discovered | Contents | UTM Easting (Zone 14N) | UTM Northing (Zone 14N) |
|---|-----------------|------------------|---------------------------|----------------------------|
| Mallard (<i>Anas platyrhynchos</i>) | ~5/20/2015 | 8-12 eggs | 524730 | 5283439 |
| Great Blue Heron (nesting colony) (<i>Ardea herodias</i>) | 5/15/2015 | Unknown | 523420 | 5285043 |
| Red-tailed Hawk (<i>Buteo jamaicensis</i>) | 5/13/2015 | Unknown | 526608 | 5282912 |
| Red-tailed Hawk (Kriider's) (<i>Buteo jamaicensis</i>) | 6/8/2015 | Unknown | 524944 | 5286536 |
| Killdeer (<i>Charadrius vociferus</i>) | 5/29/2015 | 2 eggs | 524551 | 5282196 |
| Northern Flicker (<i>Colaptes auratus</i>) | 6/8/2015 | Unknown | 524998 | 5286471 |
| Horned Lark (<i>Eremophila alpestris</i>) | 5/16/2015 | recently fledged | 524771 | 5283022 |
| Sedge Wren (<i>Cistothorus platensis</i>) | 5/29/2015 | 5 eggs | 524763 | 5282286 |
| European Starling (<i>Sturnus vulgaris</i>) | 6/8/2015 | Nestlings | 524916 | 5286618 |
| Savannah Sparrow (<i>Passerculus sandwichensis</i>) | 5/25/2015 | 4-5 eggs | 525650 | 5283201 |

Appendix C: Summary of eBird checklist data

| Species Name | Proportion of eBird checklists with inclusion of each species | | | | | |
|---|---|----------|-----------|-----------|-----------|-----------|
| | May 1-5 | May 6-10 | May 11-15 | May 16-20 | May 21-25 | May 26-31 |
| Canada Goose - <i>Branta canadensis</i> | 100 | 50 | 40 | 67 | 100 | 100 |
| Gadwall - <i>Anas strepera</i> | -- | 25 | -- | -- | -- | 100 |
| American Wigeon - <i>Anas americana</i> | 33 | -- | -- | -- | -- | -- |
| Mallard - <i>Anas platyrhynchos</i> | 67 | 62 | 60 | 33 | 100 | 100 |
| Blue-winged Teal - <i>Anas discors</i> | 33 | 25 | -- | -- | 100 | 100 |
| Northern Shoveler - <i>Anas clypeata</i> | 33 | -- | -- | -- | -- | 100 |
| Northern Pintail - <i>Anas acuta</i> | -- | 12 | -- | -- | -- | -- |
| Green-winged Teal - <i>Anas crecca</i> | -- | -- | -- | -- | -- | 100 |
| Redhead - <i>Aythya americana</i> | -- | 12 | -- | -- | -- | -- |
| Ring-necked Duck - <i>Aythya collaris</i> | -- | 12 | -- | -- | 100 | -- |
| Lesser Scaup - <i>Aythya affinis</i> | -- | -- | -- | -- | -- | 100 |
| Ruddy Duck - <i>Oxyura jamaicensis</i> | -- | 12 | -- | -- | -- | -- |
| Gray Partridge - <i>Perdix perdix</i> | -- | -- | -- | 33 | -- | -- |
| Ring-necked Pheasant - <i>Phasianus colchicus</i> | 33 | 12 | -- | 33 | -- | -- |
| Sharp-tailed Grouse - <i>Tympanuchus phasianellus</i> | 67 | 25 | 40 | 67 | 100 | 100 |
| Red-necked Grebe - <i>Podiceps grisegena</i> | -- | 12 | -- | -- | -- | -- |
| Double-crested Cormorant - <i>Phalacrocorax auritus</i> | -- | 38 | -- | -- | 100 | 100 |
| American White Pelican - <i>Pelecanus erythrorhynchos</i> | -- | 12 | 20 | 33 | -- | -- |
| Great Blue Heron - <i>Ardea herodias</i> | -- | 12 | 20 | -- | 100 | -- |
| Great Egret - <i>Ardea alba</i> | -- | -- | -- | -- | 100 | -- |
| Northern Harrier - <i>Circus cyaneus</i> | 33 | 38 | 20 | -- | 100 | -- |
| Bald Eagle - <i>Haliaeetus leucocephalus</i> | -- | -- | -- | -- | -- | -- |
| Swainson's Hawk - <i>Buteo swainsoni</i> | -- | -- | -- | 33 | -- | -- |
| Red-tailed Hawk - <i>Buteo jamaicensis</i> | -- | 38 | 40 | 33 | 100 | -- |
| Rough-legged Hawk - <i>Buteo lagopus</i> | -- | -- | -- | -- | -- | -- |
| Buteo sp. - <i>Buteo sp.</i> | 33 | -- | -- | -- | -- | -- |
| Sora - <i>Porzana carolina</i> | -- | 12 | -- | -- | -- | -- |
| American Golden-Plover - <i>Pluvialis dominica</i> | -- | 12 | -- | -- | -- | -- |
| Killdeer - <i>Charadrius vociferus</i> | 67 | 38 | 40 | -- | -- | 100 |
| Willet - <i>Tringa semipalmata</i> | 33 | 25 | 20 | 33 | -- | 100 |
| Lesser Yellowlegs - <i>Tringa flavipes</i> | -- | 25 | -- | -- | -- | -- |

Appendix C: Summary of eBird checklist data

| Species Name | Proportion of eBird checklists with inclusion of each species | | | | | |
|---|---|----------|-----------|-----------|-----------|-----------|
| | May 1-5 | May 6-10 | May 11-15 | May 16-20 | May 21-25 | May 26-31 |
| Upland Sandpiper - <i>Bartramia longicauda</i> | -- | 12 | -- | -- | -- | -- |
| Wilson's Snipe - <i>Gallinago delicata</i> | 33 | 38 | -- | 67 | 100 | -- |
| Franklin's Gull - <i>Leucophaeus pipixcan</i> | -- | 38 | -- | -- | -- | -- |
| Ring-billed Gull - <i>Larus delawarensis</i> | -- | -- | 20 | 33 | 100 | -- |
| Forster's Tern - <i>Sterna forsteri</i> | -- | 12 | -- | -- | -- | -- |
| Rock Pigeon - <i>Columba livia</i> | -- | 12 | -- | -- | -- | -- |
| Mourning Dove - <i>Zenaidura macroura</i> | 67 | 75 | 20 | 100 | 100 | -- |
| Red-headed Woodpecker - <i>Melanerpes erythrocephalus</i> | -- | -- | -- | -- | 100 | -- |
| Yellow-bellied Sapsucker - <i>Sphyrapicus varius</i> | -- | -- | -- | 33 | -- | -- |
| Downy Woodpecker - <i>Picoides pubescens</i> | -- | -- | -- | -- | -- | 100 |
| Northern Flicker - <i>Colaptes auratus</i> | -- | 12 | -- | -- | 100 | -- |
| American Kestrel - <i>Falco sparverius</i> | -- | 12 | -- | -- | -- | -- |
| Merlin - <i>Falco columbarius</i> | -- | 12 | 20 | 33 | -- | -- |
| Peregrine Falcon - <i>Falco peregrinus</i> | -- | 12 | -- | -- | -- | -- |
| falcon sp. - <i>Falco sp.</i> | -- | -- | -- | 33 | -- | -- |
| Alder/Willow Flycatcher (Traill's Flycatcher) - <i>Empidonax alnorum/traillii</i> | -- | -- | -- | 33 | -- | -- |
| Least Flycatcher - <i>Empidonax minimus</i> | -- | 12 | 20 | 67 | 100 | -- |
| Western Kingbird - <i>Tyrannus verticalis</i> | -- | -- | -- | -- | 100 | -- |
| Eastern Kingbird - <i>Tyrannus tyrannus</i> | -- | -- | -- | 67 | 100 | 100 |
| Loggerhead Shrike - <i>Lanius ludovicianus</i> | -- | -- | 20 | -- | -- | -- |
| Blue-headed Vireo - <i>Vireo solitarius</i> | -- | -- | 20 | -- | -- | -- |
| Warbling Vireo - <i>Vireo gilvus</i> | -- | -- | -- | -- | -- | 100 |
| Red-eyed Vireo - <i>Vireo olivaceus</i> | -- | -- | 20 | -- | -- | -- |
| Black-billed Magpie - <i>Pica hudsonia</i> | 33 | -- | -- | -- | -- | 100 |
| American Crow - <i>Corvus brachyrhynchos</i> | -- | 12 | -- | -- | -- | -- |
| Common Raven - <i>Corvus corax</i> | -- | -- | -- | -- | -- | -- |
| Horned Lark - <i>Eremophila alpestris</i> | 100 | 75 | 80 | 67 | 100 | -- |
| Tree Swallow - <i>Tachycineta bicolor</i> | -- | 50 | -- | 67 | 100 | 100 |
| Bank Swallow - <i>Riparia riparia</i> | -- | -- | -- | -- | -- | 100 |
| Barn Swallow - <i>Hirundo rustica</i> | 33 | 25 | 20 | 67 | -- | 100 |
| Cliff Swallow - <i>Petrochelidon pyrrhonota</i> | -- | -- | -- | 33 | -- | -- |

Appendix C: Summary of eBird checklist data

| Species Name | Proportion of eBird checklists with inclusion of each species | | | | | |
|--|---|----------|-----------|-----------|-----------|-----------|
| | May 1-5 | May 6-10 | May 11-15 | May 16-20 | May 21-25 | May 26-31 |
| House Wren - <i>Troglodytes aedon</i> | -- | -- | -- | 33 | -- | 100 |
| Sedge Wren - <i>Cistothorus platensis</i> | -- | -- | -- | -- | -- | 100 |
| Ruby-crowned Kinglet - <i>Regulus calendula</i> | -- | -- | 20 | 33 | -- | -- |
| Swainson's Thrush - <i>Catharus ustulatus</i> | -- | -- | 20 | 33 | -- | -- |
| American Robin - <i>Turdus migratorius</i> | 33 | 38 | -- | 33 | 100 | 100 |
| Brown Thrasher - <i>Toxostoma rufum</i> | -- | -- | 20 | -- | 100 | -- |
| European Starling - <i>Sturnus vulgaris</i> | -- | 12 | -- | -- | 100 | -- |
| Chestnut-collared Longspur - <i>Calcarius ornatus</i> | 100 | 25 | 60 | 67 | 100 | -- |
| Ovenbird - <i>Seiurus aurocapilla</i> | -- | -- | 20 | 33 | -- | -- |
| Black-and-white Warbler - <i>Mniotilta varia</i> | -- | -- | 20 | 33 | -- | -- |
| Tennessee Warbler - <i>Oreothlypis peregrina</i> | -- | -- | -- | 33 | -- | -- |
| Orange-crowned Warbler - <i>Oreothlypis celata</i> | -- | 12 | 20 | 33 | -- | -- |
| Nashville Warbler - <i>Oreothlypis ruficapilla</i> | -- | -- | 20 | 33 | -- | -- |
| American Redstart - <i>Setophaga ruticilla</i> | -- | -- | 20 | 33 | -- | -- |
| Magnolia Warbler - <i>Setophaga magnolia</i> | -- | -- | 20 | 33 | -- | -- |
| Blackburnian Warbler - <i>Setophaga fusca</i> | -- | -- | -- | 33 | -- | -- |
| Yellow Warbler - <i>Setophaga petechia</i> | -- | -- | -- | 67 | 100 | 100 |
| Blackpoll Warbler - <i>Setophaga striata</i> | -- | -- | 20 | -- | -- | -- |
| Yellow-rumped Warbler - <i>Setophaga coronata</i> | -- | 12 | -- | 33 | -- | -- |
| Chipping Sparrow - <i>Spizella passerina</i> | -- | -- | -- | -- | 100 | -- |
| Clay-colored Sparrow - <i>Spizella pallida</i> | 67 | 75 | 80 | 67 | 100 | 100 |
| Field Sparrow - <i>Spizella pusilla</i> | 33 | -- | -- | -- | -- | -- |
| Vesper Sparrow - <i>Pooecetes gramineus</i> | 33 | 62 | 80 | 33 | -- | -- |
| Lark Sparrow - <i>Chondestes grammacus</i> | 33 | -- | -- | -- | -- | -- |
| Savannah Sparrow - <i>Passerculus sandwichensis</i> | 33 | 38 | 40 | 67 | 100 | 100 |
| Grasshopper Sparrow - <i>Ammodramus savannarum</i> | 33 | 62 | 60 | 67 | 100 | 100 |
| Henslow's Sparrow - <i>Ammodramus henslowii</i> | -- | 12 | -- | -- | -- | -- |
| Song Sparrow - <i>Melospiza melodia</i> | -- | 25 | -- | -- | -- | 100 |
| White-throated Sparrow - <i>Zonotrichia albicollis</i> | -- | 25 | -- | -- | -- | -- |
| Bobolink - <i>Dolichonyx oryzivorus</i> | -- | -- | -- | 33 | 100 | -- |
| Red-winged Blackbird - <i>Agelaius phoeniceus</i> | 33 | 75 | 40 | -- | 100 | 100 |

Appendix C: Summary of eBird checklist data

| Species Name | Proportion of eBird checklists with inclusion of each species | | | | | |
|--|---|----------|-----------|-----------|-----------|-----------|
| | May 1-5 | May 6-10 | May 11-15 | May 16-20 | May 21-25 | May 26-31 |
| Western Meadowlark - <i>Sturnella neglecta</i> | 100 | 100 | 100 | 67 | 100 | 100 |
| Yellow-headed Blackbird - <i>Xanthocephalus xanthocephalus</i> | -- | 25 | 20 | 67 | 100 | -- |
| Brewer's Blackbird - <i>Euphagus cyanocephalus</i> | 33 | 62 | -- | 100 | 100 | -- |
| Common Grackle - <i>Quiscalus quiscula</i> | 33 | 38 | -- | 67 | 100 | 100 |
| Brown-headed Cowbird - <i>Molothrus ater</i> | 67 | 62 | -- | 67 | 100 | 100 |
| Orchard Oriole - <i>Icterus spurius</i> | -- | -- | -- | -- | -- | 100 |
| American Goldfinch - <i>Spinus tristis</i> | -- | -- | 20 | 100 | 100 | 100 |

Appendix D: Bird species observed at Camp Grafton North during May, 2015

| Species | Species |
|---|--|
| Canada Goose (<i>Branta canadensis</i>) | Tree Swallow (<i>Tachycineta bicolor</i>) |
| Wood Duck (<i>Aix sponsa</i>) | Barn Swallow (<i>Hirundo rustica</i>) |
| Gadwall (<i>Anas strepera</i>) | Black-capped Chickadee (<i>Poecile atricapillus</i>) |
| Mallard (<i>Anas platyrhynchos</i>) | White-breasted Nuthatch (<i>Sitta carolinensis</i>) |
| Blue-winged Teal (<i>Anas discors</i>) | House Wren (<i>Troglodytes aedon</i>) |
| Northern Shoveler (<i>Anas clypeata</i>) | Gray-cheeked Thrush (<i>Catharus minimus</i>) |
| Northern Pintail (<i>Anas acuta</i>) | Swainson's Thrush (<i>Catharus ustulatus</i>) |
| Hooded Merganser (<i>Lophodytes cucullatus</i>) | American Robin (<i>Turdus migratorius</i>) |
| Ring-necked Pheasant (<i>Phasianus colchicus</i>) | Gray Catbird (<i>Dumetella carolinensis</i>) |
| Wild Turkey (<i>Meleagris gallopavo</i>) | Brown Thrasher (<i>Toxostoma rufum</i>) |
| Horned Grebe (<i>Podiceps auritus</i>) | European Starling (<i>Sturnus vulgaris</i>) |
| Western Grebe (<i>Aechmophorus occidentalis</i>) | Cedar Waxwing (<i>Bombycilla cedrorum</i>) |
| Double-crested Cormorant (<i>Phalacrocorax auritus</i>) | Ovenbird (<i>Seiurus aurocapilla</i>) |
| Great Blue Heron (<i>Ardea herodias</i>) | Northern Waterthrush (<i>Parkesia noveboracensis</i>) |
| Great Egret (<i>Ardea alba</i>) | Black-and-white Warbler (<i>Mniotilta varia</i>) |
| Turkey Vulture (<i>Cathartes aura</i>) | Tennessee Warbler (<i>Oreothlypis peregrina</i>) |
| Osprey (<i>Pandion haliaetus</i>) | Nashville Warbler (<i>Oreothlypis ruficapilla</i>) |
| Cooper's Hawk (<i>Accipiter cooperii</i>) | Mourning Warbler (<i>Geothlypis philadelphia</i>) |
| Broad-winged Hawk (<i>Buteo platypterus</i>) | Common Yellowthroat (<i>Geothlypis trichas</i>) |
| Killdeer (<i>Charadrius vociferus</i>) | American Redstart (<i>Setophaga ruticilla</i>) |
| Spotted Sandpiper (<i>Actitis macularius</i>) | Cape May Warbler (<i>Setophaga tigrina</i>) |
| Franklin's Gull (<i>Leucophaeus pipixcan</i>) | Magnolia Warbler (<i>Setophaga magnolia</i>) |
| Ring-billed Gull (<i>Larus delawarensis</i>) | Bay-breasted Warbler (<i>Setophaga castanea</i>) |
| Forster's Tern (<i>Sterna forsteri</i>) | Yellow Warbler (<i>Setophaga petechia</i>) |
| Mourning Dove (<i>Zenaida macroura</i>) | Chestnut-sided Warbler (<i>Setophaga pensylvanica</i>) |
| Ruby-throated Hummingbird (<i>Archilochus colubris</i>) | Blackpoll Warbler (<i>Setophaga striata</i>) |
| Belted Kingfisher (<i>Megaceryle alcyon</i>) | Palm Warbler (<i>Setophaga palmarum</i>) |
| Downy Woodpecker (<i>Picoides pubescens</i>) | Yellow-rumped Warbler (<i>Setophaga coronata</i>) |
| Hairy Woodpecker (<i>Picoides villosus</i>) | Canada Warbler (<i>Cardellina canadensis</i>) |
| Northern Flicker (<i>Colaptes auratus</i>) | Wilson's Warbler (<i>Cardellina pusilla</i>) |

Appendix D: Bird species observed at Camp Grafton North during May, 2015

| Species | Species |
|---|---|
| Pileated Woodpecker (<i>Dryocopus pileatus</i>) | White-throated Sparrow (<i>Zonotrichia albicollis</i>) |
| Alder Flycatcher (<i>Empidonax alnorum</i>) | Harris's Sparrow (<i>Zonotrichia querula</i>) |
| Least Flycatcher (<i>Empidonax minimus</i>) | sparrow sp. (<i>Emberizidae sp. (sparrow sp.)</i>) |
| Eastern Phoebe (<i>Sayornis phoebe</i>) | Rose-breasted Grosbeak (<i>Pheucticus ludovicianus</i>) |
| Eastern Kingbird (<i>Tyrannus tyrannus</i>) | Red-winged Blackbird (<i>Agelaius phoeniceus</i>) |
| Yellow-throated Vireo (<i>Vireo flavifrons</i>) | Brewer's Blackbird (<i>Euphagus cyanocephalus</i>) |
| Blue-headed Vireo (<i>Vireo solitarius</i>) | Common Grackle (<i>Quiscalus quiscula</i>) |
| Warbling Vireo (<i>Vireo gilvus</i>) | Brown-headed Cowbird (<i>Molothrus ater</i>) |
| Red-eyed Vireo (<i>Vireo olivaceus</i>) | Baltimore Oriole (<i>Icterus galbula</i>) |
| Blue Jay (<i>Cyanocitta cristata</i>) | House Finch (<i>Haemorhous mexicanus</i>) |
| American Crow (<i>Corvus brachyrhynchos</i>) | House Sparrow (<i>Passer domesticus</i>) |
| Spotted Towhee (<i>Pipilo maculatus</i>) | |
| Chipping Sparrow (<i>Spizella passerina</i>) | |
| Clay-colored Sparrow (<i>Spizella pallida</i>) | |
| Song Sparrow (<i>Melospiza melodia</i>) | |

Appendix E: Point count data summary

| Species | Individuals detected | Detection rate (%) |
|---|----------------------|--------------------|
| Canada Goose - <i>Branta canadensis</i> | 186 | 72.2 |
| Gadwall - <i>Anas strepera</i> | 1 | 2.8 |
| Mallard - <i>Anas platyrhynchos</i> | 26 | 33.3 |
| Blue-winged Teal - <i>Anas discors</i> | 6 | 8.3 |
| Ring-necked Duck - <i>Aythya collaris</i> | 4 | 2.8 |
| Lesser Scaup - <i>Aythya affinis</i> | 5 | 5.6 |
| Unidentified Duck | 32 | 16.7 |
| Sharp-tailed Grouse - <i>Tympanuchus phasianellus</i> | 11 | 13.9 |
| Double-crested Cormorant - <i>Phalacrocorax auritus</i> | 23 | 25.0 |
| American White Pelican - <i>Pelecanus erythrorhynchos</i> | 22 | 16.7 |
| Great Blue Heron - <i>Ardea herodias</i> | 1 | 2.8 |
| Northern Harrier - <i>Circus cyaneus</i> | 3 | 8.3 |
| Red-tailed Hawk - <i>Buteo jamaicensis</i> | 1 | 2.8 |
| Sandhill Crane - <i>Grus canadensis</i> | 2 | 2.8 |
| Killdeer - <i>Charadrius vociferus</i> | 7 | 16.7 |
| Willet - <i>Tringa semipalmata</i> | 4 | 8.3 |
| Wilson's Snipe - <i>Gallinago delicata</i> | 13 | 30.6 |
| Mourning Dove - <i>Zenaidura macroura</i> | 12 | 25.0 |
| Merlin - <i>Falco columbarius</i> | 1 | 2.8 |
| Western Kingbird - <i>Tyrannus verticalis</i> | 2 | 2.8 |
| Loggerhead Shrike - <i>Lanius ludovicianus</i> | 1 | 2.8 |
| Black-billed Magpie - <i>Pica hudsonia</i> | 1 | 2.8 |
| Common Raven - <i>Corvus corax</i> | 1 | 2.8 |
| Horned Lark - <i>Eremophila alpestris</i> | 16 | 30.6 |
| Tree Swallow - <i>Tachycineta bicolor</i> | 48 | 11.1 |
| Northern Rough-winged Swallow - <i>Stelgidopteryx serripennis</i> | 2 | 2.8 |
| Bank Swallow - <i>Riparia riparia</i> | 26 | 2.8 |
| Barn Swallow - <i>Hirundo rustica</i> | 24 | 16.7 |
| Black-capped Chickadee - <i>Poecile atricapillus</i> | 1 | 2.8 |
| American Robin - <i>Turdus migratorius</i> | 2 | 5.6 |
| Chestnut-collared Longspur - <i>Calcarius ornatus</i> | 29 | 38.9 |
| Yellow Warbler - <i>Setophaga petechia</i> | 9 | 11.1 |
| Clay-colored Sparrow - <i>Spizella pallida</i> | 50 | 86.1 |
| Vesper Sparrow - <i>Pooecetes gramineus</i> | 21 | 44.4 |
| Savannah Sparrow - <i>Passerculus sandwichensis</i> | 4 | 11.1 |
| Grasshopper Sparrow - <i>Ammodramus savannarum</i> | 57 | 86.1 |
| Song Sparrow - <i>Melospiza melodia</i> | 2 | 5.6 |
| Bobolink - <i>Dolichonyx oryzivorus</i> | 15 | 27.8 |
| Red-winged Blackbird - <i>Agelaius phoeniceus</i> | 35 | 38.9 |
| Western Meadowlark - <i>Sturnella neglecta</i> | 65 | 91.7 |
| Yellow-headed Blackbird - <i>Xanthocephalus xanthocephalus</i> | 14 | 25.0 |
| Brewer's Blackbird - <i>Euphagus cyanocephalus</i> | 2 | 5.6 |
| Common Grackle - <i>Quiscalus quiscula</i> | 2 | 2.8 |
| Brown-headed Cowbird - <i>Molothrus ater</i> | 15 | 33.3 |
| Unidentified Blackbird | 217 | 50.0 |