# Monitoring the Birds of Agate Fossil Beds National Monument: 2010 Field Season Report

## March 2011

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# ROCKY MOUNTAIN BIRD OBSERVATORY

***Mission**: To conserve birds and their habitats*

***Vision**: Native bird populations are sustained in healthy ecosystems*

***Core Values**:*

1. ***Science** provides the foundation for effective bird conservation.*
2. ***Education** is critical to the success of bird conservation.*
3. ***Stewardship** of birds and their habitats is a shared responsibility.*

***RMBO accomplishes its mission by:***

- ***Monitoring** long-term bird population trends to provide a scientific foundation for conservation action.*
- ***Researching** bird ecology and population response to anthropogenic and natural processes to evaluate and adjust management and conservation strategies using the best available science.*
- ***Educating** people of all ages through active, experiential programs that create an awareness and appreciation for birds.*
- ***Fostering** good stewardship on private and public lands through voluntary, cooperative partnerships that create win-win situations for wildlife and people.*
- ***Partnering** with state and federal natural resource agencies, private citizens, schools, universities, and other non-governmental organizations to build synergy and consensus for bird conservation.*
- ***Sharing** the latest information on bird populations, land management and conservation practices to create informed publics.*
- ***Delivering** bird conservation at biologically relevant scales by working across political and jurisdictional boundaries in western North America.*

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Sunrise at Agate Fossil Beds National Monument, By Sarah Kormos. Used with Permission.

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# EXECUTIVE SUMMARY

Rocky Mountain Bird Observatory conducted bird surveys in Agate Fossil Beds National Monument in the Northern Great Plains Inventory and Monitoring Network of the National Park Service using methods that allow for estimating detection probability through the principles of Distance sampling and occupancy estimation. We conducted surveys between 18 May and 23 June 2010 at points established by the National Park Service in 2001. A single observer collected data on multiple visits to each point in both prairie and riparian habitats. Overall, the technician recorded 4,291 bird detections of 55 species, 11 of which are priority species (species identified in plans by Nebraska Game and Parks, Partners in Flight and US Fish and Wildlife Service as a priority). We estimated densities for 10 species, four of which are priority species. We estimated probability of occupancy for 26 species, of which seven are priority species.

The technician surveyed 40 points classified as Prairie with 5 visits to 39 points and four visits one point. The technician recorded 2,219 bird detections of 49 species, 11 of which are priority species. We estimated densities for 10 species, four of which are priority species. We estimated the proportion of points occupied (Psi) for 23 species, six of which are priority species.

The technician surveyed 14 points classified as Riparian with 10 visits to each point. We recorded 2,072 bird detections of 45 species, eight of which are priority species. We estimated densities for five species, one of which is a priority species. We estimated the proportion of points occupied (Psi) by 19 species, four of which are priority species.

With one season of data, we were able to obtain robust density estimates for the most common species in the park by utilizing repeat visits to each point. We also obtained occupancy estimates for less common species. Many common species in the park are experiencing severe declines throughout their range, making the National Park Service lands very valuable to these populations of declining bird species. Management of this park is essential to the stabilization of these bird populations. The National Park Service's ecological monitoring framework objectives include determining landbird population and community composition trends at both the park (unit) and landscape level. With long-term landbird population and occupancy data, as well as habitat data, monument staff can effectively manage for prairie and riparian landbirds. Monitoring landscape-level trends will require larger scale implementation throughout the Northern Great Plains Network as well as partnerships with other agencies. Both the monitoring design employed at Agate Fossil Beds National Monument in 2010 and the established Integrated Monitoring in Bird Conservation Regions design will serve as important tools in achieving this objective.

# ACKNOWLEDGEMENTS

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# INTRODUCTION

The National Park Service is cooperating with Rocky Mountain Bird Observatory (RMBO) to develop a landbird monitoring program for the 13 parks within the Northern Great Plains Inventory and Monitoring Network (NGPN). The NPGN has identified landbirds as a vital sign for long-term monitoring. Agate Fossil Bed National Monument (AGFO) was incorporated into the NGPN in 2010 from the Heartland Network (HTLN). Bird monitoring with single visits to 54 locations occurred in Agate Fossil Beds National Monument (AGFO) between 2001 and 2006 (excluding 2002). A revised monitoring program was developed and implemented in Wind Cave National Park (WICA) in 2008 and 2009 with repeat survey visits to increase the number of bird detections. Monitoring at AGFO in 2010 provides a comparison between the previous protocols used at AGFO and WICA and will shape the development of long-term landbird monitoring in other parks of the NGPN.

Monitoring is an essential component of wildlife management and conservation science (Witmer 2005, Marsh and Trenham 2008). Common goals of population monitoring are to estimate the population status of target species and to detect changes in populations over time (Thompson et al. 1998, Sauer and Knutson 2008). Effective monitoring programs can identify species that are at-risk due to small or declining populations (Dreitz et al. 2006) provide an understanding of how management actions affect populations (Alexander et al. 2008, Lyons et al. 2008), evaluate population responses to landscape alteration and climate change (Baron et al. 2008, Lindenmayer and Likens 2009) as well as provide basic information on species distributions.

The native Great Plains grasslands of North America are disappearing at an alarming rate. Grassland landscapes have been converted to cropland or livestock pasture (29% of shortgrass, 41% of mixed-grass, and 99% of tallgrass prairie have been converted to cropland or livestock pasture (Knopf and Samson 1997). The interruption of ecological processes that shape the prairie such as periodic wildfire and grazing practices have further reduced historical prairie habitat for many grassland bird species. North American Breeding Bird Surveys (BBS) data (1966 and 2007) indicates that 61% of 24 grassland bird species show evidence of population declines (Sauer et al. 2008). AGFO supports a native shortgrass prairie and monitoring its breeding bird population may provide one measure for assessing the ecological integrity and sustainability of this prairie (Peitz 2007).

The specific objectives of the AGFO monitoring program are:

- Conduct bird surveys at AGFO using the established HTLN and RMBO bird monitoring protocols.
- Use the monitoring strategy developed at WICA (2008-2009) where observers visit predetermined points a minimum of 3 times throughout the breeding season.
- Develop a sampling protocol that allows density estimation for common species and occupancy estimation for uncommon species

# METHODS

## Site Selection

AGFO selected permanent sampling locations by overlaying a systematic grid of 400 x 400 m cells (originating from a random starting point) on a park map (Peitz 2007). A point was placed on the corner of each of these cells, thus each point was spaced approximately 400 m apart. The orientation of the grid was rotated 45 degrees from North to prevent sampling sites from being influenced by man-made features (roads, fences, etc.) oriented along cardinal directions. Because riparian habitat makes up 15.6% of the total park area (965 ha) and supports a different suite of species than the surrounding prairie habitat, a separate stratum was added.to the plan. This stratum includes the area within 125 m on either side of the stream channel (Niobrara River). Within the riparian stratum, plots were located at 250-m intervals along the extent of the stream. Any plots from the overall park grid that fell within the riparian stratum were discarded. Forty plots were established in prairie habitat, with an additional 14 plots established in the riparian stratum (Fig. 1). Sampling locations remain unmarked and are located with a Global Positional System (GPS) unit each time a point is visited.

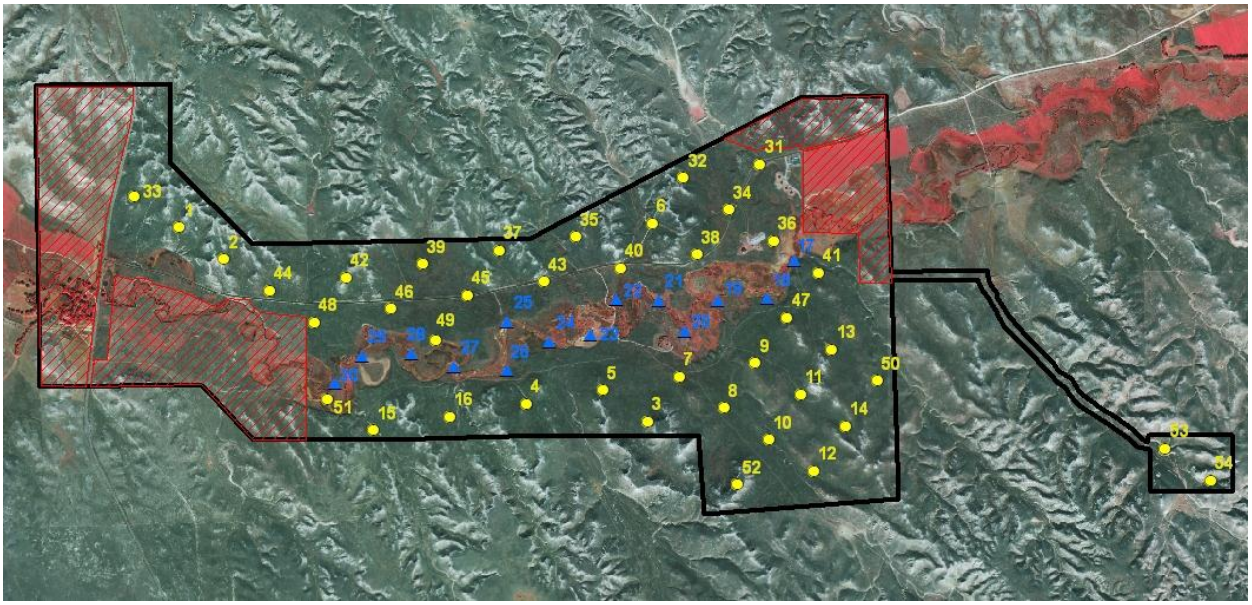

Figure 1. Survey locations at Agate Fossil Beds National Monument, 2010 (Peitz 2007).

## Sampling Design

We surveyed birds at each point using methods that allow for estimating detection probability through the principles of Distance sampling and Occupancy estimation. Distance sampling theory was developed to account for the decreasing probability of detecting an object of interest (e.g., a bird) with increasing distance from the observer to the object (Buckland et al. 2001). The detection probability is used to adjust the count of birds to account for birds that were present but undetected. Application of distance theory requires that three critical assumptions be met: 1) all birds at the sampling location (distance = 0) are detected; 2) distances of birds are measured accurately; and 3) birds do not move in response to the observer's presence (Buckland et al. 2001, Thomas et al. 2010).

Occupancy estimation is most commonly used to quantify the proportion of sample units (i.e., points) occupied by an organism (MacKenzie et al. 2002). The application of occupancy models requires multiple surveys of the sample unit in space or time to estimate a detection probability

(MacKenzie et al. 2006). Occupancy estimation uses a detection probability to adjust the proportion of sites occupied to account for species that were present but undetected (MacKenzie et al. 2002). The assumptions of occupancy estimation are 1) the probabilities of detection and occupancy are constant across the sample units, 2) each point is closed to changes in occupancy over the sampling season, 3) the detection of species at each point are independent, and 4) the target species are never falsely identified (MacKenzie et al. 2006).

The field technician conducted point counts (Buckland et al. 2001) following protocol established by RMBO (Hanni et al. 2009). An average of 12 points were visited each day, with five visits in the prairie stratum and 10 visits in the riparian stratum. Points were surveyed in the morning, beginning ½-hour before sunrise and concluding no later than 11 a.m. The survey duration was six minutes in 2010 because an even number of minute intervals facilitated the estimation of site occupancy. For every bird detected during the six minute period, the observer recorded species, sex, horizontal distance from the observer, minute of bird detection, and type of detection (e.g., call, song, visual). Distances were measured using laser rangefinders. When it was not possible to measure the distance to a bird, the observer estimated distance by measuring to some nearby object. Birds flying over but not using the immediate surrounding landscape were recorded as "flyover" detections and were not included in the estimates of density or occupancy.

We considered all non-independent detections of birds (i.e., flocks or pairs of conspecific birds together in close proximity) as part of a 'cluster' rather than as independent observations. The observer recorded the number of birds detected within the cluster along with a letter code to keep track of each distinct cluster.

At the start and end of each transect, the observer recorded time, ambient temperature, cloud cover, precipitation, and wind speed. Points were located using a hand-held GPS unit. Before beginning each six-minute count, the observer recorded vegetation data (within a 50 meter radius), and distance from a road (if within 100 meters). We recorded vegetation data according to the dominant habitat type and structural stage, and the relative abundance, percent cover, and mean height of trees, shrubs by species, as well as grass height and groundcover. We recorded vegetation data quietly to allow birds, potentially disturbed by our approach, time to return to their normal habits prior to the beginning each count.

Prior to conducting surveys, the technician completed an intensive five-day training program to ensure full understanding of field protocols, and to practice bird and plant identification and distance estimation in a variety of habitats. For more detailed information about survey methods and vegetation data collection protocols, refer to RMBO's Field Protocol for Spatially Balanced Sampling of Landbird Populations on our Avian Data Center website: http://www.rmbo.org/public/monitoring/protocols/Field_protocol_for_spacially_balanced_sampling_2010_V3.pdf.

## Data Analysis

### *Distance Analysis*

Analysis of distance data was accomplished by fitting a detection function to the distribution of recorded distances. The distribution of distances can be a function of characteristics of the object (e.g., for birds, its size and color, movement, volume of song or call, and frequency of call), the surrounding environment (e.g., density of vegetation), and observer ability. Because detectability varies among species, we analyzed the data separately for each species.

We used the analysis software Distance 6.0 (Thomas et al. 2010) to estimate detection probabilities using our point count data. We estimated densities of species for which we obtained a sufficient number of independent detections ($n \geq 60$). We fit the following functions to the distribution of distances for each species:

- Half normal key function with cosine series expansion
- Hazard rate key function with cosine series expansion (Buckland et al. 2001).

We used Akaike's Information Criterion (AIC) corrected for small sample size (AICc) and model selection theory to select the most parsimonious detection function for each species (Burnham and Anderson 2002).

*Occupancy Analysis*

We estimated avian detection (*p*) and occupancy (Psi) probabilities using the single season occupancy model (MacKenzie et al. 2002) implemented in program MARK (White and Burnham 1999). The model estimated 1) the probability of detecting a species given presence (*p*), and 2) the proportion of the points occupied by a species (Psi) (MacKenzie et al. 2002). Because the points were not visited on a consistent schedule across the study area, we were unable to estimate survey specific detection probabilities. Therefore, we modeled *p* as a function of survey date to account for temporal variation in detection. We estimated *p* for each stratum using the logit link and Psi for each stratum using the sin link function. The ordinal date covariate was standardized using the *z*-transformation. We truncated the data, using only detections within 125 meters of the sample points, which resulted in a plot size of 4.9 ha. Truncating the data at 125 meters allowed us to estimate occupancy over consistent plot sizes and ensured that the points were independent (points were spread 400 m apart in Prairie and 250 m apart in Riparian). We estimated the proportion of points occupied for all species with greater than 10 detections after truncating the data.

We evaluated eight estimation models with different structure on *p* and Psi. The detection probability (*p*) was held constant across strata, allowed to vary by strata, allowed to vary by survey date, or allowed to vary by strata and survey date. The occupancy rate (Psi) was held constant across strata or allowed to vary by strata. As with the Distance analyses, we used Akaike's Information Criterion (AIC) corrected for small sample size (AICc) and model selection theory to select the most parsimonious model from which the estimates of Psi were derived for each species (Burnham and Anderson 2002).

Unless otherwise specified, all bird species names listed in this report are from the American Ornithologists'' Union (A.O.U.) Check-list of North American Birds, Seventh Edition (2007).

# RESULTS

A single field technician surveyed 54 points within Agate Fossil Beds National Monument between 18 May and 23 June 2010. The technician surveyed each point multiple times throughout the season for a total of 339 sampling occasions. During these visits, the technician recorded 4,291 bird detections of 55 species, 11 of which are priority species according to Nebraska Game and Parks Commission (NGPC), Partners In Flight (PIF) and US Fish and Wildlife Service (USFWS) (Appendix A). For a complete list of detected and how many points they were detected on see Appendix B. We estimated densities for 10 species, four of which are priority species. We estimated the proportion of points occupied for 26 species, of which eight are priority species. We were unable to estimate the fraction of points occupied by the

*Sora (Porzana carolina),* Virginia Rail (*Rallus limicola*) and Wilson's Snipe (*Gallinago delicata*) because low detection probabilities resulted in unreliable occupancy rates.

## Prairie

The field technician surveyed 40 points classified as Prairie in AGFO between 18 May and 23 June 2010; of which, 39 points were surveyed five times and one point was surveyed four times. The field technician recorded 2,219 bird detections of 49 species, 11 of which are priority species.

The Western Meadowlark (*Sturnella neglecta*)(517 detections), Red-winged Blackbird (*Agelaius phoeniceus*) (274 detections), and Lark Bunting (*Calamospiza melanocrys)* (266 detections) were the most frequently detected species. We estimated densities for 10 species, four of which are priority species (Table 1). The data yielded robust density estimates (CV < 50%) for eight of these species. We estimated the proportion of points occupied (Psi) for 23 species, six of which are priority species (Table 2). The data yielded robust occupancy estimates (CV < 50%) for 17 of these species.

Table 1. Estimated densities per $km^2$ (D), percent coefficient of variation of estimates (% CV), lower (LCL) and upper (UCL) confidence limits on D and sample sizes (n) of breeding bird species in Prairie habitat within Agate Fossil Beds National Monument, 2010. S indicates the number of points used in analyses. Priority species are bolded.

| **Species** | **Prairie (S=40)** | | | | |
|---|---|---|---|---|---|
| | **D** | **% CV** | **LCL** | **UCL** | **n** |
| Common Yellowthroat | 25.2 | 87 | 11.8 | 41.7 | 39 |
| **Grasshopper Sparrow** | 75.9 | 49 | 40.5 | 182.9 | 88 |
| Horned Lark | 53.4 | 60 | 11.6 | 74.7 | 91 |
| **Lark Bunting** | 47.3 | 26 | 24.7 | 71.8 | 232 |
| **Lark Sparrow** | 81.9 | 25 | 40.7 | 116.8 | 148 |
| Mourning Dove | 4.3 | 21 | 3.0 | 6.4 | 103 |
| Ring-necked Pheasant | 0.7 | 27 | 0.4 | 1.2 | 58 |
| Rock Wren | 4.5 | 49 | 0.9 | 9.9 | 40 |
| Red-winged Blackbird | 107.4 | 26 | 58.0 | 165.2 | 143 |
| **Western Meadowlark** | 112.5 | 23 | 62.2 | 168.9 | 398 |

Table 2. Estimated proportion of sample units occupied (Psi), percent coefficient of variation of Psi (% CV), lower (LCL) and upper (UCL) confidence limits and number of points with one or more detections (n point) of breeding bird species in Prairie habitat within Agate Fossil Beds National Monument, 2010. Dashes indicate the data were insufficient for estimating site occupancy. A Psi estimate equal to 1 indicates the species was detected on all transects surveyed. S indicates the number of points used in analyses. Priority species are bolded.

| | **Prairie (S=40)** | | | | |
|---|---|---|---|---|---|
| **Species** | **Psi** | **% CV** | **LCL** | **UCL** | **n point** |
| American Goldfinch | 0.353 | 56 | 0.090 | 0.749 | 5 |
| American Robin | 0.288 | 52 | 0.088 | 0.630 | 3 |
| Bank Swallow | 0.091 | 56 | 0.029 | 0.250 | 3 |

| Species | Prairie (S=40) | | | | |
|---|---|---|---|---|---|
| | Psi | % CV | LCL | UCL | n point |
| Barn Swallow | 0.545 | 26 | 0.281 | 0.786 | 7 |
| Brown-headed Cowbird | 0.461 | 30 | 0.222 | 0.719 | 12 |
| Blue-winged Teal | 0.043 | 100 | 0.005 | 0.270 | 1 |
| **Cassin's Sparrow** | 0.415 | 26 | 0.227 | 0.631 | 13 |
| Cliff Swallow | 0.522 | 23 | 0.300 | 0.735 | 10 |
| **Common Nighthawk** | 0.426 | 33 | 0.194 | 0.696 | 9 |
| Common Yellowthroat | 0.360 | 22 | 0.225 | 0.522 | 14 |
| Eastern Kingbird | 0.108 | 48 | 0.041 | 0.255 | 4 |
| **Grasshopper Sparrow** | 0.656 | 12 | 0.484 | 0.795 | 25 |
| Horned Lark | 0.671 | 12 | 0.504 | 0.804 | 26 |
| Killdeer | 0.801 | 14 | 0.502 | 0.942 | 14 |
| **Lark Bunting** | 0.755 | 9 | 0.598 | 0.865 | 30 |
| **Lark Sparrow** | 0.938 | 5 | 0.783 | 0.984 | 37 |
| Mourning Dove | 0.939 | 13 | 0.185 | 0.999 | 21 |
| Ring-necked Pheasant | 0.676 | 44 | 0.128 | 0.967 | 6 |
| Rock Wren | 0.367 | 24 | 0.217 | 0.547 | 13 |
| Red-winged Blackbird | 0.716 | 10 | 0.551 | 0.838 | 28 |
| Say's Phoebe | 0.443 | 62 | 0.082 | 0.876 | 7 |
| Western Kingbird | 0.308 | 32 | 0.154 | 0.522 | 6 |
| **Western Meadowlark** | 1 | - | - | - | 40 |
| **Yellow Warbler** | 0.077 | 56 | 0.025 | 0.214 | 3 |

## Riparian

The field technician surveyed 14 points classified as Riparian in AGFO between 18 May and 23 June 2010. Each point was surveyed 10 times throughout the season. The field technician recorded 2,072 bird detections of 45 species, eight of which were priority species.

The Red-winged Blackbird (849 detections), Common Yellowthroat (*Geothlypis trichas*) (203 detections), and Western Meadowlark (193 detections) were the most frequently detected species. We estimated densities for five species, one of which is a priority species (Table 3). The data yielded robust density estimates (CV < 50%) for four of these species. We estimated the proportion of points occupied (Psi) by 19 species, 4 of which are priority species (Table 4). The data yielded robust occupancy estimates (CV < 50%) for 15 of these species.

Table 3. Estimated densities per $km^2$ (D), percent coefficient of variation of estimates (% CV), lower (LCL) and upper (UCL) confidence limits and sample sizes (n) of breeding bird species in Riparian habitat within Agate Fossil Beds National Monument, 2010. S indicates the number of points used in analyses. Priority species are bolded.

| Species | Riparian (S=14) | | | | |
|---|---|---|---|---|---|
| | D | % CV | LCL | UCL | n |
| Common Yellowthroat | 178 | 61 | 133.9 | 238.3 | 194 |
| Mourning Dove | 4.2 | 24 | 2.7 | 6.3 | 70 |

| Species | Riparian (S=14) | | | | |
|---|---|---|---|---|---|
| | D | % CV | LCL | UCL | n |
| Ring-necked Pheasant | 1.2 | 38 | 0.6 | 2.5 | 42 |
| Red-winged Blackbird | 780 | 17 | 537.5 | 1041.7 | 722 |
| **Western Meadowlark** | 63 | 25 | 33.7 | 98.1 | 158 |

Table 4. Estimated proportion of sample units occupied (Psi), percent coefficient of variation of Psi (% CV), lower (LCL) and upper (UCL) confidence limits and number of points with one or more detections (n point) of breeding bird species in Riparian habitat within Agate Fossil Beds National Monument, 2010. Dashes indicate the data were insufficient for estimating site occupancy. A Psi estimate equal to 1 indicates the species was detected on all transects surveyed. S indicates the number of points used in analyses. Priority species are bolded.

| | Riparian (S=14) | | | | |
|---|---|---|---|---|---|
| **Species** | **Psi** | **%CV** | **LCL** | **UCL** | **n point** |
| American Goldfinch | 0.854 | 38 | 0.028 | 0.999 | 7 |
| American Robin | 0.288 | 52 | 0.088 | 0.630 | 4 |
| Bank Swallow | 0.662 | 20 | 0.380 | 0.862 | 9 |
| Barn Swallow | 0.545 | 26 | 0.281 | 0.786 | 7 |
| Brown-headed Cowbird | 0.461 | 30 | 0.222 | 0.719 | 3 |
| Blue-winged Teal | 0.565 | 37 | 0.196 | 0.874 | 6 |
| **Cassin's Sparrow** | 0.072 | 96 | 0.010 | 0.374 | 1 |
| Cliff Swallow | 0.522 | 23 | 0.300 | 0.735 | 8 |
| **Common Nighthawk** | 0.426 | 33 | 0.194 | 0.696 | 4 |
| Common Yellowthroat | 1 | -- | -- | -- | 14 |
| Eastern Kingbird | 0.502 | 27 | 0.260 | 0.742 | 7 |
| **Grasshopper Sparrow** | 0.072 | 97 | 0.010 | 0.371 | 1 |
| Killdeer | 0.801 | 14 | 0.502 | 0.942 | 11 |
| Mallard | 0.951 | 23 | 0.002 | 1.000 | 10 |
| Marsh Wren | 0.287 | 42 | 0.112 | 0.562 | 4 |
| Mourning Dove | 0.939 | 13 | 0.185 | 0.999 | 12 |
| Ring-necked Pheasant | 0.676 | 44 | 0.128 | 0.967 | 7 |
| Red-winged Blackbird | 1.000 | -- | -- | -- | 14 |
| Say's Phoebe | 0.112 | 100 | 0.013 | 0.556 | 1 |
| Western Kingbird | 0.308 | 32 | 0.154 | 0.522 | 5 |
| **Western Meadowlark** | 1 | -- | -- | -- | 14 |
| **Yellow Warbler** | 0.357 | 36 | 0.157 | 0.624 | 5 |

# DISCUSSION

## Grassland Priority Species

We were able to estimate density for four priority species detected in the Prairie stratum. RMBO also generated density estimates for these species in the Pawnee National Grassland, Comanche National Grassland, Oglala National Grassland, and Buffalo Gap National Grassland in 2010 (White et al 2010). Pawnee and Comanche National Grasslands, like AGFO, are in Bird Conservation Region 18 (BCR) 18) and have shortgrass prairie as the dominant habitat. The other grasslands are in the Badlands and Prairies BCR (BCR 17), but are in the same geographical region. Comparisons between these areas serve to place the AGFO bird community in the context of its region. We were unable to compare occupancy estimates between the two studies due to differences in study designs.

Grasshopper Sparrow (*Ammodramus savannarum*) had a higher density in AGFO than in other BCR 18 grasslands, but fewer than BCR 17 grasslands (Table 5). Lark Bunting densities were variable between grasslands and are difficult to assess because their populations tend to follow annual environmental factors, such as rainfall (Shane 2000). With this said, densities were higher in AGFO than the Buffalo Gap National Grassland, which is within 50 km and presumably has similar environmental conditions.

Lark Sparrow (*Chondestes grammacus*) had a high density in AGFO (D=81.9 birds/km$^2$) compared to the other national grasslands we surveyed. The next highest density for Lark Sparrow was 37.24 birds/km$^2$ in the Comanche National Grassland. We did not detect them in the Buffalo Gap or Oglala National Grassland National Grassland (43 points surveyed). Western Meadowlark densities were also unusually high in AGFO (D=112.5 birds/km$^2$). The next highest density was 45.93 birds/km$^2$ in the Oglala National Grassland and all estimates had robust estimates (CV<50%).

The comparatively high densities of grassland priority species suggest that AGFO is an important area for grassland birds. Additionally, these results imply a diverse grassland because it supports a wide array of grassland birds that have different microhabitat preferences (A. Poole 2011).

Table 5. Estimated densities per $km^2$ (D), percent coefficient of variation of estimates (% CV), and sample sizes (n) of priority bird species in Prairie habitat within Agate Fossil Beds National Monument (AGFO) and nearby national grasslands, 2010. S indicates the number of points used in analyses for AGFO and the number of transects used in analyses for national grasslands.

| Species | AGFO Prairie (S=40) | | | Pawnee NG (S=10) | | | Comanche NG (S=8) | | | Oglala NG (S=2) | | | Buffalo Gap NG (S=3) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | D | %CV | n | D | %CV | n | D | %CV | n | D | %CV | n | D | %CV | n |
| Grasshopper Sparrow | 75.9 | 49 | 88 | 18.2 | 32 | 38 | 9.4 | 61 | 15 | 102 | 14 | 23 | 106.4 | 13 | 62 |
| Lark Bunting | 47.3 | 26 | 232 | 71.8 | 25 | 228 | 8.2 | 31 | 20 | 14.6 | 100 | 5 | 49.6 | 55 | 44 |
| Lark Sparrow | 81.9 | 25 | 148 | 3.3 | 62 | 6 | 37.2 | 37 | 38 | - | - | - | - | - | - |
| Western Meadowlark | 112.5 | 23 | 398 | 30.5 | 19 | 182 | 26.4 | 19 | 121 | 45.9 | 19 | 32 | 33 | 37 | 55 |

## Previous surveys at AGFO

This monitoring builds upon similar surveys conducted in the monument over five breeding seasons between 2001 and 2006 (Pietz 2007). We surveyed the same points as in those seasons, however instead of one visit to each point, we incorporated multiple survey visits to increase the number of bird detections for density estimation and allow the estimation of detection probabilities for occupancy estimation. The park originally calculated densities of birds per ha and we converted these estimates to birds per km for comparison. Across all years, Red-winged Blackbird and Western Meadowlark were the only species that have density estimates for each year in both the Prairie and Riparian strata. Grasshopper Sparrow has density estimates for each year, but only for the Prairie stratum. There are no statistically comparable estimates of probability of occupancy because past surveys only included one visit per point.

This year we recorded the highest densities of Red-winged Blackbirds in both strata among the six years of surveys (Tables 6 and 7). Red-winged Blackbirds were unusually dense in the Prairie stratum (D=107.4 birds/km$^2$), where the density was more than double the next highest season (D=41.5 birds.km$^2$ in 2001). We also recorded the highest density to date of Western Meadowlark in the Prairie (D=112.5 birds/km$^2$). The previous high was in 2003 (D=68.1 birds/km$^2$). In all years the Western Meadowlark density had robust % CVs. Western Meadowlark was also relatively dense in the Riparian stratum, but all other years have estimates with % CV above 50. This year the density of Grasshopper Sparrow in the Prairie stratum (D=75.9 birds/km$^2$) was within the range of past density estimates. All density estimates had % CV below 50, except for 2001.

The high density estimates for Red-winged Blackbird and Western Meadowlark could be explained by the high amount of rainfall in Nebraska during the 2010 summer (May-July). This summer was the wettest summer since 1993 (National Oceanic and Atmospheric Administration (NOAA) 2011). The 14.75 inches of precipitation was 4.05 inches more than in 2005, the next wettest survey period.

We investigated the possibility of combining the previous data with the 2010 data in order to increase sample sizes for density estimates, but in this case it did not improve the number of species we were able to generate density estimates for. This is because the previous years of data had small sample sizes, likely due to single visits to each point each year. If monitoring continues, we will combine 2010 data with future data to obtain more robust estimates for species with current density estimates and increase the overall number of species with greater than 60 detections.

Currently with six seasons of variable effort surveys we cannot reach any conclusions about long-term population trends, because there is high annual variation in population sizes of the grassland birds we were able to generate estimates for. However, 2010 population estimates can be calculated for species with density estimates if we know the areas of the strata surveyed. We recommend calculating these areas if landbird monitoring continues at AGFO.

Table 6. Estimated densities per km$^2$ (D) and percent coefficient of variation of estimates (% CV) of bird species in Prairie habitat within Agate Fossil Beds National Monument, by year. 2001-2006 data converted from Pietz (2007).

| | 2001 | | 2003 | | 2004 | | 2005 | | 2006 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **D** | **% CV** | **D** | **% CV** | **D** | **% CV** | **D** | **% CV** | **D** | **% CV** | **D** | **% CV** |
| Grasshopper Sparrow | 104.6 | 86 | 161.9 | 21 | 138.2 | 23 | 49.1 | 27 | 94.3 | 28 | 75.9 | 49 |
| Red-winged Blackbird | -- | -- | 41.5 | 95 | 31.1 | 90 | 19.9 | 100 | 16.9 | 83 | 107.4 | 26 |
| Western Meadowlark | 7.1 | 39 | 68.1 | 21 | 40.7 | 29 | 41.9 | 15 | 43.3 | 24 | 112.5 | 23 |

Table 7. Estimated densities per km$^2$ (D) and percent coefficient of variation of estimates (% CV) of bird species in Riparian habitat within Agate Fossil Beds National Monument. 2001-2006 data converted from Pietz (2007).

| | 2001 | | 2003 | | 2004 | | 2005 | | 2006 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **D** | **% CV** | **D** | **% CV** | **D** | **% CV** | **D** | **% CV** | **D** | **% CV** | **D** | **% CV** |
| Red-winged Blackbird | 434.9 | 30 | 262.5 | 30 | 742.5 | 29 | 323.4 | 27 | 321.8 | 44 | 780 | 17 |
| Western Meadowlark | 14.7 | 59 | 66.7 | 77 | 19.1 | 48 | 46.8 | 56 | 11 | 61 | 63 | 25 |

## Notable Species for the Monument

Our survey period overlaps with the breeding season for most birds detected. Thus, many of the birds detected were likely breeding within the park. The purpose of these surveys was to determine landbird densities and community composition trends and we will not report on breeding activity beyond the few northwest Nebraska rare breeder species detected during surveys.

*Savannah Sparrow (Passerculus sandwichensis)*
Savannah Sparrows are rare breeders in northwest Nebraska and there are few documented breeding locations. A singing bird was detected on 21 May in the Prairie stratum. It was not detected in the next four visits to this point or anywhere else within the park. This date is after the migration window (Sharpe et al) yet before the breeding safe dates according to the Nebraska Breeding Bird Atlas (2006).

*Brewer's Blackbird (Euphagus cyanocephalus)*
One female was recorded on 20 May. Elsewhere in the state where Brewer's Blackbirds do not breed, late migrants can linger until early June (Sharpe et al 2001). However, there is a breeding population in Sioux County.

*Cinnamon Teal (Anas cyanoptera)*
One male was recorded on 23 and 24 May. It was not recorded after this. This species was also recorded in 2006 (Peitz 2007). Cinnamon Teal are rare nesters in northwest Nebraska.

*Mountain Bluebird (Sialia currucoides)*
A singing male was recorded on 24 May. This bird was most likely a late migrant, since habitat at AGFO is not its preferred breeding habitat.

## Recommendations for Future Monitoring

The National Park Service's ecological monitoring framework objectives include determining landbird population and community composition trends at both the park (unit) and landscape level (Gitzen et al. 2010). Landscape level trends will require partnerships with other agencies. During the past two summers RMBO and its partners have implemented a monitoring program for breeding landbirds across the Rocky Mountains, Great Plains and Intermountain West using a spatially balanced survey design and protocol (White et al 2010). During 2010, surveys were conducted in areas surrounding AGFO and the NGPN. Incorporating bird surveys at AGFO into this program could be a way to reduce costs and provide more accurate comparisons between bird populations within the park, the NGPN and other areas managed by different agencies. Because of the monument's small size it is more efficient to overlay a systematic grid of cells, and then select a uniform point within each cell, than to select a spatially-balanced grid of points where all points are surveyed. In larger park units, such as WICA, the spatially balanced design is more efficient. Incorporating landbird monitoring into each park within the NGPN will require looking at each park individually and designing a sampling plan that fits the characteristics of that particular park. The benefit of this nested design is that because detection probabilities should not differ between parks, we can make comparisons of species' densities among parks, among strata and to other areas outside NPS management. The scalability of this design allows also for intense sampling in some years, and reduced sampling when funding dictates, which may be the case in small Park Service units such as AGFO. This report emphasizes the

improvements made to effectively monitoring the landbird species of AGFO and helps to shape the development of long-term landbird monitoring in other parks of the NGPN.

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# APPENDIX A

List of priority species detected in Agate Fossil Beds National Monument according to Partners In Flight, Nebraska Game and Parks Commission, and US Fish and Wildlife Service (Partners in Flight 2005, Schneider et al. 2005, United States Fish and Wildlife Service 2008), what type of priority species[1], and whether we generated density or occupancy estimates for that species.

| Species | PIF BCR 18 | NGPC | USFWS BCR 18 | Density | Occupancy |
|---|---|---|---|---|---|
| Cassin's Sparrow | RC, RS | | | N | Y |
| Common Nighthawk | RC | | | N | Y |
| Grasshopper Sparrow | RC, CS, RS, | | | Y | Y |
| Lark Bunting | RC, CS, RS, | | BCC | Y | Y |
| Lark Sparrow | RC | | | Y | Y |
| Loggerhead Shrike | RC | Tier II | | N | N |
| Northern Harrier | RC | Tier II | | N | N |
| Say's Phoebe | RS | | | N | Y |
| Swainson's Hawk | CC, RS | Tier II | | N | N |
| Western Meadowlark | RS | | | Y | Y |
| Yellow Warbler | RC | | | N | Y |

[1]CC = Continental Concern Species; RC = Regional Concern Species; CS = Continental Stewardship Species; RS = Regional Stewardship Species; NGPC: Tier I = globally or nationally most at-risk of extinction; Tier II = State Critically Imperiled, State Imperiled or State Vulnerable; USFWS BCR 18, BBC= Birds of Conservation Concern for BCR 18.

# APPENDIX B

Number of points, by strata, where each species was detected at least once during season and number of individual detections during season.

| | Prairie | | Riparian | |
|---|---|---|---|---|
| Species | # of points detected on | # of detections | # of points detected on | # of detections |
| American Goldfinch | 5 | 9 | 7 | 11 |
| American Kestrel | 1 | 1 | -- | -- |
| American Robin | 5 | 11 | 5 | 10 |
| Bank Swallow | 3 | 7 | 9 | 26 |
| Barn Owl | 1 | 1 | 1 | 1 |
| Barn Swallow | 8 | 9 | 7 | 20 |
| Blue Grosbeak | 1 | 1 | 2 | 3 |
| Blue-winged Teal | 1 | 1 | 7 | 12 |
| Brewer's Blackbird | 1 | 1 | -- | -- |
| Brown Thrasher | 1 | 1 | 1 | 6 |
| Brown-headed Cowbird | 14 | 25 | 3 | 3 |
| Canada Goose | 1 | 1 | -- | -- |
| Cassin's Sparrow | 13 | 28 | 1 | 1 |
| Cinnamon Teal | -- | -- | 2 | 2 |

| Species | Prairie | | Riparian | |
|---|---|---|---|---|
| | # of points detected on | # of detections | # of points detected on | # of detections |
| Cliff Swallow | 10 | 14 | 8 | 18 |
| Common Grackle | 2 | 3 | 4 | 9 |
| Common Nighthawk | 9 | 14 | 5 | 9 |
| Common Yellowthroat | 14 | 51 | 14 | 203 |
| Eastern Kingbird | 5 | 11 | 7 | 40 |
| Eurasian Collared-Dove | 3 | 4 | 4 | 4 |
| European Starling | 2 | 4 | 1 | 2 |
| Grasshopper Sparrow | 25 | 94 | 1 | 1 |
| Great Blue Heron | 3 | 4 | 7 | 11 |
| Great Horned Owl | -- | -- | 1 | 1 |
| Horned Lark | 26 | 96 | -- | -- |
| Killdeer | 19 | 28 | 11 | 44 |
| Lark Bunting | 31 | 266 | -- | -- |
| Lark Sparrow | 37 | 164 | -- | -- |
| Loggerhead Shrike | 1 | 3 | -- | -- |
| Mallard | 2 | 2 | 11 | 31 |
| Marsh Wren | -- | -- | 4 | 22 |
| Mountain Bluebird | -- | -- | 1 | 1 |
| Mourning Dove | 40 | 126 | 13 | 80 |
| Northern Flicker | 3 | 3 | 1 | 2 |
| Northern Harrier | 3 | 5 | 5 | 8 |
| Northern Shoveler | -- | -- | 2 | 2 |
| Orchard Oriole | -- | -- | 1 | 1 |
| Red-winged Blackbird | 33 | 274 | 14 | 849 |
| Ring-necked Pheasant | 33 | 59 | 13 | 45 |
| Rock Wren | 25 | 92 | -- | -- |
| Savannah Sparrow | 1 | 1 | -- | -- |
| Say's Phoebe | 16 | 25 | 4 | 4 |
| Sora | 3 | 3 | 8 | 12 |
| Swainson's Hawk | 2 | 3 | 2 | 3 |
| Tree Swallow | 2 | 2 | 1 | 5 |
| Turkey Vulture | 1 | 1 | -- | -- |
| Upland Sandpiper | 8 | 8 | 4 | 4 |
| Virginia Rail | 2 | 3 | 7 | 9 |
| Western Kingbird | 6 | 10 | 5 | 11 |
| Western Meadowlark | 40 | 517 | 14 | 193 |
| Western Wood-Pewee | 2 | 2 | 2 | 4 |
| Wilson's Snipe | 15 | 25 | 8 | 15 |
| Wood Duck | 1 | 1 | 4 | 4 |
| Yellow Warbler | 3 | 13 | 5 | 34 |

| Species | Prairie | | Riparian | |
|---|---|---|---|---|
| | # of points detected on | # of detections | # of points detected on | # of detections |
| Yellow-headed Blackbird | 8 | 11 | 8 | 18 |