Breeding Birds of Lacreek NWR: 2015

US Fish and Wildlife Service and Bird Conservancy of the Rockies

Lacreek NWR
29746 Bird Road
Martin, SD 57551

Introduction

As a result of the National Wildlife Refuge Improvement Act of 1997 and Part 602 (National Wildlife Refuge System Planning) of the Fish and Wildlife Service Manual, each National Wildlife Refuge was required to create a fifteen year management plan titled the Comprehensive Conservation Plan (CCP). The plan defines the role that Lacreek National Wildlife Refuge (LNWR) plays in support of the National Wildlife Refuge System and provides long-term guidance to management programs and activities (LNWR CCP 2006). One of the purposes of the CCP was to identify "priority wildlife species" that occupy the refuge and their specific habitats requirements. To provide the baseline bird data needed to direct the creation of the LNWR CCP, the USGS Northern Prairie Wildlife Research Center and the LNWR developed a survey to determine the breeding birds throughout the refuge in 2002 and 2003 (unpubl. report Finkbeiner and Johnson 2002, Allen and Johson 2003). Once this survey was completed, bird species presence was determined with in each ecotype on the refuge as well as abundance. Next we looked at several federal, state, and private "birds of concern lists." These lists are created based on population status and habitat conditions for bird species in certain biological regions. Some birds, such as the long-billed curlew appear on as many as eight different lists. The species that appeared on many multiple lists and were confirmed nesters on the refuge were of the highest management concern and deemed "priority species" within the CCP (Table 1). From the USGS survey it was determined, that the refuge's grasslands and wet meadows provide breeding habitat for many obligate grassland birds including species of biological concern such as bobolink (*Dolichonyx oryzivorus)*, grasshopper sparrow (*Ammodramus savannarum*), and upland sandpiper (*Bartramia longicauda)* (USFWS 2002). Once the Lacreek CCP priority species were identified, an extensive literature search was conducted to determine the specific habitat requirements for each priority species (Summary Table 2). Things like plant composition, patch size, litter depth, and distance from trees were used to create science-based CCP objectives for the grassland and wet meadow habitats found on the refuge.

In order to assess the current status of breeding birds on the refuge, a point count survey was conducted during the breeding season of 2015 by LNWR and the Bird Conservancy of the Rockies (Conservancy). Additionally, specific habitat variables such as litter depth, plant composition, and VOR etc. were measured at points where priority species occurred within upland and wet meadow habitats. Comparisons were then made between survey periods to determine if any changes in densities have occurred since the initial baseline survey. The purpose of this survey was to: 1) determine the densities of breeding birds in the upland and wet

meadow habitats on Lacreek NWR; 2) compare the results of this survey to the USGS surveys and determine if changes occurred in bird densities; 3) characterize habitat and identify key habitat variables for priority species; and 4) confirm habitat requirements for priority species that were outlined in the Lacreek NWR upland and wet meadow habitat objectives.

Table 1. Priority species based on its appearance on four or more "birds of concern" lists and confirmed breeding on the refuge, Lacreek National Wildlife Refuge CCP.

Priority Species	*Life Cycle Activity*	*Priority Status Noted*
Long-billed Curlew	Breeding, Migration	BCCBCR17&19, BCR 17(B), BCR 19 (W)(B), AUD, SD Plan, SD Hert
Wilson's Phalarope	Breeding, Staging, Migration	BCCBCR17&19, BCR 17(B), BCR 19(B), AUD, RSHBRD, SD Plan
Trumpeter Swan	Wintering, Migration	BCR 17(B)(W), BCR 19(B)(W), AUD, SD Plan
Short-eared Owl	Breeding	BCCBCR17, BCR 17(B)(W), BCR 19(W), AUD
Burrowing Owl	Breeding	BCCBCR17, BCR 17(B), BCR 19(W), SD Plan, SD Hert
Marbled Godwit	Staging, Migration	BCCBCR17, BCR 17(B), AUD, RSHBRD, SD Plan
Upland Sandpiper	Breeding, Migration	BCCBCR17, BCR 17(B), BCR 19(B), RSHBRD, SD Plan
Bell's Vireo	Breeding, Migration ?	BCCBCR 19, BCR 17(B), BCR 19(B), AUD, SD Plan
A. White Pelican	Breeding,	BCR 17(B), BCR 19(B), SD Plan, SD Hert
Dickcissel	Breeding, Migration	BCCBCR17, BCR 17(B), BCR 19(B), AUD
Grasshopper Sparrow	Breeding, Migration	BCCBCR17, BCR 17(B), BCR 19(B), SD Plan
Northern Harrier	Breeding, Migration	BCCBCR 19, BCR 17(B), BCR 19(B), BCR 19(W)
Waterfowl	Breeding, Migration, Staging, Wintering	

Note: BCC= Birds of Conservation Concern (USFWS 2002); BCR =Bird Conservation Region (No. American Bird Conservation Initiative); BCR 17 is Badlands and Prairie Region and BCR 19 is Central Mixed Grass Prairie Region; AUD= Audubon; RESBRD=Northern Plains Regional Shorebird Plan; SD Plan= South Dakota All Bird Conservation Management Plan; SD Hert= South Dakota Natural Heritage Program.

Table 2. Nesting and foraging habitat requirements for selected grassland birds.

Species	*Vegetation height*	*Litter*	*Patch size (acres)*	*Distance from trees*
Bobolink	25 to 45 cm	3.4 to 9.1 cm	100	45 m
Burrowing owl	<13 cm	minimal	10	Greater than 100 m
Dickcissel	21 to 100 cm	1.6 cm	25	prevent woody encroachment
Long-billed Curlew	<30 cm	minimal	104	avoids trees and shrubs
Grasshopper sparrow	20 to 60 cm	Not available	20	50 m
Sharp-tailed grouse	15 to 40 cm	idle for several years	150	Greater than 50 m
Short-eared owl	30 to 60 cm	2-8 yrs. of litter	183	Not available
Upland sandpiper	3 to 60 cm	2.3 cm	250	100 m

Source: Grant 1965; Wiens 1973; Clark 1975; Duebbert and Lokemeon 1977; Redmond et al. 1981; Johnsgard 1983; Prose 1987; Renken 1987; Messmer 1990; Haug et al. 1993; Herkert et al. 1993; Pampush and Anthony 1993; Helzer 1996; Hughes 1996; Madden 1996; Connelly et al. 1998; Clayton and Shcmutz 1999; Helzer and Jelinski 1999; Dugger and Dugger 2002; Laubhan et al. 2005.

Methods

Habitat Classification and Point Selection:

As part of the USGS breeding bird study on LNWR, eight vegetative ecotypes were delineated based on National Vegetation Classification System (NVCS) criteria and refuge-specific information needs (Table 3) (unpubl. report Finkbeiner and Johnson 2002, and Allen and Johnson 2003). A grid of points spaced 450 m apart was generated in GIS and overlaid on the digital vegetation NVCS ecotype map (BLM 2002). Bird point counts were conducted throughout the refuge (excluding open water areas and the pelican nesting islands) and bird densities (# birds/100 ha) by ecotype were determined for 2002 and 2003. Additionally, area searches were conducted in prairie dog towns and secretive marsh bird surveys in impounded wetlands alternatively to point counts in each of these habitats. Of primary interest during the 2015 survey were bird species that occurred in the uplands, sandhills, and wet meadows habitats, so points that fell within areas such as impounded wetlands, streams, forested wet lands, prairie dog towns, and close to the refuge boundary were excluded from this survey because of specific information needs, and time and personnel limitations. Furthermore, marshbird surveys have been conducted almost annually since 2004 on LNWR and a Master's Thesis project concerning site specific marsh bird-habitat relationships within wetland areas was previously conducted by McWilliams (2010). For these reasons, playback call surveys for secretive waterbirds were not conducted in 2015 as in the USGS survey. Consequently, a total of 200 points were selected on LNWR within five habitat types: dry mixed-grass prairie, dry shurbland, introduced grassland, restoration area, and wet meadow (Table 3). There were a greater number survey points in the introduced grass and restoration area ecotypes during 2015 because some points that fell in the provisional or other eco-types during the USGS survey were later assigned to the appropriate ecotype, i.e., an agriculture field (provisional) was converted to a restoration, or "other" was eventually classified visually in the field.

Table 3. Major ecotypes on Lacreek NWR as well as the number of points and area surveyed during the USGS and USFWS/Conservancy survey.

Vegetative Eco-type	Number of Points 2002 and 2003	Area Surveyed (ha) 2002 and 2003	Number of Points 2015	Area Surveyed (ha) 2015
Dry mixed-grass prairie	71	222.9	51	160.0
Dry plains shrubland	28	87.9	14	47.1
Introduced grassland	58	182.1	60	185.1
Restoration Areas	18	56.5	27	81.6
Mesic plains shrubland	3	7.1	0	0.0
Wet meadow	81	207.2	48	150.6
Forested wetland	3	4.7	0	0.0
Provisional land use	59	152.3	0	0.0
Other	6	18.8	0	0.0
Total	**327**	**939.5**	**200**	**624.4**

Bird survey methods:

There were differences in techniques between the USGS survey (2002, 2003) and the LNWR/Bird Conservancy survey (2015): 1) double observes were not used the first round in 2015, 2) surveys ended at 10 AM as opposed to 11 AM during the USGS survey, 3) early and late surveys were defined as before 8AM and after 8AM in 2015, 4) only female brown-headed cowbirds were recorded during the USGS survey, and 5) bird locations were recorded at any distance in 2015, but restricted to 100 m during the USGS survey with the exception of raptors that were recorded at an unlimited distance for each survey.

One hundred ninety-nine points were surveyed between May 27, 2015 and June 09, 2015 with points being surveyed twice during this period. One of the wet meadow points was not surveyed because it was inaccessible due to high water. The first round of surveys began in May and the second round began in June. Observers navigated to each point using hand-held Garmin Global Positioning System (GPS) units, and conducted surveys beginning ½-hour before sunrise and concluded no later than 10 AM. Each point was surveyed by a different observer each round, so that no point was surveyed by the same individual twice. Visits to each station were alternated between early (before 8AM) and late (after 8AM) morning. In some instances it was not feasible to survey a point early one round and late the next, in this situation the points were surveyed early both rounds because birds are generally more vocal before 8AM. Bird observations were recorded using the Integrated Monitoring in Bird Conservation Region (IMBCR) forms. GPS related data were recorded immediately before bird surveys were conducted. If the observer was not able to survey from the exact point, the point count survey was conducted from anywhere within 25-m of the exact point. Each survey day, observers recorded their name, start and end times, point identification, GPS accuracy, and weather conditions (ambient air temperature, cloud cover, precipitation and wind speed). During the five minute point count, the following data were recorded: start time, bird species, sex (if possible), horizontal distance from the observer, minute, and type of detection (e.g., call, song, visual). All bird species were recorded in an unlimited distance category, and observers measured distances to each bird using laser rangefinders. When it was not possible to measure the distance to a bird, observers estimated the distance by measuring to some nearby object. Any bird flushed before or after the point count were recorded, but the distance from the observer was not determined. Observers 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. Observers recorded the number of birds detected within each cluster along with a letter code to distinguish between multiple clusters. Surveys were not conducted in the presence of winds > 24 mph (Beaufort scale 5), steady rain, or excessive noise.

Habitat Characterization methods:

Since identifying priority species habitat requirements was of primary interest for creating habitat models and was used to check CCP objectives, we measured habitat only where priority bird species were recorded and not at all point count station locations. Unfortunately, we didn't

have the personnel resources available to conduct the bird and habitat surveys simultaneously, so we began the habitat surveys one week after the completion of the bird surveys on June 16, 2015. An ArcMap script was used to generate 25 meter transects with the endpoint of the transect located directly at the same location as the bird point count station. The azimuth of each transect was randomly chosen by the script. To determine where habitat characterization would take place, we first identified all the points where at least one priority species was recorded during the

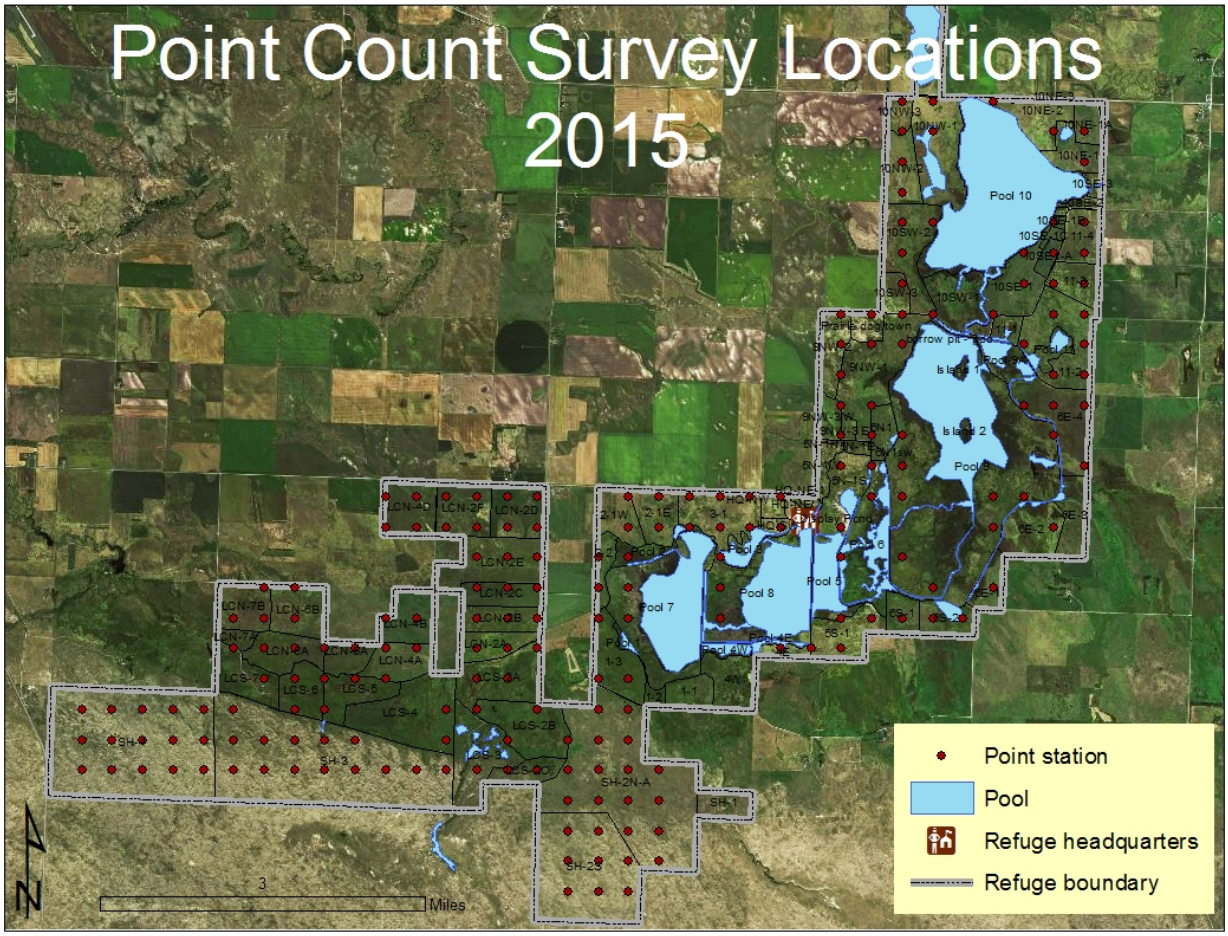


Figure 1. Point count locations on Lacreek National Wildlife Refuge. Two hundred points total with 199 completed in 2015 (one point was not accessible due to high water).

point count breeding survey (see Table 2 for species). A list of points was then generated indicating the presence or absence of a priority species. Each point where a priority species occurred was labeled a "use point" alternatively each point were no priority species occurred was labeled a "non-use" point. We then eliminated any use points where priority species were recorded at distances greater than 200 meters from the observer. Once the use points were identified, we determined if there were a sufficient number of points to create habitat models for each priority species. We decided to collect habitat data if there were at least 25 independent bird observations for each priority species e.g., at least 25 grasshopper sparrow, 25 upland

sandpiper, 25 bobolink etc. If these criteria were met, we further eliminated any points where priority species were recorded at distances greater than 100 meters from the observer, with the expectation of upland sandpiper. We retained all points where upland sandpipers were recorded so we would have enough samples to create a habitat model for this species. We chose a 100 meter radius for the bound because that was the greatest distance which birds were recorded during the USGS survey (except raptors), and it was reasoned bird/habitat associations would be representative of what priority species require within this distance. The final list of use points where habitat measurements were taken was where at least one or more priority species occurred within a 100 meter radius of the point count station.

The transect file generated from the point count station shape file was then used to navigate to and place transects. Since the transects in the shapefile were only 25 meters long and we needed data for an additional 25 meters we extended the transect so that the point count station location was at the midpoint of the 50 meter transect. At each transect we collected vegetation composition data using the belt transect method, and structure data at the 10m, 20m, 30m, and 40m location to include grass and forb effective vegetation height (GEVH and FEVH), visual obstruction reading (VOR), litter depth, and distance to trees. A tree was defined as any tree or shrub that was over three meters in height in accordance with the CCP upland and wet meadow objectives. The distance to trees was estimated using a range finder and any distances greater than 301meters were recorded as >301 because there were instances of no trees present or trees were present at a distances greater than what the range finder could accurately detect. Patch size was determined later using the NVCS vegetation map, and was defined as an area contiguous with the habitat transect that was of the same cover type and condition as the survey area (Bakker et al. 2002).

Bird Abundance Data Analysis:

Once all of the point count surveys were completed, the field data sheets were scanned, saved as .pdf files and the data was entered into the Conservancy database. An Excel spreadsheet of all the Conservancy database information for this survey was created and provided to the refuge, as well as the scanned data sheet files. A copy of the original spreadsheet was created for analysis, and the original was saved so all the data from the survey was conserved. Within the analysis spreadsheet of the 2015 survey data, any birds recorded beyond 100 meters (except for raptors) was eliminated so that density estimates were calculated in the same manner as the baseline USGS survey. During the USGS survey, the distances from the observer to bird(s) were only estimated within a 100-m radius while all birds at any distance were recorded during the 2015 survey. After all the survey points with birds within a 100-m radius were identified, the ecotype surrounding each point was categorized based on the NVCS map. Next the number of hectares within each ecotype was determined in ArcMap 10.1 by: 1) creating a 100-meter radial buffer around each point, 2) using the select by location function to select only the areas of the NVCS map that occurred within that 100-m buffer, 3) using the selection by attribute function to then select each ecotype (dry mixed-grass prairie, wet meadow, etc.) within the buffers, and 4) once

those areas were selected for each ecotype the total number of hectares was calculated with the calculate geometry function.

Bird point count densities are often reported as the number of birds per hectare(s) (Pulliam and Enders 1971, Ralph et al. 1995, Benoit et al. 2001, Diefenbach et al. 2003) as was the case with the USGS survey. Consequently, densities were calculated using this same method for this analysis. Although counts and densities were calculated for all species observed within each ecotype, only the four highest ranking bird species occurring each year and the birds of concern listed in the CPP were used for comparisons between the USGS and the 2015 survey. To evaluate if any changes had occurred in bird densities within each ecotype, the averages and variances were estimated for each year of the survey, 95% confidence intervals were calculated, and then the results compared. Variances were calculated using Number Cruncher Statistical Software (Hintze 2013) by running a bootstrap on the max number of birds per species recorded at each point. The max number was defined as the highest count of a species recorded either round of the survey, and not a total count of birds for both surveys combined. Next the density estimates were compared, and if a density fell within the 95% confidence interval it was assumed there was no statistical difference between the estimates and thus no changes occurred. If the threshold density was outside the 95% confidence interval it was assumed that there was a statistical difference between the densities and that a change did occur. This procedure was repeated for the priority species listed in the CCP (Table 2) with the exception of calculating densities within each ecotype for analyzes i.e., the density and variance estimates for each priority species in each ecotype were combined to obtain a single density and associated variance values for each species.

Bird Habitat Analysis:

We had enough bird observations to create habitat models for three priority bird species: 1) bobolink, 2) grasshopper sparrow, and 3) upland sandpiper. We entered all vegetative species composition and structure data into excel i.e., percent native grass, percent invasive grass, litter depth, and VOR etc. We then filtered transects based on one of the three bird species so that only specific transects were analyzed. For example, when calculating the average litter depth for upland sandpiper we only displayed and analyzed the transects that corresponded with the points where sandpipers were observed. We then conducted descriptive statistical analysis for these transects to determine averages, variances, and ranges for each habitat variable. We also looked at percentiles for each variable to examine how they related to the CCP upland and wet meadow objectives. The CCP objectives outline specific parameters for vegetation composition and structure, patch size, and distance from trees; all of which were derived from scientific studies conducted on the priority species listed in the CCP (Table 2).

Next the excel file was saved as a .cvs file and imported into R. The dataset of all the transect data was subset for bobolink, grasshopper sparrow, and upland sandpiper so that there were no duplicate records. Logistic regression was used to create models for each priority species and to identify the important habitat variable(s) for each priority species. First, use and non-use fields

were created with in the subset for each species, so that the number 1 represented the presence (use) of a species and the number 0 represented the absence (non-use) of a species. So when creating a model for bobolink, or the other two priority bird species, every point and associated transects where a bobolink was recorded was now represented as a 1 and everything else was represented as a 0. Habitat models were created solely for these species because there were not enough observations made of other priority species. We used Akaike's information criterion (AIC) (Akaike 1969) as a basis for model selection. We considered the model that yielded the smallest AIC value the best approximation for the information in the data set (Burnham and Anderson 1998).

Results

Bird abundance by ecotype and comparisons of survey results: The maximum number of breeding bird pairs recorded at each point from the two surveys and the densities were determined within each ecotype vegetation classification. Of the 43 species recorded in dry mix-grass prairie, western meadowlark (50.62 pairs/100 ha), red-winged blackbird (33.12 pairs/100 ha), and grasshopper sparrow (30.00 pairs/100ha) were the most common species recorded.

Fourteen species were recorded in dry plains shrubland, of which the western meadowlark (34.00 pairs/100 ha), lark sparrow (14.87 pairs/100ha), and mourning dove (10.62 pairs/100ha) were most common. These were also the top species recorded during the 2003 USGS survey.

The most common of the 58 species recorded in the introduced grasslands were red-winged blackbird (76.71 pairs/100ha), western meadowlark (44.84 pairs/100ha), and bobolink (28.63 pairs/100ha). These were also the top species recorded during the 2003 USGS survey.

Of the 37 species recorded in restoration areas, the highest ranking species were western meadowlark (62.52 pairs/100 ha), red-winged black birds (56.39 pairs/100ha), bobolink (45.36 pairs/100 ha), and grasshopper sparrow (23.29 pairs/100 ha).

Of the 52 species recorded in wet meadows, the top species recorded were red-winged blackbird (94.95 pairs/100 ha), common yellowthroat (25.23 pairs/100ha), and western meadowlark (27.89 pairs/100ha).

Table 4. Comparison of densities (per 100 ha) of highest ranking species in each eco-type per year.

Year	**2002**			**2002**		
Habitat	Dry mixed-grass prairie	count	density	Dry plains shrub	count	density
Species	Western meadowlark	104	65.00	Western meadowlark	29	61.62
	Grasshopper Sparrow	67	41.87	Lark sparrow	16	34.00
	Bobolink	25	15.62	Grasshopper Sparrow	5	10.62
	Red-winged blackbird	16	10.00	Mourning Dove	3	6.37
Year	**2003**			**2003**		
Habitat	Dry mixed-grass prairie	count	density	Dry plains shrub	count	density
Species	Western meadowlark	39	25.37	Western meadowlark	23	52.36
	Grasshopper Sparrow	23	14.96	Lark sparrow	15	34.15
	Red-winged blackbird	18	11.71	Mourning dove	2	4.55
	Bobolink	16	10.41	Grasshopper Sparrow	1	2.28
Year	**2015**			**2015**		
Habitat	Dry mixed-grass prairie	count	density	Dry plains shrub	count	density
Species	Western meadowlark	81	50.62	Western meadowlark	16	34.00
	Red-winged blackbird	53	33.12	Lark sparrow	7	14.87
	Grasshopper Sparrow	48	30.00	Mourning dove	5	10.62
	Bobolink	17	10.62	Grasshopper sparrow	1	2.12
Habitat	Dry mixed-grass prairie	2002	48	Dry plains shrub	2002	17
Richness		2003	60		2003	22
		2015	43		2015	14

Table 4 (continued). Comparison of densities (per 100 ha) of highest ranking species in each eco-type per year.

Year	**2002**			**2002**		
Habitat	Introduced Grass	count	density	Restoration Area	count	density
Species	Western meadowlark	103	55.64	Western meadowlark	45	55.16
	Red-winged blackbird	51	27.55	Red-winged blackbird	22	26.97
	Grasshopper Sparrow	45	24.31	Bobolink	20	24.52
	Bobolink	38	20.53	Grasshopper Sparrow	11	13.48
	Cliff swallow	46	24.85			
Year	**2003**			**2003**		
Habitat	Introduced Grass	count	density	Restoration Area	count	density
Species	Red-winged blackbird	47	31.21	Western meadowlark	14	20.28
	Western meadowlark	26	17.26	Red-winged blackbird	13	18.83
	Bobolink	13	8.63	Grasshopper Sparrow	6	8.69
	Cliff swallow	32	21.25	Bobolink	1	1.45
	Grasshopper Sparrow	8	5.31			
Year	**2015**			**2015**		
Habitat	Introduced Grass	count	density	Restoration Area	count	density
Species	Red-winged blackbird	142	76.71	Western meadowlark	51	62.52
	Western meadowlark	83	44.84	Red-winged blackbird	46	56.39
	Bobolink	53	28.63	Bobolink	37	45.36
	Grasshopper sparrow	14	7.56	Grasshopper Sparrow	19	23.29
	Cliff swallow	9	4.86			
Habitat	Introduced Grass	2002	47	Restoration Area	2002	34
Richness		2003	58		2003	41
		2015	58		2015	37

Table 4 (continued). Comparison of densities (per 100 ha) of highest ranking species in each eco-type per year.

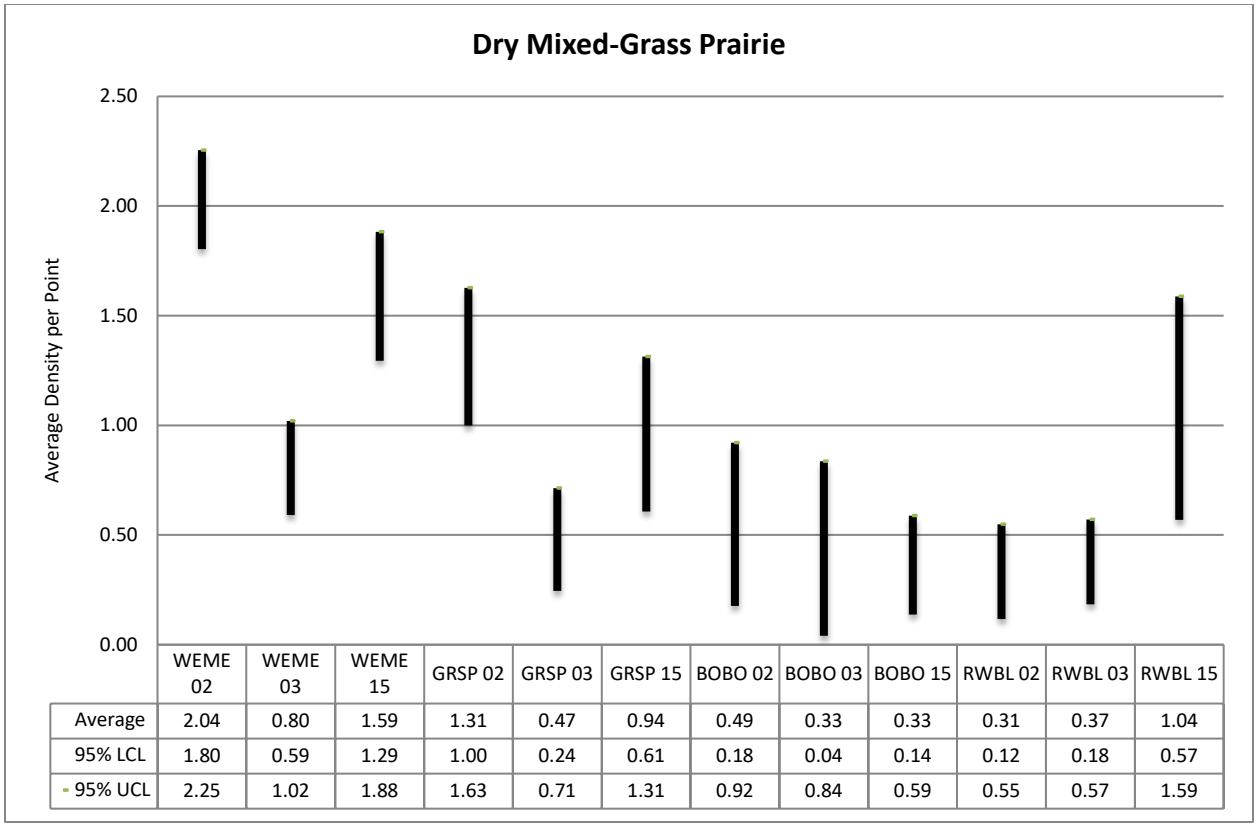
Year	**2002**		
Habitat	Wet Meadow	count	density
Species	Red-winged blackbird	112	74.37
	Bobolink	40	26.56
	Common yellowthroat	49	32.54
	Western meadowlark	53	35.19
Year	**2003**		
Habitat	Wet Meadow	count	density
Species	Red-winged blackbird	53	39.28
	Common yellowthroat	19	14.08
	Bobolink	15	11.12
	Western meadowlark	11	8.15
Year	**2015**		
Habitat	Wet Meadow	count	density
Species	Red-winged blackbird	143	94.95
	Common yellowthroat	38	25.23
	Western meadowlark	42	27.89
	Bobolink	18	11.95
Habitat	Wet Meadow	2002	66
Richness		2003	65
		2015	52

Table 5. Summary of changes that occurred between the highest ranking species of USGS baseline survey in the 2002 and the USFWS/Conservancy survey in 2015.

Ecotype	**Dry mixed-grass prairie**	**Change in 2015**	**Dry plains shrub**	**Change in 2015**
Species	Western Meadowlark	Decrease	Western Meadowlark	Decrease
	Grasshopper Sparrow	Slight decrease	Lark Sparrow	Decrease
	Red-winged Blackbird	Increase	Mourning Dove	No change
	Bobolink	No change	Grasshopper Sparrow	Decrease
Ecotype	**Introduced grass**	**Change in 2015**	**Restoration Area**	**Change in 2015**
Species	Red-winged Blackbird	Increase	Western Meadowlark	No change
	Western Meadowlark	Decrease	Red-winged Blackbird	Increase
	Bobolink	Increase	Bobolink	Increase
	Cliff Swallow	Decrease	Grasshopper Sparrow	Increase
	Grasshopper Sparrow	Decrease		
Ecotype	**Wet meadow**	**Change in 2015**		
Species	Red-winged Blackbird	Increase		
	Common Yellowthroat	No change		
	Western Meadowlark	No change		
	Bobolink	No change		

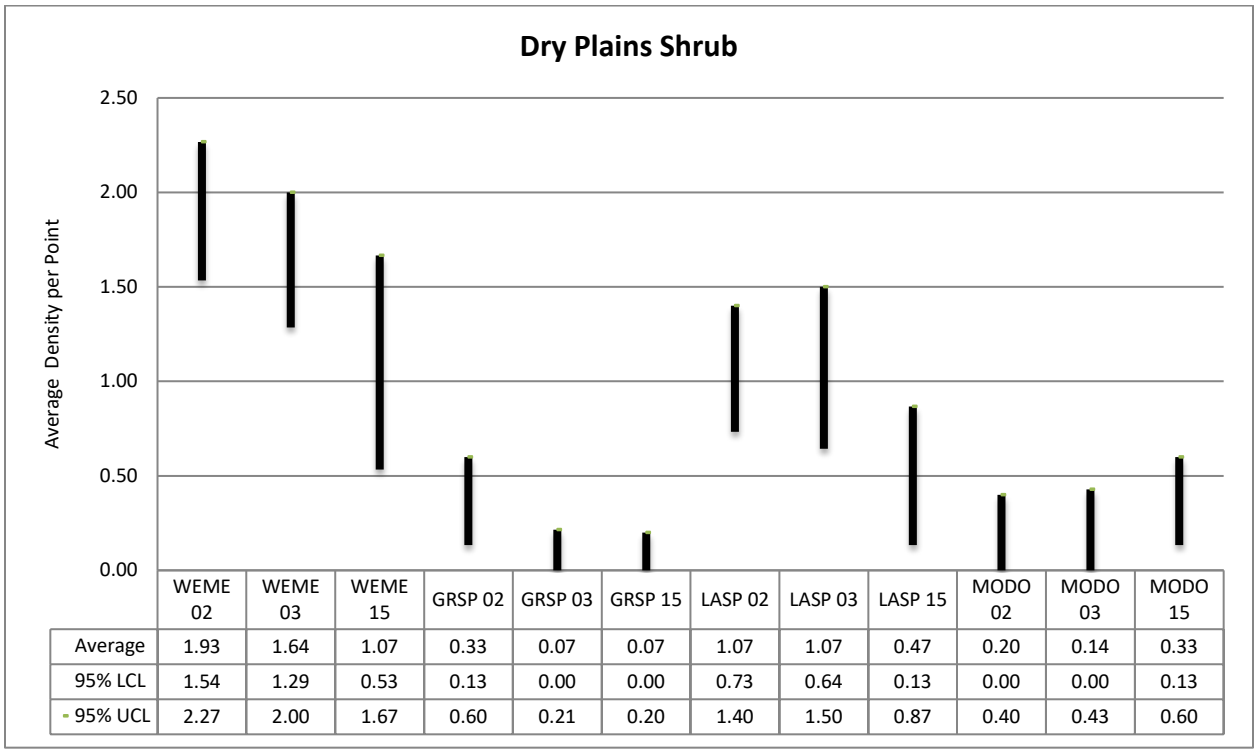
Table 6. Summary of changes that occurred between the highest ranking species of USGS baseline survey in the 2003 and the USFWS/Conservancy survey in 2015.

Ecotype	**Dry mixed-grass prairie**	**Change in 2015**	**Dry plains shrub**	**Change in 2015**
Species	Western Meadowlark	Increase	Western Meadowlark	Decrease
	Grasshopper Sparrow	Increase	Lark Sparrow	Decrease
	Red-winged Blackbird	Increase	Mourning Dove	No change
	Bobolink	No change	Grasshopper Sparrow	No change
Ecotype	**Introduced grass**	**Change in 2015**	**Restoration Area**	**Change in 2015**
Species	Red-winged Blackbird	Increase	Western Meadowlark	Increase
	Western Meadowlark	Increase	Red-winged Blackbird	Increase
	Bobolink	Increase	Bobolink	Increase
	Cliff Swallow	No change	Grasshopper Sparrow	Increase
	Grasshopper Sparrow	No change		
Ecotype	**Wet meadow**	**Change in 2015**		
Species	Red-winged Blackbird	Increase		
	Common Yellowthroat	Increase		
	Western Meadowlark	Increase		
	Bobolink	Increase		



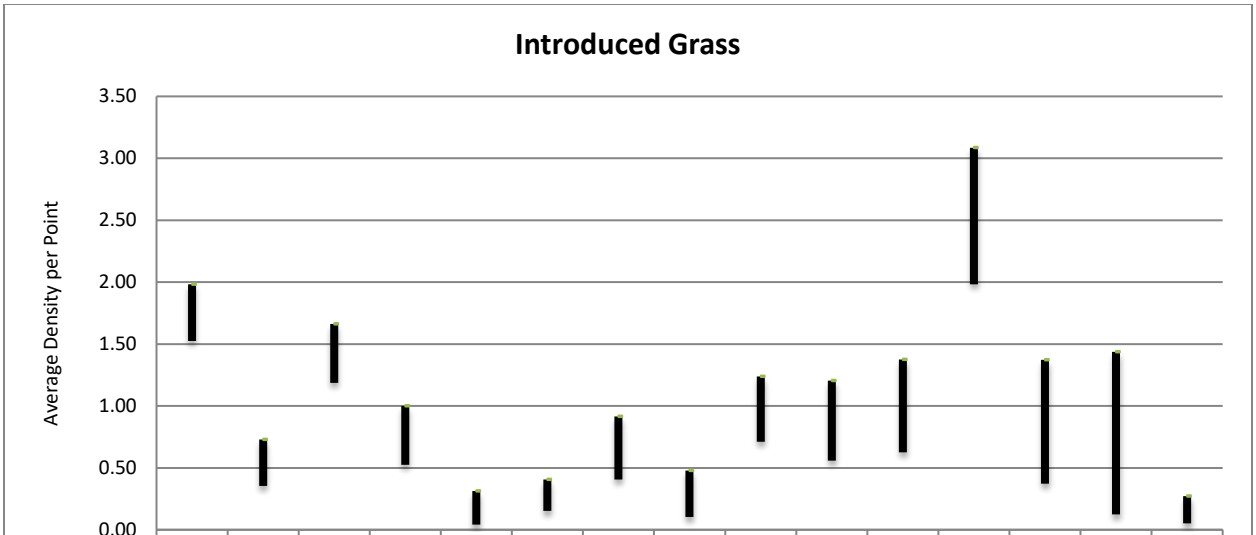
	WEME 02	WEME 03	WEME 15	GRSP 02	GRSP 03	GRSP 15	BOBO 02	BOBO 03	BOBO 15	RWBL 02	RWBL 03	RWBL 15
Average	2.04	0.80	1.59	1.31	0.47	0.94	0.49	0.33	0.33	0.31	0.37	1.04
95% LCL	1.80	0.59	1.29	1.00	0.24	0.61	0.18	0.04	0.14	0.12	0.18	0.57
95% UCL	2.25	1.02	1.88	1.63	0.71	1.31	0.92	0.84	0.59	0.55	0.57	1.59

Figure 2. Changes in densities for selected bird species with in the dry-mixed grass prairie ecotype.



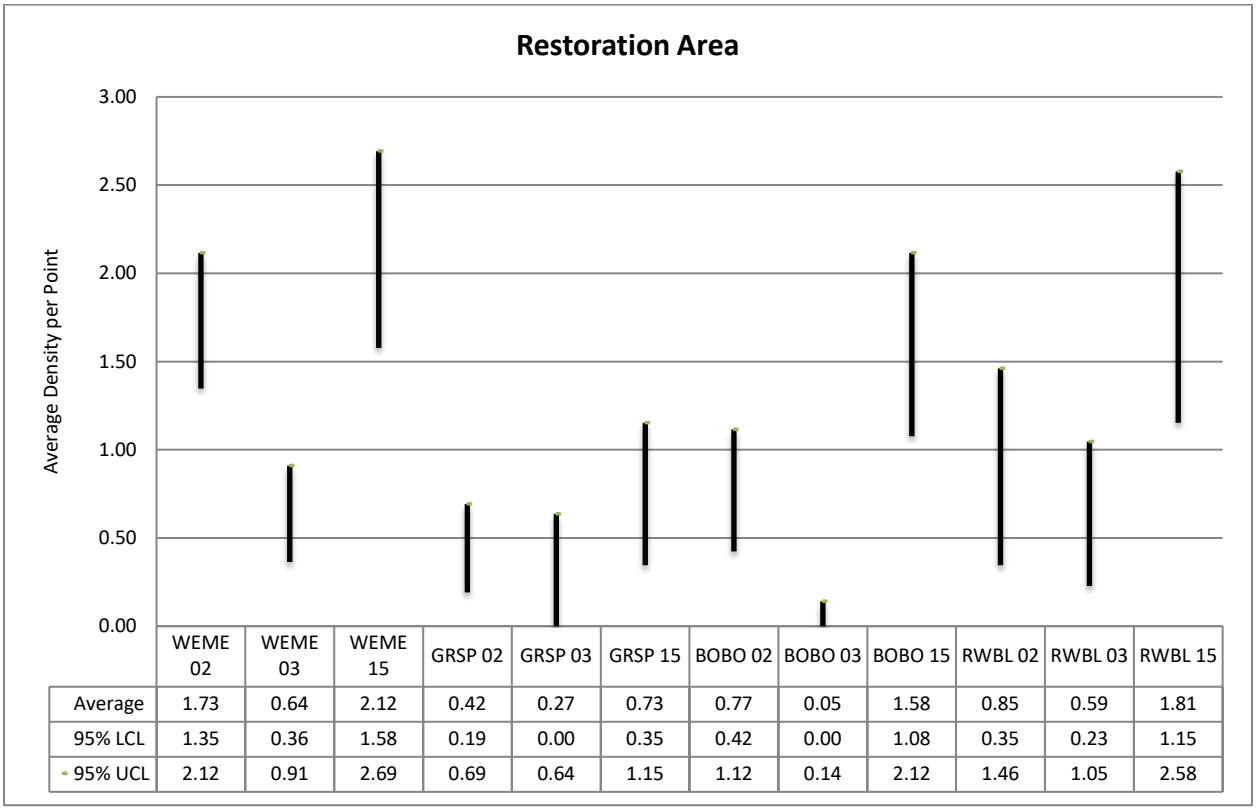
	WEME 02	WEME 03	WEME 15	GRSP 02	GRSP 03	GRSP 15	LASP 02	LASP 03	LASP 15	MODO 02	MODO 03	MODO 15
Average	1.93	1.64	1.07	0.33	0.07	0.07	1.07	1.07	0.47	0.20	0.14	0.33
95% LCL	1.54	1.29	0.53	0.13	0.00	0.00	0.73	0.64	0.13	0.00	0.00	0.13
95% UCL	2.27	2.00	1.67	0.60	0.21	0.20	1.40	1.50	0.87	0.40	0.43	0.60

Figure 3. Changes in densities for selected bird species with in the dry plains shrub ecotype.



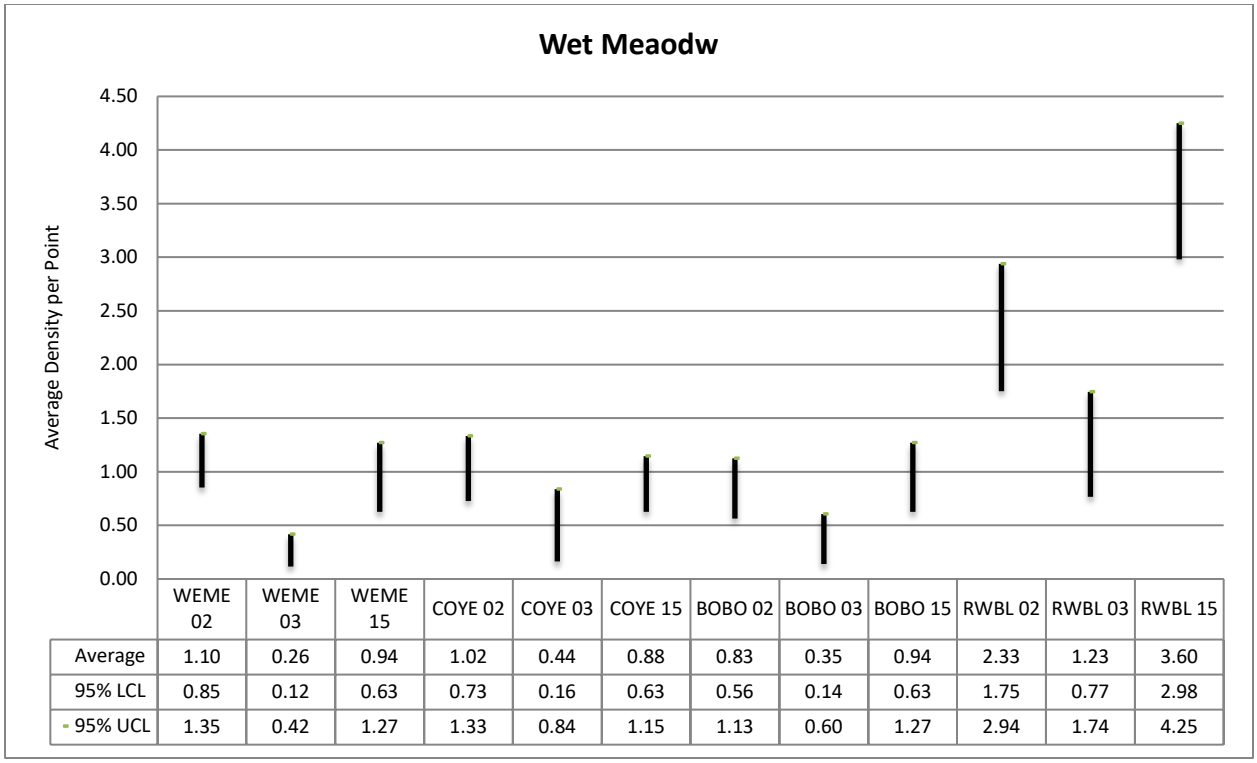
	WEME 02	WEME 03	WEME 15	GRSP 02	GRSP 03	GRSP 15	BOBO 02	BOBO 03	BOBO 15	RWBL 02	RWBL 03	RWBL 15	CLSW 02	CLSW 03	CLSW 15
Average	1.75	0.54	1.42	0.76	0.17	0.27	0.64	0.27	0.97	0.86	0.98	2.51	0.78	0.67	0.15
95% LCL	1.53	0.35	1.19	0.53	0.04	0.15	0.41	0.10	0.71	0.56	0.63	1.98	0.37	0.13	0.05
95% UCL	1.98	0.73	1.66	1.00	0.31	0.41	0.92	0.48	1.24	1.20	1.38	3.08	1.37	1.44	0.27

Figure 4. Changes in densities for selected bird species with in the introduced grass ecotype.



	WEME 02	WEME 03	WEME 15	GRSP 02	GRSP 03	GRSP 15	BOBO 02	BOBO 03	BOBO 15	RWBL 02	RWBL 03	RWBL 15
Average	1.73	0.64	2.12	0.42	0.27	0.73	0.77	0.05	1.58	0.85	0.59	1.81
95% LCL	1.35	0.36	1.58	0.19	0.00	0.35	0.42	0.00	1.08	0.35	0.23	1.15
95% UCL	2.12	0.91	2.69	0.69	0.64	1.15	1.12	0.14	2.12	1.46	1.05	2.58

Figure 5. Changes in densities for selected bird species with in the restoration area ecotype.



	WEME 02	WEME 03	WEME 15	COYE 02	COYE 03	COYE 15	BOBO 02	BOBO 03	BOBO 15	RWBL 02	RWBL 03	RWBL 15
Average	1.10	0.26	0.94	1.02	0.44	0.88	0.83	0.35	0.94	2.33	1.23	3.60
95% LCL	0.85	0.12	0.63	0.73	0.16	0.63	0.56	0.14	0.63	1.75	0.77	2.98
95% UCL	1.35	0.42	1.27	1.33	0.84	1.15	1.13	0.60	1.27	2.94	1.74	4.25

Figure 6. Changes in densities for selected bird species with in the wet meadow ecotype.

Changes in bird abundances of CCP priority species:

The average number of birds per point was calculated from the raw data for each survey year (Table 5). To determine if any changes in densities had occurred between years, the variance and confidence intervals were estimated for each species using the bootstrap method. Results indicate that there were increases the densities of American white pelican, Bell's vireo, northern harrier, sharp-tailed grouse, short-eared owl, trumpeter swans and Wilson's phalarope since 2002, and since 2003 all species have increased or held steady (Table 7).

Table 7. Summary of changes in densities (per point) that occurred for CCP priority species between the USGS baseline survey in the early 2000's and the USFWS/Conservancy survey in 2015.

Priority Species	2002	2003	2015	Change since 2002	Change since 2003
A. White Pelican	0.00	0.00	0.03	Increase	Increase
Bell's Vireo	0.02	0.01	0.04	Slight increase	Slight increase
Bobolink	0.62	0.26	0.73	No change	Increase
Burrowing Owl	0.03	0.01	0.02	No change	No change
Dickcissel	0.08	0.00	0.04	Slight decrease	Increase
Grasshopper Sparrow	0.76	0.24	0.48	Decrease	Increase
Long-billed Curlew	0.01	0.01	0.01	No change	No change
Marbled Godwit	0.02	0.02	0.03	No change	No change
Northern Harrier	0.01	0.02	0.03	Slight increase	No change
Sharp-tailed grouse	0.01	0.02	0.03	Slight increase	Slight increase
Short-eared Owl	0.00	0.00	0.02	Increase	Increase
Trumpeter Swan	0.00	0.00	0.01	Increase	Increase
Upland Sandpiper	0.09	0.01	0.07	No change	Increase
Wilson's Phalarope	0.04	0.02	0.09	Slight increase	Increase

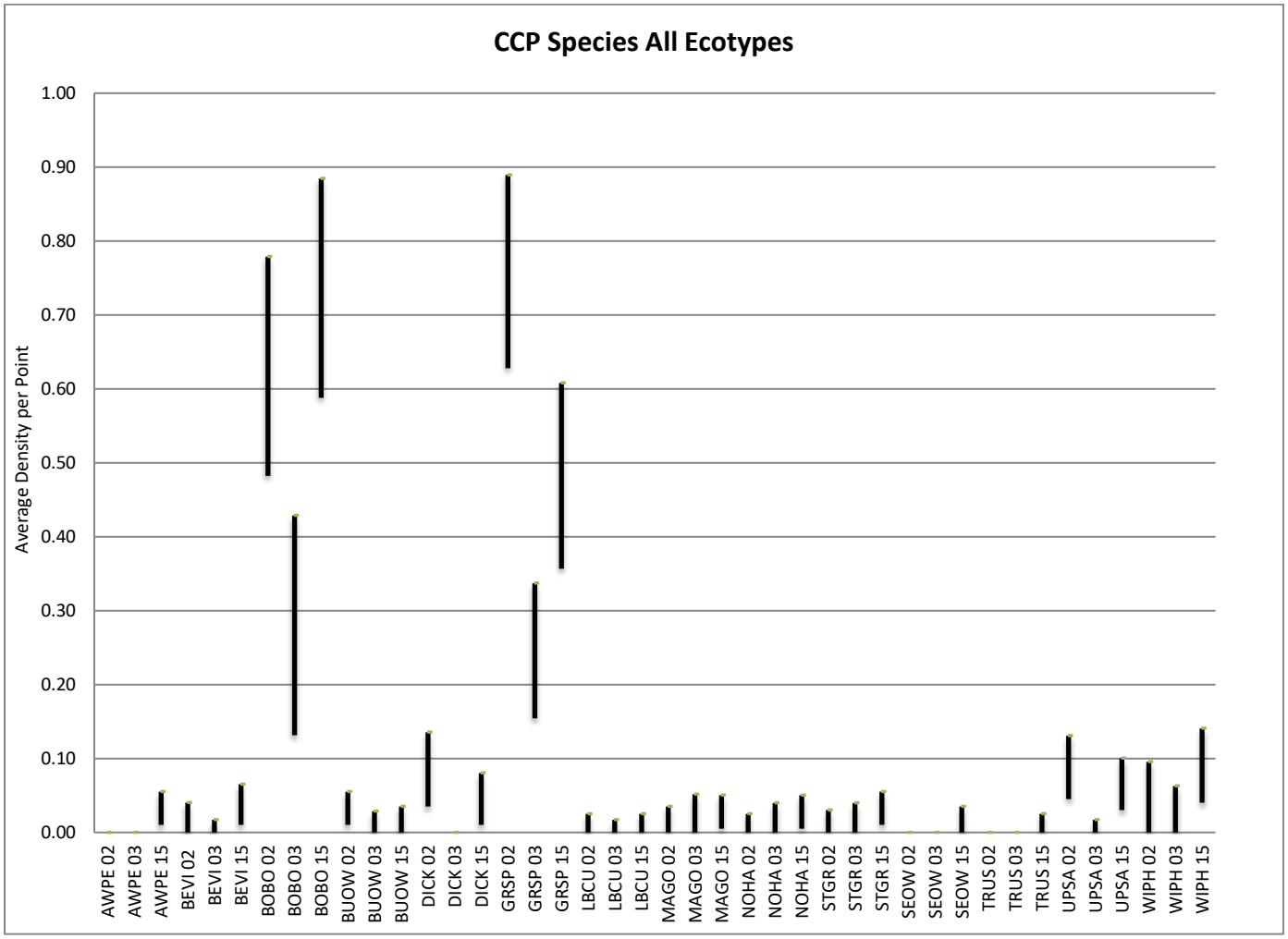


Figure 7. Changes in priority species densities listed in the CCP.

Habitat Models for Priority Species:

To determine habitat associations for bobolink, grasshopper sparrow, and upland sandpiper, 98 transects were used with 55 being classified as non-use transects and the remaining classified as used by a priority species. Model variables were litter, effective grass height, effective forb height, visual obstruction reading (VOR), distance to trees, patch size, and percent plant species composition. Patch size was an important variable for bobolink with the average patch size being 57.60 hectares (±28.50). The distance from trees and percent native grass were both important variables at sites where grasshopper sparrows were present. There were no grasshopper sparrows present within sites that were less than 235.75 meters from trees, with the average distance to trees being 293.58 meters (±19.49). The percent native grass was an additional variable significant to grasshopper sparrow with the average percent native grass being 37.9% (±34.43) as compared to locations where they were not detected with native grass composition being less than 10%. For upland sandpiper litter was the most important habitat variable with an average litter depth being 2.75 cm (±1.70).

Table 8. Variables identified as significant predicators of presence of three priority species.

Species	Habitat Model	$\bar{x}$	SD	Range	25% Quantile	50% Quantile	75% Quantile
Bobolink	Patch size (ha)	54.60	28.50	16.11 to 307.3	30.61	57.02	69.94
Grasshopper Sparrow	Distance to trees (m)	293.58	19.49	235.75 to 301	301	301	301
	Native grass (%)	37.9	34.43	0 to 99	6.50	30.00	68.75
Upland Sandpiper	Litter depth (cm)	2.75	1.70	0.55 to 6.50	1.38	2.25	3.75

Table 9. Habitat models for priority species.

Species	Habitat Model	df	Akaike's information criterion (AIC)
Bobolink	Grass height	2	131.22
	VOR	2	131.50
	Distance to tree	2	131.47
	Patch size	2	122.87
	Native grass (% comp)	2	124.44
	Patch size + tree	3	124.86
Grasshopper Sparrow	Grass height	2	124.07
	Native grass (% comp)	2	119.50
	Distance to tree	2	117.39
	Distance to tree + native grass	3	115.85
Upland Sandpiper	Litter depth	2	111.34
	Patch size	2	114.68
	Distance to tree	2	115.27
	Native grass (% comp)	2	115.21
	Patch size + litter depth	3	112.27

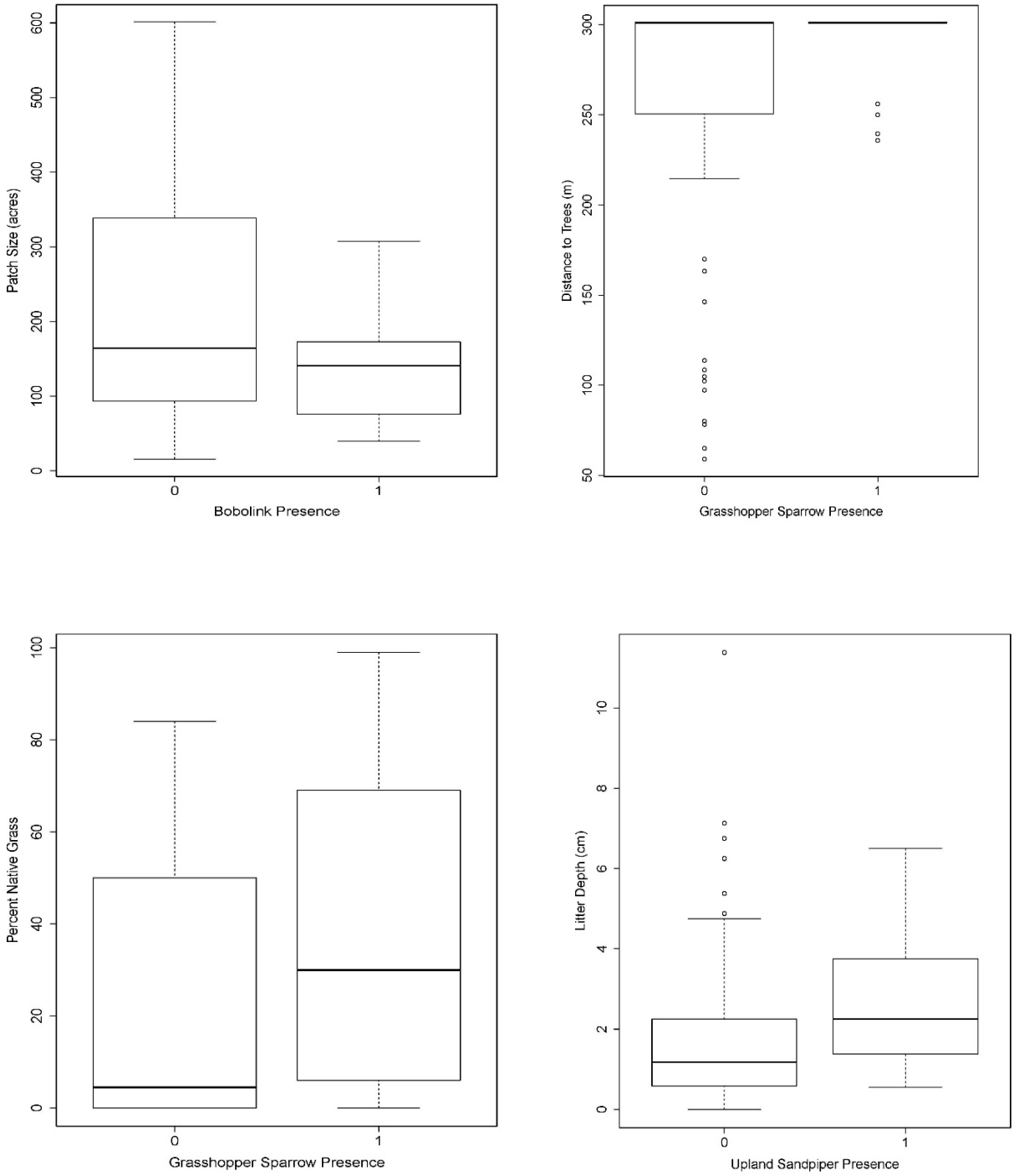


Figure 8. Box plots of important habitat variables indicating the differences in measurement were priority bird species were present (1) and absent (0).

Table 10. Summary of habitat variables for bobolink, grasshopper sparrow, and upland sandpiper. These variables were identified as important requirements for these priority species in the Lacreek CCP.

Species	Vegetation Height Mean (cm)	CCP Vegetation Height (cm)	Litter Mean (cm)	CCP Litter (cm)	Patch size Mean (ha)	CCP Patch size (ha)	Distance to tree Mean (m)	CCP Distance to tree (m)
Bobolink	49	25 to 45	2.7	3.4 to 9.1	55	40	265	45
Grasshopper sparrow	44	20 to 60	2.2	Not available	77	8	294	50
Upland sandpiper	51	3 to 60	2.8	2.3	83	101	268	100

Discussion

Species Abundance:

Although there were not enough observations available to determine changes in all species evaluated, there were positive increases within those species where adequate data was available for analysis with the exception of grasshopper sparrows. Decreases in some species like American white pelican and burrowing owl are likely due to a fluke or differences in survey techniques between the USGS survey and the 2015 survey. During the 2003 USGS survey there unusual densities (67.3/100ha) of American white pelicans observed in restoration areas, and pelicans are not normally observed in these ecotypes. Perhaps there was a temporary wetland within the restoration that provided foraging habitat i.e., amphibians. The reason pelicans were there is not understood, but no pelicans were observed in any restoration areas in 2002 or 2015. Therefore the apparent decrease in pelicans is probably not due to an actual drop in the number of breeding pelicans present on the refuge. Also breeding on the pelican island has been evaluated every year since 2005 and that trend data provides a more adequate representation of production occurring on the refuge.

The changes in burrowing owl densities could be because of the different methods used to survey these birds. During the USGS survey, area searches were conducted in prairie dog towns which were not completed in 2015. The reason being is that refuge staff have conducted burrowing owl surveys annually since 2004 using play back recordings and we reasoned there was sufficient trend data available for that species so we didn't conduct area searches. We were also uncertain if there would be adequate resources (financial and time) available to complete surveys beyond point count stations.

Timing of the surveys may have also been a factor for the apparent decrease in dickcissel. Dickcissel generally arrive on the refuge in late May/early June, and since the USGS survey concluded in early July as opposed to early June during the 2015 survey, it may be that some dickcissel had not arrived on the refuge. Perhaps additional dickcissel might have been recorded in 2015 had the survey ended later in the breeding season.

Apparent decreases in long-billed curlew and upland sandpiper may be attributed to having less short grass available on the refuge because of an above average precipitation year, or populations may be decreasing in general across the mixed-grass prairie. Reasons as to why changes may

have occurred are not known and should not be inferred without additional research. The same is true for sharp-tailed grouse, short-eared owl and northern harrier.

Although Trumpeter Swan was listed as a priority species in the CCP, swans do not use the refuge extensively for breeding but rather for migration and staging. Breeding swans have been observed at low numbers (<5 pairs across the entire refuge in any one year) since their reintroduction, but they were mentioned in this report because they are listed in the CCP.

Habitat Associations:

The relationship between the occurrences of bobolink with habitat variables indicate that patch size was the best predictor of this species on Lacreek NWR. This was also the case in other studies that occurred in the Midwest. Results of several studies indicate they are area sensitive and prefer large grassland areas over small (Herkert et al. 1993, O'Leary and Nyberg 2000). Herkert (1991) reported that the minimum area on which bobolinks were found was 10-30 ha (25-74 acres) in Illinois tallgrass prairie fragments. The minimum patch size requirement for bobolinks in wet meadows in Nebraska was 46 ha (114 acres), with a perimeter-area ratio of about 0.010 (Helzer 1996, Helzer and Jelinski 1999). Occurrence of bobolinks was positively correlated with patch area and inversely correlated with perimeter-area ratio (Helzer and Jelinski 1999). In this survey, the mean patch size was 55 ha (135 acres) which is just slightly higher than what was identified as the required patch size for bobolink in the CPP. Bobolink was one of the priority species identified that would likely use sites on Lacreek NWR that met certain criteria that were used to create the upland objective which included patch size, vegetation height, and distance from trees. The mean patch size for bobolink in this survey also meets the upland objective created for the patch size requirement of at least 125 acres in the "tall" category.

The relationship between the occurrences of grasshopper sparrows with habitat variables indicate that distance from trees and the percent native grass were the best predictors of this species on Lacreek NWR. Although grasshopper sparrows used both native and tame grass in other areas (Wilson and Belcher 1989, Madden 1996), they also prefer grasslands of intermediate height and are often associated with clumped vegetation interspersed with patches of bare ground (Blankespoor 1980, Vickery 1996). Many of the units within Lacreek NWR that have a native grass component are of intermediate heights, the native grasses are often species that form clumps, and some bare ground is also present. The units that are composed mostly of invasive grasses often have taller and denser vegetation that is sod forming (this is true if a defoliation treatment was not implemented during the breeding season). This might be a reason why native grass was an important habitat variable for grasshopper sparrow on the refuge. However, the percent of native grass at sites where grasshopper sparrows occurred averaged only 38% and ranged from 0% to 99%. Regardless, the percent native grass required for this priority species could provide important guidance for the management of uplands habitat on the refuge. A parameter for the percent native grass required by priority species was not determined during the CCP process, and this could provide manager's a minimum native vegetation composition objective within upland habitats. Distance from shrubs and trees was also an important habitat indicator and this is consistent with many studies where there was a negative correlation between

presence of grasshopper sparrows and woody vegetation (Winter 1998, Rotenberry and Wiens 1980). The average distance to a tree in this survey was 294 m which is much farther than the requirement of 50 m mentioned in the CCP. In other studies grasshopper sparrows also tended to avoid forested edge areas due to brown-headed cowbird parasitism, which might also be the case here. In Minnesota tallgrass prairie, nest depredation and brood parasitism decreased farther from woody edges, and nest depredation rates were lower on large than on small grasslands (Johnson and Temple 1990). Furthermore, the probability of encountering grasshopper sparrows was highest on large fragments far from a forest edge and >4 yr postburn; however, nest productivity was highest for nests far from a forest edge and 1 yr postburn (Johnson and Temple 1986). Delisle (1995) found that only one of 31 territories in Nebraska CRP fields had >50% of its area within 50 m of an edge.

The relationship between the occurrences of upland sandpipers with habitat variables indicate that litter depth was the best predictor of this species on Lacreek NWR. The average litter depth was 2.8 cm which is just slightly higher than the habitat requirement noted in the CCP. The range of litter depth varied from extremely short (0.55 cm) to moderate (6.5 cm). Variation in vegetation structure is common in upland sandpiper depending on timing of nesting and life cycle requirements. In Wisconsin, choice of nesting site changed as the season progressed; early nests were located in pasture and later nests were in ungrazed prairie. Prior to the time when upland sandpipers in Colorado began incubating nests, they used heavily grazed fields more often and weedy fields less often than expected; however, during incubation upland sandpipers appeared to prefer lightly grazed fields (average vegetation 17-23 cm tall) (Bolster 1990). Upland sandpipers require grasslands of various heights for rearing broods. In Minnesota, broods used weedy fields, open areas within oldfields, and overgrazed pastures (Dorio 1977, Dorio and Grewe 1979). Marshy areas of sedge and cattails (*Typha*) that had dried during drought were used as escape cover by broods (Dorio 1977). In Wisconsin, brood rearing occurred mostly in heavily grazed (vegetation <10 cm tall) pastures, followed by ungrazed pastures and hayfields (Ailes 1976). Late-summer feeding occurred mainly in heavily and moderately grazed pastures; lightly grazed pastures were used infrequently (Ailes 1980).

There were close comparisons for some, but not all, of the selected habitat requirements we documented for bobolink, grasshopper sparrow, and upland sandpiper and the requirements outlined in the Lacreek NWR CCP (Table 10). For bobolink there were slight differences in vegetation structure and patch size, but we found a rather large difference between the distances to trees. We observed distances to trees were much farther than what has been noted during other studies. This situation was also the case for grasshopper sparrow with structure being comparable to the CCP, but there differences were in distance to trees and patch size. During this survey, we observed greater patch sizes and distances to trees. For upland sandpiper the only substantial discrepancy was distance to trees, and again we observed greater distances than what was listed in the CCP.

Recommendations

1) Conduct a breeding bird abundance survey in 5 years to develop trend data for priority species. This could aid in setting breeding pair goals for each species as it relates to the Refuge Habitat Management Plan (HMP).

2) Modify the upland habitat objectives in the Lacreek NWR CCP to reflect percent native grass composition and not a floristic quality assessment (FQA) C score value. The CCP objectives for upland habitats is to increase floristic quality assessment "C" scores with in tall, medium, and short patches that are a given distance from trees. Floristic quality assessment "C" scores are used to assess the condition of native plant communities based on the degree of tolerance to disturbance and site fidelity (Stohlgren et al. 1995). Thus more "conservative" species that are less tolerant of frequent disturbance which display a high fidelity receive a higher score as compared to species that can tolerate changes in habitat or environmental conditions (Mushet and Euliss 2005). Most native grass species have lower C values because they can tolerate frequent disturbances like grazing and burning, and as a result a patch of native grass that could provide breeding habitat for priority bird species could also have a low average C score value. Since the percent native grass was an important habitat variable for grasshopper sparrows, it is recommended that the CCP upland objectives be changed from an increase in C score value to a native grass composition of a minimum of 38%.

3) Increase the distance from trees component in the upland objectives to reflect distances that were observed during this survey. The average distance from trees was different than cthe distances stated in the CCP for all three species. In the CCP objectives distances to trees in the tall and medium category were 49 meters, but we recorded distances much greater than that for bobolink and grasshopper sparrow. The objective for the short category reads that patches should be 100 meters from trees, but we also recorded greater distances than that for upland sandpiper. Distance to trees should be increased to a minimum of 294 meters in the tall category and 268 meters in the short category.

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Table 11. Species count per ecotype.

Species	DMP	DPS	IG	RA	WM	Total
American Bittern	2	0	2	1	8	13
American Coot	0	0	0	1	1	2
American Crow	0	0	0	0	1	1
American Goldfinch	1	1	9	4	6	21
American Kestrel	0	0	0	0	1	1
American Robin	2	0	3	0	2	7
American White Pelican	1	0	3	0	1	5
Bald Eagle	0	0	0	0	0	0
Bank Swallow	0	0	0	0	0	0
Barn Swallow	0	0	6	2	5	13
Bell's Vireo	1	0	1	1	4	7
Black Tern	0	0	0	0	3	3
Black-crowned Night-Heron	0	0	2	0	2	4
Blue Grosbeak	0	1	0	0	0	1
Blue Jay	0	0	0	0	1	1
Blue-winged Teal	4	0	18	1	19	42
Bobolink	17	0	53	37	29	136
Brewer's Blackbird	0	0	2	1	0	3
Brown Thrasher	0	1	4	0	1	6
Brown-headed Cowbird	42	13	51	20	41	167
Bullock's Oriole	0	0	0	0	0	0
Burrowing Owl	1	0	0	1	1	3
Canada Goose	0	0	0	3	1	4
Cedar Waxwing	1	0	0	0	0	1
Chipping Sparrow	1	0	0	0	0	1
Clay-colored Sparrow	1	0	2	2	0	5
Cliff Swallow	3	0	9	3	17	32
Common Goldeneye	0	0	0	0	0	0
Common Grackle	2	0	7	1	4	14
Common Nighthawk	0	0	0	0	0	0
Common Tern	0	0	0	0	0	0

Table 11. continued. Species count per ecotype.

Species	DMP	DPS	IG	RA	WM	Total
Common Yellowthroat	7	0	37	5	38	87
Dickcissel	8	0	0	0	0	8
Double-crested Cormorant	0	0	4	0	2	6
Downy Woodpecker	0	0	2	0	0	2
Eared Grebe	0	0	1	0	0	1
Eastern Bluebird	0	0	0	0	0	0
Eastern Kingbird	5	1	16	4	3	29
Eastern Meadowlark	8	1	16	1	15	41
Eurasian Collared-Dove	0	0	0	0	0	0
European Starling	0	0	0	2	1	3
Ferruginous Hawk	0	0	0	0	0	0
Field Sparrow	0	0	0	0	0	0
Forster's Tern	0	0	0	0	1	1
Franklin's Gull	0	0	0	0	0	0
Gadwall	0	0	2	1	0	3
Grasshopper Sparrow	48	1	14	19	11	93
Great Blue Heron	0	0	3	1	1	5
Great Egret	0	0	0	0	2	2
Great Horned Owl	2	0	0	0	2	4
Greater Yellowlegs	0	0	0	0	1	1
Great-tailed Grackle	0	0	0	0	0	0
Green-winged Teal	2	0	0	0	0	2
Hairy Woodpecker	0	0	1	0	0	1
Henslow's Sparrow	0	0	1	0	3	4
Horned Lark	6	0	6	1	0	13
House Sparrow	0	0	0	0	0	0
House Wren	0	0	0	1	0	1
Killdeer	5	0	5	0	3	13
Lark Bunting	1	0	0	0	0	1
Lark Sparrow	10	7	1	0	0	18
Least Flycatcher	0	0	1	0	0	1
Loggerhead Shrike	1	1	0	0	0	2
Long-billed Curlew	2	0	0	0	0	2
Mallard	6	0	6	1	11	24
Marbled Godwit	1	0	0	0	3	4
Marsh Wren	2	0	8	1	18	29
Mourning Dove	5	5	16	6	8	40
No Birds	72	34	25	10	16	157
Northern Bobwhite	0	0	0	1	0	1
Northern Flicker	0	0	0	1	0	1
Northern Flicker (Intergrade)	0	0	0	0	1	1

Table 11. continued. Species count per ecotype.

Species	DMP	DPS	IG	RA	WM	Total
Northern Flicker (Yellow-shafted)	0	0	0	0	0	0
Northern Harrier	2	0	2	0	1	5
Northern Pintail	0	0	3	2	1	6
Northern Rough-winged Swallow	0	0	0	0	0	0
Northern Shoveler	4	0	4	1	6	15
Orchard Oriole	2	0	6	3	8	19
Pied-billed Grebe	0	0	1	0	1	2
Pine siskin	0	0	1	0	0	1
Prairie Falcon	0	0	0	0	0	0
Redhead	0	0	1	0	0	1
Red-headed Woodpecker	0	0	0	0	0	0
Red-tailed Hawk	0	0	0	0	0	0
Red-winged Blackbird	53	1	142	46	143	385
Ring-necked Duck	0	0	0	1	0	1
Ring-necked Pheasant	13	3	25	3	11	55
Sandhill Crane	0	0	0	0	0	0
Savannah Sparrow	0	0	1	1	1	3
Say's Phoebe	0	0	2	0	0	2
Sedge Wren	3	0	7	0	7	17
Sharp-tailed Grouse	1	2	2	0	1	6
Short-eared Owl	0	0	3	0	0	3
Snowy Egret	0	0	0	0	0	0
Song Sparrow	1	0	1	0	0	2
Sora	0	0	1	0	4	5
Swainson's Thrush	0	0	0	0	1	1
Swamp Sparrow	1	0	7	0	18	26
Tree Swallow	2	0	1	1	6	10
Trumpeter Swan	2	0	0	0	0	2
Turkey Vulture	0	0	0	0	0	0
Unknown Bird	1	0	1	0	0	2
Unknown Blackbird	0	0	1	0	1	2
Unknown Duck	0	0	0	0	0	0
Unknown Gull	0	0	1	0	0	1
Unknown Meadowlark	0	0	0	0	0	0
Unknown Sandpiper	0	0	0	0	1	1
Unknown Sparrow	0	0	0	1	1	2
Unknown Swallow	0	0	0	1	0	1
Unknown Woodpecker	0	0	0	0	0	0
Upland Sandpiper	3	1	3	1	3	11
Vesper Sparrow	0	1	1	0	0	2

Table 11. continued. Species count per ecotype.

Species	DMP	DPS	IG	RA	WM	Total
Virginia Rail	1	0	2	0	7	10
Warbling Vireo	0	0	0	1	1	2
Western Bluebird	0	0	0	0	0	0
Western Grebe	0	0	0	0	0	0
Western Kingbird	2	0	1	2	1	6
Western Meadowlark	81	16	83	51	42	273
Wild Turkey	0	0	1	1	1	3
Willet	2	0	3	1	4	10
Willow Flycatcher	0	0	2	0	2	4
Wilson's Phalarope	3	0	5	1	4	13
Wilson's Snipe	2	0	3	0	1	6
Wood Duck	1	0	0	1	3	5
Yellow Warbler	0	0	8	1	5	14
Yellow-breasted Chat	0	0	0	0	0	0
Yellow-headed Blackbird	4	0	21	5	19	49

Table 12. Species density per 100 hectares per ecotype.

Species	DMP	DPS	IG	RA	WM	Total
American Bittern	1.25	0.00	1.08	1.23	5.31	8.87
American Coot	0.00	0.00	0.00	1.23	0.66	1.89
American Crow	0.00	0.00	0.00	0.00	0.66	0.66
American Goldfinch	0.62	2.12	4.86	4.90	3.98	16.50
American Kestrel	0.00	0.00	0.00	0.00	0.66	0.66
American Robin	1.25	0.00	1.62	0.00	1.33	4.20
American White Pelican	0.62	0.00	1.62	0.00	0.66	2.91
Bald Eagle	0.00	0.00	0.00	0.00	0.00	0.00
Bank Swallow	0.00	0.00	0.00	0.00	0.00	0.00
Barn Swallow	0.00	0.00	3.24	2.45	3.32	9.01
Bell’s Vireo	0.62	0.00	0.54	1.23	2.66	5.05
Black Tern	0.00	0.00	0.00	0.00	1.99	1.99
Black-crowned Night-Heron	0.00	0.00	1.08	0.00	1.33	2.41
Blue Grosbeak	0.00	2.12	0.00	0.00	0.00	2.12
Blue Jay	0.00	0.00	0.00	0.00	0.66	0.66
Blue-winged Teal	2.50	0.00	9.72	1.23	12.62	26.07
Bobolink	10.62	0.00	28.63	45.36	19.26	103.87
Brewer’s Blackbird	0.00	0.00	1.08	1.23	0.00	2.31
Brown Thrasher	0.00	2.12	2.16	0.00	0.66	4.95
Brown-headed Cowbird	26.25	27.62	27.55	24.52	27.22	133.16
Bullock’s Oriole	0.00	0.00	0.00	0.00	0.00	0.00
Burrowing Owl	0.62	0.00	0.00	1.23	0.66	2.51
Canada Goose	0.00	0.00	0.00	3.68	0.66	4.34

Table 12. Species density per 100 ha per ecotype.

Species	DMP	DPS	IG	RA	WM	Total
Cedar Waxwing	0.62	0.00	0.00	0.00	0.00	0.62
Chipping Sparrow	0.62	0.00	0.00	0.00	0.00	0.62
Clay-colored Sparrow	0.62	0.00	1.08	2.45	0.00	4.16
Cliff Swallow	1.87	0.00	4.86	3.68	11.29	21.70
Common Goldeneye	0.00	0.00	0.00	0.00	0.00	0.00
Common Grackle	1.25	0.00	3.78	1.23	2.66	8.91
Common Nighthawk	0.00	0.00	0.00	0.00	0.00	0.00
Common Tern	0.00	0.00	0.00	0.00	0.00	0.00
Common Yellowthroat	4.37	0.00	19.99	6.13	25.23	55.72
Dickcissel	5.00	0.00	0.00	0.00	0.00	5.00
Double-crested Cormorant	0.00	0.00	2.16	0.00	1.33	3.49
Downy Woodpecker	0.00	0.00	1.08	0.00	0.00	1.08
Eared Grebe	0.00	0.00	0.54	0.00	0.00	0.54
Eastern Bluebird	0.00	0.00	0.00	0.00	0.00	0.00
Eastern Kingbird	3.12	2.12	8.64	4.90	1.99	20.79
Eastern Meadowlark	5.00	2.12	8.64	1.23	9.96	26.95
Eurasian Collared-Dove	0.00	0.00	0.00	0.00	0.00	0.00
European Starling	0.00	0.00	0.00	2.45	0.66	3.12
Ferruginous Hawk	0.00	0.00	0.00	0.00	0.00	0.00
Field Sparrow	0.00	0.00	0.00	0.00	0.00	0.00
Forster’s Tern	0.00	0.00	0.00	0.00	0.66	0.66
Franklin’s Gull	0.00	0.00	0.00	0.00	0.00	0.00
Gadwall	0.00	0.00	1.08	1.23	0.00	2.31
Grasshopper Sparrow	30.00	2.12	7.56	23.29	7.30	70.28
Great Blue Heron	0.00	0.00	1.62	1.23	0.66	3.51
Great Egret	0.00	0.00	0.00	0.00	1.33	1.33
Great Horned Owl	1.25	0.00	0.00	0.00	1.33	2.58
Greater Yellowlegs	0.00	0.00	0.00	0.00	0.66	0.66
Great-tailed Grackle	0.00	0.00	0.00	0.00	0.00	0.00
Green-winged Teal	1.25	0.00	0.00	0.00	0.00	1.25
Hairy Woodpecker	0.00	0.00	0.54	0.00	0.00	0.54
Henslow’s Sparrow	0.00	0.00	0.54	0.00	1.99	2.53
Horned Lark	3.75	0.00	3.24	1.23	0.00	8.22
House Sparrow	0.00	0.00	0.00	0.00	0.00	0.00
House Wren	0.00	0.00	0.00	1.23	0.00	1.23
Killdeer	3.12	0.00	2.70	0.00	1.99	7.82
Lark Bunting	0.62	0.00	0.00	0.00	0.00	0.62
Lark Sparrow	6.25	14.87	0.54	0.00	0.00	21.66
Least Flycatcher	0.00	0.00	0.54	0.00	0.00	0.54
Loggerhead Shrike	0.62	2.12	0.00	0.00	0.00	2.75
Long-billed Curlew	1.25	0.00	0.00	0.00	0.00	1.25

Table 12. continued. Species density per 100 hectares per ecotype.

Species	DMP	DPS	IG	RA	WM	Total
Mallard	3.75	0.00	3.24	1.23	7.30	15.52
Marbled Godwit	0.62	0.00	0.00	0.00	1.99	2.62
Marsh Wren	1.25	0.00	4.32	1.23	11.95	18.75
Mourning Dove	3.12	10.62	8.64	7.36	5.31	35.06
No Birds	45.00	72.24	13.51	12.26	10.62	153.63
Northern Bobwhite	0.00	0.00	0.00	1.23	0.00	1.23
Northern Flicker	0.00	0.00	0.00	1.23	0.00	1.23
Northern Flicker (Intergrade)	0.00	0.00	0.00	0.00	0.66	0.66
Northern Flicker (Yellow-shafted)	0.00	0.00	0.00	0.00	0.00	0.00
Northern Harrier	1.25	0.00	1.08	0.00	0.66	2.99
Northern Pintail	0.00	0.00	1.62	2.45	0.66	4.74
Northern Rough-winged Swallow	0.00	0.00	0.00	0.00	0.00	0.00
Northern Shoveler	2.50	0.00	2.16	1.23	3.98	9.87
Orchard Oriole	1.25	0.00	3.24	3.68	5.31	13.48
Pied-billed Grebe	0.00	0.00	0.54	0.00	0.66	1.20
Pine siskin	0.00	0.00	0.54	0.00	0.00	0.54
Prairie Falcon	0.00	0.00	0.00	0.00	0.00	0.00
Redhead	0.00	0.00	0.54	0.00	0.00	0.54
Red-headed Woodpecker	0.00	0.00	0.00	0.00	0.00	0.00
Red-tailed Hawk	0.00	0.00	0.00	0.00	0.00	0.00
Red-winged Blackbird	33.12	2.12	76.71	56.39	94.95	263.30
Ring-necked Duck	0.00	0.00	0.00	1.23	0.00	1.23
Ring-necked Pheasant	8.12	6.37	13.51	3.68	7.30	38.99
Sandhill Crane	0.00	0.00	0.00	0.00	0.00	0.00
Savannah Sparrow	0.00	0.00	0.54	1.23	0.66	2.43
Say's Phoebe	0.00	0.00	1.08	0.00	0.00	1.08
Sedge Wren	1.87	0.00	3.78	0.00	4.65	10.30
Sharp-tailed Grouse	0.62	4.25	1.08	0.00	0.66	6.62
Short-eared Owl	0.00	0.00	1.62	0.00	0.00	1.62
Snowy Egret	0.00	0.00	0.00	0.00	0.00	0.00
Song Sparrow	0.62	0.00	0.54	0.00	0.00	1.17
Sora	0.00	0.00	0.54	0.00	2.66	3.20
Swainson's Thrush	0.00	0.00	0.00	0.00	0.66	0.66
Swamp Sparrow	0.62	0.00	3.78	0.00	11.95	16.36
Tree Swallow	1.25	0.00	0.54	1.23	3.98	7.00
Trumpeter Swan	1.25	0.00	0.00	0.00	0.00	1.25
Turkey Vulture	0.00	0.00	0.00	0.00	0.00	0.00
Unknown Bird	0.62	0.00	0.54	0.00	0.00	1.17
Unknown Blackbird	0.00	0.00	0.54	0.00	0.66	1.20
Unknown Duck	0.00	0.00	0.00	0.00	0.00	0.00

Table 12. continued. Species density per 100 hectares per ecotype.

Species	DMP	DPS	IG	RA	WM	Total
Unknown Gull	0.00	0.00	0.54	0.00	0.00	0.54
Unknown Meadowlark	0.00	0.00	0.00	0.00	0.00	0.00
Unknown Sandpiper	0.00	0.00	0.00	0.00	0.66	0.66
Unknown Sparrow	0.00	0.00	0.00	1.23	0.66	1.89
Unknown Swallow	0.00	0.00	0.00	1.23	0.00	1.23
Unknown Woodpecker	0.00	0.00	0.00	0.00	0.00	0.00
Upland Sandpiper	1.87	2.12	1.62	1.23	1.99	8.84
Vesper Sparrow	0.00	2.12	0.54	0.00	0.00	2.67
Virginia Rail	0.62	0.00	1.08	0.00	4.65	6.35
Warbling Vireo	0.00	0.00	0.00	1.23	0.66	1.89
Western Bluebird	0.00	0.00	0.00	0.00	0.00	0.00
Western Grebe	0.00	0.00	0.00	0.00	0.00	0.00
Western Kingbird	1.25	0.00	0.54	2.45	0.66	4.91
Western Meadowlark	50.62	34.00	44.84	62.52	27.89	219.86
Wild Turkey	0.00	0.00	0.54	1.23	0.66	2.43
Willet	1.25	0.00	1.62	1.23	2.66	6.75
Willow Flycatcher	0.00	0.00	1.08	0.00	1.33	2.41
Wilson's Phalarope	1.87	0.00	2.70	1.23	2.66	8.46
Wilson's Snipe	1.25	0.00	1.62	0.00	0.66	3.53
Wood Duck	0.62	0.00	0.00	1.23	1.99	3.84
Yellow Warbler	0.00	0.00	4.32	1.23	3.32	8.87
Yellow-breasted Chat	0.00	0.00	0.00	0.00	0.00	0.00
Yellow-headed Blackbird	2.50	0.00	11.34	6.13	12.62	32.59