NORTH DAKOTA GAME AND FISH DEPARTMENT

Final Report

Influence of Habitat Types on Grassland Bird Diversity

Project T2-8-R

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State Wildlife Grant Proposal – Final Report

Project Title: Influence of habitat type on grassland bird diversity

Species of Conservation Priority: Upland Sandpiper (*Bartramia longicauda*), Grasshopper Sparrow (*Ammodramus savannarum*), Nelson's Sparrow (*Ammodramus nelsoni*), Sedge Wren (*Cistothorus platensis*), Le Conte's Sparrow (*Ammodramus leconteii*), and Bobolink (*Dolichonyx oryzivorus*)

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Location: Benson, Ramsey, Towner, and Cavalier County (Devils Lake Wetland Management District) and Eddy County (Arrowwood Wetland Management District)

NOTE: Certain sites that were surveyed were dropped and not included in the analysis. These sites were dropped to maintain replicates that were not spatially autocorrelated.

Objectives:

The U.S. Fish and Wildlife Service, Devils Lake Wetland Management District (DLWMD) plans to reseed 3,035 hectares of formerly cropped waterfowl production areas. The area will be reseeded to diverse, multi-species native seed mixes over the next 15-years. This is a new restoration practice in this region, and therefore limited data is available on the wildlife response. Our goal is to develop a graduate project in partnership with the DLWMD to study grassland bird use of the previously described restorations. This research is designed to monitor the relationship between grassland songbirds and prairie restoration. This is a management driven study that embraces the process of adaptive management. The following are the proposed objectives:

1. Evaluate grassland bird species (a) abundance, (b) species richness, and (c) associated densities in the following vegetation types: reconstructed prairie, warm-season natives, dense nesting cover, old dense nesting cover, and remnant prairie.
2. Assess landscape variables that may impact bird species abundance, species richness, and associated densities to assist DLWMD staff in prioritizing sites for restoration and the appropriate seed mixes to use.

Methods: *Bird Survey Methods*

Between 2008-2011 (see Table 2 for dates), I surveyed five types of grasslands for grassland birds: 1) multi-species natives (MSN) - areas seeded with a mixture of native grasses and forbs, 2) warm-season natives (WSN) - areas with seeded three to four warm-season grasses and not more than six forbs, 3) dense nesting cover (DNC) – areas seeded with a wheatgrass (*Agropyron)* species, alfalfa (*Medicago sativa),* and yellow sweetclover (*Melilotus officinalis*) mixture within the last 15 years, 4) old dense nesting cover (ODNC)– areas seeded with a form of dense nesting cover (i.e., non-native grasses, such as smooth brome (*Bromus inermis*)) ≥ 15 years ago, and 5) remnant prairie (REM) - areas that have never been plowed. All sites were on WPAs, NWRs, and a private grassland easement within the Devils Lake and Arrowwood WMDs, located in Cavalier, Benson, Ramsey, Towner and Eddy counties, northeastern and east-central North Dakota, USA (average site size of 88 ha.; Figure 1; Table 3; see Appendix A for site specific seed mixtures).

Sites were selected for the five vegetation types described above from available habitat within the mixed-grass prairie across the Devils Lake and the Arrowwood WMDs. MSN, WSN, and DNC sites are uncommon in this study area as they are either new restoration practices (MSN and WSN) or age restricted (DNC), which limited available sites. To qualify as a study site, the species seeded for a particular vegetation type had to make up most of the study site. REM sites were selected based on historical land use records rather than vegetation cover. The ONC sites were selected based on time since seeding (i.e., these sites were seeded ≥ 15 years ago), and must have had no tillage or weed control. Using the qualifiers described above, 32 sites were chosen among the five habitat types.

Points were distributed within each site in proportion to the amount of habitat available within the five vegetation types in accordance to the point placement restrictions described below (Table 5). The number of survey points per vegetation type reflects differences in size of available habitat and the amount of hectares contained within each site. Survey points were placed in a restricted randomization design (random locations with restrictions on placement) within the 32 sites (Table 4). Using 'Geospatial Modeling Environment' ('Hawth's Analysis Tools') in ArcMap™ 9.3.1 (Environmental Systems Research Institute, Redlands, CA), Survey points were placed within the boundaries of each WPA, NWR, or grassland easement surveyed. To meet sampling restrictions, points were repositioned if placed within a wetland, < 100 m from a site edge, and/or < 300 m from another point.

Nearly all of the study sites selected contained a single vegetation type surrounded by an agricultural matrix. However, to obtain a large enough sample size, two of the WPAs contained multiple vegetation types no nearer than > 1.61 km of each other. A minimum distance of 1.61 km between sites was chosen to try and ensure that the multiple vegetation types within a WPA were not adjacent to each other allowing them to be considered separate sites. The Martinson WPA contained WSN and MSN vegetation types and the Register WPA contained DNC and MSN vegetation types. Both WPAs were categorized as two separate sites. Register WPA was split into the sites Register 1 and Register 2, while Martinson WPA was split into sites Martinson 1 and Martinson 2.

The Register 1 and Register 2 sites contained eleven survey points in total. Two observers were required to complete the survey of the WPA in a single day. The primary observer trained the secondary observer on survey protocol prior to performing surveys. A "practice point" was surveyed by both observers simultaneously and observer results were compared. Upon completion of the "practice point," the primary and secondary observers surveyed their portion of the eleven survey points within the Register site.

Throughout the course of the study (2008-2011), one survey point was eliminated and two survey points were excluded for a year. In 2010 a DNC survey point was removed from the Tarvestad WPA because of rising water. Langley WPA and Haven WPA were added in 2010 to increase the number of survey points within REM.

Survey points and sites were uploaded into a Trimble® GeoXT™ GPS Unit (Trimble Navigation Limited, Sunnyvale, CA) upon completion of making a map in ArcMap™ 9.3.1. Survey sites were located using a Trimble® GeoXT™ GPS Unit and identified a day in advance to ensure survey locations were accessible. Each bird survey point was surveyed twice per field season using a 100 m fixed-radius survey method to catch the peak breeding season for grassland birds, which begins early-May and ends mid-August (Stewart 1975, Winter et al. 2004). Cyr et al. (1995) found that point counts with a radius ≥ 100 m are the most appropriate for bird surveys in an agricultural landscape. The first round of surveys began no earlier than 15 May and finished no later than 18 June. The second round of surveys began immediately after the first round was completed and continued until July. All surveys were completed by 08 July each year (Table 2). Surveys started with the southernmost sites and worked north, which ensured the breeding birds had arrived at their breeding sites. The order of sites stayed consistent from the first round of surveys to the second. The same points were surveyed each year with additional points added in 2010.

Surveys took place between sunrise and 1030 Central Standard Time (CST) with four to seven points surveyed per person per day. Surveys ceased when wind speed exceeded 24 km/h based on a Kestrel® 4500/4500 NV Weather Meter™ (Kestrel® Sylvan Lake, MI) or if precipitation exceeded a drizzle (adapted from protocols in Anderson and Ohmart 1977; Robbins 1981; and Ralph et al. 1995).

A single observer recorded data at each survey point with ≤ two single observers during the full study period (2008-2011). Each survey was conducted over a 12-minute period, which included a two-minute cool down stage upon arrival at the point. This resulted in 10 minutes of actual survey time within a 100 m fixed-radius. The cool down stage ensured the birds became acclimated to observers' presence and behaved as naturally as possible (Bollinger et al. 1988).

Singing male birds within the 100 m fixed-radius were recorded after identification (song or sight). This gave singing male densities at each point. Double counting and overestimating the number of individuals at each point was avoided by spacing survey points by a distance of > 300 m (Ralph et al. 1995). Birds that flew over the 100 m fixed-radius survey area without landing were only recorded if they were using the habitat for acts such as displaying or aerial feeding (Johnson and Igl 2001).

Data from the first and second round of surveys in each year were pooled to get a representation of all the birds observed at a point. If a site contained multiple points, all points were pooled to determine the site-level species composition (see Appendix B for site specific avian observations).

Vegetation Surveys.

To evaluate local habitats, vegetation composition, structure, and litter depth was surveyed on all sites between 2009 and 2011 (Table 6). Vegetation was sampled using: 1) a belt transect method to estimate plant species composition and frequency of plant groupings (Grant et al. 2004b); 2) visual obstruction reading (VOR) as a measure of vegetation density and height (Robel et al. 1970); and 3) litter depth as a measure of dead, accumulated vegetation from previous growing seasons (Facelli and Pickett 1991). Habitat use by grassland birds has been shown to be influenced by vegetation composition and structure (Wiens 1969, Whitmore 1979, Rotenberry and Wiens 1980, Madden et al. 2000, Grant et al. 2004a). Litter depth has also been shown to have an influence on grassland birds. Swengel and Swengel (2001) show that litter depth had a strong correlation with grassland bird abundance. Vegetation composition was measured during peak biomass (July-August 2009-2011; Grant et al. 2004b). VOR and litter depths were measured during the first round of bird surveys in 2011 (Table 2) as these factors may affect nest-site selection (Fletcher and Koford 2004, Jones and Bock 2005). Remnant prairie has taken decades to decline and become invaded due to lack of management (Grant et al. 2004 and Murphy and Grant 2005). With the objective of the USFWS to look at species composition changes, the need to monitor was not necessary every year.

Vegetation was sampled on all sites that were surveyed for grassland birds. Bird survey points marked the beginning of some, but not all, vegetation transects. We measured vegetation composition along 25 m transects. Vegetation classes were recorded at 0.5 m intervals according to the most prevalent vegetation group (Appendix C; Grant et al. 2004b). There are 44 possible vegetation classes each 0.5 m interval of the 25 m transect could be categorized as (Appendix C; Grant et al. 2004b). A total of fifty observations were recorded for each transect. Vegetation classes could be recorded more than once per transect. Herbaceous codes available to use in the belt transect method (Appendix C) were sorted into a “native” and “non-native” category (Grant et al. 2004b). To be considered a “native” code, >50% dominance of native herbaceous plants, including forbs, was required. To be considered a “non-native” code, <50% dominance of native herbaceous plants, including forbs, was required. Using the “native” and “non-native” categories, the average number of times a “native” code was used to describe the vegetation in a transect interval across all of the transects per site estimated the proportion of the vegetation which was native for that site. This was done for each site surveyed. Each transect was sampled once during the study period (2008-2011) and all transects within a site were measured in one year.

VORs were measured using a Robel pole that had alternating decimeters (dm) painted red or white. Additionally, each half-dm was marked with a black stripe (adapted from protocols in Robel et al. 1970). The highest dm or half-dm where vegetation begins to hide the pole 100% and no other part of the pole can be seen below this mark was recorded in each of the four cardinal directions 4.0 m from the Robel pole and 1.0 m above the ground (Robel et al. 1970). The average VOR reading per point per site was determined to get a representation of the entire site. This was done for each site surveyed. Each VOR point was sampled once during the study period (2008-2011) and all VOR points within a site were measured in one year.

Litter was defined as dead vegetation accumulated from previous growing seasons (Facelli and Pickett 1991) and was measured from the soil surface (cm). The average litter depth reading per site was determined to get a representation of the entire site. This was done for each site surveyed. Each litter depth point was sampled once during the study period (2008-2011) and all litter depth points within a site were measured in one year.

Within each site, one transect was placed for every eight to 10 acres and one VOR point was placed for every five to eight acres using restricted randomization design. We sampled 372 vegetation transects (Table 6). We placed vegetation transects and VOR points within WPAs, NWRs, and a grassland easement using the same methods used to place bird survey points (see *Bird Survey Methods*). Litter depth was measured at each VOR point. We sampled a total of 649 VOR and litter depth points (Table 6). Most transects were stratified by ecological sites (e.g., hilltops and hillsides) to address soils and environmental variation (Sedivec and Printz 2012). However, transects and VOR points were repositioned if placed in a wetland or < 150 m apart from other vegetation transects or points or < 100 m from roads or site edges, making it a restricted randomization design. Both ends of each vegetation transect were marked with Stake Chasers®, (Abilene, TX), attached to a wooden stake inserted flush with the soil and recorded with a Trimble® GeoXT™ GPS Unit.

Bird and Vegetation Analyses. We hypothesized that different vegetation types would influence bird species richness. We hypothesized that vegetation structure, composition, and litter depth would as play a role in bird species richness also. We calculated bird species richness and used a Tukey's Post-hoc test on the results of an ANOVA to determine bird species richness differences between vegetation types (R Development Core Team 2010). This was done by getting the overall number of grassland obligate, grassland user, and wetland species observed within each site. 95% confidence intervals were then calculated and compared to determine if species richness differed between vegetation types.

We calculated the percentage of native vegetation (PNV), mean litter depth, and mean vegetation structure (Robel) for each study site and used an Analysis of Covariance (ANCOVA) to determine if vegetation type influenced bird species richness taking into consideration the PNV, the average Robel reading, and the average litter depth reading within each site in separate ANCOVA analyses (R Development Core Team 2010). Each ANCOVA was performed investigating the interaction between vegetation type and the PNV, vegetation type and the average Robel reading, or vegetation type and the average litter depth as model terms. ANOVA was also used to determine if there was a difference between the five vegetation types surveyed in PNV, average Robel reading, and average litter depth (R Development Core Team 2010). The statistical tests were considered significant at $P \leq 0.05$.

Geographic Information System Data. The GIS data used for this project was obtained from the University of North Dakota – Geography Department (UND) and the United States Fish and Wildlife Service – Devils Lake Wetland Management District (USFWS – DLWMD). I used National Agriculture Imagery Program (NAIP) aerial photographs obtained from UND and a WPA layer obtained from the USFWS – DLWMD. The

photographs were taken in 2009 by the United States Department of Agriculture: Farm Service Agency (USDA: FSA).

Landscape Classification/Digitizing. Aerial photographs were obtained of the landscape surrounding WPAs, NWRs, and grassland easements surveyed for grassland birds from the Department of Geography at the University of North Dakota. The National Agriculture Imagery Program (NAIP) aerial photographs were digitized in ArcMap 9.3 to classify varying landscape variables. The photographs were taken in 2009 by the USDA: FSA. For each site surveyed, I have begun classifying cover types of land within the site. Habitat classification as defined by the 2001 National Land Cover Data was used to categorize the landscape in northeastern North Dakota into nine primary cover types: 1) grassland/herbaceous; 2) row crop; 3) open water; 4) emergent vegetation; 5) forested upland; 6) shrubland; 7) developed; 8) barren land; and 9) roads. The developed and roads cover classes were further broken down into separate sub-classes as not all land is developed evenly and as not all roads have the same traffic densities. The developed areas were broken down based on the amount of area covered by constructed material, while roads were broken down into various categories based on surface type. The developed cover class was broken down into three sub-classes: 1) low intensity – includes areas with constructed materials and vegetation. Constructed surfaces account for 20-49% of total cover, 2) medium intensity – includes areas with constructed materials and vegetation. Constructed surfaces account for 50-79% of total cover, and 3) high intensity – includes highly developed areas where people reside or work in high numbers. Constructed surfaces account for 80-100% of total cover. The roads cover class was broken down into two sub-classes: 1) gravel – unpaved surfaces consisting of course, rocky material. Gravel roads are generally less traveled and usually in rural areas and 2) paved – generally more travelled roads with surfaces of tar, asphalt, or concrete. For each cover class, a separate shapefile was created in ArcCatalog and given the WPA layers coordinate system.

Results: Twenty grassland obligate, grassland user, and wetland avian species were observed during the course of this study within five vegetation types (2008-2011). MSN and DNC had the highest bird richness; while ONC had the lowest bird richness (Table 7). Of the twenty grassland obligate, grassland user, and wetland avian species observed, three were found only on REM sites (Orchard Oriole *Icterus spurius*, Gray Catbird *Dumetella carolinensis*, and Willow Flycatcher *Empidonax traillii*), two species found only on MSN sites (Marbled Godwit *Limosa fedoa* and Horned Lark *Eremophila alpestris*), and one species found only on WSN sites (Tree Swallow *Tachycineta bicolor*; Table 8).

The results suggest that certain vegetation types influence bird species richness (1-way ANOVA, $F_{4, 27} = 6.3319$, $p = 0.001$). A Tukey's Post-hoc test was performed on the results of the ANOVA and found the mean bird species richness of WSN, DNC, and MSN was statistically higher than ONC but REM could not be distinguished from either ONC or the group of WSN, DNC, and MSN (Figure 2).

The ANCOVA with the PNV as a covariate indicated a significant effect of PNV and vegetation type but no significant interaction between the two (Table 10). Bird richness increased as the PNV within a site increased (Figure 5). The ANCOVA with the

average Robel reading as a covariate indicated a significant effect of vegetation type but no significant effect of average Robel reading or the interaction between the two (Table 10). The ANCOVA with the average litter depth as a covariate indicated a significant effect of vegetation type but no significant effect of average littler depth or the interaction between the two (Table 10).

The results also suggest that certain vegetation types influence PNV (Table 9, 1-way ANOVA, $F_{4, 27} = 18.021$, $p = < 0.001$). A Tukey's Post-hoc test was performed on the results of an ANOVA and found the mean PNV of WSN, REM, and MSN was significantly higher than ONC and DNC (Figure 3). However, the mean PNV was not statistically different between WSN, REM, and MSN, or between DNC and ONC (Figure 3). Additionally, it was shown that certain vegetation types influence average litter depth (Table 9, 1-way ANOVA, $F_{4, 27} = 2.8996$, $p = 0.0406$) A Tukey's Post-hoc test was performed on the results of an ANOVA and found the mean average litter depth of was statistically higher than ONC (Figure 4). However, the mean average litter depth was not statistically different between WSN, MSN, DNC, and REM (Figure 4).

The results from this study found that WSN, DNC, and MSN showed higher bird species richness ONC. However, when looking to see if the vegetation types were statistically different from one another, it was found that the DNC, REM, MSN and the WSN vegetation type were not different from one another; nor was ONC and REM. It was found, however, that DNC, MSN, and WSN vegetation types were different from the ONC vegetation type in terms of bird species richness (Figure 2). Due to the complexity of the grassland ecosystem, vegetative variables contained within each vegetation type are influencing the bird species richness as well as the vegetation type overall. With a higher PNV within a site showing a statistically positive relationship with bird species richness, this would suggest that the MSN sites would have a higher bird species richness than the other vegetation types, which we found (mean bird species richness = 12).

Discussion: In agreement with our predictions, we found vegetation type had a significant influence on the occupancy of United States Fish and Wildlife Service lands by grassland birds (Table 9). These results suggest a multitude of vegetation types as being beneficial or usable habitat. It was also found that vegetation type had a significant influence on the percentage of native vegetation within a field as well as the amount of litter. However, it was not shown to influence the Robel reading within a field.

We found that as the percentage of native vegetation increased within a site, bird species richness increased as well (implications from this study, Wilson and Belcher 1989, among others; Figure 5). Since we previously found that percentage of native vegetation had a direct, positive relationship with bird species richness, we can suggest that vegetation types with higher percentage of native vegetation (e.g., remnant prairie, multi-species natives, and warm-season natives) are more beneficial to grassland obligate, grassland users, and wetland avian species than vegetation types with lower percentage of native vegetation (e.g., old dense nesting cover and dense nesting cover).

Although remnant prairie, which had a high percentage of native vegetation, did not have the highest bird species richness (n = 9), the vegetation type still has a major impact in the amount of usable habitat available. With most of the remaining remnant prairie available to sample being of poor quality, this may have caused a lower amount of bird species richness to be observed and also may have caused there not to be a difference

noticed between old dense nesting cover and remnant prairie vegetation types in terms of bird species richness.

In conclusion, it was discovered that land management agencies have more than one option when converting formerly cropper or idled lands into restored grasslands. The warm-season native and multi-species native vegetation types had statistically similar mean bird species richness as well as statistically similar percentage of native vegetation. This suggests that these two restoration practices appear to be the most beneficial of the vegetation types surveyed, along with remnant prairie sites. Dense nesting cover also showed to be beneficial when looking at bird species richness alone, giving it the potential for use in future restorations. However, since old dense nesting cover had the lowest observed bird species richness (n = 7) and has low percentage of native vegetation, a management decision to restore these sites to a different seed mix (e.g., multi-species native or warm-season native) would make the land more beneficial to grassland obligates, grassland users, and wetland bird species.

Results of this work will aid in improving and informing future management decisions and restoration projects conducted by land managers in the federal, state, and private sectors. Based on the results of this study, management decisions can now be made with the knowledge that all vegetation types are not equally beneficial grassland obligate, grassland users, and wetland species of songbirds. The results of our study also provide measureable indicators to reflect the effectiveness of this costly and intensive restoration strategy as well as providing an option to land managers. While dense nesting cover and multi-species native seed mixes showed higher bird species richness than the other vegetation types, they were not statistically different from the warm-season native seed mix. Thus, giving land managers three seed mixes to choose from when restoring land. This option will prove important when planning their yearly restoration projects around annual budgets as the average cost/acre for these three seed mixes is drastically different, ~$50, ~$175, and ~$25, respectively (Table 1). As many grassland bird species have been shown to be area-sensitive (i.e., requiring large tracts of grassland for breeding; Peterson 1983, Bollinger 1988, Bollinger et al. 1990, Bollinger and Gavin 1992, Smith 1992), conservation and restoration of grasslands will play a significant role in reversing the current, negative population trend of grassland songbirds.

Note: Objective 3. “Compare Breeding Bird Survey data and possibly other state-wide and regional data to the results of this proposed study to obtain an overall representation of bird populations for the respective years as well as communities/habitat type.” was not addressed in this final report but a thesis is anticipated later in 2013.

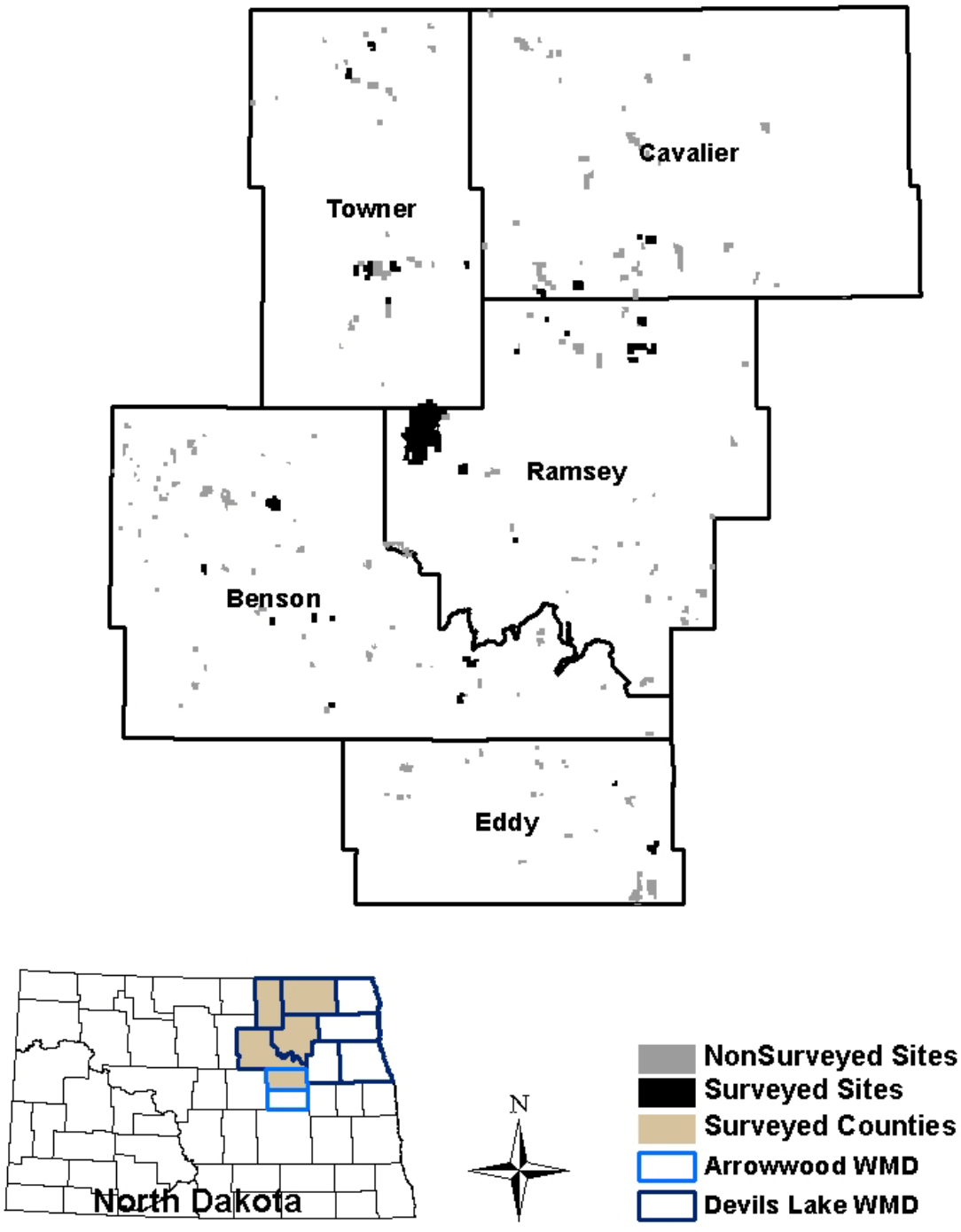

Figure 1. Survey locations for grassland birds on WPAs, NWRs, and private lands (n = 32) in northeastern and east-central North Dakota, USA, 2008-2011.

Table 1. Average Cost/Acre of each seed mixture. Prices vary depending on year and species contained within mixture (Devils Lake Wetland Management District Staff, personal communication).

Seed Mixture	Average Cost/Acre
MSN (grass/forb)	$175 (Ranges from $120-$300+)
WSN (grass)	$50
DNC (grass)	$25

Table 2. Start and end dates of 100 m fixed-radius point count surveys for grassland birds. Note: The second round of the 2009 field season began prior to the completion of the first round due to an additional site added to the REM vegetation type to increase the sample size.

	Round 1		Round 2	
Year	Start	End	Start	End
2008	28 May	16 June	18 June	01 July
2009	18 May	03 June	28 May	24 June
2010	15 May	12 June	13 June	01 July
2011	18 May	11 June	14 June	08 July

Table 3. Plant species included in each vegetation type seed mixture seeded within the Devils Lake WMD, North Dakota, USA. Note: Not every species within the seed mixture is seeded at each site of the corresponding vegetation type. Additionally, each species may or may not have been present during the study period. See Appendix A for site specific seed mixtures.

Plant Species			Vegetation Type			
Family	Scientific Name	Common Name	DNC	ONC	MSN	WSN
Apiaceae	*Zizia aurea*	Golden Alexander				X
Asteraceae	*Echinacea angustifolia*	Purple Coneflower				X
	Gaillardia aristata	Blanket Flower			X	
	Helianthus maximilianii	Maximilian Sunflower			X	
	Helinathus annuus	Wild Sunflower				X
	Liatris ligulistylis	Meadow Blazingstar			X	
	Liatris pycnostachya	Prairie Blazingstar			X	
	Liatris spp.	Blazingstar spp.				X
	Ratibida columnifera	Prairie Coneflower			X	
	Rudbeckia hirta	Black-eyed Susan			X	
	Solidago rigida	Stiff Goldenrod			X	X
Fabaceae	*Amorpha canescens*	Leadplant			X	
	Astragalus canadensis	Canada Milkvetch			X	
	Dalea candida	White Prairie Clover			X	
	Dalea purpurea	Purple Prairie Clover			X	
	Medicago sativa	Alfalfa	X	X		X
	Melilotus officinalis	Yellow Sweetclover	X	X		X
	Vicia americana	American Vetch			X	
Lamiaceae	*Monarda fistulosa*	Wild Bergamot			X	
Linaceae	*Linum lewisii*	Lewis Flax			X	

Table 3 Cont. Plant species included in each vegetation type seed mixture seeded within the Devils Lake WMD, North Dakota, USA. Note: Not every species within the seed mixture is seeded at each site of the corresponding vegetation type. Additionally, each species may or may not have been present during the study period. See Appendix A for site specific seed mixtures.

Plant Species			Vegetation Type			
Family	Scientific Name	Common Name	DNC	ONC	MSN	WSN
Poaceae	*Linum perenne*	Blue Flax			X	
	Agropyron elongatum	Tall Wheatgrass	X	X		
	Agropyron intermedium	Intermediate Wheatgrass	X	X		
	Agropyron smithii	Western Wheatgrass	X	X	X	X
	Agropyron trachycaulu	Slender Wheatgrass		X	X	X
	Andropogon gerardii	Big Bluestem			X	X
	Andropogon scoparius	Little Bluestem			X	X
	Bouteloua curtipendula	Sideoats Grama			X	X
	Bouteloua gracilis	Blue Grama			X	
	Bromus inermis	Smooth Brome		X		
	Calamovilfa longifolia	Prairie Sandreed			X	
	Elymus canadensis	Canada Wildrye			X	X
	Panicum virgatum	Switchgrass	X		X	X
	Phalaris	Reed Canarygrass		X		
	Sorghastrum nutans	Indiangrass			X	X
	Spartina pectinata	Prairie Cordgrass			X	
	Sporobolus heterolepis	Prairie Dropseed				X
	Stipa comata	Needleandthread			X	
	Stipa spartea	Porcupine Grass			X	

Table 3 Cont. Plant species included in each vegetation type seed mixture seeded within the Devils Lake WMD, North Dakota, USA. Note: Not every species within the seed mixture is seeded at each site of the corresponding vegetation type. Additionally, each species may or may not have been present during the study period. See Appendix A for site specific seed mixtures.

Plant Species			Vegetation Type			
Family	Scientific Name	Common Name	DNC	ONC	MSN	WSN
	Stipa viridula	Green Needlegrass		X	X	
Ranunculaceae	*Thalictrum pubescens*	Tall Meadowrue				X
Rosaceae	*Rosa arkansana*	Prairie Rose			X	X
Rubiaceae	*Galium boreale*	Northern Bedstraw				X
Scrophulariaceae	*Penstemon grandiflorus*	Shell-leaf Penstemon			X	

Table 4. Surveyed sites for grassland birds within the Devils Lake and Arrowwood WMDs, North Dakota, USA. Multi-species natives (MSN) - areas seeded with a mixture of native grasses and forbs. Warm-season natives (WSN) - areas with seeded three to four warm-season grasses and not more than six forbs. Dense nesting cover (DNC) – areas seeded with a wheatgrass (*Agropyron)* species, alfalfa (*Medicago sativa)*, and yellow sweetclover (*Melilotus officinalis*) mixture. Old dense nesting cover (ONC) – areas seeded with a form of dense nesting cover (i.e., non-native grasses, such as smooth brome (*Bromus inermis*)) ≥ 15 years ago. Remnant prairie (REM) - areas that have never been plowed. 2008 – '08, 2009 – '09, 2010 – '10, and 2011 – '11.

					Years Surveyed			
Site	County	Vegetation Type	Area (ha.)	Survey Points	'08	'09	'10	'11
Phil Aus	Ramsey	DNC	130	2	X	X	X	X
Register 1	Towner	DNC	69	3	X	X	X	X
Stephens	Towner	DNC	130	2	X	X	X	X
Tarvestad	Ramsey	DNC	65	2	X	X	X	X
Hofstrand	Benson	MSN	89	2		X	X	X
Lake Alice	Ramsey	MSN	44	2	X	X	X	X
Martinson 2	Ramsey	MSN	130	2		X	X	X
Register 2	Towner	MSN	130	8	X	X	X	X
Edwards	Cavalier	ONC	251	2			X	X
Freund	Towner	ONC	61	1			X	X
Howes	Ramsey	ONC	41	1			X	X
Pintail	Ramsey	ONC	61	1			X	X
Putman	Towner	ONC	65	1			X	X
Solberg	Cavalier	ONC	65	2			X	X
Stinkeoway	Cavalier	ONC	32	1			X	X
Tweten	Benson	ONC	53	1			X	X
Waltz	Towner	ONC	179	4			X	X
Deep Valley	Benson	REM	121	2	X	X	X	X
Grassland Easement	Benson	REM	112	3	X	X	X	X
Haven	Eddy	REM	264	2			X	X
Langley	Eddy	REM	49	2			X	X
Lone Tree	Benson	REM	113	2	X	X	X	X
Melass	Benson	REM	97	2			X	X
Sullys Hill	Benson	REM	61	2	X	X	X	X
Ziegler	Ramsey	REM	65	1	X	X	X	X
Avocet Island	Ramsey	WSN	41	1	X	X	X	X
Breakey	Ramsey	WSN	130	2	X	X	X	X
Elias	Ramsey	WSN	65	2	X	X		
Halvorson	Towner	WSN	190	2	X	X	X	X
Martinson 1	Ramsey	WSN	65	2	X	X	X	X
Rolling Rock	Benson	WSN	65	2		X	X	X

Table 4 Cont. Surveyed sites for grassland birds within the Devils Lake and Arrowwood WMDs, North Dakota, USA. Multi-species natives (MSN) - areas seeded with a mixture of native grasses and forbs. Warm-season natives (WSN) - areas with seeded three to four warm-season grasses and not more than six forbs. Dense nesting cover (DNC) – areas seeded with a wheatgrass (*Agropyron)* species, alfalfa (*Medicago sativa)*, and yellow sweetclover (*Melilotus officinalis*) mixture. Old dense nesting cover (ONC) – areas seeded with a form of dense nesting cover (i.e., non-native grasses, such as smooth brome (*Bromus inermis*)) ≥ 15 years ago. Remnant prairie (REM) - areas that have never been plowed. 2008 – '08, 2009 – '09, 2010 – '10, and 2011 – '11.

					Years Surveyed			
Site	County	Vegetation Type	Area (ha.)	Survey Points	'08	'09	'10	'11
SBA	Towner	WSN	65	2		X	X	X

Table 5. Yearly sample sizes (number of sites surveyed) for five vegetation types surveyed for grassland birds within the Devils Lake and Arrowwood WMDs, North Dakota, USA.

	Yearly Sample Size (number of sites surveyed)							
Vegetation Type	2008		2009		2010		2011	
	Points	Sites	Points	Sites	Points	Sites	Points	Sites
DNC	9	4	9	4	9	4	9	4
ONC	0	0	0	0	14	9	14	9
MSN	10	2	14	4	14	4	14	4
REM	9	5	9	5	13	8	13	8
WSN	9	5	13	7	11	6	11	6

Table 6. Sample sizes of surveyed sites for vegetation composition, vegetation structure, and litter depth within the Devils Lake and Arrowwood WMDs, North Dakota. MSN - areas seeded with a multi-species native mixture. WSN - areas that have been seeded specifically with a warm-season mixture. DNC – areas seeded with a wheatgrass/alfalfa mixture. ONC – areas seeded to dense nesting cover ≥ 15 years ago. REM - areas that have never been plowed. Sample sizes are presented as XX/YY, where XX is the number of vegetation transects surveyed and YY is the number of VOR and litter depth points surveyed.

		Sample Size and Year Surveyed			
Site	Vegetation Type	2008	2009	2010	2011
Bull Moose	DNC	-/-	09/-	-/-	-/17
Phil Aus	DNC	-/-	11/-	-/-	-/20
Register	DNC	-/-	10/-	-/-	-/16
Tarvestad	DNC	-/-	-/-	10/-	-/06
Edwards	ONC	-/-	-/-	-/-	06/71
Freund	ONC	-/-	-/-	05/-	-/13
Howes	ONC	-/-	-/-	07/-	-/05
Pintail	ONC	-/-	-/-	08/-	-/21
Putman	ONC	-/-	-/-	06/-	-/15
Solberg	ONC	-/-	-/-	-/-	10/20
Stinkeoway	ONC	-/-	-/-	-/-	06/10
Tweten	ONC	-/-	-/-	03/-	-/09
Waltz	ONC	-/-	-/-	-/-	17/48
Hofstrand	MSN	-/-	-/-	-/-	19/30
Lake Alice	MSN	-/-	-/-	-/-	07/15
Martinson	MSN	-/-	-/-	-/-	12/28
Register	MSN	-/-	-/-	-/-	11/26
Deep Valley	REM	-/-	-/-	20/-	-/21
Grassland Easement	REM	-/-	-/-	-/-	25/47
Haven	REM	-/-	-/-	14/-	-/43
Langley	REM	-/-	-/-	08/-	-/18
Lone Tree	REM	-/-	-/-	16/-	-/13
Melass	REM	-/-	-/-	21/-	-/13
Native Prairie Unit	REM	-/-	-/-	38/-	-/30
Ziegler	REM	-/-	-/-	08/-	-/10
Avocet Island	WSN	-/-	-/-	08/-	-/02
Breakey	WSN	-/-	11/-	-/-	-/14
Elias	WSN	-/-	11/-	-/-	-/14
Halvorson	WSN	-/-	09/-	-/-	-/15
Martinson	WSN	-/-	10/-	-/-	-/12
Rolling Rock	WSN	-/-	-/-	06/-	-/09
SBA	WSN	-/-	-/-	10/-	-/18

Table 7. Variation of grassland and wetland bird species richness per vegetation type.

Vegetation Type	Number of Sites	Min. Species Richness	Max. Species Richness	Mean Species Richness
ONC	9	3	10	7
REM	8	5	12	9
WSN	6	9	12	11
MSN	4	9	15	12
DNC	4	10	13	12

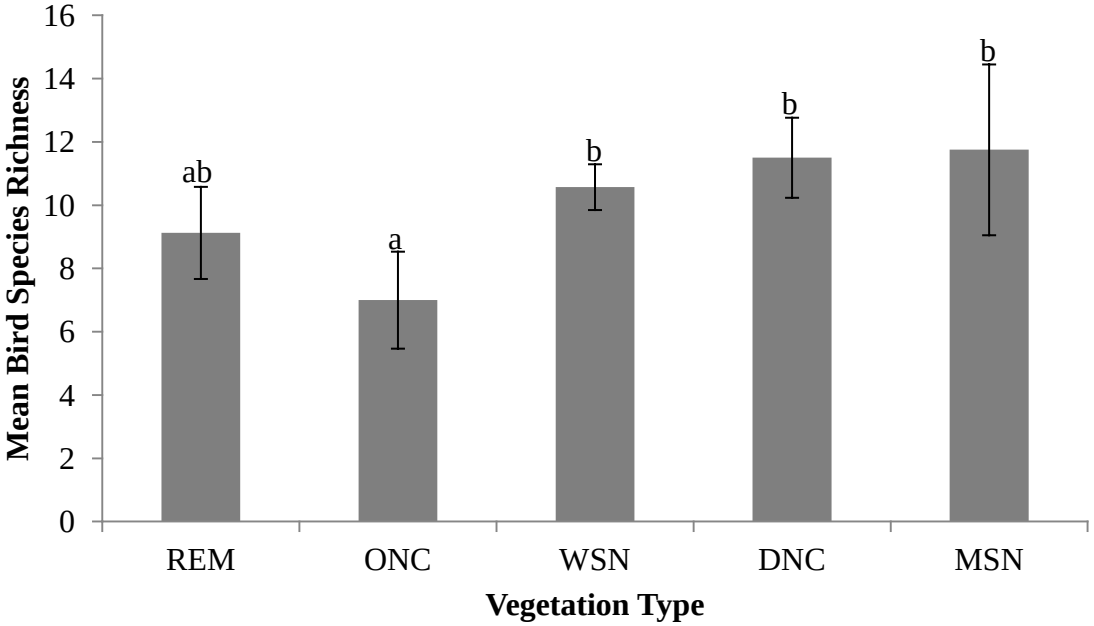

Figure 2. Tukey's Post-hoc test on the results of an ANOVA looking to see if the different vegetation types influenced bird species richness. Error bars represent 95% confidence intervals. A and B are used to indicate groups that are different based on the Tukey's Post-hoc test.

Table 8. Presence and Absence of 20 grassland obligate, grassland user, and wetland avian species on five vegetation types.

Avian Species			Vegetation Type				
Family	Scientific Name	Common Name	DNC	MSN	WSN	ONC	REM
Alaudidae	*Eremophila alpestris*	Horned Lark		X			
Charadriidae	*Charadrius vociferus*	Killdeer		X	X		
Columbidae	*Zenaida macroura*	Mourning Dove		X	X		X
Emberizidae	*Ammodramus leconteii*	Le Conte's Sparrow	X	X	X	X	X

Table 8 Cont. Presence and Absence of twenty grassland obligate, grassland user, and wetland avian species on five vegetation types.

Avian Species			Vegetation Type				
Family	Scientific Name	Common Name	DNC	MSN	WSN	ONC	REM
	Ammodramus nelsoni	Nelson's Sparrow	X	X	X	X	X
	Ammodramus savannarum	Grasshopper Sparrow	X	X	X		X
	Melospiza melodia	Song Sparrow	X	X	X		X
	Passerculus sandwichensi	Savannah Sparrow	X	X	X	X	X
	Pooecetes gramineus	Vesper Sparrow		X			X
	Spizella pallida	Clay-colored Sparrow	X	X	X	X	X
Fringillidae	*Spinus tristis*	American Goldfinch	X				X
Hirundinidae	*Tachycineta bicolor*	Tree Swallow			X		
Icteridae	*Agelaius phoeniceus*	Red-winged Blackbird	X	X	X	X	X
	Dolichonyx oryzivorus	Bobolink	X	X	X	X	X
	Icterus spurius	Orchard Oriole					X
	Molothrus ate	Brown-headed Cowbird	X	X	X	X	X
	Quiscalus quiscula	Common Grackle			X	X	X
	Sturnella neglecta	Western Meadowlark	X	X	X	X	X
	Xanthocephalus xanthocephalus	Yellow-headed Blackbird	X	X	X	X	X
Mimidae	*Dumetella carolinensis*	Gray Catbird					X
Parulidae	*Dendroica petechia*	Yellow Warbler	X	X	X		X
	Geothlypis trichas	Common Yellowthroat	X	X	X	X	X
Scolopacidae	*Bartramia longicauda*	Upland Sandpiper	X		X		X

Table 8 Cont. Presence and Absence of twenty grassland obligate, grassland user, and wetland avian species on five vegetation types.

Avian Species			Vegetation Type				
Family	Scientific Name	Common Name	DNC	MSN	WSN	ONC	REM
	Gallinago delicata	Wilson's Snipe	X	X	X		
	Limosa fedoa	Marbled Godwit		X			
Troglodytidae	*Cistothorus platensis*	Sedge Wren	X	X	X	X	X
Tyrannidae	*Empidonax traillii*	Willow Flycatcher					X
	Tyrannus tyrannus	Eastern Kingbird	X	X	X	X	X
	Tyrannus verticalis	Western Kingbird	X	X			X

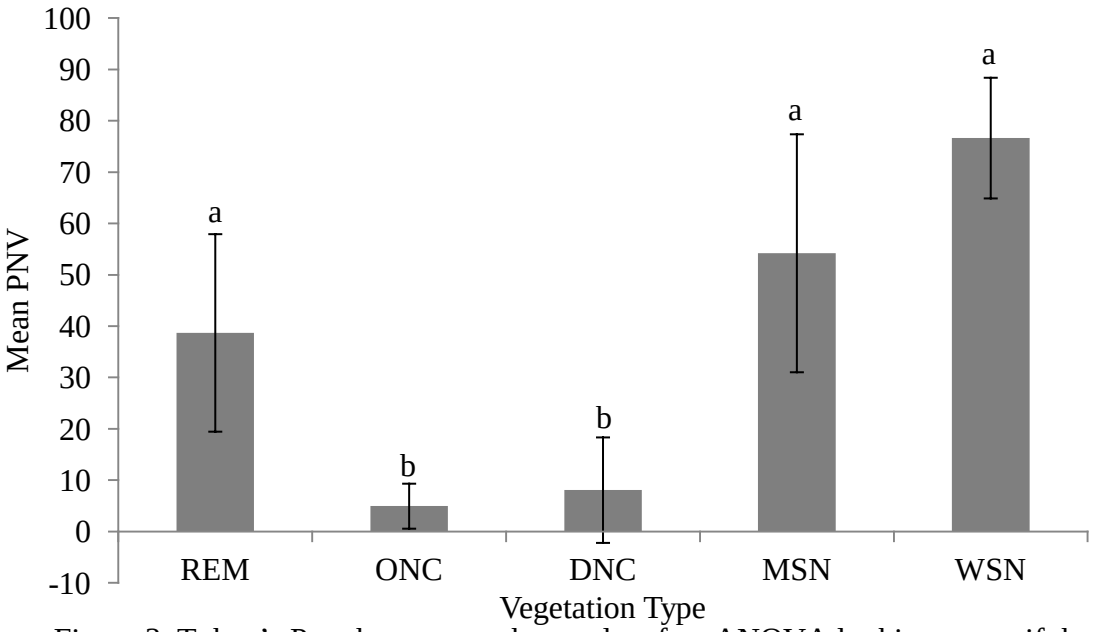

Figure 3. Tukey's Post-hoc test on the results of an ANOVA looking to see if the different vegetation types influenced PNV. Error bars represent 95% confidence intervals. A and B are used to indicate groups that are different based on the Tukey's Post-hoc test.

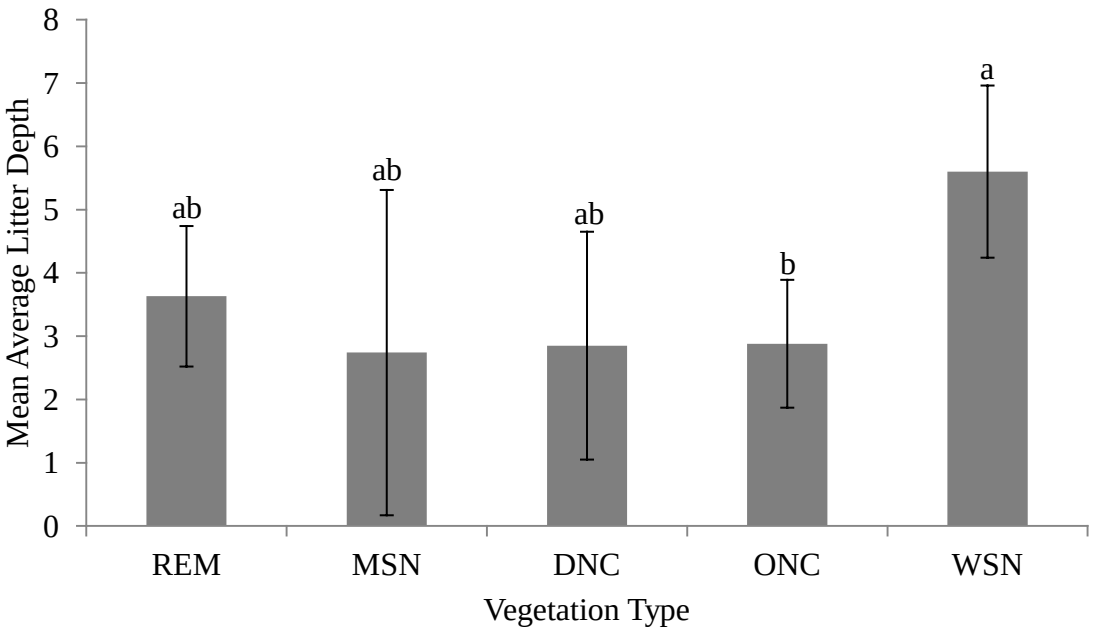

Figure 4. Tukey's Post-hoc test on the results of an ANOVA looking to see if the different vegetation types influenced average litter depth. Error bars represent 95% confidence intervals. A and B are used to indicate groups that are different based on the Tukey's Post-hoc test.

Table 9. Results of three 1-way ANOVAs for PNV, average Robel reading and average litter depth of vegetation types. Factors were vegetation type (DNC, MSN, WSN, ONC, and REM).

Covariate		Df	F Value	P Value
PNV				
	Vegetation Type	4	18.021	<0.001***
	Residuals	27		
Average Robel Reading				
	Vegetation Type	4	0.770	0.554
	Residuals	27		
Average Litter Depth				
	Vegetation Type	4	2.900	0.041*
	Residuals	27		

Significant Codes: '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 10. Results of ANCOVAs of three vegetation measurements influenced by vegetation type. PNV = Percentage of Native Vegetation.

Covariate	Terms	Df	F Value	P Value
PNV				
	PNV	1	8.403	0.008**
	Vegetation Type	4	4.205	0.011*
	PNV x Vegetation Type	4	0.916	0.472
	Residuals	22		
Average Robel Reading				
	Average Robel Reading	1	0.008	0.931
	Vegetation Type	4	6.454	0.001**
	Average Robel Reading x Vegetation Type	4	0.849	0.509
	Residuals	22		
Average Litter Depth				
	Average Litter Depth	1	0.817	0.376
	Vegetation Type	4	5.752	0.003**
	Average Litter Depth x Vegetation Type	4	0.308	0.869
	Residuals	22		

Significant Codes: ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘’ 1

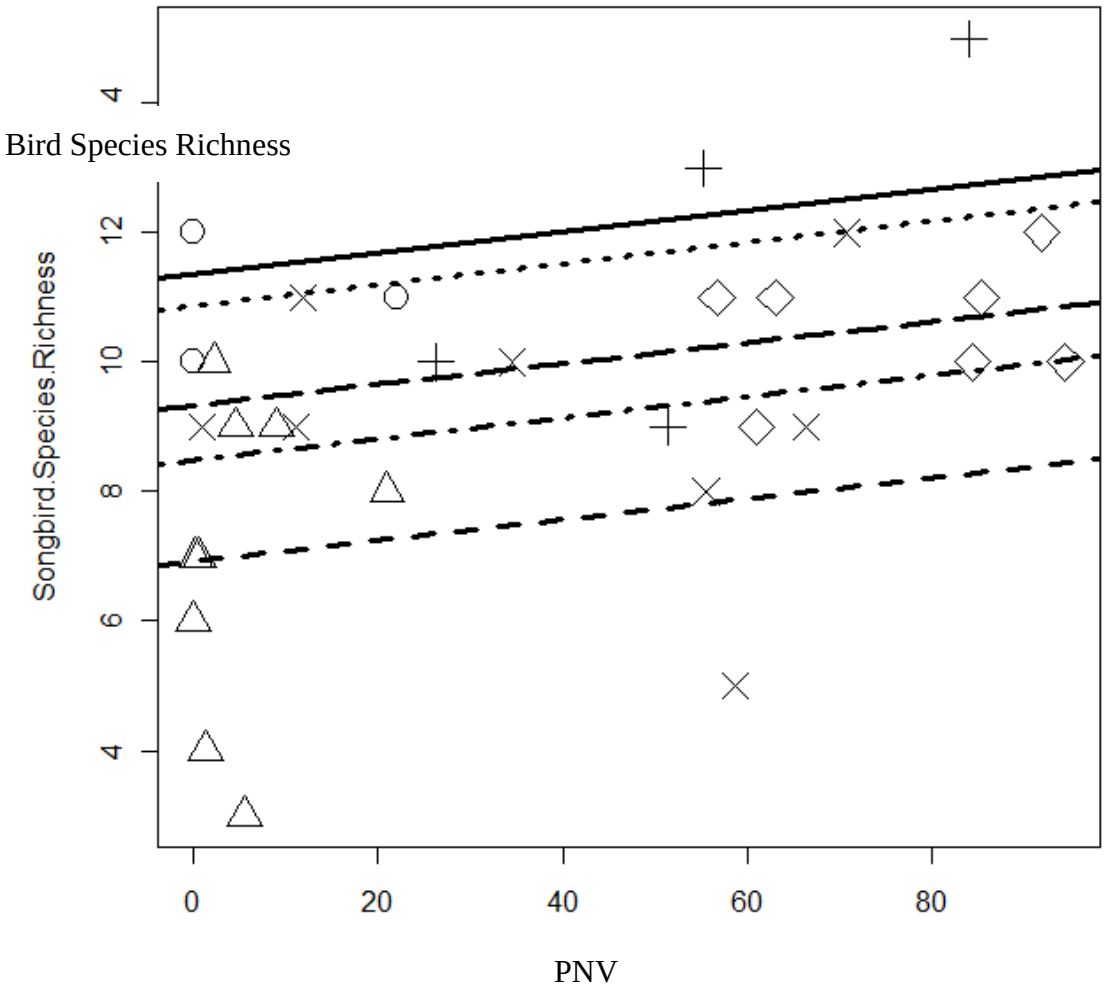

Figure 5. Influence of the percentage of native vegetation on bird species richness. Solid line and O represent DNC, dashed line and Δ represent ONC, dotted line and + represent MSN, dot-dash line and X represent REM, and long dashed line and ◊ represent WSN vegetation types.

Appendix A
Site Specific Seed Mixtures

DNC

Plant Species			Sites			
Family	Scientific Name	Common Name	Register	Phil Aus	Tarvestad	Stephens Memorial – Bull Moose
Fabaceae	*Medicago sativa*	Alfalfa	X	X	X	X
	Melilotus officinalis	Yellow Sweetclover	X	X	X	X
Poaceae	*Agropyron elongatum*	Tall Wheatgrass	X	X	X	X
	Agropyron intermedium	Intermediate Wheatgrass		X	X	X
	Agropyron smithii	Western Wheatgrass	X			
	Panicum virgatum	Switchgrass				X

MSN

Plant Species			Sites			
Family	Scientific Name	Common Name	Register	Hofstrand	Lake Alice	Martinson
Asteraceae	*Echinacea angustifolia*	Purple Coneflower		X	X	X
	Gaillardia aristata	Blanket Flower	X	X	X	X
	Helianthus maximilianii	Maximilian Sunflower		X	X	X
	Liatris ligulistylis	Meadow Blazingstar	X			
	Liatris pycnostachya	Prairie Blazingstar		X		
	Ratibida columnifera	Prairie Coneflower		X		X
	Rudbeckia hirta	Black-eyed Susan	X	X	X	X
	Solidago rigida	Stiff Goldenrod	X			
Fabaceae	*Amorpha canescens*	Leadplant		X		
	Astragalus canadensis	Canada Milkvetch	X		X	
	Dalea candida	White Prairie Clover	X			
	Dalea purpurea	Purple Prairie Clover	X	X	X	X
	Vicia americana	American Vetch	X			

Appendix A: MSN Cont.

Lamiaceae	*Monarda fistulosa*	Wild Bergamot	X	X		
Linaceae	*Linum lewisii*	Lewis Flax			X	X
	Linum perenne	Blue Flax		X		
Poaceae	*Agropyron smithii*	Western Wheatgrass	X	X	X	X
	Agropyron trachycaulum	Slender Wheatgrass	X	X	X	X
	Andropogon gerardii	Big Bluestem	X	X		X
	Andropogon scoparius	Little Bluestem	X		X	
	Bouteloua curtipendula	Sideoats Grama	X	X	X	X
	Bouteloua gracilis	Blue Grama		X		X
	Elymus canadensis	Canada Wildrye	X	X	X	X
	Panicum virgatum	Switchgrass	X	X	X	X
	Sorghastrum nutans	Indiangrass	X	X	X	X
	Stipa comata	Needleandthread	X			
	Stipa spartea	Porcupine grass		X		
	Stipa viridula	Green Needlegrass	X	X	X	X
Roasaceae	*Rosa arkansana*	Prairie Rose	X			
Scrophulariaceae	*Penstemon grandiflorus*	Shell-leaf Penstemon		X		X

WSN

Plant Species			Sites						
Family	Scientific Name	Common Name	Martinson	Rolling Rock	Avocet Island	Breakey	Elias	Halvorson	SBA
Apiaceae	*Zizia aurea*	Golden Alexander				X	X		
Asteraceae	*Cirsium arvense*	Canada Thistle				X			
	Helinathus annuus	Wild Sunflower				X	X		

Appendix A: WSN Cont.

	Liatris spp.	Blazingstar spp.					X	X		
	Solidago rigida	Stiff Goldenrod					X	X		
Fabaceae	*Astragalus canadensis*	Canada Milkvetch	X							
	Medicago sativa	Alfalfa	X	X	X					
	Melilotus officinalis	Yellow Sweetclover					X	X	X	X
Poaceae	*Agropyron smithii*	Western Wheatgrass							X	X
	Agropyron trachycaulum	Slender Wheatgrass							X	X
	Andropogon gerardii	Big Bluestem	X	X	X				X	X
	Andropogon scoparius	Little Bluestem					X	X	X	
	Bouteloua curtipendula	Sideoats Grama					X	X		
	Calamovilfa longifolia	Prairie Sandreed							X	
	Elymus canadensis	Canada Wildrye					X	X		
	Panicum virgatum	Switchgrass	X	X	X	X	X	X		
	Sorghastrum nutans	Indiangrass	X	X	X	X	X			X
	Spartina pectinata	Prairie Cordgrass					X	X		

Appendix A: WSN Cont.

	Sporobolus heterolepis	Prairie Dropseed						X	X		
Ranunculaceae	*Thalictrum pubescens*	Tall Meadowrue						X	X		
Rubiaceae	*Galium boreale*	Northern Bedstraw						X	X		

ONC

Plant Species			Site								
Family	Scientific Name	Common Name	Waltz	Solberg	Stinkeoway	Freund	Tweten	Pintail	Howes	Edwards	Putman
Fabaceae	*Medicago sativa*	Alfalfa		X	X	X			X	X	X
	Melilotus officinalis	Yellow Sweetclover	X	X	X	X	X	X	X	X	X
Poaceae	*Agropyron elongatum*	Tall Wheatgrass		X	X				X	X	
	Agropyron intermedium	Intermediate Wheatgrass		X	X				X	X	
	Agropyron smithii	Western Wheatgrass			X			X			
	Agropyron trachycaulum	Slender Wheatgrass			X			X			
	Bromus inermis	Smooth Bromegrass	X			X	X				X
	Phalaris arundinacea	Reed Canarygrass						X			
	Stipa viridula	Green Needlegrass			X			X			

Appendix B
Site Specific Avian Observations

DNC

Avian Species			Sites			
Family	Scientific Name	Common Name	Register	Phil Aus	Tarvestad	Stephens Memorial
Emberizidae	*Ammodramus leconteii*	Le Conte's Sparrow	X	X	X	X
	Ammodramus nelsoni	Nelson's Sparrow	X	X	X	X
	Ammodramus savannarum	Grasshopper Sparrow	X			
	Melospiza melodia	Song Sparrow	X			
	Passerculus sandwichensi	Savannah Sparrow	X	X	X	X
	Spizella pallida	Clay-colored Sparrow	X	X	X	X
Fringillidae	*Spinus tristis*	American Goldfinch		X		
Icteridae	*Agelaius phoeniceus*	Red-winged Blackbird	X	X	X	X
	Dolichonyx oryzivorus	Bobolink	X	X	X	X
	Molothrus ate	Brown-headed Cowbird	X	X	X	X
	Sturnella neglecta	Western Meadowlark	X	X		
	Xanthocephalus xanthocephalus	Yellow-headed Blackbird		X	X	
Parulidae	*Dendroica petechia*	Yellow Warbler			X	
	Geothlypis trichas	Common Yellowthroat	X	X	X	X
Scolopacidae	*Bartramia longicauda*	Upland Sandpiper		X		

Appendix B: DNC Cont.

	Gallinago delicata	Wilson's Snipe				X
Troglodytidae	*Cistothorus platensis*	Sedge Wren	X	X	X	X
Tyrannidae	*Tyrannus tyrannus*	Eastern Kingbird	X			
	Tyrannus verticalis	Western Kingbird				X

MSN

Avian Species			Sites			
Family	Scientific Name	Common Name	Register	Hofstrand	Lake Alice	Martinson
Alaudidae	*Eremophila alpestris*	Horned Lark	X			
Charadriidae	*Charadrius vociferus*	Killdeer		X		
Colimbidae	*Zenaida macroura*	Mourning Dove			X	
Emberizidae	*Ammodramus leconteii*	Le Conte's Sparrow	X	X	X	X
	Ammodramus nelsoni	Nelson's Sparrow	X	X	X	X
	Ammodramus savannarum	Grasshopper Sparrow	X		X	
	Melospiza melodia	Song Sparrow		X	X	X
	Passerculus sandwichensi	Savannah Sparrow	X	X	X	X
	Pooecetes gramineus	Vesper Sparrow	X			
	Spizella pallida	Clay-colored Sparrow	X	X	X	X
Icteridae	*Agelaius phoeniceus*	Red-winged Blackbird	X	X	X	X
	Dolichonyx oryzivorus	Bobolink	X	X	X	X
	Molothrus ate	Brown-headed Cowbird	X	X	X	X
	Sturnella neglecta	Western Meadowlark	X	X		
	Xanthocephalus xanthocephalus	Yellow-headed Blackbird		X		
Parulidae	*Dendroica petechia*	Yellow Warbler				

Appendix B: MSN Cont.

	Geothlypis trichas	Common Yellowthroat	X	X	X	X
Scolopacidae	*Gallinago delicata*	Wilson's Snipe				
Scolopacidae	*Limosa fedoa*	Marbled Godwit	X			
Troglodytidae	*Cistothorus platensis*	Sedge Wren	X	X	X	X
Tyrannidae	*Tyrannus tyrannus*	Eastern Kingbird	X	X		
	Tyrannus verticalis	Western Kingbird				

WSN

Avian Species			Sites						
Family	Scientific Name	Common Name	Martinson	Rolling Rock	Avocet Island	Breakey	Elias	Halvorson	SBA
Charadriidae	*Charadrius vociferus*	Killdeer			X				
Columbidae	*Zenaida macroura*	Mourning Dove							
Emberizidae	*Ammodramus leconteii*	Le Conte's Sparrow	X		X	X	X	X	X
	Ammodramus nelsoni	Nelson's Sparrow	X		X	X	X	X	X
	Ammodramus savannarum	Grasshopper Sparrow						X	
	Melospiza melodia	Song Sparrow	X		X		X	X	
	Passerculus sandwichensi	Savannah Sparrow	X	X	X	X	X	X	X
	Spizella pallida	Clay-colored Sparrow	X	X	X	X	X	X	X
Hirundinidae	*Tachycineta bicolor*	Tree Swallow						X	

Appendix B: WSN Cont.

Icteridae	*Agelaius phoeniceus*	Red-winged Blackbird	X	X	X	X	X	X	X
	Dolichonyx oryzivorus	Bobolink	X		X	X	X	X	X
	Molothrus ate	Brown-headed Cowbird	X	X	X	X	X	X	X
	Quiscalus quiscula	Common Grackle		X			X		
	Sturnella neglecta	Western Meadowlark		X				X	
	Xanthocephalus xanthocephalus	Yellow-headed Blackbird	X	X	X	X	X		
Parulidae	*Dendroica petechia*	Yellow Warbler					X	X	
	Geothlypis trichas	Common Yellowthroat	X	X	X	X	X	X	X
Scolopacidae	*Bartramia longicauda*	Upland Sandpiper				X			
	Gallinago delicata	Wilson's Snipe		X			X		
Troglodytidae	*Cistothorus platensis*	Sedge Wren	X	X	X	X	X	X	X
Tyrannidae	*Tyrannus tyrannus*	Eastern Kingbird				X		X	X

ONC

Avian Species			Sites								
Family	Scientific Name	Common Name	Waltz	Sol-berg	Stinke-oway	Freund	Tweten	Pintail	Howes	Edw-ards	Putman
Emberizidae	*Ammodramus leconteii*	Le Conte's Sparrow	X	X	X		X			X	
	Ammodramus nelsoni	Nelson's Sparrow	X	X	X			X	X	X	X
	Passerculus sandwichensi	Savannah Sparrow	X	X	X	X	X	X	X	X	X
	Spizella pallida	Clay-colored Sparrow	X	X	X	X	X	X	X	X	X
Icteridae	*Agelaius phoeniceus*	Red-winged Blackbird	X		X		X	X	X		
	Dolichonyx oryzivorus	Bobolink	X	X	X	X	X	X		X	X
	Molothrus ate	Brown-headed Cowbird	X	X	X		X	X	X		
	Quiscalus quiscula	Common Grackle	X						X		
	Sturnella neglecta	Western Meadowlark	X								
	Xanthocephalus xanthocephalus	Yellow-headed Blackbird		X				X			
Parulidae	*Geothlypis trichas*	Common Yellowthroat		X				X	X		
Troglodytidae	*Cistothorus platensis*	Sedge Wren	X	X	X		X	X	X	X	

Appendix B: ONC Cont.

Tyrannidae	*Tyrannus tyrannus*	Eastern Kingbird	X

REM

Avian Species			Sites							
Family	Scientific Name	Common Name	Deep Valley	Grassland Easement	Lone Tree	Melass	Sullys Hill	Ziegler	Langley	Haven
Columbidae	*Zenaida macroura*	Mourning Dove					X			
Emberizidae	*Ammodramus leconteii*	Le Conte's Sparrow			X		X			
	Ammodramus nelsoni	Nelson's Sparrow						X		
	Ammodramus savannarum	Grasshopper Sparrow	X	X	X		X		X	X
	Melospiza melodia	Song Sparrow			X		X	X	X	X
	Passerculus sandwichensi	Savannah Sparrow	X	X	X	X	X	X	X	X
	Pooecetes gramineus	Vesper Sparrow		X						
	Spizella pallida	Clay-colored Sparrow	X	X	X	X	X	X	X	X
Fringillidae	*Spinus tristis*	American Goldfinch			X					
Icteridae	*Agelaius phoeniceus*	Red-winged Blackbird	X	X	X	X	X	X	X	X
	Dolichonyx oryzivorus	Bobolink	X	X	X	X	X	X	X	X

Appendix B: REM Cont.

	Icterus spurius	Orchard Oriole					X			
	Molothrus ate	Brown-headed Cowbird		X	X	X	X	X	X	X
	Quiscalus quiscula	Common Grackle		X					X	
	Sturnella neglecta	Western Meadowlark		X			X			X
	Xanthocephalus xanthocephalus	Yellow-headed Blackbird	X	X				X		
Mimidae	*Dumetella carolinensis*	Gray Catbird					X			
Parulidae	*Dendroica petechia*	Yellow Warbler			X		X			
	Geothlypis trichas	Common Yellowthroat	X		X		X		X	X
Scolopacidae	*Bartramia longicauda*	Upland Sandpiper	X	X						
Troglodytidae	*Cistothorus platensis*	Sedge Wren					X	X	X	
Tyrannidae	*Empidonax traillii*	Willow Flycatcher					X			
	Tyrannus tyrannus	Eastern Kingbird	X	X	X		X	X		X
	Tyrannus verticalis	Western Kingbird	X				X			

Appendix C

North Dakota Plant Associations – Belt Transect Method (Grant et al. 2004b)

Belt Transect Codes

Shrub and Tree Types

Low shrub (generally <1.5 m tall)

11 snowberry dense; other plants few or none
12 snowberry; remainder mostly native grass-forb types
13 snowberry; remainder mostly Kentucky bluegrass
14 snowberry; remainder mostly smooth brome (or quackgrass)
15 silverberry; add modifier 15[2] = native grass-forb, 15[3] = Kentucky bluegrass, 15[4] = smooth brome, 15[5] = crested wheatgrass
16 snowberry; remainder mostly crested wheatgrass
18 meadowsweet; add modifier as above 18[2], 18[3], 18[4], or 18[5]
19 other low shrub (user defined – add modifier as above)

Tall shrub/tree (generally ≥ 1.5 m tall)

21 native shrub (chokecherry, buffaloberry, hawthorn, willow, etc.)
22 shrub-stage aspen
23 introduced shrub (caraganna, Russian olive, etc.)
31 aspen
33 shade-tolerant woodland tree (green ash, box elder, American elm, etc.)
34 oak
35 introduced tree (Siberian elm, juniper, spruce, etc.)

Native Grass-Forb and Forb Types (>95% dominance by native herbaceous plants, including forbs)[a]

41 dry cool season (sedges, green needlegrass, needle-and-thread, wheatgrass species, prairie junegrass, forbs)
42 dry warm season (little bluestem, prairie sandreed, blue gramma, forbs)
43 mesic cool-warm mix (big bluestem, switchgrass, porcupine grass, prairie dropseed, forbs)
46 meadow (fowl bluegrass, foxtail barley, northern reedgrass, fine-stem sedge species, baltic rush, prairie cordgrass)
47 wetland; robust emergent vegetation or open water (cattail, river bulrush, bur-reed, common reed grass, manna grass)
48 clubmoss/lichen

Appendix C: Belt Transect Codes Cont.

49	forb
51	Kentucky bluegrass >95% (or >50% if mixed with other non-natives)
52	Kentucky bluegrass and native grass-forbs, Kentucky bluegrass 50-95%
53	native grass-forbs and Kentucky bluegrass, Kentucky bluegrass 5-50%
61	smooth brome >95% (or >50% if mixed with other non-natives)
62	smooth brome and native grass-forbs, smooth brome 50-95%
63	native grass-forbs and Smooth brome, smooth brome 5-50%
71	crested wheatgrass >95% (or >50% if mixed with other non-natives)
72	crested wheatgrass and native grass-forbs, crested wheatgrass 50-95%
73	native grass-forbs and crested wheatgrass, crested wheatgrass 5-50%
74	quackgrass >95% (or >50% if mixed with other non-natives)
75	quackgrass and native grass-forbs, quackgrass 50-95%
76	native grass-forbs and quackgrass, quackgrass 5-50%
77	reed-canary grass
78	tall, intermediate, or pubescent wheatgrass
79	other introduced grass (user defined)
Introduced Weed Types	
81	leafy spurge
85	Canada thistle
87	absinthe wormwood
88	other induced weeds (user defined)
98	tall introduced legume: sweetclover or alfalfa
Other	
91	barren/unvegetated (e.g., rock, anthill, bare soil); dead vegetation
99	other – user defined

[a]Prairie rose, bearberry, winterfat, and cactus are considered a native forb with respect to these categories

In the event of an apparent equal mix of Kentucky bluegrass and smooth brome – consider as code 61 or 62

EXPENDITURES

The cost for technical assistance during the period of March 1, 2010 to December 31, 2012 was as follows:

Personnel	$ 47,633.73
Travel	$ 1,014.97
Equipment and Supplies	$ 1,646.94
Tuition Waiver	$ 7,603.52
Indirect	$ 13,271.40
Total	$ 71,170.56

Funding Sources:

50% Federal (State Wildlife Grant)	$ 28,180.00
50% Non-federal (University)	$ 28,180.00
Total	$ 56,360.00

Funding Sources Amendment 1:

65% Federal (State Wildlife Grant)	$ 9,609.56
35% Non-federal (University)	$ 5,201.00
Total	$ 14,810.56