NORTH DAKOTA GAME AND FISH DEPARTMENT

FINAL REPORT

An ARM Approach at Understanding the Interactions between Landscape, Vegetation Type, Grassland Bird Productivity, Alternative Prey, and Predator Density

Project T-43-R

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Submitted by
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An ARM approach at understanding interactions between landscape cover, vegetation type, grassland bird productivity, co-existing prey, and predator density.

Species of conservation priority (SoCP): Sprague's Pipit, Grasshopper Sparrow, Baird's Sparrow, Lark Bunting, Dickcissel, Sedge Wren, Marbled Godwit, Willet, Wilsons Phalarope, Upland Sandpiper, Le Conte's Sparrow, Bobolink, Chestnut-collared longspur, Nelson's Sparrow, Northern Harrier, Northern Pintail, American Bittern, Richardson's Ground Squirrel

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Anticipated Activity Period: 1 April 2014 – 31 March 2016
Location: On private, state, and federal properties in Tewaukon and Kulm Wetland Management Districts

Need: Declines in numerous populations of grassland nesting birds are thought to be caused by declines in productivity due to loss of native grasslands. Numerous conservation organizations including the United States Fish and Wildlife Service (USFWS) and state agencies such as North Dakota Game and Fish (NDGF) have acquired lands with previous cropping histories with the expressed purpose of providing planted habitat for nesting ducks. Because early studies indicated nest density and success of ducks was greater in a mixture of intermediate wheatgrass (*Thinopyrum intermedium*), tall wheatgrass (*Thinopyrum ponticum*), alfalfa (*Medicago sativa*), and sweet clovers (*Melilotus spp.*) commonly referred to as dense nesting cover (DNC) when compared to 3-5 species of native vegetation that were established for comparison, these former crop fields have been mostly converted to DNC. However, more recent studies have found that the abundance and diversity of grassland organisms, including grassland nesting passerines, is below that found in native prairie vegetation (Sample 1989, Delisle and Savidge 1997, Larivière and Messier 2000, Jonas et al. 2002, Klug et al. 2007, Bakker and Higgins 2009). For example, Baird's sparrows (*Ammodramus bairdii*) and Sprague's pipits (*Anthus spragueii*), appear to use short, sparse grass structure, and mostly associate with native bunch grasses, rather than the broad-leaved, introduced species used for DNC mixes (Madden et al. 2000). Further, marbled godwits (*Limosa fedoa*) and willets *(Tringa semipalmata)* typically select native grass cover over tame-grass cover, which is similar to the species composition of DNC (Kantrud and Higgins 1992).

The lower duck nesting density and success previously found in native vegetation plantings relative to DNC is most often explained by the limited number of species of vegetation (3 – 5 species) used in the native vegetation plantings. Low diversity plantings are more susceptible to invasion of exotic plant species and provide lower productivity at maturity. Historic plantings of 3-5 species of native vegetation were quickly invaded by exotic species that are undesirable to nesting ducks and resulted in relatively low duck productivity. More recently, wildlife managers have initiated a species-rich (16-32 species) approach of native vegetation establishment that reaches a saturation point (Guo et al. 2006, Larson 2011), and therefore, is more resistant to invasion of exotic species (Carpinelli 2001, Pokorny 2002, Sheley and Half 2006). This new approach of species-rich native plantings is more consistent with ecologically-based habitat restoration objectives, may be more long-term cost efficient, and should provide productive nesting habitat for grassland passerines and waterfowl when planted in landscapes with abundant grassland and high wetland densities. Many studies have found that avian abundance and reproductive success is greatest in grasslands with moderate to high native species cover (Scheiman et al.

2003, Lloyd & Martin 2005, Flanders et al. 2006, Kennedy et al. 2009). While the science behind successfully establishing high-diversity native vegetation plantings is emerging, conservation agencies are beginning to implement this restoration activity at landscape-levels (i.e., Prairie Pothole Region), thus, the potential influence on grassland nesting bird populations of this new management strategy should be considered before this activity becomes a regular management practice.

Recent research indicates ducks select restored species-rich native vegetation at a level similar to DNC, but in some years nest success in the native vegetation is considerably lower leading to an ecological trap (Haffele et al. 2013). Haffele et al. 2013 speculated annual variation in nest success most likely occurred due to variation in abundance of predators between years. Additionally, other studies have found grassland passerines select native vegetation at a level similar to or greater than native grasslands, but to our knowledge no studies have compared nest success of passerines between patches of DNC and species-rich native vegetation. Thus, there is no way to know whether species rich native vegetation may be providing a similar ecological trap for nesting passerines during some years. Therefore, this study seeks to better understand the interaction between landscape cover and grassland bird productivity. Specifically, this research seeks to understand the role that vegetation cover type plays in influencing grassland bird nesting density and success by gaining an understanding of the effects that vegetation cover has on the interacting wildlife communities.

Currently, the most common cover types include planted introduced forbs and grasses (DNC), planted native vegetation, and native sod. Although the vegetation species richness gradient observed across the 26 study plots will not allow us to directly test between the efficiency of DNC and species-rich native vegetation at producing grassland bird habitat, these sites should provide adequate cover type variability to compare variation in avian productivity, vegetation structure, predator, and co-existing prey abundance in response to different levels of vegetation species richness. Results will provide predictions of how co-existing prey, predators, and grassland bird productivity should respond on experimental plots of DNC and species-rich native cover currently being planted.

Objectives

1) Collect baseline data on abundance and productivity of grassland nesting birds in a continuum of cover types from almost monotypic stands of Kentucky Bluegrass or Smooth Brome to highly diverse native sod across 2 landscapes (Drift Prairie and Missouri Coteau) in North Dakota.
2) Compare nest survival and density of grassland nesting ducks and non-duck avian species among fields with varying composition of vegetation.
3) Assuming bird productivity differs between vegetation types, test between the 4 hypothesized causes (vegetation structure alone, increased predator abundance mediated by increased co-existing prey, increased predator abundance influenced directly by vegetation, or a combination of these factors).

Expected Results and Benefits

This study will provide data on the responses of grassland nesting birds and interacting wildlife communities to different vegetation cover types. Results of this study will aid in identifying the most promising restoration techniques of grassland habitat for breeding birds that maximizes habitat heterogeneity beneficial to a greater number of grassland organism and also best limits predation rates. Additionally, this information can provide managers with insight into potential benefits of high-diversity native vegetation to Species of Conservation Priority (SoCP). This information can be used to determine if the greater expense of high diversity plantings is justifiable in terms of observable wildlife benefits. This study will directly address a conservation action to “conduct baseline research/surveys to establish baseline information on SoCP.” identified in the North Dakota Comprehensive Wildlife Conservation Strategy in three landscapes (Planted and Tame Grassland, Prairie Drift, and Missouri Coteau) (Hagen et al. 2005). To fully prioritize management and implementation actions, managers must understand how various SoCP vary geographically and across habitat and cover types. This research will provide baseline data (abundance and reproductive success) for a variety of SoCP including: Sprague's Pipit, Grasshopper Sparrow (*Ammodramus savannarum*), Baird's Sparrow, Lark Bunting (*Calamospiza melanocorys*), Dickcissel (*Spiza americana*), Sedge Wren (*Cistothorus platensis*), Marbled Godwit, Willet, Wilson's Phalarope (*Phalaropus tricolor*), Upland Sandpiper (*Bartramia longicauda*), Le Conte's Sparrow (*Ammodramus leconteii*), Bobolink (*Dolichonyx oryzivorus*), Chestnut-collared longspur (*Calcarius ornatus*), Nelson's sharp-tailed sparrow(*Ammodramus nelsoni*), Northern Harrier (*Circus cyaneus*), American Bittern (*Botaurus lentiginosus*), and Richardson's Ground Squirrel *(Urocitellus richardsonii*) breeding in different types of tame vegetation and in native vegetation of two landscapes. This information can then be used to monitor long-term changes and identify differences between the Drift Prairie and Missouri Coteau, to better understand what causes variation within each of these landscapes. Results of this study may also indirectly benefit two additional conservation actions addressed in the North Dakota Comprehensive Conservation Plan. These include the "control of noxious weeds through biological and chemical methods" identified under these three landscapes (USFWS 2008). Additionally, results of this study can aid to "…redesign ranking criteria for new Conservation Reserve Program (CRP) sign-ups" identified under the Planted or Tame Grassland landscape (USFWS 2008). Species-rich plantings of native vegetation resist invasion by noxious weeds (Guo et al. 2006). If results from this study support the use of species-rich native planting as an efficient cover for wildlife, increases in this practice may lead to a reduction in problems caused by noxious weeds. Furthermore, this study will produce baseline data on the wildlife benefits of seed mixes with varying plant species diversity, providing information that could be used for scoring in future CRP enrollments.

Approach:

To compare grassland bird productivity among vegetation communities, density and nesting success of breeding ducks and passerine species were monitored on 16-20 ha (dependent on field size) randomly selected upland cover plots in 17 fields ranging in vegetation in species composition from monotypic stands of smooth brome and wheat grass to species rich stands of native sod within the Tewaukon NWR, and Kulm Wetland Management Districts. This study followed the well-established methods detailed by Haffele et al. (2013) for duck nest searching. Each plot was searched 7 times on 7 day intervals. Duck nests were located using teams of 2 dragging a 50 m cable-chain behind all-terrain vehicles (Klett et al. 1986). Speeds were kept between 3-8 km/h by keeping ATV's in low gear allowing drivers to stay in a straight line and watch the cable drag (Klett et al. 1986). Dragging at speeds faster than 8 km/h increases the likelihood of the chain passing over a nest without flushing the hen (Haffele et al. 2013). Nest searching occurred between 0700 and 1400 hrs to maximize the probability of the hen being on the nest (Gloutney et al. 1993). Starting location of plots for each drag were alternated to prevent the same area of the field being searched during the same time of day; thus, reducing the possibility of a hen being on an incubation break during subsequent searches. Each located nest was marked at 10 m north of the nest with a 1-m wooden stake painted orange on the top to allow easy visualization in the field by searchers. A metal rod painted orange was placed on the north rim of the nest bowl at each nest to assist with relocation. Nests were monitored at 5-day intervals until fate is determined (e.g., successful, depredated, abandoned). Clutch size and incubation status were determined at each nest visit. Incubation status was determined using a simple field candler (Weller 1956) made from 1-inch radiator hose. After each visit, the nests were covered using material from the nest and a marker in the form of an X made out of vegetation will be placed on top. If the X was found undisturbed on the next visit, it was considered it abandoned due to investigator disturbance and censored it from survival analysis. To estimate passerine nest survival and density similar methods were used. However, in place of the 50 m duck chain, a 25 m looped rope with chain attachments was drug by 3 observers to locate nests on randomly selected 4 ha plots within each 20 ha study plot.

In addition to monitoring avian productivity, ancillary data was collected on vegetation structure and species composition, small mammal and arthropod abundance, and predator abundance at the field level that will help explain variation in nest survival found in the previous study, allowing for a more efficient test of cover type. Vegetation species composition and percent cover values were identified for each study plot once during the duration of this study. Since study plots will not be re-seeded during the duration of this study, it is expected that species composition will not fluctuate significantly during this time. Robel pole measurement at each duck nest were used to determine characteristic vegetation density and height within each study plot. This will account for differences in vegetation structure due to annual variation and management practices occurring outside of the study season. Because the primary prey (microtine, ground squirrels, and arthropods) of raccoons, skunks and foxes may influence distribution of these meso-predators and ground squirrels are themselves predators to nesting passerines, differences in the abundance of these primary prey items between the habitat types were tested for. Small mammal abundance was estimated by placing 100 Sherman live traps in a 100 m by 100 m grid (10 m between each trap) for 3 consecutive nights in each plot twice per year, once near the beginning of the nesting season in mid-May and once in the middle of the nesting season in mid-June. Captured individuals were affixed with an individually coded standard Monel ear tag. To monitor terrestrial macro-invertebrate abundance (a primary forage for some meso-predators), the drop trap method described by Jonas et al. (2002) was used at 10 randomly selected sites within each field. Macro-invertebrate sampling occurred twice during the field season in early June and mid-July. Individual samples were dried in a desiccating oven at 60 degrees Celsius for 24 hours to reach a constant mass (Davis 2006) and weighed to estimate arthropod biomass per 1 m^2.

Results and Discussion

Objective 1: *Collect baseline data on abundance and productivity of grassland nesting birds in a continuum of cover types from almost monotypic stands of Kentucky Bluegrass or Smooth Brome to highly diverse native sod across 2 landscapes (Drift Prairie and Missouri Coteau) in North Dakota*.

Summary statistics - During May to July 2014, 319 duck nests and 28 passerine nests were located on the 17 study plots in North Dakota. Seven species of nesting ducks were encountered on North Dakota Study plots during the 2014 field season (Table 1). Survival statistics were determined for each individual North Dakota cooperator (Table 2). 27 passerine nests of 6 species were located and monitored for survival during the 2014 season, and one additional shorebird nest (UPSA) was located (Table 3). Survival statistics for non-duck bird nests were not estimated for each individual North Dakota cooperator due to low sample size.

During the second field season from May to July 2015, 359 duck nests and 135 non-duck nests were located on the 17 study plots in North Dakota. Seven species of nesting ducks were encountered (Table 5). Survival statistics were determined for each individual cooperating agencies (Table 6). Twelve species of non-duck avian nests were located and monitored for survival during the 2015 season (Table 7). Fledging success for grassland nesting passerines (N=122) was determined for each individual North Dakota and South cooperating agency (Table 8).

Nesting Density (Figure 4) and Nesting Success (Figure 5) was determined for grassland nesting ducks during May to July 2014 and 2015 and grassland nesting passerines during May to July of 2015 on 17 study plots in North Dakota.

Few Species of Conservation Concern were located within plots with only 4 Grasshopper Sparrow, 5 Sedge Wren, 1 Upland Sandpiper, 23 Bobolink, 1 Northern Harrier, 36 Northern Pintail nests were located during the 2 years. More efficient nest searching will likely increase this total considerably during the final year of the study.

Objective 2: *Compare nest survival and density of grassland nesting ducks and non-duck avian species among fields with varying composition of vegetation.*

Duck Nest Density and Vegetation Species Richness – We found a slightly negative correlation between duck nest density and vegetation species richness (Figure 4). This result is inconsistent with Haffele et al. (2013) who found similar duck nesting densities between relatively low diversity DNC and high diversity reconstructed prairies. We intend to conduct further analysis that includes additional plots from mixed grass prairies in South Dakota to verify the robustness of this result. Additionally, further analysis is required to determine whether this is a direct relationship or a confounding relationship between vegetation richness, duck nest density, and an additional variable such as wetland availability. These analyses will be conducted after the 2016 field season

Passerine Nest Density and Vegetation Species Richness - In contrast to the duck nesting data, there appears to be a slight increase in passerine nest density and vegetation species richness (Figure 4). Again, a more in-depth analysis with additional plots will likely better elucidate this relationship.

Duck Nest Success and Vegetation Species Richness – Inconsistent with predictions based on results of Haffele et al. (2013), we found no relationship between duck nest success and vegetation species richness. Currently, neither this, nor our small mammal data (Figure 5) support our hypothesis that more species rich native vegetation supports a greater abundance of small mammals, thus attracting a greater abundance a meso-predators. Unfortunately, for reasons explained below, we were not able to directly index abundance of meso-predators, but results of the duck nest success data suggests no relationship exists among sites in North Dakota. Again, including the additional South Dakota sites and more in-depth analysis may provide a different perspective for this result.

Passerine Nest Success and Vegetation Species Richness - For passerines, as with nesting density, it appears there was a slight increase in nest success with species richness of vegetation (Figure 5). The difference in the relationship between duck nest success and vegetation and passerine nest success and vegetation is likely due to the difference in the composition of the predator communities that influence nest success. For example, we found nor relationship between duck nest success and passerine nest success among plots indicating the factors that are influencing duck nest success differ from the factors that influence passerine nest success. Again, further more complex analyses with the larger data set will be required to better elucidate these relationships.

Small Mammals – During the 2014 field season, 432 total small mammals of 7 species were captured on ND plots (Table 4). During the 2015 field season 334 small mammals of 9 species were captured across all study plots (Table 9). Additionally, 61 recaptures were collected on subsequent trap nights. We found no indication of a relationship between small mammal abundance and vegetation species richness on the 17 plots in North Dakota (Figure 6), suggesting that at least in this area small mammal abundance wasn't influencing variation in meso-predator abundance among plots.

Vegetation richness – We conducted 51 vegetation survey transects (3 in each plot) to characterize vegetation species composition and richness. Vegetation species richness varied across fields (2 to 23 species), as did dominant species. However, the introduced species, Smooth Brome grass and Kentucky Bluegrass, were the two dominant vegetation species across all North Dakota and South Dakota study plots.

Invertebrates - During terrestrial invertebrate sampling, > 1000 individuals were collected, and are currently being processed and identified at the SIUC laboratory. During July 2014, invertebrate biomass varied across ND study sites (Figure 3). This variation was partially explained by a slight increase in invertebrate biomass with vegetation species richness (Figure 7). In the 2016 field season, in addition to the invertebrate biomass data as described above, we are collecting pollinator data using water bowl traps and sweep nets. This data should provide additional insight into the availability of coexisting prey for small mammals and meso-predators among sites with varying degrees of vegetation species richness, as well as provide insight into how species richness of vegetation influences the ability of habitat to support pollinators, a declining but economically important component of the prairie ecosystem.

Meso-predators – Our original intent was to index meso-predator abundance using bait stations and track plates. During the spring of 2014 persistent rain fall washed tracks form plates to frequently to provide an index of meso-predator abundance. To prevent a re-occurrence of this issue in spring of 2015, we borrowed trail cameras to photograph and index meso-predators at bait trap stations. Unfortunately, it appears the cameras we used were old and no longer sensitive to the movement of meso-predators, thus, again, we were unable to index meso-predator abundance among plots. In the spring of 2016 we purchased new trail cameras, thus we expect to get good meso-predator data for only 1 of the 3 years of the study and have no data to report at this time.

Objective 3: *Assuming bird productivity differs between vegetation types, test between the 4 hypothesized causes (vegetation structure alone, increased predator abundance mediated by increased co-existing prey, increased predator abundance influenced directly by vegetation, or a combination of these factors).*

Based on the first 2 years of data there appears to be no impact of vegetation on duck nest success and only a slight influence of vegetation richness on passerine nest success during our study period at these study sites. Thus, we are unable to test the hypotheses as described with the data currently available. We will continue to address this hypothesis with data collected in South Dakota and data collected during the 2016 field season.

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Table 1: Quantity of nests found for each species of nesting ducks encountered within study plots of North Dakota cooperating agencies during May-July of 2014.

Collaborator	BWTE	MALL	GADW	NSHO	NOPI	LESC	AMWI
Kulm WMD	46	28	19	12	9	2	2
Tewaukon NWR	62	49	15	11	9	-	1
NDGF	15	17	10	3	4	2	-

Table 2: Duck nest survival statistics for North Dakota cooperating agencies during May-July 2014. *Mayfield Daily Survival Rate (DSR), Hatching Success (Mayfield HS), and percent of depredated (PRED), abandoned (ABD), and unknown fates are represented.

Collaborator	DSR	MF HS	PRED	ABD	UNK
Kulm	0.966	0.298	0.475	0.102	0.076
Tewaukon	0.973	0.377	0.408	0.082	0.041
NDGF	0.961	0.248	0.431	0.157	0.059

Table 3: Quantity of non-duck bird nests found for each species of nesting ducks within study plots of North Dakota cooperating agencies during May-July of 2014.

Collaborator	BOBO	CHSP	CCSP	COGR	EAKI	GRSP	SASP	SEWR	UPSA
Kulm WMD	-	-	12	1	2	1	-	-	1
Tewaukon NWR	3	-	3	-	-	2	-	1	-
NDGF	1	-	-	-	-	-	1	-	-

*Due to a low sample size of located passerine nests during May to July 2014, fledging success estimates were not included in this analysis.

Table 4: Summary of small mammal captures in North Dakota Study Fields in the Kulm WMD, NDGF WPAs, and Tewaukon NWR during 2014 field season. Table does not reflect individuals recaptured. Bold text indicates most frequently captured species across all 12 study sites.

Species	Quantity
Deer Mouse (*Peromyscus* sp.)	**157**
Prairie Vole (*Microtus ochrogaster*)	**151**
Meadow Vole (*Microtus pennsylvanicus*)	**79**
Thirteen-lined Ground Squirrel (*Ictidomys tridecemlineatus*)	**34**
Short-tailed Weasel (*Mustela erminea*)	4
Meadow Jumping Mouse (*Zapus hudsonius*)	4
Least Weasel (*Mustela rixosa*)	1
Northern Grasshopper Mouse (*Onychmoys leucogaster*)	1
Short-Tailed Shrew (*Blarina brevicauda*)	1

Table 5: Quantity of nests found for each species of nesting duck within study plots of North Dakota cooperating agencies during May-July of 2015.

Species	Kulm WMD	NDGF	Tewaukon NWR
BWTE	56	18	37
MALL	50	29	22
GADW	29	9	19
NSHO	7	-	10
NOPI	4	4	6
LESC	6	1	-
AMWI	-	3	-
UNK.	3	1	-

Table 6: Duck nest survival statistics for North Dakota cooperating agencies during May-July 2015. *Mayfield Daily Survival Rate (DSR), Hatching Success (Mayfield HS), and percent of depredated (PRED), abandoned (ABD), and unknown fates are represented.

Collaborator	DSR	Mayfield HS	PRED	ABD	Unknown
Kulm WMD	0.954	0.192	0.595	0.083	0.048
Tewaukon NWR	0.945	0.138	0.553	0.088	0.044
NDGF	0.922	0.058	0.733	0.107	0.000

Table 7: Quantity of non-duck bird nests found within study plots of North Dakota cooperating agencies during May-July of 2015.

Species	Kulm WMD	Tewaukon NWR	NDGF
AMBI	1	-	3
BOBO	6	6	7
CCSP	54	23	5
EAKI	1	-	-
GRSP	1	-	-
NOHA	1	-	-
RNPH	-	3	1
SASP	2	3	2
SEWR	2	2	-
STGR	2	-	2
UNSP	2	2	-
WEME	4	-	-

Table 8: Non-duck fledging success for North Dakota cooperating agencies during May to July 2015.

Collaborator	Fledging Success
Kulm WMD	0.281
NDGF	0.652
Tewaukon NWR	0.415

Table 9: Summary of small mammal captures in North Dakota Study Fields in the Kulm WMD, NDGF WPAs, and Tewaukon NWR during 2015 field season. Table does not reflect individuals recaptured. Bold text indicates most frequently captured species across all 12 study sites.

Species	Count
Deer Mouse (*Peromyscus* sp.)	**173**
Thirteen-Lined Ground Squirrel (*Ictidomys tridecemlineatus*)	**72**
Meadow Vole (*Microtus pennsylvanicus*)	**57**
Meadow Jumping Mouse (*Zapus hudsonius*)	13
Franklin's Ground Squirrel (*Spermophilius franklinii*)	11
Grasshopper Mouse (*Onychomys* sp.)	3
Short-tailed Shrew (*Blarina brevicauda*)	3
Richardson's Ground Squirrel (*Urocitellus richardsonii*)	1
Short-tailed Weasel (*Mustela erminea*)	1

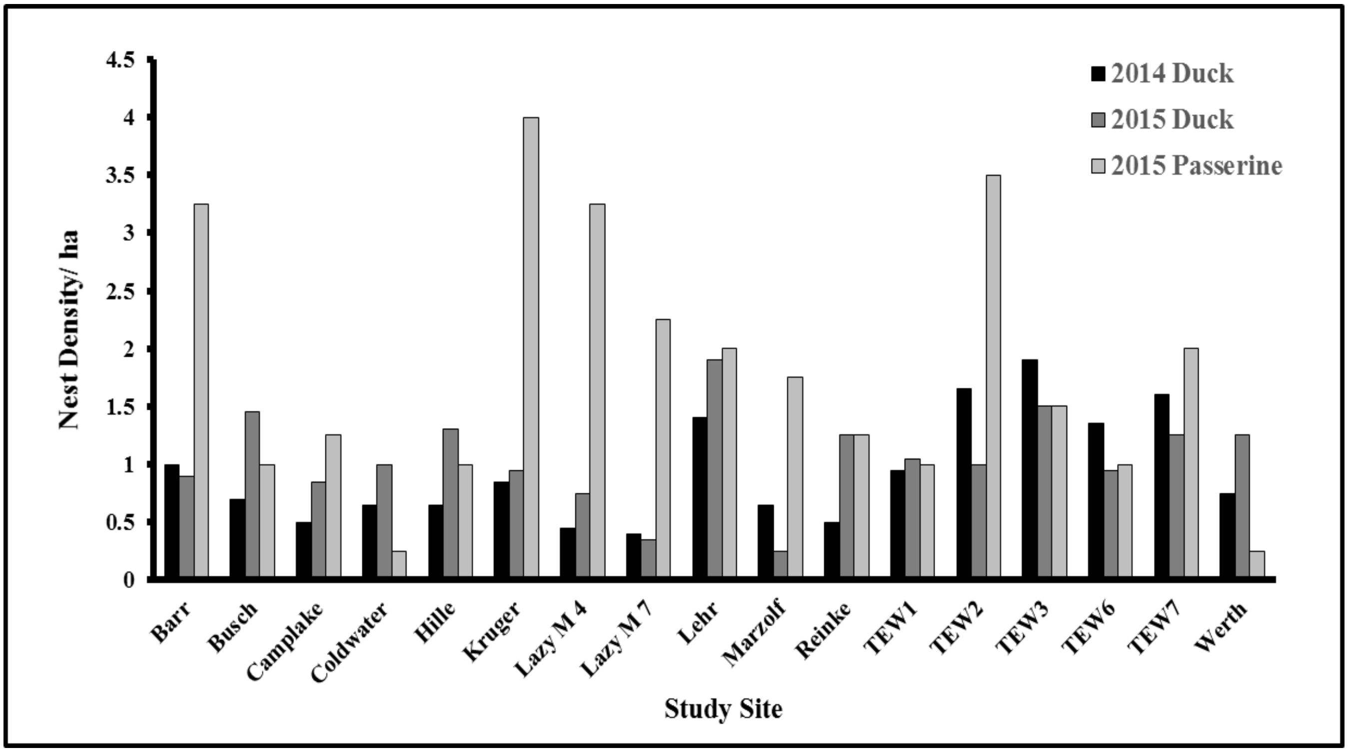

Figure 1: Density (per hectare) of duck and passerine nests located within North Dakota cooperating agencies study plots during May to July of 2014 and 2015.

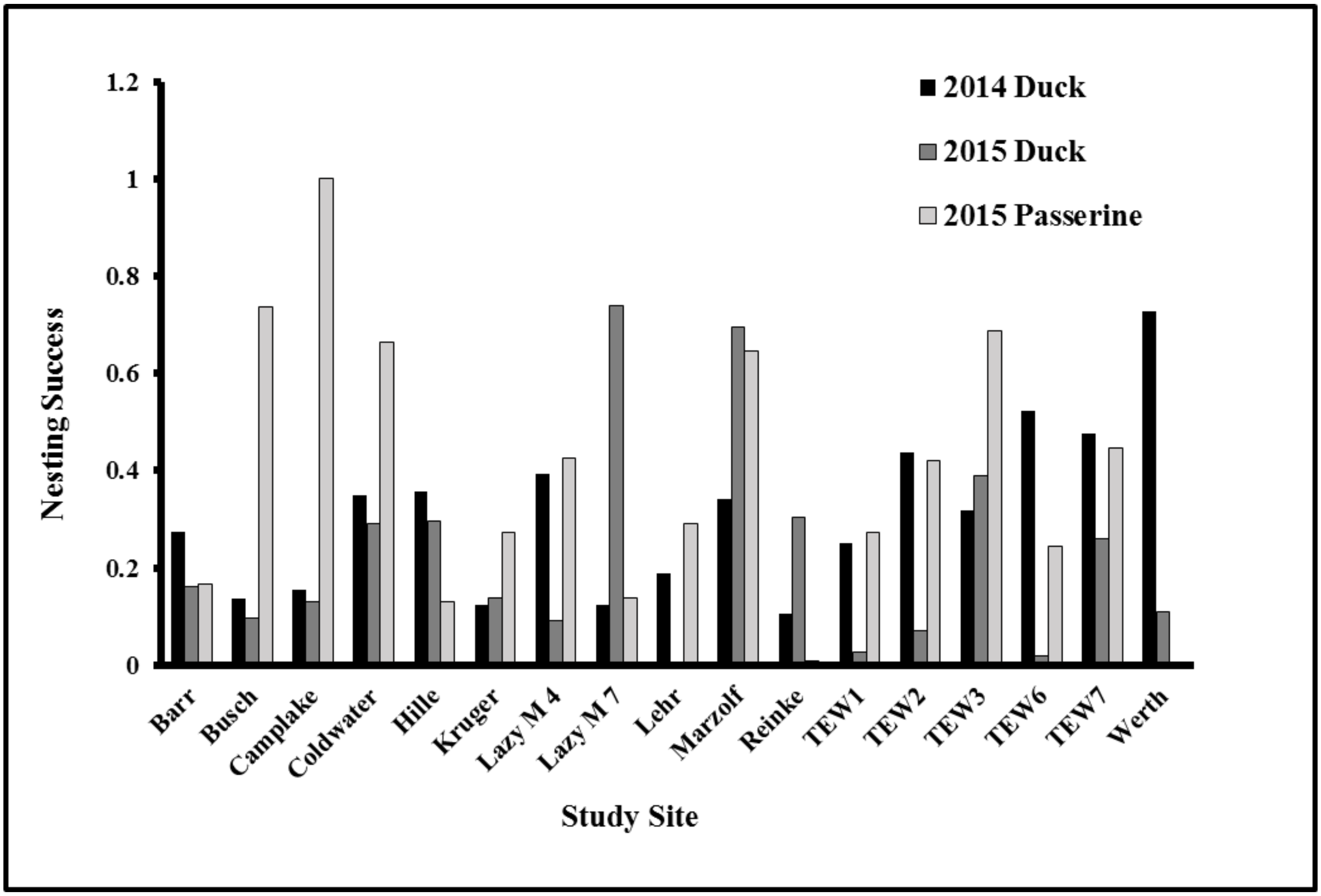

Figure 2: Mayfield nesting success estimated of duck and passerine nests located within North Dakota cooperating agencies study plots during May to July of 2014 and 2015. An assumed exposure period of 35 days for ducks and 22 days for passerine species was used in calculations.

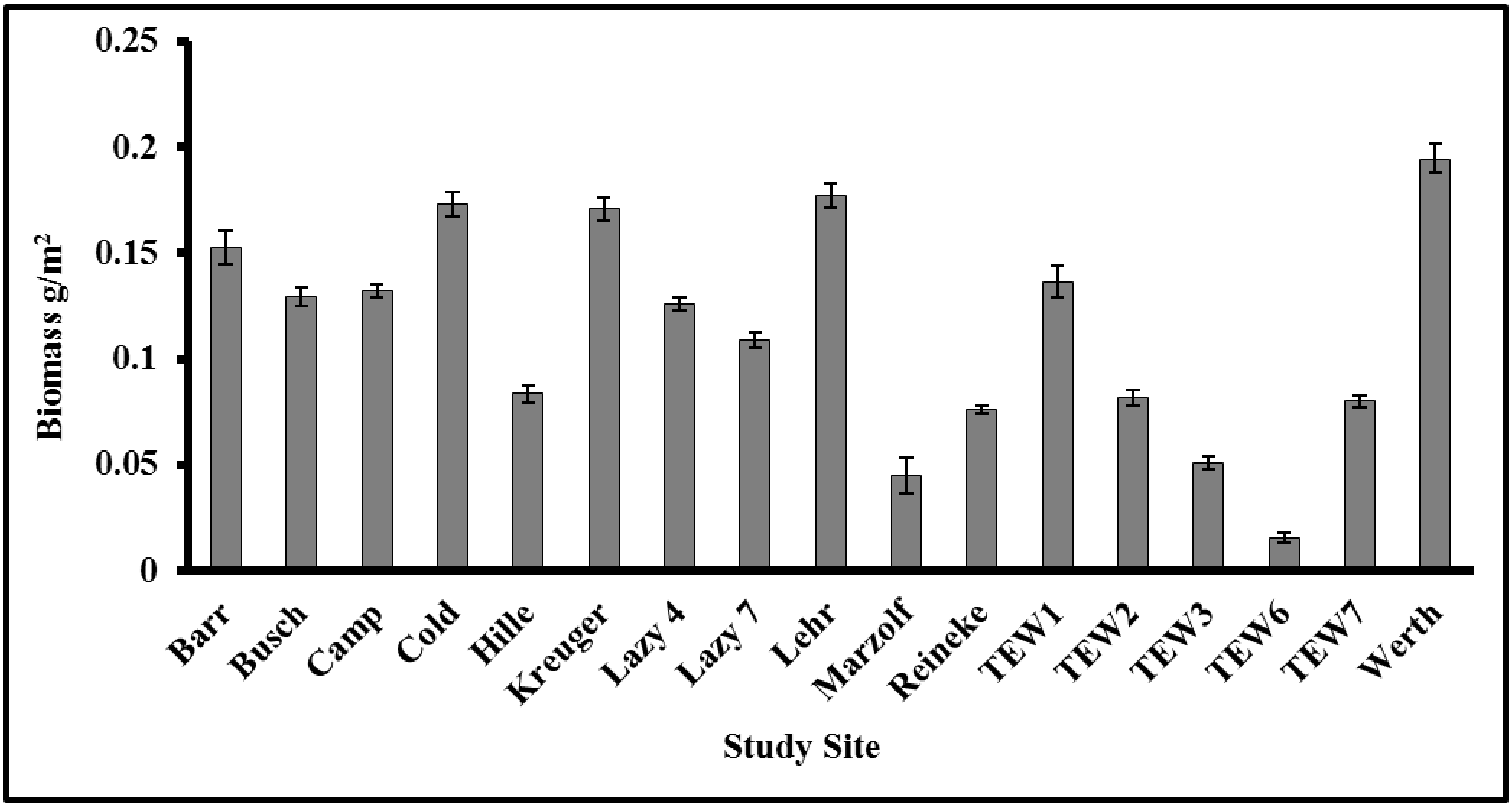

Figure 3: Mean (±SE) terrestrial invertebrate biomass at study sites located in North Dakota during July 2014.

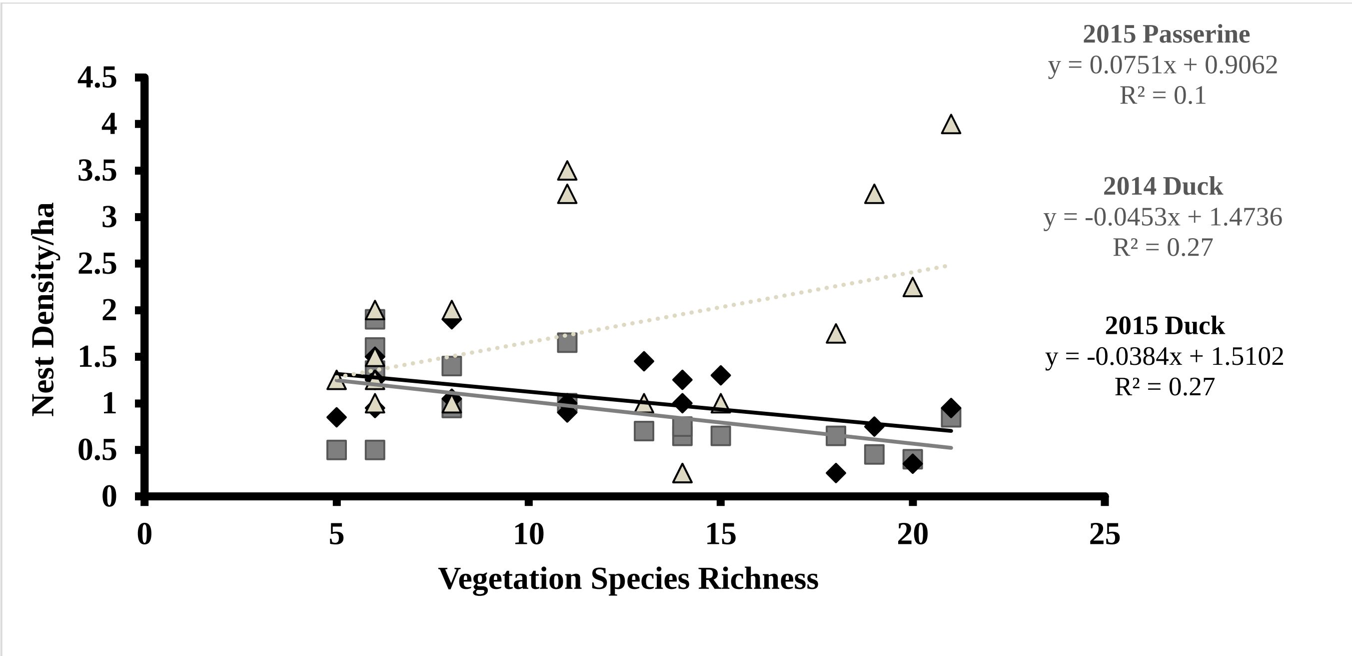

Figure 4. Correlations between vegetation species richness and nest density of ducks during May-July 2014 and 2015, and correlation between passerine nest density and vegetation species richness from data collected during May-July 2015.

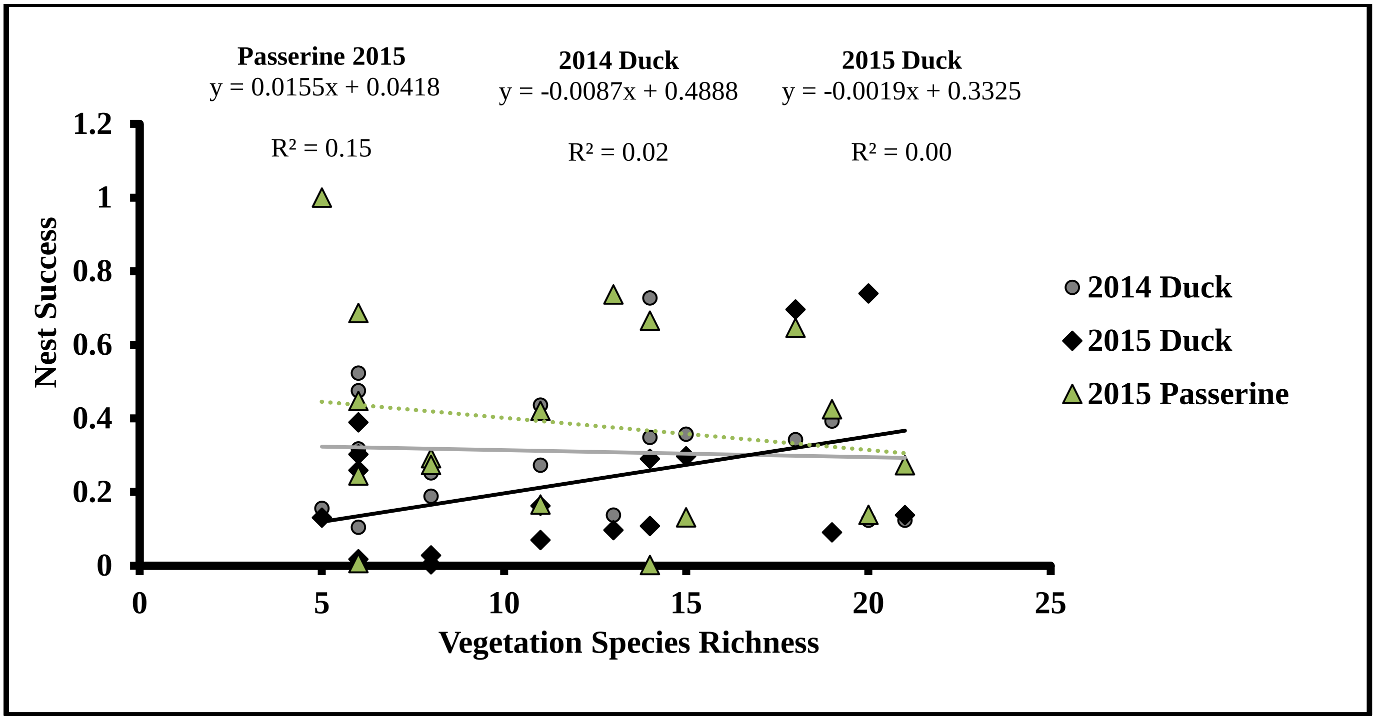

Figure 5. Correlations between vegetation species richness and nest success of ducks during May-July 2014 and 2015, and correlation between passerine nest success and vegetation species richness from data collected during May-July 2015.

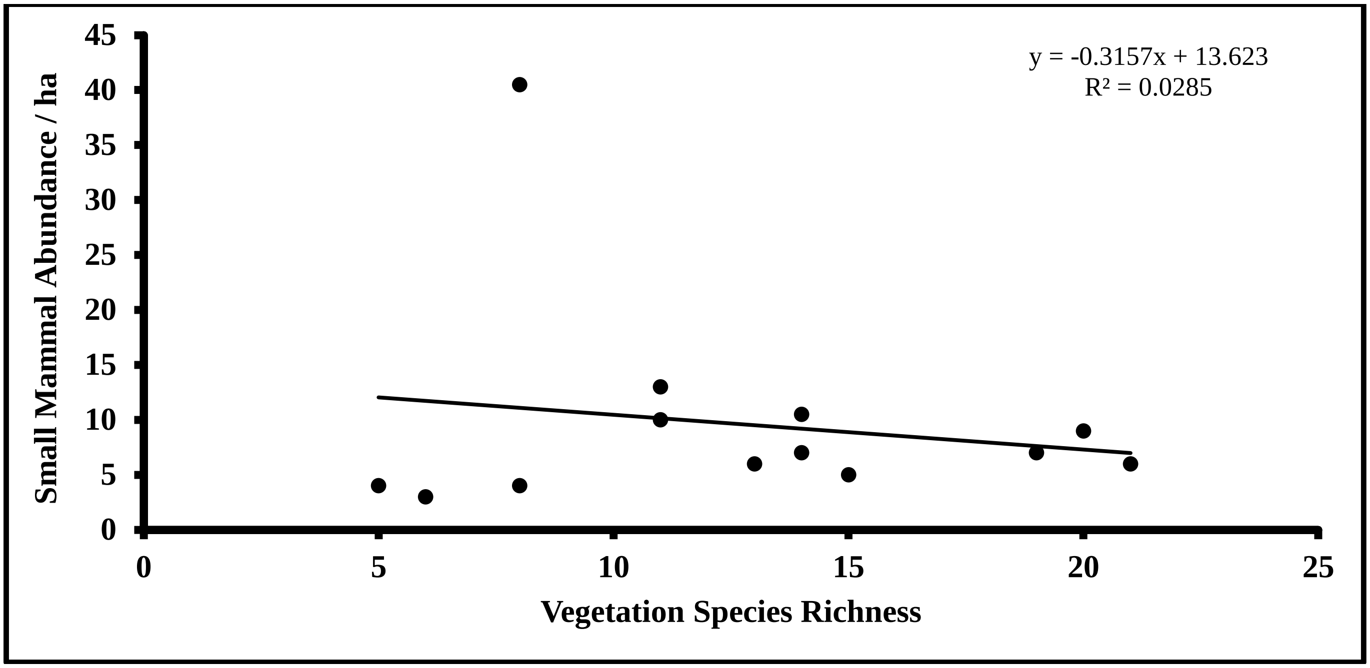

Figure 6. Correlation between small mammal density and vegetation richness among 17 plots in North Dakota

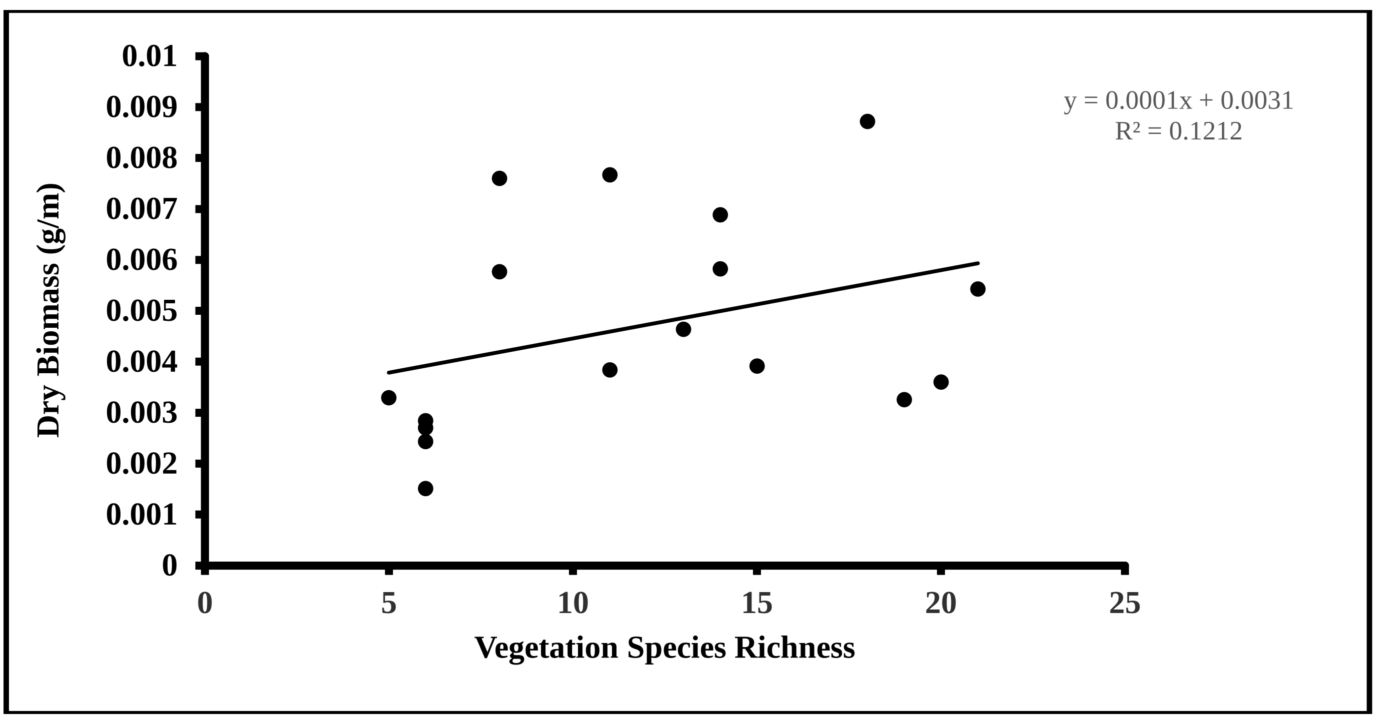

Figure 7. Correlation between invertebrate biomass and vegetation species richness among 17 plots in North Dakota