SOUTH DAKOTA DEPARTMENT OF GAME, FISH AND PARKS
WILDLIFE DIVERSITY SMALL GRANTS PROGRAM REPORT

2009

Project Title:

Developing Adaptive Management Methods and Assessing the Status of Species of Concern in the Leola Hills Landscape of the Missouri Coteau.

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INTRODUCTION

The Leola Hills Landscape located in the Missouri Coteau of north-central South Dakota has been designated by The Nature Conservancy an ecologically significant area and a priority site for protection and stewardship. The landscape supports a rich diversity of butterfly and avian species, including several endemic grassland birds that are declining across their range and have been identified as priorities for conservation (South Dakota Department of Game, Fish, and Parks 2006). The Leola Hills landscape is one of the largest contiguous areas of intact native mixed-grass prairie in the Missouri Coteau, with a high proportion of the area protected through conservation ownership and easements. In 2006, The Nature Conservancy completed an analysis of the ecological health and threats to conservation targets in the Leola Hills landscape (Miller 2006). Our analysis found that the conservation area is large enough to support viable grassland and wetland communities and the full diversity of species anticipated to occur in the area; however, the condition (an integrated measure of the composition, structure, and biotic interactions) and landscape context (a measure of the dominant environmental regimes, processes and connectivity) is likely outside its natural range of variation and will require protection and management intervention to retain significant habitat for several species of concern.

The following report assesses the status and condition of conservation targets identified in both The Conservancy's Conservation Action Plan and the South Dakota Wildlife Action Plan, including the native mixed-grass prairie system, butterfly species, and grassland bird species. This report presents the second year of a proposed long-term monitoring program toward defining best management practices at the scale of a ranch or landscape that take multiple species of concern into consideration as well as potentially conflicting management objectives such as controlling invasive species. Given a need for long-term data, we developed monitoring methods that are feasible given limited time and funding while also producing data applicable to landowners with distinct land management objectives. This is the first phase in developing an effective adaptive management program for evaluating our success in achieving conservation objectives as well as providing information and outreach to other landowners.

PROJECT OBJECTIVES

This project expanded on our knowledge and data obtained in 2008 with a focus on broadening the scale of the project to include lands in conservation and private ownership. Objectives of the proposed project included:

1. Evaluate the status and condition of butterflies, grassland birds, and native plant species in the Leola Hills landscape and assess management practices influencing the current condition.
2. Develop feasible methods for long-term, landscape scale monitoring that will produce data applicable to multiple partners, fill information gaps, and inform management decisions.
3. Gather information on the level of tolerance species of concern have toward invasive cool season grasses and how management practices implemented to reduce cool season grasses impact species of concern.

METHODS

This project represents the second year of monitoring across lands within the Leola Hills landscape as a means of informing management decisions and outreach programs. Survey points were located 50 meters from wetlands, fences, or roads to reduce edge effect. At each point grassland birds, butterflies, and plant communities were surveyed as described below. Overall, points were stratified across different disturbance regimes (high, moderate, and low grazing intensity; rest; patch-burn grazing; and bison grazing) and across different levels of exotic cool season invasion (high, moderate, and low invasive composition) as available on lands owned and managed by The Nature Conservancy, Ducks Unlimited, US Fish and Wildlife, and private landowners in McPherson and Edmunds counties of South Dakota.

Butterflies

Butterfly surveys were conducted from July 8 through August 12 at 68 survey points in 2009. We used a point count method adapted from the checklist method described by Royer et al. (1998) as a way to correlate presence and abundance of butterfly species to management and plant species composition in a defined area over time and space. Presence of all butterfly species observed within a 50-meter fixed radius point were recorded along with a general abundance rank [low (1-3), moderate (4-6), high (7-10), very high (>10)] for each species. Butterfly surveys coincided with the Regal Fritillary and Dakota Skipper flight period on days with weather parameters

offering best possibilities for observing butterflies (dry, low wind speed, moderate temperature). Technicians performing surveys had little to no prior experience with butterflies. Most butterflies within survey points were caught to verify species identification using the "Field Guide to Butterflies of South Dakota" (Marrone, 2002) until technicians were comfortable identifying species in flight. Butterflies were temporarily placed in a glass jar to avoid handling and inadvertently injuring them while technicians identified the species. Visual obstruction and litter depth measurements were taken at five predetermined locations within the point to describe the vegetation structure at the time of the point count. Each survey point was ranked 1 through 4(< 5 forb species, 5-10 species, 10-20 species, or >20 species, respectively) based on the abundance of forbs flowering at the time of the survey.

Grassland Birds

Frequency and density data was collected for all grassland-affiliated birds at 80 points from May 29 - July 1, 2009. All grassland birds detected visually and/or aurally within a fixed 100-meter radius point were recorded. For passerines, females were noted when observed but only males were included in data analysis. Birds observed flying over a survey point were noted but only included if observed within the 100-meter radius point. Each count was ten minutes in duration and completed within the first five hours after sunrise. Counts were not conducted if continuous rain or high winds were present. Visual obstruction and litter depth measurements were taken at five predetermined locations within the point to describe the vegetation structure at the time of the count.

We used the "Thayer Birding Software's Guide to Birds of North America" to train staff in identifying birds by sight and sound. The computer software provided technicians with a good foundation prior to field training and was used periodically to confirm species identification and refine the birding skills of technicians.

Plant Communities

In addition to vegetation structure measurements taken during the bird and butterfly surveys, we conducted a modified-G transect method to measure plant species composition and to document the level of invasive and native plants. Vegetation data was collected during late July through early October to capture both cool and warm season species. In each survey point, the dominant plant community (native versus exotic and graminoid versus forb) in 1-m^2 plots was recorded at 10-meter intervals along a 300- meter transect laid out in a "G" formation (Figure 1). Presence was recorded for 13 selected native plant species in each ¼ section of the 1-m^2 plot (Figure 2). Presence of two exotic plant species, Kentucky bluegrass and smooth brome, was recorded in each ¼ section of a 0.25- m^2 plot at 10-m intervals along transects. Plant species were selected based on their value as indicators to ecosystem diversity, health, and disturbance regimes as well as ease of identification. In addition, presence/absence of an additional 24 selected plant species, including 9 exotic species, 2 native-invasive species, and 13 native species, (Figure 3) were recorded if present anywhere within the transect area (50-meters from the center of the transect).

RESULTS

This project provided a wealth of baseline information that will be used to compare trends over space and time. The intent of this report is to summarize the data obtained in 2009; the second year of this monitoring project. Although some discussion and inferences about the data follow, care should be taken to avoid making strong conclusions due to the limitations of the data.

Vegetation Structure

Vegetation structure measurements collected during both the bird and butterfly survey were grouped into classes by litter depth and visual obstruction readings (Figure 4). Survey points captured a broad continuum of structure. Average litter depth ranged from a low of 1(cm) to a high of 8.4 during butterfly surveys and 1.1 to 13 during bird surveys (Figure 5). Average VOR ranged from 0.7 (dm) to 3.15 during butterfly surveys and 0.5 to 3.8 during bird surveys. Sample size was low at the extreme low and high end of the continuum of litter depth and VOR measurements. The majority of points fell into litter classes 2 - 5 and VOR classes 2 - 4.

Butterflies

Frequency and relative abundance of butterfly species was documented within a fixed 50-meter radius point. A total of 18 butterfly species were detected in 2009. The Clouded Sulphur, Common Wood-Nymph, Manitoba Fritillary, and Regal Fritillary were the most common species occurring in 97.06%, 94.12%, 64.71%, and 47.06% of the survey points, respectively. These same four species were also the most common in 2008. Some species detected in 2008 were not detected in 2009, while a few new species were detected in 2009 (Figure 6).

In 2008 we found no relationship between the number of butterfly species and the general abundance of forbs in the survey point (Miller 2008). In 2009 a comparison between the number of butterfly species showed a positive relationship with the abundance of forbs in flower at the time of the butterfly survey (Figure 7). However, the sample size for points with a higher flowering forb rank of 3 and 4 was much higher than the sample size in the lower flowering forb rank of 1 and 2. Survey points with a high flowering forb abundance rank did not always have a high number of butterfly species. Therefore, other vegetation characteristics and/or specific forb species may need to be considered when managing for habitat capable of supporting a diverse butterfly population.

Vegetation measurements collected during the butterfly surveys were grouped into classes from lowest to highest (1-6). The Clouded Sulphur and Common Wood Nymph were very common in 2009 occurring in almost all transects regardless of litter depth or VOR class (Figure 8). Occurrence of the Manitoba Fritillary declined as the VOR class increased; with no occurrences in VOR class 6. The Manitoba Fritillary occurred in all litter depth classes however percent occurrence was higher in classes 3-6 compared to classes 1 and 2. The Regal Fritillary was not present in the lowest or highest VOR classes; seeming to prefer VOR classes in the middle range and higher litter depth classes.

Grassland Bird Results

Sixteen grassland bird species were observed during 2009. The Grasshopper Sparrow, Western Meadowlark, Bobolink, and Savannah Sparrow were the most abundant species occurring in 88.8%, 76.3%, 48.8%, and 33.8% of survey points, respectively (Figure 9). These same four species were also the most common in 2008. The Lark sparrow was a new species detected at one survey point in 2009. Overall there was an increase in the average number of birds (5.3) and average bird species (3.2) detected per point in 2009 compared to 2008.

Vegetation measurements collected during the bird surveys were grouped into classes from lowest to highest (1-7). Due to a very low number of survey points in VOR class 5, 6 or 7 these three classes were lumped together (Figure 4). The grasshopper sparrow occurrence was lowest in VOR classes 5, 6 and 7. It occurred frequently across all other survey points regardless of VOR or litter depth class (Figure 10). The occurrence of savannah sparrows and western meadowlarks increased as the litter depth class increased. In addition the occurrence of these two species increased with VOR class to a point then decrease as the VOR class increased. The Bobolink did not occur in litter depth or VOR class 1.

Plant Communities

The survey points selected in 2009 represented a full continuum of low to high dominance of exotic cool season grasses (Figure 11). In 2009, both Kentucky bluegrass and smooth brome occurrence was determined within ¼ sections of 0.25-m^2 plots versus 1-m^2 plots for native species. The frequency of Kentucky bluegrass was still high throughout all transects. However, in some plots Kentucky bluegrass presence included only a few stems. Therefore if management is successful at reducing Kentucky bluegrass in the future this trend is more likely to be detected by using the smaller plot size. Smooth brome occurred across all transects without regard to whether transects were predominantly native or not. However the frequency of smooth brome occurrence within individual transects was higher for transects with a predominately exotic composition. This suggests that management may play a larger role in reducing smooth brome while Kentucky bluegrass is ubiquitous and may require extraordinary efforts to control.

Silverleaf scurfpea occurred just as often in transects that were composed predominately of native plants as transects that were predominately exotic. Lead plant, purple coneflower, and fringed sage were more likely to occur in transects with a higher native composition. Western snowberry occurred more often in transects located on lands in the northern end of our survey range. The frequency of native warm season grasses has higher in transects dominated by natives. Western wheatgrass and *Stipa* spp. seemed to occur just as often in transects regardless of whether the transect was predominately native or not. However, percent frequency of *Stipa* spp. was greater in transects that were predominantly native. While there seemed to be little difference in western wheatgrass percent frequency within transects that were native compared to those that were predominately exotic (Figure 11).

DISCUSSION

The following is a discussion of our progress on project objectives from the 2009 monitoring season. After only years of data collection we are cautious about drawing conclusions from the limited data we have at this time. As we continue this monitoring program we expect the inferences made from the data will either be strengthened or refuted over time. There is a great need for long-term data in order to understand the variation that exists in how

plant and animals respond to management within the context of a landscape and potentially competing management objectives.

Butterflies and Forbs

In 2009 we used a very simple index of flowering forb abundance to see if this may be an indicator of butterfly habitat compared to forbs in general (forbs that are not necessarily flowering during the prime butterfly flight period). The relationship butterflies had to flowering forb abundance in 2009 (Figure 7) suggests that management to increase forbs may improve butterfly habitat if the forbs are flowering during the flight period for key butterfly species. Timing management treatments so that forbs are flowing during butterfly flight periods may provide more suitable habitat for butterflies. Also, we found a lower frequency of plots dominated by forbs or a forb/grass mix in transects with a high exotic grass component. Management treatments that reduce or control exotic cool season grasses may also improve forb abundance and butterfly habitat. Grazing or fire disturbances that either don't allow forbs to flower or remove flowers before or during the peak butterfly flight periods may have a negative impact on butterflies even in areas with a rich diversity of plants capable of supporting diverse butterfly populations.

The majority of transects in 2009 were composed of a grass/forb mix with only a few plots within transects being dominated by forbs (Figure 11). The frequency of plots dominated by forbs or a grass/forb mix increased as transects were more native. In 2009 we wanted to look at the value of other selected plant species as indicators of health and function of a grassland system. Presence of thirteen native plant species was recorded in each transect. As expected, the number of selected native plant species occurring within transects was higher in transects with a native plant community (Figure 12). Interestingly, there was no relationship between the number of exotic species between transects that were native versus exotic. We expected the number of exotic forbs to be higher in areas that are predominately exotic. If anything there is a slight trend toward more exotic forb species in transects with a higher native composition. We are aware that land managers are implementing methods to reduce exotic species in the areas surveyed. Without active control methods for exotic species we may have seen a larger number of exotic forb species in transects. It is very possible that management treatments that increase forbs may increase both native and exotic forbs. Without management to control exotic species they may become prevalent even under management treatments meant to promote native diversity. It is important to note that our monitoring in 2009 only included presence within the area and not abundance. In future monitoring efforts it may be valuable to develop an index for evaluating the abundance of selected forb species both native and exotic in addition to evaluating the relationship between the abundance of noxious weeds which may be treated chemically versus the abundance of other exotic species that are not targeted for chemical control.

Bird and Butterfly Tolerance of Cool Season Invasive Grasses

The Missouri Coteau is highly invaded by cool season exotic grasses. This issue posses questions related to the level at which invasive grasses may become detrimental to species of concern. Management for cool season grass control may directly or indirectly conflict with habitat requirements of specific species. As in 2008 we again found no relationship between the abundance of birds, bird species or butterfly species to the percent native composition of survey points (Figure 13). However, as discussed earlier, a higher number of butterfly species were found at survey points with a higher number of forb species in flower (Figure 7). Therefore, butterfly species may respond favorably to at least forb diversity even if the area is not predominately native as long as the forbs are in flower during the flight period.

If species of concern are tolerant of a high level of invasive cool season plants land managers may be able to focus their attention on creating habitat for those species or focus on diversity of plants in general rather than on control of invasive species. In essence cool season grasses may be managed as a functional component within the landscape. More data will be needed to ascertain the direct impact of invasive species on specific species of concern as well as the indirect effects of management treatments intended to reduce cool season grasses. Our educated guess at this time would be that a variety of management treatments may be compatible in large landscapes where areas of undisturbed prairie are left to harbor species requiring more vegetation structure in the spring. However, as habitat becomes more fragmented and degraded it may become increasingly important to know if and where specific species of concern exist in order to ensure that entire populations or islands of suitable habitat are not disturbed at the wrong time.

Management treatments

Our monitoring efforts in 2009 included lands managed by two non-profit conservation organizations as well as lands under private and federal management. Across the survey area land managers have very different

management objectives. Conservation land managers attempt to create a mosaic of habitat types by utilizing different management treatments over time and space. It is believed that wildlife species will find suitable habitat within this mosaic. Common grassland bird and butterfly species seem to be tolerant of many management treatments. Therefore it may behold land managers to focus more on management treatments that favor the habitat preferences of rare species or species with specific needs knowing that the common species will still find suitable habitat. In 2009 management treatments were described through vegetation classes for litter depth and visual obstruction readings. Survey points were located more often in classes in the middle of the range of vegetation structures while only a few survey points represented the extreme ends of the vegetation structure continuum (Figure 4). This prompts questions related to if the variation in vegetation structure across the landscape is too similar. Does the mosaic of vegetation structure within the landscape contain the right proportion of vegetation structure classes? Would wildlife species fair better if we implement management treatments that resulted in greater representation of vegetation structure classes at the low and high end of the continuum?

Data was compiled from both 2008 and 2009 to show the range of vegetation structure values used by each grassland bird and butterfly species. As expected the common species utilized a wide range of vegetation structures whereas less common species seem to be more specific (Figures 14-17). The Baird's Sparrow, Sprague's Pipit, and Chestnut-collared Longspur exhibit the most restricted range of vegetation structures used in both 2008 and 2009. The Clay-colored sparrow was also fairly limited in the range of vegetation structure used. However, the Clay-colored sparrow is also restricted by presence of shrubs, primarily western snowberry.

The minimum and maximum litter depth values that include all bird species were 2.4 – 5cm, which corresponds to litter depth classes 2-4. The minimum and maximum VOR values used by all bird species were 0.75 – 1.6(dm), which correspond to VOR classes 1-3. It seems a greater focus on management treatments that result in lower litter depth and biomass (VOR) may provide more available habitat for species of concern such as the Sprague's pipit and Baird's sparrow which seem to be more restricted in the type of vegetation structure utilized.

Butterflies exhibited more variation between years in the range of vegetation structure values used which may be related to the of availability forbs as a nectar of source in addition to other landscape characteristics, management treatment variables, or climate conditions not measured here. The range of litter depth values used by all butterfly species was 1.9-6.4(cm) which corresponds to litter depth classes 2-5. The range of VOR values used by all butterfly species was 1.3-2.15 (dm) which corresponds to VOR classes 2-4.

The highest range of vegetation structure values were used primarily by common species. Therefore, management regimes resulting in low to moderate litter depth and VOR may be more suitable for a wider array of butterfly and bird species. It is important to note that data from 2009 is limited by what was available in the survey area. In general, the native composition was low in survey points located in areas with high litter depth or VOR classes. In addition the number of selected plant species (diversity) was also lower in these survey points. In future years it may be valuable to manipulate management treatments to allow for a comparison of species occurrences between native/high plant diversity areas and exotic/low plant diversity areas with similar vegetation structure.

Conclusion

The variation in vegetation or habitat that is created on a landscape level by landowners with differing management objective may be valuable in producing a mosaic of various habitats that support diverse wildlife populations, including many species of concern. Conservation and resource management professionals may take caution in promoting management treatments that result in uniform vegetation structure across a large area. In a landscape that is dominated by and seemingly very vulnerable to invasion of exotic cool season grasses, it will be very important to sort out the multitude of factors that need to be considered when implementing management objectives that include species of concern as well as preservation of native prairie. From our 2008 and 2009 data, it seems our rare grassland bird species may need disturbances resulting in lower litter depth and VOR. However, our sample size for survey points in the extreme ends of the vegetation structure class was low as was the number of observations of rare species. Therefore the limited range of vegetation structure values used in 2008 and 2009 may be a factor of low sample size rather than habitat preference. It seems both grassland birds and butterflies are compatible with disturbances that reduces litter depth and VOR and may be less tolerant of idled grasslands with high litter depth and VOR values. Since exotic cool season grasses tend to increase under idle or under-grazed management scenarios, this is a good sign that we may be able to balance multiple objectives related to providing habitat for species of concern while also using disturbance regimes to promote and maintain native prairie. This is expected since species native to the Missouri Coteau physiographic region evolved with and are adapted to a highly dynamic system including intense grazing and fire.

This report concludes the second year of a long-term monitoring program. As with many monitoring programs we may have prompted more questions than we answered. However, our intentions over the long-term

will be to utilize this baseline data to inform management objectives and manipulate management variables while continuing to monitor the response of species to see if we can more effectively achieve our conservation objectives. The ability to effectively manage grasslands for species of concern while also maintaining native prairie in the face of invasive species will become increasingly important as habitat within this landscape is lost or becomes more fragmented and degraded.

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Figure 1. Spatial representation of modified-G transect in relationship to 100-meter radius grassland bird point count and 50-meter radius butterfly count.

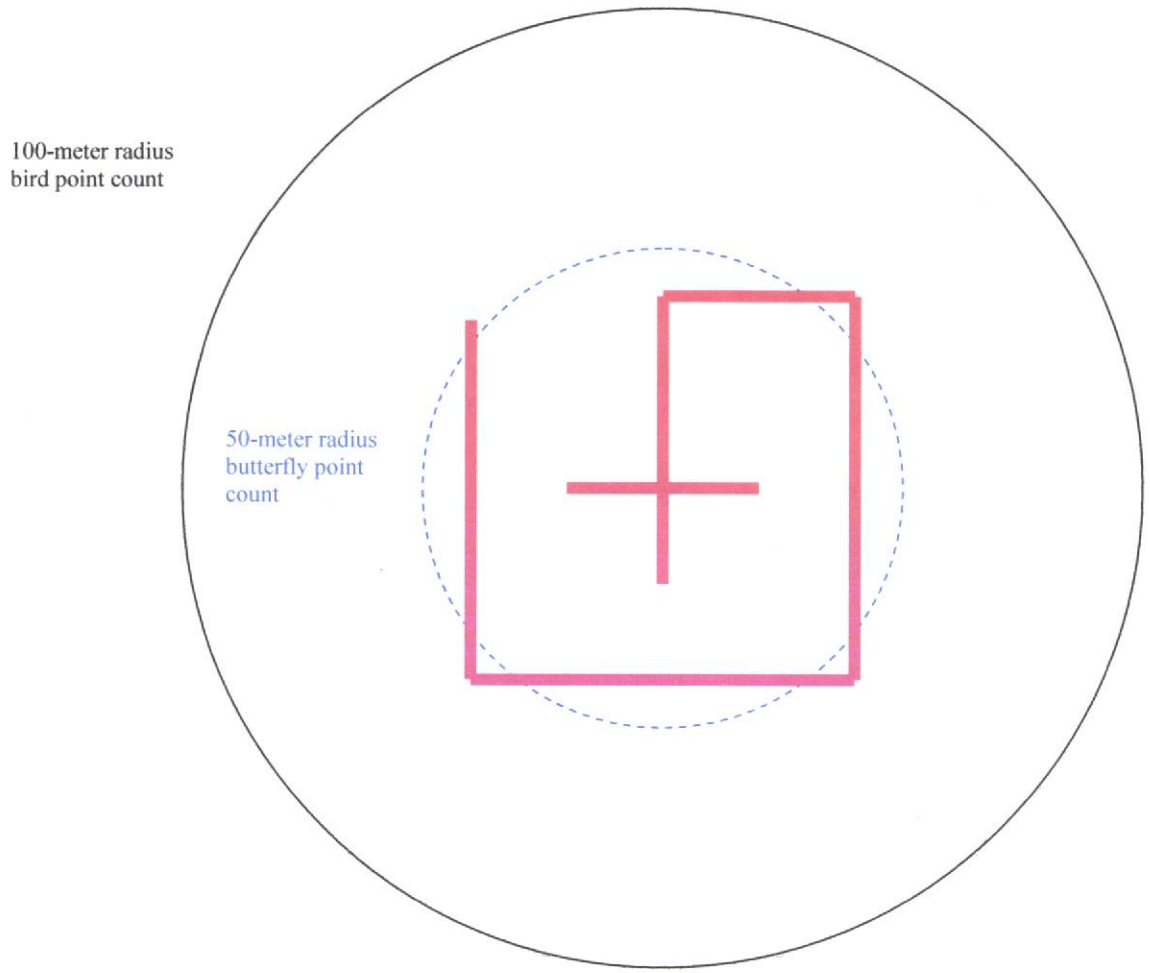


Figure 2. Percent occurrence of selected plant species in transects. Presence of thirteen native plant species recorded in each ¼ section of 1-m^2 plots along a 300-meter modified-G transects. Presence of Kentucky bluegrass and smooth brome was recorded in each ¼ section of 0.25-m^2 plots during surveys conducted in 2009.

Common name	Scientific name	Exotic Cool Season Grass	Native Warm Season Grass	Native Cool Season Grass	Native Shrub	Native Forb	Grazing Decreaser	Grazing Increaser	FQI C value	Percent occurrence
Big bluestem	*Andropogon gerardii*		X				X		5	86%
Little bluestem	*Andropogon scoparius*		X				X		6	82%
Blue grama	*Bouteloua gracilis*		X				X		7	62%
Sideoats grama	*Bouteloua curtipendula*		X				X		5	18%
Lead plant	*Amorpha canescens*					X	X	X[2]	9	55%
Purple coneflower	*Echinacea angustifolia*					X	X		7	74%
Silverleaf scurfpea	*Psoralea argophylla*					X		X	4	95%
Fringed sage	*Artemisia fringida*					X		X	4	58%
Western Snowberry	*Symphoricarpos occidentalis*				X				3	35%
Stipa spp.[1]	*Stipa viridula, S. spartea, S. comata*			X					5,8,6	97%
Western wheatgrass	*Agropyron smithii*			X			X	X	4	95%
Kentucky bluegrass	*Poa pratensis*	X		X					*	100%
Smooth brome	*Bromus inermis*	X		X					*	100%

[1]Green needlegrass, Needleandthread, and Porcupine grass were recorded together as *Stipa* spp.
[2]Lead plant seems to increase under bison grazing and decrease under cattle grazing.

Figure 3. Presence of the plant species listed below was recorded if observed within the transect area (within a 50-meter radius from the center GPS point). The Floristic Quality Index (FQI) Coefficient of Conservatism (C) and the percent occurrence is listed for each species.

Common name	**Scientific name**	**FQI C value**	**Percent occurrence**
Exotic			
Canada thistle	*Cirsium arvense*	*	77%
Sweet clover	*Melilotus alba or officinalis*	*	73%
Goat's beard	*Tragopogon dubius*	*	55%
Field Bindweed	*Convolvulus arvensis*	*	45%
Yellow toadflax	*Linaria vulgare*	*	42%
Wormwood sage	*Artemisia absinthium*	*	29%
Perennial sow thistle	*Sonchus arvensis*	*	8%
Leafy spurge	*Euphorbia esula*	*	6%
Crested wheatgrass	*Agrpyron cristatum*	*	5%
Native invasive			
Ragweed	*Ambrosia sp.*	0	89%
Curly cup gumweed	*Grindelia squarrosa*	1	55%
Native			
White sage	*Artemisia ludoviciana*	3	95%
Prairie coneflower	*Ratibida columnifera*	3	85%
Wild onion	*Allium sp.*	7	70%
Prairie rose	*Rosa arkansana*	3	68%
Prairie clover	*Dalea sp.*	8	61%
Stiff sunflower	*Helianthus rigidus*	8	52%
Missouri Goldenrod	*Solidago missouriensis*	3	44%
Prairie violet	*Viola pedatafida*	8	17%
Blanket flower	*Gaillardia aristata*	5	15%
Showy milkweed	*Asclepias speciosa*	4	5%
Groundplum milkvetch	*Astragalus crassicarpus*	7	3%
Prairie smoke	*Geum triflorum*	8	0%
Downy paintbrush	*Castelleja sessiliflora*	8	0%

Figure 4. Number of survey points in each Litter Depth and VOR Class in 2009. (See Figure 5 for average litter and VOR data corresponding to each class.)

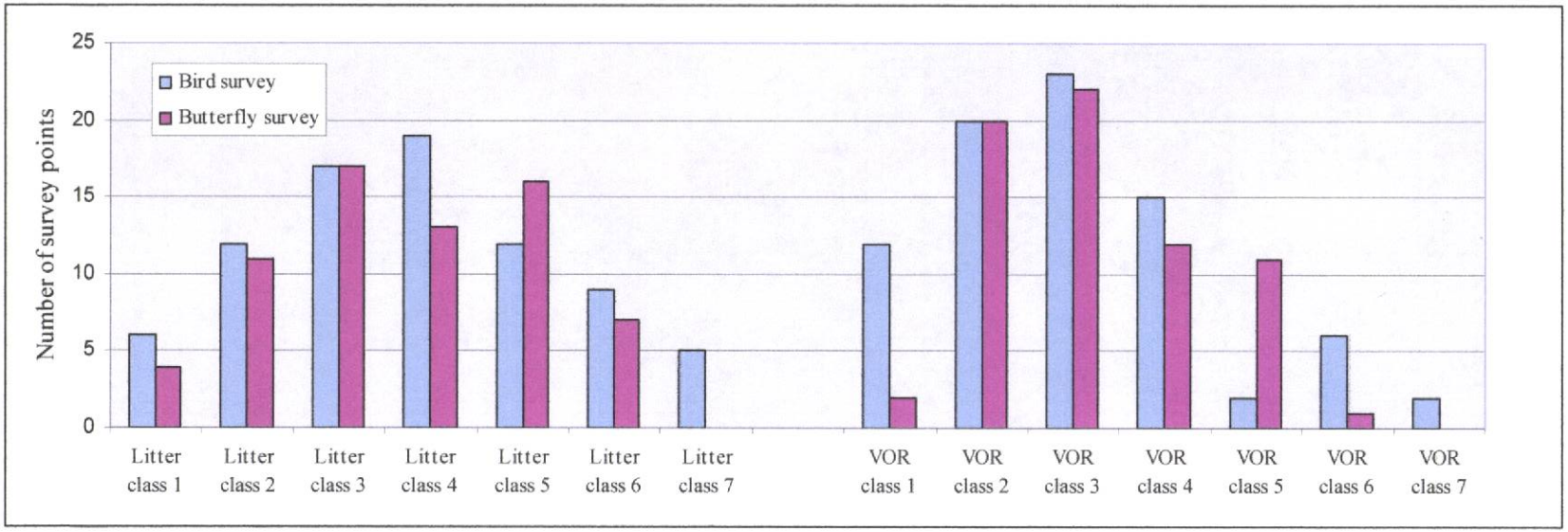


Figure 5. Range of litter depth and Visual obstruction readings (VOR) used to classify points.

Class	Average VOR (dm)	Average litter (cm)
1	< 0.9	< 1.5
2	1-1.5	1.6-2.9
3	1.6-2	3-4.5
4	2.1-2.5	4.6-5.9
5	2.6-3	6-7.5
6	3.1-3.5	7.6-8.9
7	>3.6	>9

Figure 6. Comparison of percent occurrence (%) of butterfly species occurring at survey points in the Leola Hills area of north-central South Dakota during 2008 and 2009.

Butterfly Species Common Name	**Scientific name**	**2008 Percent occurrence in survey points**	**2009 Percent occurrence in survey points**
Total percent of points with butterflies present		94.33	100.0
Clouded Sulphur	*Colias philodice*	48.23	97.06
Common Wood-Nymph	*Cercyonis pegala nephele*	78.72	94.12
Manitoba Fritillary	*Speyeria aphrodite manitoba*	57.45	64.71
Regal Fritillary	*Speyeria idalia*	42.55	47.06
Cabbage White	*Pieris rapae*	0.71	39.71
Melissa Blue	*Lycaeides melissa*	9.93	23.53
Monarch	*Danaus plexippus*	0.71	19.12
Painted Lady	*Vanessa cardui*	2.13	13.24
Pearl Crescent	*Phyciodes tharos*	10.64	8.82
Long Dash	*Polites mystic dacotah*		8.82
Orange Sulphur	*Colias eurytheme*	3.55	7.35
Variegated Fritillary	*Euptoieta claudia*		5.88
Western White	*Pontia occidentalis*	0.71	2.94
Tawny Edge Skipper	*Polites themistoces*		2.94
Meadow Fritillary	*Boloria bellona*		2.94
Gray Copper	*Lycaena dione*	1.42	1.47
Northern Crescent	*Phyciodes cocyta*		1.47
Myrina Fritillary	*Boloria selene myrina*	3.55	0
Peck's Skipper	*Polites peckius*	0.71	0
Mourning Cloak	*Nymphalis antiopa*	0.71	0
Checkered White	*Pontia protodice*	0.71	0
Eastern-Tailed Blue	*Everes comyntas*	0.71	0
Unidentified		10.65	50.0

Figure 7. Comparison of the number of butterfly species detected at points versus the flowering forb abundance rank [1 (< 5 species), 2 (5-10 species), 3 (10-20 species), 4 (>20 species)].

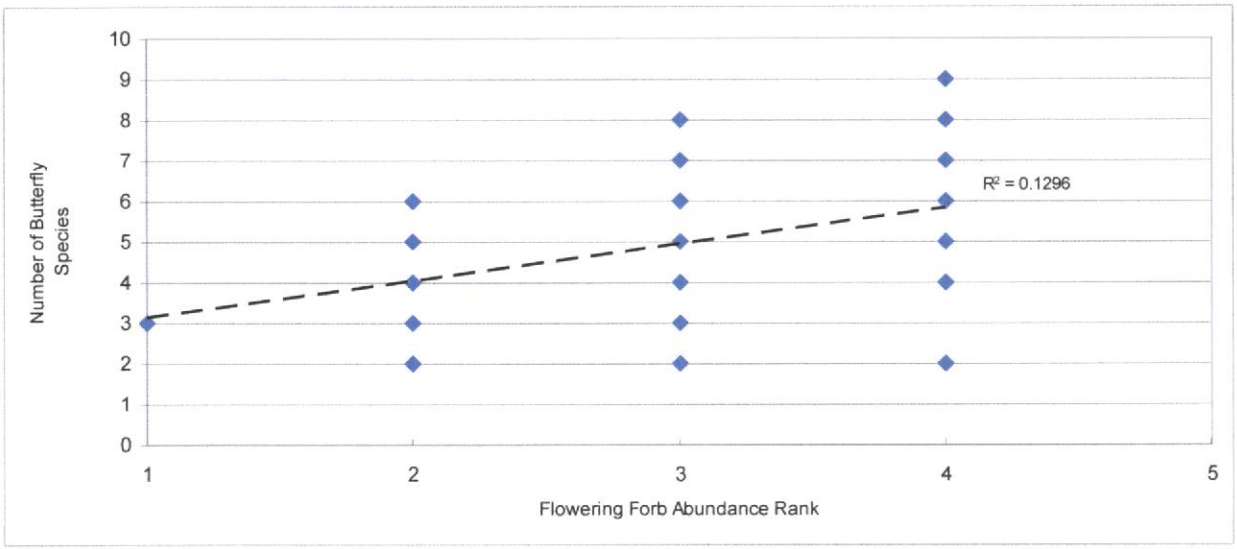


Figure 8. Percent occurrences of the four most abundant butterfly species in transects classified by litter depth and visual obstruction reading (VOR).

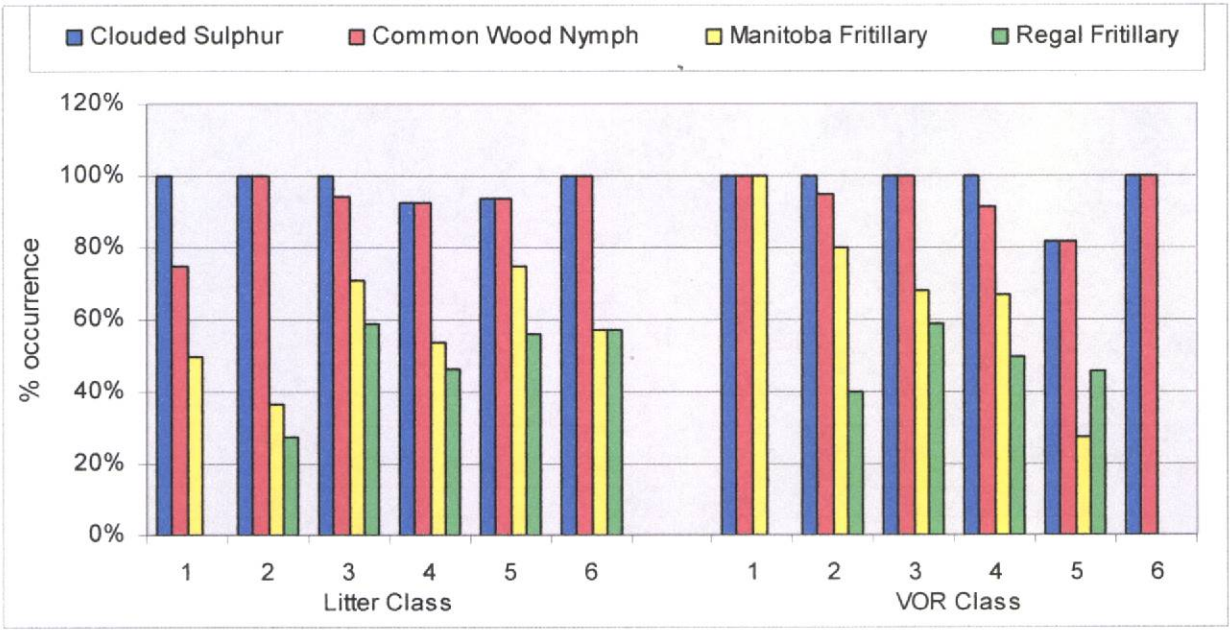


Figure 9. Comparison of total number of birds (includes only males for passerines), and percent occurrence (%) of grassland birds detected during point count surveys in the Leola Hills Landscape of north central South Dakota.

		1st Survey 2008		2nd Survey 2008		2009	
Common name	***Scientific name***	**Total number of birds**	**Percent occurrence (number of occurrences)**	**Total number birds**	**Percent occurrence (number of occurrences)**	**Total number of birds**	**Percent occurrence (number of occurrences)**
Grasshopper Sparrow	*Ammodramus savannarum*	152	87.0% (81)	173	91.5% (75)	141	88.8% (71)
Western Meadowlark	*Sturnella neglecta*	97	65.6% (61)	112	73.2% (60)	105	76.3% (61)
Bobolink	*Dolichonyx oryzivorus*	61	43% (40)	43	31.2% (29)	65	48.8% (39)
Savannah Sparrow	*Passerculus sandwichensis*	23	22.6% (21)	39	37.8% (31)	32	33.8% (27)
Brown-headed Cowbird	*Molothrus ater*	25	15.1% (14)	37	29.3% (24)	34	26.3% (21)
Upland Sandpiper	*Bartramia longicauda*	12	10.7% (10)	11	7.5% (7)	1	1.3% (1)
Clay-colored Sparrow	*Spizella pallida*	7	64.5% (6)	7	7.3% (6)	14	11.3% (9)
Eastern kingbird	*Tyrannus tyrannus*	8	4.3% (6)	0	0% (0)	1	1.3% (1)
Sprague's Pipit	*Anthus spragueii*	2	2.2% (2)	5	3.6% (3)	4	5% (4)
Baird's Sparrow	*Ammodramus bairdii*	3	3.2% (3)	0	0% (0)	3	3.8% (3)
Chestnut- collared Longspur	*Calcarius ornatus*	3	3.2% (3)	0	0% (0)	13	8.8% (7)
Willet	*Catoptrophorus semipalmatus*	2	2.2% (2)	0	0% (0)	2	1.3% (1)
Vesper Sparrow	*Pooecetes gramineus*	1	1.1% (1)	1	1.2% (1)	0	0% (0)
Dickcissel	*Spiza americana*	1	1.1% (1)	0	0% (0)	2	2.5% (2)
Sharp-tailed Grouse	*Tympanuchus phasianellus*	0	0% (0)	1	1.2% (1)	6	7.5% (6)
Lark Sparrow	*Chondestes grammacus*					2	1.3% (1)
Marbled Godwit	*Limosa fedoa*	0	0% (0)	1	1.2% (1)	1	1.3% (1)
Total number of points		93		82		80	
Average number of bird per point		4.26		5.24		5.33	
Average number of species per point		2.64		2.90		3.22	

Figure 10. Percent occurrence of the four most common grassland bird species in survey points classified by litter depth and visual obstruction readings (VOR). See Figure 5 for the range of values associated with each class.

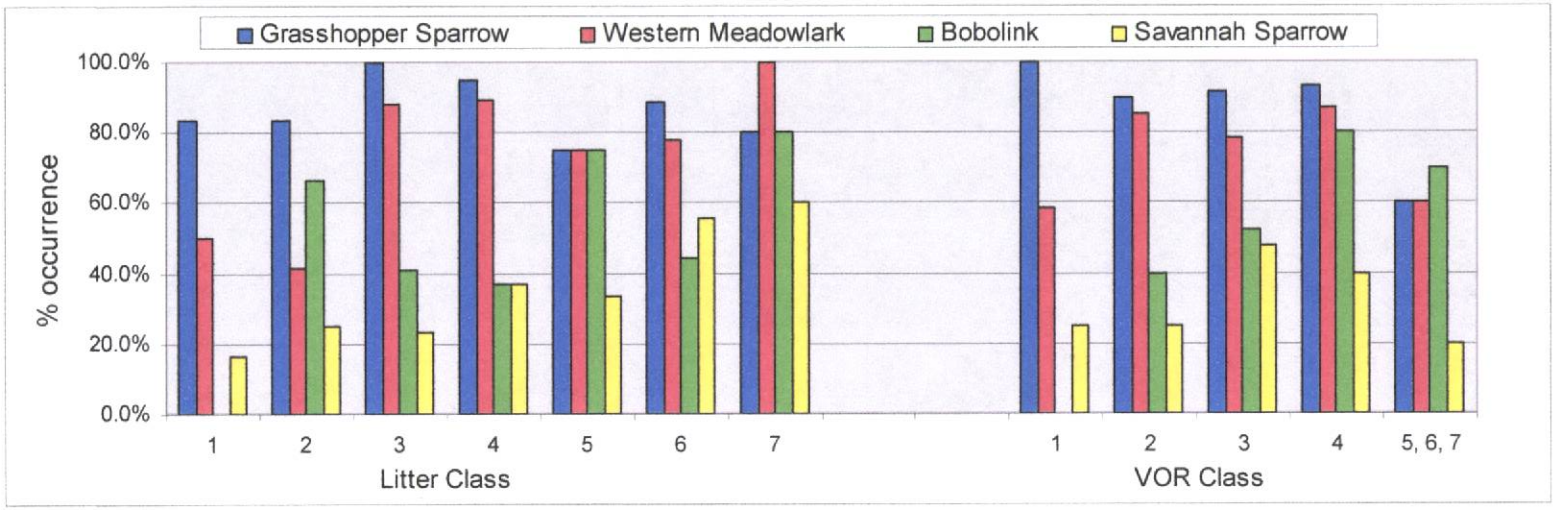


Figure 11. Comparison of dominant plant community frequency (native vs. exotic, grass vs. forbs) and percent frequency of selected plant species within each 300-meter transect surveyed in 2009. Transects are listed in order of increasing native plant composition from left to right.

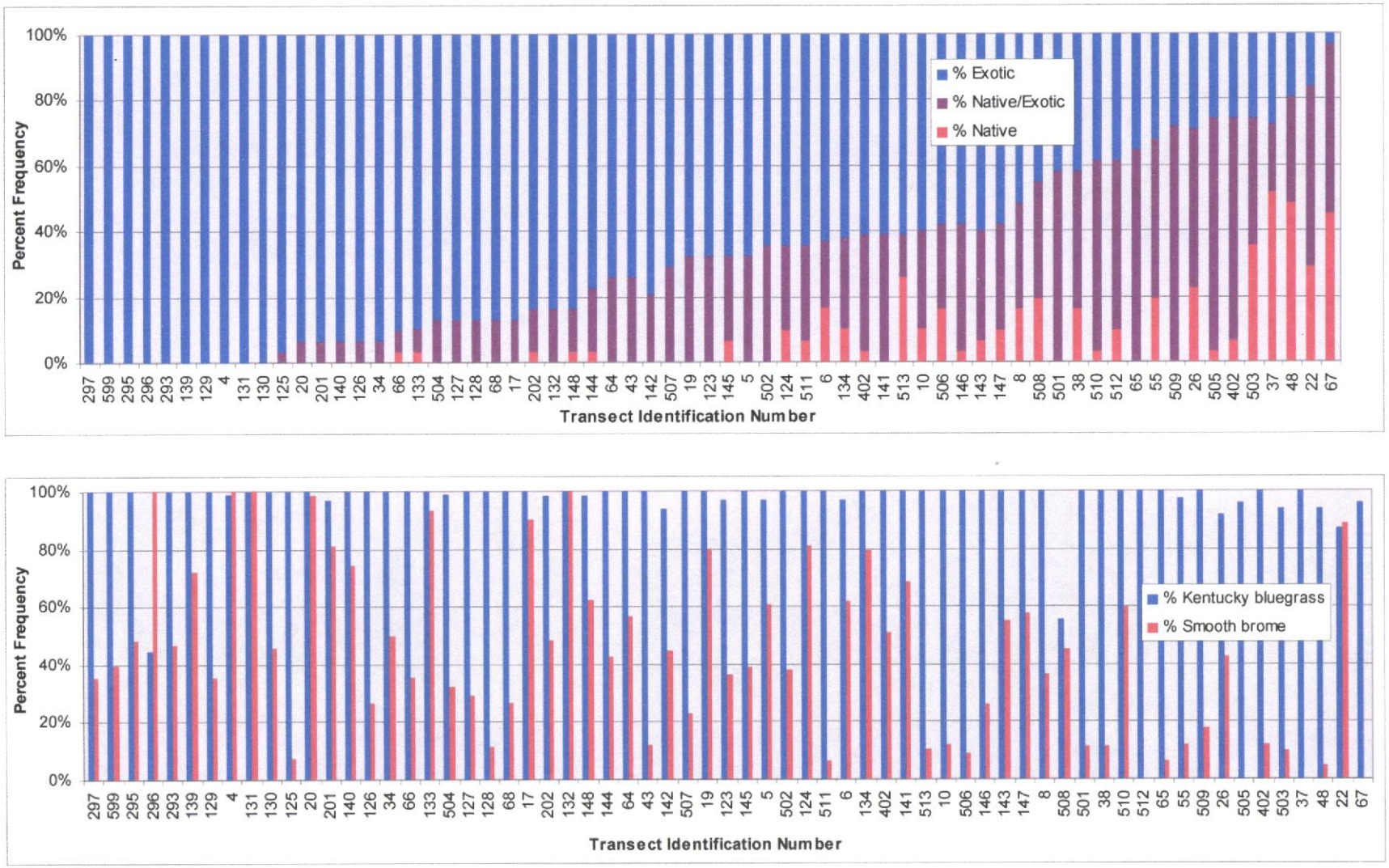
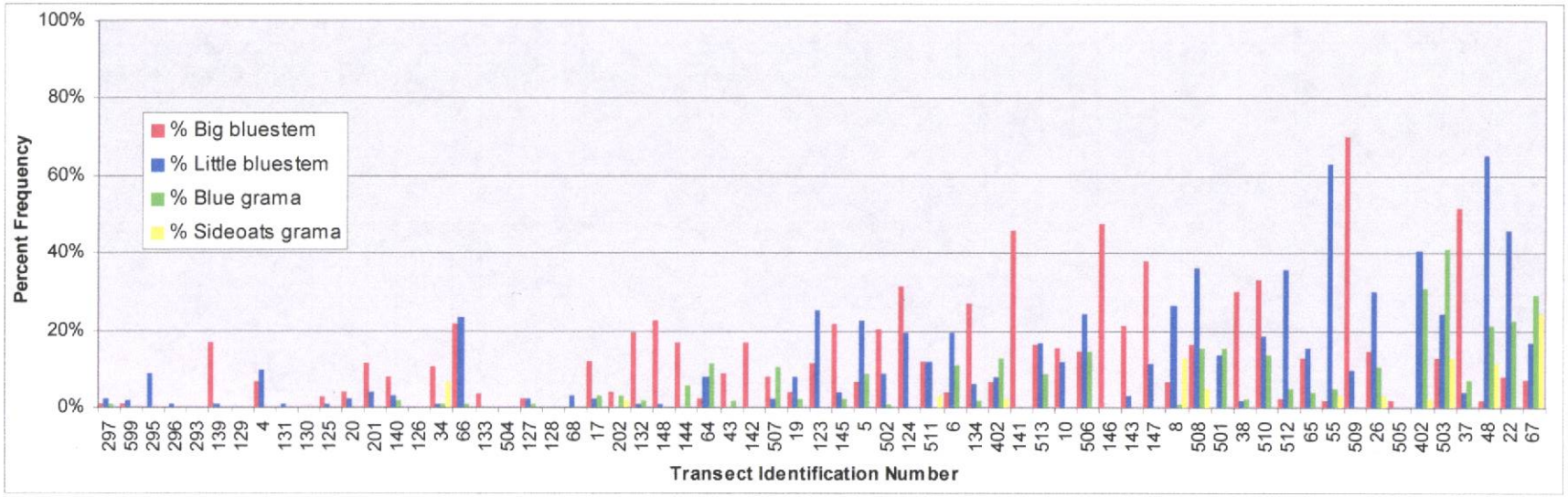


Figure 11. (Continued)



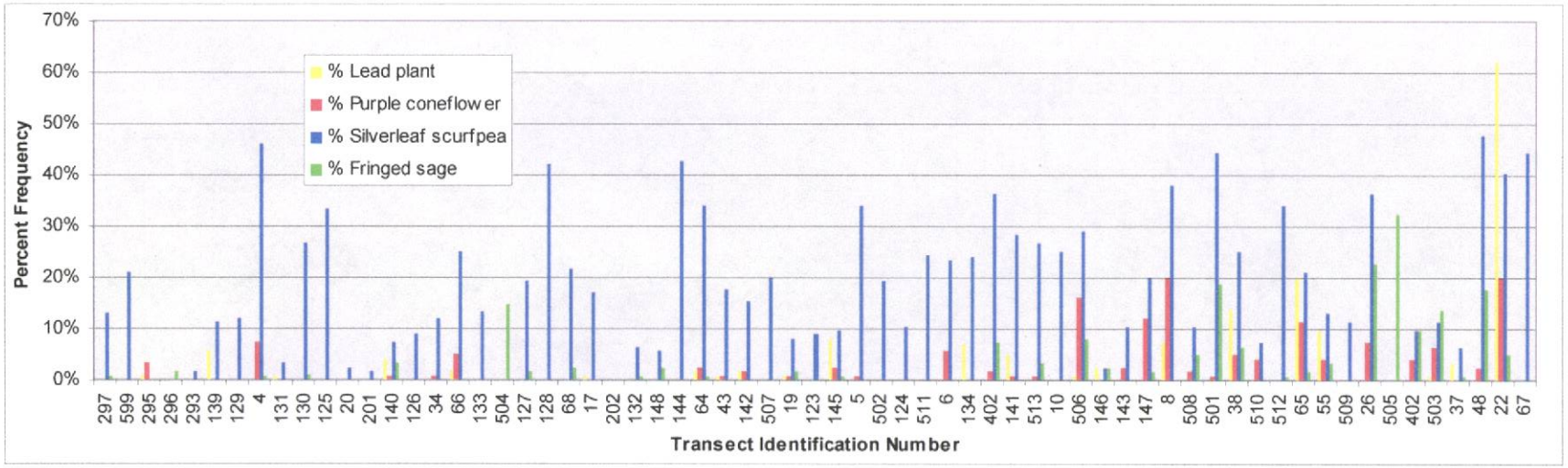
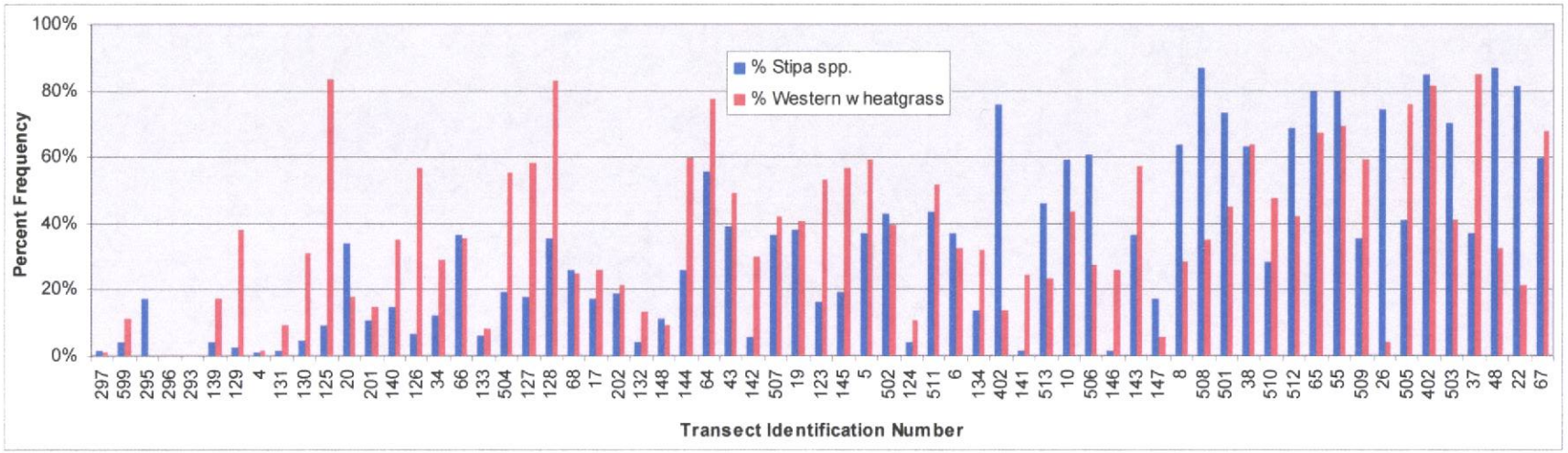


Figure 11. (Continued)



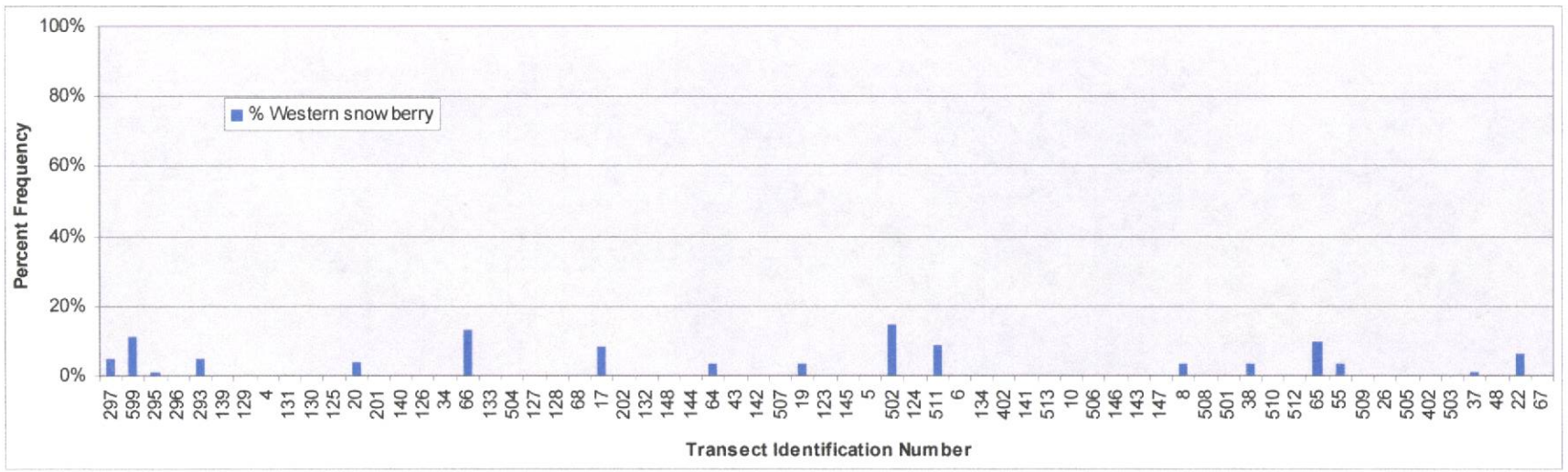


Figure 11. (Continued)

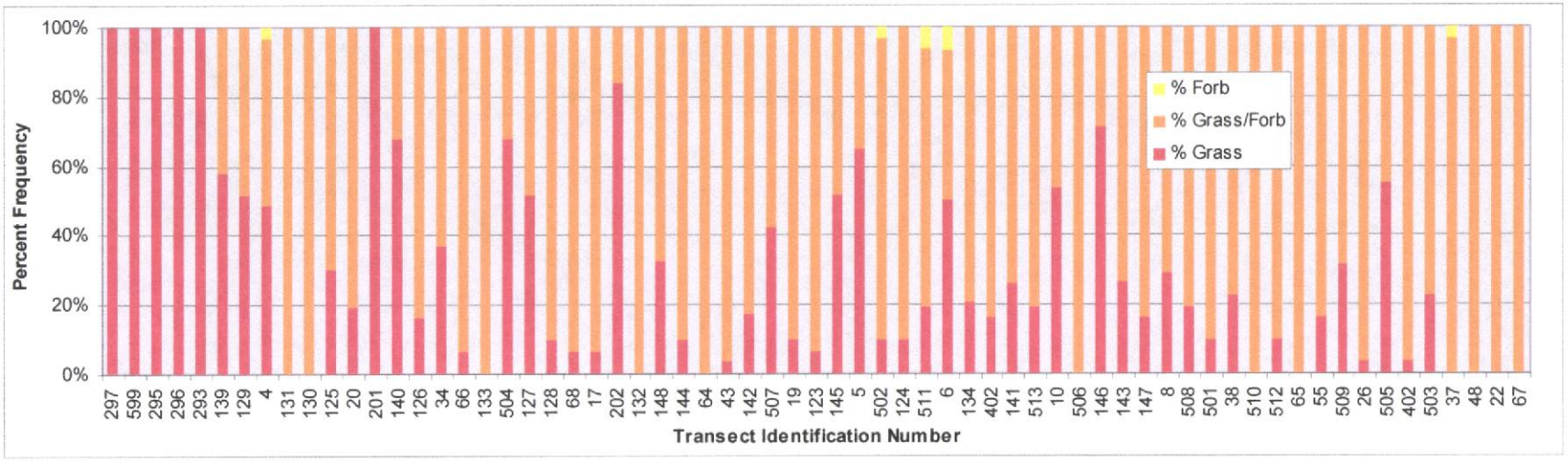


Figure 12. Comparison of the number of 13 selected native plant species and 9 selected exotic plant species present within each transect area (within 50-meter radius of the center GPS point of the vegetation transect). Transects are listed in order of increasing native plant composition from left to right. (See Figure 3 for a list of the selected plant species used in 2009).

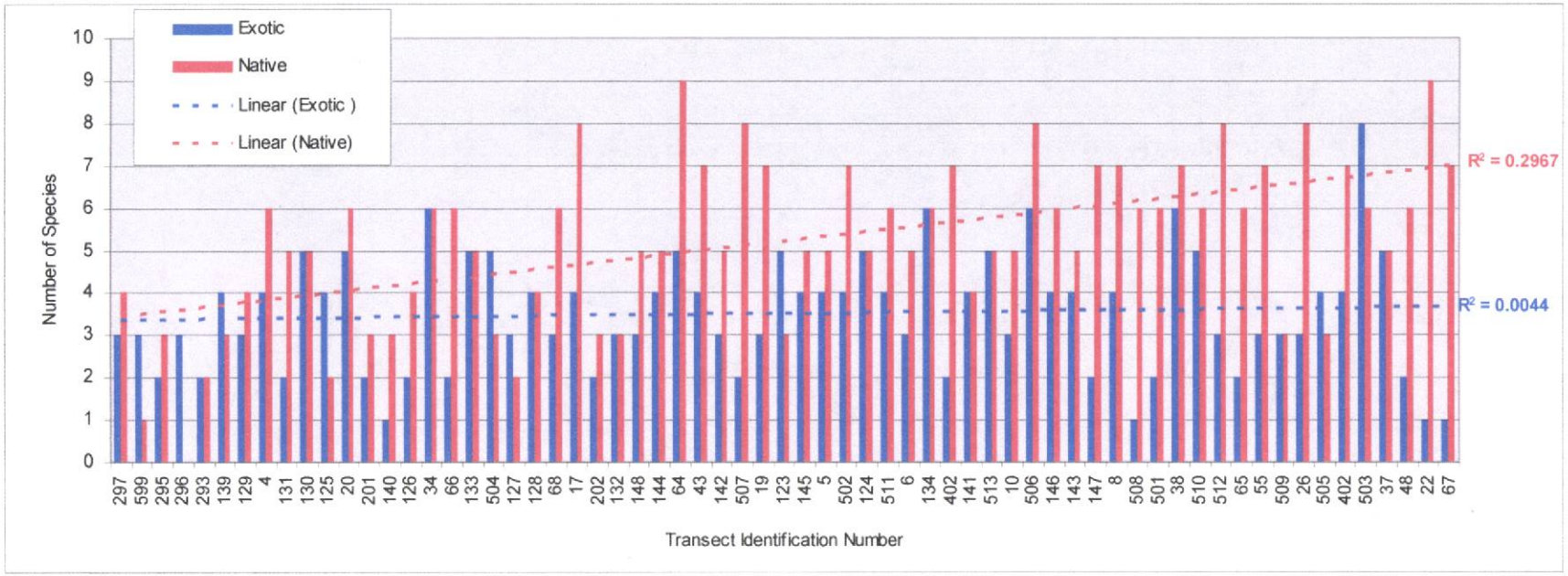


Figure 13. Number of grassland birds (includes only males for passerines), bird species and butterfly species detected at survey points in 2009. Survey points are listed in order of increasing native plant composition from left to right based on results of the vegetation survey.

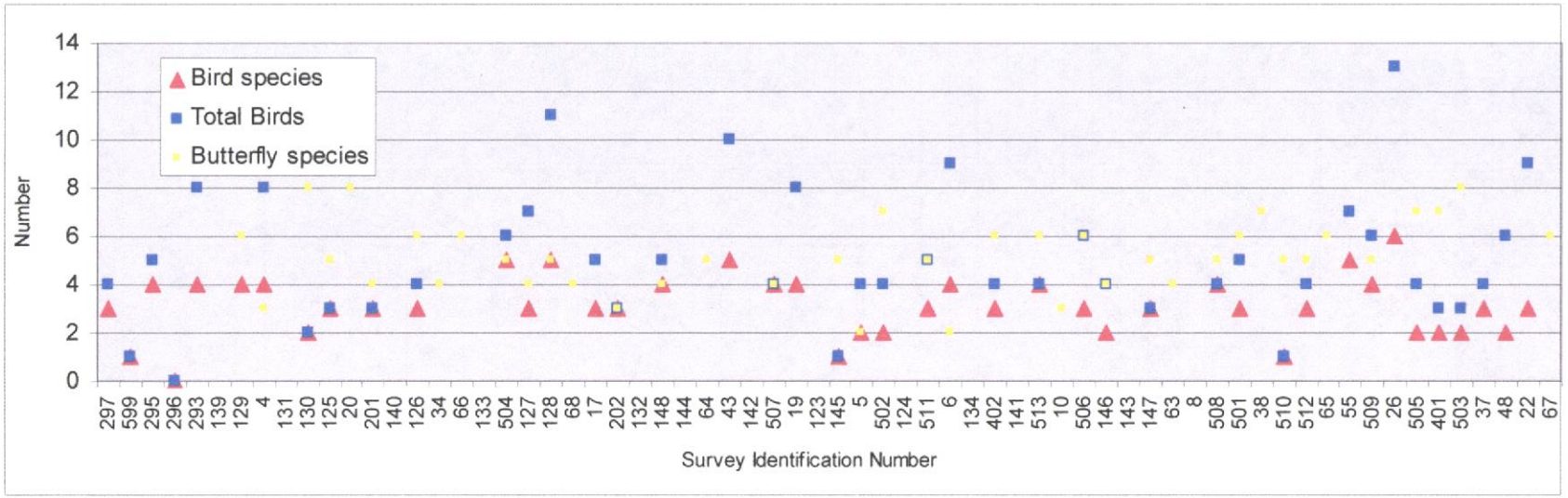


Figure 14. Range of litter depth values recorded at survey points where various grassland bird species occurred in 2008 and 2009.

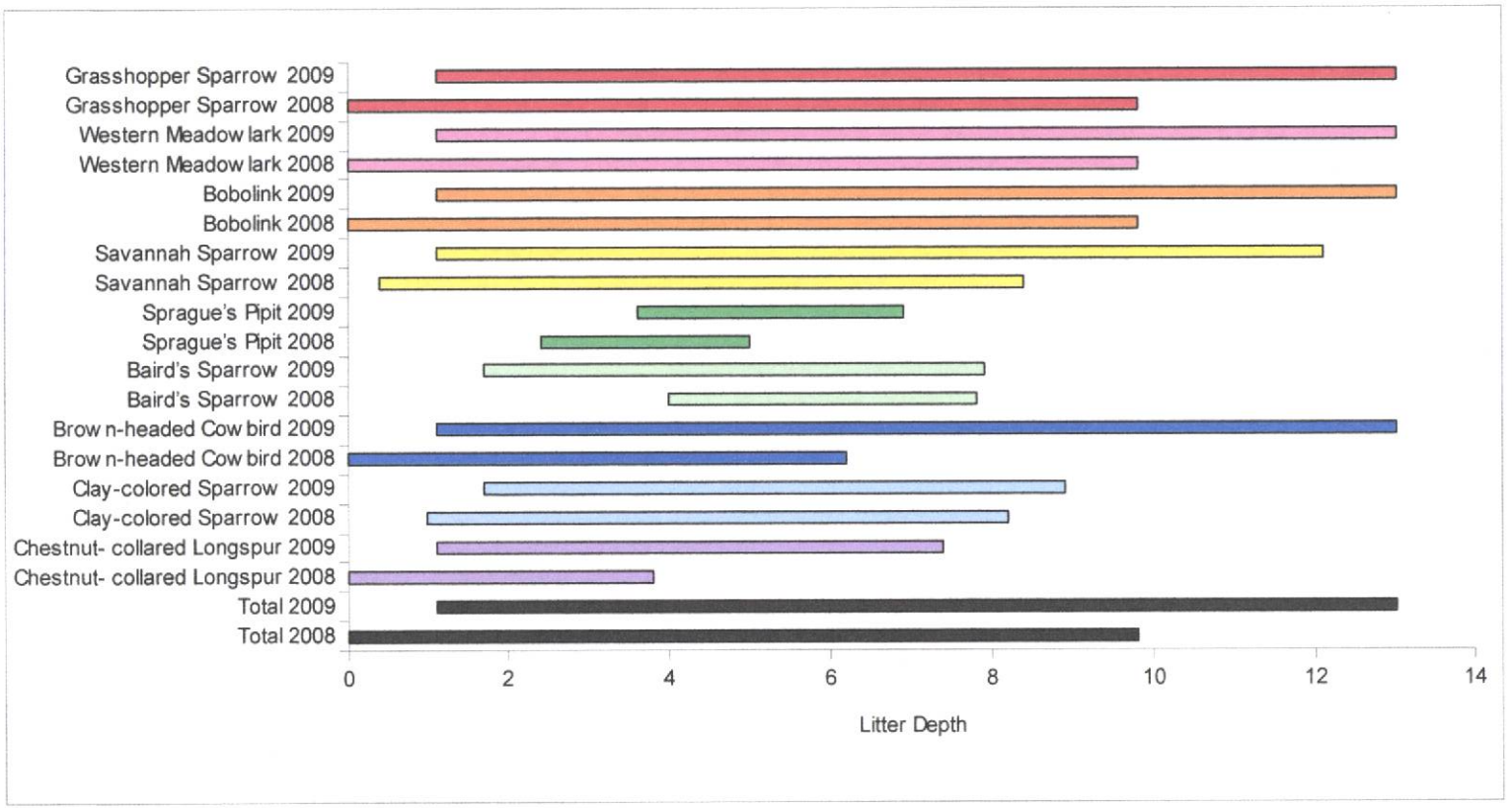


Figure 15. Range of visual obstruction readings (VOR) recorded at survey points where various grassland bird species occurred in 2008 and 2009.

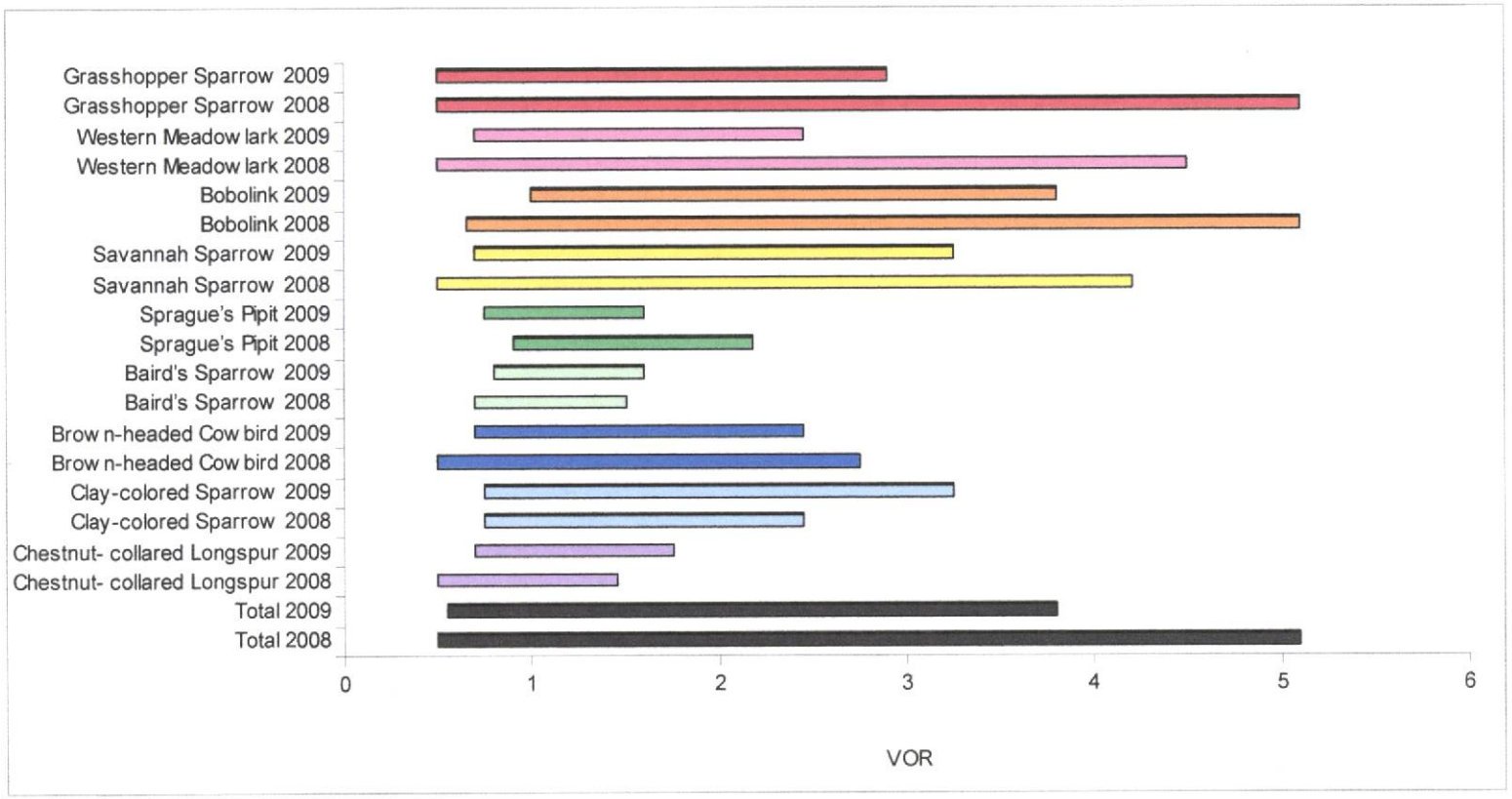


Figure 16. Range of litter depth values recorded at survey points where various butterfly species occurred in 2008 and 2009.

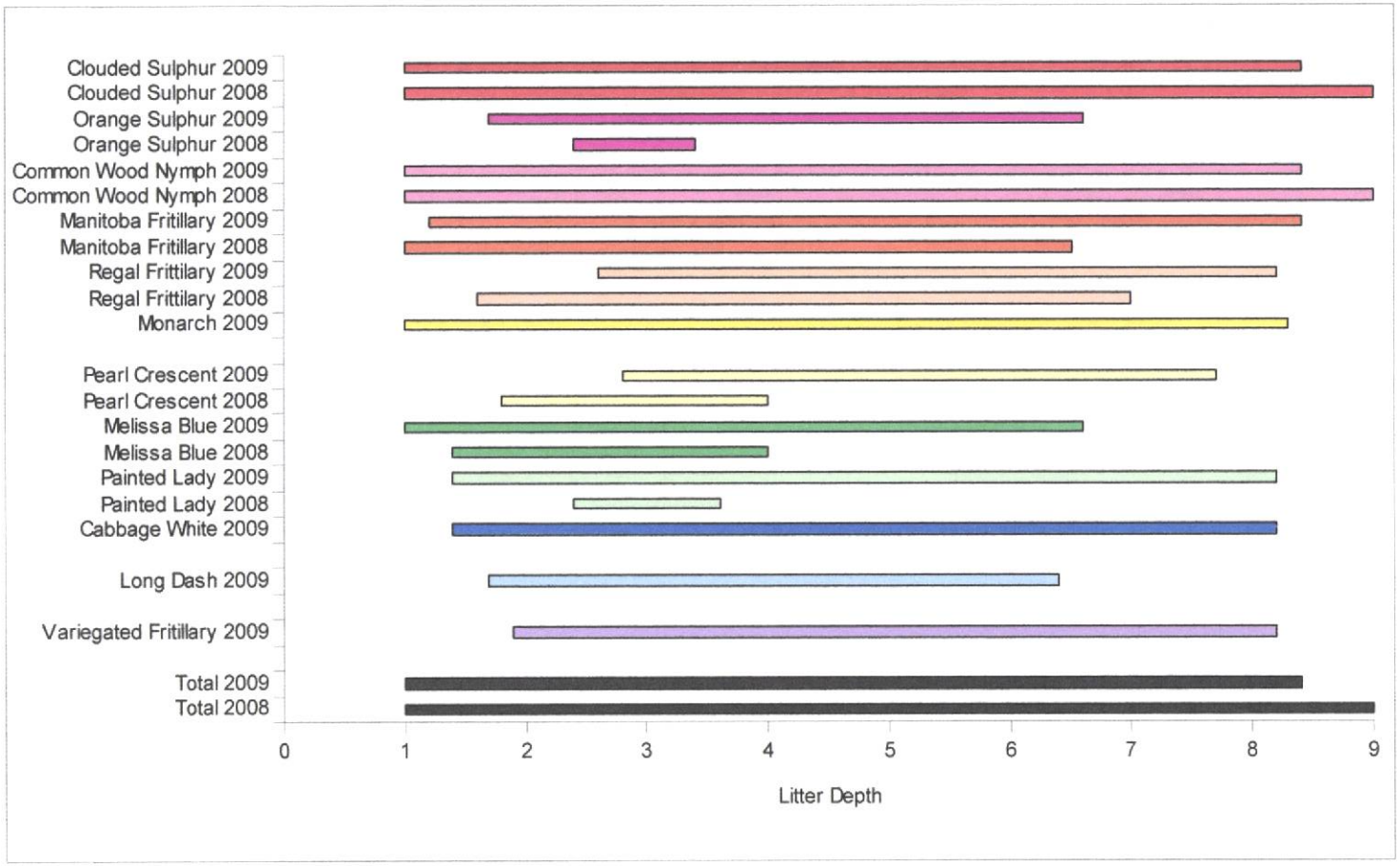


Figure 17. Range of visual obstruction readings (VOR) recorded at survey points where various butterfly species occurred in 2008 and 2009.