Restoration of Sand Prairie in Illinois: Seed Banks and Existing Vegetation

Final Report for Illinois DNR Wildlife Preservation Fund awards

Grant Agreement Number: 06035W

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Time Frame of Report:

June 2005-August 2006

Project Objectives (as described in application):

Our objectives for this research were to compare the vegetation of native sand prairie to the present and potential vegetation of former sand prairie that was protected from external impacts and vegetation for 80 years, and former sand prairie with a long grazing history. The specific questions we proposed to address:

1) What are the levels of species diversity and richness of native and nonnative species in a) unvegetated former sand prairie, under recently removed storage platforms? b) successional sand prairie recovering from a long history of heavy grazing? c) former sand prairie dominated by exotic annual grasses? d) remnant sand prairie?

2) How will species diversity and composition change with soil disturbance in former sand prairie with histories of grazing, or where plant growth was inhibited?

3) How do species diversity and composition in sand soil seed banks differ with divergent land use histories?

Changes from initial proposal: Upon implementation of treatments under recently removed storage platforms, it was discovered that the soil had been previously disturbed and was not an adequate reference for testing differences in soil seed banks. These plots were dropped from the study, and are not discussed in the Project Summary.

Completed Project Description:

Vegetation surveys and management applications (in the form of soil disturbance) were initiated in 2005 at study sites on formerly grazed sand prairie in northwestern Illinois. Vegetation monitoring was conducted in the summer of 2005-2006 to provide baseline information on species composition and richness, and to quantitatively assess responses to experimental soil disturbance. Lessons learned from the project are being applied to new research on the same study sites.

Summary of the Project Accomplishments:

See Attached Report

Total Project Expenditures funded by SWG funds:

See Attached details (provided by the Illinois Natural History Survey)

Other Project Funds Used:

Phillip W. Smith Memorial Fund - Illinois Natural History Survey (2005)
Summer Fellowship - UIUC Dept of Plant Biology (2005)
Illinois Native Plant Society (2006)

SUMMARY OF PROJECT ACCOMPLISHMENTS

Introduction

Tallgrass prairie once dominated the landscape of the Midwest, but through large-scale conversion to agriculture, this natural resource has been reduced to a few remnants. In order to conserve this highly fragmented system and the species dependent on it, prairie restorations are now essential to augment the native tallgrass prairie that remains. Ideally, seed for restorations should come from local prairies, because local genotypes are more likely to establish successfully than genotypes from more distant sources (e.g., Gustafson et al. 2002, 2004). One source of these local seeds lies dormant in the soil. Native species may persist in the seed bank in areas where the soils were not cultivated intensively (Rabinowitz 1981, Kirkman 1994). However, seed banks can also be a refuge for so called 'weedy' species that are undesirable in restoration. Species identification and quantification of prairie seed banks is pertinent to detecting the extent of introduced species, maintaining local genetic integrity, buffering species against extinction (Levin 1990), and increasing native species diversity (Venable 1998).

Research Objectives

This study investigated quantitative aspects of sand prairie vegetation and the effects of historical disturbance, in addition to experimental manipulation to evaluate potential management techniques. Selected management techniques were chosen from currently used and potential techniques to further restoration aims and utilize natural seed banks. Our objectives stem from the need for characterization of seed banks in sand prairies and whether they play a positive role through introduction and maintenance of native species or a negative role through the continuance of weedy and introduced species. A concurrent study (not presented here) quantitatively assessed the germinable seed bank of these prairies. The results of this research provide applicable knowledge to restoration and management of sand prairies throughout the tallgrass prairie biome. The revised research questions we addressed were:

1. How does extant vegetation from sand prairies with different disturbance histories (grazing and plant invasion history) vary in species richness and composition?

2. How do different management techniques affect recruitment, cover, and richness of native and introduced species in formerly grazed sand prairies? How do these responses differ in the presence of an introduced invasive perennial grass?

Study Site Descriptions

Study sites were located on dry mesic sand prairie in northwestern Illinois along the Mississippi River (Figure 1). The sand prairies along the Mississippi were formed as sand was released as glacial outwash and deposited along a historic floodplain. These types of inland sand deposits share characteristics of movement and soil composition with other sand areas, such as low organic content and shifting sands when vegetation is removed.

Because of their characteristic low fertility and high potential for erosion through shifting sands, inland sand prairies were not converted to row crop agriculture until the widespread availability of fertilizers. Instead, some sand prairies were maintained as pasture, and thus may have been 'conserved' in some state of their original form. It is with this past land use in mind that the research sites can be categorized. Sand prairies were selected from sites with the following historical disturbance regimes:

(1) Historically grazed until 1970, and not subject to large-scale incursion by introduced species (Formerly Grazed, Not Invaded) (FG-NI),

(2) Heavily grazed until 2000, but with low occurrence of introduced species (Grazed, Not Invaded) (G-NI), and

(3) Heavily grazed until 2000, with evidence of large-scale invasion by introduced species, specifically the perennial rhizomatous mat forming grass *Bromus inermis* (Grazed, Invaded) (G-I).

Native prairie vegetation exists in each of the sites but to varying amounts and composition as influenced by its past history.

Historically grazed (FG-NI) vegetation characterization was conducted in and adjacent to Thomson-Fulton Sand Prairie, an Illinois Nature Preserve in Whiteside County, Illinois (Figure 2). The preserve was grazed until its dedication as a nature preserve in 1970. Management of the preserve and surrounding areas since 1970 has included the removal of grazing and the implementation of prescribed burns. Adjacent areas in the survey were subject to similar management conditions and included abandoned road and railway right-of-way immediately adjacent to the preserve. The most frequent species included little bluestem (*Schizachyrium scoparium*) and prickly pear (*Opuntia macrorhiza*), with common forbs including western ragweed (*Ambrosia psilostachya*) and prairie mallow (*Callirhoe triangulata*) as well as many other interstitial forbs and legumes. The 86 ha site is a mosaic of dry and dry-mesic sand prairie distinguished primarily by topography and resulting vegetation. Survey sites were selected from representative dry-mesic sand prairie, all located within a one km radius. Six transects (layout described in experimental design) to sample the vegetation and seed bank

were dispersed as follows: four were located on the preserve and two were located immediately outside the preserve in abandoned right-of-way (road and railway ROW).

Heavily grazed (G-NI and G-I) disturbance types were located within the Lost Mound Unit of the Upper Mississippi River National Wildlife Refuge in JoDaviess County, Illinois (Figure 3). This area was formerly the Savanna Ordnance Depot, a U.S. Army base established in 1917 for munitions storage. Infrastructure constructed on site in the surveyed areas was completed in the first half of the 1900's and included rows of native soil-covered bunkers and access roads (Figure 4). Despite this infrastructure, large areas of open land, not disturbed by ground-moving activities, remained as native vegetation. To minimize the risk of fire, the land was heavily grazed for 80+ years with approximately 1,500 head of cattle yearly from May to October. The cattle had access to the approximately 810+ ha that contained sand prairie, up until 2000 when they were permanently removed from the areas surveyed. Invaded and non-invaded survey sites were selected from areas not disturbed by ground-moving activities.

Heavily grazed and not invaded (G-NI) transects at Lost Mound were arbitrarily selected from areas mapped as dry-mesic prairie (Robertson 1997). Several measures were used to include or exclude areas within this site type. A visual estimate of dominance (approximately 50 percent) by the native bunch-forming grass *S. scoparium* was required. This visual estimate was later confirmed using the cover collected during field surveys. Sites could not include patches of *B. inermis*, the grass used to characterize the invaded sites. Transects were also oriented in order to avoid native shrubby prairie vegetation (*Rhus aromatica*) and large patches of crown-vetch (*Coronilla varia*), an introduced nitrogen-fixing invasive present at Lost Mound. Selection of sites in this manner resulted in a dominant vegetation closely aligned with the historical community prior to grazing as described by Henry Allan Gleason who visited the site in 1907 (Gleason 1910). Dominant species in the extant vegetation were largely composed of the same grasses and sedges observed by Gleason, including *S. scoparium, Leptoloma cognatum, Koeleria macrantha, Panicum villosissimum,* and *Cyperus schweinitzii.* Transects were separated across the site as follows. A rise in topography runs diagonally across Lost Mound. This area, approximately 1,750 m wide, is dominated by dry sand prairie, with dry-mesic sand prairie located on both west and east sides. Three of the transects were on the west and three on the east of the dry sand prairie. All transects were separated from adjacent transects by ≥ 500 m.

Heavily grazed and invaded (G-I) sites were located in areas that would have been populated by the same species listed above, but were invaded by grass *B. inermis*. Many of the species that occur in non-invaded sites also occur in the invaded sites, but native species cover

is much lower. Introduction of *B. inermis* has been limited to a few areas at Lost Mound, but the non-native grass appears to be aggressively spreading where it is present. It is unknown whether its introduction was unintentional and came in with cattle or spread from localized plantings outside of the study areas. Individual transects were selected from areas within each invasion using a visual estimate of dominance by *B. inermis*. This visual estimate was later quantified using the cover collected during field surveys. Survey sites were placed within the two major invasion foci at Lost Mound, with the edges of the invasions approximately 3 km apart, separated by dry and dry-mesic sand prairie. The invasion center on the east side of the site contains four transects which are all located within a 1 km radius. The invasion center on the west side of Lost Mound is smaller and the two transects are separated by 200 m.

Experimental Design

Vegetation surveys were conducted along permanent 50-m transects, six transects in each of the three sites. 2x4 m plots were established every 10 m along alternating sides of each transect (Figure 5). At the FG-NI site, no management techniques were applied and surveys were limited to control plots. At the G-NI and G-I sites, treatment plots were created along with control plots. At these sites, each plot was randomly assigned one of the following treatments: control or one of 3 management techniques. This resulted in a total of 30 replicates of each treatment per site.

Two management treatments were installed in April 2005: a 'mow' treatment and a 'mow+soil disturbance' treatment. In the 'mow' treatment, cut vegetation was left in place, to simulate a typical management mow treatment. In the 'mow+soil disturbance', cut vegetation was removed and soil was raked to a maximum 2 centimeter depth, to determine if seed banks could be stimulated to grow by exposing buried seeds to surface conditions. A subset of these treatments was applied to new plots in April 2006, due to extreme drought at the study sites in 2005. The third management technique was an application of the mow+soil disturbance treatment in multiple years (applied in 2005 and 2006) to estimate the effect of repeated disturbance.

Extant Vegetation Surveys

Vegetation surveys were conducted in early (June) and late (August) summer in both 2005 and 2006 to account for temporal variation in species composition and differences in cover between cool and warm season grasses. Species richness and percent cover were determined from a 1x0.5 m sub-plot within each 2x4 m plot, sub-plots not placed within 0.5 m of the edge of

the plot (Figure 5). Sub-plot frames, only in place during sampling, were viewed from above to assign a Daubenmire cover class for each species present.

Daubenmire Class	Range of Plot Cover	Midpoint
1	0-5%	2.5
2	5-25%	15
3	25-50%	37.5
4	50-75%	62.5
5	75-95%	85
6	95-100%	97.5

Class midpoints were used in the statistical analysis. Species frequently overlapped and some sub-plots exceeded 100 percent cover. Cover by bare-ground and dead vegetation was also recorded for each sub-plot. Species present in the larger 2x4 m plot, but absent from the sub-plot, were recorded to get a total species richness account for each transect. Nomenclature for species identification follows Gleason and Cronquist (1991).

PRELIMINARY RESULTS

Visual estimates of dominance by the key classification species (*S. scoparium* in G-NI and *B. inermis* in G-I) were quantified using cover data from 2005 (Figure 6). Transects within the G-I site ranged from an average of 20 – 60% *B. inermis* cover per sub-plot, with overlapping percentages between transects. All G-I transects were included within the subsequent analysis. Within the G-NI site, one transect (Transect S1) was determined to be a significant outlier, with *S. scoparium* accounting for only 2% of the cover in sub-plots (Figure 7). This transect was eliminated from the final analysis. The remaining five transects had an average of 45 – 65% *S. scoparium* cover per sub-plot.

Species composition, functional groups, and life history traits for all three sites sampled in 2005-2006 were compiled (Tables 1-3). Species richness and percent cover were surveyed in all plots in 2005-06. Historical disturbance regime alters overall species richness and the ratio of native:introduced per sub-plot: FG-NI (9.9 : 0.4) G-NI (9.5 : 3.0) and G-I (6.8 : 2.8) (Figure 8). As should be expected by the selection method of the sites and transects, percent cover of introduced species is greater in the G-I site, than in FG-NI and G-NI sites.

Neither the mow nor the disturbance treatment resulted in a response of increase in species richness or change in species cover as compared to each treatment or the controls in the G-NI site (Figure 9) or the G-I site (Figure 10). This lack of response or lack of detection of a response is discussed below.

CONCLUSIONS

Preliminary results show that there has been no whole scale response to the implemented treatments. There are several possible reasons for these results. First, the soil disturbance may not have been severe enough to elicit a response from the seed bank. New treatments are currently being established in a comparison study (funded by alternate sources), which will disturb the soil to a lower depth. Additionally, a soil disturbance treatment is being added in the fall to account for possible seasonal effects. Seed addition is also planned to account for limitations in the seed bank. Lastly, a response may not have been detected due to the sampling time frame or analysis method. For this reason, vegetation sampling will continue for the 2007 field season to determine if there is a delayed response from the vegetation. Post-hoc tests on individual species responses and species turn-over within individual sub-plots will be analyzed to assess additional variables.

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Levin, D.A. (1990). The seed bank as a source of genetic novelty in plants. *American Naturalist*, 135: 563-572.

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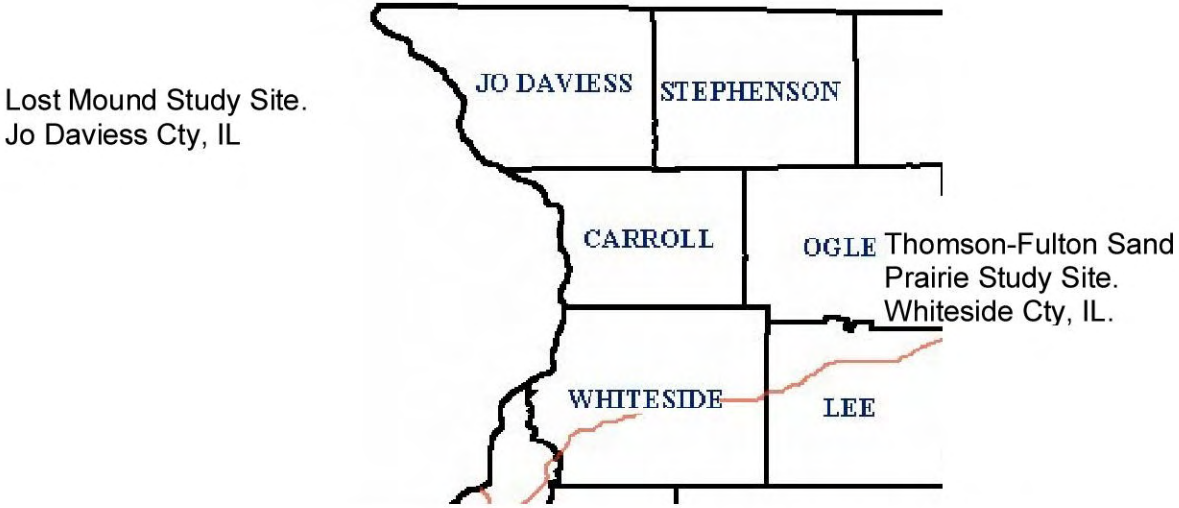

Figure 1. Study Site locations in northwestern Illinois.

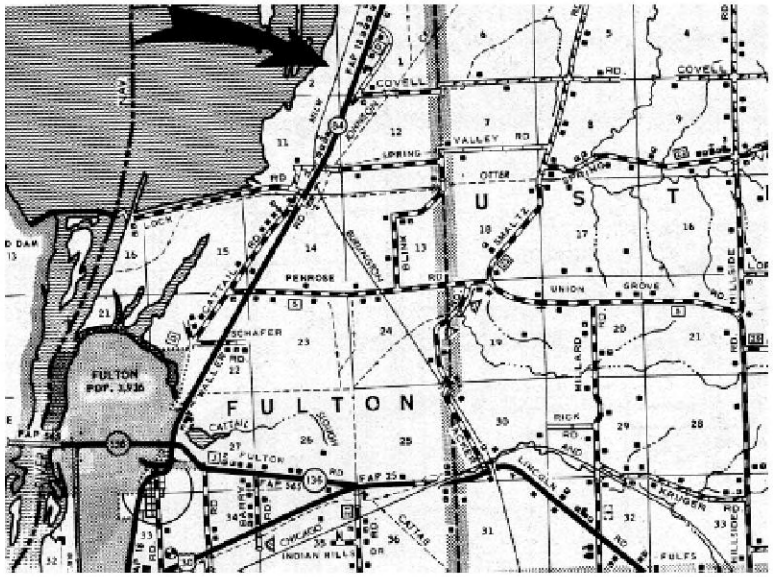

Figure 2. Location map of Thomson-Fulton study site.

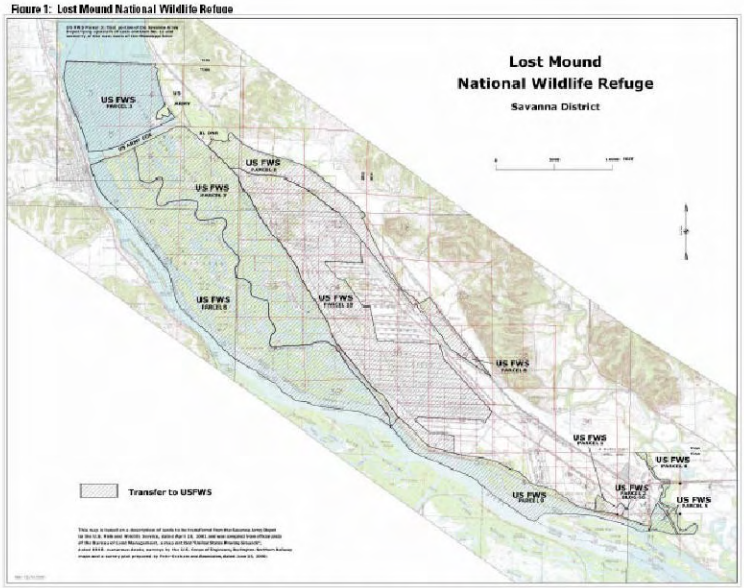

Figure 3. Overview map of Lost Mound study site.

Figure 4. Satellite imagery of Lost Mound study site (south end of site where transects are located).

Image Sources: Illinois Department of Natural Resources – Illinois Nature Preserves. McFall and Karnes 1995 (Fig 2)
Environmental Assessment and Interim Comprehensive Conservation Plan (Fig 3)
Aerial Imagery Service (Fig 4)

Figure 5: Transect, Plot and Sub-Plot Layout
50-meter Transect
Designation of 2 X 4 meter plots:
Control (C)
Mow (M)
Disturb (D) – 2005 (3), 2005+06 (2), 2006 (3)
6 transects in each of three sites.
All plots monitored 2005+06
No management applications at FG-NI.

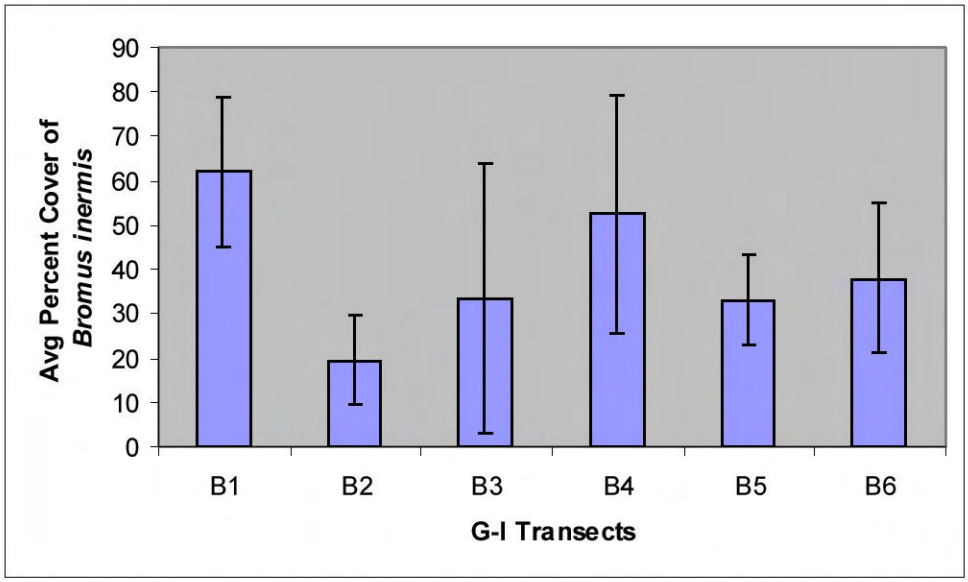

Figure 6. Comparisons of average cover (class midpoints, Daubenmire scale) of 'classification' species *Bromus inermis* in 1X1/2 meter subplots in Grazed, Not Invaded transects. Sampling data from June 2005. Lost Mound, Jo Daviess Cty, IL.

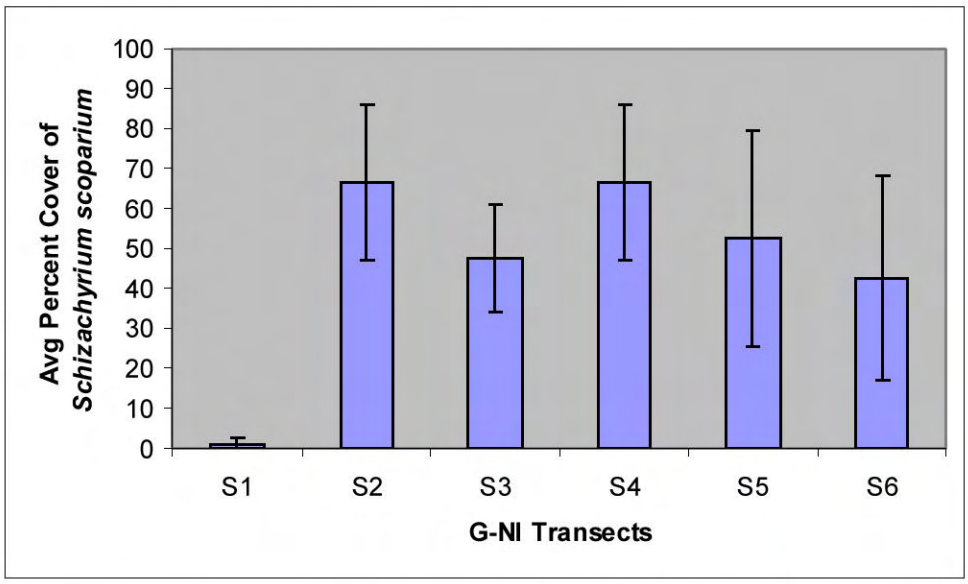

Figure 7. Comparisons of average cover (class midpoints, Daubenmire scale) of 'classification' species *Schizachyrium scoparium* in 1X1/2 meter subplots in Grazed, Not Invaded transects. Sampling data from August 2005. Lost Mound, Jo Daviess Cty, IL.

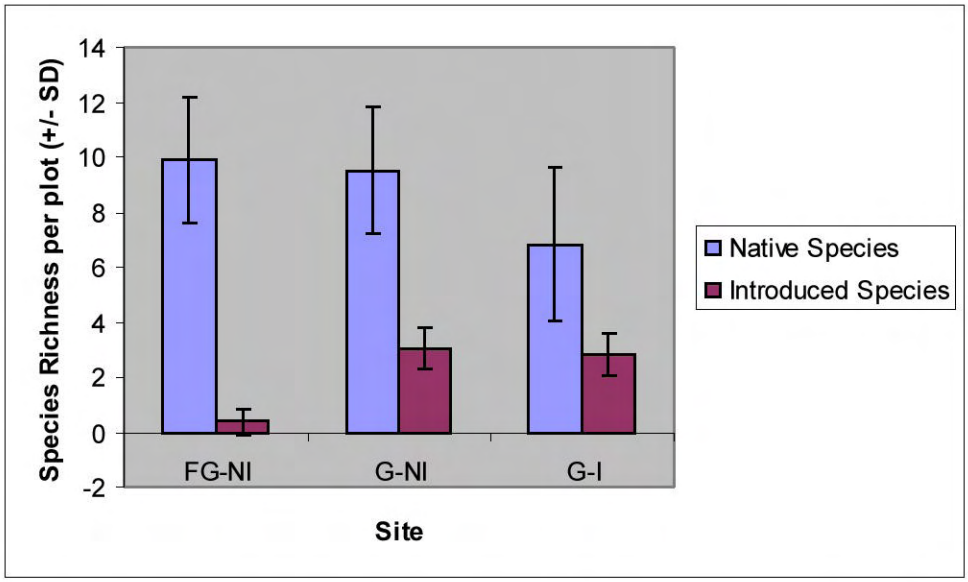

Figure 8. Comparisons of average species richness in 1X1/2 meter subplots in all sites: Historically Grazed-Not Invaded (FG-NI), Thomson-Fulton Sand Prairie; Grazed-Not Invaded (G-NI), Lost Mound; Grazed-Invaded (Lost Mound) . Sampling data from August 2005.

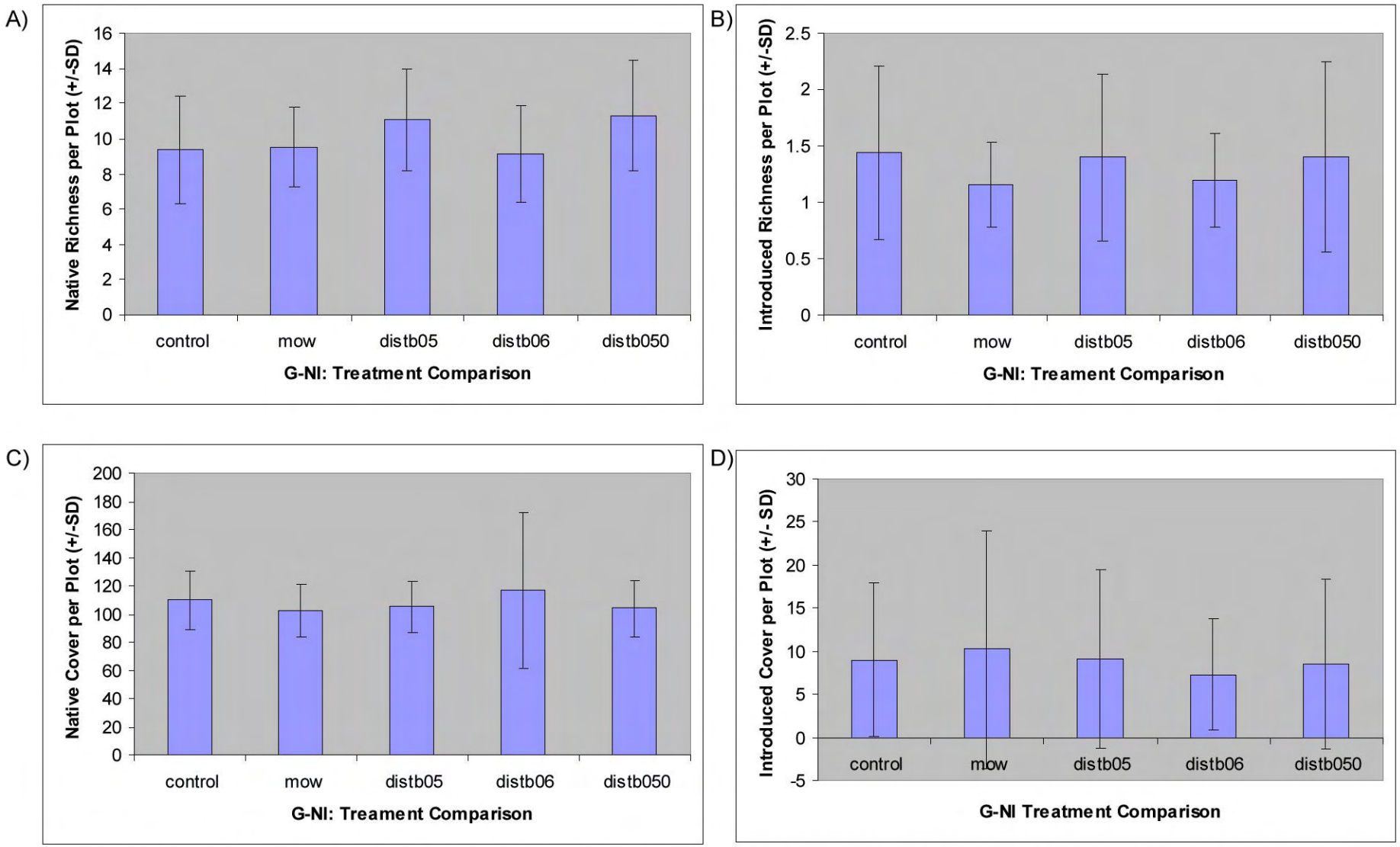

Figure 9. Treatment comparisons within the Grazed-Not Invaded Site. Treatment categories are as follows: control, mow, distb05 (soil disturbance in 2005), distb06 (soil disturbance in 2006), distb050 (soil disturbance in 2005 and 2006). No significant response was detected in native (A) or introduced (B) species richness or native (C) or introduced (D) species cover per sub-plot. One plot was eliminated from D, since its variance led to a std dev greatly passing across the x-axis. Sampling data from August 2006. Lost Mound, Jo Daviess Cty, IL.

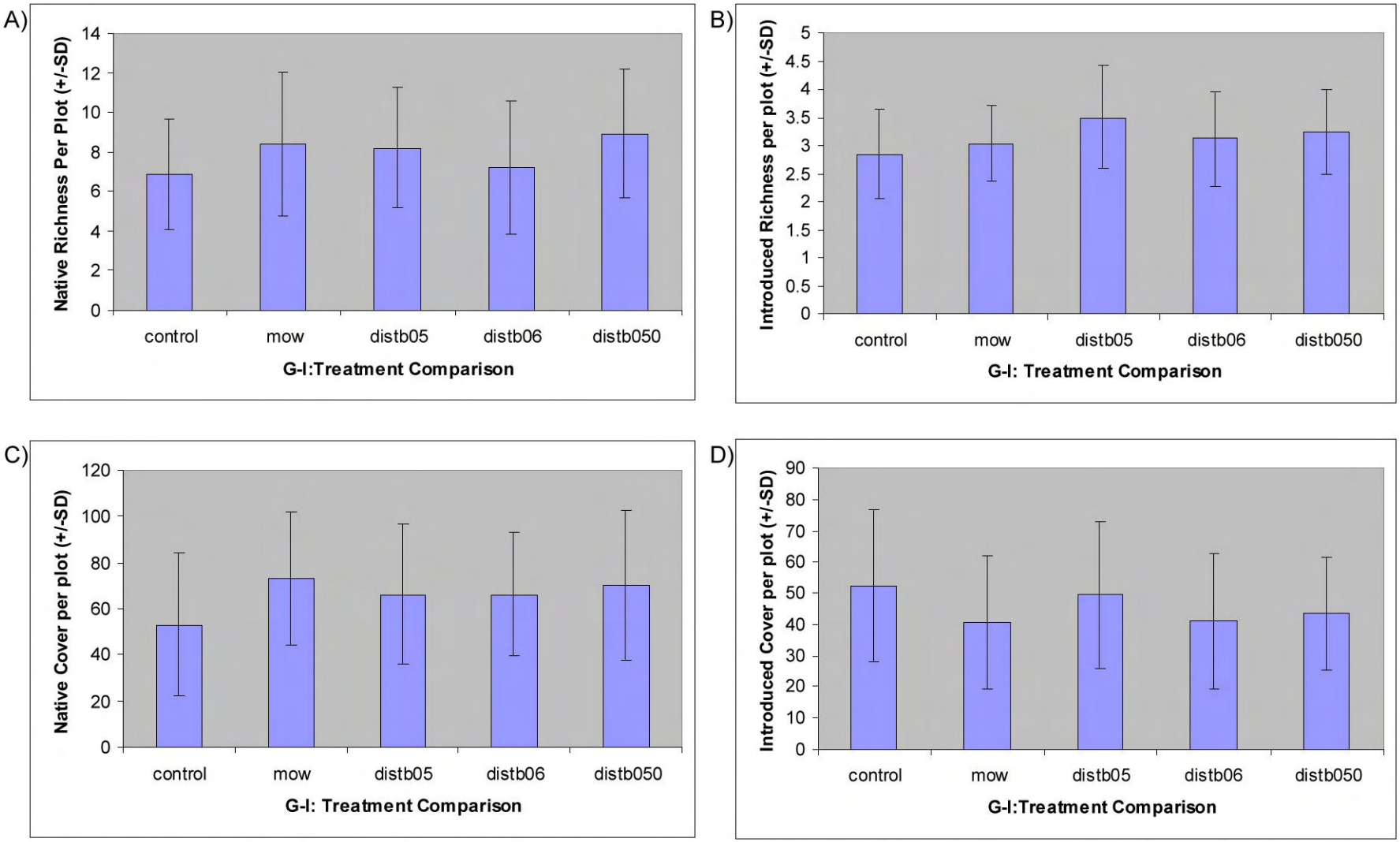

Figure 10. Treatment comparisons within the Grazed-Invaded Site. Treatment categories are as follows: control, mow, distb05 (soil disturbance in 2005), distb06 (soil disturbance in 2006), distb050 (soil disturbance in 2005 and 2006). No significant response was detected in native (A) or introduced (B) species richness or native (C) or introduced (D) species cover per sub-plot. Sampling data from August 2006. Lost Mound, Jo Daviess Cty, IL.

Table 1. Species List: Historically Grazed and Non-Invaded Sand Prairie (FG-NI). Thomson-Fulton Sand Prairie, Whiteside Cty, IL. Species listed were identified during sampling in June and August surveys 2005.

Species	Family	Function Group	Life History	Native or Introduced?
Ambrosia psilostachya	Asteraceae	F	P	N
Arabis lyrata	Brassicaceae	P	A	N
Asclepias purpurascens	Asclepiadaceae	F	P	N
Asclepias verticillata	Asclepiadaceae	F	P	N
Brickellia eupatoriodes	Asteraceae	F	P	N
Calamovilfa longifolia	Poaceae	G	P	N
Callirhoe triangulata	Malvaceae	F	P	N
Carex cephalophora	Cyperaceae	S	P	N
Carex muhlenbergii	Cyperaceae	S	P	N
Carex pensylvanica	Cyperaceae	G	P	N
Carex tonsa	Cyperaceae	S	P	N
Commelina erecta	Commelinaceae	F	P	N
Conyza canadensis	Asteraceae	F	A	N
Coreopsis palmata	Asteraceae	F	P	N
Cyperus filiculmis	Cyperaceae	S	A	N
Cyperus schweinitzii	Cyperaceae	S	A	N
Euphorbia corollata	Euphorbiaceae	F	P	N
Helianthus pauciflorus	Asteraceae	F	P	N
Koeleria macrantha	Poaceae	G	P	N
Krigia virginica	Asteraceae	F	A	N
Lepidium densiflorum	Brassicaceae	F	A	N
Leptoloma cognatum	Poaceae	G	P	N
Lespedeza capitata	Fabaceae	L	P	N
Opuntia macrorhiza	Cactaceae	F	P	N
Panicum depauperatum	Poaceae	G	P	N
Panicum oligosanthes var. scribnerianum	Poaceae	G	P	N
Panicum villosissimum	Poaceae	G	P	N
Panicum virgatum	Poaceae	G	P	N
Paspalum bushii	Poaceae	G	P	N
Physalis virginiana	Solanaceae	F	P	N
Plantago patagonica	Plantaginaceae	F	A	I
Poa pratensis	Poaceae	G	P	I
Polygala polygama	Poaceae	F	B	N
Rumex acetosella	Polygonaceae	F	P	N
Schizachyrium scoparium	Poaceae	G	P	N
Solidago nemoralis	Asteraceae	F	P	N
Stipa spartea	Poaceae	G	P	N
Tephrosia virginiana	Fabaceae	L	P	N
Toxicodendron radicans	Anacardiacaea	V	P	N
Tradescantia ohiensis	Commelinaceae	F	P	N
Triodanis perfolata	Campanulaceae	P	A	I
Vioala pedata	Violaceae	F	P	N
Vulpia octoflora	Poaceae	G	A	N

Functional Groups: F=forb, G=grass, L=legume, E=ephemeral, S=sedge, V=Woody Vine, CR=Vascular Cryptogam; Life History: A=annual, P=perennial, B=biennial; Native or Introduced: N=Native, I=Introduced.

Table 2. Species List: Heavily Grazed and Non-Invaded Sand Prairie (G-NI). Lost Mound, Jo Daviess Cty, IL. Species listed were identified during sampling in June and August surveys 2005-2006.

Species	Family	Function Group	Life History	Native or Introduced?
Achillea millefolium	Asteraceae	F	AP	N
Ambrosia psilostachya	Asteraceae	F	P	N
Antennaria neglecta	Asteraceae	F	P	N
Arenaria serpyllifolia	Caryophyllaceae	P	A	I
Artemisia campestris	Asteraceae	F	B	N
Asclepias verticillata	Asclepiadaceae	F	P	N
Berteroa incana	Brassicaceae	F	A	I
Bromus racemosus	Poaceae	G	A	I
Carex brevior	Cyperaceae	S	P	N
Carex muhlenbergii	Cyperaceae	S	P	N
Carex pensylvanica	Cyperaceae	S	P	N
Carex tonsa	Cyperaceae	S	P	N
Conyza canadensis	Asteraceae	F	A	N
Cyperus filiculmis	Cyperaceae	S	A	N
Dalea purpurea	Fabaceae	L	P	N
Erigeron strigosus	Asteraceae	F	B	N
Euphorbia corollata	Euphorbiaceae	F	P	N
Hedeoma hispidum	Lamiaceae	F	A	N
Helianthus pauciflorus	Asteraceae	F	P	N
Koeleria macrantha	Poaceae	G	P	N
Krigia virginica	Asteraceae	F	A	N
Lepidium densiflorum	Brassicaceae	F	A	N
Leptoloma cognatum	Poaceae	G	P	N
Linum sulcatum	Linaceae	F	A	N
Lithospemum carolinense	Boraginaceae	F	P	N
Medicago lupulina	Fabaceae	L	A	I
Oenothera rhombipetala	Onagraceae	F	B	N
Opuntia macrorhiza	Cactaceae	F	P	N
Oxalis dillenii	Oxalidaceae	F	P	N
Panicum depauperatum	Poaceae	G	P	N
Panicum oligosanthes var. scribnerianum	Poaceae	G	P	N
Panicum villosissimum	Poaceae	G	P	N
Panicum virgatum	Poaceae	G	P	N
Paspalum bushii	Poaceae	G	P	N
Penstemon pallidus	Scrophulariaceae	F	P	N
Physalis virginiana	Solanaceae	F	P	N
Plantago patagonica	Plantaginaceae	F	A	I
Poa compressa	Poaceae	G	P	I
Poa pratensis	Poaceae	G	P	I
Polygala polygama	Polygalaceae	F	B	N
Polygonum tenue	Polygonaceae	F	A	N
Potentilla argentea	Rosaceae	F	P	I
Potentilla recta	Rosaceae	F	P	I
Rumex acetosella	Polygonaceae	F	P	I

Schizachyrium scoparium	Poaceae	G	P	N
Selaginella rupestris	Selaginellaceae	CR	P	N
Solanum carolinense	Solanaceae	F	P	N
Sorghastrum nutans	Poaceae	G	P	N
Sporobolus clandestinus	Poaceae	G	P	N
Sporobolus cryptandrus	Poaceae	G	P	N
Tradescantia ohiensis	Commelinaceae	F	P	N
Triodanis perfolata	Campanulaceae	P	A	I

Functional Groups: F=forb, G=grass, L=legume, E=ephemeral, S=sedge, V=Woody Vine, CR=Vascular Cryptogam; Life History: A=annual, P=perennial, B=biennial; Native or Introduced: N=Native, I=Introduced

Table 3. Species List: Heavily Grazed and Invaded Sand Prairie (G-I). Lost Mound, Jo Daviess Cty, IL. Species listed were identified during sampling in June and August surveys 2005-2006.

Species	Family	Function Group	Life History	Native or Introduced?
Achillea millefolium	Asteraceae	F	AP	N
Ambrosia psilostachya	Asteraceae	F	P	N
Antennaria neglecta	Asteraceae	F	P	N
Arenaria serpyllifolia	Caryophyllaceae	P	A	I
Asclepias verticillata	Asclepiadaceae	F	P	N
Bouteloua hirsuta	Poaceae	G	P	N
Bromus inermis	Poaceae	G	P	I
Bromus racemosus	Poaceae	G	A	I
Carex brevior	Cyperaceae	S	P	N
Carex muhlenbergii	Cyperaceae	S	P	N
Coronilla varia	Fabaceae	L	P	I
Cyperus filiculmis	Cyperaceae	S	P	N
Hedeoma hispidum	Lamiaceae	P	A	N
Koeleria macrantha	Poaceae	G	P	N
Lepidium densiflorum	Brassicaceae	F	A	N
Leptoloma cognatum	Poaceae	G	P	N
Lithospemum carolinense	Boraginaceae	F	P	N
Medicago lupulina	Fabaceae	L	A	I
Opuntia macrorhiza	Cactaceae	F	P	N
Panicum depauperatum	Poaceae	G	P	N
Panicum oligosanthes var. scribnerianum	Poaceae	G	P	N
Panicum villosissimum	Poaceae	G	P	N
Paspalum bushii	Poaceae	G	P	N
Physalis virginiana	Solaneceae	F	P	N
Poa compressa	Poaceae	G	P	I
Poa pratensis	Poaceae	G	P	I
Polygala polygama	Polygalaceae	F	B	N
Potentilla argentea	Rosaceae	F	P	I
Potentilla recta	Rosaceae	F	P	I
Rumex acetosella	Polygonaceae	F	P	I
Schizachyrium scoparium	Poaceae	G	P	N
Solanum carolinense	Solanaceae	F	P	N
Sorghastrum nutans	Poaceae	G	P	N
Sporobolus clandestinus	Poaceae	G	P	N
Sporobolus cryptandrus	Poaceae	G	P	N
Tradescantia ohiensis	Commelinaceae	F	P	N
Verbena stricta	Lamiaceae	F	P	N

Functional Groups: F=forb, G=grass, L=legume, E=ephemeral, S=sedge, V=Woody Vine, CR=Vascular Cryptogam; Life History: A=annual, P=perennial, B=biennial; Native or Introduced: N=Native, I=Introduced

Photograph 1. Installation of 'disturbance' treatment by volunteer in Grazed, Non-Invaded site. 'Mowed' treatment plot is visible on left side of photograph. Lost Mound, Jo Daviess County, IL. April 2005

Photograph 2. Vegetation monitoring frames in control plot in Grazed, Non-Invaded site. Dominant grass is *Schizachyrium scoparium* (little bluestem) and blue flower is *Tradescantia ohiensis* (smooth spiderwort). Lost Mound, Jo Daviess County, IL. June 2005.

Photograph 3. 'Disturbance' treatment plot in Grazed, Invaded site. Dominant grass is *Bromus inermis* (smooth brome). Lost Mound, Jo Daviess County, IL. April 2006.

Photograph 4. Landscape view of multiple treatment plots in Grazed, Invaded site. Dominant grass is *Bromus inermis* (smooth brome). Lost Mound, Jo Daviess County, IL. April 2006.

Photograph 5. Vegetation monitoring in 'disturbed' plot in Grazed, Invaded site. Vegetation is a mix of invasive grasses, native forbs and native grasses. Lost Mound, Jo Daviess County, IL. June 2006.

Photograph 5. Vegetation monitoring in Grazed, Non-Invaded site by University of Illinois undergraduate student intern. Lost Mound, Jo Daviess County, IL. June 2006.