

Vegetation Dynamics at Fort Larned National Historic Site

Final Report

James Stubbendieck, Professor of Grassland Ecology and
Alanna Heinen, Ecology Research Assistant
Department of Agronomy and Horticulture
University of Nebraska-Lincoln

Background: Prairie restoration has been a goal at the Fort Larned National Historic Site (Figure 1) since it was brought into the National Park Service more than 40 years ago. Nearly all of the land within the boundaries was cultivated before establishment of the park. An exception is the detached Santa Fe Trails Ruts tract (Unit 12). This tract was grazed but not cultivated in the past.

Prior to settlement, the majority of the area would have been occupied by Bluestem-Grama Prairie (*Andropogon-Bouteloua*) with dominants of little bluestem (*Schizachyrium scoparium*), sideoats grama (*Bouteloua curtipendula*), and blue grama (*Bouteloua gracilis*) (Kuchler 1964). Taller species occurring more commonly to the east in the Bluestem Prairie (*Andropogon-Panicum-Sorghastrum*) would have been abundant in the rich soils of the Pawnee River bottomlands. Dominant species would have been big bluestem (*Andropogon gerardii*), switchgrass (*Panicum virgatum*), and indiangrass (*Sorghastrum nutans*). In an effort to recreate the historic scene of heavily grazed prairie surrounding the fort, buffalograss (*Buchloe dactyloides*) and blue grama were the primary components of the seeding mixtures. A seedbank of weeds from the period of cultivation, invasion of exotic species, extended dry periods, and flooding all contributed to varied success of the restorations.

Percent basal cover by species was determined 28 years ago (Stubbendieck et al. 1980), and foliar cover and frequency were determined in 1983 and 1984 (Becker et al. 1986). An analysis of the vegetation has not been conducted since.

Methods: To determine long-term vegetation change, we planned on resampling the botanical composition in three management units that contained distinct types of vegetation in the 1980s: Unit 1 (dominated by warm-season native grasses and weeds), Unit 2 (dominated by warm-season native grasses and introduced cool-season annual grasses and weeds), and Unit 12 (native prairie in the detached Santa Fe Trails Ruts tract) (Figure 1). While we were conducting the work, personnel at the Fort Larned National Historic Site asked us to sample Unit 6 which was seeded in 2005 using an experimental post-burn/chemical suppression technique.

The modified step-point sampling technique (Owensby 1973) was used in 1980 to determine botanical composition based on basal cover, and the technique was repeated in 2008. Density of sampling (sample points per acre) were similar both years (Table 1). In both 1980 and 2008, sampling was conducted in summer when both cool-season and warm-season could be detected, and we returned each fall to verify the identification of plants that were immature at the time of sampling. We planned on collecting foliar cover data to compare it to data collected in 1983 and 1984 (Becker et al. 1986), but the original transect markers were no longer present.

Results: Major changes occurred in all of the units over the 28-year period from 1980 to 2008.

Unit 1: In 1980, Unit 1 was a relatively good representation of a western Kansas short grass prairie. Buffalograss and blue grama accounted for over 60% of the botanical

composition (Table 2). Weedy species such as downy brome (*Bromus tectorum*), tall lettuce (*Lactuca canadensis*), kochia (*Kochia scoparia*), and common dandelion (*Taraxacum officinale*) were noted, and they comprised a total of about 20% of the botanical composition. By 2008, the amount of buffalograss and blue grama had declined to only a trace. Smooth brome (*Bromus inermis*) was dominant comprising over 70% of the vegetation (Table 2, Figure 2). Other than indiangrass and sideoats grama, warm-season prairie grasses were minor components of the vegetation. Native perennial prairie grasses made up about 25% of the botanical composition in 2008 (Table 2, Figure 3). Total exotic species more than tripled from 1980 to 2008 (Figure 4). The total number of species declined slightly from 1980 (51) to 2008 (46). The Sorensen Similarity Index equals 0.64 indicating only a 64% overlap of species between the two sampling dates (Sorensen 1948, Looman and Campbell 1960).

Unit 2: The botanical composition of Unit 2 in 1980 was similar to that of Unit 1. Buffalograss and blue grama totaled 48% (Table 3), and downy brome (29.3%) was a major concern. By 2008, Unit 2 had been divided into two subunits (A and B), and data were collected separately from the two. Unit 2A was dominated by big bluestem (46.2%) and switchgrass (21.1%). Big bluestem was present in 1980, but not in a great enough amount to be quantified by sampling. By 2008, vegetation in Unit 2B had deteriorated beyond that in Unit 1. Smooth brome increased from a trace to 91.4% (Table 3, Figure 2). Downy brome was no longer a problem because it, along with most other species, had been replaced by smooth brome. Botanical composition of native perennial grasses decreased from 52.2% in 1980 to 6.6% in 2008 (Table 3, Figure 3). Total number of species in the combined unit was 59 and 44 in 1980 and 2008, respectively. The

Sorensen Similarity Index was 0.59 for Unit 2A and 0.53 for Unit 2B revealing an overlap of species of less than 60% between 1980 and 2008.

Unit 6: Eight grass species [big bluestem, little bluestem, indiangrass, switchgrass, sideoats grama, blue grama, western wheatgrass (*Elymus smithi*), and buffalograss] and eight forb species [Illinois bundleflower (*Desmanthus illinoensis*), Indian blanket (*Gaillardia pulchella*), Maxmillian sunflower (*Helianthus maxmilianii*), pitchers sage (*Salvia azurea*), plains coreopsis (*Coreopsis tinctoria*), purple prairieclover (*Dalea purpurea*), partridge pea (*Chamaechrista fasciculata*), and prairie coneflower (*Ratibida columnifera*) were planted into Unit 6 in 2005. All 16 species were found growing in the unit in 2008 (Table 4). Unfortunately, the major component of the vegetation was smooth brome (76.4%) (Table 4, Figure 2). In 1980, smooth brome made up only a trace of the vegetation. Other major changes were substantial decreases in buffalograss, kochia, downy brome, hairy chess (*Bromus commutatus*), and green foxtail (*Setaria viridis*). A major concern is the presence (6.8%) of yellow old world bluestem (*Bothriochloa ischaemum*) thought to have been a contaminant in the 2005 seeding mixture. Native perennial grasses comprised 14% of the vegetation (Table 4, Figure 3), while native forbs contributed about 2% to the botanical composition. A total of 57 and 47 species were recorded in 1980 and 2008, respectively. As would be expected for a prairie that was restored between sampling dates, the Sorensen Similarity Index was relatively low at 0.43.

Unit 12: The vegetation in the detached unit containing Santa Fe Trail ruts was the most diverse in 1980 with 96 species, and several were unique to this unit. In 2008, we recorded 100 species (Table 5). While the total number of species was similar from

1980 to 2008, the botanical composition was not. Western ragweed (*Ambrosia psilostachya*), red threeawn (*Aristida purpurea*), Japanese brome (*Bromus japonicus*), buffalograss, and woolly plantain (*Plantago patagonica*) noticeably declined while ticklegrass (*Agrostis scabra*), big bluestem, and yellow foxtail (*Setaria pumila*) increased. Native perennial grasses decreased from 1980 to 2008 (Figure 3). A trace of yellow old world bluestem was recorded in the survey. The Sorensen Similarity Index was 0.73 indicating only a 73% overlap of species between 1980 and 2008.

Discussion: A complete record of the management from 1980 to the present would be helpful in trying to understand the major changes in botanical composition.

Unfortunately, we do not have those records. Management in the late 1970s to 1980 (Stubbendieck et al. 1980), 1983 to 1985 (Becker et al. 1986), and 1999 to present (Revello, unpublished fire history; hereafter Revello) is known.

Unit 1: Soon after establishment of the Fort Larned National Historic Site, short grass prairie species were seeded in Unit 1. Until at least 1980, this unit was mowed more than once each year to maintain the appearance of a short grass prairie surrounding the fort. Mowing allowed a thick mat of litter to accumulate. A combination of haying and burning was recommended to reduce the litter and downy brome (Stubbendieck et al. 1980). Unit 1 was mowed in May and July 1983 (Becker et al. 1986). It was burned in May 2000 and April 2004 (Revello). Inadequate fire frequency has allowed the smooth brome to expand from a trace in 1980 to 70% in 2008 (Table 2). Once smooth brome reaches this level, management options for control are limited. Mowing is not an effective option. Other management options include the use of herbicides or annual late spring prescribed burning for a number of years. Timing would be critical, and forcing

fire through smooth brome with little other vegetation to help carry the fire would be a challenge. Annual burning will be critical until the amount of smooth brome has been reduced to 5% or less. Skipping burning for a year or two in this annual sequence will allow the smooth brome to quickly recover and could potentially set back the recovery by several years. Kochia, tall lettuce, and other broadleaf plants have decreased, likely in response to herbicides applied for field bindweed (*Convolvulus arvensis*) and other weeds and competition from smooth brome.

Unit 2A: Unit 2A has an excellent stand of tall grasses (Table 3). It is much different than Unit 2B or Unit 1, and its management history since 1980 does not adequately explain the changes recorded in 2008. It may have been seeded or renovated. While the vegetation is more indicative of the site potential, it does not visually blend with the units on its adjacent sides. It was mowed occasionally until at least 1984 (Becker et al. 1986) and burned in 2000, 2003, and 2008 (Revello). The short grasses, buffalograss and blue grama, essentially have been eliminated because they cannot tolerate shading from the taller grasses. Occasional application of fire in late April or early May should maintain the current vegetation.

Unit 2B: Smooth brome increased from a trace in 1980 to 91.4% in 2008 (Table 3). Other than a complete restoration, techniques are not available to convert the vegetation to a desirable mixture in a reasonable amount of time. Only 6.6% of native perennial grasses remain. The existing vegetation is unlikely to carry fire or to respond to the influences of prescribed burning. Few forbs remain which may be a response to herbicides applied to control field bindweed.

Unit 6: Stubbendieck et al. (1980) recommended reseeding Unit 6. Before then, it had been planted to a mixture of short grasses that were not as well adapted as tall grasses to the site. In addition, kochia comprised 17.8% of the vegetation (Table 4). The unit was burned in mid-April 1983, but less than 50% of the area burned because of lack of standing fuel and the presence of a wet layer of downy brome mulch (Becker et al. 1986). It was burned in May 2002. It was burned again in April 2005 at initiation of an innovative experimental prairie restoration. Glyphosate was applied about two weeks following the burn to control smooth brome (Revello 2008). Sixteen species were then drilled into the site. Unfortunately, control of the smooth brome was not as successful as planned (Revello 2008). While all 16 seeded species were found growing on the site in 2008, smooth brome remains a serious problem as it comprises 76.4% of the vegetation (Table 4). If enough standing grasses were present to carry a fire, repeated annual late spring (late April to early May) burns may reduce the smooth brome. Yellow old world bluestem is well established on the site (6.8%) and represents a greater potential problem, because it will respond favorably to prescribed burning. Several herbicides have been tested to control yellow old world bluestem, but none have been shown to reduce this species without reducing the other warm-season grasses (Harmony et al. 2004). Personnel at the Fort Larned National Historic Site should consider an aggressive application of glyphosate to try to eliminate this species. A series of spot applications could be tried, but applications over the complete unit may be more successful, especially if the land is kept fallow with herbicides for two growing seasons before replanting. This technique may slow the spread of the yellow old world bluestem into other units, and it should control the smooth brome. The presence of yellow old world bluestem should be

considered to be a major threat to the vegetation resources at the Fort Larned National Historic Site and its control should be a focal point for management.

Unit 12: There is no mention of management in the records concerning Unit 12. The assumption is that it has not been mowed, burned, or grazed. Since buffalograss and some of the forbs have decreased, it is possible that herbicides have been applied to portions of the unit to control field bindweed (Table 5). Buffalograss is one of the few grasses that are negatively affected by herbicides applied to control broadleaf weeds. Shading by taller species may be having a detrimental impact on short prairie grasses such as buffalograss. It would be unlikely that all of Unit 12 could be burned in late April or early May because of inadequate and discontinuous fuel. Application of fire to patches of taller grasses and any other places that adequate fuel has accumulated should be considered. Timely mowing may reduce yellow foxtail and maintain the appearance of a Kansas short grass prairie. A few plants of yellow old world bluestem were found in Unit 12 and should be controlled with spot treatments of herbicide before these plants can become wide spread.

Conclusions: The vegetation at the Fort Larned National Historic Site has changed markedly and more than was expected from 1980 to 2008 (Figures 2, 3, and 4). Although the exact cause is unknown, a number of factors including removal of natural disturbances, such as fire, and possibly weather extremes from the mid-1980s to the early or mid-1990s may have allowed smooth brome to rapidly expand in units 1, 2B, and 6 (Figure 2). While use of fire has increased in the last decade, it has not been applied in an adequate frequency to significantly decrease smooth brome. Homestead National Monument of America has applied prescribed fire to its reconstructed tallgrass prairie on

about a four-year interval since about 1998. While the level of smooth brome is lower at Homestead Nation Monument of America, the relative frequency increased eight-fold (0.04 to 0.32%) from 1998 to 2006 (James and DeBacker 2007). During the same period, frequency of Kentucky bluegrass (*Poa pratensis*), another cool-season exotic species, increased by more than 35% (0.48 to 0.76%). DeKeyser (2008) compared the vegetation in 1984 with that of 2007 at the Knife River Indian Villages National Historic Site in North Dakota. He found that the species composition had changed on several ecological sites from a high percentage of native grasses and forbs to a high percentage of invasive species such as smooth brome and Kentucky bluegrass. DeKeyser (2008) concluded that the study emphasized the relevance of historic disturbances, such as fire and grazing, and the potential consequences of non-disturbance in the Northern Great Plains Mixed Grass Prairie. Results from the Fort Larned National Historic Site show similar trends for the Mixed Grass Prairie in the Central Great Plains and supports the conclusion that removing natural disturbances will result in a significant shift of vegetation from native warm-season grasses to invasive cool-season species.

The vegetation in Unit 1 may respond positively to carefully timed, repeated applications of fire. But, vegetation in Unit 2B has passed the threshold where proper application of prescribed burning could be expected to return the species composition to desired levels. Yellow old world bluestem poses a unique problem in Unit 6 (Table 4), as well as in Unit 12 (Table 5). Complete prairie restoration of Units 2B and 6 should be evaluated. The vegetation in Unit 2A is excellent, and will be maintained by proper application of prescribed burning. Vegetation in Unit 12 would benefit from occasional mowing to reduce the overstory or taller plants and occasional application of fire to areas

where adequate fuel has accumulated. Careful monitoring of the vegetation, as well as the population of prairie dogs, may provide information that managers can use to maintain the balance of prairie dogs and the desired botanical composition.

We recommend that the vegetation in the remaining units of the Fort Larned National Historic Site be sampled to gain a better understanding of the dynamics of this important natural resource. This information would be critical to future management plans.

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Table 1. Density of sampling (sample points per acre) in 1980 and 2008.

	<u>Sample points per acre</u>	
	<u>1980</u>	<u>2008</u>
Unit 1	30.1	35.2
Unit 2	28.8	
A		32.4
B		33.1
Unit 6	34.9	40.2
Unit 12	33.6	40.1

Table 2. Fort Larned Unit 1 Species Composition (%)

	<u>1980</u>	<u>2008</u>
	----- % -----	
Western ragweed (<i>Ambrosia psilostachya</i>)	T*	1.6
Big bluestem (<i>Andropogon gerardii</i>)	--**	2.8
Common milkweed (<i>Asclepias syriaca</i>)	--	T
Heath aster (<i>Aster ericoides</i>)	--	T
Silver bluestem (<i>Bothriochloa laguroides</i> subsp. <i>torreyana</i>)	5.4	T
Sideoats grama (<i>Bouteloua curtipendula</i>)	3.0	7.6
Blue grama (<i>Bouteloua gracilis</i>)	29.2	T
Smooth brome (<i>Bromus inermis</i>)	T	70.4
Japanese brome (<i>Bromus japonicus</i>)	0.2	0.6
Downy brome (<i>Bromus tectorum</i>)	10.1	0.3
Buffalograss (<i>Buchloe dactyloides</i>)	32.7	T
Field bindweed (<i>Convolvulus arvensis</i>)	--	0.2
Bermudagrass (<i>Cynodon dactylon</i>)	1.2	--
Tansymustard (<i>Descurainia pinnata</i>)	T	--
Canada wildrye (<i>Elymus canadensis</i>)	0.1	0.2
Western wheatgrass (<i>Elymus smithii</i>)	0.5	0.9
Annual sunflower (<i>Helianthus annuus</i>)	--	T
Kochia (<i>Kochia scoparia</i>)	6.0	--

Tall lettuce (<i>Lactuca canadensis</i>)	2.4	T
Gray-green woodsorrel (<i>Oxalis dillenii</i>)	--	T
Switchgrass (<i>Panicum virgatum</i>)	--	0.2
Virginia groundcherry (<i>Physalis virginiana</i>)	--	T
Kentucky bluegrass (<i>Poa pratensis</i>)	0.1	T
Russian thistle (<i>Salsola tragus</i>)	0.7	T
Little bluestem (<i>Schizachyrium scoparium</i>)	1.2	1.5
Yellow foxtail (<i>Setaria pumila</i>)	T	0.1
Indiangrass (<i>Sorghastrum nutans</i>)	0.8	9.4
Tall dropseed (<i>Sporobolus compositus</i>)	--	1.9
Sand dropseed (<i>Sporobolus cryptandrus</i>)	0.1	T
Scarlet globemallow (<i>Sphaeralcea coccinea</i>)	--	0.2
Common dandelion (<i>Taraxacum officinale</i>)	2.4	--
Yellow goatsbeard (<i>Tragopogon dubius</i>)	T	T

* Trace, less than 0.1%

** None was sampled

Other species observed in Unit 1 but not encountered while sampling:

Yarrow (*Achillea millefolium*)

Bur ragweed (*Ambrosia grayi*)

False boneset (*Brickellia eupatorioides*)

Pitseed goosefoot (*Chenopodium berlandieri*)

Narrowleaf lambsquarters (*Chenopodium desiccatum*)

Yellowspine thistle (*Cirsium ochrocentrum*)

Wavyleaf thistle (*Cirsium undulatum*)

Illinois bundleflower (*Desmanthus illinoensis*)

Stinkgrass (*Eragrostis cilianensis*)

Snow-on-the-mountain (*Euphorbia marginata*)

Prostrate spurge (*Euphorbia prostrata*)

Foxtail barley (*Hordeum jubatum*)

Little barley (*Hordeum pusillum*)

White mulberry (*Morus alba*)

Wild alfalfa (*Psoraleidium tenuiflorum*)

Red sorrel (*Rumex acetosella*)

Green foxtail (*Setaria viridis*)

Western ironweed (*Vernonia baldwinii* subsp. *interior*)

Table 3. Fort Larned Unit 2 Species Composition (%)

	<u>1980</u>	<u>2008</u>	
		<u>2A</u>	<u>2B</u>
	----- % -----		
Bur ragweed (<i>Ambrosia grayi</i>)	0.2	--**	T*
Western ragweed (<i>Ambrosia psilostachya</i>)	1.0	0.9	T
Giant ragweed (<i>Ambrosia trifida</i>)	--	T	--
Big bluestem (<i>Andropogon gerardii</i>)	--	46.2	0.6
Heath aster (<i>Aster ericoides</i>)	--	T	--
Silver bluestem (<i>Bothriochloa laguroides</i> subsp. <i>torreyana</i>)	0.6	T	T
Sideoats grama (<i>Bouteloua curtipendula</i>)	0.8	3.6	2.0
Blue grama (<i>Bouteloua gracilis</i>)	25.1	--	T
Smooth brome (<i>Bromus inermis</i>)	T	5.9	91.4
Downy brome (<i>Bromus tectorum</i>)	23.9	T	T
Buffalograss (<i>Buchloe dactyloides</i>)	23.0	--	--
Narrowleaf lambsquarters (<i>Chenopodium</i> <i>desiccatum</i>)	--	0.4	--
Windmillgrass (<i>Chloris verticillata</i>)	T	--	--
Field bindweed (<i>Convolvulus arvensis</i>)	0.4	T	0.7
Horseweed (<i>Conyza canadensis</i>)	2.1	T	--
Bermudagrass (<i>Cynodon dactylon</i>)	0.1	--	--
Illinois bundleflower (<i>Desmanthus illinoensis</i>)	--	T	--

Western wheatgrass (<i>Elymus smithii</i>)	1.7	0.8	--
Spotted spurge (<i>Euphorbia maculata</i>)	T	T	--
Annual sunflower (<i>Helianthus annuus</i>)	0.6	6.5	T
Kochia (<i>Kochia scoparia</i>)	1.7	T	T
Tall lettuce (<i>Latuca canadensis</i>)	3.8	--	--
Alfalfa (<i>Medicago sativa</i>)	T	--	--
White sweetclover (<i>Melilotus albus</i>)	0.3	--	--
Yellow sweetclover (<i>Melilotus officinalis</i>)	--	8.1	T
Switchgrass (<i>Panicum virgatum</i>)	1.4	21.2	1.3
Virginia groundcherry (<i>Physalis virginiana</i>)	T	T	T
Kentucky bluegrass (<i>Poa pratensis</i>)	--	--	0.8
Little bluestem (<i>Schizachyrium scoparium</i>)	T	2.0	0.5
Russian thistle (<i>Salsola tragus</i>)	0.6	--	--
Yellow foxtail (<i>Setaria pumila</i>)	T	T	T
Green foxtail (<i>Setaria viridis</i>)	--	T	0.3
Indiangrass (<i>Sorghastrum nutans</i>)	0.2	3.9	2.2
Scarlet globmallow (<i>Sphaeralcea coccinea</i>)	T	T	--
Sand dropseed (<i>Sporobolus cryptandrus</i>)	1.0	T	T
Common dandelion (<i>Taraxacum officinale</i>)	T	T	T

* Trace, less than 0.1%

** None was sampled

Other species observed in Unit 2 but not encountered while sampling:

Yarrow (*Achillea millefolium*)

Annual ragweed (*Ambrosia artemisiifolia*)

Dwarf milkweed (*Asclepias pumila*)

Common milkweed (*Asclepias syriaca*)

Hairy chess (*Bromus commutatus*)

Japanese brome (*Bromus japonicus*)

Field sandbur (*Cenchrus longispinus*)

Yellowspine thistle (*Cirsium ochrocentrum*)

Buffalo gourd (*Cucurbita foetidissima*)

Foxtail barley (*Hordeum jubatum*)

Little barley (*Hordeum pusillum*)

Pepperweed (*Lepidium densiflorum*)

Witchgrass (*Panicum capillare*)

Fall panicum (*Panicum dichotomiflorum*)

Curly dock (*Rumex crispus*)

Tall dropseed (*Sporobolus compositus*)

Table 4. Fort Larned Unit 6 Species Composition (%)

	<u>1980</u>	<u>2008</u>
	----- % -----	
Jointed goatgrass (<i>Aegilops cylindrica</i>)	T*	--**
Bur ragweed (<i>Ambrosia grayi</i>)	--	0.2
Giant ragweed (<i>Ambrosia trifida</i>)	1.1	--
Big bluestem (<i>Andropogon gerardii</i>)	--	0.5
Yellow old world bluestem (<i>Bothriochloa ischaemum</i>)	--	6.8
Silver bluestem (<i>Bothriochloa laguroides</i>)	0.7	0.5
Sideoats grama (<i>Bouteloua curtipendula</i>)	--	8.6
Blue grama (<i>Bouteloua gracilis</i>)	0.5	T
Hairy chess (<i>Bromus commutatus</i>)	7.3	T
Smooth brome (<i>Bromus inermis</i>)	0.2	76.4
Downy brome (<i>Bromus tectorum</i>)	34.1	T
Buffalograss (<i>Buchloe dactyloides</i>)	20.7	T
Shepherds purse (<i>Capsella bursa-pastoris</i>)	T	--
Field bindweed (<i>Convolvulus arvensis</i>)	1.1	0.5
Tansymustard (<i>Descurainia pinnata</i>)	0.1	--
Flixweed tansymustard (<i>Descurainia sophia</i>)	1.8	--
Illinois bundleflower (<i>Desmanthus illinoensis</i>)	--	0.2
Ellisia (<i>Ellisia nyctelea</i>)	T	--
Western wheatgrass (<i>Elymus smithii</i>)	1.1	0.1

Catchweed bedstraw (<i>Galium aparine</i>)	0.1	--
Maximilian sunflower (<i>Helianthus maximiliani</i>)	--	0.5
Little barley (<i>Hordeum pusillum</i>)	0.1	T
Kochia (<i>Kochia scoparia</i>)	17.8	--
Tall lettuce (<i>Lactuca canadensis</i>)	1.5	T
Henbit (<i>Lamium amplexicaule</i>)	1.8	--
Switchgrass (<i>Panicum virgatum</i>)	--	1.4
Knotweed (<i>Polygonum</i> sp.)	T	--
Upright prairieconflower (<i>Ratbida columnifera</i>)	--	0.5
Black-eyed Susan (<i>Rudbeckia hirta</i>)	--	0.2
Russian thistle (<i>Salsola tragus</i>)	0.6	T
Pitcher Sage (<i>Salvia azurea</i>)	T	0.5
Little bluestem (<i>Schizachyrium scoparium</i>)	--	0.4
Green foxtail (<i>Setaria viridis</i>)	6.2	0.1
Indiangrass (<i>Sorghastrum nutans</i>)	--	2.5
Common dandelion (<i>Taraxacum officinale</i>)	T	T
Poison ivy (<i>Toxicodendron radicans</i>)	--	0.5

* Trace, less than 0.1%

** None was sampled

Other species observed in Unit 6 but not encountered while sampling:

Green milkweed (*Asclepias viridiflora*)

Partridge pea (*Chamaecrista fasciculata*)

Plains coreopsis (*Coreopsis tinctoria*)

Purple prairieclover (*Dalea purpurea*)

Purple coneflower (*Echinacea angustifolia*)

Snow-on-the-mountain (*Euphorbia marginata*)

Indian blanket (*Gaillardia pulchella*)

Virginia groundcherry (*Physalis virginiana*)

Common pokeweed (*Phytolacca americana*)

Buffalobur (*Solanum rostratum*)

Western ironweed (*Vernonia baldwinii* subsp. *interior*)

Table 5. Fort Larned Unit 12 Species Composition (%)

	<u>1980</u>	<u>2008</u>
	----- % -----	
Ticklegrass (<i>Agrostis scabra</i>)	-- **	2.5*
Redroot pigweed (<i>Amaranthus retroflexus</i>)	--	0.5
Annual ragweed (<i>Ambrosia artemisiifolia</i>)	--	T
Western ragweed (<i>Ambrosia psilostachya</i>)	5.8	0.9
Big bluestem (<i>Andropogon gerardii</i>)	1.9	3.5
Rock-jasmine (<i>Androsace occidentalis</i>)	T	T
Red threeawn (<i>Aristida purpurea</i>)	4.8	T
Prairie threeawn (<i>Artistida oligantha</i>)	--	0.5
Dwarf milkweed (<i>Asclepias pumila</i>)	0.3	1.1
Woolly locoweed (<i>Astragalus mollissimus</i>)	0.2	T
Yellow old world bluestem (<i>Bothriochloa ischaemum</i>)	--	T
Silver bluestem (<i>Bothriochloa laguroides</i> subsp. <i>torreyana</i>)	--	0.5
Sideoats grama (<i>Bouteloua curtipendula</i>)	0.6	T
Blue grama (<i>Bouteloua gracilis</i>)	0.2	0.5
Smooth brome (<i>Bromus inermis</i>)	--	T
Japanese brome (<i>Bromus japonicus</i>)	6.1	0.9
Downy brome (<i>Bromus tectorum</i>)	0.4	0.1
Buffalograss (<i>Buchloe dactyloides</i>)	36.1	17.1

Sedges (<i>Carex</i> spp.)	1.3	2.3
Pitseed goosefoot (<i>Chenopodium berlandieri</i>)	T	T
Yellowspine thistle (<i>Cirsium ochrocentrum</i>)	--	0.3
Low horseweed (<i>Conyza ramosissima</i>)	1.6	--
Plains coreopsis (<i>Coreopsis tinctoria</i>)	--	0.2
Western wheatgrass (<i>Elymus smithii</i>)	7.4	7.1
Spurges (<i>Euphorbia</i> spp.)	1.3	0.5
Snow-on-the-mountain (<i>Euphorbia marginata</i>)	0.7	0.8
Annual sunflower (<i>Helianthus annuus</i>)	--	T
Kochia (<i>Kochia scoparia</i>)	9.7	8.2
Tall lettuce (<i>Lactuca canadensis</i>)	--	T
Pepperweed (<i>Lepidium densiflorum</i>)	0.2	0.2
Stiff flax (<i>Linum rigidum</i>)	--	T
Mouse-tail (<i>Myosurus minimus</i>)	--	0.4
Gray-green woodsorrel (<i>Oxalis dillenii</i>)	8.1	7.9
Virginia groundcherry (<i>Physalis virginiana</i>)	--	0.5
Woolly plantain (<i>Plantago patagonica</i>)	5.8	T
Kentucky bluegrass (<i>Poa pratensis</i>)	0.1	0.3
Pennsylvania smartweed (<i>Polygonum pensylvanicum</i>)	--	0.4
Upright prairieconeflower (<i>Ratibida columnifera</i>)	--	T
Russian thistle (<i>Salsola tragus</i>)	0.7	--
Tumblegrass (<i>Schedonnardus paniculatus</i>)	--	0.2
Yellow foxtail (<i>Setaria pumila</i>)	--	14.9

Buffalobur (<i>Solanum rostratum</i>)	0.1	0.5
Gray goldenrod (<i>Solidago nemoralis</i> subsp. <i>decemflora</i>)	0.6	1.1
Indiangrass (<i>Sorghastrum nutans</i>)	0.2	0.3
Tall dropseed (<i>Sporobolus compositus</i>)	0.9	1.4
Common mullein (<i>Verbascum thapsus</i>)	--	0.5
Prostrate vervain (<i>Verbena bracteata</i>)	0.3	0.5
Cutleaf ironplant (<i>Xanthisma spinulosum</i>)	T	--

* Trace, less than 0.1%

** None was sampled

Other species observed in Unit 12 but not encountered while sampling:

Yarrow (*Achillea millefolium*)

Drummond's onion (*Allium drummondii*)

Carolina foxtail (*Alopecurus carolinianus*)

Pale amaranthus (*Amaranthus albus*)

Carolina anemone (*Anemone caroliniana*)

Antelope-horn (*Asclepias asperula*)

Common milkweed (*Asclepias syriaca*)

Spider milkweed (*Asclepias viridis*)

Heath aster (*Aster ericoides*)

Purple poppymallow (*Callirhoe involucrata*)

Shepherds purse (*Capsella bursa-pastoris*)

Musk thistle (*Carduus nutans*)

Field sandbur (*Cenchrus longispinus*)

Windmill grass (*Chloris verticillata*)

Wavyleaf thistle (*Cirsium undulatum*)

Marestail (*Conyza canadensis*)

Missouri pincushion cactus (*Coryphantha missouriensis*)

Buffalo gourd (*Cucurbita foetidissima*)

Prairie larkspur (*Delphinium virescens*)

Tansymustard (*Descurainia pinnata*)

Inland saltgrass (*Distichlis spicata*)

Barnyard grass (*Echinochloa crus-galli*)

Spike-rush (*Eleocharis acicularis*)

Stinkgrass (*Eragrostis cilianensis*)

Round-leaf spurge (*Euphorbia serpens*)

Slimseed spurge (*Euphorbia strictospora*)

Scarlet gaura (*Gaura coccinea*)

Curlycup gumweed (*Grindelia squarrosa*)

Prairie sunflower (*Helianthus petiolaris*)

Foxtail barley (*Hordeum jubatum*)

Little barley (*Hordeum pusillum*)

Eastern redcedar (*Juniperus virginiana*)

White wildparsley (*Lomatium orientale*)

Narrowleaf four-o'clock (*Mirabilis linearis*)
Carpetweed (*Mollugo verticillata*)
Plains pricklypear (*Opuntia polyacantha*)
Witchgrass (*Panicum capillare*)
Fall panicum (*Panicum dichotomiflorum*)
Scribners panicum (*Panicum oligoanthes* var. *scribnerianum*)
Devils claw (*Proboscidea louisianica*)
Red sorrel (*Rumex acetosella*)
Curly dock (*Rumex crispus*)
Little bluestem (*Schizachyrium scoparium*)
Green foxtail (*Setaria viridis*)
Cutleaf nightshade (*Solanum triflorum*)
Scarlet globemallow (*Sphaeralcea coccinea*)
Sand dropseed (*Sporobolus cryptandrus*)
Common dandelion (*Taraxacum officinale*)
Yellow goatsbeard (*Tragopogon dubius*)
Puncturevine (*Tribulus terrestris*)
Sixweeks fescue (*Vulpia octoflora*)

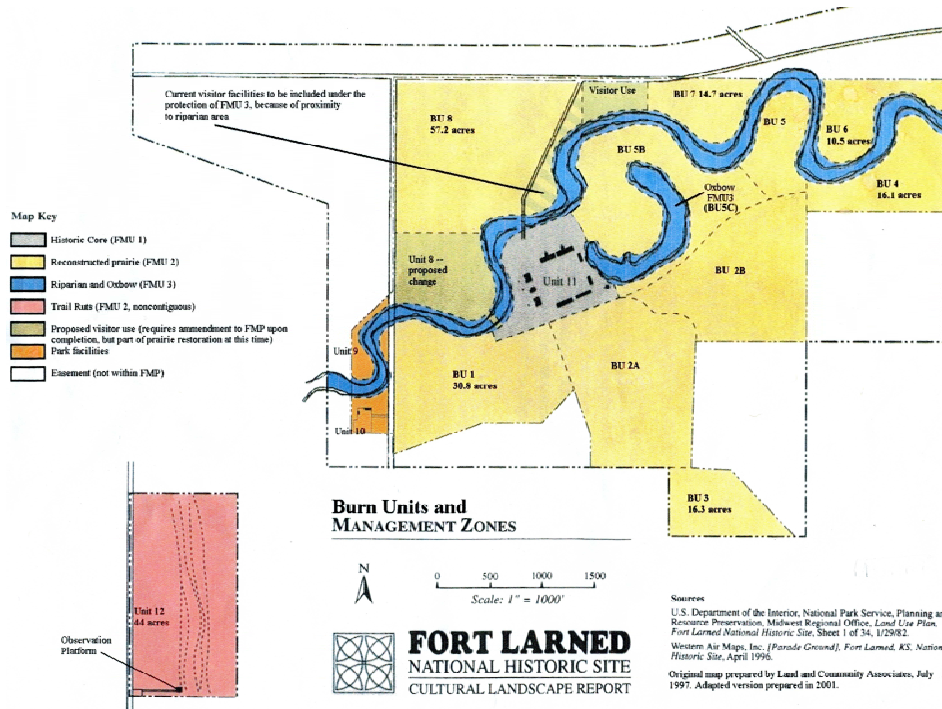


Figure 1. Fort Larned National Historic Site.

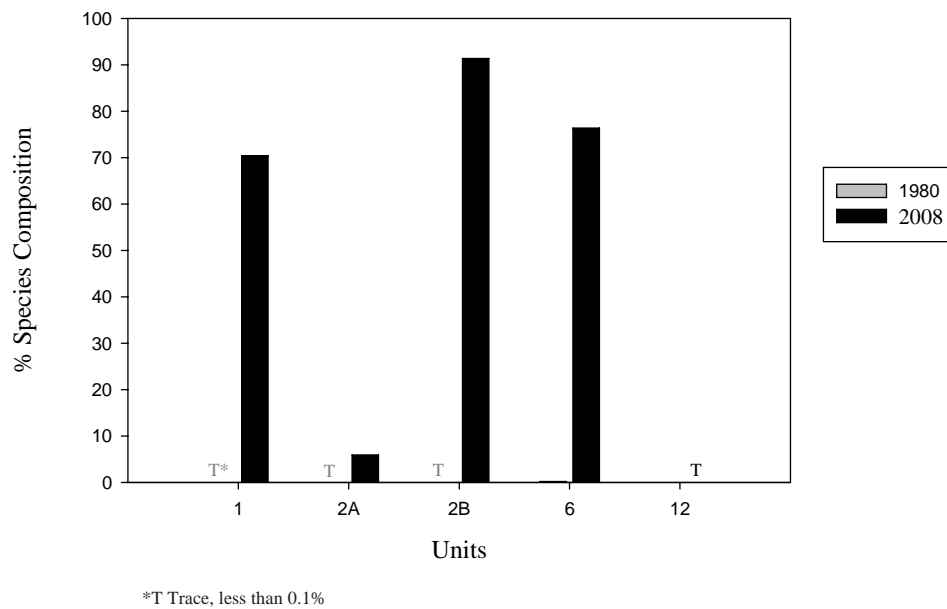


Figure 2. Summary of changes from 1980 to 2008 in smooth brome in Units 1, 2A, 2B, 6, and 12 of the Fort Larned National Historic Site.

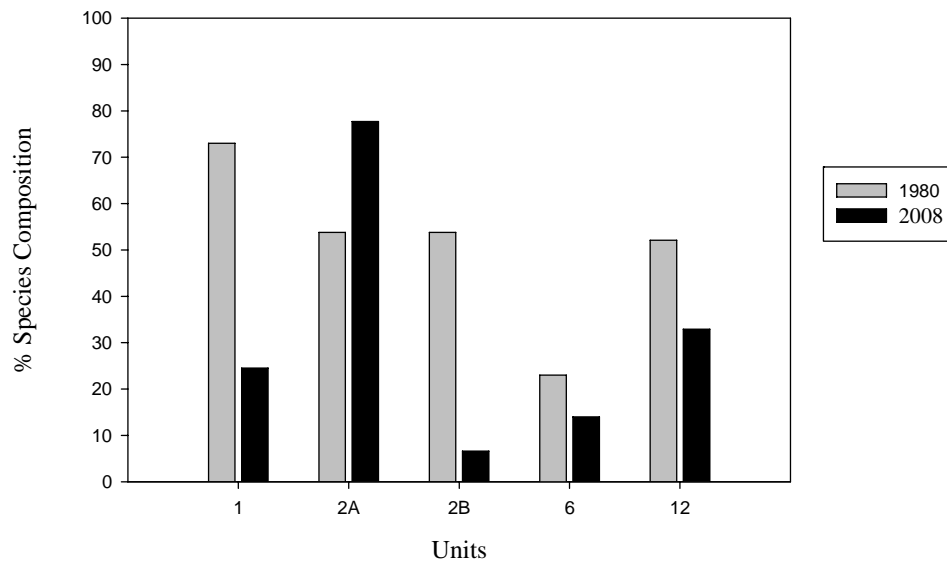


Figure 3. Summary of changes from 1980 to 2008 in native perennial grasses in Units 1, 2A, 2B, 6, and 12 of the Fort Larned National Historic Site.

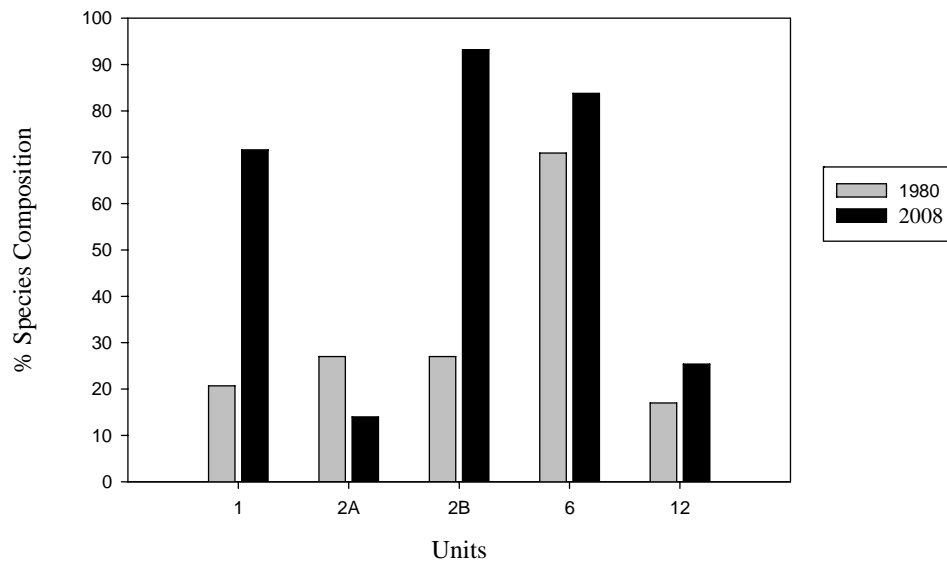


Figure 4. Summary of changes from 1980 to 2008 in exotic species (including smooth brome) in Units 1, 2A, 2B, 6, and 12 of the Fort Larned National Historic Site.