EVALUATION OF ECOLOGICAL SITE CLASSES AND COMMUNITY CLASSES FOR REGIONAL SCALE MODELING OF CONSERVATION EFFECTS ON GRAZING LANDS: MLRA 74

Steve Barker, Resource Management System L.L.C.
Pat Shaver, Rangeland Management Services L.L.C.
Edits/Oversight by Loretta J. Metz, USDA-NRCS, Resource Assessment Division, CEAP-Grazing Lands.

INTRODUCTION

The Grazing Lands Component of the Conservation Effects Assessment Project is evaluating the development and use of general Ecological Site Classes and Community Classes within Major Land Resource Areas for regional and national scale modeling of conservation effects. National Resources Inventory (NRI) data was correlated to the identified to provide data for the Agricultural Policy/Environmental eXtender (APEX) model and other models. The Rangeland Hydrology and Erosion Model (RHEM) was used to do assessments of runoff and erosion for this evaluation.

DEFINITIONS

ECOLOGICAL SITE CLASS

Ecological Site Classes are proposed subdivisions of a Major Land Resource Area (MLRA) or Land Resource Unit (LRU). They are similar in concept to a general soil survey map unit – a general grouping of ecological sites by major landforms and vegetation types. An Ecological Site Class generally differs from other kinds of land in the kinds and amounts of vegetation produced, and in the responses to disturbances, recovery mechanisms, and management. Three Ecological Site Classes were initially identified, working with the expert soil and range scientists in MLRA 74:

- Loamy Upland Site Class
- Sandy Upland Site Class
- Terrace Site Class

Each Ecological Site within the MLRA was correlated to an Ecological Site Class.

PLANT FUNCTIONAL GROUPS

The Plant Functional/Structural Group indicator is defined in Interpreting Indicators of Rangeland Health (version 4) as, "*A suite or group of species that because of similar shoot or root structure, photosynthetic pathways, nitrogen fixing ability, life cycle, etc., are grouped together on an ecological site basis.*"

The presence, dominance and relative proportions of plant functional groups affect soil, hydrologic and biotic variables including:

- the kinds and amounts of canopy and foliar cover
- litter cover
- plant spacing
- amount and arrangement of bare ground
- structure and continuity of vegetation which then influences the potential to carry fire and regulate fire intensity
- grazing preferences
- wildlife habitat values
- runoff and erosion rates

The change in presence, dominance and/or proportion of plant functional groups is the primary attribute used to characterize States and Community Phases within an Ecological Site Description.

Standardized Plant Functional Groups based on growth form and primary flowering season (as opposed to photosynthetic pathway) were developed for this project as a method to standardize how plant communities are evaluated and correlated to a specific Community Class. Cool season (C_3) and warm season (C_4) photosynthetic pathways are not known and/or the information is readily available for many species. Most plant references provide a flowering period for each species. The dominant flowering period (spring or summer) was used to characterize when the plants are in a reproductive phase. This is often when treatment is applied in order to encourage or suppress seed production. All plant species found in the MLRA were assigned to one of the plant functional groups, and production by functional group was calculated for each NRI Primary Sampling Unit (PSU) community.

Community Class

Community Classes are proposed as generalized plant communities within an Ecological Site Class. A Community Class is differentiated from other Community Classes by the presence and relative proportions by annual production of plant functional groups. The Community Class name is created using the most dominant 7 functional groups, in descending order. Initial Community Classes were identified using the Community Phases within the Ecological Site Descriptions, with input from the local experts in the MLRA.

Each NRI PSU in the MLRA was correlated to a Community Class where possible. Some PSU data points were not used when the data (species present and/or production) was questionable. Additional Community Classes that are not currently represented in the Ecological Site Descriptions were added based on NRI data (mostly non-native dominated communities). Community Class names are derived using the top seven plant functional groups, listed in descending order of annual production. The production for the plant functional groups is calculated from the NRI PSUs that are correlated to the Community Class.

Plant Community

The actual plant community at any given location, at a point in time.

Figure 1: Kansas Tallgrass Prairie

Ecological Site Classes and Community Classes for Major Land Resource Area 74 – Central Kansas Sandstone Hills

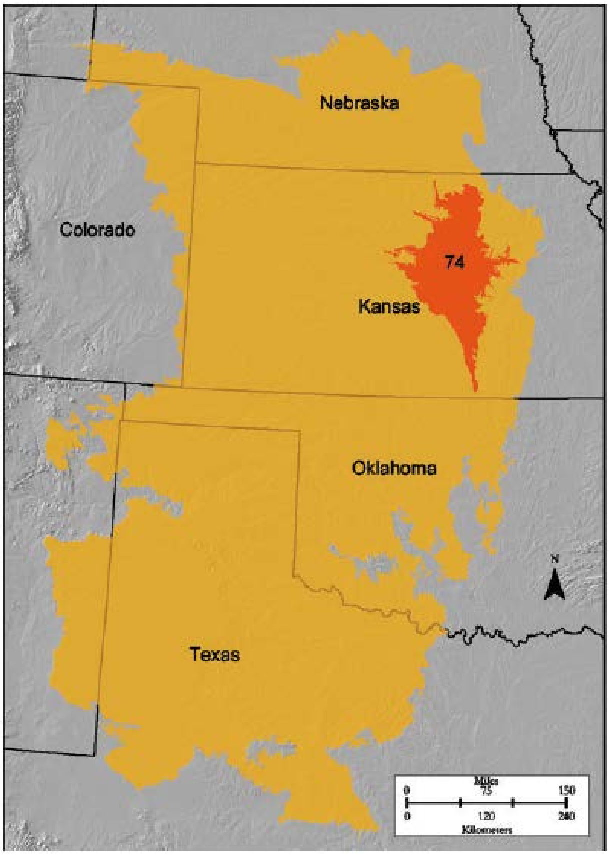


Figure 2: MLRA 74 map from Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296

MLRA 74 occurs in the western half of the Flint Hills of Kansas. This area is part of the Central Great Plains Winter Wheat and Range Region (LRR H). The area is generally characterized by broad undulating plains dissected by wide floodplains and terraces. Elevations range from 1310 feet to 1640 feet above mean sea level. Cretaceous sandstone bedrock, shale, and Permian limestone underlay this region. The central portion of the MLRA was once a major drainage way for glaciers that extended near the northern end of this MLRA. Many of the soils contain buried fluvial deposits from this period.

Plant communities are dominated by tall- and mid-grasses, including big bluestem, switchgrass, sideoats grama and western wheatgrass. Fire plays a major role in maintaining these tallgrass plant communities.

The following climate information is from the Loamy Upland (PE 26-30) Ecological Site Description.

"The area has a typical mid-continental climate with wide fluctuations in both daily and annual temperature variations. Typically winters are relatively short, mostly December through February. They can, however, be extremely cold because of frequent polar "expresses" or "Alberta Clippers" that rush cold air down from the arctic. Warmer temperatures prevail for about half of the year providing for a long growing season. The climate data listed in the tables below represent high and low ranges and averages for the climate stations and dates listed. For additional climate data, access the National Water and Climate Center at http://www.wcc.nrcs.usda.gov ."

	Averaged
Frost-free period (days):	*152*
Freeze-free period (days):	*175*
Mean annual precipitation (inches):	*33*

Monthly Precipitation (Inches):												
	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
High	*1.18*	*1.51*	*3.93*	*3.74*	*6.58*	*5.65*	*7.11*	*5.74*	*3.80*	*3.65*	*2.63*	*1.45*
Low	*0.21*	*0.18*	*0.75*	*1.27*	*2.42*	*2.05*	*1.06*	*1.28*	*1.04*	*0.60*	*0.42*	*0.25*

FIGURE 3

Monthly Temperature (°F):												
Month	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
High	*39.0*	*45.5*	*56.3*	*66.9*	*75.9*	*87.0*	*92.7*	*90.6*	*82.1*	*70.4*	*53.5*	*42.3*
Low	*17.2*	*21.9*	*31.5*	*41.5*	*52.5*	*62.0*	*67.4*	*65.5*	*56.2*	*44.0*	*30.8*	*21.2*

FIGURE 4

Representative Climate Stations

(1) KS1767, Concordia WSO Airport, KS. Period of record 1971-2000

(2) KS4178 Kanopolis Lake, KS Period of Record 1971-2000

(3) KS4712 Lincoln 2 ESE, KS Period of Record 1971-2000

(4) KS5363 Minneapolis, KS Period of Record 1971-2000

(5) KS7160 Salina FAA Airport, KS Period of Record 1971-2000

(6) KS8578 Washington, KS Period of Record 1971-2000

(7) KS8946 Wilson Lake, KS Period of Record 1971-2000

TYPICAL AGRICULTURAL OPERATIONS

Most of the agricultural producers in MLRA 74 are farmers who also run some cattle. There are a few ranches. Most cattle are English breeds – Angus and Hereford. Red Angus have become more popular in recent years. There are some Limousin and Charolais breeds. Weaning weights average 500 lbs. for heifers and 550 lbs. for steers. Early calving is done around April 1. Late calving is done in late June through early July. NRCS grazing prescriptions use 25% harvest efficiency and about 50% utilization levels. Conservative stocking rates average 8 to 10 acres per AU, with many producers running as high as 5 acres per AU.

The rangelands are primarily grazed during the spring growing season when the corn gets planted (late March through April). The calves are worked and the cows are put in the pastures with the bulls. Most producers do not rotate grazing during the summer. Many producers utilize an intense early grazing (90 day grazing) strategy on their rangelands. Those that use a rotation on the rangeland will generally have a 2nd pasture that the herd is moved to around June. Once the crops are harvested in October, the livestock are moved onto crop residue and/or are fed hay on dry lots during the dormant season.

Drought strategies include early weaning (Feb-March) and de-stocking based on planned trigger dates. Having a plan that identifies which animals will go first is encouraged. Other options include using alternative crops, crop stubble etc.

Resource Management Systems

Prescribed Grazing

Livestock grazing is not a significant driver of plant community changes within MLRA 74. Excessive continuous livestock grazing can reduce the production of tallgrasses, pushing the communities to more of a mid-grass community phase. But reducing the grazing pressure quickly restores the tallgrasses.

Prescribed Grazing is commonly applied in this MLRA to build up fuel loads for Prescribed Burning. Deferment from grazing is not typically done after a springtime prescribed fire – the livestock are often put in the pasture while it is still smoking. It is more common to defer grazing after summer fires, but that is not always done.

Range Planting

This practice rarely used in MLRA 74. There is always a sufficient seed source for the desirable species to become re-established. With normal rainfall, reestablishment can occur in one year. Smooth brome was introduced into this area in the late 1800s, and became widely established following the Dust Bowl years, due to its resistance to drought. It is a cool season rhizomatous grass that competes with the warm season native grasses.

Prescribed Burning

Prescribed Burning is an essential conservation practice for maintaining the tallgrass prairie plant communities MLRA 74. 2.5 million acres were burned last year (2014) in Kansas – it is a commonly used tool. Potential regulatory measures from the Environmental Protection Agency (EPA) are becoming a concern because of the air quality issues related to burning and smoke management. But without fire, the tallgrass prairie cannot be maintained. Fire controls shrub encroachment and moves all of the plant communities back to tallgrass prairie. Increasing prescribed fire to every year or two on the Smokey Hill Air National Guard Bombing Range has shown increases in plant pedestalling from erosion. For this reason and others, a fire frequency of every 3 to 5 years is recommended.

Burning is normally done in early spring (March) before growth and spring rains start. Prescriptions are normally 40% relative humidity with 5-15 mph wind speeds. Fuel loads dictate frequency. Burning decreases in dry years with low fuel loads. Full recovery after fire normally occurs within 30 days of burning. Dormant season burning followed by grazing can help control smooth brome.

Research shows higher vegetative production on regularly burned sites. Fire also solves grazing distribution problems. Stocker cattle can gain 3 lbs/day in the spring on a burned site. Up to 32 lbs of additional gain per animal can be achieved in 90 days (0.35 lbs/day) on burned sites when compared to unburned sites.

Brush Management

This practice is done both mechanically and chemically in MLRA 74. The NRCS State Technical Committee recommendation is to use mechanical instead of chemical methods whenever possible.

Eastern redcedar becomes sexually mature at 6-8 years old. Birds, primarily robins and waxwings, readily spread the seeds (900 per day), and the sites quickly become invaded by red cedar. Mechanical treatment (mostly shredding) is the preferred method of restoring older invaded sites with larger shrubs. Most herbicides are not effective. Eastern redcedar does not sprout, so control methods just need to remove everything above the lowest growth on the plant. Fires hot enough to scorch all the leaves of a red cedar can kill the plant. Annual maintenance treatment – lopping off new shrubs as they come up - is also encouraged as the least cost alternative.

Shredding is commonly used. Mechanical control also includes individual plant cutting with chainsaws or Agra-axe. Mechanical treatment on invaded sites (no fire for 10 years) costs about $100 per acre. Canopy cover on these sites is generally 10-15%.

2, 4-D and Picloram (trade name "Grazon P+D") is the primary chemical formulation used to control other woody species such as smooth sumac and wild plum. Aerial application is common. 1-2 quarts per acre active ingredient is recommended by Kansas State University. Application is done during the spring flowering period in May-June.

Herbaceous Weed Control

This practice is used to control musk thistle in MLRA 74. Aerial application of chemicals is commonly used. Application of chemicals decreases native forbs in the plant communities.

Spraying glyphosate (trade name "Roundup") to control smooth brome is done in the fall, within 10 days after a hard freeze when the native grasses are dormant. Retreatment is required for effective control.

Upland Wildlife Habitat Management

Wildlife in MLRA 74 includes deer, turkey, greater prairie chicken, bobwhite quail, pheasant and geese. Species of concern may soon include long-eared bats and monarch butterflies. The lesser prairie chicken does not occur in this MLRA. Communities of plum and other species will be left more intact as wildlife cover for areas being managed more for quail habitat.

Fencing

Both standard barbed wire and electric fencing are used in MLRA 74. Wire height and spacing complies with wildlife recommendations for deer. Bottom wire heights are 18 inches, but smooth wire is not required. Electric fences are permanent – not tape or single strand electric.

LIVESTOCK WATER DEVELOPMENTS

Ponds are commonly used to provide water for livestock in MLRA 74. Windmills and solar pumps with storage and troughs are also used. One water per every 160 acres is recommended to reduce distribution problems. Three days of storage is normally designed for windmills and solar pumps.

COMMON CONSERVATION PRACTICES

The following table provides information about the kinds of conservation practices that the landowners in MLRA 74 are investing in. The table shows the most common conservation practices applied with NRCS assistance on grazed rangeland in MLRA 74 during fiscal years 2006-2011.

Code	Practice Name	Times Applied	Amount Applied	Acres Benefitted
528	Prescribed Grazing (ac)	725	99,821	96,376
314	Brush Management (ac)	672	18,293	79,867
645	Upland Wildlife Habitat Management (ac)	157	19,742	20,356
338	Prescribed Burning (ac)	118	12,950	14,008
614	Watering Facility (no)	81	112	13,637
378	Pond (no)	79	82	8,573
595	Integrated Pest Management (ac)	79	12,724	12,771
516	Pipeline (ft)	63	146,772	9,077
382	Fence (ft)	43	92,928	8,150
642	Water Well (no)	39	39	6,384
342	Critical Area Planting (ac)	38	80	4,495
472	Access Control (ac)	29	1,611	1,611
574	Spring Development (no)	24	24	5,534
550	Range Planting (ac)	11	130	653

FIGURE 5

Ecological Site Classes and Community Phases

There are currently fourteen Ecological Sites described in MLRA 74. Ten of those were selected by the local soil and range specialists to include in the development of Ecological Site Classes. The four ecological sites that were not included represent small, isolated ecological sites that primarily occur in adjacent MLRAs, where their concepts were developed.

The ten selected Ecological Sites were grouped into three Ecological Site Classes for MLRA 74 by the local soil and range specialists:

- Loamy Upland Class
- Sandy Upland Class
- Terrace Class

MLRA 74 Loamy Upland Ecological Site Class

The Loamy Upland Ecological Site Class makes up 90% of MLRA 74. Ecological Sites correlated to the Loamy Upland Site Class are:

- R074XY015KS Loamy Upland (PE 26 - 30)
- R074XY007KS Clay Upland (PE 26 - 30)
- R074XY012KS Limy Upland (PE 26 - 30)
- R074XY030KS Shallow Sandstone (PE 26 - 30)

The Loamy Upland Ecological Site Class occurs on broad upland plains. Soil depths range from deep to shallow over sandstone, shale and limestone bedrock. Soil surface textures range from sandy loam to clay loam. Slopes are generally less than 15%. Where these soils have been farmed, the granular structure of the soil surface is gone, and the soil color is much lighter.

The reference plant communities for the Ecological Sites in this Site Class are all dominated by tallgrasses and midgrasses. Eastern redcedar and Osage orange (hedge) will invade these sites if fire is suppressed. Prescribed burning is common. The normal fire return period is 5-6 years. If the fire frequency is longer than about 5 years, the red cedar get over 3 to 4 feet tall and may not be controlled with a single fire, but multiple fires can effectively restore the site. Brush Management may be recommended in these situations to accelerate restoration. The Loamy Upland site is the most common ecological site within this Ecological Site Class. The Clayey Upland site has a loamy surface 10-12 inches deep, with a heavy clay subsurface of at least 40-50% clay. Tall dropseed is a good indicator of the Clayey Upland site on areas with continuous grazing use. When these sites get compacted, sod grasses such as blue grama become more dominant. Four Community Classes were identified by the local experts for the Loamy Upland Site Class based on the combined Ecological Site Descriptions.

- Tallgrass, Midgrass, Shortgrass
- Tallgrass, Shrub, Tree
- Shortgrass, Shrub
- Forbs, Annuals, Tallgrass, Midgrass, Shrubs

Figure 6: MLRA 74 Loamy Upland Ecological Site Class

The "Forbs, Annuals…" Community Class is currently dominated by non-native species, based on the available NRI data. Non-native plant functional groups are shown with the "(I)" designation (introduced). The following five Community Classes have been characterized for the Loamy Upland Site Class from available NRI data. Community Class are differentiated by the presence and relative proportions by annual production of plant functional groups. The Community Class name is created using the seven most dominant functional groups from the available NRI data, listed in descending order.

- **074X6.1** Summer Tallgrass, Summer Midgrass, Summer Perennial Forb, Spring Rhizomatous Grass(I), Spring Midgrass, Spring Annual Grass(I), Spring Rhizomatous Grass
- **074X6.2** Summer Tallgrass, Deciduous Tree, Summer Midgrass, Summer Perennial Forb, Spring Rhizomatous Grass(I), Deciduous Subshrub, Spring Annual Grass(I)
- **074X6.3** Spring Rhizomatous Grass, Spring Perennial Grasslike, Spring Annual Grass(I), Summer Perennial Forb, Summer Rhizomatous Grass, Summer Tallgrass, Spring Rhizomatous Grass(I)
- **074X6.4** Spring Annual Grass(I), Summer Tallgrass, Spring Annual Forb(I), Summer Perennial Forb, Spring Rhizomatous Grass(I), Summer Midgrass, Summer Annual Forb

- **074X6.5** Spring Rhizomatous Grass(I), Spring Annual Grass(I), Spring Rhizomatous Grass, Spring Annual Grass, Summer Perennial Forb, Summer Tallgrass, Summer Midgrass

074X6.3 is a Community Class that includes rushes and sedges. This community likely occurs in swales or low areas that receive additional moisture or are seasonally flooded. There is not enough NRI data available to reasonably characterize this community.

074X6.5 is a Community Class currently dominated by smooth brome, an introduced cool season perennial grass.

Community Class numbers used in this document correspond with the community class numbers assigned in a separate database that was developed for this project. The Community Class numbers shown in this document may not be sequential. The database includes the full NRI and Ecological Site Description datasets used for this project. This database has been delivered to the NRCS CEAP-Grazing Lands component leader in Temple, Texas.

Average annual soil loss and average annual runoff estimates for the Community Classes in this study were estimated using the Rangeland Hydrology and Erosion Model (RHEM) developed by ARS at the Southwest Watershed Research Lab in Tucson, Arizona. Salina CAA AP (Station 147160) was selected to be the representative climate station for the RHEM model runs for MLRA 74. The erosion and runoff amounts are average total annual values estimated by the model, using the climate information for that station, and the site and vegetative characteristics from the NRI data points. The following charts for provide average values from NRI data and RHEM model results for NRI PSUs correlated to each Community Class. A summary table with additional data can be found in Appendix D.

.

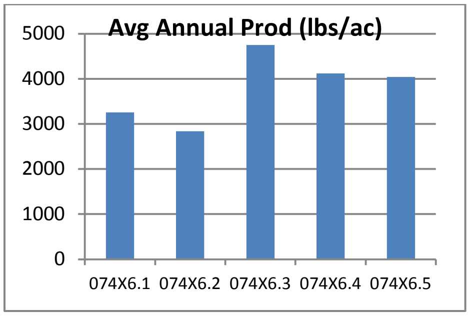


FIGURE 7

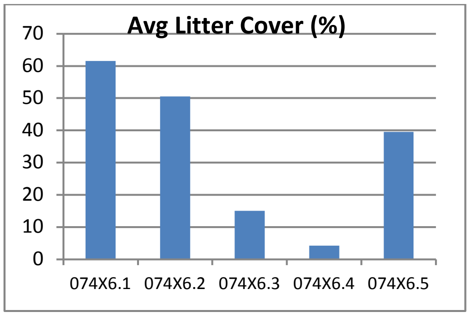


FIGURE 8

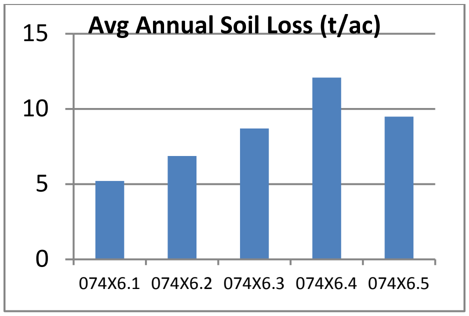


FIGURE 9

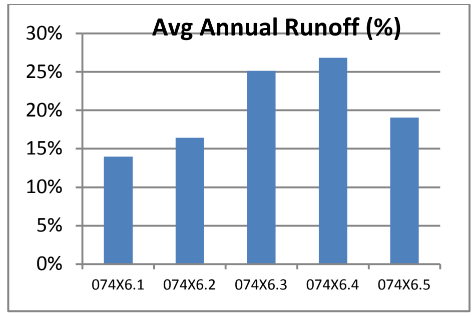


FIGURE 10

MLRA 74 Loamy Upland Ecological Site Class State and Transition Model

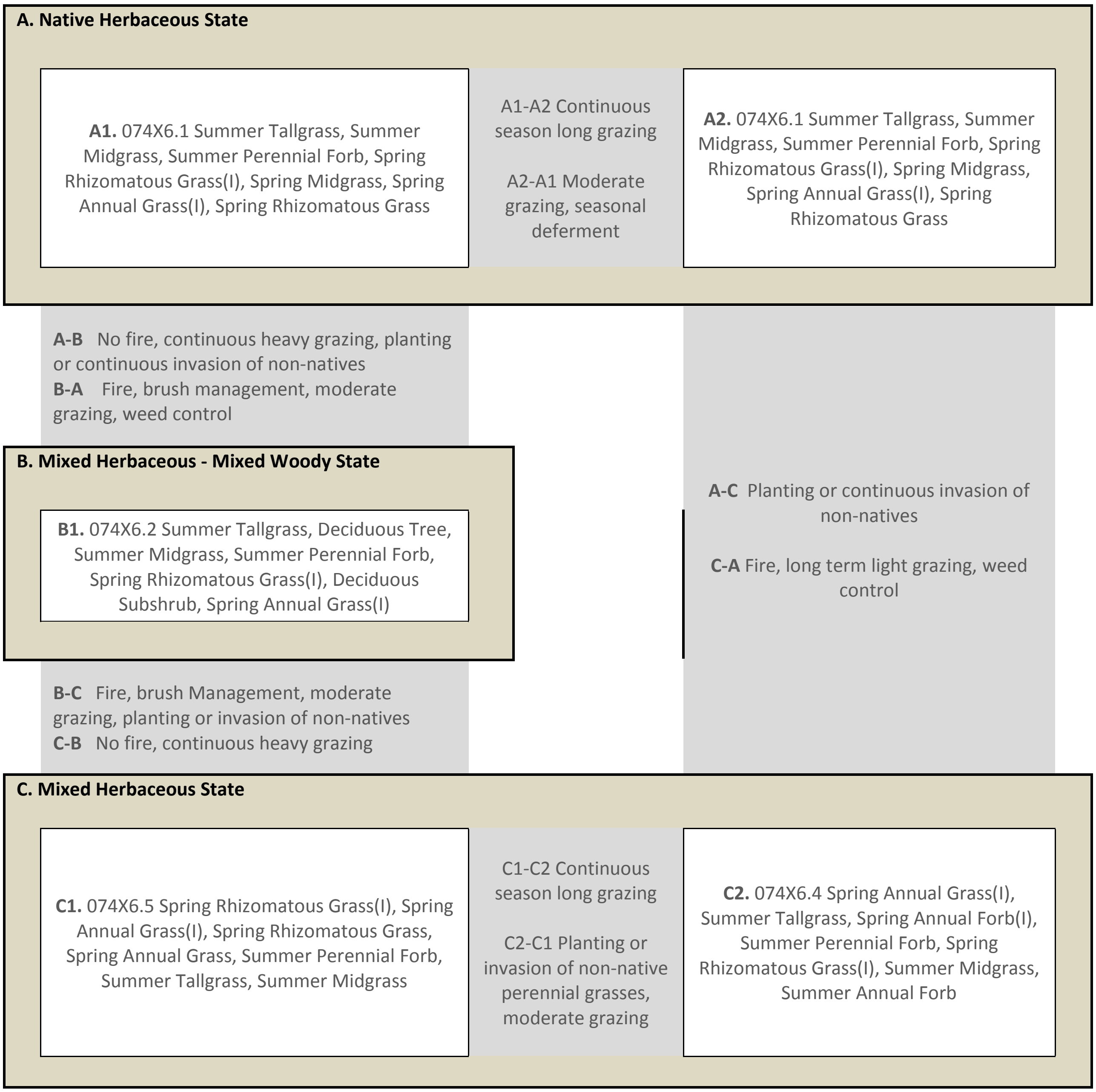


FIGURE 11

Non-native herbaceous species such as Japanese brome are now present to some extent on nearly every NRI location. Plant communities correlated to the Native Herbaceous State are dominated by native species that can reasonably represent the native communities for modeling purposes.

The vegetation for the reference state for the MLRA 74 Loamy Upland Site Class consists of big bluestem, Indiangrass, switchgrass, prairie cordgrass, eastern gamagrass, little bluestem, Maximilian sunflower, Missouri goldenrod, and leadplant (see appendix B for scientific names). According to the STM, an absence of fire or grazing may cause the vegetation to transition into a shrub and tree state with big bluestem, little bluestem, Indiangrass, composite dropseed, white sagebrush, cuman ragweed, eastern redcedar, wild plum, smooth sumac, and honey locust. Fire, and/or brush management and moderate grazing with some deferment is demonstrated to return this state to reference conditions.

The following publications support the STM by offering similar conclusions in the studies. Hulbert (1969) described the effect that fire had on reducing litter and thus increasing the yield of big bluestem, which according to the state and transition model decreases without disturbance. Further, Brag and Hulbert (1976) assessed a site that had transitioned into the shrub and tree state with eastern red cedar and invaders such as smooth sumac. Through the use of aerial photography, the study supported the STM prediction that woody invasion increased overtime if fire was not implemented. The third publication supported the STM by indicating the increase in productivity on a loamy upland site in which grasses were clipped and nitrogen was added, which encouraged the return to reference grass biomass. The final publication supported the STM and examined the shrub and tree state with an eastern redcedar invasion. This study examined several soil types, one of which was a loamy upland and supported the STM by observing that the increase of eastern redcedar is accompanied by an increase in other shrubs and that grazing and fire decreased the shrubs and trees.

Hulbert, L. C. 1969. Fire and Litter Effects in Undisturbed Bluestem Prairie in Kansas. Ecology, vol. 50(5): 874-877.

This study was conducted on the boundary line of Morris and Dickinson Counties, Kansas. It examined the effects of burning on undisturbed bluestem prairie as related to litter removal. The experiment was designed with two by two meter plots that were subjected to four treatments of burning, clipping and removal of litter, burning the clipped litter and removing the ash, and the control of natural litter. This site was predominantly big bluestem, but had some patches of wild plum and coralberry. There were some rare examples of composite dropseed, cuman ragweed, white sagebrush, and pitcher sage. However, in adjacent grazed plots there was a variety of grass and forb species present. For evaluation, plant height was measured and the density of tillers was obtained. Additionally, yield of forage was taken by clippings that were oven dried.

It was found that tiller density was 1.5 to 2.7 times higher on the denuded plots than those with litter. Height growth was slowed by litter early in the growing season, but was increased once the plant was taller in the later season. Additionally, yield was higher on the denuded plots than on the control. This was evident in the clipping weight difference of 3g in the control to the 7.7g in the treated. Heavier and denser tillers in the treated resulted in three to five times higher production in late May. The conclusion of this study was that litter removal by either clipping or burning increases the yield of big bluestem.

Bragg, T.B. and L.C. Hulbert. 1976. Woody Plant Invasion of Unburned Kansas Bluestem Prairie. Journal of Range Management, vol. 29 (1): 19-24.

This study assessed the post-settlement invasion of trees and shrubs in the bluestem prairie of Geary County in the Flint Hills of Kansas. Regular vegetation of the bluestem prairie is predominantly big and little bluestem, Indiangrass, with some amounts of switchgrass, sideoats grama, blue grama, hairy grama, buffalograss, and Kentucky bluegrass. There are a few woody plants and forbs including leadplant and inland ceanothus. Slope forests are dominated by chinquapin oak, American elm, and eastern redcedar. These particular sites showed observation of American elm, redcedar, and chinquapin oak with major shrub invaders of smooth sumac, roughleaf dogwood, and buckbrush. The objective of the study was to ascertain the rate of woody plant invasion on various soils of burned and unburned bluestem prairies to appraise the role of fire in these environments. Twelve site were selected that met predetermined management objectives. Of these sites, five had been burned regularly, five had been unburned for at least 20 years, and two had been treated with herbicides. The site was evaluated using aerial photos, General Land Office survey data, and field observations. The earliest aerial photo was taken in 1937. The woody encroachment was observed by using acetate grid overlay on grid squares that represented a 20 x 20m ground area. Soil boundaries were marked and woody plant coverage was grouped into categories of absent, less than 5%, 5 to 50%, 50 to 95%, or 95 to 100%.

The results of the aerial photo data indicated that tree cover had increased by 8% from 1856 to 1969. Section line data showed that portions of the prairie that had remained unburned for the past 30 years or more had an increase of woody encroachment by 16%, with tree and shrub cover combined at 34%. The various soil types, had differing responses to the increase of woody encroachment including rapid invasion on lowlands, lower-slope, and steep, rocky soils. In contrast, invasion was slowest on upland soils with high clay content. Overall the 34% increase in unburned areas of the Flint Hills was in contrast to the 1% increase in the burned from 1937 to 1969.

Owensby, C.E., R.M. Hyde, and K.L. Anderson. 1970. Effects of Clipping and Supplemental Nitrogen and Water on Loamy Upland Bluestem Range. Journal of Range Management, vol. 23(5): 341–346.

This study occurred on a True Prairie loamy upland site in Kansas. It investigated the effects of adding water and nitrogen separately and in combination to bluestem range for four years. The experimental design was a split-split plot replicated four times. Main plots were years, sub plots were three clipping treatments, and sub-sub plots were four nitrogen and water additions. Botanical composition, soil moisture, and herbage yields were inventoried and a moisture-use efficiency calculated.

Herbage yields were highest in the first year, in which natural precipitation was higher and mulch removal may have caused the results. The following year was extremely dry and produced very low yields, even with the addition of water to moisture plots. This was the general theme throughout the years of the study. However, it was found that addition of nitrogen had the potential to increase yields. Additionally, plots that were clipped in July and August resulted in increased herbage production and water-use efficiency. Soil moisture levels were generally lower in the nitrogen plots than that of the control. Basal cover decreasers big bluestem, little bluestem, and Indiangrass varied throughout the study. Most years of the study the cover increased. Moisture addition did increase the cover of most species and nitrogen increased the cover of Kentucky bluegrass, tall dropseed, and sideoats grama. The most notable increased was in Kentucky bluegrass which had an early season growth. Sedges did increase with nitrogen but perennial-forbs were unaffected. Final conclusions were that increased dry-matter yields on nitrogen plots were above control by 0.75 to 1.0 ton/acre. However, this came with a shift to cool-season grass species which negates most response to nitrogen fertilization.

Owensby, C.E., K.R. Blan, B.J. Eaton, and O.G. Russ. 1973. Evaluation of Eastern Redcedar Infestations in the Northern Kansas Flint Hills. Journal of Range Management, vol. 26(4): 256-260.

This study took place in the True Prairie of the Kansas Flint Hills. It investigated the associations of cattle stocking rate, precipitation, and redcedar invasion. The vegetation of these sites was predominantly big and little bluestem, Indiangrass, and switchgrass. The soils of the range sites were grouped into loamy upland, limestone breaks, clay upland, and limy upland to assemble the same plant communities and plant productions. Additionally, eight pastures were selected in the county to evaluate stocking rates and precipitation effects of which management history was known. Four of the study areas had light to moderate invasions of eastern redcedar and four had heavy invasions. One hundred circular, tenth-acre plots were randomly selected in the sites. The information collected included number of trees, number of trees producing seed, tree age, range site, estimated range-condition class, direction of slope exposure, other brush species present, estimated abundance of other brush, and cattle stocking rates. Additionally, thirty supplemental pastures were recorded to give the experiment a broader base. These pastures included 10 with essentially no redcedar invasion, 10 with light to moderate invasion, and 10 with heavy. The control methods that were tested included foliar-applied herbicides, soil-applied granular herbicides, and controlled burning.

Results determined that 96% of the redcedars on these sites were less than 10 years old. Differences among years on the heavily invaded pastures demonstrated a population increase sigmoid curve. Grazing indirectly affected redcedar establishment by influencing the amount of mulch. On all range sites, it was seen that redcedar invasion declined with the increase of cattle stocking rate. In one year, redcedar invasion declined 6.3 trees per acre per animal unit month (AUM), with the following year increasing to 13.8 trees per acre per AUM. Precipitation had a significant effect on redcedar invasion. On heavily invaded areas, for each additional inch of rainfall, invasion decreased only 0.2 tree per acre. It was also found that the same factors that retard redcedar establishment also slow that of osage orange, roughleaf dogwood, honey locust, and smooth sumac. It was found that foliar-applied herbicides partially controlled redcedars but did not kills them. However, herbicide granules were more effective than the foliar sprays. Control by fire affected more of the small redcedars than the larger trees, successfully eliminating 89% of seedlings, 83% of small trees, 39% of medium ones and a total of 63% of all classes. Therefore, it was determined that redcedar can be eliminated by fire but larger trees must be addressed by alternative measures. Final conclusions of the study determined that: 1) Redcedar is most restricted by fire and cutting, 2) Heavier stocking rates reduce redcedars in the bluestem growing and dormant season, 3) Redcedars invade all upland sites equally, 4) Slope exposure does not change redcedar population growth, 5) Invasion of redcedars is also accompanied by that of other brush, 6) Redcedars 6 to 7 years old produce seeds, 7) Redcedars in this study area grow 0.27 inches in diameter and 7.85 inches in height in a year, 8) Herbicide granules controlled redcedar more effectively than foliar-applied.

MLRA 74 Sandy Upland Ecological Site Class

This Ecological Site Class occurs on upland plains. Surface soil textures range from loamy sand to sand. Soils are generally deep. This ecological site class occurs on sand dune areas. Ecological Sites correlated to this Ecological Site Class are:

- R074XY022KS Sandy (PE 26 – 30)
- R074XY021KS Sands (PE 26 - 30)

Fire readily maintains the tallgrass community on these sites. Without fire, smooth sumac, plum and hedge invade these sites. Plum and osage orange invasion can be managed with fire, but smooth sumac invasions require chemical treatment for control. The Sands ecological site is the best representation of this Ecological Site Class, but there is no NRI data available for that ecological site. The Sandy ecological site was correlated to enable NRI data to be used for characterizing this Ecological Site Class.

Two Community Classes were identified from the Ecological Site Descriptions for the Sandy Uplands Ecological Site Class.

- Tallgrasses
- Tallgrasses, Shrubs, Trees

FIGURE 12: SANDY UPLAND ECOLOGICAL SITE CLASS

The following two Community Classes were evaluated. Only one NRI point is available to represent each of the proposed Community Classes from the Sandy Ecological Site.

- **074X7.1** Summer Tallgrass, Summer Midgrass, Summer Perennial Forb, Spring Midgrass, Summer Rhizomatous Grass, Summer Perennial Grasslike, Summer Annual Grass
- **074X7.2** Summer Tallgrass, Evergreen Tree, Summer Midgrass, Summer Perennial Forb, Summer Rhizomatous Grass, Summer Perennial Grasslike, Spring Midgrass

The following graphs provide average values from NRI data and RHEM model results for the NRI sampling units correlated to each Community Class. A summary table with these values and additional data can be found in Appendix D.

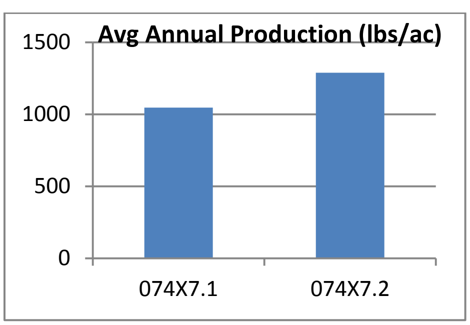


FIGURE 13

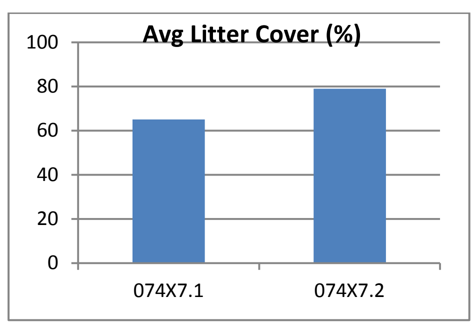


FIGURE 14

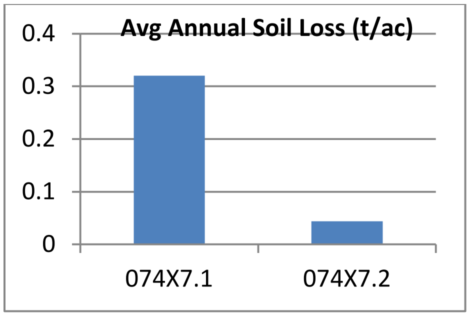


FIGURE 15

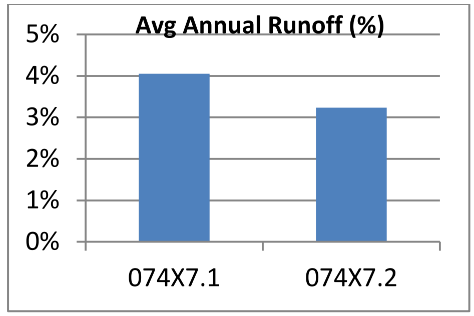


FIGURE 16

MLRA 74 SANDY UPLAND ECOLOGICAL SITE CLASS STATE AND TRANSITION MODEL

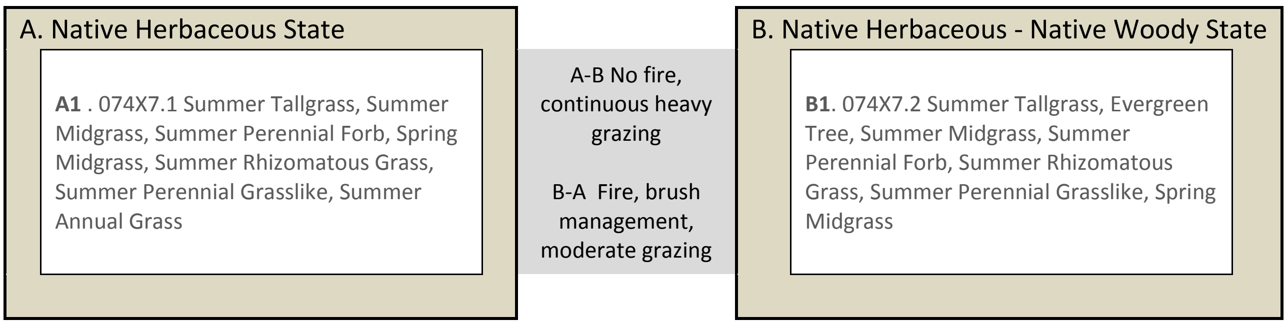


FIGURE 17

The MLRA 74 Sandy Upland Class state-and-transition model (STM) depicts a reference state with vegetation including switchgrass, Indiangrass, little bluestem, sand lovegrass, Canadian wildrye, needle-and-thread, and Maximilian sunflower. With a lack of fire or grazing the vegetation may transition into a shrub and tree state. The vegetation in the shrub and tree state is sand dropseed, hairy grama, purple lovegrass, sandbur, white sagebrush, cuman ragweed, prairie sunflower, chickasaw plum, skunkbush sumac, smooth sumac, roughleaf dogwood, and eastern redcedar. With the input of disturbances such as fire and/or brush management and light grazing with deferment there is a possibility of the shrub and tree state return to the reference state.
The following publications support the information from the STM. The first publication demonstrates the transition from shrub and tree state back into an increased biomass of grasses via the input of fire. The second publication discusses the effect grazing and nitrogen input has on the vegetation. As the STM suggests, there was an increase in grass biomass when grazing and/or mowing was implemented.

ABRAMS, M.D., A.K. KNAPP, AND L.C. HULBERT. 1986. A TEN-YEAR RECORD OF ABOVEGROUND BIOMASS IN A KANSAS TALLGRASS PRAIRIE: EFFECTS OF FIRE AND TOPOGRAPHIC POSITION. AMERICAN JOURNAL OF BOTANY, VOL. 73(10): 1509-1515.

Study sites on the Konza Prairie Research Natural Area in a grassland dominated by *Andropogon, Sorghastrum* and *Panicum* species were examined to ascertain the effect of disturbances, namely fire, have on aboveground production. Additionally, this study included predominate forbs cumen ragweed*,* white sagebrush*,* and aster.

Measurements were taken of mid-season live and dead above-ground biomass for a ten year period. The sites included deep, non-rocky lowlands in annually burned and unburned watersheds. To estimate production, all aboveground biomass was clipped at ground level two to four times from quadrats that were randomly placed along transects.

Results indicated that lowland sites of both burned and unburned plots had significantly higher biomass than upland sites that were burned and unburned. Additionally, live biomass was greater on burned than unburned lowland sites. Upland and lowland sites burned and unburned sites were averaged to find that burned live aboveground biomass was 422g m^{-2}, while unburned was 364g m^{-2} during the ten year period. The year with the highest drought comprised of the lowest aboveground biomasses for all of the plots. When biomass was separated into the various components, it was found that graminoids were 40% lower and forbs/woody species were 200-300% greater in the unburned plots than in the burned plots. This study agreed with the views of various other studies, that mid- to late- spring burning increases production in comparison to unburned prairie.

Collins, S.L., A.K. Knapp, J.M. Briggs, and J.M. Blair. 1998. Modulation of Diversity by Grazing and Mowing in Native Tallgrass Prairie. SCIENCE, vol. 280: 745-747.

This experiment was designed to evaluate the interactive effects of grazing, nitrogen enrichment, and fire frequency on plant species diversity in a native tallgrass prairie in northeastern Kansas. The first experiment was comprised of four replicate 12x12m plots that were annually burned with the combinations of burned only, nitrogen addition, mowing, and nitrogen plus mowing. An untreated control group that was not burned was also included. The plots were evaluated with aerial cover visually estimated in a 10 m^2 circular quadrat. Aboveground biomass was measured by harvesting all plants in a 0.1m^2 quadrat.

Results found that the addition of nitrogen led to a ten-fold increase in inorganic soil nitrogen pools. The aboveground biomass was highest in the nitrogen addition plots. Two years displayed grasses to account for greater than 95% of the total biomass of the plots on the treated plots. In contrast, the control plots displayed only 56 to 68% grass aboveground biomass. Nine years after the experiment took place, species richness on the annually burned, nitrogen added plots had more than double than the plots that were not mowed. Towards the end of the study, it was found that no woody species or C_3 plants were found on any of the annually burned or burned plus N-addition plots. In contrast, the species richness of C_3 plants on burned N-addition mowed plots was equal to the richness of the control. Woody species were not found on the mowed sites.

A second experiment focused on watersheds in the Konza prairie that were subjected to various combinations of prescribed burning and grazing of bison. The experiment was designed as a split-plot with random designations of fire frequencies and grazed and ungrazed portions. Vegetation cover was estimated at the beginning of the study with 40 permanently marked $10m^2$ circular quadrats in two replicate watersheds. Total species richness was highest on the grazed watersheds and lowest on the annually burned. Grasses accounted for 80% of aboveground biomass in the annually burned sites. The total species richness was significantly greater on the grazed and annually burned than on the control. The richness of the C_3 species including grasses, forbs, and woody plants was lowest on the burned but not grazed plots. However, it was double the amount on plots that were burned and grazed. Therefore, grazing by native herbivores was concluded to lead to higher species richness under conditions that would otherwise decrease diversity. Also, the studies demonstrated that the abundance of C_4 plant species increases as fire frequency increases. Additionally, it was found that grazing increased the number of forbs present. The conclusion of this research was that maintaining top-down disturbances such as grazing can lead to the retention of diversity of native vegetation.

MLRA 74 Terrace Ecological Site Class

The Terrace Ecological Site Class consists of broad, flat floodplains along the rivers. These sites benefit from additional moisture from run-on, occasional to frequent flooding, and/or water tables within reach of vegetation. The Ecological Sites correlated to this Ecological Site Class are:

- R074XY013KS Loamy Lowland (PE 26 - 30)
- R074XY014KS Loamy Terrace (PE 26 - 30)
- R074XY004KS Clay Lowland (PE 26 - 30)
- R074XY023KS Sandy Lowland (PE 26 - 30)

The Loamy, Clay, and Sandy Lowland Ecological Sites are immediately adjacent to the rivers. The present plant communities along the rivers are dominated by elm, Osage orange, and cottonwood tree galleries. The Loamy Terrace ecological site is on the broader high stream terraces within the floodplain. The Loamy Terrace site is almost all farmed in this MLRA. Primary crops are corn and wheat. The reference plant communities for these Ecological Sites are dominated by tallgrasses with scattered trees. Fire is the natural disturbance that maintains tallgrass dominance on these sites. Where fire has been suppressed for long periods, tree removal is needed to help restore the tallgrass communities.

Three Community Classes were identified for the Terrace Ecological Site Class from the Ecological Site Descriptions with input from the local soil and range scientists:

- Tallgrass
- Shrubs and Trees
- Forbs and Annual Grasses

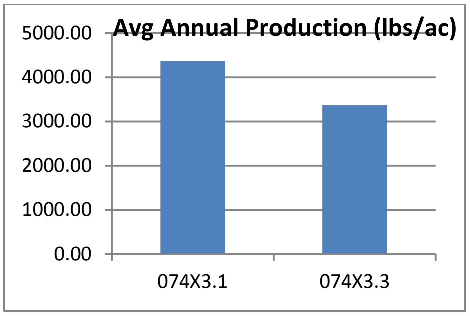
FIGURE 18: MLRA 74 TERRACE ECOLOGICAL SITE CLASS

Only two Community Classes have NRI data available. Only one data point is available to represent the Tallgrass Community Class, and it contains a significant amount of non-natives such as Kentucky bluegrass and Japanese brome. An annual community dominated by Japanese brome is the most common Community Class in the NRI data.

The ground cover data for the NRI points correlated to this Site Class show ground cover as 99-100% bare ground. This is highly unlikely, with plant communities producing 3000-4000 lbs/acre.

- **074X3.1** Summer Tallgrass, Summer Midgrass, Spring Rhizomatous Grass(I), Summer Perennial Forb, Spring Annual Grass, Spring Annual Grass(I), Summer Annual Forb
- **074X3.3** Spring Annual Grass(I), Spring Rhizomatous Grass, Summer Perennial Forb, Summer Tallgrass, Summer Midgrass, Spring Rhizomatous Grass(I), Deciduous Subshrub

The following graphs provide average values from NRI data and RHEM model results for the NRI points correlated to each Community Class. A summary table with these values and additional data can be found in Appendix D.



Ground cover for the NRI points associated with the Terrace Ecological Site Class all show 99-100% bare ground with no litter cover. Modeling soil erosion and runoff data for this Site Class would require valid ground cover data.

FIGURE 19

MLRA 74 Terrace Ecological Site Class State and Transition Model

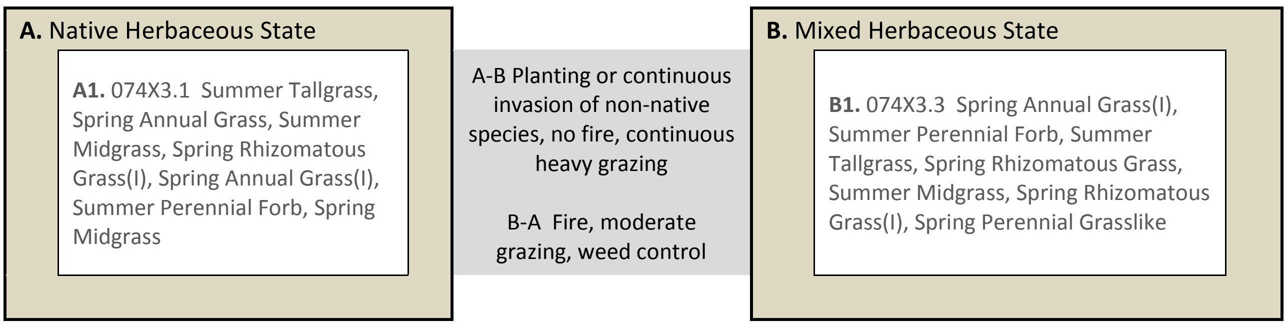


FIGURE 20

Summary

A significant amount of time was spent analyzing available data from NRI, Soil, and Ecological Site databases to develop Ecological Site Classes and Community Classes for this project. While this approach was generally useful, the knowledge and experience of the local soil and range specialists is critical for the final selection and grouping of ecological sites in the MLRA. Local experts are able to quickly identify ecological sites that are not significant to the MLRA, and ensure that grouping sites into Ecological Site Classes includes their responses to disturbances, use and management, which are typically not well characterized in the data.

Most of the Ecological Site Classes and the corresponding Community Classes proposed by the local experts have some NRI data that can be utilized to characterize those communities for modeling at the MLRA scale. However, the number of NRI sample units available to characterize most Site Classes within the MLRA was generally low – typically less than 8 data points. This Major Land Resource Area is relatively simple compared to other areas with more topography. In many areas, the available MLRA data will need to be supplemented with additional data to help characterize the dominant Community Classes for the Ecological Site Classes.

Appendix A. MLRA 74 Ecological Site Classes showing the Ecological Sites, Ecological Site IDs, and Plant Community Classes that were Correlated to each Site Class.

MLRA	Ecological Site Class Name	Ecological Site Names	Ecological Site ID
74	**Loamy Upland**	Loamy Upland (PE 26 - 30)	R074XY015KS
		Clay Upland (PE 26 - 30)	R074XY007KS
		Limy Upland (PE 26 - 30)	R074XY012KS
		Shallow Sandstone (PE 26 - 30)	R074XY030KS
		Plant Community Class Names, from NRI data	**Plant Community Class ID**
		Summer Tallgrass, Summer Midgrass, Summer Perennial Forb, Spring Rhizomatous Grass(I), Spring Midgrass, Spring Annual Grass(I), Spring Rhizomatous Grass	074X6.1
		Summer Tallgrass, Deciduous Tree, Summer Midgrass, Summer Perennial Forb, Spring Rhizomatous Grass(I), Deciduous Subshrub, Spring Annual Grass(I)	074X6.2
		Spring Rhizomatous Grass, Spring Perennial Grasslike, Spring Annual Grass(I), Summer Perennial Forb, Summer Rhizomatous Grass, Summer Tallgrass, Spring Rhizomatous Grass(I)	074X6.3
		Spring Annual Grass(I), Summer Tallgrass, Spring Annual Forb(I), Summer Perennial Forb, Spring Rhizomatous Grass(I), Summer Midgrass, Summer Annual Forb	074X6.4
		Spring Rhizomatous Grass(I), Spring Annual Grass(I), Spring Rhizomatous Grass, Spring Annual Grass, Summer Perennial Forb, Summer Tallgrass, Summer Midgrass	074X6.5
MLRA	**Ecological Site Class Name**	**Ecological Site Names**	**Ecological Site ID**
74	**Sandy Upland**	Sandy (PE 26 – 30)	R074XY022KS
		Sands (PE 26 - 30)	R074XY021KS
		Plant Community Class Names, from NRI data	**Plant Community Class ID**
		Summer Tallgrass, Summer Midgrass, Summer Perennial Forb, Spring Midgrass, Summer Rhizomatous Grass, Summer Perennial Grasslike, Summer Annual Grass	074X7.1
		Summer Tallgrass, Evergreen Tree, Summer Midgrass, Summer Perennial Forb, Summer Rhizomatous Grass, Summer Perennial Grasslike, Spring Midgrass	074X7.2
MLRA	**Ecological Site Class Name**	**Ecological Site Names**	**Ecological Site ID**
74	**Terrace**	Loamy Lowland (PE 26 - 30)	R074XY013KS
		Loamy Terrace (PE 26 - 30)	R074XY014KS
		Clay Lowland (PE 26 - 30)	R074XY004KS
		Sandy Lowland (PE 26 - 30)	R074XY023KS
		Plant Community Class Names, from NRI data	**Plant Community Class ID**
		Summer Tallgrass, Summer Midgrass, Spring Rhizomatous Grass(I), Summer Perennial Forb, Spring Annual Grass, Spring Annual Grass(I), Summer Annual Forb	074X3.1
		Spring Annual Grass(I), Spring Rhizomatous Grass, Summer Perennial Forb, Summer Tallgrass, Summer Midgrass, Spring Rhizomatous Grass(I), Deciduous Subshrub	074X3.3

Appendix B. MLRA 74 Common Plant Species, and Plants Named in the Report

Common Name	Symbol	Scientific Name	Functional Group
alfalfa	MESA	Medicago sativa	Spring Perennial Forb(I)
American elm	ULAM	Ulmus americana	Deciduous Tree
annual ragweed	AMAR2	Ambrosia artemisiifolia	Summer Annual Forb
aromatic aster	SYOB	Symphyotrichum oblongifolium	Summer Perennial Forb
aster	ASTER	Aster	Spring Perennial Forb
Baldwin's ironweed	VEBA	Vernonia baldwinii	Summer Perennial Forb
Bicknell's sedge	CABI3	Carex bicknellii	Spring Perennial Grasslike
big bluestem	ANGE	Andropogon gerardii	Summer Tallgrass
black locust	ROPS	Robinia pseudoacacia	Deciduous Tree
blue grama	BOGR2	Bouteloua gracilis	Summer Rhizomatous Grass
buckbrush	CECU	Ceanothus cuneatus	Evergreen Shrub
buffalograss	BUDA	Buchloe dactyloides	Summer Rhizomatous Grass
camphorweed	HESU3	Heterotheca subaxillaris	Spring Midgrass
Canada goldenrod	SOCA6	Solidago canadensis	Summer Perennial Forb
Canadian horseweed	COCA5	Conyza canadensis	Spring Annual Forb
Canadian wildrye	ELHI4	xElyleymus hirtiflorus	Spring Tallgrass
cheatgrass	BRTE	Bromus tectorum	Spring Annual Grass(I)
chickasaw plum	PRAN3	Prunus angustifolia	Deciduous Shrub/Tree
chinquapin oak	QUMU	Quercus muehlenbergii	Deciduous Tree
common dandelion	TAOF	Taraxacum officinale	Spring Perennial Forb
common yarrow	ACMI2	Achillea millefolium	Spring Perennial Forb
common yellow oxalis	OXST	Oxalis stricta	Summer Perennial Forb
composite dropseed	SPCO16	Sporobolus compositus	Summer Midgrass
coralberry	SYOR	Symphoricarpos orbiculatus	Deciduous Shrub
corn	ZEMA	Zea mays	Summer Annual Grass
cottonwood	POPUL	Populus	Deciduous Tree
Cuman ragweed	AMPS	Ambrosia psilostachya	Summer Perennial Forb
dotted blazing star	LIPU	Liatris punctata	Summer Perennial Forb
dropseed	SPORO	Sporobolus	Summer Midgrass
eastern gamagrass	TRDA3	Tripsacum dactyloides	Summer Tallgrass
eastern redcedar	JUVI	Juniperus virginiana	Evergreen Tree
fairy slipper	CABU	Calypso bulbosa	Spring Perennial Forb
fall witchgrass	DICO6	Digitaria cognata	Summer Midgrass
field bindweed	COAR4	Convolvulus arvensis	Summer Perennial Forb(I)
field pussytoes	ANNE	Antennaria neglecta	Summer Midgrass
fox sedge	CAVU2	Carex vulpinoidea	Spring Perennial Grasslike
golden currant	RIAU	Ribes aureum	Deciduous Shrub
goldenrod	SOLID	Solidago	Spring Perennial Forb

Common Name	Symbol	Scientific Name	Functional Group
green antelopehorn	ASVI2	Asclepias viridis	Summer Perennial Forb
green bristlegrass	SEVI4	Setaria viridis	Summer Annual Grass(I)
hairy grama	BOHI2	Bouteloua hirsuta	Summer Shortgrass
heavy sedge	CAGR4	Carex gravida	Spring Perennial Grasslike(I)
Heller's rosette grass	DIOL	Dichanthelium oligosanthes	Spring Midgrass
hoary false goldenaster	HECA8	Heterotheca canescens	Summer Annual Forb
hoary verbena	VEST	Verbena stricta	Summer Annual Forb
honey locust	GLTR	Gleditsia triacanthos	Deciduous Shrub/Tree
indiangrass	SONU2	Sorghastrum nutans	Summer Tallgrass
inland ceanothus	CEHE	Ceanothus herbaceus	Deciduous Shrub
inland rush	JUIN2	Juncus interior	Spring Perennial Grasslike
Japanese brome	BRJA	Bromus japonicus	Spring Annual Grass(I)
jointed goatgrass	AECY	Aegilops cylindrica	Summer Annual Grass(I)
Kentucky bluegrass	POPR	Poa pratensis	Spring Rhizomatous Grass(I)
kochia	KOSC	Kochia scoparia	Spring Annual Forb(I)
largebracted plantain	PLAR3	Plantago aristata	Summer Annual Forb
leadplant	AMCA6	Amorpha canescens	Deciduous Subshrub
little barley	HOPU	Hordeum pusillum	Spring Annual Grass
little bluestem	SCSC	Schizachyrium scoparium	Summer Midgrass
lovegrass	ERAGR	Eragrostis	Spring Midgrass
Maximilian sunflower	HEMA2	Helianthus maximiliani	Summer Annual Forb
Missouri goldenrod	SOMI2	Solidago missouriensis	Summer Perennial Forb
needle-and-thread	HECO26	Hesperostipa comate	Summer Midgrass
nettle	URTIC	Urtica	Summer Shortgrass(I)
nodding plumeless thistle	CANU4	Carduus nutans	Spring Perennial Forb(I)
Nuttall's prairie parsley	PONU4	Polytaenia nuttallii	Summer Perennial Forb
Nuttall's sensitive-briar	MINU6	Mimosa nuttallii	Summer Perennial Forb
osage orange	MAPO	Maclura pomifera	Deciduous Tree
Pennsylvania smartweed	POPE2	Polygonum pensylvanicum	Spring Annual Forb
pitcher sage	SAAZG	Salvia azurea var. grandiflora	Summer Perennial Forb
plains bristlegrass	SEVU2	Setaria vulpiseta	Summer Midgrass
plains muhly	MUCU3	Muhlenbergia cuspidata	Summer Midgrass
prairie bluets	HENI4	Hedyotis nigricans	Summer Perennial Forb
prairie broomweed	AMDR	Amphiachyris dracunculoides	Summer Annual Forb
prairie cordgrass	SPPE	Spartina pectinate	Summer Tallgrass
prairie fleabane	ERST3	Erigeron strigosus	Summer Annual Forb
prairie rose	ROAR3	Rosa arkansana	Deciduous Subshrub
prairie spiderwort	TROC	Tradescantia occidentalis	Summer Perennial Forb
prairie sunflower	HEPE	Helianthus petiolaris	Summer Annual Forb

Common Name	Symbol	Scientific Name	Functional Group
prairie threeawn	AROL	Aristida oligantha	Summer Midgrass
purple lovegrass	ERSP	Eragrostis spectabilis	Spring Midgrass
purple poppymallow	CAIN2	Callirhoe involucrata	Spring Perennial Forb
purpletop tridens	TRFL2	Tridens flavus	Summer Midgrass
rough false pennyroyal	HEHI	Hedeoma hispida	Summer Annual Forb
roughleaf dogwood	CODR	Cornus drummondii	Deciduous Shrub/Tree
rush	JUNCU	Juncus	Spring Perennial Grasslike
sand dropseed	SPCR	Sporobolus cryptandrus	Summer Midgrass
sand lovegrass	ERTR3	Eragrostis trichodes	Summer Midgrass
sandbur	CENCH	Cenchrus	Summer Shortgrass
sedge	CAREX	Carex	Spring Perennial Grasslike
shortbeak sedge	CABR10	Carex brevior	Spring Perennial Grasslike
sideoats grama	BOCU	Bouteloua curtipendula	Summer Midgrass
skunkbush sumac	RHTR	Rhus trilobata	Evergreen Shrub
slimflower scurfpea	PSTE5	Psoralidium tenuiflorum	Summer Perennial Forb
small-leaf spiderwort	TRFL	Tradescantia fluminensis	Spring Perennial Forb(I)
smooth brome	BRIN2	Bromus inermis	Spring Rhizomatous Grass(I)
smooth sumac	RHGL	Rhus glabra	Deciduous Shrub
spikerush	ELEOC	Eleocharis	Spring Perennial Grasslike
sticky skullcap	SCRE3	Scutellaria resinosa	Summer Perennial Forb
stiff goldenrod	OLRI	Oligoneuron rigidum	Summer Perennial Forb
sweetclover	MEOF	Melilotus officinalis	Spring Annual Forb(I)
switchgrass	PAVI2	Panicum virgatum	Summer Tallgrass
tall dropseed	SPCO16	Sporobolus compositus	Summer Tallgrass
tall fescue	LOAR10	Lolium arundinaceum	Spring Rhizomatous Grass
tufted lovegrass	ERPE	Eragrostis pectinacea	Summer Annual Grass
tumble windmill grass	CHVE2	Chloris verticillata	Summer Annual Grass
tumblegrass	SCPA	Schedonnardus paniculatus	Summer Midgrass
Virginia groundcherry	PHVI5	Physalis virginiana	Summer Perennial Forb
wavyleaf thistle	CIUN	Cirsium undulatum	Summer Perennial Forb
western silver aster	SYSE2	Symphyotrichum sericeum	Summer Perennial Forb
western wheatgrass	PASM	Pascopyrum smithii	Spring Rhizomatous Grass
wheat, winter	TRITI	Triticum	Spring Annual Grass
white heath aster	SYER	Symphyotrichum ericoides	Summer Perennial Forb
white sagebrush	ARLU	Artemisia ludoviciana	Summer Perennial Forb
white sweetclover	MEAL12	Melilotus alba	Spring Annual Forb(I)
wild plum	PRAM	Prunus americana	Deciduous Shrub/Tree
witchgrass	PACA6	Panicum capillare	Summer Annual Grass

APPENDIX C. MLRA 74 COMMUNITY CLASSES AND NUMBER OF CORRELATED NRI SITES

MLRA Community Class	Number of PSUs	Community Class with Lbs/Ac	Dominant Species by Weight
074X3.1	1	Summer Tallgrass (1896), Spring Annual Grass (773), Summer Midgrass (710), Spring Rhizomatous Grass(I) (581), Spring Annual Grass(I) (223), Summer Perennial Forb (174), Spring Midgrass (3)	big bluestem (ANGE), little barley (HOPU), Kentucky bluegrass (POPR), little bluestem (SCSC), Japanese brome (BRJA), sand dropseed (SPCR), common yellow oxalis (OXST), Indiangrass (SONU2), switchgrass (PAVI2), sideoats grama (BOCU)
074X3.3	5	Spring Annual Grass(I) (1730), Summer Perennial Forb (615), Summer Tallgrass (358), Spring Rhizomatous Grass (296), Summer Midgrass (113), Spring Rhizomatous Grass(I) (110), Spring Perennial Grasslike (39)	Japanese brome (BRJA), tall fescue (LOAR10), western wheatgrass (PASM), wreath goldenrod (SOCA4), slimflower scurfpea (PSTE5), white sagebrush (ARLU), big bluestem (ANGE), Kentucky bluegrass (POPR), little bluestem (SCSC), goldenrod (SOLID)
074X6.1	53	Summer Tallgrass (1459), Summer Midgrass (746), Summer Perennial Forb (326), Spring Rhizomatous Grass(I) (167), Spring Midgrass (138), Spring Annual Grass(I) (70), Spring Rhizomatous Grass (65)	Indiangrass (SORGH), big bluestem (ANGE), Sporobolus spp. (SPORO), little bluestem (SCSC), hoary false goldenaster (HECA8), heavy sedge (CAGR4), Baldwin's ironweed (VEBA), prairie spiderwort (TROC), Indiangrass (SONU2), tall dropseed (SPCO16)
074X6.2	11	Summer Tallgrass (1077), Deciduous Tree (459), Summer Midgrass (361), Summer Perennial Forb (345), Spring Rhizomatous Grass(I) (155), Deciduous Subshrub (142), Spring Annual Grass(I) (78)	osage orange (MAPO), green ash (FRPE), big bluestem (ANGE), Illinois bundleflower (DEIL), black locust (ROPS), prairie rose (ROAR3), little bluestem (SCSC), smooth sumac (RHGL), smooth brome (BRIN2), yellow sundrops (CASE12), slimflower scurfpea (PSTE5)
074X6.3	2	Spring Rhizomatous Grass (2195), Spring Perennial Grasslike (1182), Spring Annual Grass(I) (560), Summer Perennial Forb (157), Summer Rhizomatous Grass (122), Summer Tallgrass (118), Spring Rhizomatous Grass(I) (100)	tall fescue (LOAR10), inland rush (JUIN2), Japanese brome (BRJA), fox sedge (CAVU2), Buffalograss (BUDA), big bluestem (ANGE), smooth brome (BRIN2), spikerush (ELEOC), nettle (URTIC), Cuman ragweed (AMPS), sweetclover (MEOF), tumble windmill grass (CHVE2)
074X6.4	22	Spring Annual Grass(I) (1663), Summer Tallgrass (536), Spring Annual Forb(I) (304), Summer Perennial Forb (274), Spring Rhizomatous Grass(I) (263), Summer Midgrass (258), Summer Annual Forb (190)	kochia (KOSC), Japanese brome (BRJA), annual ragweed (AMAR2), little barley (HOPU), tumblegrass (SCPA), jointed goatgrass (AECY), switchgrass (PAVI2), smooth brome (BRIN2), cheatgrass (BRTE), little bluestem (SCSC), big bluestem (ANGE), buckbrush (CECU)
074X6.5	4	Spring Rhizomatous Grass(I) (2814), Spring Annual Grass(I) (355), Spring Rhizomatous Grass (327), Spring Annual Grass (169), Summer Perennial Forb (164), Summer Tallgrass (91), Summer Midgrass (41)	smooth brome (BRIN2), tall fescue (LOAR10), Japanese brome (BRJA), Virginia wildrye (ELSU), narrowleaf four o'clock (MILI3), Canada goldenrod (SOCA6), big bluestem (ANGE), bindweed (CONVO), purpletop tridens (TRFL2), Indiangrass (SONU2)
074X7.1	1	Summer Tallgrass (352), Summer Midgrass (251), Summer Perennial Forb (224), Spring Midgrass (91), Summer Rhizomatous Grass (74), Summer Perennial Grasslike (40), Summer Annual Grass (7)	Cuman ragweed (AMPS), switchgrass (PAVI2), Indiangrass (SONU2), little bluestem (SCSC), Heller's rosette grass (DIOL), sand dropseed (SPCR), blue grama (BOGR2), yellow nutsedge (CYES), fall witchgrass (DICO6), white sagebrush (ARLU)
074X7.2	1	Summer Tallgrass (486), Evergreen Tree (300), Summer Midgrass (272), Summer Perennial Forb (76), Summer Rhizomatous Grass (66), Summer Perennial Grasslike (36), Spring Midgrass (29)	Indiangrass (SONU2), eastern redcedar (JUVI), purpletop tridens (TRFL2), big bluestem (ANGE), little bluestem (SCSC), sideoats grama (BOCU), Buffalograss (BUDA), Cuman ragweed (AMPS), yellow nutsedge (CYES), Heller's rosette grass (DIOL)

APPENDIX D. MLRA 74 COMMUNITY CLASSES AND AVERAGE NRI AND RHEM VALUES

Site Class Name	MLRA Comm	Comm Class Name	Avg Lbs/Ac	Avg Pct Runoff	Avg Ann SoilLoss ton/ac	Avg PctCov Bunch grass	Avg PctCov Sod grass	Avg PctCov Shrubs	Avg PctCov Bare	Avg PctCov Rock	Avg PctCov Litter
Terrace Class	074X3.1	Summer Tall Grass, Spring Annual Grass, Summer Midgrass, Spring Rhizomatous Grass(I), Spring Annual Grass(I), Summer Perennial Forb, Spring Midgrass	4366	30%	1.4	36	1	0	99	1	0
Terrace Class	074X3.3	Spring Annual Grass(I), Summer Perennial Forb, Summer Tall Grass, Spring Rhizomatous Grass, Summer Midgrass, Spring Rhizomatous Grass(I), Spring Perennial Grasslike	3365	31%	12.5	19	4	2	100	0	0
Loamy Upland Class	074X6.1	Summer Tall Grass, Summer Midgrass, Summer Perennial Forb, Spring Rhizomatous Grass(I), Spring Midgrass, Spring Annual Grass(I), Spring Rhizomatous Grass	3257	14%	5.2	44	7	2	33	1	62
Loamy Upland Class	074X6.2	Summer Tall Grass, Deciduous Tree, Summer Midgrass, Summer Perennial Forb, Spring Rhizomatous Grass(I), Deciduous Subshrub, Spring Annual Grass(I)	2834	16%	6.9	42	3	1	41	2	51
Loamy Upland Class	074X6.3	Spring Rhizomatous Grass, Spring Perennial Grasslike, Spring Annual Grass(I), Summer Perennial Forb, Summer Rhizomatous Grass, Summer	4752	25%	8.7	50	14	0	78	8	15

Site Class Name	MLRA Comm	Comm Class Name	Avg Lbs/Ac	Avg Pct Runoff	Avg Ann SoilLoss ton/ac	Avg PctCov Bunch grass	Avg PctCov Sod grass	Avg PctCov Shrubs	Avg PctCov Bare	Avg PctCov Rock	Avg PctCov Litter
		Tall Grass, Spring Rhizomatous Grass(I)									
Loamy Upland Class	074X6.4	Spring Annual Grass(I), Summer Tall Grass, Spring Annual Forb(I), Summer Perennial Forb, Spring Rhizomatous Grass(I), Summer Midgrass, Summer Annual Forb	4117	27%	12.1	22	5	1	93	1	4
Loamy Upland Class	074X6.5	Spring Rhizomatous Grass(I), Spring Annual Grass(I), Spring Rhizomatous Grass, Spring Annual Grass, Summer Perennial Forb, Summer Tall Grass, Summer Midgrass	4039	19%	9.5	44	4	0	55	0	40
Sandy Upland Class	074X7.1	Summer Tall Grass, Summer Midgrass, Summer Perennial Forb, Spring Midgrass, Summer Rhizomatous Grass, Summer Perennial Grasslike, Summer Annual Grass	1045	4%	0.3	20	1	3	27	0	65
Sandy Upland Class	074X7.2	Summer Tall Grass, Evergreen Tree, Summer Midgrass, Summer Perennial Forb, Summer Rhizomatous Grass, Summer Perennial Grasslike, Spring Midgrass	1289	3%	0.0	31	6	1	17	0	79

ACKNOWLEDGEMENTS

This report was funded through USDA-NRCS CEAP-Grazing Lands and was developed in Calendar Year 2015, using ecological site, soil mapping, and NRI (2004-2011) data available in that year.

Many highly dedicated and talented individuals helped with this project. At the risk of leaving out some of the individuals who contributed, Loretta Metz, Steve Barker, and Pat Shaver would like to thank the following people for their input and support.

Joel Brown, NRCS NEST, Las Cruces NM
Brandon Bestelmeyer, ARS Las Cruces NM
Phil Heilman, ARS Tucson AZ
Mark Nearing, ARS Tucson AZ
Mariano Hernandez, ARS Tucson AZ
Jebediah Williamson, ARS Las Cruces NM
Joe Anderson, MLRA SSPL Salina KS
Jeff Hellerich, ARSS Manhattan KS
David Kraft, State RMS Emporia KS
Chad Remley SSS Salina KS
Dwayne Rice, Area RMS Lincoln KS
Doug Spencer, Area RMS Marion KS
Dusty Tacha, Area RMS Hutchinson KS
Chris Tecklenburg, ESIS Hutchinson KS
Cleveland Watts, SSRD Salina KS

References

Abrams, M.D., A.K. Knapp, and L.C. Hulbert. 1986. A Ten-Year Record of Aboveground Biomass in a Kansas Tallgrass Prairie: Effects of Fire and Topographic Position. American Journal of Botany, vol. 73(10): 1509-1515.

Bragg, T.B. and L.C. Hulbert. 1976. Woody Plant Invasion of Unburned Kansas Bluestem Prairie. Journal of Range Management, vol. 29 (1): 19-24.

Collins, S.L., A.K. Knapp, J.M. Briggs, and J.M. Blair. 1998. Modulation of Diversity by Grazing and Mowing in Native Tallgrass Prairie. SCIENCE, vol. 280: 745-747.

Hulbert, L. C. 1969. Fire and Litter Effects in Undisturbed Bluestem Prairie in Kansas. Ecology, vol. 50(5): 874-877.

Nearing, M. A. et. al. 2011. A Rangeland Hydrology and Erosion Model. American Society of Agricultural and Biological Engineers, vol. 54(3).

Owensby, C.E., R.M. Hyde, and K.L. Anderson. 1970. Effects of Clipping and Supplemental Nitrogen and Water on Loamy Upland Bluestem Range. Journal of Range Management, vol. 23(5): 341–346.

Owensby, C.E., K.R. Blan, B.J. Eaton, and O.G. Russ. 1973. Evaluation of Eastern Redcedar Infestations in the Northern Kansas Flint Hills. Journal of Range Management, vol. 26(4): 256-260.

Pellant, M., P. Shaver, D.A. Pyke, and J.E. Herrick. 2005. Interpreting indicators of rangeland health, version 4. Technical Reference 1734-6. U.S. Department of Interior, Bureau of Land Management, National Science and Technology Center, Denver, CO. BLM/WO/ST-00/001+1734/REV05. 122 pp.

USDA Natural Resources Conservation Service. 2006. Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296.

USDA Natural Resources Conservation Service Ecological Site Description (ESD) System - Ecological Site Description reports for ecological sites in MLRAs 74 and 77C.

USDA Natural Resources Conservation Service Field Office Technical Guide for Kansas and Texas.