# Chapter 5. Plant Communities and Landscape Features

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## 5.1 INTRODUCTION

Smoky Hill ANGR encompasses approximately 34,000 acres. Most of the landscape is native prairie, making it the largest known public holding of the Dakota Hills tallgrass prairie vegetation type. The major management categories on Smoky Hill ANGR include pastures, hay meadows, and the impact area.

### 5.1.1 Management Areas on the Smoky Hill ANGR

#### 5.1.1.1 Impact Area

The management of the impact area (see Figure 5.1) at Smoky Hill ANGR may be unique across the entire Great Plains as it is a large acreage of native prairie managed only by the use of fire. While there are other parcels of land within the tallgrass prairie that are neither hayed nor grazed, those parcels are not as large as the Smoky Hill ANGR or as frequently burned. The frequently prescribed and accidental burns, especially hot, often wind-blown during the heat of summer occur at least once annually, and have resulted in a local landscape primarily devoid of thatch.

These conditions result in comparatively high percentages of bare ground and a species composition largely composed of perennial, highly conservative prairie plants (desirable plants that do not tolerate disturbance except fire). The assemblage of plants within the impact area may reflect the beauty and composition of the prairies before the advent of European settlement and confined livestock grazing, although the burning regime is probably uncharacteristically frequent.

#### 5.1.1.2 Native Prairie Pastures

The pasture areas at Smoky Hill ANGR are leased for grazing from 1 May to 31 October and stocked at a rate of 1000 pounds per 7 acres. Double- stocked grazing for a shorter duration (ending at the end of May) is also possible under the lease agreement.

Grazing by livestock in a confined area affects the quality and quantity of vegetation. Cattle seek certain plants (decreasers) and avoid other species (increasers or weeds) based on palatability. Continuous moderate to heavy grazing often results in the decline or elimination of the most palatable species. For this reason we were especially interested in studying areas of pastures at Smoky Hill ANGR.

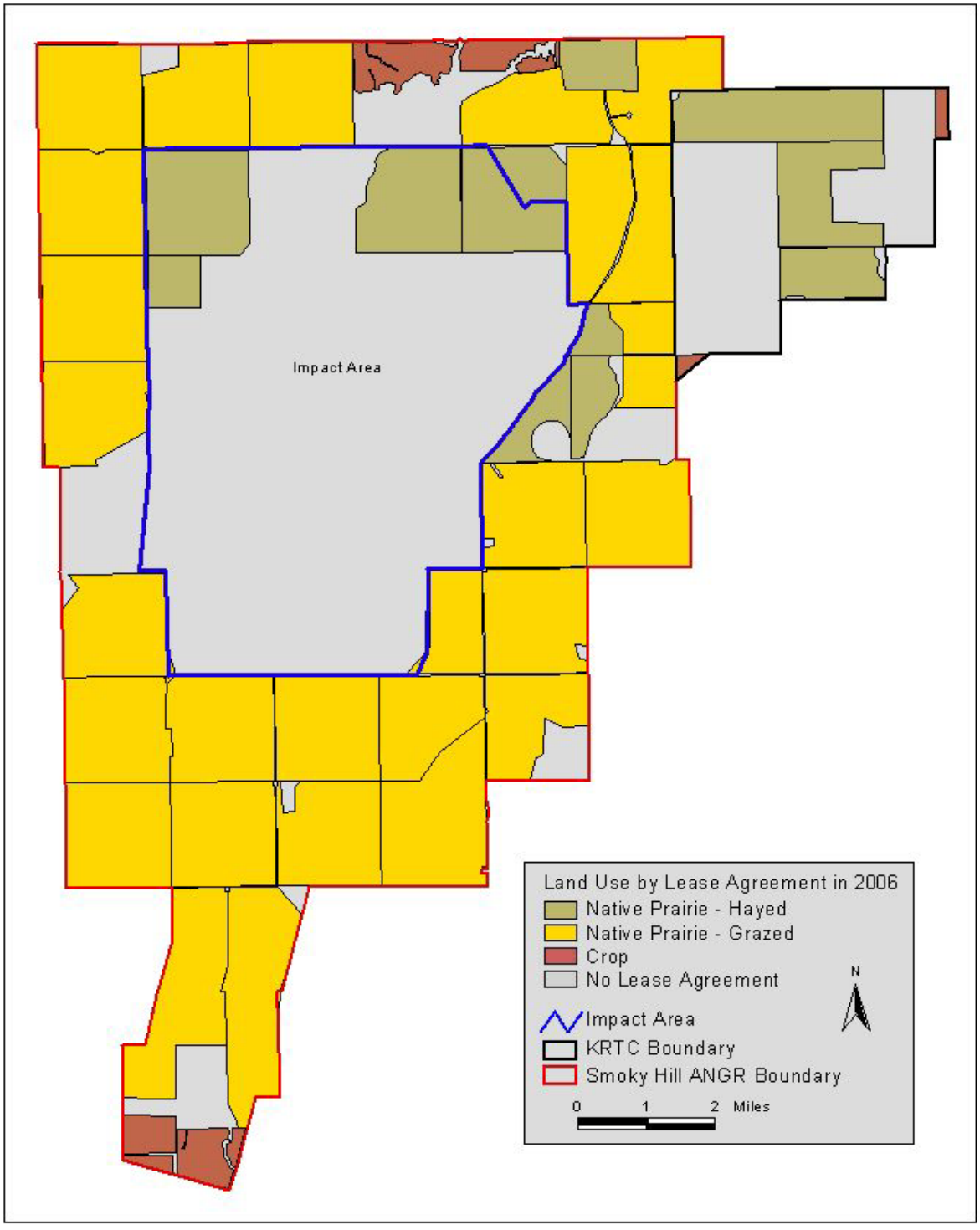


Figure 5.1. Land Use of Smoky Hill ANGR.

#### 5.1.1.3 Native Prairie Hay Meadows

The hay meadows at Smoky Hill ANGR are cut and baled once a year between 1 July and 1 August. Haying as a management technique puts less selective pressure on plant species composition than does grazing. The cutting of hay is non-selective, taking equally of all plants in a unit. However it does select against some plants that mature seed in the late summer by preventing them from reproducing by seed. Many grasses, after being cut, are capable of flowering and setting seed before frost. Typically, few forbs (non-woody, broad-leaved plants) manage to mature and produce seed after being mowed. Nevertheless, these long-lived perennials plants seem to flourish under a haying regime.

#### 5.1.1.4 Riparian Areas

The majority of wooded areas on Smoky Hill ANGR are found within a narrow strip along Spring Creek. Very few mature trees were noted during formal and informal surveys of riparian zones of Smoky Hill ANGR. Some of these wooded areas have increased in size due to not being burned.

### 5.1.2 Past Land Uses

#### 5.1.2.1 Public Land Surveys

The original vegetation in this part of the state was mostly native tallgrass prairie. For Saline County, prairie was observed on 96 percent of the county. The public land surveys were conducted in 1859 to delineate the boundaries of section lines for every square mile so that they could soon be settled. For this reason every section line was walked by surveyors and measured. They also mapped the lands (Figure 5.2) as prairie or forest and recorded field notes. We felt it would be important to incorporate this data as a baseline for our report. The result of the survey work shows that over 99.7 percent of Smoky Hill ANGR was native prairie and trees were confined to 91 acres primarily along the creeks in the northern portion of the Range. Tree species observed included: cottonwood, elm, walnut and willows (Kansas Society off Land Surveyors 2006)

#### 5.1.2.2 Land Use before Smoky Hill ANGR Establishment

The tallgrass prairie that undulates over the Smoky Hill ANGR is a mosaic of varying types and qualities of grassland. Within the mostly virgin (unplowed) prairie are small areas of former cropland, as well as other vestiges of early homesteads. In the historical documents, we know that there was some farmland in the 1940s when Smoky Hill ANGR was being established. In order to determine the past land use, we purchased contact prints for 39 black and white aerial photos taken in 1938 (obtained through King Visual Archives of Hyattsville, Maryland). Each photo was scanned, saved in the TIFF file format and georeferenced to the UTM zone 14, NAD 1983 projection. Three polygon shape files were created from these images using ArcView GIS. Fields clearly identifiable as being under cultivation were digitized as former cropland. Fields for which there was some uncertainty as to whether or not they were under cultivation were digitized as possible crop fields. Developed areas containing groups of structures were digitized

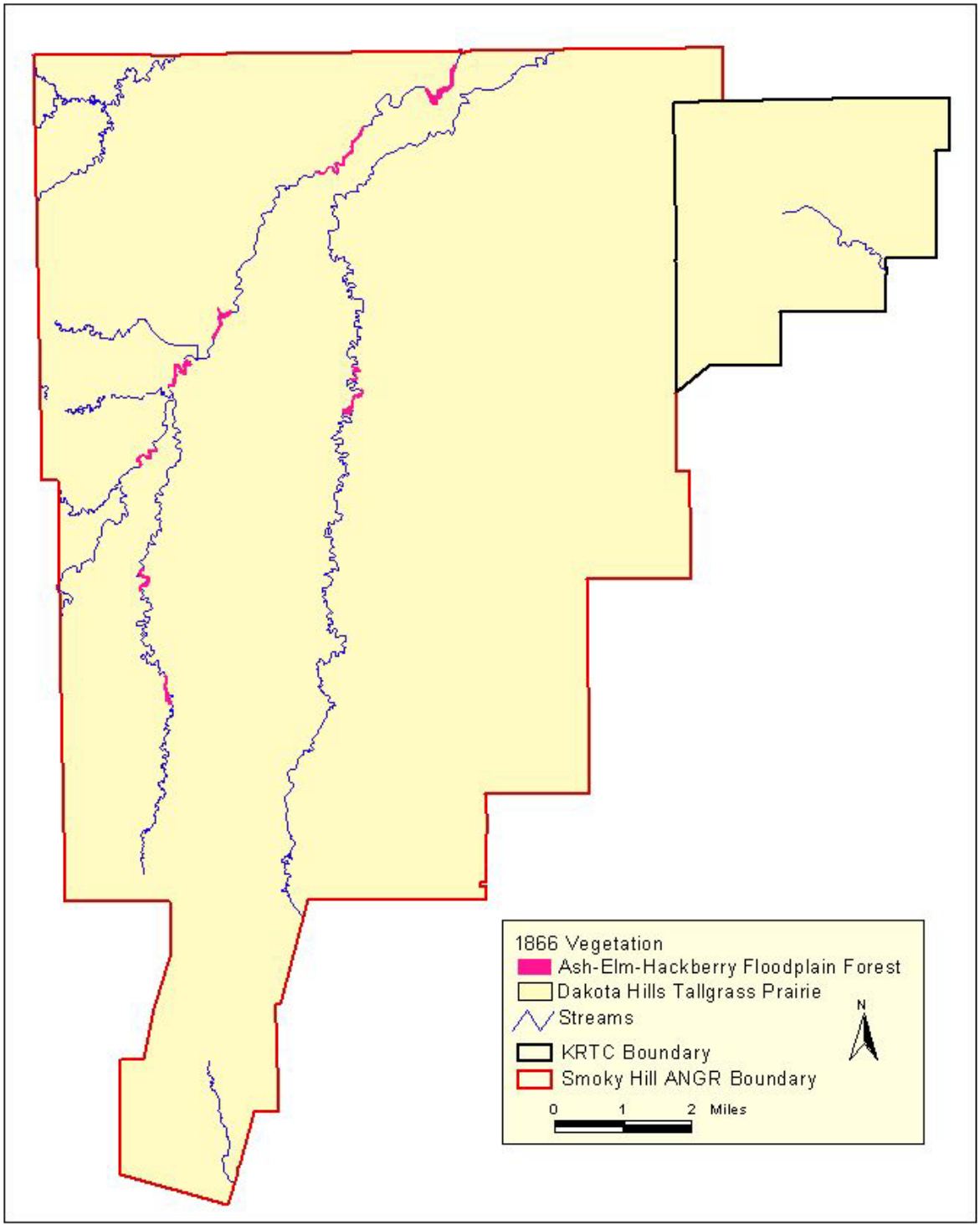


Figure 5.2. Map of Public Land Survey of 1859.

as former farmsteads. Polygon boundaries were adjusted using the public land survey system (PLSS) grid to correct for minor deviations in georeferencing. From doing this work we were able to map the land use of Smoky Hill ANGR (Figure 5.3). We determined that over 2700 acres had formerly been cropland, which comprises about 8 percent of the land area. In some cases it was difficult to tell if the area was cropland or significantly disturbed due to over-grazing or other management practices. This past cropland has a significant affect on the plant species diversity today. In those areas that are managed as native prairie today, but formerly cropped, many of the conservative species have not returned to these areas, or if they have, there are in much smaller numbers. Throughout Smoky Hill ANGR, inconsistencies in the quality of the grasslands can be seen. Some of these differences are attributable to past land uses. A familiarity with weedy plants, as well as the species composition of native high quality prairies, enables a subjective, qualitative judgment of prairie parcels. A more quantitative procedure, the floristic quality index, is detailed below. Both subjective and quantitative procedures were used to characterize the condition of sites in this study.

### 5.1.3 Objectives of Community Vegetation Data Collection

We had several objectives in collecting vegetation data:
a) To create permanent plots to enable long-term studies of land management effects.
b) To assess the effects of recent management practices (e.g., grazed vs. hayed vs. impact area) on diversity and quality of plant communities of all units.
c) To map all natural communities and identify outstanding examples.

## 5.2 METHODS

### 5.2.1 Community Assessments

Many factors related to plant species composition and the density of both the vegetation and of individual species are considered in order to determine the quality of an area and its plant communities. These factors, recorded and quantified as percent cover, are used in determining condition grades and floristic quality assessment. Within each section or management area, three locations for plots were randomly selected (Table 5.1) for upland areas. Plot data were used to characterize the vegetation of the area (Figure 5.4). Some plots were marked permanently (Figure 5.5).

### 5.2.2 Percent Cover of Plant Species

Square plots measuring 20 meters on each side were laid out using a measuring tape. All plant species occurring within the plots were identified. An estimate of cover (the area covered by each plant species as a percentage of the whole plot) was recorded following the techniques of Daubenmire (1959). The same procedure was repeated for a 1 $m^2$ plot nested within the 20 $m^2$ plot. Nested vegetation plots form an efficient method for collecting plant community data and insuring maximum accuracy of species identification.

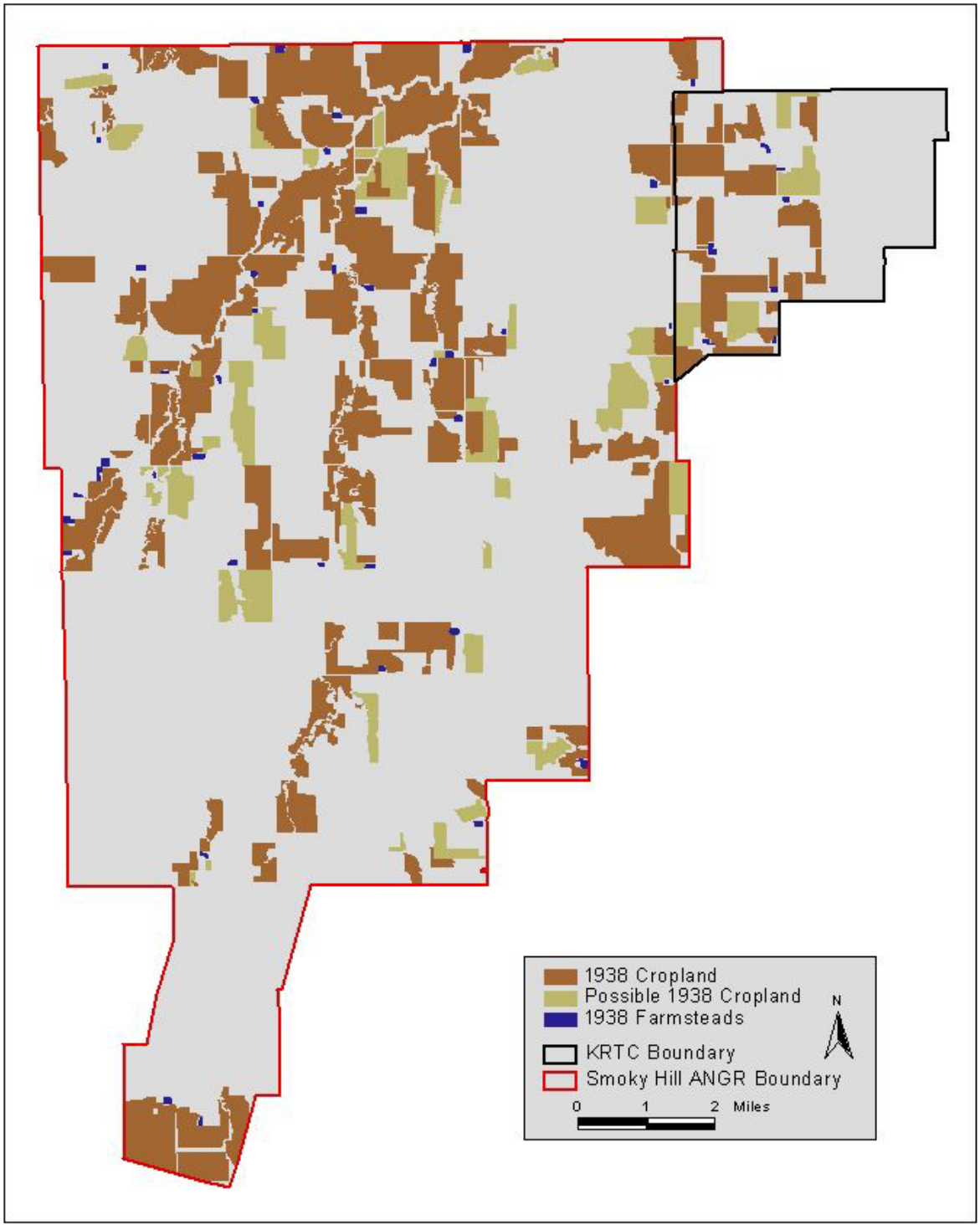


Figure 5.3. Land Use at Smoky Hill ANGR in the late 1930s.

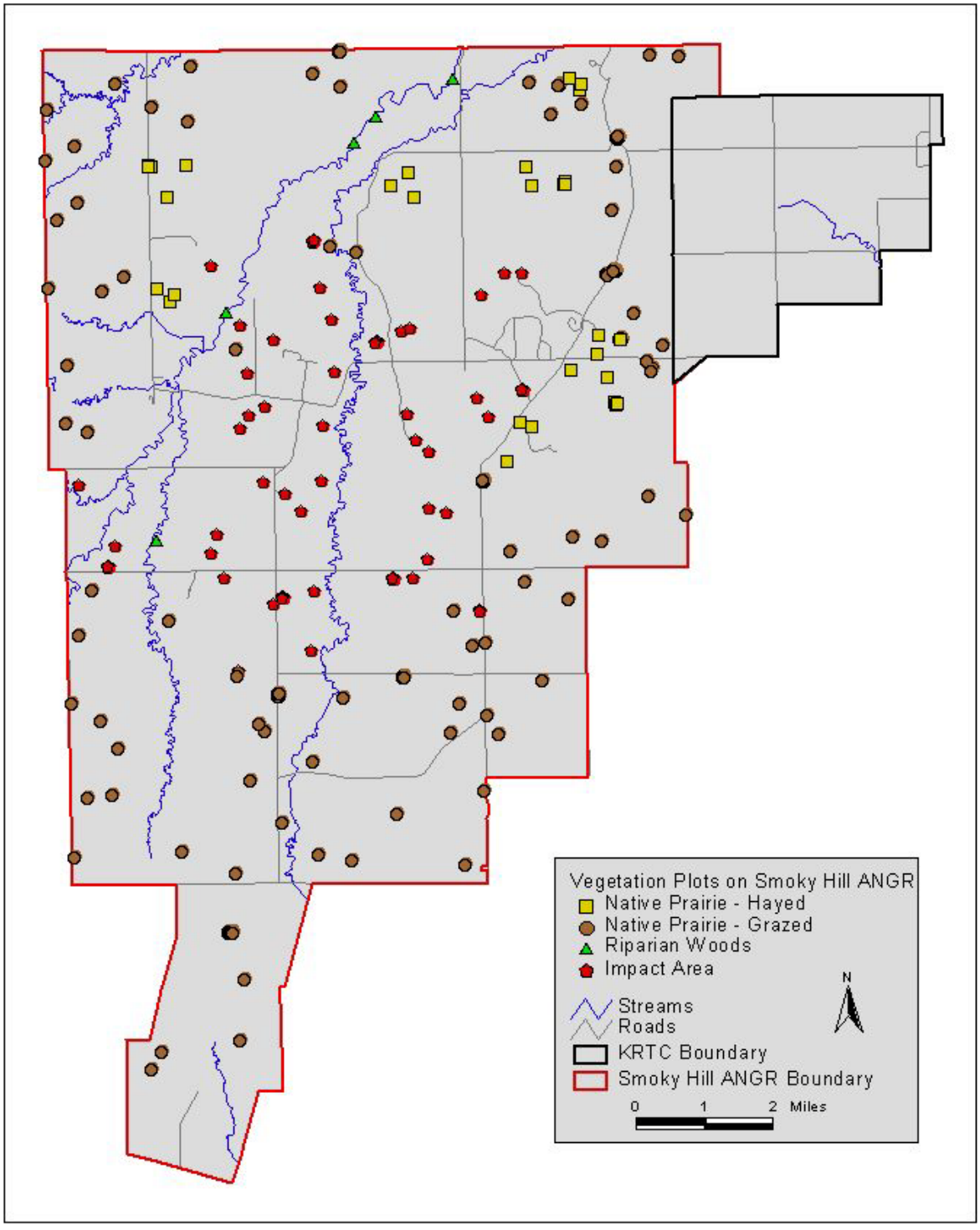


Figure 5.4. Locations of all vegetation plots on Smoky Hill ANGR.

| Fire Section # | °N | °W | Averaged Condition Grade |
|---|---|---|---|
| **Impact Area** | | | |
| 23 | 38.72796 | -97.84370 | B |
| 32 | 38.71309 | -97.85777 | B |
| 33 | 38.72152 | -97.84281 | A |
| 34 | 38.71389 | -97.83287 | A |
| 35 | 38.72312 | -97.80692 | A |
| 42 | 38.70201 | -97.85731 | A |
| 43 | 38.70232 | -97.84252 | B |
| 44 | 38.70010 | -97.82618 | A |
| 45 | 38.70676 | -97.80710 | B |
| 52 | 38.68469 | -97.86276 | B |
| 53 | 38.69292 | -97.84944 | A |
| 54 | 38.68999 | -97.82071 | A |
| 62 | 38.66821 | -97.85809 | B |
| 63 | 38.67847 | -97.85020 | B |
| 64West | 38.68090 | -97.83032 | A |
| | | | |
| **Hay Meadows** | | | |
| 24 (H1) | 38.73738 | -97.82693 | B |
| 25 (H2) | 38.73550 | -97.79948 | B |
| 45 (H7) | 38.69695 | -97.81001 | A |
| 46 (H8) | 38.70495 | -97.79082 | A |
| 36 (H9) | 38.71377 | -97.78976 | B |
| 22 (H10) | 38.73854 | -97.87268 | B |
| 32 (H11) | 38.71968 | -97.86961 | B |
| 16 (H16 ) | 38.74847 | -97.79630 | A |
| | | | |
| | | | |
| | | | |

| Fire Section # | °N | °W | Averaged Condition Grade |
|---|---|---|---|
| **Pastures** | | | |
| 11 | 38.74677 | -97.89091 | B |
| 12 | 38.74712 | -97.87238 | B |
| 13 | 38.75446 | -97.83890 | C |
| 15 | 38.74930 | -97.79997 | B |
| 16 | 38.74201 | -97.78928 | B |
| 21 | 38.73970 | -97.89121 | C |
| 26 | 38.72302 | -97.79188 | B |
| 31 | 38.72204 | -97.89095 | C |
| 36 | 38.72336 | -97.79002 | B |
| 36C | 38.71390 | -97.78934 | C |
| 41 | 38.71117 | -97.88775 | D |
| 46 | 38.71088 | -97.78472 | B |
| 55 | 38.69451 | -97.81407 | C |
| 56 | 38.68918 | -97.77822 | C |
| 61 | 38.67536 | -97.87043 | B |
| 64 | 38.67634 | -97.81520 | B |
| 65 | 38.67194 | -97.81402 | C |
| 71 | 38.66415 | -97.88772 | C |
| 72 | 38.66768 | -97.85829 | C |
| 73 | 38.66481 | -97.85093 | C |
| 74 | 38.66733 | -97.82861 | C |
| 75 | 38.66175 | -97.81403 | B |
| 81 | 38.64269 | -97.88761 | C |
| 82 | 38.65301 | -97.85625 | B |
| 83 | 38.64721 | -97.85067 | C |
| 84 | 38.65128 | -97.81469 | C |
| 91 | 38.63178 | -97.86035 | C |
| 92 | 38.63196 | -97.85980 | C |

Table 5.1. Fire Section and Condition Grade.

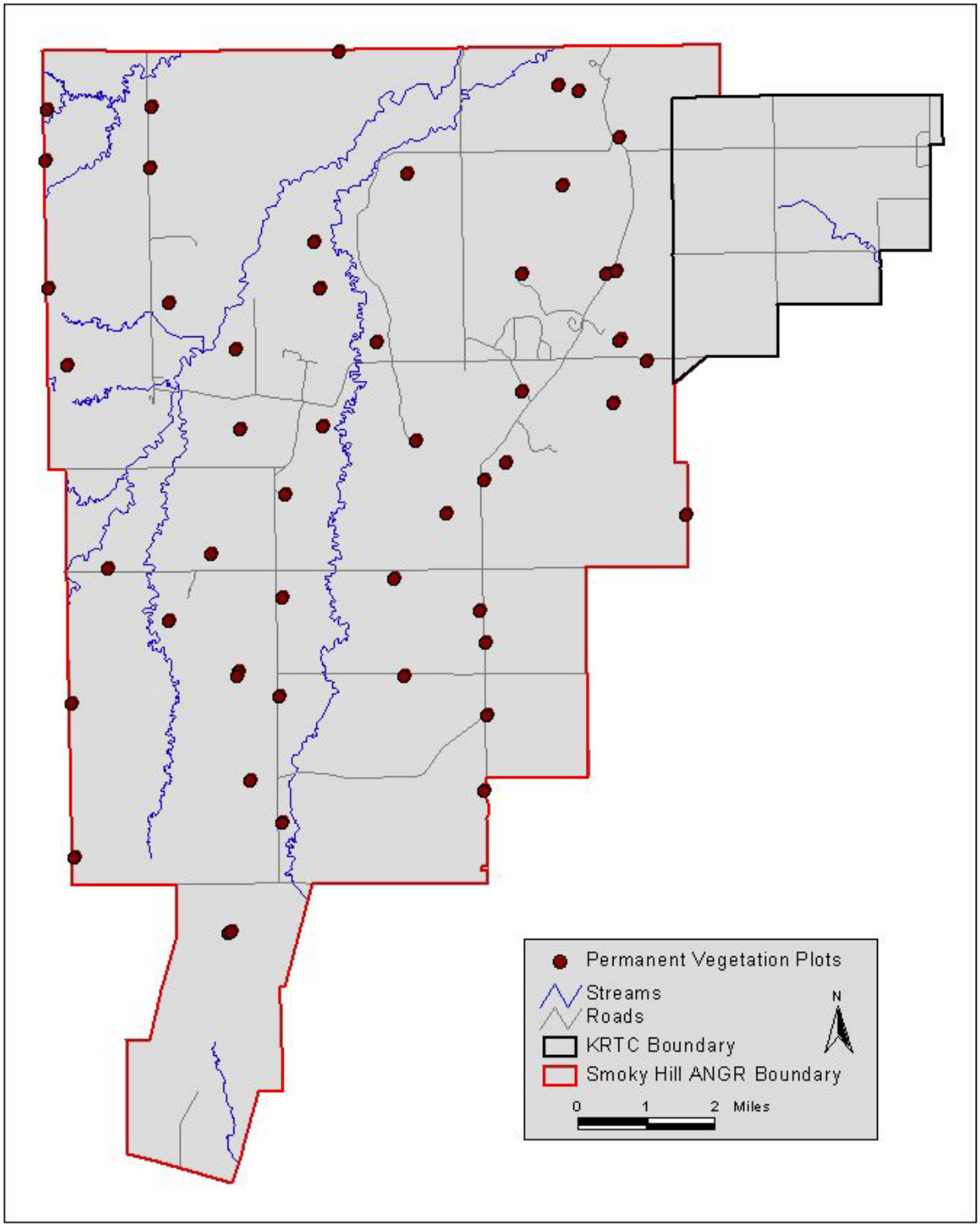


Figure 5.5. Locations of permanent vegetation plots (Fire sections correspond to Figure 5.1).

Within each section or management unit, one of the three plots surveyed was marked permanently. At each corner of that 20 $m^2$ plot, a 30 cm-long piece of rebar was driven in the soil to ground level. Global positioning system (GPS) coordinates were recorded at each corner of that plot. To facilitate relocation of these plots, permanent fixtures, such as fence posts, were painted red and used as starting points for triangulation to one corner of the permanent plot. In the impact area, where fence posts were not always available, target vehicles were used as triangulation points. Locations of the permanent plots are provided in Table 5.1 and Figure 5.5. Permanent plots will enable resampling of exact areas in order to more accurately track changes in the condition of the prairies. For each of the non-permanent plots, a single set of GPS coordinates was recorded. The cover data collected in the plots will provide a basis for assessing changes to the vegetation over time.

All plants within the plots were identified and recorded in the field. Plant species that could not be determined with confidence in the field were pressed and dried and taken to the R. L. McGregor Herbarium at the University of Kansas for identification by Craig Freeman and Caleb Morse.

### 5.2.3 Condition Grades

A condition grade is a subjective field assessment of the impact that human disturbance has had on a site. We used standard Natural Heritage procedures (NatureServe 2005) to determine the grade, based on estimates of native species richness, abundance of exotic species, and ecological processes. The potential grades range from A to D. A-grade occurrences are pristine or relatively undisturbed while D-grade sites are severely disturbed but still retain some semblance of their pre-settlement character.

### 5.2.4 Floristic Quality Assessment and Shannon Diversity Index

Floristic quality assessment (FQA) is a standardized tool used to estimate the overall ecological quality of a site based on the presence of vascular plants growing there (Freeman and Morse 2002, Swink and Wilhelm 1994, Taft et al.1997). This quantitative measure can facilitate comparison of different sites within a plant community as well as the tracking of changes over time at a single site.

Native Kansas plant species have been assigned a coefficient of conservatism (CoC) from 0 to 10 by a panel of experts. These values are based on relative tolerance to disturbance and fidelity to natural plant communities. The CoC values range from 0-1 for species that thrive in severely disturbed habitats to 9-10 for plant species restricted to intact, high quality natural areas.

An inventory of the plant species at a site is used in conjunction with the CoC values to calculate an average coefficient of conservatism (C) and a floristic quality index (FQI) for each site according to methods outlined in Freeman and Morse (2002). The FQI is the mean C multiplied by the square root of the total number of plant species in the plot (FQI = mean C x $\sqrt{N}$).

A one-way ANOVA and the LSD post-hoc test were used to determine pair-wise comparisons among the different management types.

Diversity, using the Shannon Index was also calculated for each vegetation plot. Shannon's diversity index is useful for characterizing species diversity because it provides more information about the structure of a plant community than simply species richness. Shannon's diversity index accounts for both the abundance and evenness of the species within a community.

### 5.2.5 Soils

Soils samples were collected from every management unit on Smoky Hill ANGR and from every section in the impact area. In each unit or section, soil was taken from two locations. The first sample was taken from within the permanent plots that were established during the vegetation sampling. A second sample was obtained from near one of the other two vegetation plots sites in each unit.

Soil was obtained by sinking a soil coring device into the ground to a depth of 8 inches. At each location, three core samples were taken and placed into a plastic bag labeled with the location. The samples were air dried, ground with mortar and pestle, sieved, and sent to the Soils laboratory at Kansas State University for analysis of N, P, and organic matter.

### 5.2.6 Rangeland Areas Adjacent to Smoky Hill ANGR

We sampled rangeland areas immediately adjacent to Smoky Hill ANGR to see if there were any significant differences between the two areas as they were managed similarly before World War II. We selected areas of rangeland immediately to the west and northeast of the range (Figure 5.6) because they were still being used as rangeland and had the same general soils as those in the grazed areas of Smoky Hill ANGR.

### 5.2.7 Riparian Area

In order to characterize the woodland areas of Smoky Hill ANGR, five 20 $m^2$ plots and five nested 1 $m^2$ plots were surveyed within the riparian areas along Spring Creek (Figure 5.4). Spring Creek is the largest drainage within Smoky Hill ANGR and trees line both side of the creek in a band of varying width.

The cover data for all plant species within these plots will provide a basis for assessing changes to the riparian corridor over time and for comparison with historical records. Species richness data for the riparian plots were also assessed. Since the riparian areas on Smoky Hill ANGR cover so few acres, statistical analysis was not performed on the plot data.

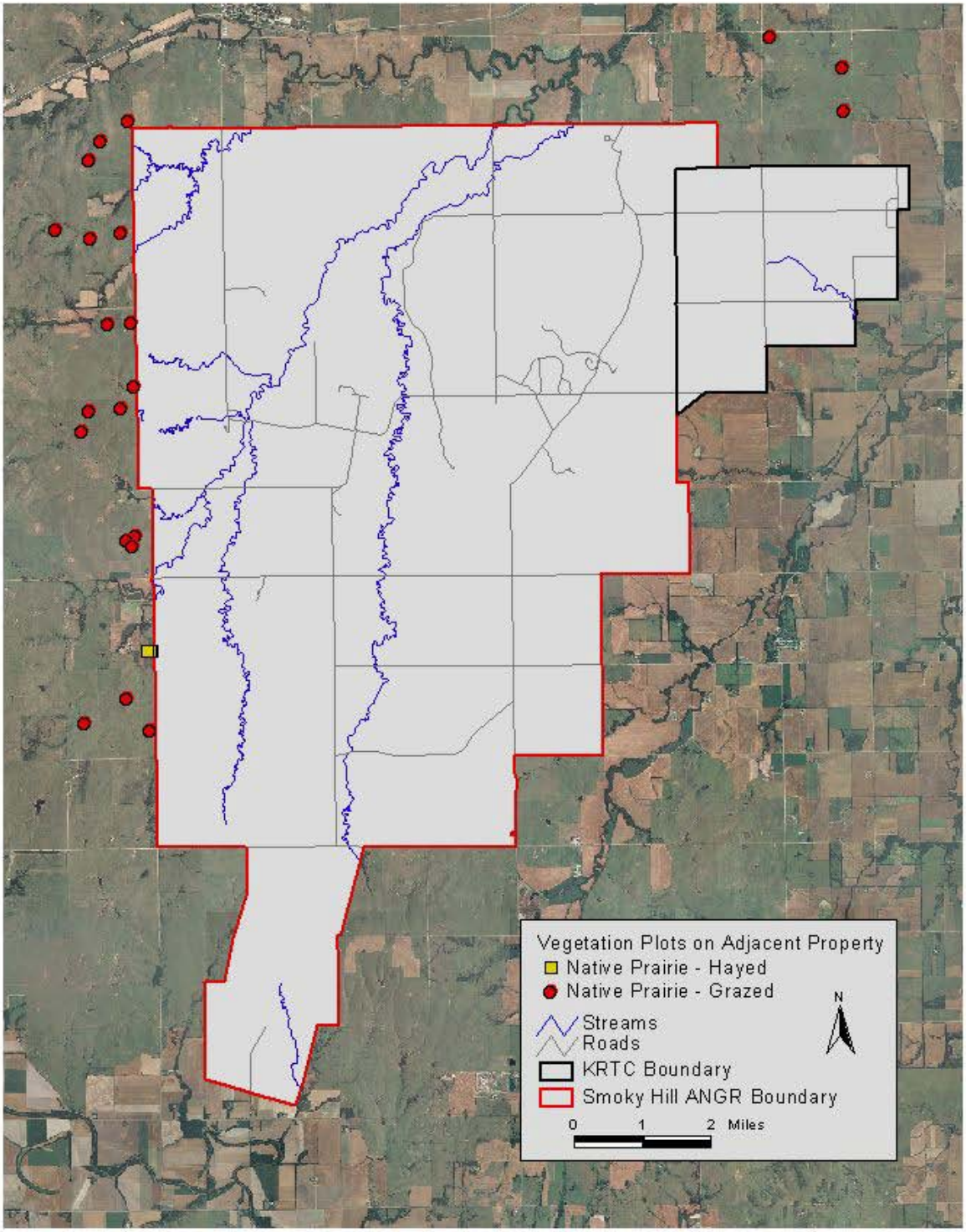


Figure 5.6. Locations of vegetation plots sampled from adjacent private ranches.

## 5.3 RESULTS

### 5.3.1 Former Crop Fields and Historic Landscape

Areas of cropland were found in many places throughout Smoky Hill ANGR, but were most common along the creeks in the north-central part of the property. Other evidence of the past land use were the hedge rows and farmsteads, mapped in Figure 5.3. The wind breaks and hedgerows amount to 65 acres of land and although they are not native, they do provide some habitat for birds and animals. Ponds with 10 meter buffers were also mapped as they provide habitat and these buffer areas near ponds were some of the most likely sites to find musk thistle (*Carduus nutans*), as pond areas often have more disturbance by livestock because they spend more time here as they like to be near water.

### 5.3.2 Plant Communities and Landscape Features of Smoky Hill ANGR

The Smoky Hill ANGR is comprised of the following plant communities and landscape features. While there may be some other plant communities reflecting seeps, small wetland areas and other types, these are very small and not easily discernable. The classification is discussed below and mapped locations are given in Figure 5.7.

1. Natural/Semi-natural Vegetation
    a. Natural/Near-natural Vegetation
        1. Dakota Hills Tallgrass Prairie (*Andropogon gerardii-Panicum virgatum-Schizachyrium scoparium*)
        2. Ash-Elm-Hackberry (*Fraxinus-Ulmus-Celtis*) Floodplain Forest
        3. Dakota Sandstone Sparse Vegetation
    b. Semi-natural/Altered
        1. Go-back Land/Tallgrass Prairie
        2. Cultivated Fields
        3. Wind breaks and Hedgerows
        4. Ponds
        5. Firebreaks
        6. Developed Areas
        7. Former Farmsteads
        8. Military Practice Disturbance

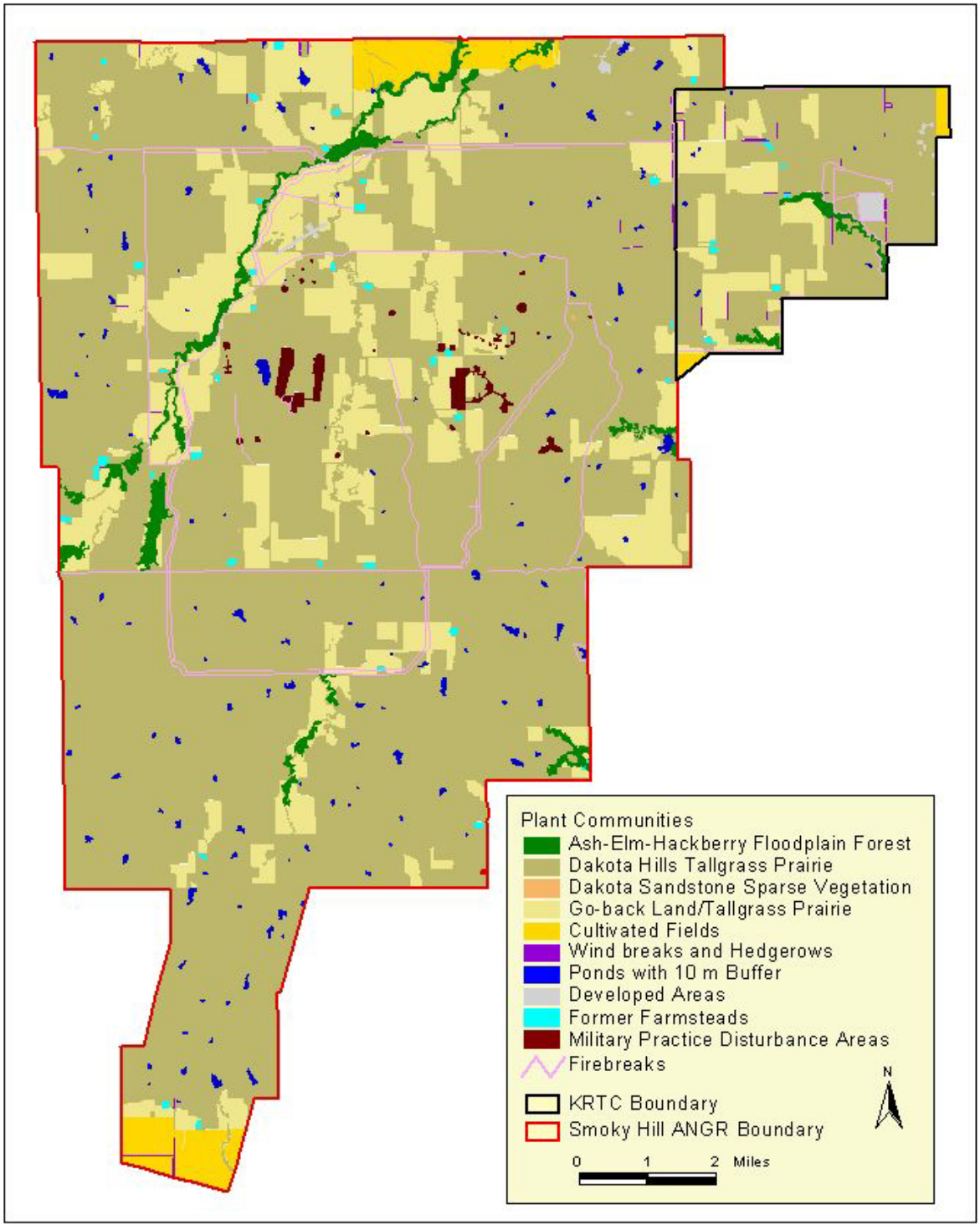


Figure 5.7. Plant Communities and Landscape Features.

### 5.3.2.1 Natural Communities at Smoky Hill ANGR

**Dakota Hills Tallgrass Prairie** are areas also known as the *Andropogon gerardii - Panicum virgatum - Schizachyrium scoparium* Dakota Sandstone Herbaceous Vegetation (Code for National Classification is CEGL 005231) (Lauver et al. 1999).
This community type is know from the Smoky Hills physiographic province in north-central Kansas and into a very small adjacent area in Nebraska. It is an extensive vegetation type, which occurs in large patches across the landscape. Its habitat is typically moderately sloping to steep side slopes and ridge tops on uplands, and in hills with numerous Dakota sandstone outcrops. It is the dominant plant community at Smoky Hill ANGR and covers over 25,000 acres. The soils are shallow, somewhat excessively drained to moderately deep, and well-drained loamy soils, formed in material weathered from sandstone and sandy shale. It is the dominant natural vegetation across the uplands of Smoky Hill ANGR. Other species found in this community type are listed in the plant community data summary in Appendix 5.1.

**Ash-Elm-Hackberry Floodplain Forest** are areas also known as the *Fraxinus pennsylvanica - Ulmus* sp. - *Celtis occidentalis* Forest (CEGL 002014) (Lauver et al. 1999). This community type is found in the eastern half of Kansas and in the following
states: IA, IL, IN, MI, NE, and OH. It is also a large patch type of landscape. Its habitat is nearly level bottoms and terraces along major streams, rivers, and creeks. The soils for this community are typically deep, poorly drained to well drained, formed in silty and clayey recent alluvium. It is only found along the major creek drainages on the northern portion of the Smoky Hill ANGR and covers over 600 acres. Other species are listed in Appendix 5.2.

**Dakota Sandstone Sparse Vegetation** are the rock outcrop areas on Smoky Hill ANGR. This community type is found across the Dakota Sandstone formation areas of the Smoky Hill physiographic province, usually at the top of a rock hill or around cliffs. The soils are very thin if there are any, and very sandy. Only a very few examples of this could be found on Smoky Hill ANGR, but they include Soldier's Cap Mound and Potato Hill. Some fairly unique species occur in these areas including Tharp's spiderwort, *Tradescantia tharpii*; Virginia hoary-pea, *Tephrosia virginiana*; and blue funnel-lily, *Androstephium caeruleum*.

### 5.3.2.2 Semi-natural Communities and Landscape Features at Smoky Hill ANGR

The following types of semi-natural vegetation and landscape features were observed:

**Go-back Land/Tallgrass Prairie** are comprised of areas on Smoky Hill ANGR that were cultivated before World War II (see Figure 5.7), but have since regained a tallgrass prairie character because they have been managed through grazing and burning as if they were native prairie. Many of these areas do not have the high plant species diversity as other sites, but they are important habitat. They are typically found near to creeks and in areas with deeper soil. These are an important component of the landscape and cover over 6,000 acres.

**Cultivated Fields** are still being farmed on about 760 acres in the northern part of the property.

**Wind breaks and Hedgerows** and scattered around old farmsteads and fields, but also are occurring along roads in the northeast part of Smoky Hill ANGR. They are planted with a

variety of trees. These areas can provide habitat for some bird and animal species and cover about 760 acres.

**Ponds** are located throughout the property. We have mapped a 10 m buffer around them as the buffer is often a disturbed area that are more likely to have musk thistle, *Carduus nutans*, and other weeds. Including their buffers, they total about 270 acres.

**Firebreaks** are a management disturbance and often have weedy vegetation due to the annual tilling. They are linear features, actually tilled strips used to control fires.

**Developed Areas** are buildings and the lands immediately around them which may be planted to lawn grasses or is disturbed. These areas total about 70 acres.

**Former Farmsteads** are scattered across the facility, usually are disturbed and have some trees.

**Military Practice Disturbance** areas also typically have more weedy species due to the disturbance of the soil. They total a little less than 200 acres.

### 5.3.3 Plant Community Data from Tallgrass Prairie

During the spring and summer of 2003 and 2004, grassland surveys were completed on 156 plots (20 $m^2$ with nested 1 $m^2$) in 52 management units across Smoky Hill ANGR. Factors recorded during the study included species richness, percent cover of each plant species, and a condition grade for each plot. Statistical analysis of the results is reported using the data from the 20 $m^2$ plots which captured greater plant species diversity.

#### 5.3.3.1 Species Richness

Species richness is the total number of species in a given area. It was determined for each plot (Figure 5.8). It ranged from a high of 69 species in one hay meadow plot (fire section 11) to 19 species in a pasture plot (fire section 13).

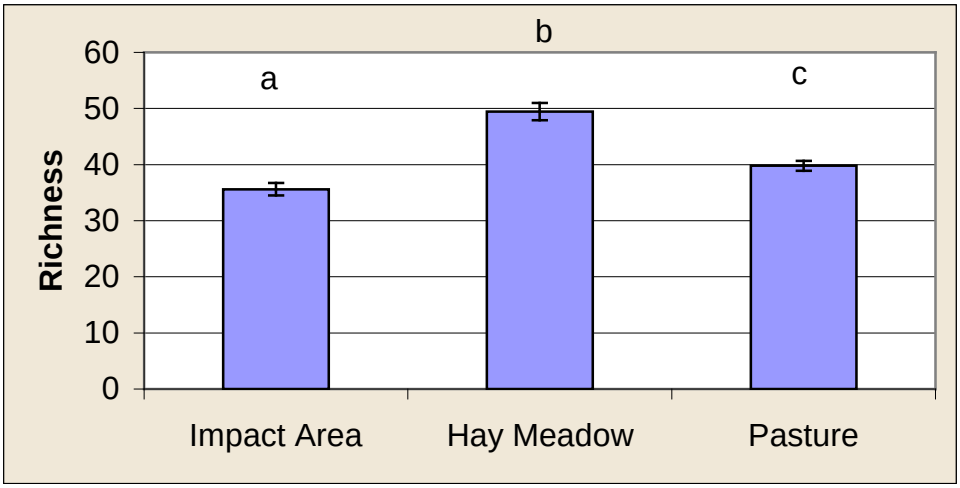


Figure 5.8. Mean richness values (average of all species by plot) and standard errors by management type. Different letters above the bars indicate significant differences among treatments ($p<0.05$).

We identified and recorded 238 species of plants within all plots. (Due to the size of the file, the plot data are recorded on the CD included with this report or are available from the authors.) These represented 51 different families of plants. There were 213 (90%) native species and 23 (10%) species not native to Kansas. A list of all plant species recorded within the plots along with the average cover of each species by management type is located in Appendix A. All nomenclature follow the R. L. McGregor Herbarium Collection Information Management System (CIMS).

**5.3.3.2 Percent Cover**

The percent cover of individual plant species in the plots is one of the criteria used to estimate the condition grade of a site. A synopsis of the cover values is shown below (Table 5.2). A percentage greater than 100% indicates that plants of more than one species cover the ground densely and overlap. Hay meadows had the highest average cover of plants among the three treatments (174.77%). Conversely, the impact area had the highest average cover of bare ground (6.28%). The higher coverage of bare ground in the impact area is probably due to the frequent burning that occurs there, but some sites have been disturbed by previous land use practices. Hay meadows had the least average bare ground. Hay meadows seem to experience the least disturbance of the three management types, with neither the frequent burning of the impact area nor the hoof disturbance and loss of vegetative cover due to grazing seen on the pastures.

| | Impact Area | Hay Meadows | Pastures | Overall Average |
|---|---|---|---|---|
| **Total average cover per plot** | 140.45% | 174.77% | 147.54% | 149.76% |
| **Average cover of bare ground per plot** | 6.28% | 1.94% | 4.50% | 4.61% |

Table 5.2. Synopsis of Percent Cover by Management Type. Note vegetation layers overlap so plant cover can total more than 100%.

Throughout the Smoky Hill ANGR, little bluestem (Schizachyrium scoparium) had the highest average cover (37.93%) in the plots (Table 5.3), followed by big bluestem (*Andropogon gerardii*) at 24.18% and rough dropseed (*Sporobolus asper)* at 14.04%. Little bluestem and big bluestem are characteristic and desirable species. Rough dropseed is an increaser species (a plant that becomes more abundant in the presence of grazing or other disturbances; see Fraser and Kindscher 1998). Cover values of the top ten species include three forbs. Western ragweed (*Ambrosia psilostachya),* a native species considered to be fairly weedy, had an average coverage of 6.01%; heath aster (*Symphyotrichum ericoides),* considered to be fairly neutral in terms of disturbance, had an average cover value of 2.17%, and narrow-leaf scurf-pea (*Psoralidium tenuiflorum*), a legume of moderate palatability, had an average cover of 2.07%. Other forbs

| Scientific Name | Common Name | CoC Values | Hay Meadows | Impact Area | Pastures |
|---|---|---|---|---|---|
| *Schizachyrium scoparium* | little bluestem | 5 | 56.0 | 36.7 | 33.4 |
| *Andropogon gerardii* | big bluestem | 4 | 38.5 | 30.2 | 17.0 |
| *Erigeron strigosus* | daisy fleabane | 4 | 10.2 | | |
| *Sorghastrum nutans* | Indiangrass | 5 | 8.3 | 3.9 | 7.8 |
| *Sporobolus asper* | rough dropseed | 3 | 7.8 | 3.9 | 21.1 |
| *Bromus japonicus* | Japanese Brome | * | 5.4 | | 10.8 |
| *Psoralidium tenuiflorum* | many-flowered scurfpea | 3 | 4.8 | | 2.2 |
| *Rudbeckia hirta* | black-eyed Susan | 2 | 4.5 | | |
| *Artemisia ludoviciana* | Louisiana sagewort | 2 | 2.6 | | |
| *Hesperostipa spartea* | porcupinegrass | 8 | 2.4 | | |
| *Ambrosia psilostachya* | western ragweed | 3 | | 3.4 | 8.9 |
| *Poa pratensis* | Kentucky bluegrass | * | | | 6.9 |
| *Bouteloua curtipendula* | side-oats grama | 5 | | 10.0 | 5.1 |
| *Bouteloua gracilis* | blue grama | 5 | | 7.3 | 3.6 |
| *Pascopyrum smithii* | western wheatgrass | 2 | | 3.4 | |
| *Symphyotrichum ericoides* | heath aster | 5 | | 5.2 | |
| *Koeleria pyramidata* | Junegrass | 6 | | 3.1 | |
| **Average total cover by management type** | | | **174.7** | **140.4** | **147.5** |

Table 5.3. Comparison of the ten grassland species with the highest average percent cover values per plot by management type on Smoky Hill ANGR. An asterisk (*) indicates species not native to Kansas.

with substantial coverage include daisy fleabane (*Erigeron strigosus),* and Louisiana sagewort (*Artemisia ludoviciana).* Only two non-native species had average plot coverages in the top ten; Japanese brome (*Bromus japonicus*) and Kentucky blue grass (*Poa pratensis*). These weedy grasses thrive in and are indicative of a high degree of physical disturbance in the plots.

An analysis of the top ten species with the highest average percent cover by management type provides some insights:

- Average total percent cover of these species was significantly higher in hay meadows than in either the impact area or pastures.
- Little bluestem (*Schizachyrium scoparium*) has the highest cover values among all three management types.
- Hay meadow coverages are distinctive in having porcupine grass (*Hesperostipa spartea),* a highly desirable and palatable forage grass. There is one non-native species, Japanese brome (*Bromus japonicus),* on the list. There are four forbs on the list.
- The impact area averages differ from the hay meadows in having no non-native species present in the top ten coverages. There are two forbs on the list.
- On the pasture list, there are two forbs and two non-native species.

### 5.3.3.3 Condition Grade

Based on estimates of species composition, percent cover of those species, and ecological processes, a grade was assigned to each plot at the time of our field survey work. The impact area and hay meadows had significantly higher grades than the pasture sites (Figure 5.9), reflecting the local loss of some species in pasture areas and increased weediness.

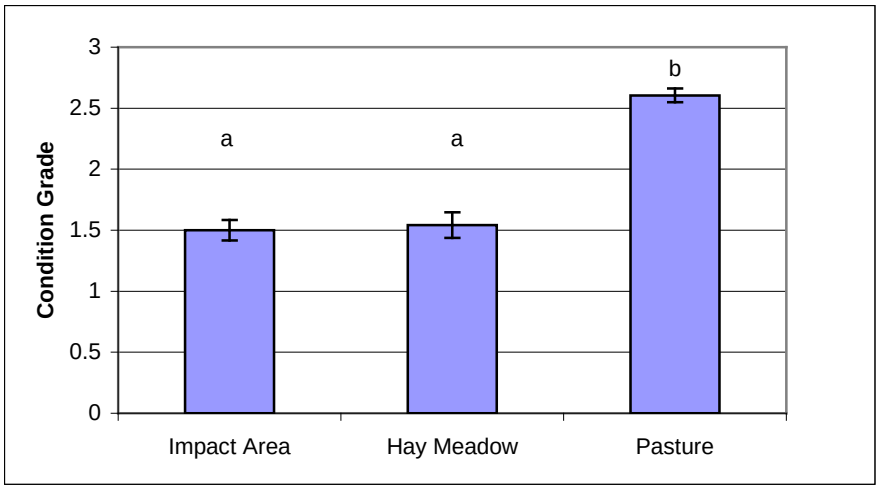


Figure 5.9. Comparison of mean condition grades assigned to plots by management type. For condition grade, A=1, B=2, C=3. Shorter bars indicate higher condition grades. Different letters above the bars indicate significant differences among treatments ($p$<0.05).

### 5.3.3.4 Floristic Quality Assessment

Floristic quality assessment is calculated based on the Coefficient of Conservatism (CoC) values of each plant species present in a given area. The CoC values and number of species representing those values within the Smoky Hill plots is shown in Table 5.4.

| CoC value | * | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of species | 23 | 36 | 25 | 24 | 32 | 23 | 33 | 22 | 14 | 4 | 0 | 0 |

Table 5.4. Number of species in each of the coefficients of conservatism values. An asterisk (*) indicates species not native to Kansas.

None of the 238 species recorded within the $20m^2$ plots had a CoC value greater than 8. While much of Smoky Hill ANGR qualifies as a high-quality, intact natural area, all of it has been impacted by grazing, homesteading, military usage, roads, and other human disturbances. These factors make it unlikely that conservative species, those receiving a CoC of 9 or 10, would occur here very frequently, if at all. It is even less likely that those species would show up in the vegetation plots, which were located in representative locations rather than either the best or least disturbed areas of each unit.

Each of the three management types was statistically different in terms of floristic quality assessment (Figure 5.10). Hay meadows had the highest average score, followed by the impact area, and then pastures. Annual haying seems to be a superior method of managing the prairie for high-quality diversity. Many, if not all, of the hay meadows on Smoky Hill ANGR were probably grazed prior to World War II, making the statistical difference even more noteworthy.

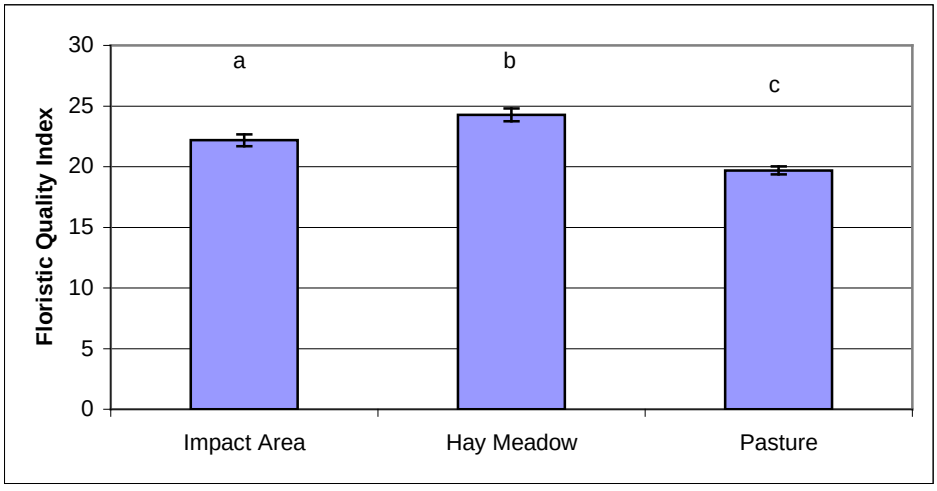


Figure 5.10. Comparison of mean floristic quality indices by management type. Different letters above the bars indicate significant differences among treatments ($p<0.05$).

This indicates that haying (cutting tracts once per year and removing the biomass, maintains or improves the quality of the prairie vegetation. Long-term annual haying could be improved as a management technique with some years of rest for recovery of plant stature and seed development.

### 5.3.3.5 Shannon's Diversity Index

Shannon's Diversity Index values were calculated for each management type (Figure 5.11). The impact area had the lowest diversity (2.0333) and was significantly different from the other two management types. Hay meadows (2.1725) and pastures (2.1693) had higher values and were not significantly different from each other.

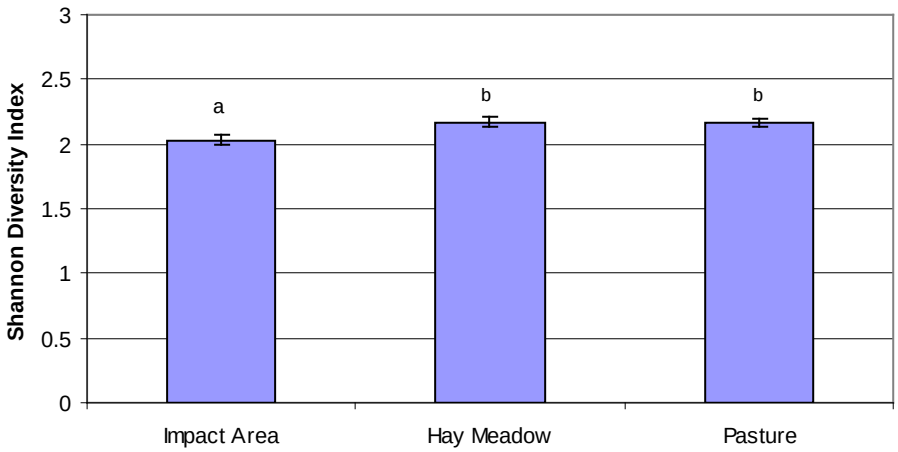


Figure 5.11. Comparison of mean Shannon's Diversity indices by management type. Different letters above the bars indicate significant differences among treatments ($p<0.05$).

Shannon's diversity index, unlike the floristic quality index, treats all species as being of equal value. Therefore, a site with numerous invasive or weedy species would score higher than a site with fewer, but more conservative species (Andreas *et al*. 2004).

### 5.3.3.6 Soils

The results of the soil testing at all vegetation sampling sites indicate that the soil quality does not vary much between the haying impact, or pasture areas on Smoky Hill ANGR (Figure 5.12). There may be many reasons for their similarity, but one important factor could be that their management has been relatively consistent during the last 10-20 years.

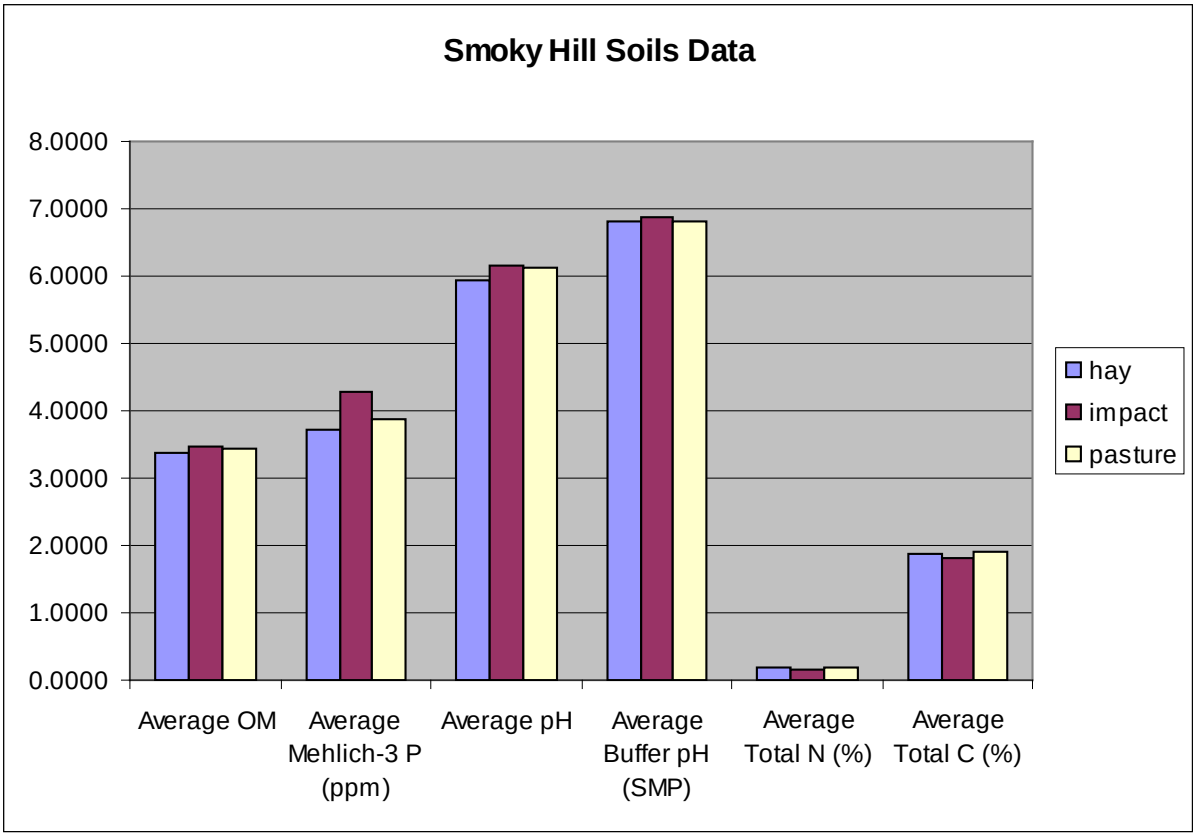


Figure 5.12. Data compare differences in nutrients between hay impact and pasture areas.

### 5.3.3.7 Comparison with Adjacent Privately-Owned Pasture

Surveys were conducted for 18 plots on six private properties adjoining Smoky Hill ANGR (Figure 5.6). While the number of plots examined is not large enough for statistical analysis, we can gain some insight from the data.

The adjoining ranches had vegetation very similar to the areas we sampled on pastures on Smoky Hill ANGR. Differences might emerge if substantially more off-range pastures were surveyed. Stated stocking rates on neighboring ranches were similar to those mandated on the Smoky Hill ANGR. And in many respects the areas had similar management.

During the course of interviews with three neighboring ranchers, each one complained about the musk thistle (*Carduus nutans*) populations on Smoky Hill ANGR. Two of the ranchers interviewed stated that the aerial spraying performed on Smoky Hill ANGR was ineffective and that the best technique was either hand-digging or a combination of hand-digging and spot-spraying. Hand-digging and spot-spraying were the preferred methods of all the ranchers interviewed. Since few musk thistles were seen on Smoky Hill ANGR during the plot monitoring, rancher's perception may not be in line with the actual situation. Whereas ranchers pull up thistles as they see them during the summer, the leaseholders on Smoky Hill ANGR seem

to do little follow-up care of the pastures. Musk thistle was noted in only 12 of 85 pasture plots on Smoky Hill ANGR. In each of those instances, the cover was only a trace. Grazing does seem to encourage musk thistle as it was only see on only one of 24 plots sampled on hay meadow and none of the 43 plots in the impact area.

**5.3.4 Riparian Woodland Results** The cover data for all plant species noted in the riparian plots are summarized in Appendix B. Species richness within the riparian woodland sites ranged from 4 to 33 species. We recorded a total of 49 vascular plant species of which 92% are native and 8% are introduced in Kansas

A summary of the coefficients of conservatism values for the species recorded in the riparian plots is shown in Table 5.5. None of the CoC values is greater than 5, indicating the lack of conservative woodland species.

| CoC value | * | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of species | 4 | 11 | 9 | 11 | 9 | 2 | 3 | 9 | 0 | 0 | 0 | 0 |

Table 5.5. Coefficients of conservatism values for all species noted in riparian plots. An asterisk (*) indicates a non-native plant species

Because C of C values were not high, the average FQI of the riparian plots is low, indicating a fairly low-quality woodland resource (Table 5.6). The most common tree species in the plots are common hackberry (*Celtis occidentalis),* black walnut, (*Juglans nigra),* slippery elm (*Ulmus americana),* and green ash (*Fraxinus pennsylvanica).* All of these species have CoC values in the 0–3 range. Native trees commonly occur in early successional woodland areas.

| | |
|---|---|
| **Average richness / plot** | 16.4 |
| **Average number of native species / plot** | 15.5 |
| **Average FQI /plot** | 6.7 |

Table 5.6. Average richness and Floristic Quality Index (FQI)values for riparian plots.

Statistical analysis of this data was not performed because the sample size was so small (five plots) as riparian vegetation covers less than 2% of Smoky Hill ANGR.

## 5.4 CONCLUSION

Smoky Hill ANGR encompasses a large and uniquely preserved example of the tallgrass prairie. The size of this largely unfragmented tallgrass prairie makes it a valuable reservoir of biological diversity for the Great Plains.

Thoughtful management of Smoky Hill ANGR has resulted in a generally good quality of grassland communities throughout the property. The absence of any major weed infestation attests to the quality of the range, its management, and good grazing practices. The impact area is unique. It contains a low component of weedy species and the highest percent cover of conservative plant species (with coefficient of conservatism values of 6–8). The hay meadows contain the greatest species richness, the highest average cover of vegetation, the least bare ground, and the highest floristic quality index of the three management types.

The plant surveys conducted on Smoky Hill ANGR have provided a quantitative assessment of the effects of current management practices on plant diversity and plant community quality. The permanent plots provide valuable baseline data on the condition of the vegetation and can be used to track changes over time.

## 5.5 NOTE OF APPRECIATION

The staff of Smoky Hill ANGR has been exceedingly helpful and professional in coordinating access to the impact zone and areas of the buffer zone, and assisting with this project. The assistance of Erika Noguera, Brye Lefleur, Jake Vail, Vaughn Salisbury, Todd Aschenbach, Erin Questad, and Suneeti Jog enhanced the many, but enjoyable, hours of fieldwork. Many thanks to Jeff Elliott for his contributions to the vegetation studies. Jennifer Delisle gave many hours of support and guidance in map making. Caleb Morse and Craig Freeman always cheerfully identified plant specimens.

## 5.6 GLOSSARY

Coefficient of conservatism (CoC): A number on a scale from 0 to 10 that represents an estimated probability that a plant species is likely to occur in a landscape relatively unaltered from what is believed to be a pre-settlement condition. A value of 0 indicates the probability is almost 0, while a value of 10 indicates the plant is almost certain to be found only in an undegraded natural community. Introduced plants were not part of the pre-settlement flora, so no coefficient is assigned to them.
Conservative species: Plants that do not tolerate much disturbance, such as grazing and tilling. These plants have a high coefficient of conservatism value.
Cover: The area within a designated plot that is taken up by each plant species as a percentage of the whole plot when viewed from above.
Decreaser: A plant species that becomes less abundant in the presence of grazing or other disturbances.
Floristic quality index (FQI): This standardized tool for natural area assessment combines the conservatism of the species present with a measure of the diversity of the site to yield a quantitative assessment of a site.

Forb: A non-woody, broad-leaved plant; a non-grasslike herb.
Increaser species: A plant species that becomes more abundant in the presence of grazing or other disturbances.
Richness**:** A measure of biological diversity referring to the number of species in an area.
Riparian: The parcel of land that includes the channel and an adjoining strip of the floodplain, generally considered to be 100 feet on each side of the channel.

## 5.7 LITERATURE CITED AND DATA SOURCES


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