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COMBINING HISTORICAL RECORDS AND GEOSPATIAL TECHNIQUES TO ANALYZE LAND USE MODIFICATION IN A TALLGRASS PRAIRIE LANDSCAPE

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COMBINING HISTORICAL RECORDS AND GEOSPATIAL TECHNIQUES TO ANALYZE LAND USE MODIFICATION IN A TALLGRASS PRAIRIE LANDSCAPE

A DISSERTATION APPROVED FOR THE
DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL SUSTAINABILITY

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Abstract

The land use practices that accompanied settlement across central North America changed the structure and function of the North American tallgrass prairie landscape. Tallgrass prairie vegetation has experienced the largest areal reduction compared to other North American vegetation types. Euro-American settlement over the past 150 years is reported in historical records providing the data to study land use modification in the tallgrass prairie. The decline or loss of tallgrass prairie habitat was also accompanied by habitat fragmentation, a change in the spatial configuration of the original landscape. Land use practices that lead to the loss and fragmentation of tallgrass prairie include conversion to monoculture row crop production, introduction of non-native forage crops, woody plant encroachment, overgrazing, and urban expansion.

This dissertation research used qualitative and quantitative methods to understand how modification in land use from the pre-settlement period to 2008 has altered the tallgrass prairie. In the first chapter I conducted a review of historical agriculture reports to determine when and why the non-native grass tall fescue (*Schedonorus phoenix*) was introduced into Oklahoma tallgrass prairies. I found that the two primary reasons for introduction were for prevention of soil erosion and to increase forage production, therefore increasing farm profits. In chapter two I used historical spatial data obtained from the General Land Office to determine land use practices that initially altered the tallgrass prairie landscape following settlement. I used spatial data and historic records to reconstruct the tallgrass prairie landscape in

northeastern Oklahoma at the time of the Public Land Survey. I determined that the main drivers for loss and fragmentation of the tallgrass prairie vegetation was initiated by opening Indian Territory to railroads and settlers, the invention and widespread use of barbed wire fencing, which allowed for enclosure of, and an increase in cultivated fields, and the allotment of native lands. The third chapter quantified the areal loss and fragmentation of the tallgrass prairie vegetation by comparing tallgrass prairie land cover from pre-settlement, to 1896, to 2008. Landscape metrics were calculated to measure the degree of fragmentation. I found that 85% of the original tallgrass prairie landscape had been lost through land use changes. The tallgrass prairie that remained on the landscape was remnant patches maintained as either rangeland or hay meadows. Hay meadows represent traditional landscapes maintained to produce native prairie hay. These traditional landscapes harbor high species diversity and require little input of labor, fuel or chemicals to maintain them, compared to non-native monoculture pastures. This dissertation project studied land use changes by applying concepts and methods from the fields of geographic information science, biogeography, historical ecology, landscape ecology and conservation biology. The knowledge gained from this dissertation research can be used for the conservation and/or restoration of landscapes fragmented from land use modification.

Preface

The perspective of historical ecology is to understand the interaction between human influence and its effect on natural environments. This dissertation project focused on agricultural land use practices and their influence on tallgrass prairie vegetation. Tallgrass prairie vegetation has experienced the greatest degree of landscape alteration, fragmentation and loss due to human land use practices compared to other vegetation types in North America. For this reason tallgrass prairie vegetation will be used as the setting in which to explore impacts of human land use on natural environments. The dissertation is broken down into three independent chapters with the purpose of submitting each chapter for publication to an academic journal.

It is estimated only 1% of tallgrass prairie vegetation in North America remains following Euro-American settlement of the Prairie Peninsula that includes portions of Kansas, Iowa, Illinois, Indiana, Missouri, Ohio, Oklahoma and Wisconsin (Transeau 1935; Samson and Knopf 1994). In Oklahoma, Duck and Fletcher (1945) report that 5.3 million ha or 30% of Oklahoma's total land area of 18 million ha was potentially tallgrass prairie. The most extensive contiguous tract of tallgrass prairie is located in northeast Oklahoma, and was selected as the study site for chapters two and three of this dissertation research. This area is referred to as the Cherokee Prairie.

Tallgrass prairie vegetation occurs along a precipitation gradient in North America between the deciduous forest in the east and the mixed grass prairie west. The tallgrass prairie is distinguished by four perennial tall grasses, which

are big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*) and switchgrass (*Panicum virgatum*). Areas where tallgrass prairie is present have climates that include periodic droughts, a prevalence of westerly and southerly winds, and topography that is level to gently rolling with gentle northwestern slopes which allow fires to spread in upland areas creating and maintaining prairie vegetation (Sauer 1950; Axelrod 1985).

Tallgrass prairies are maintained by the removal of excess biomass and woody vegetation by fire and grazing. Grasses tend to produce more biomass than can be decomposed, and if the excess biomass is not removed grassland productivity declines. This is because grasses have evolved to die down to their underground organs in the presence of drought, fire and grazing, and regrow from these underground organs after these disturbances. When such disturbance regimes are absent, excess biomass accumulates (Anderson 1990). The excess biomass, or leaf litter, inhibits new spring growth due to the slow the warming of the soils and because of a decrease in insolation (Weaver and Fitzpatrick 1934). In the absence of fire and grazing, woody plants encroach on prairies, and these prairies will be converted to shrublands or forests (Collins 1990).

Within in the context of agricultural research, chapter one explores when and why non-native forage crops were introduced into Oklahoma tallgrass prairies. The two paradigms that prompted research into non-native forage crops were soil erosion control and prevention, and forage production. There

appeared to be favoritism to research non-native forage crops compared to native prairies, because introduced crops were referred to as “tame” crops while native prairies were called “wild”. The main institution conducting this research was the Oklahoma Agricultural Experiment Station (OAES). For chapter one, I conducted an historical review of OAES reports to determine when and why one particular non-native grass, tall fescue, (*Schedonorus phoenix*) was introduced into tallgrass prairies. Tall fescue was selected for this review because it has been widely used to overseed native tallgrass prairie rangelands and hay meadows. Tall fescue causes problems where it has been introduced because it is toxic when monoculture stands are grazed by livestock. This toxicity occurs in stands of tall fescue infected with an endophytic fungus that produces alkaloids.

Tall fescue also reduces biodiversity where it is introduced. Cool season tall fescue pastures and meadows are considered high input low diversity grasslands, because they require biannual fertilization to maintain high levels of productivity, compared to native hay meadows dominated by warm season grasses. When cool season hay meadows are fertilized, it encourages growth of a single species therefore reducing floristic diversity (Jog et al. 2006; Foster et al. 2009). The positive and negative consequences of introducing a non-native crop discussed in this paper can be applied to other non-native crops, such as kudzu (*Pueraria Montana)*, and sericea lespedeza (*Lespedeza cuneata)* which were also introduced for soil erosion control and forage production.

The metadata complied for chapter one came from OAES reports, bulletins and fact sheets. Additional sources included United States Department of Agriculture reports and censuses and Oklahoma newspaper articles. The objective of this chapter is to answer the following questions: why are non-native forage plants introduced into the United States? When and why was tall fescue, specifically, introduced into Oklahoma? This chapter was written with the intention of publishing in the *Chronicles of Oklahoma*.

Settlement in the Cherokee Prairie began in the 1820's, and was accelerated with the forced removal of the Cherokee and Creek Nations following passage of the Indian Removal Act in 1830. Prior to the removal of the Creek and Cherokee Nations to the Cherokee Prairie area, the prairie was home to the Osage. The Osage ranged over the country on their hunting and marauding expeditions from the Missouri River to the Red River and from the Mississippi River to the Rocky Mountains (Forman 1936).

What makes the settlement, and therefore land use patterns of the Cherokee Prairie, unique is the communal land use system used. Under the communal land use system all land was owned by the Creek and Cherokee Nation governments and only improvements such as houses, barns and fences were owned by individual citizens. At the end of native sovereignty all land moved into private ownership, via allotment of communally held land. The land use patterns under the communal system were documented in the Public Land Survey (PLS).

The only data pertaining to land use prior to the PLS in the Cherokee Prairie were Indian Affairs Commissioner Reports and the accounts of travelers through the region. Thomas Nuttall, in the summer of 1819, describes the landscape of the Cherokee Prairie as “twenty miles of this route was without any path, and through grass three feet deep, often entangled with brambles, particularly with the tenacious saw-briar (*Schrankia horridula*)….a cheerless uniformity of the extensive plain, still wrapt in primeval solitude. Not even a tree appeared, except along the brooks of Grand and Verdigris” (Nuttall 1821).

During an expedition in 1832, Washington Irving, described a “wide monotonous ride … over 12 miles of prairie until he came upon the [Grand] river which was described as a park land type of country covered with prairie hens [greater prairie chicken] and pigeons... [then] encamp for the night at Saline and leave the next day for Ft. Gibson and ride through prairie and cane breaks as they arrive at the Arkansas River” (Irving 1944).

From the traveler accounts it is clear that the land cover consisted of abundant tallgrasses on the uplands with narrow wooded drainage basins and wooded bottomlands. There also seems to be a bias in the tone of the travelers against the prairie, viewed as monotonous and lonely. This landscape would have been foreign to people who were used to the landscapes of the eastern deciduous forest of the United States.

Chapter two explores how land use modified the distribution of historical tallgrass prairie land cover prior to allotment of Indian Territory. The goal of this chapter is to answer the following questions: What was the extent of tallgrass

prairie under the communal land use system in the Cherokee Prairie? What was the predominant land use practices just prior to and at the time of the PLS? How did land use alter the tallgrass prairie landscape? Did settlers prefer woodlands over prairies to cultivate? Chapter two was written with the intent to submit for publication to *Geographical Review.*

Small tallgrass prairie remnant patches, referred to as hay meadows, are rarely grazed and tend to have higher species richness compared to tallgrass prairie rangelands because they lack grazing pressure and are not sprayed with herbicides. Hay produced from these meadows are used to supplement feed for livestock during the winter months when access to rangelands is limited. Hay meadows are maintained by annual mowing of the prairie. Mowing tallgrass prairie for hay production can mimic fire and grazing disturbance regimes by removing aboveground biomass, and maintaining grassland productivity and species richness (Collins et al. 1998).

Chapter three examines the degree of habitat fragmentation from pre-settlement, to 1896 and to 2008. The goal of this chapter is to answer the following research questions: how has the tallgrass prairie land cover changed from the pre-settlement period to 2008; to what degree has fragmentation occurred; do these fragments show a random distribution or a pattern that might reveal why they persist; why do these remnants persist in a region suitable for agriculture production and why has so much tallgrass prairie has been converted to non-native grasses? Is it due to land suitability? To answer these questions, I used aerial photography to create a 2008 tallgrass prairie

rangelands and hay meadow GIS spatial data layers. The 2008 data layer was then compared to a 1896 and pre-settlement tallgrass prairie GIS data layers created from the PLS. These data layers were used to quantify the degree of habitat fragmentation. Chapter three was written with the intent to submit for publication either to *Landscape Ecology* or *Conservation Biology.*

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Chapter 1:

Tame grass, wild grass;

The introduction of Tall Fescue into Oklahoma Prairies

Hay produced in Oklahoma was often referred to as "tame grass" and "wild grass" in agricultural reports such as the “Oklahoma Agricultural Statistics 1894-1947” and “First Biennial Report to the Oklahoma State Board of Agriculture” (Oklahoma State Board of Agriculture 1907-1908; OAES 1949). To someone from outside the agriculture community, these terms might be puzzling. But in agricultural jargon of the late 19th century and first half of the 20th century introduced forage grasses were referred to as “tame” grasses, while native prairie hay was termed “wild” hay. Malin (1984) proposed that tame forage plants were introduced because farmers thought they were superior to the wild or native prairie grasses.

The objective of this study is to understand why non-native forage grasses were introduced into Oklahoma tallgrass prairies. This study used the timing and rationale for the introduction of tall fescue (*Schedonorus phoenix),* a grass native to Europe, as a model for understanding the introduction and spread of non-native forage grasses into Oklahoma grasslands. As with other non-native species that have been introduced to the United States, the dissemination of tall fescue has positive and negative outcomes. The positive outcomes are primarily economic, whereas the adverse outcomes are a degradation of the prairie ecosystem. The impact to Oklahoma grasslands can be subtle, such as overseeding native grasslands with tall fescue, or dramatic,

when native grasslands are completely converted to low diversity tall fescue pastures.

Unfortunately, were tall fescue has been overseeded it has become an invasive species. As an invasive species it out competes native grasses decreasing plant biodiversity and decreasing habitat and food sources for wildlife. Where tall fescue becomes established it creates monocultures due to its ability to reproduce abundantly both asexually and sexually.

There are two opposing views of the introduction of non-native plants; those focused on the conservation of native species, and therefore the eradication of non-native plants, and those focused on the agricultural uses of non-native plants, and therefore the spread of non-native plants. Ironically, these opposing views are represented within the same branch of government. For example, the USDA Forest Service is actively involved in research to eradicate non-native species that have become invasive (Miller et al. 2010). On the other hand, agricultural experimental stations, which are also funded through the USDA, are actively involved in research to optimize agricultural usage of the same invasive species. There is a gap in the literature to explain why species that have become invasive continue to be spread and planted. Therefore, the motivation for conducting this research was to understand why species that are considered invasive within the conservation biology community continue to be promoted for their usefulness by the agricultural community (Fribourg et al. 2009).

Non-native Plant Introductions

The phrase "non-native species" refers to plants or animals that have been moved from one region to another. Transport and establishment of such species can be done either intentionally or unintentionally. Also, the scale of transfer can vary greatly. In other words, species may be transported from one continent to another or from one region within a continent to another. Reasons for intentionally introducing a species typically are centered on efforts to enhance agricultural production or management of natural resources, such as abatement of soil erosion, wildlife cover and increased forage production.

When non-native forage plants are intentionally introduced to an area, the goal is to produce superior varieties of “grass and legume species that will enable farmers to feed their livestock more adequately and more economically” (Wheeler 1950). These introduced crops are planted as forage for the purpose of grazing pastures or hay crops to feed livestock. The use of non-native or tame grass hay crops within Oklahoma increased from 108,000 acres in 1899 to 1.1 million acres in 1947 (Figure 1.1). Commonly introduced grasses included Johnson grass (*Sorghum halepense*), Timothy grass (*Phleum pretense*), red top (*Agrostis gigantea*), orchard grass (*Dactylis glomerata*), blue grass (*Poa pratensis*), and crab grass (*Digitaria sanguinalis and D. ischaemum*), all native to regions outside North America (United States Census Office 1902).

Farmers were motivated to plant tame grasses for hay crops because of higher yields per acre and price per ton, compared to the wild native prairie hay.

The average yield in tons per acre from 1914 to 1947 was 1.37 tons per acre for tame hay and 0.97 tons per acre for prairie hay (Figure 1.2a). For the same period, the average price per ton for tame hay was $11.20/ton compared to $8.98/ton for prairie hay (Figure 1.2b) (OAES 1949). Pasture and hay was produced from native grasslands before the introduction of non-native forage crops. Prior to statehood, the majority of forage was produced from tallgrass prairies in the eastern half of the state (Hewes 1944, Elder 1954 and Harper 1957). However, the hay yield varied from year to year in relationship to the amount and distribution of seasonal rainfall (Briggs, Gallup and Darlow 1948; Elder 1954; Harper 1957). Prairie hay is cut in July to foster native warm season grasses, and to optimize nutrient and biomass yields (Bruner 1931; Briggs, Gallup and Darlow 1948; Rollins and McMurphy 1984).

Oklahoma Agricultural Experiment Station

The Oklahoma Agriculture Experiment Station (OAES) is the seat of testing and improvements of forage plants. The OAES was established in 1891 at Oklahoma A & M College in Stillwater (Green 1990) as part of the Agriculture Experiment Station system that exists at state land grant colleges. On July 2, 1862, President Lincoln approved the Land-Grant College Act that provided each state college with publicly held land that could be sold and funds used to endow the agricultural colleges (Deering 1945). Federal funds for state experiment stations were managed by the Office of Experiment Stations (a branch of the USDA established in 1888) and appropriated under four acts of

congress; Hatch, Adams, Purnell, and Bankhead-Jones Acts (OAES1906-1907; OAES 1926-1930; Deering 1945).

The Experiment Station was tasked with the search for “new knowledge that will solve some problem facing Oklahoma agriculture, or will open up new opportunities for it” (OAES 1948-1950). The knowledge gained from research conducted at the OAES was disseminated to the public in a variety of ways. Initially, communication between experiment station staff and the agricultural community was via written letters. Later, the OAES began to disseminate station bulletins, which answered specific questions about agricultural matters of current interest to farmers (OAES 1906-1907). By 1948 the OAES was disseminating information through a “What’s New” newsletter, a brief guide to current farm research at the OAES. It was published twice yearly, and contained a summary of all new station bulletins and extension circulars.

Actions by the OAES to disseminate information went beyond these publications, though. The OAES also relied on a network of county extension agents, 4-H club activities, vocational agricultural teachers, technicians at soil conservation districts, field men at banks, chambers of commerce and industries related to agriculture. OAES staff members also reported research results through radio programs, newspaper articles, farm magazines, and public speeches. Hands-on experience was provided to farmers at annual field days. Field days at the stations gave farmers not only the opportunity to see of research outcomes firsthand, but to hear station staff members (OAES 1948-1950). Some of the research conducted by the OAES in the middle of the 20th

century involved the introduced forage plants that increased forage production and yields and provided year round livestock grazing.

Tests of improved forage grasses in Oklahoma Territory began at the end of the 19th century. Success was at first elusive because improved forage plants did not respond well to the prairie environment. In 1899, for example, there were field trials of Timothy grass, but yields were light (OAES 1899-1900). Bermuda grass (*Cynodon dactylon*), which would eventually become a leading pasture grass in the state, was found to do well in southern Oklahoma, but "not one of the cultivated or tame grasses can as yet be confidently recommended for the territory as a whole" (OAES 1897). Bermuda had been imported into the United States from Africa, which shared some climatic conditions with southern Oklahoma. So through much of the territorial period, native grasses were a main source for forage, as research and breeding trials continued to develop improved and cultivatable tame forage plants (OAES 1897).

At the national level, the USDA sent agronomists to distant continents in search of plants species with economic promise, resulting in a steady stream of new grasses and forages for trial. Strain selection and testing and promotion of introduced grasses by the USDA resulted in the spread of non-native grasses over large areas of the United States (Archer and Bunch 1953). Some of these plants were eventually disseminated to Oklahoma Territory. Trials conducted by the OAES were set up to test the climatic suitability, productivity, ease of harvest and management and nutritive value of non-native grasses (Wheeler 1960).

In Oklahoma, early research by the OAES to improve forage production focused on alfalfa (*Medicago sativa*), a member of the legume family of Mediterranean origin, which could be cut for hay. The first research published by the OAES, in 1897, reported alfalfa to be the most valuable introduced pasture and hay crop for Oklahoma (OAES 1897). Bermuda grass was not suggested as a grass for lawn and permanent pasture in Oklahoma until 1900 (OAES 1902).

The 1930s brought a new suite of challenges for Oklahoma agriculturalists and the OAES, the greatest of which was “preserving and restoring the fertility of our most valuable natural resource, the soil” (Deering 1945). Even by 1897 it was recognized that native grasses should not be plowed for crop production because “many acres have been plowed which, with our present knowledge, would have been more wisely left covered with native grasses” (OAES 1897), advice that may have staved off the impending disaster of the Dust Bowl. The “limitless grassland” which lured the pioneers west, was eroded due to plowing and overstocking cattle on rangelands (Archer and Bunch 1953). In a period of 30 years in Oklahoma, following the Dust Bowl, cropland decreased by 7 million acres and the number of farms growing crops decreased by 100,000 (Figure 1.3a and Figure 1.3b; USDA (1950, 1997), and it is estimated that 2 million acres of that land was ruined from soil and water erosion. In most places where the soil has been continually cropped, from eight to twelve inches of topsoil was washed or blown away (Keso 1946).

The USDA bulletin *Soil Erosion*, published in 1911, was the first official documentation of the severity and magnitude of soil erosion in the United States. In general the bulletin promoted grass varieties that were introduced from other countries and would “flourish greatly and perform their office quickly in the new environment,” specifically recommending Johnson grass or Bermuda grass to control soil erosion in the Southeastern United States (McGee 1911; Deering 1945). By the 1930s Bermuda grass was recommended as a way to “heal” many acres of eroded grassland in Oklahoma (Figure 1.4; Arkansas-Verdigris Soil Conservation District Work Program1938; Keso 1946).

Two agencies in the USDA were responsible for implementing soil conservation measures; the Soil Conservation Service (SCS) and the Agriculture Adjustment Agency (AAA). The latter was absorbed into a new agency named the Production and Marketing Administration (PMA) in 1945. The AAA was established in 1933 under President Roosevelt's New Deal to regulate farm production and distribute benefit payments. One AAA benefit programs paid farmers $3.00 per acre to plant Bermuda grass sod (Deering 1945). At the Wagoner County AAA office a Bermuda grass sod conversion program was in place by 1936 (Wagoner County Extension Homemakers Council 1980).

The search for solutions to stem the tide of soil erosion and increase year-round forage yield and grazing continued to focus on non-native species and programs for their improvement. The Cherokee Hills Conservation District was converting abandoned cropland “at a rapid rate” to tame pasture because

the cropland was comprised of “weeds and low order grasses” that can only provide forage for one cow per twenty acres (USDA, 1966). In 1938, the Bryan County Soil Conservation District encouraged farmers to plant permanent pastures of Bermuda grass with bur clover (*Medicago polymorpha*), hop clover, lespedeza (*Lespedeza cuneata*), rye (*Lolium* spp.), Sudan grass (*Sorghum bicolor*) and Johnson grass, to “meet the need of more highly productive permanent pasture” (Bryan County Soil Conservation District, 1938).

The Jack Hall Ranch, 10 miles north of Edmond, Oklahoma, converted a once eroded cropland to a productive ranch through a regimen of fertilization and drilling oats (*Avena sativa*), followed by overseeding with sweet clover (*Melilotus* sp.), lespedeza, bluestem (*Andropogon* sp.), fescue (*Schedonorus* sp.) and vetch (*Vicia* sp.), which produced “a good year round pasture with summer and winter grasses and legumes in the mixture” (Oklahoma Farm, Fields and Pastures Sunday, June 20, 1954). According to Harlen (1957) many thousands of acres of abandoned farmland were rejuvenated into improved pastures that yielded 4 to 5 times as much as the original grassland.

Tall fescue the Plant

Tall fescue is a perennial grass native to Europe that has become naturalized across most of North America and is one of the most widely planted introduced grasses in the United States (Figure 1.5; Ball et al. (1993). Tall fescue is currently found in all States, with the apparent exception of North Dakota and Indiana, throughout much of Canada, excluding Manitoba, Nunavut

and Northwest Territories (USDA 2012). In its native range, tall fescue grows in damp pastures and meadows, and wet places throughout Europe and North Africa, extending to western Siberia (Buckner et al. 1979).

In the case of tall fescue, climatic conditions have restricted large-scale production to the eastern half of Oklahoma (Figure 1.6). Tall fescue is a cool season grass, meaning it grows best when the average temperature is above 7^{o}C. Growth is inhibited when the average daily temperatures fall below 1^{o}C or rise above 30^{o}C. Average annual rainfall at or above 90 cm per year is necessary for tall fescue, although it will grow in central Oklahoma when irrigated. Thus, maximum growth and production of tall fescue occurs during the cool spring conditions, followed by semi-dormancy during the hot summer months, with resumed growth in the fall (Redmon et al. 1995).

Although tall fescue performs well in most soils in eastern Oklahoma (Harlen and Elder 1952; Redmon et al.1995), it can handle a wide range of soils because it can tolerate highly acidic to alkaline soils and needs gravely loam to poorly drained clay, but prefers moist to very moist conditions (USDA 1957). Tall fescue is a perennial, bunch grass that spreads asexually through crown expansion. It can grow to a height of two to five feet per year (Figure 1.7) (Burns and Chamblee 1979, Redmond, Pratt and Woods 1995).

Tall Fescue Introduction

Ironically, for such an agriculturally important plant, tall fescue was introduced into the United States as a contaminant in meadow fescue seed.

Meadow fescue (*Schedonorus pratensis)* – introduced from Europe prior to 1800 - was commonly planted in pastures in humid temperate areas of North America (Hoveland 2009). The success of this grass would be curtailed by the appearance of oat crown rust (*Puccinia coronata*), which began infesting meadow fescue in 1905. It was a turning point in the history of tall fescue in North America, because although oat crown rust, a fungus, infected meadow fescue, it did not infect tall fescue. Thus, tall fescue replaced meadow fescue in production because it made more vigorous growth of foliage and was rust resistant (Vinall 1909; USDA 1948).

Broad scale plantings of tall fescue did not begin until the development of cultivars Alta and Kentucky 31. Alta originated from plant breeding at the Oregon State University Experiment Station in 1923 and was selected for winter hardiness (USDA 1948). The discovery and development of Kentucky 31, the cultivar most often planted in Oklahoma, has a unique story.

Plants possessing the traits of what would become Kentucky 31 had been growing undiscovered on a farm in Menifee County, Kentucky, apparently for many years. Then in 1931, while judging a sorghum contest in the county, agronomist E. N. Fergus of the University of Kentucky was alerted to a unique stand of grass. What made this fescue pasture unique was that the plants stayed green throughout the winter. Fergus visited the site, collected seed and began plant trials. The University of Kentucky experimental station began testing in 1932, and the Kentucky 31 cultivar was released in 1943 and heavily

promoted by Fergus (Cope 1949, Buckner, Powell and Frakes 1979, and Hoveland 2009).

Tall fescue promotion in Oklahoma began shortly after the release of Kentucky 31. Kentucky 31 was promoted throughout eastern Oklahoma for two applications; erosion control and cattle forage. As an agent of erosion control, tall fescue was, and still is, planted because of its ability to form a deep, dense uniform sod and grow vigorously in soil moisture conditions ranging from flood to drought (USDA 1948; Archer and Bunch 1953; USDA 1957; Wheeler 1960). Tall fescue was introduced into bottomlands, drainage ditches and along right-of-ways because of its ability to grow in waterlogged situations (Harlen and Elder 1952).

SCS districts throughout the southeastern U.S. begin seed production of tall fescue for use as an erosion control agent in 1943 to “promote the rapid expansion of tall fescue acreage in the south-central and southeastern United States” (Buckner, Powell and Frakes 1979). The Little River Soil Conservation District in McCurtain County became one such seed production center in Oklahoma. In 1951, the Idabel Chamber of Commerce sponsored an excursion to Tennessee to purchase 27,000 lbs of fescue seed. By 1952 the Little River Conservation District had produced 250,000 lbs of fescue seed on 11,000 acres of land (Dexter 1953).

Second, tall fescue was promoted as a forage crop because it remains green for more days of the year than any other improved forage grass in Oklahoma (Harlen and Elders 1952). It also produces excellent hay as well as

pasture during the spring and fall, thus complementing the native warm season grasses. But the yield in hay is greater for tall fescue than native grasses (Archer and Bunch 1953).

Tallgrass prairie dominates areas where tall fescue has been overseeeded. Although the majority of grassland vegetation in Oklahoma lies in central and western Oklahoma, the northeastern region of the state also consists of large tracts of prairie. Oklahoma is a prairie state and much of the vegetation is grassland. Of the 18 million ha total land area of Oklahoma, 9.5 million ha (53%) is grasslands (Duck and Fletcher 1945). Tallgrass prairies are described as regions with a lush growth of four tall grasses: big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*) and switchgrass (*Panicum virgatum*). These grasses can grow to approximately 120 cm or higher in mesic sites (Risser 1981). Since these species begin growth in late spring and develop flowers in late summer, they are referred to as warm season grasses.

The green foliage season of native prairie, where warm season grasses predominated, was extended by overseeding native rangelands and meadows with tall fescue (Mitchell, Ewing and McMurphy 1985). Overseeding requires a light disking of existing native rangeland before either drilling or broadcasting the tall fescue seed (Archer and Bunch 1953; Willard 1962) at 15 lbs of seed per acre between September 20 and October 20 (McMurphy, Rommann and Webb 1975). In the eastern Oklahoma woodlands of the Ozarks and Ouachita

Highlands, trees and brush were cleared and reseeded with tall fescue to produce pasture (McMurphy, Rommann and Webb 1975).

Tall fescue was first mentioned in the OAES biennial report from 1948-1950 as an introduced forage grass (OAES 1948-1950). Field trials began at multiple experiment stations 1952-1968, including El Reno, Muskogee, and Perkins. The most extensive testing was conducted at two now defunct facilities; the Heavener Southeast Soil Improvement station (closed in 1968) and the Southeastern Pasture Fertility Research Station at Coalgate (closed in 1961) (OAES 1950-1952; Fuller et al. 1971). The Eastern Oklahoma Pasture Research Station at Wainwright (closed in 1977), in Muskogee County, studied the productivity of tall fescue with different applications of fertilizers from 1962 to 1964. This was followed by a study of steer weight gain when fed tall fescue hay as winter forage was conducted during the winter feeding seasons between 1968 and 1969 at the Muskogee Station (Fuller et al. 1971).

Tall fescue first appeared in the USDA SCS agronomy handbook in the year 1949. The Daily Oklahoman newspaper reported tall fescue growing trials for the years 1948-1949 on a farm in Kiowa County. The farmer was provided a small quantity of Kentucky 31 seed to plant in a demonstration pasture, because “this new grass is giving excellent results in the eastern states but has yet to prove to be a valuable pasture this far west” (Farm Notes, 1948). Given the hot, semi-arid conditions of southwestern Oklahoma, it is doubtful this trial was successful.

In the more humid eastern portion of the state, farmer R.B. French of Cherokee County reported that tall fescue was very promising because it stayed green the year round. He was one of the few farmers in the county who had tried fescue for one year (Farm Notes, 1949).

When considering the success of tall fescue in Oklahoma, it is important to consider climate. The geographic distribution of all plants is influenced by precipitation and temperature, so when a plant is moved to a new geographic locality, agronomists and horticulturists strive to understand the response of cultivars to climate, and the climate of Oklahoma presents some unique challenges for successful plant introductions. For example, the amount and timing of precipitation varies substantially between eastern and western Oklahoma. The average annual precipitation in Oklahoma ranges from approximately 130 cm in the far southeast portion of the state to 80 cm in central and 40 cm in the far northwest corner of the panhandle (Johnson 2006a). The annual number of days below freezing in Oklahoma follows a gradient from southeast to northwest as well. The southeast portion has less than 59 days below freezing on average while the northwest corner of the panhandle has approximately 130 (Johnson 2006b). This variation in climate across the state means that xeric, and cold tolerant plants can grow in the northwest while mesic plants that do not tolerate frost grow well in the southeast. In 1952, the OAES published a pamphlet that delineated the state into regions using climate and soil variables

Because it is a cool season grass, tall fescue extends the green foliage season for cattle where native, warm season grasses predominate. It is adapted to grow during the cool, moist conditions of spring and fall, and becomes dormant, or at least less productive, during the hot, dry conditions of Oklahoma summers (Cully, Cully and Hiebert 2003). Tall fescue will continue to grow, albeit slowly, during the winter months of December, January and February. The growth rates starts to increase in late February leading to flowering and seed production in May. Tall fescue becomes semi-dormant during the hot summer months of June, July and August at which time the native warm season grasses become productive. Tall fescue usually resumes growth in late August or early September (Mitchell, Ewing and McMurphy 1985; Redmon, Pratt and Woods 1995).

A rotational system of tame pastures was promoted to increase yields of forage because a single field cannot produce continuous year-round high yields (Cope 1949; USDA 1957). Buckner, Powell and Frakes (1979) report that the *Front Porch Farmer* highly recommended the use of tall fescue for use in a system of year-round grazing, and "undoubtedly had much to do with the spread of Kentucky 31". *Front Porch Farmer* recommends Kentucky 31 as a winter forage crop in a grazing rotation with kudzu (*Pueraria montana)*, sericea lespedeza (*Lespedeza cuneata*), coastal Bermuda grass and ladino clover, all non-native species (Cope 1949).

In the USDA bulletin "Useful and Ornamental Grasses" tall fescue was touted as valuable grass either for mowing or rangeland. "It is exceedingly

hardy, and produces a very large amount of excellent quality hay, succeeding best on lands with adequate moisture" (Lamson-Scribner 1896). Tests for tall fescue as a hay crop were conducted at OAES from 1968-1969. It was found that tall fescue produced good quality hay, although not superior in quality to alfalfa, Sudan grass or midland Bermuda grass, and sericea lespedeza (Fuller et al. 1971).

The advantage of growing tall fescue for hay compared to native prairie hay is increased yield. The advantages are clear for the farmer: approximately one ton per acre, harvested once in July for native grasses compared with one to two tons per acre of tall fescue that can be harvested twice a year. Native hay meadows that have been overseeded with tall fescue have had their spring production increased, but require a biannual nitrogen application to double the yields of a fescue cutting (Mitchell, Ewing and McMurphy 1985).

Conclusions

The conversion of native tallgrass prairie in Oklahoma to tall fescue pastures, beginning in approximately 1948, was initiated for soil erosion control in eroded abandoned croplands and overgrazed rangelands, and to increase forage production. Since that time tall fescue has become one of the most widely planted forage grasses in the United States (Matthews 2000).

Tall fescue was rapidly spread throughout the southeastern United States following the release of the popular cultivar Kentucky 31. This cultivar was well adapted to a variety of soils and soil moisture regimes. These

qualities made Kentucky 31 ideal for soil erosion control. Tall fescue was promoted throughout the southeast as a soil erosion control agent by the SCS. The other quality that made Kentucky 31 so sought after was its ability to grow almost year round in the southeastern United States. Its ability to produce foliage longer than most other forage grasses made it ideal for year round grazing systems or for increasing hay production.

The year round growth of tall fescue provided farmers with a winter forage crop, and higher yields to complement their native warm season grasses. In Oklahoma, the OAES performed grazing and hay research on tall fescue starting in 1952, which showed greater gains in beef cattle and hay yield for tall fescue than native grasses.

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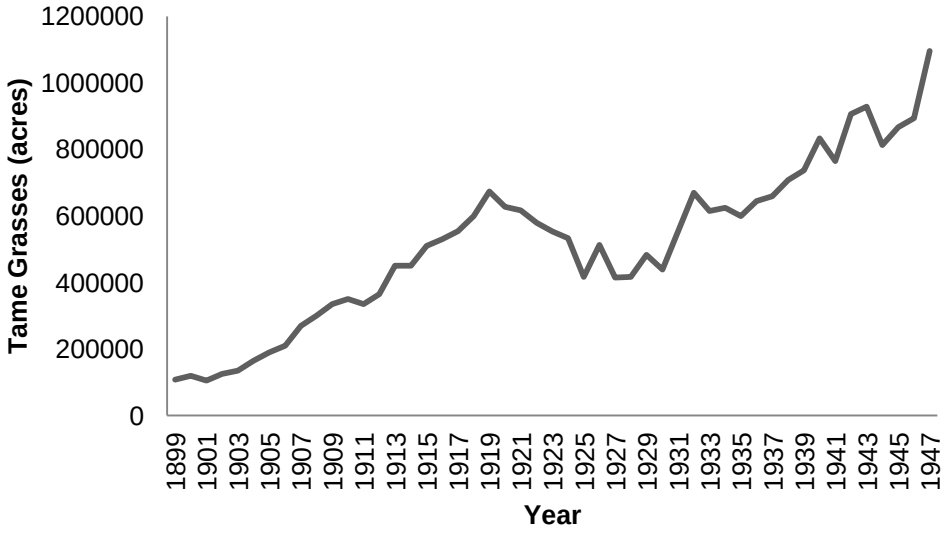
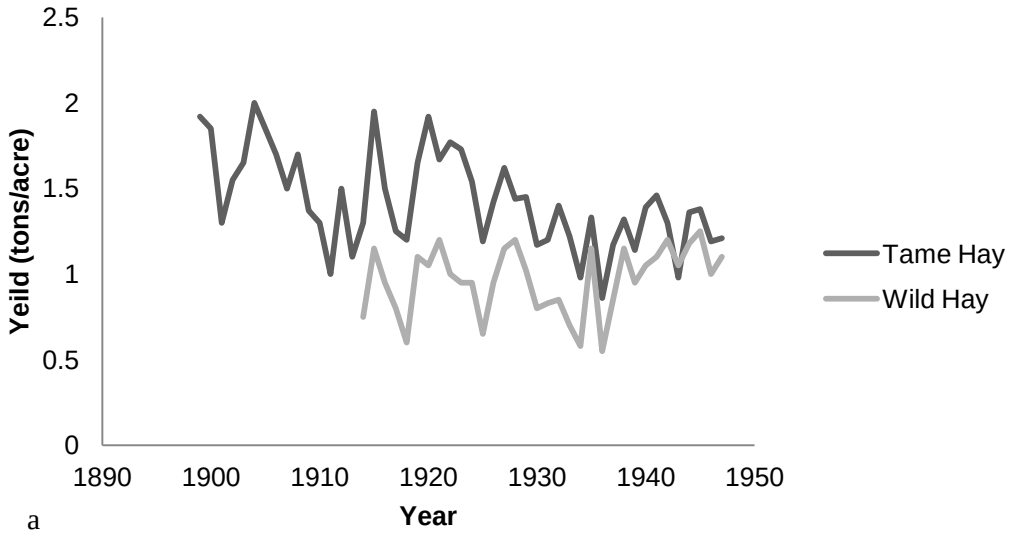
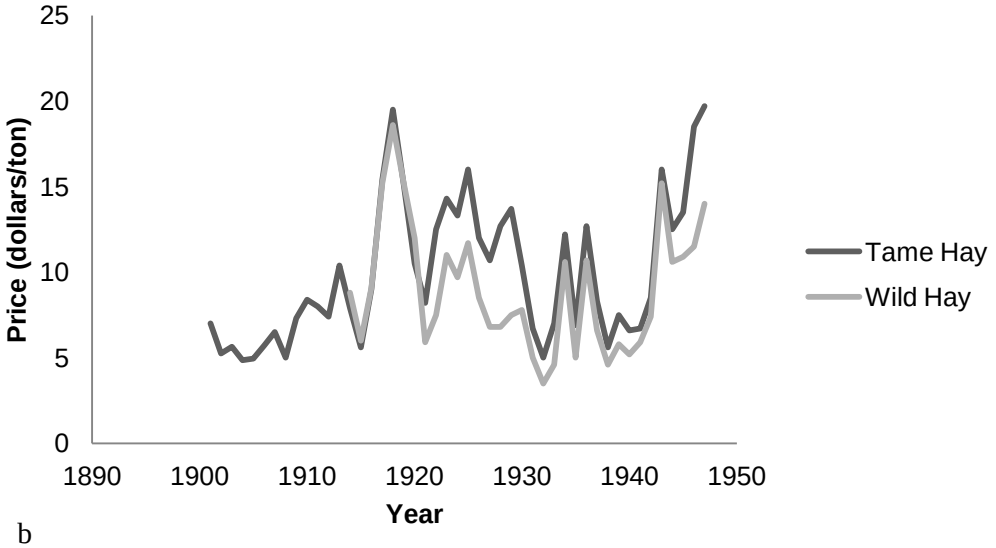


Figure 1.1. Acreage of tame grasses (acres) planted in Oklahoma from 1899 to 1947 (OAES 1949)

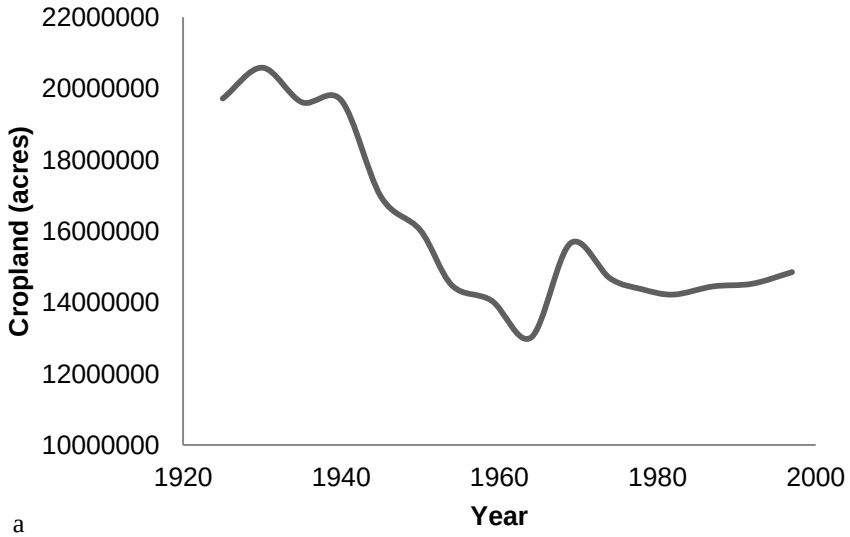


a

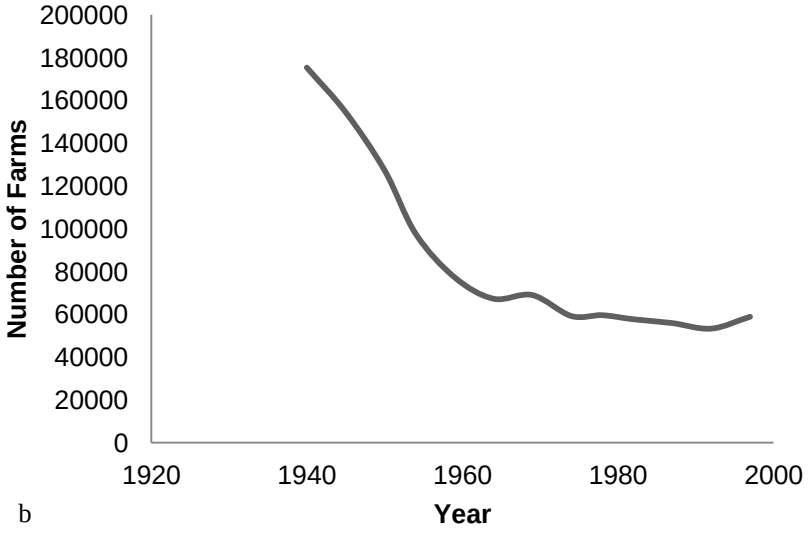


b

Figure 1.2. (a) Production of tame hay and wild hay (tons/acre) (b) Price of tame hay and wild hay (dollars/ton) in Oklahoma between the years 1899-1947. Data was not collected for wild hay prior to 1914 (OAES 1949).



a



b

Figure 1.3. (a) Number of acres in crop production in Oklahoma between 1925-1997, (b) number of farms growing crops between 1940 -1997 (USDA 1950, 1997).



Figure 1.4. Image of erosion control at Stillwater, Oklahoma Project Area described as “Branched gully completely healed by Bermuda grass”. Edd Roberts Collection, Oklahoma Historical Society Research Division.

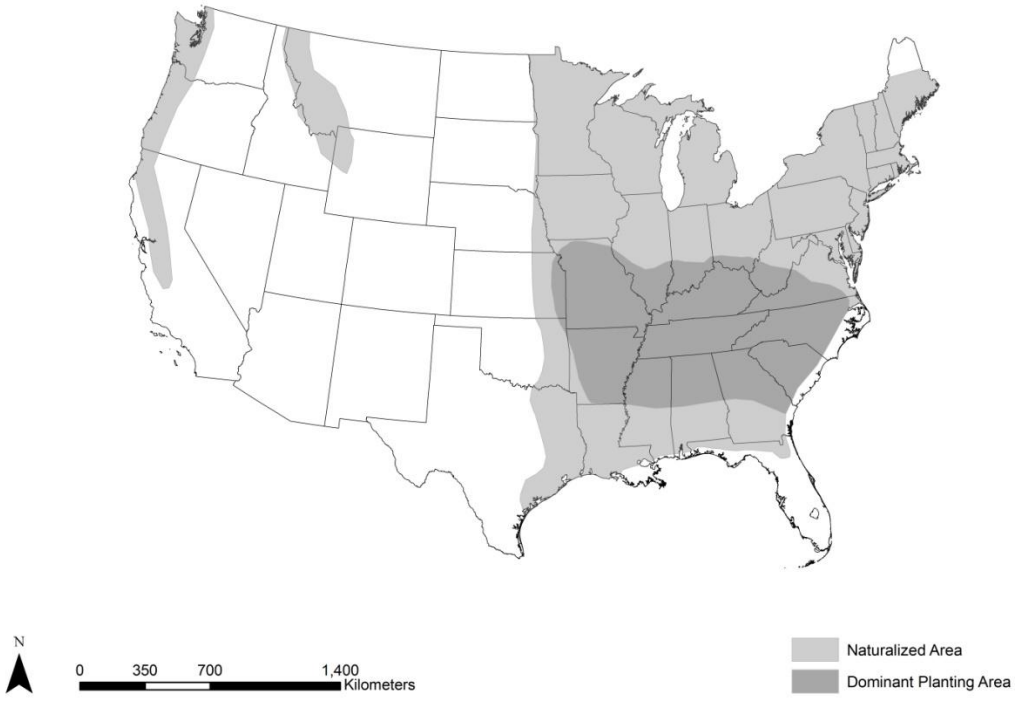


Figure 1.5. Distribution of tall fescue's naturalized area (*light grey)*, which includes most of the eastern U.S. and portions of the Pacific Northwest. The dominant planting area (*dark* grey) where tall fescue has been preferred for hay and livestock production. Map adapted from Ball et al. (1993)

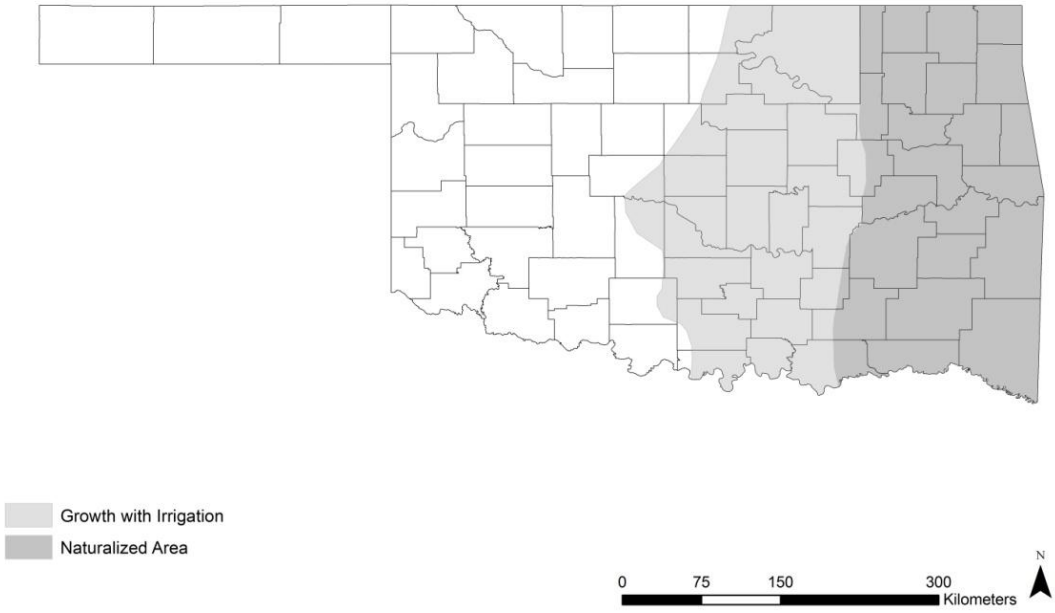


Figure 1.6. Naturalized area of tall fescue, most suitable for hay and pasture production in Oklahoma (*dark grey)*, area suitable for hay and pasture production with irrigation (*light grey*). Map adapted from Harlen and Elder (1952).





Figure 1.7. Tall fescue with seed set growing in a drainage ditch in Payne County, Oklahoma (*left),* tall fescue growing in a drainage ditch in Oklahoma County, Oklahoma (*right*).

Chapter 2

Reconstructing Land Use Patterns in a Tallgrass Prairie Landscape, Using Public Land Survey Records, Circa 1896

Abstract

The land use practices that accompanied settlement across central North America changed the structure and function of the North American tallgrass prairie landscape. Tallgrass prairie vegetation has experienced the largest areal reduction compared to other North American vegetation types. Euro-American settlement over the past 150 years is reported in historical records providing the data to study land use modification in the tallgrass prairie. In this study historical spatial data obtained from the General Land Office was used to understand how land use practices initially altered the tallgrass prairie landscape, within a portion of Indian Territory, referred to as the Cherokee Prairie. The spatial data used include plats from the Public Land Survey (PLS) of Indian Territory and the USDA Land Capability Classification. The PLS plats were used to reconstruct the historic tallgrass prairie land cover as well as transportation networks, fencing and settlements. The PLS field notes general descriptions were used to support the spatial data obtained from the plats. The USDA Land Capability Classification was used to determine the relationship between preference for cultivation sites and land cover type at the time of the PLS. This study determined that the largest land use change was the result of opening Indian Territory to railroads. This expanded the settlement of land by Euro-America settlers and opened the flow of commerce into and out of Indian

Territory. The invention and widespread use of barbed wire fencing allowed for enclosure of vast tracts of tallgrass prairie and aided in the increase in cultivated fields. The increase in cultivated lands changed the main land use in the Cherokee Prairie from rangeland to crop cultivation. My analysis shows that settlers preferred cultivating tallgrass prairie over woodlands within the Cherokee Prairie. The preference of prairie cultivation over woodland cultivation was likely because bottomlands were poorly drained and upland woodlands were too rocky to cultivate.

Introduction

It is estimated that since 1830 there has been an 82-99% decline of tallgrass prairie vegetation in North America, exceeding the areal loss of any other major ecosystem in North America (Samson and Knopf 1994). In Oklahoma Duck and Fletcher (1945) report that 5.3 million ha or 30% of Oklahoma's total land area of 18 million ha was potentially tallgrass prairie. The most extensive, contiguous tract of tallgrass prairie was located in northeast Oklahoma, in a region often referred to as the Cherokee Prairie.

The primary destructive force in the tallgrass is land conversion, a process that began almost two centuries ago in the Cherokee Prairie, first with the forced removal of Native Americans from the southeastern United States followed-up by extensive Euro-American settlement in the late 19th century. Settlement in the Cherokee Prairie began in the 1820's, and accelerated with the forced removal of the Cherokee and Creek Nations following passage of the

Indian Removal Act in 1830 (Figure 2.1). The Creeks immigrated to Indian Territory between the years 1828 and 1836 from present-day Georgia and Alabama. The first party emigrated in 1828 and settled at the three forks of the Arkansas, Verdigris and Grand Rivers, near present day Muskogee, Oklahoma. These people were referred to as the Lower Creeks and were from the towns of Coweta, Broken Arrow and Big Springs in Georgia. The Upper Creeks from Locha Pokas, Georgia arrived in 1836 and settled near present day Tulsa, Oklahoma (Debo 1943).

The Cherokee followed a different route to Indian Territory, emigrating to the west between the years 1818 and 1839. In 1818, a considerable number settled on the Arkansas River in present day state of Arkansas. These Cherokees were moved to Indian Territory in 1829 and 1830, and were joined by approximately 8,000 additional Cherokees from the southeastern United States in 1837. The largest movement of Cherokees, approximately 22,000, was initiated under the direction of Chief John Ross in 1838 and 1839 during the infamous Trail of Tears (Hewes 1940, 1944).

Communal Land Use System

From the time of settlement until the end of native sovereignty in the Cherokee Prairie, the Indian Nations practiced a system of communal land ownership. At the end of native sovereignty all land moved into private ownership. The land use patterns under the communal system can be documented using data from the Public Land Survey (PLS).

The communal land use system within Indian Territory allowed for natural resources, such as land, grass, coal and timber, to be held in common for the equal benefit of all citizens and could not be bought or sold (Meserve 1896). All soil and unfenced areas were held in common by tribal citizens. Although tribal government held the land, individual citizens held title to improvements such as barns, houses and fencing. Before such improvements could be constructed, the tribal member needed a permit and these improvements could not encroach on prior claims (Graeber 1945). Tribal land tenure entitled any citizen to cultivate as much land as he chose and livestock could range over the public domain (Debo 1943; Graeber 1943). This land use system was in place until the allotment of tribal lands between the years 1903-1910. During this time the communal land use system, the only one existing in America at that time, shifted to one of private land ownership (Graeber 1945; Hewes 1978).

Allotment was a process of dividing the communally held land of Indian Territory so that it could be distributed to tribal citizens to be owned in severalty. Land allotment in Indian Territory began with the passage of the Dawes Severalty Act of 1887, which stated that land should be allotted in 160 acre tracts to tribal citizens and the surplus land sold to the U.S. government and in turn to homesteaders. Although the Five Civilized Tribes (Cherokee, Chickasaw, Choctaw, Creek, and Seminole) were originally exempt from this act (Debo 1991; Carter 1999), the Commission to the Five Civilized Tribes (also known as the Dawes Commission) was established to negotiate the allotment of communally held tribal lands, and persuade the individual members to accept

U.S. citizenship in 1893 (Carter 1999; Hagen 2003). The allotment for a Creek citizen was 160 acres, or a quarter-section, while a Cherokee citizen was allotted 110 acres. The process of allotment was virtually complete by 1910 and the Dawes Commission was abolished in 1914 (Debo 1991).

Mapping the Cherokee Prairie at the time of allotment were the surveyors of the General Land Office (GLO). The United States government funded the Public Land Survey (PLS) of Indian Territory in accordance with the Treaty of 1866, thus facilitating allotment and the end of communal land ownership within Indian Territory (Meserve 1896; Kappler 1904). The surveyors were instructed to evaluate the natural resources of the land including change in landform, soil quality, coal and oil deposits, agricultural suitability of the land, and timber quality, so that an allotted parcel could be appraised (Hewes 1942). In understanding the role of settlement and land conversion, the PLS represents the earliest and most accurate data source for the analysis of settlement patterns, cultural landscapes, and human modification to land cover for Indian Territory (Watkins 2007). According to one surveyor, who helped conduct the PLS in Indian Territory, he was supplied with the best surveying equipment, and after working throughout Oklahoma, Louisiana, Arkansas and Texas, the Indian Territory survey was “at least the best survey I know”(Moore 1950).

The Tallgrass Prairie Ecosystem

As with other ecosystems, the decline in tallgrass prairie is the product of expanding human population and attendant land use changes. Although establishment of structures on the landscape led to some conversion, plowing grasslands and planting crops, as well as overgrazing by livestock led to both loss in acreage and an alteration of plants and animal species composition. Koper et al. (2010) found that the floristic composition of South Dakota tallgrass prairies was closely tied to land ownership and land use practices, which ultimately explained the observed variability and the persistence of rare tallgrass prairie stands. Prairies are of particular conservation concern because of the high number of rare species they contain (Sampson and Knopf 1994). Some of the rare plant species found in tallgrass prairie stands include the endemic species Oklahoma beardtongue (*Penstemon oklahomensis*), which blooms in early May, and is found in undisturbed tallgrass prairie stands that have not been overgrazed or plowed. In Oklahoma certain prairie orchids are of conservation concern. The Oklahoma grasspink (*Calopogon oklahomensis*), and the western fringed prairie orchid (*Platanthera praeclara*) are considered rare due to the decline in tallgrass prairie vegetation (Parham 2010; Oklahoma Natural Heritage Inventory 2010).

Many vertebrate species are rare due to overhunting and loss of habitat. Until about 1890 game species in Oklahoma tallgrass prairies were plentiful. In one account by an Indian Territory settler, he recalled from the late 1860's to the 1870's plentiful game, "often we would see deer on the way to and from school. The prairie chickens would light in the yard, and the pigeons were so

numerous that sometimes they would darken the sun. Turkeys could be had any time. The deer as venison was dressed and salted and kept for winter" (Chandler 1937). Another settler remembers counting fifty-three deer in route to school and the "turkey in the hills and the prairie chickens were so numerous you could hear them drumming or cooing of a morning in every direction until they would become annoying" (Branstetter 1937). Another settler remembers "thousands of prairie chickens and many deer while making trips to [Pryor Creek]. I remember we used to bell our horses and cows and turn them out on the range and the prairie chickens would make so much noise, shortly after daylight, that we had to get up before day to get our horses, or we could not hear the bell for the prairie chickens" (Barney 1937). The greater prairie chicken (*Tympanuchus cupido*) has since declined due to habitat loss and fragmentation (Birdwell et al. 2009).

There are approximately 131 mammal species found in the North American grasslands (Kaufman and Kaufman 1997). Ungulates and browsers, such as pronghorn (*Antilocarpa americana*), deer (*Odocoileus hemionus and O. virginianus*) and elk (*Cervus canadensis*), play a role in the structure and function of prairie ecosystems (Hartnett, Steuter, and Hickman 1997). The North American bison (*Bison bison*), is a keystone species that influences the structure and function of North American Grassland ecosystems. Bison grazing patterns follow warm-season grass abundance, and bison wallows and urine deposition create heterogeneity in prairie species composition. The bison had such a dramatic decline in numbers that it went from an estimated 30 million to

almost extinction within a dozen years of commercial market hunting (McHugh 1979; Vinton and Collins 1997). In the tallgrass prairies of Oklahoma there was a recollection of bison found around Pryor, Oklahoma. One Cherokee woman remembers her father going on hunting trips. She recalls “one time these Cherokees killed four of those animals at one trip….these hunting expeditions would generally last about two weeks….the buffalo would go to the Salt Springs near the Grand River to lick the salt [and] when this happened the Cherokees went on these expeditions. The meat was dried so it would keep during the summer months and in the winter they would hang this up as they do beef” (Hines 1937).

Data recorded by the PLS present a unique opportunity to reconstruct past landscapes and document land-use practices, because the data were systematically gathered at regional scales, but at the finest spatial resolution (one mile). The PLS data are best used at regional scales and in conjunction with other data sources to maximize interpretation (Whitney and Decant 2001; Schulte and Mladenoff 2001). For example, Anderson et al. (1996) used PLS records, federal census, lumber and agricultural records, accounts of early settlers and historians, scientific reports, maps and photographs to reconstruct land use of the lower St. Croix River valley from the 1830’s to 1990’s.

If researchers are able to understand the land use history of a particular prairie and why land use decisions were made they will better understand the structure and function of these landscapes (Foster et al. 2003; Hietel et al. 2004; Lunt and Spooner 2005). This study uses concepts from historical ecology, which is

concerned with a historical premise on the changes in relationships between human societies and their immediate environments (Balée 1998) to answer the following questions. 1) What was the extent of tallgrass prairie under the communal land use system in the Cherokee Prairie? 2) What were the predominant land use practices just prior to and at the time of the PLS? 3) How did land use alter the tallgrass prairie landscape? 4) Which land cover type, prairie or woodlands, did settlers prefer to cultivate? Changes in land use practices resulted from the introduction of railways, well drilling machinery, the steel plow, barbed wire fencing and the opening of Indian Territory to settlement, the range cattle industry and allotment of tribal lands. These questions will be addressed by analyzing digital spatial data layers created from the PLS plats and the USDA Land Capability Classification (USDA 2006). These spatial data will be supported with a review of the PLS general descriptions, oral history reports, and government documents.

Methods

Study Area

The area selected for study, referred to as the Cherokee Prairie, a regional designation based on similarity of land use, vegetation, soil and water resources, is located in northeastern Oklahoma (Blair and Hubbell 1938; Carter and Gregory 2008). The study area is and bounded by the Kansas border on the north, the Grand River on the east, the Arkansas River on the south and the 96th meridian on the west. The Cherokee Prairie includes all of Craig, Nowata,

Rogers, and Washington counties and portions of Delaware, Mayes, Muskogee, Ottawa, Tulsa and Wagoner counties (Figure 2.2).

Two geomorphic provinces characterize the geology of the Cherokee Prairie: the Claremore Cuesta Plains and the Neosho Lowlands. The Claremore Cuesta Plains are the most distinguishing feature of the landscape and consists of resistant Pennsylvanian sandstone and limestone forming cuestas between broad shale plains. The surface is characterized by broad valleys and rolling hills to level plains separated by roughly parallel southwest to northeast oriented escarpments. The Neosho Lowlands border the study area to the east of the Grand River and consist of gently rolling shale lowlands and low escarpments and buttes capped by Pennsylvanian sandstone and Mississippian limestone.

The Cherokee Prairie is in the drainage basin of three major rivers: the Verdigris River, the Grand (Neosho) River and the Arkansas River. These rivers and their larger tributaries are entrenched in broad floodplains (Bruner 1931; Blair and Hubbell 1938; Curtis, Ham and Johnson 2008). The minimum elevation in the Cherokee Prairie is 148 m and the maximum elevation is 314 m (Gesch 2007).

The predominant upland soil association in the Cherokee Prairie is the Dennis-Bates-Taloka-Parsons, which are clayey, loamy and humus rich soils on very gentle slopes (3%). The Shidler-Summit-Corbin-Catoosa-Steedman soil associations are found in a small portion of the uplands, referred to as the Bluestem Hills. They are clayey, silty and humus rich soils on gentle slopes

(6%). Both the Bluestem Hills and the Cherokee Prairies contain deep, dark colored soils mostly with clay subsoils developed on shales, sandstones and limestones under tallgrass vegetation. The Osage-Verdigris soil association is characteristic of lowland soils and is very deep, clayey, silty and slightly acidic, humus rich soils on nearly level slopes (1%) (Carter and Gregory 2008).

The Cherokee Prairie climate is typical for a North American grassland ecoregion with hot, dry summers and mild winters; however, this area tends to receive higher annual precipitation than the grasslands of the Great Plains to the west. The average annual precipitation varies between 112 cm on the western edge of the Cherokee Prairie and 121 cm on the east. The average annual temperature is 15.5°C. The growing season is between 195 days in the north and 215 days in the south of the Cherokee Prairie (Johnson 2006a, 2006b).

The Cherokee Prairie lies between the blackjack-post oak forest type, referred to as the cross timbers, to the west, and the Ozark Plateau to the east. The cross timbers are dominated by blackjack oak (*Quercus marilandica*) and post oak (*Quercus stellata*), whereas the Ozarks are dominated by white oak (*Quercus alba*), mockernut hickory (*Carya alba*) and American basswood (*Tilia americana*) (Duck and Fletcher 1945; Hoagland 2000).

Vegetation in the Cherokee Prairie is dominated by tallgrass prairie, which predominates in most upland areas, with bottomland hardwood forests and oak-hickory woodland occurring to a lesser degree. Four perennial grasses characterize the tallgrass prairie: big bluestem, little bluestem, Indiangrass and

switchgrass. Forbs, which occur in lesser abundance than grasses include: compassplant (*Silphium laciniatum*), dotted blazing star (*Liatris punctata*), rattlesnake master (*Eryngium yuccifolium*) and butterfly milkweed (*Asclepias tuberosa*) (Weaver and Fitzpatrick 1934; Buck and Kelting 1962).

Bottomland hardwood forests occur on the floodplains of the Verdigris, Grand (Neosho) and Arkansas Rivers, as well as their larger tributaries, such as the Caney and Cabin Creeks. Typical overstory species include American elm (*Ulmus americana*), sugarberry (*Celtis laevigata*), green ash (*Fraxinus pennsylvanica*), pecan (*Carya illinoinensis*), and pin oak (*Quercus palustris*) (Brabander et al. 1985; Hoagland and Wallick 2003). Trees in these forests grow to approximately 6 meters tall or taller. The forests are inundated at least on a temporary or intermittent basis (Cowardin et al.1979).

Public Land Survey

The PLS system was adopted in the Land Ordinance of 1785. The system was intended as a way to dispose of the western lands and relieve the financial burdens of the United States after the Revolutionary War. The western lands were seen as an asset that could be sold and profits realized, but by 1820 the attitude of congress towards those lands changed from revenue generation to orderly settlement of the growing U.S. population. The PLS employed a rectangular system, which divided the land into square townships measuring six miles on a side, each containing thirty-six square-mile sections (Stewart 1935). Townships are related to two standard coordinates, or lines, to which the

township can be referred. The major north-south lines are called meridians and the east-west lines are called baselines. Townships are numbered north or south of a specific baseline and the range is numbered east or west of a specific meridian (Whitney and Decant 2001).

The township and range lines were surveyed first followed by the section lines. A survey crew, consisting of approximately 20 men, first surveyed quadrangles that were twenty-four miles square, then townships that were six miles square, and finally sections that were one mile square (Moore 1950). Township and section lines were measured using a two-pole chain of approximately 33 or 66 feet, consisting of 50 or 100 links, respectively (Stewart 1935; Whitney and Decant 2001). Each township corner was marked with a 4' by 4" iron tube, split and spread at the ground end, and capped with a brass plate stamped with the township, range, and section identification (Moore 1950). When surveying the sections, surveyors traversed the boundaries between all sections and in doing so marked the intersection of section lines and the midpoint between corners, or quarter sections, using stones, and if stones were not available pits were dug or timber cut and driven into the ground (Moore 1950; Schulte and Mladenoff 2001).

The surveyors recorded their observations for the field notes and plats in pocket notebooks, or field tablets. The field notes were fully transcribed from these notebooks in ink to create a permanent record (White 1991). Because they are written in longhand, the field notes can be difficult to interpret but provide a wealth of data about land use. The instructions to the surveyors

required recording the location of all prairies, marshes, swamps, ravines, lakes, ponds, mountains, hills, and all other natural or artificial topographical features (White 1991). The field notes also include the names roads, fences, creeks and prairies that intersect the line being surveyed, as well the features at section and quarter sections corners. Corresponding points in chains and links were recorded in the field notes. At the end of every mile a description of the land (e.g. level or hilly) the quality of the soil for cultivation, and timber quality are recorded (Stewart 1935). These section line descriptions are particularly useful for the information they provide on the physiognomy of the vegetation (Whitney and Decant 2001). At the end of the field notes for every township a general description was recorded.

The general description concludes the field notes and consisted of a one or two paragraph description of the general character of the land cover focusing on topography, timber and soil quality for a township (Stewart 1935; Whitney and Decant 2001).

These field notes form the basis of the township plat. Surveyors were required to return their original field notes and an accurate plat or sketch exhibiting “the true situation of all objects noted in the field book” to the government (Stewart 1935). These sketches along with the field notes were translated into the final plat. Plats were produced at a scale of two inches per mile, or one inch to 40 chains (Whitney and Decant 2001). Plats detail the locations of rivers and creeks, lakes, swamps, prairies, hills, mountains, and other natural objects, as well as mines, salt springs, salt licks, mills, towns, and

villages, and forges, factories, cotton gins and other such items of information, as well as general course of traveled roads and tracks, railroads, telegraph lines and canals (Stewart 1935; White 1991)

Data collection and digitization

A digital geodatabase was created consisting of spatial data derived from the PLS plats. These data fall within three categories; land cover, settlement, fences and transportation. Prior to digitizing, each PLS plat was georeferenced to known points on the township and range layer from the *Digital Atlas of Oklahoma* (Rea and Baker 1997). To georeference, four known points, or control points, were selected on the PLS plat then aligned and linked to their equivalent geographic location on the modern township and range digital layer (Rumsey and Williams 2002). The data were digitized at scale of 1:10,000 to maintain the same level of detail. Each data layer was projected to North American Albers Equal Area Conic.

Mapping land cover is accomplished by developing a land cover classification system, delineating areas of relative homogeneity (basic cartographic “objects”), then labeling these areas using categories defined by the classification system (Fischer and Gregory 2001). The land cover layer classification developed for this study created polygons that were labeled as woodland, cultivation, lakes, orchard, ponds, prairie, rivers, and wetlands. Fences and transportation routes were represented as polylines within the geodatabase. Fences included all enclosures delineated on the plat, and were

categorized as wire, rail, board, picket and stone fences, as denoted by the surveyors. The transportation data included railroads and wagon roads. The settlement data, which included residence, churches, schools, cemeteries, mills, fords and ferries were digitized as points. ArcGIS 9.3 (ESRI, Redlands, Calif.) was used for digitization and analysis. Patch Analyst, an ArcGIS extension, was used to calculate the landscape metrics of total landscape area, number of patches, mean patch size and standard deviation for polygons (Remple 2008).

The PLS general descriptions (Appendix 1), were used as a primary data source to clarify and enrich the data found in the PLS plats. The surveyors at the conclusion of the field notes recorded the general descriptions. For this study the general description for each township was transcribed verbatim into a spreadsheet. The general descriptions were used to provide information on the agricultural suitability of prairie and woodland land cover types for each township, and supporting land use information.

The STATSGO2 land capability classes (LCC) provided the second source of information on land suitability (USDA 2006; Watkins 2007). The LCC was developed by creating interpretive groupings based on individual mapping units of the soil survey, which show the location and extent of different kinds of soil, for agricultural purposes. Soils were classified as arable if they had the ability to sustain production of commonly cultivated crops that do not require specialized site conditioning or if could do so after site treatment. Soils were classified as non arable if they were unsuitable for longtime sustained use for

cultivated crops. The LCC consists of eight categories of agricultural land suitability. Categories 1-4 represent areas best suited for, and that present the fewest obstacles to cultivation (arable soils). Categories 5-8 are the least suited for cultivation, but are the best suited for pasturage or grazing (non arable soils) (Table 2.1) (USDA 2006; and USDA). Within the GIS an intersect overlay operation was performed to determine the total landscape area that prairie and woodland land cover types occupy per LCC.

A prairie and woodland land cover data layer identified from the PLS plats to determine if settlers preferred prairie or woodland sites for cultivation. The prairie and woodland land cover data layer was created by digitizing only the prairie and woodland land cover types. To create this data layer the woodlands were digitized by delineating the shading of woodlands from prairie on the plats, which created a land cover that was made up of either prairie or woodland. A similar analog map was created by Fitch (1900) to determine the abundance of timber in Indian Territory. A cultivation data layer was created by selecting all cultivation polygons from the initial land cover data layer. This cultivation layer was then intersected with the prairie and woodland vector layer to determine the percentage of total landscape area of cultivation found in either prairie or woodland land cover types.

Results and Discussion

In the 1870s the PLS of Oklahoma Territory was completed along with the PLS of the Chickasaw Nation, Quapaw, Seneca and Peoria lands. In the

1890s the Chickasaw Nation was resurveyed and the remainder of Indian Territory was surveyed (Hoagland 2006). The Cherokee Prairie portion of Indian Territory was completed from March 1896 to July 1897. There were 182 township plats created, of which 52 were fractional (i.e. township does not contain a full 36 sections). One or two deputy surveyors and approximately two dozen surveyors surveyed each township. In all there were 21 different deputy surveyors employed throughout the Cherokee Prairie survey (Appendix 2).

Tallgrass prairie was the dominant land cover type within the Cherokee Prairie. Cultivation was the land cover that followed tallgrass prairie in total landscape area and woodlands were the third largest land cover class. Woodlands that were digitized within the Cherokee Prairie were either bottomlands or cross timbers that occurred in upland areas. The land cover classes with the smallest total landscape area were orchards, wetlands, towns and hydrological classes of rivers, lakes and ponds (Figure 2.3).

Cultivation

Of the total 1,060,252 hectares that constitute the Cherokee Prairie, 213,665 hectares (20%) were cultivated (Figure 2.4). Settlers appeared to prefer prairie over woodland vegetation to cultivate. The analysis show that cultivation occurred in 25% of the prairie landscape area while only occurred in 6% of the woodland landscape area (Table 2.2).

The following relationship was observed when the LCC data layer was intersected with the PLS prairie and woodland data layer (Figure 2.5). First,

68% of class 2 and 44% of class 3, which represent the land most suitable for cultivation, coincide with the upland prairie polygons. Bottomland areas occur in 72% of class 4. Cross timbers occur in 58% of class 5. Prairie occurring on the shallow soil Flint Hills region occurred 76% in class 6. Prairie also constituted 57% of class 7, which represents the class least suitable for cultivation. The LCC of water was not included in the analysis because this represents lakes that were created after the time of the PLS (Figure 2.6). The LCC of 1 and 8 are not present within the study area. Class 1 is represented along the floodplains of the Canadian, North Canadian and Cimarron rivers in central Oklahoma and the Red river in southern Oklahoma. Class 8 is represented in the sand dunes north of the North Canadian and Cimarron rivers in western Oklahoma.

In a similar analysis to determine land suitability and early settlement cultivation patterns, Warren (1984) investigated soil drainage classes in conjunction with five soil associations, based on soil characteristics, and looked at soil rates classified by the PLS surveyors to determine what characteristics were important to historic land use in northeast Missouri. He determined that cultivated fields were not always located on the most fertile soils, and soil drainage also played a role in field cultivation. Prairie soils that were considered fertile and rated moderately high row crop productivity were not selected for cultivation by settlers because they are found on flat landforms, with a dense claypan and drain poorly. Bottomland soil associations had the highest productivity but were both seasonally inundated and poor drained and therefore

less likely to be selected for cultivation. The soil association most likely to be cultivated by settlers in northeast Missouri was in the transition of prairie and woodlands; although it was slightly less productive, it had better drainage.

The soils rated as poor (3rd and 4th rate) in the Missouri PLS field notes were on relatively rough terrain such as sloping forest valley sides, poorly drained bottomlands, and level or wet upland prairies. However, good soils (1st and 2nd rate) occur on high, well-drained bottomland terraces, level upland forests or gently rolling uplands near prairie-timber ecotones. From Warren's (1984) analyses on the fringe of the prairie peninsula settlers and surveyors (when assigning soil rates for the disposal of land) were mostly concerned with soil drainage. This is because successful cultivation required considerable investments of "time, energy and capital to establish systems of artificial drainage" and these things were not in abundant supply on the frontier.

The PLS general description for the Cherokee Prairie highlights four soil classes, or rates described by the surveyors, these are: 1st, 2nd, 3rd, and 4th. There were no instructions to guide the classification of soil rates. Therefore, the classification appears to be subjective and based on the experience and background of the deputy surveyors (Anderson 2004). The objective of the surveyors in the Cherokee Prairie was to classify the soil so that it could be appraised for the disposal of land through allotment. In the Cherokee Prairie 1st and 2nd soil rates were considered suitable for crop cultivation, while 3rd and 4th rate soils were appropriate only for livestock grazing. Some 4th rate soil was simply described as worthless.

In the Cherokee Prairie, much of the tallgrass prairie was denoted as 2nd rate in the general descriptions. For example, in T25N, R21E surveyors J.W. Riley and J.S. Gibson, wrote “this township is all rolling prairie land…the soil is good 2nd rate”. In T29N, R19E surveyors, F.M. Johnson and Fred Watts, noted “with the exception of the southeastern portion of the township, next to Cabin Creek, is prairie, gently rolling. The soil is productive and makes excellent farms”. However, in T18N, R16E the land is described as “broken and only fit for cattle grazing”. Although a large portion of the prairie was already under cultivation by the time of the PLS (see Figure 2.4), there were large tracts of prairie suitable for cultivation that were not plowed. Such sites were likely used for livestock grazing. The PLS was conducted just after the peak of the range cattle industry (Dale 1960) and much of the 1st and 2nd rated soil that was not under cultivation was held by large land holders who used the prairie as a cattle range, and this could account for the lack of cultivation in large intact tracts of prairie.

Watkins (2007) PLS reconstruction of the Choctaw Nation found the opposite relationship between land cover and cultivation. In the Choctaw Nation, which is predominately a forest landscape, there was a lack of cultivation in prairie areas. This could have been because settlers were not solely concerned with agricultural potential, but rather preferred sites in close proximity to timber, placing them further from productive soils.

The cultivated areas in the Cherokee Prairie represent either fields of crop plants or small gardens. Watkins (2007) found that gardens were adjacent to

residences in the Chcotaw Nation, but were not always depicted on the plats differently than fields. However, in the Cherokee Prairie there is no mention of gardens in the general description. Orchards were the only other man made land cover class, besides cultivation, depicted on the plats. These were represented as small polygons filled in with tree symbols. Many of orchards containing apple and peach trees, with an occasional vineyard, could be seen (U.S. Office of Indian Affairs 1872) and fruit growing was of considerable importance in Indian Territory (Condra 1907). There were approximately 84 orchards for a total of 601 ha occurring in the Cherokee Prairie.

In 1872, corn, wheat, oats, potatoes and rice were the main crops harvested in the Creek and Cherokee nations (Figure 2.7). However, in three general descriptions cane was mentioned as a crop being cultivated. It is unclear if this cane crop was a variety of sweet sorghum used to make molasses or if it was sugar cane. In only one of the three townships was it referred to as sugar cane. In one instance, the surveyor's F.E. Joy and H.S. Hackbusch refers to the cane as sugar cane; "attention being devoted chiefly to stock raising and corn, wheat and sugar cane" (T21N, R19E). In the other two townships it is only referred to as cane. For instance, in T19N, R17E surveyors H.S. Hackbusch and F.E. Joy wrote that " [the township] is used for grazing - being fenced in every portion. In the southwest corner may be found corn, hay and cane fields. In T23N, R19E, F.E. Joy and H.S. Hackbusch wrote that "Almost all of the land is in use either as pasture or under cultivation, the principle crops being wheat, corn and cane". It is interesting to note that only

three townships mention the production of cane and all three were surveyed by F.E. Joy and H.S. Hackbusch. If cane was a more predominate crop in the Cherokee Prairie it was not mentioned by other surveyors.

The total number of hectares under cultivation increased little in the Creek and Cherokee Nations from 1872 to 1884 (Figure 2.8). In 1872 the total area under cultivation for both the Creek and Cherokee Nations was 60,702 hectares. By 1884 the total increased to 76,889 hectares (U.S. Office of Indian Affairs 1872, 1884). However, comparing these figures with the area under cultivation in the Cherokee Prairie at the time of the PLS shows a large increase in the area of cultivation at 213,665 hectares (Figure 2.3).

The Cherokee Nation was the larger of the two nations in terms of land holdings and population size with 1,863,613 hectares and a population, in 1892, of approximately 26,000. The land holding of the Cherokee Nation within the Cherokee Prairie is 890,306 hectares (84% of total Cherokee Prairie landscape). The Cherokee Prairie only contains a small portion of the total Creek Nation, 163,822 hectares (16% of total Cherokee Prairie landscape), compared to the total 1,251,657 hectares of land holdings, with a population of approximately 12,000 in 1892 (U.S. Office of Indian Affairs 1892).

Comparing the amount of cultivation between the Cherokee and the Creek nations, within the Cherokee Prairie, the Creek nation had 8,491 hectares (6%) of land under cultivation on 215 fields with a mean area of 40 hectares. The Cherokee nation had 205,174 hectares (23%) under cultivation with 2,738 fields and a mean area of 75 hectares (Table 2.3). By 1886 with

improved machinery, the Commissioner of Indian Affairs mentions passing farms ranging in size from 50 to 400 or 500 acres, “the fields on the prairie are getting numerous, larger and cultivated” (U.S. Office of Indian Affairs 1886).

Baum (1940) found that although the total land holdings of the Creek Nation were over half as large as that of the Cherokee Nation they only cultivated a quarter of the land she attributes this to the discrepancy in population size. The population of the Creek Nation was less than half the size of the Cherokee Nation, 12,000 and 26,000, respectively in 1892 (Commissioner’s Report 1892). The smaller area under cultivation for the Creek Nation could also be accounted for because of the large grazing lands found in the southern portion of the Cherokee Prairie are those held by the Creek Nation. There were also fewer roads, fences and settlements in the Creek Nation compared to the Cherokee Nation in the study area (Table 2.4).

Woodlands

Of the total 1,060,252 hectares that constitutes the Cherokee Prairie, 220,196 hectares (21%) were woodlands (Figure 2.3). The woodlands within the Cherokee Prairie would have been either bottomland forests or cross timbers woodlands. One reason bottomlands would not have been perceived as suitable for cultivation as upland areas is seasonal inundation. In the general description, sections in twelve different townships along larger streams were described as prone to overflow during the wet seasons, making crop production difficult. For example, in T18N, R16E the entire bottomland along the Verdigris

river is described by surveyor's J.C. Wilkinson and T.H. Thorn as "subject to overflow from 1 to 12 ft deep and while it has a rich alluvial soil of 1st rate quality, the entire area is worthless except for the timber."

The land cover type that corresponded to soils the least suitable for cultivation was the cross timbers woodlands. Soils at cross timbers sites were described as too rocky to be cleared for cultivation. For example, J.C. Wilkinson and T.H. Thorn describe in T20N, R16E the "uplands are covered with a scrubby growth of oak and hickory are unfit for cultivation, the soil in these sections is sandy and stony averaging 4th rate". Much like the underlying soils, the timber quality of cross timbers woodlands was assessed as poor and suitable only for use as fuel or as low quality lumber. H.S. Hackbusch and F.E. Joy describe in T21N, R17E "the little [timber] there is, owing to its inferior size and quality, being suitable only for fuel" and F.M. Johnson in T23N, R21E describes "the timber is a fairly good quality, and is used for fuel and rough building, such as rail fences, grain cribs and stock sheds".

While the tallgrasses provided summer forage for livestock, the bottomlands provided shelter and forage during the relatively mild winters. The mild and comparatively short winters in the Cherokee Prairie allowed for stock to be "roughed through" the winter without requiring grain or fodder to feed them (Baum 1940). Winter forage was scarcely necessary, because cattle could take shelter and forage on giant cane (*Arundinaria gigantea*) in the bottomlands (Moore 1874; Baum 1940), a practice first used by the Spanish in the 17th (Wilkinson et al. 1978). Giant cane, a member of the bamboo subfamily

(Bambusoideae) of grasses, often forms dense stands on the margins and in the understory of bottomland forests in the eastern United States. Historically, canebrakes covered large areas. The naturalist Thomas Nuttall (1821), who traveled through the Cherokee Prairie region (then Arkansas Territory) in 1819, reported a canebrake at the confluence of the Verdigris and Grand Rivers that was two miles (3.2 km) wide.

Tallgrass Prairie

The principle land use prior to the Civil War in the Cherokee Prairie was cattle grazing. But as the Civil War swept through Indian Territory the pastoral way of life established on the Cherokee Prairie was left in ruins. During the war there was almost a complete destruction of the cattle herds that grazed the prairie. According to George A. Culter, U.S. Agent for the Creek Indians, "Indian Country was probably the finest grazing country in the world and is alive with cattle" (U.S. Office of Indian Affairs 1863). Prior to the Civil War the Cherokee Nation was hailed for "its rich prairie pasturage, covered with immense herds of fine cattle and ponies; with farm improvements that would do credit to the States". However, after the Civil War the prairies were desolate: "The chimney monuments point out the spots where once happy families enjoyed domestic ease and tranquility…fences and agriculture implements destroyed, cattle stolen, former fields over grown with weeds" (U.S. Office of Indian Affairs 1865).

The large herds that had existed on the Cherokee Prairie before the Civil War would take about twenty-five years to rebuild (Figure 2.9). Many people

during the war moved their cattle herds from the south side of Grand River to the north side— the Cherokee Prairie—for protection (U.S. Office of Indian Affairs 1863). According J. Harlen, U.S. Agent for the Cherokee Indians, there were thousands of cattle grazing there and six months later, “hardly one can be seen” (U.S. Office of Indian Affairs 1863). The disappearance of the cattle herds was due to cattle rustling, by the Union army, the Indians living south of the Grand River, and Confederate troops supposedly taking enough beef to supply the entire western army. But marauding white men from the North accounted for the most stolen cattle (U.S. Office of Indian Affairs 1863, 1865).

There were two classes of farms in Indian Territory in the late 19th century. The first was the subsistence farm, usually operated by full blood Indians living in small cabins and cultivating only a few acres. The second was large farms run by mixed bloods or adopted white citizens (those who became citizens through marriage), who might operate farms in excess of 1,000 acres (Baum1940; Hewes 1940; Dale 1960).

Expanses of tallgrass prairie that were not under cultivation were held by large range cattle businesses. According to U.S. Indian Agent George Butler, “this is decidedly stock raising country and but little expense or exertion is necessary to raise cattle” (U.S. Office of Indian Affairs 1859). The communal land use system and the expansive tallgrass prairie vegetation in place in Indian Territory not only facilitated the development of the range cattle industry, it also created cattle barons. These “enterprising citizens, by either exploiting the lenient pasture laws, or evading them entirely” accumulated large ranges in

which to pasture their herds (Greaber 1943). For example, W.E. Halsell, a Texan married to a Cherokee woman, had a large cattle ranch near Bartlesville. His holdings extended from the Creek boundary north almost to Bartlesville and from the Osage boundary almost to the Verdigris River (Debo 1943; Demoss 1976). Some of these land holders, many of whom were from Texas cattle families, were considered intruders in Indian Territory (Meserve 1896). Intruders were a people without tribal membership and were therefore in violation of the law. Many whites in Indian Territory fell into this category (U.S. Office of Indian Affairs 1896).

In response to the land use abuses, the governments of the Five Civilized Tribes passed laws to limit the size of land holdings used for pasture. The Cherokee laws stated that pasture size could not exceed 50 acres (Cherokee Nation 1893). Creek law allowed for one-square mile of public domain, by a citizen, to be enclosed for the purposes of raising livestock as long as it did not encroach on other citizens. However, a citizen could build a pasture larger than one-square mile so long as they had the permission of those residing within the pasture or within one-half mile of the proposed enclosure. To legally acquire larger land holdings, a plat of the proposed enclosed pasture was to be submitted to the Principal Chief and there was an annual $0.05 per acre tax on proposed enclosures exceeding one mile (Muskogee Nation 1893; Graeber 1945). To circumvent these laws some citizens made scattered improvements within one-half mile of each other to obtain control over huge tracts of land (Greaber 1945a).

Hay production

Prairie hay production was only mentioned on four occasions in the general description. In T19N, R17E, H.S. Hackbusch and F.E. Joy mention hay fields in the southwest corner. In T20N, R13E, J.C. Wilkinson and W.H. Thorn mention that the grasses were considered valuable for grazing or hay. In T23N, R14E, F.M. Johnson and Fred Watts describe most of the valuable land is under cultivation but the remainder is used for pastures or hay fields. And in T27N, R18E, J.P. Thayer and Fred Watts mentioned that "the central portion is covered with loose limestone, which makes the land useless for anything but hay and stock range". Land use practices for tallgrass prairie, such as pasturage or hay fields, was not depicted or classified on the plats, so there is no way to determine what areas were hay fields and which were used as pasture. This is because some prairie was fenced to keep livestock in for pasturage and some was fenced to keep livestock out of hay fields, but all prairies were drawn in the same manner on the plats. It is safe to assume that hay fields and pastures were rotated based on grazing patterns, as was the land use practices employed for prairies during the 20th century (Drew 1947; Shortridge 1973).

In Indian Territory, the largest amounts of hay were produced in the Cherokee Prairie to provide winter forage for cattle and horses (Hewes 1944; Elder 1954; USDA 1957; Harper 1957). Native hay in winter was in great demand for shipping to the Kansas City stockyards and the mining towns of southwest Missouri and locally for feeding cattle shipped into Indian Territory.

Native hay brought $0.25 per acre, and the demand for hay was so great that straw stacks are all disposed of to cattlemen (Merserve 1893). An adequate supply of winter hay improved the conditions for raising cattle compared to the conditions for raising cattle prior to the 1880's (Green 1978).

Selling prairie hay was big business in the Cherokee Prairie although it was illegal to do so without permit. It was illegal for any citizen to sell prairie hay exceeding a wagon load to persons passing through the nation. Hay could not be sold outside of the Cherokee Nation or to any non-citizen. Any citizen wanting to ship or sell prairie had to acquire a permit through the nation describing where the hay would be sold and shipped in addition to a $0.20 per ton tax sold on prairie hay. And any violation of this law could warrant a fine of $500-$1,000 and a default of the fine could warrant imprisonment of six to twelve months. It was also illegal for a citizen to cut hay within a quarter-mile of a neighbor's improvements without his consent (Cherokee Laws 1893). According to Merseve (1893) illegal hay production still took place. Intruders would cultivate between 50-500 acres of land and save the remainder for pasture or hay. He states that it was not uncommon to see "large gangs of white men cutting, curing and pressing hay and loading it into freight cars for shipment to Kansas City and Chicago".

To facilitate the hay business, which accumulated great wealth, (Graeber 1945; Dale 1960; Hewes 1978) hay commission companies were located in hay export centers throughout the region. Hay export businesses were established in towns such as Vinita, Choteau, Pryor Creek, and Tulsa. Hay commission

companies acted as middlemen between farmers and customers. The hay export centers maintained large storage barns, especially at the railroad shipping points (Shortridge 1973;see Figure 2.10). During the late part of the 19th and the early part of the 20th centuries, railroads were the main transportation for the hay to reach markets. Prairie hay in the Cherokee Prairie was brought baled as much as six miles, and was either stored in large barns or loaded directly on to cars so that it could be shipped out in the winter to places such as Kansas, Missouri, Arkansas, and Louisiana (Condra 1907; Teague 1967). The annual shipment for some towns along the Missouri-Kansas-Texas (Katy) railway was a thousand or more cars (Condra 1907).

Settlement

There were 4,405 manmade structures in the Cherokee Prairie at the time of the PLS (Figure 2.11). The most numerous categories were 4,191 residences, 55 schools, 24 coal mines or pits, 22 churches and 17 post offices. Sometimes, but not always, the plats would label the names of people or families that lived in the residence. Of the 4,191 residences that were mapped only 475 or 11% were labeled. This was probably due to the difficulty in finding the names of residents. The best way to find the demographic data would be to use information from the PLS in addition to census data. Hewes (1940) found that using census data, Commissioner's reports, church and school attendance records gave an accurate depiction of the Cherokee Nation demographics.

A typical residence in the Cherokee Nation might have been a double log house (probably more likely to occur in the Ozark portion of the Cherokee Nation), or a box house. Some residences would have included stables, cribs, meat houses, stock pens and hay ricks (U.S. Office of Indian Affairs 1886). Several structures were mapped and labeled on the Cherokee Prairie PLS plats, such as three mills (one was J.B. Bartle's flouring mill, the namesake of Bartlesville) and there were also five hotels, four stores, three depots and three blacksmiths. In towns such as Nowata, Tulsa, Vinita and Wagoner (the more populous towns) there were few settlement points labeled. Some residences in these towns were represented as city blocks instead of points, so the plats do not accurately depict the number of residences. It is likely that there were many more hotels, stores, depots, etc. in the Cherokee Prairie but they were not labeled on the plats.

The number of settlement points was highest in the prairie with 2,197 points, cultivation with 1,026 points and woodland with 516 points. There likely was more settlement points in the prairie because prairie had the greatest landscape area. To determine which land cover contained the most settlement points, the density of settlement points per square kilometer in prairie, cultivated and woodland land cover types was calculated. The average number of settlement points per square kilometer of land cover area varied little between land cover types, but cultivation had slightly more at 0.48 points/km^2 prairie had 0.36 points/km^2 and woodlands had 0.23 points/km^2 (Table 2.5). The reason settlement points occurred more in cultivation land cover type was because

settlers relied on growing crops and gardens for income and sustenance. Bottomlands would be the least suitable location for a residence due to river overflow and an “unhealthy climate” found along the larger river bottoms such as the Verdigris river in T21N, R15E described by F.M Johnson and Fred Watts, or a “sick bend” found along the Grand River where the “water is poor and as a general rule the health is not good” in T24N, R23E described by H.S. Hackbusch and R.P. Howell.

Fencing

In 1896, there were 14,973 kilometers of fencing in the Cherokee Prairie (Table 2.6). The northern part of the Cherokee Prairie was much more fenced, due to the larger amount of cultivation than the southern portion, or in the Creek Nation (Figure 2.12). Hewes (1944) found that settlement was most complete in the northeastern portion of the Cherokee Prairie, were many of the townships were extensively fenced. This gradient in settlement was likely due to the proximity to Missouri and Kansas and markets that were connected by railway at junctions such as Vinita. Within the Cherokee Prairie the majority of fencing was wire, followed by rail, and a few board and picket fences.

Barbed wire was the most widely used type of fencing in the Cherokee Prairie because it was efficient to use and inexpensive to buy and there was a lack of timber to construct many rail fences. Wire fence was also preferred because it did not shade crops or harbor weeds, insects and small animals like other fencing materials, such as Osage orange (*Maclura pomifera*) hedge

fencing, or rail fencing (Hayter 1939). In 1896 barbed wire fencing could be bought at any town in the Cherokee Nation for $2.25-2.75 for 100 lbs. To build a two-strand fence, 200 lbs would stretch 80 rods (i.e. a quarter of a mile) (Meserve 1896). During the 1870's a small farmer could enclose a field with a three-string fence for about $150 per mile (Hayter 1939). However, this new fencing material was not always beneficial to cattleman.

Livestock were often killed from wounds inflicted by the barbs when the wound would become infected with maggots from Mexican screw worm flies, once infected an animal could die within a few days (Hayter 1939; Green 1978). The death rate of livestock was also high from lightening strikes on the wire fences and cattle becoming trapped during blizzards (Hayter 1939). Fencing was also a factor in depleting much of the scarce timber on the western plains, because timber from creek bottoms was cut and used to construct fence posts (Meserve 1896; Hayter 1939).

One use for fencing in the Cherokee Prairie was keeping livestock out of cultivated areas. One settler remembers that instead of using fencing to keep livestock in, cultivated land was fenced to keep hogs and cattle out (Simerson 1937). Around Pryor Creek very little land was fenced. The only land that was fenced was cultivated, and the rest was open range that facilitated cattle raising (Banstetter 1937). Fences not only protected growing crops from livestock, but also gave the farmer an opportunity to use the fields as pasture after harvest. Fences also compelled travelers to follow the roads rather than crossing agricultural fields, a common practice on the frontier (Hayter 1939).

Drift fences were conspicuous on the Cherokee Prairie landscape (see Figure 2.12 inset). They were built in disconnected sections, at natural changes in the terrain to direct cattle during the grazing season or aid in roundups (Mayes County Historical Society 1977). They are called drift fences because they blocked the way of unattended cattle from drifting across the range, and they also worked to protect areas from becoming over grazed (McCallum and McCallum 1965).

Wire fencing was also used as a way for cattle ranchers to claim vast amounts of communally held land for pasture. In 1884 it was estimated that 121,406 ha (300,000 acres) of Cherokee land and 40,469 ha (100,000 acres) of Creek land was enclosed by fencing (U.S. Office of Indian Affairs 1884). Wire fencing was illegal from 1882-1892 in the Cherokee Nation, after 1892 it could be used legally as long as it was seven strand, securely fastened to posts set within fifteen feet of one another (Cherokee Laws 1893; Graeber1943; Hewes 1940, 1978). The intent of this law was to restrict cattlemen from enclosing vast tracts of public domain for pasturage.

Railroads

At the time of the PLS there were 450 kilometers of railway traversing the Cherokee Prairie (Figure 2.13). Surveyors reported the Kansas, Missouri and Texas (Katy), the St. Louis and San Francisco (Frisco), and the Kansas and Arkansas Valley rail companies were operating in the Cherokee Prairie at that time. Prior to the railroads there was no efficient way to transport commodities

into or out of Indian Territory. The arrival of railroads to Indian Territory not only facilitated the growth of agriculture, commerce, and town development, but also the exploitation of timber and game (Hewes 1940).

For example in 1882, a passenger and freight train would make frequent stops between Tulsa and Vinita for people to shoot prairie chickens (Debo 1943). Another example of game exploitation was the now extinct passenger pigeon (*Ectopistes migratorius*). In the Saline district there were many pigeons that would roost on Fourteen Mile Creek and white men would go there and kill pigeons with clubs (Barney 1937). The pigeons used to be so numerous that it would black out the sky. Indian Territory was on the western edge of the passenger pigeon's range that extended form coastal Massachusetts to the Great Plains and from northern Mississippi to Nova Scotia. Within a short period of time, probably in the 1880s, the passenger pigeon went from approximately 3 billion birds to zero (Quammen 1996). In the summers, plentiful wild pigeons were killed by the Indians in great numbers and a market for the pigeons was found outside of Indian Territory where thousands were shipped out, some would bring a nickel per bird (Baum 1940; Quammen 1996).

It was the post bellum peace treaties that ultimately introduced railroads into Indian Territory. These treaties stipulated that each nation must grant a right of way through its territory to railroad companies. The commissioner's report states that the lack of railways in Indian Territory was a "serious drawback in the progress of industrial pursuits" because vast quantities of corn,

wheat, cattle, sheep, hogs, bacon, butter and cheese could not reach markets outside the territory (U.S. Office of Indian Affairs 1859).

The construction of the railroads began in 1870 in the Cherokee Prairie. The Missouri, Kansas and Texas railroad (or the Katy) was the first railroad. The Katy ran from the Kansas border in the northeast, to the southwest following the Texas Road, to Muskogee. The Texas Road, a cattle trail in existence since before the Civil War was, by 1871, the main thoroughfare between Texas and Kansas City and other northern cattle markets. By the end of 1872 the Katy had reached the Red River (Johnson 1946). In 1871 the Atlantic and Pacific railroad, later the St. Louis and San Francisco Railway (Frisco) in 1896, was completed in the Cherokee Prairie in 1886 (Allhands 1925). In 1886 the Kansas and Arkansas Valley was authorized to build a railroad from Ft. Smith, Arkansas northwest through Indian Territory and leaving the Territory at Caney, Kansas (Kappler 1904b).

The Cherokee Nation had reserved one-square mile around each railroad station for a town, by 1890 prominent towns located around railway stations were Tahlequah and Vinita (Kappler 1904; Baum 1940). Claremore was established at a railroad switch for the Atlantic and Pacific (Cornatzer 1938). The laws in the Creek Nation established a width of 200 feet from the center of the main rail bed on each side as a right of way and an additional 2000 feet in length at railroad stations (Muskogee Laws 1893).

The arrival of railroads offered a way to move livestock that were grazing on the open prairie to be shipped out to markets such as Kansas City, Chicago

and St. Louis. Township T19N, R17E contains Bull Creek station and Inola station, which were shipping points along the Kansas and Arkansas Valley railroad for cattle and coal. Along the Katy, Adair and Chouteau were shipping points for cattle (Mayes County Historical Society 1977). In the Creek Nation during the spring, thousands of head of Texas cattle were brought on the Katy to Muskogee and driven across the Creek Nation to graze, and in the fall driven to the Frisco, at Red Fork, near Tulsa to be shipped to market. The large land holder, W.E.Hasell, would buy longhorns every spring from Texas, and fatten them on his ranch in the summer then ship them off in the fall. His livestock operation employed fifty-five men, six-hundred horses, and regularly put up six hundred tons of hay for winter feeding for the 30,000 cattle that roamed his range (Debo 1943).

The railroads also connected the open range region to the Corn Belt where cattle could be grain finished (Dale 1960). With the rail service it was possible to ship cattle, hogs, wheat and corn to livestock markets. Cattle and hogs were driven and hauled by wagon during the late summer months to stockyards provided by the railroads. Forty to sixty carloads of cattle and hogs would leave points of shipment for the Kansas City markets, generally being loaded on a Saturday night in order to be on the market early the following Monday morning (Teague 1967).

Due to the open range nature of the Cherokee Prairie, locomotive collisions with livestock were common in unfenced areas (Demoss 1976). To address this situation, the 1866 treaty with the Cherokee Nation specified that

the right-of-way, 200 feet in width on each side of the railway, be fenced making railroad companies some of the largest consumers of wire fencing (Kappler 1904; Hayter 1939; Baum 1940). The fencing of right-of-ways is observed on the plats. Wire fencing runs the entire length, and on both sides, of the railways throughout the Cherokee Prairie (see Figure 2.11 inset).

Roads

The road network in the Cherokee Prairie consisted of 11,547 kilometers of roads (Figure 2.14) and has been described as “merely trails and are mostly traveled by foot and horseback, wagons being used less and in smoother regions” (Condra 1907). The roads throughout the Cherokee Prairie connected settlers to their fields, neighbors, and to trading points, such as railroad stations and towns. In addition to the Treaty requirements for the establishment of railroads, provisions for road construction in the Territory were also included. For example, roads in the Cherokee nation, which were 40 feet wide, were required to be plowed and smoothed as much as possible. In 1893 people legally residing in the nation were required to work on the roads. Maximum amount of labor was ten days per year or four days in any one month. People objecting to road service were subject to either a $10.00 or $25.00 fine, and they could appoint a substitute to do the required road work in their place (Cherokee Laws 1893). In the Creek Nation all male citizens over the age of 18 were required to work on public road maintenance or pay a fee of $1.00 not to work (Muskogee Nation 1893).

Most plats did not label the towns to which the roads were connecting, although the instructions to do so were listed in the PLS field instructions. It appears to have been at the discretion of the deputy surveyor or possibly the plat cartographer. For example, what was probably the Texas Road was not labeled as such, nor was it labeled throughout the entire Cherokee Prairie. In plat T17N, R18E the road between Gibson and Wagoner was labeled as "Gibson and Wagoner road". The Texas Road runs in a southwestern to northeastern direction and follows the Katy Railroad throughout the Cherokee Prairie. The Texas Road came into present day Wagoner County just north the three forks area (the confluence of the Grand, Arkansas and Verdigris Rivers). This was important trading route that linked Indian Territory to Texas, Kansas and Missouri.

Conclusion

The opening of Indian Territory was spurred on by the need to exploit the natural resources of the land. The outside forces that pushed for exploitation of the natural resources in Indian Territory are described by Moore (1874), "[Indian Territory] has all of these resources just waiting for someone to come and make them useful. The tribes certainly were not doing this. They were just waiting for the opening of their land to use those resources and civilize them …the more they have been encouraged in old customs the more formidable they have become as obstructions in the way of progress". The exploitation began with provisions for railroads that brought commerce and settlers into Indian Territory

through the Post Bellum peace treaties. The exploitation was extended by intruders usurping the rich grazing lands and finally the allotment of native lands, which transferred the communally held land to private ownership. The end of the communally land use system was finalized with the entrance of Indian Territory into Oklahoma statehood in 1907.

The dominant natural resource in the Cherokee Prairie at the time of the PLS, just prior to the end of the communal land use system, was tallgrass prairie. Therefore, the land use practices revolved around exploiting this natural resource through cultivating the rich fertile prairie soil or grazing of livestock. By 1892 the use of plows allowed more rapid break up of prairie sod, and barbed wire fencing facilitated the expansion of pasturage on the prairie, thus allowing settlements to move further upland away from bottomland areas, and lead to a more complete occupation of the prairie. Before the expansion of prairie settlement, settlers would remain close to wooded areas where they could obtain wood for rail fencing (Webb 1931Hewes 1940, 1944; Mayes County Historical Society 1977).

The range cattle industry that supported the cattle grazing enterprise on the tallgrass prairie was short lived and replaced by row crop production. The decline in the usefulness of the tallgrass prairie for grazing land led to the widespread destruction and fragmentation of tallgrass prairie habitat. What remained after the survey of land for allotment was a tallgrass prairie fragmented by wheat and corn fields. In the post war period, when the heyday of the trail drives began, the rich potential of Indian Territory prairies drew

Texas cattlemen north (Doran 1976). Indian Territory became swept up in the development of the great range cattle industry, which spread gradually from the Rio Grande to the plains of Montana (Graeber 1943).

The opening of the Cherokee Prairie to settlers resulted in a collapse of the range cattle industry, which ultimately led to the destruction of the tallgrass prairie. Doran (1976) proposes that the height of the range cattle industry in Indian Territory was 1885. As the frontier moved west under the philosophy of manifest destiny the range cattle industry saw its demise. The sustainment of the range cattle industry was viewed as low priority in the eyes of the government whose main goal was disposal of land through settlement (Tyson 1978).

By the 1870's the Corn Belt was sending numerous high-grade bulls to the range cattle areas. At this time the infrastructure for raising cattle in Indian Territory began to improve, with construction of ponds, fencing pastures, and better utilization of summer ranges, thus eliminating some of the hardships and making conditions more suitable for well bred cattle (Dale 1960). There was a general tendency of the cattle industry in the 1880's to shift from native stock to improved breeds (Baum 1940). With the improvement of livestock breeds expansive grazing lands were not needed, this new stock could be confined to smaller lots and fed seed grains such as soy and corn. This would be one catalyst for increasing the acreage of row crops where once extensive tallgrass prairie existed. According to Dale (1960), there were three reasons for the collapse of the range cattle industry. First, there was less area available for

grazing because white settlers transformed cow country into a crop-growing region. Secondly, and a result of the decrease in rangeland, the Corn Belt became devoted to fattening cattle while the range was devoted to rearing cattle. Finally, the decrease in rangeland was the result of the open public domain passing into private land ownership via allotment. As the Dawes Commission continued its work of allotting the lands of the Five Civilized Tribes the open range began to disappear. White settlers rapidly filled the unoccupied land, and soon the introduction of stocky, well bred cattle, reared for intensive grazing, replaced long horned cattle breed for grazing on the range. This was the end of the great range livestock industry, unique in its development under the communal land use system, as it gradually became “lost in a checkerboard of grain fields and livestock farms” (Graeber 1943).

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Table 2.1 Land Capability Classification

Class	Land Capability Classification Definitions
1	Soils in Class 1 have few limitations that restrict their use.
2	Soils in Class 2 have some limitations that reduce the choice of plants or require moderate conservation practices
3	Soils in Class 3 have severe limitations that reduce the choice of plants or require special conservation practices, or both.
4	Soils in Class 4 have very severe limitations that restrict the choice of plants, require very careful management, or both
5	Soils in Class 5 have little or no erosion hazard, but have other limitations impractical to remove that limit their use.
6	Soils in Class 6 have very severe limitations that make them generally unsuited to cultivation limit their use largely to pasture, etc.
7	Soils in Class 7 have very severe limitations that make them unsuited to cultivation and that restrict their use to grazing, etc.
8	Soils (and landforms) in Class 8 have limitations that preclude their use for commercial plant production and restrict their use.

Table 2.2 Cultivation within prairie and woodland land cover classes.

	Total landscape area (ha)	Total landscape area of cultivation (ha)	% of total landscape area under cultivation
Prairie	803,281	198,870	25
Woodland	251,221	14,834	6

Table 2.3.Cultivation of the Cherokee and Creek Nations in the Cherokee Prairie.

	Number of Patches	Mean Patch Size (ha)	Standard Deviation (ha)	Total Landscape Area (ha) within Cherokee Prairie	Total Cultivated Area (ha)	Percent of Landscape Cultivated
Cherokee	2,738	75	139	890,306	205,174	23
Creek	215	40	67	163,822	8,491	5

Table 2.4. Settlement points, transportation and fences in the Creek and Cherokee Nations in the Cherokee Prairie.

	Number of Settlement Points	Transportation (km)	Fences (km)	Total landscape area (ha)
Cherokee	3,922	10,787	13,948	890,306
Creek	439	1,792	1,229	163,822

Table 2.5. Number of settlement points per land cover area.

	Number of settlement points	Land cover area (km^2)	Density (settlement/km^2)
Cultivation	1,026	2,137	0.48
Prairie	2,197	6,125	0.36
Woodland	516	2,202	0.23

Table 2.6. Fence type in the Cherokee Prairie

Fence Type	Length (km)
Wire	14,052
Rail	886
Board	28
Stone	6
Picket	0.6
Total	14,973

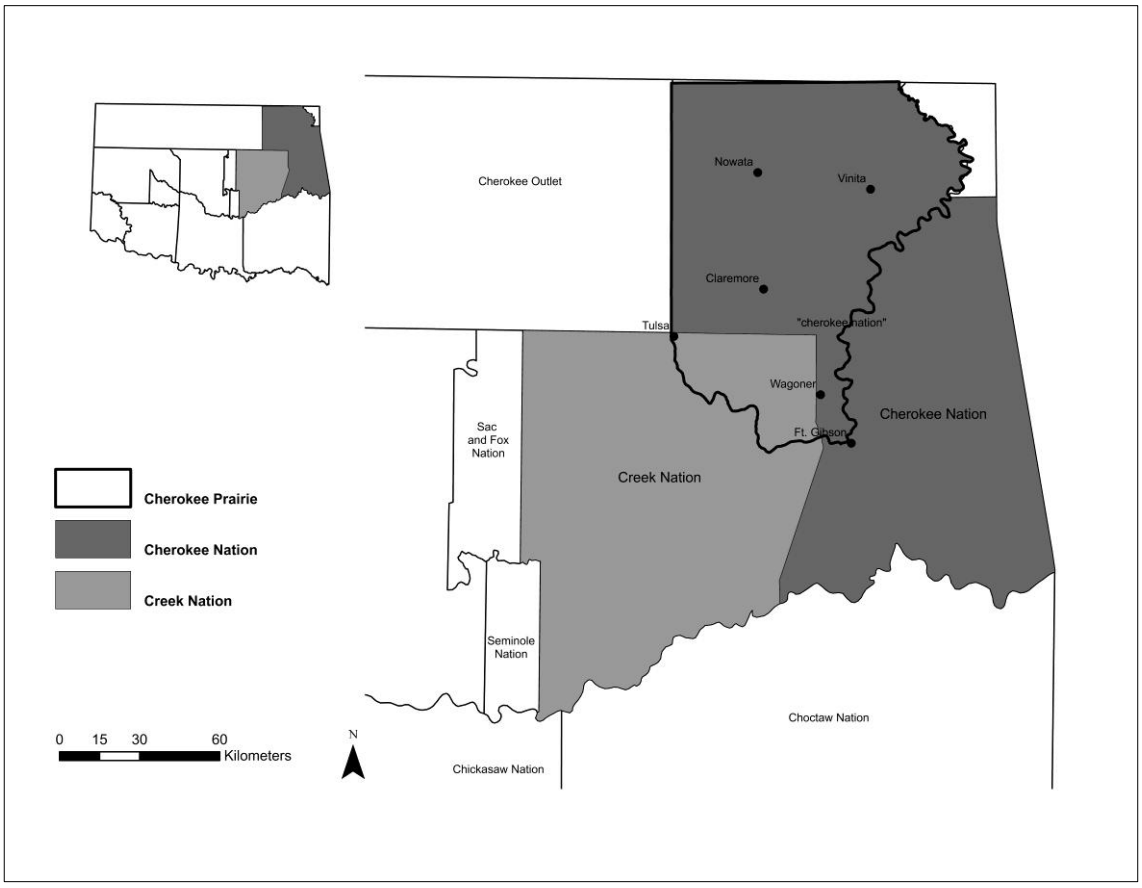


Figure 2.1. Location of Cherokee and Creek Nations in Indian Territory, circa 1890.



Figure 2.2. Study area location in northeast Oklahoma.

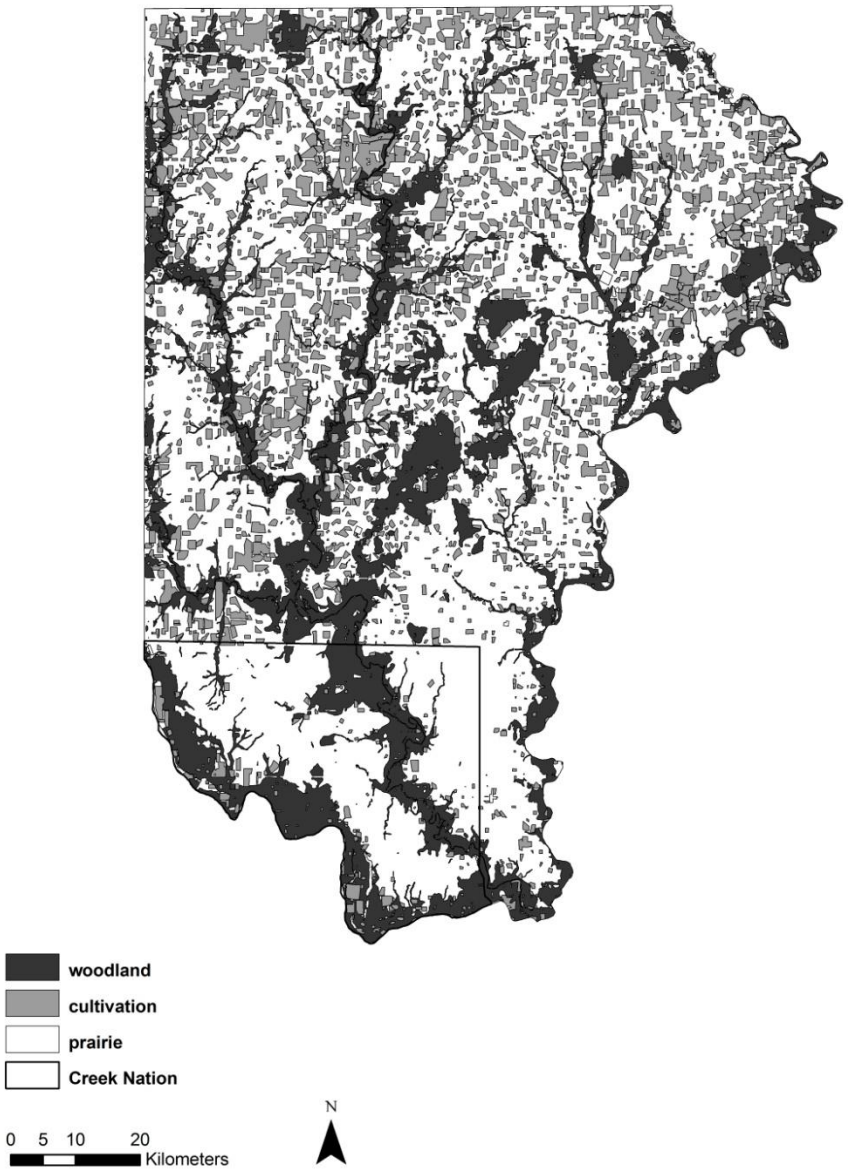


Figure 2.3. Land cover within the Cherokee Prairie., circa 1896.

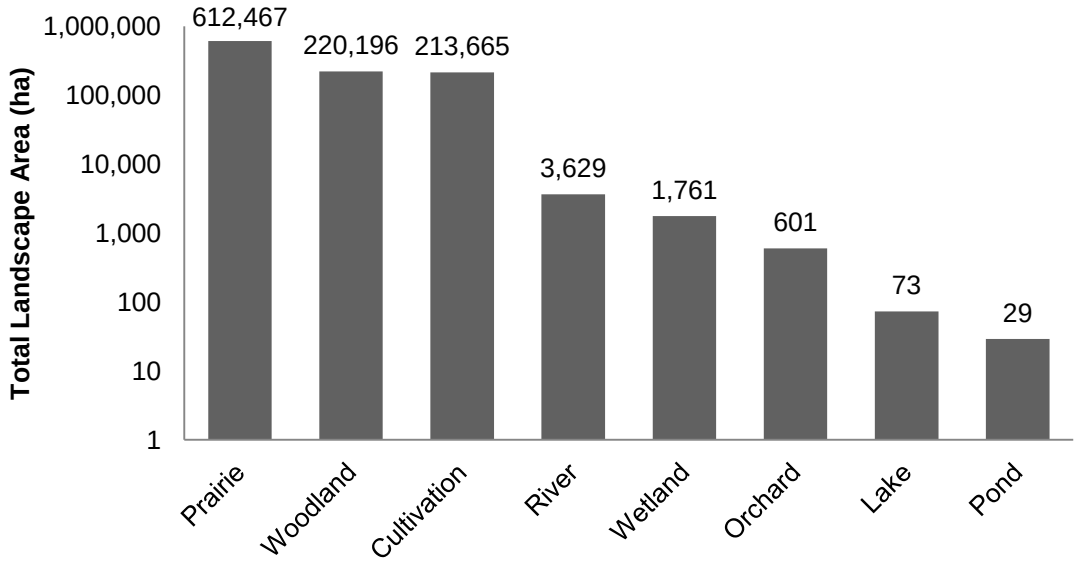


Figure 2.4. Comparison of landscape area (ha) calculated for all land cover classes.

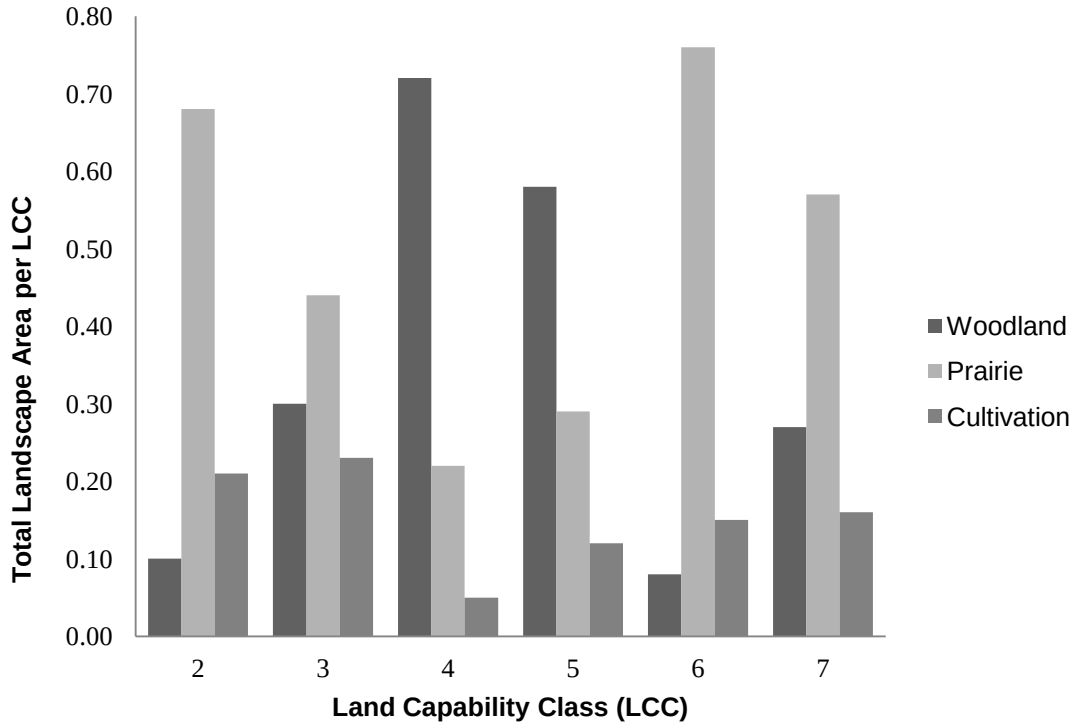


Figure 2.5 Comparison of total landscape area of land cover class per land capability class.

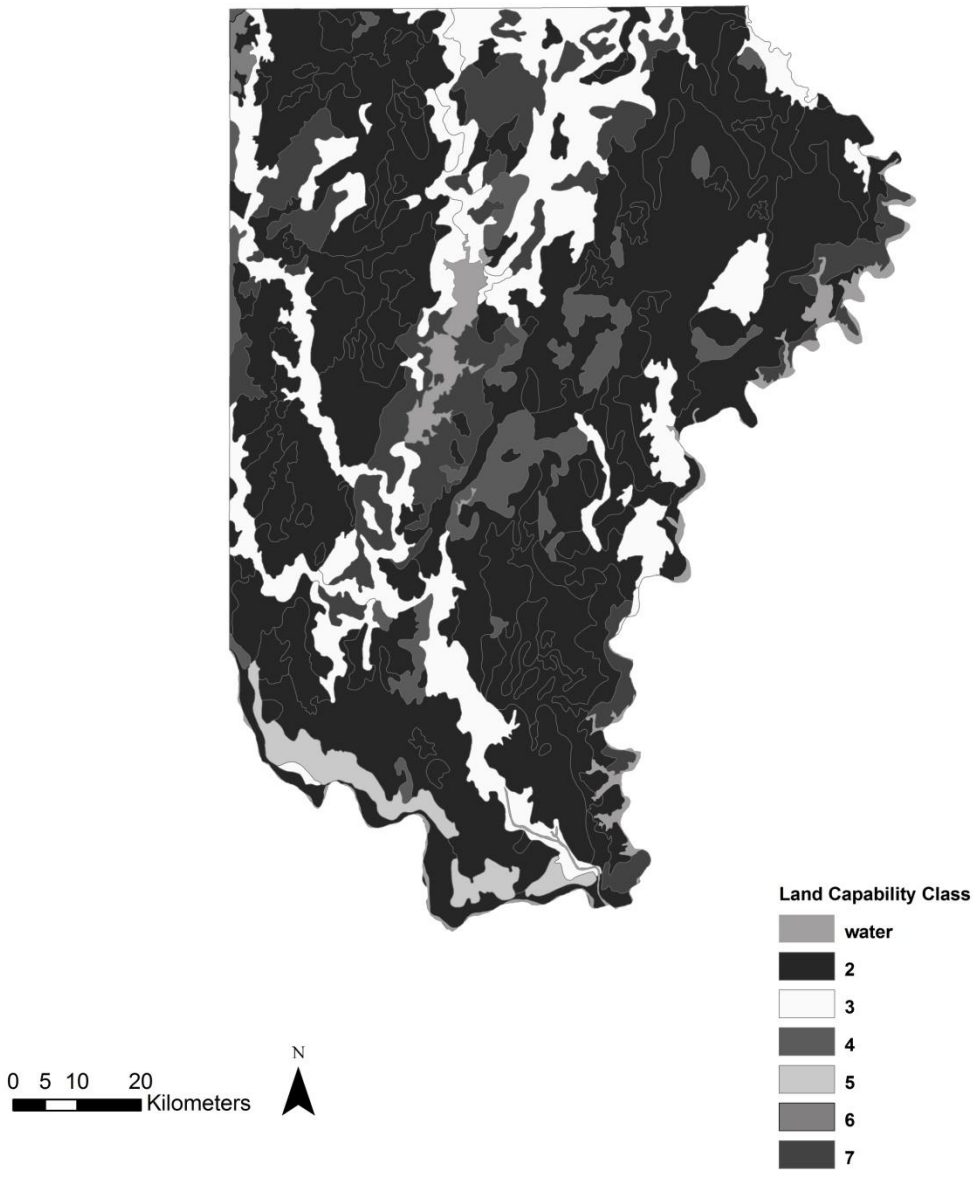


Figure 2.6. The distribution of land capability classes within the Cherokee Prairie (USDA 2006).

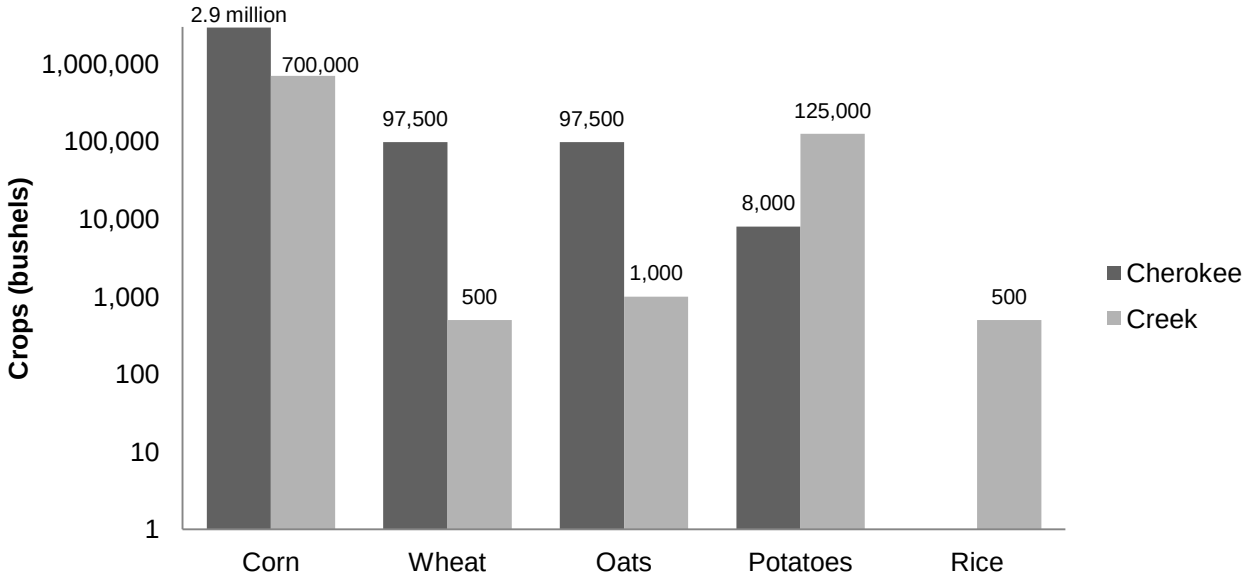


Figure 2.7. Comparison of crop yields for the Cherokee and Creek Nations for the year of 1872. (U.S. Office of Indian Affairs 1872).

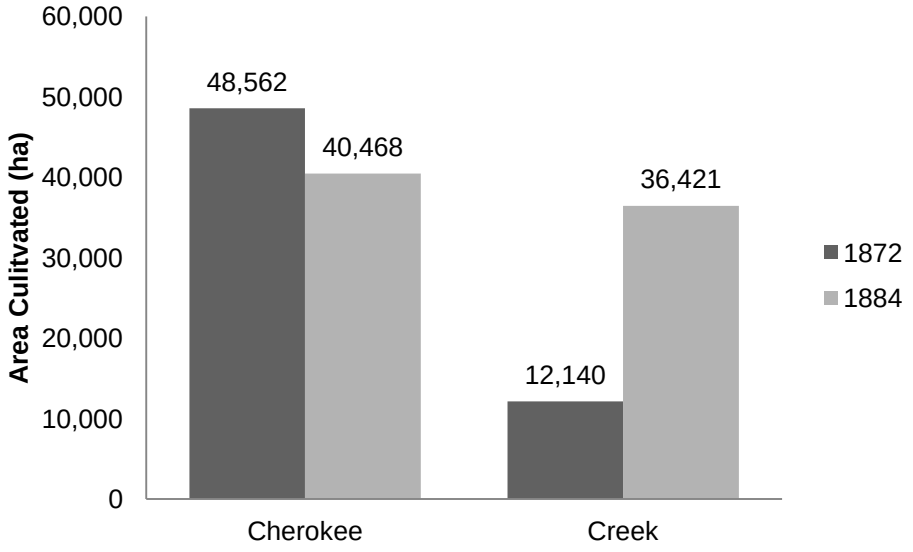


Figure 2.8. Comparison land under cultivation in the Cherokee and Creek nations for the years 1872 and 1884 (U.S. Office of Indian Affairs 1872, 1884).

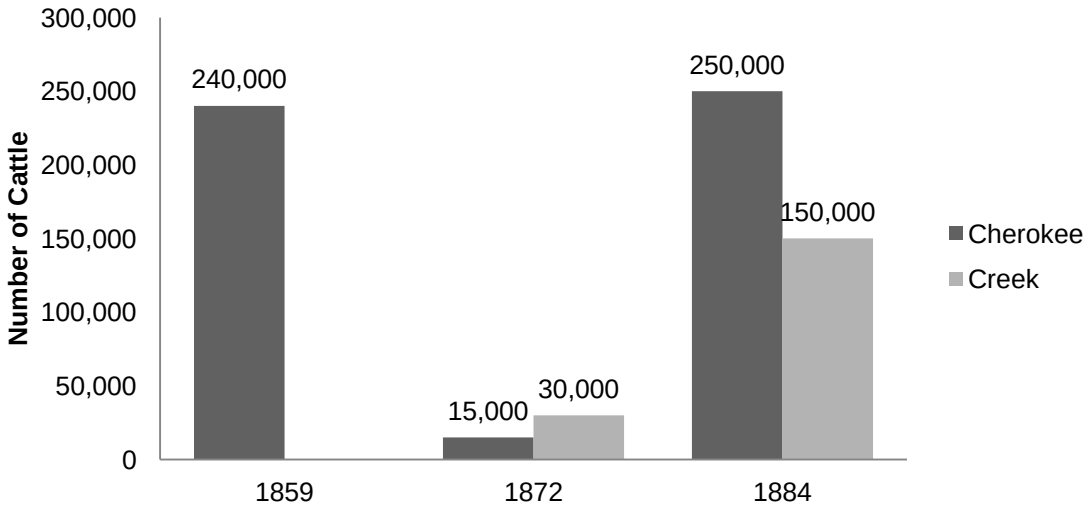


Figure 2.9. Comparison of the number of cattle raised in the Cherokee and Creek Nations for the years 1859, 1872, and 1884. No data available for the Creek Nation in 1859. (U.S. Office of Indian Affairs 1859, 1872, 1884)

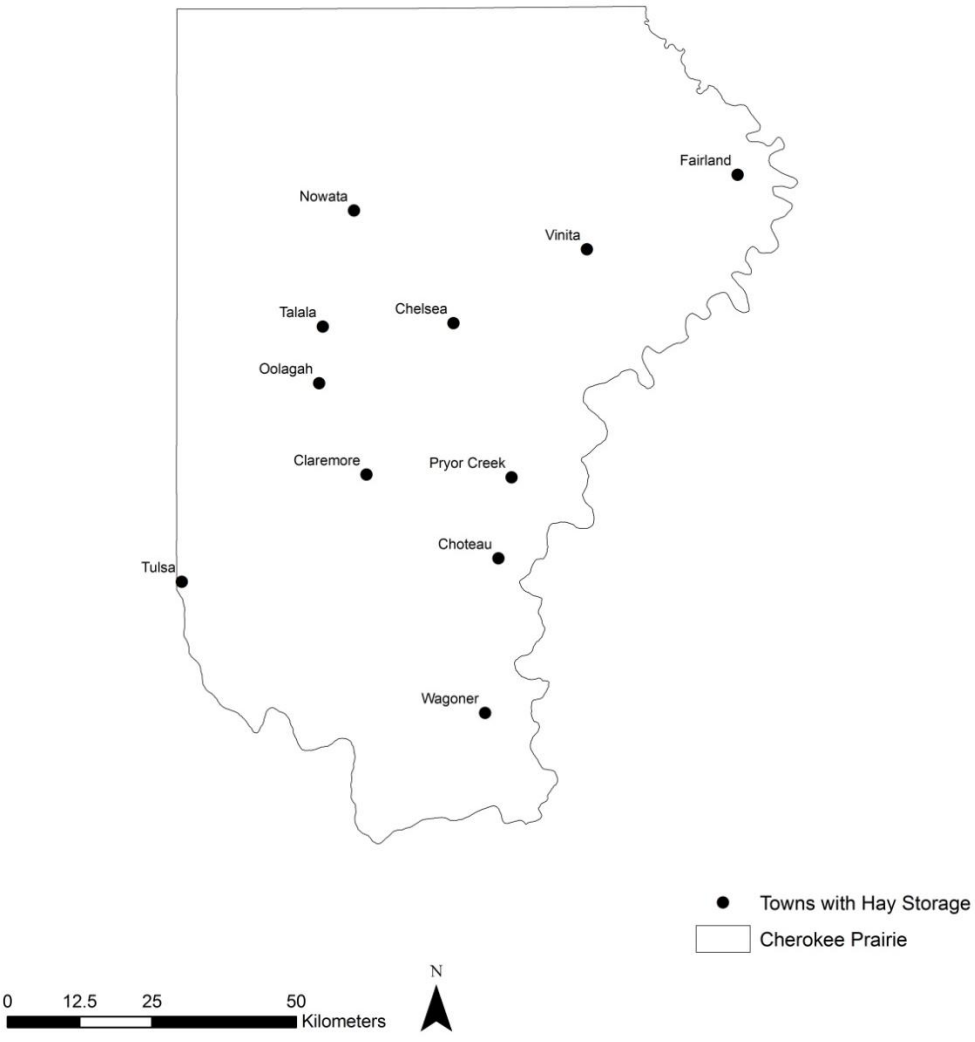


Figure 2.10. Location of hay storage facilities in the 1890's within the Cherokee Prairie. Map based on the Digital Sanborn maps, 1867-1970.

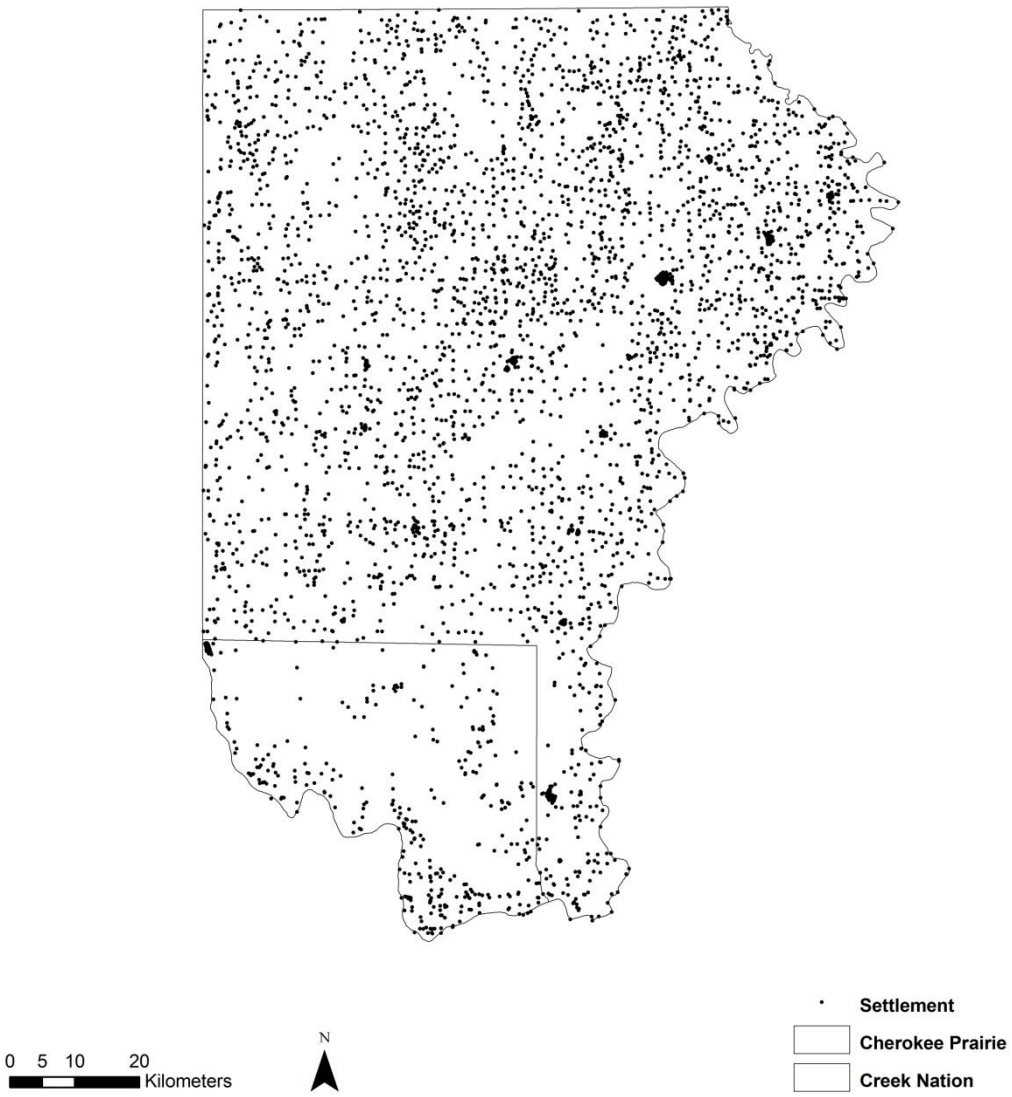


Figure 2.11. Settlement points in the Cherokee Prairie at the time of the PLS.

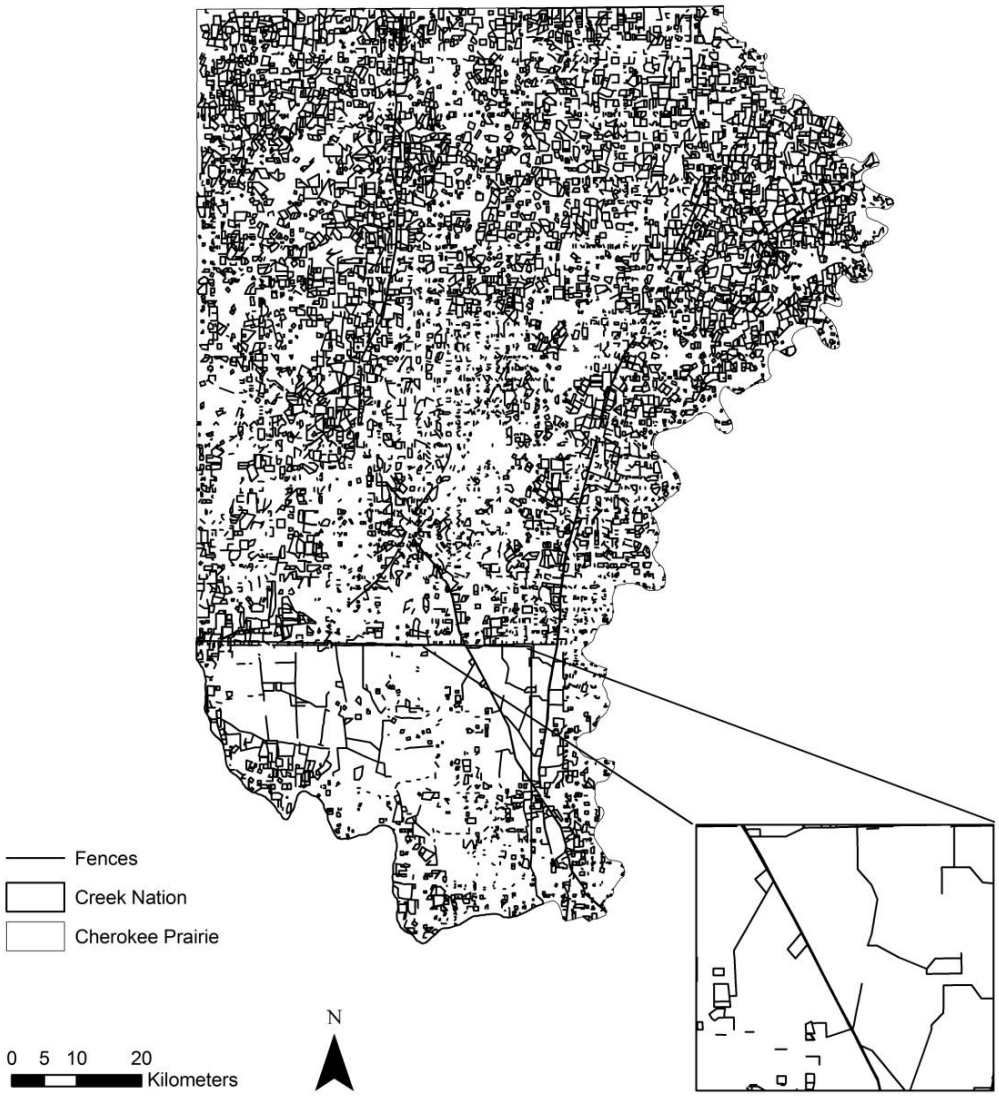


Figure 2.12. Fences in the Cherokee Prairie at the time of the PLS.

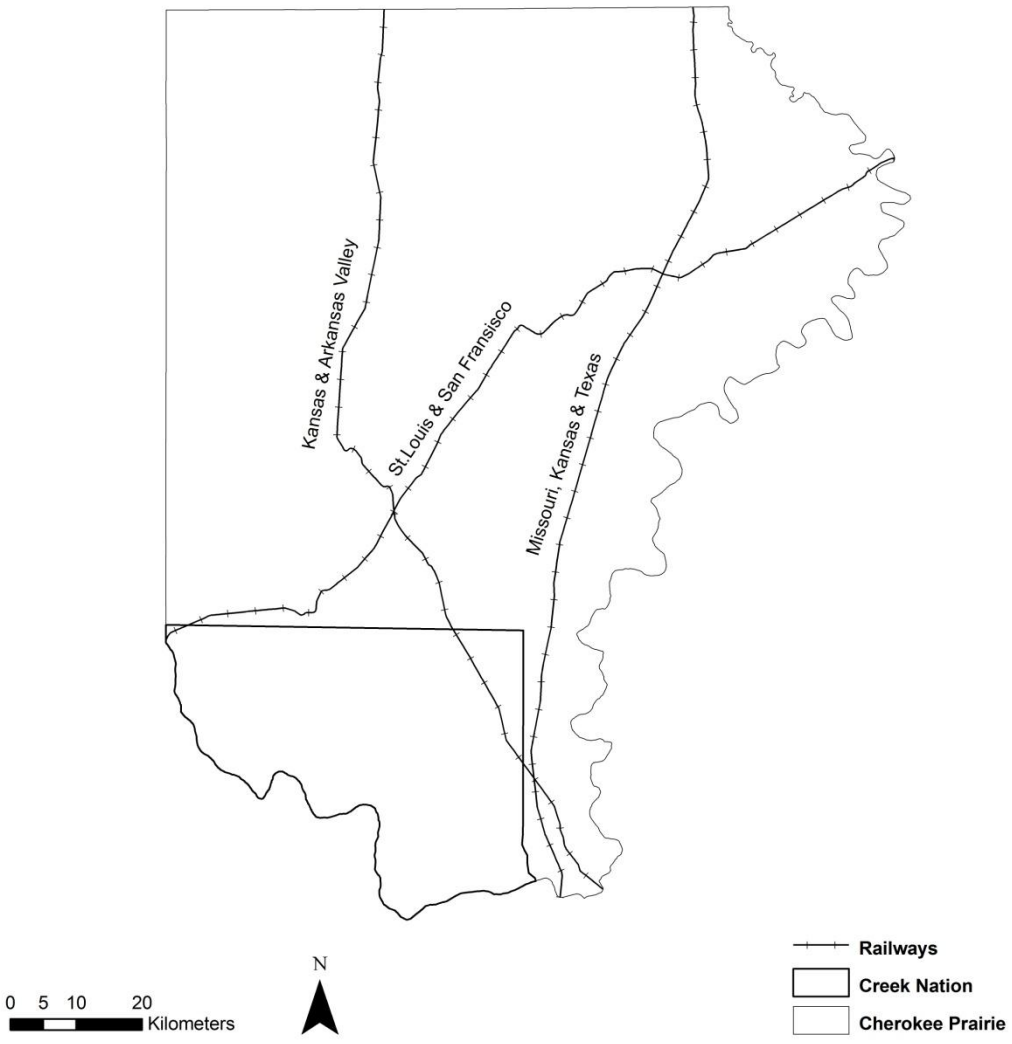


Figure 2.13.Railroads in the Cherokee Prairie at the time of the PLS.

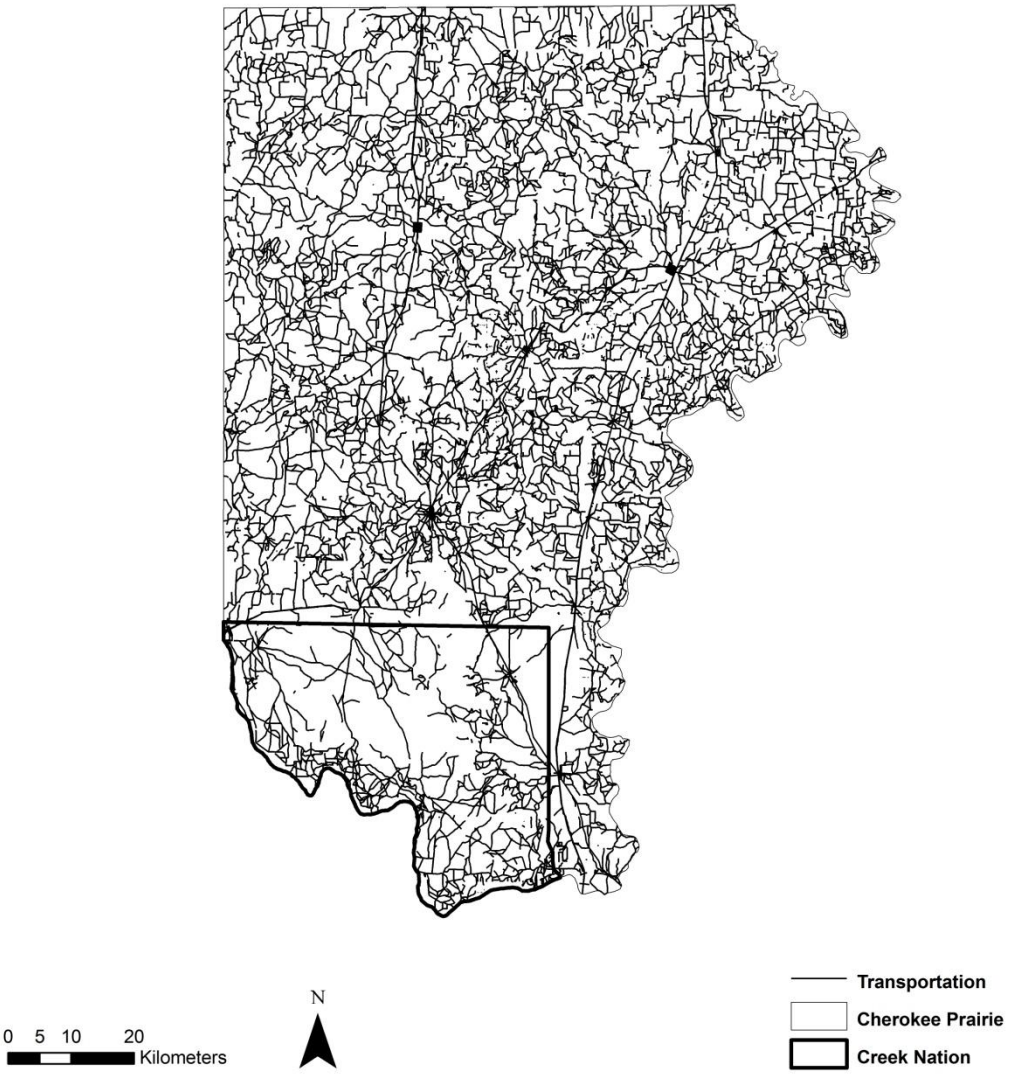


Figure 2.14. Road networks in the Cherokee Prairie at the time of the PLS.

Chapter 3:

Remnant Hay Meadows in a Fragmented North American Tallgrass Prairie Landscape

Abstract

The objectives of this study were to quantify the loss and fragmentation of tallgrass prairie vegetation within the Cherokee Prairie, located in northeastern Oklahoma, between the pre-settlement period and 2008, and to determine if the distribution of remnant fragments on the landscape was random. If there was a clustered pattern to the distribution of remnant patches what explained this pattern? The pre-settlement and 1896 tallgrass prairie spatial data layers were created from Public Land Survey (PLS) Plats. The 2008 spatial data layer was created from a comparative analysis of County Mosaic images published by the National Agriculture Imagery Program, the Oklahoma GAP Analysis (OKGap) vegetation raster data, and The Nature Conservancy's Untilled Landscapes vector data. We found that the total landscape area of tallgrass prairie vegetation decreased by 85% from the pre-settlement period to 2008 and the number of remnant tallgrass prairie patches quadrupled from 1896 to 2008. Large remnant tallgrass prairie patches are maintained as cattle grazing operations found mostly on unarable land. However, the majority of small remnant patches were native hay meadows maintained for annual hay production. These patches displayed a clustered pattern distribution and were found on arable land. Native hay meadows represent important reservoirs of biodiversity. Within the Cherokee Prairie

native hay meadows are potential habitats for rare tallgrass prairie species, such as Oklahoma grass pink (*Calopogon oklahomensis*), western prairie fringed orchid (*Platanthera praeclara*), and the endemic Oklahoma beardtongue (*Penstemon oklahomensis*). Threats to protecting native hay meadows include conversion to more profitable land uses, which include urban expansion of the Tulsa metropolitan area, and introduction of non-native forage crops, such as tall fescue (*Schedonorus phoenix*).

Introduction

It is estimated that since 1830 there has been an 82-99% decline of North American grasslands, exceeding the areal loss of any other major ecosystem in North America (Samson and Knopf 1994). Grasslands were the dominant pre-settlement vegetation for most of the Great Plains and the Prairie Peninsula of Illinois, Indiana, and Ohio. The decline in grasslands in North America can be attributed to changes in land use. These changes include “sod busting” and conversion of once contiguous grasslands to crop production and introduction of non-native forage grasses, fire suppression, and over grazing, (Leach and Givnish 1996; Coppedge et al. 2001, 2007; Cully et al. 2003; Koper et al. 2010), creating remnant prairie patches embedded in a mixed agricultural matrix. These isolated remnant grassland patches are embedded in an agricultural matrix, a medium in which remnant patches are embedded that forms the majority of the landscape (McIntyre and Hobbs 1999).

Landscape metrics have been calculated for grassland remnants to quantify habitat fragmentation over time (Bruun 2000; Soons et al. 2005; Cousins 2006; Williams 2007). Changes in land use that result in remnant patches create a fragmented habitat. Habitat fragmentation produces not only a change in spatial configuration of habitats, but causes a loss or reduction in area of the original habitat (Haila 2002; Fahrig 2003). North American grasslands studies have measured land cover dynamics (measured as number of patches, patch size, and edge effects) over a time to determine the degree and effects of fragmentation (Coppedge et al. 2001; Koper et al. 2010).

Native biodiversity can be lost through increased edge effects and isolation (Saunders et al. 1991). Edge effects can be separated into two categories, abiotc and biotic, both of which can result in changed in landscape functions (Harrison and Bruna 1999; Koper et al. 2010). The abiotic affects of increased edge include increased light and wind penetration into the interior of a patch thereby increasing insolation and decreasing humidity within the patch. The biotic edge effect of concern is transmissibility of invasive species that occur in high abundances near the edge of the remnant grassland patch (Leach and Givnish 1996; Harrison and Bruna 1999; Cully et al. 2003; Wilsey, Martin and Polley 2005).

As prairie patches become more isolated, seed dispersal is hindered due to the increasing distance between populations. Reduced dispersal success is of particular relevance in grasslands, because constituent species tend to have short dispersal distances (Rabinowitz and Rapp 1980), thus decreasing the

likelihood of rescue effects from extant populations. Since tallgrass prairie remnants are often widely separated and embedded within almost continuous agricultural lands, there is probably little or no migration between remnants due to poor dispersal ability of grassland plant species (Wilsey, Martin and Polley 2005; Soons 2005). Woody species in tallgrass prairie patches show a non-linear decline as the degree of surrounding habitat, or matrix, increases. In other words, once the matrix habitat reaches a threshold size relative to the remnant patch, species diversity will dramatically decline (Bascompte and Rodriguez 2001). Cousins et al. (2003) found that an extinction threshold was reached when grasslands decreased from 10%-30% of their original landscape area.

The objective of this study is to quantify the extent of fragmentation in tallgrass prairie vegetation by examining historic and current land cover in the Cherokee Prairie located in northeast Oklahoma. In Oklahoma, Duck and Fletcher (1945) report that 5.3 million ha or 30% of Oklahoma's total land area of 18 million was potentially tallgrass prairie. The most extensive, contiguous tract of tallgrass prairie is located in northeast Oklahoma, in a region often referred to as the Cherokee Prairie. The area is typical of other tallgrass prairie regions in that the land cover has changed from open grassland to row crop production, livestock grazing, and conversion to non-native forage grasses, with hay meadow remnants of varying size distributed throughout. Specific questions addressed here are: How has the tallgrass prairie land cover changed from the pre-settlement period to 2008 and to what degree has fragmentation occurred?

Do these fragments show a random distribution or a pattern that might reveal why they persist? Did the hay meadows on the modern landscape exist in the late 19th century? And why do these remnants persist in a region suitable for agriculture production where so much tallgrass prairie has been converted to non-native grasses? Is the retention of tallgrass prairie due to land suitability? In this study we distinguish between three types of management practices in prairie landscapes: introduced forage pastures, native rangelands and native hay meadows (Hughes and Huntley 1988; Tunnell 2004). Introduced forage crops are varieties of grasses or legumes planted for the purpose of feeding livestock for grazing pastures or as hay crops that will produce higher yields than native prairies (Wheeler 1950). Tall fescue (*Schedonorus phoenix), a* cool-season C_3 grass, is the introduced forage plant most commonly encountered in northeastern Oklahoma.

A native rangeland is prairie that is maintained by livestock grazing. At moderate levels of grazing a growth response allows plants to stimulate vegetative growth and increase the size of seeds (McNaughton 1983). However, intensive grazing can result in a decrease of certain plant species that are more palatable to livestock. These plants are called decreasers and include grasses such as big bluestem, little bluestem, Indiangrass and switchgrass, and forbs such as lead plant (*Amorpha canescens*), wooly sunflower, rattlesnake master and blazing star (*Liatris sp*.). Increasers are plant species that replace the decreaser species and are less palatable to grazers. These plants, considered weedy species, benefit from increased light, water and nutrients due

to removal of decreaser plants. Examples of increasers are broomweed (*Amphiachyris dracunculoides*), ironweed (*Vernonia baldwini*), yarrow (*Achillea millefolium*) and whorled milkweed (*Asclepias verticillata*) (Weaver and Hansen 1941; Drew 1947). In addition, herbicides are often applied to reduce forb cover.

Hay meadows, on the other hand, are native tallgrass prairie remnants that are rarely grazed, and tend to have more rare species compared to tallgrass prairie pastures. Herbicides typically are not applied. Native hay meadows are unique habitats within the tallgrass prairie landscape because "they support several high fidelity taxa, exhibit the greatest species richness, and have a low number of exotic species" and are therefore considered high conservation priorities (Jog et al. 2006, Jefferson 2005). Even though native hay meadows are important reservoirs of biodiversity they have received little study (Jog et al. 2006; Stefanescu, Penuelas and Filella 2005; Foster et al. 2009).

Methods

Study Area

The area selected for study, referred to as the Cherokee Prairie, is located in northeastern Oklahoma (Figure 3.1) (Blair and Hubbell 1938; Carter and Gregory 2008). The Cherokee Prairie encompasses 1,054,128 ha and includes all of Craig, Nowata, Rogers, and Washington counties and portions of Delaware, Mayes, Muskogee, Ottawa, Tulsa and Wagoner counties.

Two geomorphic provinces comprise the Cherokee Prairie; the Claremore Cuesta Plains and the Neosho Lowlands. The Claremore Cuesta Plains consist of resistant Pennsylvanian sandstone and limestone forming cuestas between broad shale plains. The surface is characterized by broad valleys and rolling hills to level plains separated by roughly parallel southwest to northeast oriented escarpments. The Neosho Lowlands, in the eastern portion of the study area, border the Grand River, and is characterized by gently rolling shale lowlands with low escarpments and buttes capped by Pennsylvanian sandstone and Mississippian limestone.

Three large rivers drain the Cherokee Prairie: the Verdigris, Grand (Neosho), and the Arkansas. These rivers and their larger tributaries are entrenched in broad floodplains (Bruner 1931; Blair and Hubbell 1938; Curtis, Ham and Johnson 2008). The minimum elevation in the Cherokee Prairie is 148 m and the maximum elevation is 314 m (Gesch 2007).

The primary upland soil association is the Dennis-Bates-Taloka-Parsons, which is a loamy-clay and humus rich soils, on very gentle slopes (3%). The Cherokee Prairies contain deep, dark colored soils mostly with clay subsoils developed on shales, sandstones and limestones under tallgrasses. The Osage-Verdigris soil association occupies lowlands and is very deep, silty-clay, slightly acidic, and humus rich soils on nearly level slopes (1%) (Carter and Gregory 2008).

The Cherokee Prairie climate is typical for a North American grassland ecoregion with hot, dry summers and mild winters; however, this area tends to

receive higher annual precipitation than grasslands of the Great Plains to the west. The average annual precipitation varies between 112 cm on the western edge of the Cherokee Prairie and 121 cm on the eastern edge. The average annual temperature is 15.5°C. The growing season is between 195 days in the north and 215 days in the south of the Cherokee Prairie (Johnson 2006a and Johnson 2006b).

The Cherokee Prairie lies between the blackjack-post oak forest type, referred to as the Cross Timbers, to the west, and the Ozark Plateau to the eastern. The Cross Timbers are dominated by blackjack oak (*Quercus marilandica*) and post oak (*Quercus stellata*). The Ozarks are dominated by white oak (*Quercus alba*), mockernut hickory (*Carya alba*) and American basswood (*Tilia americana*) (Duck and Fletcher 1945; Hoagland 2000). These tree species can also be found in forested portions of the Cherokee Prairie. The vegetation of the Cherokee Prairie is dominated by tallgrass prairie, which occurs in most upland areas, with bottomland hardwood forests and oak-hickory woodland occurring to a lesser degree. The tallgrass prairie is characterized by four perennial grasses; big bluestem, little bluestem, Indiangrass and switchgrass. Forbs, which occur in lesser abundance, include compassplant (*Silphium laciniatum*), dotted blazing star (*Liatris punctata*), rattlesnake master (*Eryngium yuccifolium*) and butterfly milkweed (*Asclepias tuberosa*) (Weaver and Fitzpatrick 1934; Buck and Kelting 1962).

Bottomland hardwood forests within this area occur in the floodplains of the Verdigris, Grand (Neosho) and Arkansas Rivers and their larger tributaries,

such as the Caney and Cabin Creeks. This woody vegetation is approximately 6 meters tall or taller and is flooded or has a water-saturated soil at least on a temporary or intermittent basis (Cowardin et al.1979). Typical overstory species include American elm (*Ulmus americana*), sugarberry (*Celtis laevigata*), green ash (*Fraxinus pennsylvanica*), pecan (*Carya illinoinensis*), and pin oak (*Quercus palustris*) (Hoagland and Wallick 2003 and Brabander et al. 1985).

Data Collection

The hay meadow geodatabase consist of data derived from numerous sources, providing a snapshot from three periods in time. The chronology was pre-settlement, historic (late 19th century) and contemporary (early 21st century) land cover. The lack of early 20th century data in the study is due to inconsistent aerial images within the study area. For instance, one county in the study area may have had a flight date for aerial photographs in 1937, but the adjacent county did not have a flight date until 1952. For this reason early 20th century aerial imagery was not included in this study.

The Pre-settlement and historic data were compiled from township plats mapped by the General Land Office (GLO). Multiple sources of spatial data were collected to compile the contemporary land cover, including aerial photography and data products produced by government agencies and non-governmental organizations.

The GLO was active in Oklahoma during the last quarter of the 19th century, and some portions of the state were actually surveyed twice. The

Cherokee Prairie region, however, was only surveyed once in the 1890s (Hoagland 2006). The GLO plats were selected because these data provide the only quantitative dataset for land cover during early Indian-Euro-American settlement in Oklahoma and the United States (Bourdo 1956; Whitney and DeCant 2001). The PLS surveys have been used extensively to evaluate land cover conversion in many localities (e.g. Fassett 1944; Curtis 1956; Mladenoff and Howell 1980; Zhang et al. 2000; and others), but less so in Oklahoma.

The Public Land Survey (PLS) was conducted from March 1896 to July 1897 in the Cherokee Prairie (U.S. Department of the Interior 2012) and generated 182 township plats, 52 of which were fractional (i.e. township does not contain a full 36 sections). Each PLS plat image was geo-referenced using the Township and Range layer from the *Digital Atlas of Oklahoma* (Rea and Baker 1997). To geo-reference, four known points, or control points, were selected on the PLS plat then aligned and linked to the equivalent geographic location on the modern township and range digital data layer (Rumsey and Williams 2002).

The plat cartographers distinguished between different land cover types, such as prairie, cultivation and woodlands, by using a combination of shading and/or symbology when drawing the plats. Categories delineated on each plat prior to digitizing were tallgrass prairie, woodlands and cultivation.

The 1896 PLS data layer was used to create a pre-settlement vegetation data layer. The pre-settlement data layer was produced based upon the assumption that before settlement there was no cultivation in the study area and only two

land cover types would have been present: prairie and woodland. The pre-settlement data was produced by digitizing only woodland and prairie land cover from the PLS plats and eliminating all cultivation polygons that were embedded within the prairie or woodland polygons.

The contemporary layer was developed using the 2008 National Agricultural Imagery Program (NAIP) compressed county mosaic images (USDA-FSA Aerial Photography Field Office 2008), the Oklahoma GAP Analysis (OKGap) land cover raster data layer, and the Nature Conservancy's Untilled Landscape vector data layer (The Nature Conservancy 2000). The OKGap data includes 46 land cover types, and was created from interpretation of Landsat Thematic Mapper imagery and field reconnaissance. It is coarse grained (30 meter pixel resolution), 0.81 hectare minimum mapping unit, raster version of land cover for Oklahoma (Fisher and Gregory 2001). The OKGap datar was used to create a new raster layer containing only land cover types of tallgrass prairie and cool-season pasture. This data was used to aid in delineating warm season tallgrass prairie from cool-season tall fescue pastures on the county mosaic images.

The Nature Conservancy's Untilled Landscapes vector data layer are large tracts of intact tallgrass prairie generally greater than 30,000 hectares. These tracts were created by using Landsat Thematic Mapper and confirmed by expert knowledge (The Nature Conservancy 2000). The Untilled Landscapes data was used to determine large intact tracts of prairie on the county mosaic images.

Visual interpretation of the 2008 county mosaic images were used to delineate tallgrass prairie stands from other land cover types. Norderhaug (2000) found that the most accurate method for detecting and delineating native grasslands from other grassland types (i.e. warm season versus cool season) was to use indicators for identification. Texture, shape of remnant patch, and color were found to be the most accurate for delineating tallgrass prairie on county mosaics (Glenn and Ripple 2004).

The 2008 county mosaic images were selected for digitizing the tallgrass prairie vegetation layer because they are leaf-on images taken in July of 2008 at 1 m^2 pixel resolution. The phenological timing of these images allows for accurate delineation of warm season tallgrass prairie from non-native cool season grasses, such as tall fescue. Reese (1982) found that this time period was the most accurate way to identify prairie communities on aerial imagery because cool season grasses will be dormant during the hot, dry growing season of warm season grasses. Areas on the images that display a blue-green signature during the warm, dry summer months, such as July, are indicative of warm-season native tallgrass prairie.

Hay meadows were also delineated using location data from previously studied hay meadows. This was accomplished using the legal land descriptions for 140 hay meadows (Figure 3.2) that were surveyed by Buck (1959) and Eyster-Smith (1984), and a survey of potential sites for populations of the western prairie fringed orchid (*Platanthera praeclara*) (Hoagland 1999). The

legal descriptions for these hay meadows were overlain on the 2008 NAIP images.

All spatial data layers were digitized at a scale of 1:10,000 to maintain the same level of detail. The data was placed in a geodatabase and their spatial coordinates were projected in North American Albers Equal Area Conic. All digitizing and analysis took place using ArcGIS 9.3 (ESRI, Redlands, Calif.).

Field Reconnaissance

Once the contemporary land cover layer was completed, 10% of the polygons were randomly selected for ground-truthing during May, June and July of 2009. We found that, just as Norderhaug (2000), that aerial photos (i.e. county mosaics) were good for locating tallgrass prairie stands at a large scale, but that field visits were needed to enhance the accuracy and definitively classify tallgrass prairie land cover. Any discrepancies between the vegetation classified using the images and what is identified on the ground were noted and adjusted in an editing process before the final product was produced.

Locating field sites involved not only revisiting Buck's (1959) and Eyster-Smith's (1984) sites, but documenting previously unrecorded hay meadow locations. Land management practices provided the best indicator of sites maintain as hay meadows. For example, broken fences or no fencing is typically of areas managed as hay meadows. Since livestock do not graze these sites, fencing is not necessary. Likewise, an abundance of decreaser plant species is indicative of hay meadows. These species thrive when the

selective grazing pressure is removed from tallgrass prairies. Examples of these decreaser species are compass plant (*Silphium laciniatum*), rattlesnake master (*Eryngium yuccifolium*) and blazing star (*Liatris sp.*) (Gould 1941). Coordinates were recorded for all hay meadow sites using a (Garmin; GPSMAP 79Cx) GPS unit.

Data Analysis

Quantification of landscape pattern is necessary for understanding the effects of landscape pattern on ecological processes and for documenting temporal change in a landscape (Turner, Gardner and O'Neill 2001). Therefore, the following suite of landscape metrics were calculated to quantify change overtime in the Cherokee Prairie: total area (total area occupied by tallgrass prairie land cover), number of patches (measure degree of fragmentation; the greater the number of patches the greater degree of fragmentation), and mean patch size (average area patches occupy on the landscape; the smaller the patch size the greater degree of fragmentation), total edge, mean patch edge and density of edge per patch area (proxy for determining potential edge effects; the greater the parameter per area the greater exposed edge per patch). Landscape metrics were calculated using Patch Analysts, a version of FRAGSTATS created as an ArcGIS extension (McGarigal and Marks 1995; Remple 2008).

I calculated the average nearest neighbor for the 2008 hay meadow layer (distance between each feature centroid and its nearest neighbors

centroid location, then all of the nearest neighbor distances were averaged). This measure was calculated to determine if there was clustering between hay meadow patches or if the distribution was uniform (Norderhaug 2000; Coppedge et al. 2001). The nearest neighbor is expressed as an index and is the ratio of the observed distance between patches divided by the expected distance (expected distance is based on a hypothetical random distribution with the same number of features covering the same total area). If the nearest neighbor index is less than 1 the pattern is considered clustered, if the index is greater than 1 the pattern is considered uniform. The analysis provides a Z score that is a measure of the standard deviation. Very high or a very low (negative) Z scores, associated with very small p-values, are found in the tails of the normal distribution, this indicates that it is very unlikely that the observed pattern is a random spatial pattern represented by the null hypothesis.

An identity overlay spatial analysis operation was performed to quantify the change in tallgrass prairie land cover between 1896 and 2008 tallgrass prairie data layer. All spatial analysis operations were conducted in ArcMAP 9.3 (ESRI, Redlands, Calif.).

To determine the relationship between suitability for cultivation and the persistence of tallgrass prairie remnants, an analysis of land suitability of remnants was calculated by overlaying the 2008 land cover data layer with the USDA land capability classification data layer (USDA 2006; USDA). The STATSGO2 land capability classes (LCC) consisted of eight classes of agricultural land suitability. Classes 1-4 are best suited for, and present the

least number of obstacles for cultivation, classes 5-8 are the least suited for cultivation, and are best suited for pasture or grazing purposes. (Table 3.1) (USDA 2006, and USDA).

Results

Land Cover Change

The change in landscape matrix from tallgrass prairie to an anthropogenic land cover matrix can be observed in the map comparison of the three time periods (Figure 3.3). The Cherokee Prairie encompasses 1,054,128 ha. Of that area the pre-settlement tallgrass prairie occupied 803,281 ha (76%), in 1896 tallgrass prairie occupied 612,467 ha (58 %) and in 2008 tallgrass prairie occupied 119,604 ha (11%) of the total landscape. That is a decrease in total landscape area of approximately 85% from the pre-settlement period to 2008 (Figure 3.4a).

Changes in landscape pattern between the study periods included a decrease in mean patch size; pre-settlement had a mean of 15,448 ha, and 1896 had a mean of 2,303 ha, and 2008 had a mean of 128 ha (Figure 3.4b). There was also an increase in the number of patches from the pre-settlement period (52 patches), to 1896 with (266 patches), to 2008 with (938 patches) (Figure 3.4c).

The edge density, measured as the ratio between parameter (m) and area (ha) increased from pre-settlement to 2008 (Figure 3.5a). Edge density was a good indicator of the increase in possible edge effects as a result of

increased fragmentation from the pre-settlement period to 2008. The mean patch edge decreased from the pre-settlement period to 2008 (Figure 3.5b). This is another indication of the increase in fragmentation, because the mean patch edge decreased as the size of patches decreased from pre-settlement to 2008. The total edge increased in 1896 from the pre-settlement period then decreased again from 1896 to 2008 (Figure 3.5c). This was due to the increase in cultivation (and an increase in the number of patches) from pre-settlement to 1896, but the dominant matrix still remained tallgrass prairie. However, from 1896 to 2008 there was an increase in the number of tallgrass prairie patches, but total area of tallgrass prairie decreased during the same period and therefore the dominant matrix changed from tallgrass prairie to other agricultural land cover types.

Calculations from the identity overlay operations were used to determine if 2008 tallgrass prairie stands had been restored from cultivated fields during from 1896 to 2008. This analysis shows that between 1896 and 2008 there were 103,110 ha converted from cultivated fields back to tallgrass prairie. These results indicate that patches identified in 2008 as tallgrass prairie may not have always been tallgrass prairie.

Three patterns were observed after locating the Buck (1959) and Eyster-Smith (1984) hay meadows sites on the county mosaics images, and then verifying them through ground truthing. First, there has been a decrease in the number of hay meadows within the study area. Eyster-Smith (1984) attempted to relocate the Buck (1959) sites and found that of the 67 sites only 42%

remained. After attempting to relocate all of the 67 Buck (1959) sites for the current study only 33 of those sites remained in 2008. Second, hay meadows that are maintained can produce hay for long periods of time. While about 50% of the Buck (1959) sites have disappeared, 50% were still in hay production in 2008. Eyster-Smith (1984) collected species data on eight of the same sites that Buck (1959) studied and all of those hay meadows are still in production today. Many of those remnant meadows have been producing hay for at least 60 years. Thirdly, many of the hay meadows that have not persisted have been turned into housing additions, especially those close to the Tulsa metropolitan area, or converted to non-native forage pastures, such as tall fescue (*Schedonorus phoenix).*

The null hypothesis that the pattern of hay meadow distribution was uniform was not supported by the findings. The average nearest neighbor analysis indicates that there is clustering among the hay meadow patches, and therefore they are not uniformly located. The observed mean distance for hay meadows was 1,252 (m) and the expected random value was 2,056 (m), with the nearest neighbor ratio being 0.59, with a Z-score of -21.42 and p value of 0.0000.

Land suitability analysis

The land capability classes with the greatest landscape area were classes 2 and 3, followed by class 7 (Figure 3.6). The greatest area of hay meadows and pasture occurred in class 2 (Figure 3.7). Class 2 represents the

land most suitable for cultivation, followed by class 3 and the class least suitable for cultivation is class 7. Intuitively it seems that remnant rangelands would occur in class 7, because this is the land that is most suitable for grazing. However, it is not clear why hay meadows would occur to the greatest extent in classes 2 and 3, as these classes are best suited for cultivation. This pattern also supports the assumption that there are cultural reasons for the persistence of remnant hay meadows and rangelands in classes 2 and 3, because it would be more profitable to grow improved non-native forage grasses or row crops, such as corn or wheat on the remnant grasslands. The land capability classes of 1, 6 and 8 were not present within the study area. Class 1 is present along the floodplains of the Canadian, North Canadian and Cimarron rivers in central Oklahoma and the Red river in southern Oklahoma. Class 6 represents portions of the Flint Hills, the Ouachita Mountains and portions of the canyon lands in western Oklahoma. Class 8 is represented in the sand dunes north of the North Canadian and Cimarron rivers in western Oklahoma.

Discussion

The fragmentation of tallgrass prairie from the pre-settlement period to 2008 was a result in changes in agricultural land use practices. The result of this change in land use practices has been that remnant tallgrass prairie patches are embedded in a matrix of mixed land cover types. Coppedge et al. (2001) found that remnant Great Plains grasslands were embedded in a mixture of croplands with an increase in woody vegetation due to conversion to

croplands and an increased invasion of eastern red cedar (*Juniperus virginiana*) from a reduction in grassland fire frequency. Grassland landscapes containing large numbers of smaller intermingling patches appear to provide an environment conducive to rapid woody encroachment by providing isolated patches with pockets of seed sources (Coppedge et al 2007). The change in land cover from grassland to woody species decreases habitat for breeding and wintering grassland bird species (Samson and Knopf 1994, Coppedge et al. 2001; 2007). Winter, Johnson and Faaborg (2000) found that woody edges in grassland fragments appear to serve as travel routes for mammalian nest predators. Brood parasitism also increases with proximity to woody edge habitat. Patten et al. (2006) found that brood parasitism rates by the brown-headed cowbird (*Molothrus ater*) increased with nearness to woody vegetation, which is prevalent along tallgrass prairie roadsides.

The changes in land use within the tallgrass prairie in northeastern Oklahoma that could have lead to a loss in total landscape area was an increase in cultivation (213,664 ha) from the pre-settlement period to the time of the PLS. A further decline in total landscape area in grassland that resulted from the conversion of tallgrass prairie to introduced non-native forage grasses in Oklahoma after the time of the PLS (Figure 3.8). Gustavsson et al. (2007) found a land use change sequence in which 18th century croplands were converted to pastures in Swedish grasslands. Likewise, prairie stands that were present in 2008 may not have always been prairie but could have been cropland at one time. This study found that 103,113 ha of cultivated land in the

PLS layer was returned to prairie by 2008. The restoration of cropland to prairie could have been the result of the allotment of land in Indian Territory from the period of 1903-1910 (Hewes 1978) or cropland abandonment after the 1930s that coincides with the migration of farmers west (Figure 3.9).

The tallgrass prairie that remained on the landscape in 2008 is remnant patches maintained as either rangelands or hay meadows. The hay meadows are small remnant patches, mean patch size 22 ha, that represent relics left over from traditional land use practices. These small remnants are important on the tallgrass prairie landscape because they can play a role in increasing the persistence of metapopulations, decreasing the degree of isolation between patches, act as stepping stones and increasing connectivity among patches (Koper et al. 2010). We found that these prairie patches displayed a clustering pattern and occurred on soil suitable for crop production. This suggests that there are cultural reasons for maintaining these prairies. Williams et al. (2007) found that in fragmented grasslands in Australia, cultural variables played the biggest role in determining the presence of remnant grassland patches, while environmental variables played a very little role.

But what factors might account for the persistence of these grassland remnants in an active agricultural landscape? Historically, commercial wealth was gained from prairie hay (Graeber 1945; USDA 1957; Dale 1960; Hewes 1978). The eastern half of Oklahoma historically produced the largest amount of prairie hay in the state, approximately 400,000 tons annually (USDA 1957; USDA 1959; Hewes 1978). However, currently growing prairie hay is not very

profitable. As of March 2012, prairie hay brought $90.00/ton (Nebraska Department of Agriculture 2012), and on average prairie hay produces approximately one ton per acre per year. In many cases low input farming, such as hay meadows, may cover basic needs but it is often not very profitable, because this type of farming doesn't always cover the costs of current technology equipment (e.g. tractors, fuel) (Küster 2004).

There are several advantages to growing prairie hay over other crops. Prairie hay is the cheapest and easiest crop to produce by comparison. Prairie hay operations require only one to six weeks of work per year, during which time hay meadows are cut, baled and cleared (Shortridge 1973; Riley 2005). The land holdings are too small to be profitable as the only source of income, however, but because of the small input of labor growing prairie hay permits employment outside of farming (Shortridge 1973; Foster et al. 2009).

These traditional land use practices tend to produce landscapes that display high levels of biodiversity due to the low levels of intervention, or low input farming practices. This creates a greater variety of ecological niches and a wider range of ecological processes. In contrast, high input farming involves monoculture farming systems where highly bred crop cultivars are planted and synthetic fertilizers and pesticides are applied (McIntyre and Hobbs 1999). Because of the low intensity of traditional farming landscapes they represent sustainable land use that supports biodiversity (Hughes and Hundley 1988; Phillips 1998; Küster 2004).

In a study comparing traditional, low input, hay meadows versus modern, high input hay meadows, Norderbaug (2000) found that traditional hay meadows were more species rich. The traditional management regimes for hay meadows create a very particular habitat, which supports a wide range of flora and fauna and therefore encourages high species diversity (Norderbaug 2000; Riley 2005).

Hay meadows are important features on a landscape because they hold cultural, agricultural and ecological significance (Phillips 1998; Norderbaug 2000; Riley 2005). In addition to high biodiversity, low input land use practices, such as hay meadows, provide other ecosystem services, such as respect for the land's capability, conservation of soil and water, and maintenance of plant cover, and sequestration of carbon (USDA 1957; Samson and Knopf 1994; Philips 1998). Culturally, hay meadows are grounded in a regional identity (Küster 2004), and support the identity of the picturesque unbroken grasslands with buffalo grazing. They also provide aesthetics to the landscape with the bright floral display of tall grasses and blooming wildflowers. Hay meadow conservation has also entered the arena of sustainability; both for biofuel and livestock feed. As a source of biofuel materials (Tillman et al. 2006; Wallace and Palmer 2007), hay meadows would serve as a low input high diversity (LIHD) sources of biofuel with low costs for labor, fuel, and machinery, while retaining high numbers of native species (Foster et al. 2009). As the demand for grass fed beef has increased, so has the need for a sustainable livestock

industry. Hay meadows can also serve as a LIHD source for forages (Kamp 2006; Pollan 2006).

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Table 3.1 Land Capability Classification

Class	Land Capability Classification Definitions
1	Soils in Class 1 have few limitations that restrict their use.
2	Soils in Class 2 have some limitations that reduce the choice of plants or require moderate conservation practices
3	Soils in Class 3 have severe limitations that reduce the choice of plants or require special conservation practices, or both.
4	Soils in Class 4 have very severe limitations that restrict the choice of plants, require very careful management, or both
5	Soils in Class 5 have little or no erosion hazard, but have other limitations impractical to remove that limit their use.
6	Soils in Class 6 have very severe limitations that make them generally unsuited to cultivation limit their use largely to pasture, etc.
7	Soils in Class 7 have very severe limitations that make them unsuited to cultivation and that restrict their use to grazing, etc.
8	Soils (and landforms) in Class 8 have limitations that preclude their use for commercial plant production and restrict their use.

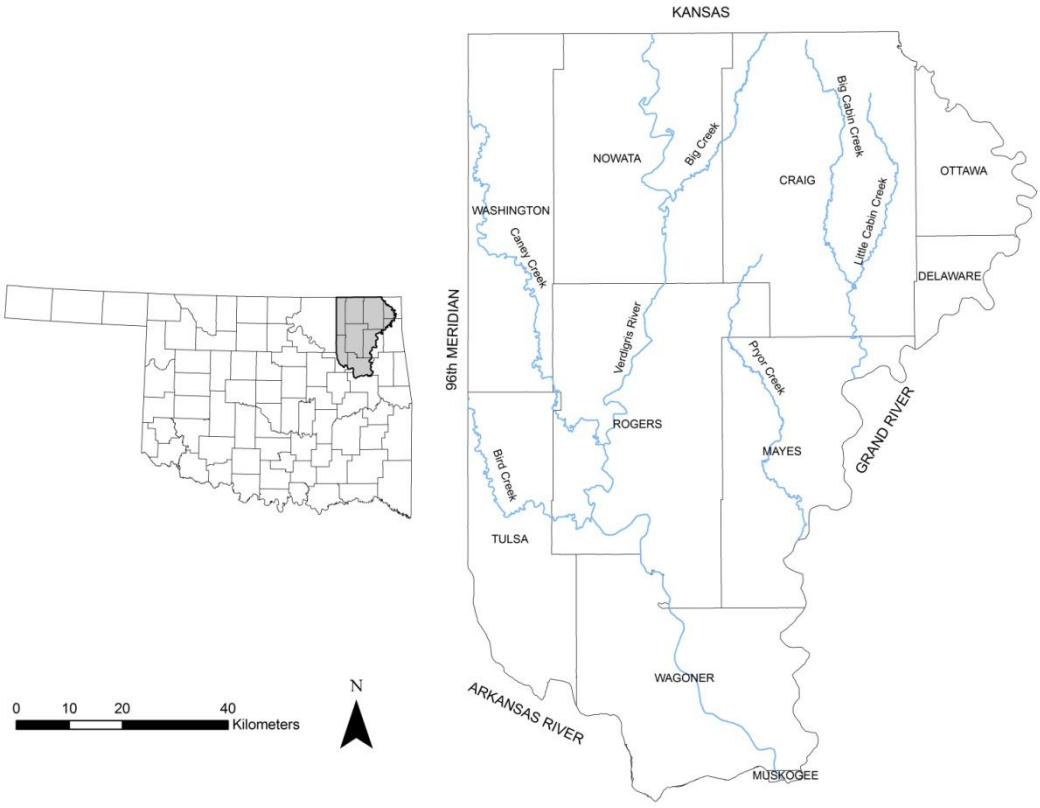


Figure 3.1. Location of study area in northeast Oklahoma.

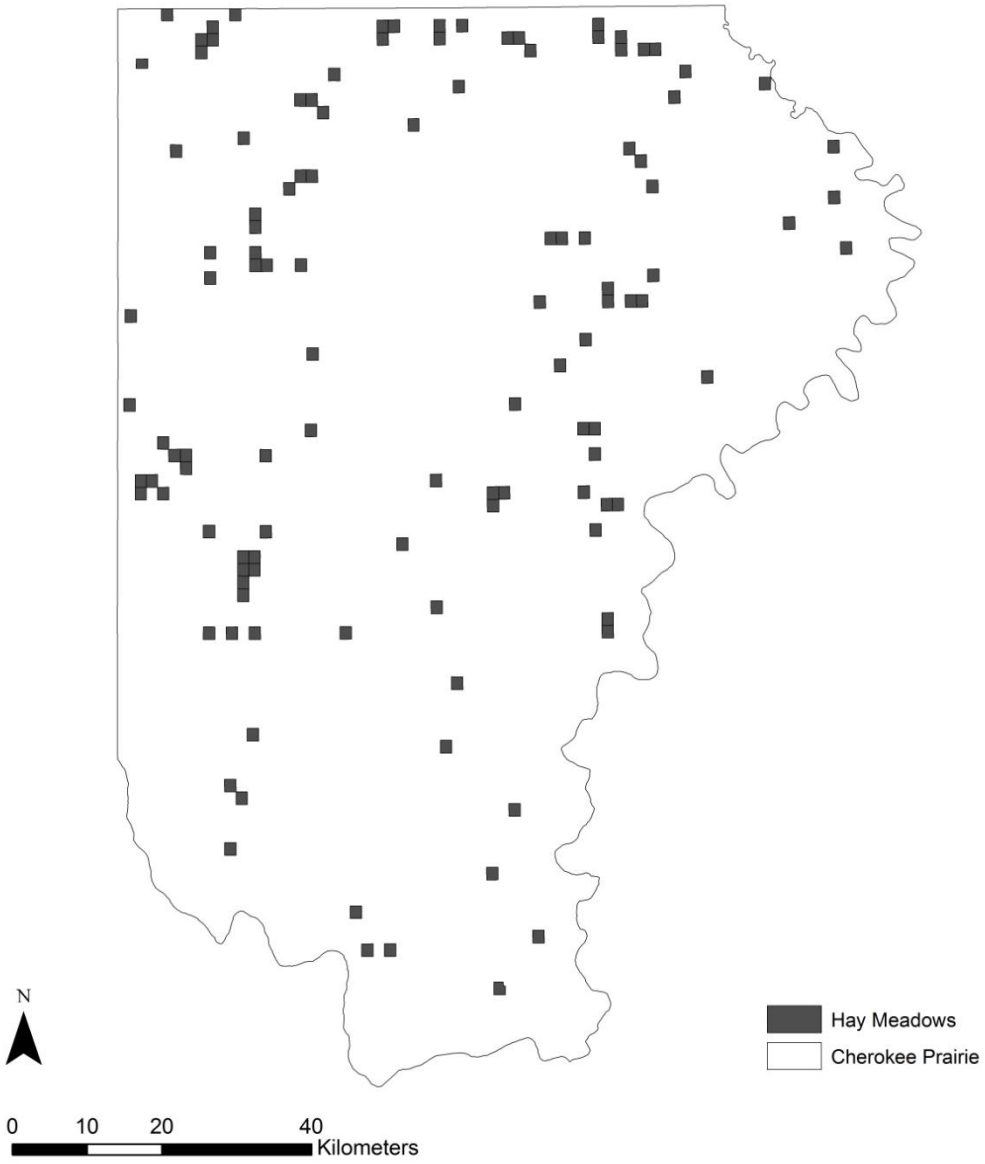


Figure 3.2. Previously surveyed hay meadows located from the legal land descriptions (Buck 1959, Eyster-Smith 1984, Hoagland 1999).

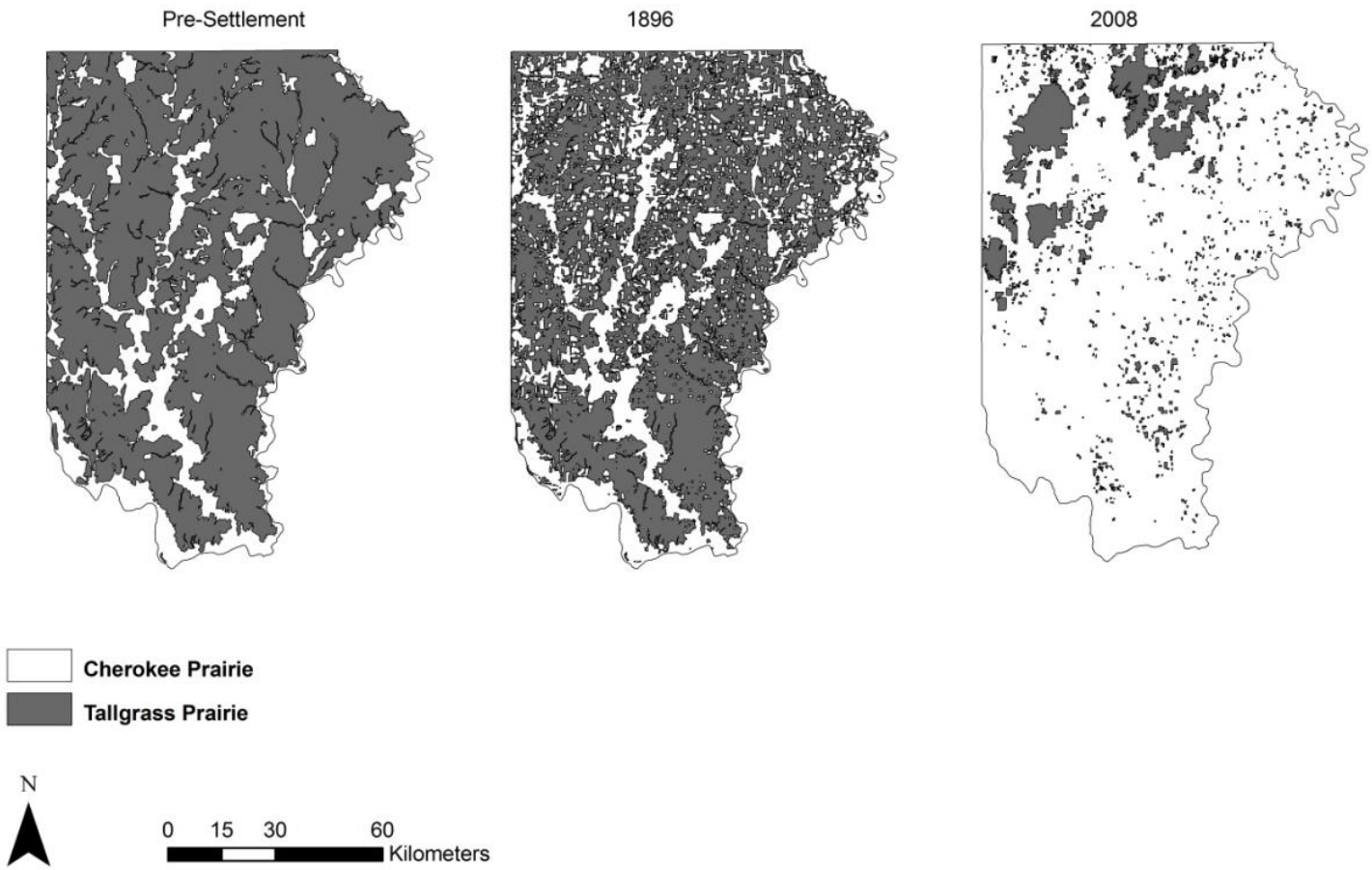
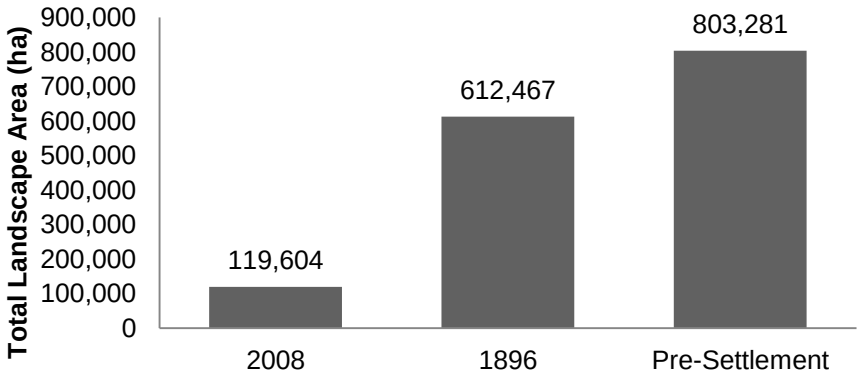
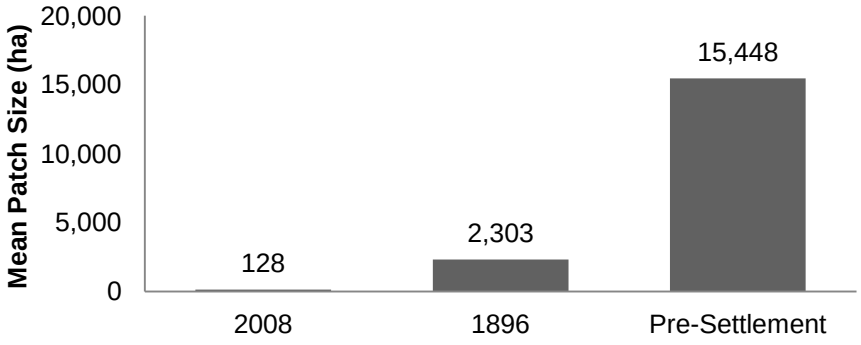


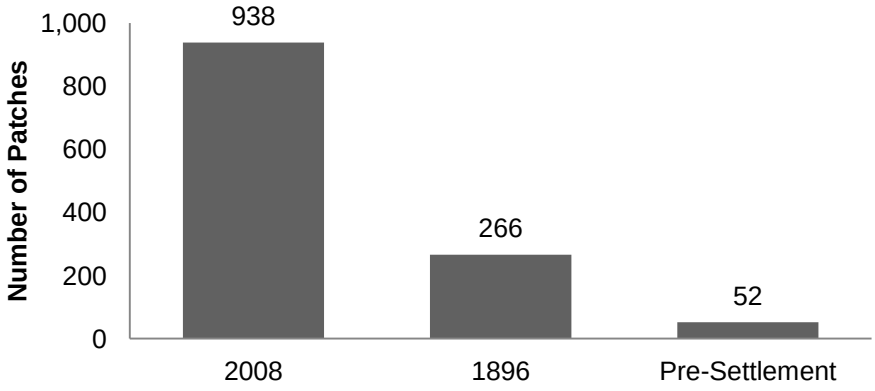
Figure 3.3. Comparison of tallgrass prairie land cover class between pre-settlement, 1896 and 2008.



a

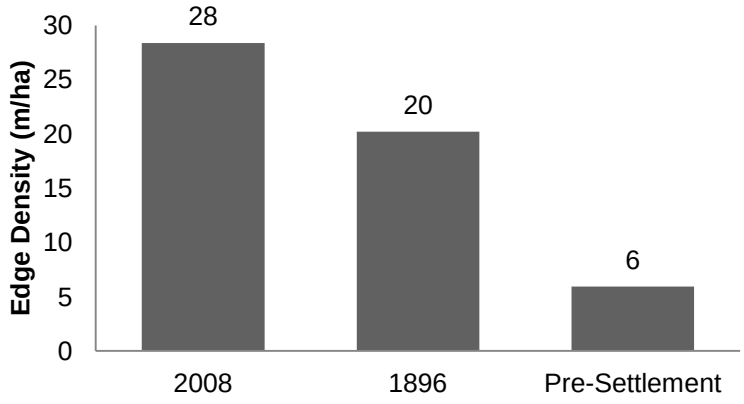


b

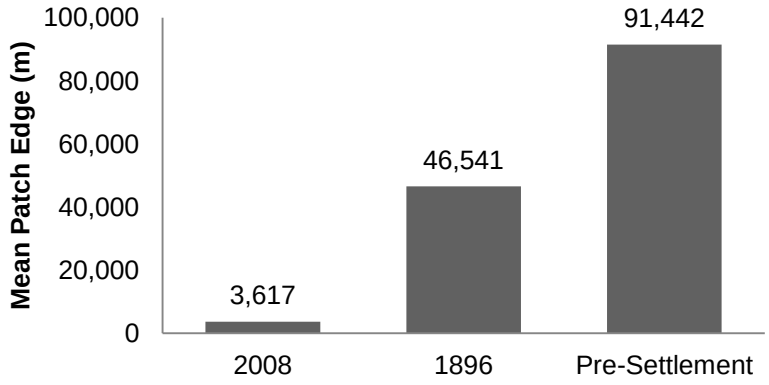


c

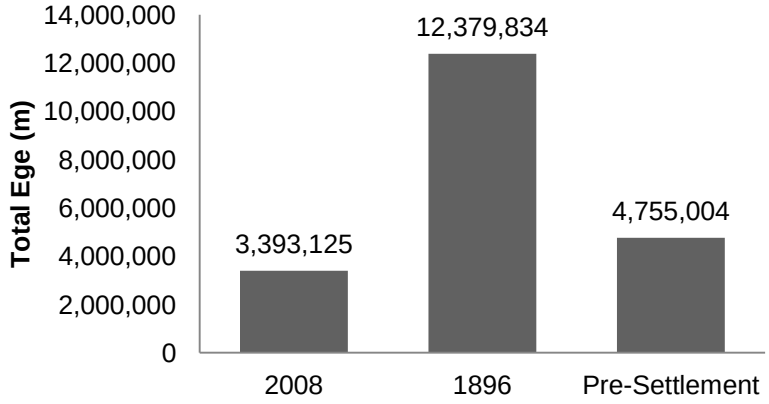
Figure 3.4. Comparison of (a) total landscape area (ha) (b) mean patch size (ha) and (c) number of patches between the study years, pre-settlement, 1896, and 2008.



a

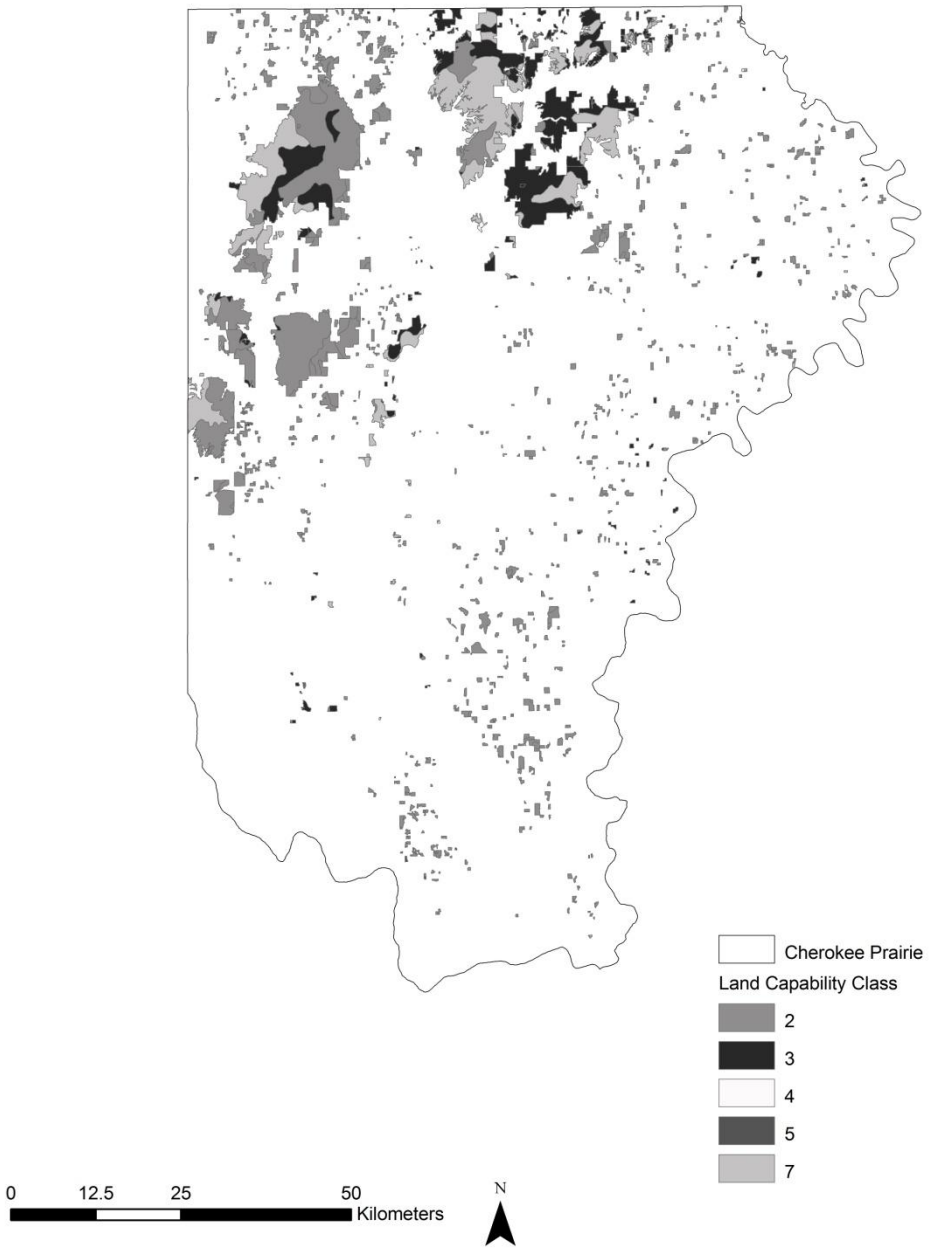


b



c

Figure 3.5. Comparison of (a) edge density (m/ha), (b) mean patch edge (m), and (c) total edge (m) between the study years, pre-settlement, 1896, and 2008.


Cherokee Prairie
Land Capability Class
2
3
4
5
7
0
12.5
25
50
Kilometers
N

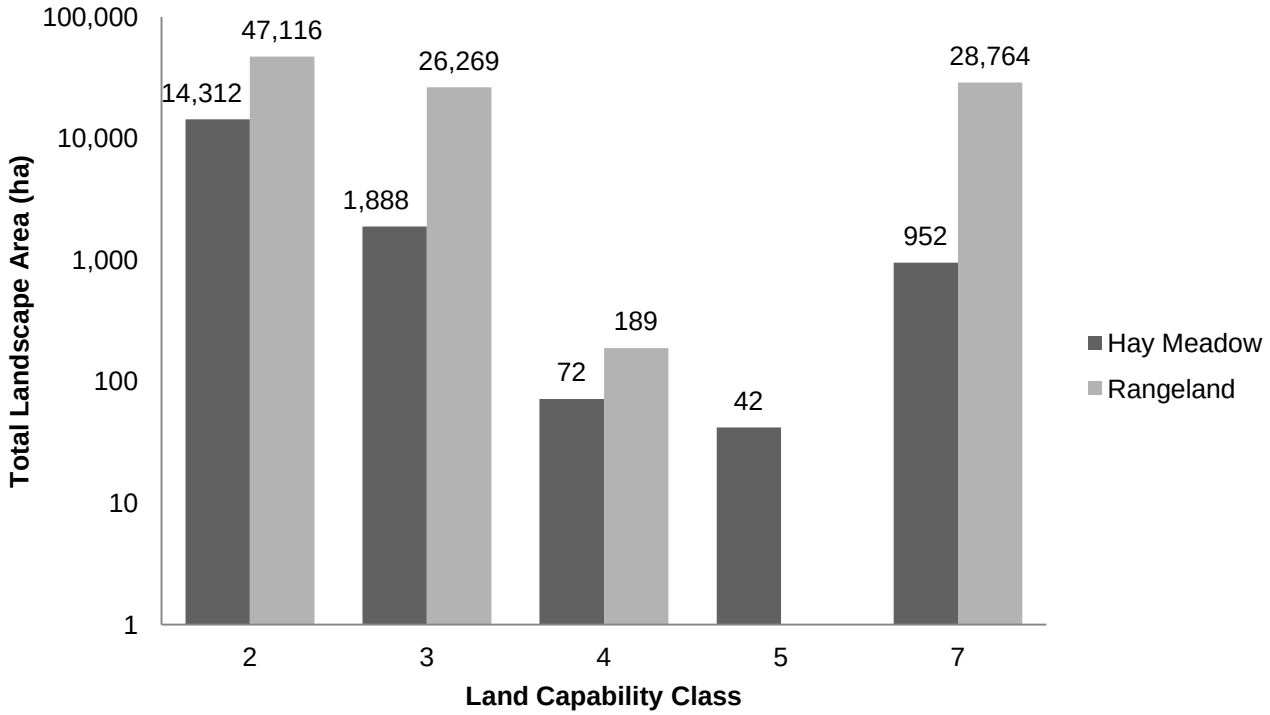


Figure 3.7. Comparison between total landscape area (ha) of hay meadows and rangeland per land capability class.

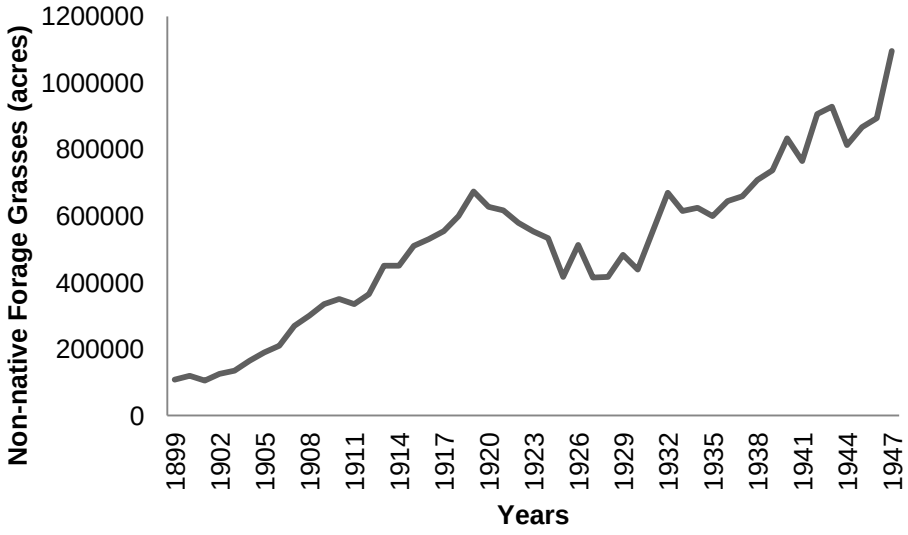


Figure 3.8. Production of introduced non-native forage grasses in Oklahoma for the years 1899-1947 (Oklahoma Agricultural Experimental Station, 1949).

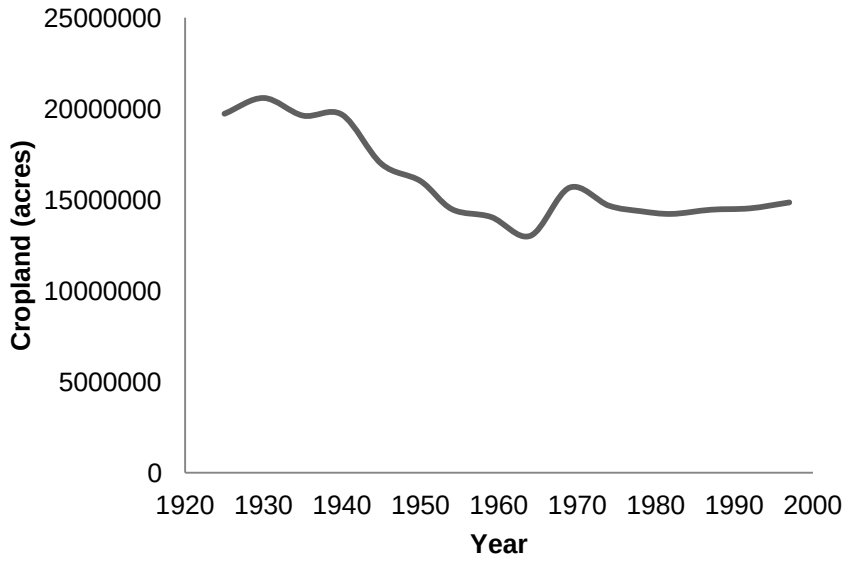


Figure 3.9. Cropland production (acres) in Oklahoma between the years 1920 and 1997 (USDA 1959, 1964, 1969, 1974, 1992, 1997).

Chapter 4:

Conclusions:

From analyzing the data from the Public Land Survey (PLS) plats it became apparent that quite a bit of settlement had already taken place by the time of the survey in 1896. Therefore, the PLS land cover did not represent a pre-settlement condition and should not be used as a baseline for comparing the degree of fragmentation. Because no pre-settlement data existed for the study area I created the pre-settlement land cover data layer. I constructed this data from the PLS plats by predicting what the pre-settlement land cover would have been in the absence of any cultivation or settlement. The assumption that was made to create this land cover was that the woodland and prairie extent would have been almost the same as the PLS extent if all cultivated fields were removed from the land cover data. The pre-settlement spatial data layer that was created by removing the cultivation polygons from the land cover allowed me to create a baseline land cover from which to quantify the degree of fragmentation.

A theme throughout this research was using historic data (i.e. agriculture reports, censuses, Indian Affairs Commissioner reports and the Public Land Survey general description) especially the reconstruction of historic spatial data using the PLS plats. A few limitations to using this data need to be addressed. Unfortunately when using the PLS to reconstruct historic land cover one is only getting a snap shot into what was actually going on at the time. That is why it is

important to use as many sources as is possible to support the PLS data, this helps to fill in any gaps in the data. Another limitation of using the PLS plats was that the surveyors were only walking and surveying sections lines so the interior of the section was an extrapolation what the surveyors found along section lines. With this information taken into consideration one can judiciously use the PLS plat data to reconstruct historic land cover. It is best to use these data over a large enough area to determine the patterns of land cover.

I have concluded that one of the shortcomings to using government reports and documents that are not peer reviewed and this leads to subjective views expressed within the reports. I found this to be the case in the government reports and general descriptions used to support the PLS data, and for determining the introduction of tall fescue. These tended to be biases towards using certain forage crops or exploiting certain natural resources found within the study area. For example, the Commissioner's report on Indian Affairs had a bias towards assimilating the Cherokee and Creek people into white culture as well as exploiting their natural resources. The OAES and USDA reports were biased towards improved or "tame" forage crops and showed a lack of interest in native or "wild" tallgrass prairie vegetation. For future research to understand how these biases played a role in land use decisions I would like to analyze the data found in the general descriptions based on what each deputy surveyor reported. In doing this I would like to determine if there was a relationship between which surveyor worked a township and what features were reported in the field notes general descriptions.

Information gathered from the Indian Affairs Commissioner's reports in conjunction with the 1896 PLS land cover data and general descriptions revealed that fragmentation from crop production began after the Civil War in the Cherokee Prairie. This fragmentation was the result of enclosing fields with barbed wire fencing for increased corn and wheat production, and livestock grazing. In the pre-settlement period the dominant landscape matrix of the Cherokee Prairie was tallgrass prairie. The matrix continued to be prairie until some time period between 1896 and 2008. During this period, the matrix changed from prairie to mixed agricultural land uses, such as monoculture row crop production or introduction of non-native forage crops. The change in the matrix likely occurred after the farmland abandonment of the 1930s. However, I was not able to quantify this change because the inconsistent flight dates for aerial photographs in the first part of the 20th century. For future research I plant to understand more precisely when this change in matrix occurred. To do this I will select a subsample of hay meadows and determine if they were present on the aerial photographs during the first part of the 20th century.

The introduction of non-native forage crops caused a more subtle degree of fragmentation, called landscape variegation. This occurs when the original land cover is intact but is either highly degraded or altered. This was observed in the tallgrass prairie from overgrazing, encroachment of woody plants species and overseeding by non-native forage plants.

The most ubiquitous of the forage plants found in eastern Oklahoma was tall fescue (*Schedonorus phoenix*). I determined that tall fescue, just as other

forage crops introduced into the United States, was introduced because of ideal growth characteristics for forage crops. These characteristics include abundant growth both vegetatively and sexually, extreme moisture tolerance (both drought and water logged conditions), and tolerance to wide temperature ranges. In addition to these characteristics, these plants are being introduced outside of their native range, and are able to exploit resources in the introduced range and out-compete or displace native species. Many introduced species are able to grow and reproduce in seasons when native species are dormant giving them a competitive edge. All of these traits have made introduced plants desirable to be spread liberally across the North American landscape because they make excellent soil erosion control agents, forage crops and in a few cases excellent turf grass. On the negative side of these super performing plants is that they can displace native plant species or even take over entire landscapes as is the case with kudzu (*Pueraria Montana)*, and sericea lespedeza (*Lespedeza cuneata)*. When native plants are eliminated from the landscape the functioning of the community is disrupted such as a decline in preferred forage of browsers, ungulates and insects, habitat and food for birds and preferred pollen for insects.

At the extreme end of habitat loss and fragmentation mapped in this research was a decrease by approximately 85% of the original tallgrass prairie vegetation in 2008. The habitat loss of tall grass prairie in the study area was due largely to conversion to row crops such as corn, cotton and wheat. A large portion of the prairie that was lost was taken up by Tulsa urban development. At

the time of the Public Land Survey in 1896 the towns such as Broken Arrow, Claremore, Jenks, Owasso, Skiatook, and Sapulpa, either did not exist or were only small towns with a railroad station. The Tulsa metropolitan area is the largest area of urban expansion in the study area, however other communities have expanded into the prairie, such as Bartlesville, Muskogee and Wagoner.

What remains on the landscape after habitat fragmentation is remnant tallgrass prairie patches. In prairie landscapes these remnants are maintained as rangelands or native hay meadows. Driving through northeastern Oklahoma just east of Bartlesville there are still large tracts of intact prairie. Most of these are maintained as cattle grazing operations. But if you drive down section line roads you will happen upon lovely small native tallgrass prairie hay meadows. These little remnants are usually less than a quarter of a section in area but contain an abundance of biodiversity, compared to the monoculture pastures or row crops surrounding them. I was first introduced to these remnants when I started the Ph.D. program in the summer of 2006. For my graduate research assistantship I was tasked with mapping these and all tallgrass prairie remnants. From that time on I wanted to understand what these remnant hay meadows were and why they existed. That has been the motivator on my quest through this dissertation. I like to think that hay meadows exist because of the kindness and will of prairie loving land owners. But likely these hay meadows are relics from traditional land use practices that were important sources of winter forage during the range cattle industry of the 1880s and for forage for draft animals on the farm. But once corn fed breeds of cattle were introduced

and tractors and cars replaced horses and mules, there was less of a demand for prairie hay. With a decline in prairie hay demand came a demand for introduced non-native forage crops such as alfalfa (*Medicago sativa*), Bermuda grass (*Cynodon dactylon*), and tall fescue. The increased demand in non-native forage crops was due to the higher yields they produce compared to prairie hay, therefore, there is no economic benefit to growing prairie hay. It is likely that landowners who maintain hay meadows do not live near their land holdings, or the land is in a trust and they do not depend on their hay crops as their sole income source. The land owners who continue to grow prairie likely do so for aesthetics, conservation, tradition, and because it is an easy crop to grow, requiring no pesticides or fertilizer and only a few weeks of labor. For future research and to aid in conserving these rare habitats it would be worthwhile to collected data about whom the land owners are, and why they maintain prairie hay meadows.

The research from this dissertation will help to fill in any knowledge gaps that remain in understanding how changes in land use practices over time can alter the landscape through habitat loss and fragmentation. The conclusions gained from this research can provide information to aid in the conservation of threatened landscapes. Threatened landscapes, (e.g. tallgrass prairie) provide valuable ecosystem services, such as erosion control and nutrient cycling, provide habitat for threatened and rare species, enhance the aesthetics, and economic benefits, in hay production and rangeland grazing.

Appendix 1. General Description from the Public Land Survey of the Cherokee Prairie.

Township	General Description
15N16E	This township is largely bottomland; the soil in creek and river bottoms is a red sandy loam, classed as 1st and 2nd rate. The timber is heavy and consists of oak, hickory, ash, cottonwood, sycamore and walnut. In the south and eastern parts are several prairies. The land is rolling. The soil classed as 2nd and 3rd rate. The Arkansas river which is a stream about 20 chs. wide with low bank and muddy water enters between sections 5 and 6 flows in a southeasterly direction to section 22 then flows northwest and leaves the township between sections 7 and 12. The current hugs the right bank throughout the township. This township is well watered by the Arkansas river and several creeks and branches. About one half of the township is in cultivation and yields well. - March, 20th 1896. F.M. Johnson, U.S. Surveyor. Charles Ellot Cabell, U.S. Surveyor.
15N17E	The greater part of this township is gently rolling prairie land, 2nd rate soil, and well drained and watered. With a good proportion of the land now under cultivation. There are numerous small creeks and branches throughout the township. Pecan creek is the largest of these and carries water in all seasons of the year, courses the southeast part of the township. Along nearly all of these creeks and branches is a good growth of oak, elm, pecan, hickory and ash timber. Making fuel and easy article at any location within the boundary of the township. There is an Indian Mission situated in the center of section 26. The Arkansas river courses in an easterly direction through the northern part of the township entering through sections 7 and 18 on the west and leaving through sections 1 and 12 on the east. This river will average about 20 chs. in width, from bank to bank. While the main water channel will average only about 7 or 8 chs. in width, the rest being sand bars. The entire bed of this river is made of quick sand, making it not only dangerous to cross, but allowing the main channel to change continually. The water is quite salty. The land along the river is of 1st and 2nd rate, some of it being too sandy for cultivation. The sub-soil is a particular kind of red clay found only along this stream. The timber along this stream is of the very best quality of oak, elm, walnut, hackberry, hickory, sycamore, and cottonwood, some of the trees measuring 4 ft in diameter. The population of the township will probably not exceed 400 people. Most of whom belong to the negro and Creek Indian race. The chief occupation of the residents is farming and stock raising. - R.L.M. McAlpine, U.S. Surveyor. J.W. Riley, U.S. Surveyor.

15N18E This township is possibly one of the most fertile townships in the Creek Nation, taken as a whole. It is composed of a gently rolling , and nearly level prairie, and rich bottom land along the Arkansas river. The whole of the township may be classed as bottom land as there is little difference between upland and bottom proper. In the extreme western-central portion, there are some small stoney ridges. There is quite a heavy growth of timber in the immediate bottom along the river, consisting of oak, elm, ash, hickory, pecan, walnut, persimmon, hackberry, mulberry, locust, redbud, sycamore, and cottonwood. The Arkansas river, averaging about 22.00 chs. wide, flows through the township, entering in sections 6 and 7, and leaving in section 12. The township is very well watered by numerous creeks and branches, draining into the river. The Missouri, Kansas and Texas railway runs through the eastern portion of the township, entering the township in section 13 and leaving in section 34. Muskogee a town of about 3200 inhabitants is, and 2" to the most important town in the Territory, is located in section 26. This is quite a commercial center for both the wholesale and retail trade. It is also a "freight division" of the above mentioned railway. An orphan asylum is located on top of a prairie ridge in section 20. Farming is the leading occupation outside of Muskogee. The population of the entire township is about 4500.- March 25" 1896. T.H.R. Johnson, U.S. Surveyor. C.H. Hickman, U.S. Surveyor.

15N19E This township is in both the Creek and Cherokee nations and is very much cut up by creeks and rivers. It is nearly all a level bottom, with the exception of the extreme southeast corner, which is hilly and mountainous descending to the Arkansas river. The soil of the township may be classed as 1" and 2" rate, except on the hills, which is a stony 3" and 4" rate. The township has a very heavy growth of timber consisting of elm, ash, pecan, walnut, hickory, hackberry, mulberry, locust, redbud, persimmon, wild plum, various oaks and undergrowth. Some prairie is found in the western portion, but is covered with undergrowth in many places. The large streams of water flow in the township. The Arkansas river enters in section, flows east to section 9 thence south to section 28 thence east again and leaves the township in section 25. Grand river enters in section 2 and on a southwesterly course empties into the Arkansas in section 9. Verdigris river enters through sections 5 and 6 and on a southeasterly course empties into the Arkansas in section 5. Numerous creeks of no importance drain the township from all directions. A slough about 3.00 chs wide extends from the Grand river in section 11 southward in to the southeast corner of section 14. A small lake is found in the southern portion of section 10 and northern portion of section 15. The east boundary of the Creek nation extends through the township intersecting the south boundary at a point between sections 6 and 31, bears N18°18'E to a point in the center of the northwest 1/4 of the northeast 1/4 of section17; from which point it bears N45°50'E to the closing corner of fractional sections of 8 and 17;

15N19E cont. from which it bears N45°43'E to the 38" opposite the mouth of the Grand river; thence if follows the old original meanders of right bank of the Arkansas river, westward to the aux meander opposite to the mouth of the Verdigris river, thence from aux meander on corner of left bank Verdigris to meander corner of fractional sections 5 and 32 on north boundary of township. The boundary line is well marked by iron monuments for rocky mile corner. Two railroads run through the township. The Missouri, Kansas and Texas entering in section 6 and leaving in section 18. The Kansas and Arkansas Valley, controlled by the Missouri Pacific system enters in section 3 and leaves in section 24. Ft. Gibson, a town of about 1500 people is located on the Kansas and Arkansas Valley railway in sections 1, 2, 11 and 12. This is an old fort used a great deal in the early days and is yet, to a small extent, by the U.S. Army. This is the old house of Jefferson Davis, where he lived for several years after the Civil War. The foundation is the only trace left of his home, the entire building has been torn down and carried of by curiosity seekers who have flocked there to get some relics of ex-President's house. Wybrook, a small county post office is located on the Missouri, Kansas and Texas railway in section 6. There are five good ferries in the township, two across the Arkansas, two at the mouth of the Grand river, and one across Grand river near the Kansas and Arkansas Valley railway bridge. Bacouch College is located in the southeast 1/4 of the northwest 1/4 of section 18. The population of the entire township is 2200. - May, 5 1896. R.L. McAlpine, U.S. Surveyor. W.T. Turner, U.S. Surveyor.

16N16E The greater portion of this township is low level bottoms. The soil is a dark, sandy loam and very productive. There is a large rolling prairie in the eastern portion nearly all of which is under fence. Oak, ash, cottonwood, elm, sycamore, walnut, and other kinds of timber, with a dense growth of undergrowth and vines are found along the Arkansas river. The township is well watered by the Arkansas river which runs nearly due south through the western portion and by many small streams. Nearly all of the bottom land is under cultivation. There are settlers scattered over the entire township engaged in agriculture. W.H. Thorn, U.S. Surveyor. Frank Lewis, U.S. Surveyor.

16N17E This township is with the exception of a little timber in the northern, southern and northeastern parts, rolling prairie with narrow belts of timber skirting the small creeks. The soil is 2nd rate and produces wheat, oats and corn in abundance, there are several large and well improved farms. There is a large number of cattle and horses in the township. The township is fairly well watered by the small creeks that course through it, Verdigris River runs through the northeast corner, the soil along it is 1st rate and all under cultivation. The timber in this township is oak, hickory, elm, ash, walnut, pecan, sycamore, hackberry and cottonwood. There is one store, church and school house in this township. - W.T. Turner, U.S. Surveyor. R.L. McAlpine, U.S. Surveyor.

16N18E This township contains rolling and level land is about two-thirds timbered and the remainder prairie. It is watered by the Arkansas river and Verdigris river. The former entering the township at the southwest corner of section 34 entering section 35 and leaving the township at the southeast corner of section 36. The Verdigris river enters the township at the northeast corner of section 6 and flows in a southeast course making numerous bends and touching and passing through the following sections 6, 5, 8, 4, 9, 10, 15, 22, 27, 26, 23 and leaves in section 24. The Missouri, Kansas and Texas railroad enters the township at the southeast corner of section 24 and is built through sections 24, 13, 12, 11 and leaves township in section 2. There are some few farms along the rivers, and the land in bottom would be classed as 1st rate and that of the other portions as 2nd and 3rd rate. This township is no doubt valuable for both grazing and farming purposes. The timbers are oaks, elm, ash, locust, hickory, hackberry, mulberry, and etc. Gibson station is the only village in the township it contains about 50 people. One or two stores, one post office and blacksmith and is in western quarter of section 12. - T.H.R. Johnson, U.S. Surveyor. C.H. Hickman, U.S. Surveyor.

16N19E This township is mostly rolling prairie and timbered lands, while along the rivers are narrow bottoms. The township is well watered as it has two rivers. The Grand river in the eastern part and the Verdigris river in the western part. The northern part of the township is prairie and is used for grazing, the farms being along the river bottoms. The timber is principally oak, ash, hickory, elm, and sycamore found mostly in the river bottoms. The Kansas and Arkansas Valley railroad transverses the western part of the township entering in section 34 and leaving it in section 6. The Missouri, Kansas and Texas railroad crosses the southwestern part. - W.T. Turner, U.S. Surveyor. R.L. McAlpine, U.S. Surveyor.

17N13E This township is well cultivated and thickly settled. The land along the Arkansas river is 1st rate soil and produces abundant crops. The southern and western portions of the township are composed of rolling timber and prairie. The latter being well watered and is good grazing land. Oak, elm, ash, locust, walnut, birch, cottonwood, sycamore and willow are found along the Arkansas river and in the bottom lands throughout the township. Perry P.O. is situated in section 17. The township is well transversed by roads. The Arkansas river flows through the northeast portion of the township. - F.M. Johnson, U.S. Surveyor. C.E. Cabell, U.S. Surveyor.

17N14E This township is made up of all varieties of land from level river bottoms to range and broken ridges. The Arkansas river enters the township in section 18 forming the principle source of water supply and a system of drainage from north and south. The river is from 30 to 70 chs. flowing over a sandy bottom in an easterly direction leaving in sections 25 and 36. On either side of the river are the low flat bottoms, covered with heavy timber and dense underbrush. On the south the land is somewhat broken, especially so in the southeast were it is very rough. On the north the land is almost level and gently rolling in the extreme north. There are numerous creeks in the township the principle ones being Broken Arrow creek on north and Snake creek on south forming a system of drainage to the river and providing and abundant water supply. The township is transversed by numerous roads making all parts easily accessible. The only crossing on the river is Moody's ferry in section 21. The township is well settled by white settlers who have well cultivated farms along the Arkansas river. Weer P.O. is located in section 1, Wealaka P.O. in section 28. The Presbyterian Mission and Broken Arrow church in section 5. Soil: in bottom 1st and 2nd rate; on upland 2nd and 3rd rate. Timber in bottom oak, elm, ash, walnut, pecan, hickory, sycamore, hackberry, shittin and gum. In upland oak and hickory. Underbrush briars, vines, etc. Population about 250 whites. - T.M. Johnson, U.S. Surveyor. Charles Ellott Cabell, U.S. Surveyor.

17N15E The Arkansas river courses the southern sections of this township entering in section 30 flowing nearly due east and leaving in section 25. The river bottoms are covered by a dense growth of underbrush, soil very fertile, rich sandy 1st and 2nd rate. Ash, elm, hickory, cottonwood, black walnut, red bud, oak, sycamore and pecan are found in large quantities on the river banks. The remaining portion of the township is generally rolling country covered with a thick growth of oak and hickory timber. The township is well watered by numerous creeks and their tributaries. There are few settlers and the roads are amply sufficient for their accommodation. - May, 11 1896. F.M. Johnson, U.S. Surveyor. Charles E. Cabell, U.S. Surveyor.

17N16E This township is all prairie except the river bottoms. The soil is classed as 2nd rate in prairie and alluvial 1st and 2nd rate in the river bottoms. Heavy cottonwood, sycamore, oak, walnut, elm, ash, and box elder are found in the river bottoms. The township is well water by the Verdigris river which crosses the northeast part and the Arkansas river which crosses the southwest part of the township and by several creeks and branches. The principle occupation of the people is cattle raising. - F.M. Johnson, U.S. Surveyor. Charles Ellot Cabell, U.S. Surveyor.

17N17E The greater part of the township is bottom land, which in the winter and early spring is subject to overflow. The soil is rich and productive rating as 1st class and is well cultivated with cotton, corn and other grains being the chief crops. The southwest part of the township and a smaller portion of the northeast are composed of uplands, which affords excellent grazing. Oak, hickory, pecan, maple, box elder, elm, ash, sycamore, and cottonwood are the principle varieties of timber and are of such a size as to be of considerable value. Flowing from the northwest to the southeast, with many bends, the Verdigris river transverses the township. The drainage is good being towards the river. Half and quarter breeds constitute the population which is not large. - J.W. Riley, U.S. Surveyor. H.S. Hackbusch, U.S. Surveyor.

17N18E This township lying both in the Creek and Cherokee Nations, consists of gently rolling prairie land. In the southwestern corner, and also along the banks of Coal creek elm, ash, hickory and the different varieties of oak timber are found. The soil of the entire township is 1" and 2" rate - no 3" or 4" rate can be noticed. Coal and numerous other creeks furnish plenty of water for both farm and stock raising purposes. The township is very thickly settled - having about 3,500 population, and carry on farming and merchandise business on a medium scale. The town of Wagoner with about 2,000 population lies in sections 9, 10, 11, 14, 15, and 16 with limits 2 miles square. It was incorporated under Arkansas laws June 4" 1896. The original town site survey was made by one Mr. Gates. His meridian lines were intended to be true north and south lines, but they are proven to have been by a magnitude variation of 4o07'E, which is about 4o out. No connection has been made with incorporated limits, and our lines. The town site is located in a very good section of the country, and the trade comes from many miles around which makes it one of the most important towns in the northern part of Indian Territory. The Missouri, Kansas and Texas; and the Kansas and Arkansas Valley railways intersect at this point and transverse the township from north to south. There are some very good indications of coal in the northwest corner. The boundary line of the Creek and Cherokee Nations runs through the first tier of sections from north to south. - June, 4" 1896. W.T. Turner, U.S. Surveyor. J.W. Riley, U.S. Surveyor.

17N19E This township is composed of high rolling prairie, and timbered lands along the east and west: and low bottom lands through the center. Grand river enters the township in section 2, flowing in a southwesterly direction, passes through sections 2, 3, 9, 10, 15, 16, 22, 27, 28, and 33 and leaves in section 34. The bottoms along the river are very fine for agriculture purposes being 1st and 2nd rate. Oak, elm, ash, hickory, hackberry, sycamore, walnut, and cottonwood timber grow in abundance. The low lands along the eastern bank of the river show signs of a recent overflow. There are three good ferries in the township, two churches, one well traveled road and several fine farms. The population of about 250, mostly whites, Indians and Negros engaged in farming and stock raising. - May, 27th 1896. W.T. Turner, U.S. Surveyor. J.W. Riley, U.S. Surveyor.

18N12E The land of this township varies from the bottom lands of the Arkansas river and Pole Cat creek to the almost mountainous western portion of the township. The surface is generally rolling. Very good soil of a sandy nature, is found in the bottoms, but the remainder of the township is very sandy and rocky and good for only pasturage and that in limited extent. Sandstone of poor quality is found generally. The township is well watered by the Arkansas river in the northeastern and Pole Cat creek and its tributaries in the central and southern parts. Varieties of oak and hickory are found; with sycamore, ash, elm, walnut and pecan, in the bottom lands. There are a few families settled along the creek bottoms, and these compose the only settlements. - Geo. W. Hooper, U.S. Surveyor. Frank Lewis, U.S. Surveyor.

18N13E The township is rough and broken except the southwest portion in the valley of the Arkansas river. The soil in this valley is rich black loam and remarkably fertile. The soil in all other parts of the township is sandy and covered with loose sandstone which renders it practically worthless. Along the valley of the Arkansas river and Pole Cat creek are found oak, ash, elm, hickory, walnut, pecan, sycamore, and cottonwood timber. The balance of the township, with the exception of prairie in northeast corner, is covered with black jack oak and hickory. The township is sparely settled and fairly well transversed with roads. - J.C. Wilkinson, U.S. Surveyor. W.H. Thorn, U.S. Surveyor.

18N14E The township is nearly all rolling prairie with a luxuriant growth of grass. The soil is rich, dark, sandy loam and 2nd and 3rd rate. Timber is found along the banks of creeks and drains comprising oak, sycamore, walnut and elm. The township is well watered by numerous creeks and drains. Sections 1 and 2 are hilly, 135 feet above the plain. There are indications of coal in section 20 and 21. But few settlements were observed. - J.C. Wilkinson, U.S. Surveyor. W.H. Thorn, U.S. Surveyor.

18N15E This township is generally rolling prairie affording an abundant growth of grasses and good soil for agriculture purposes. The soil excepting on the highest point is a dark sandy loam. The hills are gravely and good only for pasturage. A poor quality of sandstone is found generally. Croppings of coal are formed in the northwestern portion of the township. There are found numerous springs and small branches but no streams of importance. - J.C. Wilkinson, U.S. Surveyor. W.H. Thorn, U.S. Surveyor.

18N16E This township is of high rolling prairie expect in eastern part along the Verdigris river which is a low level river bottom covered with a heavy growth of oak, elm, ash, walnut, pecan, sycamore, cottonwood, and hickory timber with a dense growth of underbrush briars and vines. The entire bottom is subject to overflow from 1 to 12 ft deep and while it has a rich alluvial soil is 1st rate quality, the entire area is worthless except for the timber. The Verdigris river enters the township in section 2 leaving in section 1 and reentering in section 25 flowing southwest and leaving the township is section 36. The balance of the township is high rolling prairie, and with the exception of sections 4, 5, 7, 8, 17, and 18 the soil is light sand mixed with gravel making it unfit for cultivation and valuable only for pasturage. The exceptions noted have a sandy soil 2nd rate quality and the greater part are under cultivation. The township is provided with a good system of roads making all parts easily accessible. The Verdigris river with the several creeks and branches provides an abundant water supply. - J.C. Wilkinson, U.S. Surveyor. W.H.Thorn, U.S. Surveyor.

18N17E This township is largely gently rolling prairie, the most of which is under cultivation. Along the east boundary the soil is covered in places with loose limestones. The soil, as a whole, with the exception of the above mentioned locality, may be classed as the very best 1st and 2nd rate. Bottomlands are especially productive the soil being a black loam adapted to raising corn. The bottom lands extending a mile out in the interior on each side of the Verdigris river, is thickly timbered with the usually varieties of trees, as are found in all river bottoms of the Indian Territory. Verdigris river entering though the west boundary of the township in section 6 and leaving through section 30, flows through the western half of the township. This river is on an average, about 4.00 chs. wide, with a very good stream of water. The tributaries of this river, add very greatly to the water of the township. The Kansas and Arkansas Valley railway runs through the extreme northeast corner. The population of the township consists largely of whites who carry on farming on a minimum scale. - August, 18" 1896. C.W. Goodlove, U.S. Surveyor. T.H.R. Johnson, U.S. Surveyor.

18N18E This township lying both in the Creek and Cherokee Nations, is gently rolling prairie. However, some elm and ash timber is found along the banks of the creeks and branches. The soil of the township is generally 2nd rate there is a little 3rd rate in the northwestern corner. Numerous creeks, branches and springs water the township very well. Flat Rock creek, which follows along the east boundary is about 50 lks. wide, and has a stream of very good water. The Kansas and Arkansas Valley railway runs through the western portion entering in section 7 and leaving in section 32. The Missouri, Kansas and Texas railway transverses the township also, entering in section 2 and leaving in section 34. Leliaetta a "flag" station on this road is in section 22. The Creek and Cherokee boundary line runs through the eastern tier of sections on a true bearing of north and south. The township is very well settled by a white population who carry on farming on a medium scale. - August, 12" 1897. C.W. Goodlove, U.S. Surveyor. T.H.R. Johnson, U.S. Surveyor.

18N19E This township contains very little bottom land and is covered in bottom, with very dense undergrowth. The timber of any notes are oak, ash, elm, hickory, pecan, hackberry, box elder, walnut, and coffee bean. Grand river runs through the entire township entering in section 2 and leaving in section 35. The eastern portion of this township contains many cliffs, rocky ridges, canyons. Along the extreme western edge the township is the only prairie land. Clear creek and Tame Dennis are the only creeks of notes. The soil in bottom is classed as 1st and 2nd rate, but is subject to overflow. The soil of prairie is classed as 3rd rate. The population is about 150 people. There is a good ferry in sections 20 and 26. A number of small farms are found in the bottoms. - W.T. Turner, U.S. Surveyor. J.W. Riley, U.S. Surveyor.

19N12E This township contains nearly every kind of land, from bottomland to rocky hills. The soil ranges from sandy, rocky hill land to rich loam. The soil along the Arkansas River is a rich sandy loam and classes as 1st rate, in the central is hilly - classes as 4th rate, the prairie land in the south and western parts as 2nd rate. Cottonwood, sycamore, oak, ash, walnut, pecan, elm and hickory are found in the river bottom; oak and hickory on the hills and rolling land. The township is well watered by the Arkansas river and by several creeks and branches. The Arkansas river enters the township in sections 7 and 8, flows in a northeast direction to the corner of sections 2, 3, 10 and 11 and then to section 36. The St. Louis and San Francisco railroad enters in section 31 and bears northeast and leaves in section 1. Red Fork is a town of 80 inhabitants lying in section 28. Tulsa is a growing town of 2000 inhabitants in sections 1 and 2.- Frank Lewis, U.S. Surveyor. Geo. W. Hooper, U.S. Surveyor.

19N13E This township consists of rolling prairie and timbered land. There is no bottomland and the soil is sandy and rocky a poor 3rd rate. Mingo creek, which flows along the east boundary, is the only water course of any importance, and it is only about 50 links wide. Prairie land makes fair pasturage. The township is well transversed by roads, and has few inhabitants. The town of Tulsa is one mile west of the northwest corner of the township. - F.M. Johnson, U.S. Surveyor. C.E. Cabell, U.S. Surveyor.

19N14E The township is entirely rolling prairie land soil is classed as 2nd rate. The township is drained by small creeks and their tributaries. There are a few settlers and the roads are sufficient for their accommodation. - Charles E. Cabell, U.S. Surveyor. F.M. Johnson, U.S. Surveyor.

19N15E This township is prairie with the exception of a narrow belt of timber on the eastern side and a small belt in the northwest corner. Oak and hickory are the principle woods, but along the streams are found ash, elm, sycamore and walnut. The soil is sandy and rocky, with the exception of creek bottoms, affords only pasturage. The northern part of the township is well watered by two creeks and their tributaries, but with the exception of Adam's creek in the southeastern part, the streams are small an unimportant. The few settlers are principally in the southeastern part on Adam's creek. -F.M. Johnson, U.S. Surveyor. Charles Ellot Cabell, U.S. Surveyor.

19N16E This township is composed of level river bottom land with alluvial soil of 1st rate quality. The Verdigris river flows through the township in a southeasterly direction, entering in section 5 and leaving in section 35, the river has a very wide bottom, which is low and flat and covered with a heavy growth of timber and underbrush. With every rise of the river the entire bottom is overflowed from 5 to 12 ft. deep - the overflow is in the nature of back water. The banks of the river are quite high, and water backs up in Adam's creek; which flows into the river in section 35; easily overflowing the low creek banks and spreading on the township from the river to the low range of hills on the western boundary. East of the river the overflow is not as bad. The banks are high enough to hold the water except in some few places. Owing to this overflow the township is practically useless for agricultural purposes, in spite of its fertile soil, roads and almost all other topography is lost by reason of overflow. Land low, flat river bottom. Soil alluvial 1st rate. Timber oak, elm, ash, walnut, pecan, hickory, sycamore, maple, willow, hackberry, cottonwood, dogwood, gum, cedar and redbud. Underbrush same with briars and vines. Stone sandstone. Township uninhabited except on extreme borders. - J.C. Wilkinson, U.S. Surveyor. W.H. Thorn, U.S. Surveyor.

19N17E This township is mainly all rolling ground with the exception of a large peak in section 10 and a few hills in the western tier of sections. It is used for grazing - being fenced in every portion. In the southwest corner may be found corn, hay and cane fields. Bull Creek station is located in section 28 and is a shipping point for cattle and coal only. Coal mined at this station in small quantities. Inola station is located in section 4 - another shipping point for cattle. Both of these stations are located on the Kansas and Arkansas Valley railway. Timber is only found along the banks of the creeks and consists of elm, pecan, hickory and sycamore. The boundary line between the Creek and Cherokee Nations, runs through the northeastern tier of sections on a true east west bearing. The Kansas and Arkansas Valley railway runs through the township from northwest to southeast on a tangent of S2935'E entering in section 5 and leaving in section 36. - August, 29", 1896. H.S. Hackbucsh, U.S. Surveyor. F.E. Joy, U.S. Surveyor.

19N18E The township lying in both the Creek and Cherokee Nations is all high rolling prairie, except along the banks of Brush creek in the northeast corner, which is heavily timbered with elm and dense undergrowth. The western is exceedingly rough and rolling. The soil of the township ranges from 1" to 3" rates. A very small portion is cultivated, as nearly the entire township is used for cattle raising. The Missouri, Kansas and Texas railway runs through the township from north to south entering in section 1 and leaving in section 35. Both the north and east boundaries of the Creek Nation run through the township cornering in the northwest 1/4 of the northwest 1/4 of section 1. - August, 29" 1896. C.W. Lovegood, U.S. Surveyor. T.H.R. Johnson, U.S. Surveyor.

19N19E The township, except the southwest portion, which is partially prairie, is covered with a dense growth of oak, elm and various other kinds of timber. The land is generally high rolling and ridged. The Grand river enters the township in section 4 on the north from whence it flows in a southeast course through the township leaving in section 35 on the south. The bottoms along the stream vary in width from one mile to one chain. The bottom lands are 1st rate soil and very productive, but are subject to overflows and are therefore not very extensively cultivated. The timber in the bottoms is of good quality. The land throughout the rest of the township is 2nd, 3rd and 4th rate. The township is well watered and drained by several smaller streams and branches flowing to the Grand river. In sections 26 and 35, is an island, which covers nearly forty acres of area, here the soil is 1st rate and the timber is of good building quality. The island is also subject to overflows the banks only averaging 15 ft in height above low water mark. The island is not under cultivation. - F.E. Joy, U.S. Surveyor. J.W. Riley, U.S. Surveyor.

20N12E This fractional township borders on the eastern edge of Oklahoma, and is 6 miles long and a little less than a mile and a half in width. The land is nearly all rolling prairie or cultivated land. The soil is a sandy loam, classes as 1st, 2nd and 3rd rate. Most of the land is fenced for cultivation or pasture. There is not much water. Timber consists of small oak, hickory, elm, pecan and locust. Signs of coal show in the branches drains. - Frank Lewis, U.S. Surveyor.

20N13E The soil in this township will average a good 2nd rate. In the southern half is a sandy loam and in the northern half - along Bird creek and its tributaries - it is alluvial and will raise abundant crops. The southern portion is largely prairie and the grass makes it valuble for hay and grazing. Ash, elm, oak, hickory, sycamore, pecan and hackberry timber is found in the creek bottoms. The township is well watered and fairly well settled and wheat is the principle crop. - J.C. Wilkinson, U.S. Surveyor. W.H. Thorn, U.S. Surveyor.

20N14E In the middle, east and northeast portions of this township are of rough and broken land being covered with loose limestone where the soil is 3rd and 4th rate. The south and southwest portions are prairie with the soil being 2nd and 3rd rate. Bird creek and Mingo creek are the principle water courses. The former runs from the northwest, through the middle sections, to the east. The latter runs north through the western tier of sections emptying into Bird creek. The land bordering these streams is timbered with oak, hickory, ash, elm and pecan with dense underbrush. The St. Louis and San Francisco R.R. bears east and west through sections 25, 26, 27, 28, 29 and 30. - J.C. Wilkinson, U.S. Surveyor. W.H. Thorn, U.S. Surveyor.

20N15E Township is level river bottom and rolling prairie and affords 1st, 2nd and 3rd rate soil, well adapted to agriculture. It is well watered by Verdigris river, Bird creek, and their tributaries. There are several small lakes found, the largest of which, Big Lake, is a sheet of water three quarters of a mile long by one half a mile wide. It lies in sections 13, 14, 23 and 24. The river and creek bottoms are covered with a heavy growth of oak, hickory, ash, elm, hackberry, pecan, cottonwood, walnut and sycamore timber. The village of Catoosa in the southwestern part of the township, is incorporated under Cherokee Laws. It has about fifty families and contains two churches and eight small stores. Catoosa is the trading center for the settlers scattered throughout the township. - J.C. Wilkinson, U.S. Surveyor.

20N16E This township is made up of every variety of land. The eastern portion is prairie, while the western half consists of river bottom and rocky, broken uplands. The Verdigris river bottom, ranging in width from 1 to 3 miles, is covered with a heavy growth of oak, ash, elm, sycamore, mulberry, pecan, hackberry and cottonwood, the land, though subject to overflow, is rich and well adapted to agricultural purposes. The uplands covered with a scrubby growth of oak and hickory are unfit for cultivation, the soil in these sections is sandy and stony averaging 4th rate. The township is well watered by the Verdigris river, Dog creek and a number of smaller water courses. The river, ranging from 4 to 8 chains wide, enters the township in section 19 taking an irregular course through the western sections, leaves in section 32. But few roads of any consequence transverse the township. A large portion of the land is taken up by farms, this is especially true of those sections lying near the Verdigris river bottoms, where most of the population is centered. Agriculture and stock raising are the principle industries carried out by the inhabitants of this township. - J.C. Wilkinson, U.S. Surveyor. W.H. Thorn, U.S. Surveyor.

20N17E This township with little exception is better adapted as used for range. A few cultivated fields can be found. The land is mostly high rolling prairie, soil sandy. The timber is located in the south central portion and of very poor quality. This township is transversed in western part by the Kansas and Arkansas Valley railroad. The inhabitants are whites and Indians. - September, 2" 1896. H.S. Hackbusch, U.S. Surveyor.

20N18E The township is composed almost entirely of gently rolling prairie; the only timber being a narrow strip along Choteau creek consisting of oak, ash, elm, pecan, sycamore, birch and hickory. Choteau creek averaging 100 lks wide flows from the northwest to the southeast portion of the township and furnishes its stock water. The M, K and T RR runs through the eastern part of the township from north to south. Choteau, a town of about 300 inhabitants is located on the M,K and T RR in the northwest corner of section 25. There are about 150 Inhabitants in township exclusive of Choteau engaged in farming and stock raising. - T.H.R. Johnson, U.S. Surveyor. C.W. Goodlove, U.S. Surveyor.

20N19E This township is generally rough and rugged being made up of hills, gulches, ridges, level and rough land. The bottom land, along the Grand river, affords good farming inducements except that it is nearly all subject to overflows. The land throughout the remainder of the township is rocky and hard to cultivate. There is some very good timber in the bottoms, the walnut, oak and ash is well fit for lumber. The timber throughout the rest of the township is only good for fencing and fuel. There are several good farms or ranches in the township which are well stocked with horses, cattle and hogs. In fact the entire township, except the river bottom, is best adapted to stock raising. Grand river, Choteau creek and several other smaller creeks and branches affords the township with plenty of water for all practical purposes through all seasons of the year. There are no railroads nor towns in the township. The population will possibly reach 200 in number. All of whom are apparently in good financial circumstances. - F.E. Joy, U.S. Surveyor. J.W. Riley, U.S. Surveyor.

21N12E The township is made up of rolling mountainous timbered land in the southern portion and gently rolling prairie in the northern. Oak and hickory are the principle timbers found in the uplands, while oak, ash, elm, walnut, pecan, sycamore and hackberry grown in the creek bottoms. The soil ranges from 1st to 4th rates, and considerable land is under cultivation. Hominy, Delaware and Bird creeks form the principle water supply. The settlers about forty in number are engaged in agricultural pursuits and stock raising. - F.M. Johnson, U.S. Surveyor. Chas Ellot Cabell, U.S. Surveyor.

21N13E The middle and eastern portions of the township are made up of prairie, with but few streams of water. Each section, however is more or less under cultivation, being adapted to corn and wheat. The western and southwestern portions lie along Bird and Delaware creeks and other small streams along which there is considerable flat lands covered for the most parts with timber and underbrush. The timber comprises oak, hickory, elm, cottonwood and walnut. Houses were noted in each section with possibly one or two exceptions. - C.E. Cabell, U.S. Surveyor. F.M. Johnson, U.S. Surveyor.

21N14E Township is principally made up of rolling prairie, largely under cultivation. The soil is alkali, and owning to the fact there are but few creeks and drains the earth is hard. With proper irrigation the township is capable of producing profitable crops. Corn and wheat are the chief products. There are numerous fine springs and wells in middle and southeast portions of the township. Limestone is the principle rock to be found with sandstone in the middle sections. Oak, hickory, and elm timber is found in the first and third mile in the southeastern part of the township. Ely Post Office is in section 11. The township is well settled houses being observed in sections 1, 2, 3, 4, 8, 9, 10, 11, 12, 14, 15, 20, 21, 22, 24, 25, 26, 28, 30, 31, 33, 34 and 35.

21N15E The eastern and northwestern parts of this township are prairie. The soil is classed as 2nd and 3rd rate. The Verdigris river, which is a stream about 5 chs. Wide, enters in section 3 and flows in a general southwest course through the township and leaves in section 32. On the eastern side of the river the land is level river bottom densely timbered with cottonwood, sycamore, oak, elm, ash, pecan, walnut, and hickory. The soil is classed as 1st rate. On the west side of the river the land is broken some of the hills and ridges are 250 ft above high water mark. The soil is classed as 3rd and 4th rate. The timber is oak, elm and hickory. The St. Louis and San Francisco railroad crosses the southeast part of the township. On account of unhealthy climate the inhabitants are few and little farming is done. - F.M. Johnson, U.S. Surveyor. Fred Watts, U.S. Surveyor.

21N16E This township is equally divided into timber and prairie land. The east and southeastern portions being heavily timbered with oak, elm and hickory. While the north and northwestern portions are rolling prairie. The land is well watered by Dog and Panther creeks and their tributaries. Dog creek flows through the center of the township and its tributaries drain all of the surrounding country. Panther creek flows through and drains the southeastern part of the township. The land is generally suited for agriculture and the township is sprinkled thickly with farms in a good state of cultivation. The farmers have a good market and shipping point in Claremore. Claremore is situated in sections 8, 9 and 16 at the junction of the St. Louis and San Francisco and the Kansas and Arkansas Valley railroads. It is chartered under the laws of the Cherokee Nation and boasts a population of more than fifteen hundred souls. On account of its railroad facilities it is quite a business center and shipping point. - Fred Watts, U.S. Surveyor. F.M. Johnson, U.S. Surveyor.

21N17E This township consists of almost entirely rolling prairie the soil of which is sandy loam and well adapted to agriculture and grazing. In the northwestern portion there are some well defined hills and ridges but none of them attain any considerable elevation over the surrounding country. The drainage is good, numerous creeks and smaller streams furnish an abundant water supply except in extremely dry seasons. There is very little timber in the township, the little there is, owing to its inferior size and quality, being suitable only for fuel. The improvements are numerous and substantial. The settlers include whites, Indians and Freedman. - H.S. Hackbusch, U.S. Surveyor. F.E. Joy, U.S. Surveyor.

21N18E The eastern portion of this township is mainly level prairie land, the soil of this portion is a sandy loam on 1" rate. The remaining portion is high rolling prairie, broken by numerous timbered ridges and the soil ranges from 2" to 4" rate. In the northwest corner is a ridge timbered only by the different varieties of oak. In the creek bottoms, all over the township elm, ash and hickory timber is found. Pryor creek, flowing through the eastern portion, and its many tributaries, water the township very well. The inhabitants are largely white and cultivation of the soil is their only industry. The Missouri, Kansas and Texas railway transverses the southeast corner bearing northeast and southwest. The western part of the town of Pryor Creek is located in section 12. - T.H.R. Johnson, U.S. Surveyor. C.W. Goodlove, U.S. Surveyor.

21N19E The township is quite thickly settled by lawful citizens and non-citizen renters, attention being devoted chiefly to stock raising and corn, wheat and sugar cane. Almost any portion of township affords excellent pasture. The land is rolling upland the soil is a sandy loam of second class. Pryor creek transverses the southwest portion and is never dry. Water being found in pools in all seasons of the year. The drainage is good being towards the creek. Rock is very scarce, the only portion in which it may be found being the southwest and southern part and only in blanket form there. Timber of very poor quality may be found along the creek and branches. The town of Pryor Creek is located in sections 7, 8 and 18 and extends over sections 13 in T21NR18E. The estimated population is 600. The M,K and T railway passes through the center of this village and affords fine market resources. The town also has a weekly paper and schools and churches are numerous. - H.S. Hackbucsh, U.S. Surveyor. F.E. Joy, U.S. Surveyor.

21N20E This township contains every variety of land, from mountainous to river bottom. The eastern part is very rocky and broken. Timber, oak and hickory. Soil, 4th rate. The ridges are covered with small, loose flint rocks. The gulches and ravines are from 50 to 100 feet deep. Grand river enters the township in section 4, flowing south, and leaves the township in section 34. The timber and brush along the river bottom is very dense. Timber comprises oak, ash, elm, hickory, pecan, hackberry, locust and cottonwood. Soil, 1st rate. The eastern part is rolling prairie. Soil from 1st to 2nd rate. The Cherokee Orphan Asylum is situated in the northeast corner of section 22 and contains about 150 inmates. Wolf and Saline are the two largest creeks. Abandoned salt wells in section 26. Population about 300. Post Office of Cherokee Orphan Asylum is Saline. Average width of river bottom about (one) mile. - J.W. Riley, U.S. Surveyor. C.W. Goodlove, U.S. Surveyor.

22N12E This fractional township is nearly all level, with black sandy and alluvial soils, with the exception of the several marshes, is exceptionally well adapted to agricultural purposes. Bird creek, a sluggish stream of about 1 chain in width, flows across the township from northwest to southeast. A belt of timber of about 1/2 a mile wide, extends along this stream; the principle varieties being oak, hickory, ash, elm, pecan, hackberry, cottonwood and sycamore. The Skiatook Mission, or Friends School, with an attendance of about one hundred and thirty scholars, is situated in the northwest 1/4 of section 1. Skiatook Post Office and Wm. Roger's store are situated in the southeast 1/4 of section 11. - J.C. Wilkinson, U.S. Surveyor. W.H. Thorn, U.S. Surveyor.

22N13E This township contains rolling land. The soil is sandy loam and classes as 2nd and 3rd rate. Timber is scarce in this township there being only a few trees only the ridges of the small drains and creeks. This township is almost entirely prairie with several rocky ridges, which class as 4th rate. Along some of the ravines in the eastern half of this township surface indications of coal were noted. Houses were noted in sections 12, 15, 18, 19, 22, 26, 28, and 33. - J.C. Wilkinson, U.S. Surveyor. W.H. Thorn, U.S. Surveyor.

22N14E The eastern half of this township is of creek bottom land and is valuable only for its timber. The west and southwest portions are of rolling prairie where to soil is gravelly and of 3rd rate. The river and creek bottoms were found to be well timbered besides growing a dense underbrush. The timber comprises red oak, bur oak, elm, cottonwood and sycamore. Houses were observed and noted in sections 2, 3, 7, 10, 12, 13, 17, 18, 19, 21, 22, 25, 27, 28. One coal bank was found on line, which is about evenly divided between sections 20 and 21. - W.H. Thorn, U.S. Surveyor. J.C. Wilkinson, U.S. Surveyor.

22N15E This township contains chiefly rolling land; along the Verdigris river and Caney creek, however is level. The soil in bottoms along the Verdigris river and Caney creek is good and classes as 1st rate, being capable of producing abundant crops. The soil of the remaining portion of the township is stoney and of comparatively no agricultural value, but well suited for grazing. Cottonwood, sycamore, elm, ash and other kinds of timber are found along the Verdigris river and Caney creek. Oak and hickory predominate in the higher parts. Gold is said to have been found in sections 27 and 28. The township is well watered by the Verdigris river and Caney creek. There are a few settlers and a fair amount of the land is being cultivated. The Kansas and Arkansas Valley railroad runs through the eastern part, which gives fairly good railroad connections with any point in the township. - August, 17 1896. W.H. Thorn, U.S. Surveyor. J.C. Wilkinson, U.S. Surveyor.

22N16E This township is rolling prairie land, except along Dog creek and the central part, which are covered with a heavy growth of timber. The numerous drains, branches and streams provide an abundant source of water supply. Dog creek is the largest creek in the township, flows through the southwest part draining that portion of the township to the southwest. The Verdigris river makes a bend on the western boundary of the township flowing through sections 7 and 18; drainage from the north and west. A good system of roads makes all parts easily accessible. The township is well settled and most of the more valuable land is under cultivation, the principle crops being corn and wheat. The township is transversed by two railroads the St. Louis and San Francisco in the southeast bearing northeast and southwest and the Kansas and Arkansas Valley in the southwest bearing northwest and southeast. There is a coal pit in section 20. Land level and rolling. Soil sandy 1st, 2nd and 3rd rate. Timber: oak, elm, ash, walnut, pecan, hickory, sycamore, cottonwood and hackberry. - F.M. Johnson, U.S. Surveyor. Fred Watts, U.S. Surveyor.

22N17E This township is almost entirely in timber, the land rolling and in many places broken and covered with rocks. Some of the land would be suitable for farming, but improvements are scarce. The timber is of inferior quality and would be fit only for fuel. The creeks and smaller streams furnish sufficient water except in the very dry seasons. The St. Louis and San Francisco railroad courses the northwest corner of the township. - H.S. Hackbusch, U.S. Surveyor. F.E. Joy, U.S. Surveyor.

22N18E This township is largely composed of gently rolling prairie, with soil ranging from 1" to 3" rate. There is a strip of timber along the entire north boundary, ranging in width from 1/2 mi. to 2 miles. The various oaks, and hickory are the only varieties found in this strip. The soil here is covered with loose sandstone making it worthless or 4" rate. The township is very poorly watered, as the creeks and branches afford no water at all, except in the rainy seasons of the year. The main industry of the settlement is farming. - T.H.R. Johnson, U.S. Surveyor. C.W. Goodlove, U.S. Surveyor.

22N19E The surface of this township is rolling prairie uplands, with the exception of the western portion which is mostly creek bottom land. The soil is a sandy loam and will class as 1st and 2nd grade. The only timber is found along the creek and is chiefly oak, elm, walnut and hickory, with dense underbrush and green briar, the quality is such that it is used for fencing and fuel only. Rock is very sparse. What little there is, being of a very poor quality of limestone. The chief occupation of the settlers is farming and stock raising. The Missouri, Kansas and Texas railroad transverses the entire width of the township through the western, entering in section 32 on the south boundary and leaving through section 4 on the north. - H.S. Hackbusch, U.S. Surveyor. F.E. Joy, U.S. Surveyor.

22N20E This township contains several varieties of land. In the southeast portion of the township and also west of Island river, are rough, flint stone ridges; the western half and the extreme northeast part of the township are composed of gently rolling prairie; while adjacent to Island river, rather narrow bottom land are found. The soil of the bottoms and most of the prairie land is 1st rate and makes excellent farming land. That of the ridges is classed as 4th rate. Heavy timbers is found in the bottoms, the more abundant kinds being oak, elm, hickory, maple, walnut, ash, hackberry and sycamore. The trees found on the ridges chiefly oak, hickory and black locust are scrubby and of little commercial value. Grand river, a stream with average width of 8.00 chs, flows through the township from section 4 to section 33 with first a southeast then a southwest course. Into this empty Rock creek, Spavinaw creek and many minor tributaries; by which the greater part of the township is well watered. Wolf creek, having a southeast course, drains the southwest quarter of the township. The inhabitants, numbering about 200, are engaged in farming and stock raising, both of which pursuits are encouraged by favorable natural conditions. - T.H.R. Johnson, U.S. Surveyor. J.W. Riley, U.S. Surveyor.

23N12E The southern part of this fractional township is broken and timbered with oak and hickory. The soil is classed as 4th rate. The northern part is prairie. The surface rolling and broken, the soil 2nd, 3rd and 4th rate. The township is well watered and has few inhabitants. - F.M. Johnson, U.S. Surveyor.

23N13E This township is all rolling prairie, the soil is generally sandy and classes as 2nd and 3rd rate. It is not of much agricultural value, but is well suited for grazing, and is fairly well watered by numerous small creeks. There are however, but few inhabitants, and but little land under cultivation. - F.M. Johnson, U.S. Surveyor. Fred Watts, U.S. Surveyor.

23N14E This township is composed of rolling prairie and level creek bottom land the soil on upland is sand, 3rd rate, while that of the creek bottom is a rich loam, 1st and 2nd rate. The drainage of the township is towards the south. Caney creek and Rabbs creek being the principle means they together with the numerous branches form a good system of drainage and water supply. Caney creek enters the township in section 5 flows south and leaves in section 34. This is the largest creek in the township, is from 1-2 chs. wide, and has a wide and fertile bottom. Rabbs creek enters the township in section 1 flows a little to the southwest and empties into Caney creek in section 34. The township is all prairie except the creek bottoms where is found the usual timber - as oak, elm, ash, walnut, pecan, hickory, sycamore, hackberry and cottonwood. A good system of roads running in all directions makes all parts of the township easily accessible. The township is well populated and most of the more valuable land is under cultivation - the balance is used for hay fields and pastures. There are two coal pits in the township one in section 25 and the other between sections 25 and 26. - F.M. Johnson, U.S. Surveyor. Fred Watts, U.S. Surveyor.

23N15E The township is principally of rolling prairie land. The Verdigris river crosses the southeast corner flowing in a southwest direction. The soil in the river bottom is very fertile and is about all under cultivation. The upland soil is divided into two classes, limestone in the east and sandstone in the west, both furnishing a second rate soil, well adapted to agricultural purposes, and which is under cultivation in many places. The Kansas and Arkansas Valley transverses the central part of the township bearing north and south. Oolagah a small village of about 250 inhabitants is situated in section 28 on the railroad. Four-Mile creek flows through the central part of the township in a southwest direction, and with its tributaries forms an abundant water supply. The township is provided with a good system of public roads, making all parts easily accessible. There are numerous indications of coal in the northwest corner of the township and one large bank in section 18. Land level and rolling. Soil 1st and 2nd rate. Timber: oak, elm, ash, walnut, pecan, hickory, sycamore, cottonwood and willow; underbrush the same with briars and vines. Sandstone and limestone. - F.M. Johnson, U.S. Surveyor. Fred Watts, U.S. Surveyor.

23N16E This township is made up of rolling prairie and flat river bottom the former occupying the eastern portion, while the western sections are principally low river bottom. The Verdigris river bottom ranging from 1 to 3 miles in width is covered with a heavy growth of pecan, elm, sycamore, ash, cottonwood, hackberry, walnut, and maple, together with a dense growth of underbrush. The soil in the river bottom is 1st rate and consequently well adapted to raising of crops. The Verdigris river enters the township in section 3 and flowing an irregular southwesterly course leaves in section 30. The streams from 4 to 6 chs. wide and 1 to 3 ft deep, forms the principle water supply for the township. There are a number of well traveled roads transversing the township. The inhabitants are well scattered throughout the township, some being engaged in farming while others are occupied in stock raising. - F.M. Johnson, U.S. Surveyor. Fred Watts, U.S. Surveyor.

23N17E The southern portion, parts of western and northern portions of this township are thickly covered with timber comprising mainly oak, hickory and occasionally pecan and walnut. The St. Louis and San Francisco railroad transverses the township from the northeast to southwest corner. The agriculture is mainly corn and wheat. It is also a good grazing district. In section 4 coal of a fair quality is mined for local trade. In section 5 is an abandoned oil well it having been replaced by one in the township north. The township is well transversed by roads, is well settled and has an abundant water supply. The surface is rolling and in some places broken and rocky. The rock changes from limestone to sandstone about one mile south of the north border. Bushyhead station is located in section 21 and Foyil station is located in section 32. - H.S. Hackbusch, U.S. Surveyor. F.E. Joy, U.S. Surveyor.

23N18E The township is nearly all rolling prairie. The soil is 1st and 2nd rate. Pryor creek flows in a southeast course across the township and Little Pryor creek empties into it in section 18, coming from the northeast part of the township. Gap creek flows in a general south course through the extreme east part. These creeks and several smaller creeks have narrow, fertile, timbered bottoms. The soil is 1st rate. The timber is oak, elm, hickory, ash, sycamore and hackberry. These creeks afford an abundant water supply. Farming and cattle raising are the occupations of the inhabitants, of which there are about one hundred and twenty five. - T.H.R. Johnson, U.S. Surveyor. C. W. Woodhouse, U.S. Surveyor.

23N19E With the exception of the extreme northwest and southeast corners where the is scattering oak, elm and hickory timber, this township is made up of gently rolling prairie land with a second rate soil draining towards the east to Rock creek and thence to the Grand river. Almost all of the land is in use either as pasture or under cultivation, the principle crops being wheat, corn and cane. The township is provided with a good system of public roads, making all parts easily accessible. The two principle creeks are Rock creek in the eastern part and Bitter creek in the northwest these two with the branches provide an abundant water supply. A small coal mine is located in section 8 and is owned and worked by one man. The Missouri, Kansas and Texas railroad transverses the township with a general bearing of N16E and S16W entering in section 2 and leaving in section 33. A village named Adair is located in the corner of sections 27, 28, 33 and 34 on the M,K and T railroad. The village has a population of about 350; is not incorporated with an area of one-square mile. The township as a whole is well settled. Land rolling. Soil 2nd rate. Timber: oak, ash, elm, and hickory. Sandstone and limestone. Patton Station, located on the M,K and T RR is situated in section 14. - F.E. Joy, U.S. Surveyor. H.S. Hackbusch, U.S. Surveyor.

23N20E The township is nearly all rolling prairie the soil 2nd rate. The Grand river enters in section 25 and flows southeast and leaves in section 33. There is a narrow fertile timbered bottom along the river. The soil is 1st rate. The timber is oak, elm, ash, hickory and walnut. Grand river, Rock creek and several small creeks and branches afford an abundant supply of water. Township is thickly populated and well improved. - H.S. Hackbusch, U.S. Surveyor. John Phelan, U.S. Surveyor.

23N21E The land in this township is rough and rigid, level and gently rolling. Grand river enters through section 12 and courses northwest for 2 miles distance, southeast for 4 miles distance, and northwest and west for about 5 miles distance leaving through section 30. All the land south of the river except a very small portion that lies in the extreme southwest corner of the township and known as Lynch Prairie, is rough and broken, hilly and ridged , covered with a dense growth of timber. The land on the south side of the river is so rough that it is of little value except for grazing purposes. The timber is a fairly good quality, and is used for fuel and rough building, such as rail fences, grain cribs and stock sheds. The land on the north side of the river is nearly all low, flat bottoms, heavily timbered and covered with dense underbrush, green briars and vines. Back from the river a short distance the land is about 1/2 under cultivation. The soil is sandy loam and runs from 1st to 3rd rate. There are probably 100 houses on the north side of the river and about 50 houses on the south side of the river. The population of the entire township is about 650, nearly all white people. Whose occupation is farming and stock raising. There are three islands in Grand river and within this township. They are all low flat and heavily timbered, subject to inundation nearly every spring and fall. These islands are located; one in section 10 and 15, one in section 23 and one in sections 19 and 20. The soil on these islands is strictly 1st rate, but none of them are cultivated on account of overflow. - H.S. Hackbucsh, U.S. Surveyor. R.P. Howell, U.S. Surveyor.

23N22E This township lying in the breaks of Grand, or Neosho river, is composed of nearly ever kind of land, from a level bottom to mountainous. The extreme southeast and southwest corner also the central northern portion is a gently rolling plateau. The northwest corner is a level bottom. The remainder rather mountainous. The soil runs all four classes - the bottom is a black loam, or 1"rate, that on the plateau is 1" and 2", and the mountainous land is 3" and 4" rate. Grand river averaging 9.50 chs in width crosses the northwest corner - entering through section 4 and leaving in section 7. There is quite a wide bottom on either side of the river in section 5, 6, 7, and 8, which is largely cultivated. Duck creek, 150 lks. wide enters the township and empties into Grand river in section 4. Numerous other creeks, not worth noting, flow through the township. The timber of the township is composed of elm, ash, hickory, pecan, walnut, locust, hackberry, cottonwood, sycamore and the different varieties of oak. Bolin's, one of the largest ferries on Grand river, crosses in section 7. This ferry is the main crossing for all parties traveling between points in the Northern Territory and Arkansas. The population of the entire township is about 150 - comprised largely of whites and negroes. The main occupation of these people is farming. - December, 24 1896. J.W. Riley, U.S. Surveyor. T.H.R. Johnson, U.S. Surveyor.

24N12E This fractional township borders on the east boundary of Oklahoma and is about half prairie and half timbered land. The surface is hilly and broken. The soil is 3rd and 4th rate. The timber is oak, elm, hickory, and a little sycamore and cottonwood. Little farming is done by the few inhabitants. This township is poorly watered. - W.H. Thorn, U.S. Surveyor.

24N13E This township is nearly all prairie the eastern third is level prairie bottom. The soil is sandy 1st and 2nd rate. The western 2/3 is rolling prairie. The soil is sandy, 2nd and 3rd rate. Caney river crosses the northeast part of the township. Double creek flows in a southeast direction across the township. These streams with several creeks and branches afford an abundant supply of water. Ringo Post Office and several stores and dwelling houses are in the southwest 1/4 of section 1. About half of this township is fenced for farming and grazing purposes. - J.C. Wilkinson, U.S. Surveyor. W.H. Thorn, U.S. Surveyor.

24N14E This township contains some very good farming land along the Caney creek bottoms, but is principally a high sandy, rolling prairie, which is much better as grazing than as farming land. The soil will average a good 3rd rate. The timber is all along Caney creek and comprises oak, ash, elm, hickory, pecan, walnut, hackberry, maple, sycamore and cottonwood. The township is fairly well settled and is transversed by roads. It is well watered by Caney creek and its tributaries. - J. Wilkinson, U.S. Surveyor. W. H. Thorn, U.S. Surveyor.

24N15E This township is high, rolling prairie and the soil ranges from dark, sandy loam to sandy and rocky 2" and 3" rate. Scattering elm, ash, the different varieties of oak, and hackberry timber is found along the creeks. Slight croppings of coal, are also found throughout the township. The Kansas and Arkansas Valley railroad runs through the township from north to south. The village of Talala, situated on the railroad, is in the southwest 1/4 of section 27. It consists of 2 stores, 1 hotel, a railroad station and about 10 dwellings. The township is fairly well watered by numerous creeks and branches. September, 3 1896. W.H. Thron, U.S. Surveyor. J.C. Wilkinison, U.S. Surveyor.

24N16E The township contains rolling and level land. The soil along Verdigris river and Talala creek is good and classes as 1st rate being well suited for agricultural purposes. That of the remaining portion is stoney and of little value agriculturally, but well suited for grazing. Ash, elm, walnut and cottonwood and other timbers are found along Verdigris river and Talala creek. Oak and hickory predominate on the higher ground. The township is well watered by Verdigirs river and Talala creek and their tributaries. There are a few settlers and a fair proportion of the land is under cultivation. August, 26 1896. J.C. Wilkinson, U.S. Surveyor. W.H. Thorn, U.S. Surveyor.

24N17E The surface of this township is rolling, broken and heavily timbered from the southwest to the northeast corners. In the eastern, western and extreme northern portions considerable land is under cultivation; the farms are well improved and the settlers seem prosperous. Corn is the chief agriculture product. Cattle raising is a flourishing industry. The timber is of varieties common to this section, but owing to its inferior quality had no commercial value. David, a village of about one hundred and fifty inhabitants is situated in sections 26 and 36. The line between sections 24 and 25, crosses the west boundary of the town of Chelsea about twenty five residences of that town in these sections. The St. Louis and San Francisco railroad transverses the southwest corner of the township. Oil has been discovered in the southwest portion of the township and coal is mined in section 5. - F.E. Joy, U.S. Surveyor. H.S. Hackbusch, U.S. Surveyor.

24N18E The township is composed of numerous ridges in the northeast, central and extreme southeast portions, timbered with different varieties of oak, - gently rolling prairie in the western, middle-eastern, and high rolling prairie in the southern portions. The soil of these ridges and also the high rolling prairie is generally 2" and 3" rate, while that of the gently rolling prairie, and creek bottoms is 1" rate. The township is well watered by Pryor creek which flows, which flows through the western portion from north to south, its tributaries and numerous small branches. The St. Louis and San Francisco railroad transverses the township from northeast to southwest. The main occupation of the settlement is farming. - T.H. R. Johnson, U.S. Surveyor. C.W. Goodlove, U.S. Surveyor.

24N19E This township is about evenly divided between prairie land and timber land - the eastern portion being a gently rolling prairie, with the soil ranging 1" and 2" rate; while the western portion is a high rolling timber land - soil 3" and 4" rate. There are, however, some prairie glades in this part that may be classed as 1" and 2" rate. There are no creeks of any consequence, but the township is very well watered, for stock purposes by numerous large ponds. The eastern portion is thickly settled with white population, who indulge in farming to a great extent, with some stock raising. The different varieties of oak timber predominate, there being no other timber worth notice. The geological formation of this township is largely sandstone, especially in the rolling western portion. The St. Louis and San Francisco railway crosses the northwest corner from northeast to southwest and the Missouri, Kansas and Texas the southeast corner from northeast to southwest. - John Phalen, U.S. Surveyor. H.S. Hackbusch, U.S. Surveyor.

24N20E Nearly three fourths of this township is first rate farming land. The western part is gently rolling prairie, limestone soil 1st rate. Along Big Cabin creek the land is composed of low broken flintstone ridges and covered with oak, hickory, elm and pecan timber. These ridges slope off gradually to the east into gently rolling timbered and prairie land. The township is well watered and drained by Big Cabin creek and its tributaries, White Oak, Little Cabin and Locust creeks together with numerous branches and drains. Big Cabin creek is from 1 to 2 chs wide and has a narrow heavily timbered bottom, on either side, this bottom land is bordered on either side by flint and lime stone ridges which slope gradually to the east or west. The M.K. and T. R. R. traverses the northwest portion of the township bearing northeast and southwest entering and leaving through sections 4 and 19. The principle occupation of the inhabitants is stock raising and farming. - J.W. Riley, U.S. Surveyor. T.H.R. Johnson, U.S. Surveyor.

24N21E This township is rolling with the exception of a ridge about 100 feet high ranging through the northern portion about 4 miles from the south boundary and is generally covered with oak and hickory timber. The main body of the township is prairie and nearly all under cultivation in wheat and corn. Oak, hickory, elm, ash and walnut timber is to be found in the southeastern, southwestern, western, and northwestern portions in great abundance and of very fine quality. The township is well watered by Mustang and Locust creeks the former flowing out of the township in the southwest corner the latter in the northwest corner, draining the whole township with the exception of the northeast and southeast corners. The inhabitants are chiefly inter-married whites. The cattle industry is extensively carried on in this township. In the center of section 31 there is a zinc prospect shaft 40ft deep and it is being developed. In section 13 there has been located a U.S. Geol. Survey triangulation station. There are good roads all throughout the township, but no stores or churches, there is a school house in section 7. - H.C. McClure, U.S. Surveyor.

24N22E This township is composed of a gently rolling prairie in the north and northwest - high timbered ridges in the southeast; and a gently rolling timber land in the southwest portions. The soil may be rated from 1" to stoney 4" rates. The 1" and 2" rate is found only in the bottom lands, and on the prairies- the 3" and 4" rate is found on the ridges, henceforth mentioned, as being in the southeast portion. The timber of the township consists of elm, ash, pecan, hickory, walnut, hackberry, cedar, sycamore, cottonwood, undergrowth and the various oaks. Grand river averaging about 9 chs in width enters the township in section 12 and in a general southwest course, leaves the township in section 33. This river, with its many tributaries furnishes abundance of water for all purposes. The population is largely whites who carry on farming on a medium scale. - T.H.R. Johnson, U.S. Surveyor. J.W. Riley, U.S. Surveyor.

24N23E This township is very rough and broken in the southern, southwest and southeast portions. The soil is very rocky and practically worthless. The ridges range from 60 to 125 ft above river level, and are covered with good quality oak, hickory and some pine timber. In rainy seasons this portion of the township is well watered by springs. The drainage of which is towards the river. Honey creek enters in section 12, flows in a western course, and empties into Grand river in section 22. Good farms can be found along creek and river in some places. The soil north of river is of 2nd rate and will raise good crops. This bend is known as "sick bend", the water is poor, and as a general rule health is not good in that portion. Afton a town on the St. Louis and San Francisco railroad, 15 miles north is the trading point. Population of township about 350. Timber along river is oak, elm, hackberry, walnut, hickory, ash and maple. - February, 18 1897. H.S. Hackbusch, U.S.Surveyor. R.R. Howell, U.S. Surveyor.

25N12E This township borders on the eastern boundary of Oklahoma. The southern part is level and mostly rolling prairie. The soil 1st and 2nd rate. Caney Creek runs across the northeastern corner of the township. It has a narrow fertile bottom, which is timbered with oak, elm, cottonwood and sycamore. The soil is 1st rate. The remainder of the township is broken timberland. The soil is 3rd and 4th rate. The timber oak, elm and hickory. The creeks and branches afford an abundant supply of water. About 1/3 of the township is fences for farming or pasture. - F.M. Johnson, U.S. Surveyor.

25N13E The soil in the bottom along Caney Creek and its tributaries is a rich black loam, and most of it is under cultivation. In the northeast and southwest portion the soil is rocky and cannot be rated higher than 3rd rate. The timber comprises oak, elm, hickory, walnut, pecan, sycamore and cottonwood. The township is fairly well inhabited and is well transversed by roads. - F.M. Johnson, U.S. Surveyor. F.W. Watts, U.S. Surveyor.

25N14E The township is mostly open rolling prairie. Well watered and drained by three large creeks - viz - curl, Four-mile and Hogshooter together with numerous branches and the tributaries thereof. The soil in the bottoms is of a rich loam and is generally under cultivation. The principle products being corn and wheat. The prairie uplands is chiefly used for grazing purposes. - F.M. Johnson, U.S. Surveyor. F. Watts, U.S. Surveyor.

25N15E This township is made up of rolling prairie most of which is cut up by farms and pasture. The only timber found is along the creeks and larger drains. The soil ranges from 1st to 3rd rate and is well adapted to agricultural purposes. The township is well watered by a number of creek and small branches, which are found running throughout almost all of its parts. The Kansas and Arkansas Valley road entering the township in section 36 passes through the town of Watooa located in section 25 and leaves in section 13. The township is quite thickly populated by a class of people who are engaged in farming and stock raising. - F.M. Johnson, U.S. Surveyor. Fred Watts, U.S. Surveyor.

25N16E This township, T25N,R16E, is crossed in a generally southern direction by the Verdigris River. Its bottom lands are heavily timbered with oak, elm, hickory, cottonwood, sycamore and walnut. The soil is a rich black loam, 1st rate, and is largely under cultivation. Lightening, Salt and Fool Creeks empty into the Verdigris from the east and Double Creek from the west. The soil of their creek bottoms is rich like that of the river and covered with a heavy growth of timber. On the prairies the land is of limestone and sandstone formation and is suitable only for pasture. There are however, a number of fields under cultivation. The Kansas and Arkansas Valley railroad crosses at the northwest corner of the township. The post office of Al-lu-we is situated in the eastern part of section 25. - F.M. Johnson, U.S. Surveyor. Fred Watts, U.S. Surveyor.

25N17E The township contains chiefly rolling prairie and level bottoms. In the northwestern portion, however, hilly timbered land of poorer quality is found. The soil along Lightening and Salt creeks and their tributaries is good, classing as 1st rate, and a considerable portion of the bottomland is under cultivation. The prairies are more suitable for grazing purposes, the soil being of a lower grade. The principle varieties of timber to be found in the township are: several kind of oak, ash, walnut, hickory, elm, cottonwood, sycamore and pecan, and these mostly along the streams, the upland is almost entirely prairie. Coal seems to underlie the entire township, and is near the surface in many places. Sandstone and limestone abound, and would undoubtedly afford excellent building material. The township is well watered by Lightening Creek, Salt Creek, and their numerous tributaries. It is thickly settled chiefly by whites, who are engaged principally in farming and to some extent in stock-raising.

25N18E Township is largely rolling prairie land, with a few timbered hills. But in the southern portion and in the creek bottoms, oak, elm, and hickory timber is found. The soil of this township with the exception of the narrow flats along the creeks, is almost entirely worthless ranging 3" and 4" rate. About the only industry is cattle raising, while a few negroes cultivate a portion of the soil to a small extent. The township is very well watered by California Creek and numerous large branches and their tributaries. - F. Watts, U.S. Surveyor. F.M. Johnson, U.S. Surveyor.

25N19E This township is nearly all rolling prairie except timbered ridges in the southwestern and broken land in the north-central parts and a narrow timbered bottom along the Paw Paw and Pecan Creeks. The soil in the prairie is classed as 2nd and 3rd rate, in the timber as 3rd and 4th rate. The timber on the hills and ridges is oak and hickory. In the creek bottoms oak, elm, hickory, pecan and walnut. The township is well watered by the creeks and branches. The St. Louis and San Francisco railroad enters the township in section 32 and bears in a general northeast direction and leaves in section 13. About have of the township is fenced for pasture or farming. - F.M. Johnson, U.S. Surveyor. Fred Watts, U.S. Surveyor.

25N20E The township contains, principally, two varieties of land - bottomland and upland prairie - the only exception being found in sections 5 and 6, where it is hilly and broken. The soil in the bottoms along Big Cabin Creek and the smaller streams emptying into it is generally black and fertile, and is classed as 1st rate. Excepting those portions which are subject to overflow, the bottom land makes very desirable farms. The uplands, level and rolling and contain different classes of soil, from 2nd to 4th rate; and form by far the greater part of the township. Along the streams are found many kinds of timber, the more prominent varieties being oak, hickory, ash, elm, pecan, sycamore, hackberry and cottonwood. The hills of section 5 and 6 are covered with black-jack and post oak. There are indications of coal in many places along the creek banks. Sandstone formations exist in abundance. The township is well watered by Big Cabin Creek and its tributaries, two of the latter, Little Cabin creek and Paw Paw creek being of considerable size. The town of Vinita [formerly known as Downingsville, with an estimated population of 600, is located in sections 15, 16, 21, and 22 and embraces about one square mile of territory. It possesses 4 churches, 2 hotels, 1 high school and several stores. The Willie Hassels College is situated at about the center of section 15.

25N20E cont. Two railroads transverse this township. The Missouri, Kansas and Texas railroad, bearing about N26E and S26W, follows a direct course from the northwest portion of section 1 to section 33, passing along the east border of Vinita. The San Francisco and St. Louis railroad enters the town crossing the M. K. and T. line at right angles then runs parallel to Illinois avenue and north of same. The San Francisco and St. Louis railroad follows an indirect route across the township from section 24 to section 18. - W.H. Thorn, U.S. Surveyor. J.P. Thayer, U.S. Surveyor.

25N21E This township is all rolling prairie land with the exception of the narrow timbered bottom along Little Cabin creek. The soil is good 2nd and in Little Cabin creek bottom is 1st rate. The timber comprises oak, ash, elm, walnut, and sycamore. Nearly all the land is for farming and grazing. Little Cabin creek enters in section 4 and flows in southwest corner and leavers in section 19. The Atlantic and Pacific division of the St. Louis and San Francisco railroad bears about N30E from section 19 to section 1. The township is fairly well watered by Locust and Little Cabin creeks. Population about 300.

25N22E The township has been rolling prairie: the ground in most places being a sandy loam it is well adapted to farming: along the banks of a few creeks and drains will be found a scattering growth of oak, elm, pecan and walnut timber. The township is well watered by Horse creek which enters the township is section 3 and leaves in section 36. There are a great many springs along the banks of this creek. The population of this township is about 300, the occupation being chiefly farming. Fly creek rises in section 21 and flows east, and empties into Horse creek in section 23. - June, 26 1897. T.H.P. Johnson, U.S. Surveyor. Robert J. Howell, U.S. Surveyor.

25N23E The township is made fractional by the Seneca Nation, the south boundary of which bears west through the north part of sections 25, 26, and 27 to Grand river. The boundary is up the river to east boundary of township to section 34. The land is high rocky timbered, high rolling prairie, and river bottom. The high rolling timbered land is in the northeast and northwest part of the township. The timber being principally black-jack, post oat and some red oak and hickory. The surface in this part is covered with loose flint rock - the soil is worthless for farming. The north, central and southeast parts are high rolling prairie. The soil is 3rd rate. The gently rolling prairie, the high land in the north part of the township and Grand river, is nearly all under cultivation and produces good crops of corn and wheat. The soil is classed as second rate. Grand river enters the township in section 24 flowing in a general southwestern course, leaving the township in section 32. The soil along the river is of 1st and 2nd rate and produces abundant crops: the timber in general throughout the township consists of oaks, ash, cottonwood, sycamore, elm, hickory, walnut, hackberry, dogwood and some scattering vine along the bluff on south bank of river. The township is well watered by Grand river, Hickory creek and many excellent springs. Echo Post Office is located in the southeast corner of section 28 on the main route between Indian Territory and South-West City, Missouri. Near this post office there are houses and a blacksmith shop. The estimated population of the township is 540. - July, 24 1897. J.W. Riley, U.S. Surveyor. J.S. Gibson, U.S. Surveyor.

25N24E This fractional township is divided into two parts. That part cut off by Grand river contains four fractional sections. River enters in section 6 course S60W and leaves in section 19 course southwest. This portion is 3rd rate and timbered with oak and hickory. The second part is between the 6th standard parallel north and south boundary of Seneca Indian Reservation and contains 6 full and 6 fractional sections. This portion of the township is principally prairie fields, but with some oak, hickory and hackberry timber along Wolf creek. Wolf creek enters the township in section 35 flows northwest and leaves in section 31. The population of the entire township consisting of the two fractions, is about 150. - July, 24 1897. T.H.R. Johnson, U.S. Surveyor. R.P. Howell, U.S. Surveyor.

26N12E This fractional township borders on east boundary of Oklahoma the southern part is mountainous. The surface is covered with limestone and sandstone. The timber is small oak and hickory. The soil is classes as 4th rate. The eastern part is gently rolling prairie, the soil is classed as 1st and 2nd rate. The northern part is level creek bottom. The timber is oak, ash, elm, pecan, hickory, cottonwood, and sycamore. The soil is 1st rate. The township is well watered by Caney, Sand and Butler Creeks. Bartlesville is a village of about 300 inhabitants situated in the NE 1/4 of section 12 and the NW 1/4 of section 7 T26NR13E. About 1/3 of township is fenced for farming and grazing purposes. - W.H. Thorn, U.S. Surveyor.

26N13E This township with the exception of the valley of Caney Creek in the western portion, is high rolling prairie. The soil is limestone and will average about 3rd rate. The soil in the creek bottoms is a sandy loam and is rated as 2nd grade. The prairie land is good grazing land and the bottoms makes fair farming land. The timber along Caney Creek and its tributaries comprises - oak, ash, elm, hickory, pecan, walnut, box elder, maple and sycamore. The township is fairly well watered. Is well transversed by roads and is thickly settled. J.B. Bardles' flouring mill of about 50 bbls daily capacity, a store and small hotel comprising Bardlesville are in section 6. - J.C. Wilkinson, U.S. Surveyor; W.H. Thorn, U.S. Surveyor

26N14E Township T26NR14E is distinctly a township for grazing purposes. It is all level and rolling prairie, the sandy 2nd and 3rd rate soil of which, is only suitable for the raising of grasses. Hogshooter Creek, a stream, dry most of the time, runs through the western part of the township. Its banks are covered with oak, elm, ash, pecan, hickory, walnut, and sycamore timber and the soil of its small bottom is a 1st rate black, loam. Limestone of poor quality is found in the northwestern quarter of the township. - J.C. Wilkinson, U.S. Surveyor; W.H. Thorn, U.S. Surveyor.

26N15E The township is well watered being transversed by numerous creeks, and branches. The soil is a sandy loam on 2nd rate; except in the southwest corner where it is covered with loose limestones: making it worthless, on 4th rate. Elm, oak and hickory timber is found on the banks of creeks and drains. - J.C. Wilkinson, W.H. Thorn, U.S. Surveyors.

26N16E The township contains rolling and level land . The soil varies from 1st to 4th rate. Along the Verdigris River the soil is good and classes as 1st rate being well suited for agriculture purposes. The soil of higher portions of the township is generally of a limestone formation well suited for grazing but of little value agriculturally. Oak, elm, ash and scattering walnut timber is found along the Verdigris River. The township is well watered by the Verdigris River and its tributaries. The town site of Nowata is incorporated under the Cherokee and Arkansas Laws is situated in sections 29, 30, 31, and 32 on the Kansas and Arkansas Valley Railroad and contains a population of about 600 people. - J.S. Wilkinson, W.H. Thorn, U.S. Surveyors. October, 17 1896.

26N17E The southeastern part of this township is a low valley well watered and drained by Salt Creek and its tributaries. Lightning Creek comes in on the east, and goes out on the south side of section 36. The soil in this portion of the township offers fine farming facilities and is nearly all under cultivation at the present time. Ruby Post Office is located about centrally located in section 12. This little village is composed of one church, two stores, one blacksmith shop, and four or five dwelling houses and affords a very fair market for farm produce. The estimated population is about fifty. The remainder of the township is rough and rolling made up of short ridges and hills, and the soil is poor, being covered with loose limestone and sandstone. The timber is scattering on the hills and very dense in bottoms, oak, hickory, elm, pecan, walnut and sycamore respectfully are the only varieties of timber found, except a few scattering cedars along the small creek (Indian Creek), which runs into Big Creek. Big Creek courses diagonally through the northwest corner of the township entering at the corner to sections 4 and 5 on the north and leaving in section 19 on the west. The bottom along this creek varies from 1 chain to 40 chains in width is low and marsh and covered with a dense growth of timber and underbrush, and is subject to overflows. All except the low valleys, in the southeastern part of the township, and mentioned in the first part of the description, is best adapted for grazing purposes. Wheat and cattle raising is the leading industry of the people. - F.F. Sweet, U.S. Surveyor; W.H. Thorn, U.S. Surveyor.

26N18E The township is mostly level prairie, quite thickly settled, farming the principle occupation of the inhabitants. The cattle business is also carried out quite extensively. The land is fairly well watered by Lightening Creek in the southern and several small creeks and branches in the central and northern parts. The soil is generally rocky and may be classed as 3rd rate. Lucas Post Office, is located in the northern quarter of section 9. A belt of oak, hickory, elm and sycamore timber is found on Lightening Creek. - J.P. Thayer, U.S. Surveyor; Fred Watts, U.S. Surveyor.

26N19E This township is in a large open prairie it is watered by West of Big Cabin, Pawpaw, and Thompsons Creeks and numerous branches and drains. The drainage in the township is south and east. The township is well settled and a large part of the land is under cultivation the principle crops being corn and wheat. A good system of roads makes all parts easily accessible. The surface is in general rolling - a few small hills are found in the western part. The soil is sandy loam running from 1st to 4th rate. Numerous indications of coal in large quantities are found in the southern part particularly sections 27 and 28. There is one coal bank near the center of section 13. Land rolling. Soil 1st to 4th rate. Timber, oak, elm, walnut and hickory along creeks. Stone - sandstone. - F.M. Johnson, Fred Watts, U.S. Surveyors.

26N20E The township contains level rolling land. The soil along Big Cabin Creek is of a rich, dark loam and well suited for agricultural purposes. That of the remaining portion classes as 2nd rate and is covered with abundant growth of rich and nutritious grasses, and would produce good crops with a little cultivation, but is best suited for stock grazing and raising. Oak, ash, elm and walnut and other kinds of timber are found along Big Cabin Creek. There is a coal bank in section 27, the coal being near the surface and the vein being from about 12 to 18 inches thick. The township is well watered by Big Cabin Creek and its tributaries. The Missouri, Arkansas and Texas railroad runs through sections 25 and 36. Mark's mill for grinding corn is situated in section 17 and has capacity of 30 barrels per day. - February, 8 1897, W.H. Thorn, J.F. Thayer.

26N21E The township is all under fence and largely under cultivation. The land is rolling and the soil is of 1st, 2nd and 3rd rate. Wheat, corn and oats are the principle products. Roads and houses throughout the township are good. The inhabitants of the township are principally whites and quarter breed Indians and the population is about 300. Little Cabin, Jones and Coal Creeks are the larger water courses; flowing in a southwestern direction. Timber on banks of creeks oak, hickory, ash, elm, hickory and sycamore. The M, K and T railroad enters the township in section 5 and leaves in section 30. Vinita the nearest large town is about 9 miles southwest. - J.W. Riley and J.S. Gibson, U.S. Surveyors.

26N22E This township is composed of gently rolling prairie land all under fence; the soil is 2nd rate, and about 1/3 of the entire township is under cultivation; the remainder being enclosed for meadows. Wheat, corn and oats are the principle products. The township is poorly watered Horse Creek in the southwest part and a spring of in the southeast are the only streams of any consequence the are from 75 to 100 lks wide. The St. Louis and San Francisco railroad runs across the southeast part of the township and Afton situated in sections 28, 29, 32, and 33 is the only trading point, it has about 500 inhabitants. The population of the entire township is about 750. - July, 2 1897, J.H.R. Johnson, R.P. Howell, U.S. Surveyors.

26N23E This township consists of rolling prairie land of 2nd, 3rd and 4th rate most of which is under cultivation. The extreme eastern part of the township is very rocky and broken and is covered with a scrubby growth of hickory and oak timber. The Atlantic and Pacific division of the St. Louis and San Francisco railroad enters the township in section 2 and leaves in section 18. Grand River passes through the northeastern part of section 1 and runs in a southeastern direction. Fairland a town on the Frisco railroad is in sections 8 and 9, contain several good stores, 2 churches, 1 school, a hotel and a post office and has a population of about 600. It is an incorporated town under Arkansas statutes but has never been surveyed. To locate the center of town, which is the point of intersection of railroad and main street. I began at center of railroad and intersection of section lines between section 8 and 9 which is 16.04 chains N0° 3'N of the corner of sections 8,9,16, and 17 and run up ....42.67 chain on tangent N59° 46'E at which point two intersection main street bearing N30 14'E and S30 °14' E. The point center of town is 24 N of center of train. The corporations limits extent east, west, north and south of this point 1/2 mile distance. Ogee Chee or Prairie city is a chartered town under Cherokee Laws on the Frisco and has been surveyed, and land office streets and lots, and was the original site for Fairland. The limits of said town extend east, west, north and south from center of railroad and street 1/2 mile distance. The only plate of the town is in possession of the Supreme Court of the Cherokee Nation and is therefore inaccessible. - July, 13 1897, J.S. Gibson, J.W. Riley, U.S. Surveyors.

26N24E This fractional township contains two full sections and 13 fractional sections. Grand River enters is section 6 and flows southeast and leaves the township is section 32 flowing S60°N. The township is very rough, only the river bottom and part of section 7 being in cultivation. River bottom land is 1st rate and upland is 3rd rate. In the north part of section 32 there are very good indications of lead and zinc. The principle product is corn. The timber oak, locust, elm, ash, hickory and pecan. The population of the township is about 50. Occupation farming. - Robert P. Howell, T.H.R. Johnson. U.S. Surveyors.

27N12E This fractional township borders on the East boundary of Oklahoma. The southern part is mostly prairie. A high range of hills runs through the western part of the township. The soil is 4th rate. The timber is oak, elm, and hickory. Caney Creek flows in a generally Southerly course through the Eastern part. The creek bottom is fertile. The timber is oak, elm, cottonwood, pecan, sycamore, walnut, and hickory. Carrey Creek and several branches afford an abundant supply of water. There are few inhabitants chiefly engaged in farming and cattle raising. -F.M. Johnson, U.S. Surveyor.

27N13E This township is almost entirely prairie. The soil is sandy and ranges from 1st to 3rd rate. It is watered by Caney creek and its tributaries- Coon Creek, Smith Caney and Four Mile Creek. The timber along those streams comprises oak, elm, hickory, walnut, pecan, cottonwood, and sycamore. It is fairly well watered and will traversed by roads, the principal one being the Caney and Bartlesville road along which is a telephone line. - F.M. Johnson U.S. Surveyor, F. Watts Jr. U.S. Surveyor.

27N14E The township is mostly open rolling and level prairie land. The soil, except on the high ridges, is a black limestone and is so very shallow over the stone as to render the soil almost useless for cultivation and farming purposes. On the ridges the soil is sandy and of an inferior grade. The timber is nearly all small, oak, hickory, elm, pecan and persimmon, are about the only varieties found. Coon creek courses the S.E. portion of the township and together with its tributaries affords fair drainage to the land. There are only a few inhabitants now in the township and they, for the most part, are engaged in stock raising and grazing. Which gives about the most beneficial results that can be derived from the land.- F.M. Johnson, U.S. Surveyor. F. Watts, U.S. Surveyor.

27N15E This township is largely rolling prairie. The soil is nearly all sandy 3rd rate, with the exception of creek bottoms and foothills, where it is a sandy loam, or second rate. California and Wolfe Creek are the only creeks of any consequence. But several reunion branches traverse the township, making it fairly well watered. The various oaks, elm, ash, hickory, and pecan timber is found in creek bottoms. There is scarcely any or no settlement, it being used mainly for stock raising.- F.M. Johnson, F. Watts, U.S. Surveyor.

27N16E This township is made up of rolling prairie and flat river bottom. The Eastern half is comprised of the bottom lands of the Verdigris river, while the Western portion is prairie. The Verdigris river bottom is covered with a heavy growth of elm, pecan, ash, sycamore, hackberry, walnut, and cottonwood, together with a dense growth of underbrush. The soil although subject to overflow is well adapted to the raising of crops. Much land is cut up, by a great number of fields, this is especially true of the Western portion where the soil is good. The township is well watered by the Verdigris river and its smaller tributaries. The average width of this river is hardly 3 chains, but in many places it reaches a width of 5 to 6 chains.

27N17E This township is nearly all prairie. The land is level, rolling and broken. The soil is 2nd, 3rd, and 4th rate, with good grass for pasture. Loose limestone prevents much farming. Big creek and Coal Creek have narrow bottoms, with fertile soil and dense timber of oak, elm, hickory, ash, walnut, pecan, hackberry, sycamore and cottonwood. Coal is found along Big creek and Coal creek. The township is well watered. Most of the inhabitants are negroes. Their chief occupation is cattle raising.- R.H. Thorn, U.S. Surveyor and F.F. Sweet, U.S. Surveyor.

27N18E This township is nearly all gently rolling prairie land, except in the Southeastern portions, where it is nearly level, and the central portion, which is rough and broken by mounds and ridges ranging from 75 feet to 125 feet high. The soil in the creek bottom may be classed as first rate, while that on the rolling prairies runs from 2nd to 4th rates. In several portions, especially in the central, it is covered with loose limestone, which makes it useless for anything but hay and stock range. Elm, Oak, Walnut and Sycamore timber is found along the creeks and branches. The Northwestern portion, as well as the Northern, are very well watered by Big and Clear creeks, and their tributaries, the former traverses the Northwest edge, and the latter flows along the Northern boundary. The remainder is watered by numerous branches. Most of the settlement in this township is negro, whose main occupation is farming, and stock raising.- J.P. Thayer, F. Watts, U.S. Surveyors.

27N19E This township is situated in a large open prairie. The surface is gently rolling although fairly level in the northern portion. The soil averages about third rate. It is a sandstone formation in the southeast and of limestone in the rest of the township. Middle Durbin and West Cabin creek are the principal streams; the former in the East and the latter in the West and South. The southern part of the township is well cultivated, while very little cultivation is done in the northern portion. The township is thinly populated, is fairly well traversed by roads, the principal one being the Vinita and Coffeeville Road. Bituminous coal is found in larger quantities in sections 15, 16, 21, and 22, and quite a number of strip mines are being worked.- F.M. Johnson, U.S. Surveyor, F. Watts Jr., U.S. Surveyor.

27N20E The southwestern portion of this township is rocky, rolling and broken timber land, the remainder level and gently rolling prairie. There is also a strip of timber along Big Cabin Creek. The principal varieties of timber are oak, ash, elm, hickory, pecan, hackberry, sycamore, and maple. The soil of the township is 2nd, 3rd, and 4th rate. Big Cabin Creek, Whiskey and McDonald Branches are the principal streams. There are a number of well fenced and well improved farms in the township, and several fine pastures. Farming and cattle raising are the chief industries of the settlers, who are mostly whites. Coal is found in the northwestern portion of the township and along Big Cabin Creek. There is a church in the S.W. 1/4 of section 22. J.P. Thayer and W.H. Thorn, U.S. Surveyors.

27N21E This township contains level and rolling land. The soil is 2nd and 3rd rate excepting along Little Cabin Creek where it is rich sandy loam. The prairies are covered with an abundant growth of rich grass and are well adapted to cattle raising. The MK and T Railroad enters the township in section 32 and leaves in section 5. Blue Junction is the most important trading point it is a town on the Railroad and is located in sections 20, 21, 28 and 29. In places along Little Cabin Creek there is timber, such as oak, ash, elm, and hackberry. March 10th, 1897. F.W. Watts and F.M. Johnson, U.S. Surveyors.

27N22E This township is nearly all rolling prairie land and the soil is 2nd and 3rd rate. Most of the land is fenced in for farming and grazing purposes. The township is fairly well watered streams and small creeks and branches. The population is about 325 most of whom are white renters and quarter breed Indians. Coal is found in section 2 and 18 on Coal creek and is dug for local use. J.W. Riley, J.S. Gibson, U.S. Surveyors. July 5th, 1897.

27N23E This township is divided into gently rolling prairie land in the South and West part and rolling and level timbered land in the East. The soil in the prairie is 2nd rate, and that along the river and in the timbered part being 1st and 2nd rate. Neosho and Grand river forms the eastern boundary of this township and where the bluff or ridges do not make into the river the soil is 1st rate, this part, when not in cultivation are heavily timbered with oaks, elm, hickory, sycamore, ash, maple and willow. The ridges have post oak, red oak, blackjack and hickory. There are around 150 inhabitants in the township engaged in farming and stock raising- their principal products are corn, wheat, and oats. Hudson creek is the only important stream in the township is about 100 links wide and furnishes an abundant supply of stock water. Its flow serves that northern part of the township in a NE direction. The Cherokee, Ottawa, and Wyandotte Nation. July 12th, 1897. T.H.R. Johnson, R.P. Stowell, W.H. Thorn, U.S. Surveyors.

27N24E This fractional township consists principally of river bottom lands, covered with a dense growth of briars and vines. Grand river enters the township in section 30 passing through sections 19, 20, and 29 and leaves in section 31. The bend in the river is known as Audrain bend. The population of the township is about 50, most of whom are engaged in farming. The water is obtained from wells, and some springs along the river banks. The St. Louis and San Francisco RR enters the township in section 31 running north 60 degrees E leaving the township by crossing a four span river bridge over Grand river in section 29. Spring river empties into Neosho river just above this bridge and from this point the river is known as Grand River. Land is of 1st and 2nd rate: Timber Oak, Elm, Hickory, Sycamore and Cottonwood. July 12th, 1897. Robert J Howell, U.S. Surveyor.

28N12E This township is level bottom land, all under cultivation. The northern part is all hilly and rolling prairie, very rocky, suitable for grazing. Oak, Hickory, Elm, Cottonwood, and other kinds of timer is found along Caney Creek in the Southern part. Inhabitants: Whites and Indians, about equally divided in numbers. November 19th, 1896. W.H. Thorn, U.S. Surveyor.

28N13E This township contains chiefly level and rolling land. The soil along Caney, Cotton, and Brush Creek is good and classes as first rate, being well suited for agricultural purposes. The remaining portion is generally stoney and best suited for grazing. Oak, Elm, Ash, Walnut and other kinds of timber are found along the creek. The township is well watered by Caney, Cotton, and Brush Creeks and their tributaries. The township is not thickly settled but there is considerable land under cultivation. Nov. 16th, 1896. J.G. Wilkinson, F.F. Sweet, U.S. Surveyors.

28N14E This township contains two varieties of land: Level and gently rolling; rough, mountainous mounds and hills. The soil may nearly all be classified 2nd rate, except in sections 7-10, and 19, which is very rough ridges and mounds covered with loose stone and scrub oak timber. The soil here is 4th rate and fit only for grazing purposes. The township is well watered and traversed by Coon and Cotton creeks together with the many branches and streams forming the tributaries thereof. Except in the afore-mentioned sections, the land throughout the entire township is mostly under cultivation. The chief products being wheat and corn. Coon post office is located on the old Coffeyville and Bartlesville stage line in section 22. Most all varieties of timber will be found along the creeks and branches. J.C. Wilkinson and W.H. Thorn, U.S. Surveyors.

28N15E This township is mainly rolling prairie- The soil is very fertile along the narrow bottoms of California and Hickory creeks. The soil of the whole township could be class and sandy 2nd and 3rd rates. The North-western portion is very well timbered with Hickory and the various Oaks; also, scattering Elm and Hackberry timber is found in the creek bottoms and on some drains. The township is fairly well watered by California Creek in the SW, and Hickory Creek in the NE corner. The township is largely settled with white population, who have cultivated a greater portion of the land. J.C. Wilkinson, W.H. Thorn, U.S. Surveyors.

28N16E This township contains three varieties of land: broken, level, and rolling. The Eastern part of the township is rough and broken, the surface covered with loose limestone, and 4th rate soil of such rocky nature, that it is only fit for raising grazers for pasturage. The Verdigris River runs in a general southerly direction through the central part of the township. The large river bottoms are of a good 1st rate sandy loam and are covered with a heavy growth of Oak, Hickory, Elm, Walnut, Pecan, Box Alder, Maple, and Sycamore timber. The Western part of the township is gently rolling and the soil a 2nd rate sandy loam, is well suited to cultivation. The township is well watered by the Verdigris River in the central part, Hickory creek in the west, and Cedar creek in the southeastern part. The settlers are principally colored, and few whites being found around Cedar Creek. W.H. Thorn, J.C. Wilkinson, U.S. Surveyors.

28N17E Except in the extreme southeastern portion of this township the land is high, rolling prairie. The S.E. portion is low level land. The soil is black limestone, and of a very good quality. The entire township is drained and water by Cedar creek and its tributaries. Along this creek are numerous deep and rocky canyons from 10 to 60 feet deep. Oak, Elm, Hickory, Sycamore, and Cedar timber with thorn underbrush may be found along the creeks and branches. The land in these canyon bottoms is covered to such an extent with stone as to render it useless for other than grazing purposes. There are few inhabitants. F.F. Sweet, W.H. Thorn, U.S. Surveyors.

28N18E This township is nearly all prairie and the general character of the country rolling. The creek bottoms of which there are several, are very fertile and large areas are in cultivation. Big and Brush Creek flow in a southerly direction through the Western portion of the township. These streams, with the East Fork of Big Creek and Clear Creek, furnish the water supply of the township. The banks of most of the streams are skirted with timber, the common varieties being oak, elm, ash, hickory, walnut and hackberry. There are evidences of coal in the township, outcroppings occur but no mines have been developed. Coal is dug, however, for home consumption. The inhabitants are white and freedmen, and the improvements throughout the township give evidence that they are thrifty and prosperous. Hudson Post Office is situated in the NW 1/4 of section 26. There is a store and blacksmith shop in section 29. Fred Watts and J.P. Thayer, U.S. Surveyors.

28N19E This township is nearly all rolling prairie. The soil is of limestone loam class as 1st, 2nd, and 3rd rate. In the northwestern part some oak, elm, hickory, and hackberry timber is found. The township is fairly well watered by several creeks and branches. Coal is found in nearly all parts of the township especially in 35. F.M. Johnson, Fred Watts, U.S. Surveyors.

28N20E This township is nearly all prairie, the only timbered land being in the west and northwestern portions and along Big Cabin Creek. The soil averages 2nd and 3rd rate, and there are large areas in cultivation throughout the township. The timber is oak, hickory, ash, elm, cottonwood, sycamore, walnut, and pecan, but most of it is small and would be of little commercial value. Big Cabin Creek flows in a southeasterly direction across the township, this stream with numerous tributaries furnishes an abundant water supply. Most of the country west of Big Cabin Creek is underlaid with coal from twelve to eighteen inches thick. Coal is also found in other portions of the township, and has been mixed to some extent. The settlers are mostly whites, and have well improved farms and are apparently in a prosperous condition. Kimmiron Post Office is situated in the SW 1/4 of section 7, and Prairie Center, a small village, is in the NW 1/4 of section 27. W.H. Thorn and J.P. Thayer, U.S. Surveyors.

28N21E This township contains 3 varieties of land- Level, Rolling, and Broken. Nearly all the land can be classed as 2nd and 3rd rate except the NE part which is very Broken and stony and covered with a dense growth of scrubby oak. The SE portion of the township along cow creek contains fertile lands and also in sections 1 and 2. The township is well watered by "East Cabin Creek" in SW and "Cow" Creek in SE portions. Scattering timber (oak elm and ash) is found along "Cow" creek. Welch Station is located in S.E. portions of section 30, and the MK and T RR. It is a village with a population of about 50, has 20 dwelling homes, 3 stores, 1 church, 1 Slate and one Black smith shop. It is a good shipping point. The MK and T RR enters the township in section 32 and leaves in section 6. White settlements in several portions of the township. W.H. Thorn, J.P. Thayer, U.S. Surveyors.

28N22E This township has two varieties of land: Rolling, and level bottom. In the SW portion of the township can be found high rolling prairie, and the soils there is usually 4th rate. The remaining portions of the township, that lying in the vicinity of Neosho River and Stoneshoe Lake is alluvial, rich sandy loam of 1st rate quality. The timber is oaks, hickory, elm, pecan, ash, walnut, maple, sycamore, and cottonwood. Cow creek rises in the extreme western tier of sections, flows east through sections 19,20 , 29, 28; emptying into Grand river in section 27. Mud creek river in section 6 flows SE through sections 7, 8, 17; and emptying into Grand river in section 16. The prairie lands throughout the township are covered with a rich growth of grass, and the bottoms have a dense growth of underbrush making the entire township valuable for grazing. The township is made fractional by Grand or Neosho River, which river is the boundary here but the Cherokees, Pawnees, and Ottawas. The inhabitants are principally whites- with no schools or churches. Stoneshoe lake lies in sections 6, 7, and 8. The lake is about 3/4 of a mile long and about 7 chains wide, the banks are an average of 5 feet high. March 6th, 1897. W.H. Thorn and J.E. Blackburn, U.S. Surveyors.

28N23E This township is made fractional by Grand river, its Eastern boundary. The soil is about 1st first rate through the entire township and covered with a dense growth of briars and undergrowth, and heavy timber. The timber consists of oak, elm, ash, pecan, maple, sycamore and cottonwood. W.H. Thorn, U.S. Surveyors.

29N12E This township contains level rolling and hilly land. The level land in the East and South is nearly all under cultivation. In the North and Northwest the land is rolling and hilly prairie, of a rocky formation, suited for grazing but of little value agriculturally. The township is settled almost entirely by whites. - November 23, W.H. Thorn, U.S. Surveyor

29N13E This fractional township is nearly all level and gently rolling prairie; the soil of which being a black-sandy loam, well adapted to agriculture, which is evidenced by the areas of land in cultivation. There are also a number of large pastures in the township. The only timbered land is along the water courses, the varieties of timber being oak, elm, walnut, sycamore, and hickory. Little Carrey Creek and the North and South Forks of Cotton Creek are the principal streams. - W.H. Thorn, F.F. Sweed, U.S. Surveyors

29N14E This township contains chiefly level and rolling land. In the North-Central part the land is high rolling prairie suited for grazing but of little value agriculturally. The remaining land is principally level; soil 1st and 2nd rate and suited for agricultural purposes. The township is well watered by Opossum and Cotton creeks. The township is settled chiefly and most of the suitable land is under cultivation. December 10th, 1896- W.H. Thorn, U.S. Surveyor.

29N15E The timber in the Eastern portion of the township is Elm, scrub-Oak and Sycamore, along creeks and branches. In the Western portion is Oak, Hickory, Walnut, and heavy Oak undergrowth. The land is rolling, somewhat broken, and well drained by O'Possum creek and its tributaries. Along this creek is some low flat land, the soil here may be rated 1" rate, the remainder varies from 2" to 4" rates. Both lime and sandstone may be found throughout the entire township. - F.F. Sweed, U.S. Surveyor.

29N16E This fractional township borders on the South boundary of Kansas; nearly all the land is rolling prairie. The soil is classed and 2nd and 3rd rate. The Verdigris River flows in a general southerly course through the west part of the township; the bottoms on either side of this river are level and fertile. The soil is classed as 1st and 2nd rate. The timber is oak, elm, hickory, ash, pecan, hackberry, cottonwood, and sycamore. The supply of water is abundant. Farming and cattle ranching are the chief occupations of the inhabitants.

29N17E This fractional township contains no other variety of land but level and gently rolling prairie. This is covered with an abundant growth of grass, making stock-raising both easy and profitable. The soil belongs mainly to the 2nd and 4th classes, and produces fine crops, without irrigation. Much of the land is under cultivation. Timber is scarce and is to be seen only on the borders of streams in the S.E. and extreme W portions of the fractional township. Elm, Oak, and Ash predominate. Limestone of a poor quality is found on nearly all of the drains; also scattered around in many places on the prairies. The fractional township is rather poorly watered by two small branches and Brush creek, the latter touching only sections 24, 25, and 26. The settlers are chiefly white, engaged in farming and stock-raising. -W.H. Thorn, U.S. Surveyor.

29N18E The eastern part of this fractional township is rolling and broken, being cut by deep ravines whose general course is S.W. In the west, there is a ridge, which bears N.E. and S.W. Thence we find a gradual sloping toward the western boundary of the fractional township. The soil, except in the extreme S.E., is very good and to a great extent is under cultivation. The most fertile portion is the valley just east of the ridge mentioned above. Timber is not very abundant and is found only on the borders of the streams, especially in the Southern half of the fractional township. The principal varieties are Oak, Elm, Hickory, Sycamore, Ash, Hackberry, Cottonwood. This land is fairly well watered by "Big" Creek, Brush Creek, Boggs branch, and their tributaries. The majority of inhabitants are whites, and of a thrifty disposition. Farming is the chief occupation. - Fred Watts, J.P. Thayer, U.S. Surveyors.

29N19E This fractional township, excepting a very small portion in the S.E., is prairie, mostly gently rolling. The soil is productive, and makes excellent farms. In fact, the greater part of the township is under cultivation. Along Cabin creek, in the S.E. part of the township, is to be found some timber. The principal varieties are Oak, Hickory, and Elm. Big Cabin creek, takes its rise in this township, and flows in a southerly direction. A few other smaller and less important streams help water this township. Evidences of coal are noticeable, especially in sec. 25, but it is little worked. -F.M. Johnson, Fred Watts, U.S. Surveyors.

29N20E This fractional township is rolling prairie, excepting fractional strips on either side of Russel creek, where is the only timber in the township. The soil is fairly good and well adapted to agricultural purposes. A large portion of the township, especially the northern half, is under cultivation. The timber along Russel creek is principally Oak, Elm, Ash, and Sycamore, and is of little value commercially. The township is well watered by Russel creek, Elm creek, and their tributaries. The Missouri, Kansas, and Texas R.R., bearing N. and S., crosses the eastern part of the township. Russel creek Switch is situated in township 36. The inhabitants of this portion of the country are of the agricultural class, engaged in farming and stock-raising. -F.M. Johnson, Fred Watts, U.S. Surveyors.

29N21E Fractional township 29N, R21E, is made fractional to the N by Kansas, to the E by Grand-Neosho River, which stream is at this point, the W Boundary of the Peoria Nation. It has 7 full sections and 10 fractional. The land is very good and most of it well adapted for agricultural purposes. Russell Creek is the most important stream, and empties into the Grand-Neosho River in section 21. The timber is oak, hickory, elm, hackberry and cottonwood. -March 5th, 1897. F.M. Johnson, Fred Watts, Surveyors.

Appendix 2. Date, Cartographers, and Deputy Surveyors of Public Land Survey Plats for Cherokee Prairie 1896-1897

Township	Date Surveyed	Cartographer	Deputy U.S. Surveyors
15N16E	March 1896	C. Stoll	F.M Johnson and C.E. Cabell
15N17E	March 1896	G.F.C. Merriss	R.L. McAlpine and J.W. Riley
15N18E	March 1896	R.C. Kirtland	T.H.R. Johnson and C.H. Hickman
15N19E	April 1896	C.H. Dana	W.T. Turner and R.L. McAlpine
16N16E	March 1896	C. Stoll	W.H. Thorn and Frank Lewis
16N17E	March 1896	R.C. Kirtland	R.L. McAlpine and W.T. Turner
16N18E	April 1896	R.C. Kirtland	T.H.R. Johnson and C.H. Hickman
16N19E	May 1896	R.C. Kirtland	R.L. McAlpine and W.T. Turner
16N20E	May 1896	A.F Hassan	T.H.R. Johnson and C.H. Hickman
17N13E	April 1896	C. Stoll	F.M. Johnson and C.E. Cabell
17N14E	May 1896	F.E. Matthes	F.M. Johnson and C.E. Cabell
17N15E	May 1896	F.E. Matthes	F.M. Johnson and C.E. Cabell
17N16E	May 1896	S.A. Detwiler	F.M. Johnson and C.E. Cabell
17N17E	August 1896	A.R. Stevens	J.W. Riley and H.S. Hackbusch
17N18E	June 1896	A.F Hassan	J.W. Riley and W.T. Turner
17N19E	June 1896	A.F Hassan	J.W. Riley and W.T. Turner
18N12E	April 1896	Wms. Welch	Frank Lewis and Geo. W. Hooper
18N13E	April 1896	C. Stoll	J.C. Wilkinson and W.H. Thorn
18N14E	April 1896	R.C. Kirtland	J.C. Wilkinson and W.H. Thorn
18N15E	May 1896	J.F Pfau	J.C. Wilkinson and W.H. Thorn
18N16E	May 1896	S.A. Detwiler	J.C. Wilkinson and W.H. Thorn
18N17E	August 1896	A.R. Stevens	T.H.R. Johnson and C.W. Goodlove
18N18E	August 1896	A.F. Hassan	T.H.R. Johnson and C.W. Goodlove

18N19E	June 1896	A.F. Hassan	J.W. Riley and W.T. Turner
19N12E	May 1896	C. Stoll	Frank Lewis and Geo. W. Hooper
19N13E	June 1896	C. Stoll	F.M. Johnson and C.E. Cabell
19N14E	June 1896	R.C. Kirtland	F.M. Johnson and C.E. Cabell
19N15E	May 1896	J.F Pfau	F.M. Johnson and C.E. Cabell
19N16E	May 1896	S.A. Detwiler	J.C. Wilkinson and W.H. Thorn
19N17E	August 1896	A.F. Hassan	H.S. Hackbusch and F.E. Joy
19N18E	August 1896	A.F. Hassan	C.W. Goodlove and T.H.R. Johnson
19N19E	July 1896	G.F.C. Merriss	F.E. Joy and J.W. Riley
20N12E	May 1896	C. Stoll	F. Lewis
20N13E	July 1896	C.H. Dana	J.C. Wilkinson and W.H. Thorn
20N14E	July 1896	R.C. Kirtland	J.C. Wilkinson and W.H. Thorn
20N15E	June 1896	J.F Pfau	J.C. Wilkinson
20N16E	May 1896	S.A. Detwiler	J.C. Wilkinson and W.H. Thorn
20N17E	Sept 1896	n/a	F.E. Joy and H.S. Hackbusch
20N18E	Sept 1896	M. Kirkpatrick	T.H.R. Johnson and C.W. Goodlove
20N19E	July 1896	G.F.C. Merriss	J.W. Riley and F.E. Joy
20N20E	July 1896	G.F.C. Merriss	G.W. Goodlove and T.H.R. Johnson
20N12E	July 1896	C. Stoll	C.E. Cabell and F.M. Johnson
21N13E	June 1896	Pearson Chapman	C.E. Cabell and F.M Johnson
21N14E	July 1896	A.F. Hassan	C.E. Cabell and F.M. Johnson
21N15E	July 1896	C.H. Dana	Fred Watts and F.M. Johnson
21N16E	July 1896	Cudlipp. Del.	Fred Watts and F.M. Johnson
21N17E	September 1896	G.F.C. Merriss	H.S. Hackbusch and F.E. Joy
21N18E	September 1896	R.C. Kirtland	T.H.R. Johnson and C.W. Goodlove
21N19E	October 1896	S.A. Detwiler	H.S. Hackbusch and F.E. Joy
21N20E	October 1896	A.F. Hassan	J.W. Riley and C.W. Goodlove

22N12E	July 1896	C. Stoll	J.C. Wilkinson and W.H. Thorn
22N13E	July 1896	Pearson Chapman	J.C. Wilkinson and W.H. Thorn
22N14E	August 1896	A.F. Hassan	J.C. Wilkinson and W.H. Thorn
22N15E	August 1896	C.H. Dana	J.C. Wilkinson and W.H. Thorn
22N16E	August 1896	S.A. Detwiler	F.M. Johnson and Fred Watts
22N17E	September 1896	G.F.C. Merriss	H.S. Hackbusch and F.E. Joy
22N18E	September 1896	R.C. Kirtland	T.H.R. Johnson and C.W. Goodlove
22N19E	October 1896	A.R. Stevens	H.S. Hackbusch and F.E. Joy
22N20E	October 1896	J.F Pfau	T.H.R. Johnson and J.W. Riley
23N12E	September 1896	C. Stoll	F. M. Johnson
23N13E	September 1896	Pearson Chapman	F.M. Johnson and Fred Watts
23N14E	September 1896	A.F. Hassan	F.M. Johnson and Fred Watts
23N15E	August 1896	C. H. Dana	F.M. Johnson and Fred Watts
23N16E	August 1896	S.A. Detwiler	F.M. Johnson and Fred Watts
23N17E	September 1896	G.F.C. Merriss	H.S. Hackbusch and F.E. Joy
23N18E	September 1896	R.C. Kirtland	T.H.R Johnson and C.W. Goodlove
23N19E	October 1896	R.C. Kirtland	H.S. Hackbusch and F.E. Joy
23N20E	October 1896	R.C. Kirtland	H.S. Hackbusch and R.P. Howell
23N21E	January 1897	n/a	H.S. Hackbusch and R.P. Howell
23N22E	December 1896	n/a	J.W. Riley and T.H.R. Johnson
24N12E	September 1896	C. Stoll	W.H. Thorn
24N13E	September 1896	Pearson Chapman	J.C. Wilkinson and W.H. Thorn
24N14E	September 1896	A.F. Hassan	J.C. Wilkinson and W.H. Thorn
24N15E	September 1896	C. H. Dana	J.C. Wilkinson and W.H. Thorn
24N16E	August 1896	S.A. Detwiler	J.C. Wilkinson and W.H. Thorn

24N17E	September 1896	G.F.C. Merriss	H.S. Hackbusch and F.E. Joy
24N18E	September 1896	R.C. Kirtland	T.H.R. Johnson and C.W. Goodlove
24N19E	November 1896	G.F.C. Merriss	H.S. Hackbusch and J. Phelan
24N20E	November 1896	A.R. Stevens	J.W. Riley and T.H.R. Johnson
24N21E	January 1897	n/a	H.S. Hackbusch and H.C. McCluer
24N22E	January 1897	n/a	T.H.R. Johnson and J.W. Riley
24N23E	February 1897	n/a	H.S. Hackbusch and R.P. Howell
25N12E	October 1896	Wms. Welch	F.M. Johnson
25N13E	September 1896	A.F. Hassan	F.M. Johnson and Fred Watts
25N14E	October 1896	R.C. Kirtland	F.M. Johnson and Fred Watts
25N15E	October 1896	J.F Pfau	F.M. Johnson and Fred Watts
25N16E	October 1896	J.F Pfau	F.M. Johnson and Fred Watts
25N17E	January 1897	A.F. Hassan	W.H. Thorn and J.P. Thayer
25N18E	January 1897	R.C. Kirtland	F.M. Johnson and Fred Watts
25N19E	January 1897	S.A. Detwiler	F.M. Johnson and Fred Watts
25N20E	January 1897	A.F. Hassan	W.H. Thorn and J.P. Thayer
25N21E	June 1897	n/a	J.W. Riley and J.S. Gibson
25N22E	June 1897	n/a	R.P. Howell and T.H.R. Johnson
25N23E	July 1897	n/a	J.W. Riley and J.S. Gibson
25N24E	July 1897	n/a	T.H.R. Johnson and R.P. Howell
26N12E	September 1896	C. Stoll	W.H. Thorn
26N13E	September 1896	C.J. Brock	J.C. Wilkinson and W.H. Thorn
26N14E	October 1896	R.C. Kirtland	J.C. Wilkinson and W.H. Thorn
26N15E	October 1896	J.F Pfau	J.C. Wilkinson and W.H. Thorn
26N16E	October 1896	R.C. Kirtland	J.C. Wilkinson and W.H. Thorn
26N17E	January 1897	A.F. Hassan	T.T. Sweet and W.H. Thorn
26N18E	January 1897	R.C. Kirtland	J.P. Thayer and Fred Watts

26N19E	January 1897	S.A. Detwiler	F.M. Johnson and Fred Watts
26N20E	February 1897	G.F.C. Merriss	W.H. Thorn and J.P. Thayer
26N21E	June 1897	n/a	J.W. Riley and J.S. Gibson
26N22E	June 1897	n/a	T.H.R. Johnson and R.P. Howell
26N23E	July 1897	n/a	J.S. Gibon and J.W. Riley
26N24E	July 1897	n/a	R.P. Howell and T.H.R. Johnson
27N12E	November 1896	C.Stoll	F.M. Johnson
27N13E	November 1896	C.J. Brock	F.M. Johnson and Fred Watts
27N14E	November 1896	R.C. Kirtland	F.M. Johnson and Fred Watts
27N15E	November 1896	J.F Pfau	F.M. Johnson and Fred Watts
27N16E	October 1896	R.C. Kirtland	F.M. Johnson and Fred Watts
27N17E	December 1896	A.F. Hassan	W.H. Thorn and F.F. Sweet
27N18E	December 1896	R.C. Kirtland	J.P. Thayer and Fred Watts
27N19E	February 1897	S.A. Detwiler	F.M. Johnson and Fred Watts
27N20E	February 1897	G.F.C. Merriss	J.P.Thayer and W.H. Thorn
27N21E	March 1897	n/a	Fred Watts and F.M. Johnson
27N22E	July 1897	n/a	J.W. Riley and J.S. Gibson
27N23E	July 1897	n/a	F.M. Johnson, R.P Howell and W.H. Thorn
27N24E	July 1897	n/a	R.P. Howell and T.H.R. Johnson
28N12E	November 1896	C. Stoll	W.H. Thorn
28N13E	November 1896	A.F. Hassan	J.C. Wilkinson and F.F. Sweet
28N14E	November 1896	R.C. Kirtland	J.C. Wilkinson and W.H. Thorn
28N15E	November 1896	J.F Pfau	J.C. Wilkinson and W.H. Thorn
28N16E	October 1896	Pearson Chapman	J.C. Wilkinson and W.H. Thorn
28N17E	December 1896	A.F. Hassan	F.F Sweet and W.H. Thorn
28N18E	December 1896	G.F.C. Merriss	Fred Watts and J.P. Thayer
28N19E	February 1897	S.A. Detwiler	F.M. Johnson and Fred Watts

28N20E	February 1897	G.F.C. Merriss	W.H. Thorn and J.P. Thayer
28N21E	February 1897	n/a	W.H. Thorn and J.P. Thayer
28N22E	March 1897	n/a	W.H. Thorn and J.E. Blackburn
28N23E	February 1897	n/a	W.H. Thorn
29N12E	November 1896	C.Stoll	W.H. Thorn
29N13E	November 1896	F.E. Matthes	W.H. Thorn and F.F. Sweet
29N14E	December 1896	C. Stoll	W.H. Thorn
29N15E	December 1896	C. Stoll	F.F. Sweet
29N16E	December 1896	C. Stoll	Fred Watts
29N17E	December 1896	A.F. Hassan	W.H. Thorn
29N18E	December 1896	R.C. Kirtland	Fred Watts and J.P. Thayer
29N19E	February 1897	S.A. Detwiler	F.M. Johnson and Fred Watts
29N20E	February 1897	G.F.C. Merriss	F.M. Johnson and Fred Watts
29N21E	March 1897	n/a	F.M. Johnson and Fred Watts