Vegetation Management Plan for Arbuckle District, Chickasaw National Recreation Area, Murray County, Oklahoma

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INTRODUCTION

The following is a report to the U.S. Department of interior, National Park Service, regarding research intended to aid Natural resource managers at the Chickasaw National Recreation Area.   for Natural resource management has long relied on the application of sound scientific research to achieve management objectives. This report provides a set of recommendations for vegetation management in the Arbuckle District of the Chickasaw National Recreation Area (CNRA). These recommendations will be based upon the use of General Land Office Plats and surveyor notes. A brief review of pertinent literature was completed to provide background for land managers at CNRA.   However, the restoration and maintenance of grassland communities has been studied by range managers and scientists in the rapidly growing field of restoration ecology. The amount of data currently available on this subject is voluminous and recommendations for grassland restoration change regularly. In order to aid CRNA in making decisions regarding restoration and management activities in UGSA, this report will provide a review of the scientific literature regarding native prairie restoration in conjunction with data gathered by Hoagland et al. (1998).

The recommendations provided in this report were developed in the context of disturbance ecology, a body of ecological theory which maintains that disturbance is integral to the persistence of ecosystems and species diversity (Picket and White 1985). Furthermore, this theory states that natural communities never achieve a steady-state or climax stage, but are constantly responding to the affects of the most recent disturbance.   Reice (1994) summarizes these ideas thus: “biological communities are always recovering from the last disturbance. Disturbance and heterogeneity, not equilibrium, generate biodiversity."

The most common forms of disturbance in North American grasslands are fire and grazing by large ungulates. Smaller scale disturbances are created by fossorial mammals. It is well documented that the disturbance provided by fire and grazing were disrupted following Euro-American settlement (see Collins and Wallace [1991]). The absence of disturbance in grassland ecosystems results in a decline in species diversity and deterioration of physical structure. The absence of fire facilitates an increased abundance of woody plants and/or accumulations of thatch; undecomposed organic material on the ground surface (Vogl 1974, Rice and Parenti 1978).

One structural component affected in the absence of disturbance is a decline in productivity (e.g, the annual yield of biomass expressed as $g/m^2/yr$), which can be readily reversed by the reintroduction of burning or mowing. In the case of mowing, it is crucial to remove the mown material to avoid thatch build-up (Kelting 1957, Penfound and Kelting 1950, Penfound 1964). Grassland productivity has been shown to decrease by as much as 83% due to reduction of light and soil moisture (Weaver and Roland 1952, Engle et al. 1987, Smith and Stubbendieck 1990). Rice and Parenti (1978) conducted a literature review and field experiments to determine why productivity declined in the absence of fire. They found the key factor to be soil temperature in the early growing season. At sites which were burned and denuded, the soil temperature reached 21°C 5 weeks before sites that were left with standing dead material and thick litter layers. The major prairie grasses have the C_4 photosynthetic pathway (an adaption to hot, dry conditons) that operates optimally at relatively high temperatures, so the earlier soil temperatures are elevated the sooner growth begins. Once the disturbance regime is restored to a site, species diversity and structural complexity increases and woody plant abundance declines.

Landscape level effects of woody plant encroachment in grasslands and savannas are a decrease in regional heterogeneity as a result of canopy closure (Rice and Penfound 1959, Johnson and Risser 1975, Archer 1995). At the local level, it has been demonstrated that an increase in woody plant cover results in decreased species diversity (Gehring and Bragg 1992).

It is the goal of grassland restoration and management to return these forms of disturbance to the natural landscape. Management plans often recommend the reestablishment of one factor but neglect the other. This may be due to cost constraints or availability of trained personnel. But most often management treatments often fail to mirror the “natural” disturbance intervals. Howe (1994) criticized prairie management that relies on dormant-season burning and exclusion of grazing, a management regime which promotes heavy dominance by tall warm-season grasses (i.e., big bluestem, indiangrass and switchgrass). Howe suggested that grazing plus a varied burn schedule should be used to increase biodiversity in managed prairies. A diverse regime of relatively moderate disturbances will reduce dominance by one group of plant species and increase the opportunity for more species to live in a given site.

I. Analysis of park historic vegetation

I.A. Vegetation cover in 1871 and 1897

Plat maps were acquired from the Oklahoma State Department of Libraries, Archive Division for the following townships: T1N, R3E; T1S, R2E; T1S, R3E. Each

Plats was digitized using ArcInfo® (ESRI, Redland, California). The following layers were developed for each plat: settlement, transportation, fencing (1897 only), hydrology, agriculture and vegetation. When digitizing was completed all plats for a given year were joined and edited. The settlement layer consisted of residences, store fronts and other structures. The transportation layer included roads, railroads, and railroad grades. All streams mapped on a plat were digitized into the hydrology layer. The accuracy with which surveyors mapped small-order streams is questionable, particularly in 1871 when small-order streams were mapped in a “brica-braca” pattern. The agriculture layer was composed of cultivated fields and orchards, although the later was infrequently noted. The vegetation layer was composed of grassland and forest/woodland and was the major surface type mapped on all plats. Although designated as grasslands, it should be noted that this category probably includes grazed and ungrazed areas, a distinction not made on the plats or in the Surveyor notes. The title forest/woodland refers to all woody vegetation, because the plats give little indication of tree density.

Human impact appears minimal in the 1871 land cover map (Fig. 2a). Forest/woodland Settlement was restricted to one residence and road development was limited. The majority of the study area is covered by forest grassland vegetation. No agricultural fields were present. Contrasts this with conditions on the 1897 landcover (Fig. 2b). Road development is extensive. I railroad grade crosses the southern boundary of the study area. Ten residences are scattered throughout the study area and several are clustered in the developing town of Sulphur. Agricultural fields have increased markedly. The amount of woody vegetation has decreased, particularly in the north portion of the study area.

I.B. Tree ring data

Tree ring data were collected from two sites; Lower Rock Creek (Table 3) and Veteran's Lake (Table 4). Both sites yielded trees of considerable age.   At Lower Rock Creek, two *Quercus stellata* were aged at 244 and 284 years. No other species had members of this age. One *Q. muehlenbergii* oak was aged at 165 years. This site had a rather dense growth of trees with many individuals of *Juniperus virginiana*. Five J. virginiana trees were cored with an average estimated age of 85 years. The growth form of many of the *Q. stellata* trees, was characterized by large limbs growing at right angles to the trunk, indicating that they had previously grown in open, woodland situation.

Fewer trees were cored at the Veteran's Lake site. Again, *Q. stellata* was the oldest aged tress, ranging from 90-235 years of age. The site was characterized by fewer *J. virginiana* trees than the previous site. Only one *J. virginiana* was cored and its age was estimated at 75 years. The habitat overall was composed of trees growing in "islands" interspersed among grassland vegetation. *Schizachyrium scoparium-Bouteloua curtipendula* was the dominant grassland vegetation type in the this area, with *Muhlenbergia reverchonii* patches along the streams. *Echinocereus reichenbachii* was common in the area.

It is typical among older trees for the centers to rot, thus obscuring the true age of the tree. We found this to be the case with the older oaks in particular. Based on these data, it is clear that several of the trees in the area predate the 1871 land survey, thus further indicating the long-term occurrence of woody vegetation at CNRA.

I.C. Comparison of 1956 and 1997

Aerial photography was not available for 1937. The next available year was in the 1940's, but upon inspection, there was no appreciable different in vegetation patterns and landscape composition between that year and 1956. Therefore our analyses were limited to the years 1956 and 1997.

Land cover/land use information was digitized from 1956 and 1997 aerial photography. All aerial photographs were mosaiced and cover types delineated by hand. Vegetation types were transcribed onto mylar and digitized using ArcInfo® (ESRI, Redland, California). Cover types included water, urban/disturbed, active cropland, old-field, grassland/pasture, redcedar grassland, redcedar dominated, and hardwood dominated. The two redcedar cover types are based upon density of trees; redcedar grasslands are sparsely vegetated with woody plants and redcedar dominated are densely vegetated with interlocking crowns in some cases. Redcedar grasslands can be found on the westside of the Upper Guy Sandy Area (not limited to the area of active redcedar removal). The hardwood dominated class consists of both crosstimbers vegetation and bottomland forest. Since it proved difficult to distinguish these cover classes on the 1956 aerial photography, they were lumped into one class. For the sake of comparison, we included Lake of the Arbuckles on the map.

The increase of redcedar dominated vegetation types is pronounced. Extensive areas of the current Chickasaw National Recreation were covered by redcedar grassland in 1956. This is particularly true of the Platt National Park area and much of upper Rock Creek. Between the years 1956 and 1997 many areas of redcedar grassland transitioned to redcedar dominated vegetation. Areas mapped as grassland/pasture on the eastside of Rock Creek wee completely replaced by this vegetation type. In some cases, the redcedar dominated class infiltrates the hardwood dominated areas. Active cropland is completely replaced by redcedar by oldfield vegetation. This includes johnsongrass dominated bottomlands. The Urban/disturbed cover class increased as well, particularly along the margins of Lake of the Arbuckles.

II. Synopsis of previous vegetation studies

There have been a limited number of vegetation studies conducted at the CNRA. Most were performed in prior to 1955 and address the Arbuckle Mountains as a whole. Two early overviews of Oklahoma vegetation describe vegetation in the Arbuckle Mountain region as a mosaic of forest, woodland and grassland (Bruner 1931, Blair and Hubbell 1938). A later study of upland forests in the state describe the vegetation in the region as oak-hickory forest and woodlands (Rice and Penfound 1959). <u>Quercus stellata</u>, <u>Q</u>. <u>marilandica</u>, and <u>Carya texana</u> are the predominant trees in upland habitats. Secondary species include <u>Q</u>. <u>muhlenbergii</u>, <u>Q</u>. <u>shumardii</u>, and <u>Ulmus alata</u>. Understory species include <u>Cercis canadensis</u>, <u>Prunus mexicana</u>, and <u>Viburnum rufidulum</u> (Bruner 1931, Blair and Hubbell 1938, Rice and Penfound 1939).

There are no published studies of CRNA vegetation, although several studies were conducted in the Platt National Park. A floristic treatment of CNRA by Hoagland and Johnson is in press and a manuscript is a preparation based upon a vegetation study conducted by the same authors. All published accounts of Platt vegetation were prepared by Dale (1959, 1965). Dale (1965) reports upland forest vegetation composed of the species listed above. He emphasizes the importance of U. alata in many stands. Bottomland forests are composed dominated by Ulmus rubra, Celtis laevigata, and Fraxinus pennsylvanica. Associated plant species in these habitats included Arisaema dracontium, Carya cordiformis, C. illinoensis, Chasmanthium latifolium, Cocculus carolinus, Elephantopus caroliniana, Elymus virginicus, Juglans nigra, Quercus macrocarpa, and Q. shumardii.

Shrubland vegetation dominated by Quercus sinuata var. breviloba was also described by Dale (1965). Associated species in these vegetation type include Bouteloua curtipendula, Bouteloua hirsuta, Bouteloua rigidiseta, Engelmannia pinnatifida, Forestiera pubescens, Fraxinus texensis, Quercus buckleyi. Quercus sinuata var. breviloba is a diminutive shrub which grows on calcium-based substrates.

Dale (1959) studied the composition of grasslands at Platt. A minor grassland type reported is dominated by Muhlenbergia reverchonii, with Dodecatheon meadia, Hedyotis nigricans, Hypoxis hirsuta, Lesquerella ovalifolia var. alba, Opuntia macrorhiza as associates. This vegetation type tends to occur at low slope positions on tight clay soils.

The major grassland type described by Dale (1959) was dominated by Schizachyrium scoparium and Bouteloua hirsuta. Associated species include Bouteloua curtipendula, Echinacea atrorubens, Eryngium leavenworthii, Ruellia humilis, Sporobolus asper, and Thelesperma filifolia. As soils become increasing shallow and shallow, rocky Schizachyrium scoparium gives way to Bouteloua curtipendula. Most of the associated species are similar to above, but Bouteloua rigidiseta, Crotonopsis elliptica, Chaetopappus asteroides, Echinocereus caespitosa, Lithospermum tenellum, and Sida procumbens (Dale 1959).

A popular natural history account of Platt, prepared by Barker and Jameson (1975), also considered vegetation. Their descriptions follow the work of Dale (1959, 1965). They reported the predominant forest type at CRNA to be Quercus stellata - Q. marilandica forest and woodlands. Grasslands range from tall and mixed grass prairie types. Areas were shallow soils predominate are occupied by a variety of shortgrass types.

III. Management recommendations

The results of this study clearly demonstrate that forest/woodland vegetation covered more of the CNRA than previously thought (Figure 1). Much of the “grassland” vegetation appears to be the product of land clearing begun late in the nineteenth century (Figure 2).

IV. Vegetation monitoring

No restoration or management effort is complete without monitoring protocols (Masters 1997). We recommendation that CRNA personnel follow the monitoring guidelines established the National Park Service “Western Region Fire Monitoring Handbook.” The goals of monitoring at UGSA are twofold. First, to monitor the efficacy of eastern red cedar removal and re-establishment of a burn regime. Secondly, to evaluate the effectiveness of johnson grass treatments. All monitoring efforts will require personnel trained in plant identification. Since a goal of prairie restoration is to maintain species diversity, a careful accounting of changes in species composition will have to analyzed over time.

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Table 1: Importance values derived from 1871 General Land Office surveyor notes.

Scientific name	Surveyor identification	1N3E	1S2E	1S3E	Average
Acer negundo	Box elder	0.00	1.88	0.00	0.6
Carya illinoinensis	Pecan	2.78	10.15	0.00	4.3
Carya spp.	Hickory	2.43	3.64	10.20	5.4
Celtis spp.	Hackberry	0.00	11.96	1.95	4.6
Cercis canadensis	Red bud	0.00	0.91	0.00	0.3
Diospyros virginiana	Persimmon	2.27	0.00	0.00	0.8
Fraxinus spp.	Ash	0.00	8.74	6.63	5.1
Juglans nigra	Black walnut	0.00	0.00	5.75	1.9
Morus sp.	Mulberry	0.00	0.00	1.08	0.4
Platanus occidentalis	Sycamore	0.00	6.18	2.12	2.8
Populus deltoides	Cottonwood	14.19	40.24	0.00	18.1
Quercus alba	White oak	11.68	10.63	0.00	7.4
Quercus macrocarpa	Bur oak	8.65	0.00	0.00	2.9
Quercus palustris	Pin oak	6.07	2.60	6.36	5.0
Quercus spp.	Oak	0.00	2.95	0.00	1.0
Quercus stellata	Post oak	133.67	136.22	198.76	156.2
Quercus velutina	Black oak	86.97	42.58	43.91	57.8
Robina pseudoacacia	Locust	0.00	0.00	1.13	0.4
Salix spp.	Willow	0.00	6.43	0.00	2.1
Ulmus sp.	White elm	4.79	0.00	0.00	1.6
Ulmus spp.	Elm	26.49	14.90	22.12	21.2

Table 2: Importance values derived from 1897 General Land Office surveyor notes.

Scientific name	Surveyor identification	1N3E	1S2E	1S3E	Average
Carya illinoinensis	Pecan	2.78	13.12	18.76	11.6
Carya spp.	Hickory	2.43	2.54	3.43	2.8
Celtis spp.	Hackberry	0.00	14.92	3.10	6.0
Diospyros virginiana	Persimmon	2.27	1.28	0.84	1.5
Fraxinus spp.	Ash	0.00	12.24	8.14	6.8
Juglans nigra	Black walnut	0.00	0.00	5.46	1.8
Juniperus spp.	Cedar	0.00	1.79	0.00	0.6
Platanus occidentalis	Sycamore	0.00	0.00	5.73	1.9
Populus deltoides	Cottonwood	14.19	3.05	0.00	5.7
Quercus alba	White oak	11.68	0.00	9.89	7.2
Quercus macrocarpa	Bur oak	8.65	1.60	5.52	5.3
Quercus marilandica	Black jack	0.00	13.31	4.06	5.8
Quercus palustris	Pin oak	6.07	4.11	3.02	4.4
Quercus rubra	Red oak	0.00	26.31	41.55	22.6
Quercus stellata	Post oak	133.67	172.98	141.41	149.4
Quercus velutina	Black oak	86.97	8.27	5.39	33.5
Salix spp.	Willow	0.00	1.45	0.00	0.5
Sideroxylon lanuginosum	Shittum	0.00	0.00	1.05	0.3
Ulmus spp.	Elm	26.49	23.02	42.66	30.7
Ulmus sp.	White elm	4.79	0.00	0.00	1.6

Table 3: Estimate age of individual trees sampled at Rock Creek site. (UR = unrecorded)

Species	Tag number	Diameter	Est. age
Juniperus virginiana	1	29	83
J. virginiana	2	30	80
J. virginiana	3	34	85
J. virginiana	4	30.7	69
J. virginiana	5	37.8	85
Quercus buckleyi	6	UR	40
Q. buckleyi	7	33	50
Q. muehlenbergii	8	27.9	50
Q. muehlenbergii	9	40.1	165
Q. stellata	10	40.1	110
Q. stellata	11	49	172
Q. stellata	12	45.5	284
Q. stellata	13	26.7	60
Q. stellata	14	31.2	75

Q. stellata	15	29.2	70
Q. stellata	16	29.2	67
Q. stellata	17	59	60
Q. stellata	18	25.7	50
Q. stellata	19	19.8	50
Q. stellata	20	33	65
Q. stellata	21	47.5	244
Q. stellata	22	31.8	65

Table 4: Estimate age of individual trees sampled at Veteran's Lake site. (UR = unrecorded)

Species	Tag number	Diameter	Est. age
Juniperus virginiana	29	28.1	75
Quercus buckleyii	23	UR	75
Q. stellata	24	35.7	UR
Q. stellata	25	27.9	90
Q. stellata	26	39.5	120
Q. stellata	27	43.7	155
Q. stellata	28	40.1	190
Q. stellata	30	43.5	235

Figure 1: Vegetation of the Upper Guy Sandy Area (from Hoagland et al. 1998).

Figure 2: Map of the CNRA as reconstruction from General Land Office Survey plats.

A) 1871, B) 1897.

Figure 3: Vegetation of the CNRA compiled from aerial photography. A) 1956, B) 1997

RESTORATION RECOMMENDATIONS

Restoration and management recommendations are provided for each of the vegetation associations mapped in UGSA (fig. 1). Recommendations can be categorized as landscape management and species management. Landscape management refers to actions which affect multiple species (e.g., the application of fire) whereas species management addresses nuisance plants or native plant species absent from a site. Although there is considerable overlap between these categories, it is hoped that these distinctions will aid in the use of this document.

A review of the 1871 General Land Office survey Plats for the UGSA clearly show a mosaic of woodland and grassland in UGSA. The grasslands were most extensive along and to the west of Guy Sandy Creek. The 1897 survey shows that all of the areas designated as grassland in 1871 had been converted to agricultural fields. Therefore, it is recommended that grassland restoration efforts focus primarily on areas adjacent to and west of Guy Sandy Creek.

I. Deciduous Forest and Woodland Vegetation Associations

Overview

The contemporary landscape of the UGSA is a mosaic of upland and bottomland forests, woodlands, and grasslands. If we rely on the Duck and Fletcher (1943) map as an indicator of potential natural vegetation, it becomes clear that hardwood forests and woodlands dominated by post oak-blackjack oak are important components of the CRNA landscape. These forests and woodlands are referred to as the Cross Timbers and are of cultural significance to many Oklahomans. There are several issues to resolve when considering management of the cross timbers vegetation, but of primary concern is the density of tree species. Although it is clear that fire affects species composition and density, historical travel accounts leave a contradictory record (Hoagland et al., 1999). Some visitors to the region described the cross timbers a “pathless thicket of somber timber” (Nuttall, 1821) and “forests of cast iron” (Irving, 1835), implying a closed canopy aspect with a dense understory. But Marcy (in Foreman, 1947) reported that “At six different points where I have passed through it, I have found it characterized by these peculiarities; the trees, consisting primarily of post-oak and black-jack, standing at such intervals that wagons can without difficulty pass between them in any direction”. Therefore, research is needed elucidate the distribution, composition and density of tree species in this vegetation type using the earliest possible records. Until such information is available, we do not recommend that any actions be taken at this time to manage hardwood resources in the UGSA.

II. Coniferous woodland vegetation associations

Overview

The management goals in this section are twofold; reduce the cover of eastern red cedar and restore prairie vegetation. It should be emphasized that throughout the United States, tallgrass prairie has been reduced to a small fraction of its presettlement area and is currently the focus of several conservation efforts (Risser et al. 1981, Steinauer and Collins 1996). The tallgrass prairie varies considerably in species composition from place to place (Risser 1990), although it is usually dominated by one or more of the "big four" grasses: big bluestem (*Andropogon gerardii*), little bluestem (*Andropogon scoparius*), Indiangrass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*). Protected prairie remnants in Oklahoma include the 24,000-ha Wichita Mountains Wildlife Refuge (Crockett 1964) and the Nature Conservancy's recently established Tallgrass Prairie Preserve is about 12,000 ha (The Nature Conservancy n.d.).

In the UGSA, the only coniferous vegetation type is the eastern red cedar (*Juniperus virginiana*) woodland association (Hoagland et al. 1998). Transect data collected during a previous study demonstrated that much of the original prairie flora exists at sites within this vegetation unit in UGSA (see Hoagland et al.1998). Therefore we do not recommend augmenting species composition by seeding or other techniques. Careful management of these areas is likely to yield a fairly quick return to grassland conditions.

Eastern red cedar is a species native to North America and Oklahoma. It is regarded as a colonizing species and, therefore, is an important component of old-field succession. But active fire suppression has allowed eastern red cedar to invade millions of acres of North American grasslands (Bragg and Hulbert 1976, Wilson and Schmidt 1990). The historical abundance (individuals/acre) of eastern red cedar is perceived as being less than at present because it is not adapted to fire. Some statistics regarding the distribution and abundance of eastern red cedar in Oklahoma serve to illustrate the relationship between fire suppression and the abundance of red cedar. For example, the rate of *Juniperus* species encroachment in grasslands has accelerated throughout Oklahoma in recent decades, from an estimated 1.5 million acres in the 1950's to 3.5 milion acres in 1985 (Snook 1985). There are two species of *Juniperus* in the Arbuckle Mountains: *J. asheii* and *J. virginiana*, both of which occur in CRNA. However, *J. virginiana* is the dominant species in UGSA. *Juniperus asheii* occurs species in Arkansas, Missouri, Oklahoma and Texas (Little 1975). *Juniperus virginiana* is a more broadly distributed species and has long been recognized as a threat to the ecological integrity of grassland ecosystems (Rice and Penfound 1959, Johnson and Risser 1975). The two species differ in growth form; *J. asheii* has a rounded crown whereas *J. virginiana* is conical.

Control methods

An extensive body of literature exists regarding the management of eastern red cedar. The cost-effectiveness for management of eastern red cedar can be ranked in increasing order as fire, chemical techniques, and cutting. Herbicides, such as Picloram and Paraquat, have been used to control eastern red cedar (Johnsen and Dalen 1984, Engle et al. 1984). These treatments are applied to individual trees on the ground, foliar herbicides having been deemed ineffective. Although many studies have explored chemical control methods of eastern redcedar, burning has long been recognized as the most cost effective method for controlling the spread of this species (Stritzke and Rollins 1984). Given the potential deleterious effects of chemicals on water resources at CRNA, combination of fire and cutting is recommended.

The effectiveness of fire depends on the size of the trees. Fire is regarded as a cost effective method for reducing the abundance and curtailing the future expansion of trees. (Engle et al. 1997). Between 90% and 100% of trees with crown radi of three feet or less may be destroyed during a controlled burn. The ability of fire to destroy larger trees is a function of the season during which a burn is conducted and fuel availability. The most effective burns for removal of eastern red cedar are conducted when wind speeds range from 10 to 15 miles/hour, relative humidity is less than 50%, ambient air temperatures of 65^{o}F to 85^{o}F, and the presence of adequate fine fuels are present (Stritzke and Rollins 1984). The most effective form of woody plant management, however, is a combination of techniques. In addition, we recommend that CNRA attempt a 50% reduction in eastern red cedar cover over five years in UGSA.

Continued maintenance of herbaceous communities

1. Fire

Fire is a crucial component of functional prairie and woodland ecosystems (Collins and Wallace 1990). All plans for restoration and management of grassland and woodland systems must give thorough consideration to the establishment of burning regimes.

Periodic (3-5 year cycle) burning in late winter or early spring promotes vigorous growth of the dominant native grass species and eliminates woody vegetation from a prairie site. Burning kills tree and shrub sprouts, returns minerals to the soil, and promotes growth of native grasses by allowing for earlier warming of the soil. The establishment of a patch oriented system of burns and burning schedules which will promote biotic diversity. It must be noted that burning treatments during dry years can adversely impact the vigor of little bluestem and sideoats grama (*Bouteloua curtipendula*; Wink and Wright 1973*).*

We recommend periodic late-winter burning, with an occasional summer burn on a three to five-year cycle, if feasible, in the UGSA. Burning plus grazing is the most “natural” alternative (Collins 1987, Howe 1994). There is considerable evidence (Vogl 1974, Pyne 1982) that mid- and tallgrass prairies were maintained for several thousand years by lightning fires and fires set by Native Americans. Mowing every 3-5 years with removal of the dead plant material is an acceptable alternative to burning. Some of the larger tree seedlings and saplings would have to be removed by cutting, especially if the sites are to be mowed.

Kaufman et al. (1990) reviewed the literature concerning fire effects on small mammals and reported on their own research in the tallgrass prairies of Kansas. They found that small-mammal species did not all react in the same way to burning. Migration rather than mortality is the principal effect. Some small-mammal species tend to migrate to unburned areas after a fire, while others move from unburned areas to the burned site.   Populations and species composition of the small-mammal fauna usually return to the pre-burn condition within a year or two after a fire. Bendell (1974) found that birds also had different species responses to fire. Since birds are highly mobile, they can easily move to a different area. Fire effects on members of other animal groups are less well known, but are thought generally to follow the same pattern (or lack of pattern) as observed in birds and small mammals (Ahlgren 1974).

2. Mowing versus grazing

Several papers have examined the affects of mowing on Oklahoma grasslands. Mowing or denudation (with removal of old litter) retards the development of woody vegetation and allows the earlier warming of the soil. Removal of the plant nutrients (minerals) in the litter might eventually result in a loss of soil fertility. However, if removal is done in late winter or early spring, most of the nutrients will have leached out of the dead plant material and returned to the soil. In this case, reduction in soil fertility would occur very slowly or not at all. Mowing would probably be more expensive than burning, but would not require the close coordination with other agencies and/ or cause concern among nearby residents. Early work by Crockett (1965) and Hazell (1964) were concerned with damaged to prairie vegetation as a result of mowing. They noted that if a prairie was mowed early enough for substantial regrowth to occur or after the major grasses were dormant in the fall, there was no reduction in plant vigor. Penfound (1964) found that early spring denudation (mowing combined with removal of the mowed material and old packed-down litter) increased forage production in the following growing season.

Moderate grazing can result in increased species diversity by removing excess dead plant material (Howe 1994). The cost effectiveness of grazing would have to carefully evaluated. The total acreage of UGSA would most likely be sufficient for a small herd of bison. We recommend that CRNA personnel consult with managers at the Witchita Mountains Natonal Wildlife Refuge and the Nature Conservancy’s Tallgrass Prairie Preserve. Grazing by domestic cattle is another option, but the behavior and aesthetic appeal of cattle is quite different from bison. Reintroduction of grazing by cattle to simulate bison grazing may also be considered as a supplemental alternative

(Howe 1994). Any decisions regarding grazing will have to be made in light of current NPS policy.

III. Old field vegetation

Overview

The vegetation in the old-field category at USGA is primarily Johnson grass (*Sorghum halepense*) herbaceous association (fig. 1). John grass is considered to be one of the ten worst weeds in the world (Holm et al. 1977). It was introduced to North America from Mediterranean Europe and Africa in the 1830's (Holm et al. 1977). Although originally introduced as a forage species it has become a nuisance weed. Under stressful conditions, such as drought, high temperature or frost, it produces hydrocyanic acid which is toxic to cattle.

The life history of Johnson grass facilitates it’s ability to colonize an area. For example, it is a prolific seed producer, with each inflorescence producing hundreds of seeds throughout the growing season. The seeds are able to remain dormant in the soil for a long period of time. Johnson grass spreads into disturbed areas and adjacent habitats via a vigorous network of rhizomes. When these rhizomes are severed, they are capable of each producing a new individual (Warwick and Black 1983). Although capable of out-competing many species, Johnson grass has difficulty invading stable prairies, but once established it is extremely persistent. Established stands in old-fields and bottomland may persist for many years (Heath et al., 1973).

Johnson grass (*Sorghum halpense*) will be the greatest impediment to grassland restoration in the lowland areas of CRNA as a whole and UGSA in particular. Although a drastic reduction in the acreage of Johnson grass is recommended, it is difficult for us to provide a time table or more specific recommendation. The reason for this is simple, the most frequently cited and successful methods involve application of herbicides in conjunction with other treatments. The extensive use of herbicides may be contradictory to CRNA policies. Therefore, CRNA staff will need to develop a Johnson grass control program (i.e., techniques to be adopted, scale of treatment, etc.) following careful review of policy. A review of some techniques that have met with success follows.

Control Methods

The literature regarding chemical control of Johnson grass is extensive. Chemicals are typically applied in tandem with a mechanical control method. The use of soil active herbicides is discouraged due to residual effects (Hunter et al. 1974). Two foliar herbicides which have been deemed effective in Johnson grass control are glyphosate (trade name: roundup) and dalapon (trade name: dowpon). Both are mildly toxic and decay rapidly in the soil. However, these herbicides are not specific to grasses and will kill all plants in which they come into contact. Portable applicators are necessary to insure that Johnson grass is treated directly with limited collateral damage. A 2% solution of Glyphosate should be applied in June just prior to seed set (Solecki 1997).

The herbicides MSMA (monosodium methanearsonate) and DSMA (disodium methanearsonate) has been used to selectively reduce Johnson grass along roadsides

(Cooperative Extension Service 1992). Repeated applications of MSMA will reduce Johnsongrass in prairies, but will probably not completely eliminate it. MSMA has been shown to effectively control grass seedlings (Barrentine et al. 1992). The treatment for roadside populations of Johnson grass is 6 lb MSMA/gallon of water, applied at 0.5 gallon/acre. The treatment is repeated two or three times a annually for two or three years. The best time to apply herbicides is when the grass is actively growing, 18 inches or greater in height, and is beginning to bloom (McWhorter 1981).

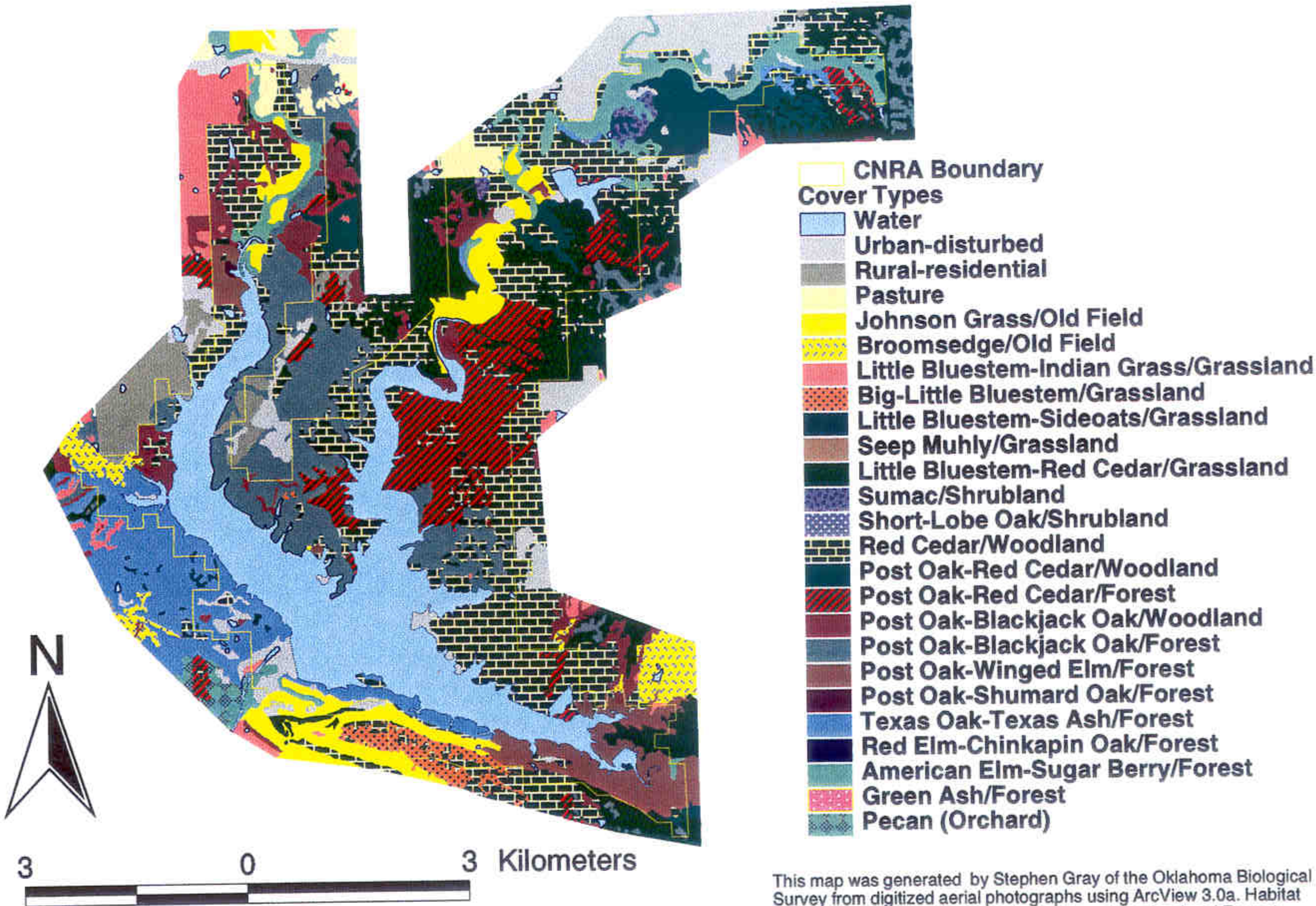
Management publications recommend that herbicides be applied in conjunction with grazing and mowing. Repeated mowing early in the growing forces Johnson grass to draw upon carbohydrate reserves in the rhizome. This eventually weakens the plants and impairs its ability to resprout. In addition repeated mowing prevents Johnson grass from producing additional seed. In fact, seedlings appear to be particularly susceptible to mowing and clipping (Horowitz 1972). Plowing breaks-up Johnson grass rhizomes and brings them to the surface. The rhizomes, thus exposed, will desicate. One study noted a 99% reduction in rhizome production following six thorough tillings at two week intervals (Warwick and Black 1983). In addition, late season plowing may result in winter kill of rhizomes (Solecki 1997). Any treatments of Johnsongrass in the UGSA should begin on a scale to evaluate the efficacy of the treatment.

Following the successful eradication of Johnsongrass, a cover of prairie grasses should be re-established. Given the size of the Johnsongrass/old-field sites, we recommend seeding as opposed to laying of prairie sod. Seeding can be accomplished by a drill or broadcasting. Again, given the area requiring coverage, we recommend mechanical broadcasting as opposed to hand broadcasting. Whether a drill or broadcast method is used will depend upon the resources available to the CRNA, however, drills have proven to be the most effective method for reseeding a prairie (Morgan 1997). Specailized drills for native prairie species are available.

We recommend that a mixture of big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and Indiangrass (*Sorghastrum nutans*). Prairie forbs will most likely re-establish themselves from seed sources in surrounding sites. If resources are available, however, a mixture of prairie forbs could be seeded at the site. Appendix 1 provides a list of forbs suitable for planting at the UPGSA based on data collected by Hoagland et al. (1998). It is best to seed areas in the spring and early summer to coincide with the rainy season.

Figure 1: Vegetation and land cover of the Chickasaw National Area (from Hoagland et al. 1998).

Vegetation of the Chickasaw NRA



This map was generated by Stephen Gray of the Oklahoma Biological Survey from digitized aerial photographs using ArcView 3.0a. Habitat delineation was based on surveys by Bruce Hoagland and Forrest Johnson of the Oklahoma Biological Survey.

Figure 2: Vegetation and land cover of CNRA in 1871 and 1897. These reconstructions were developed from General Land Office Survey plats.

Landcover, Chickasaw National Recreation Area: 1871, 1897

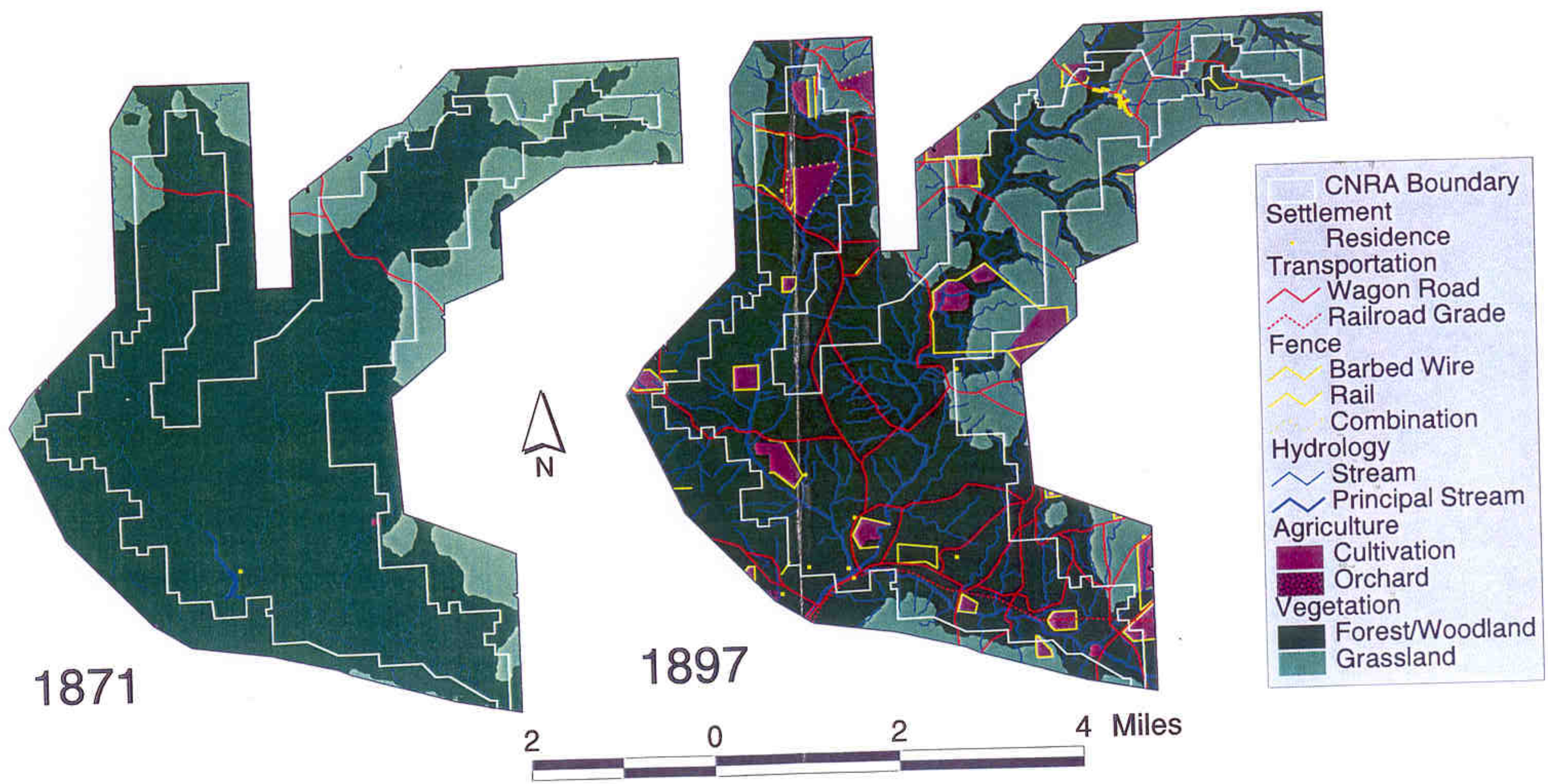


Figure 3: Vegetation and land cover of Murray County in 1871. These reconstructions were developed from General Land Office Survey plats.

Landcover, Murray Co., Oklahoma, 1871

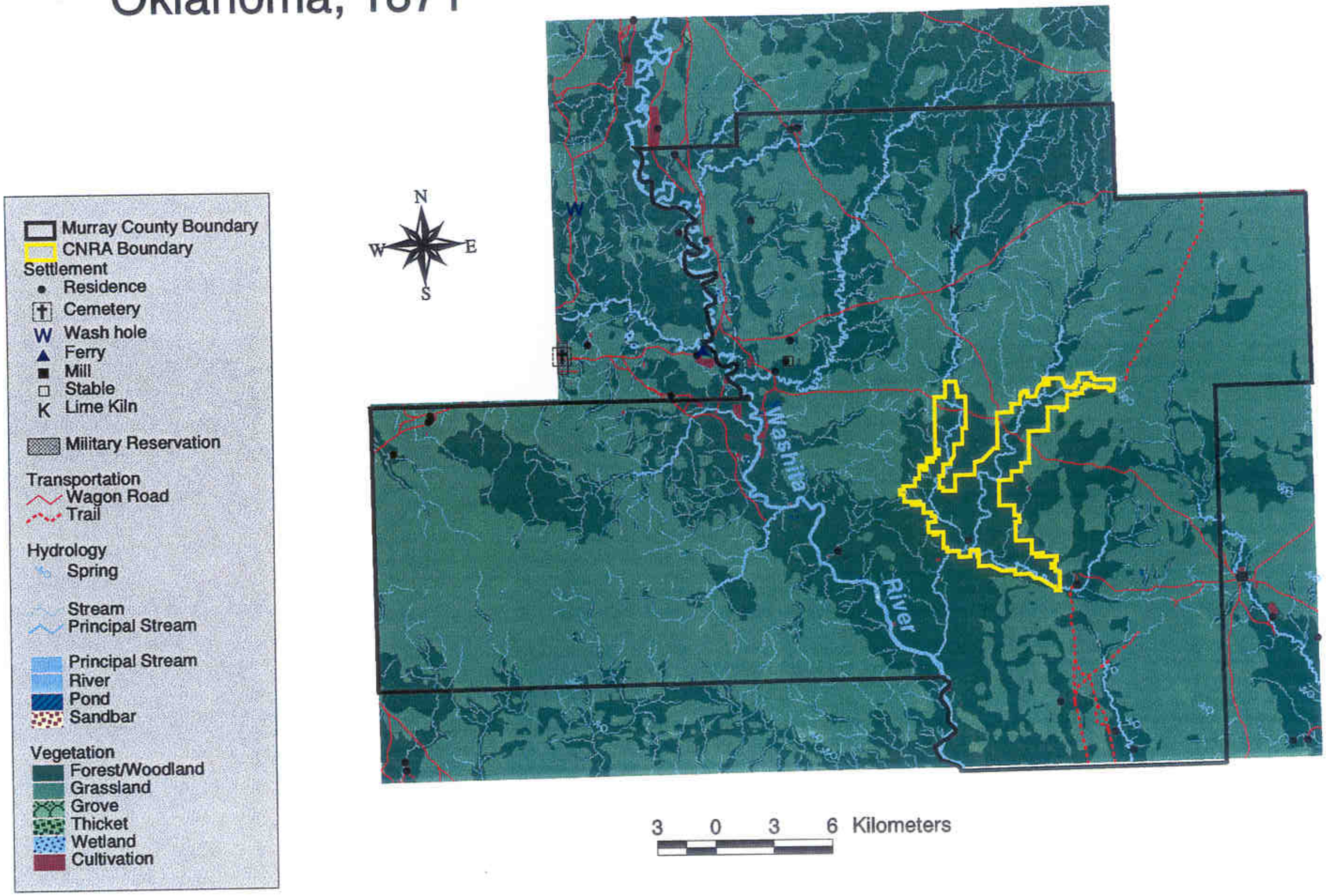


Figure 4: Vegetation and land cover of Murray County in 1871. These reconstructions were developed from General Land Office Survey plats.

Landcover, Murray Co., Oklahoma, 1897

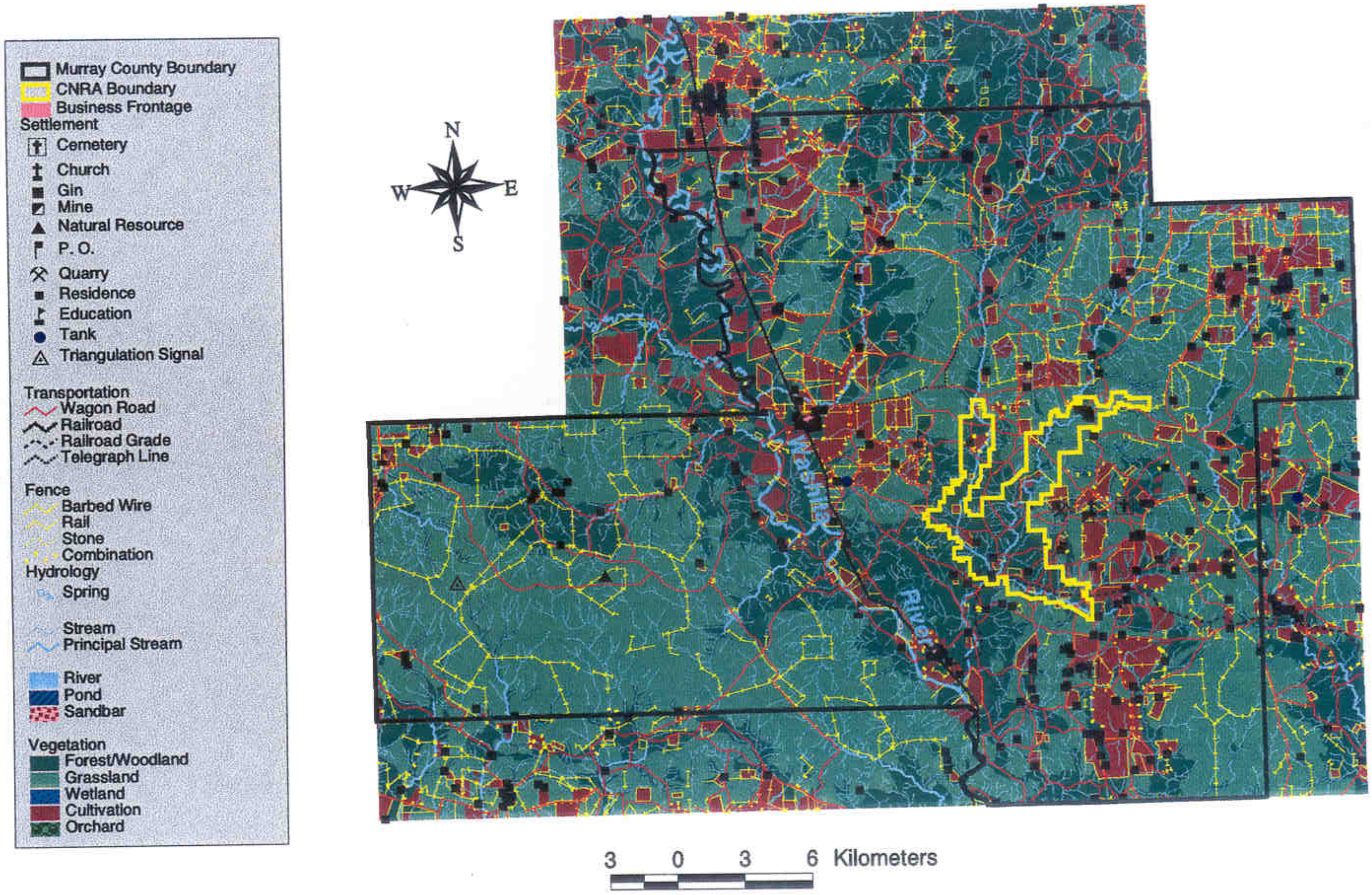
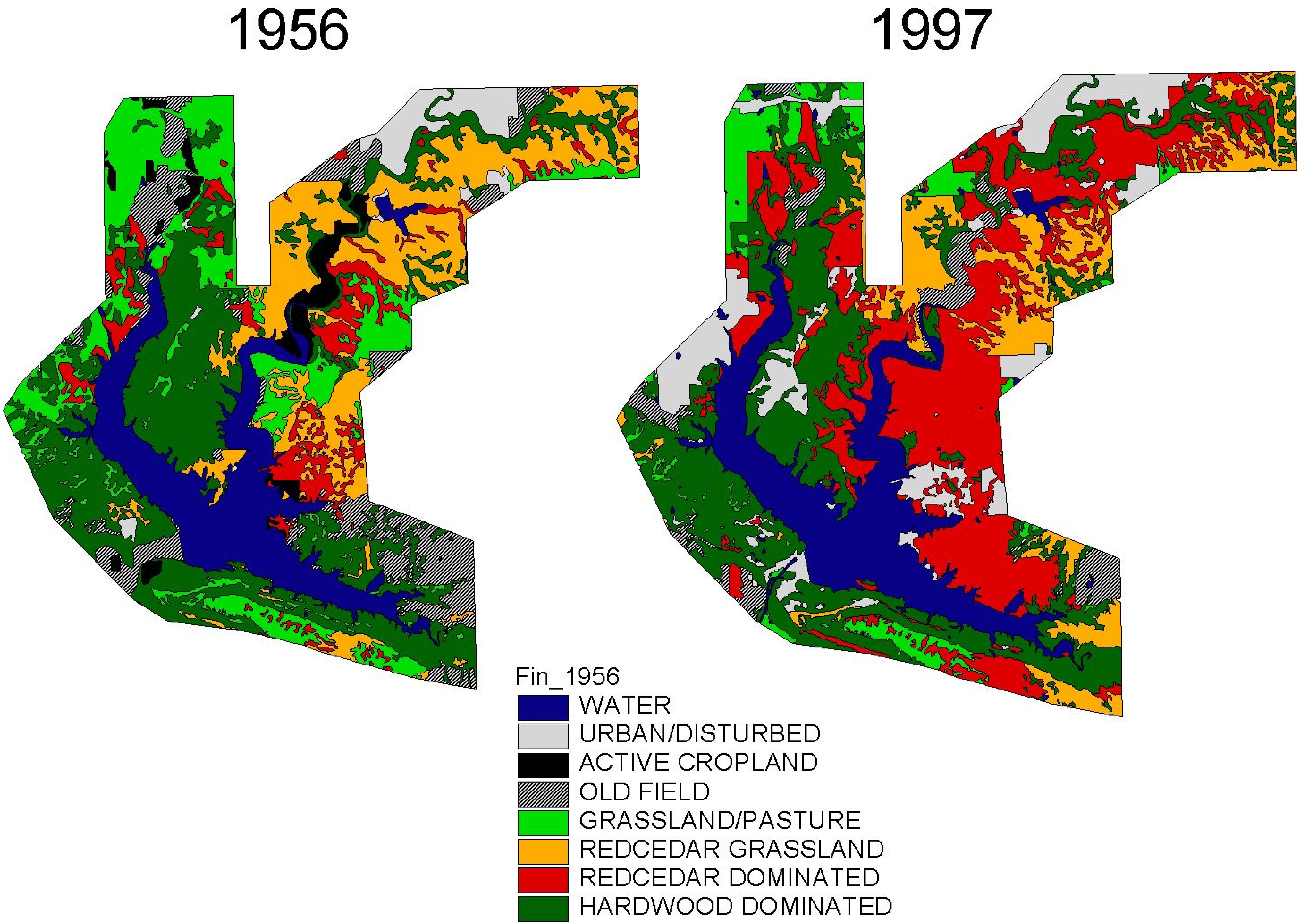


Figure 5: Vegetation and land cover of the Chickasaw National Recreation Area in 1956 and 1997. Maps were developed from aerial photography.


1956
1997
Fin_1956
WATER
URBAN/DISTURBED
ACTIVE CROPLAND
OLD FIELD
GRASSLAND/PASTURE
REDCEDAR GRASSLAND
REDCEDAR DOMINATED
HARDWOOD DOMINATED