LAND COVER/LAND USE

Historic Land Cover/Land Use

Historical land cover within the uplands of the upper Big Piney Watershed probably consisted of open woodlands comprised of post oak and black oak with an understory of shrubs and grasses such as bluestem (MDC 1997a). Occasional savanna openings were also probably common. The more dissected areas of the uplands most likely consisted of mixed oak woodland and forest.

In the more central portion of the watershed, pine and oak-pine woodlands probably occurred on the uplands underlain by sandstones of the Roubidoux Formation, while oak and oak-pine forest probably dominated the lower slopes as well as more dissected portions of this area (MDC 1997a). In valley bottoms having rich alluvial soils, a forest of mixed hardwoods likely existed.

The land cover blanketing the rugged topography of the lower Big Piney watershed is believed to have consisted of oak and mixed hardwood forest open woodlands and scattered glades on exposed ridges and sideslopes with occasional fens in narrow valleys (MDC 1998c).

The Ozark region was first discovered by Native American hunting parties (Rafferty 1980) (Jacobson and Primm 1994). Archeological evidence suggests that these early hunters initially concentrated their efforts on the Ozark fringe along the Missouri and Mississippi Rivers (Rafferty 1980). Initially, Native American peoples inhabiting the Ozarks subsisted as hunters, living in small, transient camps (Jacobson and Primm 1994). As Native American cultures on the fringes of the Ozarks gradually made the transition to a more settled agrarian existence in larger villages, inhabitants in Ozark Highlands, as reference by Chapman (1975 and 1980), probably continued existing as hunters/foragers; although it is suggested that the latter began living in larger, more permanent camps from which hunting and foraging activities were conducted. The limited degree of cultural change by groups in the Ozarks interior may have been the result of geographic isolation within the rugged topography of the Ozarks and/or the lack of suitable agricultural land in the interior, among other factors (Rafferty, 1980). While inhabitants of the Ozarks Fringe may have had occasional contact with isolated groups of interior inhabitants during hunting and gathering expeditions, local ecological factors were probably more influential on interior inhabitants (Chapman 1980).

Prior to the beginnings of European Settlement in the early 1700s, the larger agriculture-based villages in the central Mississippi valley on the Ozarks fringe had been abandoned. It is believed that a climatic shift to cooler, drier summers and the resulting failure of maize crops on which early agriculture was based, may have caused their abandonment (Chapman 1980, Jacobson and Primm 1994). Another contributing factor may have been the occurrence of various epidemics resulting from living in larger crowed villages (Chapman 1980). Whatever the cause(s), remnants of these villages and cultures are believed to have reassembled to form the Osage Tribe which existed throughout much of the Ozarks as European settlement of the area began to occur. (Jacobson and Primm 1994).

Native American use of fire, as well as naturally occurring incidences of fire (i.e. lightening strikes), are believed to have been a large factor in determining the types of vegetation found by Schoolcraft (1821) and others as exploration of the Ozarks interior began to occur after the Louisiana Purchase of 1803. Native Americans are believed to have set fires for many reasons including harassment of enemies as well as an aid in hunting. These fires stimulated warm-season grasses such as bluestem and eliminated woody undergrowth thus creating open woodlands or savannas.

European settlement of the Ozark fringe began in the early 1700's under French and, later, Spanish political control. After the Louisiana Purchase of 1803, American settlers began settling the same areas earlier occupied by the Spanish and French. The Osage, in treaty with the federal government, relinquished claims to much of the Ozarks interior in 1808, although they refused to relinquish their hunting rights in this area (Rafferty 1980). Settlement of the Ozarks Interior increased after the war of 1812 (Jacobson and Primm 1994). Many of the early settlers came from states such as Indiana, Illinois, Kentucky, Virginia, and Tennessee (Rafferty 1983). Most of these states were previously considered the frontier prior to the Louisiana Purchase, thus many settlers brought along skills they had learned for survival in frontier territory. Early settlers subsisted by hunting and fishing as well as maintaining gardens in the small bottomland areas which they cleared. In addition early settlers raised livestock which grazed on the open range of the slopes and uplands in the summer. In the winter livestock were fed from forage crops cultivated and harvested from the bottom lands (Jacobson and Primm 1994). The annual practice of burning was continued by early settlers in order to enhance the livestock forage of the uplands. In addition to the influx of settlers of European origin which occurred after the war of 1812, Native American tribes such as the Cherokee, Shawnee, and Delaware, which had been displaced from the East, began moving through the region (Jacobson and Primm 1994). As the population of the area increased, more settlers were forced to settle the uplands (Ryan and Smith 1991). Fenced pasture began to replace the practice of open range. These two factors reduced the use of fire on the uplands, thus decreasing the grassland and savanna type land cover (Ryan and Smith 1991; Jacobson and Primm 1994). This region was only sparsely settled until the late 1800's, when the economic values of the vast timber resources were discovered.

Much of the virgin forest of the Ozarks remained relatively undisturbed by logging until the late 1800s (Cunningham and Hauser 1989). Within the Big Piney Watershed however, logging of the pines began as early as 1816 with sawmills being constructed along the Big Piney River during the proceeding years (Ryan and Smith 1991; Jacobson and Primm 1994). By 1820, the Big Piney was being used to transport a large number of logs, as well as processed lumber products, which eventually made their way to St. Louis via the Gasconade and Missouri Rivers (Ryan and Smith 1991; Jacobson and Primm 1994). Williams (1904) gives insight into the exploitation of the pine forests in Texas County by the turn of the century when he states that pine was "formerly scattered throughout the county, but became predominant only in Jackson and Current townships bordering the southwest corner of Dent county. It is valued at $5.00 to $7.50 an acre making a total resource of approximately $100,000; rapidly being converted into money".

As the pines began to be depleted and the importance of railroad transportation grew, logging of hardwoods for railroad ties, barrel staves, tool handles and other products increased. Williams

(1904) stated that in Pulaski County, "railroad ties are a leading source of income to all farmers living within hauling distance of the railroad or rivers". Portable mills became common. In regards to the extent of timber exploitation in the Pulaski county, Williams (1904) states that by 1904, "two thirds of the timbered lands have been cut over and bordering the railroad and creeks, practically all merchantable size trees have been made into railroad ties and rough board lumber".

As the timber resource began to play out in the area, residents turned increasingly toward farming the rugged cut-over land in an attempt to eke out a means of survival. Initially row crop farming on an increased scale was attempted. This is exemplified by a sharp increase occurring between 1880 and 1900 in the acres of corn and wheat harvested within the counties of the Big Piney Watershed as shown in Figure Lu01. This type of land use would have undoubtedly contributed to erosion and thus sedimentation and an increased gravel load in the streams of the area. Over time, much of the area was found to be unsuitable for large scale row-cropping. Figure Lu01 shows the relatively rapid decline of acres harvested of corn and wheat in the counties of the area after 1900. In many counties of the Ozarks, livestock populations experienced sharp increases as row cropping declined. Cattle populations within the counties of the Big Piney Watershed shared this trend, while hog populations experienced a relatively steady decline (Figure Lu02). The increase in cattle led to an increased need for pastureland and thus seasonal burning became commonplace once again to help increase and maintain open pasture. Hay also became an important crop. The amount of acres of hay harvested in the watershed experienced a sharp increase after 1880, leveling off somewhat in 1910 and then experiencing a sharp spike in 1950. Between 1960 and 1996, the acres of hay harvested continued to increase. While it might be assumed initially that acres of hay harvested would be a direct reflection of the increase in cattle, the patterns don't appear to necessarily reflect each other perhaps owing to the possibility that counties of the watershed probably exported hay to other areas.

The era of modern natural resource management began in the Big Piney Watershed in the 1930s as the state and federal government began buying up the tired land. The largest purchaser of land within the watershed was the USFS. Initially, a large portion of natural resource rehabilitation on USFS land was accomplished by the Civilian Conservation Corps (CCC); a work program of the Great Depression. In the Ozarks, CCC camps were established in various places to provide lodging for workers of the CCC. One such camp was established near St. Roberts Missouri (Sternberg et al. 1998). This camp would later become Fort Leonard Wood. The MDC, the state agency responsible for the management of the state's fish, forest, and wildlife, became established in 1937 and would be responsible for state natural resource management efforts in the watershed. Natural resource managers initiated reforestation programs, natural resource education, and fire suppression to name a few.

In an effort to determine the effects of land use changes on stream disturbance in the Ozark Region, Jacobson and Primm (1994) evaluated recent (1993) conditions of Ozark streams, pre-settlement period historical descriptions, stratigraphic observations, and accounts of oral-history responses on river changes during the last 90 years for the Jacks Fork River and Little Piney Creek Watersheds. This led Jacobson and Primm (1994) to the conclusion that Ozark streams are disturbed from their natural conditions. Jacobson and Primm (1994) state that this "disturbance has been characterized by accelerated aggradation of gravel, especially in formerly

deep pools, accelerated channel migration and avulsion, and growth of gravel point bars". Jacobson and Primm (1994) also suggest that "land use changes have disturbed parts of the hydrologic or sediment budgets or both".

As part of the effort to determine the effects Jacobson and Primm (1994) summarized the land use changes from pre-settlement conditions to the 1970's in the Little Piney Creek Watershed (Table Lu01) and summarized the following in regards to the Ozark landscape:

> "Different types of land use have taken place on different parts of the landscape, and at different times, resulting in a complex series of potential disturbances. Uplands have been subjected to suppression of a natural regime of wildfire, followed by logging, annual burning to support open range, patchy and transient attempts at cropping, a second wave of timber cutting, and most recently, increased grazing intensity. Valley side slopes have been subjected to logging, annual burning, and a second wave of logging. Valley bottoms were the first areas to be settled, cleared, and farmed; removal of riparian vegetation decreased the erosional resistance of the bottom lands. More recently, some areas of bottomland have been allowed to grow back into forest. The net effects of this complex series of land-use changes are difficult to determine and separate from natural variability."

Jacobson and Primm (1994) offer the following observations which summarize the probable, qualitative changes to runoff, soil erosion, and riparian erosional resistance on parts of the Ozarks landscape relative to man's impact (Table Lu02):

1. Initial settlement of the Ozarks may have initiated moderate channel disturbance because of decreased erosional resistance of cleared bottom lands. This trend would have been countered by decreased annual runoff and storm runoff that accompanied fire suppression in the uplands.

2. Because of low-impact skidding methods and selective cutting during initial logging for pine during the Timber-boom period, logging would have had minimal effects on runoff and soil erosion. Low-impact methods and selective cutting continued to be the norm in timber harvesting of hardwoods until the late 1940's, when mechanization and diversified markets for wood products promoted more intensive cutting. Locally, log and tie jams, tie slides, and logging debris may have added to channel instability by diverting flow, but because aggradation and instability also occurred on streams not used for floating timber, these factors were not necessary to create channel disturbance.

3. Significant channel disturbance probably began in the Timber-boom period because of continued clearing of bottom land forests and road building in the riparian zone. This hypothesis is supported by evidence that significant stream disturbance began before the peak of upland destabilization in the post-timber-boom period. Extreme floods during 1895 to 1915 may have combined with lowered erosional thresholds on bottom lands to produce the initial channel disturbance.

4. The regional practice of annual burning to maintain open range had the most potential to increase annual and storm runoff and soil erosion because of its considerable areal extent and repeated occurrence. Burning would have been most effective in increasing runoff and erosion on the steep slopes that had been recently cut over during the timber boom. Generally, accelerated soil erosion was not observed after burning, and relict gullies presently (1993) are not apparent on valley-side slopes and uplands. These observations support the hypothesis that burning did not produce substantial quantities of sediment.

5. The greatest potential for soil erosion on valley slopes and upland areas occurred during the post-timber-boom period when marginal upland areas were cultivated for crops. Accelerated erosion of plowed fields was observed and noted by oral-history respondents and by soil scientists working in the Ozarks during the post-timber-boom period.

6. Valley bottoms have the longest history of disturbance from their natural condition because they were the first to be settled, cleared, and farmed. The lowered resistance to stream erosion that results from removing or thinning riparian woodland would have been a significant factor, especially on small to medium sized streams for which bank stability and roughness provided by trees are not overwhelmed by discharge. Disturbance of bottom land riparian forest increased as free-range grazing, crop production, and use of valley bottoms for transportation expanded and reached a peak in the post-timber-boom period. Headward extension of the channel network because of loss of riparian vegetation may have increased conveyance of the channel network (and hence flood peaks downstream) and removed gravel from storage in first and second order valleys at accelerated rates. This hypothesis is supported by a lack of other source areas for gravel and by observations that gravel came from small stream valleys, not off the slopes.

7. During present (1993) conditions, channel instability seems somewhat decreased in areas where the riparian woodland has recovered, but stability is hampered by high sedimentation rates because of large quantities of gravel already in transport and effects of instability in upstream reaches that lack a riparian corridor.

8. Land use statistics indicate that the present trend in the rural Ozarks is toward increased populations of cattle and increased grazing density. This trend has the potential to continue the historical stream-channel disturbance by increasing storm runoff and sediment supply and thus remobilization of sediment already in transit.

The combined human populations of the counties (Phelps, Pulaski, and Texas) of the Big Piney River Watershed experienced net growth between 1900 and 1990 of approximately 110% (Figure Lu03)(OSEDA 1998). Statistics for the individual counties indicate that while Texas County experienced a net decline in population of 3%, the counties of Phelps and Pulaski experienced increases of 148% and 297% respectively. The dramatic increase in population in

Pulaski County, as well as the combined population increase in the counties of the Big Piney Watershed overall, is undoubtedly largely due to the reactivation of FLW in 1950 and the associated influx of military as well as civilian personnel associated directly and indirectly with the activity and business generated by Fort Leonard Wood.

The 2000 human population within the Big Piney Watershed was estimated to be 31,144 persons (Blodgett J. and CIESIN 1996). This is a 1.8% decrease from the estimated 1990 population. Population density in 2000 was approximately 41.3 persons per square mile as compared to the overall population density for Missouri which was approximately 80.3 persons per square mile (Figure Lu04). Of course, one must take into account the effect of the states urban centers on this estimate.

Projections of human population increase of Missouri counties have been calculated by the Missouri Office of Administration (MOA), Division of Budget and Planning for three different projection scenarios in a report entitled "Projections of the Population of Missouri Counties By Age, Gender, and Race: 1990 to 2020" (MOA 1999). Combined population estimates for Phelps, Pulaski, and Texas Counties from 2000-2020 have been used to calculate percent increase in population for three scenarios. The difference in scenarios is based on calculated long-term, recent, and zero migration. The scenarios project a combined population increase of 20.0%, 25.8%, and 20.7% respectively by the year 2020.

Ecological Classification

The Ecological Classification System (ECS) is a management tool which provides a means of "describing distribution of current and potential natural resources in a manner that considers land capability upfront" using a knowledge of landform, geology, soils, and vegetation patterns (MDC 1997a). There are several levels of classification within the ECS. For purposes of this document the three lowest levels are dealt with. These levels are, in descending order, section, subsection, and land type association (LTA). The Big Piney Watershed intersects 1 sections, 2 subsections and 11 LTAs.

The Ozark Highlands Section is the only ecological section intersected by the Big Piney Watershed. This section consists of very old and highly weathered plateaus which, coupled with its physiographic diversity and central geographic location relative to the continent, has created a region of unique ecosystems harboring many endemic species (MDC 1997a).

The subsections intersected by Big Piney Watershed include the Gasconade River Hills and the Central Plateau (Figure Lu05).

The Gasconade River Hills Subsection

The Gasconade River Hills Subsection "intersects a substantial portion of the Ozark Region on the north. This subsection is associated with the hilly and dissected lands flanking the Big and Little Piney Rivers and the Gasconade River and its tributaries. These streams cut from the Jefferson City-Cotter formation, through the Roubidoux into the Gasconade formation. They also

have mainly deep, cherty heavily leached soils which support oak and oak-pine woodland and forest." (MDC 1997b).

The Central Plateau Subsection

The Central Plateau Subsection "represents the high, flat to gently rolling plains that are the least eroded remnant of the Salem Plateau. Underlain primarily by Jefferson City-Cotter dolomites or Roubidoux sandstone/dolomite, the plains are often mantled in a thin layer of loess and have droughty soils. Streams are mainly intermittent, low gradient headwater streams that are often losing. Savannas and woodlands were originally the dominant vegetation types" (MDC 1997a).

Land Type Associations (LTAs) represent the smallest level of the three levels previously mentioned (Figure Lu05). LTAs intersecting the Big Piney Watershed include the Following:

Middle Gasconade River Oak Woodland/Forest Breaks (13.4%)
Little Piney Oak Woodland Dissected Plain (1.2%)
Upper Gasconade Oak Woodland Dissected Plain (37.7%)
Big Piney Hills Oak Woodland Dissected Plain (4.4%)
Licking Oak Savanna/Woodland Plain (6.4%)
Ft. Wood Oak Savanna/Woodland Plain (0.7%)
Big Piney Oak Woodland Dissected Plain (5.8%)
Big Piney River Oak-Pine Woodland/Forest Hills (18.7%)
Big Piney Pine-Oak Woodland Dissected Plains (4.0%)
Cabool - Mt. Grove Oak Savanna/Woodland Plain (0.4%)
North Fork River Oak-Pine Woodland/Forest Hills (0.1%)

Table Lu03 gives descriptions of LTAs within the watershed.

The ECS could prove to be a useful tool for planning and implementing management activities by providing an indication of what natural resource management options will be more adapted to specific areas thus increasing the success of management decisions as well as helping to ensure that management decisions are ecologically enhancing.

Current Land Cover

Approximately 62.7% of the Big Piney Watershed is forested based on analysis of MoRAP (1999) Missouri Land Cover data. Grassland is the second most prevalent land cover accounting for about 36.6% of the total watershed area. The categories of cropland and urban account for approximately 0.1% and 0.6% of the total watershed area respectively, while the land cover category of water accounts for approximately 0.1% of the watershed area (Table Lu04, Figures Lu06 and Lu07). Forest cover is the most dominant land cover type in all eleven digit hydrologic units within the watershed except the Upper Big Piney. The Lower Big Piney unit has the highest percentage of forest cover at 80.8%, while the Upper Big Piney unit has the lowest at 44.9%. This unit also has, by far, the largest percentage of grassland at 54.7%.

Soil and Water Conservation Projects

There are no Agricultural Nonpoint Source Special Area Land Treatment (**AgNPS-SALT**), EARTH, or **PL-566** projects within the Big Piney Watershed. A Special Area Land Treatment (**SALT**) project was conducted in a large portion (42,880 acres) of the West Piney Watershed between 1995 and 1999 (MDNR 2003). Within this area, 8,157 acres were identified as needing treatment and 6,724 acres received treatment. Goals of the project included "Control soil erosion on woodland and pastures using no-till, livestock exclusion, streambank stabilization and good forage and woodland management".

Public Land

Knowledge of land ownership within a watershed is an important key to understanding various characteristics of a watershed as well as addressing watershed related issues and concerns. Within the Big Piney Watershed, approximately 24% (114,972 acres) of land is under public ownership (Table Lu05 and Figure Lu08). The USFS holds the largest amount of publicly owned land totaling 88,942 acres. This is followed by the Department of Defense (FLW 24,133 acres) and the Missouri Department of Conservation (1,896 acres). The public land within the watershed includes approximately 109 miles of permanent stream and 14 stream accesses.

Analysis of land ownership percentages within eleven digit hydrologic units reveals that the Upper Big Piney Unit has the smallest percentage of public land at 3.4%, all of which is managed by the MDC (Table Lu06 and Figure Lu09). The Lower Big Piney Unit has the highest percentage of public land at 69.0%. The majority of this land is managed by the Department of Defense (as part of FLW) and the USFS.

Table Lu01. Land cover/ land use change from pre-settlement period conditions (1820's) to the 1970's in the Little Piney Watershed, Missouri (Jacobson and Primm 1994).

1820's Category	1970's Category	Area sq. miles	% Change From 1820's
Shrub and brush rangeland	Urban/developed	0.9	0
	Reservoirs	0	0
	Pasture/cropland	36.4	22
	Deciduous forest	123.4	76
	Evergreen Forest Land	2.4	1
	Mixed Forest Land	<0.1	0
Deciduous forest	Urban/developed	4.3	2
	Reservoirs	0.4	0
	Pasture/cropland	82.8	25
	Deciduous forest	151.0	75
	Evergreen forest land	0.1	0
	Mixed forest land	0.4	0
	Barrens	0.4	0
Mixed forest	Deciduous forest	1.6	100
Barrens	Urban/developed	0	0
	Pasture/cropland	7.6	39
	Deciduous forest	11.9	61

Table Lu02. Summary of probable qualitative changes to runoff, soil erosion, and riparian erosional resistance on parts of the Ozarks landscape relative to pre-settlement period conditions. Reproduced in whole from Jacobson and Primm (1994).

Period	Uplands	Valley Slopes	Valley Bottoms
Pre-settlement	Baseline	Baseline	Baseline
Early Settlement			
Annual Runoff	Decrease	Slight Increase	N/A
Storm Runoff	Decrease	Slight Increase	N/A
Upland Sediment Yield	Decrease	Slight Increase	N/A

Table 2 continued

Riparian Erosional Resistance	N/A	N/A	Moderate Decrease
Timber-Boom			
Annual Runoff	Slight Increase	Slight Increase	N/A
Storm Runoff	Slight Increase	Moderate Increase	N/A
Upland Sediment Yield	Slight Increase	Moderate Increase	N/A
Riparian Erosional Resistance	N/A	N/A	Decrease
Post-Timber-Boom			
Annual Runoff	Moderate Increase	Increase	N/A
Storm Runoff	Moderate Increase	Increase	N/A
Upland Sediment Yield	Moderate Increase	Increase	N/A
Riparian Erosional Resistance	N/A	N/A	Substantial Decrease
Recent			
Annual Runoff	Slight Increase	Slight Increase	N/A
Storm Runoff	Slight Increase	Moderate Increase	N/A
Upland Sediment Yield	Slight Increase	Slight Increase	N/A
Riparian Erosional Resistance	N/A	N/A	Decrease

N/A=Not Applicable

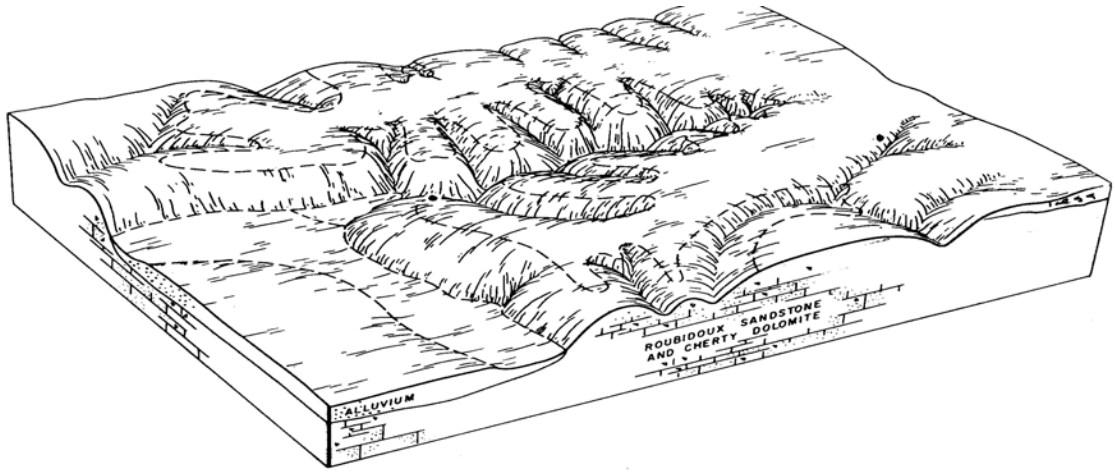
Table Lu04. Percent land cover for eleven digit hydrologic units within the Big Piney Watershed. Data is based on analysis of MoRAP Missouri Land Cover Data (1999).

Unit Name	FOR	WET	GRAS	CRP	URB	WAT
Upper Big Piney	44.9	0.0	54.7	0.1	0.2	0.0
Middle Big Piney	69.7	0.0	29.8	0.0	0.3	0.1
Spring Creek	63.9	0.0	35.9	0.0	0.1	0.0
Lower Big Piney	80.8	0.0	16.6	0.3	2.0	0.3
Big Piney Watershed	62.7	0.0	36.6	0.1	0.6	0.1

FOR =Forest, **WET**=Wetland, **GRS**=Grassland, **CRP**=Cropland, **URB**=Urban, **WAT**=Water

Table Lu03. Descriptions of land type association (LTAs) groups as well as a condensed description of the 11 LTAs (underlined in bold with percentage of watershed in parenthesis) within the Big Piney Watershed. Descriptions and figures taken in part or whole from MDC (1997a, 1998b, and 1998c).

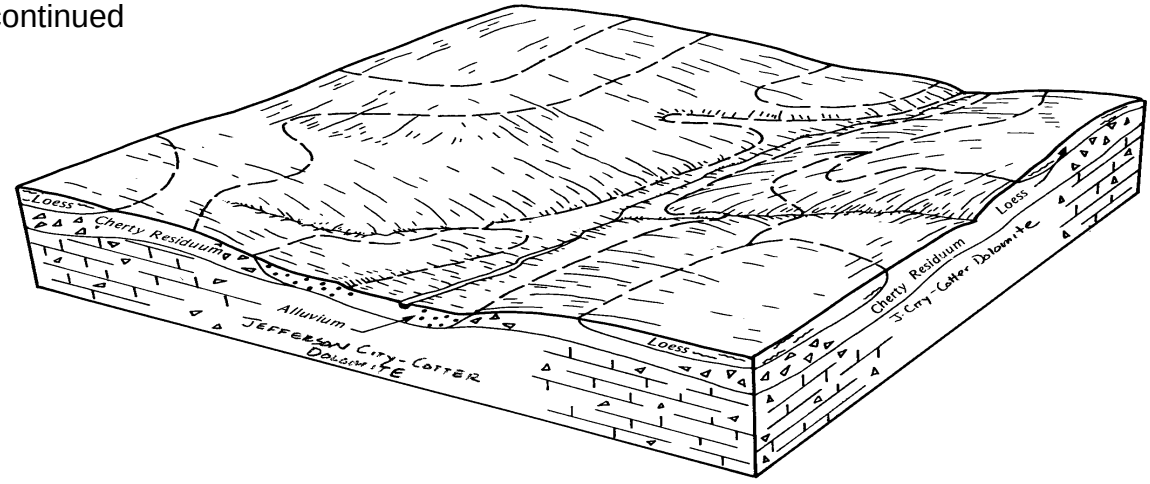
Pine-Oak Woodland Dissected Plains



Landform: Broad, flat to gently rolling plains which give way to moderately dissected and sloping lands associated with the headwaters of major drainages. Valleys are broad and local relief 100-150 feet. Clusters of karst sinkholes are common. Streams are mainly headwater streams with flashy, intermittent flow.
Geology: Underlain by cherty sandstone and dolomite of the Roubidoux Formation with frequent loess deposits on the flatter uplands.
Soils: Soils are formed principally in cherty sandstone and dolomite residuum from the Roubidoux Formation. Soils are mainly deep, cherty, and highly weathered, low base soils. However occasional fragipans and shallow to bedrock soils do occur. Most soils are extremely well drained and droughty.
HistoricVegetation: Originally covered in woodlands of shortleaf pine and mixed pine oak with an open understory of dense grass and shrub ground cover. Post oak woodlands occupied occasional loess covered flats. Unique sinkhole ponds dotted the landscape.
Current Conditions: Over 75% of this group are currently forested in dense, even-age oak and oak-pine forest. Only 20% of these forests have a strong pine component. However, the proportion of forests containing shortleaf pine is the highest in this group. Dense stands of near even age scarlet, black, and post oak occur in the place of pine. Understories are dense, woodland ground flora sparse, and oak die-back common. A substantial component of these forested lands are publicly owned. Approximately 20% of this group is currently pasture, which often occupies the broad valley bottoms or karst plains. Most sinkhole ponds have been drained, dozed or severely overgrazed. Headwater streams are subject to grazing and bank erosion.
Big Piney Pine-Oak Woodland Dissected Plain (4.0%): Flat to rolling landscape flanking the hills on either side of the Upper Big Piney river; high current pine component.

Oak Woodland Dissected Plains and Hills Group

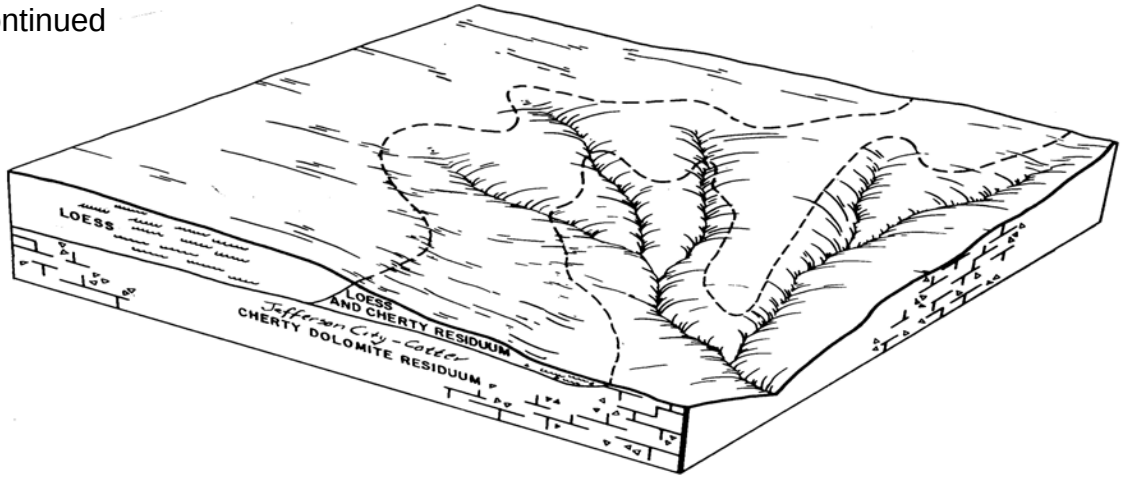
Table 3
continued



Landform: Distinguished by rolling to moderately dissected topography. Local relief is 75-150 feet. Very broad, flat ridges give way to gentle side slopes and broad stream valleys. Karst plains with frequent shallow sinkhole depressions are common. Broad stream valleys most often occupied by losing streams, however occasional seeps do occur and can spread across substantial portions of a valley.
Geology: Commonly underlain by Jefferson City-Cotter dolomites with a common loess cap. Some minor areas underlain by Roubidoux sandtones.
Soils: Soils are variable, ranging from shallow to bedrock and fragipan soils, to deep, cherty and well-drained loams. Tree root growth is often restricted by bedrock, pans or clay mineralogy, especially high in the landscape.
HistoricVegetation: Open woodlands with occasional prairie and savanna openings was the principal vegetation type. Post oak and black oak were the principal woodland tree species. Historic fire likely played an important role in maintaining an open canopy, sparse understory and a dense herbaceous ground flora. More dissected lands likely contained mixed oak woodland and forest. Unique sinkhole ponds, wet prairies and seeps were scattered in the broad valleys and depressions.
Current Conditions: Currently a mosaic of fescue pasture (35-65% cover) and dense, often grazed oak forest. The transition from open grassland to closed forest is abrupt and the patch work blocky. Very few native grasslands or savannas are known, and the dense second growth woodlands have very little ground flora. Most sinkoles, wet prairies and seeps have been drained and heavily grazed. Many roads, towns, cities and businesses are located in these LTAs.
Little Piney Oak Woodland Dissected Plain (13.4%): Dissected plains associated with the headwaters of the Little Piney river and Spring creek; Roubidoux sandstone locally common. **Big Piney Hills Oak Woodland Dissected Plain (4.4%)**: Narrow divide between Roubidoux Creek. and Big Piney R. within Gasconade Hills Subs. **Big Piney River Oak Woodland Dissected Plain (5.8%)**: Rather small dissected upland at head of Spring Creek. **Upper Gasconade Oak Woodland Dissected Plain (37.7%)**: Broad divide encompassing the headwaters of the Big Piney and Gasconade River Watersheds.

Oak Savanna/Woodland Plains Group

Table 3
continued



Landform: Very broad flat uplands slope gently to very broad flat drains or solution (karst) depressions. Local relief is less than 75 feet.
Geology: Underlain mainly by Jefferson City-Cotter dolomites with a common loess cap. Minor areas of the Roubidoux formation occur. Headwater streams are nearly all losing.
Soils: Fragipan soils or soils with shallow restrictive clays or bedrock are common, inhibiting tree root growth.
HistoricVegetation: Oak savannas and woodlands with common prairie openings were the predominant historic vegetation. While few prairies were named by original land surveyors, early descriptions portray an open, "oak prairie" landscape. Fire likely played a principal role in maintaining a grassland-open woodland structure. Some sinkhole depressions would have had unique ponds and seeps.
Current Conditions: The largest blocks and greatest acres of grassland (45-65% cover) are currently associated with these LTAs; grasslands are mainly fescue pasture. Less than 40% of these LTAs are timbered, mainly in dense, second growth oak forest (post and black oaks) with common grazing pressure. Very few quality native prairies, savannas, woodlands, sinkhole ponds or seeps are known. Many of the regions roads, towns, and businesses are associated with these LTAs.
Licking Oak Savanna/Woodland Plain (6.4%): Long, linear flat divide between Big Piney on the west and Current/ Meramec drainages on the east. **Ft. Wood Oak Savanna/Woodland Plain (0.7%)**: Small, flat upland between Big Piney and Roubidoux creek. **Cabool-Mt. Grove Oak Savanna/Woodland Plains (0.4%)**: Two narrow, high, flat divides between Gasconade and North Fork drainages.

Ozark Oak Forest Breaks

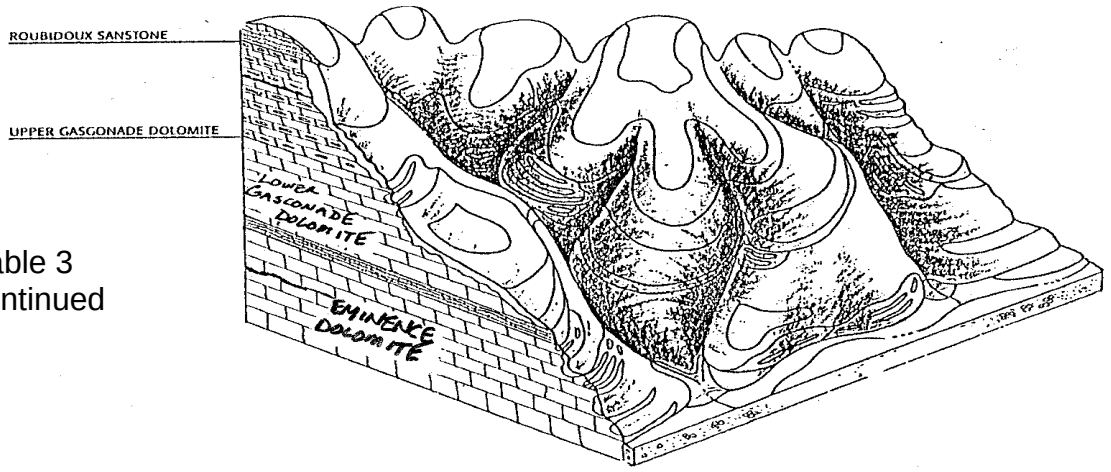
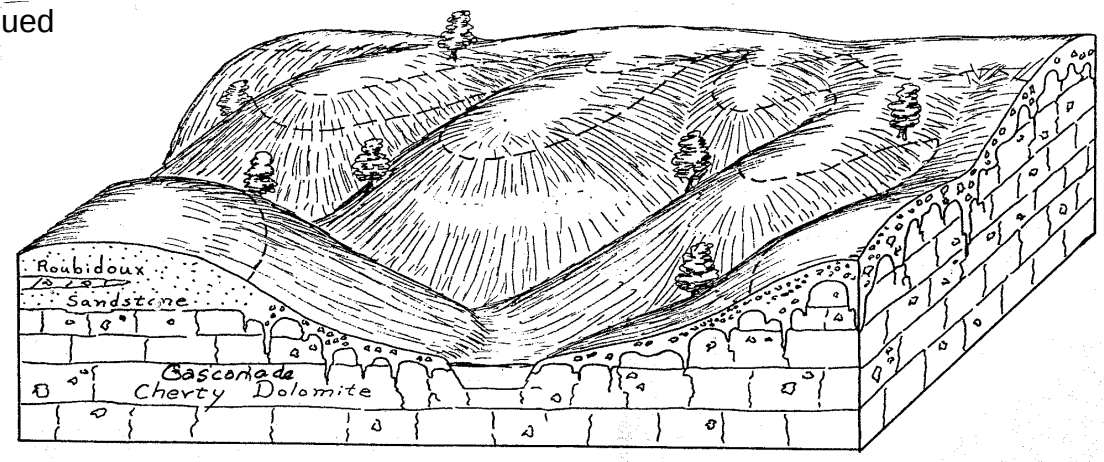


Table 3
continued

Landform: These LTAs are distinguished by local relief over 300 feet, narrow ridges, steep sideslopes and mainly narrow, sinuous valleys. Cliffs, caves and springs are common. These LTAs represent the most rugged and certainly some of the most scenic landscapes in the region.
Geology: The Current and Meramec Breaks differ from the Gasconade by having only a thin layer of Roubidox sandstone on the highest ridges, but cut deeply through the Gasconade formation into the Eminence dolomite, consequently exposing the Gunter sandstone. Consequently, unique benches occur on the Gunter sandstone, and extensive areas of more productive, higher base soils with oak and mixed hardwood forest communities occur here. The breaks along the Gasconade have a thick cap of Roubidoux sandstone on ridges and upper slopes, give way abruptly from the Plains, and only cut into the Lower Gasconade dolomite.
Soils: Areas of shallow soils are frequent with deeper cherty loam soils above and below them.
HistoricVegetation: Historic accounts indicate that these LTAs were originally forested in Oak and Mixed Hardwood Forest Types. Scattered glades and open woodlands would have occurred on exposed slopes and ridges, especially in areas of shallow soil. Relatively small fen openings occasionally filled narrow tributary valleys.
Current Conditions: Because of the steep topography, these LTAs are still mainly forested (65-85%) in second growth oak and mixed hardwood timber. Open areas are confined to valleys, and bottomland forest is in shorter supply than historically. Dolomite glades are largely overgrown with eastern red cedar, and many of the fens have been drained or heavily grazed. Numerous rare or endangered species, some restricted to these LTAs, are associated with the streams, springs, caves, cliffs and fens in these landscapes. The rivers have been recognized as natural treasures and are an important recreational resource to the entire region.
Middle Gasconade River Oak Woodland/Forest Breaks (13.4%): Very steep lands in middle of valley with abrupt fall from adjacent Plains; Roubidox sandstone ridges/upper slopes and Gasconade sideslopes/valley bottom.

Table 3
continued

Oak-Pine Woodland Forest Hills Group



Landform: Mainly broad ridges, moderately sloping (<25%) side slopes, and relatively broad entrenched valleys with local relief between 150-250 feet. Steeper, more dissected areas occur locally near larger stream valleys. Sinkhole depressions are common on broader ridges. Stream valleys vary somewhat from broad and rather shallow, to more deeply entrenched, narrow, and meandering. Many losing streams occur in valleys distant from the main rivers. Cliffs, caves and springs are commonly associated with larger, perennial stream valleys.

Geology: Roubidoux cherty sandstones and dolomites occupy most ridges and upper side slopes, while lower side slopes, especially near major streams are in cherty upper Gasconade dolomite materials.

Soils: Soils are mainly deep, highly weathered and very cherty silt loams with clays at varying depth. Broad ridges may have a loess cap with occasional fragipans, and shallow soils with dolomite bedrock near the surface occur frequently on steeper, exposed slopes.

Historic Vegetation: Pine and mixed oak-pine woodland originally dominated the more gently sloping upland surface associated with the Roubidoux Formation. Early descriptions portray an open, grassy and shrubby understory in these woodlands, a condition related to the prevalence of fire in the historic landscape. Oak and oak-pine forest occupied lower slopes and more dissected, hilly parts of these landscapes, as well as the wider and more well-drained bottom. Bottoms with richer alluvial soils and more abundant water likely were forested in mixed hardwood timber. Dolomite glade and open savanna/woodland complexes were common on exposed slopes with shallow soils. Sinkhole ponds and fens were dotted occasionally throughout.

Current Conditions: Mainly forested in second growth oak and oak-pine forests; forest cover ranges from sixty to over 80%. Most forests are rather dense, near even-age second growth, with very little woodland ground flora. The occurrence of shortleaf pine in these forests has diminished from its original extent, today having only 20-30% of the forest cover containing a substantial component (>25%) of pine. Even age stands dominated by scarlet, black, and white oak are common, oak die back is a common problem. Much of the existing timber land is associated with public land ownership. Cleared pasture lands occupy many of the broad stream valleys and highest, flattest ridges. Many glades and woodlands suffer from woody encroachment, and sinkhole ponds and fens have been drained or severely overgrazed. An exceptional proportion of state-listed species sites are associated with the streams, springs, caves, cliffs, fens, and sinkhole ponds in this group.

Big Piney River Oak-Pine Woodland/Forest Hills (18.7%): Includes most of upper valley; exceptional pine component and cleared bottoms.

North Fork River Oak-Pine Woodland/Forest Hills (0.1%): Includes most of valley; exceptional pine component and USFS ownership.

Table Lu05. Public lands within the Big Piney Watershed. Acreage and permanent stream mile estimates are approximate.

Area Name	Owner/ Leasee	Acres	Permanent Stream Miles
Baptist Camp Access	MDC	6.2	0.80
P. F. Barnes Conservation Area	MDC	118.0	
L. A. Boesl Outdoor Education Area	MDC	8.7	
Boiling Spring Access	MDC	9.5	0.25
Cabool Towersite	MDC	16.0	
Dog's Bluff Access	MDC	2.9	0.20
Dripping Springs Natural Area	MDC*	5.4	0.21
Peter A. Eck Conservation Area	MDC	380.9	0.75
Ft. Leonard Wood Towersite	MDC	60.3	
Horseshoe Bend Natural Area	MDC*	220.3	2.19
Houston Forestry Office	MDC	1.9	
Houston Towersite	MDC	12.5	
Mason Bridge Access	MDC	8.9	0.10
Mineral Springs Access	MDC	6.0	0.25
Piney River Narrows Natural Area	MDC*	248.5	2.05
Ross Access	MDC	3.1	0.05
Ryden Cave Conservation Area	MDC	29.7	
Simmons Ford Access	MDC*	3.3	0.10
George O.White State Forest Nursery	MDC	754.2	
Missouri Dept. of Conservation Total		***1,896.1***	***6.95***
Mark Twain National Forest (Houston-Rolla Dist.)	***USFS***	***88,942.3***	***87.90***
Fort Leonard Wood Military Reservation	***USDOD***	***24,133.8***	***14.16***
Big Piney Watershed Total		**114,972.2**	**109.01**

Note: This table is not a final authority. Data subject to change.

Owner/Leasee*: MDC=Missouri Department of Conservation
USFS=United States Forest Service
USDOD= United States Department of Defence

Table Lu06. Percentages of public land ownership within eleven digit hydrologic units of the Big Piney Watershed.

Unit Name	MDC	USFS	DOD	Total
Upper Big Piney	0.3	0.0	0.0	0.3
Middle Big Piney	0.4	20.9	0.0	21.3
Spring Creek	1.1	25.0	0.0	26.1
Lower Big Piney	0.1	41.9	27.0	69.0
Watershed	***0.4***	***18.4***	***5.0***	***23.8***

MDC=Missouri Department of Conservation
USFS=United States Forest Service
DOD= Department of Defense

Figure Lu01. Historical acreage estimates of selected crops harvested in Phelps, Pulaski, and Texas Counties combined (MASS 1999).

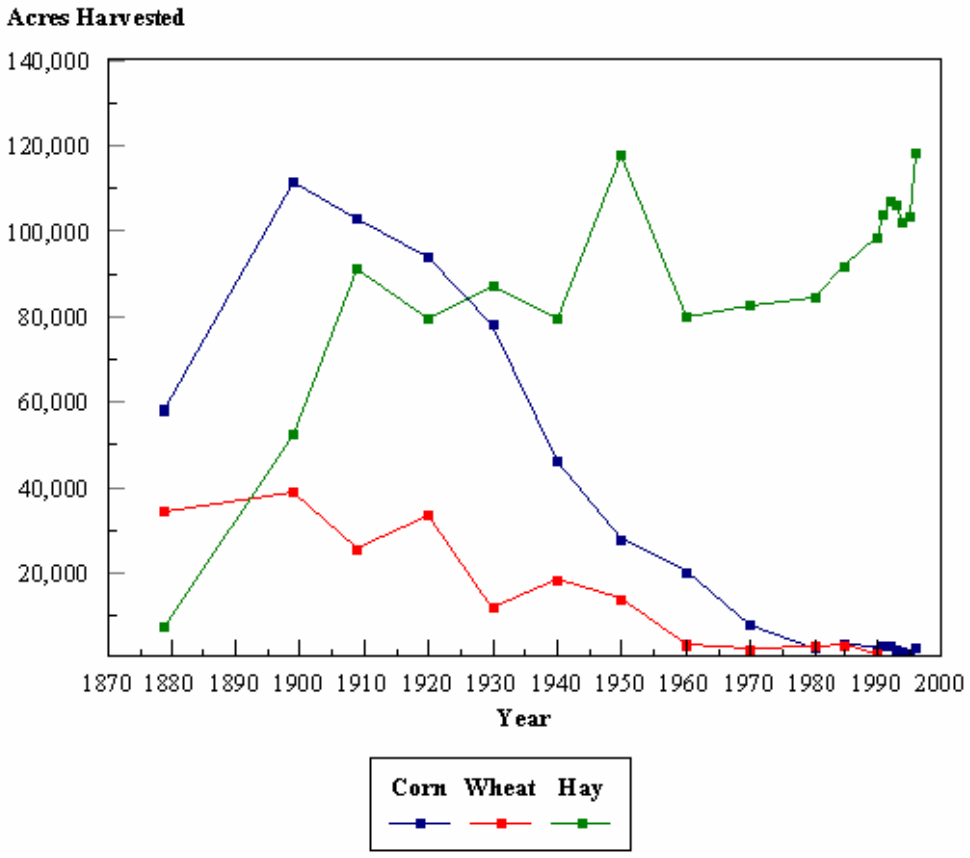
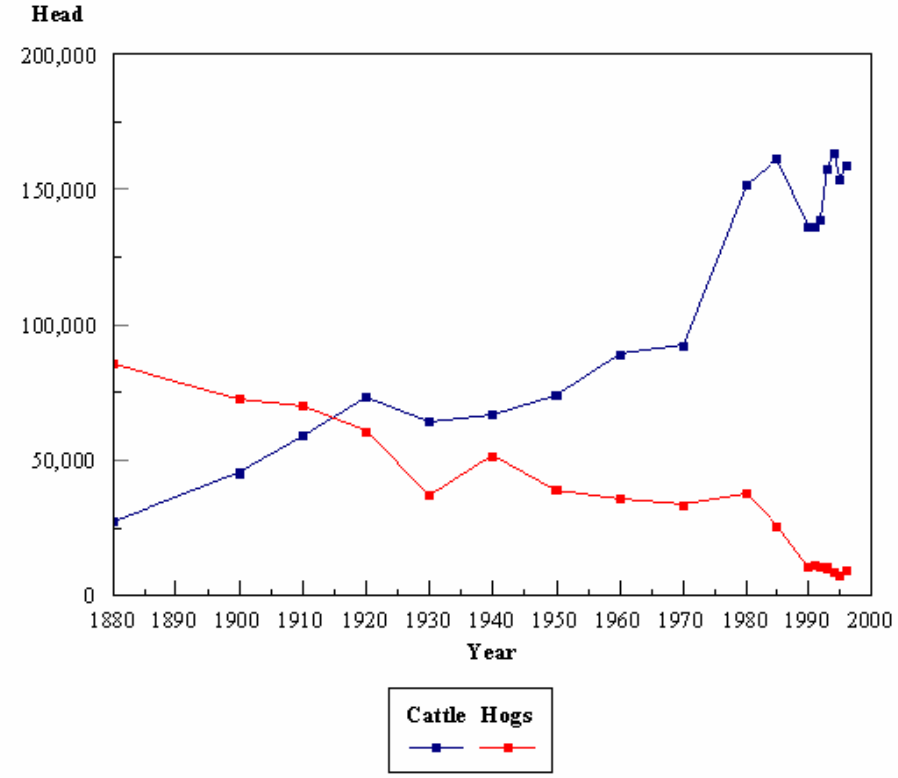


Figure Lu02. Cattle and hog population trends for Phelps, Pulaski, and Texas Counties combined (MASS 1999).



FigureLu03 Human population trends for Phelps, Pulaski, and Texas Counties (OSEDA 1998).

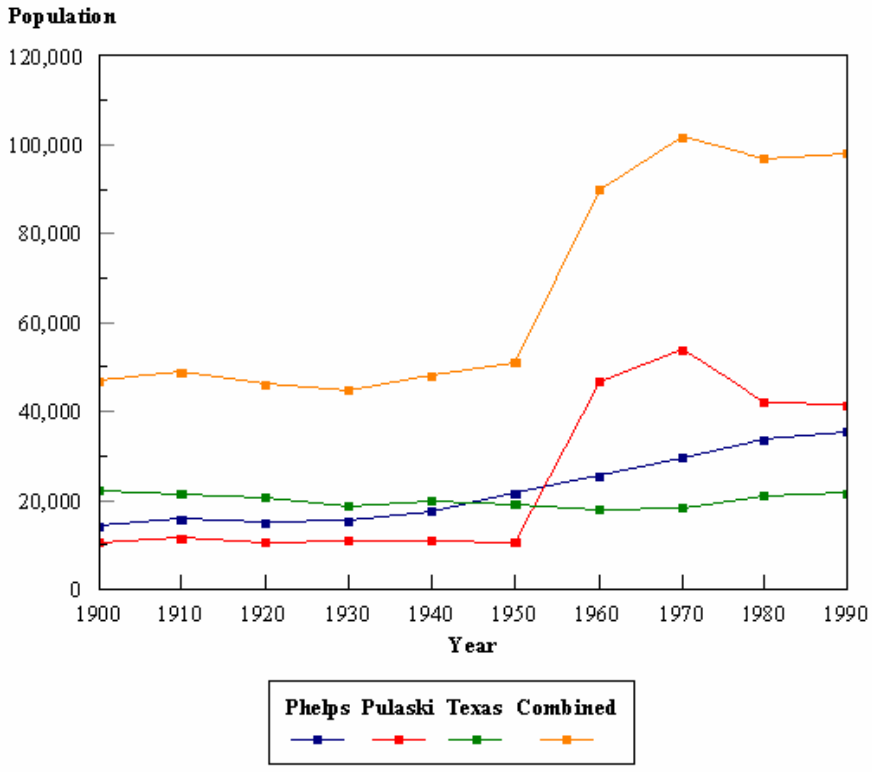


Figure Lu04.

Big Piney Watershed

Population Distribution

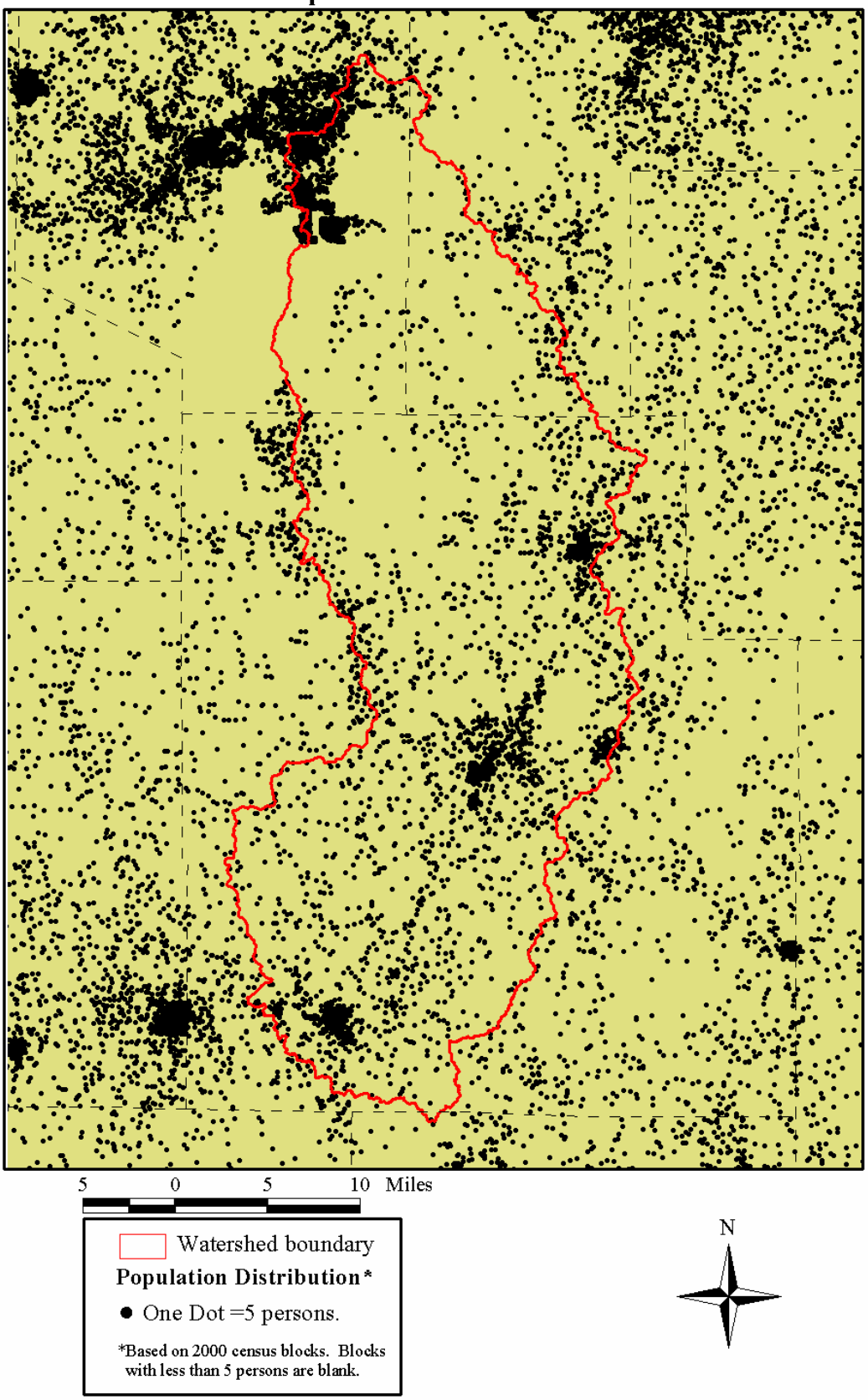


Figure Lu05.

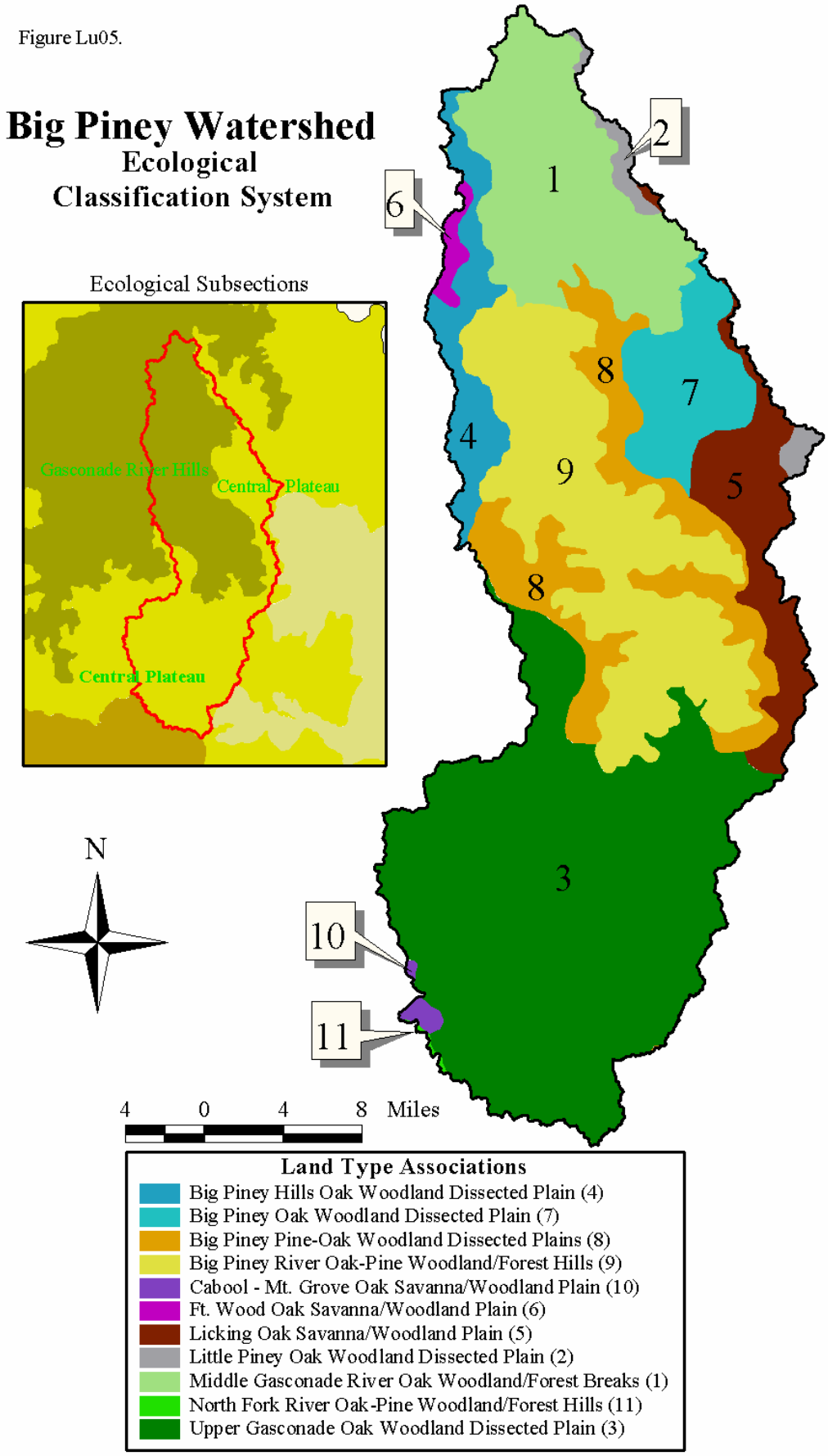

Big Piney Watershed
Ecological
Classification System
Ecological Subsections
Gasconade River Hills
Central Plateau
Central Plateau
N
1
2
3
4
5
6
7
8
8
9
10
11
4 0 4 8 Miles
Land Type Associations
Big Piney Hills Oak Woodland Dissected Plain (4)
Big Piney Oak Woodland Dissected Plain (7)
Big Piney Pine-Oak Woodland Dissected Plains (8)
Big Piney River Oak-Pine Woodland/Forest Hills (9)
Cabool - Mt. Grove Oak Savanna/Woodland Plain (10)
Ft. Wood Oak Savanna/Woodland Plain (6)
Licking Oak Savanna/Woodland Plain (5)
Little Piney Oak Woodland Dissected Plain (2)
Middle Gasconade River Oak Woodland/Forest Breaks (1)
North Fork River Oak-Pine Woodland/Forest Hills (11)
Upper Gasconade Oak Woodland Dissected Plain (3)

Figure Lu06.

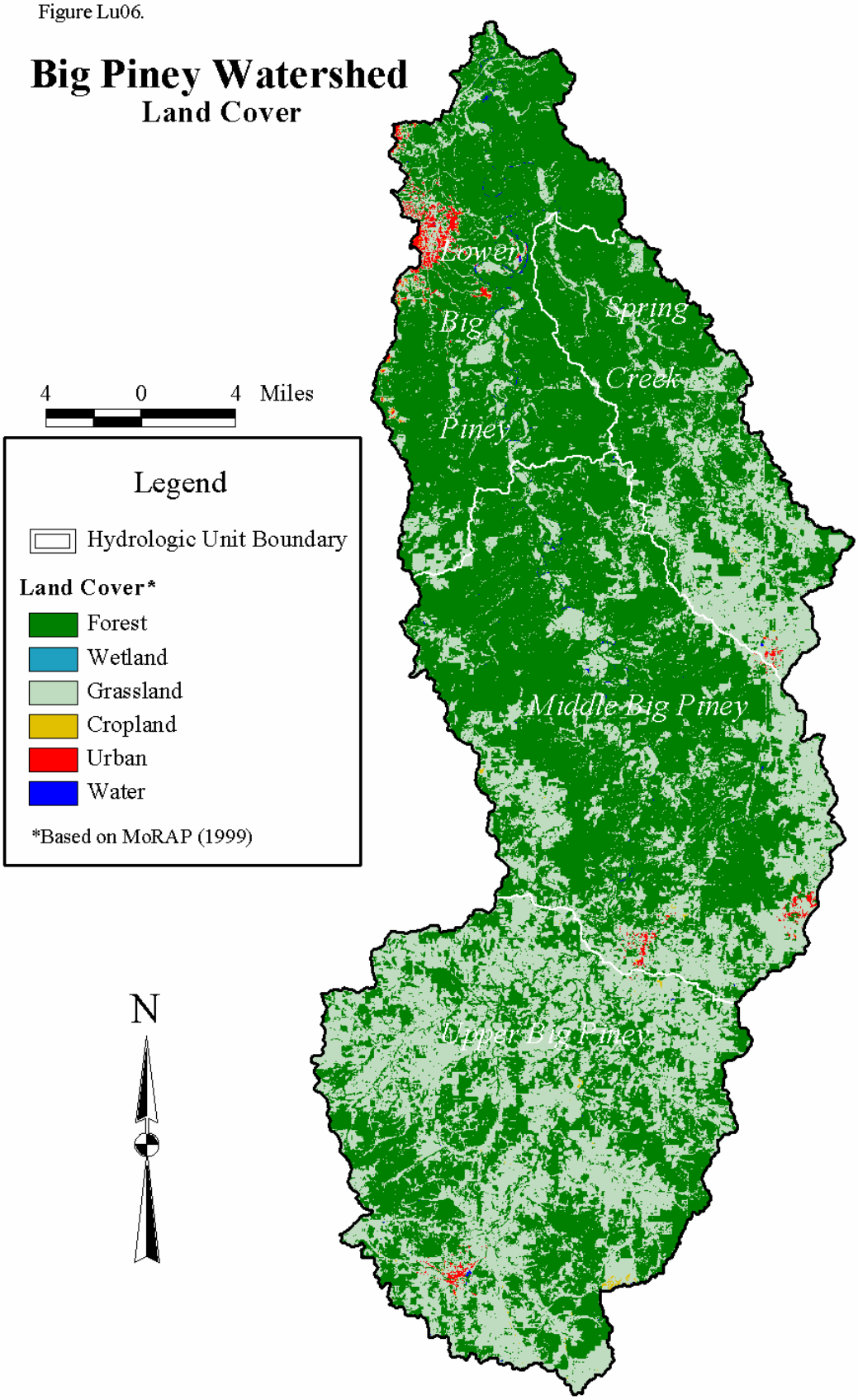

Big Piney Watershed
Land Cover
Lower Big Piney
Spring Creek
Middle Big Piney
Upper Big Piney
4 0 4 Miles
Legend
Hydrologic Unit Boundary
Land Cover*
Forest
Wetland
Grassland
Cropland
Urban
Water
*Based on MoRAP (1999)
N

Figure Lu07.

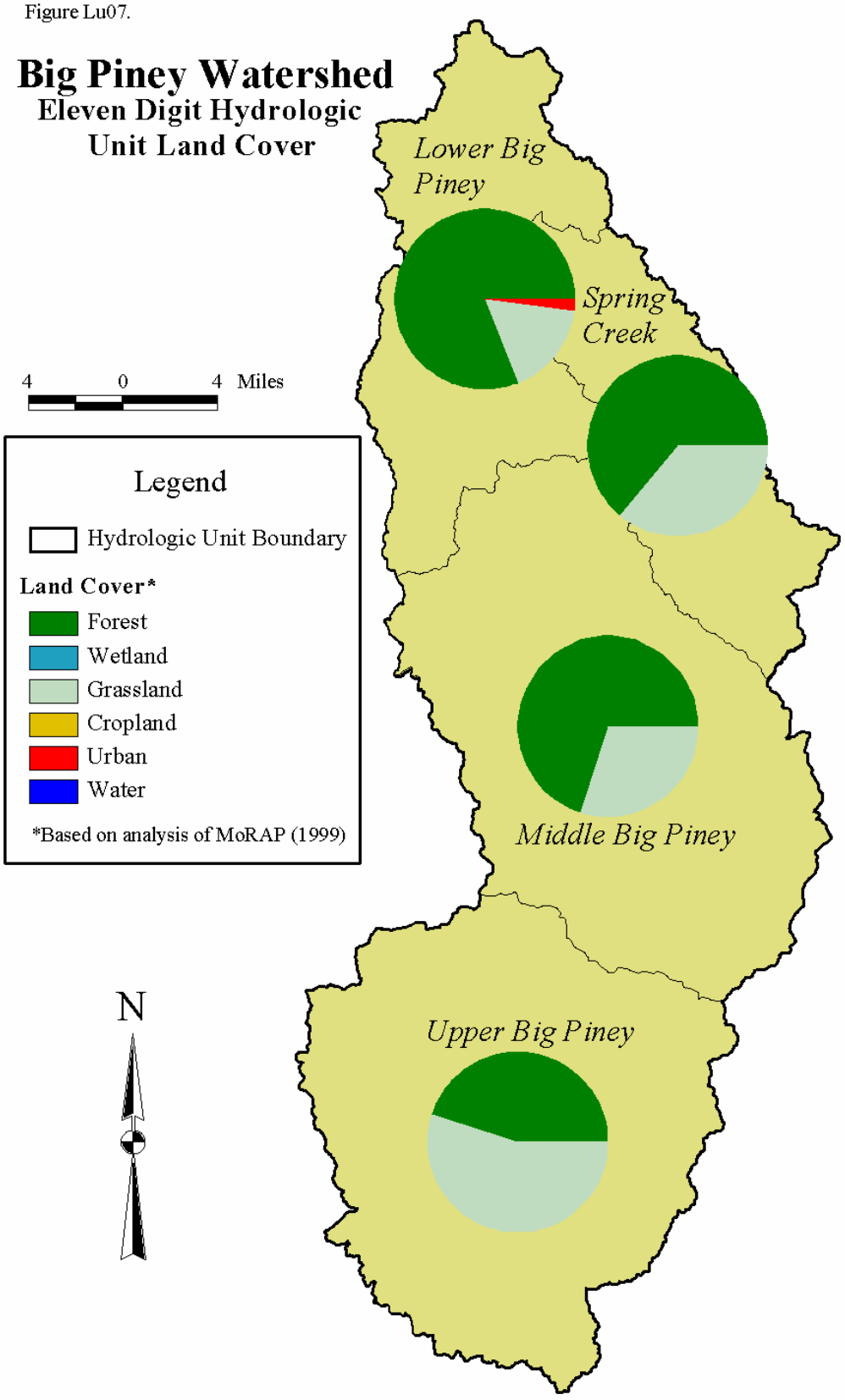

Big Piney Watershed
Eleven Digit Hydrologic Unit Land Cover
Lower Big Piney
Spring Creek
Middle Big Piney
Upper Big Piney
4 0 4 Miles
Legend
Hydrologic Unit Boundary
Land Cover*
Forest
Wetland
Grassland
Cropland
Urban
Water
*Based on analysis of MoRAP (1999)
N

Figure Lu08.

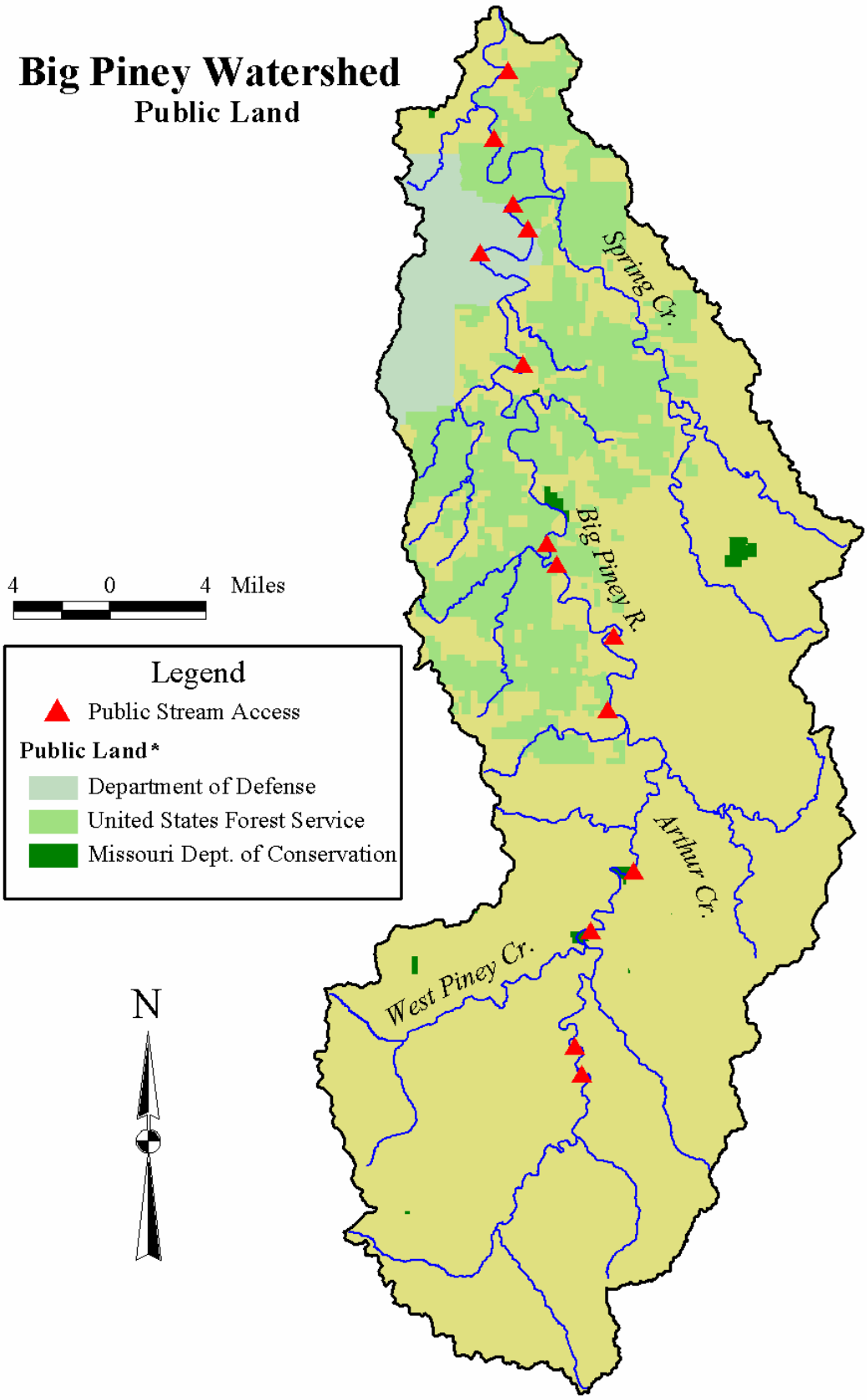
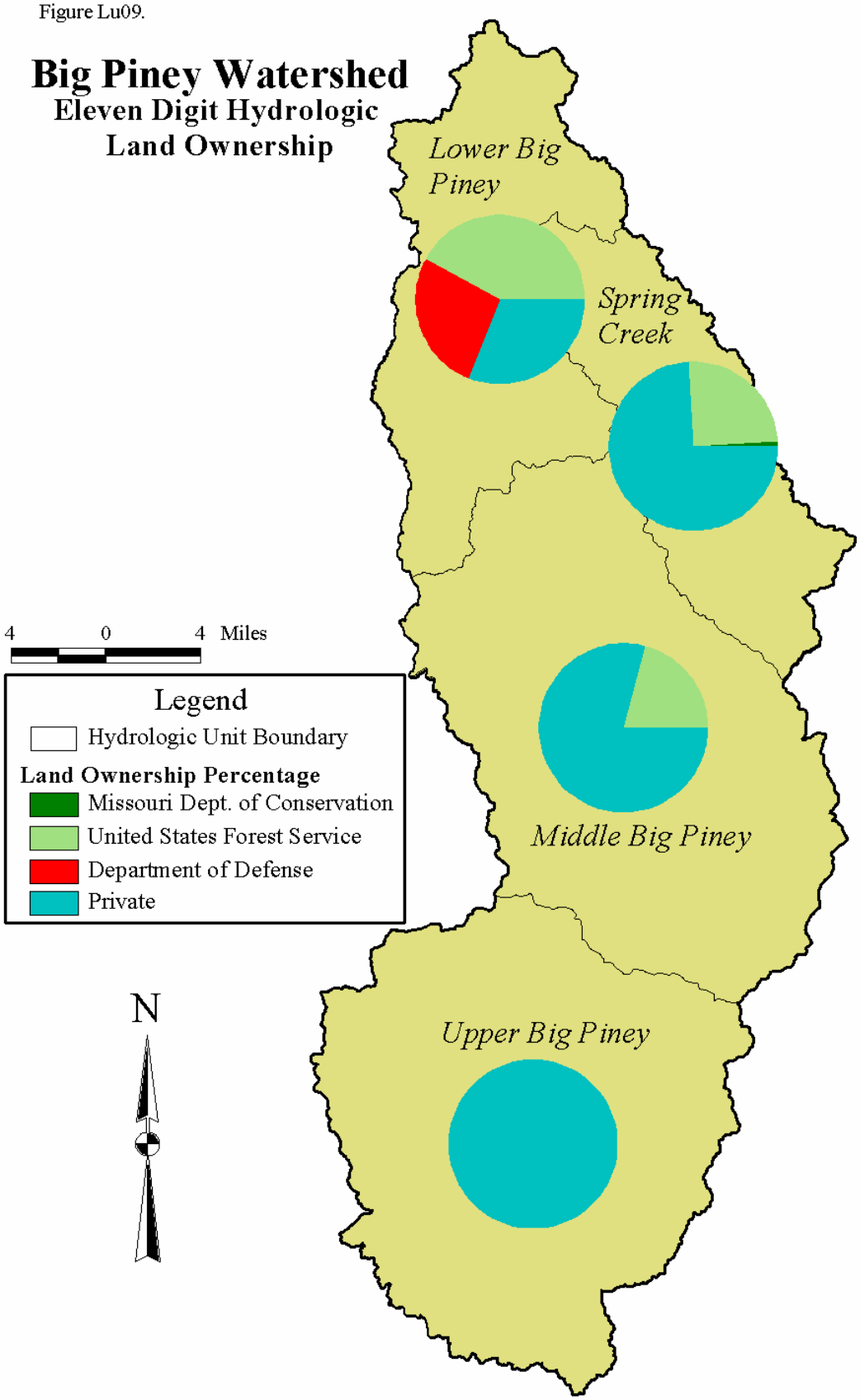

Big Piney Watershed
Public Land
Spring Cr.
Big Piney R.
Arthur Cr.
West Piney Cr.
4 0 4 Miles
Legend
Public Stream Access
Public Land*
Department of Defense
United States Forest Service
Missouri Dept. of Conservation
N

Figure Lu09.


Big Piney Watershed
Eleven Digit Hydrologic
Land Ownership
Lower Big Piney
Spring Creek
Middle Big Piney
Upper Big Piney
4 0 4 Miles
Legend
Hydrologic Unit Boundary
Land Ownership Percentage
Missouri Dept. of Conservation
United States Forest Service
Department of Defense
Private
N