Upper Saline Watershed 9-Element Plan

Prepared by The Nature Conservancy
In Partnership with the
Arkansas Natural Resource Commission

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The Nature Conservancy

SAVING THE LAST GREAT PLACES ON EARTH

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Preface

Watershed Restoration Plans are one of the most important opportunities for assessing and restoring our nation's streams. The finished product not only identifies the problems, sources and critical data gaps; it also outlines strategies to correct the problems and address data gaps, galvanizing the future efforts of government agencies, landowners, and conservation organizations. The Nature Conservancy has worked to produce a watershed plan that will foster an atmosphere of economic prosperity and watershed restoration, by residents and conservation practitioners working together under a shared vision. This watershed plan incorporates diverse stakeholder input derived from three local watershed committee meetings held over the course of 2005. The “Watershed Committee” is comprised of representatives from various local, state, and federal agencies as well as private interests and citizens. TNC commits to working with Conservation Districts, state and federal agencies, and citizens to implement this collaborative plan for the Upper Saline Watershed.

Chapter 1

Historical/Ecoregional Information

The Upper Saline Watershed boundaries fall within two distinct ecoregions within the state of Arkansas. Sixty-five percent of the Saline River Watershed falls within the Upper West Gulf Coastal Plain (UWGCP) and thirty-five percent falls within the Ouachita Mountain Ecoregion. Humans have been a powerful force in the ecological dynamics of the Ouachita Mountains and the Upper West Gulf Coastal Plain for thousands of years. Shortleaf pine spread throughout the Ouachita Mountains 1600 to 1000 years ago. This spread was accompanied by the extensive use of fire by aboriginal Americans. For more than 4000 years aboriginal Americans used fire to increase forage for game animals. They also cleared fertile areas in the major river valleys to raise crops and in doing so introduced new species of plants and animals to the Ouachitas. These activities together with a complex geological and evolutionary history created the anthropogenic phenomenon that was the tessellated landscape present when the first European settlers arrived in the area (TNC, 2003).

The majority of forests within the Upper Saline Watershed were cut over by the late 1920's and the second set of growth forest cut again in the 40's and 50's. Only fragments remain in a "pre-settlement" condition within this reordered landscape. In addition, 70 years of fire suppression has led to changes in structure and composition of the remaining forested landscape. The riparian ecosystems have historically been disrupted in many areas by the building of railroads to extract timber. Many riparian areas were then homesteaded and have not regenerated.

Ouachita Mountain Ecoregion

The Ouachita Mountain Ecoregion, including parts of Arkansas and Oklahoma, comprises a landscape of approximately 11.48 million acres of rugged mountain ridges, broad valleys, and the headwaters of several large river systems. The complex geological formations and soils of this forested landscape have created a tremendous diversity of habitat reflected in a biodiversity of ancient lineage; the Ouachitas have been available for continuous occupation by terrestrial and aquatic life for 225 million years, and are a center for endemism in North America, particularly in the realm of aquatic species (TNC, 2003).

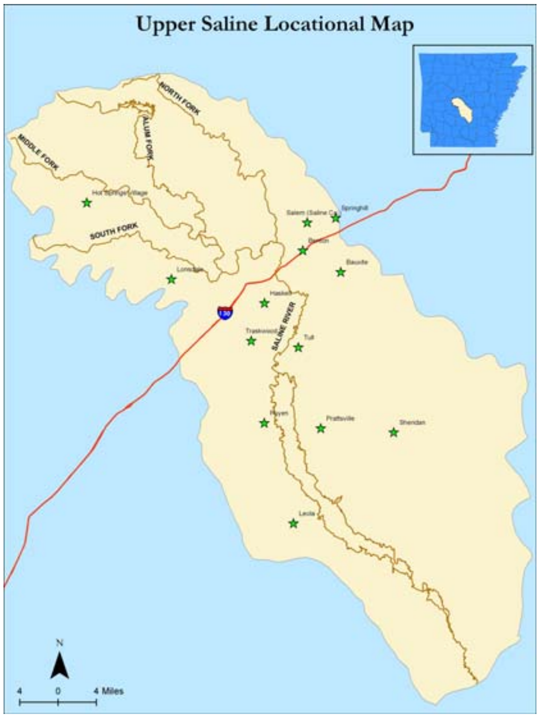
Smaller streams, like the headwaters of the Saline River, originate in the Ouachitas through surface and sheetflow-fed seeps, groundflow, and surface flow drainage. The headwaters; the North, Middle, Alum, and South Forks; feed into the Saline River, a larger high-order river, creating a transition from typical low-order streams, gravel and cobble that give way to more fine substrates, such as sand and silt.

Upper West Gulf Coastal Plain

The Upper West Gulf Coastal Plain (UWGCP) is an area of approximately 26,250,000 acres or 40,970 square miles, covering parts of Arkansas, Louisiana, Oklahoma, and Texas. Terrestrial systems in the UWGCP include bottomlands dominated by hardwood communities, primarily oak species, and more deeply flooded areas frequently have cypress and cypress-tupelo swamp vegetation. Upland areas consist of shortleaf and loblolly pines, mixed pine-hardwood communities, glades, and woodlands. Barrens and woodlands occur within this ecoregion on saline soil flats. Ancient volcanic intrusions formed bauxite deposits that are home to globally rare and endemic nepheline syenite communities.

Within the UWGCP, aquatic systems are typically characterized as low sloped, medium- to high-order streams, and riverine systems. Streams are sheet-, surface- and groundwater fed. Slower, larger rivers that originate in other ecoregions flow through the UWGCP and are home to diverse mussel and fish communities. Rivers are the predominant aquatic system in the UWGCP, and consist of substrates ranging from gravel, sand-gravel, to mud and silt. Seasonal and ephemeral flooding is a common natural aquatic process for river systems in the UWGCP.

Figure 1: Locational Map



Watershed Location and Physical Setting

The Upper Saline River Watershed includes portions of Garland, Hot Springs, Grant, Jefferson, Dallas, Cleveland, Pulaski, and Saline counties in Arkansas, and has a total drainage area of approximately 1716 square miles. The headwaters to the Saline River originate in the Ouachita Mountain ecoregion draining a portion of the mountains of west central Arkansas. The Saline River mainstem and other main tributaries including Dry Lost Creek, Francois Creek, Hurricane Creek, and Derriseaux Creek, flow through the Upper West Gulf Coastal Plain and reach a confluence with the Ouachita River near the Arkansas Louisiana border.

Demographic and Socioeconomic Conditions

The general socioeconomic conditions in the watershed can be summarized as follows:

(1) strongly silviculture oriented
(2) variable per capita income throughout the watershed
(3) increasing populations in several key areas: Benton, Hot Springs Village

Benton (pop. 21,906) and Hot Springs Village (pop. 8,397), both located within Saline County, are the most populous towns within the Upper Saline Watershed followed by the city of Sheridan (pop. 3,872) located in Grant County (Appendix A: Population Density). Saline County has experienced a growth rate of population from 1990 to 2004 of 30.1%. Outside of the rapidly growing populations within the northern portion of the watershed, the southern portion of the Upper Saline watershed is primarily devoted to timber production interspersed with small rural communities.

While silviculture is the predominant land use in the watershed, a relatively small work force is associated with this industry. Agriculture, forestry, and fishing occupations combined represent 1.5% of the workforce in Grant County and <1% of the workforce in Saline County (U.S. Census Bureau 2000).

The percent of individuals at or below poverty level is relatively low throughout the watershed with a slight increase in these statistics the further south you travel. Saline county individuals below poverty level equal 7.2%, with Grant County accounting for 10.2% of its population below poverty level.

Landscape and Topography

The majority (65%) of the Saline River watershed lies within the Upper West Gulf Coastal Plain ecoregion. The topography of the two ecoregions is very different with rugged terrain characterizing the Ouachita Highlands and rolling to flat topography representative of the Upper West Gulf Plain. The highest point within the watershed is 1,560 feet located near the Saline and Garland county boundary along Alum Fork, a tributary to the Saline River. Average relief within the Ouachita Highland region of the Saline watershed is approximately 200 feet. Slopes average less than 15% but range from 6% to 120%. The highest points in the Upper West Gulf Coastal Plain are along terraces with average relief of less than 100 feet. Slopes in this region range from 0% to 20% and average less than 5%.

The nepheline syenite outcrops in the bauxite producing region of Arkansas' West Gulf Coastal Plain are among the rarest of the igneous outcrop-based ecosystems in the southern United States. These outcrops of intrusive igneous rock provide a variety of important and specialized habitats for uncommon plant communities and rare plant species in the Coastal Plain. The Bauxite Mining Reclamation Area (BMRA) is one of three such outcroppings known from North America and is generally composed of gray nepheline syenite with gentle topography. The outcrops proper are small but numerous, interspersed with dry woodland and forest vegetation over shallow to deeper soils.

Geology

<u>Ouachita Mountains</u>

The Ouachita Mountain Ecoregion extends in a broad belt eastward from Atoka County, Oklahoma to the vicinity of Little Rock, Arkansas. The Ouachita Mountain region was created 345 million years ago by the same geophysical action that formed the Appalachian Mountains and Central Plateau of Texas. To the east, structural and stratigraphic features are buried by Cretaceous and Tertiary rocks and deposits of the Mississippi Embayment and to the west the structural trend curves south and is buried by Cretaceous strata of the Central Plains (Miser, 1929). This process has left the Ouachitas isolated from other mountain systems.

The landform of the Ouachita Mountains is an accretionary prism composed of intensely folded and deformed sandstone, shale and chert units that form one of the major fold-belt mountain ranges of the North American continent. Initial sedimentation occurred in deeply submerged ocean troughs. Silty oceanic ooze was lithified into thin layers of shale and chert during Paleozoic times. Occasional units of sandstone occur in the succession, probably emplaced by ocean currents and as fans at the heads of submarine canyons. Strata of Ordovician, Silurian, Devonian and Mississippian ages are exposed in the Ouachitas and represent this early phase of sedimentation. During late Mississippian and early Pennsylvanian periods huge deposits of sand entered the ocean from rivers which had their deltas in the area. These rivers deposited great volumes of sand and mud in the basin with accumulations reaching thicknesses of 45,000 feet. These strata are represented by the Stanley, Jackfork, Johns Valley and Atoka formations (Miser, 1929). The collision of two continental tectonic plates, Laurasia with the North American plate resulted in a mountain building process referred to as the Ouachita Orogeny. Oceanic oolitic and deltaic deposits were intensely deformed by compressive forces which were directed north toward the stable interior of the North American continent and metamorphism occurred. Twisted, warped and overturned folds and thrust faults reflect this violent collision (Viele, 1973). Deformed Paleozoic rocks were later intruded during the Cretaceous period by hydrothermal quartz and rock.

Erosion has been the dominant geological force over the last 300 million years. Soft shales have eroded away or deposited in valleys while resistant sandstones, cherts and novaculites have been formed into the dominant ridges we see today. This ridge and valley formation is characterized by long, hogback ridges with relief as great as 1600 feet above the valley floors and total elevations between 600 and 2,750 feet above sea level. These ridges run east-west and generally have long north and south facing slopes. Because of the way the rock strata fractured, north facing slopes tend to be steeper than south facing slopes. Surface rocks consist of sandstones, shales and cherts (Miser, 1934).

The Ouachita Mountains can be divided into four geologically distinct subsections (Honess, 1923) three of the four are found within the Saline River Watershed:

- **Northern Hogback Frontal Belt** (Fourche Mountains): These ridges are composed of massive formations of sandstone underlain in places by various shales.

- **Broken Bow-Benton Novaculite Uplift** (Central Ouachita Mountains): The most rugged terrain in Arkansas with sharp narrow ridges, shallow soils and narrow stony valleys. The ridges are capped with fractured novaculite, a hard, resistant siliceous igneous rock which has influenced the formation of glade communities. Found in the upper reaches of the watershed and the area is noted for its numerous springs and seeps.

- **Athens Plateau** (Piedmont): The novaculite formation grades southward to a gentler topography. Rivers flow south and drop over the fall line to the Gulf Coastal Plain. This is an area of low ridges 150-220 feet high. Uplifted toward the end of the Ouachita orogeny, this plateau was dissected by downcutting rivers.

<u>Upper West Gulf Coastal Plain</u>

The Upper West Gulf Coastal Plain (UWGCP) geologic features primarily consist of two types of materials: those deposited in shallow seas of the Mississippi Embayment during the Late Cretaceous and Early Tertiary periods, and those subsequently deposited as alluvium during the Quaternary period. The highest elevation is found along the Deweyville terrace sequence approximately 850 feet above sea level. Recent geologic formations include Quaternary age Pleistocene deposits and Holocene alluvial deposits. Very prominent terrace deposits are found along the Saline River; most are the remnants of floodplains that were deposited in the late Early Pleistocene, more than 800,000 years ago. These terraces are identified as the Montgomery Terrace and originated during interglacial periods of high sea levels. A nearly continuous terrace system that belongs to the Deweyville sequence also is found along the Saline River. These were created during a period of maximum glaciation that occurred over a span of more than 15,000 years, beginning approximately 30,000 years before present (Saucier and Smith, 1986).

Soils

In-situ soil development within the Upper Saline Watershed (USW) is strongly influenced by the parent material and topography where formed. Within the two ecoregions found in the USW, major soil groups are markedly different.

Ouachita Ecoregion Soils

The soils formed are very diverse because of the complex interplay of several factors, but most important are aspect, slope, and bedrock. The ridges are composed of sandstone and chert and extremely steep slopes with numerous rock exposures. Soils that form are thin, have low permeabilities and moderate to rapid runoff. The ridge tops are characterized with very shallow soils and rock glaciers have formed on the steepest slopes. The valleys between the ridges are underlain by shale and have a gentle relief. The valley soils are a mixture of loam and clayey loam. Drainage ranges from moderate to slow and runoff potential is moderate. The general distribution of the major soil associations in the Ouachita Highland Ecoregion of the Upper Saline River Watershed are illustrated in Figure 1.

The Upper West Gulf Coastal Soils

Soil formation in the UWGCP is very different from those of the Ouachita Mountain Ecoregion primarily because of the differences in parent material, aspect, and slope. Parent material consists predominately of sandstones, siltstones, and shale units. Soils formed on the broad upland flats and long, narrow ridges of stream terraces have subsoils of silt loam to silty clay loam. These soils are characterized as having moderate to poor drainage with moderate runoff potential. The upland soils are poorly to moderately drained and characteristically have a runoff potential that is moderate. Bottomland soils formed on nearly level topography surrounding the Saline River are frequently flooded, and are poorly drained.

Figure 2: Soil Associations Upper Saline Watershed

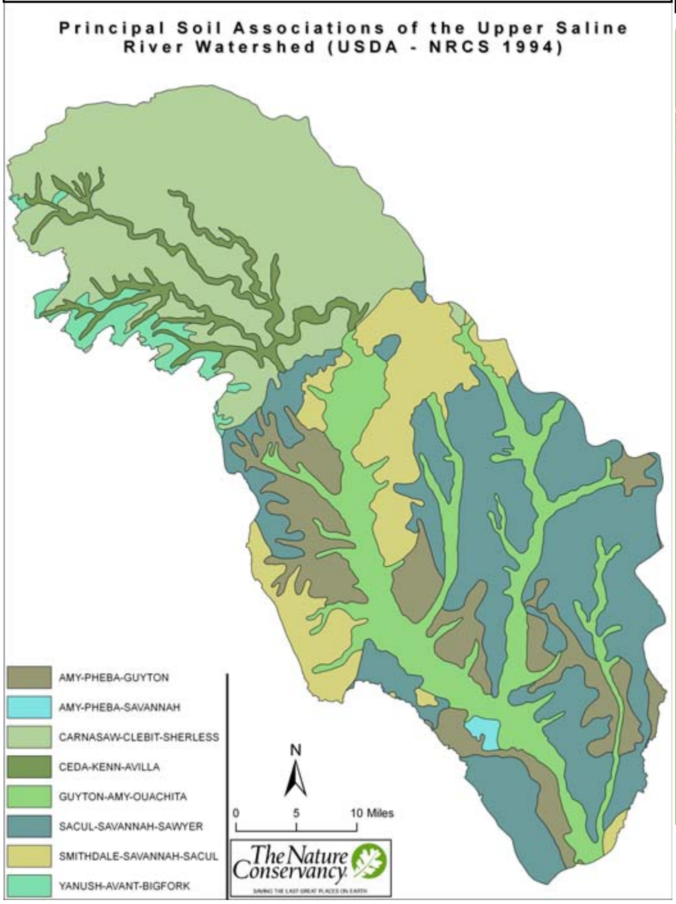


Figure 3: Slope Associations Upper Saline Watershed

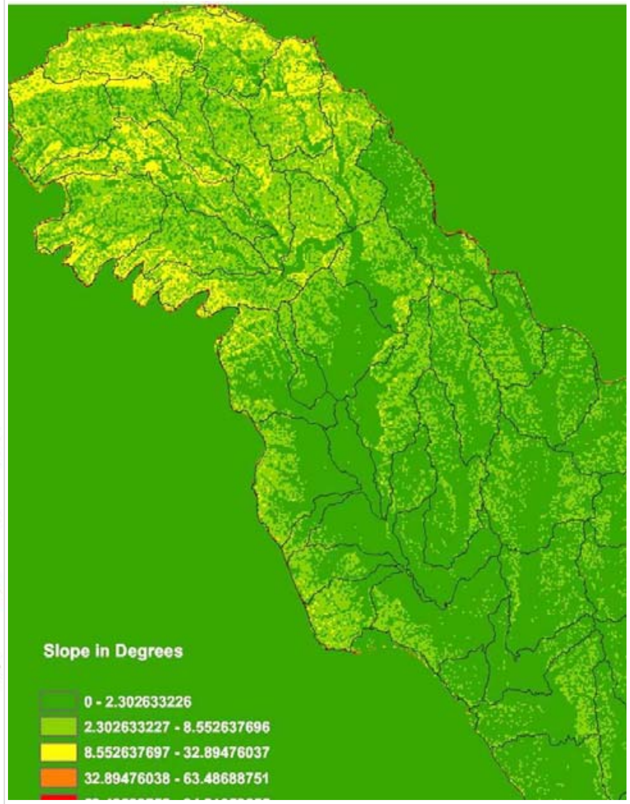


Table 1 (page 11) presents brief descriptions of the principal soil associations found in the basin. The land surface slope map (Figure 3, above) when used in conjunction with the map of the major soil associations (Figure 2, above) indicates how slope and soil types can magnify the erosive nature of precipitation and increase sediment delivery to the Saline River.

Table 1: Soil Associations and Characteristics of the Upper Saline Watershed

Map Units	Characteristics
Amy-Pheba-Guyton Amy-Pheba-Savannah	Deep, moderately well drained to poorly drained, moderately permeable to slowly permeable loamy soils.
Carnasaw-Clebit-Sherless	Well drained, undulating to steep, moderately deep and deep, gravelly and stony loamy soils on hills, mountains, and ridges
Ceda-Ken-Avilla	Deep, level to gently sloping, well drained, gravelly and loamy soils that formed in alluvial sediment.
Guyton-Amy-Ouachita	Poorly drained and well drained, level to gently undulating loamy soils on flood plains of local streams and drainageways.
Sacul-Savannah-Sawyer Smithdale-Savannah-Sacul	Poorly drained and moderately well drained, level to gently sloping loamy soils on uplands and stream terraces.
Yanush-Avant-Bigfork	Deep and moderately deep, gently sloping to very steep, well drained, very gravelly and stony soils that formed in residuum and coluvium of chert and novaculite.

These data obtained from USDA Soil Surveys (1968, 1979,1989)

Climate

The Upper Saline River watershed is located in the humid subtropical zone. Hot, sultry summers and moderately cool winters with some snow, but no accumulations, are normal. The climate is controlled by two different air masses. Warm, moist air from the Gulf of Mexico generally dominates especially in the spring and summer. Cooler, dryer air from the Central Plains enters the area in the winter (National Climatic Data Center, 1979).

Precipitation is well distributed throughout the year. Spring rainfall is important particularly because of drought conditions that routinely occur in the summer. Total precipitation ranges from 1100mm-1500mm (43-59 inches) decreasing from northeast to southwest within the watershed. Droughts occur most likely during late summer and fall (National Climatic Data Center, 1979). Moderate droughts occur at 15-20 year intervals with several, multi-year droughts even less frequent. Tornadoes and floods may occur in any month but are most likely during the spring. Strong winter winds with sleet and freezing rains occur in late December, January, and February. Temperatures average from 4-10 degrees Celsius (39 -50 degrees Fahrenheit) in January to 21-32 degrees Celsius (69-90 degrees Fahrenheit) in July. The peak high temperatures usually occur in August.

Hydrology

Streams and rivers

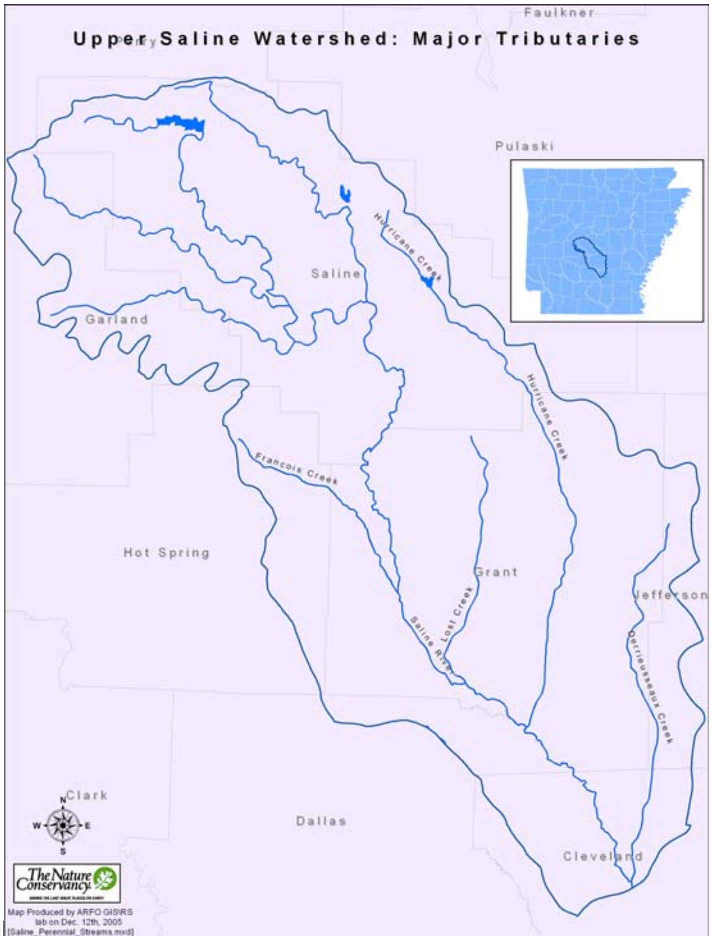


Figure 4: Major Tributaries

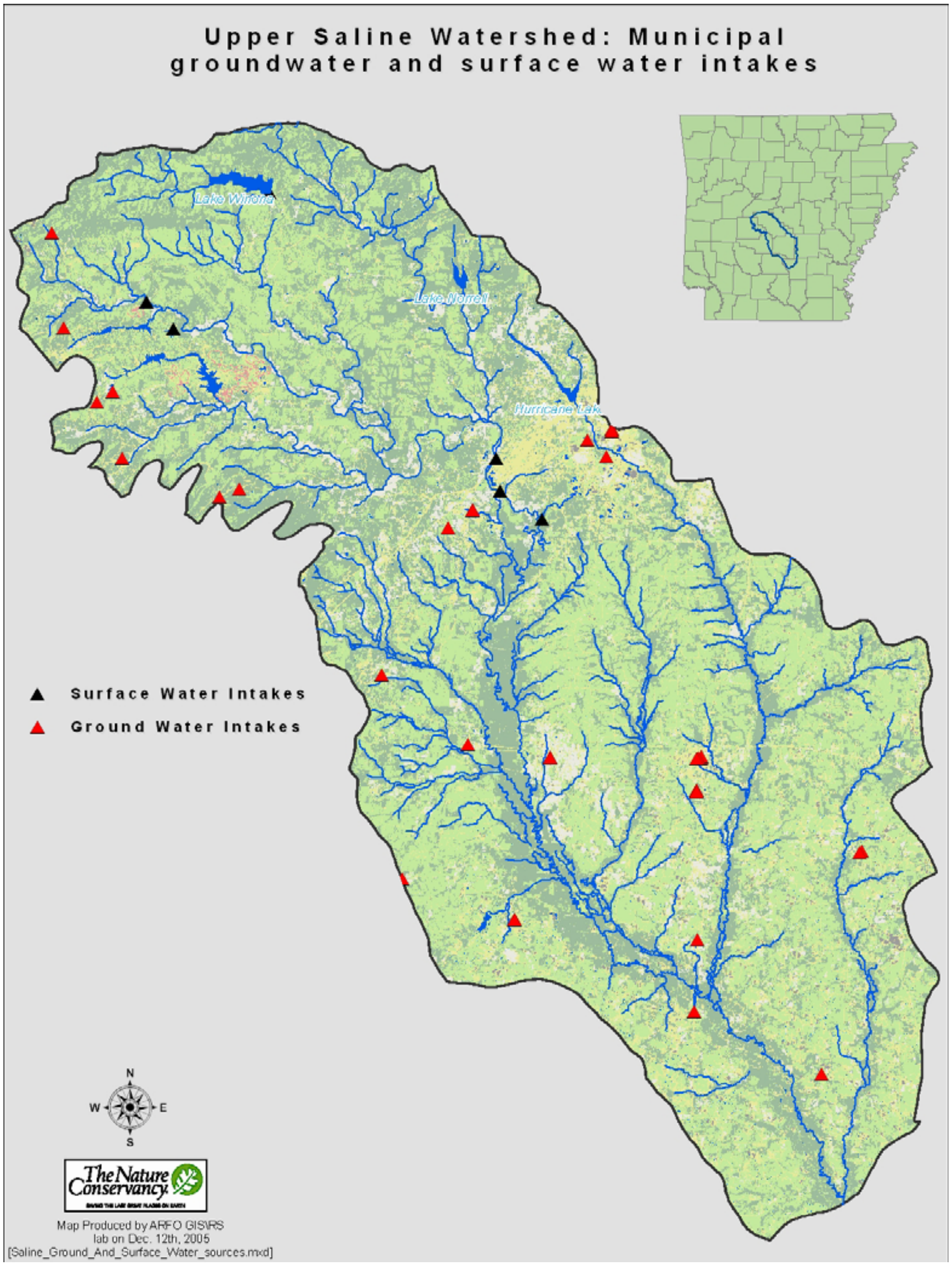
Major tributaries include: Alum Fork, Middle Fork, South Fork, North Fork, Derrieusseaux Creek, Francois Creek, Dry Lost Creek and Hurricane Creek (Figure 4). The Upper Saline River catchment is characterized by two distinct stream patterns, trellis and pinnate, in response to the underlying geology of the two ecoregions (See Appendix A: Figure 5) . Suspended sediment has been identified by the Arkansas Department of Environmental Quality (ADEQ) and the Arkansas Natural Resource Commission (ANRC) as a priority non-point source pollutant within the watershed, thus identification and prioritization of sediment sources is needed. Several parameters heavily influence sediment contributions to the Upper Saline Watershed including geologic formations, slope, and soil types.

The small headwater streams of the Saline are considered more typical of upland, cool low-order streams, and offer the most diverse fish communities. Substrates are composed of sand, gravel, cobble, and exposed bedrock. Pool/riffle/run systems are a common feature of these systems. Water is historically clear and cool with medium to high gradients. These systems provide critical habitat for mussel communities and beds, many of which are species targets, and flow into higher-order/big rivers which have lower gradients. Fish target species found in low-order streams include catfish, shiners, and darters (Robison and Buchanan, 1988). Within the Ouachita ecoregion, only two rivers have remained unimpounded including the Saline River mainstem; however, the four forks of the Saline River have multiple impounded tributaries.

Municipal Water Usage

Public water supplies provide drinking water to surrounding communities. Below is a map (Figure 4) reflecting the distribution of groundwater and surface water intakes for municipalities located in the Upper Saline Watershed. This map helps portray municipal areas that rely on the Saline Watershed for drinking purposes.

Figure 5: Municipal Water Intakes



Groundwater

Most of the ground water supplies in the Saline River Watershed are obtained from six water-bearing formations called aquifers or aquifer systems. These aquifers in order of increasing depth are the Quaternary Alluvial, Cockfield Formation, Cane River Formation, Sparta-Memphis Sand, Wilcox Group, and rocks of Paleozoic age. The withdrawals of ground water from these aquifers in 2002 are listed in Table 2 (ANRC, 2005).

Table 2: Withdrawals of Groundwater by Aquifer in 2002.

Aquifer	Mgal/d
Quaternary Alluvial	388
Cockfield Formation	3.8
Cane River Formation	0.05
Sparta-Memphis Sand	58
Wilcox Group	1.2
Paleozoic Age Rocks	0.9

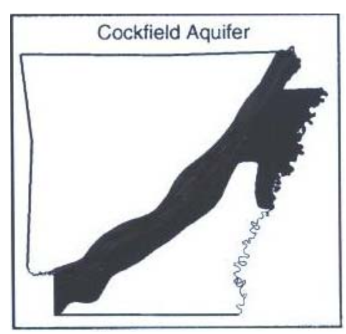
These data obtained from the ANRC (2005)

The majority of the reported ground water use in the Upper Saline Watershed comes from the Quaternary Alluvial and Sparta-Memphis Sand aquifers which are mostly utilized for public water supply use and industrial purposes. The highest demand for water consumption within the Saline River Watershed is from surface water as opposed to ground water. Adequate ground water supplies are available for consumptive use; however, current demand is not excessive and readily available. Only in Jefferson County has demand exceeded sustainability.

Characteristics of the Main Aquifers:

Quaternary Alluvial Aquifer. Sometimes called the Alluvial Aquifer is the upper aquifer of the Mississippi embayment aquifer system. In the Saline River watershed, deposition of sediment from Pleistocene and Holocene time produced a series of sands, silts and clays that constitute this alluvial aquifer and semi-confining units. The aquifer dependent upon the thickness of the confining unit can behave as a "leaky aquifer" and contribute water to the Saline River along some portions of its course.

Sparta/Memphis Sand Aquifer. This Eocene-age aquifer ranks second in total ground water withdrawals in the Saline River basin. The aquifer is composed mainly of sand with considerable amounts of silt, clay, shale, and lignite, which are found in lenses throughout the unit. Lithologically it has considerable variance both vertically and laterally. In general, water in the Sparta Aquifer is of good quality and used for domestic water supply and chiefly for irrigation.



Cockfield Aquifer. This Eocene-age aquifer ranks third in total ground water withdrawals in the watershed. The Cockfield Aquifer generally consists of fine to medium sand in the basal part and silt, clay and lignite in the upper part. The yields of water are moderate to small and are mostly used for domestic consumption.

*Figures to the right show the area extent of the main aquifers within the Upper Saline Watershed.

Land use/Land cover
Land use within the watershed is primarily forested with pine dominated industrial forest representing 43.2% and natural/mixed woods matrix of 38.2%. There is a growing urban component comprising 12.4% of the watershed's land use and a smaller, but significant portion, 6.1%, of pasture land. Prior to development, the watershed basin was predominantly covered with thick growths of a mixture of hardwoods and pines. Associated with the onset of settlers in the 1800's and the outbreak of World War II, lumbering became high priority and a chief source of income in this area. Much of the forested land is still managed today for the production of pulpwood, poles, and saw logs and is a strong economic force in the watershed.

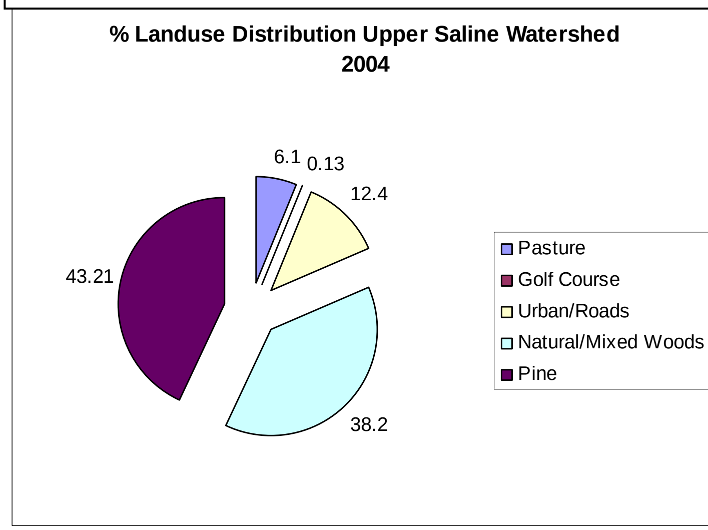


Figure 6. Land Use Distribution

Ninety five percent of the land within the watershed boundary is under private ownership (Arkansas GAP, 1992) (See Appendix A, Figure 2). Large tracts are owned by paper and timber companies with farm ownership ranging from small to large tracts of land. The majority of the agricultural lands in the watershed are devoted to the production of cattle. The 1.8 million-acre Ouachita National Forest is the South's oldest and largest National Forest, extending into parts of eleven counties in Arkansas and two counties in Oklahoma. Portions of the Ouachita National Forest located in the Upper Saline Watershed are found in Garland, Saline, and Hot Springs Counties. Winona Wildlife Management Area is included in this area as a popular hunting area managed under a cooperative agreement between the Arkansas Game and Fish Commission, U.S. Forest Service, and Weyerhaeuser Timber Company with primary ownership by the USDA and Weyerhauser Corporation. Numerous streams are found in the area, including the headwaters of the Saline River. Several man-made lakes including Lake Winona, Lake Sylvia and Bear Creek Lake are also found in this area. Total acreage managed and owned federally by the US Forest Service within the Upper Saline Watershed includes approximately 45,294 acres.

State land holdings are limited but include Jenkins Ferry State Park, approximately 32 acres south of the city of Sheridan, managed by The Arkansas State Parks. Jenkins Ferry offers restrooms, a pavilion, swimming and a launch ramp on the Saline River. There are several natural areas established within the Bauxite Mining Reclamation Area near Bauxite, AR. The Nature Conservancy owns several small preserves in this area totaling approximately 194 acres including IP Pipewort Glade Unique Area, and Dry Lost Creek Preserve. The Arkansas Natural Heritage Commission (ANHC) has recently acquired roughly 135 acres within the Middle Fork Saline sub-watershed named The Middle Fork Barrens Natural Area; a site where several globally rare, endemic plant species occur. Private ownership accounts for the remaining 1,032,434 acres of land within the Upper Saline Watershed.

Land use/Land change

The mapping and classification of land cover, roads, water and land use data is important in determining what threats are contributing to water quality and quantity change within the Upper Saline Watershed. The Nature Conservancy (TNC) utilized geographical information system and remote sensing (GIS/RS) technologies to analyze landuse practices and patterns within the watershed. TNC's Arkansas Field Office GIS\RS lab conducted a spatial and temporal analysis for the Upper Saline Watershed. Six satellite scenes of the same format were acquired from year 1986, 1992 and 2004. The images were processed consistent with advanced remote sensing techniques for landuse/landcover classes such as Pine, Natural Forest or Mixed Woods, Pasture, Roads\Urban, Golf Courses, and Water.

Next, changes in predetermined important classes were estimated and compared between the 1986 and 2004 images. The results provide a landscape level view of major landuse changes within the watershed. Also, the ability to quantify these significant changes in the Upper Saline Watershed assists TNC in determining anthropogenic impacts such as deforestation, sedimentation, declining water quality and other hydrologic alterations in the watershed. Land managers, city and county officials can then use this information to focus on employing appropriate management activities to reduce the most detrimental impacts.

Results for the analysis of the entire watershed showed that pine plantations increased by 24% with a corresponding decrease in the natural/mixed woods forest matrix by 22% (See Appendix A, Figures 3 and 4). The significant change in forest composition within the watershed is indicative of timber production activities that concentrate on establishing a strong pine plantation component of the forested landscape. The most significant change in the landscape classification was the growing urban component of the watershed. Urban area and roads increased by 47% throughout the Upper Saline with a corresponding decrease in pasture coverage by 29%. This is characterized by the expansion of Benton and Hot Springs Village into the rural areas of Saline and Garland counties, resulting in the conversion of historic cattle ranch pastures into residential development. Finally, it is important to note a significant increase in land coverage of recreational golf courses within the Upper Saline. There was an increase in golf course coverage by 231%, with an addition of 31.65 acres (128,070 square meters), from 1986 to 2004 within the City of Hot Springs Village (see tables 3 and 4). This brings the total acreage of classified golf course coverage to 45.29 acres, located within the Middle and South Fork sub-watersheds of the Saline.

Table 3: Changes in Land Use Categories 1986 to 2004

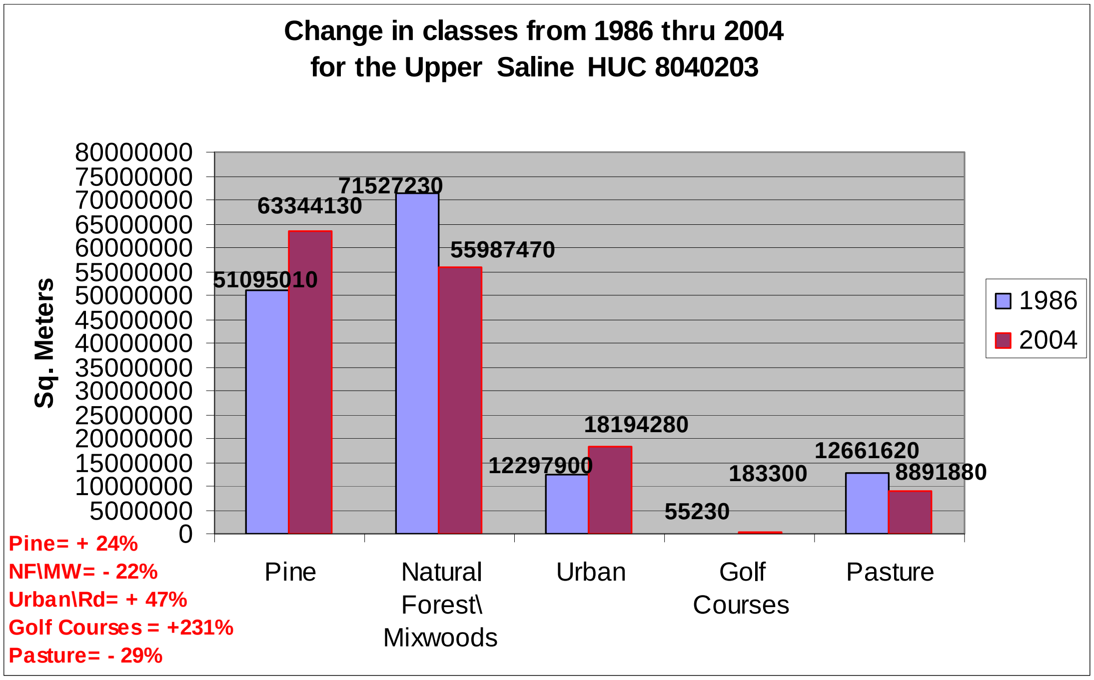
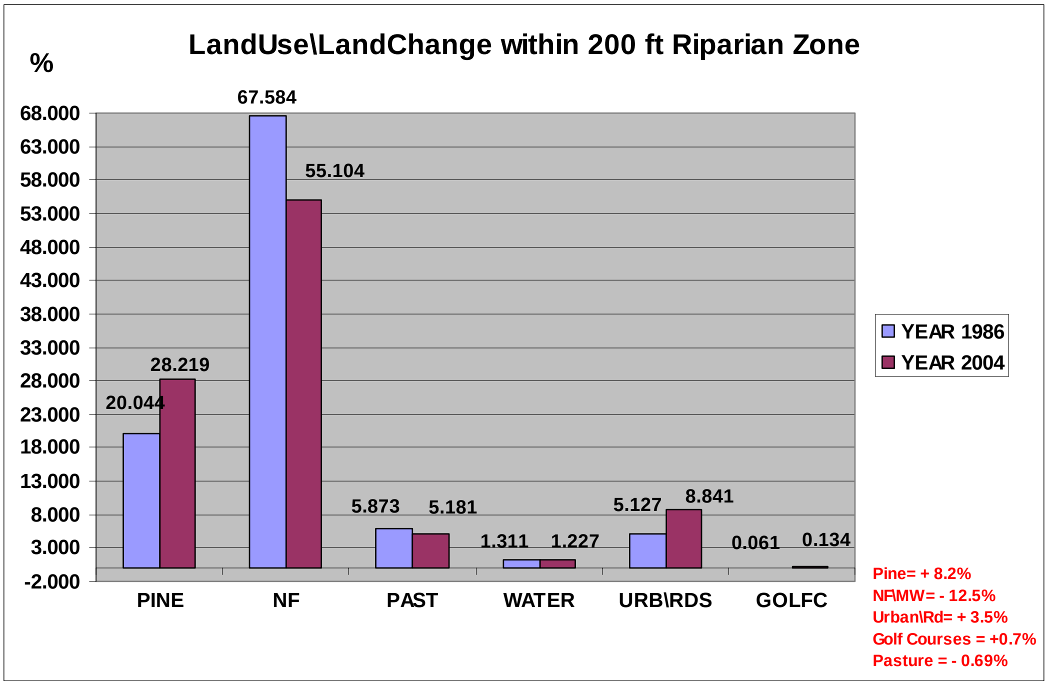


Table 4: Changes in Coverage Golf Courses 1986 to 2004

For watershed management purposes, it is important to assess land use categories in the context of land coverage within critical riparian areas of the watershed. When assessing change in land cover within the riparian areas of the Saline, defined as 100 linear feet from each side of the waters edge (Wenger, 1999), land use changes were similar to that occurring on the watershed level. There was a significant increase in the pine dominated industrial forest matrix of 8.2% and a corresponding decrease in the natural/mixed woods matrix of 12.5%, indicative of vegetation removal and regeneration within the riparian areas of the watershed. There was also a less evident increase in the urban and roads category of 3.5% indicating that some urban development and road construction is occurring within the riparian areas. There were very minor adjustments to the golf course (+.07%) and pasture (-0.69%) land use categories indicating that little of this land conversion type has occurred within the riparian zone.

Table 5: Land Use Changes within Riparian Zones Upper Saline Watershed



Water Quality

The Upper Saline Watershed, including the mainstem and major tributaries have been designated as suitable for the propagation of fish and wildlife, primary and secondary contact recreational, and public, industrial and agricultural water supplies (ADEQ, 2004). A large portion of the total stream miles within this watershed are designated as Extraordinary Resource Waters (ERW), including the Saline River and its primary headwater streams.

A fish consumption advisory has been placed on 89.9 miles of the entire Saline River due to mercury contamination, however the majority of this advisory falls within the Lower Saline River watershed (HUC 8040204). There is a segment of the Saline River, located in the Upper Saline Watershed, listed impaired due to mercury contamination (segment reach 001), although it is not included in the segments listed for fish consumption advisories at this time. Lake Winona and Lake Sylvia are also listed as impaired due to mercury contamination with additional fish consumption advisories. The fish consumption Action Level in Arkansas is based on the previous FDA guideline of 1mg/kg. EPA has since promulgated a criterion for methyl-mercury in fish tissue. It was recommended by FTN Associates in the completed TMDL for these waters in 2002 that the state of Arkansas will need to consider adopting this criterion as part of their triennial review. Observed maximum amounts of mercury present in fish tissue samples collected by ADEQ for segments and lakes listed in the Saline Watershed were reported as follows (FTN Assoc., 2002):

Table 6: Fish Tissue Sample Collection ADEQ

List of Stations	Largemouth & Spotted Bass Species	Others (includes all other species collected	
Station	Max Hg concentration mg/kg	Max Hg mg/kg	Others Common Name
Lake Winona	1.48		
Saline River Cleveland Co.	1.09	0.52	Drum
Saline River I-30 Bridge	0.80		
Saline River Jenkins Ferry	0.78	0.72	Redhorse
Lake Sylvia	1.08		

Chapter 2

9-Element Plan Watershed Based Strategy

The Upper Saline 9-Element Watershed Restoration Plan is a joint venture between the Arkansas Natural Resource Commission (ANRC) and The Nature Conservancy's (TNC) Arkansas Field Office in an attempt to prioritize specific non-point source (NPS) pollution management measures and provide a plan to the Environmental Protection Agency for the application of funds from Section 319 of The Clean Water Act for this priority watershed. In order to identify the priority NPS management measures, the following things needed to be accomplished (1) documentation of past, current, and future efforts for the evaluation of baseline ecological, hydrological, and geomorphological conditions within the Upper Saline Watershed and (2) identification of critical data gaps that inhibit prioritization of non-point pollution reduction efforts within the watershed.

There are eight watersheds within the state, including the Upper Saline Watershed (HUC 8040203), identified as priority for Section 319 funds through the ANRC. These watersheds have been identified because of known impairments or significant threats to water quality from present and future activities. It is the goal of the ANRC to expend substantial effort and resources to develop and implement "Nine Element Plans" for these eight priority watersheds with clearly stated, achievable, and measurable goals and objectives. The Nature Conservancy has worked with ANRC to develop this type of plan for the Upper Saline Watershed.

Watershed Committee Meetings

Watershed Committee Meetings #1 and #3

The Nature Conservancy of Arkansas hosted three “Watershed Committee” meetings throughout 2005 to discuss restoration planning for the Upper Saline River watershed. Involving local stakeholders in the planning process helped to ensure the plan takes into consideration input from those who live, work, or enjoy recreational activities in the watershed. Stakeholder participation in watershed planning also increases direct local involvement in best management practice (BMP) implementation. The objective of the meetings was two-fold: 1) to disseminate information on past, current, and ongoing research efforts within the watershed, and 2) to discuss stakeholder issues of concern, identify short and long term goals for the watershed, and the steps necessary to achieve those goals. Meeting participants included a variety of stakeholders within the watershed including: watershed groups, timber producers, construction/development representatives, private landowners, city/municipal representatives, county representatives, and local, state, and federal agency personnel involved with research within the Upper Saline Watershed. A complete list of representative groups is listed in Appendix B.

The following is a summary of the issues of concern and <u>potential</u> causes identified by the Upper Saline Watershed Committee.

1. **Erosion of unpaved rural roads**
   a. ***Nested Issues: increased sedimentation, turbidity, loss of aquatic habitat.***

One of the threats identified for the Upper Saline Watershed is the sedimentation associated with runoff from a dense network of unpaved roads located throughout the watershed. Unpaved roads can deliver sediment and nutrients directly into streams at crossings, or indirectly by overland flow or gullies. Roads and road ditches may intercept flow and drain it into streams, thereby acting as expanded channel networks causing an increase in sediment delivery and peak flows. Stream/road crossings, including paved and unpaved roads, were evaluated for the Upper Saline Watershed. Highest concentration for stream/road crossings were observed for the South Fork (HUC80402030201), Saline mainstem at Benton (HUC 80402030702), and Hurricane Creek sub-watersheds (80402030402) and are illustrated in Appendix C, Figure 3. Density of unpaved roads was also evaluated for the Upper Saline Watershed and indicated the highest densities in portions of the Middle Fork, Alum Fork, Hurricane Creek, and Dry Lost Creek sub-watersheds (Appendix C. Figure 4)

2. **In-stream gravel mining and unregulated sediment retention ponds.**
    a. ***Nested Issues: increased sedimentation, turbidity, loss of aquatic habitat, altered landscape & associated runoff, road damage.***

There is a need in the headwater region of the Upper Saline to identify locations of in-stream gravel mining operations. The upper four forks of the Saline, located in the Ouachita Mountain Ecoregion, are often used as sources of gravel extraction. Extraction of gravel from a stream alters the sediment budget creating the potential for channel instability, increased turbidity and degradation of habitats (Femmer, 2002). As the streams respond to mining disturbances, real estate can be lost, aquatic habitats altered, and fisheries and recreation damaged.

There was a voiced concern by the watershed committee for the incompatibility of the ADEQ's Regulations 2, "Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas" and Regulation 15, "The Arkansas Open-Cut Mining and Land Reclamation Code". In Regulation 2, it is stated that Extraordinary Resource Waterbodies shall be protected by (1) water quality controls, (2) maintenance of natural flow regime, (3) protection of instream habitat, and (4) encouragement of land management practices protective of the watershed. It is further stated in Regulation 2 that significant physical alterations of the habitat within Extraordinary Resource Waters, Ecologically Sensitive Waterbodies, or natural and scenic waterways are not allowed. Currently, there are a significant amount of permitted quarry and in-stream gravel operations state-wide through the ADEQ Surface Mining and Reclamation Division Non-Coal Program. Regulation 15 requires the maintenance of an undisturbed buffer zone of 100 ft between the permit boundary and ordinary high water mark of a waterway for open-cut mining operations. Any material removal below the ordinary high water mark must not create a violation of the state's water quality standards. Additionally, material removal must not be conducted below an elevation of one (1) foot above the elevation of the surface of the water at the time of removal. If the stream is dry, material removal may proceed to a depth equivalent to one (1) foot below the lowest point of a cross section of the stream in that location. Material removal must not create conditions that will cause the stream to change course or alter the location of the deepest part of the stream channel or cause bank or channel instability (ADEQ, 2004).

There was expressed concern that material removal from (1) foot below to (1) foot above does cause stream altered conditions and increases the susceptibility to channel instability. There was also expressed concern that allowing this extraction at the waters surface does not allow for the 100-ft buffer zone between the permit boundary and ordinary high water mark. It was suggested by the committee that state funding and resources be directed towards re-evaluating the compatibility of these two regulations. Legislative review would likely be required.

3. **Eroding streambanks.**
    a. ***Nested Issues: loss of riparian land & forest connectivity, sedimentation, turbidity, nutrient runoff.***

Eroding streambanks can influence a river through increased sedimentation and turbidity. In the Upper Saline Watershed, there are many areas in need of streambank restoration. Most sites that are experiencing rapid stream bank loss are a direct result of the removal of riparian vegetation. Forested riparian zones maintain ambient water temperatures, stabilize stream banks, filter sediment, leachates, nutrients, and other harmful pollutants, provide woody debris for macroinvertebrate and fish habitat, contribute channel forming units, and provide much of the energy input, especially in flowing water systems. Negative effects for landowners with eroding riparian areas are rapid loss of land, decreased fishery, and subsequent impacts to water quality.

4. **Hydrologic alteration**
    a. ***Nested Issues: in-stream flow concerns associated with dam construction, water diversion & withdrawals.***

Roads, stream crossings, and dams can modify a watershed's hydrologic regime and can contribute to fragmentation of aquatic habitat. These types of alterations combined with water diversions for irrigation needs can potentially alter the magnitude and timing of normal, low, and high flows within the watershed. Depicted in Appendix C is a map indicating the number of dams per (12-digit HUC) sub-watershed of the Upper Saline. A ranking of dams per square mile is also depicted to prioritize the sub-watersheds with the greatest influence of hydrologic alteration. Sub-watersheds experiencing the most hydrologic modification occur in the South Fork Saline watershed (80402030201) and the Benton area watershed (80402030401) (See Appendix C. Figures 1 and 2). Contributing factors associated with dewatering in the Saline were thought to include water use from surface and groundwater, land management, recreational/municipal needs, urban development, and impounded tributaries.

A study conducted by Dr. William G. Lahyer of Lahyer BioLogics RTEC, Inc. in 2001, indicated that "due to naturally occurring low flows in the Middle Fork Saline River, it is apparent that virtually no water is available for diversion from July through August without severe habitat loss… diversions in May, June, and November would increase the length of low flow conditions, aggravating fish recruitment from one year to the next" (Lahyer, 2001). In this particular headwater stream to the Saline, it was noted by Lahyer that flows below ten cubic feet per second (cfs) result in a precipitous drop in available habitat for fish species. A histogram depicting median flows for July over a period of 40 years indicated that 40% of the median flows recorded were below five cfs. (Lahyer, 2001) In addition to concern regarding available fisheries habitat, inquiry was voiced by the Watershed Committee regarding the potential of the issue of low flow possibly contributing to the problem of low dissolved oxygen values documented within this stream. It was recommended by the Watershed Committee for this plan to develop a coalition of stakeholders and municipalities, working in partnership, towards the development of innovative ideas and solutions to issues of future sustainable use of the local water resources. The Watershed Committee also emphasized the need for continued monitoring of flow conditions within the Middle Fork watershed by the U. S. Geological Survey with the aggressive long term goal of expanding these monitoring efforts to the other three headwater streams of the Saline River.

5. **Development/Construction/Increasing Urban Interface (Commercial, Industrial, Residential, Recreational).**
    a. ***Nested Issues: Erosion, altered landscape/land conversion, increased sedimentation.***

Soil erosion is accelerated in areas where land has been disturbed and vegetation or other natural protective cover of the soil has been removed. Increased development and the resulting increase in sedimentation was identified as an issue of concern in the Upper Saline Watershed, particularly in the growing areas of Benton and Hot Springs Village. Various forms of construction are occurring within these rapidly growing areas including commercial, industrial, residential, and recreational development. In the Middle Fork and South Fork sub-watersheds of the Saline, recreational areas have recently expanded to nine 18-hole golf courses covering approximately 45 acres, and nine man-made recreational lakes covering 2,021 total acres. The re-construction of Interstate 30 from Little Rock south to Benton has been a large component of construction within the watershed. Residential development is rapidly expanding north and northwest of the City of Benton as the construction of I-30 approaches completion. Residential development also continues to expand in the Hot Springs Village area, particularly in these areas of recent golf course and lake construction. The installation and diligent maintenance of appropriate erosion control measures is needed in all construction project areas in order to minimize the impact to both ephemeral and perennial streams.

Construction near ephemeral stream in USW, no erosion control

Silt Fence needing maintenance, USW

An issue of concern related to increased sedimentation/urban development that was identified by the committee as needing immediate attention is the expansion of Arkansas Department of Environmental Quality (ADEQ) staff to respond to complaints and sites reported for repeat violations of stormwater runoff control regulations. There are currently 13 staff employed at the ADEQ for enforcement of all regulations (ADEQ, 2005). The District Inspectors' job duties include permit compliance for all NPDES regulated facilities, storm water inspections of construction and industrial sites, permit compliance inspections for subsurface facilities, citizen complaints, response to industry, transportation, and municipality spills, investigation of fish kills, and collection of routine water samples for state water quality monitoring. There was expressed concern for the amount of these duties potentially inhibiting the ability of inspectors to respond to incidents reported within the watershed. The watershed committee suggested working with legislators to direct state financial assistance towards this problem.

6. **Inconsistent Forest Practices, i.e. inadequate streamside protection zones, and erosion of forest roads.**
    a. ***Nested Issues: increased sedimentation and turbidity following timber harvest, runoff from forest roads.***

Land use in the Upper Saline Watershed includes a large timber production component (43.2%) both from private industry and publicly managed lands. In the absence of the use of Best Management Practices (BMP's), silvicultural operations have the potential to significantly impact water quality by generating nonpoint source pollution, particularly in areas with steep topography. Most of the direct impacts to local waterways are short-term (first several years after harvest), decreasing over time as vegetation grows; however, impacts to stream morphology due to excessive sedimentation from these activities continue well into the future. There was an expressed concern by the watershed committee of the adherence to the practice of BMP implementation in timber production activities within the Upper Saline watershed and the impact from gravel roads associated with timber harvest. It was reported for 2003 for the counties of Cleveland, Garland, Grant, Hot Springs, and Saline, there is an overall 91% compliance rate for Best Management Practices (BMPs) implemented within selected surveyed areas of these counties (AFC, 2003).

7. **Mining**
    a. ***Nested Issues: increased sedimentation, high mineral content, total dissolved solids, and sulfates.***

Historical bauxite mining located in the Upper Saline watershed was addressed as an issue of concern in the watershed committee meetings. The impacts to local waterways associated with runoff from this area include changes in pH values and an increase in total dissolved solids, minerals, and sulfates delivered to the streams. There is a reclamation effort underway in this area that is discussed in detail in subsequent sections of this plan (See Chapter 3, Element One and Two).

8. **Low dissolved oxygen.**
    a. ***Nested Issues: nutrient loading/algal blooms, effects to aquatic life & recreation.***

Low dissolved oxygen has been observed by researchers within the Upper Saline Watershed. Low dissolved oxygen in the watershed can stem from high nutrient levels in the water. Potential causes for nutrient loading in the watershed were listed as municipal and industrial point sources, grazing practices, increased sedimentation in the watershed, runoff from urban areas and golf course irrigation, and septic systems. The critical dissolved oxygen standard for watersheds greater than 10 square miles in the Ouachita Mountains is 6 mg/L and if not continued throughout a 24 hour period conditions can lead to stream impairment for aquatic life. For the Upper West Gulf Coastal Plain the critical D.O. standard for watersheds greater than 10 square miles is 3 mg/L.

9. **Illegal Dumping in the watershed.**
    a. ***Nested Issues: abused public access points, lack of education.***

Illegal dumping was a voiced concern by many stakeholders for trash, litter, and the deposition of animal carcasses particularly during the hunting season, located at many bridge access points throughout the watershed. Clean-up efforts have been established through county and watershed volunteer teams. There is evidence of dumping along privately owned riparian areas in the watershed as well. Lack of information exchange and education was cited as a source of this problem within the watershed. A voluntary program through local watershed groups and county conservation districts was suggested to clean-up privately owned lands without any penalty or cost.

Chapter 3

Element 1 – Causes and Sources of NPS Pollution

Mineral Content

The domestic water supply use has been removed from Simpson, Hurricane, and Lost Creeks (seg 005, 006, 008) due to excessive mineral content. Mineral contents (chlorides, sulfates, other dissolved minerals) originate in this basin from runoff associated with open bit bauxite mining activities (ADEQ, 2004). A major reclamation project is underway in this area with regards to the open pit bauxite mines. There are currently 12,250 acres referred to as the Bauxite Mining Reclamation Area (BMRA). The Nature Conservancy's Arkansas Chapter has been working with a variety of partners in the BMRA since 1995 to manage and restore over 4,500 acres of natural areas and buffers. This effort to re-establish natural areas continues and is being accomplished through a collaborative partnership utilizing expertise in wildlife conservation, project management, ecological restoration, land reclamation, remediation, environmental management and water treatment.

Numerous treatment approaches can be taken to minimize the amount of leachate discharging from residue areas in the BMRA. All of the approaches are variations of reducing the amount of recharge water entering and subsequently exiting the residue. Some of these include increasing the rate in which surface water runs off the disposal areas, decreasing the rate of infiltration through the protective layer, or cap, and minimizing the time in which rainfall is in contact with the surface of these areas. Some of the approaches that have been considered include slope diversions, re-grading to alter slope length, re-grading to alter the degree of slope, applying a clay cap, and installing a flexible membrane liner. The cost of treating leachate is one of the most significant annual costs associated with the BMRA and will continue for many years to come. The volume of water treated and discharged is rainfall dependent, but typically 3-4 billion gallons of water are treated and discharged from the site annually.

Low Dissolved Oxygen

Low dissolved oxygen in the watershed can stem from high nutrient levels in the water. The increase in nutrients in a waterbody can create a significant increase in algal blooms during the day, particularly in the warmer months. During evening hours, the algal blooms begin to die off creating low dissolved oxygen conditions. Hurricane Creek (seg 004) is listed for impairment of aquatic life due to low dissolved oxygen violations. The source of the impairment is documented as unknown at this time by the Arkansas Department of Environmental Quality (ADEQ). Big Creek below the City of Sheridan is listed as impaired due to organic enrichment, siltation & turbidity, and lead. The local municipal wastewater discharge is identified as the impairment source for organic enrichment and lead. There have also been observed and documented dissolved oxygen violations for the Middle Fork of the Saline below Mill Creek, the location for Hot Springs Village municipal discharge. Elevated turbidity and total phosphorus is documented for the four forks of the Saline during storm events indicating both nonpoint source pollution as well as municipal point source contribution. Likely sources for nutrient impacts in the Upper Saline Watershed include point sources, agriculture/grazing practices, increased sedimentation, runoff and tailwater from golf course irrigation, and septic systems. A project is underway by the ADEQ over the next three years to help establish criteria for evaluating nutrient impacts on a watershed basis. The site for this pilot project will be located in the Upper Saline River watershed. Information from this study will be very useful for land management decisions in the future.

Siltation/Turbidity
Big Creek is listed as impaired due to siltation and turbidity. The four forks of the Saline are experiencing an increase in turbidity, particularly during storm events. The potential sources for impairments due to siltation and turbidity include riparian forest removal, stream bank erosion, construction and silviculture practices within the watershed, and stormwater runoff from gravel roads. The likely source for siltation in these streams is nonpoint source related and it is highly probable the source of sediment is coming from ephemeral streams throughout the watershed.


Pictures from Vance Bridge, confluence of Jenny Branch & Middle Fork, 2002-03

Mercury Contamination
The mercury water quality standard for Arkansas waters for all ecoregions is 0.012ug/L, expressed as total recoverable mercury. Although this water quality standard is to protect aquatic life, it was developed to protect humans from consuming aquatic life contaminated by mercury. There is a segment of the Saline River, located in the Upper Saline Watershed, listed as impaired due to mercury contamination (segment reach 001), although it is not included in the segments listed for fish consumption advisories at this time. Lake Winona and Lake Sylvia are also listed as impaired due to mercury contamination, both with fish consumption advisories.

The completed TMDL for the Ouachita River Basin, of which the Saline River watershed is part, indicates after evaluating all NPDES facilities within the watershed that less than 1% of the mercury load comes from point source wasteloads (FTN Assoc., 2002). The geology of the Ouachita Mountains contains rock with relatively high, naturally occurring mercury concentrations. The soils in the basin reflect this geology and also receive mercury from atmospheric deposition. It was determined that the predominant sources of mercury loading to the entire Ouachita River basin are from atmospheric deposition, watershed nonpoint sources, and background loads (FTN Assoc., 2002).

Geomorphologic Changes

Geomorphologic changes within the Upper Saline Watershed are worth noting as these changes tend to be indicators for trends in declining water quality and associated aquatic habitat impacts. In particular, the southern portion of the watershed found in the Upper West Gulf Coastal Plain is showing stress conditions such as (1) loss of form and function of the channel due to bank destabilization, riparian forest removal, down cutting and head cutting and (2) continuous declines in water quality due to non-point source runoff, erosion, sedimentation, channel degradation, and the effects of open-pit bauxite mining. Some of these changes, in part, might also be contributed to landscape-scale changes in gradient and baseline conditions of the Ouachita River basin. The Saline River basin and the Ouachita River basin meet near the Louisiana border. Landscape changes occurring in both watersheds meet at this point where degradation from one basin can affect the other, moving upstream or "head cutting". Other potential factors involved in degradation of the Saline River mainstem include the removal of riparian vegetation and conversion of the landscape scale forest matrix.

Streambank erosion mainstem, Saline River

The headwater region of the Upper Saline River watershed is experiencing a slightly different set of changes and impacts including (1) hydrologic regime alterations due to dam construction, water withdrawals for irrigation, and water diversion in the creation of ponds and recreational lakes, (2) streambank erosion to a lesser extent than in the mainstem due to removal of riparian buffers, and (3) declining trends in water quality due to both point source discharges and non-point source runoff, erosion, and sedimentation.

Element 2 – Non-Point Source Management Measures Needed

Section 1: Data Collection Needs

***Evaluation and prioritization of sub-watersheds*.**

Methods

To effectively and efficiently control the amount of non-point source (NPS) pollution that enters the Saline River, assessment and prioritization of sub-basins within the Upper Saline Watershed is needed. This will help to determine which sub-basins are facing the greatest threats from NPS pollution and help guide the allocation of dollars for implementation efforts in the watershed.

The prioritization process should take into account all environmental studies and historical data available for the watershed, but also incorporate a detailed land use analyses to evaluate land use changes over time. Certain parameters to consider in ranking sub-watersheds for prioritization should include (but not be limited to) number of stream-road crossings, dam densities, density of gravel roads, density of gravel roads in riparian areas, percentage of intact riparian vegetation, changes in land management activities throughout time, increase in urbanization, sediment and nutrient loads in the watershed, slope and precipitation. ANRC is currently under contract with The Nature Conservancy (TNC) to conduct this type of ranking and prioritization for the Upper Saline Watershed in a separate project.

Under contract with the Arkansas Natural Resources Commission (ANRC), the University of Arkansas Department of Biological and Agricultural Engineering has used the Soil and Water Assessment Tool (SWAT) to model priority watersheds for the Upper Saline River Watershed to include in the 2005-2009 NPS Management Program. Refer to Appendix D for a prioritization scheme of the Upper Saline sub-watershed using SWAT estimates of sediment, runoff and nutrient loads for phosphorus and nitrogen. These maps show the relative loading in quintiles for each sub-watershed, which roughly approximate the area of a 14-digit hydrologic unit code watershed. The use of both analyses, SWAT and TNC's modeling efforts, will be beneficial for prioritizing implementation and restoration efforts.

<u>Detailed inventory of the top three identified priority sub-watersheds of the Saline to determine annual sediment loading from various sources in the watershed.</u>

Methods

A detailed inventory of the top three sub-watersheds targeted for sediment reduction efforts should be conducted over the short term (1-5 years). This watershed inventory should include a detailed geomorphic assessment of the stream. Surveys should include cross-section evaluation of all representative reaches of the mainstem and a bank erosion hazard index (BEHI) inventory to locate additional problem areas. Land uses that contribute sediment to the priority watersheds should be identified and evaluated. Sediment loading delivered to the river should be estimated for each major source using GIS data, available environmental and field collected data, published export coefficients, and/or simple to complex models or relationships. Work should include (but is not limited to) a detailed evaluation of eroding streambanks; watershed erosion prediction curves; and characterization of bank materials. Also, WEPP (water erosion prediction project) modeling modules could be used to evaluate source loadings, particularly for sedimentation from gravel roads. A detailed assessment similar to this should be prioritized for the long term for evaluating nutrient concentrations for priority sub-watersheds. Development of a nutrient criteria evaluation process by the ADEQ over the next three years will set the foundation needed for such analyses.

<u>Expansion of biological assessments: fish and macroinvertebrate population studies and related community changes.</u>

Methods

There is a need to increase or expand biological data collection in the Upper Saline Watershed, particularly in conjunction with BMP implementation projects in order to identify any pre- and post-project changes to these populations (see Element 9 "Monitoring" for an overview of current biological monitoring in the USW). Following the prioritization of the top three sub-basins of the Upper Saline Watershed, it is recommended to conduct fish and macroinvertebrate sampling at two strategically placed sites per each priority sub-watershed, bi-annually for at least two years as an independent project focused solely on expanding biological monitoring within the watershed. Pre- and post-project collection of biological data should also be incorporated into site specific 319 implementation projects. At least two 319 projects implemented in the watershed over the next five years should include a biological monitoring component. In either case, sampling sites should be chosen, when possible, in conjunction with other BMP implementation projects in the watershed to monitor biological community reaction to the project efforts. This type of strategic monitoring will be essential for success comparison of different nonpoint source pollution reduction measures.

<u>Expansion of Water Quality Monitoring in key areas of the watershed.</u>

Methods

There is a need in the Upper Saline Watershed to expand water quality monitoring in a way that maximizes past and current data collection, but does not duplicate efforts (see Element 9 "Monitoring" for more information on current and past water quality monitoring efforts). The Arkansas Natural Resource Commission (ANRC) is currently dedicating efforts to establishing additional water quality monitoring stations within the Upper Saline Watershed. To locate the most appropriate locations for the addition of permanent monitoring stations, a watershed survey is needed for the Upper Saline Watershed. By conducting a "snapshot" survey in which grab samples are taken throughout the watershed within the same day, surveyors will be able to get a "picture view" of water quality conditions on an average day. This approach, combined with data analysis from all other available data sources, will help determine the most effective locations for citing new permanent water quality monitoring stations.

This effort by the ANRC to extend water quality monitoring in the Upper Saline will support the long term monitoring goals for the watershed and establish meaningful data that compliments and builds upon water quality data being produced by other organizations and agencies. With the establishment of two new permanent monitoring stations in the short term (1-5 years) for the Upper Saline, communication regarding collection efforts should be emphasized between data collection agencies and local watershed groups and county conservation districts to cross-reference with restoration efforts and determine if there is an opportunity to associate collected water quality data with pre- and post- BMP implementation efforts.

<u>An inventory of the unpaved road systems should be completed for at least three sub-watersheds (in the short term) ranked high in priority for sediment reduction efforts in the Upper Saline Watershed.</u> Note: Sedimentation rates should be modeled from the inventory to help identify and prioritize road segments for BMP implementation.

Methods
Road density within riparian areas is the best indicator of where roads may affect channel dynamics. When a road is proximal to a stream channel, it has a greater potential to affect channel morphology and the movement of materials within that channel. The U.S. Forest Service modeling software, Water Erosion Prediction Project (WEPP), Geographic Information Systems, and inventory data collected in the field could all be used to complete a detailed assessment of current road conditions and sediment reduction capabilities. The type of inventory data collected in the field should include, but not be limited to, road slope, road design (crowned, insloped, or outsloped), type of water feature (wing ditch, culvert, etc.), type of drainage ditch, and surface characteristics. When inserting this field collected data into the WEPP model it can provide an estimate of sediment loading associated with the segments studied. By extrapolating these load figures to the rest of the roads located in the watershed, it allows for a total annual sediment load estimate from all unpaved roads in the basin. Knowing the total load allows for some comparison to other sources in watersheds (i.e. streambank erosion, erosion from pastures, silviculture, etc).

Following the detailed assessment, priority road segments can be recommended for BMP implementation. This is best accomplished by working with county judges, county officials, and road crews through training workshops and on-the-ground implementation to improve roads that contribute the most sediment. Monitoring at the sites pre- and post-implementation should also be conducted to measure and document success.

Development of Nutrient Criteria for impacted streams and lakes.

Methods
There is a need to establish more explicit criteria for evaluating nutrients within the Upper Saline Watershed than just strictly by narrative evaluation. Developing a numeric criterion specific to the biological characteristics and responses evaluated for this watershed will be critical in accurately assessing nutrient impacts to water quality and aquatic life within the Upper Saline. There are certain streams in the watershed showing increases in algal blooms, associated low dissolved oxygen levels, and a variety of values for total phosphorus and nitrogen. These river and stream systems need to be evaluated to determine if they are truly impacted from local nutrient sources. In 2001, the US EPA published recommended water quality criteria for nutrients under section 304(a) of the Clean Water Act, with the intention that this document would serve as a starting point for states, tribes, interstate commissions, and others to develop refined nutrient criteria. In February of 2005, the ADEQ submitted to EPA Region VI a draft State of Arkansas Nutrient Criteria Development Plan, which is currently under review.

The ADEQ has begun a project, in the fall of 2005, with the goal of evaluating the processes outlined in the "State of Arkansas Nutrient Criteria Development Plan". These processes will be implemented in the Upper Saline River watershed (HUC 08040203) as a pilot study. In order to evaluate the Plan, two objectives must be met: 1) implementation of a nutrient criteria development survey for the watershed; and 2) development of a Macroinvertebrate Stream Condition Index (SCI) for the watershed.

Both objectives of this pilot study are intended to take three years from the project start date. A workgroup of academia, governmental, and private professionals will be established to develop the Macroinvertebrate Stream Condition Index (SCI). A separate workgroup will also be established to develop the Nutrient Criteria development methodology. Each group will also serve as a peer review council for the pilot study. A draft assessment methodology for the Nutrient Criteria Development Plan and Macroinvertebrate Stream Condition Index (SCI) will be developed and tested. Revisions of each, if necessary, will be completed and a report by the ADEQ will be drafted for recommendations for inclusion into state water quality standards.

1) An inventory and locational database for current and past in-stream gravel operations and 2) an inventory of BMP implementation for off-stream gravel operations with regards to sediment retention compliance.

Methods

There is a need in the headwater region of the Upper Saline to identify locations of in-stream gravel mining operations. The upper four forks of the Saline, located in the Ouachita Mountain Ecoregion, are often used as sources of gravel extraction. The extent of gravel mining in the Upper Saline watershed is not well known. A detailed geomorphological inventory already suggested in this plan is to be conducted for the top three priority watersheds in the short-term. This provides opportunity to survey for characteristics of past and present in-stream mining activities. An inventory and database of complaints should also be derived for the watershed. This could be an on-going partnership effort between local watershed groups, County Conservation Districts, and the ADEQ Water and Mining Division to build a database on such activity. Agency personnel conducting research within the Upper Saline watershed should be encouraged to take field notes of a visited site showing evident signs of in-stream mining. All observations should be recorded and reported to the Arkansas Department of Environmental Quality's enforcement division. A Geographic Information System (GIS) database should be developed for all sites reported in the event that there is not enough time and/or resources to act on the report immediately. This database would assist in keeping track of past, current, and potential sites through Global Positioning System (GPS) waypoint data. The sites that are verified for in-stream gravel operations should be re-visited bi-annually by ADEQ enforcement staff. County officials should also investigate incorporating database creation and mapping activities into the strategic plan for their county.

Section 2: Restoration & BMP Implementation Needs*:*

Streambank Restoration/Re-forestation of Riparian Lands.

Methods

A developed funding priority system on the County Conservation District level should give particular preference to sites that would restore rapidly eroding streambanks and re-connect forested riparian areas. This Best Management Practice (BMP) is considered a very high priority for the Upper Saline Watershed. Priority should also be given to the development of conservation plans for farms that previously have had no plans or are in need of updating. Annual status reviews to insure BMP's have been installed and are functioning as designed should be emphasized within County Conservation Districts. Following development of this funding priority system, the County Conservation Districts should submit to the ANRC for approval. Numerous benefits to the landowner have been identified for restoring riparian vegetation including the establishment of wildlife corridors increasing habitat for recreational hunting and the reduction of sedimentation to the stream establishing good habitat for recreational fishing. These benefits and the cost-share assistance programs available should be clearly communicated and emphasized to landowners within the watershed through continued outreach by the Conservation District and local watershed groups. It is a short term goal of this plan that at least two streambank restoration projects be implemented in priority areas of the Upper Saline Watershed (1-5 years). Volunteer efforts and publicity outreach should be incorporated into these projects.

Demonstration and implementation of Best Management Practices (BMP's) for land conversion activities (i.e. erosion control measures).

Methods

Forestry:

The Arkansas Forestry Commission (AFC) is responsible for a variety of programs related to silvicultural nonpoint source pollution management including; the development of recommended Best Management Practices (BMPs), the collection of BMP monitoring data, investigation of pollution complaints from silvicultural activities, and technical assistance for landowners in applying for cost-share assistance programs. The AFC also collaborates with forest industry associations, the Cooperative Extension Service, and the Arkansas Forestry Association (AFA) to provide training and technical assistance to help loggers, landowners and forest managers implement recommended silvicultural BMPs to control nonpoint sources of pollution. Found in the table below are numbers recorded for selected parameters in BMP monitoring conducted by the Arkansas Forestry Commission (AFC) in counties that fall within the Upper Saline Watershed boundaries.

Table 7: 2003 Silviculture BMP Monitoring Results Counties within USW.

Arkansas Forestry Commission (AFC) BMP Monitoring Post-Harvest 2003				
Counties w/in USW surveyed	**Total # sites surveyed**	**# sites w/o 35' SMZ**	**Avg Compliance Rate ***	**Avg. Comp. Rate 5 counties ***
Cleveland	10	2	92%	**91%**
Garland	4	1	95%	
Grant	13	1	88%	
Hot Springs	3	1	82%	
Saline	5	0	96%	

* Represents average compliance for the following categories: streamside management zones, roads, harvesting, and regeneration.

Training sessions and workshops will be critical to the continued adherence to, and expansion of, responsible erosion control practices in the Upper Saline Watershed. At least five trainings per year spread throughout the Upper Saline Watershed should be targeted for the short term covering topics including ways to minimize soil disturbance, prevent erosion, how to best care for streamside management areas, and available cost share assistance programs for riparian forest enhancement projects. Due to the credible establishment and documented success of silvicultural BMP trainings, when possible these should be coordinated with other sediment reduction workshops in the watershed including trainings for road maintenance and construction best management practices. Citizens, landowners, and watershed group members should be encouraged to attend as well.

Road Maintenance:

A good example for a workshop applicable to the local area and local watershed issues would be "Road Maintenance Best Management Practices implemented on USFS lands in the Winona Wildlife Management Area". Potential partners could include The Nature Conservancy, the Ouachita National Forest Service, and the ANRC. Integration of agency personnel, such as ADEQ Water Quality Division or the Arkansas Game & Fish Commission, into trainings would be beneficial for insight into particular aquatic protection programs and recent research/study results conducted in the watershed. Attendance numbers for these trainings should be entered into an accessible database for the ANRC to track outreach efforts regarding nonpoint source pollution reduction.

Private Land Management:

Lands owned by nonindustrial, private owners make up a significant portion of the forests in the Upper Saline Watershed and are vital to the long-term sustainability of forest coverage in the watershed. Many studies show that as tract size declines, owners become less likely to actively manage their forests. With the increasing pressure on non-industrial private landowners to produce a multitude of goods and services from their forest lands, and/or to sell or convert forest land to development in the area, it is more important than ever to provide incentives and assistance to reinvest in, reforest, and manage these lands. Benefits received from implementation of particular conservation practices on forest or pasture managed lands include reduced wind and soil erosion, establishment of alternative watering sources for livestock, enhanced water quality and wildlife habitat, as well as assurance of a reliable future supply of timber. These benefits should be emphasized to landowners in the Upper Saline Watershed through continued public education and outreach.

The Nature Conservancy (TNC) has had success in generating landowner interest in the TNC Conservation Forestry program which focuses on ecologically sustainable and economically viable forest enhancement projects. Through conservation easements, landowners can still gain economic benefit from ecological thinnings that improve the health of an overly dense forest. Re-introducing prescribed burns to fire-suppressed areas can also enhance plant and animal habitat immensely. It is a goal of this plan to enroll two to five new landowners across the Upper Saline Watershed in forest and riparian enhancement projects each year for the next five years through various cost-share programs such as Forest Land Enhancement Program (FLEP), Wildlife Habitat Incentive Program (WHIP), Conservation Reserve Program (CRP), and/or Environmental Quality Incentive Program (EQIP). WHIP, CRP, and EQIP are applied for and administered through the County Conservation Districts, whereas FLEP is administered by the Arkansas Forestry Commission. Although each program differs slightly, the goal to enhance and sustain long-term productivity of timber and non-timber resources through a variety of forest and riparian management practices is a component of each one of these program objectives. The following conservation practices qualify for each of the three programs: planting site preparation, hardwood or pine tree planting, prescribed burning, forest stand improvement to remove undesirable species, planting wildlife food plots, and erosion control measures such as water bars, wing ditches, stream crossings, etc.

Urban Development:

Riparian areas under residential development should also be prioritized for erosion protection measures as development continues to move towards riparian corridors, particularly in the increasing urban areas of Benton and Hot Springs Village. BMP implementation in these areas could include the installation of rain gardens or catchment and filter systems on residential properties, particularly in riparian areas with slopes greater than 30%. Growing municipalities should investigate opportunities to implement special zoning requirements for residential and industrial areas located in streamside management zones through local ordinances or city codes. Federal and state funding should support the development of nature trails, public access points, and organized tree plantings near riparian areas of the river to increase local interest, involvement in, and appreciation for the protection of the local natural resources.

It is hoped that at least two urban restoration projects be implemented in the Upper Saline Watershed in the next one to five years. The Urban and Community Forestry Program provides technical assistance and grants for urban forestry through a cooperative agreement with the USDA Forest Service. Communities, non-federal government agencies, educational institutions, and 501(c)3 non-profit organizations may apply for these competitive grants. This funding source could be particularly useful in the growing urban areas of the Upper Saline Watershed. In the past, funding of this type has been utilized by municipalities in many areas for hiring an urban watershed coordinator to work with local governments, watershed groups, and citizens to implement urban forestation and restoration projects.

Repair/update high impact crossings in the watershed. Implement BMP's on all sites identified in the roads analysis of the top three priority sub-watersheds of the Upper Saline.

Methods

Many culverts, dikes, water diversions, dams, and other artificial barriers have been constructed in the Upper Saline Watershed to impound and/or redirect water, all changing natural features of rivers and streams. Culverts that funnel water beneath roads are in many cases no longer serving their original purpose due to poor design. Many culverts and bridges serve as barriers preventing natural fish migrations thus keeping them from important habitats for spawning and growth. There are innovative ways to design such bridges and culverts to allow for flood control, fish passage, and functional motor passageways while maintaining the natural dimension, pattern, and profile of the stream. In the short term, following a detailed road survey of the top three priority watersheds within the Upper Saline, funding should be directed towards implementation and restoration of identified inefficient bridge and culvert crossings, and degraded road segments and ditches.

Implementation of Municipal Stormwater Pollution Prevention Programs

Methods

There is a need in the watershed to coordinate between local watershed groups, larger cities/municipalities, local schools, and Cooperative Extension Service Offices to insure that information is being disseminated to county road departments, county homebuilder associations, construction companies, and the general public to understand the effects of stormwater runoff and new approaching stormwater requirements. The City of Benton has developed a plan of action for the short term (1-5 years) to minimize the effects of stormwater runoff from the growing urban area. This progressive plan should be used as a model for other growing cities within the Upper Saline Watershed.

The City of Benton's efforts for minimizing effects to the Saline River Watershed from urban stormwater runoff include the following:

1) **Public Education and Outreach on Storm Water Impacts**
    - **a.** The City has approximately 10,000 water customers. The City will produce and distribute a utility insert on the effects of storm water runoff and steps the public can take to prevent these storm water impacts. The City will begin installing the inserts during Year 1 and repeat once every six months thereafter.
    - **b.** A minimum of 50 percent of all school children (K-12) will be educated every two years on storm water pollution by providing the School Districts in the jurisdiction of the City with materials such as videos, brochures, live presentations, and other media.
2) **Public Involvement/Participation**
    - **a.** The City will develop a program to involve school children and other volunteers in marking the storm drains to indicate the direct route to the local water resource, the Saline River, and to discourage practices that generate non-point source pollutants. The City's goal is to mark 25% of the storm drains by the end of Year 2, 50% by the end of Year 3, 75% by the end of Year 4, and 100% by the end of Year 5.
    - **b.** The City will seek to involve volunteers in a monitoring program created by the end of Year 2 to promote the stewardship of local waters. Citizen monitoring can provide important data and information during the development of the storm water program.
3) **Illicit Discharge Detection and Elimination**
    - **a.** The City of Benton has yet to survey the MS4 area to identify problems and illicit connections. To initiate this process, the City intends to develop a comprehensive map of the storm drain system, establish and carry out procedures to identify and remove illicit discharges, establish legal authority for enforcement actions, and encourage public education and involvement in eliminating illicit discharges. The development of an infrastructure map will aid the City in targeting outfalls with dry weather flows and other suspicious discharges.
    - **b.** A survey during dry weather of 20% of the storm drain system outfalls per year will be conducted to identify non-storm water flows. Areas with suspicious discharges will be inspected to detect direct connections to the wastewater system and identify areas where wastewater might be leaking into adjacent storm drain pipes.
4) **Construction Site Runoff Control**
    - **a.** Establish city regulatory and enforcement mechanisms for Erosion and Sediment Control (ESC) for construction sites greater than 5,000 square feet including planning, installation, inspection, and maintenance of ESC practices.
    - **b.** A draft of the new mechanism for appropriate storm water permits will be in effect by the end of Year 1. The City must develop a procedure to ensure that all permits are obtained for each construction site.
5) **Post-Construction Storm Water Management Development/Redevelopment**
    - **a.** Benton has substantial existing development and many new developments are still growing. For existing development, the City will develop a program for

inspection, maintenance, and upgrading of storm water infrastructure to ensure that storm water components are functioning properly and of adequate capacity.

b. By the end of Year 2, developments will be included in a mapping system which integrates the location of the water infrastructure components with schedules of inspection and maintenance.

6) **Pollution Prevention/Good Housekeeping For Municipal Operations**

a. Reduce the amount of nutrients entering receiving waters by developing a pollution prevention workshop for all municipal employees responsible for grounds maintenance and landscaping at public facilities in the first year. Once per year, hold an additional workshop for new employees and crew managers. Achieve a 40% reduction in fertilizer and pesticide use and a 25% reduction in water use after 3 years.

b. Develop plans describing spill prevention and control procedures by the end of Year 1. Conduct annual spill prevention and response training sessions for all municipal employees. Distribute educational materials to each municipal facility by the end of Year 2.

<u>Development of an Ecologically Sustainable Water Management (ESWM) Plan by the evaluation of ecological, geomorphological, anthropogenic stream flow requirements and water allocation needs.</u>

Partners Needed: local stakeholders, local government, US Fish & Wildlife Service, US Geological Survey, Natural Resource Conservation Service, Arkansas Game Fish Commission, Arkansas Natural Resource Center, Arkansas Department Environmental Quality, Arkansas Natural Heritage Commission, The Nature Conservancy.

Methods

Alteration in the Upper Saline River Watershed's hydrologic regime has been an ongoing issue of concern due to the withdrawal of water for recreational, industrial, and municipal use, changes in surface runoff patterns associated with conversion of forest land to urban development, and the impoundment of major tributaries. Extended low flow conditions, resulting from water withdrawals and diversions, can alter the natural flow regime of a river and reduce the range of available aquatic habitat. Consequently, without a stream's natural ability to periodically move sediment loads, the riverbed continues to aggrade, or accumulate, silt and sediment. This accumulation can seriously affect aquatic species habitat and recruitment, and can result in characteristic changes to the geomorphology of the stream, such as widening banks and shallower waters. The potential for escalating demands for water, particularly in the headwaters region of the watershed, to continue to decrease the flow in these critical streams was identified as an issue of concern by the Watershed Committee for this plan. It was suggested to develop a cooperative coalition of stakeholders and municipalities to discuss and address the in-stream flow needs for the four forks of the Saline River. It is hoped that such a coalition could be developed and begin meeting within the next three years.

A coalition of stakeholders, municipalities, local, state, and federal agencies, and non-profit organizations, or a Regional Watershed Management Partnership, would be tasked to do the following to establish an Ecologically Sustainable Water Management (ESWM) Protocol:

1) Estimate Ecosystem Flow Requirements – Develop initial estimates (or derive from studies already conducted) of essential flow conditions to sustain the ecological integrity of affected freshwater ecosystems (including all native species). In this case, there is research and data to utilize and potentially extrapolate regarding in-stream flow needs assessed by Dr. William Lahyer for the Middle Fork Saline River Assessment.
2) Determine Influence of Human Activities – Document the nature, degree, and location of human influences on natural flow regimes caused by all significant human uses of water including the operations of water infrastructure for storing and diverting surface and ground water, and changes in land cover that affect watershed hydrology. Computerized hydrologic simulation models have become essential tools for understanding human influences on natural watershed hydrology and river flows. These models can be used to evaluate river flow changes expected under proposed water management approaches, such as increased future human demands and associated operation of water infrastructure.
3) Identify Areas of Potential Incompatibility – Compare human-altered flow regimes with ecosystem flow requirements and identify areas of incompatibility. It is important to be as specific as possible in describing the magnitude, timing, frequency, and duration of the conflicts between water users as well as the location along the river or within the watershed in which they occur.
4) Collaboratively Search for Solutions – Identify opportunities for researching innovative solutions that could resolve incompatible human and ecosystem needs. Robust solutions will be more likely if the expertise and insights of all parties are engaged. One example of innovative techniques that could be applicable to the Upper Saline Watershed would be researching the direct use of treated wastewater for irrigation needs, particularly in light of the recreational irrigation demands of nine golf courses located in the Middle and South Fork watersheds. Innovative water conservation designs could also be researched for limiting the amount of water demands from other various land management activities and municipal needs.
5) Conduct Water Management Experiments to Resolve Uncertainty – Design and implement water management experiments to test ideas for solutions derived in Steps 1-4, and to break impasses caused by critical uncertainties. These experiments should focus on important information gaps that forestall the ability to resolve the areas of incompatibility.
6) Design and Implement an Adaptive Management Plan – Using the knowledge and fostering the relationships established during this process, create a cooperative Ecologically Sustainable Water Management (ESWM) Plan of action for long term implementation.

The role of professional scientists and conservationists in this issue of flow requirements is to provide the “best available science” from an objective, unbiased effort to serve as the technical foundation for use in water management decisions. The United States Geological Survey (USGS) will be critical in this role as the principal investigating agency in understanding the flow regime of the Middle Fork Saline River through established flow monitoring stations. The USGS will need to collect this critical data for the long term of this plan (10 years) to begin to understand the trend of natural flows within the watershed. In addition to the scientific foundation needed to determine sustainable use the role of local and state government, stakeholders, and citizens is to work together to incorporate human, ecosystem, and channel stability flow requirements as equal partners in the issue and to encourage active state involvement in the development of water allocation guidelines.

The end result would be a quantitative flow prescription addressing normal as well as extreme high and low-flow requirements. This would involve a broad-based effective scientific and political coalition. Development of this coalition should involve scientific, conservation and governmental agencies as well as local stakeholders working towards the development of effective and trusting working relationships among all partners in the project area. Federal and State financial assistance should be directed towards the development of such a partnership and once established, assistance should be directed to conducting water management experiments to resolve uncertainty.

Continued development of natural buffers within the Bauxite Mined Reclamation Areas (BMRA's)

The continued establishment of natural areas and buffers within the Bauxite Mined Reclamation Areas (BMRA's) such as the Saline River/Holly Creek Bottoms Natural Area, is priority for this watershed. The re-establishment of high-quality bottomland hardwood forests, particularly in riparian areas, is essential for filtering stormwater runoff and reducing sedimentation. There are four stream basins located within the BMRA: Blue Branch, Lost Creek, Holly Creek, and Hurricane Creek. The Blue Branch and Lost Creek basins are intermittent when leaving the BMRA, so thus provide only seasonal fish habitat. Holly Creek and Hurricane Creek are both perennial tributaries to the Saline River. The BMRA property boundary also extends to the Saline River. This riverfront location is approximately six miles downstream of established access at the I-30 Bridge and would provide a good take-out point for a short fishing float via canoe. The possibility of establishing public access in this area should be considered.

In order to accelerate the remediation of mining and its related impacts to the aquatic environment, management of both the lotic and lentic aquatic habitats on the BMRA is being accomplished using a multidisciplinary strategy. Riparian areas are a major component of the aquatic remediation plan for the Bauxite Mines Restoration Project. For intermittent streams such as Lost Creek and Blue Branch, and perennial streams such as Holly Creek and Hurricane Creek, a buffer strip or riparian zone has been established to function as described above. If any of these creeks are determined, through modeling, as high priority sub-watersheds to address non-point source pollution they should be inventoried to determine if any significant geomorphological changes need to be addressed through restoration or other.

There are a number of lakes located in the BMRA, ranging from fairly decent water quality to those with pH values < 5. A healthy and diverse aquatic community requires a pH between 6 and 9. Lakes are very dependent on the local watershed for maintaining or improving their water quality. For this and the above reasons, a minimum buffer width of 300 feet is necessary for their health and buffers up to ¼ mile around the lakes (or even wider in the natural areas) should be the target. Continuing to increase conversion from reclaimed areas in the BMRA to forested and natural shale-glade terrestrial habitat will assist in water quality protection.

As stated in the Arkansas Forestry Commission's Best Management Practices for water quality protection (2002), only non-intensive management activities should be practiced in buffer zones. Minimal activity could include prescribed fire (hazardous fuel management) and recreational activities as long as disturbance to the soil and vegetation is minimized. It is a desired short term goal of this plan to increase the natural preserves in the BMRA to include an additional three sites with at least one located within a riparian area of the Upper Saline Watershed.

<u>Development of a Conservation Easement Program for the Upper Saline Watershed</u>

Methods
It is recommended that a conservation easement program be established by a local 501 c(3) organization in the next 1-5 years for lands within the Upper Saline Watershed. Such a program would first identify priority areas within the Upper Saline Watershed, particularly riparian areas, that will best assist in water quality and instream habitat protection downstream of the site. Following identification of priority areas, groups should concentrate on development of an outreach program to inform the public regarding incentives from donation. Conservation easement donations can help to protect existing riparian hardwood forests, thereby giving landowners the opportunity to preserve their forested lands and still retain financial benefit. This approach could also protect lands within the watershed from encroaching development that would result in further non-point source pollution.

There is potential to develop this type of program through the first local watershed group recently established in the Upper Saline Watershed, AIM, Alliance for an Improved Middle Fork. Technical assistance could be provided for the establishment of such a program by the Arkansas Watershed Advisory Group (AWAG), a state group of agency and non-profit personnel developed to assist watershed groups throughout the state, or the Bayou Bartholomew Alliance, a long established watershed group located in the southeast portion of the state with extensive experience in the development of such a program.

<u>Restoration of stream dimension, pattern, and profile at all sites identified as past or current in-stream gravel operations within high priority sub-watersheds of the Upper Saline.</u>

Methods
This effort must be preceded by the 1) identification of past and current in-stream mining sites, and 2) a detailed geomorphic assessment of the watershed. The development of a complete restoration plan (in phases) may also be required for the top priority watershed of the Upper Saline basin, based on extent of restoration needs. Section 319 funds should first be prioritized to the completion of these three steps listed above for completion in the next five years. A database of funds allocated to these projects developed by ANRC could assist in analyzing a cost-benefit ratio that could reinforce the need to address incompatibilities in ADEQ’s Regulations 2 and 15 and/or address the need for additional staff in the ADEQ Mining & Water Quality divisions.

Element 3 – Information/Educational Outreach

<u>Hire 1 Water Quality Technician specific to the Upper Saline Watershed to work towards increasing utilization of cost-share programs.</u>

Technical assistance should be increased within the Upper Saline Watershed for accelerating the utilization of cost-share programs. Concentrated efforts should be geared towards priority sub-watersheds of the Saline to accelerate conservation planning in light of the very limited participation in these programs that has characterized the watershed to date (See table 8 below, also see Appendix E Conservation Plans by County).

Table 8. 2005 Implemented Farm Bill Programs HUC 8040203

Upper Saline Watershed Implemented Conservation Plans 2005		
HUC 08040203	PLANS	ACRES
CRP	0	0
EQIP	3	225
WRP	0	0
WHIP	0	0

The ANRC has provided state funding in the past to local conservation districts for water quality technicians. A Water Quality Technician would be responsible for reviewing geomorphological assessments of the priority sub-watersheds of the Saline to help identify areas in most need of restoration. The Technician could then incorporate these priority areas into a funding priority system and submit for review to the Arkansas Natural Resource Commission. The Water Quality Technician would also be responsible for partnering with local agencies and non-profits conducting research within the watershed to act as a liaison between agencies and local landowners. Pamphlets should be developed by the Water Quality Technician identifying local watershed conditions, research findings, and programs applicable and pertinent to the area for cost-share assistance in restoration. Specifically the technician could focus on educating landowners about programs that will assist in pasture and hay management, alternative watering sources for livestock, riparian re-forestation, and fencing. The Technician would also work on annual practice reviews and evaluations of implemented conservation practices. Computer hardware and Geographic Information Systems (GIS) software and training is needed for the county districts to track progress in conservation planning, particularly by sub-basin of the Upper Saline Watershed, to best prioritize future applications for funding. Financial assistance geared towards funding this type of position will be instrumental in increasing participation in important cost-share programs in the Upper Saline Watershed. The Water Quality Technician would best be supervised by the ANRC.

Disseminate information on the ecological and historical significance of the Upper Saline Watershed. Hire Watershed Coordinator to assist local watershed groups in this and other tasks.

Methods

As positive watershed awareness grows throughout the Upper Saline, the potential for more public involvement could increase the number of local watershed groups throughout the Upper Saline area. As local groups begin to organize, it is often difficult to find focus and develop a plan of action for involvement within the watershed. The first step taken by many watershed groups is to seek out funding to hire a watershed coordinator. Many watershed groups throughout the country have been successful in receiving grant money to hire a watershed coordinator anywhere from a one to six year term. Taking this step to establish a full time person educated in watershed management efforts can save a lot of time and confusion for groups that are ready to learn and get involved in restoration activities, but need focused guidance. Since information and educational outreach will be the most useful tools in changing the cumulative negative impacts to local natural resources, it is many times best to hire someone to devote the necessary time to fully research issues and develop a successful outreach program to involve stakeholders across the watershed. Duties that a watershed coordinator could perform include (but are not limited to): grant research, writing, and development of reports; development of fact sheets, quarterly newsletters, and an informational website; networking with agencies, organizations, news media, and citizens on a multi-county basis; coordination of fundraising, monthly or quarterly public meetings, watershed tours and workshops; working closely with a Water Quality Technician for the Upper Saline; and identifying, planning, and/or leading habitat restoration projects.

Disseminate information regarding in-stream gravel operations.

Methods

Educating city and county government officials and citizens within the watershed on resource extraction issues related to NPS pollution will help identify and appropriately report non-permitted and/or harmful resource extraction activities within the watershed. There have been continued reports of in-stream gravel operations within the Upper Saline Watershed reported to the Arkansas Department of Environmental Quality. There have also been complaints regarding the release of sediment retention ponds into the river from mining facilities located in and near riparian areas of the watershed. It is recommended that local watershed groups partner with the County Conservation Districts and the ADEQ to release information to stakeholders in the watershed (via fact sheets and flyers) to (1) identify what activities are legal vs. illegal, (2) distribute information on the harmful effects of in-stream mining, (3) publicize alternative sources for gravel, and (4) publicize avenues for reporting illegal activity.

Element 4 – Technical/Financial Assistance Needed to Achieve Goals

The following is an attempt to estimate costs for implementation of the guidelines set forth in this plan. Several parameters have been considered for these estimations including; necessary technical assistance, type of BMP's with associated costs for installation and maintenance, and costs associated with implementation. The total cost estimated for the implementation of an action is broken into federal versus matching dollars. Federal is considered to come from federal cost-share programs including Section 319 funding as well as farm bill programs, etc. The match portion (~43%) reflects the amount proposed to come from local government, fund-raising, nonprofit organizations, foundations, and the donation of in-kind labor, materials, and usage of equipment. The identified best management practices and associated costs listed are intended for implementation in the short term, over the next five years. It is assumed that once these tasks are complete for the top three priority sub-watersheds of the Saline, prioritization of sub-basins will be re-assessed and implementation efforts will begin for other sub-basins of high priority. This plan, of course, is intended to be a living document and will need adjustment as new tools and data become available.

Technical and Financial Assistance Needed				
Data Collection/Monitoring Needs				
	Action Item	**Federal**	**Match**	**Potential Partners**
1	Eval. & Prioritization of sub-watersheds	$ 28,000	$ 21,000	TNC, AWRC, ANRC
2	Detailed Inventory of 3 sub-watersheds	$ 169,290	$ 127,750	AGFC, TNC, ANRC
3	Bio. Assessment of fish populations: (5 years, bi-annual sampling, 6 sites)	$ 46,000	$ 35,000	AGFC, TNC, ADEQ, ANRC
4	Expansion of Water Quality Monitoring	$ 270,000	$ 330,000	ECO, ANRC, AWRC
5	Inventory Unpaved Roads, 3 watersheds	$ 34,200	$ 25,800	TNC, USFS, Saline, Grant Counties
6	Database creation for in-stream gravel operations	$ 3,675	$ 2,775	ADEQ, AIM, Saline, Grant Counties ANRC
7	Nutrient Criteria Study (3 year project)	$ 55,300	$ 41,700	ADEQ, USFWS, AGFC, USGS

Restoration and BMP Implementation Needs				
1	Implement BMP's following roads analysis for 3 priority watersheds, repair crossings	$ 85,500	$ 64,500	Saline, Grant Counties, TNC, ANRC
2	Implement streambank restoration, 2 sites	$ 22,800	$ 17,200	AGFC, ANRC, TNC, NRCS
3	2 urban forestation/restoration projects	$ 22,800	$ 17,200	AFC, ANRC, Co. Cons. Dist.
4	5 BMP workshops	$ 12,735	$ 9,765	Saline, Grant Counties, TNC, ANRC
5	2 water management research projects	$ 57,000	$ 43,000	USGS, UofA, Co. Cons. Dists.
6	Development of a Regional Sustainable Water Management Plan	$ 48,450	$ 36,550	USGS, UofA, Co. Cons. Dists.
7	Restore/Establish 3 new natural areas in the Bauxite Mining Reclamation Area (~200 acres)	$ 114,000	$ 86,000	Alcoa, TNC, ANHC, AGFC, USFWS, ANRC
Information/Educational Outreach Needs				
1	Hire Watershed Coordinator, 2 year term	$ 36,480	$ 27,520	ANRC, ADEQ, AGFC, USFWS
2	Hire Water Quality Technician for County Conservation Districts	$ 36,480	$ 27,520	ANRC, ADEQ, AGFC, USFWS

Element 5 – Schedule of Implementation

An overall schedule of the necessary tasks to successfully implement this restoration plan is summarized in Table 9 below. These identified tasks should be implemented in a minimum of three priority watersheds of the Saline in the short term (3-5 years). If outside circumstances prohibit this effort, it should be re-assessed at the end of year five and prioritized for completion in the long term. Efforts should include expanding these tasks to include additional priority subwatersheds over a period of ten years, intense educational outreach development and implementation, and monitoring of non-point source pollution reduction efforts to establish measures of success.

Table 9: Schedule of Implementation

	Action Description	Start Date	Completion Date
	Schedule of Implementation		
1	**Prioritize Sub-watersheds**		
	Land use change GIS analysis	Spring 2005	Fall 2005
	Ranking for phosphorus, nitrogen,		Spring 2004
	sediment		
	TNC Ranking	Summer 2005	Spring 2005
2	**Detailed Inventory of 1-3 sub-**		
	watersheds		
	Priority subwatershed 1:	Spring 2005	Winter 2007
	Channel Stability Assessment		
	Survey Cross Sections		
	Streambank Material Characterization		
	Flow Regime Characterization		
	Estimate sediment loads (WEPP,etc)		
	Priority subwatershed 2	Fall 2007	Spring 2008
	Priority subwatershed 3:	Fall 2008	Spring 2009
3	**Expansion of Biological Monitoring**		
	2 priority sub-basins biannually	Fall 2006	Fall 2008
	bio. Monitoring in two 319 projects	Fall 2006	Fall 2011
4	**Expansion Water Quality**		
	Monitoring		
	Watershed survey	Spring 2005	Spring 2005
	Establish 2 new permanent stations	Spring 2005	Spring 2008
5	**Unpaved Roads Inventory**		
	Priority subwatershed 1:	Fall 2006	Summer 2007
	Data Collection		
	Data Analysis & Mapping		
	Roads Workshop		
	Priority subwatershed 2:	Fall 2007	Summer 2008
	Priority subwatershed 3:	Fall 2008	Summer 2009
6	**Inventory Database for In-Stream**		
	Gravel Operations	Spring 2006	Ongoing
	Data Collection		
	Data Analysis & Mapping		
7	**Nutrient Criteria Pilot Study**	Summer 2005	Winter 2007
	Historical data compilation		
	Initial sampling assessment		
	comprehensive assess, bio. Sampling		
8	**Macroinvertebrate Stream**		
	Condition Index	Fall 2005	Winter 2007
	Data Collection		
	Data analysis / Final Report		

Schedule of Implementation			
	Action Description	**Start Date**	**Completion Date**
9	**Implement BMPs on**		
	Recommended Road Segments	Summer 2007	Ongoing
	Repair ditch & road segments		
	Repair culvert and bridge crossings		
10	**Stream Restoration: In-stream**		
	Gravel Operations	Fall 2006	Ongoing
	Restore stream dimension, pattern,		
	profile as needed		
11	**Streambank Restoration/Riparian**		
	Re-forestation	Fall 2006	Fall 2011
	2 sites in the Upper Saline Watershed		
12	**Best Management Practice**		
	Trainings & Workshops:	Fall 2006	Fall 2011
	Five trainings throughout USW		
13	**Implementation of Stormwater**		
	Pollution Prevention Program	Fall 2006	Ongoing
	City of Benton	Fall 2006	Fall 2010
	Other growing municipalities	Fall 2006	Fall 2015
14	**Development of a Regional Water**		
	Management Partnership USW	Fall 2006	Fall 2011
	Meetings Targeted (3/ year)		
	Development of Sustainable Water		
	Management Plan		
15	**Increase Natural Areas in Bauxite**		
	Mining Reclamation Area:	Fall 2006	Fall 2011
	Establish 2 new areas within BMRA		
	Establish 1 preserve in riparian area		
16	**Develop Conservation Easement**	Fall 2006	Fall 2011
	Program		
	Identify priority areas	Fall 2006	Spring 2007
	Develop an outreach program	Spring 2007	Fall 2007
17	**Increase Educational Outreach**		
	in the Upper Saline Watershed	Fall 2006	Ongoing
	Hire Watershed Coordinator	Fall 2006	Spring 2007
	Riparian Tree Planting	Fall 2006	Ongoing
	News Articles (12)	Fall 2006	Fall 2011
	Public Saline River Tours (5)	Fall 2006	Fall 2011
	Development of website/newsletters	Fall 2006	Fall 2007
18	**Increase Conservation Plans &**		
	Utilization of Cost-Share Assistance	Fall 2006	Ongoing
	Hire Water Quality Technician to cover	Fall 2006	Spring 2007
	Saline and Grant Counties		
	Enroll 2-5 landowners in cost-share	Fall 2006	Ongoing
	assistance programs per year		

Element 6 - Estimated Load Reductions

At this time, due to limited knowledge of existing pollutant loads within the watershed, the estimated load reductions suggested below are more qualitative as a re-iteration of the necessary management measures needed to achieve some reduction, without identifying the numeric reduction needed. A detailed modeling effort should be conducted for the Upper Saline Watershed to first determine specific loading estimates for priority subwatersheds including estimates for sediment, phosphorus, and nitrogen loadings. As this data becomes available, it will then be appropriate to conduct watershed modeling efforts to achieve numeric load reductions necessary for restoring the form and function of priority sub-watersheds of the Saline riverine system.

Unpaved roads can deliver sediment and nutrients directly into streams at crossings, or indirectly by overland flow or gullies. Estimates from several watersheds in the Ozark Mountains ecoregion in Arkansas suggest that 20-30% of sediment in rivers comes from unpaved roads (Van Eps, et al. 2005a; Van Eps, et al. 2005b). Road sediment is being targeted because, compared to other non-point sources of pollution such as runoff from pastures, sediment from roads is more realistic to identify and manage for successful short-term reduction. Thus, assessment and implementation dollars spent to reduce sedimentation can be maximized in the short run by investing in watershed roads assessments and prioritization, training programs, and hands-on demonstrations of the implementation of best management practices on gravel roads. It has been speculated when conducting WEPP modeling used to compare roads with and without BMP installation, that an estimated 30% reduction in sediment loading can be achieved where BMP installation has occurred.

A USFS comparative assessment of 50 watersheds in Arkansas, Oklahoma and Missouri estimates potential erosion by land use for the Upper Saline River watershed. Based on 1992 National Resource Inventory data, other land uses (including urban) had the highest potential erosion rate at 85% compared to pasture with a 6% potential erosion rate and forestry with a 3% potential erosion rate (USFS, 1999).

Prioritization should be given to establishing load reductions through modeling efforts so as to amend this portion of the Nine Element Plan. Until further data can dictate specific load reductions necessary, for the above cited reasons, focus should be prioritized to projects that address unpaved gravel roads, urban, and riparian areas so as to reduce a numerically unknown, but qualitatively prevalent amount of sedimentation to the system.

Element 7 – Performance Criteria

The main objective identified for this watershed is to restore a functional and sustainable hydrologic and sediment regime throughout the entire watershed by promoting the abatement of excessive sedimentation and non-point source pollution, restoration of identified critical sites, and the development of sustainable water management practices. These broad measures address and take into account the overall goal of sustaining a healthy population of aquatic species, protecting the integrity of the full range of natural habitats, and maintaining the economic needs of the citizens living in the watershed.

It is important to monitor the success of a watershed plan by identifying if progress is occurring within the outlined objectives. A set of criteria is needed to identify improvements in the watershed including important indicators that are more easily detected by trends rather than a set numeric value. The following criteria will assist state agencies and land managers in determining if implementation efforts are proving effective in reducing loads to the watershed. It will also help determine if significant changes need to be made to the objectives, following a short term review of the plan, in order to achieve the desired goals.

1. Biological monitoring (fish, macroinvertebrate) shows an increasing trend in populations from pre- to post-BMP implementation in at least 50% of prioritized project sites in the watershed.
2. Storm water inspections of construction and industrial sites show at least an 85% annual compliance rate with the installation and diligent maintenance of appropriate erosion control measures minimizing the impact to both ephemeral and perennial streams.
3. Short term (5 years) of water quality monitoring shows a reversing (declining) trend in turbidity values during storm events in the North, Middle, South, and Alum Forks, and Big Creek.
4. Land use change within the riparian areas of the watershed show a reversed trend of an increase in the natural/mixed woods matrix and a decrease in urban, roads, and dominant pine industrial forest matrix over the next five years.
5. BMP compliance rates for monitored forestry practices rises to above 95% and total number of surveyed tracts without an adequate Streamside Management Zone (SMZ) reduces to less than five for lands in the Upper Saline Watershed in the next five years. SMZ's are extended to a 50 foot (from a 35') requirement.
6. Water quality monitoring ceases to show dissolved oxygen violations for Hurricane Creek, Big Creek, and the Middle Fork Saline River over the next five years.

In order to monitor this criteria, there is a need to continue and expand rigorous water quality, macro-invertebrate, and fish population monitoring regimes particularly at all sites chosen for restoration or BMP implementation. Coordination with agency and non-profit organization partners is needed prior to each potential project to ensure the evaluation of success or non-success through coordination of monitoring efforts.

Element 8 – Milestones & Re-evaluation

Setting milestones for this watershed plan, or identified deliverables for a particular recommended project, will assist in determining if implementation efforts are being carried out in a timely and efficient manner during the next five years of implementation. The following items should be monitored for completion on an annual basis to ensure the appropriate progression of each project is taking place:

1. Completed maps depicting sub-watershed prioritization.
2. Sediment loading estimations per land use for inventoried priority watersheds.
3. Detailed map and restoration plan for "hot spots", or rapidly eroding streambanks, identified within priority sub-watersheds.
4. Biological monitoring data and reports for four new sampling sites within the Upper Saline Watershed.

5. Maps and a priority list of roads contributing the most sediment. A list of bridge and culvert segments identified for repair.
6. Water quality monitoring results and a developed nutrient criteria plan for nutrient impacted streams in the Upper Saline Watershed.
7. Pre- and post-project biological and/or water quality monitoring data and before and after photos taken from streambank restoration projects in the watershed.
8. Attendance lists and a developed inventory database identifying numbers of people that attend BMP trainings and workshops in the watershed on an annual basis.
9. Documentation of the number of conservation easement donations across the Upper Saline Watershed.
10. Number of positive news articles released regarding stakeholder efforts for conservation and restoration in the watershed.
11. Attendance numbers for field tours within the watershed.
12. Number of seed plantings for riparian areas in the watershed.
13. Number of conservation plans developed for farms and ranches throughout the watershed.
14. Number of forest enhancement projects completed within the watershed.
15. Total number of stakeholder meetings held throughout the watershed.

Element 9 – Monitoring

It is highest priority for this watershed to have an established long-term ecological, hydrological, and geomorphological monitoring network. Identification of existing monitoring conditions is a good first step, followed by the development of a long term monitoring plan that targets: the expansion of monitoring sites in critical sub-watersheds of the Upper Saline, the prioritization of new monitoring sites with proposed and existing BMP implementation project areas, and coordination between data collection agencies to maximize monitoring efforts.

Hydrologic monitoring needs include observations such as (1) stage, discharge, and the magnitude, frequency, time, duration of extreme high- and low-flow events, (2) channel cross sections, longitudinal profiles, (3) trend analysis of channel platform and bedform changes, and (4) river bank and bed erosion rates. Biological monitoring needs include Index of Biotic Integrity (IBI) monitoring for benthic macroinvertebrates and fish communities. Water Quality monitoring needs include establishing baseline and annual monitoring of sediment fluxes and water quality parameters, particularly for prioritized sub-basins, such as: pH , water temperature, turbidity, D.O., conductivity, total dissolved and suspended solids, and bedload. Sampling analysis for nitrates, phosphorus, pesticides, and herbicides are needed on a periodic basis.

<u>*What Has Been Done*</u>

Hydrologic & Water Quality Monitoring

Currently there are twelve water quality monitoring stations within the Upper Saline Watershed. Three of these sites are monitored continuously by the United States Geological Survey (USGS) while the other nine sites are monitored quarterly by the ADEQ. ADEQ has committed to continue this water quality monitoring for the short term. Funding is hoped to be continued in the short and long term for three continuous water quality monitoring stations installed by the USGS on Brushy Creek and the Middle Fork Saline River, currently; however; efforts are only funded to continue throughout FY 2006. There is historical water quality data recorded for seven sites monitored by the ADEQ and thirty-one sites monitored by the USGS within the Upper Saline Watershed that can be used for historical reference. (See Appendix F. USGS/ADEQ Monitoring).

The USGS, in cooperation with the Arkansas Game and Fish Commission, established the first water flow gauge in the Middle Fork watershed at the Vance Road Bridge in 2002. The "Water-Quality Assessment of the Middle Fork of the Saline River, Central Arkansas" has been a proposed cooperative study, which monitors stream flows and water quality in the Middle Fork. The multi-agency study will examine nutrient (nitrogen and phosphorus) dynamics and compare nutrient loads from the upper and mid sections of the river at Vance Bridge. The study will also examine fecal coliform (E. coli), water temperature, dissolved oxygen, pH, nitrogen, phosphorus and other related water quality measurements.

The USGS has installed stream flow gauging stations on the Middle Fork upstream of Brushy Creek and on Brushy Creek just upstream from the confluence with the Middle Fork. The USGS will collect data for three years followed by an USGS Water Resources Investigations Report assessing the water quality of the Middle Fork.

Biological Monitoring

The ADEQ has utilized bioassessments, in addition to water quality monitoring, since the 1970's as a technique to evaluate and monitor water quality and ecological health of aquatic systems. Currently, the ADEQ is the primary constituent involved in macroinvertebrate data collection in the Upper Saline Watershed. The ADEQ and the Arkansas Game & Fish Commission (AGFC) are the only two administrators collecting and distributing fish population data within the watershed. AGFC (specifically Fisheries Dist. 8) does plan to resample previously sampled sites on the Middle Fork Saline River in the short term (within 3 years). At this time, however AGFC is not committing to a long-term (5 to 10 year period) sampling plan for the Saline River. The ADEQ is currently sampling eight sites for benthic macroinvertebrates, six located within the Middle Fork watershed (804020300301, 80402030304) and two locations within the South Fork watershed (80402030202). The ADEQ is currently sampling four sites for fish populations located in the Middle Fork watershed. ADEQ has committed to continue sampling at these biological monitoring sites for the short term (3 years). (See Appendix F. USGS/ADEQ Monitoring)

Best Management Practices Monitoring

The Arkansas Forestry Commission collects and analyzes survey data on the implementation of recommended forestry BMPs in Arkansas' non-point water source silvicultural program. The ADEQ is responsible for routinely inspecting the use of BMP's associated with construction sites to reduce stormwater runoff of sediment into local waterways. The local County Conservation Districts are responsible for monitoring the adherence to BMP's implemented.

Geomorphological Monitoring

The National Water Management Center (NWMC) is working with the Arkansas Natural Resource Commission (ANRC) to develop a database of reference stream reaches in the Ouachita Mountains of Arkansas. The three-year project began in Oct 2001, with NWMC and ASWCC personnel starting the collection of field data and the analysis of hydrologic records for 50 USGS Gaging Stations. Field data collection entails topographic surveys of selected stream reaches, collection of bed and bar sediments, characterization of local geology and stream ecology sampling. The topographic surveys may run from hundreds to thousands of feet, and are intended to collect stream hydraulic geometry parameters including; thalweg elevations, reach slopes, widths, depths, cross sectional areas, channel forming indicators, and top of banks and floodplain elevations. Sediment samples are collected to assist with stream classification and help confirm channel forming discharges. Characterization of the local geology is also used to assist with stream classification and will assist in the development of the regional and regime hydraulic geometry curves. Stream ecology sampling consists of macroinvertebrate sampling to assess biological communities in the streams.

The Nature Conservancy is contracted with the ARNC to conduct a geomorphologic assessment of the Middle Fork Saline River watershed in a two year project that began in Fall of 2005.

What is Needed: Re-evaluation of monitoring needs
Several efforts have been outlined and discussed within this plan to evaluate and expand the monitoring necessary for the short term, including expansion of water quality monitoring, macroinvertebrate and fish population monitoring, and establishing a geomorphological monitoring plan starting with identified priority sub-watersheds. Monitoring efforts should be re-evaluated following five years of implementation of this plan, and as needed with the addition of new data and analysis. This evaluation should address and change if necessary, the identified monitoring needs for this watershed.

Appendix A:

Figure 1. Population Density Mapping

Figure 2. Public Vs. Private Ownership

Figure 3. Land Use Change Map Upper Saline Headwaters

Figure 4. Land Use Change Map Upper Saline Watershed 1986-2004

Figure 5. Upper Saline Hydrology: All Perennial Streams

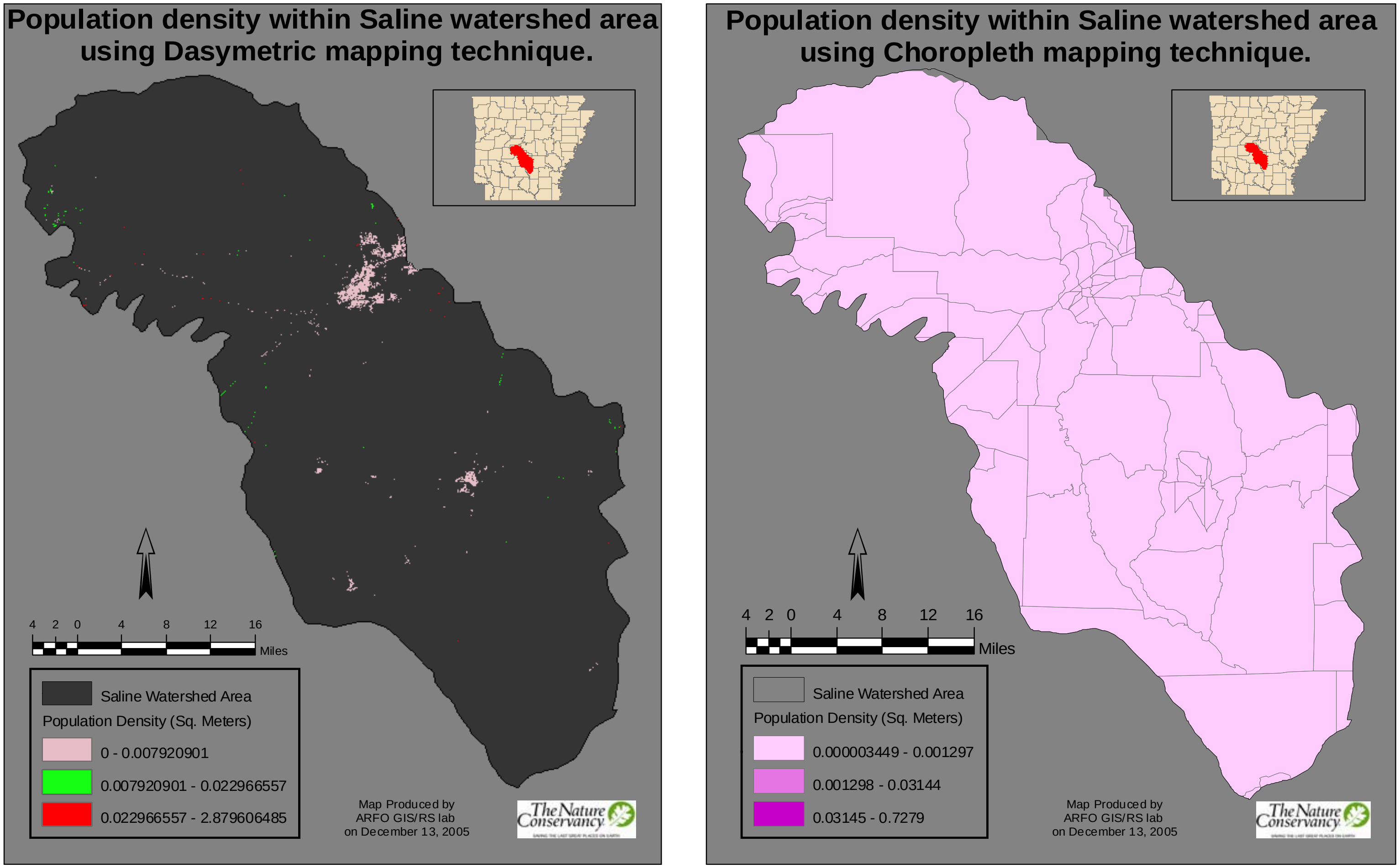


Figure 1: Dasymetric Mapping Technique

Dasymetric mapping uses remote sensing imagery to redistribute spatial data in a more accurate and logical way than the traditional choropleth mapping technique. Land use classifications within the Upper Saline Watershed are used to overlay "urban" areas with census block group data from the US Census Bureau, using 1992 NLCD landuse imagery. This provides an accurate view of the locational occurrence of the population.

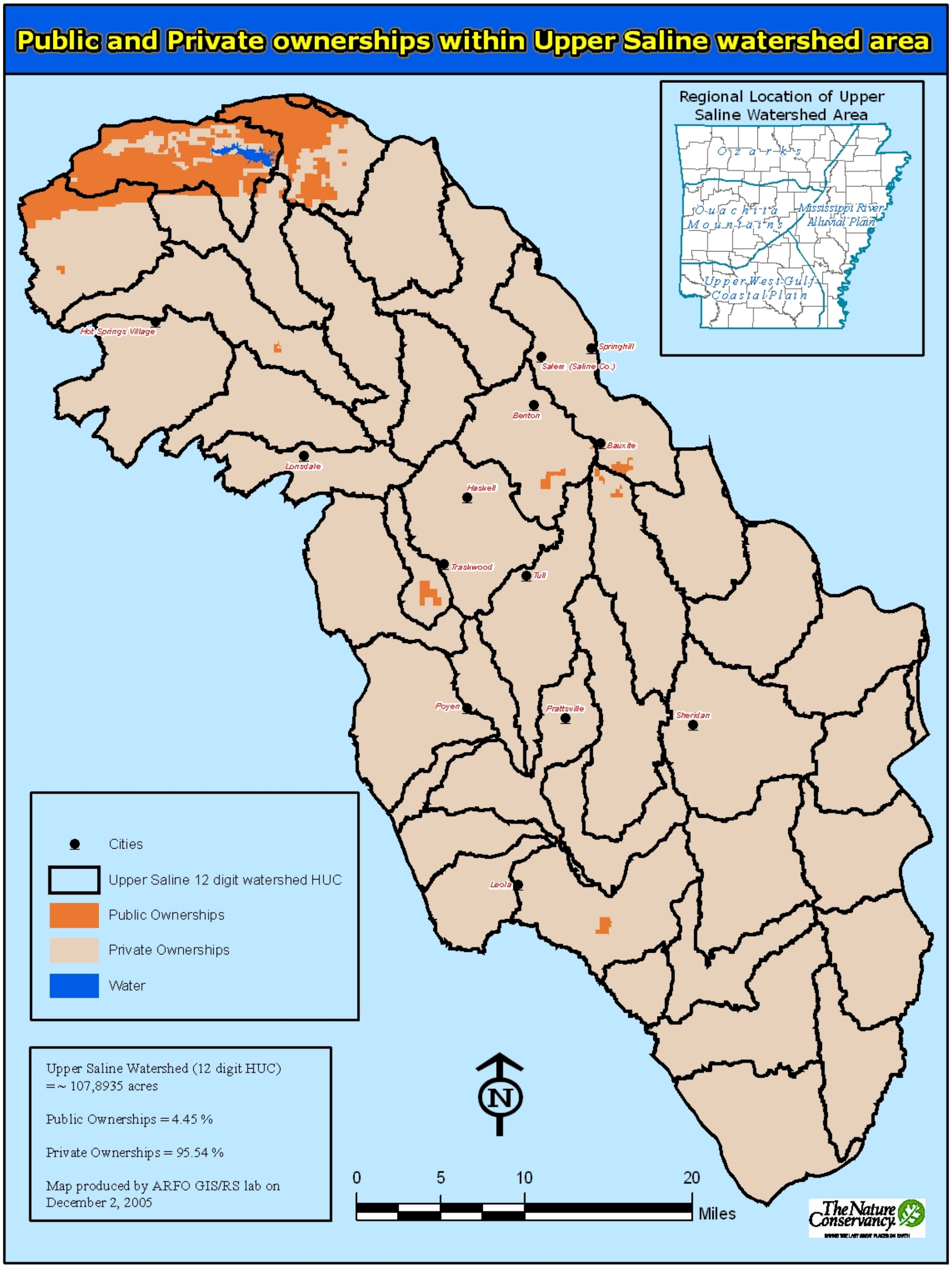
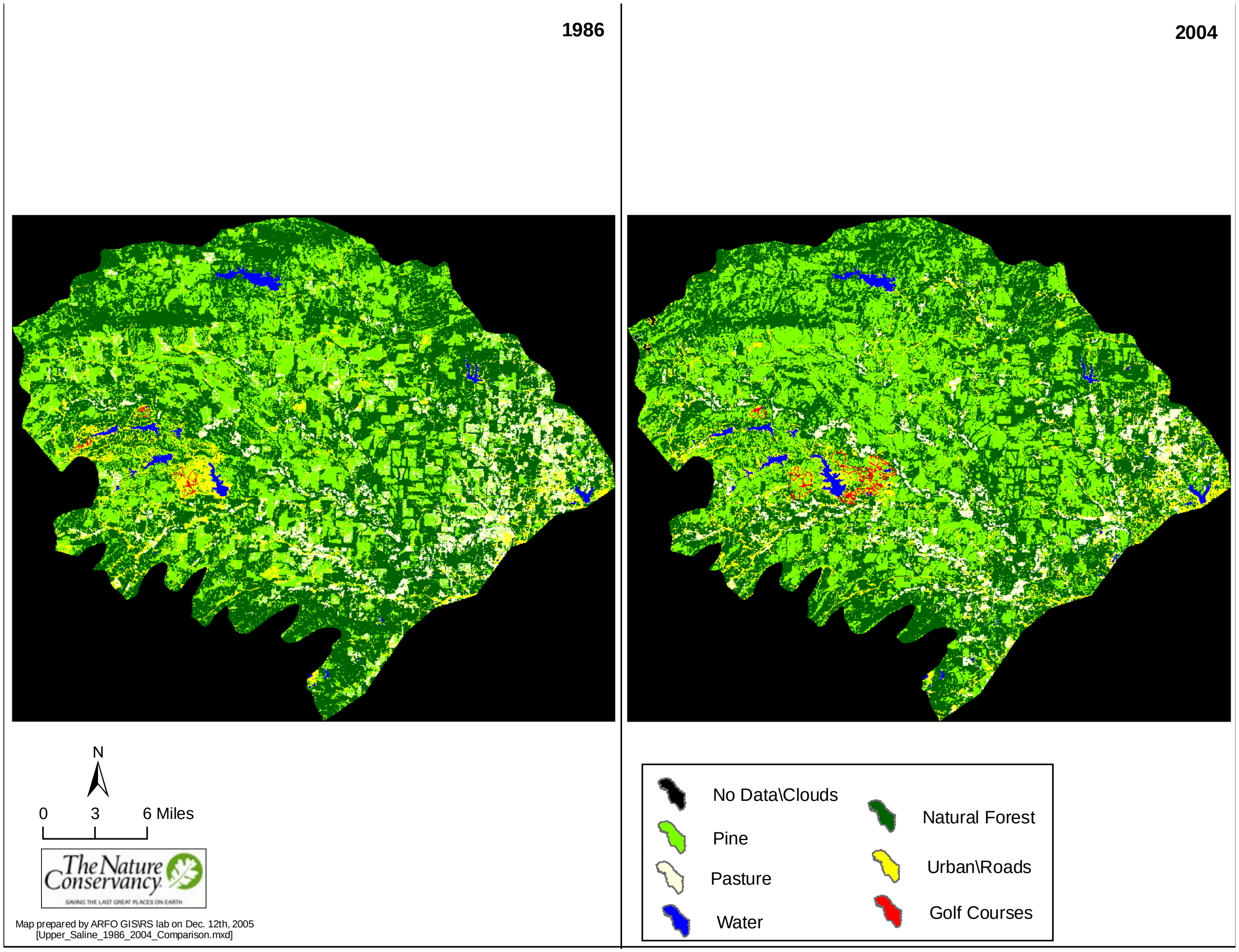


Figure 2: Public vs. Private Ownership

Figure 4: Land Use Change Headwaters Region



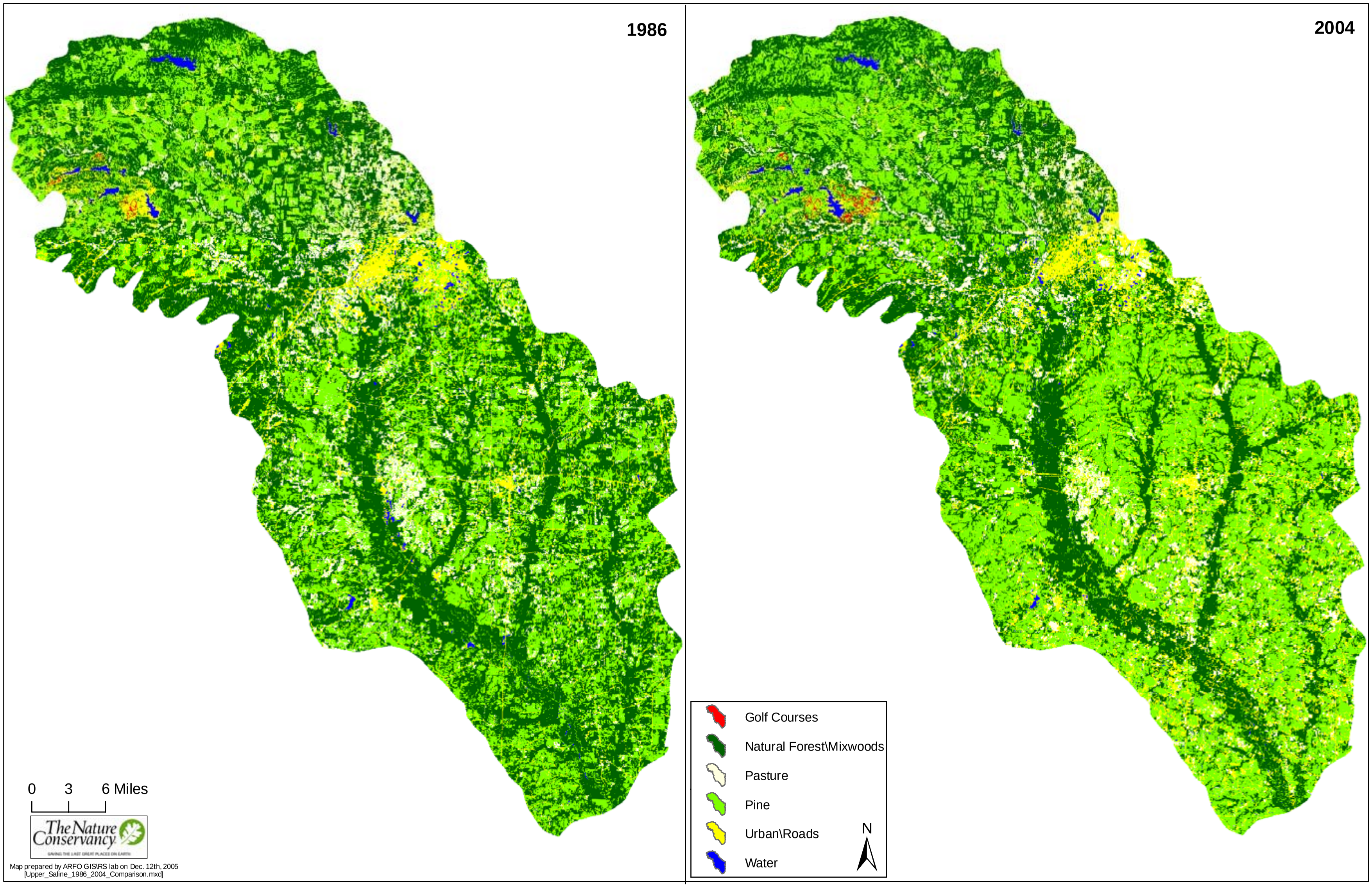


Figure 4. Land Use Change 1986-2004

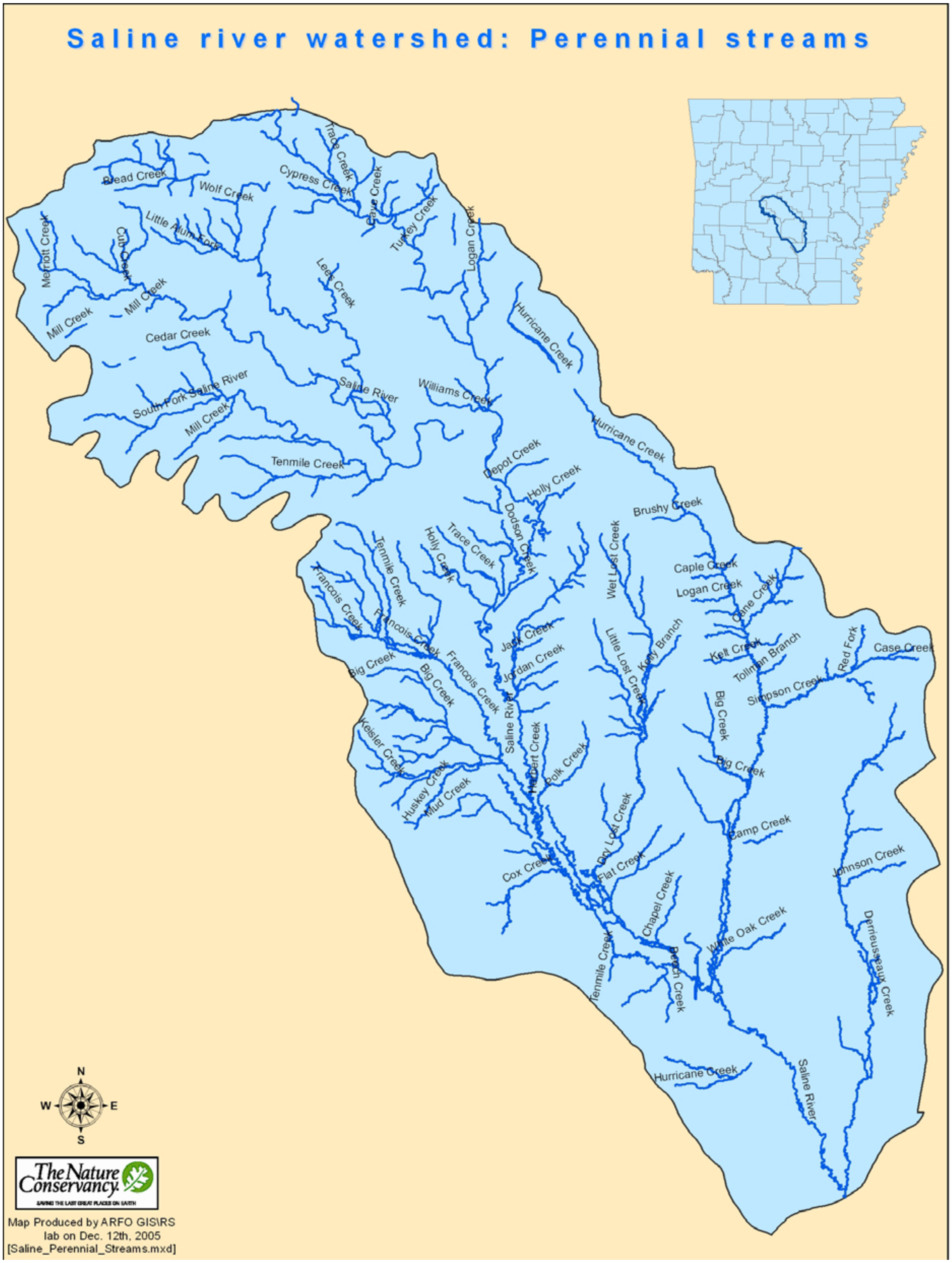


Figure 5. Upper Saline Hydrology: All Perennial Streams

Appendix B.

List of 9-Element Watershed Committee Participants

Watershed Committee Meeting Participants
Upper Saline 9-Element Planning Process

Watershed Groups:
- Alliance for an Improved Middle Fork (AIM)
- Concerned Citizens for the Middle Fork
- Environmental Community Heritage Objective (ECHO)
- Sierra Club

Timber Producers:
- Weyerhaeuser Company
- AR. Timber Producers Association
- Talbert Timber Company
- Green Bay Packaging
- International Paper Company
- Deltic Timber Corp.

Construction/Development Representatives:
- Saline County Homebuilders Association
- Benham Company

City Representatives/Citizens/Landowners:
- Benton City Mayor, Utility Commissioner
- Hot Springs Village POA Board Members
- Hot Springs Village Water/Wastewater Dept.
- Hot Springs Village Lakes & Water management Committee
- Bauxite Mining Reclamation, ALCOA
- Various citizens from Lonsdale, Benton, Hot Springs Village

County Representatives:
- Saline County Judge
- Saline County Conservation District

Local, State, and federal agency personnel involved with research within the Upper Saline Watershed:
- United States Geological Survey (USGS)
- Arkansas Game & Fish Commission (AGFC)
- Arkansas Forestry Commission (AFC)
- Arkansas Dept. of Environmental Quality (ADEQ)
- US Fish & Wildlife Service (USFWS)
- Ar. Highway & Transportation Department (AHTD)
- Arkansas Soil & Water Conservation Commission (ASWCC)
- US Forestry Service (USFS)
- Natural Resource Conservation Service (NRCS)

Appendix C.

Figure 1. Location of Dams

Figure 2. Dam Density Ranking

Figure 3. Density Ranking of Stream/Road Crossings

Figure 4. Gravel Road Density

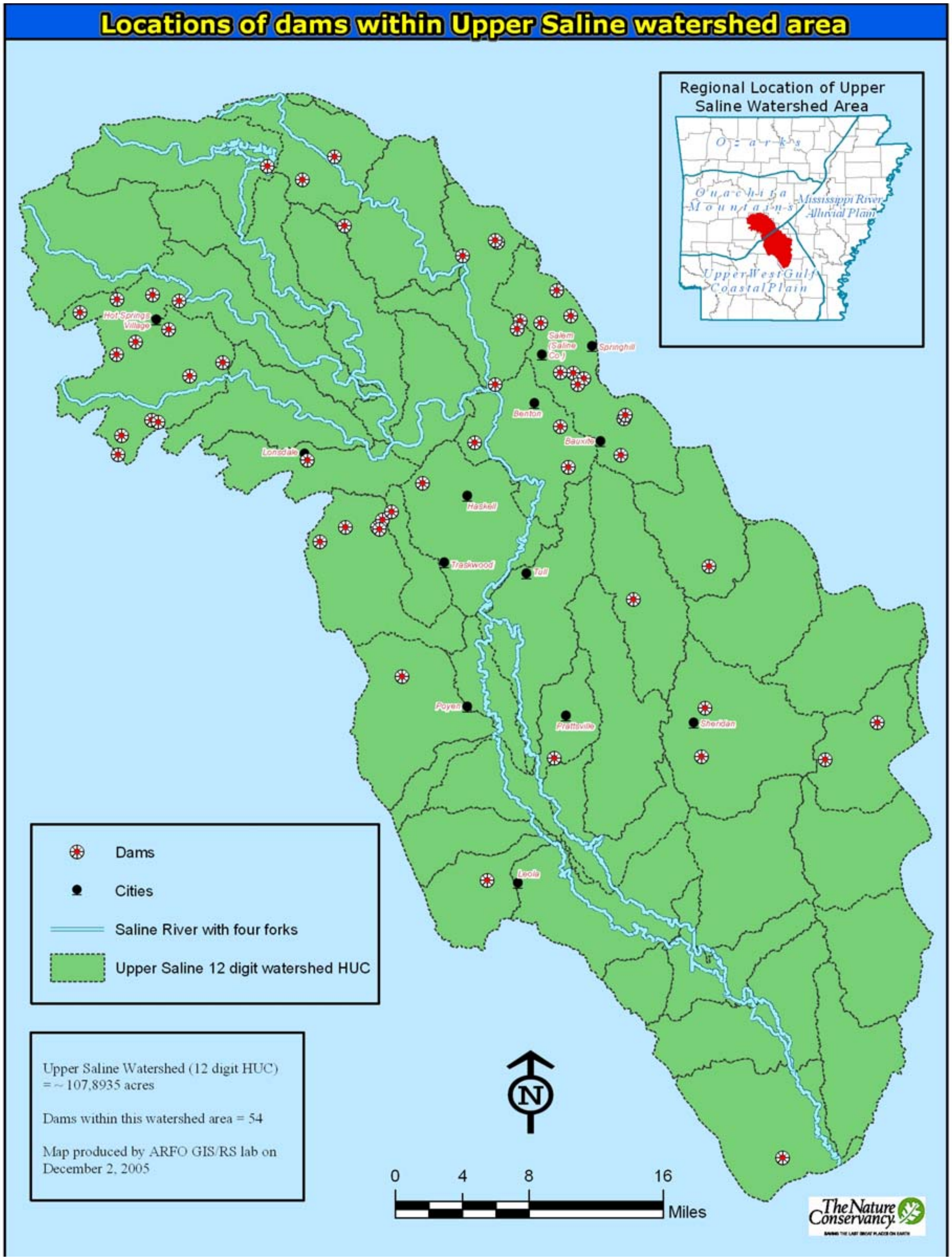


Figure 1. Dam Locations

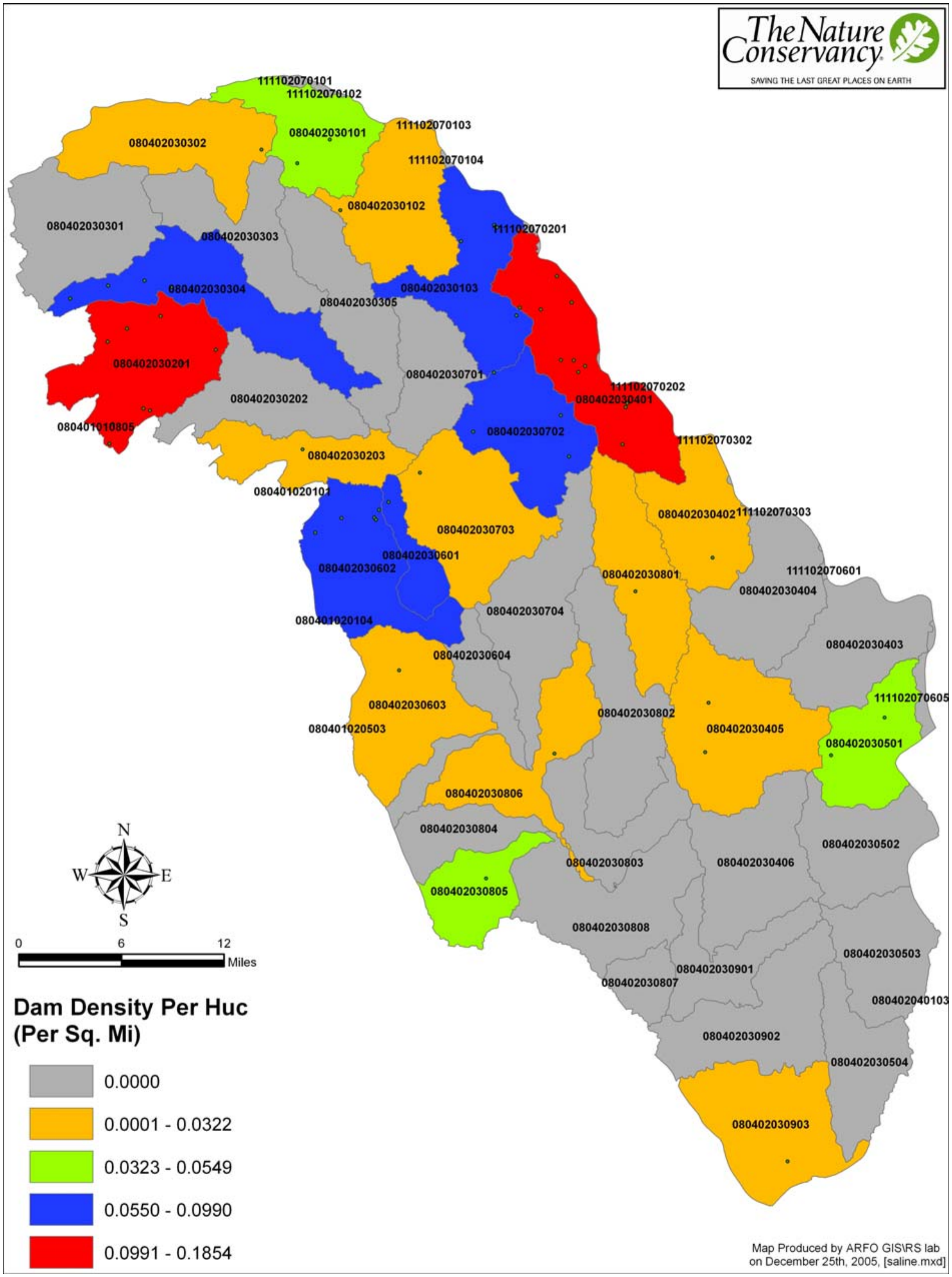


Figure 2. Dam Density, Sub-basins

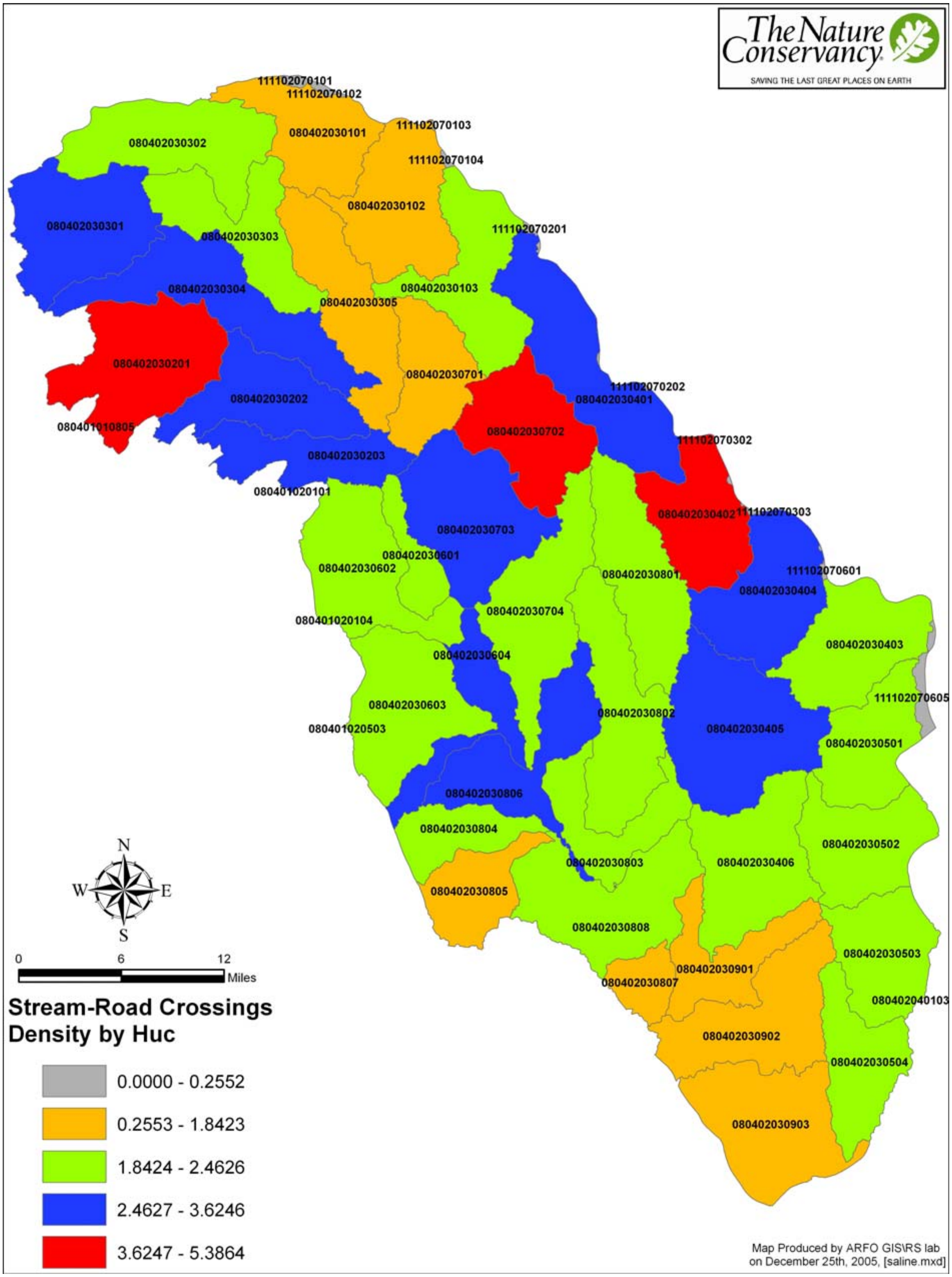


Figure 3. Density Ranking of Stream/Road Crossings

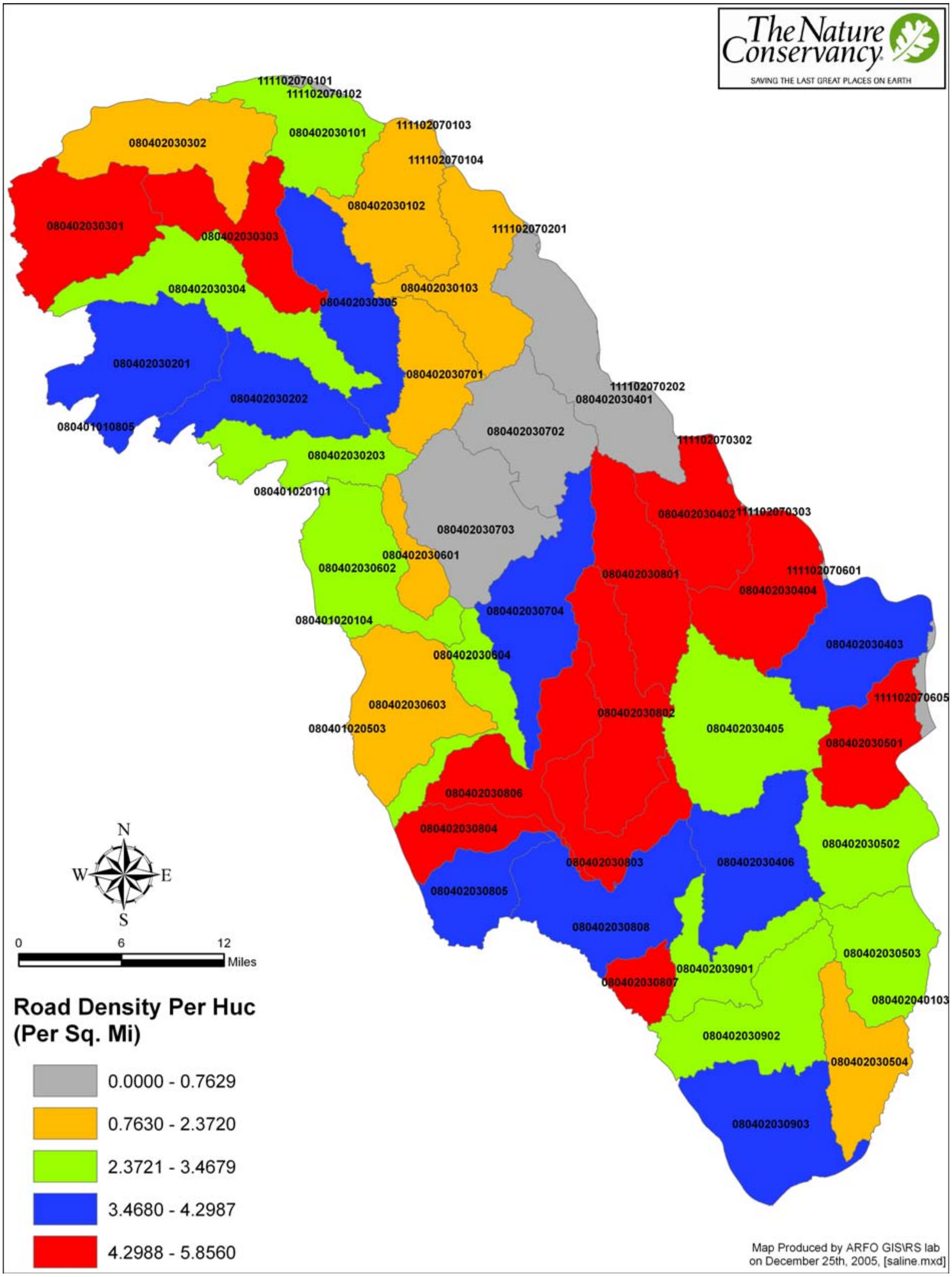


Figure 4. Gravel Road Density

Appendix D.

Figure 1. SWAT Analysis, Upper Saline Sub-basin Percentiles for Sediment

Figure 2. SWAT Analysis, Upper Saline Sub-basin Percentiles for Total Phosphorus

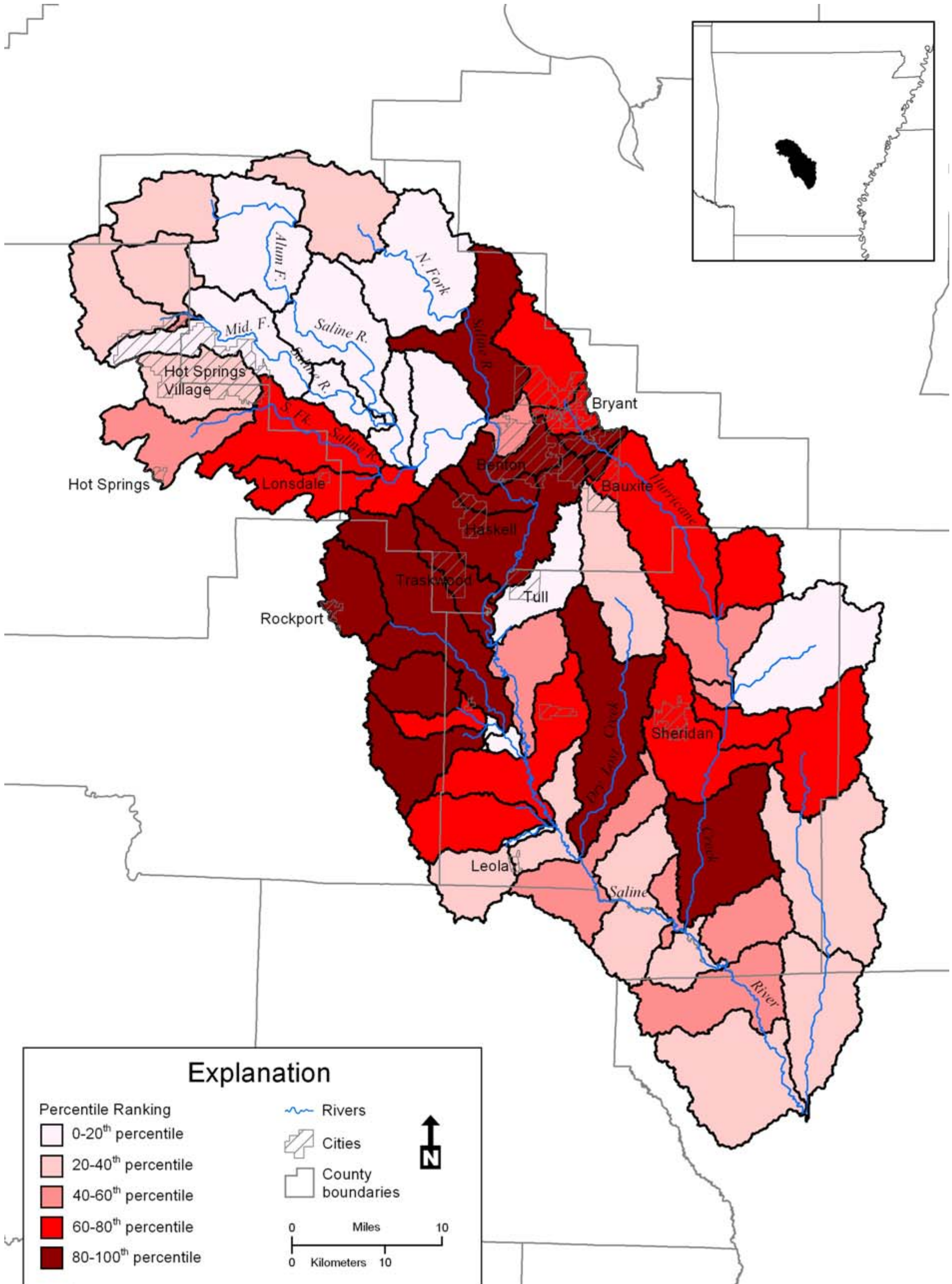


Figure 1. Percentiles - Sediment

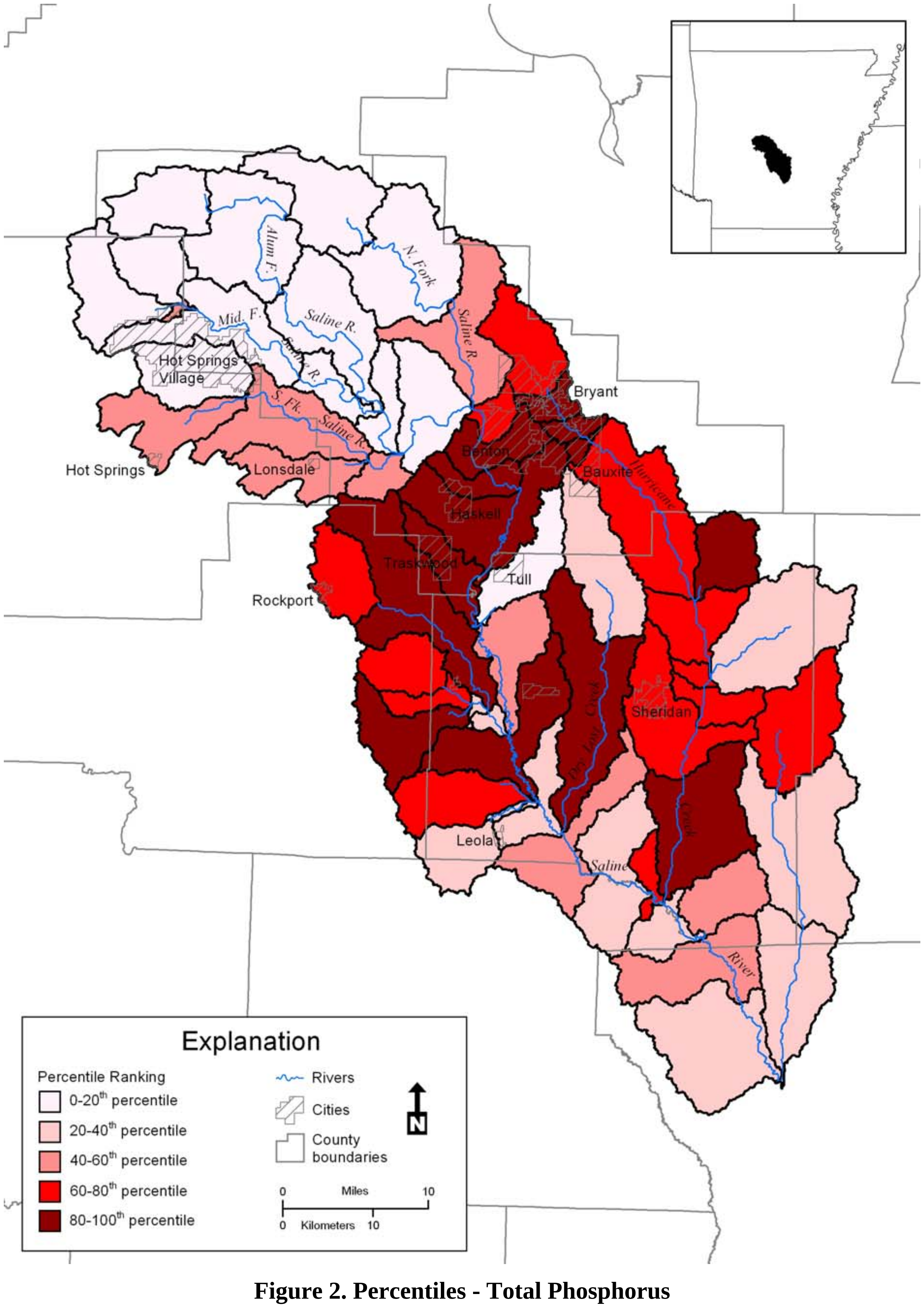


Figure 2. Percentiles - Total Phosphorus

Appendix E.

Figure 1. Implemented EQIP Practices by County and HUC 8040203, 2005

Figure 2. Implemented CRP and WRP Practices by County, 2005

Table 8: EQIP Practices by County and HUC

Environmental Quality Incentive Program

County	Practices												
	(100) (no)	(313) (no)	(314) (ac)	(316) (no)	(328) (ac)	(338) (ac)	(356) (ft)	(378) (no)	(382) (ft)	(394) (ft)	(430DD) (ft)	(449) (ac)	(464) (ac)
Saline County	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Garland County	--------	--------	--------	--------	--------	--------	--------	--------	3000.00	--------	--------	--------	--------
Hot Springs County	--------	--------	--------	--------	--------	39.00	--------	1.00	--------	3960.00	--------	--------	--------
Grant	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Jefferson	--------	1.00	--------	--------	464.00	--------	10080.00	1.00	14430.00	--------	7846.00	127.00	341.00
Dallas	--------	--------	40.00	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Cleveland	3.00	8.00	--------	3.00	--------	--------	--------	1.00	2020.00	--------	--------	--------	--------
Pulaski	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Total	3.00	9.00	40.00	3.00	464.00	39.00	10080.00	3.00	19450.00	3960.00	7846.00	127.00	341.00

County	Practices												
	(490) (ac)	(512) (ac)	(528A) (ac)	(561) (ac)	(587) (no)	(590) (ac)	(595) (ac)	(612) (ac)	(614) (no)	(633) (ac)	(642) (no)	(644) (ac)	(645) (ac)
Saline County	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Garland County	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Hot Springs County	39.00	39.00	--------	--------	--------	--------	--------	39.00	2.00	--------	--------	--------	--------
Grant	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Jefferson	--------	--------	--------	--------	4.00	504.00	460.00	--------	--------	--------	4.00	661.00	38.00
Dallas	--------	--------	--------	--------	--------	--------	13.00	--------	--------	--------	--------	--------	--------
Cleveland	--------	30.00	107.00	1.00	--------	138.00	138.00	--------	--------	296.00	--------	--------	--------
Pulaski	--------	72.00	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Total	39.00	141.00	107.00	1.00	4.00	642.00	611.00	39.00	2.00	296.00	4.00	661.00	38.00

EQIP

Practices

HUC	(382) (ft)	(394) (ft)	(490) (ac)	(338) (ac)	(612) (ac)	(313) (no)
8040203	3,000	3,960	22	22	22	1

Table 9: CRP and WRP Practices by Counties in USW

Conservation Reserve Program

County	Practices															
	(327) (ac)	(342) (ac)	(382) (ft)	(393) (ac)	(490) (ac)	(590) (ac)	(595) (ac)	(338) (ac)	(391) (ac)	(646) (ac)	(612) (ac)	(645) (ac)	(472) (ac)	(658) (ac)	(657) (ac)	(644) (ac)
Saline County	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Garland County	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Hot Springs County	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Grant	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Jefferson	10	--------	--------	--------	297	--------	5	--------	528	--------	259	--------	252	--------	--------	--------
Dallas	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Cleveland	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Pulaski	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Total	10	0	0	0	297	0	5	0	528	0	259	0	252	0	0	0

Wetland Reserve Program

County	Practices
	(657) (ac)
Saline County	--------
Garland County	--------
Hot Springs County	--------
Grant	--------
Jefferson	--------
Dallas	--------
Cleveland	--------
Pulaski	7,156
Total	7,156

Appendix 6.

Figure 1. ADEQ/USGS Monitoring Stations 2002-Present

Figure 2. ADEQ Historical Monitoring in the Upper Saline Watershed

Figure 3. USGS Historical Monitoring in the Upper Saline Watershed

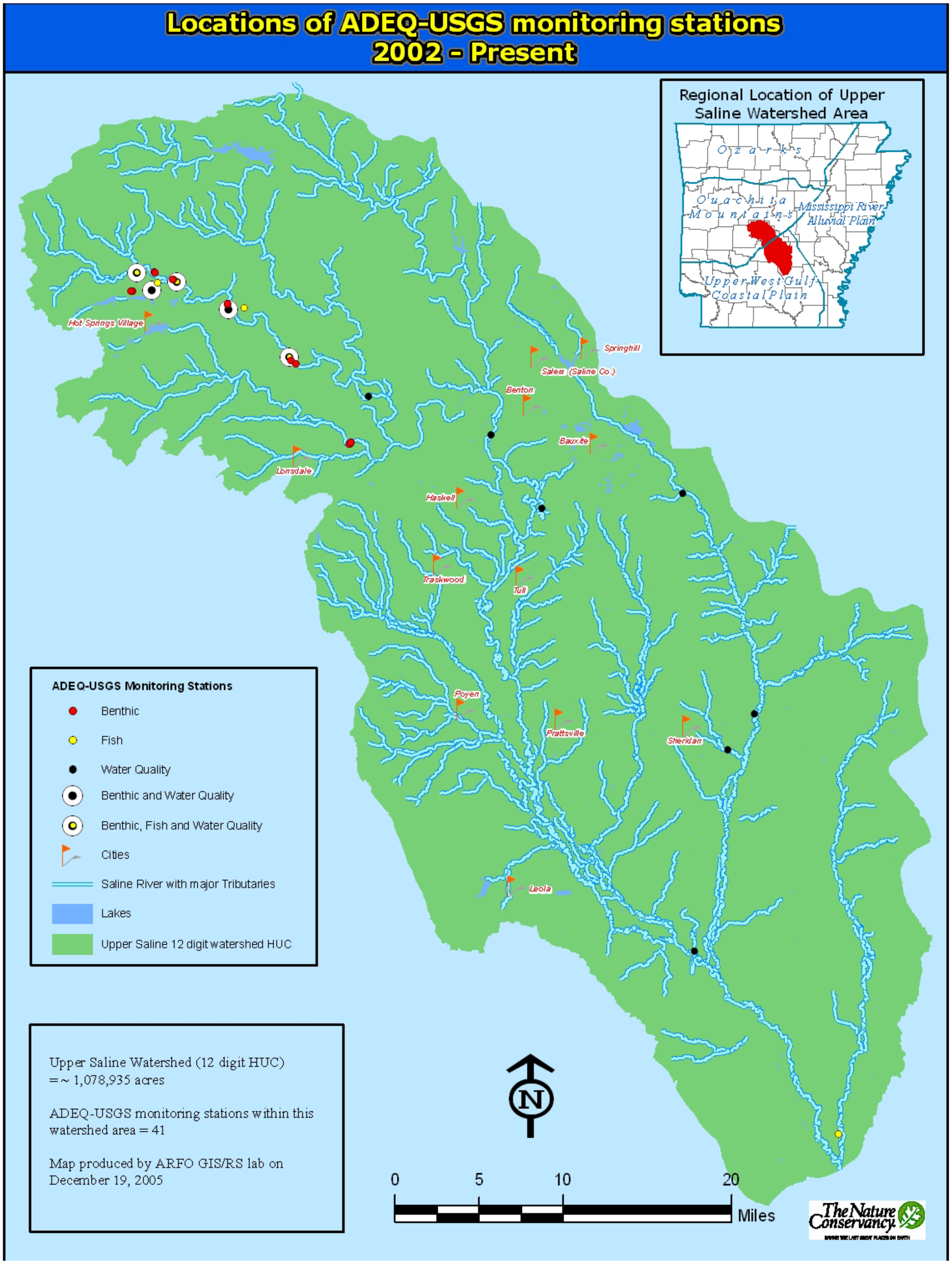


Figure 1. ADEQ/USGS Current Monitoring

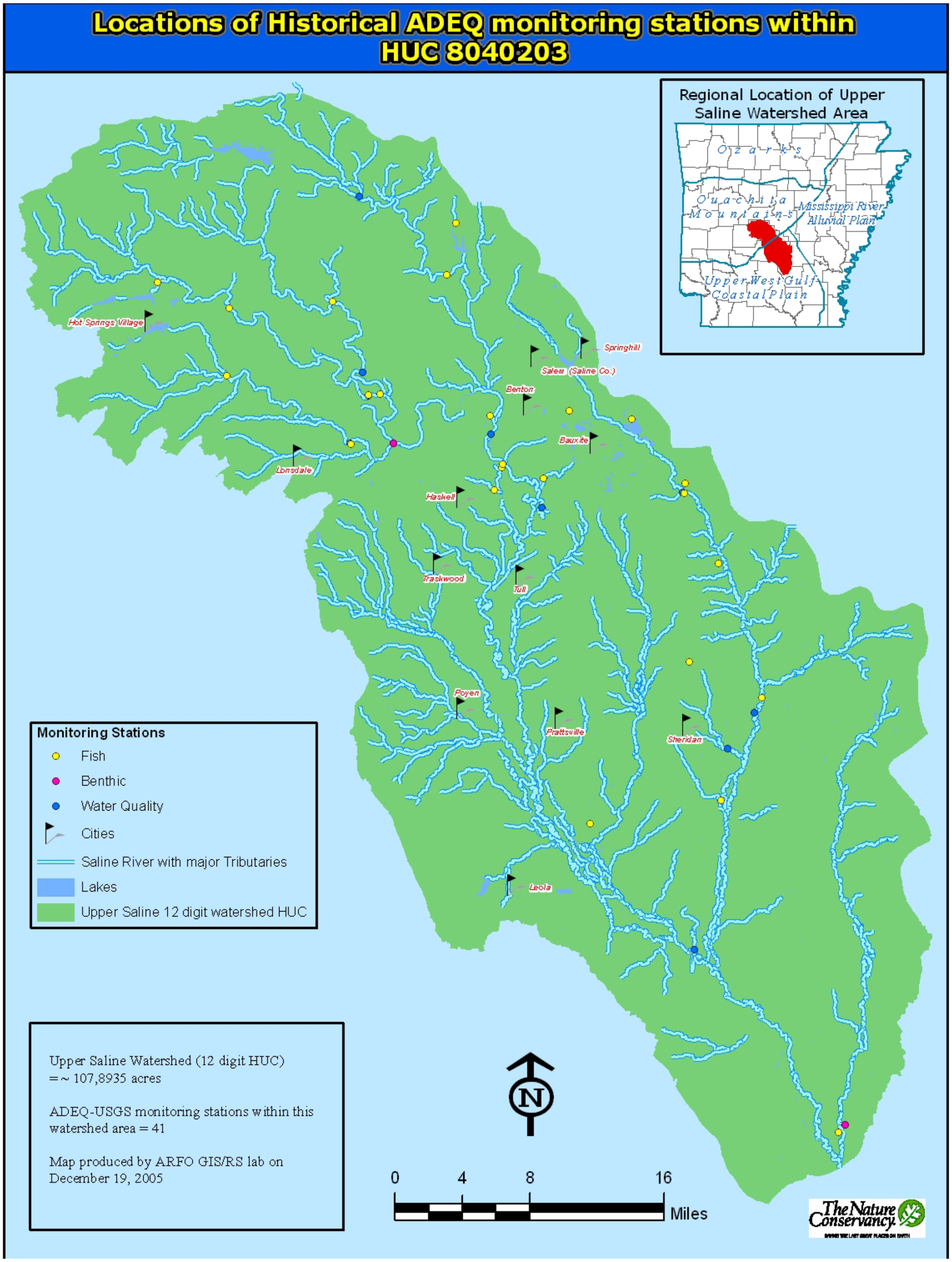


Figure 2. Historical Monitoring ADEQ

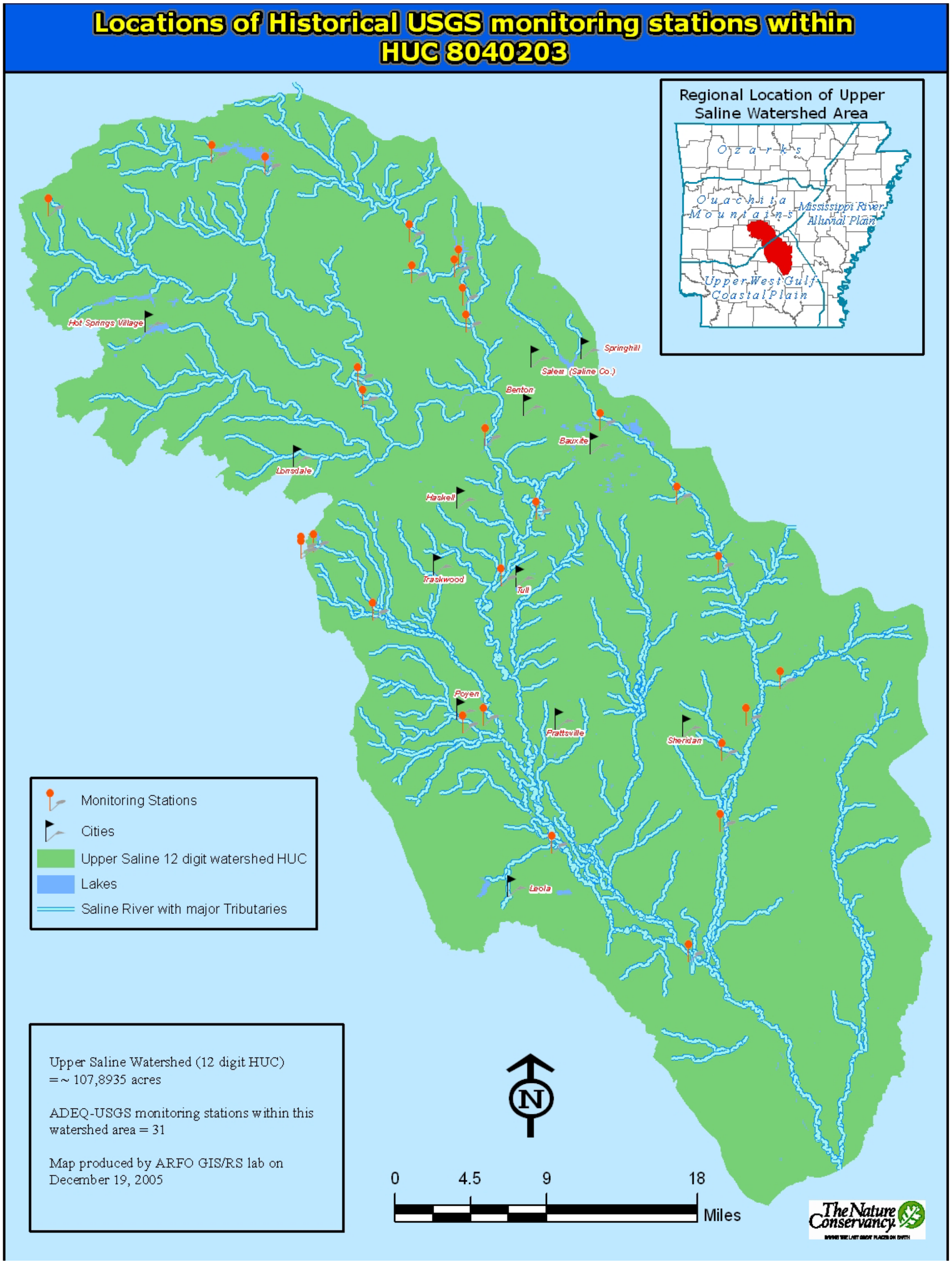


Figure 3. USGS Historical Monitoring

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