Upper Saline
Conservation Area Plan

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Project: Upper Saline River Watershed HUC 8040203

Ecoregions: Ouachita Mountains, Upper West Gulf Coastal Plain

Conservation Targets:

1: Upper Saline River Headwaters (Ouachita Mtn. Ecoregion)
Type of Target: Ecological System

2: Upper Saline River Mainstem & Lower Tributaries (Upper West Gulf Coastal Plain Ecoregion)
Type of Target: Ecological System

3: Whole Upper Saline Watershed HUC 8040203
Type of Target: Ecological System

4: Riparian Forest Matrix
Type of Target: Ecological System

5: Mussel Species of Special Concern
Type of Target: Species: Aquatic Invertebrates

6: Fish Species of Special Concern
Type of Target: Species: Fish

7: Benthic Macroinvertebrates
Type of Target: Species: Aquatic Invertebrates

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INTRODUCTION

Conservation Action Planning

The Nature Conservancy's process for helping conservation practitioners develop strategies, take action, measure success, and adapt and learn over time is called Conservation Action Planning. The Conservancy uses conservation action planning to develop area-specific conservation strategies and prepare for taking action and measuring success. These plans follow what we call the 5-S Framework:

• **Systems.** The Core Project Team identifies the species and natural communities that will be the Focal Conservation Targets for the area. This is done using element lists developed during ecoregional planning and modifying the lists to include site-specific conservation elements.
• **Stresses.** The team determines how focal conservation targets are compromised, such as by habitat reduction or fragmentation, or changes in the number of species in a forest or grassland.
• **Sources.** The team then identifies and ranks the causes, or sources, of stress for each element. The analysis of stresses and sources together make up the threat assessment.
• **Strategies.** An important step in the process is finding practical cooperative ways to mitigate or eliminate the identified threats and enhance biodiversity.
• **Success.** Each plan outlines methods for assessing our effectiveness in reducing threats and improving biodiversity--usually by monitoring progress toward established biological and programmatic goals.
• An understanding of the cultural, political and economic situation behind the threats is essential for developing sound strategies. This human context is often referred to as the sixth "S"

Executive Summary

Project Goals:

The long term conservation vision for the Upper Saline River watershed is the conservation of dynamically functioning river systems with healthy riparian and aquatic communities. This vision includes working in partnership with local communities and public entities to incorporate compatible economic and cultural interests within this watershed into the long-term conservation of the system's biodiversity. This will become critical in the next 5-10 years as population growth from the Little Rock metropolitan area continues to move westward. When water quality declines continue over extended periods, the number of sensitive species will follow suit. The goal for the Upper Saline River Conservation Area Plan (CAP) is to identify the strategies necessary to conserve the existing biodiversity, establish clear monitoring needs for the watershed, and identify available resources to complete these tasks.

Challenges/Opportunities:

To restore and maintain functioning aquatic systems and viable populations of critical aquatic species of concern, the following challenges will need to be addressed within the Upper Saline Watershed:

- Loss of aquatic habitat due to increased sedimentation and turbidity.
- Loss of riparian land and forested connectivity associated with large-scale land conversion activities.
- Hydrologic alteration and in-stream flow concerns coupled with sediment surplus conditions in the Saline River and tributaries.
- Loss of aquatic habitat due to nutrient loading and associated low dissolved oxygen conditions.

Planning Team Participants: Core planning team for this project consists of:

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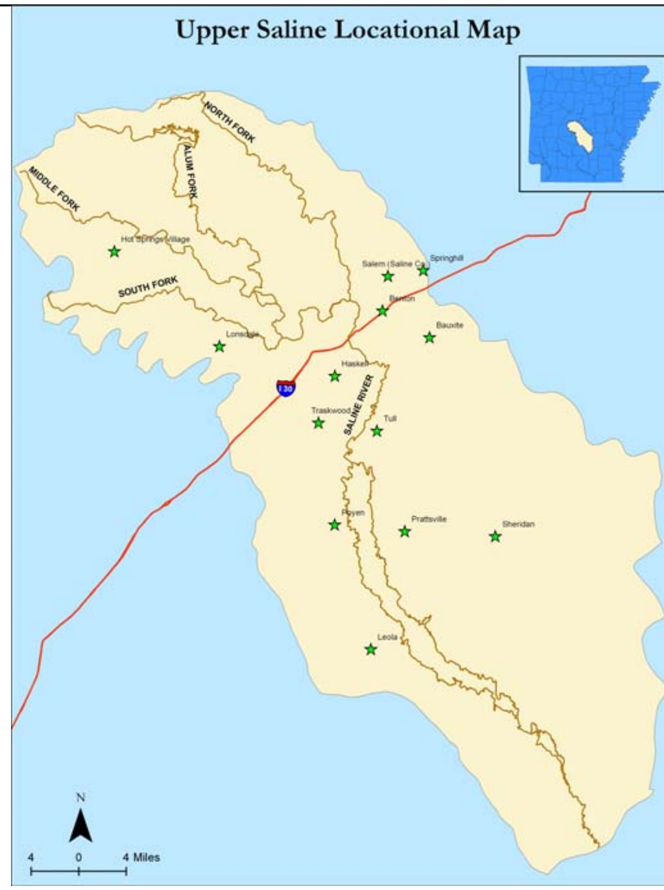
Through a series of meetings and/or correspondence with an expert panel, each expert was asked to review the list of species of greatest conservation need, the list of threats to the conservation targets, and to prioritize or rank each threat with relation to the Upper

Saline River headwaters and/or the mainstem. In addition, each expert was asked to provide supporting materials for their opinions. The expanded planning team for expert panel review of the threats assessment includes a total of 10 representatives from the following agencies and non-profit organizations: Arkansas Game & Fish Commission, U.S. Fish and Wildlife Service, USDA Forest Service Ouachita National Forest, Arkansas Natural Heritage Commission, and the Arkansas Department of Environmental Quality.

Figure 1. Locational Map



Project Description/Background: The Upper Saline River Watershed Conservation Area Plan (CAP) is aimed to identify and rank existing threats to key species representing biodiversity in this ecological system. Crossing portions of eight counties including Garland, Hot Springs, Grant, Jefferson, Dallas, Cleveland, Pulaski, and Saline counties, the Upper Saline Watershed has a total drainage area of approximately 1716 square miles. The headwaters to the Saline River; the North, Middle, Alum, and South Forks; 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.

Ecological Context: The Arkansas Comprehensive State Wildlife Plan and the Nature Conservancy's Ouachita Ecoregional Assessment has identified the Upper Saline River for containing a significant concentration of aquatic biodiversity. With the watershed boundary falling within two distinct ecoregions of the state of Arkansas; 65% within the Upper West Gulf Coastal Plain (UWGCP) and 35% percent occurring in the Ouachita Mountain Ecoregion; the Saline and tributaries provide habitat for 4 fish, 11 mussel, 2 crayfish, and 1 insect "Species of Greatest Conservation Need" (SGCN) in the State Wildlife Planning process and/or of great conservation need as determined by the expert panel for this site conservation plan. Tables 1 and 2 outline a complete list of these species.

The Saline is one of Arkansas' last major unimpounded rivers and also one of the last free-flowing in the Ouachita Mountain ecosystem. Historically, and still today, the Upper Saline Watershed has provided critical habitat for endangered, threatened, or endemic species. It is for this reason the Arkansas Department of Environmental Quality has designated the Saline and its headwaters (North, Alum, Middle, and South Forks) as Ecologically Sensitive Waterbodies. This designation is to provide additional protection from point and non-point source pollution. The Saline and tributaries are also considered Extraordinary Resource Waterbodies, recognizing the distinct combination of physical, chemical, and biological attributes that provide for scenic beauty, aesthetics, scientific values, recreational potential, and intangible social values.

The headwaters to the Saline River (North, Alum, Middle, and South) are listed on the State Registry of Natural and Scenic Rivers and have been designated by The Arkansas Game & Fish Commission (AGFC) as "Ouachita Zone Quality Streams for Smallmouth Bass". A recent fish population study conducted by AGFC for the Middle Fork of the Saline states that abundance and size structure information suggests that "factors other than angler harvest are limiting smallmouth bass populations" (AGFC, 2002).

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

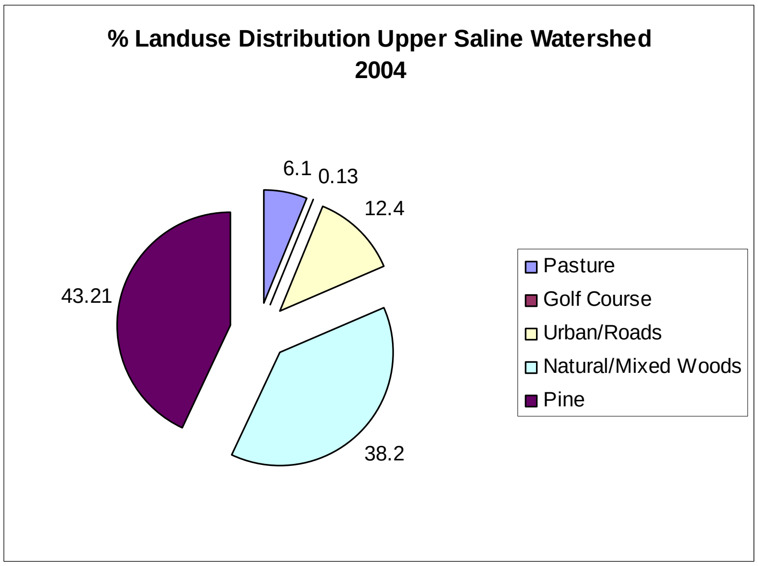
(1) strongly silviculture oriented
(2) variable per capita income throughout the watershed
(3) increasing populations in several key areas: Benton, Hot Springs Village

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. Saline County has experienced a growth rate of population from 1990 to 2004 of 30.1%. Outside of the rapidly growing populations of Benton and Hot Springs Village 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. 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.

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 2. Land use Distribution



Ninety five percent of the land within the watershed boundary is under private ownership (See Appendix N, Public vs. Private Ownership Map). 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 Weyerhaeuser Corporation. Total acreage managed and owned federally by the US Forest Service within the Upper Saline Watershed includes approximately 45,294 acres.

State land holdings within the Upper Saline Watershed 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.

Public water supplies provide drinking water to surrounding communities. Appendix K displays a map reflecting the distribution of groundwater and surface water intakes for municipalities. This map helps portray municipal areas that rely on the Saline Watershed for drinking purposes.

Conservation Targets:

In Conservation Action Planning, focal targets are the eight or fewer conservation targets used as the basis for conservation project planning and measures of success. They are the basis for setting goals, carrying out conservation actions, and measuring conservation effectiveness. In theory – and hopefully in practice – conservation of the focal targets will ensure the conservation of all native biodiversity within the functional landscapes.

Target Selection:

Target #1 -- Upper Saline River Headwaters
Target #2 -- Riparian Forest Matrix
Target #3 -- Mussel Species of Special Concern
Target #4 -- Fish Species of Special Concern
Target #5 -- Benthic Macroinvertebrates
Target #6 -- Upper Saline Mainstem & Lower Tributaries
Target #7 – Upper Saline Watershed HUC 8040203

Description of Focal Conservation Targets
Systems:

Upper Saline River Headwaters - The headwaters of the Saline River, originate in the Ouachita Mountains through surface and sheetflow-fed seeps, groundflow, and surface flow drainage. 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.

Upper Saline Mainstem & Lower Tributaries – The North, Middle, South, and Alum 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. Within the Upper West Gulf Coastal Plain (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.

Upper Saline Watershed HUC 8040203 – The entire Upper Saline Watershed, indicated by the Hydrologic Unit Code (HUC) 8040203 encompasses the headwater tributaries; the North, Middle, South, and Alum Forks, as well as the Mainstem and lower tributaries. It encompasses both the Ouachita Mountain and Upper West Gulf Coastal Plain Ecoregions and allows analysis of the Upper Saline Watershed as a whole for classifying overall threat summaries for the watershed.

Riparian Forest Matrix - 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. These inhabitants 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 Ouachita Mountains. 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 and to clear for pasture land; and in recent history, cleared for development. Many riparian areas have not regenerated.

Species:

Mussel Species of Concern – The decline of mussel communities in Arkansas has been attributed to several factors: impoundments, sedimentation, dredging, point and non-point source pollution/poor water quality, over harvesting by commercial shelling, and the introduction of exotic bivalve species. The Upper Saline Watershed is home to two globally imperiled species, the Arkansas fatmucket (*Lampsilis powellii*) and the Southern Hickorynut (*Obovaria jacksoniana),* in addition to nine other species of concern. The Arkansas fatmucket, a rare and, until recently, little-known freshwater mussel is endemic to Arkansas and restricted to the Ouachita Mountains of Western Arkansas. The U.S. Fish and Wildlife Service listed *Lampsilis powellii* as threatened in 1990 and in 1992 developed a species recovery plan. This mussel is found within six Arkansas counties:

Saline, Montgomery, Polk, Pike, Grant, and Clark; and the largest populations occur in the South Fork Ouachita, Alum Fork Saline, and the Middle Fork Saline Rivers (Burns and McDonnell, Inc. 1992). Another endemic species found in the Upper Saline Watershed is the Ouachita Creekshell (*Villosa arkansasensis),* also found only in the Ouachita Mountains. A complete list of designated mussel species of concern is located in Table 1 & 2 below.

Fish Species of Concern – The Upper Saline River Watershed is home to five fish species of concern including the endemic Ouachita madtom (*Noturus lachneri). Noturus lachneri* has been considered a "threatened" fish species in the state because of multiple complex environmental threats to its continued existence, which are coupled with the combination of a relatively small population size and sporadic and restricted distribution (Robison & Buchanan, 1995). Other species of concern include the Crystal darter, Western Sand darter, Stargazing darter, and Blue sucker.

Benthic Macroinvertebrates–

Benthic macroinvertebrate (aquatic insect) assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances. Because many benthic macroinvertebrates have limited migration patterns or a sessile mode of life, they are particularly well suited for assessing site-specific impacts. Additionally, since many species respond quickly to stress, they may also integrate the effects of short-term environmental variations. Finally, benthic macroinvertebrates serve as a primary food source for fish, including many recreationally and commercially important species and are abundant in most streams *(Barbour et. al. 1999)*.

Table 1.

Upper Saline Headwaters to Upper West Gulf Coastal Plain boundary Species of Greatest Conservation Need Occurrence List Scientific Name	Common Name	Heritage Rank
Crayfish		
Fallicambarus jeanae	Crayfish	G2S2
Fallicambarus harpi	Crayfish	G1S1
Insects		
Agapetus medicus	Arkansas agapetus caddisfly	G?S?
Fish		
Noturus lachneri	Ouachita madtom	G2S2
Crystallaria asprella	Crystal darter	G3S2?
Mussels		
Alasmidonta marginata	Elktoe	G4S3
Cyprogenia aberti	Western fanshell	G2S2
Lampsilis ornata	Southern pocketbook	G5S1
Lampsilis powellii	Arkansas fatmucket	G1G2S2
Toxolasma lividus	Purple liliput	G2S2
Villosa arkansasensis	Ouachita creekshell	G2S2

Table 2.

Saline River Mainstem HUC 8040203 Species of Greatest Conservation Need Occurrence List		
Scientific Name	**Common Name**	**Heritage Rank**
Fish		
Ammocrypta clara	Western Sand darter	G3S2?
Crystallaria asprella	Crystal darter	G3S2?
Cycleptus elongatus	Blue Sucker	G3G4S2
Percina uranidea	Stargazing darter	G3S3
Mussels		
Cyprogenia aberti	Western fanshell	G2S2
Lampsilis powellii	Arkansas fatmucket	G1G2S2
Pleurobema cordatum	Ohio pigtoe	G3S1
Pleurobema rubrum	Pyramid pigtoe	G2S2
Villosa arkansasensis	Ouachita creekshell	G2S2
Lampsilis abrupta	Pink Mucket	G2S2
Ligumia recta	Black sandshell	G5S2
Toxolasma lividus	Purple lilliput	G2S2
Obovaria jacksoniana	Southern Hickorynut	G1G2S2

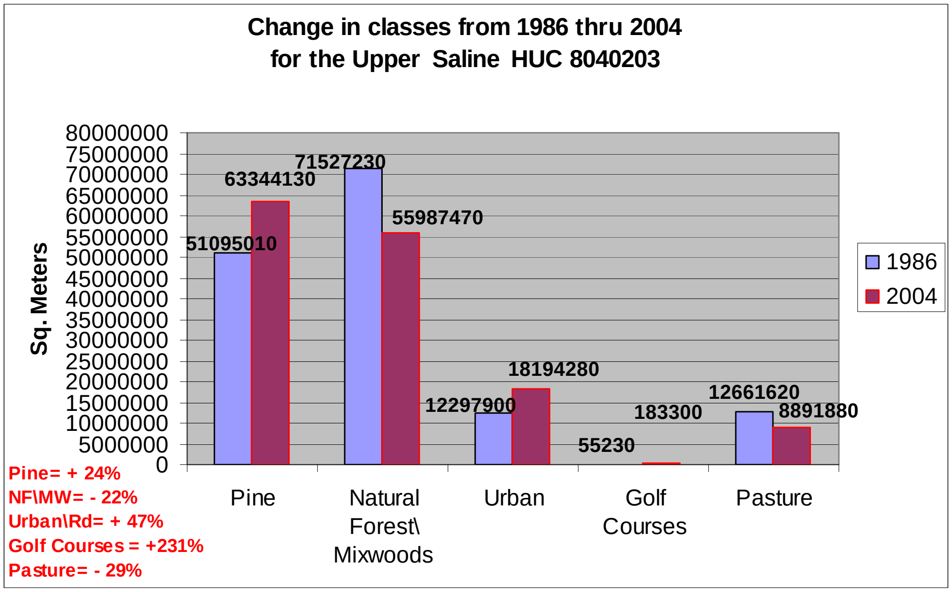
Assessing Challenges: Threats and Biodiversity Health

❖ Land Use Changes 1986-2004

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 land use 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 land use changes within the watershed. Using this analysis, TNC was able to quantify these significant changes in the Upper Saline Watershed and determine anthropogenic impacts such as deforestation, sedimentation, declining water quality and other hydrologic alterations in the watershed. This information can lead to the development of "land sensitivity maps" for which land managers, city and county officials can then use to focus on employing appropriate management activities in areas to reduce the most detrimental impacts.

Table 3. Land use change 1986-2004.



Results for the analysis of the entire watershed showed that pine dominated forest increased by 24% with a corresponding decrease in the natural/mixed woods forest matrix by 22%. 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% (50.25% when combined with "golf course" coverage) 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% from 1986, with an addition of 31.65 acres (128,070 square meters), from 1986 to 2004 within the City of Hot Springs Village. 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.

1. Viability Assessment

The long-term viability of a conservation target is a function of attributes relating to its size, condition, and landscape context. Size is a measure of the area or abundance of the conservation target's occurrence. Condition is a measure of the composition, structure, and biotic interactions that characterize the target. Landscape context relates to the ecological processes that maintain the target and the target's connectivity to habitats and resources. The following section defines the size, condition, and landscape context indicators used to rate the viability of each conservation target. Overall, the Saline River Watershed viability was rated "fair" (see Table 5: Overall Viability Summary) which indicates that the biodiversity health is outside its natural range of acceptable variation, and it requires human intervention for maintenance, if unchecked the Upper Saline Watershed will result in serious degradation. An example of the viability assessment for one focal target, Riparian Forest Matrix, is shown in Table 3 followed by a discussion of each indicator rating. For a detailed viability assessment for all focal targets refer to Appendix A.

Table 4. Example of Riparian Forest Matrix Focal Target Viability

Assessment of Target Viability

Upper Saline River Watershed

Conservation Target Enter # of Target	Category	Key Attribute	Indicator	Poor (Indicator Ratings: **Bold = Current**, *Italics = Desired*)	Fair	Good	Very Good	Current Indicator Status	Current Rating	Desired Rating	Date of Current Rating	Date for Desired Rating
Riparian Forest Matrix	Landscape Context	Landscape pattern (mosaic) & structure	Surveyed compliance rate of state forestry BMP's that particularly address SMZ's.	80%	85%	**95%**	*100%*	95% compliance rate recorded in 2003 for 5 sites in Garland County and 4 sites surveyed in Saline County.	Good	Very Good	May-03	May-07
Riparian Forest Matrix	Landscape Context	Longitudinal Connectivity	Average length of non-forested segments	>.5 km (.31 mile)	.3-.49 km (.19-.30 mile)	***.1-.29 km (.062-.18 mile)***	0-.19 km (0-.061 mile)	Avg length N.F. segments in Saline River mainstem watershed (including both perennial and intermittent streams) in 2004 was = .121 miles (.195 km) or a "good" rating. Avg. length N.F. segments, headwaters =.085 mile, also a "good" rating	Good	Good	Jul-06	Jul-16
Riparian Forest Matrix	Condition	Native Riparian Vegetation	% decrease in land classified as forested within a 200 ft riparian area.	>15%	5-15%	***<5%***	0	2.33% decrease within the designated 200ft riparian area.	Good	Good	Dec-05	Dec-15
Riparian Forest Matrix	Size	Size / extent of characteristic communities	% of 100-ft riparian buffer as forest.	<50%	51-75%	**76-90%**	*91-100%*	Whole Saline HUC = 82% forested riparian	Good	Very Good	Jul-06	Jul-11

Riparian Forest Matrix – Viability Assessment

Indicator #1: Surveyed compliance rate of state forestry BMP's that particularly address SMZ's.
Key Attribute: Landscape pattern (mosaic) & structure

Key attribute and indicator comment: Loss in streamside forest typically results in accelerated bank erosion, channel widening and shallowing, increases in stream temperature, loss of aquatic and riparian habitat and other effects. Improperly maintained streamside protection zones may adversely affect species diversity and biological productivity by degrading water quality (i.e. nutrient loading, sediment loading), energy sources and altering flow regimes and physical habitat (Davidson, Clem 2002).

Clear cutting procedures in harvesting timber can have negative impacts to water quality, typically occurring within 1-4 years following harvest. Best Management Practices are established for minimizing these effects specifically in the short run. Compliance with BMP's is necessary to maintain the health of nearby river systems, therefore BMP compliance rate, assessed by the Arkansas Forestry Commission, is a measurable way to determine the large scale effects of silviculture to the study area.

Current Indicator Status: 95% compliance rate recorded in 2003 for 5 sites in Garland County and 4 sites surveyed in Saline County. It was suggested by the expert panel for this site conservation plan that the BMP survey parameters and scoring techniques for compliance should be looked at in more depth. Particularly, it was suggested that a different weighted scoring system be used to rank BMP parameters for their importance to water quality. For example, instead of using a "yes/no" answer to determine the overall percentage of compliance, each BMP parameter should be ranked to their importance towards water quality. An example of this would be to rank the "presence of a minimum streamside management zone (SMZ) width" higher than whether or not the "SMZ is free of log decks", showing that if a SMZ does not exist, the next parameter is not applicable or as important. This indicator should be re-evaluated with new information and a new ranking system as soon as it is available.
Current Rating: Good
Date of Current Rating: 5/15/2003
Confidence / Reliability of Current Rating: Low
Current rating comment: Source: Arkansas Forestry Commission (AFC) records for 2003.
Desired Rating: Very Good
Date for Desired Rating: 5/15/2007

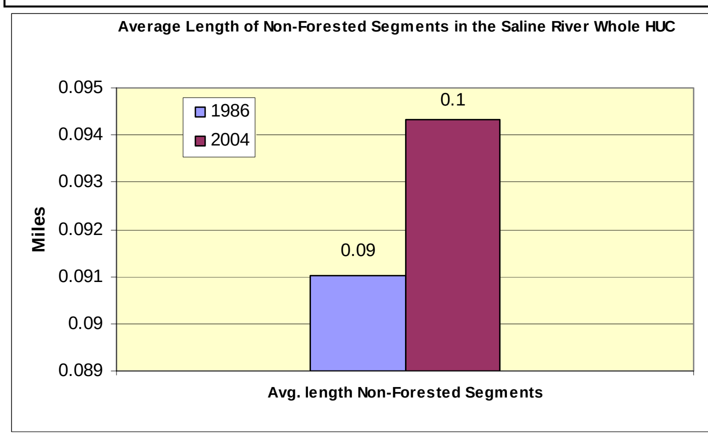
Indicator #2: Average length of non-forested segments
Key Attribute: Longitudinal Connectivity

Key attribute and indicator comment: Longitudinal connectivity between in-tact riparian areas within a watershed is important to maintain flows of energy, matter, and species. For example, propagules of riparian species commonly originate upstream or upwind of the open sand bars where they germinate (Richter et al., 1997). In addition, riparian forests provide trophic energy input to stream systems and create important in-stream habitat. As a result, riparian forests play a critical role in maintaining biotic production and species diversity, watershed hydrology, and water quality.

Indicator ratings comment: Research on Appalachian streams has indicated that even streams in heavily forested watersheds (>95% forested) cannot tolerate disruption of riparian zone vegetation of more than 1 km (.62 mile) in length (Jones et al. 1999). It was suggested by the expert panel for this site conservation plan that .5 km (.31 miles) for the average length of non-forested segments would a more appropriate "poor" indicator rating for the Upper Saline Watershed.

Jones (1999) also found that one of the strongest predictors of changes in fish assemblages was the length of non-forested riparian segments above the sample site. He found that density of "sensitive species" was reduced below non-forested riparian segments 1 km in length. Darter and benthic minnows declined above 2 km. Sculpin and two trout species declined at ~3 km patch length.

Table 5. Avg. Length of Non-forested Segments



Current Indicator Status: Average length N.F. segments in Saline River mainstem (including perennial & intermittent streams) FY2004 was = .121 miles (.195 km) or a "good" rating. Avg. length N.F. segments, headwaters =.085 mile, Whole HUC = .10
Current Rating: Good
Date of Current Rating: 7/15/2006
Current rating comment: Source: TNC GIS landuse/landchange analysis
Desired Rating: Good
Date for Desired Rating: 7/15/2016

<u>Indicator #3</u>: % decrease in land classified as forested within a 200 ft riparian area.
Key Attribute: Native Riparian Vegetation

Key attribute and indicator comment: 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.

Indicator ratings comment: Riparian forest clearing due to timber cultivation, increased pasture, or urban development has the potential to increase sedimentation to a stream, particularly if specific Best Management Practice's are not carried out within critical streamside management zones. It is important to note that although there was only a 2.75% decrease overall of forested riparian area throughout the watershed, when analyzed to determine % increase/decrease of pine-dominated forest vs. a natural/mixed woods matrix, pine increased by 8.2% and natural/mixed woods decreased by 12.5% between the 18 year period. This is indicative of vegetation removal and regeneration within the riparian areas of the watershed.

Current Indicator Status: 2.33% decrease within the designated 200ft riparian area.
Current Rating: Good
Date of Current Rating: 12/15/2005
Current rating comment: Source: TNC GIS land use analysis (1986-2004)
Desired Rating: Good
Date for Desired Rating: 12/15/2015

<u>Indicator #4</u>: % of 100-ft riparian buffer as forest.
Key Attribute: Size / extent of characteristic communities
Key attribute and indicator comment: Improperly maintained streamside protection zones may adversely affect species diversity and biological productivity by degrading water quality (i.e. nutrient loading, sediment loading), energy sources and altering flow regimes and physical habitat (Davidson, Clem 2002).
Indicator ratings comment: Wenger (1999) found that under most circumstances, a 100-ft buffer was wide enough to trap sediments, control nitrogen concentrations, and provide in-stream habitat. He found that, ideally, the buffer should extend along all streams including intermittent and ephemeral channels, and should fully encompass all wetlands.

Current Indicator Status: Whole Saline HUC = 82% forested riparian
Current Rating: Good
Date of Current Rating: 7/15/2006
Current rating comment: Source: TNC GIS landuse/landchange analysis
Desired Rating: Very Good
Date for Desired Rating: 7/15/2011

Table 6. Viability Summary Table

Overall Viability Summary *Upper Saline River Watershed*								
Conservation Targets		Landscape Context		Condition		Size		Viability
		Grade	Weight	Grade	Weight	Grade	Weight	Rank
1	Upper Saline River Headwaters	Fair	1	-	1	-	1	**Fair**
2	Riparian Forest Matrix	Good	1	Good	1	-	1	**Good**
3	Mussel Species of Special Concern	-	1	Good	1	-	1	**Good**
4	Fish Species of Special Concern	Fair	1	-	1	Fair	1	**Fair**
5	Benthic Macroinvertebrate	-	1	Fair	1	Good	1	**Good**
6	Upper Saline Mainstem & Lower Tributaries	Fair	1	-	1	-	1	**Fair**
7	Upper Saline Watershed HUC 8040203	Poor	1	-	1	-	1	**Poor**
Site Biodiversity Health Rank								**Fair**

2. Upper Saline Watershed Threats and Stresses:

Threats:

There exist several threats to the Upper Saline River system that result in loss of suitable aquatic habitat. These threats to the system can be broken down into three main classes: sedimentation, nutrification, and hydrologic alteration. Specific sources of sedimentation include land conversion (development/construction) without the use of proper erosion control, removal of riparian forest matrix, streambank erosion, runoff from county gravel roads, in-stream gravel mining, and incompatible forest harvest practices (particularly the development of logging roads). Specific sources of excess nutrients in the watershed come from municipal/industrial wastewater, fertilizers, grazing livestock, and polluted runoff. Hydrologic alteration from impounded tributaries, constructed dams, water diversions, and water withdrawals continues to be an issue of concern throughout the headwaters area of the watershed.

In addition to the identified stresses and threats occurring within the watershed, there continues to be the challenge of critical data gaps that inhibit the ability to accurately prioritize the efforts of which need to take place. In priority areas of the Upper Saline that lack sufficient data associated with the most critical threats, the acquisition of such data is ranked very high as a strategy for this site conservation plan. Collecting and providing critical baseline data makes it possible to maximize conservation efforts with regards to that specific threat.

Stresses:

Stresses represent altered or impaired ecological attributes that reduce the viability of the focal conservation targets. Each stress is rated "high," "medium," or "low" based on the severity of anticipated damage and the geographic scope of damage. The following section defines the stresses affecting the Upper Saline River ecosystem and its conservation targets.

Upper Saline River Headwaters:

	Stresses - Altered Key Ecological Attributes	Severity	Scope	Stress Rank	User Override
1	Altered landscape pattern (mosaic) and structure	High	High	High	
2	Increased nutrient concentration	Medium	Medium	Medium	
3	Soil erosion/sediment instability	High	High	High	
4	Altered Hydrology	Very High	High	High	
5	Altered Geomorphology	High	High	High	
6	Altered Species Diversity	Medium	Medium	Medium	

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. Saline County has experienced a growth rate of population from 1990 to 2004 of 30.1% (US Census Bureau, 2005). Commercial/industrial development, primary home development, and secondary home development will continue to increase as Saline and Garland counties grow. Primary and secondary home development is likely to increase faster than commercial/industrial due to the use of these counties as "bedroom" communities for neighboring Pulaski County. Due to the increasing urbanization and further expansion of Little Rock commuters towards the areas of Benton and Hot Springs Village, altered landscape pattern and structure is given a "high" rating for severity (i.e. this change could seriously degrade the headwaters over some portion of the watershed if existing circumstances continue over the next 10 years) with a "high" ranking for scope (likely to be widespread).

Although there are currently no streams within the headwaters to the Saline listed on the impaired waterways list for excess nutrients, elevated total phosphorus amounts in the headwaters have been documented by ADEQ. 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. Associated low dissolved oxygen conditions have been documented for specific sampling locations within the four forks indicating a "medium" rating for scope (likely to be localized and affect the target over some of its locations). Increased nutrient concentration is given a "medium" rating for severity which indicates the stress is likely to moderately degrade the conservation target over some portion of the target's occurrence given the continuation of the existing situation over the next 10 years.

Sediment stability and movement is a key functional piece of any riverine system and thus has a chain effect on the aquatic species that inhabit the waterbody. Increased sedimentation has been shown to reduce insect diversity, density, and species richness in streams. The transport and distribution of sediment once it has entered the river is determined by the annual flow regime. The accumulation of fine sediment in upper layers of the bed might be expected in river systems where impoundments are located up-stream of sources of fine sediment, resulting in a flow volume reduction without a corresponding reduction in fine sediment input (Osmundson et al. 2002).

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 and there are 19 impoundments within the headwaters of the Saline (Appendix L. Location of Dams, Upper Saline). Due to the expansion of water withdrawals, diversions, and impoundments and the increase in elevated turbidity levels during storm events; soil erosion/sediment instability and hydrologic alteration are both given a "high" rating for severity. A high rating indicates that sediment loading is likely to seriously degrade the headwaters over some portions of the watersheds given the existing situation continues over the next 10 years. The scope of this stress is also given a "high" rating meaning the effects from hydrologic alteration and sediment loading will likely be widespread over many locations within the headwaters of the Saline.

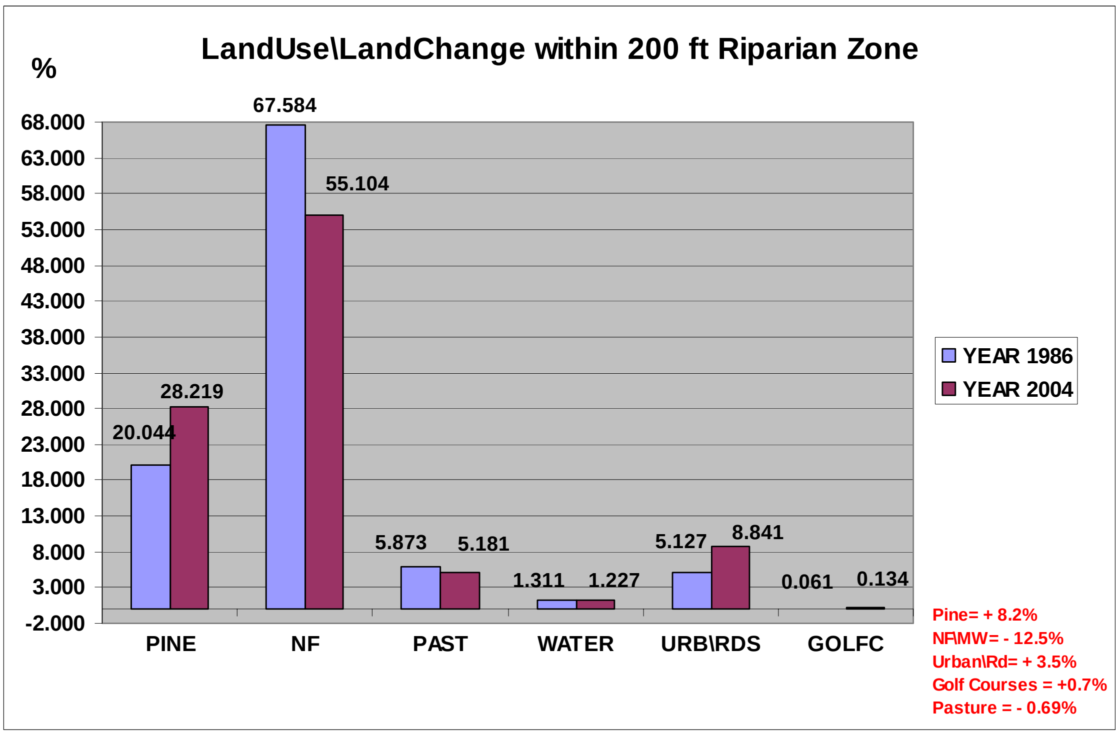
Altered geomorphology in the headwaters of the Upper Saline in the Ouachita Mountain ecoregion is at a slightly different scale than in the mainstem and lower tributaries located in the UWGCP. In the four forks, hydrologic regime alterations play a larger factor in geomorphic instability through minimization of flows while sediment inputs remain the same. This set of circumstances causes geomorphic instability in the form of aggradation from sediment inputs throughout the watershed, rather than the geomorphic instability caused by instream bank failures and streambank erosion that occur in the mainstem Saline. Due to the excessive aggradation, particularly in the Middle and South Fork watersheds, it was suggested from the expert panel that altered geomorphology be given a "high" rating for both severity and scope. This indicates that aggradation of fine sediment will likely seriously degrade the headwater river systems over many locations if current conditions persist for the next ten years.

Riparian Forest Matrix:

	Stresses - Altered Key Ecological Attributes	Severity	Scope	Stress Rank	User Override
1	Habitat Fragmentation/Loss of longitudinal connectivity	Medium	Medium	Medium	
2	Altered Size/Extent of buffer	Medium	Medium	Medium	

Throughout the entire Upper Saline Watershed there has been an increase of the category "urban/roads" of 3.5 % within a 100 ft riparian area adjacent to each stream bank; and a decrease of 2.33% in the overall forested riparian area. For this reason, habitat fragmentation is given a "medium" severity rating (could moderately degrade the target within 10 years under current circumstances). It is given a "medium" rating for scope because the effects are likely to be localized throughout the headwaters region. With 82% of the riparian area forested, the altered size of the buffer is also given "medium" ratings for severity and scope indicating the effects are likely to be moderate and localized throughout the riparian areas in the entire Upper Saline Watershed if current circumstances persist for the short term.

Table 7. Riparian Analysis, Land use changes.



Mussel Species of Concern

	Stresses - Altered Key Ecological Attributes	Severity	Scope	Stress Rank	User Override
1	Reduced presence/abundance of keystone (host) species	Medium	Low	Low	
2	Decreased diversity/species richness	High	Medium	Medium	
3	Loss of in-stream habitat	High	High	High	

Populations of mussel species can become distressed from a variety of factors, including increased sedimentation, chemical parameters such as decreased dissolved oxygen, and increased phosphorus and nitrogen, loss of habitat from alteration of hydrologic regimes, absence of keystone (host) species, and other factors. It is stated that two important factors, hydrologic variability and fish host distribution/abundance may best explain the longitudinal zonation in species that occur in the Saline River (Davidson, Clem 2002). For this reason, reduced presence/abundance of keystone (host) species is given a "medium" rating (could moderately degrade the target species in some portions of their occurrence) and a "low" rating for scope (stress is likely to be very localized in its scope, and affect the conservation target at a limited portion of the target's location at the site).

Silt-tolerant mussel species can be more abundant in conditions that are not favorable to habitat-specific species. Mussels show a wide tolerance for substrate type but many species are less abundant in finer sediments (Watters, 1999.). In situations such as this, habitat-specific species often may be replaced by soft-substrate adapted species such as anodontines and heelsplitters. Because siltation and turbidity values are routinely documented above the designated NTU values during storm events and channel instability is evident from excess sedimentation throughout the watershed, decreased diversity/species richness is given a "high" rating for severity. This means that 10 years under the current circumstances could seriously degrade the target species over some portion of their occurrences. The scope of potential decreased species diversity is given a "medium" rating indicating that the stress is likely to be localized throughout the watershed.

Hydrologic variability is important in determining fish and mussel distribution. In addition, high concentrations of suspended solids can change the physiological energetics of the mussels by significantly decreasing food clearance rates, oxygen uptake, and nitrogen elimination (Watters, 1999). Mussels are more abundant in portions of rivers that indicate highly oxygenated water swept clean of silt. The category "Loss of in-stream habitat" encompasses the effects of hydrologic variability and an increased presence of finer sediments and abundant nutrients from various land use practices. This stress is given a "high" rating for severity (hydrologic impacts and sedimentation are likely to seriously degrade the target species over some portion of their occurrences) and a "high" rating for scope, indicating that these stresses are currently widespread throughout watershed and likely to affect the target species at many of their locations.

Fish Species of Concern:

	Stresses - Altered Key Ecological Attributes	Severity	Scope	Stress Rank	User Override
1	Loss of in-stream habitat	Very High	Medium	Medium	
2	Reduced Population Size & Dynamics	High	Medium	Medium	
3	Decreased Diversity/Species Richness	High	Medium	Medium	

Loss of in-stream habitat can occur from a variety of factors such as constructed dams that inhibit the up-stream and down-stream connectivity of a channel, decreased flow, available predator food availability, increased sedimentation, and other factors. Increased sedimentation can particularly impact sight dependent feeders by reducing visibility and color perception thereby altering predator-prey relations and mating behaviors (Hynes 1960). The natural flow regime is a characteristic of suitable habitat for fish species. When a key disturbance regime such as flooding is pushed outside (typically below) its natural range of variation, ecosystems and species that depend on conditions associated with large floods may not be viable over the long term (Poff et al. 1997). Due to the high presence of dams within the watershed and alterations to the natural flow regime from increased diversions and withdrawals within the headwaters region of the Upper Saline Watershed, loss of in-stream habitat is given a ″very high″ rating for severity (likely to eliminate target species over some locations) and a ″medium″ rating, or localized, for scope.

A recent fish population study conducted by the Arkansas Game & Fish Commission for the Middle Fork of the Saline states that although largemouth bass populations continue to be stable, abundance and size structure information suggests that ″factors other than angler harvest are limiting smallmouth bass populations″ (AGFC, 2002), the more sensitive species. There is a need within the headwaters region of the watershed for an increase in current fish population surveys. Until more data is available, "reduced population size and dynamics" is given a ″high″ rating for severity and ″medium″ rating for scope (likely to be localized).

Surveys completed by the ADEQ between 2003-2005 indicate within the Middle Fork watershed, there was evidence of impact within and Mill Creek and downstream within the Middle Fork indicating impairment. This site is downstream of the Hot Springs Village wastewater treatment plant effluent, impairment was indicated by an overabundance of minnows, distinct lack of darters and other sensitive species (ADEQ, personal communication and public presentation July, 2006). Decreased diversity/species richness is a key attribute because in the presence of disturbance, proportions of darters, sunfishes, and suckers, intolerant species, piscivores, and insectivorous cyprinids are expected to decline, while the proportions of green sunfish and omnivores are expected to increase (Yoder & Smith, 1999). Again, until more data is readily available for more stream reaches within the Upper Saline Watershed, it was suggested by the expert panel for this conservation plan, that "decreased diversity/species richness" be rated "high" for severity and "medium" for scope.

Benthic Macroinvertebrates:

Stresses - Altered Key Ecological Attributes		Severity	Scope	Stress Rank	User Override
1	Reduced population size and dynamics	High	High	High	
2	Decreased diversity/species richness	High	Medium	Medium	
3	Loss of in-stream habitat	Very High	High	High	

Fine silt accumulation effects macroinvertebrate populations by reducing insect diversity, density, and species richness in streams, all key ecological attributes defined here. Due to the various water diversions and impoundments placed on tributaries and main stems of the four forks, spring flows have declined, sediment inputs have probably not. Thus, suspended sediment that was once carried downstream and through the system now has a greater tendency to accumulate on the riverbed and channel margins. Fine sediment is winnowed from the riverbed when flows reach sufficient magnitude to dislodge coarse framework particles and move the surficial armor layer. According to Osmundson (2002), it was found that a strong positive relationship exists between biomass of both primary producers and invertebrate consumers and the degree to which the substrate was free of fine sediment. Loss of in-stream habitat can come directly from increased sedimentation and decrease flows, and is likely to eliminate benthic macroinvertebrate populations over some portion of their occurrence, thus is ranked ″very high″ in severity and ″medium″ in scope (likely to be localized).

All values for the Hilsenhoff Biotic Index, an index for the health of macroinvertebrate populations used by the ADEQ, for the Middle Fork and South Forks were between 3.6 and 5.43 (Very good to Good). HBI values above 5.0 were found at the HSV WWTP Effluent. For these reasons, and until further data is available for a larger portion of the watershed, "reduced population" and "decreased diversity" rankings are considered "high" for severity, yet "medium", or localized, for scope.

Upper Saline Mainstem & Lower Tributaries:

Stresses - Altered Key Ecological Attributes		Severity	Scope	Stress Rank	User Override
1	Altered landscape pattern (mosaic) and structure	Very High	Medium	Medium	
2	Increased nutrient concentration and dynamics	High	High	High	
3	Soil Erosion/Sediment Instability	Very High	High	High	
4	Altered geomorphology	Very High	High	High	
5	Altered Species Diversity	Medium	Medium	Medium	

Wenger (1999) found that under most circumstances, a 100-foot buffer was wide enough to trap sediments, control nitrogen concentrations, and provide in-stream habitat. He found that, ideally, the buffer should extend along all streams including intermittent and ephemeral channels, and should fully encompass all wetlands. Individual analysis of land use changes between 1986 and 2004 was also analyzed for the mainstem and lower tributaries of the Upper Saline Watershed and results were as follows: an overall increase in urban/roads category of 76.2%, a decrease in pasture by 49.1% and a decrease in forested riparian area of 3.66% (see Table 8 below). For these reasons, "altered landscape pattern and structure" is given a "very high" rating for severity and "high" rating for scope, indicating that the current circumstances of urban increase continued for the next ten years would likely eliminate crucial habitat over a widespread portion of the watershed.

Table 8. Land Use Changes - % Increase/Decrease 1986-2004, Remote Sensing.

% INCREASE (+) OR DECREASE (-) IN THE DIFFERENT LAND CLASSES, 1986-2004	
CLASS	MAINSTEM
URBAN	76.20
PASTURE	-49.10
WOODS	-5.78
Riparian (PERENNIAL) Forested*	-3.66
Riparian (PI/NT) Forested **	-3.61

* - Forested Riparian Zone, Perennial streams only.

** - Forested Riparian Zone, Perennial and intermittent streams.

Hurricane Creek, a major lower tributary to the Upper Saline River is listed on the state's impaired waterways list for impairing 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 and lead. The local municipal wastewater discharge is identified as the impairment source. For these reasons, "increased nutrient concentration" is given a "high" rating for severity likely to seriously degrade aquatic habitat in localized portions of the watershed (scope = medium).

Big Creek is also listed on the "impaired waterways" list due to siltation and turbidity. The potential sources for impairments include riparian forest removal, stream bank erosion, construction and silviculture practices within the watershed, and storm water 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. For these reasons, within the Saline River mainstem and lower tributaries, "soil erosion/sediment instability" is given a "high" rating for both severity and scope.

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. The severity of altered geomorphology in the Saline mainstem is given a "high" rating indicating it is likely to seriously degrade the river system over under current circumstances. For scope of the stress, altered geomorphology is rated "high" also indicating that this stress is widespread throughout the watershed.

Streambank Erosion, Mainstem Saline River

Upper Saline Watershed HUC 8040203:

	Stresses - Altered Key Ecological Attributes	Severity	Scope	Stress Rank	User Override
1	Altered landscape pattern & structure	Very High	Medium	Medium	
2	Increased nutrient concentration & dynamics	High	Medium	Medium	
3	Soil Erosion & Sediment Instability	High	High	High	
4	Altered Hydrology	High	Medium	Medium	
5	Altered Geomorphology	High	High	High	
6	Altered Species Diversity	Medium	Medium	Medium	

Stresses identified within both the Upper Saline headwaters and the mainstem and lower tributaries are combined to analyze overall threats for the entire watershed. Land use changes from 1986 to 2004 are indicated below for the entire watershed.

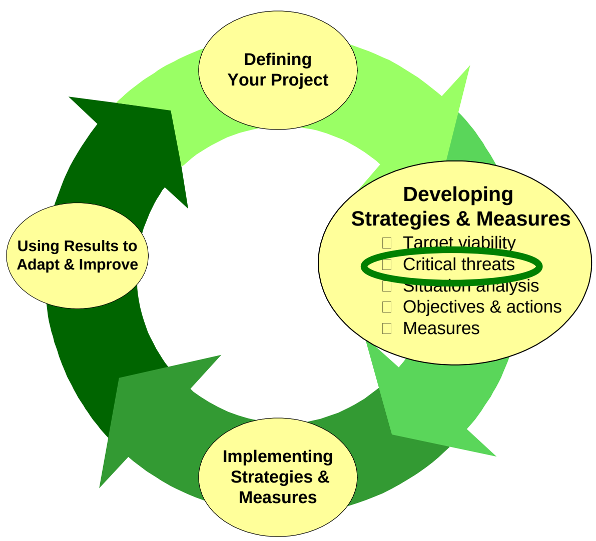
Table 9. Whole Saline HUC Land use change analysis.

% INCREASE (+) OR DECREASE (-) IN THE DIFFERENT LAND CLASSES, 1986-2004	
CLASS	WHOLE HUC
URBAN	50.95
PASTURE	-42.39
WOODS	-2.75
Riparian (PERENIAL) Forested*	-2.33

* - Forested Riparian Zone, Perennial streams only.

Threats in the Upper Saline Watershed

Each focal target's stress and source ranks were analyzed together to provide an overall threat rank for each focal target and the conservation area as a whole. One important part of the threat assessment is the determination of critical threats. Critical threats are highly ranked threats that jeopardize multiple focal targets or threats that affect at least one focal target and are ranked "very high." Critical threats necessitate development of immediate conservation strategies. Several critical threats acting at a conservation area usually indicate that the area is highly or very highly threatened.

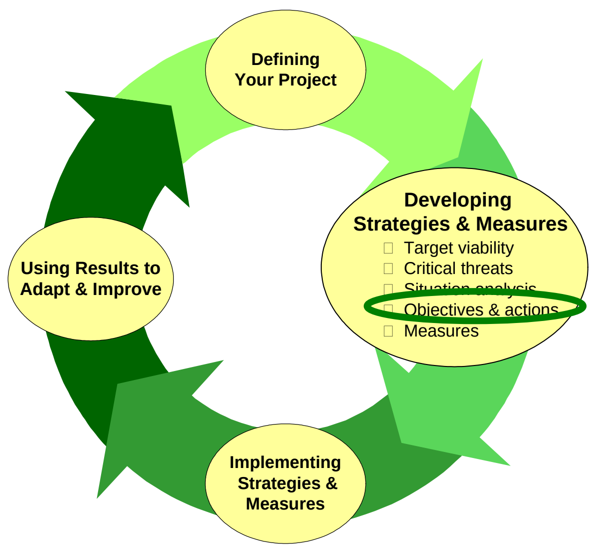


The top-ranking threats for the Upper Saline Watershed are as follows: (1) Housing and Urban Development, (2) Altered Hydrologic Regime, (3) Sedimentation, (4) Roads: unpaved, permanent, and temporary, (5) Streambank Erosion, (6) Instream Gravel Mining, and (7) Other Mining (Bauxite). See Table 10 below for the summary of all related threats to the watershed.

Table 10.

Summary of Threats *Upper Saline River Watershed*									
Threats Across Systems		Upper Saline River Headwaters	Riparian Forest Matrix	Mussel Species of Special Concern	Fish Species of Special Concern	Benthic Macroinvertebrates	Upper Saline Mainstem & Lower Tributaries	Upper Saline Watershed HUC 8040203	Overall Threat Rank
1	Housing & Urban Development: Development/Construction	Very High	Low	High	Medium	Medium	Medium	High	High
2	Altered Hydrologic Regime: Dam construction, water diversion, water withdrawals	Very High	-	Medium	Medium	Medium	Medium	High	High
3	Waste or Residual Materials: Sedimentation	High	-	High	Medium	Medium	High	High	High
4	Roads: Roads, unpaved, permanent, and temporary	High	Low	Medium	Low	Medium	Medium	High	High
5	Waste or Residual Materials: Streambank Erosion/Sedimentation	Medium	-	Low	Low	Medium	High	High	High
6	Waste or Residual Materials: In-Stream Gravel Mining	High	-	Medium	Low	Medium	-	High	High
7	Waste or Residual Materials: Mining	-	-	-	-	-	High	High	High
8	Grazing & Ranching: Agricultural Practices	High	Low	Medium	Low	Medium	Medium	Medium	Medium
9	Logging: Incompatible Forest Practices	Medium	Low	Medium	Low	Medium	High	Medium	Medium
10	Recreation Areas: Land Conversion - Golf Course	High	Low	-	-	-	-	Medium	Medium
11	Waste or Residual Materials: Point Source Discharges	Medium	-	Low	Medium	Medium	Medium	Medium	Medium
12	Waste or Residual Materials: Conversion - Golf Course	-	-	Medium	Low	Medium	-	-	Medium
13	Invasive Species: Introduction of Exotic Species	-	-	Medium	-	-	-	-	Low
Threat Status for Targets and Site		Very High	Low	High	Medium	High	High	Very High	Very High

CONSERVATION STRATEGIES: Objectives, Strategic Actions, and Action Steps



Objectives

Objectives are specific and measurable statements of what planners hope to achieve. They represent assumptions as to what needs to be accomplished and as such, become the measuring stick against which progress of the project is gauged. Objectives can be set for and linked to the abatement of threats, restoration of degraded key ecological attributes, and/or the outcomes of specific conservation actions. A good objective meets the criteria of being: impact oriented, measurable, time limited, specific, practical, and credible.

Objectives established for the Upper Saline Conservation Area Plan include:

Objective: Conservation of undisturbed areas of the watershed that assist in providing habitat for rare and/or endemic aquatic species occurring within the area.

Objective: Development of a solid monitoring foundation in order to establish baseline conditions and to determine the range of desired ecological conditions.

Objective: Establishment of an appropriate criterion with which to evaluate nutrient impairment in streams throughout the different ecoregions of Arkansas.

Objective: Increased inventory of geomorphological, biological, and sedimentological data to evaluate change over time.

Objective: Restoration of an appropriate, sustainable sediment regime including abatement of excessive sedimentation and non-point source pollution.

Objective: Restoration of ecologically appropriate sustainable hydrologic regime.

Objective: Streambank Restoration/Riparian Re-forestation.

Summary:

Potential strategic actions may be ranked on nine criteria related to Benefits (contribution, threat abatement, viability enhancement, duration, leverage), Feasibility (lead individual/institution, ease of implementation, ability to motivate), and Cost. Based on input into those three categories, TNC's Conservation Action Plan workbook assigns an overall rank to each strategic action. Below is a table indicating the given rank for each identified strategic action. The following actions were given an overall rank of "very high":

Strategic Action #1: Develop a Saline River Ecosystem Restoration Team responsible for identifying specific restoration priorities within the watershed and potential funding sources.
Comment: A Saline River Ecosystem Restoration Team would consist of a group of individuals representing several key agencies and non-profit organizations already engaged in research and/or implementation efforts within the Upper Saline Watershed. The first goal would be to (1) identify the top two strategies of restoration appropriate to address the highest ranking threats to the watershed (roads, streambanks, etc) for the short term (1-5 years), (2) prioritize the specific areas with which to implement the identified strategies and receive the most overall success of conservation, and either (3) identify available cost-share assistance programs that address the threats particular to the Upper Saline Watershed and/or (4) gather the institutions and partners necessary to fund the restoration projects. Currently, there is very low participation of any cost-share assistance programs throughout Grant and Saline counties of which occupy the majority of the Upper Saline Watershed. This strategy is aimed to directly address the low utilization and implementation of restoration activities within key areas of the watershed.

Strategic action #2: Develop a watershed map indicating (1) areas of land (example: riparian) that, if developed, would rapidly increase the river's vulnerability to increased sedimentation and channel instability, and (2) areas that could withstand low-impact development.

Comment: The development of a "land sensitivity" map indicating terrestrial areas that are of particular importance to maintaining good in-stream habitat and overall river channel stability will be crucial for county judges, city planners, engineers, and land developers as development continues to move westward from the city of Little Rock. Assistance and review/input from a leading team of experts on various aspects of overall viability of the Upper Saline Watershed to develop such a map will be needed. Specifically, the map should include habitat and foraging needs of the identified species of concern and areas necessary to maintaining the viability of all the focal conservation targets (including systems). Finally, the map should delineate areas that could withstand low-impact development including an evaluation of usage and condition of gravel roads throughout the watershed to determine potential restoration needs and/or retirement of such roads.

Strategic action #3: Develop an Ecologically Sustainable Water Management Plan (ESWM) by the evaluation of ecological, geomorphological, anthropogenic, stream flow requirements and water allocation needs.

Comment: A coalition of stakeholders, municipalities, local, state, and federal agencies, and non-profit organizations, or a Regional Watershed Management Partnership, would be tasked to establish an Ecologically Sustainable Water Management (ESWM) Protocol. A pre-requisite for developing such a plan would be to first, 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) and identify current and future human consumption needs. 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. This assessment of current conditions and needs is identified as a different strategic action, ranked lower due to cost prohibitions; however is an essential step to the development of a sustainable water management plan for the Upper Saline. Several studies should be employed for determining the overall hydrologic needs including not only what is necessary for the biological species of concern, but to answer the question, what is needed for the desired range of flows including low flows as well as routine flooding events necessary for the appropriate hydrologic regime.

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. 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.

Costs incurred for the development of an ESWM would include costs for public/group meetings to facilitate the organization of such a group. Also included is the money to hire a professional facilitator to run the meetings. The current status for this strategic action is "off track" because although there may be interest with the local community and key constituencies, the effort lacks a central agency/organization willing to take the lead.

Strategic action #4: Development of a Conservation Easement Program and/or a Land Trust organization for areas within the Upper Saline Watershed.

> **Action step #1:** 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 can also protect lands within the watershed from encroaching development that would result in further non-point source pollution.

Strategic action #5: Development of Nutrient Criteria to appropriately designate nutrient-impacted streams and lakes within different ecoregions of the State of Arkansas.

Comment: 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), particularly the headwater streams, 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.

Table 11. Strategic Actions Ranking

Strategies *Upper Saline River Watershed*					
#	Strategic Actions	Overall Rank	Benefits	Feasibility	Cost
1	Develop a Saline River Ecosystem Restoration Team responsible for identifying specific restoration priorities within the watershed and potential funding sources.	Very High	Very High	High	Medium
2	Develop a watershed map indicating (1) areas of land (example: riparian) that, if developed, would rapidly increase the river's vulnerability to increased sedimentation and channel instability, and (2) areas that could withstand low-impact development.	Very High	Very High	High	Medium
3	Develop an Ecologically Sustainable Water Management Plan (ESWM) by the evaluation of ecological, geomorphological, anthropogenic, stream flow requirements and water allocation needs.	Very High	Very High	Medium	Medium
4	Development of a Conservation Easement Program and/or a Land Trust organization for areas within the Upper Saline Watershed.	Very High	Very High	Medium	Medium
5	Development of Nutrient Criteria to appropriately designate nutrient-impacted streams and lakes within different ecoregions of the State of Arkansas.	Very High	Very High	High	Medium
6	Demonstration and implementation of Best Management Practices (BMP's) for land conversion activities (i.e. erosion control measures).	High	Very High	Medium	High
7	Evaluate, model and prioritize sediment sources for subwatersheds of the Saline found to have high sediment supply.	High	Very High	Medium	High
8	Expand collection of biological assessments: fish and macroinvertebrate data and related community changes.	High	Very High	Medium	High
9	Solicit federal and state funding to support the development of nature trails, public access points, and organized tree plantings near municipally owned riparian areas of the river.	High	Very High	Medium	High
10	Work with county judges, county officials, and road crews through training workshops and on-the-ground implementation to improve BMP implementation on roads that contribute the most sediment.	High	High	Medium	Medium
11	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).	Medium	Very High	Low	Very High
12	Complete a detailed assessment of current road conditions and sediment reduction capabilities within three of the top priority subwatersheds of the Saline. Prioritize road segments, bridges, and culverts recommended for BMP implementation.	Medium	Medium	High	Medium
13	Continued development of natural buffers within the Bauxite Mined Reclamation Areas (BMRA's).	Medium	High	Medium	High
14	Enhance outreach programs to increase application and utilization of cost-share assistance programs in the counties throughout the Saline River Watershed.	Medium	High	Medium	High
15	Implement Municipal Stormwater Pollution Prevention Programs to minimize the effects of stormwater runoff from the growing urban area.	Medium	Medium	Medium	Medium
16	Solicit federal and state funding to hire an urban watershed coordinator for rapidly growing areas in the Upper Saline Watershed (Benton, Hot Springs Village).	Medium	Medium	Medium	Medium

Resources/Monitoring:
Establishing Baseline Conditions

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 a substantial number of years (10+) worth of 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 conditions, annual monitoring of sediment fluxes, and evaluations of water quality parameters (particularly for prioritized sub-basins) including: 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.

Hydrologic & Water Quality Monitoring

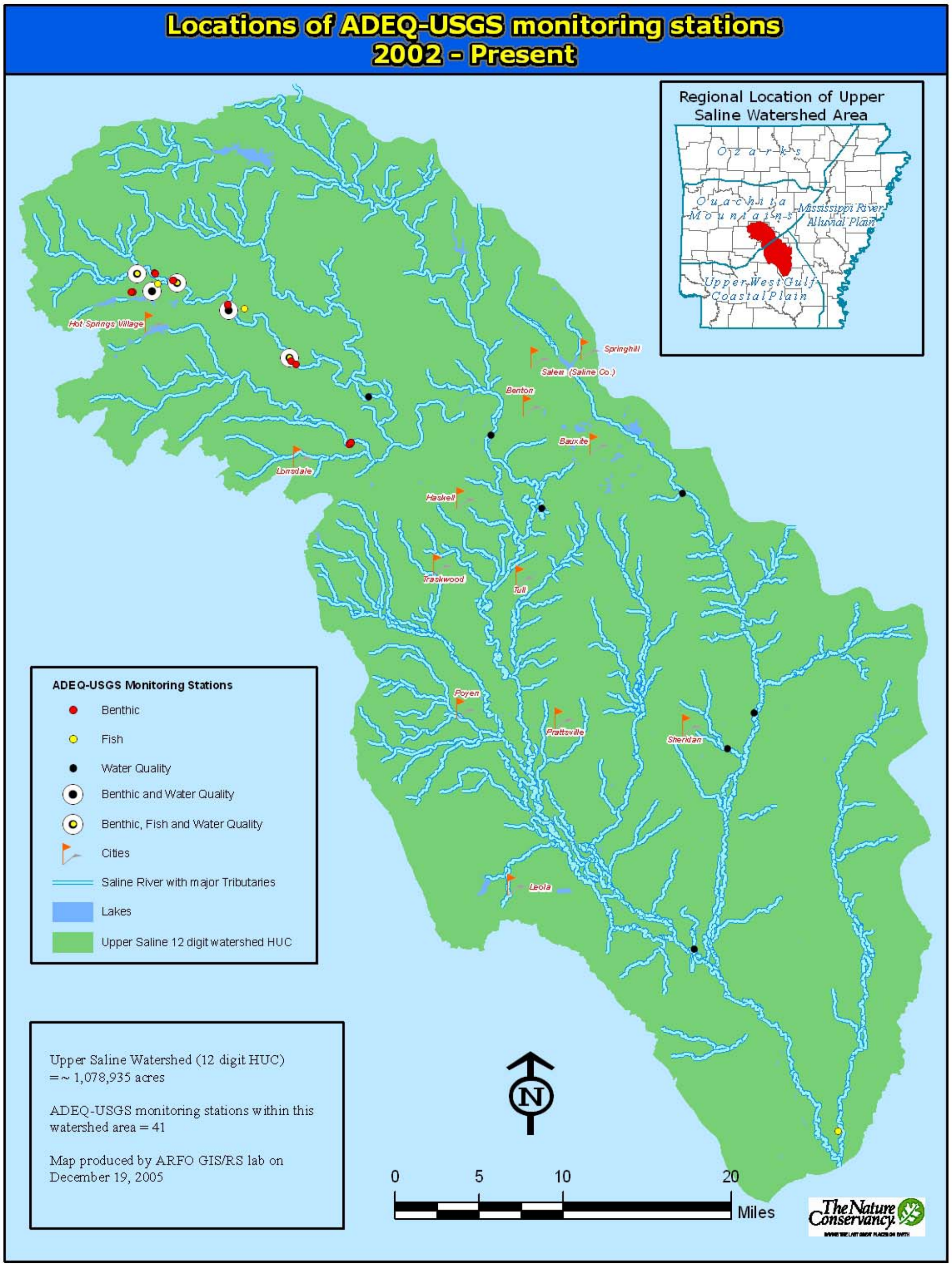
Currently there are twelve water quality monitoring stations within the Upper Saline Watershed. Three of these sites are monitored continuously by the United States Geological Survey (USGS) while the other nine sites are monitored quarterly by the ADEQ. ADEQ has committed to continue this water quality 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.

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" is a proposed cooperative study, which will monitor stream flows and water quality in the Middle Fork. The multi-agency study is working to 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 near the town of Jessieville 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 Figure 3. USGS/ADEQ Monitoring)

Figure 3. ADEQ/USGS Monitoring Stations, Upper Saline Watershed.



Best Management Practices Monitoring

The Arkansas Forestry Commission collects and analyzes survey data on the implementation of recommended forestry BMP's in Arkansas´ non-point water source silviculture program. The ADEQ is responsible for routinely inspecting the use of BMP's associated with construction sites to reduce storm water runoff of sediment into local waterways. The local County Conservation Districts are responsible for monitoring the adherence to BMP's implemented with relation to grant administration and/or farm/ranch conservation plans.

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. Project objectives for this study include the following:

1. Inventory erosion potential of the river channel streambanks.
2. Streambank site selection and in-depth site survey (to be re-surveyed 1 yr. later).
3. Inventory and assess sediment from unpaved roads.
4. Assess and model sediment from pasture/open hillslope.
5. Inventory and assess sediment from construction/land disturbance/silviculture.
6. Estimate loads delivered to the river for the identified major sources using GIS data, field collected data, published export coefficients, and models or relationships.

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.

IMPLEMENTING CONSERVATION STRATEGIES AND MEASURES

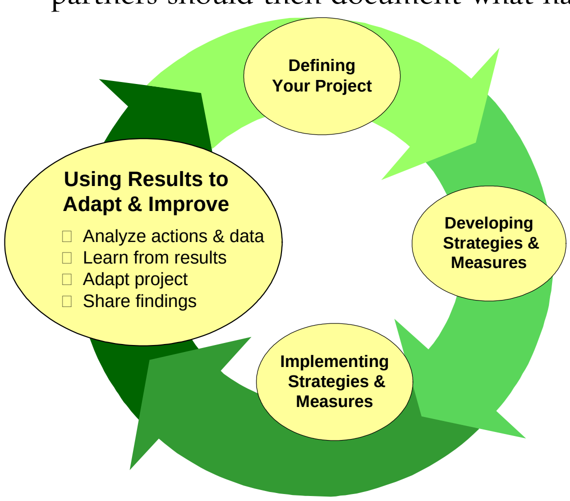
Next Steps: Work Plan Development/Implementation

A Project Implementation Team made up of conservation partners and stakeholders should be assembled, most likely stemming from the CAP expert panel group. The function of this team will be to develop specific implementation plans for each strategic action, to determine and seek resources for implementation of the tasks, and to identify further key partners to assist in implementation. In addition to breaking down the strategic actions into specific action tasks, monitoring tasks should be addressed as a measure of success for the selected objective. Full assessment of project capacity should be completed and, if necessary, identification of objectives and actions for enhancing project resources should also be included.

USING RESULTS TO ADAPT AND IMPROVE

Analyze, Learn, Adapt, & Share

Project partners should systematically take the time to evaluate the actions they have implemented, to update and refine their knowledge of the targets, and to review the results available from monitoring data. This reflection will provide insight on how actions are working, what may need to change, and what to emphasize next. Project partners should then document what has been learned and share it with other people so they can benefit from the successes and failures. Specific questions that this step answers include:



- *"What is our monitoring data telling us about our project?"*
- *"What should we be doing differently?"*
- *"How will we capture what we have learned?"*
- *"How can we make sure other people benefit from what we have learned?"*

1. **Analyze actions and data from monitoring efforts** – An annual review of the actions accomplished and results observed by the core project team and select advisors will provide continuity and facilitate learning. The challenge is to regularly use data to enrich understanding of the project and inform future work. Depending

on what type of data is available and what needs are, analysis can range from formal statistical studies to simple qualitative assessments. Expected outputs include:

□ Appropriate and scheduled analyses of your data.

2. **Use results to adapt action and monitoring plans** – The challenge is to use what has been learned from the analyses to modify the project. Expected outputs include:

□ Updated viability and threat assessments, as warranted.

□ Modifications to the objectives, strategic actions, and work and monitoring plans, as warranted.

3. **Update project documents** – It is critical to formally record updates to the project documents on a regular (at least annual) basis to capture new knowledge and changes in plans. Not only will this aid the original team, but it will protect against a loss of institutional knowledge in the case of staff transitions. If the CAP Excel Workbook is used, this spreadsheet is designed to be flexible and easy to update with new information. Whatever the recording tool, expected outputs include:

□ Regular updates of project documents.

□ Summaries of what you have learned, focusing on both process and results.

4. **Share results with key audiences** – Many other practitioners can benefit from experience gained from this project. Share with them what has been learned. The key is to communicate results in an appropriate way to each audience. Conservancy practitioners are urged, at a minimum, to share their CAP Excel Workbooks and other key findings. Also, the value of sharing experiences with partners and other practitioners outside the organization should not be underestimated. Expected outputs include:

□ Appropriate communication outputs for each key audience.

□ Project's completed CAP Excel Workbook (if available).

GLOSSARY

Acceptable Range of Variation – Key ecological attributes of focal targets naturally vary over time. The acceptable range defines the limits of this variation which constitute the minimum conditions for persistence of the target (note that persistence may still require human management interventions). This concept of an acceptable range of variation establishes the minimum criteria for identifying a conservation target as "conserved" or not. If the attribute drops below or rises above this acceptable range, it is a degraded attribute.

Adaptive Management – A process originally developed to manage natural resources in large scale ecosystems by deliberate experimentation and systematic monitoring of the results. More broadly, it is the incorporation of a formal learning process into conservation action. Specifically, it is the integration of design, management, and monitoring to systematically test assumptions in order to learn and adapt.

Action Steps – Specific tasks required to advance and make progress toward a strategic action.

CAP – Shorthand for Conservation Action Planning.

CAP Excel Workbook – An Excel-based software program developed by The Nature Conservancy to facilitate the CAP process, automate the roll-up of summary results, and serve as a consistent repository for CAP information. Can be downloaded at: CAP Workbook Download website - ConserveOnline

Conservation Action Planning (CAP) – The Nature Conservancy's process for helping conservation practitioners develop strategies, take action, measure success, and adapt and learn over time

Conservation Approach – A key part of the Nature Conservancy's *Conservation by Design Framework*. It is an integrated conservation process comprised of four fundamental components: 1) Setting priorities through ecoregional planning and global habitat assessments; 2) Developing strategies at multiple scales to address these priorities; 3) Taking direct conservation action; and 4) Measuring conservation success. The CAP process outlined in this document covers components 2-4.

Conservation Project – A set of actions undertaken by any group of managers, researchers, or local stakeholders in pursuit of a specified conservation vision and objectives. Can range in scale from managing a small site over a few weeks to an entire region over many years.

Contribution – One of the criteria used to rate the impact of a source of stress. The degree to which a source of stress, acting alone, is likely to be responsible for the full expression of a stress within the project area within 10 years. See also reversibility.

Core Project Team – A specific group of practitioners who are responsible for designing, implementing, and monitoring a project. This group can include managers, stakeholders, researchers, and other key implementers.

Critical Threats – Sources of stress that are most problematic. Most often, "very high" and "high" rated threats based on the Conservancy's rating criteria of the scope, severity, contribution, and reversibility of their impact on the focal targets

Current Status – An assessment of the current "health" of a target as expressed through the most recent measurement or rating of an indicator for a key ecological attribute. Compare to desired status.

Degraded Attribute – A key ecological attribute that is outside its acceptable range of variation.

Desired Status – A measurement or rating of an indicator for a key ecological attribute that describes the level of viability/integrity that the project intends to achieve. Compare to current status.

Direct Threats – Used as a synonym for sources of stress. Agents or factors that directly degrade targets. A project's highest ranked direct threats are its critical threats. For example, "logging" or "fishing."

Ecoregional Targets – Ecoregions are relatively large geographic areas of land and water delineated by climate, vegetation, geology and other ecological and environmental patterns. Ecoregional targets are the species, ecological communities, and ecological systems within a given ecoregion used to set conservation priorities. See also focal conservation targets.

Effectiveness Measures – Information used to answer the question: Are the conservation actions we are taking having their intended impact? Compare to status measures.

Focal Conservation Targets – A limited suite of species, communities, and ecological systems that are chosen to represent and encompass the full array of biodiversity found in a project area. They are the basis for setting goals, carrying out conservation actions, and measuring conservation effectiveness. In theory – and hopefully in practice – conservation of the focal targets will ensure the conservation of all native biodiversity within functional landscapes. Often referred to as Focal Targets.

Goal – Synonymous with vision. A general summary of the desired state or ultimate condition of the project area that a project is working to achieve. A good goal statement meets the criteria of being visionary, relatively general, brief, and measurable.

Indicators – Measurable entities related to a specific information need (for example, the status of a key ecological attribute, change in a threat, or progress towards an objective). A good indicator meets the criteria of being: measurable, precise, consistent, and sensitive.

Indirect Threats – Factors identified in an analysis of the project situation that are drivers of direct threats. Often an entry point for conservation actions. For example, "logging policies" or "demand for fish."

Integrity – The status or "health" of an ecological community or system. Integrity indicates the ability of a community or system target to withstand or recover from most natural or anthropogenic disturbances and thus to persist for many generations or over long time periods. See also viability for species.

Irreversibility – A synonym for reversibility (used in CAP Excel Workbook ratings). One of the criteria used to rate the impact of a source of stress. The degree to which the effects of a source of stress can be restored. Typically includes an assessment of both the technical difficulty and the economic and/or social cost of restoration. See also contribution.

KEA – Short for Key Ecological Attribute.

Key Ecological Attributes (also Key Attributes, or KEAs) – Aspects of a target's biology or ecology that, if missing or altered, would lead to the loss of that target over time. As such, KEAs define the target's viability or integrity. More technically, the most critical components of biological composition, structure, interactions and processes, environmental regimes, and landscape configuration that sustain a target's viability or ecological integrity over space and time. "Attribute" used as shorthand in this document.

Methods – Specific techniques used to collect data to measure an indicator. Methods vary in their accuracy and reliability, cost-effectiveness, feasibility, and appropriateness.

Monitoring Tasks – Specific activities required to measure each indicator.

Nested Targets – Species, ecological communities, or ecological system targets whose conservation needs are subsumed by one or more focal conservation targets. Often includes targets identified as ecoregional targets.

Objectives – Specific statements detailing the desired accomplishments or outcomes of a particular set of activities within a project. A typical project will have multiple objectives. Objectives are typically set for abatement of critical threats and for restoration of degraded key ecological attributes. They can also be set, however, for the outcomes of specific conservation actions, or the acquisition of project resources. If the project is well conceptualized and designed, realization of all the project's objectives should lead to the fulfillment of the project's vision. A good objective meets the criteria of being: impact oriented, measurable, time limited, specific, practical, and credible.

Opportunities – Factors identified in an analysis of the project situation that potentially have a positive effect on targets, either directly or indirectly. Often an entry point for conservation actions. For example, "demand for sustainably harvested timber."

Project Area – The place where the biodiversity of interest to the project is located. It can include one or more "conservation areas" or "areas of biodiversity significance" as identified through ecoregional assessments. Note that in some cases, project actions may take place outside of the defined project area.

Project Capacity – A project team's ability to accomplish its work. Elements include project leadership and staff availability, funding, community support, an enabling legal framework, and other resources.

Project Team – Shorthand for core project team. A specific group of practitioners who are responsible for designing, implementing, and monitoring a project. This group can include managers, stakeholders, researchers, and other key implementers.

Reversibility – One of the criteria used to rate the impact of a source of stress. The degree to which the effects of a source of stress can be restored. Typically includes an assessment of both the technical difficulty and the economic and/or social cost of restoration. Sometimes referred to as "irreversibility." See also contribution.

Scope (in the context of a threat assessment) – One of the measurements used to rate the impact of a stress. Most commonly defined spatially as the proportion of the overall area of a project site or target occurrence likely to be affected by a threat within 10 years. See also severity.

Severity – One of the criteria used to rate the impact of a stress. The level of damage to the conservation target that can reasonably be expected within 10 years under current circumstances (i.e., given the continuation of the existing situation). See also scope.

Sources of Stress – Proximate agents or factors that directly degrade targets. Synonymous with direct threats.

Stakeholders – Individuals, groups, or institutions who have a vested interest in the natural resources of the project area and/or who potentially will be affected by project activities and have something to gain or lose if conditions change or stay the same.

Status Measures – Information used to answer the questions: "How is the biodiversity we care about doing?" and/or "How are threats to biodiversity changing?" for key ecological attributes and/or threats that are not currently the subject of conservation actions. Compare to effectiveness measures.

Strategic Actions – Interventions undertaken by project staff and/or partners designed to reach the project's objectives. A good action meets the criteria of being: linked (to threat abatement or target restoration), focused, strategic, feasible, and appropriate.

Strategies – Broad courses of action that include one or more objectives, the strategic actions required to accomplish each objective, and the specific action steps required to complete each strategic action.

Stresses – Disturbances that are likely to destroy, degrade, or impair targets that result directly or indirectly from human sources. Generally equivalent to degraded key ecological attributes.

Targets – Elements of biodiversity which can include species, ecological communities, and ecological systems. Strictly speaking, refers to all biodiversity elements at a project site, but sometimes is used as shorthand for focal conservation targets.

Threats – Agents or factors that directly or indirectly degrade targets. See also direct threat, indirect threat, and critical threat.

Viability – The status or "health" of a population of a specific plant or animal species. More generally, viability indicates the ability of a conservation target to withstand or recover from most natural or anthropogenic disturbances and thus to persist for many generations or over long time periods. See also integrity for ecological communities and ecological systems.

Vision – A general summary of the desired state or ultimate condition of the project area or scope that a project is working to achieve. A good vision statement meets the criteria of being visionary, relatively general, brief, and measurable. Synonymous with project goal.

Guidance for Ranking Criteria

Stress Ranks: Severity

Severity of Damage -- the level of damage to the conservation target that can reasonably be expected within 10 years under current circumstances (i.e., given the continuation of the existing situation).

- **Very High**: The stress is likely to destroy or eliminate the conservation target over some portion of the target's occurrence at the site.
- **High**: The stress is likely to seriously degrade the conservation target over some portion of the target's occurrence at the site.
- **Medium**: The stress is likely to moderately degrade the conservation target over some portion of the target's occurrence at the site.
- **Low**: The stress is likely to only slightly impair the conservation target over some portion of the target's occurrence at the site.

Stress Ranks: Scope

Scope of Damage -- the geographic scope of impact on the conservation target at the site that can reasonably be expected within 10 years under current circumstances (i.e., given the continuation of the existing situation).

- **Very High**: The stress is likely to be very widespread or pervasive in its scope, and affect the conservation target throughout the target's occurrences at the site.
- **High**: The stress is likely to be widespread in its scope, and affect the conservation target at many of its locations at the site.
- **Medium**: The stress is likely to be localized in its scope, and affect the conservation target at some of the target's locations at the site.
- **Low**: The stress is likely to be very localized in its scope, and affect the conservation target at a limited portion of the target's location at the site.

Threat (Sources of Stress) Ranks: Contribution

Contribution -- expected contribution of the source, acting alone, under current circumstances (i.e., given the continuation of the existing management/ conservation situation).

- **Very High**: The source is a very large contributor of the particular stress.
- **High**: The source is a large contributor of the particular stress.
- **Medium**: The source is a moderate contributor of the particular stress.
- **Low**: The source is a low contributor of the particular stress.

Threat (Sources of Stress) Ranks: Irreversibility

Irreversibility -- reversibility of the stress caused by the Source of Stress.

- **Very High**: The source produces a stress that is not reversible (e.g., wetlands converted to a shopping center).
- **High**: The source produces a stress that is reversible, but not practically affordable (e.g., wetland converted to agriculture).
- **Medium**: The source produces a stress that is reversible with a reasonable commitment of resources (e.g., ditching and draining of wetland).
- **Low**: The source produces a stress that is easily reversible at relatively low cost (e.g., off-road vehicles trespassing in wetland).

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Appendix A. Detailed Viability Assessment Table.

Assessment of Target Viability
Upper Saline River Watershed

Conservation Target Enter # of Target		Category	Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Indicator Status	Current Rating
					Bold = Current	Indicator Ratings		*Italics = Desired*		
1	Upper Saline River Headwaters	Landscape Context	Nutrient concentrations & dynamics	range of Dissolved Oxygen Values during critical seasons.	Definite trend is showing D.O. values falling consistently below 6mg/l	**Trend is showing D.O. values falling below the stnd**	*No trends, D.O. is rarely falling below 6mg/l*	D.O. values are not falling below 6mg/l.	ADEQ 305 (b) report 2004.	Fair
1	Upper Saline River Headwaters	Landscape Context	Soil / sediment stability & movement	# of 303(d) listed impaired waterways for siltation/turbidity	>3	2-3	**1**	*0*	1	Good
1	Upper Saline River Headwaters	Landscape Context	Soil / sediment stability & movement	recorded Turbidity (ntu) values during storm events	Majority of storm samples throughout the watershed indicate NTU values > 18	**Storm samples throughout the watershed are showing an increasing trend towards NTU values > 18 (above ADEQ standards of 18 NTU)**	*Storm samples throughout the watershed occasionally go above 18 NTU, but no trends detected*	rarely are storm samples above NTU values of 18	The last 14 years of monthly water quality samples (source: ADEQ), Benton site shows turbidity levels spiking above 18 NTU 27 times, with 11 of those samples rising above 60 NTU. The largest recorded turbidity value was 164 NTU recorded for October 1998	Fair
1	Upper Saline River Headwaters	Landscape Context	Surface Water Flow Regime	# Dams per (12-digit) sub-watershed	low flow conditions are extreme due to dam density & water withdrawals & species populations are dramatically declining.	**dam density & water withdrawals are exasperating low flow conditions throughout the watershed, target species habitat is reducing/populations show decline.**	*dam density & water withdrawals are increasing but at a sustainable level, target species habitat is adequate.*	hydrologic alteration is not affecting aquatic habitat, historic population levels have returned.	Two subwatersheds, the South Fork and Hurricane Creek, have 7 and 9 dams respectively, all others are less than 4, so an overall fair rating is given for the Upper Saline.	Fair
2	Riparian Forest Matrix	Landscape Context	Landscape pattern (mosaic) & structure	Surveyed compliance rate of state forestry BMP's that particularly address SMZ's.	80%	85%	**95%**	*100%*	95% compliance rate recorded in 2003 for 5 sites in Garland County and 4 sites surveyed in Saline County.	Good
2	Riparian Forest Matrix	Landscape Context	Longitudinal Connectivity	Average length of non-forested segments	>.5 km (.31 mile)	.3-.49 km (.19-.30 mile)	***.1-.29 km (.062-.18 mile)***	0-.19 km (0-.061 mile)	Avg length N.F. segments in Saline River mainstem (including perennial & intermittent streams) FY2004 was = .121 miles (.195 km) or a "good" rating. Avg. length N.F. segments, headwaters =.085 mile, Whole HUC = .0943	Good

Assessment of Target Viability

Upper Saline River Watershed

					Bold = Current	Indicator Ratings		*Italics = Desired*		
Conservation Target Enter # of Target		Category	Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Indicator Status	Current Rating
2	Riparian Forest Matrix	Condition	Native Riparian Vegetation	% decrease in land classified as forested within a 200 ft riparian area.	>15%	5-15%	***<5%***	0	2.33% decrease within the designated 200ft riparian area.	Good
2	Riparian Forest Matrix	Size	Size / extent of characteristic communities	% of 100-ft riparian buffer as forest.	<50%	51-75%	**76-90%**	*91-100%*	Whole Saline HUC = 82% forested riparian	Good
3	Mussel Species of Special Concern	Condition	Presence / abundance of keystone species	fish host distribution/abundance	Host species occurence is extremely low	Host species are experiencing noticeable reduction	**Host species occurence is at a normal level**	*Host species are abundant*		Good
3	Mussel Species of Special Concern	Condition	Richness	# identified species	# identified species has decreased throughout most of the watershed.	# species identified has decreased from historical records throughout some of the watershed.	***# species identified has not reduced and is consistent with historical records throughout the watershed.***	# identified species has increased from historical population records.	The Middle & Alum Fork watersheds have had no loss in # species (18) betw. data from the 1980's and 2006, Ouachita creekshell appears to be the only species in decline. Ar. fatmucket appears to be less abundant but not at the stat. sig. level	Good
3	Mussel Species of Special Concern	Size	Size / extent of characteristic communities	# of site locations throughout the watershed.	site locations have dramatically decreased	site locations are declining, but still present throughout the stream	*additional site locations found & historical sites intact*	numerous additional site locations found	"Unknown", add'l sites were found during USFWS survey this year, but is not surprising. Previous surveys were only surveyed via access points, rather than continuous surveying by canoe. Needs to be re-assessed when further data becomes available.	
4	Fish Species of Special Concern	Landscape Context	Upstream and downstream connectivity	# Dams per (12-digit) sub-watershed	8 or more	***5-8***	1-5	0	Only two subwatersheds, the South Fork and Hurricane Creek, have 7 and 9 dams respectively, all others are less than 4, so an overall fair rating is given for the Upper Saline.	Fair

Assessment of Target Viability

Upper Saline River Watershed

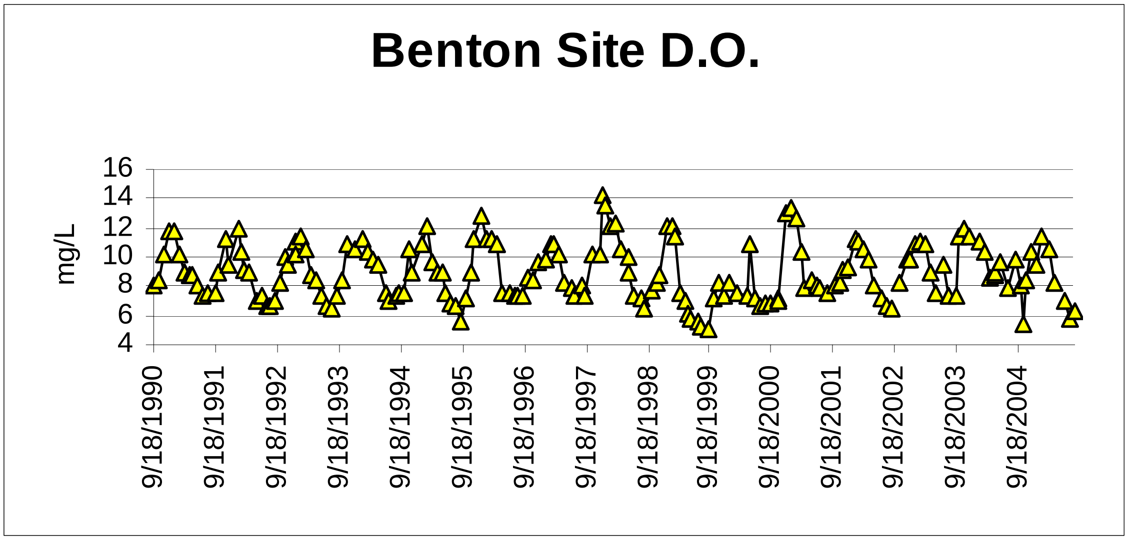
Conservation Target Enter # of Target		Category	Key Attribute	Indicator	Poor (**Bold = Current**)	Fair (Indicator Ratings)	Good	Very Good (*Italics = Desired*)	Current Indicator Status	Current Rating
4	Fish Species of Special Concern	Condition	Richness	# identified species	# identified species has decreased throughout most of the watershed.	# species identified has decreased from historical records throughout some of the watershed.	*# species identified has not reduced and is consistent with historical records throughout the watershed.*	# identified species has increased from historical population records.	Fish community surveys were conducted at five stations in the Middle Fork during 2003 - 2005. Forty-five species of fish were collected from all sites combined. This should be re-evaluated in five years time to determine species richness change.	
4	Fish Species of Special Concern	Size	Population size & dynamics	Range of Dissolved Oxygen values throughout the watershed	D.O. values throughout the watershed are consistently falling below ADEQ stnds(6 mg/l - Ouachita ecoregion, 3 mg/l - UWGCP).	**D.O. values are dropping below stnds in specific problematic locations throughout the watershed.**	*D.O. values drop below ADEQ stnds sporatically throughout the watershed with no developed trend.*	D.O. values are consistently above ADEQ stnds throughout the watershed.	Average D.O. values during a 48-hr D.O. sampling event, Oct. of 2004 - Middle Fork watershed = 4.36 mg/l, values ranged between 4.14 - 6.27 mg/l throughout the sampling period. Continuous monitoring stations in the Middle show low D.O. values as well.	Fair
4	Fish Species of Special Concern	Size	Population size & dynamics	Substrate Sedimentation score	>25% values are excessive or noticeable	10-25% of values are excessive or noticeable	*5-10% of values are excessive or noticeable*	0-5% of values are excessive or noticeable	Recent data is not available, nothing prior to the year 2000. As data becomes available, this indicator status should be revised.	
5	Benthic Macroinvertebrates	Condition	Species composition / dominance	average % tolerant organisms	15.1 and above	**10.1-15**	*5.1-10*	0-5	3 sites = 0-5% range, 5 sites = 5.1-10% range, 3 sites = 10.1-15% range, 3 sites were in the 15.1% and above range (20.83%, 27.62%, 24.06%). An overall rating of "fair" was given for the existing ranges of values.	Fair
5	Benthic Macroinvertebrates	Size	Population size & dynamics	Hilsonhoff Biotic Index values/ranges.	Many sites w/in the watershed are showing values considered "fair" to "poor" ratings (values of 5.5 and greater)	Sites are typically within the "fair" to "very good" ratings, but with evident and consistent outliers.	***Majority of sites are within the "fair" to "very good" ratings with few and inconsistent outliers.***	Majority of sites are within the "fair" to "excellent" ratings with no outliers.	All HBI values for the Middle Fork and South Forks were between 3.6 and 5.43 (Very good to Good). HBI values above 5.0 were found at the HSV WWTP Effluent.	Good

Assessment of Target Viability

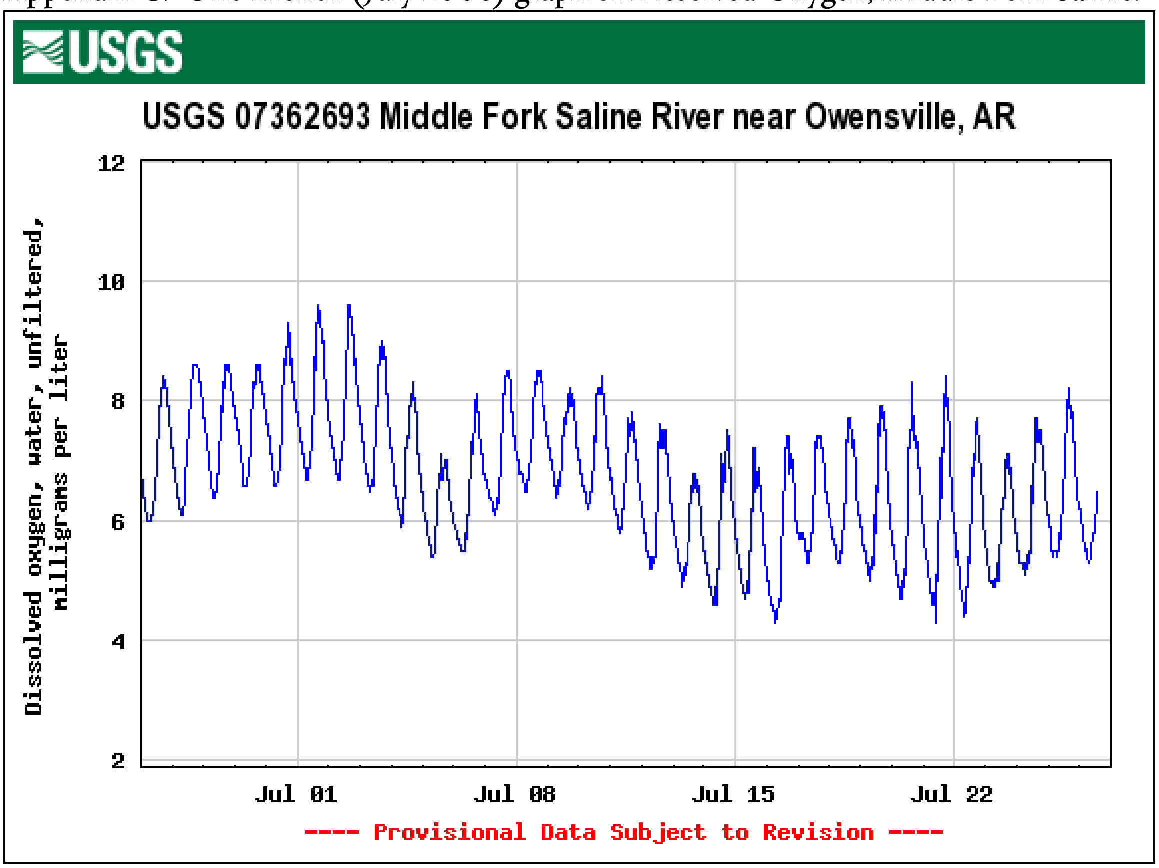
Upper Saline River Watershed

Conservation Target Enter # of Target		Category	Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Indicator Status	Current Rating
					Bold = Current	Indicator Ratings		*Italics = Desired*		
6	Upper Saline Mainstem & Lower Tributaries	Landscape Context	Nutrient concentrations & dynamics	range of Dissolved Oxygen Values during critical seasons.	Definite trend is showing D.O. values falling consistently below 3mg/l	**Trend is showing D.O. values falling below the stnd**	*No trends, D.O. is rarely falling below 3mg/l*	D.O. values are not falling below 3mg/l.	ADEQ 305 (b) report 2004. Hurricane Creek is listed on the Impaired waterways list for impairment to aquatic life through D.O. violations. Big Creek is also listed for organic enrichment and lead impacted from a wastewater treatment facility.	Fair
6	Upper Saline Mainstem & Lower Tributaries	Landscape Context	Soil / sediment stability & movement	# of 303(d) listed impaired waterways for siltation/turbidity	>3	38751	**1**	*0*	1	Good
7	Upper Saline Watershed HUC 8040203	Landscape Context	Landscape pattern (mosaic) & structure	% increase of land changed to urban terrain over the landscape of the watershed over an 18 year period.	**>50%**	25-50%	*5-24%*	<5%	+50.95%	Poor
7	Upper Saline Watershed HUC 8040203	Landscape Context	Nutrient concentrations & dynamics	# of NPDES sites per 12-digit HUC	>10 NPDES sites per 12 digit HUC	***5-9 NPDES sites per 12 digit HUC***	3-4 NPDES sites per 12 digit HUC	0-2 NPDES sites per 12 digit HUC	Hurricane Crk. - 15 NPDES, Middle Fork - 5 NPDES, all other subwatersheds less than 5.	Fair

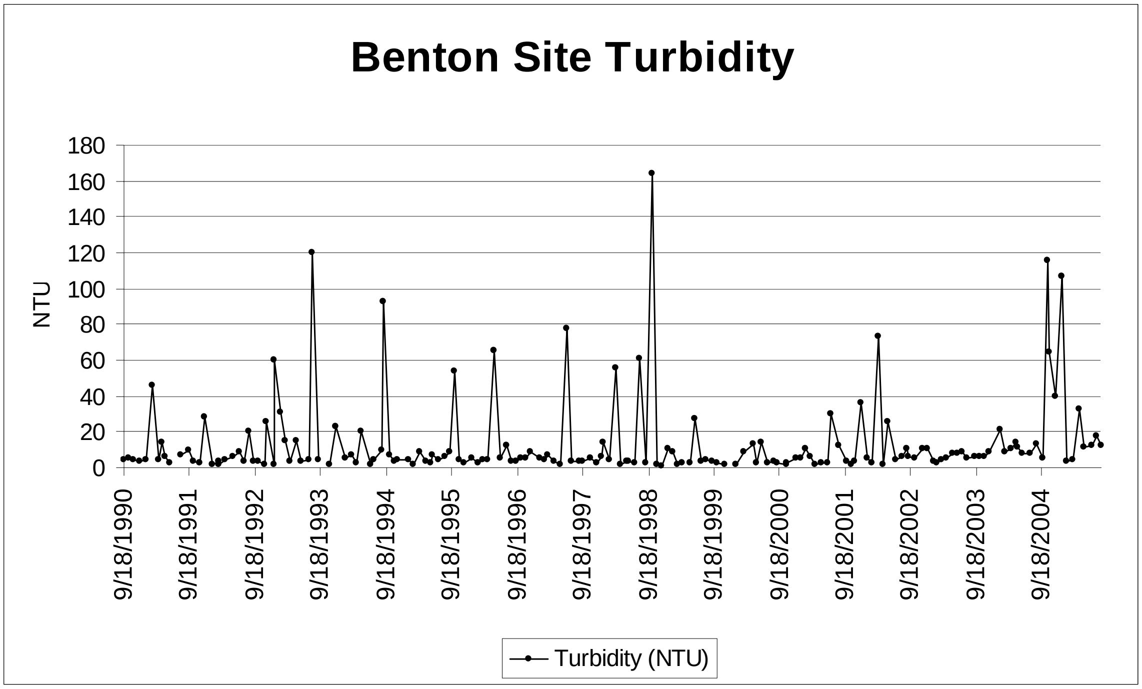
Appendix B. D.O. Range of Variability, monthly samples, Benton site, ADEQ.



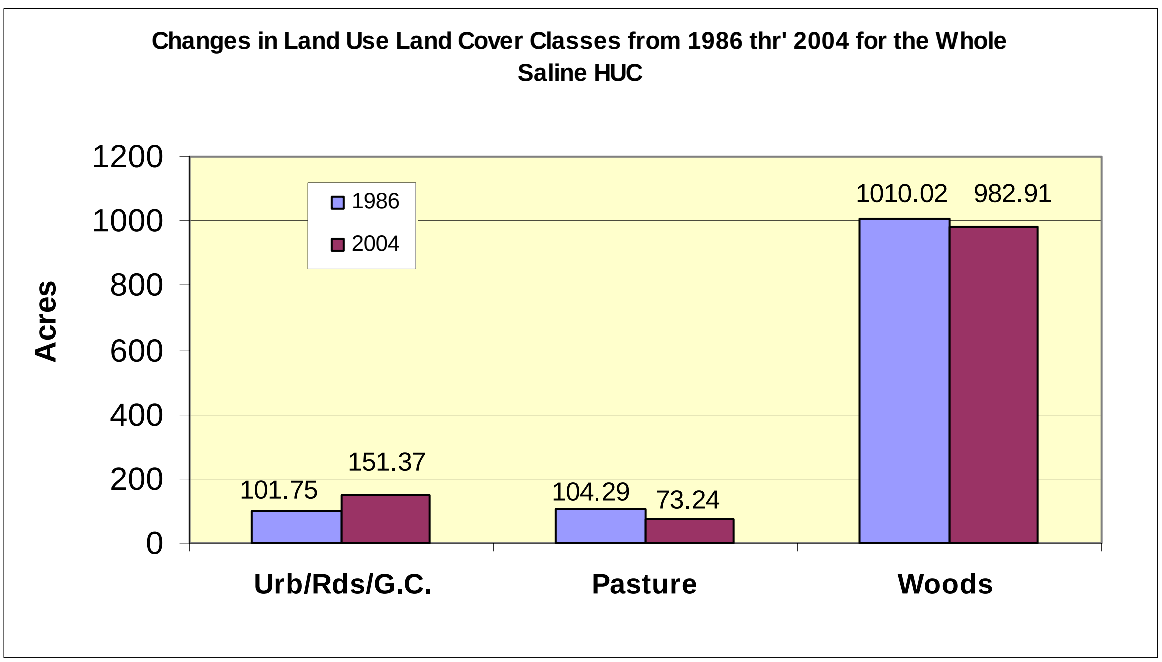
Appendix C. One Month (July 2006) graph of Dissolved Oxygen, Middle Fork Saline.



Appendix D. Range of Variability – Turbidity monthly samples, ADEQ.

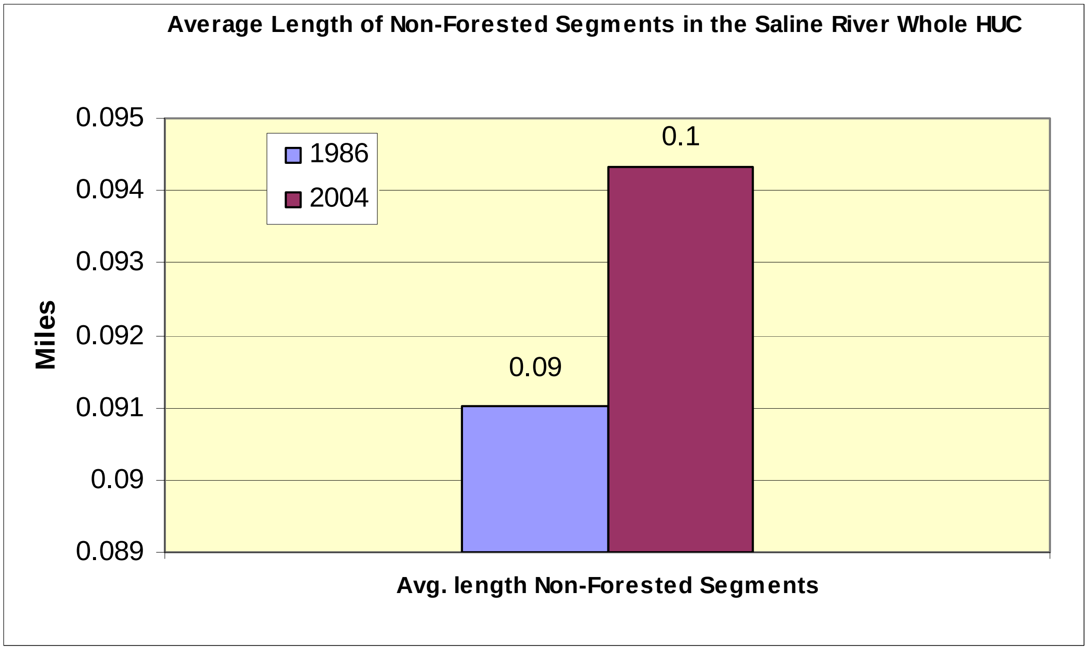


Appendix E. Changes in Land Cover/% Increase or Decrease

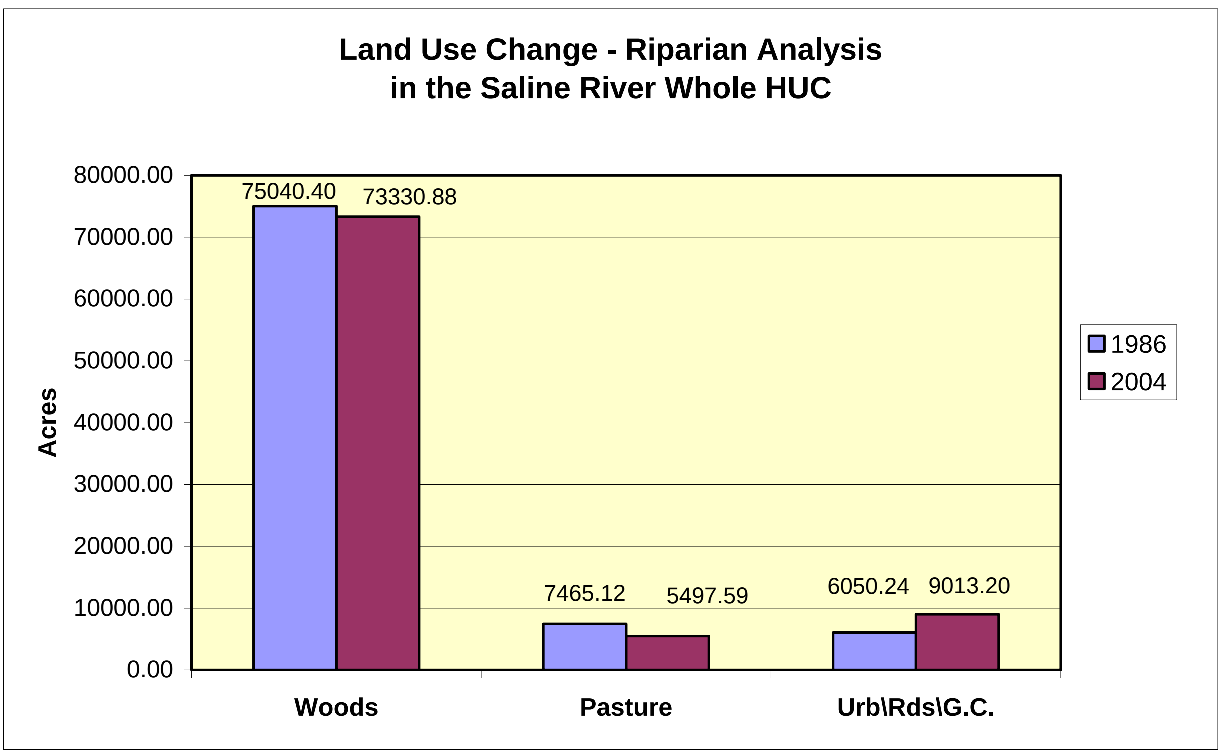


Land Classification	% Increase or decrease
URBAN	50.95
PASTURE	-42.39
WOODS	-2.75
RI (PERENIAL) Woods	-2.33

Appendix F. Average Length Of Non-Forested Segments, Upper Saline Watershed.

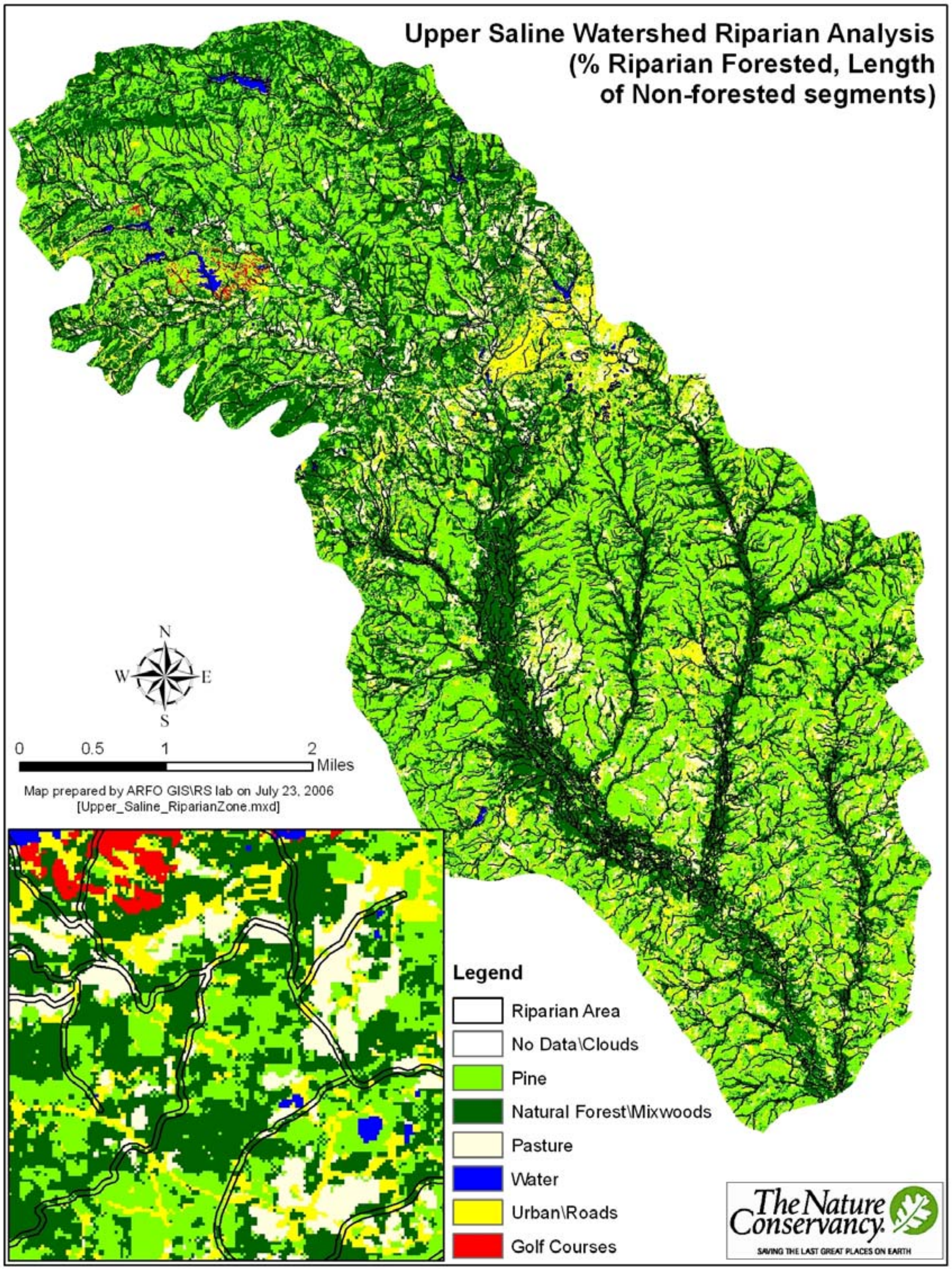


Appendix G. Land Use Change – Riparian Analysis, Upper Saline Watershed.



Land Classification	% Change 1986-2004
WOODS	-2.33
PASTURE	-35.78
URBAN	+ 48.97

Appendix H. Riparian Analysis Map:



Appendix I. Summary Table, Macroinvertebrate Data, Upper Saline Watershed.

Summary of Macroinvertebrate Data for the Upper Saline River						
ADEQ Sample ID	Collection Date	Site Description	Isopoda	Hilsenhoff Biotic Index	Intolerant Taxa	Tolerant Taxa
ADEQ2C-12	5/2/2002	South Fork River DS Tenmile Creek, 1/2 mi N of Nance, head of braided Channel US of Bridge	0.96%	4.27	7	3.35%
ADEQ2C-14	5/2/2002	South Fork DS Tenmile Creek 1/2 mi N of Nance 2nd Riffle DS of bridge Narrows Rd.	2.03%	4.31	7	3.38%
ADEQ2C-16	9/18/2002	South Fork 1/2 mi North of Nance on Narrows Rd. Head of Braided Channel US of Bridge	0.00%	4.54	5	5.59%
ADEQ2C-17	9/18/2002	1/2 mi N of Nance 2nd Riffle DS of Bridge	0.00%	4.33	4	6.86%
ADEQ2C-18	9/17/2003	Vance MFS02 Sample 1	0.00%	4.31	5	8.15%
ADEQ2C-19	9/17/2003	Vance MFS02 Sample 2	0.00%	3.6	3	7.20%
ADEQ2C-20	9/17/2003	MFS03 County Rd Sample 1	0.00%	4.22	4	2.22%
ADEQ2C-21	9/17/2003	MFS03 County Rd Sample 2	2.14%	4.47	5	11.76%
ADEQ2C-24	9/17/2003	MFS05 Talley Bridge	0.00%	4.75	5	24.06%
ADEQ2C-25	9/17/2003	MFS05 Talley Bridge	1.00%	4.07	6	12.00%
ADEQ2C-22	9/19/2003	MFS04B 3/4 mi DS Mill Creek Confluence	5.08%	4.18	4	9.32%
ADEQ2C-23	9/19/2003	MFS04B 3/4 mi DS Mill Creek	2.36%	4.40	3	13.39%
ADEQ2C-26	9/19/2003	Mill Creek DS HSV WWTP Effluent	25.71%	5.43	3	27.62%
ADEQ2C-27	9/19/2003	Mill Creek DS HSV WWTP Effluent	17.71%	5.09	3	20.83%

Appendix J. Water Quality Data Summary, Benton Site.

Summary of Water Quality Data for the Upper Saline River

Station ID	Date	TSS (mg/L)	Turbidity (NTU)	DO (mg/L)	Saline River Near Benton
OUA0026	09/18/90	6	4.4	8	
OUA0026	10/16/90	5	5.5	8.5	
OUA0026	11/13/90	3	4	10.1	
OUA0026	12/11/90	2	3.4	11.8	
OUA0026	01/22/91	4	4.7	11.7	
OUA0026	02/19/91	4	46	10.1	
OUA0026	03/26/91	1	4	9	
OUA0026	04/16/91	14	14	8.8	
OUA0026	05/07/91	7	6.2	8.8	
OUA0026	06/04/91	5	3	8.1	
OUA0026	07/02/91	4		7.4	
OUA0026	07/30/91	5	6.8	7.6	
OUA0026	09/17/91	21	10	7.5	
OUA0026	10/08/91	4	3.6	8.9	
OUA0026	11/12/91	2	2.6	11.3	
OUA0026	12/10/91	44	28	9.5	
OUA0026	01/28/92		2	11.9	
OUA0026	02/25/92	4	3.7	10.3	
OUA0026	03/03/92	3	2	9.2	
OUA0026	04/07/92	8	4.6	9	
OUA0026	05/19/92	13	6.2	7	
OUA0026	06/22/92	9	8.5	7.3	
OUA0026	07/14/92	2	3.5	6.6	
OUA0026	08/11/92	5	20	6.6	
OUA0026	09/08/92	5	3.5	7	
OUA0026	10/06/92	5	3.6	8.3	
OUA0026	11/10/92	2	2	10	
OUA0026	11/23/92	16	26	9.5	
OUA0026	01/04/93		1.9	11	
OUA0026	01/04/93	72	60	10.2	
OUA0026	02/02/93	2	31	11.5	
OUA0026	03/02/93	23	15	10.6	
OUA0026	03/30/93	1	3.2	8.8	
OUA0026	05/04/93	10	15	8.5	
OUA0026	06/01/93	4	3.2	7.3	
OUA0026	07/13/93	6	4.6	6.7	
OUA0026	08/03/93	104	120	6.4	
OUA0026	09/07/93	6	4.5	7.3	
OUA0026	10/05/93	4		8.5	
OUA0026	11/02/93	1	2.2	10.8	
OUA0026	12/14/93	17	23	10.5	
OUA0026	02/01/94	1.5	5.5	11.3	
OUA0026	03/08/94	4	7	10.4	
OUA0026	04/05/94	2.5	3	9.9	
OUA0026	05/04/94	11.5	20	9.5	
OUA0026	06/21/94	7	1.8	7.5	
OUA0026	07/12/94	5	4.8	7	
OUA0026	08/23/94	9	10	7.4	

Appendix J. ...Continued.

Summary of Water Quality Data for the Upper Saline River					
Station ID	Date	TSS (mg/L)	Turbidity (NTU)	DO (mg/L)	Saline River Near Benton
OUA0026	09/06/94	96	93	7.5	
OUA0026	10/04/94	8	7.1	7.6	
OUA0026	11/01/94	3.5	3.6	10.6	
OUA0026	11/21/94	3.5	4.7	9	
OUA0026	01/24/95	1	4.5	10.9	
OUA0026	02/14/95	1	1.8	12.2	
OUA0026	03/28/95	5.5	8.5	9.7	
OUA0026	04/25/95	3.5	3.6	9	
OUA0026	05/23/95	3.5	2.9	8.9	
OUA0026	06/06/95	7.5	7.5	7.6	
OUA0026	07/11/95		4.1	6.8	
OUA0026	08/08/95	5.5	6	6.6	
OUA0026	09/05/95	8.5	8.6	5.6	
OUA0026	10/03/95	16.5	54	7.2	
OUA0026	10/31/95	4	4.6	9	
OUA0026	11/28/95	2	2.7	11.2	
OUA0026	01/09/96		5	12.8	
OUA0026	02/13/96	2.5	2.4	11.2	
OUA0026	03/12/96	2.5	4	11.2	
OUA0026	04/09/96	3	4.8	10.9	
OUA0026	05/07/96	93	65	7.5	
OUA0026	06/18/96	3.5	5.2	7.6	
OUA0026	07/23/96	10	12	7.4	
OUA0026	08/13/96	4.5	3.5	7.4	
OUA0026	09/10/96	4.5	3.1	7.3	
OUA0026	10/08/96	6	5.6	8.6	
OUA0026	11/05/96	2.5	5.6	8.5	
OUA0026	12/03/96	5.5	8.8	9.6	
OUA0026	01/21/97		5.4	9.9	
OUA0026	02/18/97	2	4.8	10.8	
OUA0026	03/11/97		7.2	10.9	
OUA0026	04/15/97	1	3.8	10.2	
OUA0026	05/13/97	1.5	1.9	8.2	
OUA0026	06/17/97	105.5	78	7.8	
OUA0026	07/15/97	2	3.9	7.36	
OUA0026	08/26/97	2.5	3.8	8.13	
OUA0026	09/16/97	3	3.5	7.34	
OUA0026	10/28/97	3.5	5.4	10.1	
OUA0026	12/02/97	1.5	2.5	10.1	
OUA0026	12/30/97	1.5	6	14.3	
OUA0026	01/13/98		14	13.6	
OUA0026	02/10/98	3	4.5	12.2	
OUA0026	03/17/98	101.5	56	12.3	
OUA0026	04/14/98	1.5	2	10.5	
OUA0026	05/19/98	2.5	3.1	10	
OUA0026	06/02/98	4.5	3.4	8.9	
OUA0026	06/30/98	5	2.6	7.3	

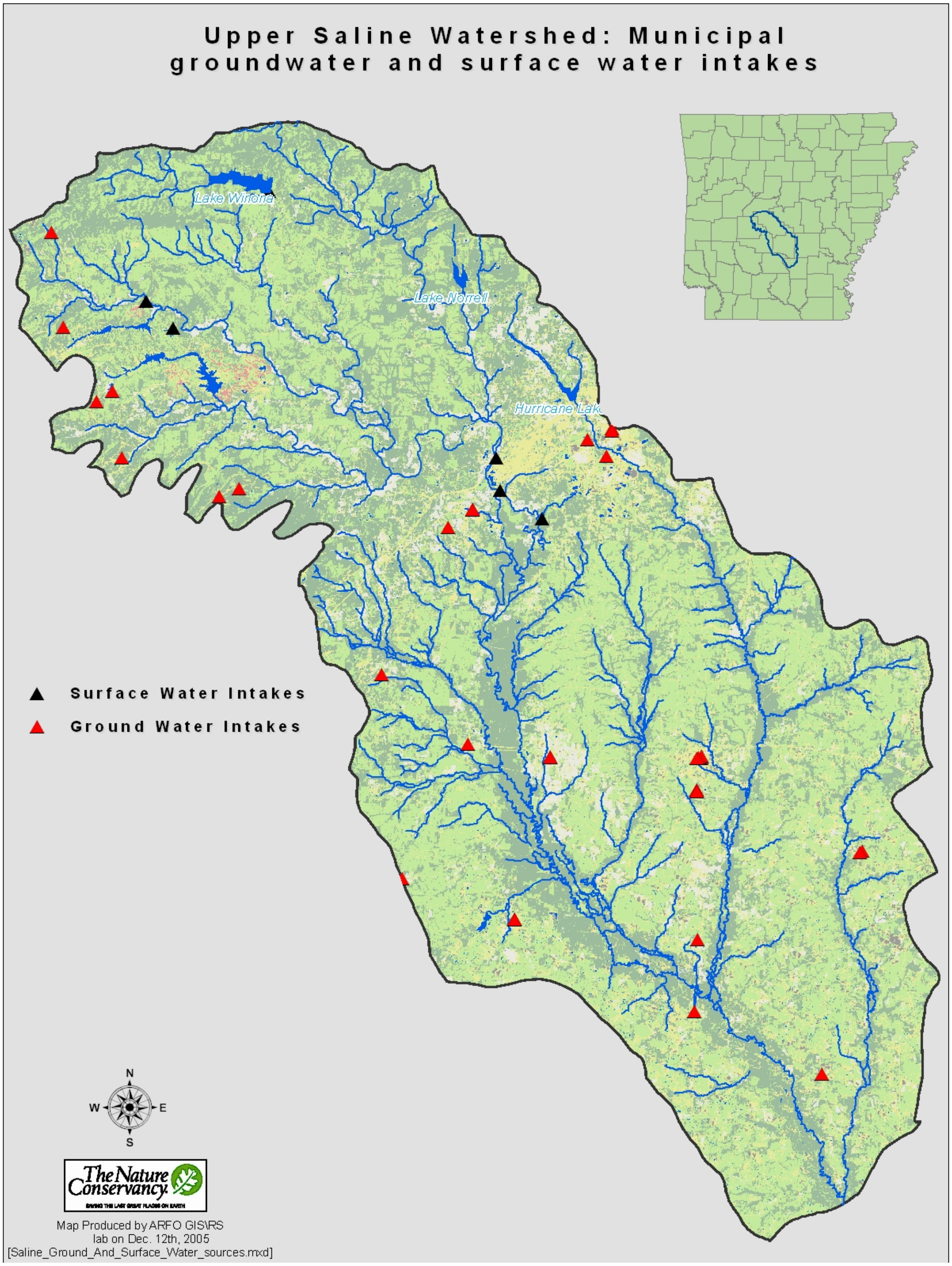
Appendix J. ... Continued.

Summary of Water Quality Data for the Upper Saline River					
Station ID	Date	TSS (mg/L)	Turbidity (NTU)	DO (mg/L)	Saline River Near Benton
OUA0026	08/04/98	51.5	61	7.2	
OUA0026	09/01/98	2	2.6	6.5	
OUA0026	10/05/98	0	164	7.7	
OUA0026	11/03/98		1.4	8.3	
OUA0026	12/01/98	1.5	1.1	8.7	
OUA0026	01/05/99	6.5	11	12.2	
OUA0026	02/02/99	5	9.1	12.1	
OUA0026	03/02/99		1.5	11.41	
OUA0026	04/20/99	2.5		6.97	
OUA0026	05/11/99	3	2.8	6.19	
OUA0026	06/01/99	12.5	27	5.85	
OUA0026	07/06/99	2.5	3.2	5.55	
OUA0026	08/03/99	6.5	4.2	5.18	
OUA0026	09/07/99	2.5	3.1	5.07	
OUA0026	10/05/99	4.5	2.9	7.13	
OUA0026	11/17/99	1.5	1.8	8.16	
OUA0026	12/14/99	12.5		7.27	
OUA0026	01/18/00		1.6	8.17	
OUA0026	02/29/00	6	9	7.51	
OUA0026	03/27/99	2	2.6	7.47	
OUA0026	04/24/00	8.5	13	7.28	
OUA0026	05/16/00	3	2.6	10.82	
OUA0026	06/06/00	12	14	7.17	
OUA0026	07/18/00	3	2.3	6.67	
OUA0026	08/15/00	5.5	3.4	6.8	
OUA0026	09/05/00	2.5	2.7	6.87	
OUA0026	10/24/00	3.5	2	7.1	
OUA0026	10/31/00	3.5	2.5	7.03	
OUA0026	12/19/00		5	12.92	
OUA0026	01/15/01	3	5.5	13.4	
OUA0026	02/13/01	10	11	12.61	
OUA0026	03/06/01	5	6.4	10.4	
OUA0026	04/03/01	1.5	2	7.9	
OUA0026	05/08/01	2.5	2.5	8.36	
OUA0026	06/12/01	4	3	8.12	
OUA0026	07/03/01	21	30	7.86	
OUA0026	08/14/01	9.75	12	7.61	
OUA0026	09/25/01	4.2	3.6	8.11	
OUA0026	10/23/01		2.1	8.28	
OUA0026	11/13/01	3.5	3.5	9.19	
OUA0026	12/18/01	45	36	9.21	
OUA0026	01/22/02	1.5	5.2	11.25	
OUA0026	02/19/02	1	2.5	11.03	
OUA0026	03/19/02	4.3	73	10.6	
OUA0026	04/16/02	1	1.9	9.82	
OUA0026	05/14/02	17.5	26	8.1	
OUA0026	06/25/02		4.8	7.1	
OUA0026	07/30/02	11.5	6.6	6.7	

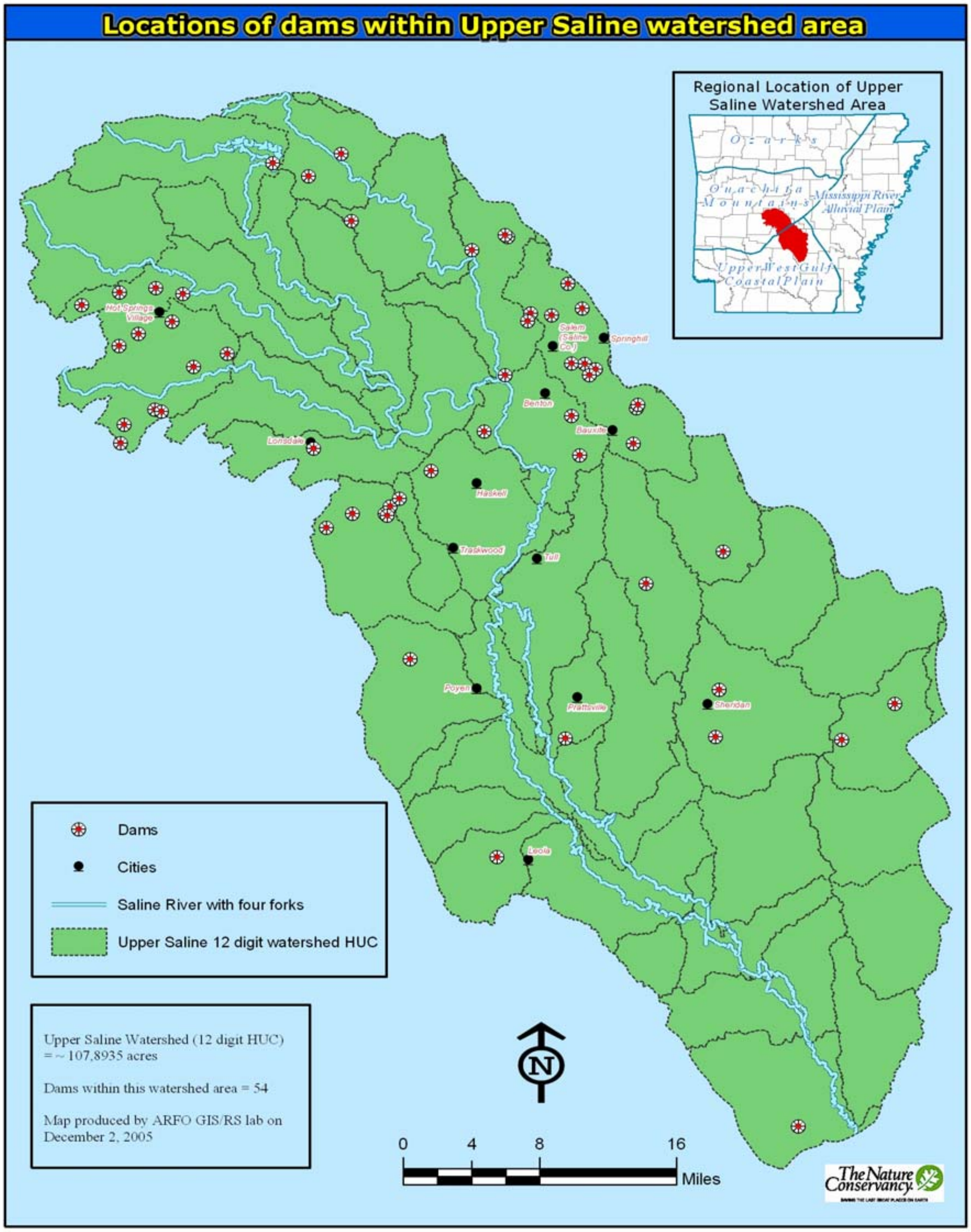
Appendix J. Continued.

Summary of Water Quality Data for the Upper Saline River					
Station ID	Date	TSS (mg/L)	Turbidity (NTU)	DO (mg/L)	Saline River Near Benton
OUA0026	08/27/02	3.5	11	6.5	
OUA0026	09/10/02	8	6.4		
OUA0026	10/15/02	5	5.3	8.3	
OUA0026	11/25/02	13.2	10.6	9.8	
OUA0026	12/17/02	3.5	10.2	9.8	
OUA0026	01/21/03		3.8	10.9	
OUA0026	02/11/03	1	2.49	11.1	
OUA0026	03/11/03	2	4.61	10.9	
OUA0026	04/08/03	2	4.92	8.9	
OUA0026	05/13/03	6	7.95	7.6	
OUA0026	06/03/03	6	7.95		
OUA0026	06/30/03	6	8.47	9.5	
OUA0026	07/29/03	4.8	5.39	7.4	
OUA0026	09/09/03	5.2	5.96	7.3	
OUA0026	10/07/03	3.2	6.26	11.5	
OUA0026	11/04/03	5.5	6.3	11.9	
OUA0026	12/02/03	1.2	9.06	11.5	
OUA0026	01/27/04	10	21.4	11	
OUA0026	02/24/04	1.8	8.55	10.3	
OUA0026	03/30/04	3	10.3	8.53	
OUA0026	04/26/04	5.8	14.4	8.78	
OUA0026	05/04/04	4	11.5	8.9	
OUA0026	06/01/04	5.5	7.84	9.68	
OUA0026	07/20/04	6.5	7.65	7.96	
OUA0026	08/23/04	7.5	13.2	9.77	
OUA0026	09/28/04	3.8	5.39	8.14	
OUA0026	10/19/04	78.7	116	5.43	
OUA0026	11/02/04	56	64.6	8.37	
OUA0026	12/07/04	20.2	39.6	10.4	
OUA0026	01/04/05	88.2	107	9.55	
OUA0026	02/01/05	1.2	3.41	11.4	
OUA0026	03/15/05	2	4.68	10.6	
OUA0026	04/12/05	21	32.8	8.24	
OUA0026	05/10/05	4	11.7		
OUA0026	06/21/05	10.2	12	7.08	
OUA0026	07/19/05	11.5	17.5	5.8	
OUA0026	08/16/05	11	12.4	6.28	

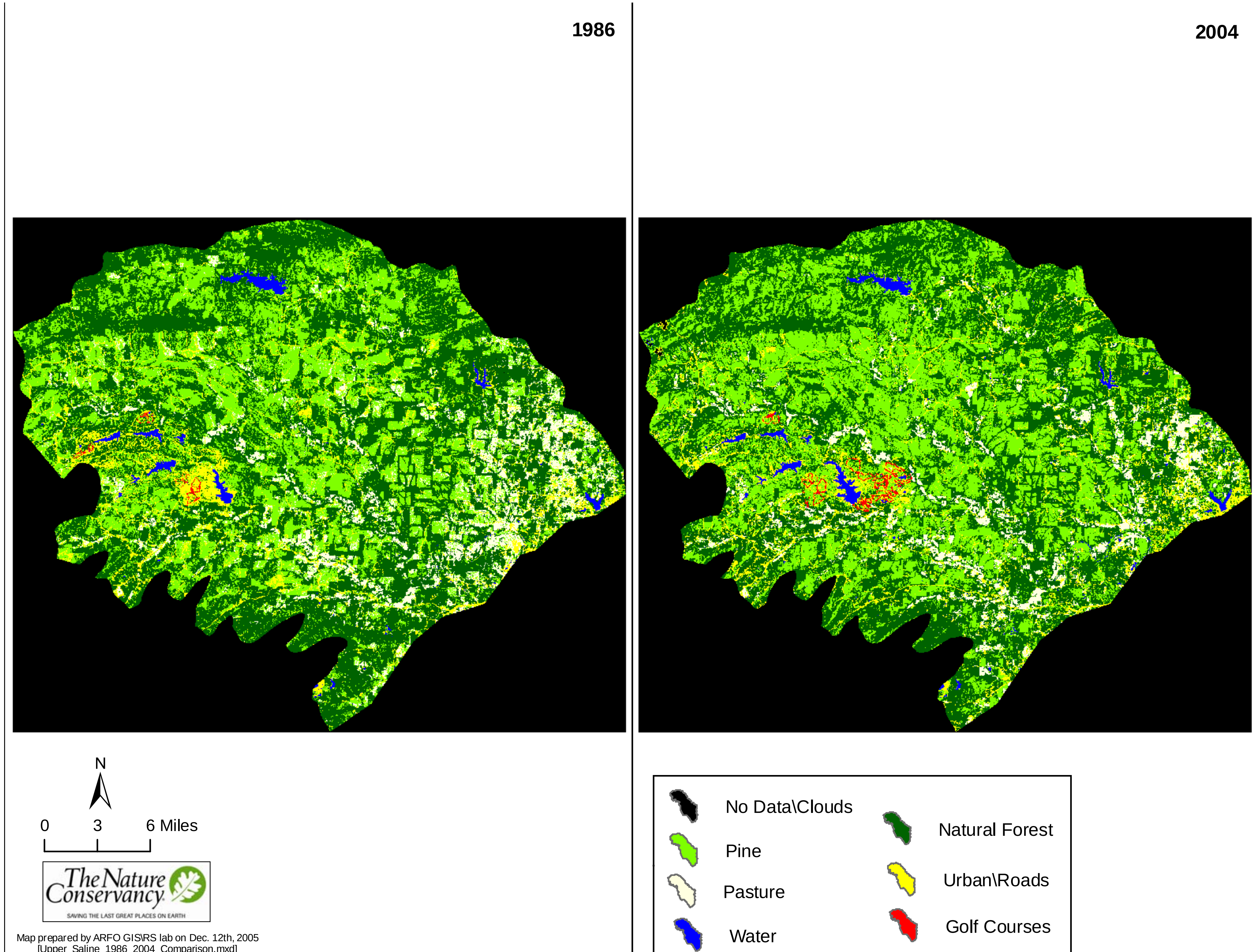
Appendix K. Municipal Withdrawals, Upper Saline Watershed.

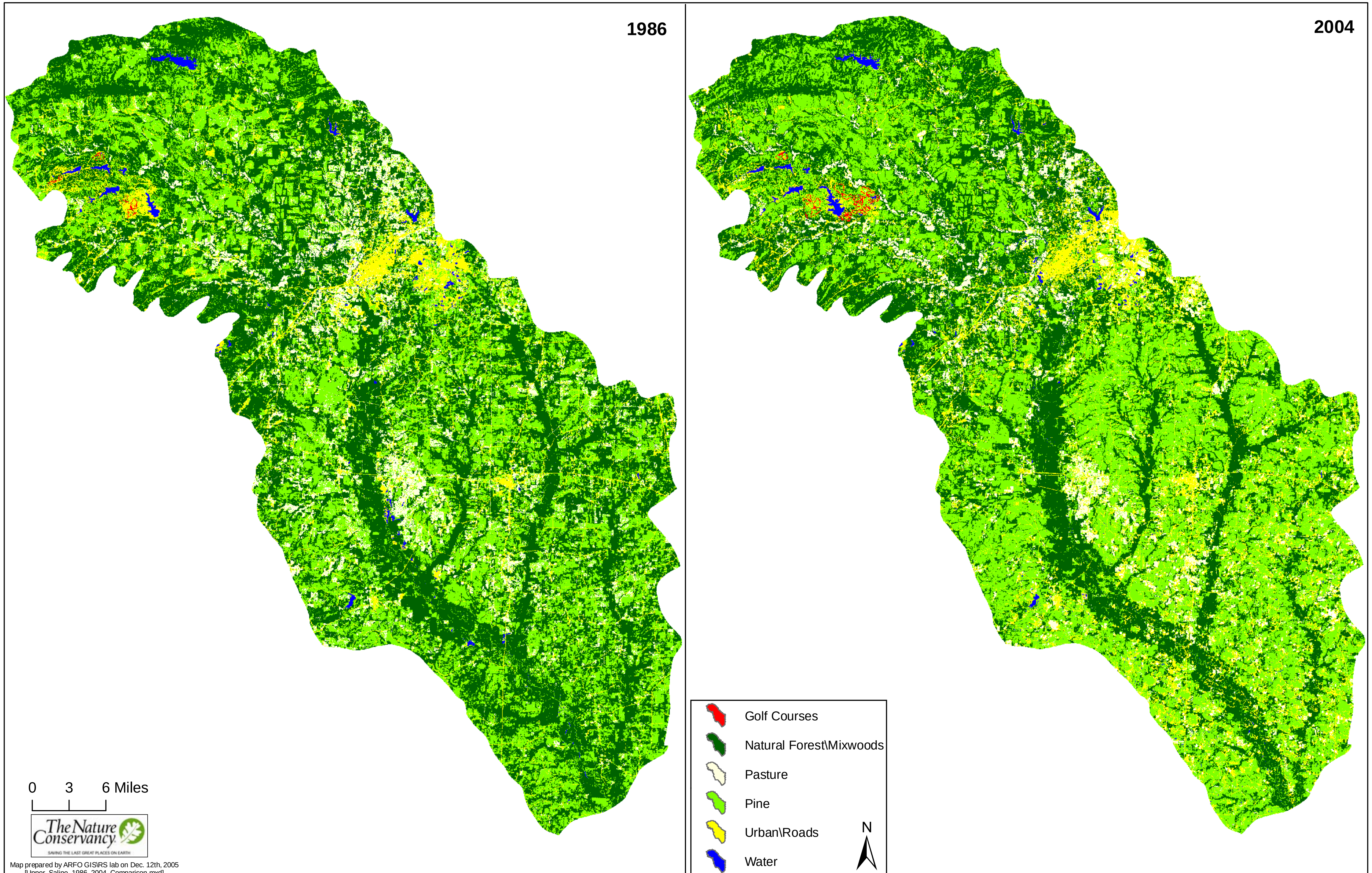


Appendix L. Location of Dams, Upper Saline

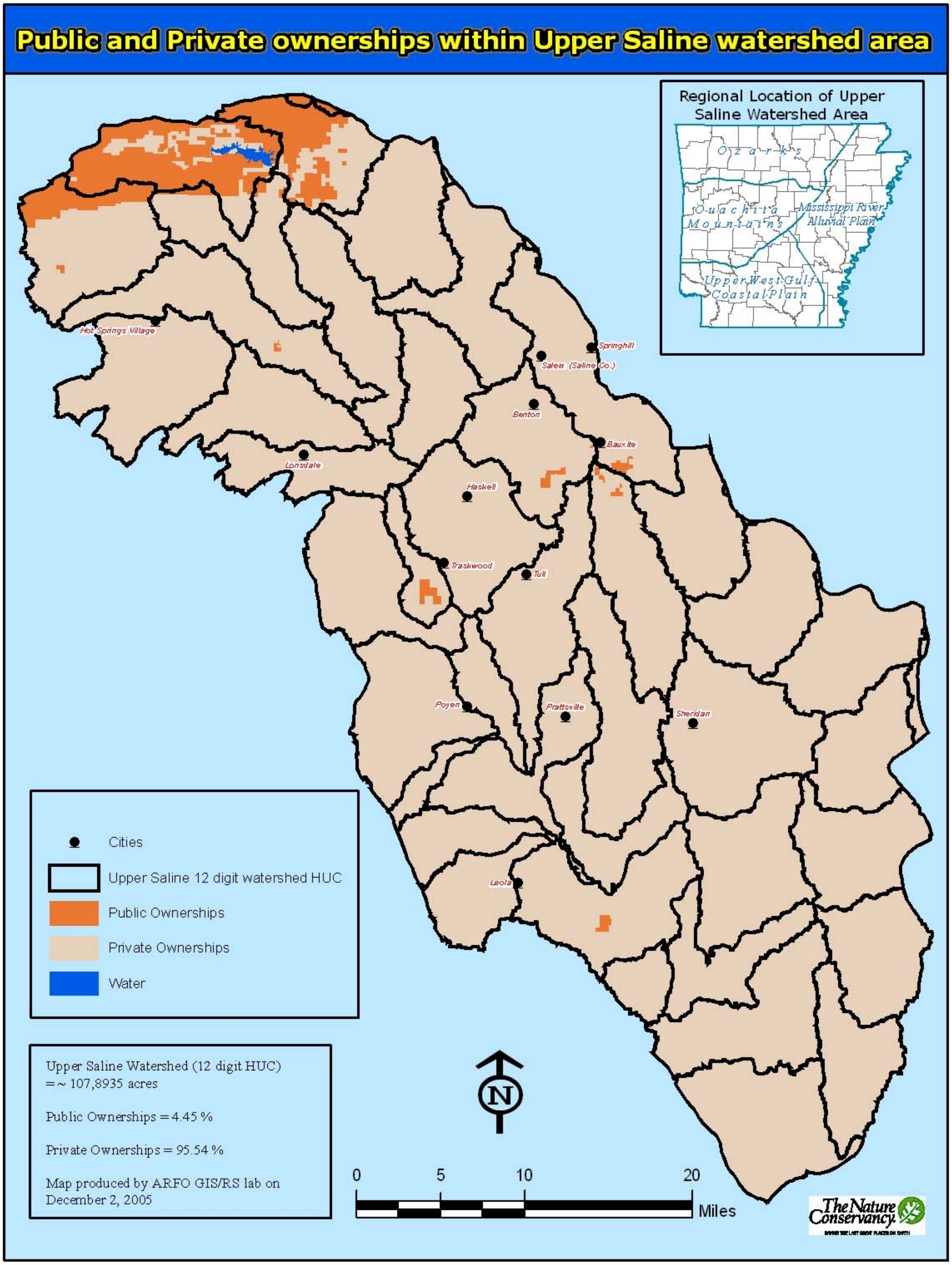


Appendix M: Land Use Change Headwaters Region, Whole HUC




1986
2004
0 3 6 Miles
The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH
Map prepared by ARFO GIS\RS lab on Dec. 12th, 2005
[Upper_Saline_1986_2004_Comparison.mxd]
Golf Courses
Natural Forest\Mixwoods
Pasture
Pine
Urban\Roads
Water
N

Appendix N. Public Vs. Private Ownership



Hydrologic Analysis of the Upper Saline Watershed AR

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July 14, 2006

Introduction: Stream gaging records from five localities within the Upper Saline River watershed were analyzed (Table 1). Two sites are located on tributaries to the Saline River (Alum Fork and Hurricane Creek) and three sites were along the mainstem of the Saline River. Other gaging stations within the watershed were not incorporated into the study because the period of record for the stations was too short to provide adequate statistical reliability to hydrological analysis.

Low-flow- and high-flow-event frequency analysis and flow duration curves were completed for the data from all five stations to determine flood, low-flow, and general flow regime characteristics. To evaluate long-term stream flow trends and potential flow alteration impacts within the Upper Saline River watershed associated with changes in consumptive water withdrawals and land use patterns, the available records were analyzed using the *Indicators of Hydrologic Alteration* (*IHA*) software package (Richter et. al., 1996). The *IHA* software makes use of 67 parameters to provide a detailed statistical profile of stream flow characteristics. Results from the IHA analysis for a suite of 33 parameters further analyzed using the Statistix software package in order to identify which of the IHA parameters exhibited a statistically significant temporal trend.

Flow Duration Analysis: Mean annual flows and median daily flows calculated for gaging stations within the Upper Saline River watershed are presented in Table 2. The mean annual flows represent the arithmetic average of annual flows recorded during the period of record for each station. The median daily flows represent the 50th percentile values (i.e., 50 % of the daily average flows at the gaging station are equal to or greater than the value cited) for the period of record for each gaging station.

Flow duration curves for periods of record for the five gaging stations within the Upper Saline River watershed are illustrated in Figure 1. The curves for the three gaging stations on the mainstem Saline River illustrate a systematic shift to higher median flow values as the area of the watershed measured by the gaging stations increases. Flow duration curves for the two tributaries both indicated some periods of zero-stream flow. Flows at the Alum Fork station are zero approximately 20

percent of the time, while flows at the Hurricane Creek stations are zero approximately 5% of the time.

Flood and Low-Flow Frequency Analysis: Flood frequency analyses were completed to estimate bankfull, mean annual, 5-yr, and 10-yr flood magnitudes at the five gaging stations analyzed for this study (Tables 2 and 3; Figure 2). For this study, all flood flow magnitudes reported were calculated using annual, instantaneous peak flow data reported by the USGS for each of the gaging stations.

Bankfull flooding events are critical to the geomorphic stability and ecological health of a river because such flow magnitudes represent the flows necessary for channel-maintenance and periodic refurbishment of major aquatic habitats within a river (Leopold et. al, 1964). Recurrence intervals for bankfull flows typically fall within the range of 1.3 to 1.7 years and a median recurrence interval of 1.5 yrs is widely adopted (Dunne and Leopold, 1978; Leopold, 1994). For this study, a recurrence interval value of 1.5 years has been used to estimate bankfull flow values presented in Table 2 pending completion of field calibration of bankfull flow recurrence intervals along the Saline River and its tributaries.

Estimated bankfull flows for the tributaries range from 4,240 cfs to 5,277 cfs (Table 2). Within the mainstem of the Saline River, the flood frequency curves are quite similar (Figure 2), and the calculated bankfull flood magnitudes range from 22,200 cfs at the Benton AR gaging station to 14,876 cfs at the Rye AR gaging stations. The lack of an increasing trend in the bankfull flood magnitudes with increased downstream distance of the gaging stations (and correspondingly larger watershed drainage areas for successive downstream gaging stations) is somewhat problematic. The general similarity of the flood frequency curves, and the shortness of the period of record for the Benton and Sheridan gaging stations suggests that the cause may in part be due to the length of the data records available. The trend could also be real, however, and examination of the physical setting of the respective gaging stations may identify a physically-based explanation for this apparently anomalous trend in bankfull flood magnitudes.

Mean annual flood magnitudes have recurrence intervals of 2.33 years (Dunne and Leopold, 1978; Leopold, 1994) and estimated values are presented in Table 2. The mean annual flood values for the three gaging stations on the mainstem of the Saline River exhibit a similar, apparently anomalous, trend as to the bankfull flood values. For reference, estimated magnitude of flood flows with 5- and 10-yr recurrence intervals are presented in Table 3.

Low-Flow Event Frequency Analysis: **Results of the frequency analysis of low-flow or minimum flow events are presented in Table 2. Low-flow event values presented in Table 2 represent low flow values within a 7-day averaging window and a 10-yr recurrence interval and are analogous to "7Q10" values. Values for 7Q10 for both tributaries are 0 cfs, and values for the three stations on the mainstem of the Saline River range from 3.5 cfs at Benton AR to 12 to 13 cfs at the stations near Sheridan AR and Rye AR.**

Analysis of Potential Flow Regime Alteration: **The *Indicators of Hydrologic Alteration* (*IHA*) software can be used to establish a pre-impact, or pre-alteration natural range of variation for a suite of up to 67 parameters that characterize the magnitude, frequency, duration, timing, and rate of hydrologic events that have been determined to be of potential significance to the ecological and geomorphological health of the system (Richter, et. al., 1996, 1997, 1998). For this study, a basic suite of 33 parameters was selected (see Table 4 for list of the parameters considered). Such a suite provides a comprehensive picture of the frequency, duration, magnitude, timing, and rate of change of characteristic high- and low-flow events, and as wells monthly median flow metrics.**

Temporal Trends in the Data: **Annual median values of the suite 33 parameters considered during the IHA analysis were further analyzed to determine if temporal trends exist. Results of such an analysis are presented in Table 4 for the four gaging stations with sufficiently long periods of records (because the period of record for the Sheridan AR gaging stations was marginally adequate, it was dropped from consideration in this exercise). Spearman Rank Correlation Coefficients (SRCC) were calculated for each of the IHA parameters to evaluate**

temporal trends. Values for the SRCCs range from -1.0 to 1.0, and the closer the value is to -1.0 or 1.0, the stronger the temporal correlation (either a negative or positive correlation, respectively). Values in Table 4 that represent statistically significant trends (>90% confidence) are highlighted in yellow.

The results suggest that few consistent temporal trends for any particular parameter exist across the watershed for the four gaging stations. Additionally, even for trends that fall within the 90% significance level, the SRCC values for such trends are rarely greater than 0.5 (or -0.5 for decreasing trends), suggesting that the strength of correlation, or strength of trend, for such parameters is typically low to at best moderate. For each gaging station, individual trend plots for each of the parameters exhibiting a statistically significant trend are plotted in figures 3 through 22. Examination of the plots suggests that most parameters have considerable variability, an observation consistent with the observed moderately to low strength of correlation SRCC values.

In general, data from the two gaging stations on tributaries to the Saline River have a greater number of significant trends than do the data from the gaging stations along the mainstem of the Saline. Among the parameters that most frequently exhibit a statistically significant trend at one or both tributary gaging stations are parameters that measure the magnitude of high- and low-flow events of various averaging periods (i.e., 1-, 3-, 7-, 30-, and 90-day periods). Interestingly, however, the one parameter for both tributary gaging stations that exhibited an increasing trend was the annual number of zero-flow days. Such a trend is consistent with increased consumptive water withdrawals within the tributary watersheds.

For the two gaging stations on the mainstem of the Saline River, the annual 1-day maximum flow event exhibited a decreasing trend at both localities, suggesting that short-duration peak flows within the reach of the Saline River between Benton AR and Rye AR are declining. Additionally, data from both stations indicates the annual number of hydrograph reversals is increasing, suggesting that the flow regime is exhibiting more annual rising- and falling-trend variability with time.

In general, however, the seemingly random variability to the pattern of occurrence of many of the other parameters with statistically significant trends defies simple explanations, but likely hints at the complexity of the causes underlying the details of altered flow regimes.

References:

Dunne, T, and Leopold, L. B., 1978. *Water in Environmental Planning.* W. H. Freeman and Co., New York, NY. 818p.

Leopold, L. B, Wolman, M. G., and Miller, J., 1964. *Fluvial Process in Geomorphology*. W. H. Freeman Co., San Francisco, CA. 522 p.

Leopold, L. B., 1994. *A View of the River*. Harvard University Press, Cambridge, MA. 298 p.

Richter, B. D., Baumgartner J. V., Powell, J., and Braun, D. P., 1996. *A Method for Assessing Hydrologic Alteration within Ecosystems.* Conservation Biology, vol. 10, 1163-1174.

Richter, B. D., Baumgartner, J. V., Wigington, R, and D. P. Braun, 1997. *How Much Water Does a River Need?* Freshwater Biology, vol. 37, 231-249.

Richter, B. D., Baumgartner, J. V., Braun, D. P., and Powell, J., 1998. *A spatial assessment of hydrologic alteration within a river network.* Regulated. Rivers: Research and Management, vol. 14, 329-340.

Tables

Gage Location	*Station ID*	*Water Body)*	*Record Period (water year)*
Reform AR	*07362587*	*Alum Fork*	*1990-2005*
Jessieville AR	**07362641**	**Middle Fork**	**2004-2005**
Owensville AR	**07362693**	**Middle Fork**	**2003-2005**
Jessieville AR	**07362656**	**Brushy Creek**	**2004-2005**
Sheridan AR	*07363300**	*Hurricane Creek**	*1962-2005**
Benton	*07363000*	*Saline River*	*1951-1980; 1984; 2001-2005*
Sheridan AR	*07363200*	*Saline River*	*1971-1983; 2001-2005*
Rye AR	*07363500*	*Saline River*	*1938-2005*
Warren AR	**07364000#**	**Saline River#**	**1929-1940#**

Table 1. **Saline River stream gaging stations. Stations used in this study are indicated by bold-face, italicized type. All stations operated by USGS (* records for old [07363400] gaging site and the current site were merged to obtain period of record indicated; # station within Lower Saline watershed)**

Station Name	*Mean Daily Flow (cfs)*	*Median Daily Flow (cfs)*	*Bankfull Flow (RI=1.5 y) (cfs)*	*7Q10 (cfs)*
Alum Fork	**47**	**8**	**4,240**	**0**
Hurricane Creek	**242**	**46**	**5,227**	**0**
Saline @ Benton	**760**	**210**	**22,200**	**3.5**
Saline @ Sheridan	**1,592**	**514**	**18,800**	**13**
Saline @ Rye	**2,612**	**684**	**14,876**	**12**

Table 2. **Average and median flow values, bankfull flow (assuming a return interval of 1.5 yr) and 7Q10 low-flow event magnitude for gaging stations in the Upper Saline River watershed.**

Station Name	*Mean Annual Flood (cfs)*	*5-yr Flood (cfs)*	*10-yr Flood (cfs)*
Alum Fork	**5,708**	**9,492**	**12,360**
Hurricane Creek	**9,056**	**12,580**	**17,380**
Saline @ Benton	**32,369**	**46,800**	**60,020**
Saline @ Sheridan	**25,395**	**38,000**	**52,500**
Saline @ Rye	**26,414**	**41,720**	**51,700**

Table 3. **Mean annual flood (return interval of 2.33 yr) flows, and 5- and 10-year recurrence interval flood flows for gaging stations in the Upper Saline River watershed.**

Variable	Alum Creek nr Reform AR	Hurricane Creek nr Sheridan AR	Saline River at Benton AR	Saline River at Rye AR
	SRC Value	SRC Value	SRC Value	SRC Value
Oct flow	-0.2198	0.1611	-0.0609	0.2219
Nov flow	-0.0784	0.1217	0.1845	-0.1411
Dec flow	-0.0722	0.1807	0.3524	-0.2009
Jan flow	-0.1500	0.1134	0.0964	-0.0739
Feb flow	0.0898	0.3238	-0.0592	-0.1950
Mar flow	-0.2800	0.1181	0.0913	-0.0460
Apr flow	-0.5641	0.1103	-0.1798	-0.0865
May flow	-0.4300	0.0085	-0.0437	-0.1878
Jun flow	-0.1007	0.3583	0.1495	-0.0017
Jul flow	0.1930	0.2411	0.0647	-0.0526
Aug flow	-0.0683	0.0246	0.1779	-0.0467
Sep flow	-0.4791	-0.2323	0.1081	0.0563
1-day min	M	-0.2736	0.0090	0.1004
3-day min	M	-0.2674	0.0717	0.1068
7-day min	M	-0.2679	0.1321	0.1376
30-day min	-0.3690	-0.1825	0.1962	0.2999
90-day min	-0.0359	-0.0258	0.0286	0.1381
1-day max	-0.1385	-0.1131	-0.3234	-0.2081
3-day max	0.1239	-0.2114	-0.2815	-0.1941
7-day max	-0.1500	-0.0383	-0.2860	-0.1712
30-day max	-0.4971	0.1592	-0.2538	-0.1387
90-day max	-0.5824	-0.1070	-0.1109	-0.1676
0-flow days	0.4495	0.4526	-0.2377	M
baseflow	M	M	0.1742	0.2926
date min	0.2675	0.3029	0.1835	-0.1695
date max	-0.1971	-0.0270	0.0997	0.1335
low-flow no.	0.2565	-0.2954	0.1165	0.1112
low-flow dur	-0.0986	0.0083	-0.1823	-0.0012
high-flow no	-0.5279	0.1165	0.2449	0.1161
high-flow dur	0.0166	0.0598	-0.0325	-0.0587
rise rate	-0.3962	0.4044	-0.1243	0.0290
fall rate	0.3326	-0.3018	-0.1290	-0.1396
reversal no.	-0.0487	-0.4567	0.6819	0.3055

Table 4. **Spearman Rank Correlation coefficients for IHA parameters from period of record prior to closure of Clearwater Dam. Parameters with statistically significant temporal trends (>90% confidence) are highlighted in yellow.**

Figures

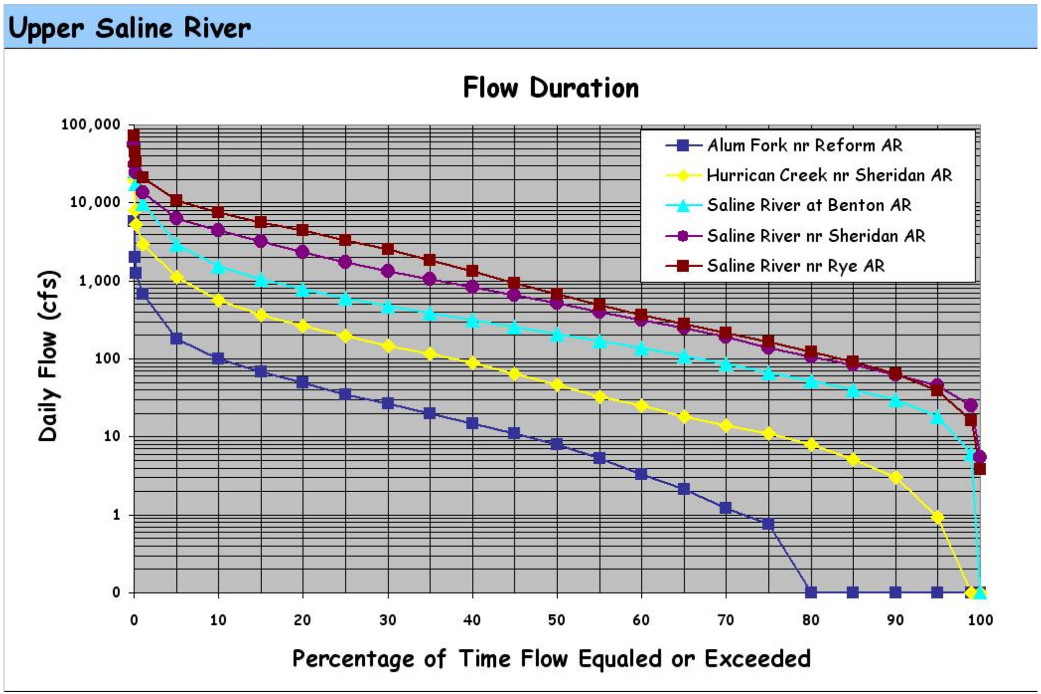

Figure 1. Flow duration curve for mean daily flows at the gaging stations throughout the Upper Saline River watershed.

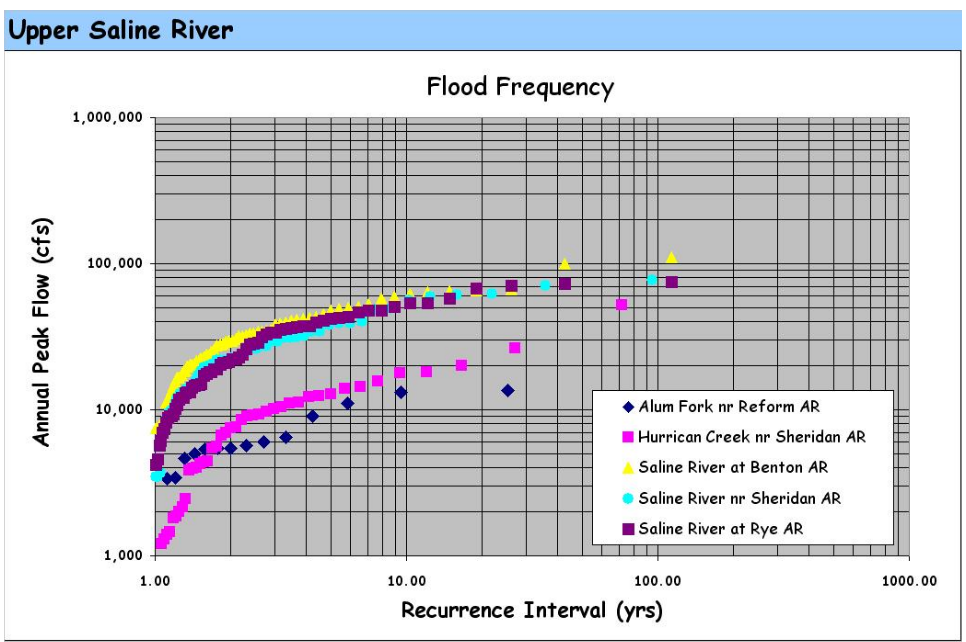

Figure 2. Flood frequency curves for annual instantaneous peak flows for gaging stations throughout the Upper Saline River watershed.

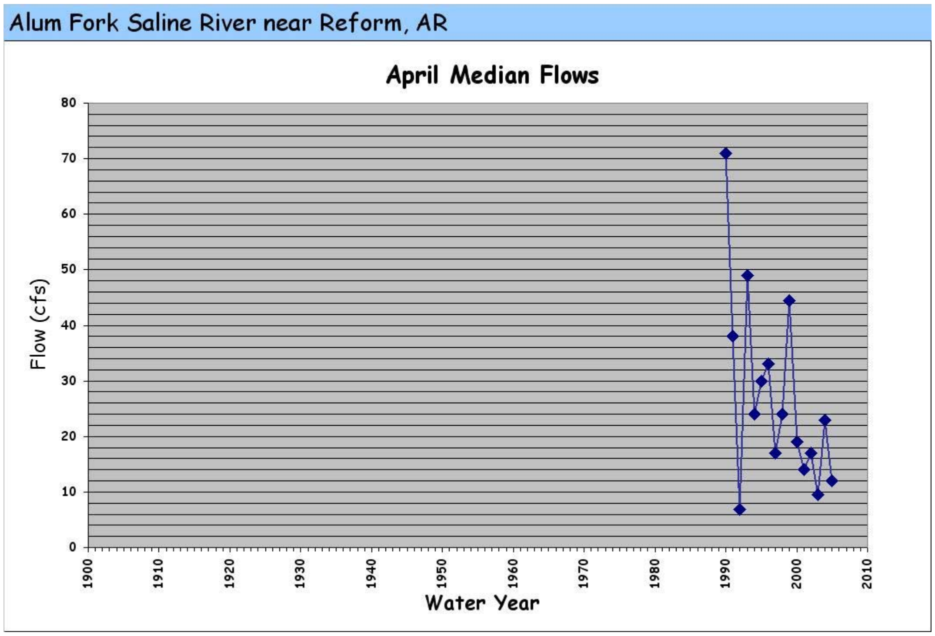

Figure 3.Median monthly flow values for April the Alum Fork for the Saline River near Reform AR.

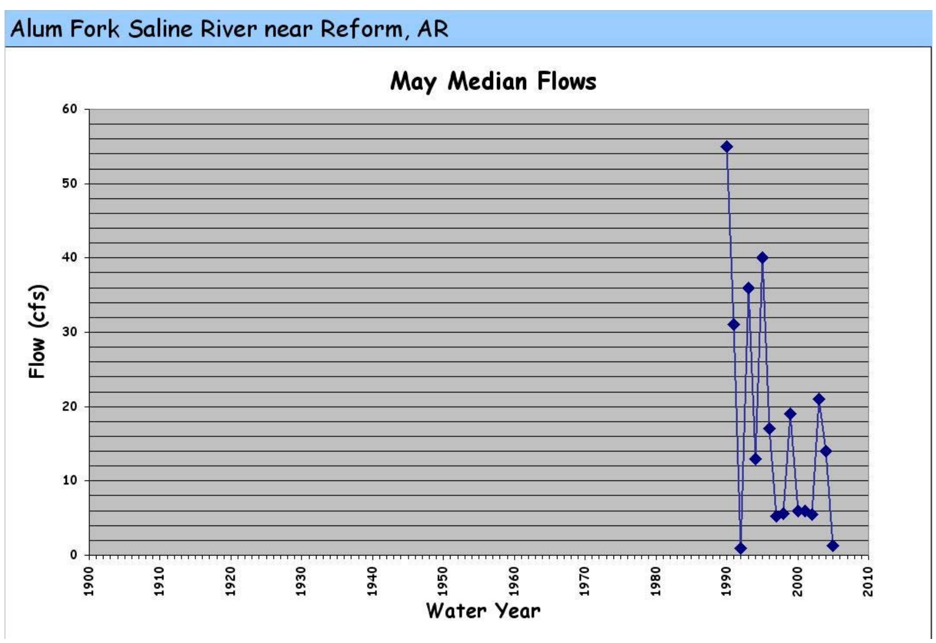

Figure 4. Median monthly flow values for May the Alum Fork for the Saline River near Reform AR.

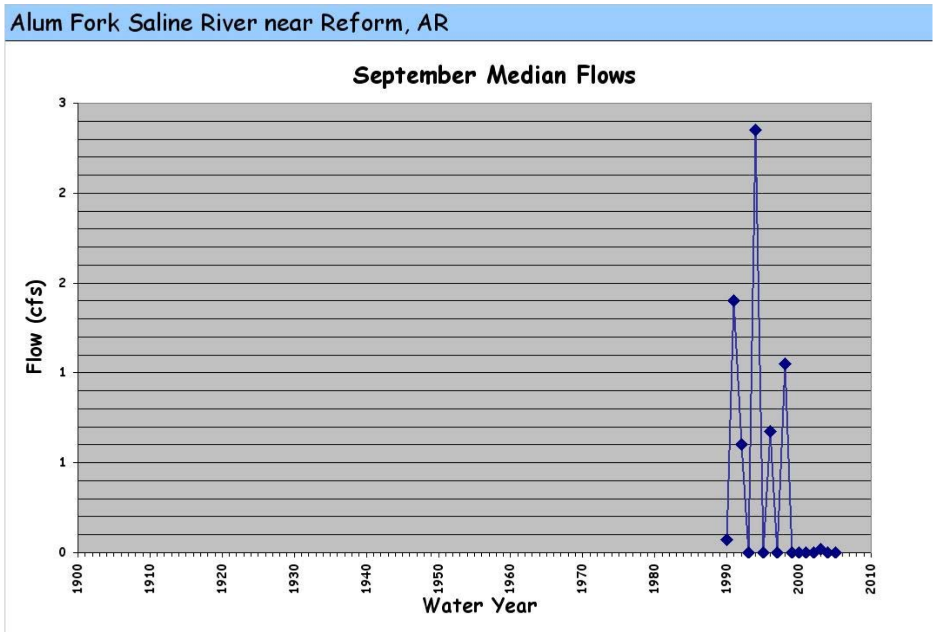

Figure 5.Median monthly low values for September for the Alum Fork of the Saline River near Reform AR.

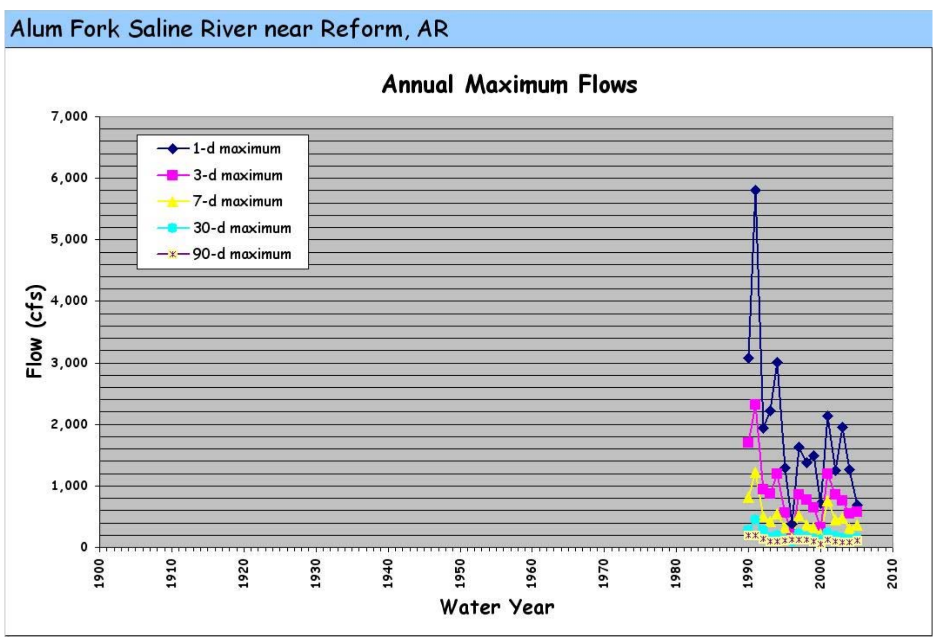

Figure 6.Annual maximum-flow event values for the Alum Fork of the Saline River near Reform AR.

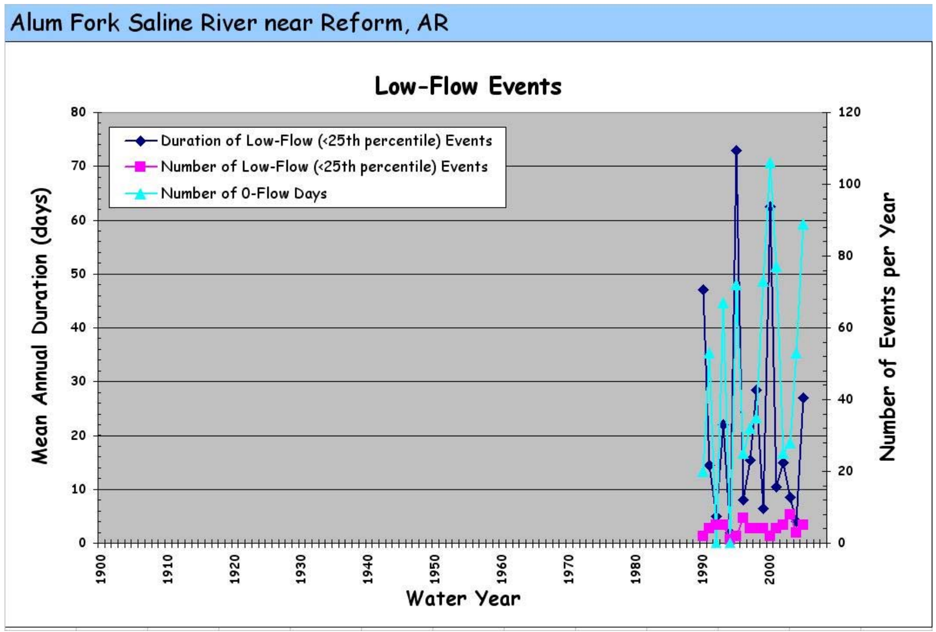

Figure 7. Annual number and duration of low-flow events (flows < 75th exceedence interval), and annual number of zero-flow days the Alum Fork of the Saline River near Reform AR.

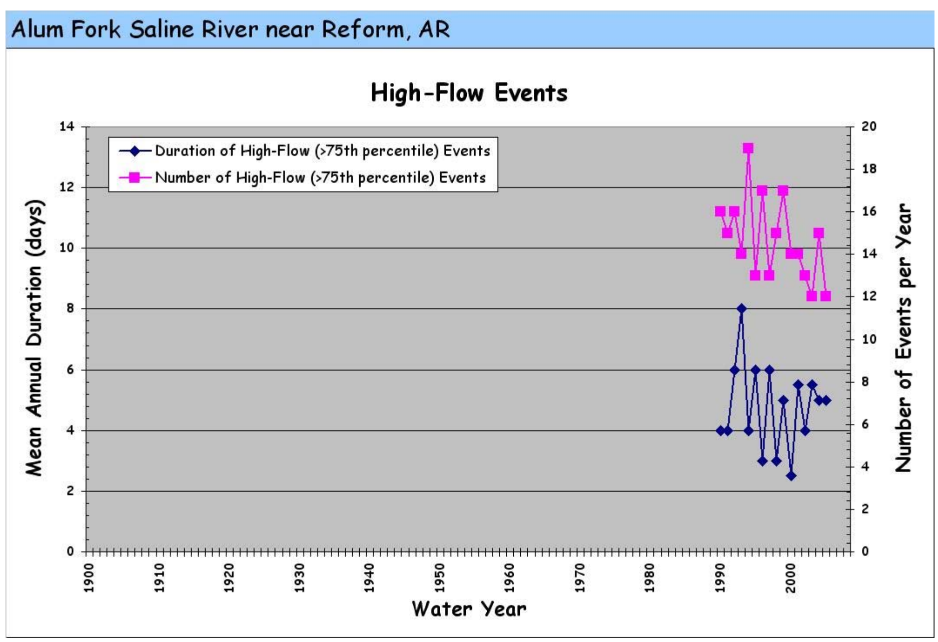

Figure 8. Annual number and duration of high-flow events (flows >25th exceedence interval), for the Alum Fork of the Saline River near Reform AR...

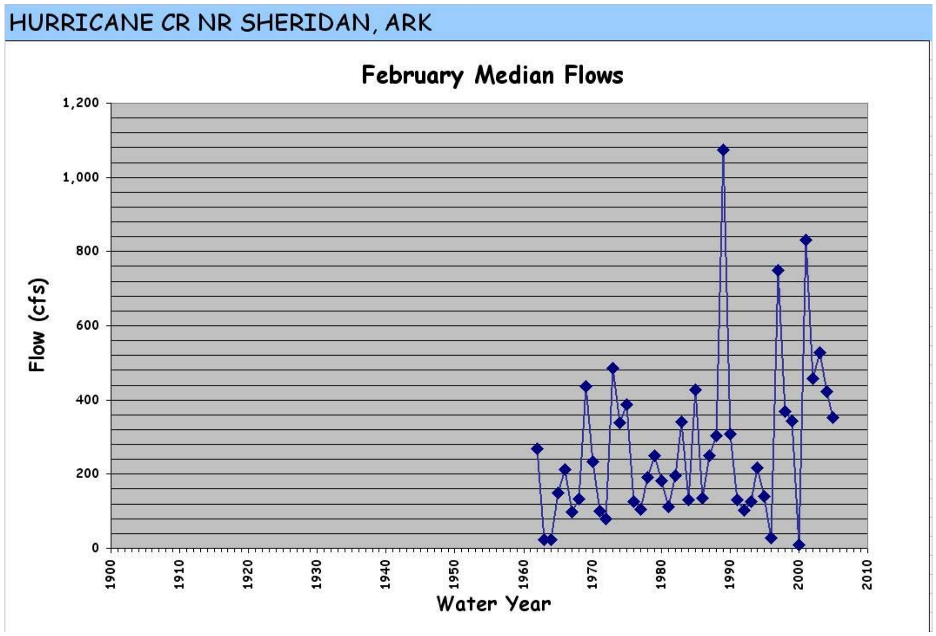

Figure 9.Median monthly flow values for February for Hurricane Creek near Sheridan AR.

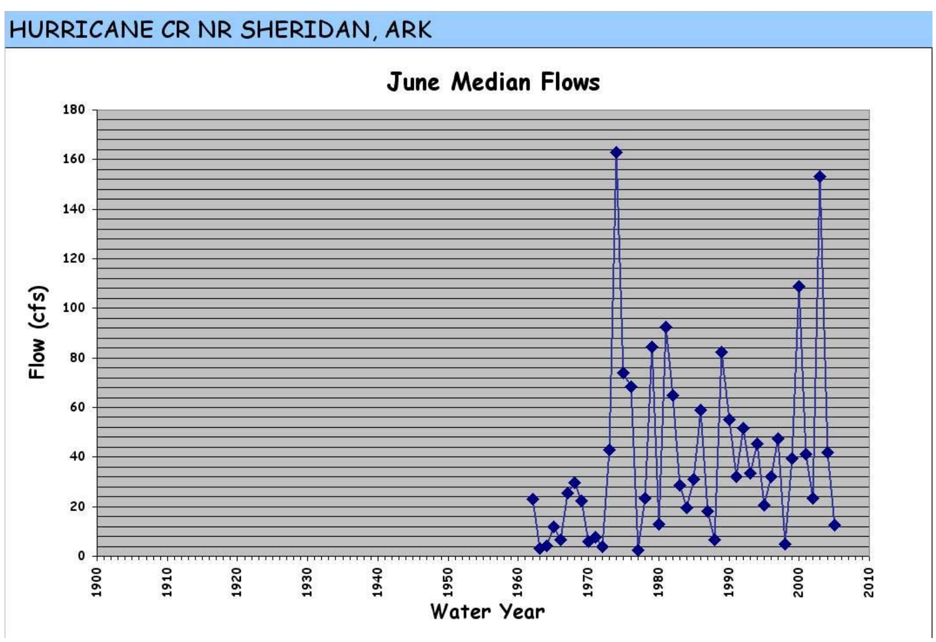

Figure 10. Median monthly flow values for June for Hurricane Creek near Sheridan AR.

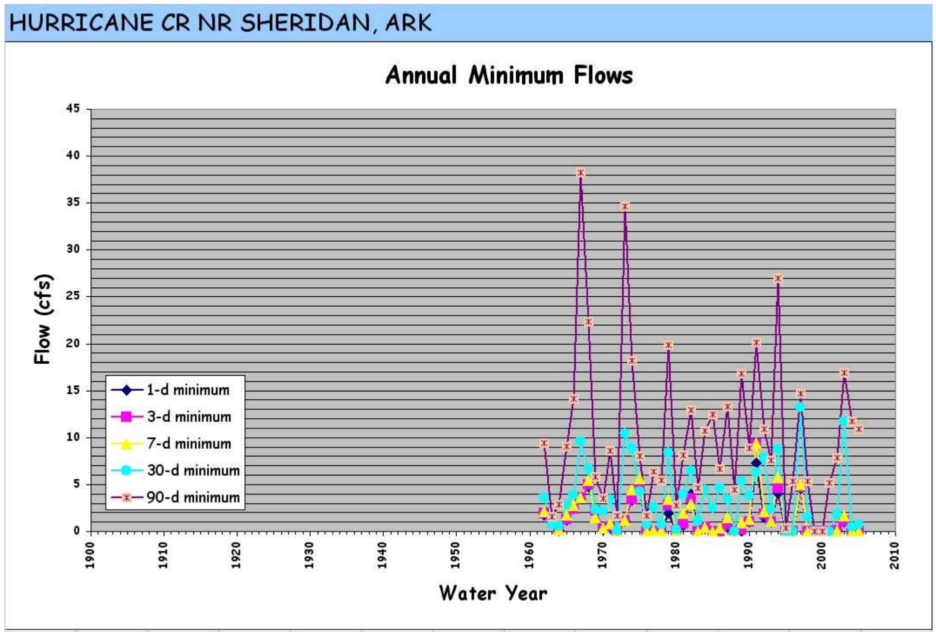

Figure 11. Annual minimum-flow event values for Hurricane Creek near Sheridan AR.

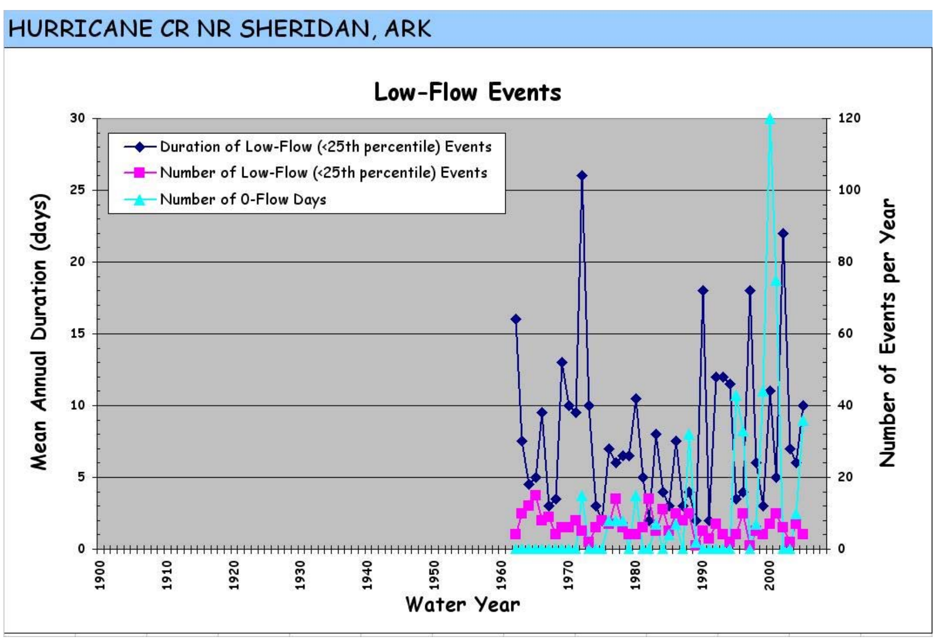

Figure 12. Annual number and duration of low-flow events (flows < 75^{th} exceedence interval), and annual number of zero-flow days for Hurricane Creek near Sheridan AR.

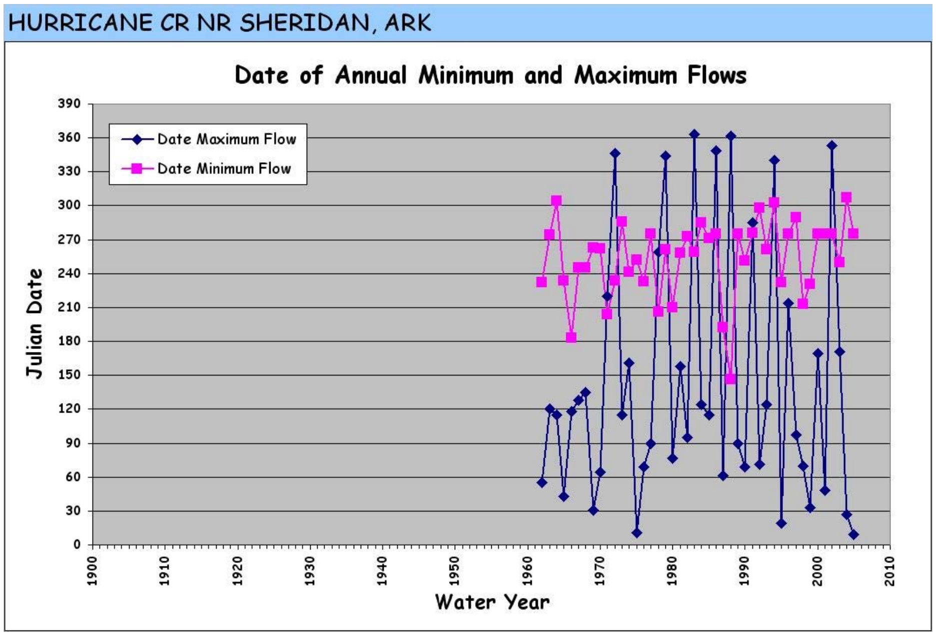

Figure 13. Julian data for the 1-day, annual maximum- and minimum-flow event for Hurricane Creek near Sheridan AR. Note January 1 corresponds to 1 on the graph.

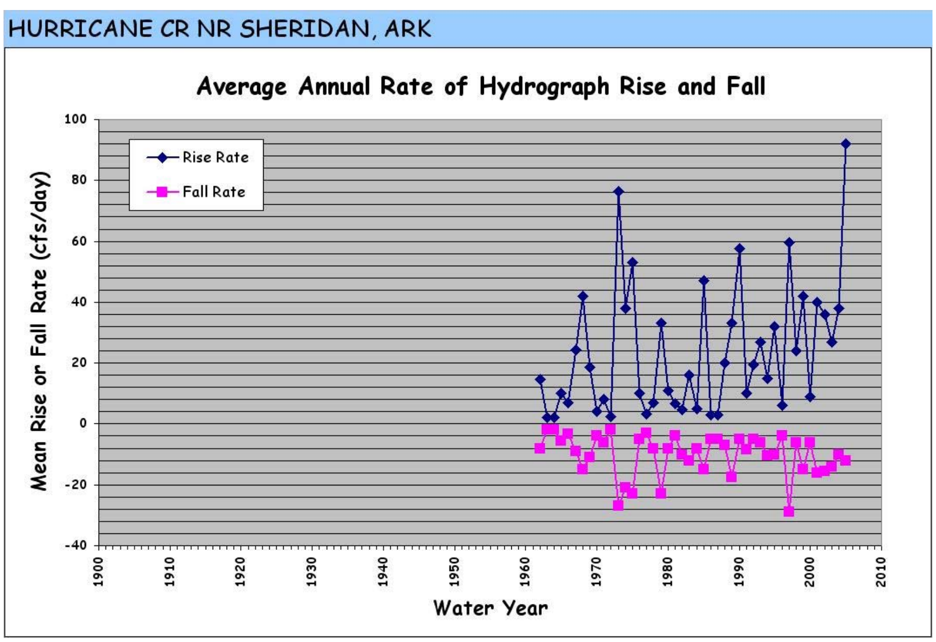

Figure 14. Average annual rate of increase and decrease during rising and falling hydrograph events for Hurricane Creek near Sheridan AR.

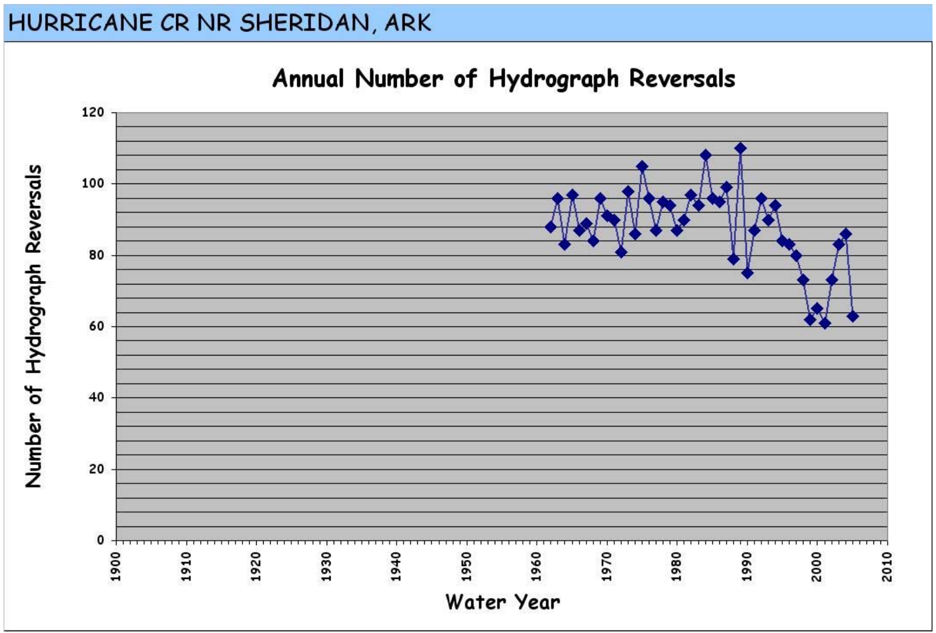

Figure 15. Average annual number of times that the hydrograph changed from rising to falling and vice versa for Hurricane Creek near Sheridan AR.

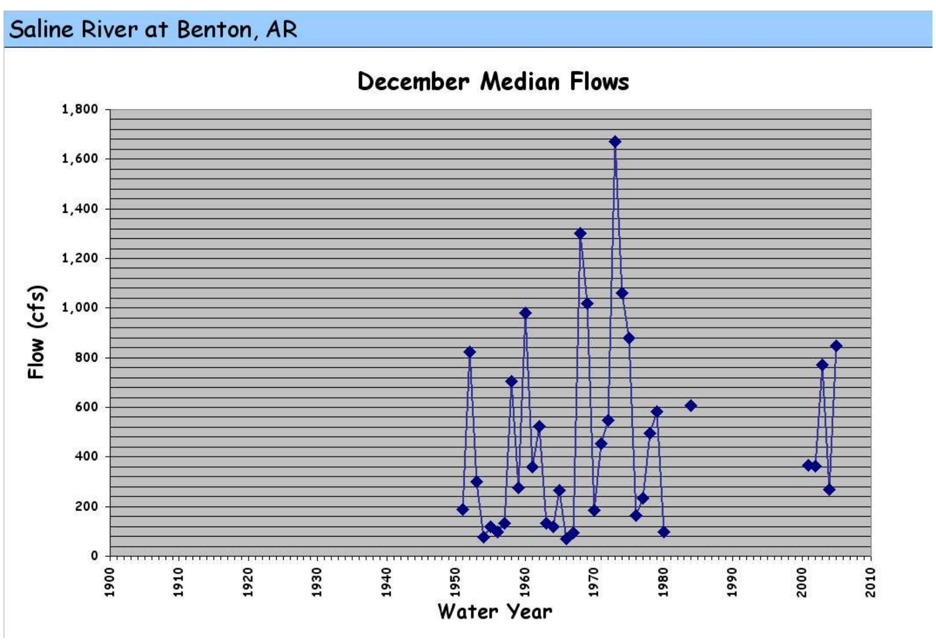

Figure 16. Median monthly flow data for December for the Saline River at Benton AR.

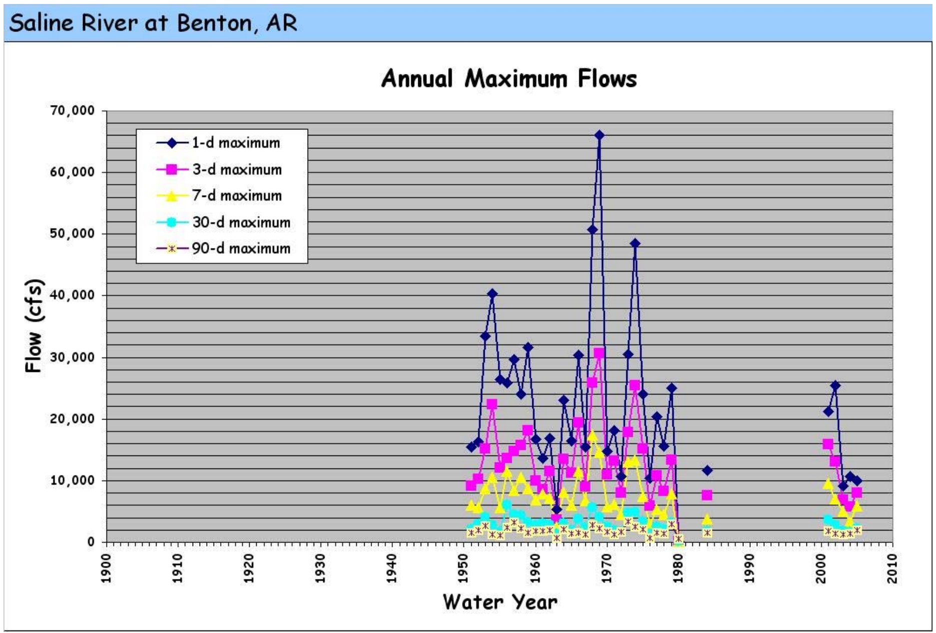

Figure 17. Annual maximum-flow event values for the Saline River at Benton AR.

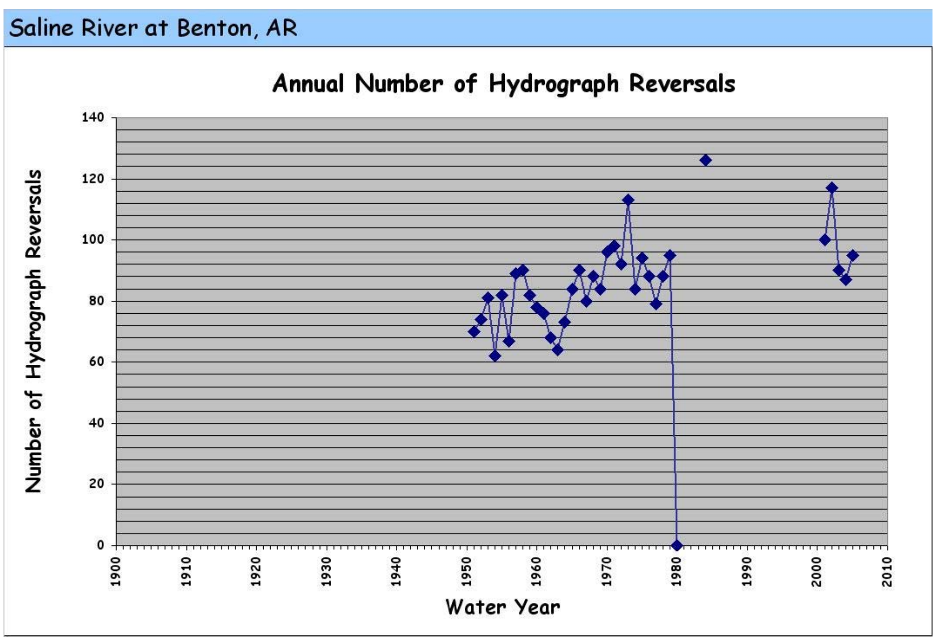

Figure 18. Average annual number of times that the hydrograph changed from rising to falling and vice versa for the Saline River near Benton AR.

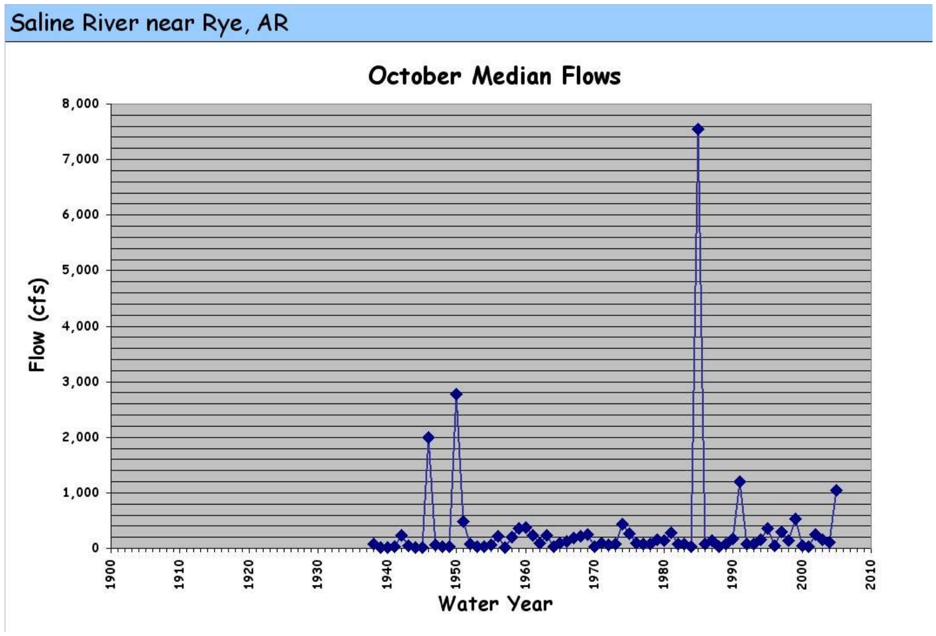

Figure 19. Median monthly flow data for October for the Saline River near Rye AR.

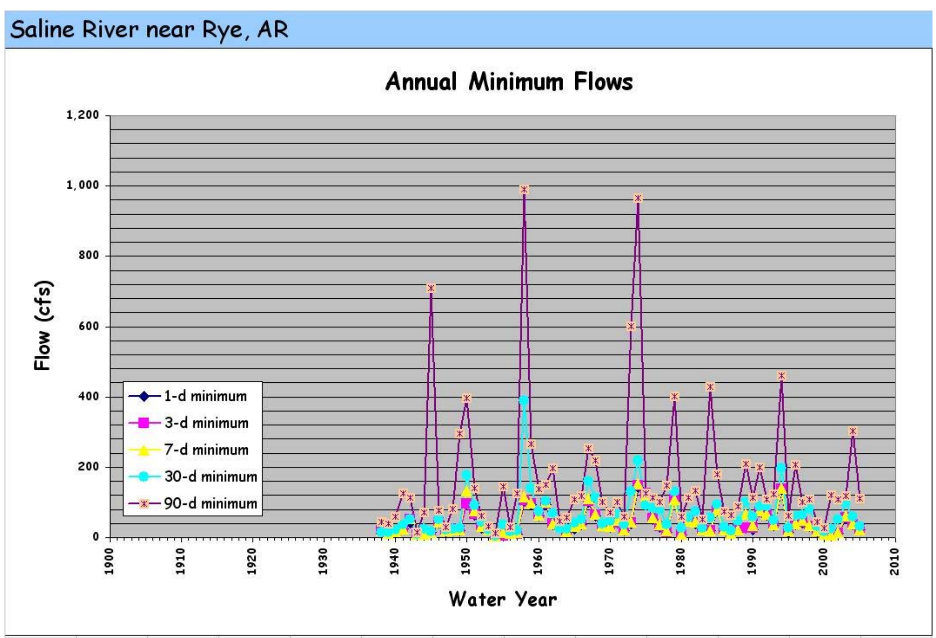

Figure 20. Annual minimum-flow event values for the Saline River near Rye AR.

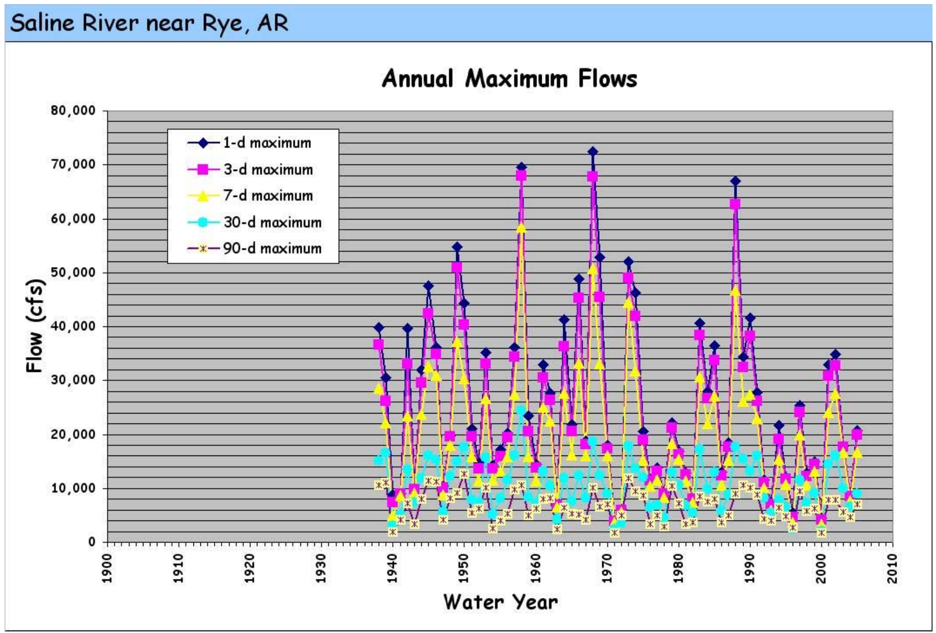

Figure 21. Annual maximum-flow event values for the Saline River near Rye AR.

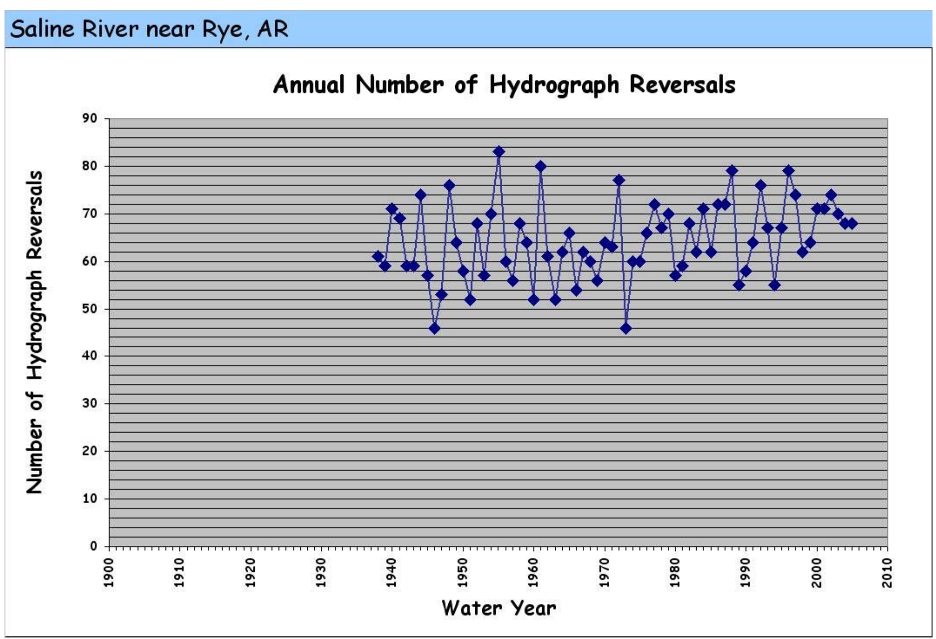

Figure 22. Average annual number of times that the hydrograph changed from rising to falling and vice versa for the Saline River near Rye AR.