North River Watershed Management Plan

2010

Fayette & Tuscaloosa Counties, Alabama

Upper North River Watershed HUC 03160112-090

Lower North River Watershed HUC 03160112-100

Deadwater Creek

Clear Creek

Lake Tuscaloosa

Bays Lake

Carroll Creek

Cedar Creek

This Plan was prepared by

Black Warrior Clean Water Partnership
with assistance from:

Geological Survey of Alabama
U.S. Fish & Wildlife Service
Alabama Department of Environmental Management
City of Berry
City of Tuscaloosa
Fayette County Soil & Water Conservation District
Alabama Forestry Commission
Tuscaloosa Health Department
University of Alabama Natural History Museum
Cawaco Resource Conservation & Development Council, Inc.
USDA/NRCS

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North River Watershed Management Plan

Introduction

The North River Watershed Management Plan (The Plan)is based on the results of existing research and reports by various public agencies, industries, and private interest groups. The goal of this document is to summarize available resources in order to holistically define water-quality issues.

Emphasis is placed on the use of voluntary best management practices (BMPs), environmental education and awareness, and cooperative decision-making processes to attain stated objectives.

Purpose of Plan

<u>Watershed Management</u>

The Plan is a useful watershed management tool designed to identify water-quality problems, issues, and concerns; on-going and future restoration activities, projects, and programs; partners and funding sources; and private sector education and outreach needs. It is also expected to present sensible strategies to protect, maintain, or improve surface water-quality; protect drinking water; manage nonpoint source polluted runoff; benefit human health and quality of life; protect threatened and endangered species, and enhance environmental awareness for citizens who live, visit, or recreate in the North River watershed. The Plan is expected to be implemented as expeditiously as possible as funding is allocated.

The Plan will address many priorities including: watershed-based planning, protection, and restoration; best management practices; education and outreach; technical assistance; and institutionalization of the Alabama NPS Management Program. It is expected to increase local environmental awareness by providing opportunities, inspiration, and motivation for partnering among many and varied public and private sectors. It also supports environmental stewardship through watershed planning and implementation efforts of the Alabama Clean Water Partnership. Improvements in water-quality are expected to be realized as citizen awareness is increased, stakeholders become more engaged in watershed-based decision-making processes, and as the watershed plan is implemented.

<u>Improve Water-quality</u>

It is the goal of this Plan to make recommendations which assist in bringing all water-quality parameters within State water-quality standards for Fish & Wildlife as identified in Chapter 335-6-10 of the Alabama Code. This Plan seeks to implement environmentally protective and economically realistic recommendations where practicable and technologically feasible in order to meet or exceed water-quality standards. BMP types and numbers in this plan are recommendations - but are based on recent studies from credible sources, current land use practices, and watershed activities. Voluntary, incentive-based approaches will be used to implement recommendations throughout the watershed. Providing opportunities for local stakeholder input and participation will continue to be a critical implementation component.

<u>ADEM Nonpoint Source Program</u>

The development and implementation of TMDL/watershed-based plans continues to be a management program priority for the Alabama Department of Environmental Management (ADEM). ADEM, in cooperation with the Alaama Clean Water Partnership (ACWP), encourages stakeholders to develop and implement scientifically-based, technically sound, environmentally protective, and economically achievable TMDL/watershed-based management plans. Program needs and recommendations are included below.

- Enhancing opportunities for stakeholder participation and input into water-quality and watershed management decision-making processes should continue.
- Dedicated and consistent sources of state and local funding are needed to help plan and implement a myriad of nonpoint source TMDL/watershed-based best management practices and activities.
- Additional resources are also needed to support water-quality monitoring and watershed assessments, citizen volunteers, and public/private sector relationships.

- Providing effective education and outreach, training, technical assistance, and technology transfer is essential to garnering and sustaining stakeholder interest about water-quality protection; increasing public awareness about the process, resources, roles, and responsibilities; and implementing practical measures to ensure long-term water-quality/watershed protection benefits.
- Environmental, economic, cultural, social, human and environmental health, threatened and endangered species, habitat protection, urban growth/development, recreation and other NPS issues should continue to be coordinated and holistically integrated into local water-quality/watershed protection management plans.
- Implementation of innovative or alternative/creative NPS management approaches should be encouraged where feasible and practical; and may include, but are not limited to: pollutant trading, permitting using a river basin or watershed approach, local government/local-issue authorities, and land use/protection incentives.

Mobile River Basin Coalition

This Plan complements the Mobile River Basin Coalition efforts to address issues that affect the Mobile River Basin. The purpose of the Coalition is to work together to develop and promote good management of the Basin's rivers and streams. The Coalition assisted the U.S. Fish & Wildlife Service in the development of the *Recovery Plan for the Mobile River Basin Aquatic Ecosystem.* Basin Recovery Plan core principles include:

- Use existing laws and regulations to protect habitat to the fullest extent.
- Encourage stream management strategies that place a high priority on conservation and restoration.
- Encourage voluntary stewardship by giving landowners and communities primary stewardship responsibilities for their watersheds.
- Provide ways for landowners and communities to have major decision-making roles in watershed management.
- Continue research efforts on imperiled species to give stakeholders increased management flexibility.

U.S. Fish & Wildlife Service – *Recovery Plan for the Mobile River Basin Aquatic Ecosystem*.

The U.S. Fish & Wildlife Service, with assistance from the Mobile River Basin Coalition, developed the Recovery Plan, which includes specific recovery criteria for federally listed threatened and endangered species. The objective of the Recovery Plan is to protect Mobile River Basin's native aquatic fauna and flora through aquatic ecosystem management by providing specific recovery objectives.

This Plan assists in the implementation of the Recovery Plan by providing specific recommendations in the North River Watershed to preserve or recover habitat, and their listed populations.

EPA Watershed Management Planning Requirements

This plan was developed to address EPA's nine (9) key elements for watershed management plans. Compliance for these requirements within this document is noted below. These requirements include:

1. (a) An identification of pollutant causes and sources or groups of similar sources that will need to be controlled to achieve load reductions estimated in the watershed based protection plan.
1. (b) Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed.
2. Estimate of load reductions expected for the management measures described.
3. A description of the management methods that will need to be implemented to achieve the load reductions estimated in #2, and an identification of the critical areas in which those measures will be needed to implement the plan.
4. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement the plan.
5. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.
6. A schedule for implementing the NPS management measures identified in the plan that is reasonably expeditious.
7. Description of interim, measurable milestones for determining whether management measures or other control actions are being implemented.
8. A set of criteria that can be used to determine whether pollutant loading reductions are being achieved over time and substantial progress is being made towards attaining water-quality standards and, if not, the criteria for determining whether the watershed management plan needs to be revised.
9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (8).

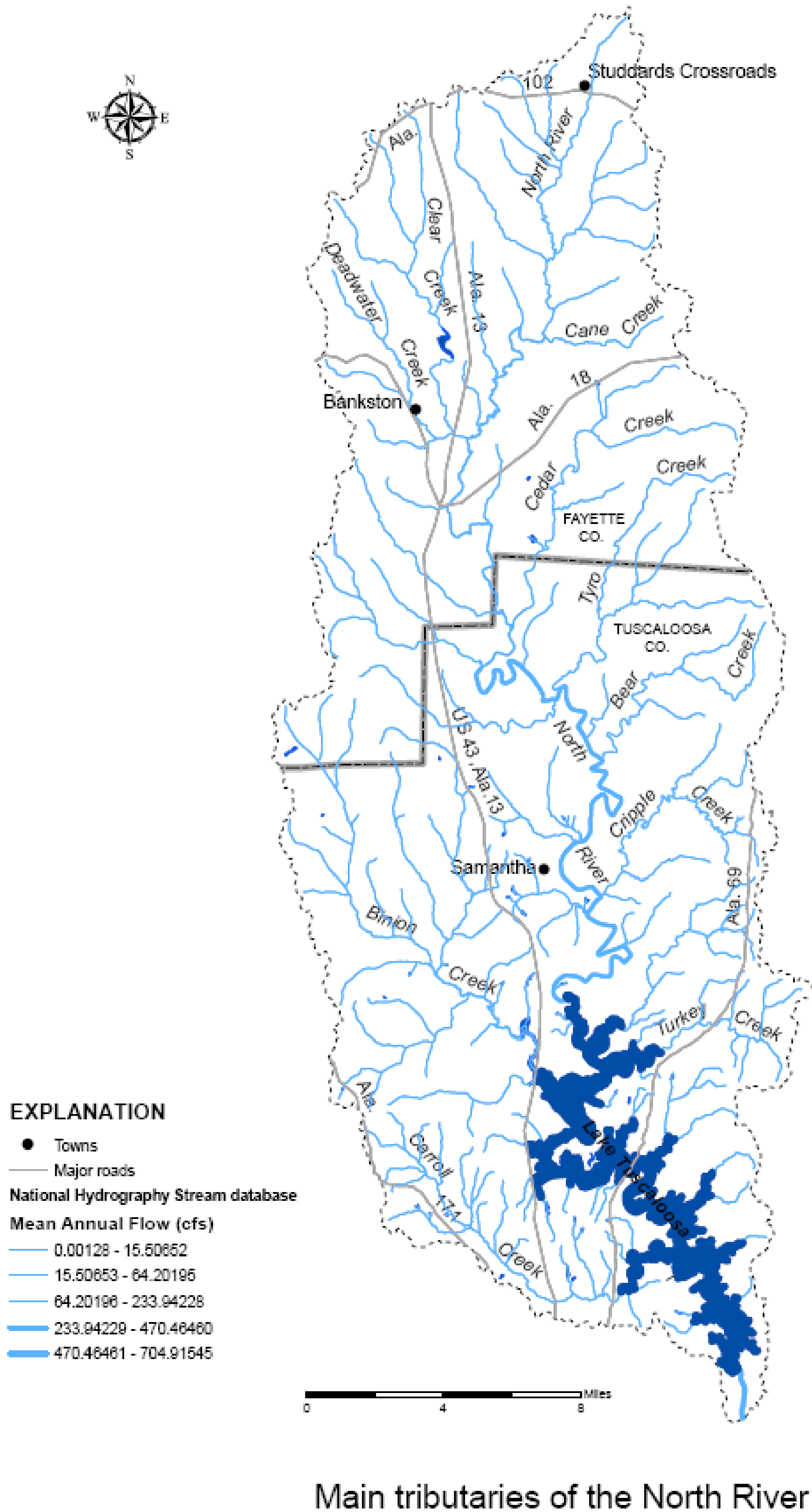


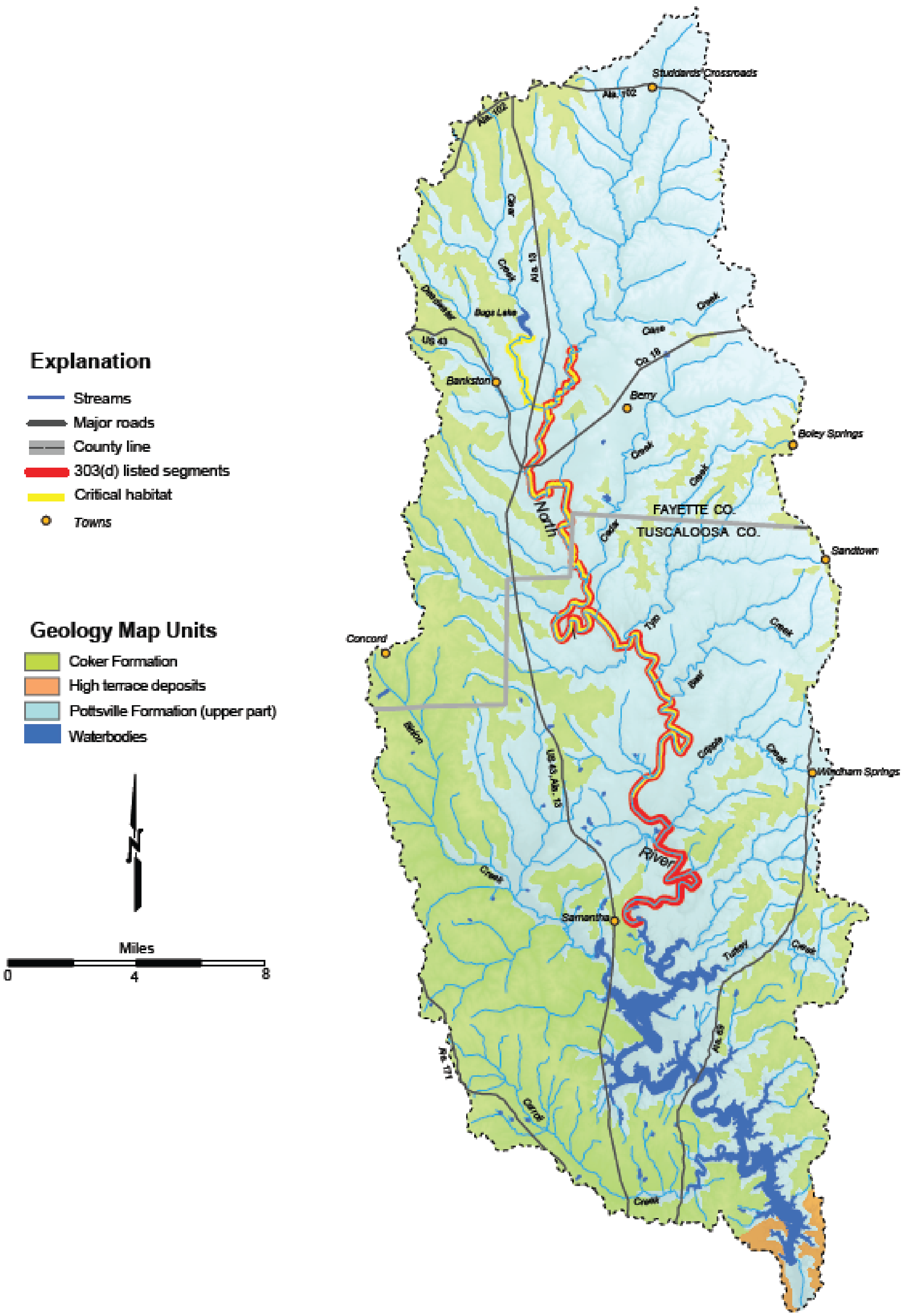
Figure 1 Main Tributaries of North River (GSA)

WATERSHED DESCRIPTION

Location

The North River is a major tributary of the Black Warrior River and drains an area of 428 square miles (274,286 acres) in Fayette, Tuscaloosa, and Walker Counties. The eastern part of the drainage occurs in the Warrior Basin District of the Cumberland Plateau, and the western and southeastern portions drain the Fall Line Hills District of the East Gulf Coastal Plain (Bodiford, 1981). The North River is the first major tributary to the Black Warrior River System north of the physiographic Fall Line near Tuscaloosa. [1]

Figure 2 North River Watershed [2]



Tributaries

Tributaries to the North River Watershed are shown in Table 1 below.

Table 1 North River Main Tributaries

TRIBUTARY NAME	LENGTH (KM)	DRAINAGE AREA (KM^2)
Bear Creek	17.397	42.471
Binion Creek	26.848	185.524
Cane Creek	6.883	20.167
Carroll Creek a/k/a Carrolls Creek	23.656	66.399
Cedar Creek	21.781	59.907
Clear Creek	19.719	93.100
Cripple Creek	16.512	45.124
Deadwater Creek	8.084	16.633
Turkey Creek	14.149	35.846
Tyro Creek	19.050	62.300

Water Use Classification

Alabama Code 335-6-11 *Water Use Classification for Interstate and Intrastate Waters* provides the definition for water-quality criteria, covering all legitimate water uses, provides the tools and means for determining the manner in which waters of the State may be best utilized, provides a guide for determining waste treatment requirements, and provide the basis for standards of quality for State waters and portions thereof. [3]

Water Use Classifications for North River, North River segments and tributaries are defined as follows:

Table 2 Water Use Classification of Stream Segments Within the North River Watershed

Stream	From	To	Classification
North River	Warrior River	City of Tuscaloosa's water supply reservoir dam	Fish & Wildlife
North River	City of Tuscaloosa's water supply reservoir dam	Binion Creek	Public Water Supply and Swimming
North River	Binion Creek	Its source	Fish & Wildlife
Binion Creek	North River	Its source	Fish & Wildlife
Cedar Creek	North River	Its source	Fish & Wildlife
Clear Creek	North River	Bays Lake Dam a/k/a Bugs Lane	Fish & Wildlife
Clear Creek	Bays Lake Dam	Its source	Public Water Supply

States 303(d) List of Impaired Waters

Section 303(d) of the Clean Water Act requires that each state identify those waters that do not currently support designated uses, and to establish a priority ranking of these waters by taking into account the severity of the pollution and the designated uses of such waters. North River has been on the State's impaired list since 1998. It is listed as impaired from Ellis Creek to Lake Tuscaloosa (38 miles) for nutrients, siltation and other habitat alteration from unknown sources. [4] Lake Tuscaloosa has been identified as impaired for mercury due to atmospheric deposition on the draft 2010 list to EPA.

According to the 2008 Integrated Water-quality Monitoring and Assessment Report (305b,) ADEM is scheduled to submit a draft TMDL for North River (AL03160112-0404-102) to EPA in the 4th quarter of fiscal year 2009.

Climate

The climate of the area is influenced by frontal systems moving from the northwest to the southeast, and temperatures change rapidly from warm to cold due to the in-flow of northern air. The average annual temperature is 64°F. The average daily temperature varies from 80°F in July to 47°F in December. Summer temperatures usually reach 90°F or higher about 70 days per year, but temperatures above 100°F are relatively rare. Freezing temperatures are common but are usually of short duration. During the winter extreme lows of 32°F or less occur about 65 times. Snowfall is rare and average only about one inch per year in the northern portion of the basin. (Alabama River Basin Cooperative Study, April 1977)

Average annual rainfall is about 54 inches. The proximity of the Gulf of Mexico is a major reason for plentiful rainfall in the basin. Climatic forces change with seasons but the direction and velocity of the winds do not vary greatly during the year. The more intense rains usually occur during the warmer months. Flood producing storms over the watershed are usually of the frontal type. They generally occur in the winter and spring and last from 2 to 4 days. Occasionally, several wet years or dry years occur in series; however, annual rainfall records indicate no patterns. The greatest probability of a drought occuring is in May and October. (Alabama River Basin Cooperative Study, April 1977) Wind in the basin is normally less than 10 miles per hour.

Predominate Soil Types

Fayette County

Ruston-Cithbert-Shubuta - Moderately deep and deep soils over thick beds of sandy or clayey marine sediments. This soil makes up about 74 % of Fayette County.
Montevallo-Enders-Townley - Shallow to moderately deep soils over shale and sandstone. This soil makes up about 17 % of the county.
Remaining soil-types include: Myatt-Stough-Mantachie (4%), Savannah-Ora (>1%), Ora-Ruston-Greenville (2%), Shubuta-Ora (2%).

Erosion Hazard of these soils:

- Ruston-Slight to Moderate
- Shubuta- Slight to Moderate
- Enders- Slight
- Ora- Slight

Tuscaloosa County

Montevallo-Nauvoo - Shallow and deep, moderately steep, well drained soils that have dominantly loamy subsoil; formed from material weathered from siltstone, sandstone, shale, and interbedded sandstone and shale. This soil makes up 30 % of the county.
Smithdale-Luverne - Deep, sloping to steep, well-drained soils that have loamy or clayey subsoil; formed in marine sediments deposited as stratified sands, silts, and clays. This soil comprises 30 % of the county.
Smithdale-Palmerdale-Pikeville - Deep, rolling to steep well-drained and somewhat excessively drained soils that have loamy subsoil; formed in thick beds of loamy and gravelly marine sediments and mine spoil materials. This soil makes up 16 % of the county.
Bama-Smithdale-Shatta - Deep, nearly level to sloping, well drained and moderately well drained soils that have loamy subsoil; formed in thick beds of loamy marine sediments. This soil comprises 12 % of the county.
Remaining soil-types include: Augusta-Amy (3%), Allen-Bodine-Decatur (2%), Adaton-Ellisville-Dundee (7%).

Erosion Hazards for these soils:

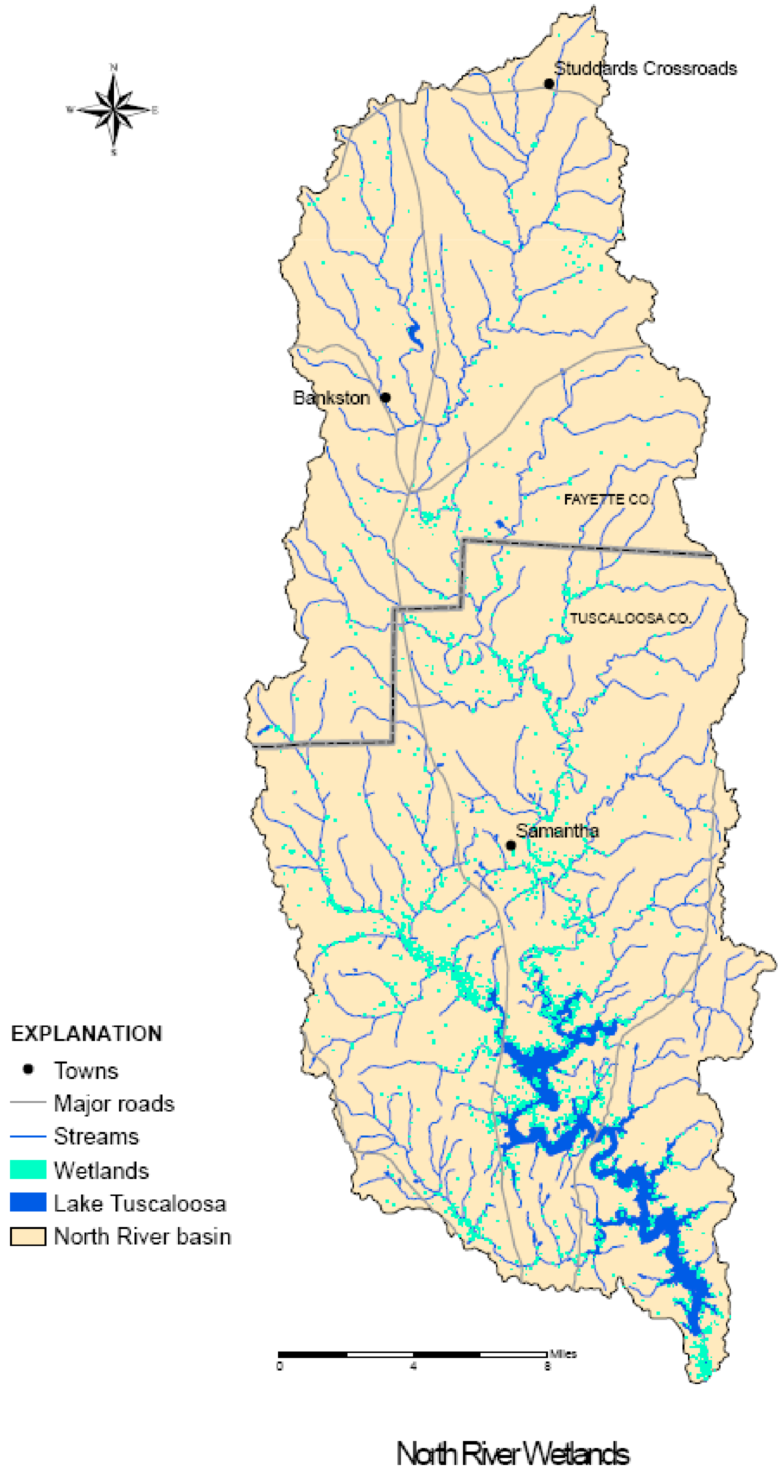
- Luverne- Moderate
- Montevallo-Severe
- Nauvoo-Slight
- Smithdale-Slight
- Palmerdale- Severe
- Pikeville-Moderate
- Bama-Slight
- Shatta-Slight

Wetlands

Wetlands provide several beneficial functions within the watershed including:

- Flood storage
- Pollutant removal
- Groundwater recharge
- Habitat
- Stream bank protection

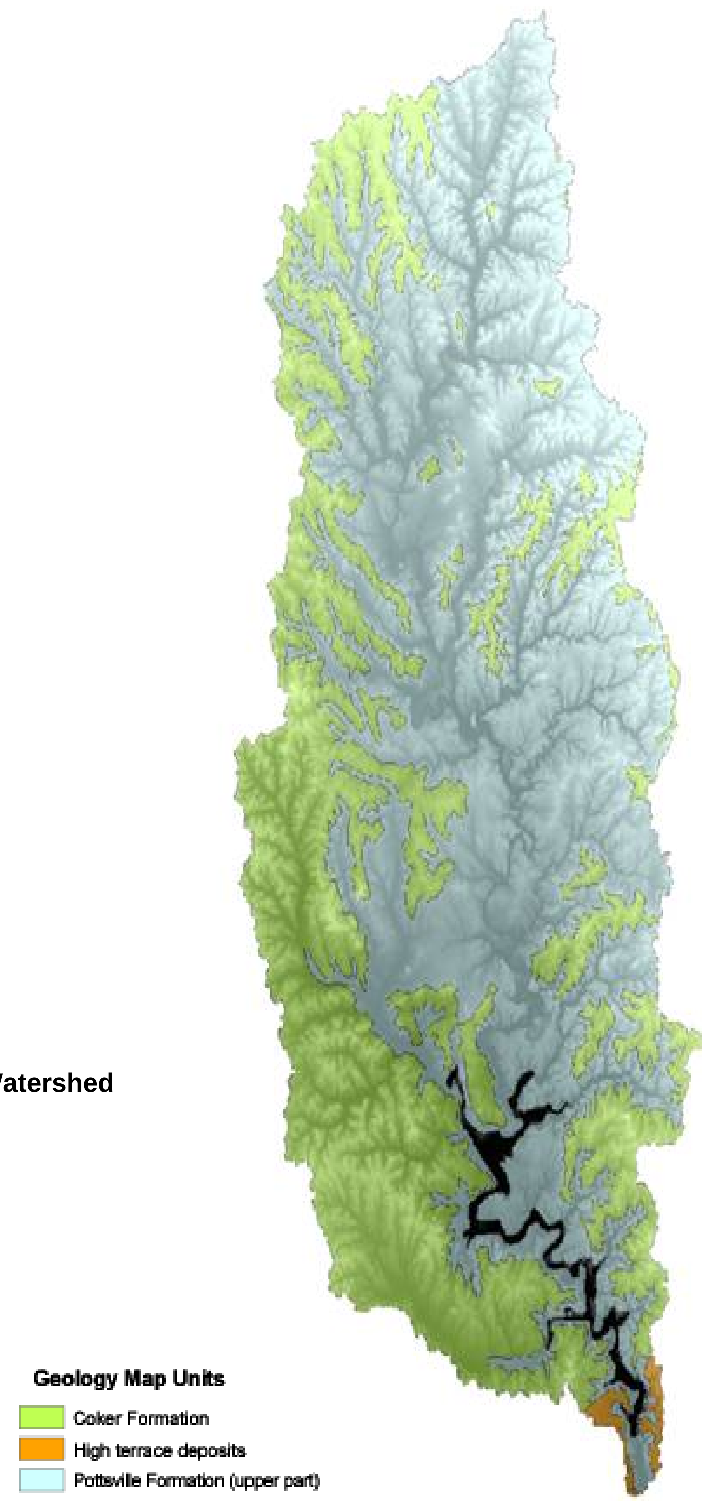
Figure 3 Wetlands Within the North River Watershed [5]



Geology

The North River drainage is underlain by two geologic formations. Rock strata of the Pottsville Formation of Pennsylvania age are exposed along the northeastern part of the watershed. More permeable Coker Formation of Cretaceous age crops out in the western and southern parts of the watershed. Streamflow rates in the upper North River are influenced by these formations, with streams draining sand and gravel deposits of the Coker Formation having well-sustained base flows during even the driest years. Those draining the more impermeable Pottsville Formation experience quick changes in flow from wet to dry seasons and reduced flows during dry seasons, and may be reduced to isolated pools. The eastern part of the drainage occurs in the Warrior Basin District of the Cumberland Plateau, and the western and southeastern portions drain the Fall Line Hills District of the East Gulf Coastal Plain (Bodiford, 1981). The North River joins the Black Warrior River at the Fall Line near Tuscaloosa. [1]

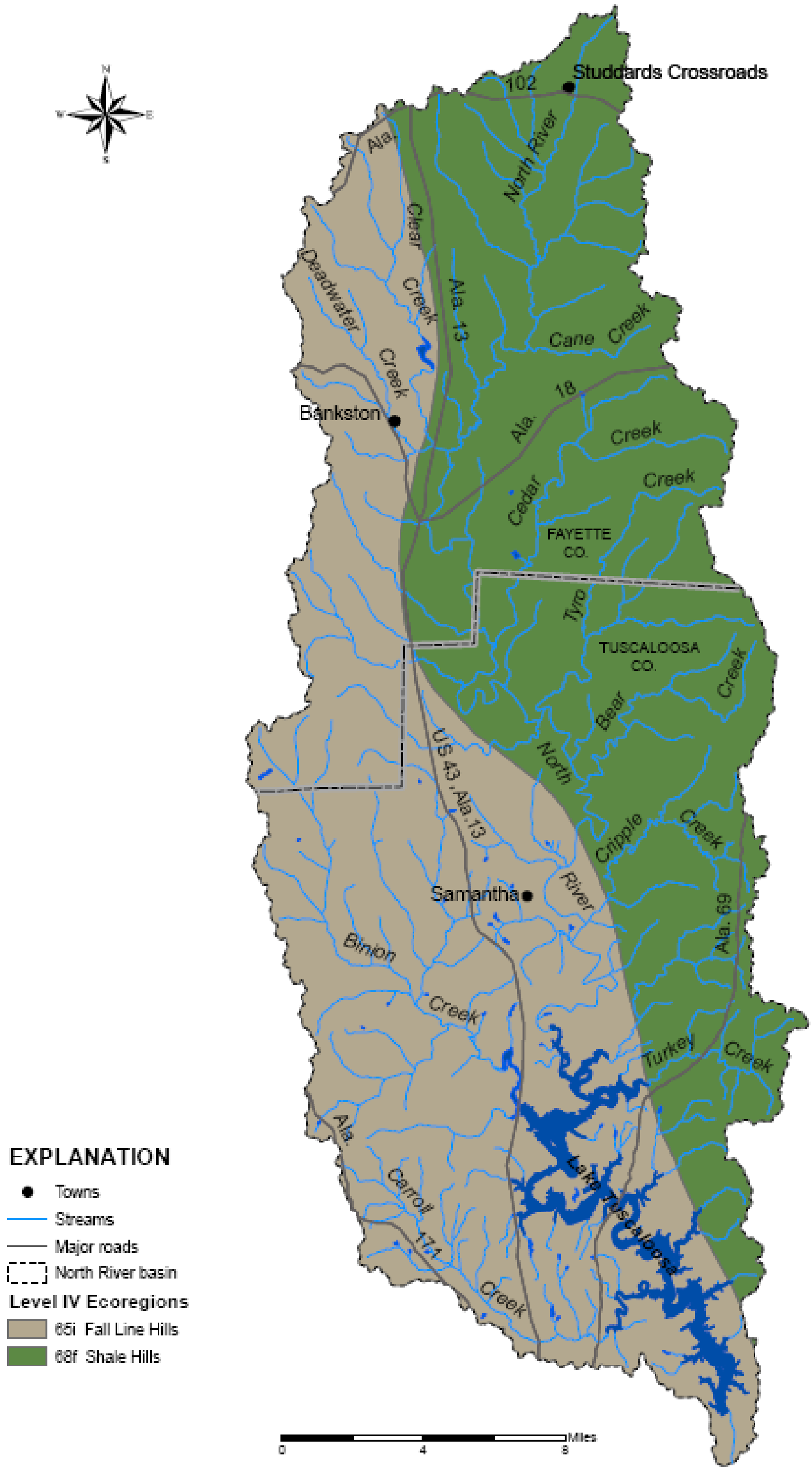
Figure 4 Geology of the North River Watershed



Ecoregion

The North River Watershed is situated within two ecoregions: The Fall Line Hills and Shale Hills. [5]

Figure 5 Ecoregions Within the North River Watershed



North River Ecoregions

Land Use/Land Cover

USDA-NASS Cropland Data Layer (USDA/NRCS 2008) was used to map the distribution of major land cover classes in the North River watershed. Seventy-seven percent of the basin is forested, with 10% of this forested area in pine stands. Ten percent of the watershed is now covered with transitional shrub/scrub and grassland, mainly as the result of past forestry and mining activities. Five percent of the basin is used for agricultural purposes, such as pasture, poultry production, aquaculture, and crop production. Crops growing in the watershed include corn, cotton, soybeans, peanuts, winter wheat, oats, and sod grass. Although the North River watershed has experienced steady population growth around Lake Tuscaloosa since the early 1970s, only 4% of the basin is currently urbanized. [6]

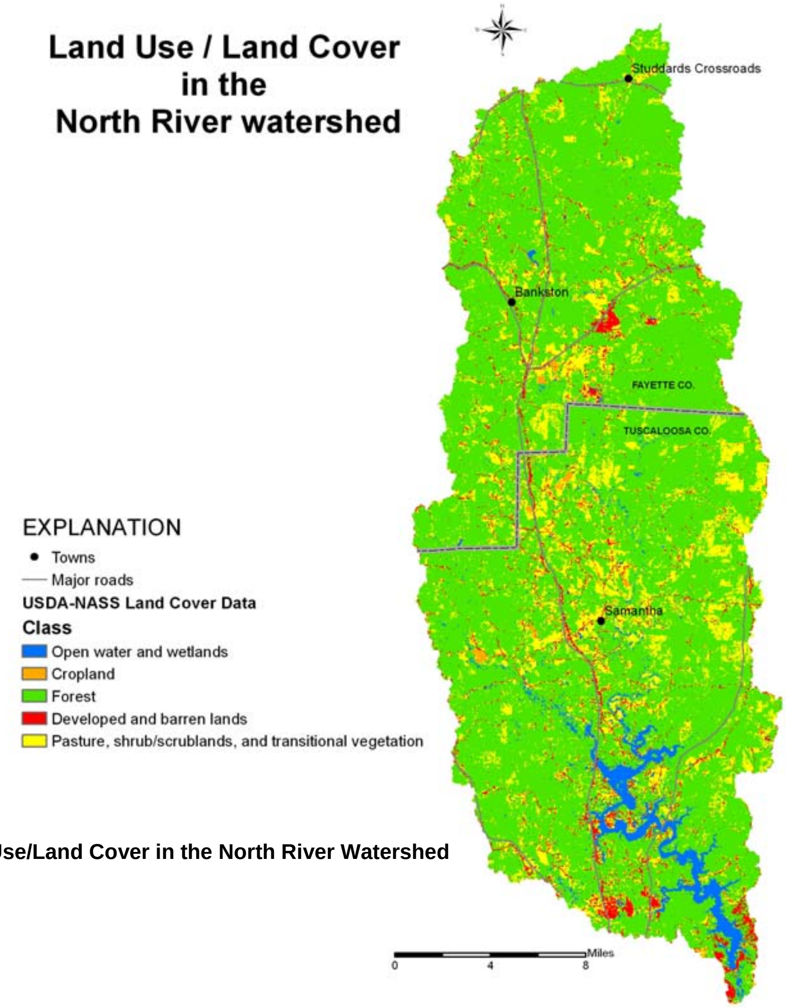


Figure 6 Land Use/Land Cover in the North River Watershed

Demographics

The North part of the watershed in Fayette and Tuscaloosa Counties is sparsely settled with only small towns serving the local population. These towns include: Berry, Bankston, New Lexinigton and Samantha. The majority of the population lies within Tuscaloosa County, which has experienced growth within the last ten years. The major population centers of Tuscaloosa County include the Cities of Tuscaloosa and Northport. There is a large economic disparity between Fayette and Tuscaloosa Counties. In all cases however, the percent of families within the watershed below the poverty level is greater than the percent of overall U.S. families. 2008 U.S. Census statistics are included below:

CITY	POPULATION	PERCENT OF FAMILIES BELOW POVERTY LEVEL
		US 9.2
Fayette County	18,495	13.1
Berry	1,238	31.4
Bankston	Not Listed	
New Lexington	Not Listed	
Samantha	Not Listed	
Tuscaloosa County	164,895	11.3
Northport	19,435	11.6
Tuscaloosa	77,906	14.2

Table 3 2008 Census Data

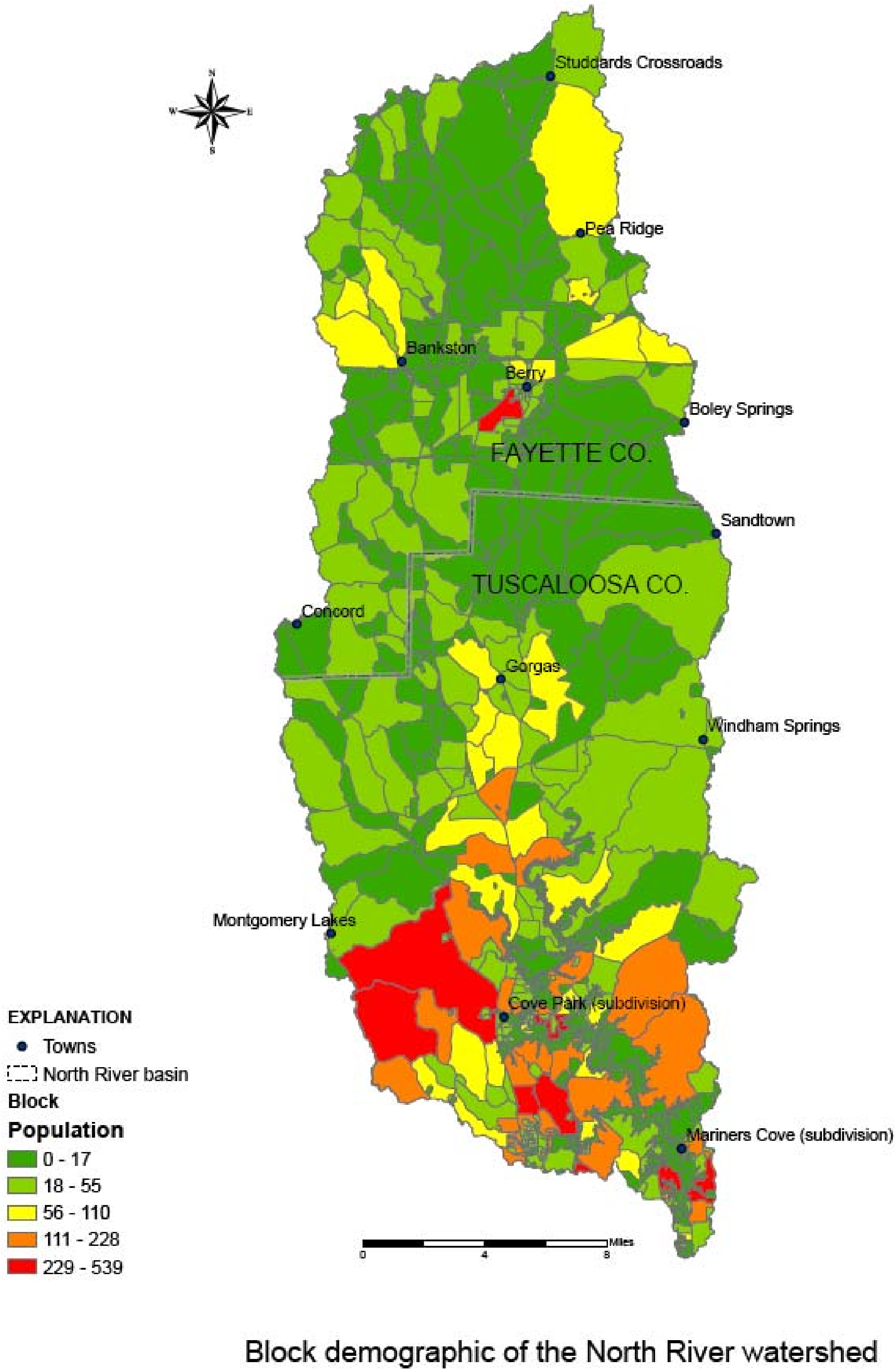


Figure 7 Population Demographics Within the North River Watershed [5]

Water Usage

Public Drinking Water Systems

North River Public Water Supply

Preliminary planning for the development of North River as an additional source of water supply for the City of Tuscaloosa was completed in 1962. Lake Tuscaloosa, a main stream water storage reservoir located in the southernmost portion of the watershed, was completed in 1970. An earthfill dam 130 feet high located about 1.5 miles upstream of the mouth of North River impounds runoff from about 415 square miles of the watershed. At an elevation of 223.2 feet above mean sea level, the reservoir covers about 5,885 acres (approximately 10 square miles). The full reservoir has a shoreline of approximately 177 miles and at some points is 2 miles wide. [7]

During base-flow conditions about 60 % of the total flow into Lake Tuscaloosa is contributed by Binion and Carroll Creeks, which drain only 22 % of the Lake Tuscaloosa basin. Mean inflow to the Lake was 1,150 ft3/s during 1983, a wet year, and 450 ft3/s suring 1985, a relatively dry year. More than 80 % of the total inflow during both years was contributed by North River and Binion, Cripple, and Carroll Creeks. About 59 % was contributed by North River. [8]

Berry Water Works Permit # AL0000596 Surface Water
Fayette County Water Coord & FPA Permit #AL0000594
Fayette Water Works Board Permit #AL0000597
Carroll's Creek Water Authority AL Permit #AL00001540 Population Served: 12,798 Purchases Surface Water
Northport Water Works Permit #AL00001307 Surface Water: Population Served: 33,975
Sand Springs Water Authority (Northport) Permit #AL00001430 Purchases Surface Water: Population Served: 3,120
Tuscaloosa Water Authority Permit #AL0001313 Surface Water: Population Served 165,000

Water and Waste Water Treatment Systems

Treated wastewater NPDES discharge permits have been issued to:

Water Treatment Facility	**Permit #**
Jerry Plott Water Treatment	R16C197
City of Northport	Unknown
Waste Water Treatment Facility	**Permit #**
Berry HCR Lagoon	AL0023922
Berry Lagoon	AL0023922
Berry WWTP	AL0023922
Northside High School	AL0050661

Table 4 Permitted Water and Waste Water Treatment Systems Within the North River Watershed

NPDES Discharges

As of September 2009, there are 122 active NPDES permits within the North River Watershed. The majority of the permits were issued for stormwater runoff relating to construction of residential or commercial properties or road building. The second largest category of permits was issued to natural gas production.

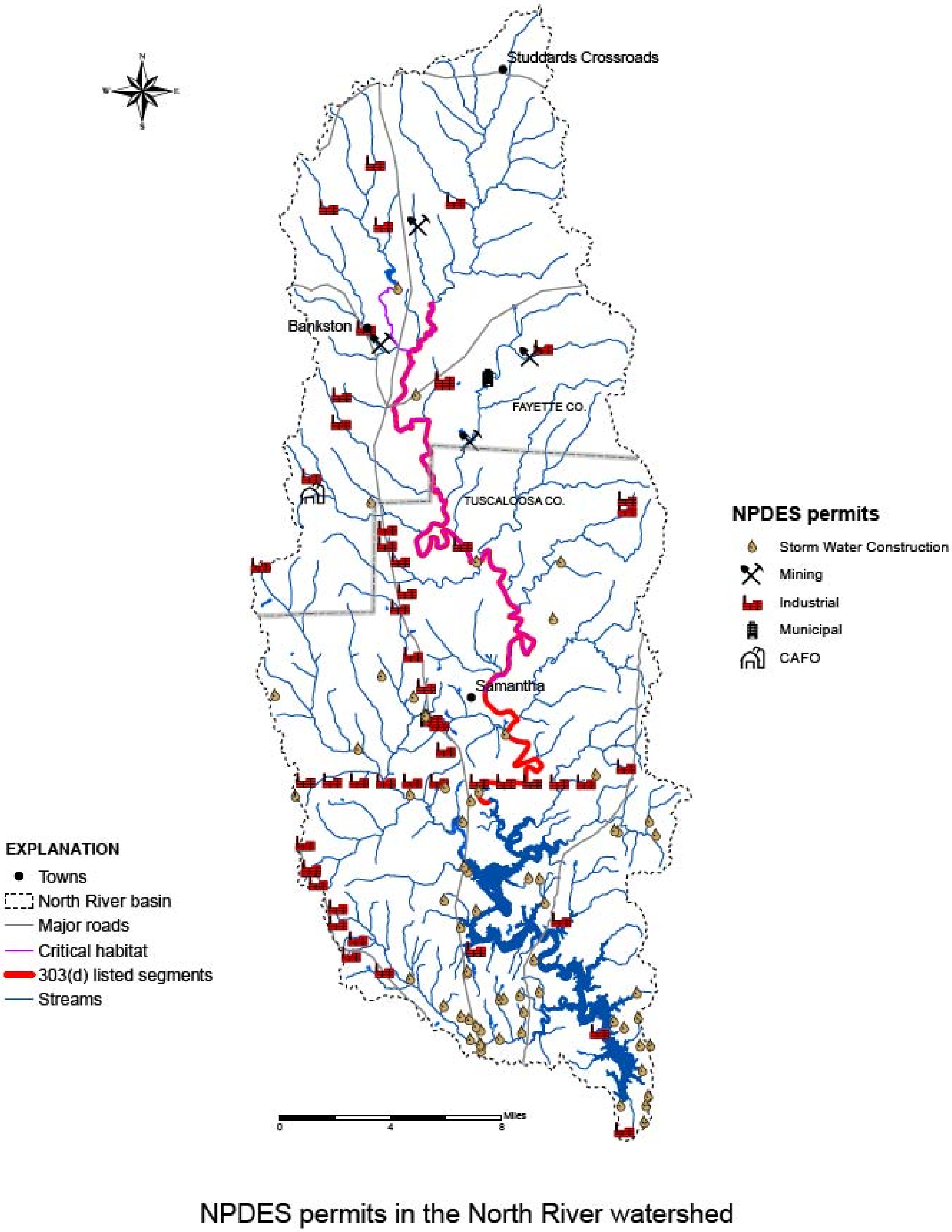


Figure 8 NPDES Permits Within the North River Watershed [5]

Recreational

Bays Lake

Bays Lake, approximately 1.8 miles northeast of Bankston, Fayette County, Alabama is a small recreational (fishing) impoundment on Clear Creek, with a surface area of approximately 80 acres.

Figure 9 Bays Lake, July 2009

Lake Tuscaloosa

Located five miles north of the cities of Tuscaloosa and Northport in west central Alabama, Lake Tuscaloosa is a 5,885-acre water supply reservoir with 177 miles of shoreline. The tailwater area (North River) flows 1.5 miles to the Black Warrior River and is a popular recreational area for many anglers. When the reservoir was impounded by the City of Tuscaloosa in 1971, little material was left behind to serve as fish habitat. Consequently, biologists suspected that the lake would be clear and infertile with relatively low fish production. This has proved to be the case, and water visibilities near the dam often exceed 20 feet. Upper reaches of the lake near Binion and Turkey Creeks are more fertile, have lower water visibilities, and are generally better areas to fish.

Lake Tuscaloosa was constructed to supply domestic and industrial water for the City of Tuscaloosa. However, the Lake has become very popular for various types of recreation including boating, swimming and fishing. There are public and private boat ramps located on the Lake, as well as several private marinas (See below.)

Figure 10 Lake Tuscaloosa (Outdoor Alabama)

The most common sport fish found in Lake Tuscaloosa include: Alabama spotted bass, largemouth bass, bluegill, redear sunfish, and white crappie. Popular non-game fish include blue catfish, channel catfish, freshwater drum, buffalo and carp. Forage species commonly found in the lake include gizzard shad and threadfin shad and various minnows and shiners.

Overall, the status of the fish population in Lake Tuscaloosa remains unchanged from the 1980s. The fishery continues to be forage limited, and growth of important sport fish species such as black bass and crappie range from below average to average. Anglers that fish the lake frequently report low catch rates and the small size of fish. During 2000, bass tournament results ranked Lake Tuscaloosa 11th out of 25 major reservoirs in pounds of bass caught per day. Lake Tuscaloosa was the site of the B.A.S.S. Federation Qualifying Tournament in 2001, which was held out of Binion Creek Access Area.

The Alabama Wildlife and Freshwater Fisheries Division stocked numerous sport fish into Lake Tuscaloosa beginning in 1970, includes largemouth bass, walleye, hybrid striped bass, and saltwater striped bass. The Division stopped stocking both hybrids and striped bass in the mid-1980s after fisheries biologists determined that production and recruitment of forage species was very limited. [9]

PUBLIC USE FACILITIES [10]	**MARINAS**
Sharps Landing	Pump and Dine
Rock Quarry Landing and Recreational Area	Bob's Marina & Campground
43 Landing (Binion Creek)	North River Yacht Club
Picnic Island (a/k/a Carroll's Creek Island)	Blue Herron Marina
Treasure Island	Smiths Marina Dry Dock

Table 5 Public Use Facilities Within the North River Watershed

REFERENCES

[1] Recent Freshwater Mussel (Bivalvia: Unionacea) Records From the North River System, Fayette and Tuscaloosa Counties, Alabama McGregor, Stuart W. and Pierson, J. Malcolm.. Geological Survey of Alabama. Reprint Series 115. Tuscaloosa, Alabama. 2001. Reprinted from Journal of the Alabama Academy of Science. V. 70, no. 4, October 1999, p.153-162.

[2] MAP: Watershed Assessment of the North River System for Recovery and Restoration of Rare Mussel Species. O'Neil, Patrick E., McGregor, Stuart W., Wynn, Elizabeth A. 2009. Geological Survey of Alabama Open File Report, p. 88.

[3] Alabama Department of Environmental Management, Water Division-Water-quality Program. Chapter 335-6-10.02

[4] 2008 Integrated Water-quality Monitoring and Assessment Report. ADEM. April 1, 2008.

[5] MAP: Geological Survey of Alabama. 2009.

[6] MAP: USDA/NRCS - National Cartography & Geospatial Center, 2008. USDA-NASS Cropland Data Layer, http://www.nass.usda.gov/research/Cropland/SARS1a.htm, acquired online November 15, 2009.

[7] Fish Species Diversity, Occurrence and Abundance in the North River Drainage System of Alabama. Jandebeur, Thomas Schroeder. A Dissertation submitted in partial fulfillment of the requirements of Doctor of Philosophy in the Department of Biology in the Graduate School of the University of Alabama. 1975.

[8] Water-quality of Lake Tuscaloosa and Streamflow and Water-quality of Selected Tributaries to Lake Tuscaloosa, Alabama, 1982-86. U.S. Geological Survey. Water-Resource Investigations Report 87-4002. 1987.

[9] www.outdooralabama.com/fishing/freshwater/where/reservoirs/tuscaloosa/. Outdoor Alabama. Alabama Department of Conservation and Natural Resources. Accessed January 25, 2010.

[10] http://laketuscaloosa.com/ Accessed January 25, 2010.

ENVIRONMENTAL IMPORTANCE

The southeast has a high number of rare aquatic species, many of which receive federal protection under the Endangered Species Act and state protection under conservation regulations. Several of these species are very restricted in distribution, have small disjunct populations, and are threatened by pollution and habitat degradation. [1]

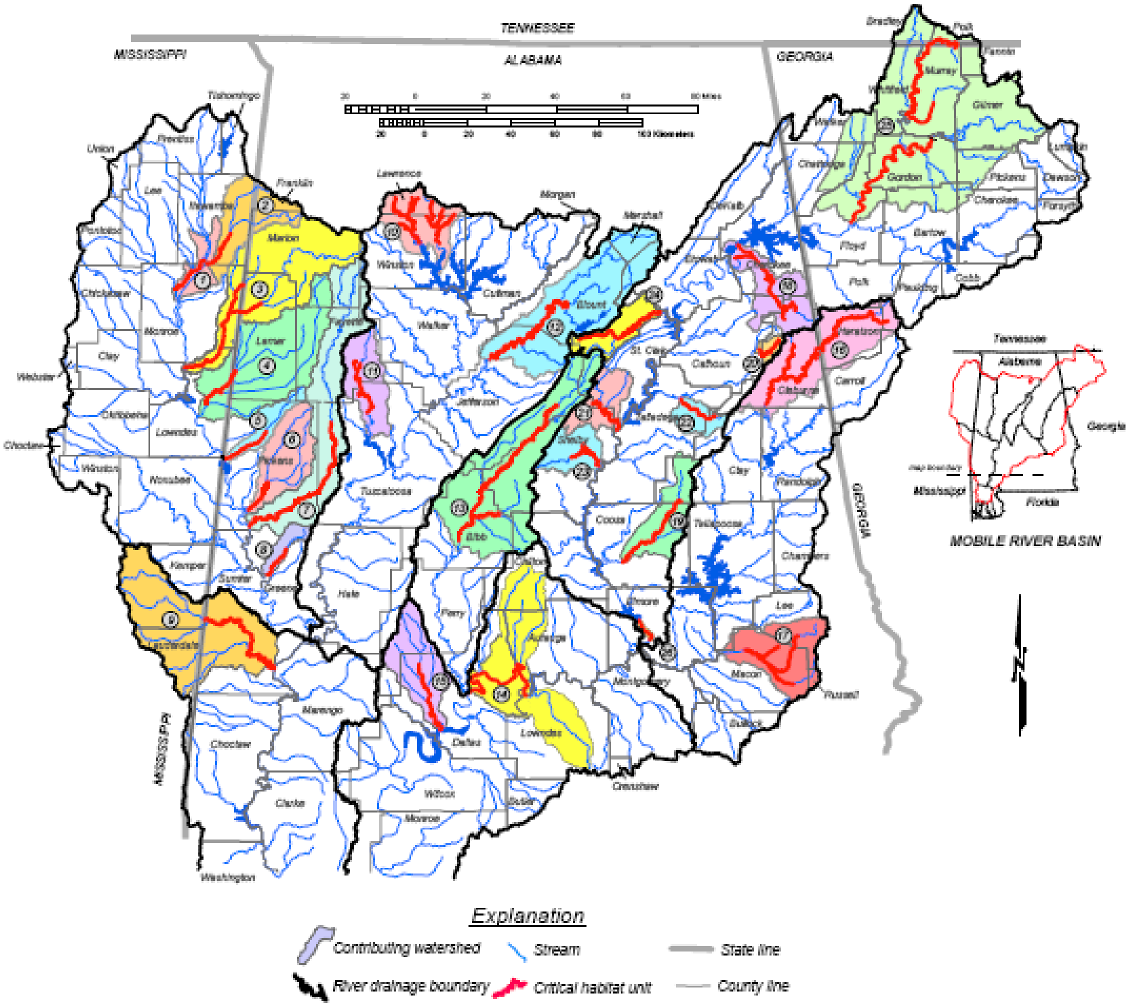
The North River watershed in west-central Alabama is within the Mobile River Basin and is an important resource for water supply and for the conservation of rare mussels in Alabama. Currently, 17 species of mussels in the Mobile River Basin are recognized as endangered or threatened by the U.S. Fish and Wildlife Service (USFWS) and 14 species in the genus *Pleurobema*, endemic to the Mobile River Basin, are considered extinct by the USFWS (Hartfield, 1994). The type locality for one of these extinct species, *Pleurobema hagler*i (= *P. furvum*) was reported to exist prior to 1920. The mussel population inhabiting North River has declined over the past 20 years to where it now only occurs as remnant populations in the upper reaches. [1]

Critical Habitat

The U.S. Fish & Wildlife Service has designated 26 river and stream segments (units) in the Mobile River Basin (69 FR 40084) as critical habitat for three threatened and eight endangered freshwater mussel species under the Endangered Species Act of 1973, as amended. The habitat units encompass approximately 1,093 miles (1,760 kilometers) of stream and river channels in four states and have been mapped and their watersheds designated as Strategic Habitat Units (SHU) for aquatic species conservation. [2]

Elements of critical habitat restoration include [3]:

- Watershed characterization and assessment
- Hydrogeologic and physiographic setting
- Biological monitoring data reflecting current condition of biological communities —watershed biological profiles
- Habitat assessment information to determine the extent of habitat degradation and availability of habitat for species of conservation concern
- Water-quality data to determine contaminant concentrations and to calculate parameter loadings
- Sediment loading data to determine the relative degree of sediment flux through a watershed
- GIS management of all data
- Identification of major watershed issues affecting listed species
- Development of an action plan and projects to address watershed issues
- Reintroduction and/or augmentation of populations as needed



1-East Fork Tombigbee River; 2-Bull Mountain Creek; 3-Buttahatchee River and Sipsey Creek
4-Luxapalila and Yellow Creeks; 5-Coalfire Creek; 6-Lubbub Creek; 7-Sipsey River; 8-Trussels Creek;
9-Sucarnoochee River; 10-Sipsey Fork and tributaries; 11-North River and Clear Creek;
12-Locust Fork and Little Warrior River; 13-Cahaba and Little Cahaba Rivers; 14-Alabama River;
15-Bogue Chitto Creek; 16-Tallapoosa River and Cane Creek; 17-Uphapee, Choctafaula, and Chewacla Creeks;
18-Coosa River and Terrapin Creek; 19-Hatchet Creek; 20-Shoal Creek;
21-Kelly and Shoal Creek; 22-Cheaha Creek; 23-Yellowleaf Creek and Muddy Prong;
24-Big Canoe Creek; 25-Oostanaula, Coosawattee, and Conasauga Rivers and Floyd Creek; 26-Lower Coosa River

Figure 11 Strategic Habitat Units Within the Mobile River Basin

The U.S. Fish & Wildlife Critical Habitat initiative furthers the goals of the *Mobile River Basin Aquatic Ecosystem Recovery Plan* (Plan). The Plan was prepared by the Service's Jackson, Mississippi Field Office, and released for public review in September 1994. It was developed to address the immediate recovery objectives of 22 aquatic species endemic to the Mobile River Basin, including the Black Warrior River sub-basin. The Plan acknowledges that irreversible changes to extensive portions of the Basin have occurred to meet human needs, and these changes have resulted in natural resource losses. It emphasizes the uniqueness and value of the Basin's imperiled native species and the aquatic and riparian habitats on which they depend. The Plan identifies the threats currently affecting these habitats and their biota. It also recognizes that humans and their activities are integral components of the ecosystem, and that recovery strategies and actions must allow for sustainable economic growth and other human needs. [4]

The objective of a recovery plan is to prevent the extinction of those species listed as endangered, and arresting the continued decline of those species listed as threatened. Specific objectives include [3]:

1. Protection of surviving mussel populations and their stream and river habitats
2. Enhancement and restoration of habitats
3. Population management including augmentation and reintroduction into portions of their historic ranges

Mussel Species [5]

During the spring and summer of 2008, mussel sampling in the North River system yielded 15 species, with 13 represented by live animals or fresh dead shells and two represented by weathered dead shells only. Two mussel collections made in the system during an unrelated study in April 2005 were also included.

The most abundant species collected during that project either live or fresh dead were *Elliptio arctata* (34 individuals), *Strophitus subvexus* (22 individuals), *Lampsilis straminea* (20 individuals), and *Villosa lienosa* (14 individuals). The most widespread were *S. subvexus* (9 stations), *V. lienosa* (7 stations), and *L. straminea* and *Quadrula asperata* (5 stations each). During the previous study (McGregor and Pierson, 1999) dominant mussels collected were *S. subvexus* (60 individuals), *Quadrula asperata* (37 individuals), *L. straminea* (27 individuals), *Pleurobema furvum* (26 individuals), and *Villosa vibex* (21 individuals). The most widespread were *S. subvexus* (23 stations), *Villosa vibex* (14 stations) and *L. straminea* (13 stations).

One federally listed endangered and one threatened species, *Pleurobema furvum* and *Hamiota perovalis*, respectively, were collected live during sampling in the North River system from 1991 to 1996, and *P. furvum* was the fourth most abundant species among 14 species reported. However, only one live and one fresh dead specimen of *P. furvum* were found during the latter study (at one station in Clear Creek), suggesting a sharp decline in abundance. Similarly, *H. perovalis* was found at five stations in the earlier study (13 live or fresh dead) but at only three stations (two in Clear Creek and one in main channel North River) during the latter study (3 live or fresh dead). *Ptychobranchus greenii*, another federally listed endangered species, which was reported by van der Schalie (1981) to occur in the drainage prior to 1920, was not collected in either study, nor was *Pleurobema hagleri*, another species known from the drainage prior to 1920, which has not been reported in the scientific literature, technical reports, or museum collections in over 30 years, and is considered extinct by the USFWS (Hartfield, 1994).

During the previous study the most diverse and abundant mussel populations was at the North River at the mouth of Cedar Creek, where 39 individuals among 8 species were collected. During the project only one weathered dead shell was found there. A station in the North River just upstream of Cedar Creek and another in the lower reach of Cedar Creek were the next most diverse locations, each with 7 species. No species were found during the project in Cedar Creek. During the latter project numerous *Elliptio arctata* were found in a unique niche preferred by that species, under large slab rocks, many of which were flipped over (19 were found under one rock).

Two species collected during the latter project were not reported by McGregor and Pierson (1999)—*Anodontoides radiatus* and *Uniomerus tetralasmus*—and one species reported during the earlier study, *Elliptio arca*, was not collected during the latter study.

This collection represents a new tributary record for the species. *Elliptio arca* strongly resembles *Elliptio arctata.* Only one fresh dead and two weathered dead shells of *E. arca* were reported by McGregor and Pierson (1999) and may have been misidentified. However, *E. arca* has been documented from the North River system (Williams and others, 2008) and their limited presence in the previous study and absence during this study may document a decline within the system.

A variety of human activities in the North River drainage have contributed to siltation of the main channel and tributaries. The substrate in pools and in some riffle areas was often dominated by a dense layer of coarse sand covered with a fine layer of silt. Live mussels were usually found in areas of slow to moderate current in relatively silt-free sand or gravel substrate.

Fish Species

Fish Species Diversity, Occurrence and Abundance in the North River Drainage System of Alabama 1975 [6]

A preimpoundment of survey of North River revealed the presence of 76 fish species in 16 families and 36 genera. A postimpoundment study in June, 1974 revealed the presence of 58 fish species [in 14 families and 29 genera] including *Cyprinius carpio, Carpiodes velifer, Pomoxis annularis* and *Ictalurus melas*, not represented in preimpoundment collections,. A combined total of 171 collections (91 preimpoundment and 80 postimpoundment) revealed the presence of 80 fish species in 16 families and 37 genera.

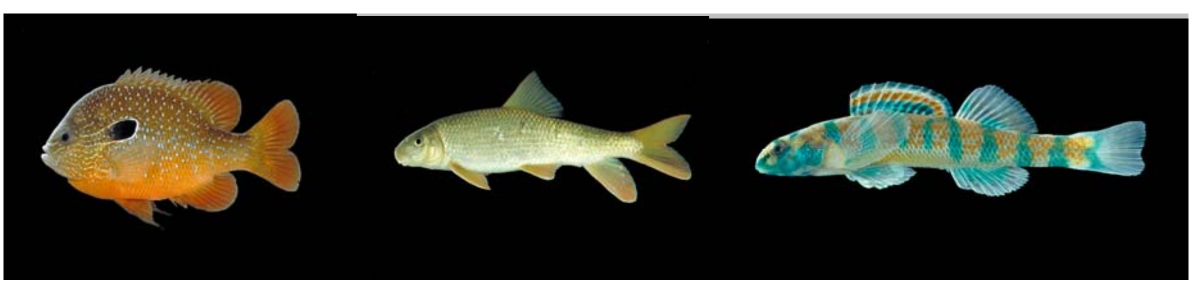
Of the fish species known to occur in North River, six are endemic to the Mobile River basin: *Notropis asperifrons, Cyprinella callistia, Cyprinella venusta, Hypentelium etowanum, Ammocrypta meridiana*, and *Etheostoma rupestre*. Range extensions are reported for six species previously unknown from above the Fall Line in the Black Warrior River system: *Strongylura marina, Notropis texanus, Erimyzon tenuis, Ammocrypta beani, Ammocrypta meridiana* and *Etheostoma swaini*. Records for *Lepisosteus oculatus, Anguilla rostrata, Opsopoeodus emiliae, Labidesthes sicculus, Etheostoma nigrum, Etheostoma parvipinne, Etheostoma proeliare* and *Percina maculata* were added to only a few known records for these species above the Fall Line in the Black Warrior River System.

Percent relative abundance by stream order and/or elevation was calculated for each species encountered during postimpoundment study. This statistic has considerable utility in analyzing distributions and abundance of fish species and in determining a species vulnerability to environmental alteration and/or deterioration. Alteration of headwater stream habitats (1st and 2nd order streams) would adversely affect the distribution and abundance of *Semotilus atromaculatus, Campostoma anomalum, Erimyzon oblongus, Lepomis cyanellus, Etheostoma swaini* and *Etheostoma artesiae*. Environmental and/or pollutional stress imparted to larger North River tributaries would undoubtedly affect the following species: *Hybopsis amblops, Cyprinella callistia, Notropis stilbius, Notropis texanus, Cyprinella venusta, Noturus gyrinus, Nourus leptacanthus, Etheostoma rupestre, Etheostoma stigmaeum,* and *Percina nigrofasciata*. *Hypentelium etowanum, Ambloplites rupestris, Ammocryptaa beani* and *Ammocrypta meridiana* may also be included in this list as they have apparently been extirpated from North River by the Lake Tuscaloosa impoundment.

Biological Monitoring in Three Tributaries to Lake Tuscaloosa, Tuscaloosa County, Alabama. 1988 [7)

Since 1980, increased coal mining has caused progressive changes in water-quality of Lake Tuscaloosa and several of its major tributaries. While these changes pose no immediate threat to drinking water supplies, they could eventually affect biotic productivity of these streams. This report includes baseline biological data which can be used to assess and manage future impacts of mining and other resource development of the aquatic resources of the area.

“It is difficult to determine the extent to which mining has adversely affected biological communities at the sampling stations and in other North River tributaries because very little pre-mining data exist. However, comparisons of current data with limited previously collected data indicate that invertebrate faunal richness has declined sharply in Turkey Creek since 1983 and some invertebrate families may have been eliminated. Fish species richness has remained relatively stable in Turkey Creek since 1979-80 and in North River since 1973-74; however, abundance has declined by greater than 60 % at both stations. Similar community trends resulting from mining activities were documented …. in Tyro Creek.



Other Threatened and Endangered Species

Alabama Water Dog - *Necturus Alabamensis* [8]

The Alabama waterdog *(Caudata Proteidae)* is part of an ancient lineage of salamanders that diverged from all other amphibians 190 million years ago in the Jurassic period. This is a secretive and nocturnal species that spends daylight hours hidden under rocks or organic debris. This species is restricted to streams in the Black Warrior River Basin of Alabama. Alabama waterdogs inhabit medium to large streams that have logs, submerged ledges, rocks, and other hiding places on the bottom. They are associated with clay substrates lacking silt, wide and/or narrow stream morphology, increased abundance of snails and larval northern dusky salamanders (*Desmognathus fuscus*), and decreased Asian clam (*Corbicula* sp.) occurrence.

Figure 12 Alabama Water Dog

This species can be found in medium–large streams of the upper (Appalachian) portions of the Black Warrior River drainage system above the Fall Line. The range of this species includes parts of the North River, Locust Fork, Mulberry Fork, and Sipsey Fork drainages and their tributaries, in Blount, Tuscaloosa, Walker, and Winston counties. This species is currently considered a candidate for listing by the U.S. Fish & Wildlife Service. The Alabama waterdog is listed as Endangered in the IUCN Red List of Threatened Species because its area of occupancy is probably less than 500 km sq., its distribution is severely fragmented, and there is continuing decline in the extent and quality of its forest habitat in Alabama.

This species is principally threatened by pollution and habitat disturbance caused by industrial, mining, agricultural, and urban activities, which have reduced and fragmented both its population and range.

Flattened Musk Turtle – *Sternotherus depressus* [9]

The flattened musk turtle is listed as a threatened species by the U.S. Fish & Wildlife Service and occurs in the upper Black Warrior River system of Alabama. Present populations are believed to exist upstream from Bankhead Dam in Blount, Cullman, Etowah, Jefferson, Lawrence, Marshall, **Tuscaloosa,** Walker, and Winston Counties. Only 15 % of the Black Warrior system (142 out of 947 stream miles, including impoundments) is thought to support viable populations (U.S. Fish and Wildlife Service 199O). Historically, the flattened musk turtle was reported as occurring in this river system from the Fall Line northward. Exact population numbers are unknown. Within the current range, only about 15 % of the habitat seems to contain healthy reproducing populations. Range-wide the species appears to be declining (Mount 1981; Ernst et al., 1983).

Although the flattened musk turtle is capable of living in a variety of streams and lakes, its optimum habitat appears to be free-flowing large creeks or small rivers having vegetated shallows about 2 feet deep alternating with pools 3 to 5 feet deep. These pools have a detectable current and an abundance of crevices and submerged rocks, overlapping flat rocks, or accumulations of boulders. There should be abundant molluscan fauna, low silt load and deposits, low nutrient content and bacterial count, moderate temperature, and minimal pollution stated that moderate sand accumulation does not seem to be harmful.

The flattened musk turtle is threatened by disease, over collecting, and by water pollution from mining, forestry, agriculture, and industrial and residential sewage effluents. This turtle has been listed for sale on several dealer price lists at above $80 each. Large collections have been documented. Most of the formerly good populations have been considerably reduced in this way in recent years. A bill passed by the Alabama legislature in May 1984 prohibits the taking of this species and may be a deterrent to commercial overexploitation in the future.

The two greatest threats to the flattened musk turtle appear to be (1) siltation from agriculture, forestry, and strip mining, and (2) over collecting for the commercial trade. Adverse effects of silt seem to be: (1) the extirpation or reduction of mollusk populations and other invertebrates on which the turtles feed; (2) physical alteration of the rocky habitats where the turtles seek food and cover; and, (3) development of a substrate in which heavy metals and other chemicals that may be toxic to the turtles tend to accumulate. A study supports findings that siltation has had a negative impact on the flattened musk turtle. The study also pointed out that habitat fragmentation, which has already occurred and is expected to continue, represents a potentially serious threat to the turtle's long-term survival.

Threatened and Endangered Plants

Mock Bishop's Weed- *Ptilimnium* [10]

Between 1905 and 1911, three species now belonging to *Ptilimnium* (Mock Bishop's Weed) were described in *Harperella*. Plants of the "*harperella*" species. Dr. Roland M. Harper of the University of Alabama first discovered *Harperella* in Schley County, on July 10, 1902. During 1905, Harper discovered a new species of *Harperella* in northern Alabama. In Alabama, colonies of plants grow along the North River. Connecting links have been discovered between the seemingly isolated localities in the Potomac River valley and northern Alabama. *P. texense*, a taxon of possible hybrid origin, needs further cytological clarification.

According to the USDA-NRCS Plants Database (www.plants.usda.gov,) a variety of *Ptilimnium - Ptilimnium capillaceum,* is listed by the federal or state government as threatened or endangered in the following states:

Kentucky – Threatened
Pennsylvania – Extirpated
Rhode Island – Special Concern

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[10] A Morphological Study of Ptilmnium. Easterly, Nathan William. Brittonia. Volume 9, Number 3, September 1957. Pages 136-145. http://www.springerlink.com/content/v16057050345pp10/ Accessed: January 8, 2010.

DATA SUMMARY

Although several studies have been performed within the North River Watershed, additional data is necessary to determine water-quality threats, pollutants and sources. Data considered for this summary included readily available information from credible sources. Following is a brief summary of recent information regarding identified and potential threats and sources of pollution.

ADEM

303(d) List [1]

Section 303(d) of the Clean Water Act requires that each state identify those waters that do not currently support designated uses, and to establish a priority ranking of these waters by taking into account the severity of the pollution and the designated uses of such waters. North River has been on the State's list of impaired streams since 1998. It is listed as impaired from Ellis Creek to Lake Tuscaloosa (38 miles) for nutrients, siltation and other habitat alteration from unknown sources. Lake Tuscaloosa has been identified as impaired for mercury due to atmospheric deposition on the draft 2010 list to EPA.

According to the 2008 Integrated Water-quality Monitoring and Assessment Report (305b) ADEM is scheduled to develop a draft TMDL for North River (AL03160112-0404-102.) This draft will be submitted to EPA in the 4th quarter of fiscal year 2009.

Surface Water Screening Assessment

In support of the ADEM NPS monitoring strategy, a 2-tiered approach is used to identify impaired waters, determine the causes and sources of impairment, and evaluate the effectiveness of pollution control activities. This approach concentrates ADEM's resources in areas with the greatest potential for impairment and where more intensive monitoring is required. Tier I monitoring, completed using ADEM's basin wide screening level assessment methods, is conducted on a repeating 5-year management cycle during ADEM's NPS and CWA 303(d) monitoring programs to identify or verify impaired waters, estimate water-quality status trends, and evaluate causes and sources of impairments.

During 2002, the Aquatic Assessment Unit (AAU) of ADEM's Field Operations Division completed the 2nd basin-wide screening assessments of the Black Warrior and Cahaba River Basins. The project included reviews of land use, departmental regulatory databases, listing documents, and monitoring data collected by multiple agencies to identify data gaps and to prioritize sub-watersheds with the greatest potential for point and nonpoint source impairment. Data were compiled and analyzed to estimate the level of impairment and to evaluate potential causes and sources of that impairment.

The Lower North River Sub-watershed (NRCS Sub-watershed number 100) was assessed under this program with findings included below. [2]

> ***NPS impairment potential:*** Biological impairment detected at sites on Binion Creek, Carroll Creek, and Cripple Creek identified lower North River as a 1997 NPS priority subwatershed (ADEM 1999a). Roadside surveys conducted in 1997, upstream of each assessment site, indicated cattle production, silviculture, and roadside erosion to be prevalent throughout the sub-watershed (ADEM 1999a). Based on the 1998 SWCD sub-watershed assessments, the potential for NPS impairment within the sub-watershed was estimated as low. However, lower North River was given a 1st priority sub-watershed rating by the Tuscaloosa County SWCD for crop and roadside erosion, excessive sediment from roads and urban development, overgrazed pastures, inadequate management of animal wastes, and access of livestock to streams.
>
> ***Assessments:*** Binion Creek was assessed at one location during the 2002 NPS screening assessment of the BWC basin group. Intensive water-quality sampling has also been conducted at stations on Bear Creek, Binion Creek, North River, and the Black Warrior River as part of ADEM's Ecoregional Reference, §303(d), and Reservoir Monitoring Programs.

Binion Creek: Habitat quality was impaired by sediment deposition and unstable banks. The macroinvertebrate and fish communities were assessed as fair and good, respectively. One time water-quality sampling conducted in June of 2002 did not indicate a cause of the impairment. Intensive water-quality data were collected monthly from the Binion Creek embayment at Lake Tuscaloosa to determine the sediment and nutrient loading to Lake Tuscaloosa. Concentrations of total nitrogen, total phosphorus, chlorophyll-*a* and total suspended solids were among the lowest of the Black Warrior tributaries.

Binion Creek at BW5U6-45 was evaluated during ADEM's 2002 ALAMAP Program. The reach was characterized by poor instream habitat and riffle quality. Dissolved oxygen was measured at 0.5 mg/L during a one-time water-quality sampling event in August of 2002.

Bear Creek: Bear Creek at BERT-4 has been intensively monitored in conjunction with ADEM's Ecoregional Reference Reach Program. In June of 2002, 7 EPT families were collected, indicating a fair macroinvertebrate community. Intensive water-quality sampling conducted from March through November of 2002 did not indicate a cause of the impairment.

North River: Intensive water-quality sampling was collected on the North River at NRRT-1 from January through August of 2002. Results showed fecal coliform concentrations >2,000 colonies/100 mL during the May sampling event. Nutrient concentrations and conductivity were periodically elevated.

Water-quality samples were collected monthly during April through October, 2002 in the upper-, mid-, and lower- Lake Tuscaloosa reservoir to evaluate nutrient and sediment loading as a source of water-quality impairment to Lake Tuscaloosa. Mean concentrations of total nitrogen and total phosphorus were among the lowest on the Black Warrior River tributaries during the 2002 sampling season. However, total phosphorus concentrations have nearly doubled since 1998. Total suspended solids have also increased throughout the reservoir since 1998.

Barbee Creek: Results of water-quality sampling conducted during August of 2002 showed fecal coliform concentrations of 770/100ml. Habitat assessment indicated good habitat quality.

Sub-watershed status: Macroinvertebrate assessments conducted during 2002 indicated impaired macroinvertebrate communities at locations on Bear and Binion creeks. Sedimentation was observed at both sites. Roadside surveys conducted in 1997, upstream of each assessment site, indicated cattle production, silviculture, and roadside erosion to be prevalent throughout the sub-watershed. Total phosphorus concentrations and total suspended solids have increased throughout Lake Tuscaloosa since 1998. However, monitoring within the Binion Creek and Lake Tuscaloosa has indicated the potential for nutrient and sediment loading from these sources to be relatively low.

Geological Survey of Alabama

Distribution and Concentration of Total Coliform and Escherichia Coli Bacteria in the North River/Lake Tuscaloosa Watershed, 2005. [3]

During the course of that investigation, a total of 422 samples were collected, 223 during high flows and 199 during low flows. Total coliform bacteria ranged from 273 to 241,960 cfu (median 4,870) for the low flow period, and from 1,046 to 242,000 cfu (median 15,000) for the high flow period. The concentration of E. coli bacteria ranged from 1 to 14,670 cfu (median 100) for the low flow period, and from 22 to 17,980 (median 488) for the high flow period. These results indicate that bacteria associated with storm water runoff during high stream flow periods was the source of high concentrations observed in Lake Tuscaloosa. During high stream flows within the lake proper, including small direct tributaries, the upper section had higher median and average bacteria concentrations compared to the middle and lower sections. During low flows, the median bacteria concentrations were similar throughout the lake, with median *E. coli* counts less than 200 cfu in the three sections. Another piece of evidence relating storm water flows with high bacteria counts is the observation that during high stream flows approximately 30.5 % of the samples collected and analyzed for *E. coli* were less than 200 cfu and 69.5 % were greater than or equal to 200 cfu. During low flows approximately 71 % of the samples were less than 200 cfu and 29 % were greater than or equal to 200 cfu.

The bacteria data set was stratified into smaller watersheds for *E. coli* and total coliforms. A majority of the watershed units, 83 %, had at least one *E. coli* count that exceeded 200 cfu during high flows. For low stream flows, 16 of the smaller watershed units (55 %) had at least one *E. coli* count greater than or equal to 200 cfu, indicating that, although storm water runoff appears to be a major source of bacteria, *E. coli* bacteria contamination may also occur in the watershed during low flow periods.

Data were further explored within the GIS environment by color coding bacteria concentration for all the stations sampled within the larger North River/Lake Tuscaloosa watershed. This analysis depicts *E. coli* and total coliform bacteria concentrations for both high and low stream flow periods. Total coliform bacteria results essentially mirror the patterns observed for *E. coli* bacteria relative to the distribution and occurrence of high and low concentrations. For *E. coli* concentrations during low flows excluding the lake proper, a large part of the eastern watershed was less than 200 cfu, while about one third to one half of the western watershed was greater than 200 cfu. Two *E. coli* samples collected during this period were between 1,000 and 10,000 cfu (stations 030 and 146) and one station (035), a small drainage at Rock Quarry landing, had an *E. coli* concentration of 14,670 cfu, the highest measured during low flows. Many stations around the lake proper had *E. coli* less than 200 cfu during low flow periods, but there were a few stations with *E. coli* between 200 and 1,000 cfu. Both Carroll and Binion creeks, major tributaries to Lake Tuscaloosa proper, had several stations with *E. coli* bacteria ranging between 200 and 1,000 cfu during low flow periods.

Elevated *E. coli* concentrations were more widespread during high stream flows. A few headwater streams, and a few small watersheds draining directly into Lake Tuscaloosa were less than 200 cfu. Several stations in main channel North River (NR1-NR6), and tributaries to North River in this area (Sandy Point Creek, Boones Creek, and lower Tyro Creek), had *E. coli* concentrations in the 1,000 to 10,000 cfu range. Headwater tributaries to Binion Creek (BC2, BC3, BT2, BT4 to BT6) and stations in the embayment of Binion Creek (004 and 007) were also in this range. All samples taken in the Carroll Creek watershed were between 1,000 and 10,000 cfu for *E. coli* including stations CC1 to CC4, CT3 and stations 077 and 086 in the embayment of Carroll Creek. Many small direct tributaries to Lake Tuscaloosa were in the 1,000 to 10,000 cfu range and included stations 011 to 013, 016, 021, 030, 032, 037, 039, 040, 041, 042, 045, 050, 061, 064, 133, 154, 179, 180, 182, 183, and 185. A few stations sampled during high stream flows had *E. coli* concentrations greater than 10,000 cfu including FC1 and NT1 in North River, CT1 and CT2 in the Carroll Creek watershed, and station 106 in Lake Tuscaloosa.

Watershed Assessment of the North River System For Recovery and Restoration of Rare Mussel Species. [4]
Water-quality impacts of historic coal surface mining are still evident in the North River watershed. Specific conductance measurements made in Cane, Cripple, and Turkey Creeks during low stream flows in 2009 were extremely elevated above ambient while conductance measurements in other tributaries were within ambient conditions. Specific conductance of the North River at Tuscaloosa Co. Hwy. 38 was extremely elevated above ambient while measurements at Fayette Co. Hwy. 30 and Co. Hwy. 80 were moderately elevated.

The habitat parameters embeddedness and degree of sediment deposition were highly correlated with the habitat index (R2=0.731 and 0.712, respectively) indicating that sediment bedload, in part, is a significant contributor to poor habitat scores in the North River. The fact that several sites in the Clear Creek system are of poor to marginal habitat quality illustrates that sediment is likely a major pollutant impacting this watershed. Field visits to the Clear Creek system in August and September 2009 confirmed that sediment is a significant issue in Clear Creek. Streams had a heavy sand and gravel bedload originating from multiple sources but predominantly from unpaved county roads.

Chemical Quality of Water of Alabama Streams, 1960: A Reconnaissance Study. [5]
North River, Turkey Creek, and Binion Creek are low in mineral content, 4 (12-24 ppm), and soft. Silica is one of the principal mineral constituents in the water of the North River.

Watershed Survey
In July of 2009, a watershed survey was led by Geological Survey of Alabama with participants from the Lower Sub-basin Committee of the Black Warrior Clean Water Partnership. Observations included excessive sedimentation from unpaved roads, as well as illegal dumpsites near the main channel of North River.

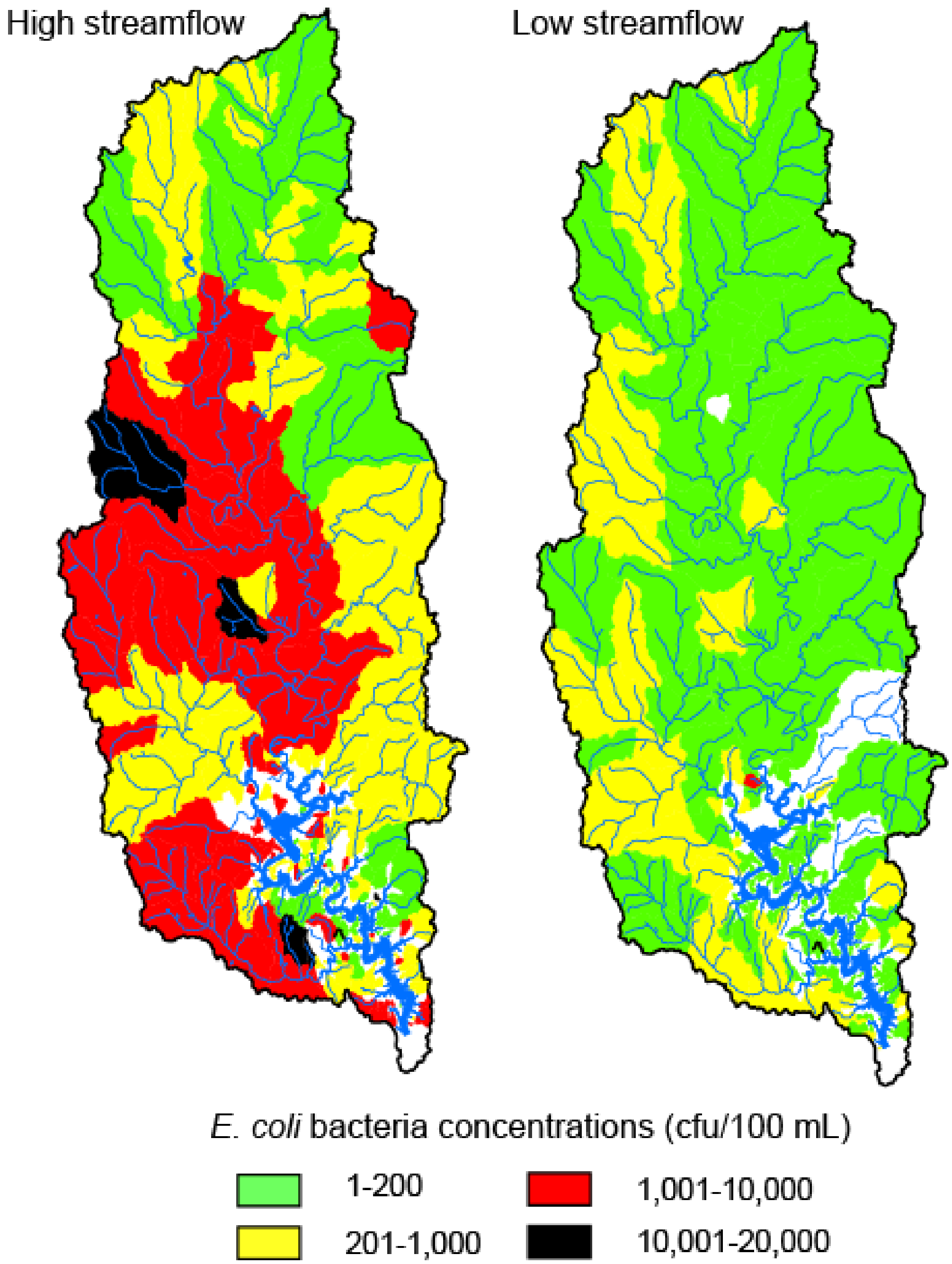

Figure 13 High/Low Flow E. coli Bacteria Concentrations (GSA)

Potential for Nonpoint Source Pollution Index
In 2010, Geological Survey of Alabama performed calculations to determine areas with the highest potential for nonpoint source pollution. Areas contributing to nonpoint source pollution need to be identified more specifically in order to restore water-quality in the North River. The resulting PNPI map of the North River watershed identifies areas where best management practices would be beneficial in efforts to mitigate nonpoint source pollution problems.

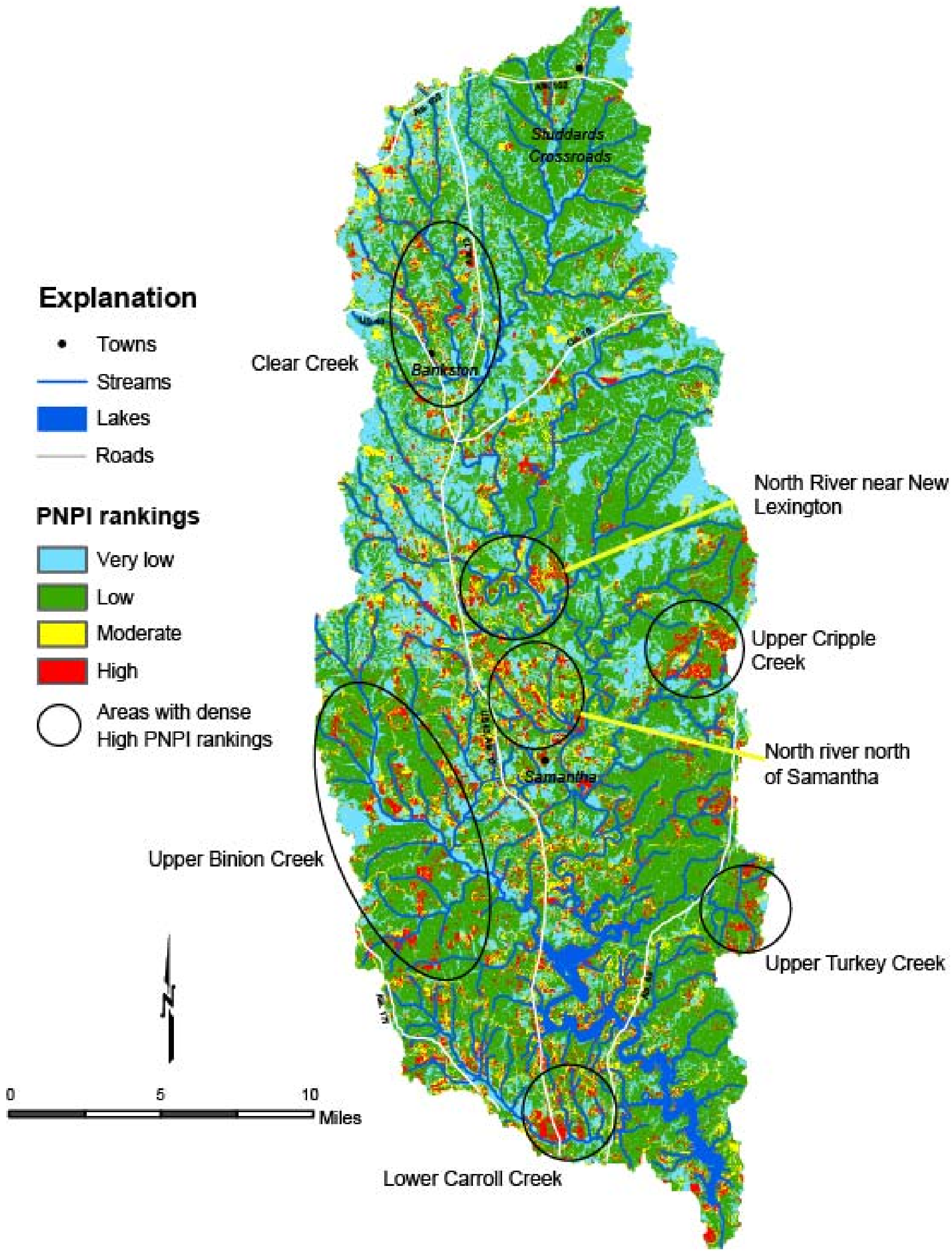

Figure 14 Nonpoint Source Pollution Index (GSA)

US Geological Survey

Estimation of Long-term Reservoir Sedimentation in Lake Tuscaloosa, Tuscaloosa County, Alabama. [6]

Lake Tuscaloosa was constructed in 1970 on North River in Tuscaloosa County, Alabama. The lake serves as the water supply for Tuscaloosa, Northport, and other communities in Tuscaloosa County and is also a major recreational attraction for west Alabama. Land uses in the North River watershed include mining, forest harvesting, agriculture, urban residential, and suburban residential. In the past, the effect of mining operations on water-quality and sedimentation in Lake Tuscaloosa was a major concern. While the mining issues are still a concern, sediment yield caused by other fast-changing land uses, including shoreline and near shoreline development, has also raised concern. The objective of this project is to advance the understanding of how suspended-sediment loads are affected by hydrologic processes and land use and to furnish data and information that contributes to the protection of a major water supply reservoir and ecosystem.

Nine major tributaries discharge to Lake Tuscaloosa: North River, Dry Creek, Turkey Creek, Binion Creek, Tierce Creek, Carroll Creek, Hamner Creek, Pole Bridge Creek and Brush Creek. This study will focus on the sediment delivery from eight of the nine major tributaries. Approximately 78 % of the watershed will be represented by the sediment sampling. Continuous discharge measurement and sediment sampling began in October 2008 and conclude in September 2011. Sediment rating curves and hydrological models will be linked to provide predictive capability for estimating long-term suspended-sediment loads to Lake Tuscaloosa.

***Assessment of Nutrient Trends and Loads for the Mobile River Basin*.** [7]

U.S. Geological Survey (USGS) surface-water sampling sites in the Mobile River Basin were reviewed for available nutrient data for the period 1970-97. Sites having sufficient nutrient data were evaluated for long-term trends in nutrient concentrations and nutrient transport was calculated for selected basins. The effort was undertaken as part of the National Water-Quality Assessment (NAWQA) Program (Gilliom and others, 1995).

USGS sampling sites having periods of continuous streamflow and nutrient data from the period 1970-97 were examined for long-term trends with the Seasonal Kendall trend test. Trends and loads were estimated for total nitrogen at 15 sites and for total phosphorus at 14 sites. The Seasonal Kendall trend test adjusts for seasonal variability using nutrient concentrations adjusted for the effects of streamflow with residuals from LOWESS (LOcally Weighted Sum of Squares) smoothed curves. Trends were also determined for sites without continuous data using multivariate regression analysis.

Results of mean total nitrogen and total phosphorus loads, and yields for the sampling station on North River near Samantha, AL (#02464000) for the period 1988-1996 are show below.

Mean Total Nitrogen Load (tons/yr)	Mean Total Nitrogen Yield (tons/mi^2/yr)	Mean Total Phosphorus Load (tons/yr)	Mean Total Phosphorus Yield (tons/mi^2/yr)
23	0.91	16.9	0.076

***Water-quality of Lake Tuscaloosa and Streamflow and Water-quality of Selected Tributaries to Lake Tuscaloosa, Alabama, 1982-86*.** [8]

"Except for pH, sulfate, and dissolved and total recoverable iron and manganese, the water-quality of the tributaries is generally within drinking water limits and acceptable for most uses. However, the water-quality of some streams that receive drainage from mined areas – North River, Little, Cripple, and Turkey creeks – is deteriorating.

Other

1999 Watershed Assessment Soil & Water Conservation Committee [10]

The North River Watershed was selected Priority 1 in Tuscaloosa County and Priority 2 in Fayette County due to potential impacts from nonpoint source pollution.

2007 Watershed Assessment Soil & Water Conservation Committee (Tuscaloosa)

The Report of Resource Concerns for HUC0136011204 Black Warrior River-North River listed the following stressors within the watershed:

<u>Animals/Plants</u>

- Livestock are overgrazing pastures
- Livestock commonly have access to streams
- Livestock water is not adequate for proper pasture rotation

<u>Water-quality and Quantity</u>

- Excessive sediment from cropland
- Excessive sediment from roads/road banks
- Excessive sediment from urban development
- Nutrients in surface waters
- Bacteria and other organisms in surface waters

<u>Other Resource Concerns</u>

- Recycling is not aggressively conducted
- Unauthorized dumping in streams
- Unauthorized dumping in turnouts

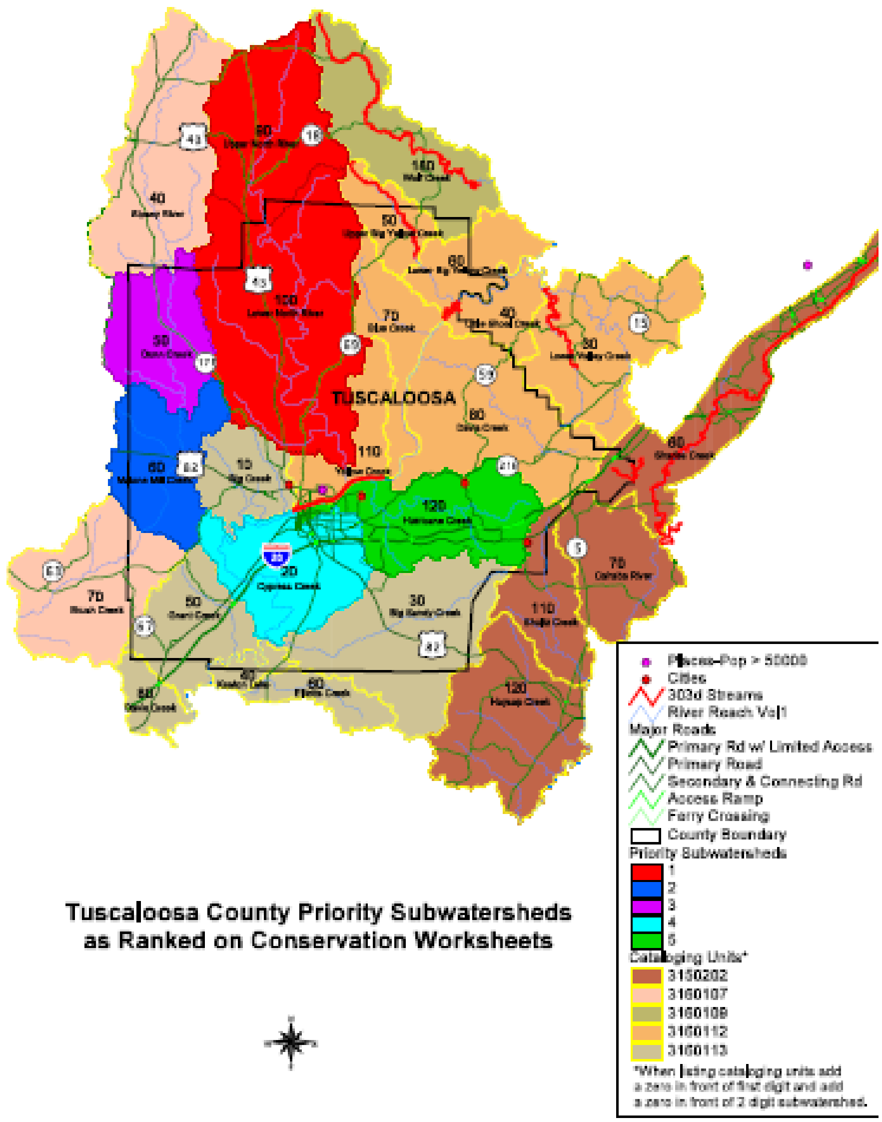

Figure 15 Tuscaloosa County Watershed Assessment

<u>Application of Environmental Decision Analysis Framework on the E.coli Problem in the Lake Tuscaloosa Watershed</u>**.** Alfaqih, Laith Salim. 2008.
In 2008, Laith Salim Alfaqih submitted a doctorial dissertation in partial fulfillment of the requirements to obtain a degree of Doctor of Philosophy in Civil Engineering at the University of Alabama. Alfaqih (2008) used *E. coli* data set from *Distribution and Concentration of Total Coliform and Escherichia Coli Bacteria in the North River/Lake Tuscaloosa Watershed, 2005* to further explore the potential sources of contamination in the watershed. Detailed hydrologic and bacteria models were developed for the watershed. <u>Unrestricted access of large animals to stream channels and poor handling of poultry waste</u> were identified as significant <u>contributors of *E. coli*</u> bacteria to the North River and that *E. coli* concentrations increased substantially in subwatersheds as the number of <u>chicken houses</u> increased.

Modeling results demonstrated that if 50 % of waste from unrestricted pasture inputs and chicken houses was controlled then about 38 % of the rain events would produce *E. coli* concentrations in Lake Tuscaloosa exceeding 200 cfu. If all sources of manure from pastures and chicken houses were controlled, then this is reduced to only 10 % of the rain events. Controls for large animal access are fencing of pasture and/or creation of a dense riparian buffer to control animal access. Controls for concentrated manure are incineration, burial, waste storage structures, composting, and filter strips. Composting was determined to be the most viable option after applying a decision analysis model (Alfaqih, 2008).

Other statistically probable sources identified included sanitary sewer overflows (Chapter 9, pg 184) particularly in Carroll's Creek.

Observations (Place) and Potential Sources

- North Hagler Road (Chapter 4, pg 88)
  - Birds living under bridge
  - Access of livestock to river
- Carroll Creek (Chapter 4, pg 95-97)
  - Residential area (septic systems)
  - Chicken farm
  - Sanitary sewer overflows (reported) [City of Northport upgrading sanitary wastewater collection system in the area.]
- Binion Creek (Chapter 7, pg 141)
- Direct correlation between precipitation and levels (Chapter 9, pg 186)
- Upper areas of the watershed (Chapter 9, pg 187)

Reasons for System Failure (Chapter 2)

- Poor community involvement
- Financial and economic issues
- Lack of resources (material, machinery, manpower) for operation and maintenance.
- Lack of education about water and sanitary issues
- Social and cultural issues
- Lack of professional and skilled individuals
- Poor enforcement of laws and regulations
- Inadequate or non-existing policies
- Balancing between developing new systems and maintaining old ones
- Unavailability of supporting infrastructure
- Lack of data and information to support decisions

Aqueous Geochemistry of Lake Tuscaloosa, West-Central Alabama, USA: Drought Response. [10]
This project studies the aqueous geochemistry of surface waters using samples representative of different seasonal conditions and land cover. Of the 21 sample locations in this study, three are located on tributaries, four transect the axis of the lake, and the rest are divided among semi-restricted coves representing forested and residential land cover. Sample chemistry is quantified for major, minor, and trace cations, anions, and nutrients, total dissolved nitrogen, DOC, and ALK.

The current study presents data collected from the lake and its tributaries during recent severe drought conditions impacting much of the southeastern United States. These data are compared with data from an identical study conducted five years ago during a more normal water year. For each sampling year, four seasonal sampling events were conducted. Both intra- and inter-annual results are reported. Historical USGS data for seven locations sampled since 1986 on a semi-annual basis illustrate a general increase in TDS and nutrients since the lake's creation. Some USGS sample locations coincide with those of the current study. Recently collected data agrees well with recent USGS data for the same locations.

It is likely that trends observed in this study are related to anthropogenic effects along the lake shore, as evidenced by the geochemical differences between residential and forested coves. Long-term trends observed in historical data are likely the result of land use in the watershed related to mining, agriculture, and residential development. It is also observed that lower flow conditions are associated with increased solute concentrations, indicating that dilution by rainfall-runoff events is an important factor moderating water-quality. These data provide some insight into the impacts prolonged drought may have on Lake Tuscaloosa water-quality.

Feasibility Report for Preliminary and Detailed Surface and Subsurface Exploration of the North River Drainage Basin. [11]
The purpose of the feasibility report prepared in 1969 was to present all geological, constructional, and hydrological factors connected with and related to the selection of the construction of dam and reservoir for Lake Tuscaloosa. The report stated (pg 19):

> *Silting may be a major problem in the North River (Lake Tuscaloosa) Reservoir as the river carries a high silt load under flood conditions. The steep gradient of the small tributaries and the very steep slopes adjacent to the reservoir are expected to be the greatest contributors of silt. If proper conservation practices are employed early, a substantial portion of the problem can be averted. Planting of trees and grass, and terracing of some slopes is recommended for areas where barren open ground exists. Construction of ponds on major tributaries would assist in reducing silt entering the reservoir.*

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[1] 2008 Integrated Water-quality Monitoring and Assessment Report. ADEM. April 1, 2008.

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[10] Aqueous Geochemistry of Lake Tuscaloosa, West-Central Alabama, USA: Drought Response. Creech, L., Jr.; Donahoe, R. J. American Geophysical Union, Fall Meeting 2008, Abstract #GC51A-0659. http://adsabs.harvard.edu/abs/2008AGUFMGC51A0659C Accessed: January 8, 2010.

[11] Feasibility Report for Preliminary and Detailed Surface and Subsurface Exploration of the North River Drainage Basin. Bruner, Thomas E., Dobbs, Danny. Kidd, Jack. Moravec, George. May 23, 1969

Documented Impairment and Watershed Stressors

It is the intention of this watershed management plan to holistically identify watershed impairments and stressors in order to develop strategies that may lead to measureable improvement in water-quality. Impairments, along with possible causes and sources, were identified using information obtained from the Data Summary.

	IMPAIRMENT					DOCUMENTED SOURCE						
Waterbody	***Sedimentation***	***Nutrients/E. coli***	***Biological Impairment***	***Agricultural Runoff***	***Specific Conductance***	***Roadside Erosion***	***Urban Development***	***Unstable Streambanks***	***Abandoned Mine Lands***	***Shoreline Development***	***Failing Septic Systems***	***Sanitary Sewer Overflows***
Barbaree Creek		✠										
Bear Creek	✠		✠									
Binion Creek	✠	✠	✠	✠		✠	✠	✠				
Boones Creek		✠										
Cane Creek					✠				✠			
Carrolls Creek		✠	✠								✠	✠
Clear Creek	✠		✠									
Cripple Creek			✠		✠				✠			
Lake Tuscaloosa (Lower)												
Lake Tuscaloosa (Upper)		✠										
Lake Tuscaloosa General	✠									✠		
North River	✠	✠	✠									
Sandy Point Creek		✠										
Turkey Creek					✠				✠			
Tyro Creek		✠										

STRATEGIES FOR WATERSHED IMPROVEMENT

This watershed management plan seeks to implement environmentally protective and economically realistic recommendations, where practical and technologically feasible, in order for North River to meet or exceed the State's Water-quality Standards for Fish & Wildlife. Recommendations are based on information in current studies provided by credible sources and stakeholder input from the Black Warrior Clean Water Partnership Lower Sub-basin Committee. Voluntary, incentive-based approaches will be used to implement recommendations throughout the watershed. Providing opportunities for local stakeholder education, input and participation will continue to be a critical component for implementation of the watershed management plan.

As a result of the varied land use within the North River Watershed, several sources and combinations of NPS pollution exist. Long-term success at reducing these types of NPS pollution will only be possible with concerted education/outreach efforts targeting the entire watershed.

Educational activities are a significant part of any watershed management plan for raising awareness of the need to protect the hydrologic systems that supply water for drinking, irrigation of crops, industrial processes, and protection of fish and wildlife. These educational activities should be implemented and focused in schools, among landowners, government officials, engineering firms, contractors, land management professionals, land developers, economic development professionals, and anyone who works in or has development activities in the watershed.

Activities to improve the North River Watershed include school visits to teach water science, watershed festivals, stream and lake cleanups, nonpoint source pollution seminars for water professionals and developers, demonstrations of best management practices and organizing lake watch and watershed watch programs.

Bacteria levels in the watershed can be reduced by adopting a process and plan by which agricultural runoff, animal waste runoff, sediment runoff (both urban and agricultural), and other waste-related activities and threats are identified, monitored, and managed through public education and application of best management practices suitable to the terrain and conditions of the North River watershed. [1]

Sub-watershed management plans for priority watersheds should be developed which will allow for the refinement of recommendations that will achieve the most water-quality benefits. Recommended sub-watersheds for priority watershed management plans include:

- Clear Creek (Critical Habitat)
- Deadwater Creek (Critical Habitat)
- Binion Creek
- Carroll Creek

GOAL	OBJECTIVE	TASK	COOPERATING PARTNER(S)	ESTIMATES OF FUNDING/TECHNICAL ASSISTANCE	
I.	**Provide watershed and nonpoint source education**				
	A.	Provide education to residents regarding residential nonpoint source runoff and its effects on water quality	Ala Museum of Natural History, City of Tuscaloosa, Fayette Co		
	1	Newspaper inserts	ACWP/RC&D/USFWS	19,000.00	1yr
	2	Cooperate and support existing stormwater program to distribute watershed	Stormwater Programs	No additional funding necessary	
	B.	Provide education to students regarding residential nonpoint source runoff and its effects on water quality			
	1	Engage the University of Alabama Museum of Natural History's Field Science Watershed Education Program to engage students.	Ala Museum of Natural History	124,000.00	3yr
	2	Provide education opportunities for students and community members regarding soil and water conservation. (EX: EnviroScape, AWW Testing)	RC&D, S&WCD	72,000.00	3yr@$12,000yr
	3	Support the City of Tuscaloosa's efforts to host a water festival for Lake Tuscaloosa	ACWP, City of Tuscaloosa	15,000.00	3yr@$5,000yr
	C	Provide education to local decision makers regarding land use planning and its role in water quality.			
	1	Utilize the expertise of local organizations to develop workshops.	ACWP	7,500.00	3yr@$2,500yr
	2	Provide support for NEMO presentations within the Watershed	ADEM, ACWP	No additional funding necessary	
II.	**Support Mobile River Basin recovery efforts of threatened and endangered species.**				
	A.	Coordinate with existing programs to restore identified reaches.	USFWS, GSA, ACWP	TBD	
	B.	Provide information to residents regarding Strategic Habitat Units and their role in preservation.	USFWS, ACWP	No additional funding necessary	
	C.	Provide interpretive watershed data for use in recovery and restoration.	USFWS, GSA, AABC		
	1	Assess the potential of species restoration in Strategic Habitat Units.			
	2	Link ecological and population response with habitat alteration.			
	3	Link habitat alteration with flow and land alteration.			
	4	Use USFWS threats and watershed assessment data to identify stream reaches that need protection, management, and/or restoration			

GOAL OBJECTIVE	TASK	COOPERATING PARTNER(S)	ESTIMATES OF FUNDING/TECHNICAL ASSISTANCE
III.	**Reduce sedimentation.**		
A.	Reduce sedimentation in urban areas		
1	Perform stormwater retrofit survey.	City of Tuscaloosa	30,000.00
2	Identify and install (where economically feasible) stormwater retrofits to control volume and velocity of stormwater runoff.	City of Tuscaloosa	150,000.00
3	Develop a shoreline management plan for Lake Tuscaloosa	City of Tuscaloosa	No additional funding necessary
B.	Reduce sedimenTation contribution from dirt roads.		
1	Catalog dirt roads contributing to sedimentaion	RC&D, S&WCD	10,000.00 1yr
2	Provide training to public works on dirt road maintenance and BMPs to contain sediment before entering the waterbody.	ACWP, RC&D, DOT	1,500.00 1yr
3	Provide demonstrations of dirt road BMPs in areas critically affected by sedimentation.	ACWP, RC&D	45,000.00 3BMPs@$15,000ea
4	Work with Oil & Gas Board to reduce sedimentation from unpaved roads.	ACWP	No additional funding necessary
C.	Reduce sedimentation from agricultural sources	USDA/NRCS S&WCD	
D.	Reduce sedimentation from abandoned mine lands	ADIR-AML	No additional funding necessary
E.	Identify technologies to remove sedimentation from Strategic Habitat Units, Lake Tuscaloosa and Tributaries	ACWP, US F&WS, GSA	TBD
IV.	**Reduce roadside litter and illegal dumpsites.**		
A.	Engage County Health Departments to identify illegal dumpsites in the area.	Health Depts	No additional funding necessary
B.	Utilize local groups (EX: Boy Scout, University Clubs) to clean up illegal dumpsites.	ACWP	3,000.00 3yr
C.	Continue to support and expand the Lake Tuscaloosa clean up.	City of Tuscaloosa	No additional funding necessary
D.	Utilize the Assign-A-Highway program to reduce roadside litter and create awareness.	ACWP/County Officials	No additional funding
E.	Install trash booms where necessary and ecomonically feasible.	City of Tuscaloosa	135,000.00 2sites

GOAL	OBJECTIVE	TASK	COOPERATING PARTNER(S)	ESTIMATES OF FUNDING/TECHNICAL ASSISTANCE	
V.	**Reduce contributions of bacterial sources.**				
	A.	Engage USDA/NRCS to work with local landowners to install BMPs to reduce nonpoint source pollution from agricultural sources.	USDA/NRCS	175,000.00	5BMPs@$35,000ea
	B.	Engage County Health Departments and County Sewer Systems to identify and correct sanitary sewer overflows.	Health Departments	No additional funding necessary	
	C.	Utilize satellite imagery from the City of Tuscaloosa to detect and correct nutrient contributions.	City of Tuscaloosa, ACWP	No additional funding necessary	
	D.	Engage local Health Departments to identify and remediate failing septic systems that may contribute to nutrient nonpoint source runoff.	Health Departments	No additional funding necessary	
VI.	**Develop strong stakeholder group**				
	A.	Develop stakeholder group to communicate and coordinate watershed efforts.	ACWP	No additional funding necessary	
	B.	Hire a watershed coordinator to coordinate watershed efforts.	ACWP	58,500.00	3yr
	C.	Prioritize sub-watersheds to focus efforts for restoration and water quality improvement. Sub-watersheds may be chosen on the basis of ecological importance, TMDL implementation, availability of substantative data and potential opportunity for restoration.	ACWP/Stakeholders	No additional funding necessary	
	D.	Develop sub-watershed management plans to direct programs and resources for watershed improvement.	ACWP/Stakeholders	30,000.00	3plans
VII.	**Continue and expand current monitoring to provide a complete understanding of stressors within the watershed.**				
	A.	Create monitoring committee to interpret current monitoring information and direct future monitoring goals.	GSA	No additional funding necessary	
	B.	Peform nutrient survey to identify contributions.	GSA/City of Tuscaloosa	80,000.00	

Support Critical Habitat Recovery Efforts[2]

The USFWS in cooperation with the Alabama Aquatic Biodviersity Center (AABC) of the Wildlife and Freshwater Fisheries Division (WFFD) of the Alabama Department of Conservation and Natural Resources (ADCNR), the Geological Survey of Alabama (GSA), and the Alabama Clean Water Partnership (ACWP) has initiated an effort to provide enhanced species recovery opportunities in the 26 Mobile River Basin critical habitat reaches. This initiative will be facilitated through the following activities:

1) Establishment of strategic habitat units. Strategic habitat units (SHU) were established for the 26 critical habitat units designated by USFWS by determining the encompassing watershed boundary at the downstream point of each critical habitat reach and then mapping this watershed unit in a Geographic Information System (GIS) (O'Neil and others, 2008). This initial step creates the spatial boundary within which recovery activities can be implemented.
2) Development of SHU-specific watershed information. For species recovery to proceed systematically and with some reasonable expectation of success, watersheds must be understood from a biological, water-quality, habitat, and land use perspective. The type of watershed information developed for each SHU is unique and depends on the type and intensity of threats that listed species face. This information can include, but is not limited to: additional biological surveys to refine species distributions; surveys to determine water-quality threats that may affect listed species; a landscape analysis to determine land cover and land use patterns, SHU watershed characteristics, and land cover changes through time; studies to elucidate poorly understood biological phenomena (reproduction periods, migration routes, breeding habitats, etc.) that are important for managing and recovering species; hydrogeologic studies to determine groundwater characteristics and recharge areas for spring and cave dwelling species; biomonitoring studies using multi-metric procedures like the Index of Biotic Integrity (IBI) to assess stream biological conditions throughout a SHU for identifying impaired stream reaches; and comprehensive habitat studies to evaluate the relative degree of habitat impairment and examine hydrologic processes shaping and degrading habitat.
3) Use the threats and watershed assessment data to identify stream reaches that need protection, management, and/or restoration. Linking the location of critically imperiled species with threats is a critical part of this process. Linking can only be done by conducting SHU-specific studies like the work in North River. Broad understanding of threats and species distributions is good but not sufficient for recovery purposes.
4) Once threats are linked with species and an action plan for recovery has been developed then species restoration can begin. This takes place through a cooperative partnership of local landowners, organizations, and agencies including watershed partnerships, local and county governments, local businesses and farmers, state and federal agencies, and other interested parties using a variety of means including: protecting stream habitat through land purchase or landowner conservation agreements; management of habitat and water-quality by eliminating polluted runoff sources and by reducing pollutant loads through more restrictive water-quality permitting and more aggressive best management practice (BMP) implementation; conducting actual riparian improvement or physically restoring a substantially degraded stream reach; restoration of biodiversity with culture-raised species; and implementation of a broad spectrum of educational initiatives aimed at school children, government officials and regulators, land owners and business professionals, and the general public with the general intent to provide credible scientifically-based information about the watershed and its importance to the economic health of the region.

- Clear Creek originates in the Coker Formation and, as such, naturally has a predominantly sand and gravel substrate. Ditches draining unpaved roads in this watershed are significant sources of sediment bedload, particularly in Deadwater Creek, when storm water transports loose sand and gravel from hilltops to stream channels. Because Bays Lake acts as a sedimentation basin for sand and gravel moving downstream, aquatic habitats in a portion of the lower reaches of Clear Creek support a varied and healthy mussel population. The impacts of sediment bedload are expressed at Fayette Co. Hwy. 93 and extend downstream to the mouth of Deadwater Creek. The Fayette County Engineering Department should be contacted and engaged in finding economical ways to reduce the loading of sediment to Deadwater Creek from unpaved roads.

- Land along Deadwater Creek and Clear Creek downstream of Bays Lake needs to be evaluated for riparian buffer improvement to better protect the remaining high quality mussel habitat and to locate any large-scale source of sediment input to these streams.
- The degree of poultry production in the watershed needs to be evaluated along with litter composting and disposal procedures. Projects to lessen water-quality impacts of poultry production should be implemented as soon as sources are identified.
- The degree of large animal production in the watershed needs to be evaluated and projects to assist landowners with alternate watering facilities, away from stream channels, should be initiated.

Stakeholder Cooperation

Understanding how the North River/Lake Tuscaloosa watershed functions hydrogeologically and how pollutants from human activities are transported by the hydrogeologic system will be key to managing water-quality in Lake Tuscaloosa. Because potential water-quality threats to Lake Tuscaloosa are watershed in extent and are many times located well beyond political and jurisdictional boundaries, cooperation between landowners, local and county governments, industries and businesses, and the general public to identify and manage water-quality threats is crucial for the future protection of this resource.

Landowners, lake users, and all local and city governments must begin thinking about Lake Tuscaloosa and the North River watershed as a single, functioning system and developing a comprehensive environmental understanding of the system and regional watershed approach for use in protecting, managing, and developing this resource. [2]

REFERENCES

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Monitoring Summary and Current Monitoring Needs

Historic and Recent Monitoring

The Water Improvement Advisory Commission (1949) undertook studies to describe the sanitary condition of waters in North River. They reported data collected on a number of days in October and November 1948 at a location on the North River 5 miles upstream of its mouth. Discharge varied from 45 to 1,200 ft^3/s, dissolved oxygen from 8.4 to 9.8 mg/L, 5-day biochemical oxygen demand (BOD_5) from 0.6 to 4.0 mg/L, pH from 5.9 to 6.7, and hardness (Ca, Mg) from 10 to 42 mg/L.

Pierce (1959) reported the results of samples collected in the North River at Ala. Hwy. 69 on three separate dates in 1956. Discharge varied from 26 to 2,060 ft^3/s, pH from 6.2 to 6.8, hardness (Ca, Mg) from 8.0 to 10 mg/L, and specific conductance from 27 to 34 μS/cm. Pierce also reported the concentrations of several major ionic constituents, including calcium, magnesium, sodium, potassium, bicarbonate, sulfate, and chloride, all of which ranged between 0 and 2.8 mg/L.

Parker (1962) used the data presented in Pierce (1959) as background water-quality information for a project to dam the North River and create Lake Tuscaloosa. Cherry (1963) reported data for four sites in the North River watershed. For the sample collected in North River near Tuscaloosa in August 1960 discharge was 100 ft^3/s, specific conductance was 31 μS/cm, hardness was 10 mg/L, and pH was 6.8. The major ions all ranged between 1.2 and 2.8 mg/L except bicarbonate, which was 11 mg/L. Water-quality at the other sites in the North River system was similar with low dissolved solids content.

Puente and others (1980) reported that surface water of selected North River tributaries in 1977-79 was generally acidic, soft, and low in dissolved solids, with water in streams draining the Pottsville Formation more mineralized than streams draining basins underlain primarily by the Coker Formation. Mooty (1985) compiled water-quality data for several tributaries in the North River system including Turkey Creek, Cripple Creek, Dry Branch, Little Creek, Bear Creek, Tyro Creek, Barbee Creek, Freeman Creek, Cane Creek, and Boone Creek.

Building on the information compiled by Mooty, Slack (1987) compared water-quality at 16 tributary and lake sampling sites (data collected October 1982 to September 1986). Particular emphasis was placed on water-quality parameters affected by the increased coal surface mining activity in the watershed from 1977 to 1986. Slack reported that the water-quality of some streams–North River, Little Creek, Cripple Creek, and Turkey Creek–was deteriorating as observed in lower pH, higher concentrations of dissolved minerals including sulfate, and higher concentrations of iron and manganese. Slack went on to conclude that Lake Tuscaloosa was becoming more mineralized and this was directly linked to the degraded quality of the North River proper caused by mining activity in the watershed. The median sulfate concentration of Lake Tuscaloosa at the dam increased from 6.2 mg/L in 1979 to 14 mg/L in 1985 (Slack, 1987) which represented a 125 % increase in six years.

A study completed by Harris and others (1985) documented the water-quality impacts of historic surface mining in the Tyro Creek watershed, an eastern tributary of the North River. Analysis of water samples collected from September 1981 to July 1984 at four sites indicated that previous surface mining for coal in the watershed resulted in increased mineral content, lower pH, higher iron and manganese concentrations, and increased sediment load in the affected watersheds. Additionally, the authors demonstrated the relationship between discharge and water-quality with ionic constituents decreasing in concentration with increasing discharge and sediment load increasing at higher flow rates. Ionic parameter concentrations generally increased over the range of low to high discharge in direct proportion to the percent of the upstream watershed that had been mined.

Harris and others (1985) collected bed sediment samples twice in the Tyro Creek watershed as part of their investigation of the effects of coal surface mining on water-quality and aquatic communities. In January 2008, a composite bed sediment sample was collected from four stations in the North River system (McGregor and Wynn, 2008), including three in the North River main channel (Fayette Co. Hwy. 30 bridge near Berry, Tuscaloosa Co. Hwy. 55 bridge [Whittson Bridge], and Tuscaloosa Co. Hwy. 38 bridge near Samantha) and one in Clear Creek at Ala. Hwy. 13 bridge near Bankston. Values of major elements and trace elements for the samples collected during that study along with values determined for sediment samples collected in the Black Warrior River (23 samples from eight stations in the Oliver Pool near Tuscaloosa) (unpublished data, Alabama Geological Survey) and the upper Cahaba River system (18 samples from six stations) (Shepard and others, 1994).

The Water Improvement Advisory Commission (1949) found fecal coliform bacteria to range from 0.36 to 210 MPN (most probable number per 100 milliliters of sample) in eight samples collected in the North River about 5 miles upstream of its mouth during October and November 1948. The Geological Survey of Alabama completed an evaluation of *E. coli* bacteria in the North River watershed, including Lake Tuscaloosa, in 2005 (O'Neil and others, 2006). Water samples were collected at 232 stations in the North River watershed. Bacteria samples were collected during high flow periods in April and June and during low flow periods in September and October. The concentration of *E. coli* bacteria ranged from 1 to 14,670 cfu (colony forming units per 100 mL of sample) (median 100) for the low flow period, and from 22 to 17,980 (median 488) for the high flow period. During high stream flows within the lake proper, including small direct tributaries, the upper section had higher median and average bacteria concentrations compared to the middle and lower sections. Direct tributaries had high bacteria concentrations (613 - 17,250 cfu) during high flows with the highest measurements made in Carroll Creek. During low flows, the median bacteria concentrations were similar throughout the lake, with median *E. coli* counts less than 200 cfu. Another piece of evidence relating storm water flows with high bacteria counts in the lake is the observation that during high stream flows approximately 30.5 % of the samples collected and analyzed for *E. coli* were less than 200 cfu and 69.5 % were greater than or equal to 200 cfu. During low flows approximately 71 % of the samples were less than 200 cfu and 29 % were greater than or equal to 200 cfu.

Alfaqih (2008) used this recent *E. coli* data set to further explore the potential sources of contamination in the watershed. Detailed hydrologic and bacteria models were developed for the watershed. Unrestricted access of large animals to stream channels and poor handling of poultry waste were identified as significant contributors of *E. coli* bacteria to the North River. The *E. coli* concentrations increased substantially as the number of chicken houses increased. Modeling results demonstrated that if 50 % of waste from unrestricted pasture inputs and chicken houses was controlled then about 38 % of the rain events would produce *E. coli* concentrations in Lake Tuscaloosa exceeding 200 cfu. If all sources of manure from pastures and chicken houses were controlled, then only 10 % of the rain events would produce *E. coli* concentrations exceeding 200 cfu.

Collections in the upper North River system upstream of Lake Tuscaloosa from 1991 to 1996 documented 14 species of unionid mussels (Pierson, 1992; Freda, 1992; McGregor and Pierson, 1999). Thirteen species were represented by live and fresh dead material and one species by a single weathered dead shell only. A total of 201 mussels, either live or fresh dead, were found at 33 stations. Another mussel survey was conducted during the spring and summer of 2008 in the North River watershed (McGregor and Wynn, 2008). Fifteen species were collected with 13 represented by live animals or fresh dead shells and two represented by weathered dead shells only. A total of 145 mussels, either live or fresh dead, were found at 29 stations.

Biological condition at 21 sites in the North River system was recently evaluated in 2009 (O'Neil and others, 2010). Four sites rated poor (Carroll Creek, Turkey Creek, Clear Creek at Fayette Co. Hwy. 93, and North River at Ala. Hwy. 102), 11 sites rated fair, and 5 sites rated good (Tyro Creek, North River at Tuscaloosa. Co. Hwy. 63, North River at Cedar Creek, Cedar Creek near its mouth, and North River at Lowery Branch). One site, North River upstream of Jenkins Cemetery, rated excellent for biological condition. Historical data existed for nine of the 21 sites where collecting methods were such that an IBI could be calculated. Biological condition degraded from fair to poor at Carroll Creek and from good to poor at Turkey Creek, was unchanged at six sites, and improved from fair to excellent at the North River at Jenkins Cemetery site.

Fish samples collected at 21 sites in the North River watershed in 2008-09 (O'Neil and others, 2009) yielded 7,465 individuals in 52 species. Cyprinids (carps and minnows) comprised about 53.7 % of the total catch among 16 species with the largescale stoneroller, *Campostoma oligolepis*, the most common cyprinid collected at 14.5 % of the total catch. Other abundant cyprinid species found in the North River were the striped shiner, *Luxilus chrysocephalus*, at 6.9 %; the silverstripe shiner, *Notropis stilbius*, at 6.1 %; and an intergrade between the pretty and Warrior shiners, *Lythrurus bellus x L. alegnotus*, at 12.3 %. Sunfishes of the family Centrarchidae were the second most abundant group at 21.7 % of the total catch among ten species with longear sunfish, *Lepomis megalotis*, and bluegill, *L. macrochirus,* the most common sunfish species at 11 and 5.4 % of the total catch, respectively. Darters in the family Percidae were the third most common group collected at 16.9 % of the total catch among eight species. The speckled darter, *Etheostoma stigmaeum*, was the most common percid species at 5.7 % followed by the blackbanded darter, *Percina nigrofasciata*, at 5 % and the redspot darter, *E. artesiae*, at 2.3 %. Species diversity was high at three sites in the North River main channel (North River near Jenkins Cemetery - 32 species; North River at Fayette Co. Hwy. 30 - 29 species; and North River near Cedar Creek mouth - 27 species) and at three tributary sites (Deadwater Creek at Clear Creek - 29 species; Cedar Creek near mouth - 27 species; and Deadwater Creek near RR tracks - 26 species).

ADEM collected water-quality data in the North River system as part of its 5-year basin rotation monitoring schedule for the state. Their most recent sample run included seven sites sampled from April through October, 2007. These sites included five in Lake Tuscaloosa (TUST-1, TUST-2, TUST-3, TUST-4, and TUST-5); one site on the main channel of North River (NRRT-1); and one site on Bear Creek (BERT-4). Samples from these sites were analyzed for several parameters including fecal coliform bacteria, chlorophyll-a, alkalinity, hardness, BOD-5, total suspended solids, chloride, total phosphorus, nitrite+nitrate nitrogen, ammonia, and total kjeldahl nitrogen. Selected trace metals were analyzed on samples from site NRRT-1 including, Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Mn, Ni, Sb, Se, Tl, and Zn.

The U.S. Geological has operated a continual streamflow gage--North River at Samantha site 02464000, 223 mi^2) for many years (period of record (1939-54 and 1969-recent). Various types of water-quality data have been collected at this site over the years including standard field and water-quality parameters (pH, specific conductance, temperature, alkalinity, hardness, BOD-5, total suspended solids), nutrients, metals, and pesticides. Additional gages are currently in operation in the North River watershed including Binion Creek below Gin Creek (02464360-1986 to present), Turkey Creek near Tuscaloosa (02464146-1981 to present), and Carroll Creek at State Hwy. 69-02464660).

Current Monitoring Needs

All of the above listed investigations over the past 50 years in the North River watershed highlight that a few significant water-quality issues are present. These include continued bacteria contamination in Lake Tuscaloosa, high rates of sedimentation in tributaries to the lake and in upper watershed tributaries that support listed mussel species, and the need to more fully assess nutrient loading to the lake. In the ADEM draft 2010 §303(d) list of impaired streams in Alabama the North River has continued to be listed for nutrients and siltation (habitat alteration). Additionally, both the North River and Lake Tuscaloosa are listed for mercury contamination due to atmospheric deposition. The North River and Lake Tuscaloosa will continue to remain on the §303(d) list until such time that a total maximum daily load (TMDL) is approved for reducing these pollutants. Water-quality monitoring will be needed to address these issues and begin the process of creating a TMDL for the North River. Monitoring will also be needed to document the recovery of mussel populations in the watershed. The following studies should be implemented soon to begin this process:

1. Determining sediment and nutrient loading rates in the Clear and Deadwater Creek watersheds will be needed to assist in evaluating future best management practices (BMP) implemented in these areas.
2. A comprehensive assessment of nutrient loading to Lake Tuscaloosa is needed to help define where future 319 projects would be most beneficial.

3. The City of Tuscaloosa should continue with its bacteria monitoring program in Lake Tuscaloosa, perhaps expanding their study area to include tributaries to the lake. This would allow better location of problem areas and allow the city to better communicate the need for implementing good stormwater management practices throughout the watershed.

Recommendations from Cited Sources

***An Evaluation of the Mussel Fauna in the North River System, 2008*. McGreagor Stuart W. Wynn, Elizabeth A. Geological Survey of Alabama. Open File Report 0814. 2008.**

- Further sampling of the mussel fauna should be executed to further refine the current distribution of mussels in the system.
- Stations that currently harbor diverse and abundant mussel populations in the system should be established and monitored periodically to document trends.
- Habitat factors that influence mussel distribution and abundance should be evaluated by such means as land cover/land use mapping, more intensive evaluation of water and sediment quality, rates of sediment loading, and other means as deemed necessary.
- Upon determination of the limiting factors to the population, steps should be taken to ameliorate those factors.
- Long-term monitoring of the system should be enacted to document recovery.

***Distribution and Concentration of Total Coliform and Escherichia Coli Bacteria in the North River/Lake Tuscaloosa Watershed, 2005.* O'Neil, Patrick E., Cook, Marlon R., Henderson, Wiley E., and Moss, Neil R. Geological Survey of Alabama. Open-File Report 0604. Tuscaloosa, Alabama. 2006.**

- Low-flow sampling revealed that ground water is generally of good quality relative to bacteria content in much of the watershed and of fair quality in some areas. Sampling during low flow also revealed a small number of *E. coli* bacteria concentrations that were greater than 10,000 cfu. <u>These watersheds should be immediately investigated to discover the source of contamination.</u>

***Watershed Assessment of the North River System For Recovery and Restoration of Rare Mussel Species*. O'Neil, Patrick E., McGregor, Stuart W., Wynn, Elizabeth A. Geological Survey of Alabama. 2009. Tuscaloosa, Alabama.**

- Additional surveys for mussels should be conducted in the Clear Creek system and in the main channel of North River between Tuscaloosa Co. Hwy. 38 and Fayette Co. Hwy. 30. The objective of these surveys should be to refine the distribution of mussels in these areas and to quantitatively determine population densities through systematic sampling.
- Nutrient status and loading in the system, both in the flowing reaches and in Lake Tuscaloosa, needs to be evaluated through a comprehensive water-quality survey in order to pinpoint subwatersheds from which nutrients are originating.
- The current level of mine drainage entering North River should also be evaluated as part of the nutrient survey. This will allow identification of water-quality-impaired small tributaries and begin restoration activities to lessen sediment runoff and mine drainage.
- Overall stream health should be periodically monitored at fixed stations throughout the watershed using the fish community IBI.

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LOAD AND LOAD REDUCTIONS

The National Land Cover Dataset (NRCS 2008) was used to determine land cover percentages for calculating the amount of nonpoint source pollution in the North River watershed (table 6 using the STEPL model tool (Tetra Tech Inc. 2003). The STEPL model was used to estimate the pollutant loading reductions that could be achieved using currently available best management practices (BMPs) in critical watersheds of the North River system (table 7. STEPL incorporated annual rainfall data, agricultural animal and septic tank densities, and geographic coverages of soil type, slope, and land use to predict nutrient (nitrogen and phosphorus) and sediment loadings in each watershed. The program provides output as to pollutant removal efficiencies for each BMP, and allowed for the adjustment of the percent of area in which the BMP was applied. The goal of the modeling exercise was to reduce the sediment load by 30 % in each watershed (table 7since this pollutant is most directly related to degraded mussel habitat. To achieve this general reduction of sediment loading in the model by 30 % both the BMP efficiencies and the estimated area that the BMPs were applied (table 8 in each watershed were manipulated with the STEPL model. The BMPs chosen for this preliminary analysis were standard applications and included settling basins for forest roads and cropland, streambank stabilization and fencing for pastureland, vegetated buffer strips for single family neighborhoods, and runoff management systems and terracing for feedlots. All loading estimates are preliminary and do not necessarily reflect the actual loading of nutrients and sediment in the watershed.

Table 6 Pre-BMP Pollutant Loading Summary by Watershed

Watershed	Nitrogen load lb/year	Phosphorus load lb/year	Sediment load ton/year
Cedar Creek	65,975	12,588	741
Clear Creek	58,256	12,783	1,070
Upper North River	133,298	27,299	1,300
Tyro Creek	15,421	3,783	435
Bear Creek	43,279	8,150	441
Binion Creek	166,790	35,246	2,847
Carroll Creek	70,312	13,916	1,193
Cripple Creek	53,677	9,734	653
Lower North River & Lake Tuscaloosa	546,630	105,992	9,104
Turkey Creek	26,955	5,511	238
Total	1,180,593	235,003	18,021

Table 7 Post-BMP Pollutant Loading Summary by Watershed

Watershed	Nitrogen reduction		Phosphorus reduction		Sediment reduction	
	lb/year	Percent	lb/year	Percent	ton/year	Percent
Cedar Creek	5,843	8.9	5,121	40.7	235	31.6
Clear Creek	18,330	31.5	5,994	46.9	311	29.1
Upper North River	10,717	8	12,305	45.1	382	29.4
Tyro Creek	3,573	23.2	651	17.2	125	28.7
Bear Creek	15,501	35.8	3,844	47.2	130	29.6
Binion Creek	12,636	7.6	11,242	31.9	883	31
Carroll Creek	25,456	36.2	6,406	46	372	31.2
Cripple Creek	7,784	14.5	4,011	41.2	191	29.2
Lower North River & Lake Tuscaloosa	53,046	9.7	40,104	37.8	2671	29.3
Turkey Creek	2,660	9.9	2,411	43.8	73	30.7
Total	155,544	13.2	92,088	39.2	5373	29.8

Table 8 Percent of Land Cover Area that BMP Was Applied By Watershed Within the STEPL Model

Watershed	Land cover class				
	Urban	Crop	Pasture	Forest	Feedlot
Cedar Creek	96	100	45	15	70
Clear Creek	34	40	65	40	90
Upper North River	60	NA	65	35	75
Tyro Creek	NA	NA	60	30	85
Bear Creek	NA	NA	55	25	75
Binion Creek	99	40	60	15	55
Carroll Creek	99	27	90	30	90
Cripple Creek	40	NA	63	25	70
Lower North River & Lake Tuscaloosa	25	45	55	15	70
Turkey Creek	76	45	70	13	70

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