# ARKANSAS WATER PLAN UPDATE
# TASK NO. 6 – SOUTH-CENTRAL ARKANSAS WATER RESOURCES PLANNING REGION

**AUGUST 11, 2014**

# ARKANSAS WATER PLAN UPDATE
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# WATER RESOURCES PLANNING REGION

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# TABLE OF CONTENTS

# TABLE OF CONTENTS (CONTINUED)

# TABLE OF CONTENTS (CONTINUED)

# TABLE OF CONTENTS (CONTINUED)



# LIST OF APPENDICES

# LIST OF TABLES

## LIST OF TABLES (CONTINUED)

## LIST OF TABLES (CONTINUED)

# LIST OF FIGURES

# LIST OF FIGURES (CONTINUED)

# LIST OF FIGURES (CONTINUED)

# LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ACS | American Community Survey |
| ADEQ | Arkansas Department of Environmental Quality |
| ADH | Arkansas Department of Health |
| ADPCE | Arkansas Department of Pollution Control & Ecology (now ADEQ) |
| AGFC | Arkansas Game and Fish Commission |
| AHF | anhydrous hydrogen fluoride |
| AHTD | Arkansas State Highway and Transportation Department |
| ANHC | Arkansas Natural Heritage Commission |
| ANRC | Arkansas Natural Resources Commission |
| APCEC | Arkansas Pollution Control and Ecology Commission |
| AP&L | Arkansas Power & Light |
| ASWCC | Arkansas Soil and Water Conservation Commission (now ANRC) |
| AWAG | Arkansas Watershed Advisory Group |
| AWP | Arkansas Water Plan |
| CAW | Central Arkansas Water |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| cfs | cubic feet per second |
| COPC | Contaminant of Potential Concern |
| CRP | Conservation Reserve Program |
| CSP | Conservation Stewardship Program |
| CWA | Clean Water Act |
| DCE | dichloroethene |
| DDD | dichlorodiphenyldichloroethane |
| DDT | dichlorodiphenyltrichloroethane |
| DO | dissolved oxygen |
| *E. coli* | *Escherichia coli* |
| EPA | United States Environmental Protection Agency |
| EQIP | Environmental Quality Incentives Program |
| FEMA | Federal Emergency Management Agency |
| FIFRA | Federal Insecticide, Fungicide, and Rodenticide Act |
| GCGW | Governor's Commission on Global Warming |
| gpm | gallons per minute |
| HUD | United States Department of Housing and Urban Development |
| LDNR | Louisiana Department of Natural Resources |
| MCL | maximum contaminant level |
| MEK | methyl ethyl ketone |
| mg/L | milligrams per liter |
| mgd | million gallons per day |
| MS4 | municipal separate storm sewer system |
| n.d. | no date |
| NCDC | National Climatic Data Center |

# LIST OF ABBREVIATIONS AND ACRONYMS (CONTINUED)

| | |
|---|---|
| NEPA | National Environmental Policy Act |
| NFIP | National Flood Insurance Program |
| NOAA | National Oceanic and Atmospheric Administration |
| NPDES | National Pollutant Discharge Elimination System |
| NPS | nonpoint source |
| NRCS | Natural Resources Conservation Service |
| NTU | Nephelometric turbidity unit |
| NWIS | National Water Information System |
| NWR | National Wildlife Refuge |
| PCBs | polychlorinated biphenyls |
| PCE | perchloroethylene |
| PCP | phencyclidine |
| PDSI | Palmer Drought Severity Index |
| RCRA | Resource Conservation and Recovery Act |
| RSWMD | Regional Solid Waste Management District |
| SCAWRPR | South-Central Arkansas Water Resources Planning Region |
| SDWA | Safe Drinking Water Act |
| SFHA | Special Flood Hazard Area |
| SGCN | Species of greatest conservation need |
| TCA | trichloroethane |
| TCE | trichloroethene |
| TDS | total dissolved solids |
| TMDL | total maximum daily load |
| TOC | total organic carbon |
| TSCA | Toxic Substances Control Act |
| TSS | total suspended solids |
| U of A | University of Arkansas |
| UCWCB | Union County Water Conservation Board |
| USACE | United States Army Corps of Engineers |
| USDA | United States Department of Agriculture |
| USDI | United States Department of the Interior |
| USFS | USDA Forest Service |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |
| VOC | volatile organic compound |
| WHIP | Wildlife Habitat Incentives Program |
| WMA | Wildlife Management Area |
| WRDA | Water Resources Development Act |
| WRPR | Water Resources Planning Region |

# 1.0 INTRODUCTION

The Arkansas Natural Resources Commission (ANRC) is responsible for preparing and periodically updating a statewide water resources planning document. The previous update of the Arkansas Water Plan (AWP) was completed in 1990. In 2012, ANRC initiated an update of the 1990 AWP to be completed in 2014.

This document was prepared as part of the 2014 update of the AWP (Project Task 6). This document provides background information about the South-Central Arkansas Water Resources Planning Region (SCAWRPR) that will be used in the 2014 AWP update. The SCAWRPR is one of five state water resources planning regions being addressed in the 2014 AWP update. The information in this document will serve as background for updated discussion and analysis of state water supplies, water demand, and alternatives for meeting the water resources needs in the SCAWRPR. This background information includes a description of the history of the planning region, its physical characteristics, natural resources, water resources, demographics, and economy. Finally, the regulatory and institutional framework for water resources management in this planning region is outlined.

# 2.0 GEOGRAPHY AND HISTORY

This section provides a general description of the geography of the SCAWRPR, a brief history of the regional culture, and an overview of historical water resources management in the region.

## 2.1 Geography

The SCAWRPR encompasses approximately 12,000 square miles in central south Arkansas (Figure 2.1). This region is bounded on the south by Louisiana. The remainder of the boundary of the SCAWRPR roughly corresponds to the hydrologic boundary of the Ouachita River basin. All or part of 21 counties fall within the SCAWRPR. Table 2.1 lists these counties, the area of each county that is in the SCAWRPR, and the corresponding percentage of the county in the SCAWRPR. Major cities in the SCAWRPR include Benton, Hot Springs, Malvern, Arkadelphia, Camden, and El Dorado.

## 2.2 History

Water resources have influenced the history of this region, and the current condition of water resources in the region is a product of human activities throughout its history. The cultural history of the region is outlined below. The history of water resources development in the planning region is summarized separately.

### 2.2.1 Cultural

Native Americans settled the SCAWRPR prior to European exploration and settlement. The Caddo tribe was well established in this region when Europeans first explored the region. They lived and farmed in the valleys and river bottoms. The Caddo were a mound-building culture. They used novaculite found in the region to make arrowheads and for trade (Department of Arkansas Heritage 2013a, Department of Arkansas Heritage 2013b, Early 2012, Foti 2008). The Caddo also used and traded salt they made from natural brine seeps that occur in the area (Early 2010).

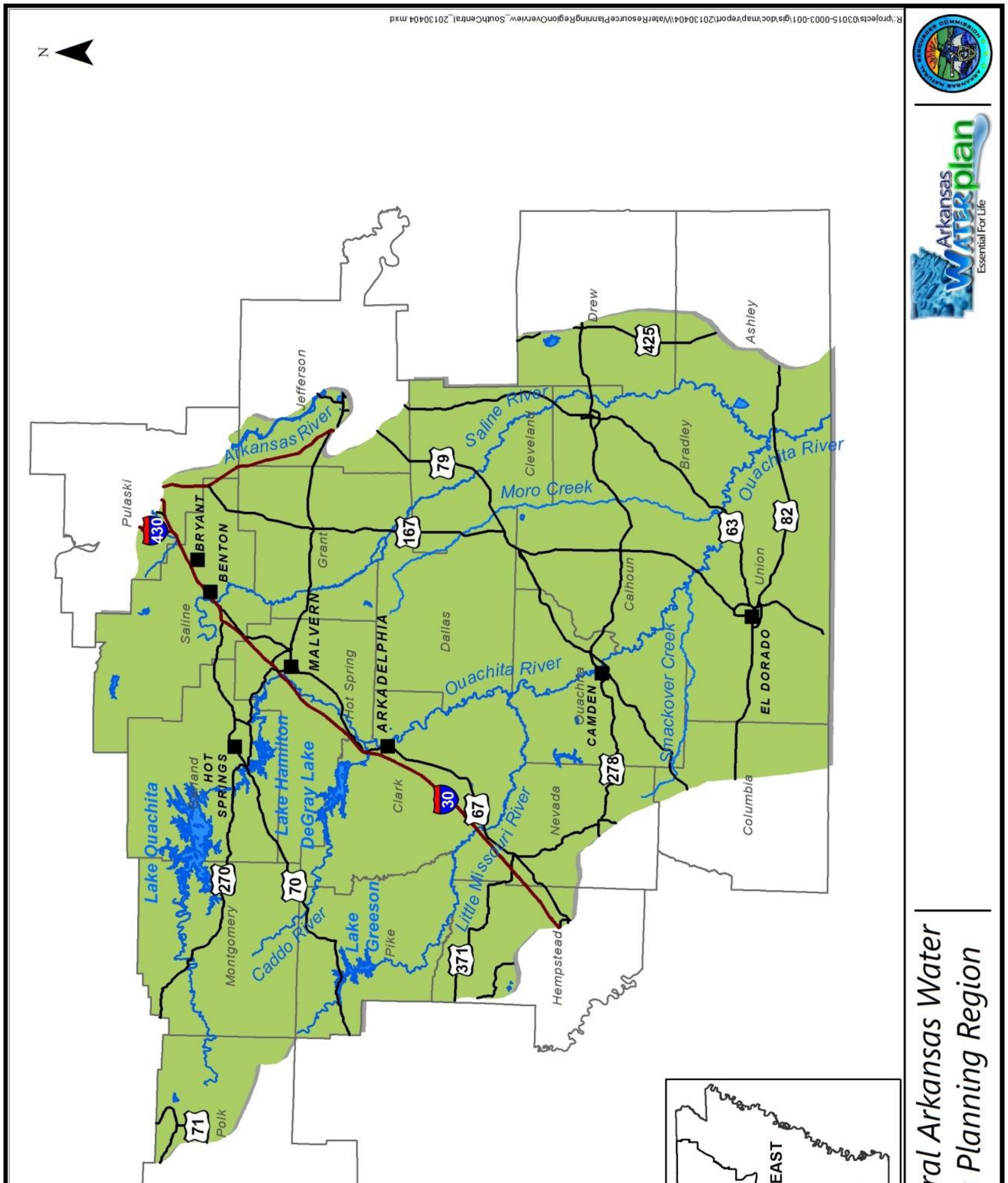


Figure 2.1. Map of the SCAWRPR.

Table 2.1. Counties in the SCAWRPR.

| County | County Area in Planning Region (square miles) | Percentage of County Area in Planning Region |
|---|---|---|
| Ashley | 317.5 | 33.8% |
| Bradley | 652.4 | 100.0% |
| Calhoun | 631.9 | 100.0% |
| Clark | 882.2 | 100.0% |
| Cleveland | 598.5 | 100.0% |
| Columbia | 261.6 | 34.1% |
| Dallas | 667.5 | 100.0% |
| Drew | 314.2 | 37.6% |
| Garland | 734.0 | 100.0% |
| Grant | 632.5 | 100.0% |
| Hempstead | 323.7 | 43.7% |
| Hot Spring | 621.7 | 100.0% |
| Jefferson | 247.9 | 27.1% |
| Montgomery | 800.3 | 100.0% |
| Nevada | 470.1 | 75.8% |
| Ouachita | 739.2 | 100.0% |
| Pike | 613.5 | 100.0% |
| Polk | 319.7 | 37.1% |
| Pulaski | 145.2 | 18.0% |
| Saline | 729.9 | 100.0% |
| Union | 1054.5 | 100.0% |
| **Total** | **11,758** | -- |

Hernando de Soto's Spanish expeditionary force were the first Europeans in the SCAWRPR, arriving in 1541. They passed through the region in 1541 on their way to southeastern Arkansas, where Hernando de Soto died in 1542. Under new leadership, the expedition then travelled to the Red River, passing through the region, and, finally, back to the Mississippi River, passing through the region once more (Key 2012).

Some 130 years later, French explorers, hunters, traders, and missionaries began exploring this region, establishing alliances with the Quapaw and Caddo Indians, and leaving behind French place-names. In 1682, French explorer La Salle claimed the region for France. In 1685, La Salle attempted to lead a group of colonists into the region from the Gulf Coast. La Salle and many of the colonists died, and other colonists were captured by the Spanish, but a few survivors did succeed in making their way to southern Arkansas, and eventually to the Arkansas River. In 1762, after the end of the French-Indian War, the SCAWRPR came under

Spanish control. Between the time of the La Salle expedition and the war, French hunters became established in the planning region, travelling along the Ouachita River and its tributaries, particularly the Saline River where natural salt licks attracted game. French hunters and traders remained in the area after the Spanish took over, and were joined by hunters and traders of other nationalities. In the 1780s, the Spanish attempted to establish a post on the Ouachita River near present-day Camden. They finally succeeded in establishing a post farther downstream, in what is now Louisiana. With the Louisiana Purchase in 1803, the territory that would become Arkansas became part of the United States (Key 2012).

At the time of the Louisiana Purchase, the Quapaw claimed the territory between the Arkansas and Red rivers, which included the SCAWRPR. In 1818, they signed a treaty where their lands were reduced to the area bounded by the Arkansas, Ouachita, and Saline Rivers. By 1825, the Quapaw were forced to move out of Arkansas to Louisiana so settlers could grow cotton.

In 1804, President Jefferson authorized exploration of the southwest portion of the Louisiana Purchase. This resulted in William Dunbar and George Hunter leading an expedition up the Ouachita River to Hot Springs.

The first significant settlement in the SCAWRPR occurred in the northern part of the region, along the Southwest Trail. Cotton plantations were established in the southern area of the planning region. By 1860, the planning region was one of the most heavily populated areas of the state due to the expansion of cotton production. At that time, Camden was one of the centers of political and commercial power in the state due to cotton agriculture. The first large-scale manufacturing operation in the state, a textile mill, was constructed in Pike County just before the Civil War (Bolton 2012).

A saltworks was established on the Saline River near Benton County around 1827 (Woodard 2012).

During the Civil War, there were a number of battles in the SCAWRPR. Several significant battles occurred in 1864 and 1865 when the Union army launched a large-scale military operation intended to move south from Little Rock to Shreveport, Louisiana. The Union army made it as far south as Camden and then was forced back to Little Rock. In 1862, Hot Springs served as the temporary state capital for several months.

After the Civil War, cotton plantations in the SCAWRPR were converted to tenant farms, or were operated using paid labor. However, cotton prices fell after the war, remaining low through the 1890s. As a result, many cotton operations were forced to shut down. In the 1930s, cotton production in the region declined, and soybean and rice production began to increase (Hawkins 2011).

In 1875, a railroad line was completed to Hot Springs to transport tourists, patients, and goods (Lancaster 2012a). In 1882, part of the Texas and St. Louis railroad line was constructed through Pine Bluff, Rison, Fordyce, and Camden. The primary purpose of this line was to transport cotton (Zbinden 2011).

The railroad also brought lumber entrepreneurs into the SCAWRPR. The first Arkansas lumber companies in the region were founded in the 1890s. By the early 1920s, nearly all the virgin timber in the state had been cut. Taking advantage of the relatively rapid regrowth rate of timber, local lumber companies began operating pine plantations in the region. The first paper mill in the region was opened in Camden in 1928 by International Paper. Other wood products-manufacturing operations established in the planning region included wood-based chemicals, food board, flake board, and plywood (Balogh 2013). By the end of the 1960s, local lumber companies had been taken over by national and international companies like International Paper and Georgia-Pacific (Balogh 2013, Moneyhon 2013).

Exploration for oil and gas began in the SCAWRPR in the early 20$^{th}$ century. Discovery of oil in 1920 set off an oil boom in south Arkansas in 1921. By 1922, 900 oil wells were in operation in the state. El Dorado became the center of the oil industry in Arkansas. Murphy Oil and Lion Oil companies were founded in the region in the early 1920s. The peak of the oil boom occurred in 1925. At that time, oil was being produced more rapidly than it could be transported to refineries. When production dropped in the late 1920s, several lawsuits were filed against Arkansas oil companies to require more responsible management of oil and gas resources. The Arkansas Oil and Gas Commission was established in 1939. Twelve major oil pools were discovered in the planning region between 1936 and 1947 (Bridges 2011).

### 2.2.2 Water Resources Development

A range of water resources development activities have occurred in this region throughout its history, as attitudes and policies have changed. Historically, human activities that have affected water resources in this planning region have included draining and clearing of wetlands, levee building, river transportation and navigation, development of surface water and ground water for water supply and hydropower, changes in cropping, wildlife habitat and wetland conservation, and development of the recreation industry in the region.

#### 2.2.2.1 Navigation

During the territorial period, rivers were important means of transportation throughout Arkansas. The Ouachita River linked southern Arkansas to New Orleans. The first steamboat navigated the Ouachita River in 1819. Steamboat traffic on the Ouachita River was the primary mode of transportation in the region until around 1910. During high water, steamboats travelled as far upriver as Camden and Arkadelphia (Gore 2009). Steamboats also navigated the Saline River as far upstream as Bridges Bluff in Cleveland County. Fifty-four steamboats have been documented operating on the Saline River (Woodard 2012).

The Ouachita-Black Rivers Navigation Project was initiated in 1902. Construction of the six locks and dams was completed in 1924. The navigation project maintains naviation on the Ouachita River from Camden downstream to the Black River (USACE Vicksburg District 2013b). In Arkansas, the Ouachita River – Black River navigation project consists of two locks and dams constructed on cutoff canals. A 9-ft navigation channel is maintained in the Ouachita River to Camden by dredging and snagging. There are two public ports on the Ouachita River in Arkansas, at Crossett and Camden (Figure 2.2). Commercial navigation on the Ouachita River is feasible year-round in Arkansas.

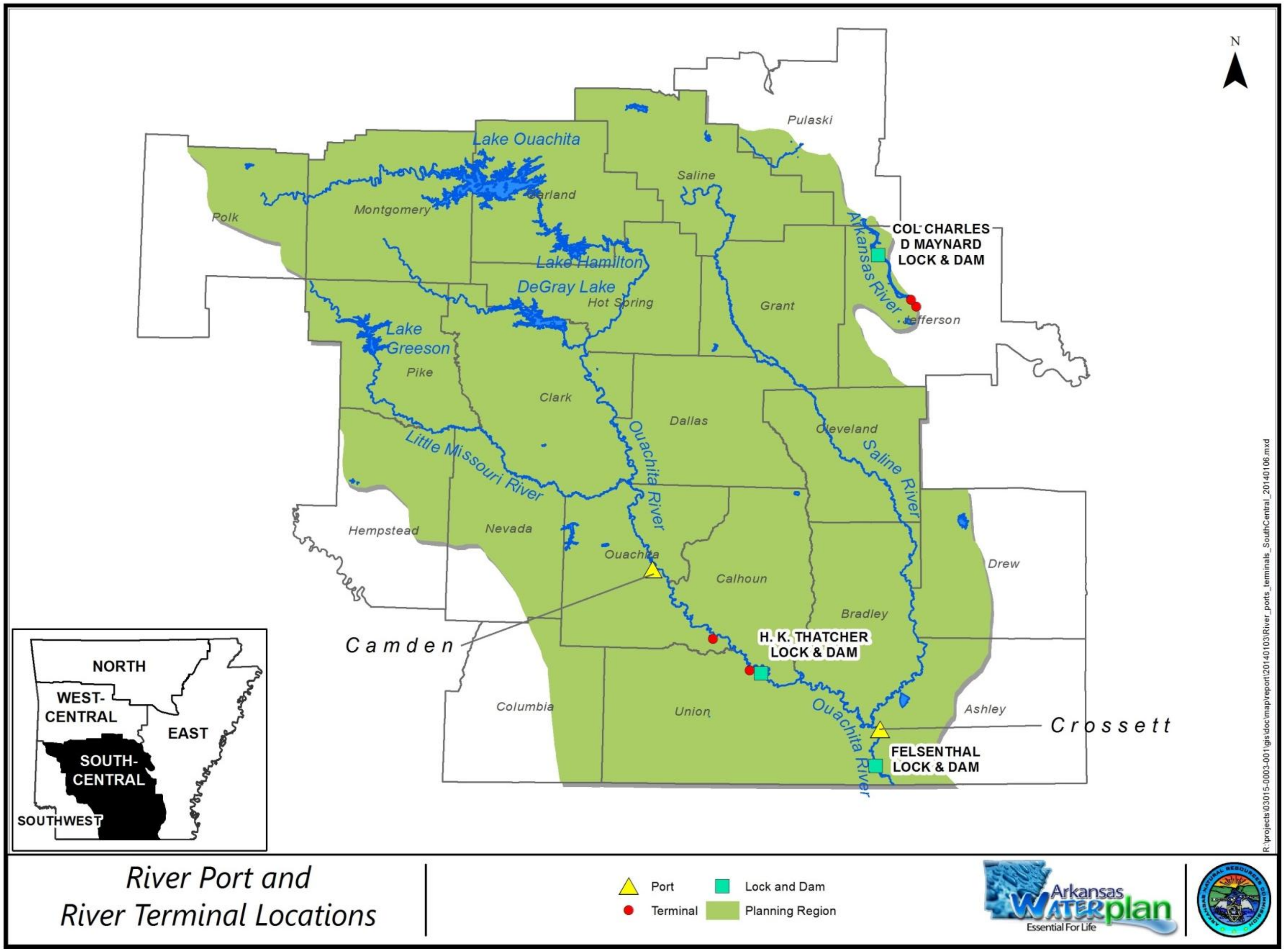


Figure 2.2. Facilities of the Ouachita-Black Rivers Navigation System within the SCAWRPR.

#### 2.2.2.2 Flood Control

In 1870, the US Congress authorized a survey of the Ouachita River to investigate improving navigation and flood prevention (Lancaster 2012b). The Flood Control Act of 1937 proposed that every major stream in the Ouachita River watershed be dammed (Woodard 2012). The Flood Control Act of 1941 authorized construction of the Narrows Dam on the Little Missouri River for flood control. The dam was completed in 1950 (Lancaster 2011).

#### 2.2.2.3 Hydropower

The first hydroelectric power facility in Arkansas was Remmel Dam, constructed on the Ouachita River in 1924. This facility was constructed by Arkansas Power & Light (AP&L). In 1931, AP&L finished construction of Carpenter Dam, a second hydroelectric power facility, upstream of Remmel Dam on the Ouachita River (Reynolds 2013).

Beginning in 1938, the US Army Corps of Engineers (USACE) began constructing hydropower dams in Arkansas (Reynolds 2013). Construction of Blakely Mountain Dam on the Ouachita River upstream of the AP&L reservoirs was initiated by USACE in 1946. This project was initially planned as a joint project by USACE and AP&L. The power plant was completed and began operation in 1955 (Lancaster 2012a). The DeGray Lake dam hydropower project on the Caddo River was authorized by the 1950 River and Harbors Act. Funds were appropriated for the project in 1961. Construction was initiated in 1964 and completed in 1966 (Lancaster 2012c).

#### 2.2.2.4 Commercial Fishing

Commercial fishing played an important role in the SCAWRPR during settlement and early development. Historical records indicate that commercial fishing occurred on the Ouachita River during the 19$^{th}$ century, though takes were not as large as from other rivers in the state (Townsend 1902, US Commisison of Fish and Fisheries 1895). In recent history, there have not been significant amounts of fish taken commercially from the Ouachita River in Arkansas (Robison and Buchanan 1988). Both the Ouachita River and Saline River are mentioned in the current state commercial fishing regulations (AGFC 2013a).

In the 1890s, pearl fishing was fashionable on the Saline River (Woodard 2012).

#### 2.2.2.5 Red River Compact

In 1955, the US Congress authorized Texas, Oklahoma, Arkansas, and Louisiana to begin negotiating a compact to resolve disputes over rights to water in the Red River and its tributaries, as well as preventing future disputes. In 1978, after 23 years of negotiations, representatives of Texas, Oklahoma, Arkansas, and Louisiana signed the Red River Compact (Lancaster 2011). The purpose of the compact is to provide for equitable apportionment of the waters of the Red River and its tributaries among the four states to ensure conservation and protection of this shared resource.

#### 2.2.2.6 Health Spas

The thermal springs of Hot Springs in Garland County were first used by native Americans (Lancaster 2012d). After the Louisiana Purchase, President Jefferson commissioned an expedition led by William Dunbar and Dr. George Hunter to travel up the Ouachita River to the already famous hot springs in what would become Garland County. The expedition arrived at the springs in 1804 and conducted studies of the springs. They noted evidence of use of the springs by locals (Shugart 2013).

Over the period from 1807 through 1830, settlement around the springs and visitors to the springs increased. There was dispute among the locals and the state legislature about whether the hot springs and surrounding area should be developed as a private health spa, or as a public resource. In 1832, the US Congress set aside the area as a federal reservation, the first national park. The thermal springs were not significantly developed until the 1880s. At that time, the first hospital was built, as well as the bathhouses, establishing the area as a health spa resort (Shugart 2013).

The Parnell Springs in Bradley County were also developed into a health resort sometime prior to 1880. Between 1880 and the 1920s, the healing Parnell Springs were the center of a booming health resort. The resort closed during the Depression (Moseley 2011).

#### 2.2.2.7 Bottled Water

A number of springs throughout the SCAWRPR have been developed through the bottled water industry. Table 2.2 lists the springs in the planning region where water is bottled for sale.

Mountain Valley Spring Water, the company that bottles water from the Hot Springs area, is probably the oldest bottled water company in the planning region. This company began operations in Garland County in the early 1870s (Speed 2007).

Table 2.2. Bottled spring water in the SCAWRPR (Arkansas Geological Survey 2012a).

| Company | Springs | County | Start of Operations |
|---|---|---|---|
| Mountain Valley Spring Water | Diamond Spring | Garland | 1871 |
| Monticello Spring Water Company[(a)] | Unnamed | Montgomery | 1923 |
| Alexa Springs[(b)] | Unnamed | Montgomery | Unknown |
| Crystal Springs Bottled Water[(c)] | Wilderness Valley Spring | Polk | Unknown |
| Mountain Pure LLC[(d)] | Walker Spring | Montgomery | Unknown |
| CG Roxane, LLC[(e)] | Cox Spring | Montgomery | 2007 |

Notes: a. http://www.monticellospringwater.com/
b. http://www.alexasprings.com
c. http://www.crystalh2o.com/products_office.html
d. http://www.mtnpurewater.com/home.htm
e. http://www.crystalgeyserasw.com/resources.html

#### 2.2.2.8 Waterfowl and Aquatic Habitat Conservation

Just after the turn of the 20$^{th}$ century, preservation of migratory waterfowl became a national priority (Morrow n.d.). The Arkansas Game and Fish Commission (AGFC) began establishing wildlife management areas (WMAs) in the region in the 1960s (Table 2.3). The US Fish and Wildlife Service (USFWS) established a National Wildlife Refuge (NWR) in the area for protection of habitat migratory waterfowl in 1975. The Arkansas Natural Heritage Commission (ANHC) has established several state natural areas in the planning region to protect aquatic and wetland habitats.

After passage of the Flood Control Act of 1937, plans were developed for damming the Saline River for the purpose of flood control, hydropower, lake recreation, and water supply. However, this plan was met by opposition from local citizens and elected officials who wanted to preserve the river in its free-flowing state. Plans to dam the Saline River languished until the 1970s when it was officially rejected by Arkansas Governor David Pryor.

Table 2.3. History of WMAs in the SCAWRPR (AGFC 2011, USFWS 2013d, ANHC 2010).

| Name | Type | Area (acres) | Counties | Year Established | Management | Purpose | Other |
|---|---|---|---|---|---|---|---|
| Beryl Anthony Lower Ouachita | WMA | 7,500 | Ashley, Union | 1987 | AGFC | Hunting, fishing, and other outdoor recreational activities | |
| Felsenthal | NWR | 65,000 | Ashley, Bradley, Union | 1975 | USFWS | Habitat for migratory waterfowl, hunting, fishing | World's largest green-tree reservoir |
| Big Timber | WMA | | Clark | 1988 | AGFC | Hunting and outdoor recreation | |
| DeGray Lake | WMA | | Clark, Hot Spring | | USACE | | |
| Electric Island | WMA | | Garland | | AGFC | | |
| Winona | WMA | 160,000 | Garland, Perry, Saline | 1968 | US Department of Agriculture (USDA), Weyerhaeuser | Wildlife enhancement | |
| Caney Creek | WMA | 85,000 | Howard, Montgomery, Pike, Polk | 1968 | USDA Forest Service (USFS) | Wildlife enhancement | |
| Muddy Creek | WMA | 150,000 | Montgomery, Scott, Yell | 1968 | USFS, Weyerhaeuser | Wildlife enhancement | |
| Poison Springs | WMA | 22,162 | Nevada, Ouachita | 1972 | ANHC, AGFC, Arkansas Forestry Commission | Hunting and other outdoor activities | |
| Two Bayou Creek | WMA | | Ouachita | | AGFC | Hunting | |
| Lake Greeson | WMA | 36,200 | Howard, Pike | 1981 | Weyerhaeuser, USACE, private | Wildlife habitat, public hunting | |
| Longview Saline | Natural Area | 2,215 | Ashley | 2011 | ANHC | Protection of water quality and endangered mussels | |

Table 2.3. History of WMAs in the SCAWRPR (continued).

| Name | Type | Area (acres) | Counties | Year Established | Management | Purpose | Other |
|---|---|---|---|---|---|---|---|
| Moro Big Pine | Natural Area, WMA | 120,000 | Calhoun | 2007 | ANHC | Habitat protection | Best and largest remaining loblolly pine flatwoods in Arkansas |
| Moro Creek Bottoms | Natural Area | 81.1 | Cleveland | 1987 | ANHC | Habitat protection | |
| Mills Park | Natural Area | 10.5 | Saline | 1990 | City of Bryant | Ecosystem protection | |
| Lorance Creek | Natural Area | 294.3 | Pulaski, Saline | 1990 | ANHC | Ecosystem preservation | |
| Middle Fork Barrens | Natural Area | 135.98 | Saline | 2004 | ANHC | Ecosystem preservation | |
| Gap Creek | Natural Area | 10.07 | Montgomery | 1981 | ANHC | Preservation, water quality | |
| Big Fork Creek | Natural Area | 13.58 | Polk | 1978 | ANHC | Preservation of creek and spring ecosystems | |
| Arkansas Oak | Natural Area | 200.27 | Nevada | 1980 | ANHC, AFC | Preservation of creek bottom and seep ecosystems | |
| Logoly | Natural Area, State Park | 200 | Columbia | 1979 | ANHC, Arkansas State Parks | Education, preservation of spring and moist ravine ecosystems | |
| Kingsland Prairie | Natural Area | 399.19 | Cleveland | 2009 | ANHC | Seasonally-wet depression ecosystem preservation | |

In 1968, the National Wild and Scenic Rivers System was created to preserve free-flowing rivers with outstanding recreational, cultural, and/or natural features. In 1979, the Arkansas Natural and Scenic Rivers System was created (ANHC 2012). The Saline River was designated as an Arkansas Natural and Scenic River by the Arkansas legislature in 1985 (Table 2.4) (Arkansas Code 15-23-313). In 1992 a portion of the Little Missouri River was added to the National Wild and Scenic Rivers System (Interagency Wild and Scenic Rivers Council n.d.).

Table 2.4. Natural/wild and scenic rivers in the SCAWRPR (ANHC 2012, Interagency Wild and Scenic Rivers Council n.d.).

| River | System | Length (miles) | County | Year designated | Agency |
|---|---|---|---|---|---|
| Saline River | State | 157 | Ashley, Bradley, Cleveland, Drew, Grant | 1985 | ANHC |
| Little Missouri River | National | 15.7 | Montgomery, Polk | 1992 | USFS |

# 3.0 PHYSICAL CHARACTERISTICS

This section summarizes the physical and biological characteristics of the SCAWRPR. This includes the physiography, geology, climate, and land use, as well as descriptions of the ecological, surface water, and groundwater resources within the planning region.

## 3.1 Physiography

Arkansas is typically divided into two major physiographic regions. These are the Interior Highlands of northern Arkansas, and the Gulf Coastal Plain of southern and eastern Arkansas. These regions are further divided into smaller physiographic provinces based on topography and geology. The “fall line” is where the two major physiographic regions in Arkansas meet.

The SCAWRPR is located primarily in the Gulf Coastal Plain physiographic region, with a part of the Interior Highlands included in the northern portion of the planning region. The physiographic subdivision of the Gulf Coastal Plain that occurs in the planning region is the West Gulf Coastal Plain province (Figure 3.1). The physiographic subdivision of the Interior Highlands that occurs in the planning region is the Ouachita Mountain province (Figure 3.1) (Fugitt, ANRC, personal communication, April 9, 2013).

### 3.1.1 West Gulf Coastal Plain Province

The West Gulf Coastal Plain physiographic province accounts for the majority of the area of the SCAWRPR (Figure 3.1). The West Gulf Coastal Plain is characterized as a south-sloping plain with gently rolling hills and broad, level to nearly level stream valleys. This area is only moderately dissected by streams. Elevations range from over 500 feet in the northern uplands to less than 50 feet (the lowest elevation in the state) along the Ouachita River at the Louisiana border (Woods et al. 2004).

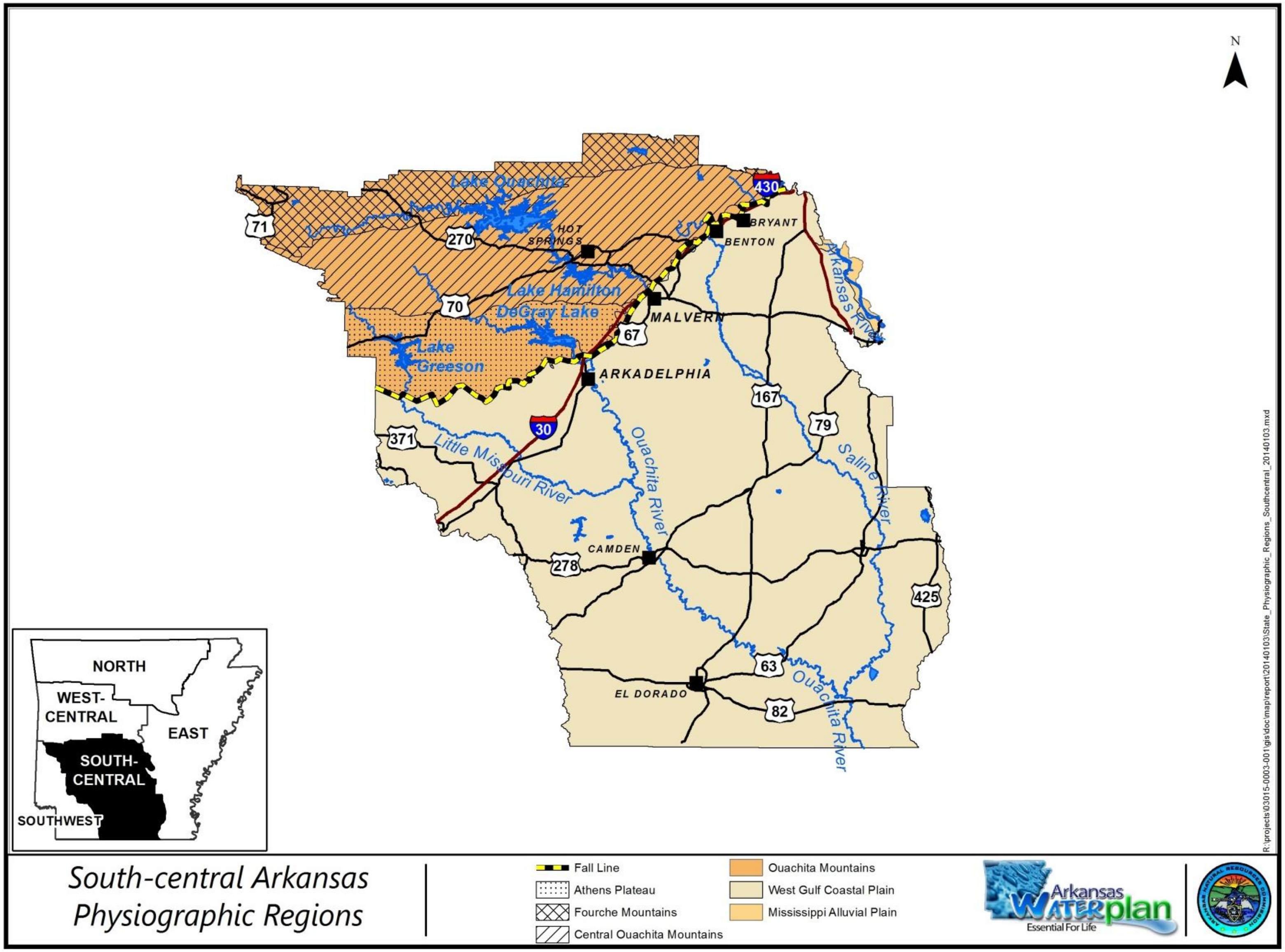


Figure 3.1. Physiographic subdivisions of the SCAWRPR.

### 3.1.2 Ouachita Mountain Province

The Ouachita Mountain Province includes the Arkansas River Valley, and the Fourche Mountains, Central Ouachita Mountains, and Athens Plateau. The Fourche Mountains, Central Ouachita Mountains, and Athens Plateau occur in the planning region (Figure 3.1). These physiographic regions are characterized by generally parallel ridges and valleys which have an east-west orientation. The different regions are distinguished largely by the spacing of the ridges. Elevations are lower in the eastern portion of the Ouachita Mountain Province and higher to the west (Foti 2011; Fugitt, ANRC, personal communication, April 9, 2013).

The Fourche Mountains are present along the northern boundary of the SCAWRPR (Figure 3.1). The Fourche Mountains include the highest ridges in the planning region, over 2,000 feet above sea level. These ridges are characteristically oriented east to west and are long, even crested, and steep-sloped (Arkansas Geological Survey 2012b). Valley floors are broad and often of considerable elevation, reaching 1,100 feet above sea level at the center around Mena.

The Central Ouachita Mountains are south of the Fourche Mountains, and are present along the northern boundary of the planning region east of Polk County (Figure 3.1). The ridges of the Central Ouachita Mountains are very close, separated by narrow valleys with steep gradients. These ridges are east-west oriented, long, even-crested, and steep-sloped. Some of the principal mountains in this area are the Caddo, Cossatot, Trap, Crystal, and Zigzag. Elevations of 2,000 feet are common, and local relief is between 300 and 900 feet.

The Athens Plateau is a very narrow belt extending along the southern edge of the Interior Highlands (Figure 3.1). Elevation is little above 500 feet and the topography has an undulating appearance. Occasional hills are remnants of an older surface. The low ridges of the Athens Plateau are generally oriented east to west.

## 3.2 Geologic Setting

Formations underlying the SCAWRPR range in stratigraphic order from the earliest deposited layers of the Cambrian Period to Quaternary alluvium. The only recognized Cambrian formation in Arkansas is the Collier Shale located in a valley in Montgomery County between the watersheds of the Ouachita and the Little Missouri Rivers. Figure 3.2 displays the surface geology of the planning region.

The varied geology of the SCAWRPR makes it rich in economically important minerals. Industrial minerals available in the Ouachita Mountain province include barite, clay, copper, crushed stone, iron, manganese, mercury, novaculite, quartz crystals, sand and gravel, soapstone, titanium, tripoli, wavelite, and vanadium. In the West Gulf Coastal Plain, bauxite/aluminum, bromine, chalk, clay, crushed stone, diamonds, gypsum, oil, sand and gravel are extracted (Mayfield 2001, USGS 2013a).

### 3.2.1 Geology of the West Gulf Coastal Plain Province

Geologic formations comprising the West Gulf Coastal Plain in Arkansas are contained within the Mississippi Embayment, which is a low-lying basin that is filled with Cretaceous age to recent sediments. The Mississippi Embayment is a structural trough (syncline) formed from downwarping and rifting related to the Ouachita orogeny. This activity resulted in a deep catch basin for sediment deposition. The axis of this syncline plunges southward, with the axis roughly parallel to the Mississippi River (Clark, Hart and Gurdak 2011). In the SCAWRPR, this is an area of low relief underlain by unconsolidated to semi-consolidated deposits of Cretaceous through Quaternary age sand and clay. Recent alluvial deposits are also associated with the major rivers in SCAWRPR such as the Saline and Ouachita.

Cycles of rising and falling sea levels from the Cretaceous through the Tertiary periods resulted in older deposits cropping out on the periphery of the embayment, in bands of varying widths roughly parallel to the fall line and dipping gently to the south and southeast. The Cretaceous-age deposits, consisting of sand, clay, gravel, marl, limestone, and chalk, represent shallow, marginal, and usually restricted marine environments. Most of the beds are coarse sand, clay, or gravel. The lowermost formation is the Trinity Group, which also contains gypsum. The Tokio and Ozan Formations represent the middle Cretaceous and contain some lignite; the upper Cretaceous is represented by the Brownstown marl, which is fossiliferous, calcareous clay, and the Nacatoch Sand. Petroleum reservoir rocks are widely distributed in Cretaceous and Jurassic sandstones and limestones underlying the planning region.

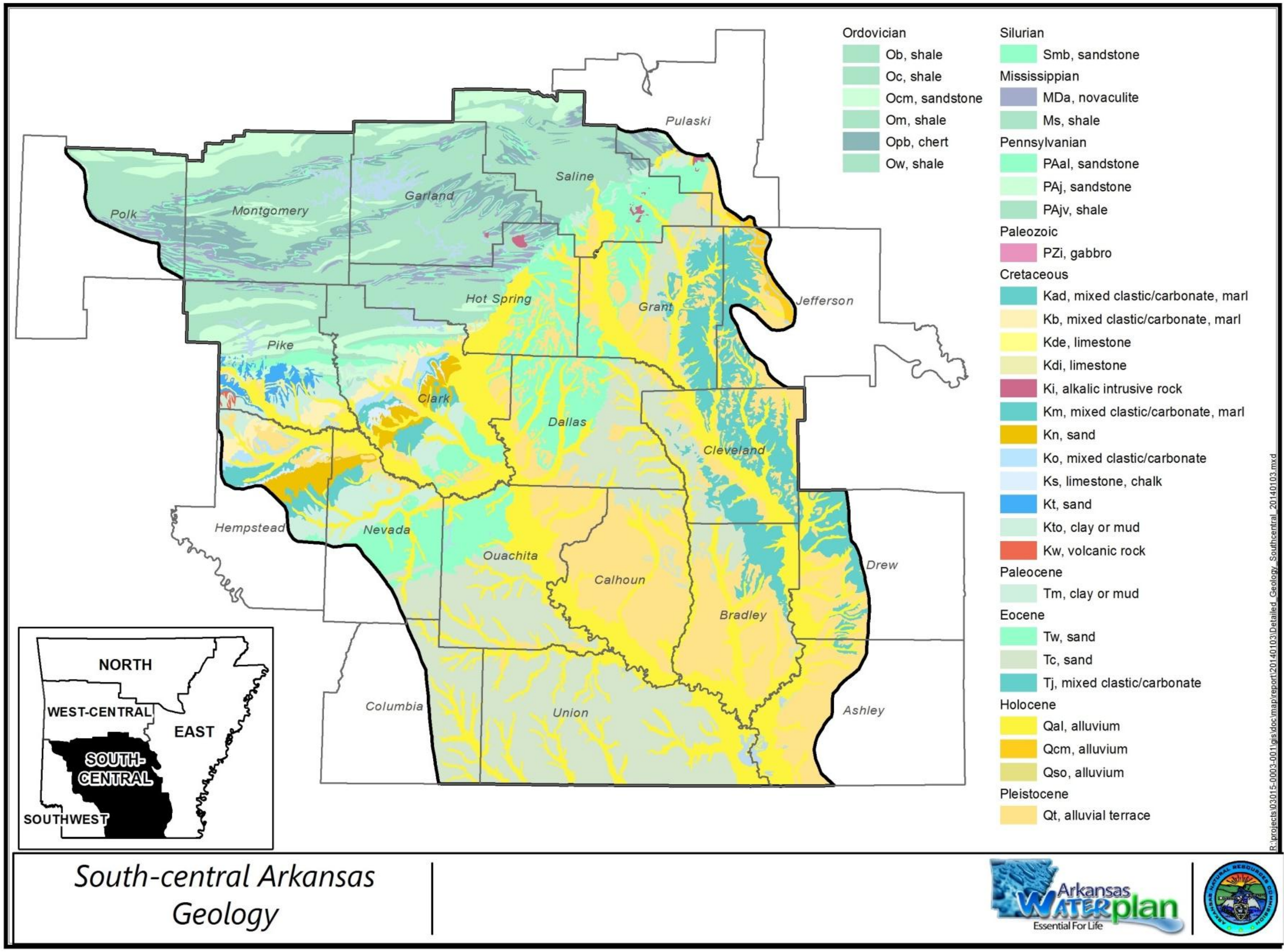


Figure 3.2. Surface geology of the SCAWRPR (Haley et al. 1993).

The Tertiary-age deposits, mostly sand, silt, and clay, represent marginal marine and alluvial deposits. Scattered deposits of lignite are found also, especially in the Wilcox Group. The Midway Group contains some semi-consolidated white limestone. The bauxite deposits of Pulaski and Saline counties occur near the surface in this area.

The hydrogeology of the West Gulf Coastal Plain can be described as layers of unconsolidated silt, sand, and gravel which function as aquifers, yielding large quantities of water to wells. These aquifers are separated by clays which store greater volumes of water but have relatively low hydraulic conductivity, and therefore do not yield adequate volumes of water to wells. The aquifers of the West Gulf Coastal Plain consist of strata with high volumes of sand which has a high hydraulic conductivity and; therefore, a high specific yield of water to wells. Groundwater resources of the SCAWRPR are described in detail in Section 3.8.

### 3.2.2 Geology of the Ouachita Mountain Province

Sedimentary Paleozoic-age rocks are exposed over the northern sections of the SCAWRPR, including Montgomery and Garland counties and portions of Polk, Pike, Clark, Hot Springs and Saline counties. This area is part of the Ouachita Mountain section of the Interior Highlands. The sedimentary rocks of the Ouachita Mountains consist of a thick sequence of shale, chert, sandstone, conglomerates, novaculite, and volcanic tuff deposited during the Paleozoic Era within an elongate, subsiding trough (Renken 1998). The Ouachita Mountains are true geosynclinal mountains formed from strata deposited in deep water settings and uplifted and deformed by the compressional events associated with continental collision. The general structure of the Ouachita Mountains is a broad uplift with complex folds and numerous complex faults (McFarland 2004). Sediments of the Ouachita Mountains are well-indurated and generally well-cemented as a result of deep burial, intense compression, and complex rock-forming history (Renken 1998).

In the Fourche Mountains and the Athens Plateau of the Ouachita Mountains, the Jackfork Sandstone is particularly important in the major mountain ridges. The Stanley Shale is the most widespread formation. Two prominent formations of the Central Ouachita Mountains are the Crystal Mountain sandstone, which is overlain by the Mazarn shale. Arkansas novaculite is exposed along the outer edge of the Central Ouachitas, sometimes referred to as the Novaculite Uplift. The novaculite is Devonian in age and is situated below the Hot Springs sandstone. It is a very hard, fine-grained silica-rich rock, which has been broken by the folding of the Ouachita Mountains.

Generally, the hydrogeology of the Interior Highlands can be described as an area of consolidated formations which yield relatively low volumes of water to wells. The low specific capacity in these wells is a direct result of the lithological nature of the strata itself. The consolidated formations typically are confined with most of the water yielded to wells coming through secondary porosity found in fractures and bedding plains. Typically, two of the most noted aquifers within the Ouachita Mountain province of the Interior Highlands are the Bigfork Chert and Arkansas Novaculite aquifers in the Central Ouachita Mountains. The Atoka Formation is significant as a source of shallow domestic wells in the Ouachita Mountains, but yields are typically small and therefore, limited for other purposes. Groundwater resources of the SCAWRPR are further described in Section 3.8.

With respect to surface water supplies, the topography of the Ouachita Mountain province is especially conducive to the development of reservoirs. Construction of dams in the narrow valleys produces reservoirs with large volumes of water storage. In general, if a quantity of water over 35 gallons per minute (gpm) is needed in the Ouachita Mountains, the potential user should develop surface water supplies. Surface water resources of the SCAWRPR are further described in Section 3.7.

## 3.3 Ecoregions

Ecoregions are areas within which ecosystems, and the type, quality, and quantity of environmental resources, are generally similar (EPA 2013d). The US Environmental Protection Agency (EPA) has defined eight ecoregions within the SCAWRPR (Figure 3.3). The high number of ecoregions in this relatively small area is a result of the variability in elevation, orientation, and geology present in this region. There are three Ouachita Mountain ecoregions within the SCAWRPR: Athens Plateau, Central Ouachita Mountains, and Fourche Mountains.

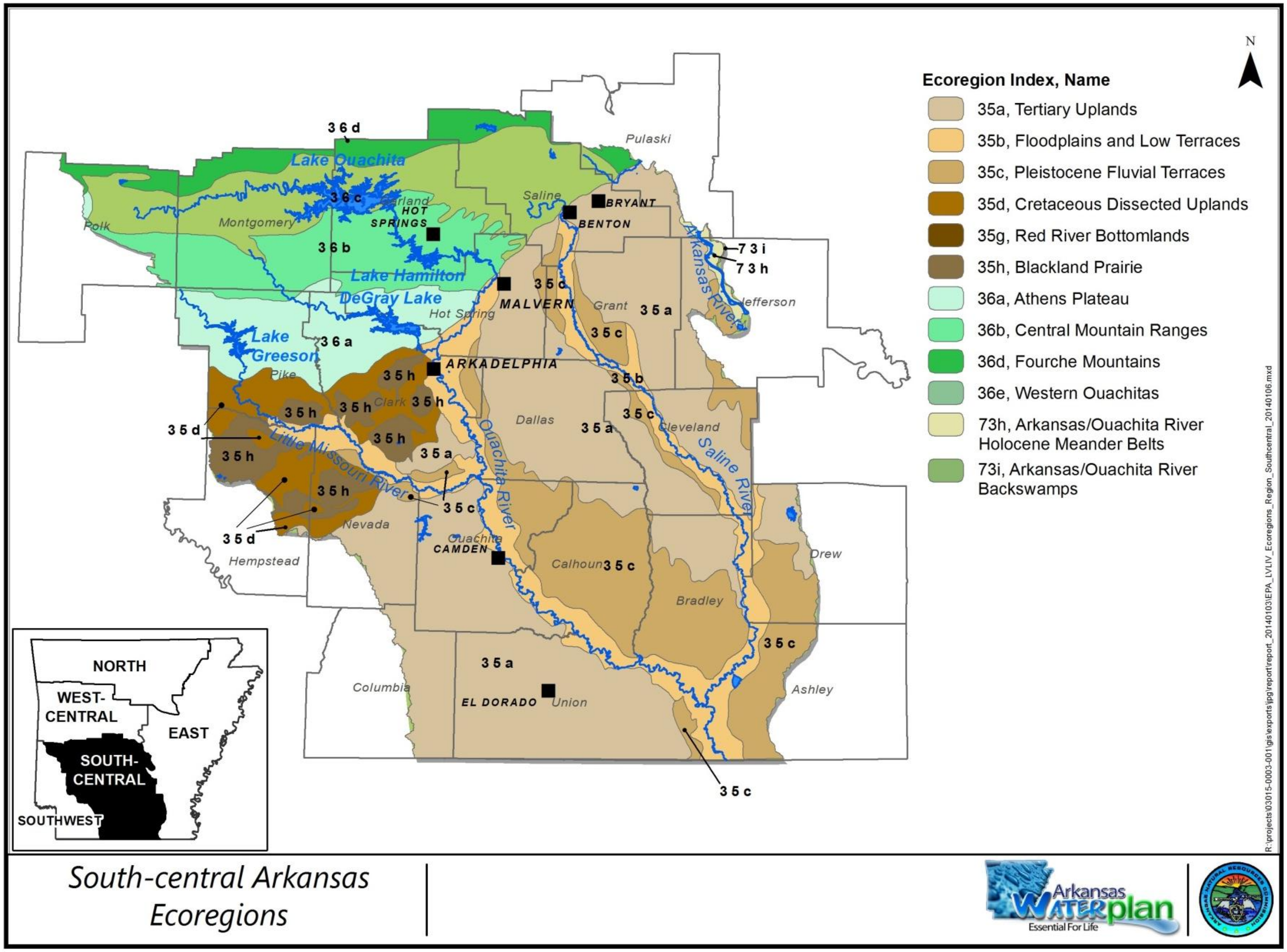


Figure 3.3. Ecoregions of the SCAWRPR (Woods et al. 2004).

There are five ecoregions within the West Gulf Coast Plain (classified as the South Central Plains Level III ecoregion): Blackland Prairie, Cretaceous Dissected Uplands, Floodplains and Low Terraces, Pleistocene Fluvial Terraces, and Tertiary Uplands. Characteristics of each of these ecoregions are summarized in Table 3.1.

Table 3.1. Characteristics of ecoregions within the SCAWRPR (Anderson 2006, Foti 2008, The Nature Conservancy 2013, Woods et al. 2004).

| Level III Ecoregion | Level IV Ecoregion | Native Vegetation | Other |
|---|---|---|---|
| Ouachita Mountains | Athens Plateau | Oak-hickory-pine forest | |
| | Central Mountain Ranges | Oak-hickory-pine forest, novaculite glades, mixed pine and upland deciduous forest on uplands | Perennial springs and seeps are common |
| | Fourche Mountains | Mixed shortleaf pine and upland deciduous forest on south-facing slopes, sugar maple and magnolia on north-facing slopes, oak-hickory-pine forest in valleys, loblolly pine in wet lowland sites along rivers, stunted oak forest and other mountain vegetation on highest ridges, e.g., Rich Mountain | |
| South Central Plains | Blackland Prairie | Woodland, savannah, and prairie | 21 globally imperiled plant communities, rare birds |
| | Cretaceous Dissected Uplands | Oak-hickory-pine forest, mixed pine and upland deciduous forest | |
| | Floodplains and Low Terraces | Southern floodplain forest and oak-hickory-pine forest | |
| | Pleistocene Fluvial Terraces | Pine flatwoods of loblolly pine and oak, hardwood wetlands, pine savannah, prairie | |
| | Tertiary Uplands | Oak-hickory-pine forest, mixed shortleaf pine-loblolly pine forest, upland deciduous forest, bottomland forest along rivers | |

Streams in the Ouachita Mountains have high gradients, and substrates are made up of gravel, cobbles, boulders, or bedrock (ASWCC 1987b, Woods et al. 2004). Fish communities in these streams are dominated by sensitive species (Woods et al. 2004).

Streams are in the South Central Plains have low gradients. Water tends to be turbid or stained and substrates are sand, gravel, and silt. Fisheries are composed of diverse species but few sensitive species.

The Cretaceous chalks and marls that occur south of the Ouachita Mountains have a relatively low permeability and do not yield much water to streams. Therefore, streams in the Cretaceous Dissected Uplands and Black1and Prairie generally have lower sustained flows during low-flow periods than streams in the rest of the South Central Plain area, which usually exhibit sustained base flow conditions as a result of the higher permeability of soils in the area that favor the transmission of water (ASWCC 1987b).

## 3.4 Aquatic Biodiversity

The complexity of the drainages and geologic history that occurs in the SCAWRPR translates into high aquatic biodiversity. The fish species in the Ouachita Mountains have experienced multiple periods of division, isolation, and mixing. As a result, 24 families of fish are found in Ouachita Mountain rivers and streams. Small streams have the most diverse fish communities.

The SCAWRPR (i.e., Ouachita River drainage) has been identified as having the second-highest number of aquatic animal species of greatest conservation need in the state; 130 out of the 268 identified (Anderson 2006). Figure 3.4 provides a summary of the aquatic and semi-aquatic species of greatest conservation need found in the planning region. Of the over 180 aquatic and semi-aquatic plant species tracked by ANHC, over 110 occur in the SCAWRPR (ANHC 2013). Of the 42 Arkansas endemic species (found nowhere else in the world), 14 occur in the planning region (Figure 3.5) (Anderson 2006). Approximately 600 miles of streams in the planning region have been designated by the Arkansas Department of Environmental Quality (ADEQ) as Ecologically Sensitive Waterbodies because they provide habitat for endemic, threatened, or endangered species (Figure 3.6) (APCEC 2011). Additional information on threatened and endangered species in the planning region is provided in Section 5.3.7. The many reservoirs in the SCAWRPR provide important resting and feeding sites for migrating water fowl.

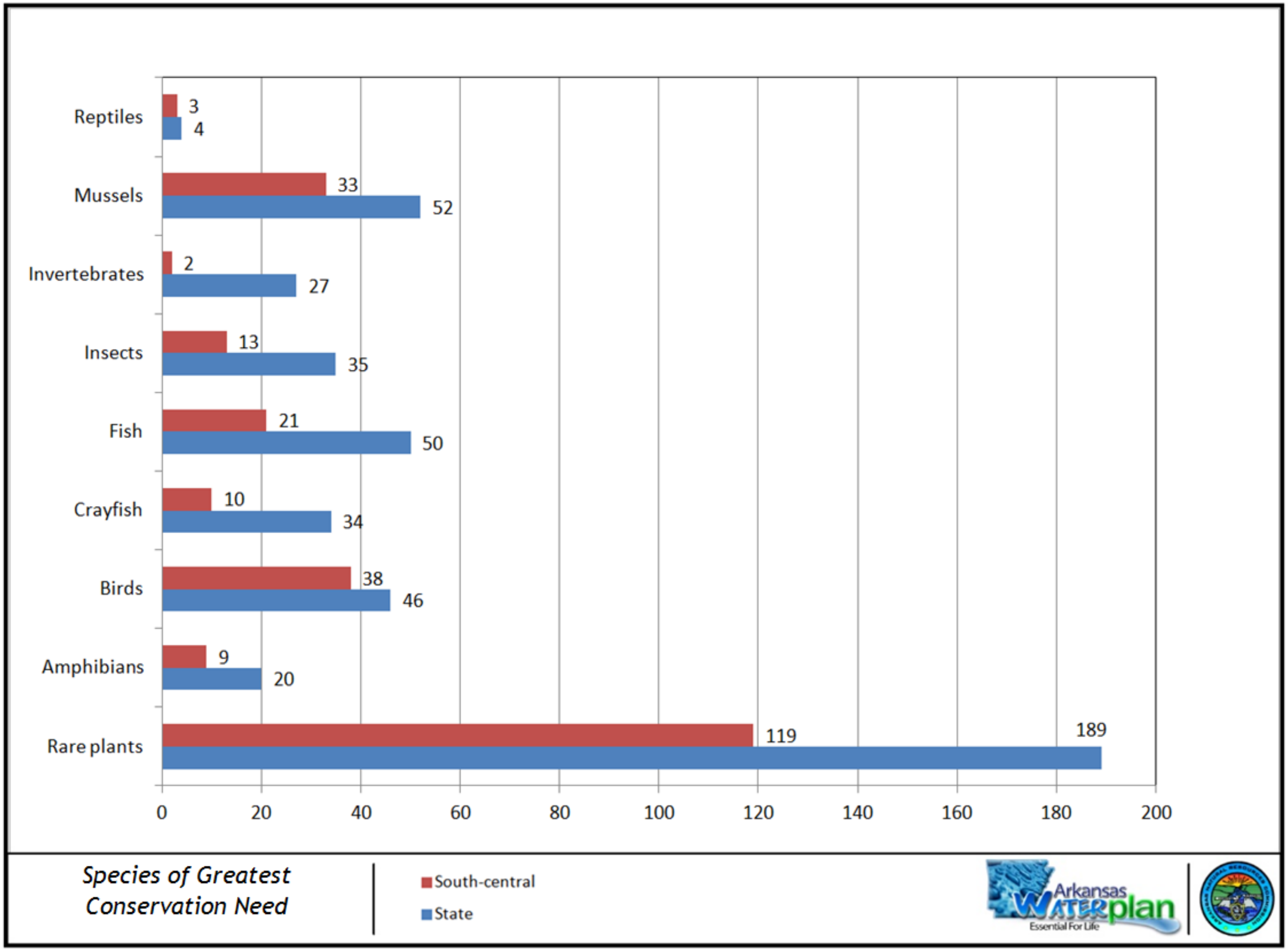


Figure 3.4. Species of greatest conservation need found in the SCAWRPR (Anderson 2006, ANHC 2013).

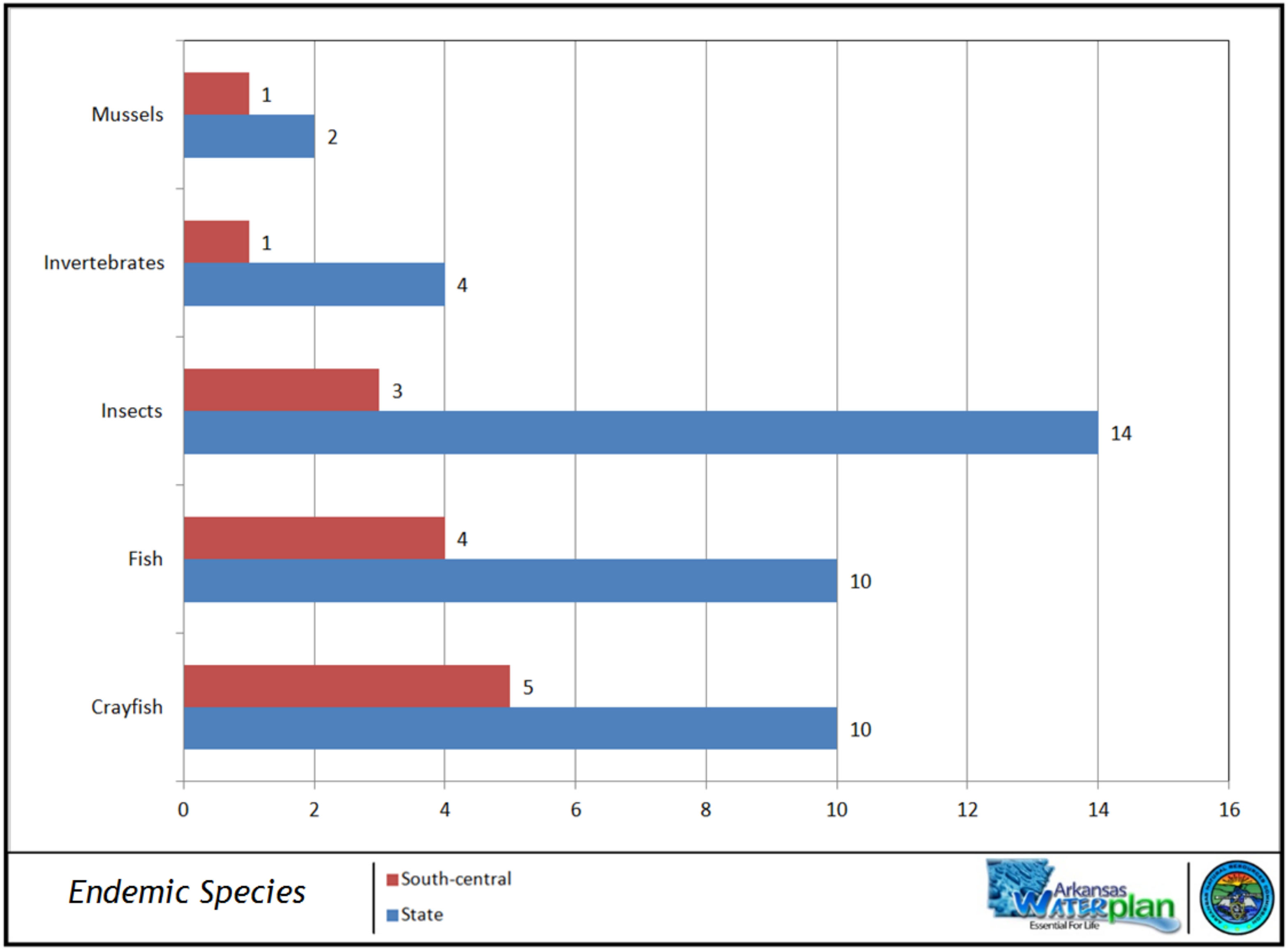


Figure 3.5. Endemic species of the SCAWRPR.

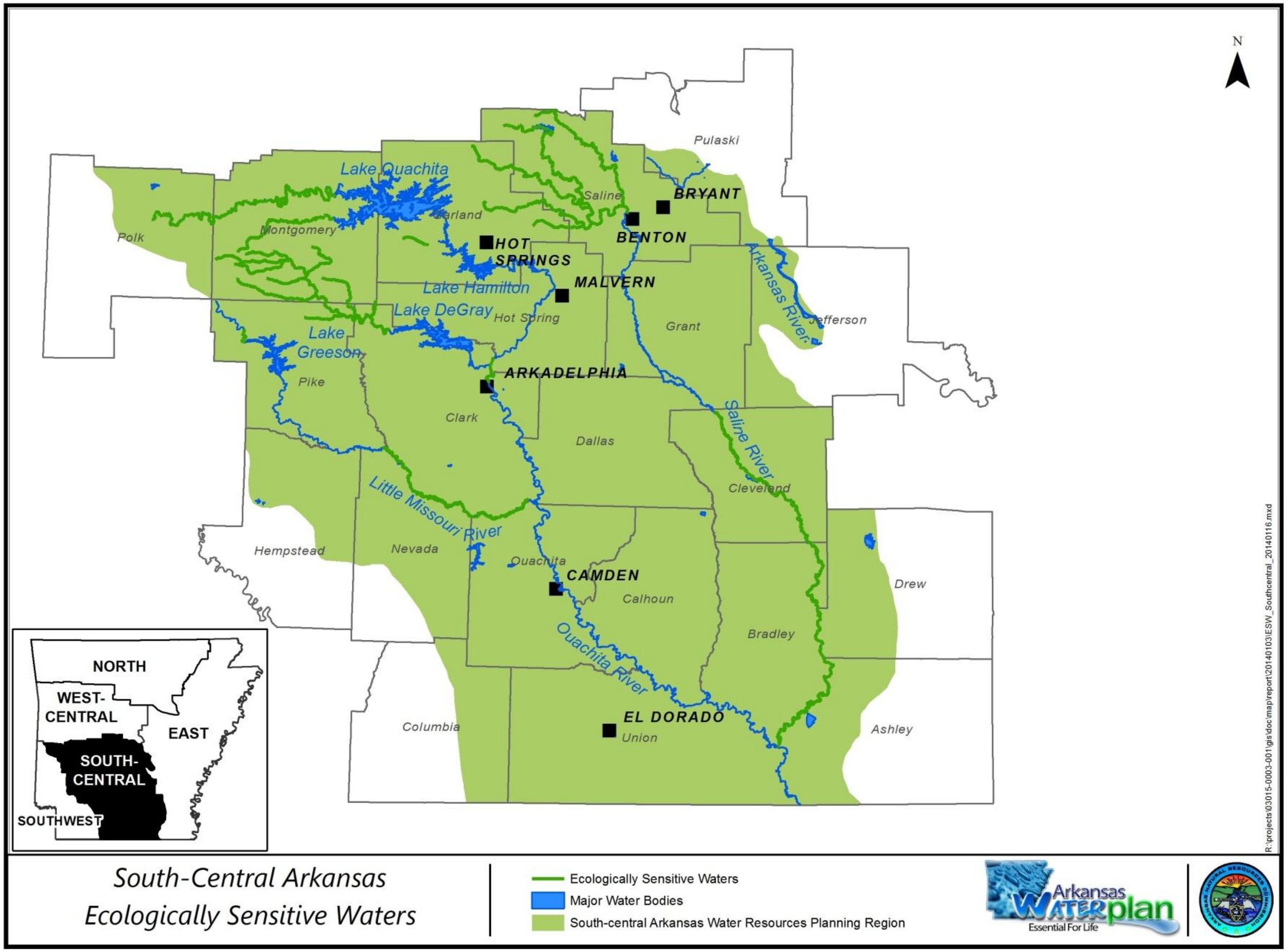


Figure 3.6. Ecologically Sensitive Waterbodies in the SCAWRPR (APCEC 2011).

## 3.5 Climate

The climate in the SCAWRPR is humid with warm summers. Temperature, precipitation, and evaporation data were obtained from the National Weather Service, National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC), and the PRISM Climate Group and reviewed. These data are available for each of the climate divisions in Arkansas (Figure 3.7). Data for climate division 8 were used to characterize the climate for the SCAWRPR. Summaries of these data are presented below, along with discussions of factors that influence climate in the SCAWRPR and long-term climate trends in the region.

### 3.5.1 Temperature

The average annual temperature in the SCAWRPR is approximately 63 ºF (NOAA NCDC 2013a). Average daytime maximum temperatures range from 92 ºF in August to 53 ºF in January (Figure 3.8). Average minimum nighttime air temperatures range from 70 ºF in July to 31 ºF in January. The average difference between the monthly normal minimum and maximum air temperatures is 23 ºF.

Variations in average annual maximum daily temperature temperatures across the planning region are shown on Figure 3.9. Temperatures are generally cooler in the higher elevations in the north. The growing season (frost-free days) in the planning region ranges from 190 to 233 days in the Ouachita Mountains to 200 to 245 days in the West Gulf Coastal Plain (Woods et al. 2004).

### 3.5.2 Precipitation

Mean annual precipitation in the SCAWRPR ranges from 66 inches in the north to 48 inches in the south (Woods et al. 2004). The high precipitation amounts in the Ouachita Mountains are due to the influence of their high elevations (Figure 3.10). When moist south winds from the Gulf of Mexico reach the Ouachita Mountains, the air is forced to rise, causing the air to cool so that the moisture condenses into clouds and rain that falls on the mountains (Foti 2011).

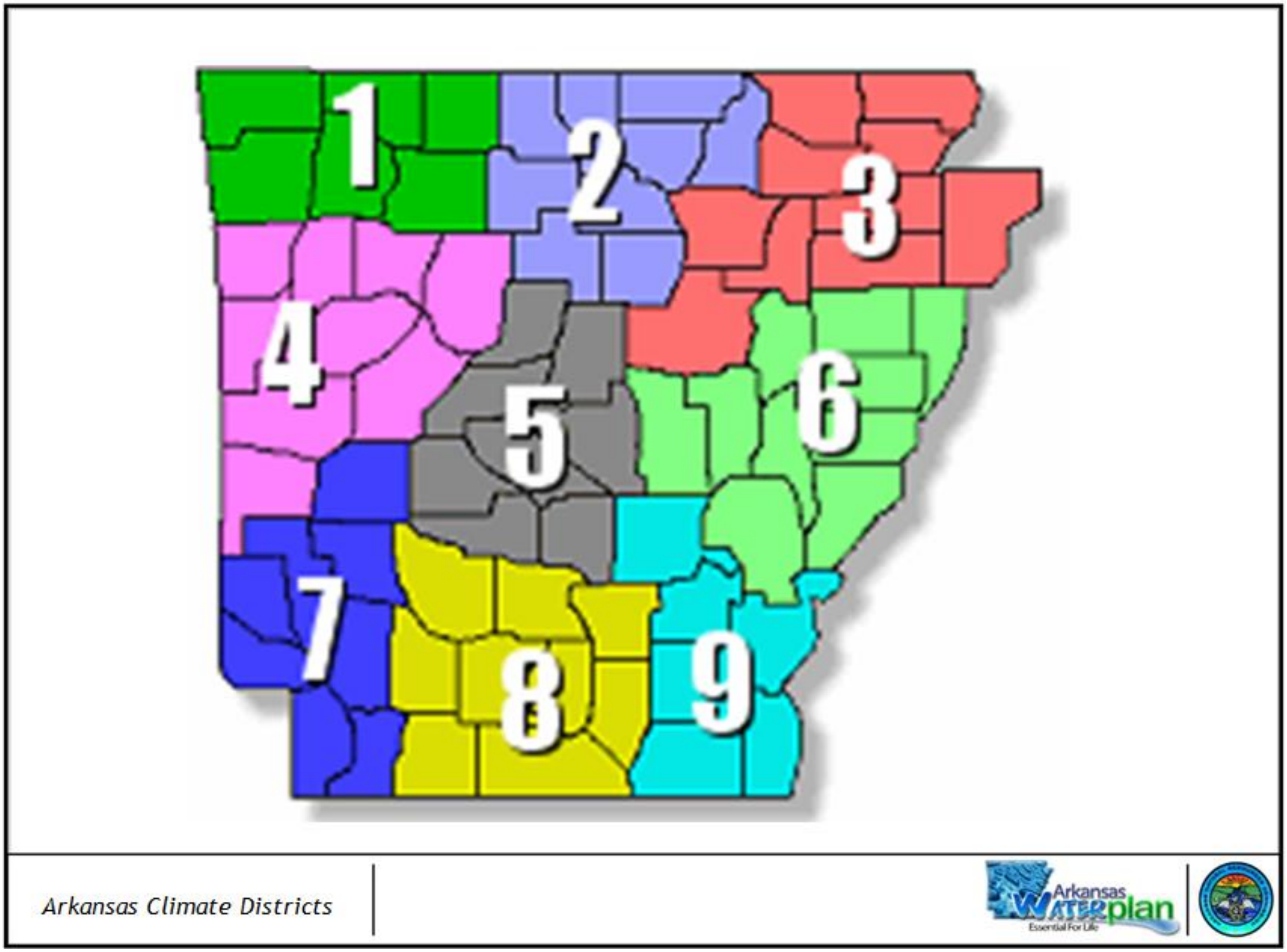


Figure 3.7. Climate divisions in Arkansas (National Weather Service 2013).

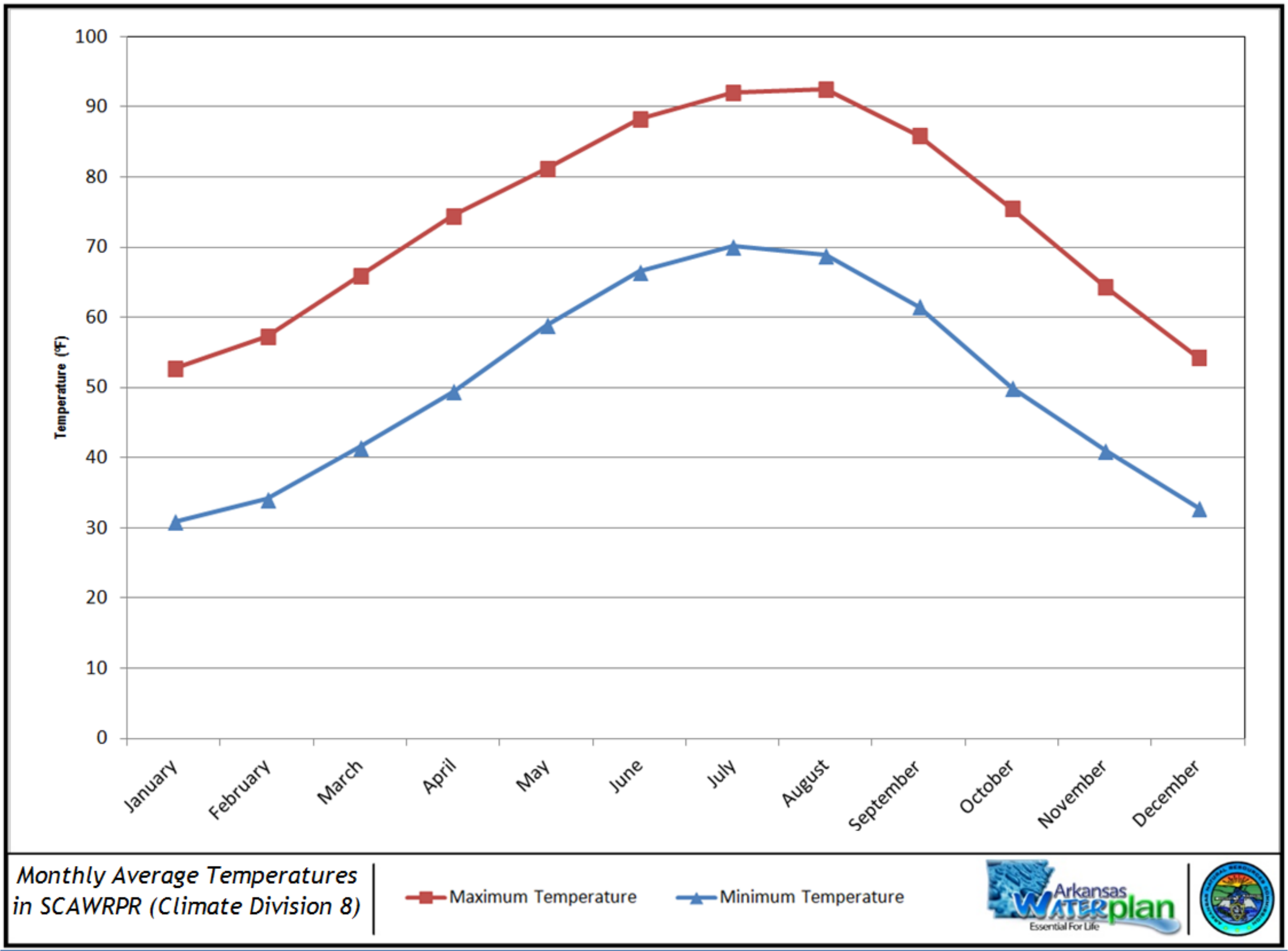


Figure 3.8. Monthly average minimum and maximum temperatures in the SCAWRPR, 1981-2010 (PRISM Climate Group 2004).

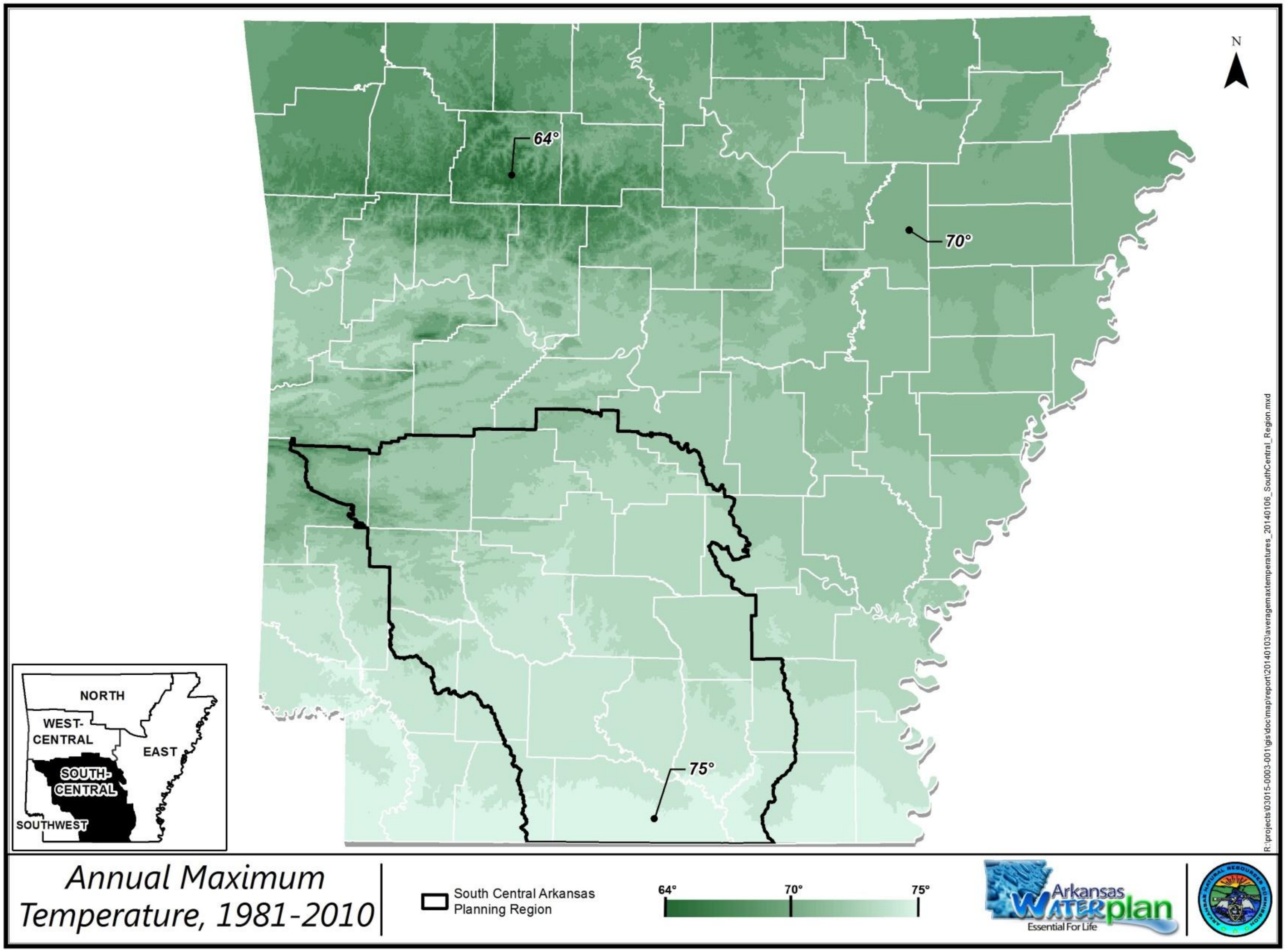


Figure 3.9. Map of average annual maximum daily temperature ($^{o}$F) in the SCAWRPR, 1981-2010 (PRISM Climate Group 2004).

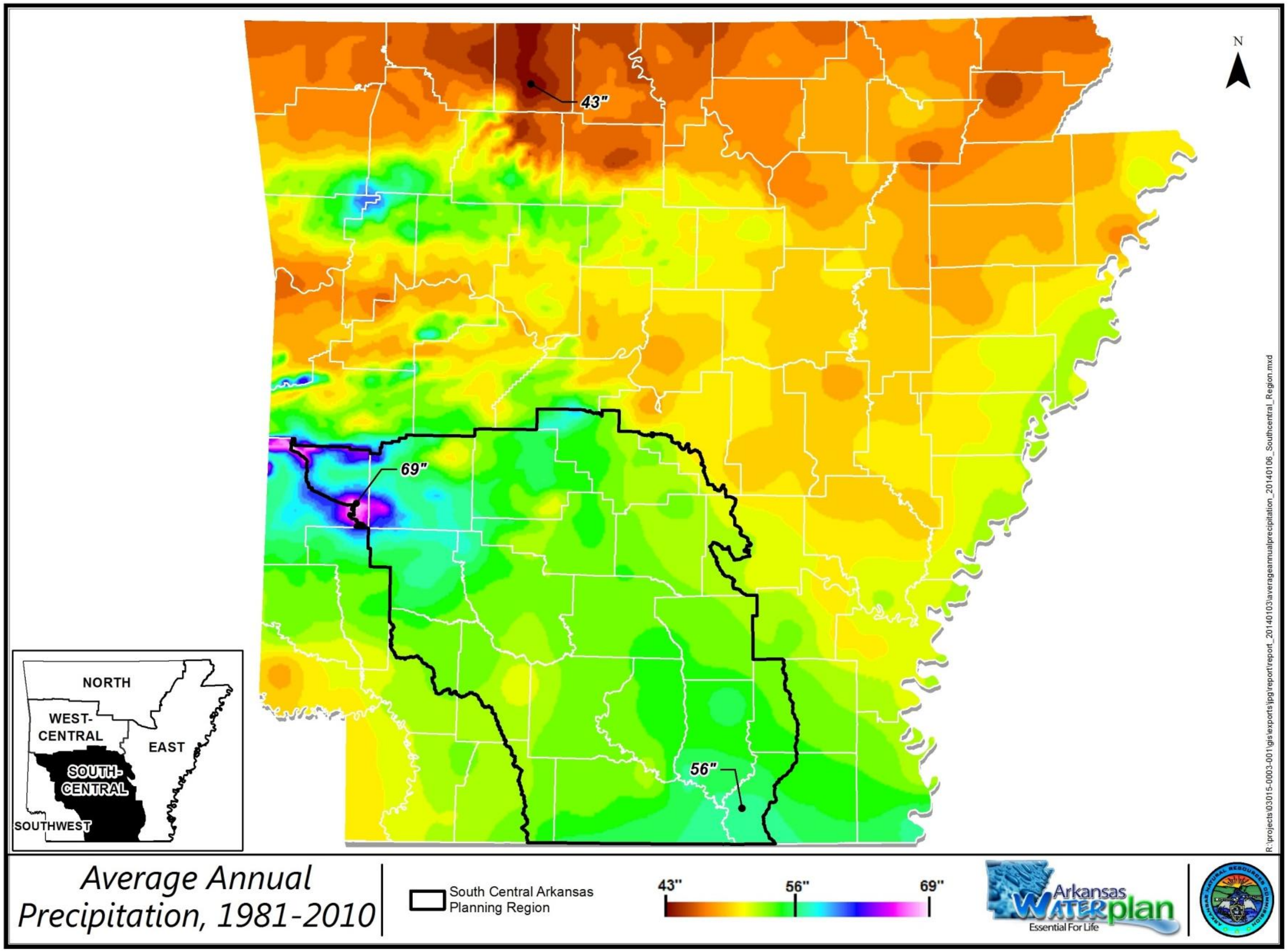


Figure 3.10. Map of average annual precipitation (inches) in the SCAWRPR, 1981-2010 (PRISM Climate Group 2004).

Mean monthly precipitation for the SCAWRPR for the period from 1981 through 2010 is shown on Figure 3.11. The months in late spring and late fall to early winter are generally the wettest. Average precipitation amounts are highest in May, and October through December. Precipitation is lowest in January and during the summer, July through September.

Summer precipitation primarily occurs during rainstorms, where locally high rainfall amounts can occur over a short period of time. During the fall, winter, and early spring, precipitation events are usually less intense and of longer duration. The majority of the precipitation in the SCAWRPR falls as rain; snow occurs here only occasionally, more frequently at the higher elevations in the Ouachita Mountains (Buckner 2011, NOAA NCDC n.d.).

### 3.5.3 Evaporation

Evaporation is the process by which water changes from liquid in soil to gaseous water vapor. When the conversion from liquid to water vapor occurs on leaves, the process is called transpiration. Evapotranspiration is the combination of these processes. The amount of evapotranspiration is controlled primarily by sunlight, but is influenced by humidity and wind (Scott et al. 1998).

Potential evapotranspiration is the maximum rate at which water in soil and on plants would change to water vapor, assuming there is no shortage of water to be changed. Actual evapotranspiration is usually less than the potential. Potential evapotranspiration is difficult to measure, but can be estimated from the meteorological measurement pan evaporation. Pan evaporation is the rate of evaporation of water from a specific style of open pan at a weather station. In humid regions like Arkansas, potential evapotranspiration is similar to pan evaporation. Based on data from eastern Arkansas, the ratio of potential evapotranspiration to pan evaporation is assumed to be 0.85. Evaporation exhibits less variation from year to year and place to place than precipitation (Scott et al. 1998). Figure 3.11 shows monthly average potential evapotranspiration estimated from pan evaporation measurements at Millwood Lake Dam in Hempstead County and Blakely Mountain Dam in Garland County for the period of 1995 through 2010 (the available period of record for these stations).

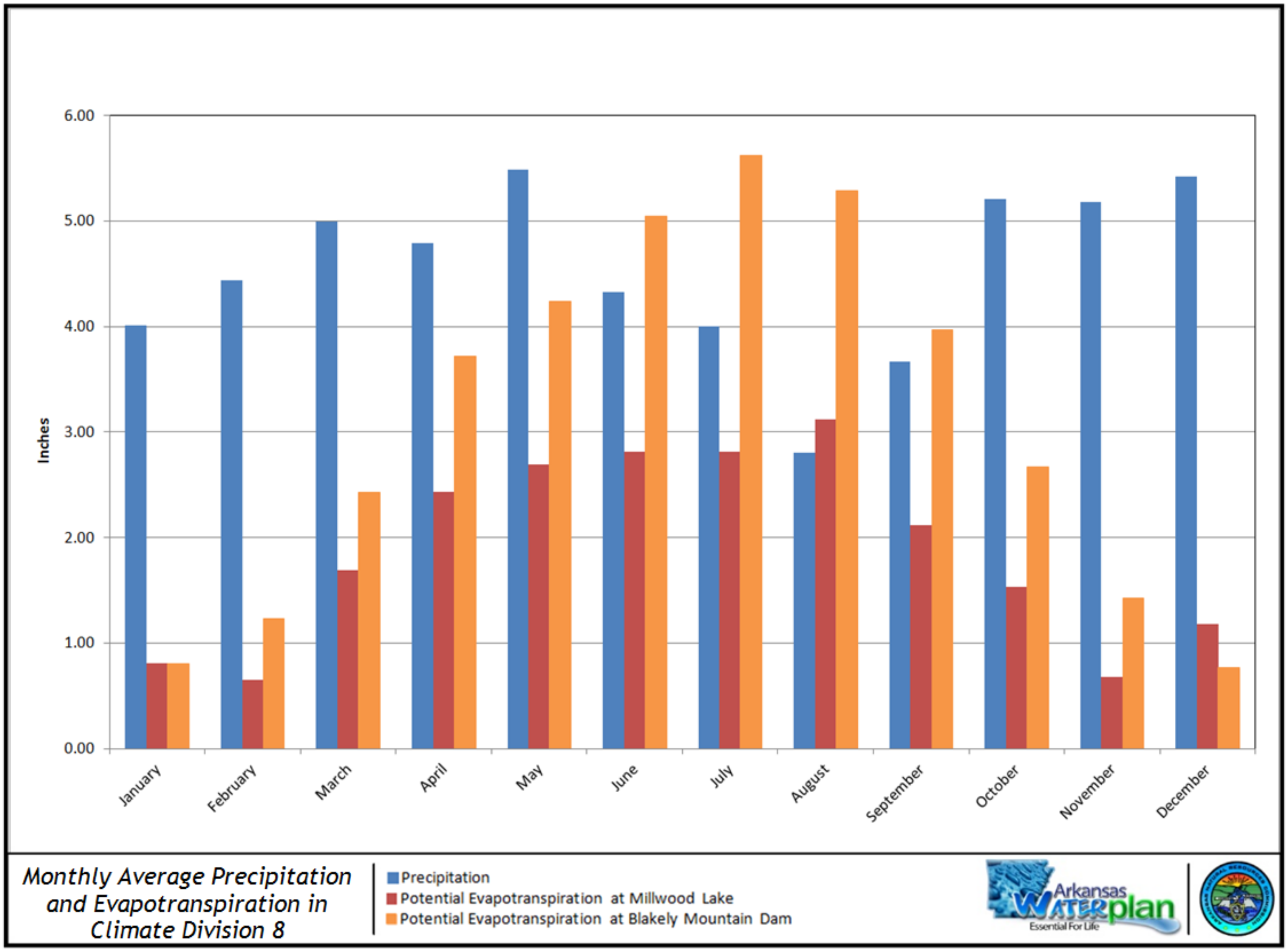


Figure 3.11. Monthly average precipitation in Climate Division 8, and potential evapotranspiration at selected sites associated with the SCAWRPR, 1981-2010 (NOAA NCDC 2013b, PRISM Climate Group 2004).

The estimated potential evapotranspiration at Millwood Lake exceeds the normal precipitation in only one month, August. The estimated potential evapotranspiration at Blakely Mountain Dam exceeds the average precipitation during the entire summer, June through September.

### 3.5.4 Drought

Although the SCAWRPR receives precipitation throughout the year, drought conditions occur in the region. One of the tools NOAA uses to determine when drought conditions exist is the Palmer Drought Indices. These indices are based on the differences of precipitation and temperatures from normal. The Palmer Drought Severity Index (PDSI) also takes into account the length of time that drought conditions last. PDSI values less than zero indicate drought conditions. An index of -2 indicates moderate drought, -3 indicates severe drought, and -4 indicates extreme drought (NOAA 2012). Figure 3.12 shows a time-series plot of PDSI values for climate division 8 in Arkansas (see Figure 3.7 for a map of Arkansas climate divisions). Periods with multiple consecutive years of drought have occurred in southwest Arkansas (Figure 3.12). This region is currently experiencing a period of drought that began in 2010 (NOAA NCDC 2013a).

### 3.5.5 Climate Variability

In 2007, the Governor's Commission on Global Warming (GCGW) was established to, among other tasks, evaluate the potential impacts of global warming on the state citizens, natural resources, and economy. The literature review conducted by the GCGW identified the following climate change effects anticipated for the state (GCGW 2008):

- Increased incidence of severe weather events,
- Increased incidence of flooding,
- Increased incidence of drought,
- Possible saltwater intrusion into aquifers resulting from sea level rise, and
- Changes in climatic zones.

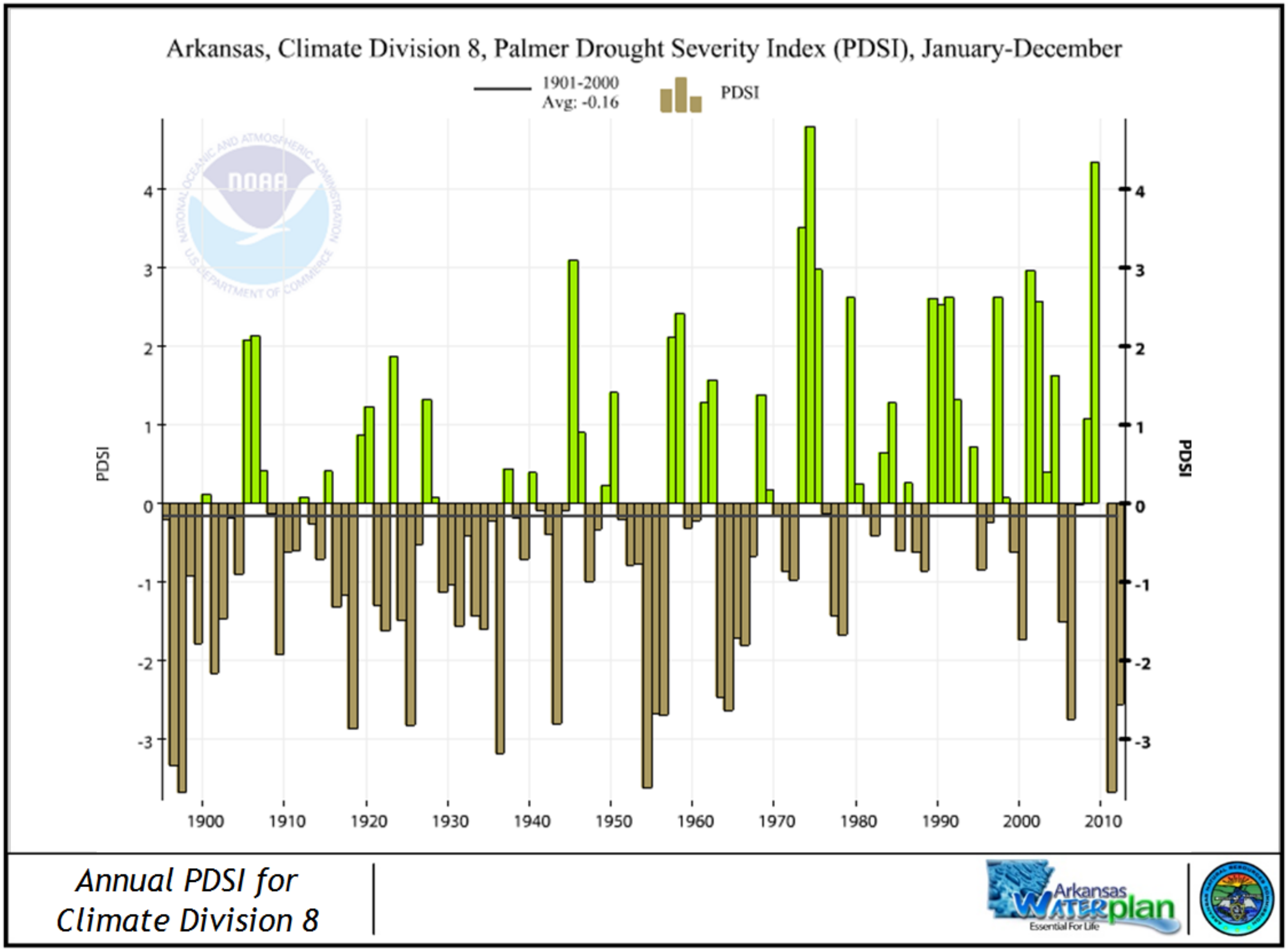


Figure 3.12. Annual PSDI for climate division 8 (SCAWRPR) (NOAA NCDC 2013c).

Plots of annual average temperature and total annual precipitation from 1895 to 2012 for the climate division 8 are shown on Figures 3.13 and 3.14, respectively. The temperature data appear to exhibit a cycle of change, where temperatures in the first half of the $20^{th}$ century were warmer than the second half, but appear to be warming again in the early $21^{st}$ century (Figure 3.13). The United States Department of Agriculture (USDA) develops a plant hardiness zone map that shows annual average minimum winter temperature. The 2012 update of the USDA map shows warmer minimum temperatures in the region as compared to the 1990 zone map. This relationship follows the cycle shown on Figure 3.13 (Clark and Karklis 2012). Precipitation totals for climate division 8 appear to exhibit a slight long-term increasing trend (Figure 3.14). A detailed analysis of long-term precipitation trends across the state is being prepared as part of the 2014 water plan update.

## 3.6 Land Use

Land use in the SCAWRPR is summarized on Figure 3.15 and mapped on Figure 3.16. Major land use categories are discussed in the sections below, including present day extent, and changes since the 1990 AWP.

### 3.6.1 Forest

The SCAWRPR is primarily forested (Figures 3.15 and 3.16). Table 3.2 lists the acreage of forest land per county in 2012 as reported by the USDA Forest Service (USFS). There are over 7.4 million acres of forest land in the counties of the SCAWRPR. Union county has the greatest acreage of forest. The majority of the forest land in the planning region (over 99%) is classified by the USDA Forest Service (USFS) as timberland, or commercial forest land, and the majority of timberland in the region is privately owned (USFS 2013). The timber industry is active in this region, particularly south of the Ouachita Mountains (Stroud 2011). A little over 1% of the forest in the SCAWRPR is national forest.

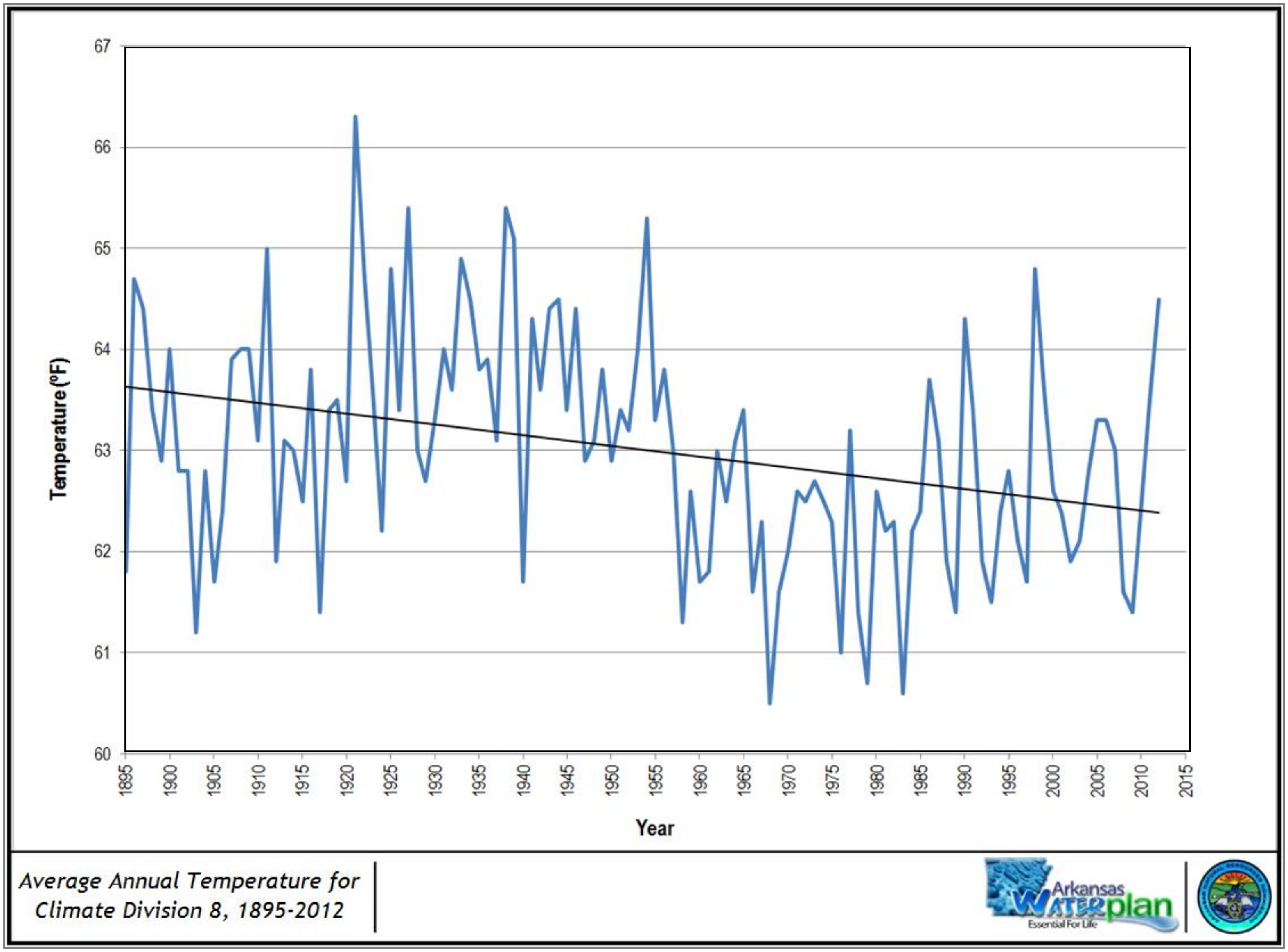


Figure 3.13. Average annual temperature for climate division 8 in the SCAWRPR (NOAA NCDC 2013c).

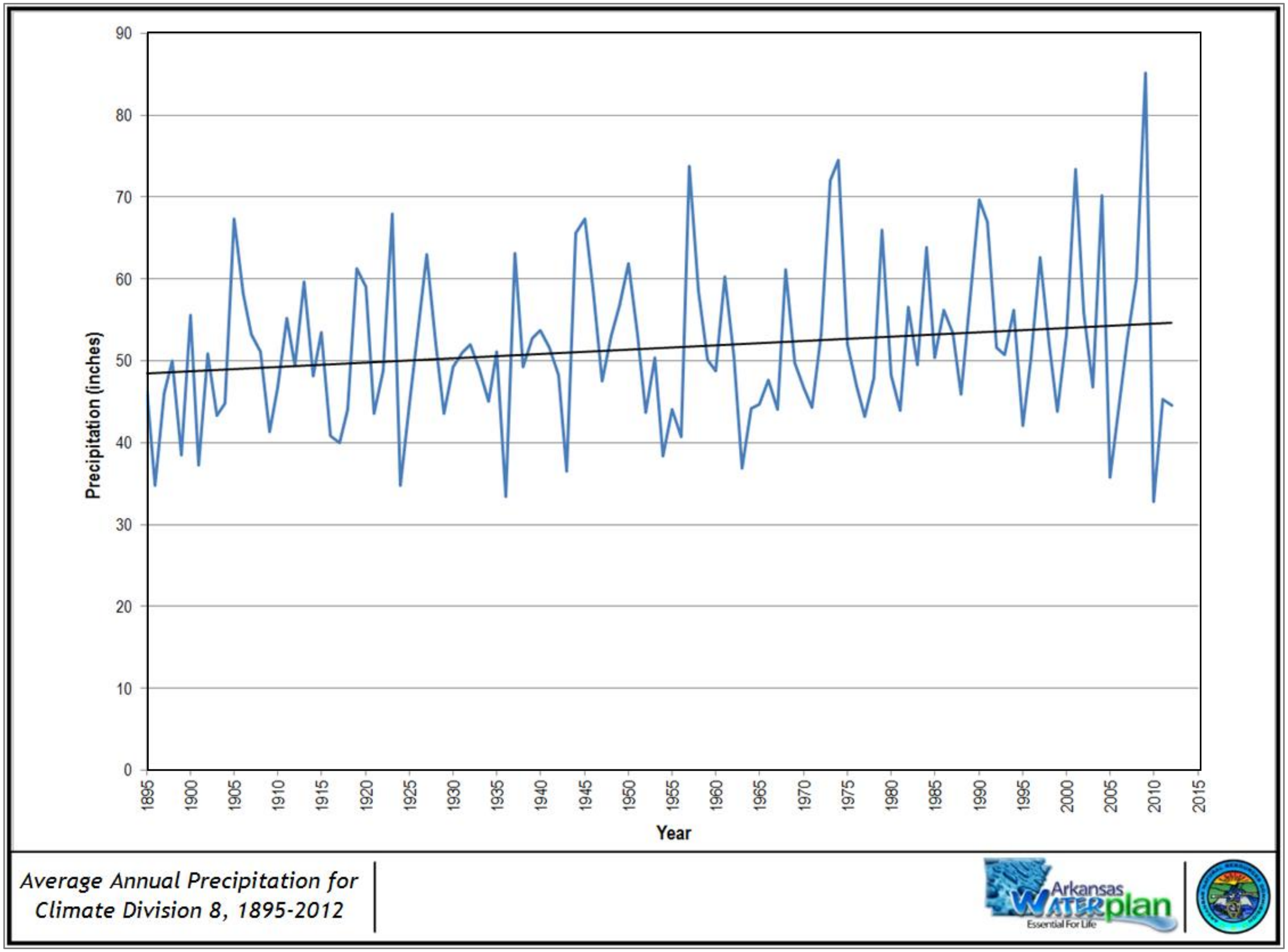


Figure 3.14. Annual total precipitation for climate division 8 in the SCAWRPR (NOAA NCDC 2013c).

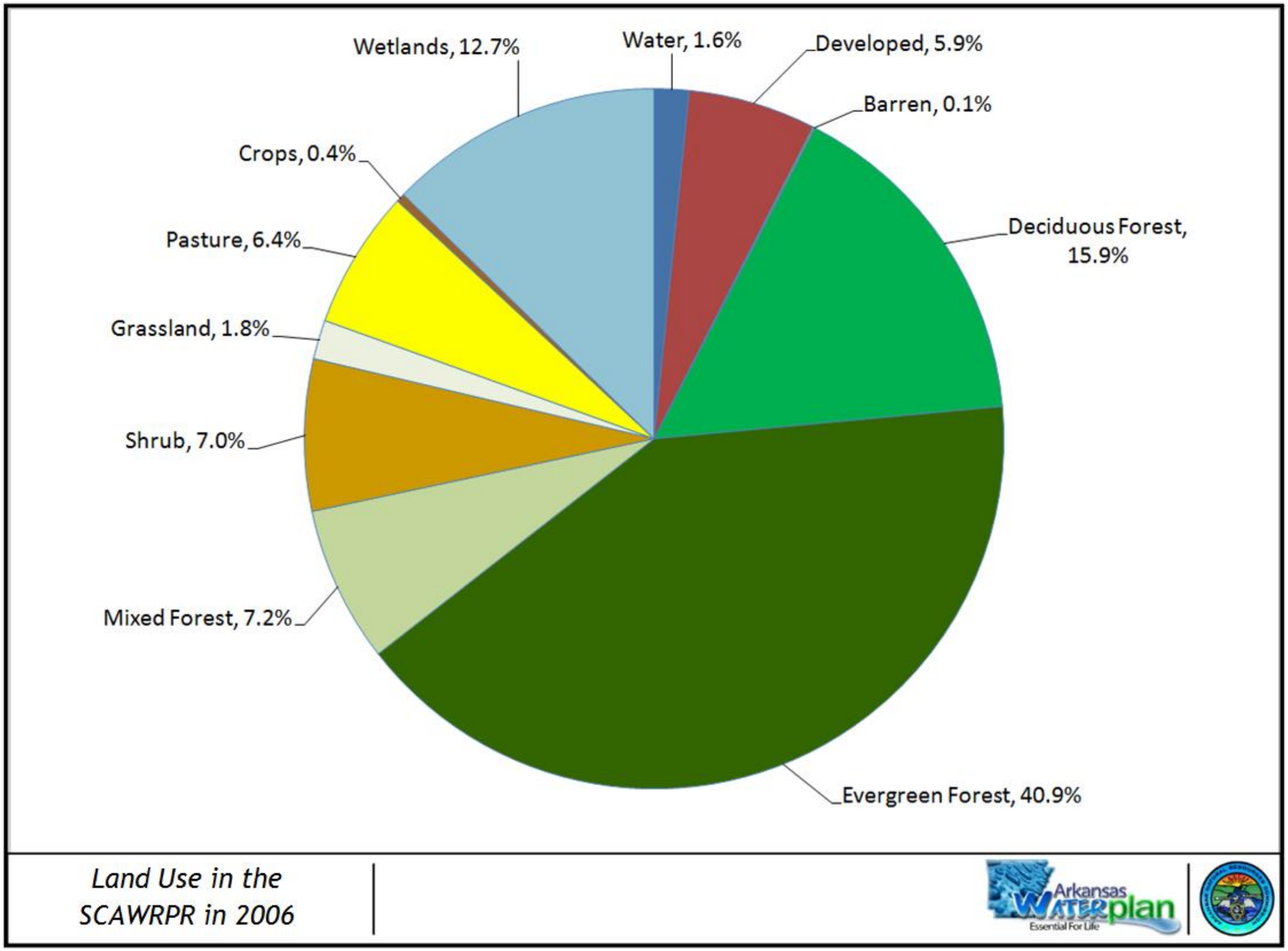


Figure 3.15. SCAWRPR land use, 2006 (Fry et al. 2011).

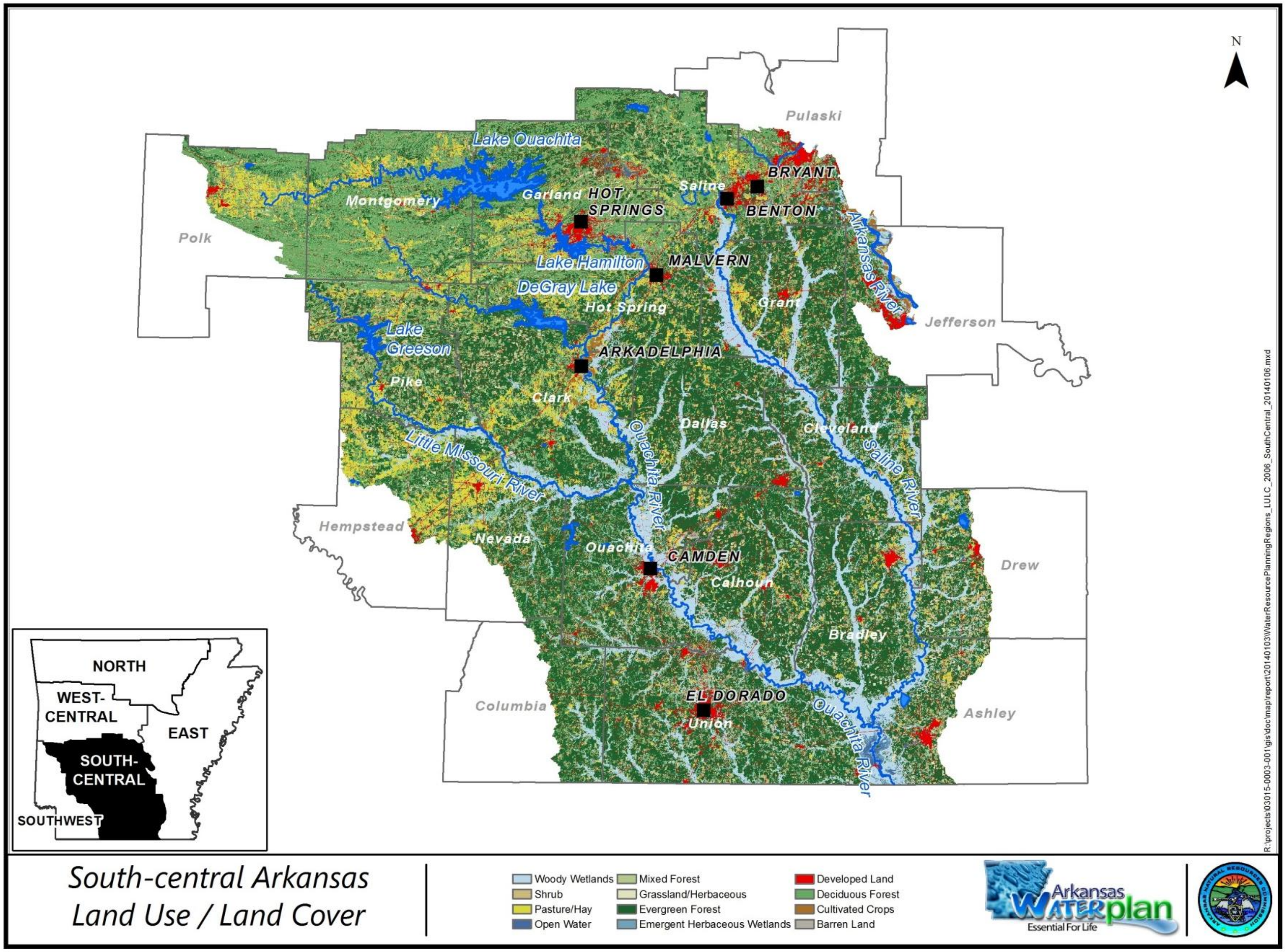


Figure 3.16. Map of 2006 land use in the SCAWRPR (Fry et al. 2011).

Table 3.2. Comparison of forest land in the SCAWRPR (ASWCC 1987a, b; USFS 2013).

| County | 1977 Forest Land (acres) | 2012 Forest Land (acres) | Change |
|---|---|---|---|
| Ashley* | 434,604 | 408,851 | - |
| Bradley | 376,975 | 356,084 | - |
| Calhoun | 365,126 | 352,330 | - |
| Clark | 443,074 | 454,473 | + |
| Cleveland | 342,966 | 320,258 | - |
| Columbia* | 400,835 | 438,645 | + |
| Dallas | 377,579 | 398,824 | + |
| Drew* | 394,532 | 407,198 | + |
| Garland | 300,604 | 381,524 | + |
| Grant | 361,827 | 398,304 | + |
| Hempstead* | 281,652 | 299,503 | + |
| Hot Spring | 297,305 | 254,138 | - |
| Jefferson* | 200,007 | 201,198 | + |
| Montgomery | 436,764 | 405,011 | - |
| Nevada* | 310,032 | 330,803 | + |
| Ouachita | 414,062 | 408,667 | - |
| Pike | 290,754 | 296,303 | + |
| Polk* | 453,808 | 431,058 | - |
| Saline | 359,913 | 315,350 | - |
| Union | 628,495 | 621,077 | - |
| **Total** | **7,470,914** | **7,479,599** | **+** |

Forest acreage for 1977 from the Resource Inventory Data System was reported by county in the 1990 AWP and is included in Table 3.2 (ASWCC 1987a, b). Because these data are from different sources, their comparability is uncertain. However, comparing these values suggest there has been no significant change in the amount of forest land in the counties of the SCAWRPR since the 1990 AWP.

### 3.6.2 Wetlands

Wetlands account for the second largest proportion of the land use in the SCAWRPR, 959,360 acres, or 12.7%. In the 1990 AWP basin reports, it was estimated that there were 567,200 acres of wetlands in the Ouachita River basin (ASWCC 1987 a, b). Because the data are from different sources, there comparability is uncertain. However, comparing these values suggests there may have been an increase in wetland area in the planning region. Wetlands in the planning region are discussed in greater detail in Section 3.7.3.

### 3.6.3 Agriculture

Agriculture accounts for less than 10% of the area in the SCAWRPR (Figure 3.15). Pasture and haylands account for the majority of this land use category (95%). In the 2007 Census of Agriculture, the total area of pasture in the counties within the planning region was 716,530 acres, with 694,412 acres of cropland (harvested and other) (USDA National Agricultural Statistics Service 2009). In the 1990 AWP, the acreage reported for pasture in the counties of the SCAWRPR was 1.1 million, with 475,304 acres of cropland (ASWCC 1987 a, b). Because these data are from different sources, their comparability is uncertain (see Table 3.3). Comparing pasture and cropland areas from the 1987 and 2007 Census of Agriculture (Table 3.3) indicates there has not been a significant change in the amount of cropland and a slight decline in pasture area.

The major crops reported for the counties of the planning region in the 2007 Census of Agriculture, in order of acreage, were forage, soybeans, cotton, and rice (USDA National Agricultural Statistics Service 2009). In the 1990 AWP, soybeans and rice were identified as the crops with the largest acreage in the Ouachita River Basin (ASWCC 1987a, b).

In the 2007 Census of Agriculture, 54% of the 694,412 acres of cropland in the counties of the planning region was irrigated (note that the amount of irrigated land was not reported for 3 of the 21 counties to protect farmers' privacy) (USDA National Agricultural Statistics Service 2009). The 1990 AWP reported that approximately 20% of the cropland in the Upper Ouachita River basin was irrigated (ASWCC 1987 b). Information on irrigated cropland was not provided for the lower Ouachita River basin in the 1990 AWP (ASWCC 1987a). In the 1987 Census of Agriculture, approximately 3% of the 696,039 acres of cropland in the planning region counties was irrigated (note that the amount of irrigated land was not reported for 13 of the 21 counties in 1987 to protect farmers' privacy) (US Census Bureau 1989). This indicates that there has been a large increase in the amount of irrigated cropland in the planning region since 1987 (over 90%).

Table 3.3. Comparison of agriculture land areas in the counties of the SCAWRPR (ASWCC 1987a, b; USDA National Agricultural Statistics Service 2009; US Census Bureau 1989).

| County | Cropland (acres) | | | Pasture (acres) | | |
|---|---|---|---|---|---|---|
| | 1987 Census of Agriculture[(a)] | 1990 AWP | 2007 Census of Agriculture[(a)] | 1987 Census of Agriculture[(b)] | 1990 AWP | 2007 Census of Agriculture[(b)] |
| Ashley* | 126,152 | 142,450 | 116,294 | 22,035 | 15,191 | 15,374 |
| Bradley | 6,835 | 6,883 | 6,123 | 19,591 | 31,165 | 16,000 |
| Calhoun | 4,037 | 2,673 | 2,976 | 16,010 | 21,667 | 10,596 |
| Clark | 41,352 | 25,887 | 20,116 | 65,247 | 75,961 | 47,982 |
| Cleveland | 6,202 | 0 | 7,684 | 108,082 | 41,717 | 14,733 |
| Columbia* | 10,952 | 0 | 10,922 | 29,095 | 62,929 | 26,133 |
| Dallas | 3,851 | 9,477 | 3,540 | 15,251 | 35,160 | 7,845 |
| Drew* | 70,867 | 74,664 | 78,184 | 37,542 | 64,528 | 20,961 |
| Garland | 6,564 | 2,130 | 7,260 | 38,408 | 56,695 | 29,270 |
| Grant | 7,514 | 0 | 9,640 | 28,339 | 39,111 | 20,192 |
| Hempstead* | 52,718 | 34,023 | 47,922 | 136,608 | 146,832 | 137,992 |
| Hot Spring | 18,550 | 5,174 | 18,927 | 64,047 | 70,329 | 44,934 |
| Jefferson* | 246,360 | 132,646 | 253,727 | 18,189 | 21,168 | 24,667 |
| Montgomery | 13,027 | 0 | 17,941 | 71,929 | 68,871 | 50,037 |
| Nevada* | 18,743 | 14,717 | 17,868 | 64,619 | 66,841 | 36,152 |
| Ouachita | 10,955 | 9,937 | 7,072 | 29,522 | 37,214 | 16,753 |
| Pike | 15,043 | 7,943 | 17,525 | 57,243 | 75,306 | 58,209 |
| Polk* | 16,337 | 2,359 | 31,026 | 103,692 | 81,251 | 92,129 |
| Saline | 14,472 | 1,963 | 11,749 | 44,836 | 55,342 | 27,560 |
| Union | 5,508 | 2,378 | 7,916 | 23,579 | 27,123 | 19,011 |
| **Total** | **696,039** | **475,304** | **694,412** | **993,864** | **1,094,401** | **716,530** |

*Note: The acreage reported is for the entire county, but part of this county is in other planning regions.
a. Sum of "harvested cropland" and "other cropland" reported in census.
b. Sum of "pastureland, all types" and "cropland used only for pasture" reported in census.

### 3.6.4 Public Land

There are over 1.2 million acres of public land in the SCAWRPR, around 16% of the land in the planning region (Table 3.4). National forest and wildlife management areas (WMAs) account for the majority of this public land (Table 3.4). There are also national parks, state parks, natural areas, wilderness areas and a National Wildlife Refuge (NWR) in the planning region.

Table 3.4. Public lands in the SCAWRPR (AGFC 2009, AHTD 2006).

| Land Use | Acreage | Percent of SCAWRPR Area | Count |
|---|---|---|---|
| City Park | 3,369 | < 1% | 132 |
| County Park | 744 | < 1% | 34 |
| Local Park | 74 | < 1% | 6 |
| National Forest | 873,238 | 11.6% | 37 |
| National Park | 5,419 | < 1% | 3 |
| NWR | 65,242 | < 1% | 1 |
| Natural Area | 1,996 | < 1% | 16 |
| Park | 33 | < 1% | 1 |
| Public Use Area | 2,789 | < 1% | 34 |
| Recreation Area | 16,424 | < 1% | 15 |
| Research Area | 15,019 | < 1% | 2 |
| State Forest WMA | 18,680 | < 1% | 2 |
| State Park | 5,982 | < 1% | 15 |
| Wayside Park | 15 | < 1% | 22 |
| Wilderness Area | 7,413 | < 1% | 3 |
| WMA | 204,964 | 2.7% | 19 |
| **Total** | **1,221,401** | **16.2%** | |

## 3.7 Surface Water

There are approximately 9,700 miles of rivers and streams in the SCAWRPR, 38,000 acres of impounded water, and 959,000 acres of wetlands (ASWCC 1981, USGS 2009, Fry et al. 2011). The major river in the region is the Ouachita River. The largest impoundments in this region are Lake Ouachita, Lake Hamilton, and Lake Catherine. Surface water availability issues, both water quantity and water quality, are discussed in detail in Section 5.

### 3.7.1 Rivers and Streams

There are approximately 9,710 miles of rivers and streams in the SCAWRPR (USGS 2009). Principal streams in the Fourche Mountains and central Ouachita Mountains generally flow eastward, e.g., the upper Ouachita River. Streams in the Athens Plateau and West Gulf Coastal Plain generally flow southward. The major river in the region is the Ouachita River (see Figure 2.1), which begins in the Ouachita Mountains in western Polk County. The river flows east through Montgomery and Garland counties, where its flow is regulated by three lakes:

Lake Ouachita, Lake Hamilton, and Lake Catherine. In Hot Spring County, it turns southwest. The Caddo River joins the Ouachita River near Arkadelphia, and the river turns southeast just downstream. Another impoundment, Lake Jack Lee, is located near the confluence of the Saline River in Union County. The river flows generally south-southeast until leaving Arkansas, and eventually flows into the Black River in Louisiana (Gore 2009).

The main tributary of the Ouachita River is the Saline River. It is a free flowing river with no impoundments. It begins north of Benton and is formed by four forks; South Fork, Middle Fork, Alum Fork, and North Fork. The Saline River flows generally southward until its confluence with the Ouachita River in the Felsenthal NWR in Union County (Woodard 2012). The federal refuge is an area of wetlands, streams, lakes, and sloughs and is the world's largest green tree reservoir (USFWS 2013c, Unknown 2011).

The Caddo River is a tributary of the Ouachita River. It is a spring-fed stream that begins in Polk County. The Caddo River flows east-southeast through Montgomery and Clark counties, where it is impounded to form DeGray Lake. A little further east it flows into the Ouachita River (Westfall 2010).

Another tributary to the Ouachita River is the Little Missouri River. It begins in south Polk County and flows south-southeast through the Ouachita Mountains. One impoundment, Lake Greeson, is found on the river (Arkansas Department of Parks & Tourism 2013).

Smackover Creek is another tributary to the Ouachita River. Its headwaters are found in southern Nevada County, where the creek flows south-southeast. It then flows east along the Columbia-Ouachita County border and Union-Ouachita County border before meeting the Ouachita River at the point where Ouachita, Calhoun, and Union counties meet (USGS 2009).

Moro Creek is also a tributary to the Ouachita River. It begins in Dallas County and flows generally southward along the Dallas-Cleveland county border and Calhoun-Bradley county border. It flows into the Ouachita between the confluences of Smackover Creek and the Saline River (USGS 2009).

The historical average annual surface runoff in the SCAWRPR ranges from approximately 11 inches in the southwest area of the planning region to approximately 15 inches in the far northwest area of the planning region (Figure 3.17). Seasonal variation in surface runoff mirrors seasonal variation in precipitation (Pugh and Westerman 2014).

Mean monthly discharges at selected gaging stations are summarized on Figure 3.18. Locations of these gages are shown on Figure 3.19. Streamflow in the SCAWRPR is generally highest from December through May because of the large amount of precipitation during this period (Figure 3.11). Similarly, streamflow is generally lowest during June through November due to lower precipitation and increased water use and evapotranspiration that occur during the growing season (see Figure 3.11).

Long-term flow records in the SCAWRPR have recently been analyzed for trends. A 1992 USGS report found that no trend existed for 7-day annual low-flow series at a gage station on the Saline River with a 50-year period of record. An analysis of stations in undisturbed watersheds showed that there were no climatic trends for the period of record and therefore it could be inferred that any increasing or decreasing flow trends could be attributed to human influences (Ludwig 1992). An updated state-wide analysis of long-term trends in flow runoff is being conducted by USGS and USACE as part of the 2014 AWP update.

### 3.7.2 Lakes and Impoundments

In 1981 there were over 38,010 acres of lakes and impoundments in the planning region (Table 3.5).The majority of the impoundments in Arkansas at that time were irrigation and aquaculture ponds (ASWCC 1981). An updated state-wide inventory of impoundments is being prepared for the 2014 AWP update. ADEQ has identified 15 significant publicly owned lakes in the planning region. These are lakes that are at least 100 acres and have access designed to enhance public use (ADPCE 1990). A list of these significant publicly owned lakes is given in Table 3.6.

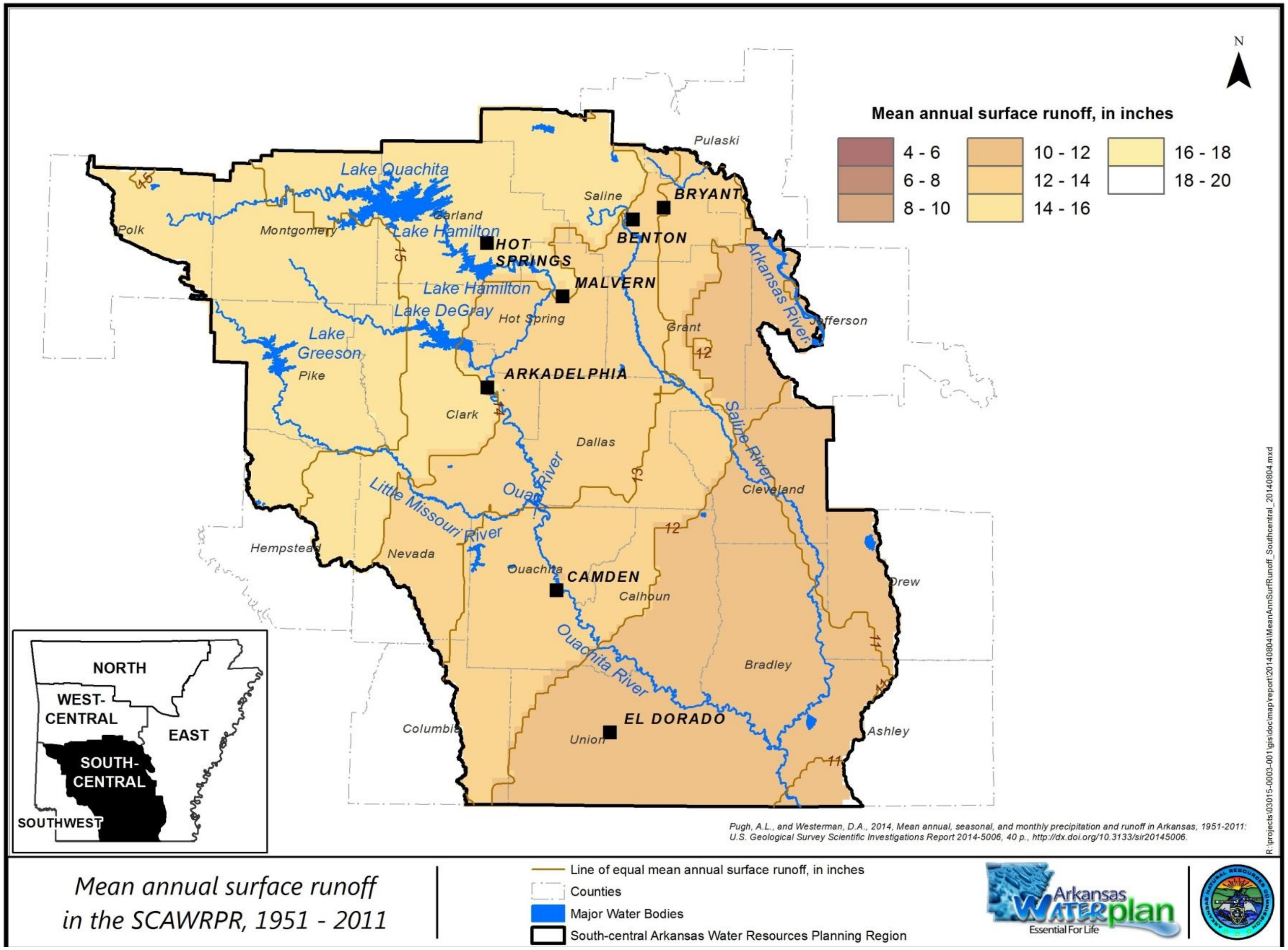


Figure 3.17. Average annual surface runoff in the SCAWRPR, 1951 to 2011 (Pugh and Westerman 2014).

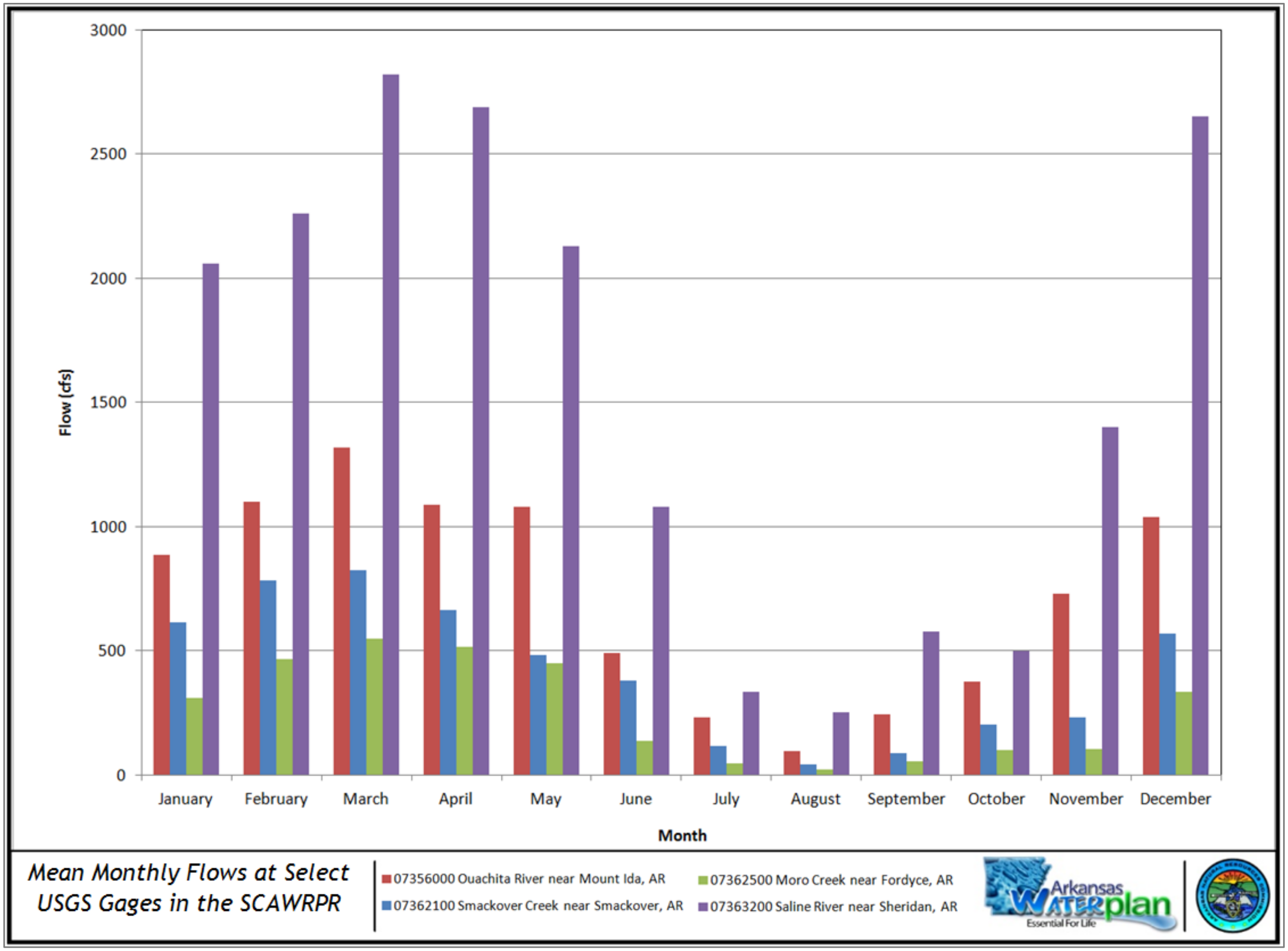


Figure 3.18. Mean monthly flows reported for USGS gaging stations on selected streams in the SCAWRPR (USGS 2014).

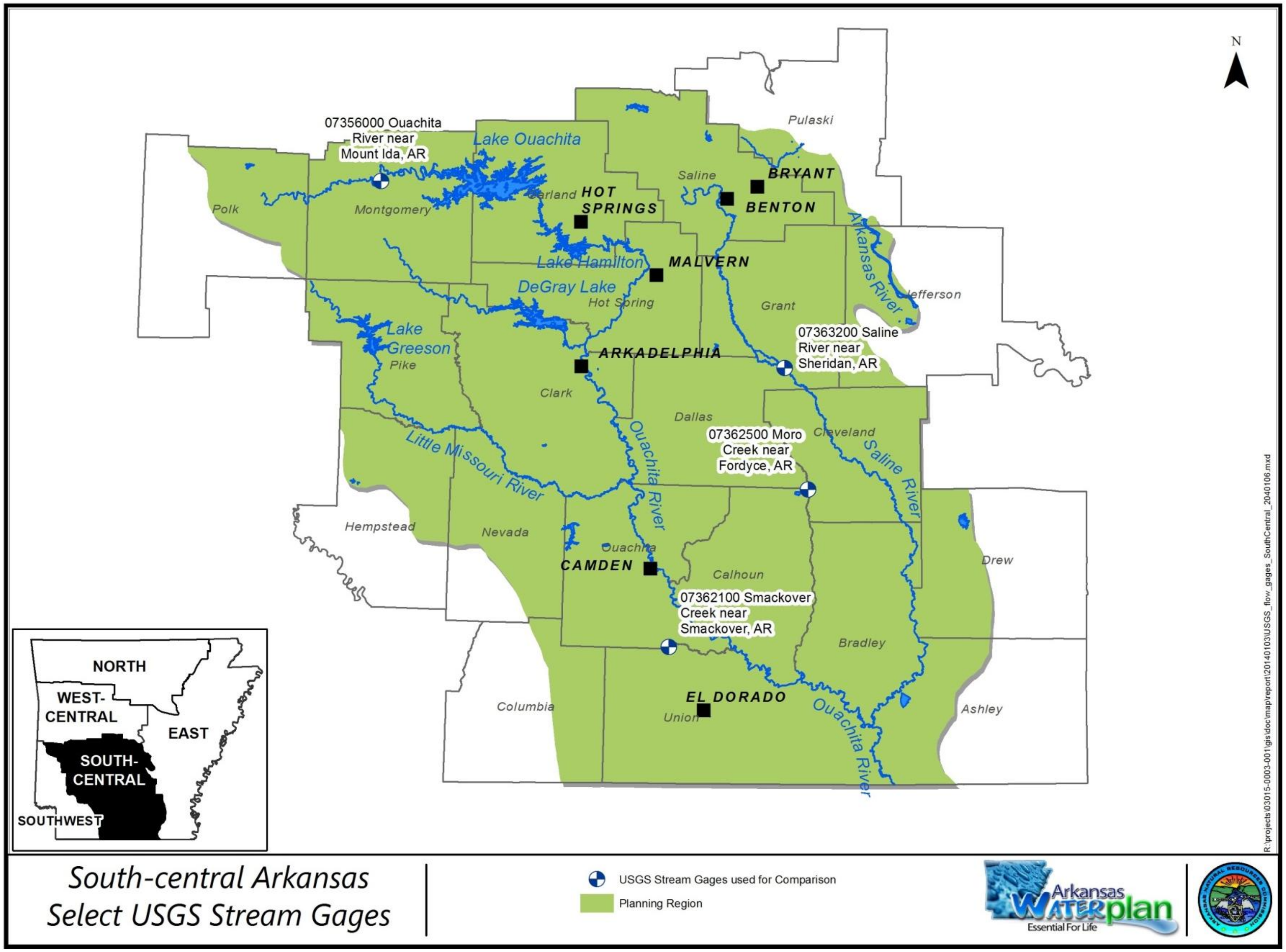


Figure 3.19. Locations of USGS gages graphed on Figure 3.18.

Table 3.5. Summary of lakes and impoundments in the SCAWRPR (ASWCC 1981).

| County | Number of Lakes and Impoundments | Area (acres) | Capacity (acre-feet) |
|---|---|---|---|
| Ashley County* | 478 | 3,200 | 12,410 |
| Bradley County | 1,170 | 1,332 | 6,225 |
| Calhoun County | 515 | 1,223 | 11,662 |
| Clark County | 1,318 | 997 | 4,494 |
| Cleveland County | 878 | 1,074 | 4,447 |
| Columbia County * | 1,283 | 1,566 | 6,763 |
| Dallas County | 645 | 418 | 2,293 |
| Drew County * | 1,307 | 741 | 1,766 |
| Garland County | 1,442 | 7,071 | 201,875 |
| Grant County | 1,251 | 2,138 | 5,037 |
| Hempstead County * | 2,665 | 2,441 | 6,002 |
| Hot Spring County | 953 | 2,477 | 37,107 |
| Jefferson County * | 371 | 495 | 5,364 |
| Montgomery County | 436 | 1,327 | 1,662 |
| Nevada County * | 1,523 | 808 | 4,367 |
| Ouachita County | 998 | 1,918 | 14,726 |
| Pike County | 1,060 | 452 | 1,518 |
| Polk County * | 1,910 | 1,439 | 7,386 |
| Pulaski County * | 735 | 1,128 | 8,284 |
| Saline County | 878 | 3,371 | 42,531 |
| Union County | 656 | 2,397 | 9,431 |
| Owned by USACE | 3 | 163,300 | 4,056,800 |
| Owned by Arkansas Department of Parks & Recreation | 1 | 3 | 17 |
| Owned by AGFC | 6 | 4,396 | 33,008 |
| **Total** | **22,482** | **205,712** | **4,485,175** |

*Part of this county is outside the SCAWRPR. The number of lakes, area, and capacity of lakes was altered so that any lake over 5 acres that was outside of the planning region was not included. An inventory of exact locations of smaller lakes was not available.

Table 3.6. Information for significant publicly owned lakes in the SCAWRPR (ADEQ 2012a).

| Name | County | Surface Area (acres) | Average Depth (feet) | Capacity (acre-feet) | Purpose |
|---|---|---|---|---|---|
| Winona | Saline | 1,240 | 30.0 | 43,000[a] | Water supply |
| Catherine | Hot Spring | 1,940 | 18.0 | 34,920[b] | Hydropower |
| Greeson | Pike | 7,200 | 39.0 | 279,700[c] | Hydropower |
| Hamilton | Garland | 7,300 | 26.0 | 189,800[b] | Hydropower |
| DeGray | Clark | 13,400 | 48.8 | 644,160[b] | Hydropower |

Table 3.6. Information for significant publicly owned lakes in the SCAWRPR (continued).

| Name | County | Surface Area (acres) | Average Depth (feet) | Capacity (acre-feet) | Purpose |
|---|---|---|---|---|---|
| Ouachita | Garland | 40,100 | 51.0 | 2,151,000[d] | Hydropower |
| Tricounty | Calhoun | 280 | 7.0 | 1,960[b] | Public fishing |
| Cox Creek | Grant | 300 | 6.0 | 1,800[b] | Public fishing |
| Calion | Union | 510 | 6.0 | 3,060[b] | Public fishing |
| Upper White Oak | Ouachita | 630 | 8.0 | 6,300[b] | Public fishing |
| Lower White Oak | Ouachita | 1,080 | 8.0 | 8,640[b] | Public fishing |
| Pine Bluff | Jefferson | 500 | 6.0 | 3,000[b] | Public fishing |
| Georgia Pacific | Ashley | 1,700 | 4.0 | 6,800[b] | Water supply |
| Felsenthal | Bradley | 14,000 | 7.0 | 98,000[b] | Recreation |

Notes:
a. From Central Arkansas Water n.d.
b. Capacity not reported; calculated as surface area (acres) times average depth (ft).
c. From http://www.lakegreeson.org/lake-greeson-narrows-dam.htm, accessed January 8, 2014.
d. From USACE Little Rock District 2009.

The largest lake entirely in the state of Arkansas is Lake Ouachita. It is the most upstream of the three lakes along the upper reach of the Ouachita River. It was formed after the completion of Blakely Mountain Dam on the Ouachita River in 1952 by USACE with funding from the Flood Control Act of 1944. A power plant was completed at the dam in 1955 (USACE n.d.[a]). The lake is maintained as Lake Ouachita State Park by the state of Arkansas, while the dam is maintained by USACE.

The next lake downstream of Lake Ouachita is Lake Hamilton. It was formed by the construction of Carpenter Dam. This dam was built by AP&L, an electric company that would eventually become Entergy. The dam was built in 1931 for the means of producing hydroelectric power. It has more potential for flooding than Lake Ouachita as it was not built for flood control (Lancaster 2012b).

Downstream of Lake Hamilton is Lake Catherine, which was formed in 1924 with the completion of Remmel Dam. This dam was also built by AP&L for the means of producing hydroelectric power. Lake Catherine State Park was created by the Civilian Conservation Corps in the 1930s and is one of the six original state parks (Smethers 2012).

The fourth impoundment on the Ouachita River is Lake Jack Lee. This lake is formed by the Felsenthal Lock and Dam, located a few miles south of the Saline River confluence. This area is also part of the Felsenthal NWR (USFWS 2013c, Unknown 2011).

DeGray Lake is an impoundment on the Caddo River. It was completed in 1972 and is managed by USACE. Hydroelectric power is produced at the dam. The lake was the first USACE lake built with pump-back capabilities. A lower lake below the main dam holds storage water that can be pumped back into the main lake if needed (USACE n.d.[b]). A resort state park is located on the banks of Lake DeGray in an area leased by the state of Arkansas from USACE (Arkansas Department of Parks and Tourism 2012b).

Lake Greeson is an impoundment found in the Little Missouri River. It was formed by the completion of Narrows Dam in 1950. The dam was built as a means of both flood control and hydroelectric power production and is maintained by USACE (Foshee 2013).

### 3.7.3 Wetlands

The SCAWRPR is located in the Coastal Plain Wetland Planning Region. All classes of wetlands are found in the region. These classes are depressions, flats, fringe, riverine, and slope wetlands (Klimas et al. 2005). Flats are found outside the direct vicinity of the rivers. The types of flat wetlands found in the Ouachita and Saline River valleys are hardwood, alkali wet prairie, pin/post oak, and wet tallgrass prairie. Riverine wetlands are found along the rivers and streams of the region. Those in the Ouachita and Saline river areas are mid-gradient riverine, low-gradient backwater, low-gradient overbank, and sand prairie. Sand prairie wetlands are extremely unique and only occur in the Ouachita River floodplain in the southern portion of the region. Depressions occur in low points that accumulate precipitation. Unconnected and floodplain depressions both occur in the SCAWRPR. Unconnected depressions are isolated from the river system. Floodplain depressions occur near the rivers and are flooded much more frequently than the unconnected depressions. Fringe wetlands occur near lakes. Reservoir fringe wetlands and connected lake margin wetlands both occur in the SCAWRPR. Reservoir fringes are wetlands that are manmade in order to provide water storage and water supply for their nearby manmade reservoir. Connected lake margin wetlands usually occur near oxbow lakes and frequently exchange flow, nutrients, and organisms with the lake. The last class of wetlands is slope wetlands. Bayheads and perennial seeps are both types of slope wetlands that occur in the SCAWRPR. Bayhead seeps are generally found in the southeast portion of the region while perennial seeps usually occur in the more northern area (Klimas et al. 2005).

A large wetland area in the SCAWRPR is in the Felsenthal NWR. It is home to the world's largest green tree reservoir, and is also considered an excellent winter waterfowl habitat (USFWS 2013c).

### 3.7.4 Surface Water Quality

Surface water quality in the SCAWRPR is generally good. Surface waters of the Ouachita Mountains overall have exceptional water quality, with low nutrient, biochemical, and turbidity concentrations in most streams. Surface water quality in the West Gulf Coastal Plain is good, with some perennial spring-fed streams as well as some intermittent creeks during summers. Water quality in the forested areas of the planning region is better than that of the pastures (Woods et al. 2004). Surface water quality issues within the SCAWRPR are discussed in detail in Section 5.

## 3.8 Groundwater

The largest and most productive of the state's major aquifers are in the Gulf Coastal Plain. The SCAWRPR is located primarily in the West Gulf Coastal Plain, which is underlain by aquifers consisting of various geologic units mainly of poorly consolidated formations that are blanketed with alluvium along the Ouachita and Saline rivers. The primary water use of these aquifers is for domestic, industrial, and public water supply.

### 3.8.1 Aquifers

There are 12 recognized aquifers in the SCAWRPR, which are listed in Table 3.7 and mapped on Figure 3.20. Many of these aquifers are designated as regional aquifers and encompass parts of several states, whereas a few of these aquifers are considered minor and are only important as local sources of water. For a detailed description of the geologic formations that comprise the aquifers in the SCAWRPR, refer to McFarland 2004. Kresse and others (2013) provide a comprehensive review of the aquifers of Arkansas to include the geologic setting, hydrologic characteristics, water levels, water use, and water quality. Much of the information presented in this section was taken or summarized from the Kresse and others (2013) report.

Table 3.7. Nomenclature, geologic age, and use for aquifers in the SCAWRPR.

| Major Division | Province | Section | Formation or Group of Formations | Geologic Age | Hydrogeologic Unit Name | Aquifer Use* |
|---|---|---|---|---|---|---|
| Coastal Plain | Gulf Coastal Plain | Mississippi Alluvial Plain and West Gulf Coastal Plain | Coastal Plain Alluvium | Quaternary | Mississippi River Valley, Ouachita-Saline | IR, PS, IN |
| | | | Jackson Group | Tertiary | Vicksburg-Jackson confining unit | D |
| | | | Cockfield Formation | Tertiary | Cockfield aquifer | PS |
| | | | Sparta Sand | Tertiary | Sparta aquifer | IR, PS, IN |
| | | | Cane River Formation | Tertiary | Cane River aquifer | PS, D |
| | | | Carrizo Sand | Tertiary | Carrizo aquifer | D |
| | | | Wilcox Group | Tertiary | Wilcox aquifer | PS, IR, IN |
| | | | Nacatoch Sand | Cretaceous | Nacatoch aquifer | PS |
| | | West Gulf Coastal Plain | Ozan Formation | Cretaceous | Ozan aquifer | D |
| | | | Tokio Formation | Cretaceous | Tokio aquifer | PS, IN |
| | | | Trinity Group | Cretaceous | Trinity aquifer | PS, IN |
| Interior Highlands | Ouachita Province | Ouachita Mountains | Johns Valley Shale<br>Jackfork Sandstone<br>Stanley Shale<br>Arkansas Novaculite<br>Missouri Mountain Shale<br>Blaylock Sandstone<br>Polk Creek Shale<br>Bigfork Chert<br>Womble Shale<br>Blakely Sandstone<br>Mazarn Shale<br>Crystal Mountain Sandstone<br>Collier Shale | Cambrian through Pennsylvanian | Ouachita Mountains aquifer | D |

*Note: IR= irrigation, PS = public supply, IN = industrial, D = domestic. Listed in order of highest use by volume. Primary use in capital letters; secondary use in small caps.

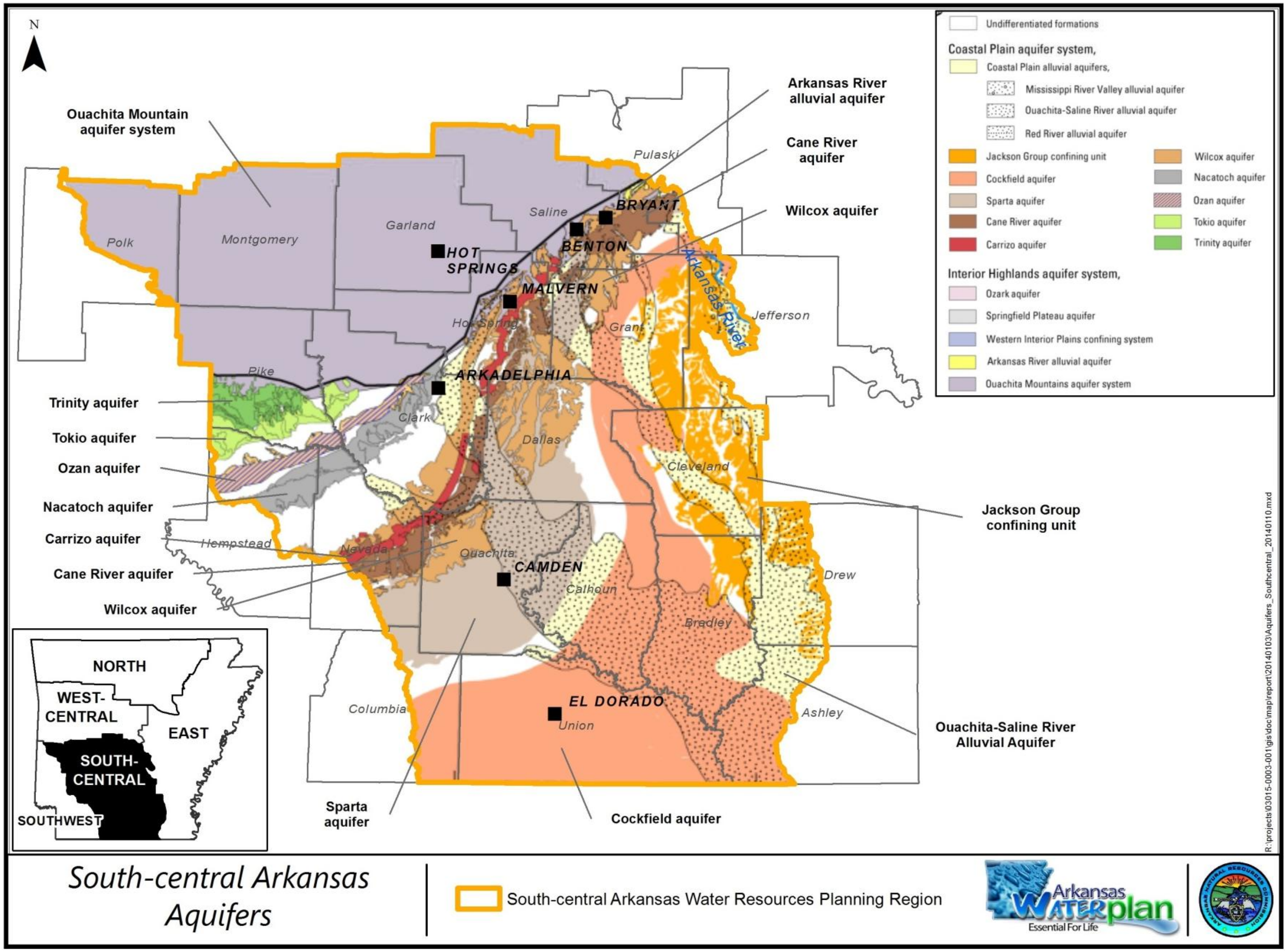


Figure 3.20. Aquifers of the SCAWRPR (Kresse et al., in review).

From youngest to oldest, the following formations serve as aquifers in the West Gulf Coastal Plain section of the SCAWRPR: alluvium associated with the Ouachita and Saline rivers, the Jackson Group, the Cockfield Formation, the Sparta Formation, the Cane River Formation, the Carrizo Sand, the Wilcox Formation, the Nacatoch Sand, the Ozan Formation, the Tokio Formation, the Trinity Group, and the Ouachita Mountains aquifer. All but the Jackson Group have been or are used as a significant source of water supply in the region. The Jackson Group is a regional confining unit that historically served as an important source of domestic supply. The Cretaceous Formations (Nacatoch Sand, Ozan Formation, Tokio Formation, and Trinity Group) are not designated as regional aquifers but are considered to be important local groundwater supplies (Kresse et al. 2013). Of these aquifers, the Sparta aquifer is the most important, yielding 82% of the groundwater used in the areas of the planning region where it occurs, during 2010.

The unconsolidated sand and gravel that comprise the Quaternary alluvial aquifers have intergranular porosity, and all contain water primarily under unconfined or water-table conditions. The hydraulic conductivity of the aquifers is variable, depending on the sorting of aquifer materials and the amount of silt and clay present, but generally it is high. The alluvial aquifers are susceptible to contamination because of their generally high hydraulic conductivity. Groundwater in the Ouachita-Saline alluvial aquifer flows along relatively short flow paths from recharge to discharge areas typical of local flow systems; however, the Mississippi River Valley alluvial aquifer has a regional flow system. Mississippi River Valley alluvial aquifer is an important aquifer in the Mississippi Alluvial Plain, but only a small portion of the alluvial aquifer occurs within the planning region (Drew and Ashley counties). The reader is referred to discussions of this major aquifer in the East Arkansas Water Resources Planning Region report.

The remaining West Gulf Coastal Plain aquifers consist of semi-consolidated and unconsolidated sand interbedded with silt, clay, and minor carbonate (limestone) rocks. Porosity is intergranular, and the hydraulic conductivity of the aquifers is moderate to high. The aquifers are in a thick wedge of sediments that dips and thickens toward the Arkansas-Louisiana border. Groundwater in topographically high recharge areas is unconfined, but it becomes confined as it moves downdip. Discharge may occur by upward leakage to shallower aquifers. These aquifers typically have lengthy regional flow paths, and because flow is sluggish near the ends of regional flow paths, the aquifers commonly contain unflushed saline water in their deeply buried, down dip parts. Where shallower aquifers have been heavily pumped, saltwater intrusion has locally contaminated groundwater. The northern one-third of the planning region lies within the Ouachita Mountains section of the Interior Highlands, where groundwater occurs in shallow, fractured, and discontinuous bedrock that results in lower porosity, storage, and yields than the laterally extensive, coarse-grained, and unconsolidated sediments of the West Gulf Coastal Plain.

#### 3.8.1.1 Ouachita-Saline Alluvial Aquifer

Alluvial deposits constituting the Ouachita-Saline rivers alluvial aquifer are thin and restricted in areal extent. Locally, the alluvium of the Ouachita and Saline rivers provides readily available groundwater. The alluvium is comprised of silt and beds of fine to very fine sand, with some clay throughout. Locally the alluvium may contain coarse sand. The alluvium ranges from 0 to 40 feet in thickness in Grant and Hot Spring counties (Halberg, Bryant and Hines 1968). Groundwater is under water table conditions (unconfined), and, where the sand is coarse, the alluvium may be in hydraulic connection with the rivers. Halberg and others (1968) noted a maximum yield of 25 gpm.

In the area of Clark, Cleveland, and Dallas counties, the alluvium of the Ouachita River is comprised of silt, clay, sand, and gravel, reaching a maximum thickness of about 40 feet (Plebuch and Hines 1969). Plebuch and Hines (1969) report that two industrial wells south of Arkadelphia yield 240 gpm each, yet nearby wells were capable of yielding much lower quantities of water, indicating a wide variability of the properties of the aquifer in this area. The groundwater in this area is under water table conditions. In most locations, deposits from the Ouachita and Saline rivers incise older Pleistocene terrace deposits and no distinction is made between the groundwater from all of these combined alluvial deposits (Kresse et al. 2013).

#### 3.8.1.2 The Jackson Group

The Jackson Group comprises an upper Tertiary-age sequence of largely unconsolidated clays with variable abundances of fossils, gypsum, marls, carbonate lenses, and lignite (Hosman and Weiss 1991, Veatch 1906); sand units are a minor but an important occurrence (Stephenson and Crider 1916). Because of the predominance of fine-grained sediments and overall low hydraulic conductivity, the Jackson Group is designated as a regional confining unit. However, groundwater in deposits of the Jackson Group served in the past as an important source of domestic and small farm water supply through the 1990s. As such, this group of deposits can be considered an aquifer, although a minor one in terms of poor yields and lack of economical supply for industrial, municipal, irrigation, and other important uses. The largest area of outcrop of the Jackson Group in Arkansas is located in the planning region south of the Arkansas River in Jefferson, Lincoln, Cleveland, Drew, and Bradley counties. Groundwater use from the Jackson Group was confined almost solely to this large area of exposed deposits. Yields to wells were reported to be very small (Plebuch and Hines 1969; Halberg, Bryant, and Hines 1968). Kresse and Fazio (2003) reported that most of the wells completed in the Jackson Group were dominantly less than 50 feet, with many less than 30 feet; only four wells were found to be deeper than 50 feet, ranging upward to 150 feet below land surface.

#### 3.8.1.3 Cockfield Aquifer

The Cockfield Formation crops out extensively over south-central Arkansas (Figure 3.20). It is exposed over practically all of Union County and parts of Bradley, Cleveland, Dallas, Grant, and Saline counties (Hosman et al. 1968; Hosman 1982; Petersen, Broom and Bush 1985). The Cockfield Formation generally consists of silt, clay, and lignite in the upper portions and sand beds near the base, which form the more permeable portions of the Cockfield aquifer (Pugh 2010). There is considerable variability in unit thickness, ranging from 100 to 700 feet. Regional groundwater flow is to the southeast; however, sustained and intense pumping in some areas of southeastern Arkansas have led to the development of cones of depression and altered flow towards these pumping centers (Hosman et al. 1968, Petersen et al. 1985).

In the outcrop area and where overlain by Quaternary alluvium, the aquifer is unconfined. Where overlain by the Jackson Group, the aquifer is confined. In the confined part of the aquifer, the potentiometric surface can be near or above land surface (Ackerman 1987, Pugh 2010).

Recharge to the aquifer occurs as precipitation in the outcrop area and as seepage from overlying Quaternary alluvium in the subcrop area. Discharge from the aquifer occurs to streams in the outcrop area, to adjacent units, and wells. In and near the outcrop area, well depths are typically shallow (less than 200 feet) and yields are generally less than 30 gpm. Further away from the outcrop area, well depths can exceed 600 feet and yields range from 100 to 500 gpm (Kresse et al. 2013).

#### 3.8.1.4 Sparta Aquifer

The Tertiary-age Sparta Sand is the thickest sand in the Mississippi embayment and its importance as an aquifer is recognized by the fact that it is second in use only to the Mississippi River Valley alluvial aquifer. The Sparta aquifer is present throughout the SCAWRPR. Kresse and others (2013) noted that the term “Sparta aquifer” is applied to a sequence of hydraulically connected sands that are often separated by silts and clays and is not an absolutely equivalent term with “Sparta Sand,” the formal name for the geologic formation. This distinction is important because by Arkansas law, Critical Groundwater Area designation criteria for the Sparta aquifer are based on the top of the geologic formation rather than the top of the aquifer (ANRC 1996); this has been an important distinction in management of the Sparta aquifer. In areas where clays and silts in the Sparta Sand (the geologic formation) occur above productive sands, the top of the Sparta aquifer does not coincide with the top of the Sparta Sand. In this report, the term “Sparta Sand” always will refer to the geologic formation (comprising sands, silts, and clays), and the term “Sparta aquifer” will refer to the sequence of productive, hydraulically connected sands that constitute a part of the geologic formation.

The Sparta Sand consists of varying amounts of sand and occasionally gravel interspersed with layers of silt, clay, shale, and lignite. The lower half of the unit generally contains more sand and the upper part of the Sparta Sand generally contains more clay and shale (Hosman et al. 1968, Petersen et al. 1985). The occurrence, continuity, and thickness of the sand beds which constitute the aquifer are quite variable but in general appear to be hydraulically connected. Hydraulic properties in the Sparta aquifer vary widely, and groundwater appears to be more easily transmitted in the thickest sand intervals. Reported well yields range from hundreds to thousands of gallons per minute (Kresse et al. 2013).

The Sparta Sand outcrops in southern Arkansas, and the Sparta aquifer is unconfined at its western extent within the Mississippi Embayment. The Sparta aquifer becomes confined by the overlying Cook Mountain Formation and the underlying Cane River Formation (Kresse et al. 2013). The Sparta aquifer is recharged by direct infiltration in the outcrop, from rivers in the outcrop, and by leakage from overlying aquifers. Natural discharge occurs by leakage through the confining and discharge to rivers within the outcrop area. Natural groundwater flow is generally down dip toward the axis of the embayment and southward toward the Gulf of Mexico.

In the area of Union County, the Sparta Sand is divisible into three distinct hydrogeologic units: the upper 200 feet is composed of thin-bedded sands and clays referred to as the Greensand (upper Sparta aquifer); the middle 50 to 155 feet is composed of clay and silt and is referred to as the Middle Confining Unit; and the lower 300 feet of thick-bedded sands is referred to as the El Dorado Sand (lower Sparta aquifer). The Greensand is overlain by the Cook Mountain Formation and regionally dips southeastward. The Greensand is partially in contact with the Middle Confining Unit and the El Dorado Sand along faults. Differences in static water levels measured in sand beds within the Greensand aquifer indicate that some clay beds in the Greensand act as confining beds locally. In some areas of Union County, the Middle Confining Unit contains sand that makes the unit difficult to distinguish from the Greensand and El Dorado Sand. However, differences in potentiometric surfaces above and below this unit confirm that it effectively isolates the upper and lower sands of the Sparta aquifer in this area. In general, the El Dorado Sand is more productive and the local flow pattern within the El Dorado sand is heavily influence by groundwater withdrawals (Hosman et al. 1968, Broom et al. 1984, Leidy and Taylor 1992, Clark and Hart 2009). The El Dorado Sand overlies the Cane River Formation and regionally dips southeastward and is faulted against the Cane River Formation in some areas (Leidy and Taylor1992).

#### 3.8.1.5 Cane River Aquifer

The Cane River Formation (hereinafter referred to as the Cane River aquifer when referring to the saturated part of the formation) is a sequence of marine clays and shale that includes minor amounts of marls, silts, and marine sand. Payne (1972) reported that the formation thickness ranged from 200 to 750 feet thick. The Cane River Formation overlies the Carrizo Sand and is overlain by the Sparta Sand. The Cane River Formation is considered an important aquifer within the planning region, where locally extensive, water-producing sands occur within the formation. Because the sand units are thin and discontinuous regionally as compared to thicker, regionally extensive sand units in adjacent formations, the clay-dominated lithology of the Cane River Formation in southern Arkansas was listed as part of a regional confining system, termed the lower Claiborne confining unit (Arthur and Taylor 1990; Clark and Hart 2009; Hart, Clark and Bolyard 2008; Hosman and Weiss 1991).

The Cane River aquifer is composed of poorly connected sand bodies 25 feet or more in thickness. Hydraulic properties in the Cane River aquifer vary widely, and groundwater appears to be more easily transmitted in the thickest sand intervals. Near the outcrop and subcrop areas in the planning region, the aquifer is under water-table conditions; however, the aquifer becomes confined by overlying and underlying beds downdip and is under artesian conditions (Petersen et al. 1985). Shallow wells in the outcrop area generally yield between 5 and 10 gpm (Hosman et al. 1968), but aquifer yields that vary between 50 and 920 gpm have been reported (Ludwig 1972, Plebuch and Hines 1969, Tait et al. 1953). Municipal wells in Dallas County each produced 50 gpm (Plebuch and Hines 1969). Although yields are variable, they are more than sufficient for smaller towns in the planning region. In Union County, the Cane River Formation is considered a confining unit with little capacity for transmission of fluids, with the exception of possible fluid transfer along fault zones (Broom et al. 1984).

The principal source of recharge to the aquifer is infiltration of precipitation through exposures in the outcrop areas (Hosman et al. 1968). Recharge may occur through younger sedimentary materials, where the Cane River Formation outcrop is covered. A minor amount of recharge takes place by upward movement from the underlying Carrizo Sand and the upper Wilcox aquifer. Water is lost from the aquifer from pumping wells and through natural discharge by upward leakage though confining units. A very minor component of natural discharge may occur as base flow into streams incised into the Cane River Formation (Hosman et al. 1968, Payne 1972).

Regional flow of water is generally south and southeast down dip toward the gulf coast and the Mississippi alluvial valley. Upward flow occurs through leaky confining units above the Cane River Formation. This occurs where the head of the Cane River Formation exceeds the head of the overlying Sparta Sand (Payne 1972, Petersen, Broom and Bush 1985).

#### 3.8.1.6 Carrizo Aquifer

The saturated part of the Carrizo Sand comprises an aquifer of limited use only in and near the outcrop area within the planning region. The Carrizo Sand consists predominately of massive-bedded quartz sands with minor amounts of interbedded clays and silts and occasional lenses of lignite. The lithology is almost uniform, being composed of more than 80% sand in the majority of Arkansas. In Clark, Cleveland, and Dallas counties, the Carrizo Sand consists mainly of very fine to medium sand, although it does contain some clay and lignite (Plebuch and Hines 1969). The Carrizo Sand is discontinuous, notably in parts of Union, Ouachita, and Columbia counties, where thicknesses of 30 feet or less occur, and is highly variable in thickness. The thickness of the Carrizo Sand in Clark, Cleveland, and Dallas counties varies considerably over short distances, ranging from about 60 to 200 feet (Plebuch and Hines 1969).

Recharge to the Carrizo Sand in the planning region comes from rainfall on the outcrop, and discharge from the Carrizo Sand occurs by withdrawals from wells and by natural leakage through the overlying confining beds. Regional flow of water is generally down dip, toward the axes of the Mississippi embayment (Hosman et al. 1968; Payne 1975).

The Carrizo aquifer is not considered to be a major aquifer in Arkansas due to its erratic distribution, and therefore available hydrologic data are limited. There is an increase in permeability with increasing thickness of sand units in the Carrizo aquifer. Except in the outcrop area, water in the Carrizo Sand is under artesian conditions and the regional flow is down dip to the east and southeast (Payne 1975). In southern portions of the planning region, the groundwater flow in the Carrizo aquifer is confined by the Wilcox Group below and the Cane River Formation above (Hosman et al. 1968).

#### 3.8.1.7 Wilcox Aquifer

The Wilcox Group is present throughout the Coastal Plain of Arkansas. Three aquifer units are used to represent the Wilcox Group: lower Claiborne-upper Wilcox aquifer [hereafter referred to as the upper Wilcox, or minor Wilcox aquifers after Hosman and others (1968), the middle Wilcox aquifer, and the lower Wilcox aquifer. The upper Wilcox Group predominates in the southern part of Arkansas and consists of complexly interbedded layers of clay, sandy clay, thin and discontinuous sand, and lignite (Joseph 1998), and the thin sands of this unit serve as aquifers (Hosman et al. 1968).

In southern Arkansas, the Wilcox Group overlies the Midway Group, crops out in a discontinuous band 1 to 3 miles wide (Joseph 1998), and commonly is overlain by terrace deposits and alluvium of Quaternary age. The Wilcox in the planning region becomes progressively thicker downdip from the outcrop, ranging in thickness from only a few feet at outcrop to about 750 feet in Bradley County (Albin 1964), and it dips toward the axis of the Mississippi Embayment at about 50 feet per mile in the south (Hosman et al. 1968). Zachary and others (1986) report that the Wilcox Group crops out in northern Nevada and Hempstead counties and underlies the Cane River Formation throughout Columbia and Union counties. In this area, the Wilcox group is composed dominantly of clay with thin erratic sand units and thin lignite beds in some areas. In the area of Columbia and Union counties, the Wilcox Group ranges from 350 to 550 feet in thickness.

Recharge to the Wilcox aquifer in the planning region is from precipitation in the outcrop areas, or from leakage through the confining clays (Hosman et al. 1968). The potentiometric surface of the Wilcox aquifer is below land surface (Hosman et al. 1968). Wells completed in the Wilcox aquifer in southeast Hot Spring County and southwestern Grant County yield 300 gpm (Halberg, Bryant and Hines 1968). The direction of groundwater flow is either down dip (southeast) or by pumping induced gradients. Pumping from minor Wilcox aquifers has caused declines in water levels in some areas.

#### 3.8.1.8 Nacatoch Aquifer

The Nacatoch Sand is a Cretaceous-age formation of interbedded lithologies, predominated by generally unconsolidated sands with local lenses and beds of fossiliferous sandy limestone (Counts et al. 1955, Plebuch and Hines 1969). Formation thickness ranges from 150 to nearly 600 feet (Boswell et al. 1965; Zachary et al. 1986). The Nacatoch Sand outcrops along a belt 3 to 8 miles wide that extends from central Clark County southwestward to the west edge of Hempstead County. The Nacatoch Sand dips south and southeast into the subsurface at a rate of about 30 feet per mile (Boswell et al. 1965; Ludwig 1972, Veatch 1906). The Nacatoch Sand is faulted downdip in Hempstead, Nevada, Ouachita, Calhoun, and Bradley counties (Petersen, Broom and Bush 1985). The lower sand unit in the Nacatoch Sand is a petroleum-producing formation in the Smackover Field of southern Arkansas (Weeks 1938).

Most wells completed in the Nacatoch aquifer are relatively low-yield wells. Throughout southwestern Arkansas, Counts and others (1955) reported well yields from 1 to greater than 300 gpm. Flowing (artesian) wells in the lower stream valleys of Nevada County yield less than 5 gpm. Wells in Hempstead and Nevada counties can be expected to yield from 150 to 300 gpm (Counts et al. 1955, Ludwig 1972). The presence of artesian wells indicates that away from the outcrop the Nacatoch aquifer is under confined conditions.

The Nacatoch aquifer receives direct recharge from precipitation in the area of its outcrop. The regional direction of groundwater flow is to the southeast (Schrader and Blackstock 2010). The flow directions may be locally controlled by clay content and faulting (Boswell and Hosman 1964). Groundwater flow and flow direction have been altered by pumping at Hope, Arkansas, where water levels in the Nacatoch sand have declined (Ludwig 1972) and a cone of depression has developed. Vertical movement upward toward Tertiary aquifers was predicted to be slow or nonexistent (Zachary et al. 1986).

#### 3.8.1.9 Ozan Aquifer

The Cretaceous-age Ozan Formation comprises an aquifer that is used solely in isolated parts of southwestern Arkansas. This aquifer is not listed in any regional reports, is one of the least-used aquifers, and contains some of the poorest-quality groundwater of any aquifer in the state. The Ozan Formation is a mixed limey, clayey, and primarily sand unit that ranges in thickness from 0 to about 200 feet thick. The Ozan Formation outcrop extends from northeastern Clark County, Arkansas, toward the southwest into Oklahoma. The outcrop ranges from 1 to 4 miles wide and through large areas is covered by terrace and alluvial deposits (Boswell et al. 1965). From central Union County eastward, the sand content and thickness of the Ozan Formation increases rapidly (Kresse et al. 2013).

Hydrologic data for the Ozan aquifer are limited because of the lack of importance as a regional water supply. Most wells completed in the Ozan aquifer are used as a domestic water supply (Boswell et al. 1965) of limited capacity and yielding highly mineralized water, and most of these wells are located in Clark County (Counts et al. 1955). Some of the wells in Clark County are flowing artesian wells (Plebuch and Hines 1969). A few wells are completed in the Ozan aquifer in Hempstead County, but the water is not suitable as a drinking water source (Counts et al. 1955). The Ozan aquifer dominantly receives recharge in the outcrop area.

#### 3.8.1.10 Tokio Aquifer

The Tokio Formation of Cretaceous-age crops out in a narrow band from southeastern Sevier County (Southwest WRPR) through Howard, Hempstead, and Pike and western Clark counties and attains a maximum width of about 10 miles in Howard County (Schrader and Blackstock 2010). Most producing wells are located within the larger outcrop belt. Ludwig (1972) listed extensive variation in well depth, ranging from less than 30 feet to 1,200 feet below ground surface for parts of Hempstead County and Lafayette and Little River counties in the Southwest WRPR.

The Tokio Formation consists of discontinuous, interbedded gray clay and poorly sorted sands, lignite, scattered carbonaceous materials, and in some areas a prominent basal gravel (Boswell et al. 1965; Counts et al. 1955; Dollof et al. 1967; Petersen, Broom and Bush 1985; Plebuch and Hines 1969). In parts of Howard and Hempstead counties, the Tokio Formation comprises three distinct aquifers, including a basal sand that grades to gravel to the east and two upper sands (Boswell et al. 1965). Toward the east the clay layers separating the sands thin and the sands merge into a massive stand, which is prevalent over most of Hempstead, southern Pike, and northern Nevada counties. The formation dips at about 60 feet per mile to the southeast away from the outcrop and ranges in thickness from 50 to more than 300 feet (Boswell et al. 1965), obtaining its maximum thickness in Miller County in the Southwest WRPR (Dollof et al. 1967). A fault zone through the Tokio Formation occurs across Hempstead, Nevada, Ouachita, Calhoun, and Bradley counties (Petersen et al. 1985, plate 8).

The Tokio aquifer receives direct recharge at its outcrop and from the overlying alluvial deposits where it subcrops (Boswell et al. 1965). At its outcrop, the Tokio Formation weathers into a sandy soil, facilitating percolation of surface and rain water into the sand (Counts et al. 1955). Flow of groundwater in the Tokio aquifer is generally toward the south or southeast away from the outcrop area (Schrader 1998).

Most wells constructed in the Tokio Formation are low-yield wells, but some wells produce 150 to 300 gpm. Many wells are flowing artesian wells (found in southeastern Pike, northeastern Hempstead, and northwestern Nevada counties) and typically produce less than 20 gpm under natural flowing conditions. The Tokio Formation is the most important source of water from artesian wells in southwestern Arkansas. Wells in central Hempstead County yield up to 300 gpm. Wells flowing as much as 90 gpm occur in the bottom-land areas adjacent to streams (Counts et al. 1955). The prevalence of artesian wells indicates that away from the outcrop the Nacatoch is under confined conditions.

#### 3.8.1.11 Trinity Aquifer

The Trinity aquifer crops out in an east-west trending band from western Sevier County through central Howard County in the Southwest WRPR to near the southeastern extent of Pike County in the SCAWRPR. The Trinity Group is a sequence of clastic rocks ranging from less than 100 feet in outcrop areas to more than 1,000 feet at downdip locations. The Trinity comprises six distinct units (Counts et al. 1955), with the Pike Gravel, the Ultima Thule Gravel Member of the Holly Creek Formation, and the Paluxy Sand (Boswell et al. 1965) comprising three aquifers within the Trinity Group. These formations achieve maximum thicknesses of 50 feet, 40 feet, and 900 feet, respectively. Wells that are screened in the Pike Gravel in southern Pike County were initially under flowing artesian conditions, but ceased to flow as potentiometric surfaces declined as a result of large withdrawals and over-pumping. Generally within Pike County, the Trinity Group is a calcareous clay with little potential to yield water. Aquifers in the Trinity Group receive recharge in the outcrop area and the direction of groundwater flow is southward (Boswell et al. 1965).

#### 3.8.1.12 Ouachita Mountains Aquifer

A thick sequence of Paleozoic rock formations in the Ouachita Mountains serves as an important source of groundwater supply for domestic users, in addition to a limited number of small commercial- and community-supply systems. The shallow saturated section of the combined formations in the Ouachita Mountains is referred to as the Ouachita Mountains aquifer (Kresse et al. 2013). Formations comprising the aquifer are predominated by thick sequences of shale, siltstones, sandstones, and other quartz formations (i.e., chert, novaculite), with minor occurrences of carbonates and other rocks.

For this system, recharge occurs as precipitation that infiltrates the ground in upland areas and percolates to the water table. Groundwater flow paths are defined by small-scale topographic features where flow occurs from elevated areas to valley floors terminating in small stream systems. Groundwater storage in these aquifers is limited primarily to fractures and faults. Quartz formations such as the Bigfork Chert and Arkansas Novaculite are very brittle and prone to dense fracturing, and most researchers working in the Ouachita Mountains identified the Bigfork Chert as the most productive aquifer in the region (Albin 1965, Cole and Morris 1986, Halberg, Bryant and Hines 1968, Kresse and Hays 2009, Stone and Bush 1984).

Yields from wells completed in the Ouachita Mountains aquifer have a fairly large range depending on individual formations and lithology, but are typically low throughout the aquifer. Albin (1965) noted that most wells in the Ouachita Mountains aquifer yielded less than 10 gpm, and yields greater than 50 gpm were rare; however, one well completed in the Bigfork Chert was recorded as yielding 350 gpm (Kresse et al. 2013). In spite of the upper range for reported yields and other hydrologic characteristics for various formations constituting the Ouachita Mountains aquifer, caution was expressed by all authors for planning and management purposes that groundwater should not be considered as a source of supply for municipal growth and economic development unless the required quantity was small (Albin 1965; Halberg, Bryant and Hines 1968; Stone and Bush 1984).

Most wells in the Ouachita Mountains aquifer are less than 100 feet deep, but can range up to approximately 700 feet deep, with static water levels generally less than 20 feet below land surface, and flowing-artesian wells found throughout the region (Albin 1965, Kresse and Hays 2009). Pumping water levels may be as much as 150 feet below land surface in deeper wells. Seasonal water-level fluctuations in wells generally are less than 10 feet; however, larger fluctuations are common in abnormally wet or dry years because the groundwater reservoirs generally have small storage capacities and are recharged by rapid infiltration of local precipitation (Albin 1965).

### 3.8.2 Groundwater Quality

In general, groundwater quality in the SCAWRPR is considered good. Groundwater chemistry in the planning region is primarily calcium-bicarbonate. Water quality characteristics of the aquifers in the planning region are described below. Issues with groundwater quality (both natural and contamination) are discussed in detail in Section 5.

#### 3.8.2.1 Ouachita-Saline Rivers Alluvial Aquifer

Kresse and others (2013) report on water quality within the alluvial deposits (including Pleistocene alluvial deposits) west of the divide between the Mississippi Alluvial Plain and the West Gulf Coastal Plain area as the Ouachita-Saline rivers alluvial aquifer without discriminating between these deposits. In general, groundwater quality of the Ouachita-Saline rivers alluvial aquifer is good when compared to EPA primary drinking water standards and levels of dissolved solids in the groundwater throughout most of this aquifer are low enough for the water to be suitable for most uses. Significantly lower concentrations of iron, arsenic and other trace metals were found in groundwater from the older Pleistocene-age terrace deposits compared to the younger, Holocene-age floodplain deposits. Flushing over time likely accounts for the differences in water quality for these deposits in Arkansas.

Numerous wells completed in the Ouachita-Saline rivers alluvial aquifer had nitrate concentrations greater than 10 milligrams per liter (mg/L), particularly in Calhoun and Bradley counties. Because most of the wells sampled in this area had well depths less than 30 feet, they possibly are shallow domestic wells, which are more vulnerable to surface sources of nitrate (for example, septic systems), and nitrate has not been reduced, which is typical for groundwater from the deeper parts of the aquifer (Kresse et al. 2013).

#### 3.8.2.2 The Jackson Group

Most groundwater in the Jackson Group is a calcium- and sodium-sulfate water type (Kresse et al. 2013). Correlations of elevated sulfate concentrations to elevated iron concentrations and extremely low-pH groundwater strongly suggest that oxidation of pyrite in some regions of the aquifer contribute to this water type. Groundwater from the Jackson Group has some of the poorest water quality of any aquifer system in the state with naturally elevated chloride (greater than 800 mg/L), sulfate (greater than 3,000 mg/L), and total dissolved solids (TDS) (greater than 5,000 mg/L) concentrations. Nitrate concentrations revealed an inverse correlation with well depth, showing the increased vulnerability to surface sources of contamination (Kresse et al. 2013).

#### 3.8.2.3 Cockfield Aquifer

The Cockfield aquifer contains groundwater that is typically of high quality and is used throughout southeastern Arkansas. The groundwater is typically a calcium-bicarbonate water type in the outcrop and subcrop areas and transitions to a sodium-bicarbonate type downgradient of these areas. Isolated areas of the aquifer contain elevated sulfate (primarily Jefferson and Drew counties) as a result of mixing with water of poor quality in underlying formations and elevated iron (Grant and Jefferson counties) concentrations that are possibly the result of infiltration of high iron-content groundwater from overlying formations (Kresse et al. 2013).

#### 3.8.2.4 Sparta Aquifer

The quality of groundwater from the Sparta aquifer throughout the SCAWRPR is very good. The groundwater generally is a sodium-bicarbonate water type throughout most of the extent of the aquifer; however, a calcium-bicarbonate water type is found in the outcrop area for the Sparta Sand. Elevated iron and nitrate groundwater concentrations are found dominantly in the outcrop area of the Sparta Sand, with lower concentrations in the downgradient direction of flow. Generally, pH values, in addition to bicarbonate and dissolved solids concentrations, increase in the Sparta aquifer with increased residence time along the flow path moving downgradient from the outcrop area for the Sparta Sand; effects are attributed to increased dissolution of carbonates. Areas of high salinity are noted in isolated areas of the Sparta aquifer, predominantly as a result of inferred upwelling from high-salinity groundwater in underlying formations (Kresse et al. 2013).

#### 3.8.2.5 Cane River Aquifer

Water quality from the Cane River aquifer is good with respect to federal drinking water standards. Groundwater from the Cane River aquifer generally is a calcium-bicarbonate water type in the outcrop area, but transitions at short distances from the outcrop area to a sodium-bicarbonate water type as a result of cation exchange processes. Nitrate concentrations were less than the maximum contaminant level of 10 mg/L as nitrogen for all samples. Salinity increases downdip of the outcrop area, and chloride concentrations can exceed the federal secondary drinking water regulation of 250 mg/L in some areas. Similar to other tertiary aquifers in the Coastal Plain, iron, nitrate, and sulfate are relatively higher in the outcrop areas (Kresse et al. 2013).

#### 3.8.2.6 Carrizo Aquifer

Groundwater in the Carrizo aquifer is of overall good quality. The aquifer has a sodium-bicarbonate groundwater with low iron concentrations as compared to many other aquifers of the Coastal Plain. Nitrate concentrations from data compiled for this report were extremely low throughout the extent of the aquifer. Sulfate and chloride concentrations generally are low for areas near the outcrop, but increase appreciably at large distances from the outcrop area (Kresse et al. 2013).

#### 3.8.2.7 Wilcox Aquifer

The Wilcox aquifer within the planning region is a viable groundwater supply only in the outcrop area; the water becomes brackish or saline within a short distance downdip of the outcrop and is unfit for most purposes (Ludwig 1972, Plebuch and Hines 1969; Terry et al. 1986). Plebuch and Hines (1969) describe groundwater from the Wilcox aquifer in Clark, Cleveland, and Dallas counties as a sodium-bicarbonate type, with water increasing in dissolved solids content and becoming a sodium-chloride type downdip. Broom and others (1984) noted that the Wilcox and Carrizo aquifers are indistinguishable in Union County, are hydraulically connected, and used solely for injection of brine. Hewitt and others (1949) noted abundant saltwater at depths of 1,000 feet in Ashley County. Ludwig (1972) described groundwater from the Wilcox aquifer as a soft to moderately hard, sodium-bicarbonate type for most of Hempstead, Lafayette, Miller, and Nevada counties. The southern extent of fresh water coincided with a fault system extending through central Miller, Lafayette, and Nevada counties, and groundwater south of the fault zone contained more than 1,000 mg/L dissolved solids based on electric logs (Ludwig 1972). Halberg and others (1968) reported that groundwater from the Wilcox aquifer in Hot Spring and Grant counties was a soft, sodium-bicarbonate type, although iron concentrations could be high and that groundwater from shallow wells was slightly acidic. Hosman and others (1968) noted that water type varied with dissolved-solids content: where dissolved-solids concentrations were low, water was either a calcium-magnesium-bicarbonate or sodium-bicarbonate type; increases in dissolved solids up to 400 mg/L were attributed to predominantly sodium and bicarbonate; and above 400 mg/L, the increase was attributed to sodium, bicarbonate, and chloride (Kresse et al. 2013).

#### 3.8.2.8 Nacatoch Aquifer

Groundwater from the Nacatoch aquifer is most important in the southwestern part of the state, although it is also an available and good-quality source of water in the extreme northeastern part of the state. In the southwestern extent, fresh water mainly is obtained from areas in or near to the area of outcrop, especially for the eastern (Clark County) and western parts (Little River and Miller counties) of the outcrop area, and salinity increases in a downgradient direction from the outcrop area to a point where the groundwater is not suitable for most uses. Gradients of increasing chloride concentration are sharpest in the western and eastern parts of the outcrop, with a larger area of fresh water downgradient of the outcrop area in the central part of the aquifer (Hempstead and Nevada counties). Concentrations of sulfate, iron, and nitrate generally are very low throughout the extent of the Nacatoch aquifer, where water-quality data were available from producing wells (Kresse et al. 2013).

#### 3.8.2.9 Ozan Aquifer

Groundwater from the Ozan aquifer represents some of the least used and poorer quality water of any aquifer in the state. Several historical reports mentioned that aquifer was used as a domestic source because in many areas no other water source was available. High chloride concentrations can occur in groundwater within the outcrop area of the Ozan aquifer, which is atypical of most Cretaceous and Tertiary aquifers of the Coastal Plain. Chloride concentrations exceeding the federal secondary drinking water regulation 250 mg/L (EPA 2009) occur mainly in central Clark County. The highest median sulfate concentrations of any aquifer in the state are found in the Ozan aquifer. Sulfate concentrations can exceed 500 mg/L (the federal secondary drinking water standard is 250 mg/L) (Kresse et al. 2013).

#### 3.8.2.10 Tokio Aquifer

Good quality water is obtained from the Tokio aquifer throughout much of its outcrop area. Sharp increases in salinity are noted in the extreme southwestern (Sevier County) and northeastern (Clark County) parts of the aquifer, limiting use at distances greater than approximately 5 miles down dip of the outcrop area. Sulfate concentrations approach 400 mg/L and chloride concentrations are greater than 1,200 mg/L near the western and eastern extent of the outcrop area. These concentrations exceed the federal secondary drinking water standards of 250 mg/L chloride and 250 mg/L sulfate. In the central part of the aquifer, salinity increases are more gradual (with concentrations in the aquifer at less than 300 mg/L as far as 20 miles from the outcrop area), affording a larger area of low-salinity, high-quality water for multiple uses. In the southwestern part of the aquifer, sulfate is the dominant anion in the aquifer.

Dedolimitization is a likely process that may account the high-sulfate, low-bicarbonate groundwater in this area of the aquifer; however, this theory requires further analysis to achieve greater confidence (Kresse et al. 2013).

#### 3.8.2.11 Trinity Aquifer

Similar to other Cretaceous aquifers in southwestern Arkansas, use of the Trinity is limited to the outcrop areas. Wells for which water-quality data were available were located only in Sevier and Howard counties (in the Southwest WRPR). Generally, water quality from the Trinity aquifer is good, although chloride and sulfate can be somewhat elevated in certain parts of the aquifer, although concentrations were less than the 250 mg/L secondary drinking water standard. All chloride concentrations, except one, were less than 15 mg/L at distances as great as 15 miles from the outcrop area, demonstrating the low overall salinity in the aquifer (Kresse et al. 2013).

#### 3.8.2.12 Ouachita Mountains Aquifer

Groundwater quality in the Ouachita Mountains aquifer is good with respect to federal primary drinking water standards. Problems in regard to taste, staining, and other aesthetic properties are related to elevated levels of iron, which is a common complaint among domestic users. Water quality and type generally are defined by the two major rock types in the Ouachita Mountains: quartz rocks (sandstone, chert, and novaculite) and shale. Groundwater from quartz formations tend to have low pH values, low dissolved solids concentrations, and are very soft water of a mixed water type representative of precipitation concentrated by evapotranspiration processes. Groundwater from shale rock in the system is characterized by strongly calcium- to sodium-bicarbonate water type, with varying constituent concentrations defined by residence time along the flow path. Sulfate and chloride concentrations tend to be elevated in some areas for groundwater from shale formations. No spatial relation was noted, however, for the distribution of iron concentrations, and high and low concentrations occurred in shale and quartz formations. Iron is abundant in numerous mineral forms in sedimentary rocks throughout

Arkansas, and elevated iron in the Ouachita Mountain aquifer were attributed to microbially mediated processes (Kresse et al. 2013).

## 3.9 Groundwater-Surface Water Connections

Surface water in the area of outcrop is a potential recharge source for aquifers within the planning region (Hosman, Long et al. 1968). In general, surface waters receive discharge from aquifers in the planning region depending upon river-aquifer head relations (Kresse et al. 2013).

# 4.0 SOCIO-ECONOMIC CHARACTERISTICS

The socio-economic characteristics of the SCAWRPR include demographics, income, employment, and industries. This section describes these characteristics and presents changes in these regional characteristics since the 1990 AWP update. In addition, the wastes generated by the communities and industries in the SCAWRPR are characterized. These wastes must be properly managed to protect water quality in the SCAWRPR.

## 4.1 Demographics

Demographic information from the 2010 US census for the counties within the SCAWRPR is presented below. Demographic data presented include population totals, the percentages of people living in urban and rural areas, above or below selected ages, and of different races. Information from the 2010 census is compared to information from the 1990 census, to identify population changes that have occurred since the 1990 AWP update. Although the 1990 AWP update reported population data from the 1980 census, the 1990 census data better represents conditions at the time of the previous update. Population changes affect the need and demand for water resources, not just for drinking water, but also for recreation, food supply, irrigation, and aesthetics. Population demographics also affect the potential tax base to pay for water infrastructure upgrades, expansion, and repairs.

### 4.1.1 2010 Population

Population data from the 2010 census for the counties within the SCAWRPR are summarized in Table 4.1 and mapped on Figure 4.1. The population of the SCAWRPR in 2010 was just under one million. Pulaski and Saline counties had the highest 2010 populations. Calhoun County had the lowest 2010 population.

Table 4.1. 2010 county populations in the SCAWRPR (Census State Data Center 2013, US Census Bureau 2012a).

| County | Total Population | | | Percent Urban Population | | |
|---|---|---|---|---|---|---|
| | 1990 | 2010 | Change 1990 to 2010(%) | 1990 | 2010 | Change in Urban Population 1990 to 2010 |
| Ashley* | 24,319 | 21,853 | -10.1% | 45.9% | 48.3% | +2.5 |
| Bradley | 11,793 | 11,508 | -2.4% | 54.7% | 50.4% | -4.3 |
| Calhoun | 5,826 | 5,368 | -7.9% | 0% | 0% | 0 |
| Clark | 21,437 | 22,995 | +7.3% | 46.7% | 45.6% | -1.1 |
| Cleveland | 7,781 | 8,689 | +11.7% | 0% | 0% | 0 |
| Columbia* | 25,691 | 24,552 | -4.4% | 43.4% | 42.5% | -0.9 |
| Dallas | 9,614 | 8,116 | -15.6% | 49.2% | 47.4% | -1.8 |
| Drew* | 17,369 | 18,509 | +6.6% | 46.7% | 51.4% | +4.7 |
| Garland | 73,397 | 96,024 | +30.8% | 58.2% | 63.1% | +4.9 |
| Grant | 13,948 | 17,853 | +28.0% | 22.2% | 25.0% | +2.8 |
| Hempstead* | 21,621 | 22,609 | +4.6% | 44.6% | 44.2% | -0.3 |
| Hot Spring | 26,115 | 32,923 | +26.1% | 35.5% | 34.0% | -1.5 |
| Jefferson* | 85,487 | 77,435 | -9.4% | 72.5% | 69.1% | -3.4 |
| Montgomery | 7,841 | 9,487 | +21.0% | 0% | 0% | 0 |
| Nevada* | 10,101 | 8,997 | -10.9% | 36.4% | 30.8% | -5.5 |
| Ouachita | 30,574 | 26,120 | -14.6% | 47.0% | 43.6% | -3.4 |
| Pike | 10,086 | 11,291 | +11.9% | 0% | 0% | 0 |
| Polk* | 17,347 | 20,662 | +19.1% | 31.6% | 26.6% | -4.9 |
| Pulaski* | 349,660 | 382,748 | +9.5% | 87.9% | 87.7% | -0.2 |
| Saline | 64,183 | 107,118 | +66.9% | 48.6% | 63.8% | +15.3 |
| Union | 46,719 | 41,639 | -10.9% | 49.5% | 45.5% | -4.0 |
| **Total** | **880,909** | **976,496** | **+10.9%** | **64.0%** | **64.8%** | **+0.9** |

*Part of this county is in another planning region

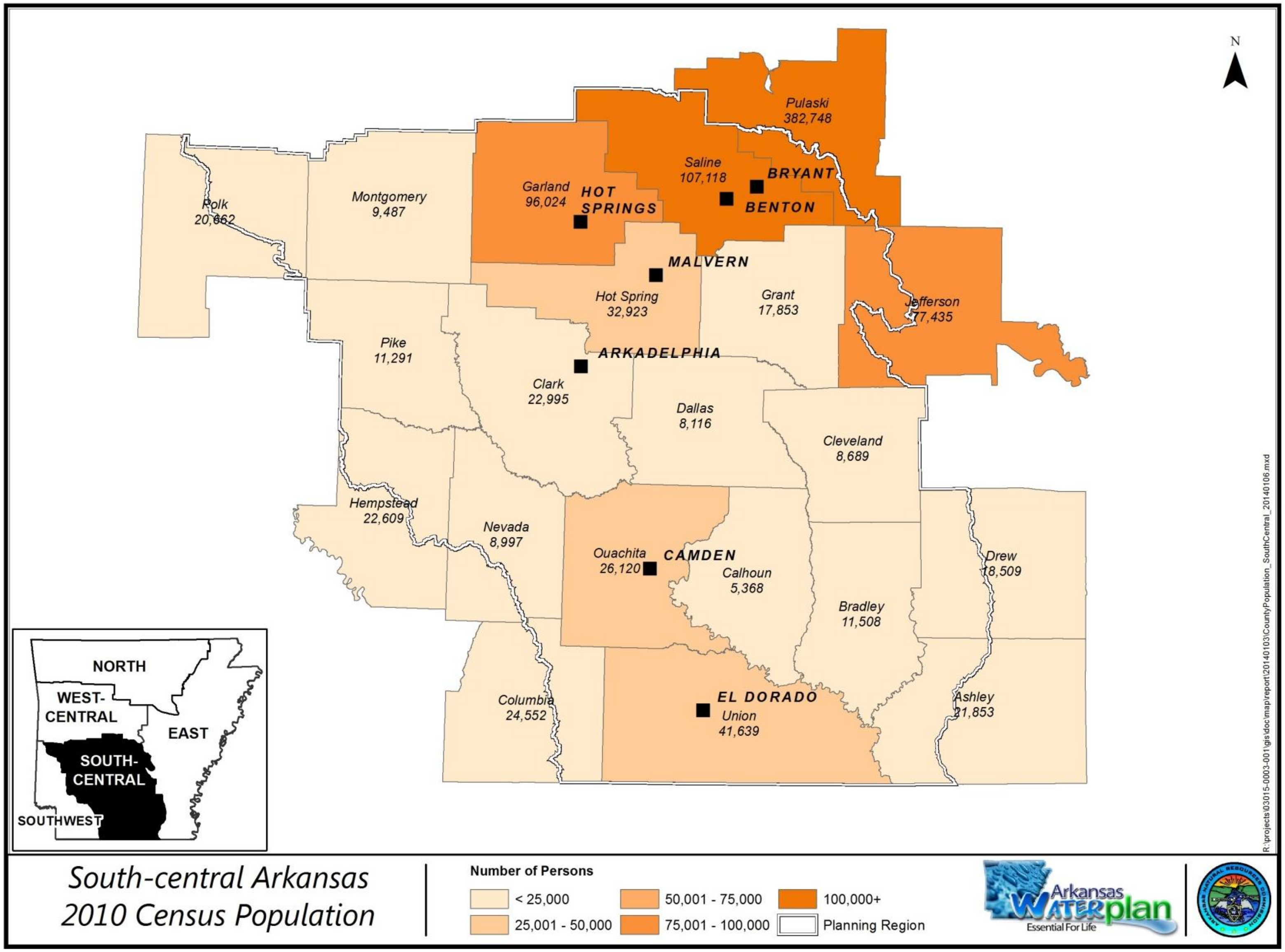


Figure 4.1. County populations from 2010 census (US Census Bureau 2012a).

Part of one Large Metropolitan Statistical Area is located within the SCAWRPR: Little Rock-North Little Rock-Conway (Figure 4.2) (US Census Bureau 2012b). Large Metropolitan Statistical Areas are geographic regions, defined by the US Office of Management and Budget, where an area of high population density has close economic ties. There are four Urbanized Areas identified in the 2010 census that are located in the SCAWRPR: Hot Springs, Little Rock, Pine Bluff, and Texarkana (Figure 4.2). These are areas with population of at least 50,000 people at a density of 1,000 to 500 people per square mile (US Census Bureau 2011a). In addition, 11 areas within the planning region were identified as Urban Clusters in the 2010 census (Figure 4.2). Urban clusters are areas with population densities of 500 to 1,000 people per square mile, which contain a total of 25,000 to 50,000 people (US Census Bureau 2011a, 2012a). The majority of the population in the SCAWRPR (65%) lives in urban areas (Table 4.1). The percentage of the county population living in rural areas varies from 87% in Pulaski County, to 0% in Calhoun, Cleveland, Montgomery, and Pike counties (Table 4.1) (US Census Bureau 2012a).

Demographic data on race for the counties within the SCAWRPR are summarized in Table 4.2. The racial make-up of the population is primarily white non-Hispanic (66%), black non-Hispanic (27%), and Hispanic (4%). Other races each account for 1% or less of the population. Demographic data on age, sex, and education level for the counties within the SCAWRPR are summarized in Table 4.3. The majority of the population in this region is between the ages of 18 and 65, 29% of adults are high school graduates, and 19% have college degrees.

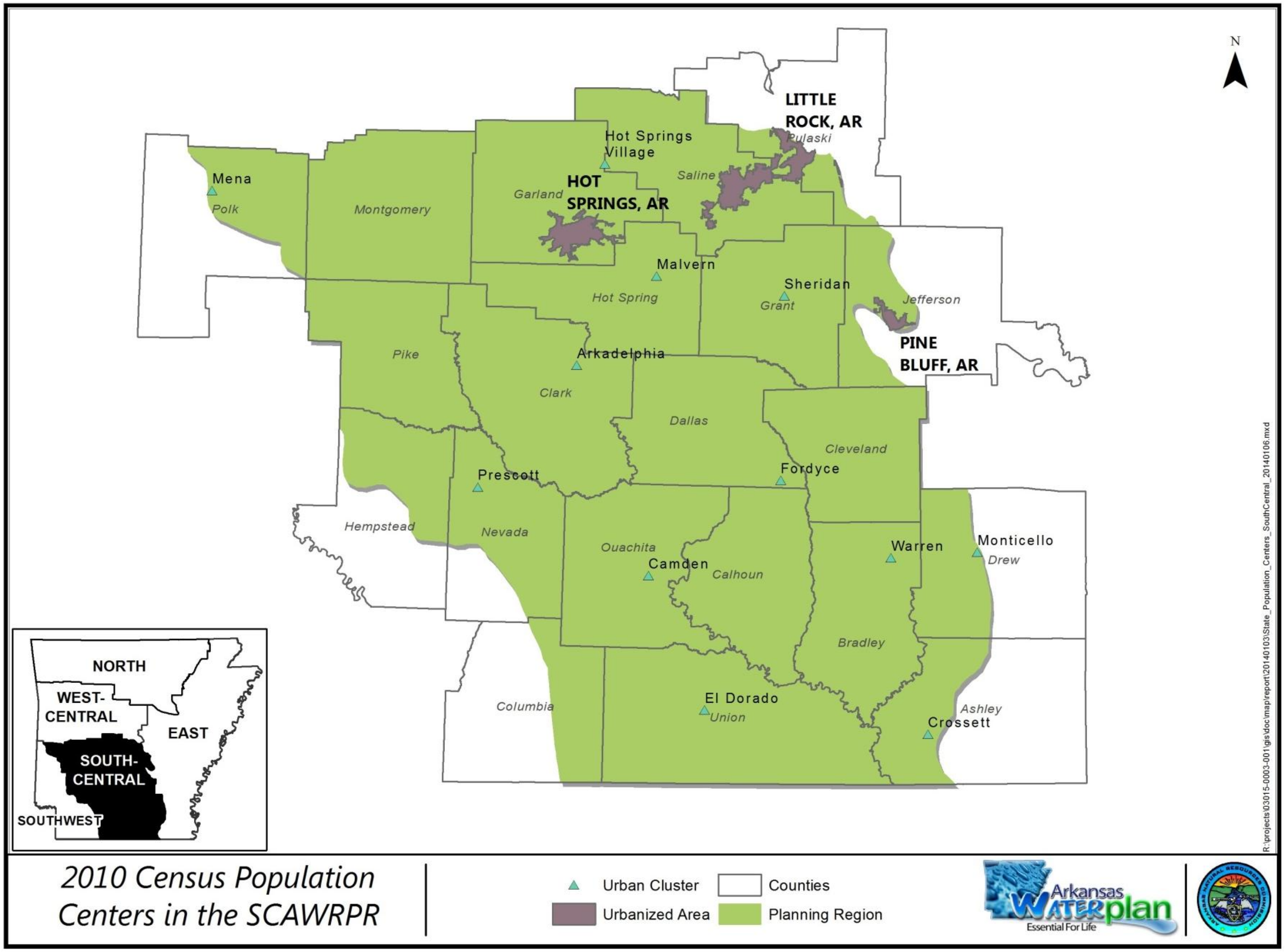


Figure 4.2. 2010 population centers located in the SCAWRPR (US Census Bureau 2012b).

Table 4.2. Demographic summary for counties in the SCAWRPR (US Census Bureau n.d.[b]).

| County | White, Non-Hispanic | Black | Hispanic | Asian | American Indian | Pacific Islander | Other Single Race | Multiple Race |
|---|---|---|---|---|---|---|---|---|
| Ashley* | 14,942 | 5,654 | 1,011 | 40 | 7 | 0 | 0 | 312 |
| Bradley | 6,748 | 3,287 | 1,417 | 0 | 58 | 0 | 0 | 70 |
| Calhoun | 3,978 | 1,287 | 66 | 0 | 0 | 0 | 0 | 86 |
| Clark | 16,222 | 5,533 | 912 | 160 | 43 | 0 | 0 | 196 |
| Cleveland | 7,398 | 1,120 | 142 | 0 | 0 | 0 | 0 | 78 |
| Columbia* | 14,617 | 9,066 | 518 | 185 | 50 | 5 | 4 | 162 |
| Dallas | 4,446 | 3,559 | 178 | 0 | 4 | 0 | 13 | 0 |
| Drew* | 12,553 | 5,163 | 442 | 129 | 11 | 0 | 0 | 201 |
| Garland | 80,601 | 7,915 | 4,514 | 782 | 519 | 18 | 175 | 1,390 |
| Grant | 16,677 | 410 | 371 | 31 | 17 | 0 | 14 | 247 |
| Hempstead* | 12,842 | 6,802 | 2,627 | 7 | 0 | 0 | 6 | 374 |
| Hot Spring | 27,647 | 3,363 | 894 | 84 | 101 | 0 | 0 | 708 |
| Jefferson* | 32,600 | 42,329 | 1,236 | 648 | 79 | 30 | 5 | 766 |
| Montgomery | 8,815 | 21 | 334 | 0 | 151 | 0 | 0 | 171 |
| Nevada* | 5,873 | 2,859 | 218 | 0 | 26 | 0 | 1 | 101 |
| Ouachita | 14,697 | 10,414 | 423 | 51 | 51 | 0 | 0 | 501 |
| Pike | 9,950 | 398 | 693 | 16 | 128 | 0 | 0 | 103 |
| Polk* | 18,489 | 36 | 1,130 | 28 | 357 | 8 | 10 | 466 |
| Pulaski* | 212,602 | 131,509 | 20,636 | 7,320 | 1,011 | 99 | 578 | 6,226 |
| Saline | 93,817 | 4,740 | 3,726 | 967 | 583 | 19 | 151 | 1,030 |
| Union | 25,964 | 13,751 | 1,393 | 262 | 104 | 0 | 0 | 405 |
| **Total** | **641,478** | **259,216** | **42,881** | **10,710** | **3,300** | **179** | **957** | **13,593** |
| **Percentage** | **66.0%** | **26.7%** | **4.4%** | **1.1%** | **<1 %** | **<1 %** | **<1 %** | **1.4%** |

*Part of this county is in another planning region

Table 4.3. Additional demographic characteristics of counties in the SCAWRPR (US Census Bureau n.d.[b]).

| County | Total female population | Total population under 18 years | Total population 65 years and over | High school graduates | College graduates[a] |
|---|---|---|---|---|---|
| Ashley[b] | 11,366 | 5,412 | 3,503 | 6,573 | 1,947 |
| Bradley | 6,036 | 2,747 | 2,068 | 3,346 | 938 |
| Calhoun | 2,576 | 1,165 | 910 | 1,794 | 470 |
| Clark | 12,010 | 4,553 | 3,374 | 5,025 | 2,471 |
| Cleveland | 4,407 | 2,197 | 1,373 | 2,742 | 1,139 |
| Columbia[b] | 12,860 | 5,612 | 3,949 | 5,676 | 3,275 |
| Dallas | 4,176 | 2,015 | 1,459 | 2,617 | 844 |

Table 4.3. Additional demographic characteristics of counties in the SCAWRPR (continued).

| County | Total female population | Total population under 18 years | Total population 65 years and over | High school graduates | College graduates[a] |
|---|---|---|---|---|---|
| Drew[b] | 9,538 | 4,383 | 2,664 | 4,349 | 2,250 |
| Garland | 49,301 | 20,150 | 19,955 | 22,173 | 14,255 |
| Grant | 8,968 | 4,296 | 2,570 | 5,160 | 1,780 |
| Hempstead[b] | 11,538 | 5,952 | 3,340 | 5,623 | 2,223 |
| Hot Spring | 16,150 | 7,703 | 5,083 | 8,900 | 3,919 |
| Jefferson[b] | 39,469 | 18,667 | 10,136 | 19,182 | 8,433 |
| Montgomery | 4,806 | 2,000 | 2,078 | 2,839 | 1,013 |
| Nevada[b] | 4,656 | 2,233 | 1,598 | 2,346 | 881 |
| Ouachita | 13,791 | 6,150 | 4,431 | 7,289 | 2,832 |
| Pike | 5,629 | 2,822 | 1,907 | 2,943 | 917 |
| Polk[b] | 10,453 | 4,895 | 4,049 | 5,460 | 1,978 |
| Pulaski[b] | 197,558 | 91,817 | 45,169 | 69368 | 66,161 |
| Saline | 52,943 | 25,514 | 15,692 | 25,846 | 16,345 |
| Union | 21,642 | 10,161 | 6,556 | 10,173 | 5,568 |
| **Total** | **499,873** | **230,444** | **141,864** | **219,424** | **139,639** |
| **Percentage** | **51.4%** | **23.6%** | **14.6%** | **29.4%**[c] | **18.7%**[c] |

Notes:
a. Includes associate degrees and bachelor degrees.
b. Part of this county is in another planning region.
c. Percentage based on population 18 years of age or older.

### 4.1.2 Changes from 1990

The population of the SCAWRPR increased by almost 11% between the 1990 and 2010 census (Table 4.1). In 1990, Pulaski and Jefferson counties had the greatest total populations in the region. Nine of the 21 counties within the SCAWRPR experienced population declines between 1990 and 2010 (Figure 4.3). Declines ranged from -2.4% in Bradley County to -15.6% in Dallas County. The remaining counties in the SCAWRPR experienced population increase between 1990 and 2010, ranging from 4.6% in Hempstead County to 67% in Saline County (Table 4.1). In Saline County, the Bauxite-Benton-Bryant area experienced the greatest population increase between 1990 and 2010 (US Census Bureau 2012b).

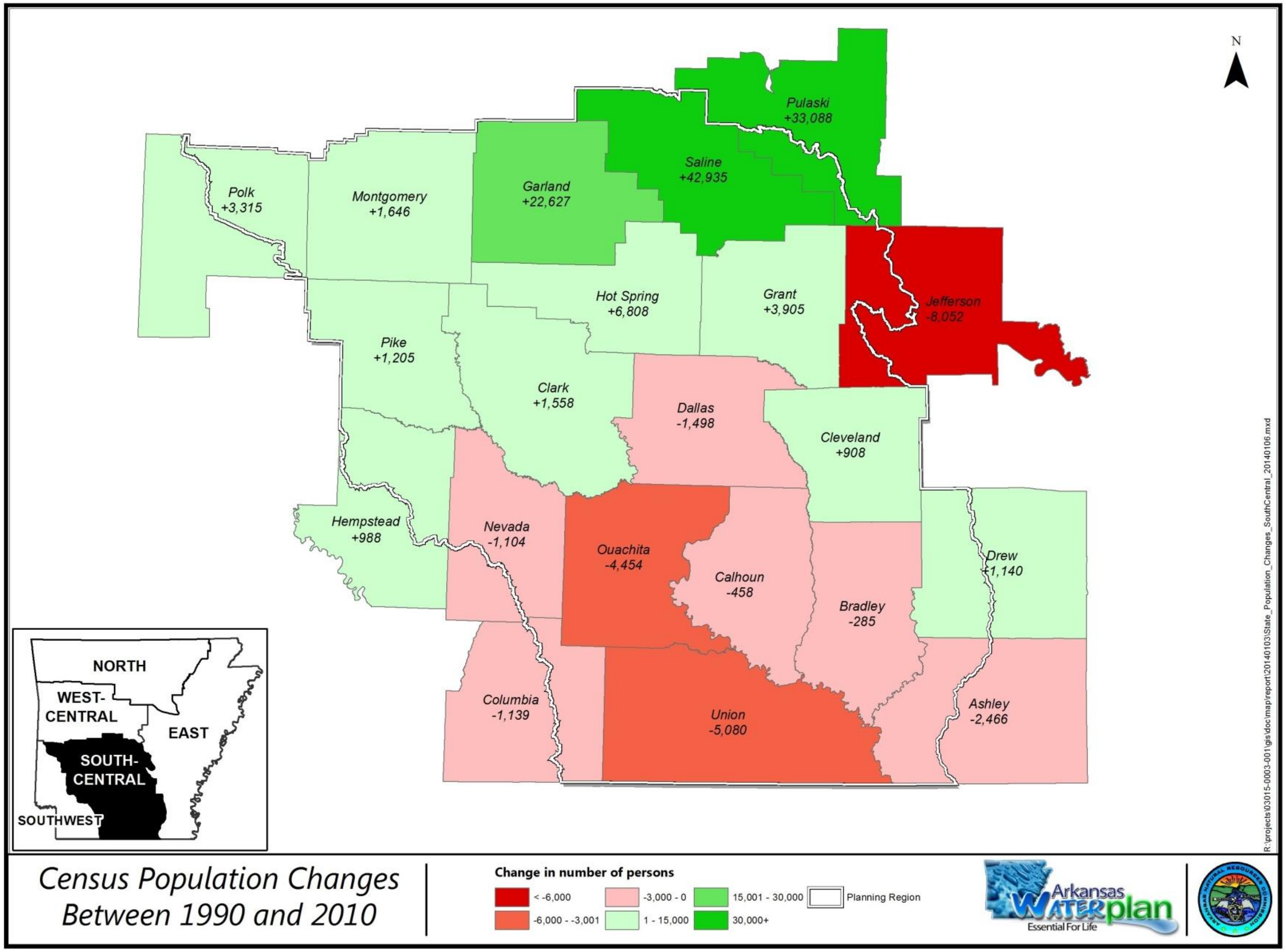


Figure 4.3. Population change between 1990 and 2010 in counties of the SCAWRPR (Census State Data Center 2013, US Census Bureau 2012a).

## 4.2 Income and Employment

Income and employment data are available by county from the US Census Bureau. Recent data are presented below to characterize employment and income levels within the SCAWRPR. Data from 1990 are also presented for comparison, to provide insight into changes that have occurred in the region since the 1990 AWP update.

### 4.2.1 Current Income and Employment Levels

Median household incomes reported by the US Census Bureau in the 2007 – 2011 Community Survey for counties in the SCAWRPR are shown in Table 4.4. The average median income in the region is $36,590, less than the state-wide median household income of $40,149 (US Census Bureau n.d.[a]). Three of the counties within the SCAWRPR are in the top five in terms of highest median household incomes in the state, including Saline County, which has the highest median household income in the state, $52,982.

The 2007-2011 Community Survey shows that counties in the SCAWRPR have some of the lowest percentages of families and population with income below poverty level. The average percentage of families with income below poverty level in these counties is 15.3%, but county values range from 6.4% in Saline County to 29.4% in Dallas County. The percentage of families with income below poverty level for Arkansas as a whole is 13.8%. The average percentage of county population with income below poverty level is 19.8%, with values ranging from 8.7% in Grant County to 34.7% in Dallas County. The percentage of Arkansas population with income below poverty level is 18.4% (US Census Bureau n.d.[a]). The average of the unemployment rates for all of the counties in the SCAWRPR is higher than the overall state unemployment rate of 8.4%. However, unemployment rates in these counties range from 3.1% in Polk County to 17.1% in Dallas County, and in 10 of the 21 counties the unemployment rate is lower than the state rate.

Table 4.4. Income and employment characteristics for counties in the SCAWRPR (Census State Data Center 2013, US Census Bureau n.d.[a]).

| County | Median Household Income | | Families with Income Below Poverty Level | | Population Below Poverty Level | | Unemployment | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2007 - 2011 | 1990 | 2007 – 2011 | 1990 | 2007 – 2011 | 1990 | 2007 – 2011 |
| Ashley* | $20,609 | $35,657 | 17.4% | 16.1% | 20.9% | 17.9% | 5.9% | 9.7% |
| Bradley | $17,259 | $32,337 | 20.4% | 19.6% | 24.9% | 25.4% | 9.0% | 6.8% |
| Calhoun | $21,198 | $30,625 | 13.5% | 7.6% | 15.6% | 9.8% | 11.1% | 6.2% |
| Clark | $18,068 | $32,998 | 18.3% | 16.0% | 23.9% | 23.0% | 6.1% | 9.8% |
| Cleveland | $19,703 | $34,292 | 14.7% | 14.0% | 19.0% | 17.8% | 6.7% | 9.3% |
| Columbia* | $18,470 | $36,163 | 19.1% | 17.9% | 24.4% | 24.8% | 8.0% | 5.6% |
| Dallas | $17,651 | $26,909 | 17.2% | 29.4% | 22.3% | 34.7% | 6.7% | 17.1% |
| Drew* | $18,906 | $32,038 | 20.2% | 19.3% | 24.2% | 25.0% | 8.7% | 11.8% |
| Garland | $20,260 | $38,210 | 13.1% | 14.3% | 18.0% | 18.5% | 5.4% | 8.8% |
| Grant | $24,278 | $50,927 | 12.9% | 5.4% | 14.9% | 8.7% | 5.5% | 7.4% |
| Hempstead* | $16,986 | $34,885 | 18.4% | 17.8% | 22.7% | 22.5% | 7.6% | 5.3% |
| Hot Spring | $19,355 | $38,188 | 15.7% | 10.0% | 18.6% | 13.4% | 8.7% | 11.2% |
| Jefferson* | $21,322 | $37,682 | 19.3% | 17.3% | 23.9% | 22.9% | 8.9% | 14.1% |
| Montgomery | $16,503 | $34,934 | 17.3% | 13.9% | 23.8% | 20.2% | 4.2% | 7.0% |
| Nevada* | $18,919 | $38,006 | 15.9% | 18.5% | 20.3% | 23.1% | 6.3% | 8.4% |
| Ouachita | $21,056 | $33,008 | 15.0% | 16.6% | 21.2% | 20.8% | 8.2% | 13.4% |
| Pike | $19,240 | $32,457 | 14.5% | 15.2% | 17.9% | 19.4% | 5.3% | 10.2% |
| Polk* | $17,789 | $32,395 | 14.7% | 14.8% | 18.5% | 20.2% | 5.5% | 3.1% |
| Pulaski* | $26,883 | $45,897 | 10.5% | 12.5% | 14.1% | 16.7% | 5.4% | 8.1% |
| Saline | $28,262 | $52,982 | 6.9% | 6.4% | 9.3% | 9.1% | 5.1% | 6.2% |
| Union | $21,041 | $37,794 | 17.7% | 19.1% | 22.0% | 22.0% | 7.0% | 8.7% |
| Average | $20,179 | $36,590 | 15.8% | 15.3% | 20.0% | 19.8% | 6.9% | 9.0% |

*Part of this county is in another planning region

### 4.2.2 Changes in Income and Employment from 1990

Information on income and employment from the 1990 census for the counties in the SCAWRPR is included in Table 4.4. This information indicates that the some of the income characteristics of this region have changed over the past two decades. The average median income in the SCAWRPR in 1990 was less than the state-wide median income of $21,147. Median incomes have increased since 1990, and there have been slight reductions in percentages of families and population with incomes below the poverty level. However, the unemployment rate is higher than in 1990.

## 4.3 Economic Drivers

Timber, tourism, agriculture, and resource extraction are important economic drivers in the SCAWRPR (Association of Arkansas Counties 2013). Transportation of goods on the Ouachita River downstream of Camden also contributes to the regional economy. The US Census Bureau conducts an economic census every 5 years. This includes information on the value of sales, and the number of people employed by the industrial sector by county. Information from the 1992 and 2007 economic census, as well as the 1990 and 2010 census, are presented below.

### 4.3.1 Current Regional Economic Drivers

The value of sales and receipts reported for the counties within the SCAWRPR in the 2007 economic census is summarized on Figure 4.4. Agriculture and forestry are not economic sectors reported in the economic census. However, agriculture and forestry contribute value to manufacturing, real estate, wholesale trade, and transportation and warehousing economic sectors (U of A Divison of Agriculture 2012). Manufacturing accounts for the largest proportion of the value of sales and receipts, closely followed by wholesale trade, with retail trade and services not far behind.

The number of people employed in the SCAWRPR by economic sectors, as reported in the American Community Survey 2007-2011 and the 2007 Economic Census, are summarized on Figure 4.5. The economic sectors for which employment is reported in these two sources are slightly different. However, both sources indicate that health care and education, retail trade, and manufacturing provide the majority of employment in the SAWRPR. Agriculture and forestry generate jobs in every economic sector, particularly manufacturing, health care, retail trade, and transportation and warehousing (included in administration on Figure 4.5) (U of A Divison of Agriculture 2012).

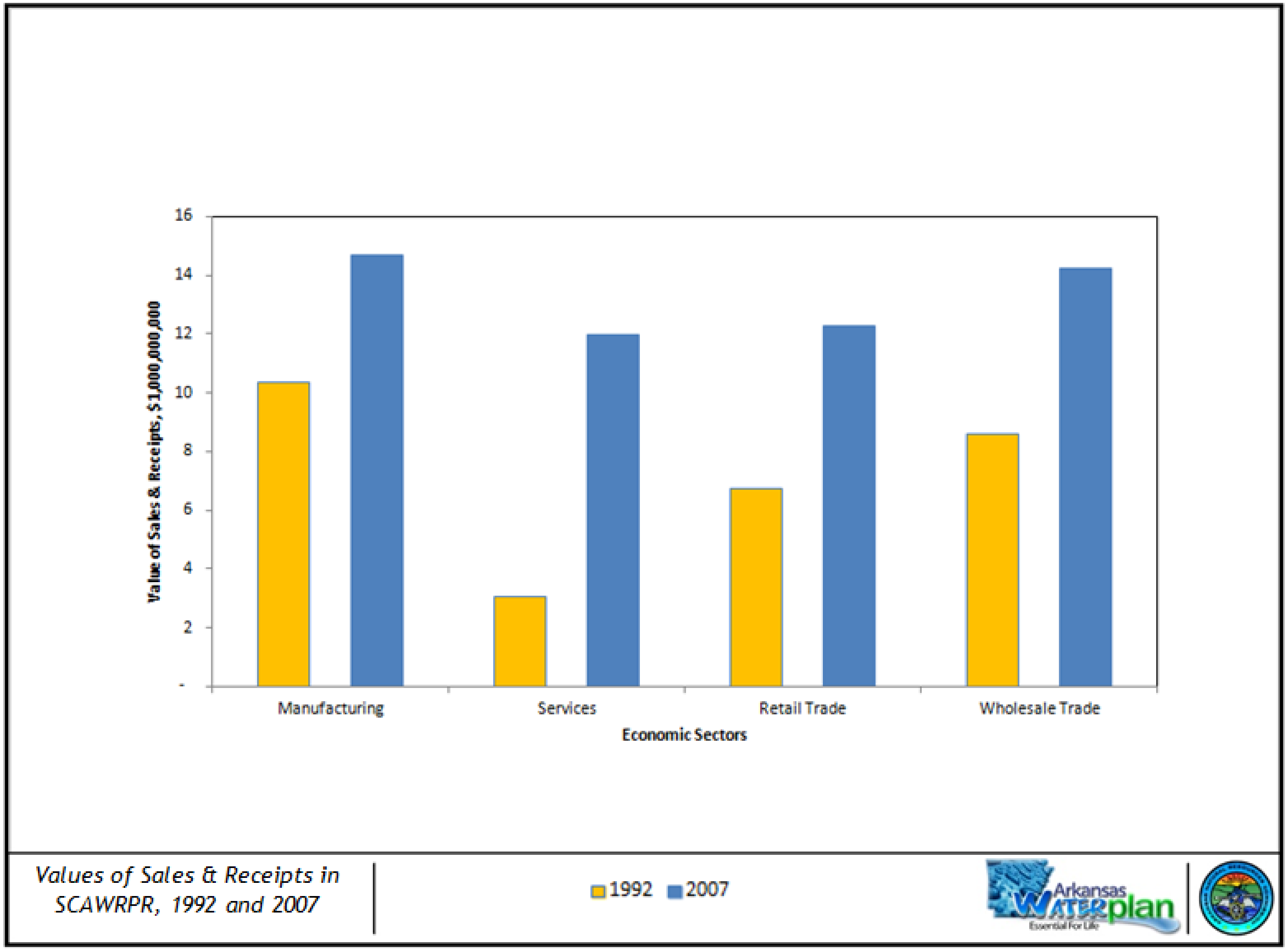


Figure 4.4. Value of sales and receipts in counties of the SCAWRPR (US Census Bureau 1993, 2011).

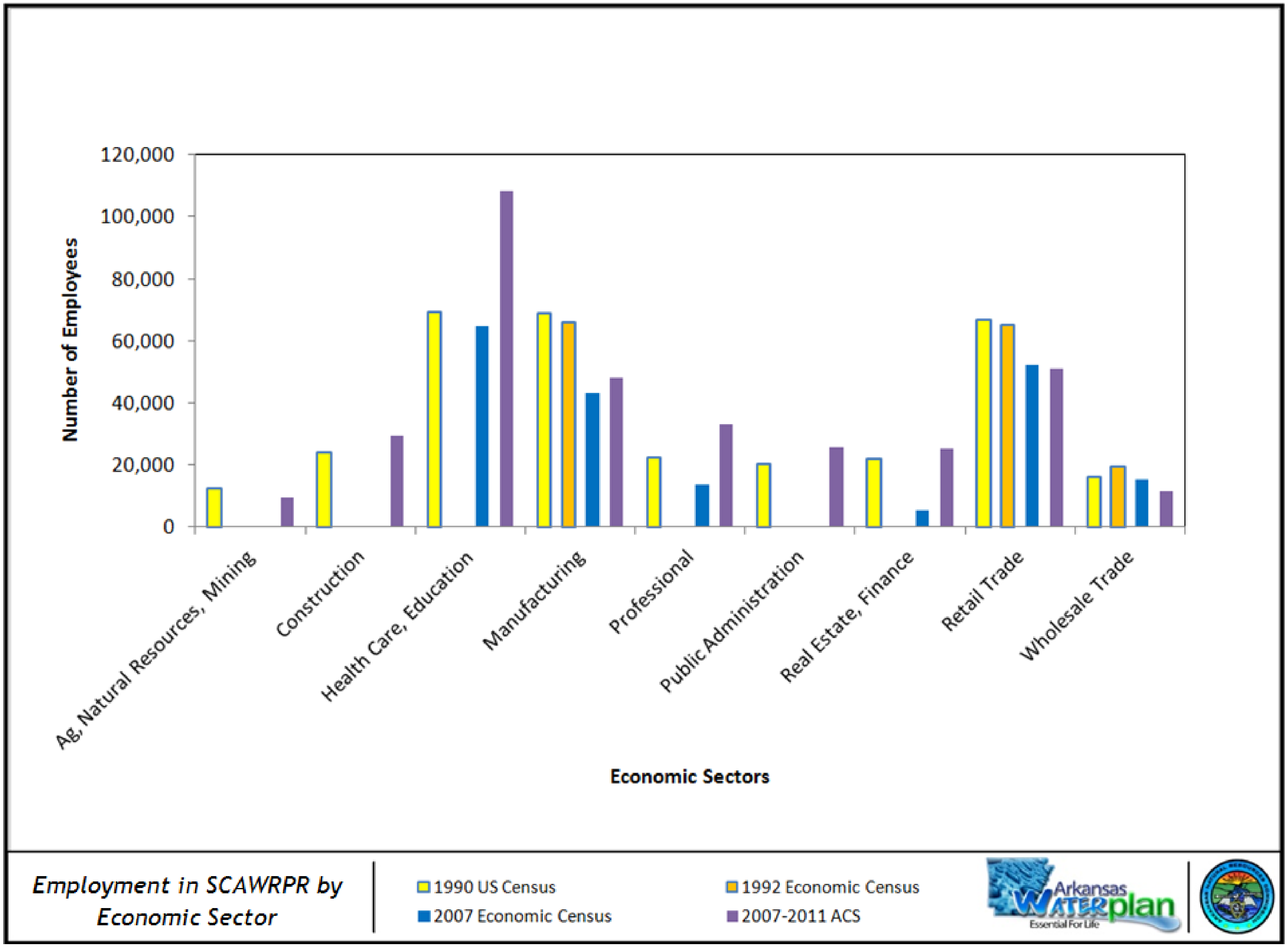


Figure 4.5. Employment in counties of the SCAWRPR by economic sector (Census State Data Center 2013, US Census Bureau n.d.[b], US Census Bureau 2011).

#### 4.3.1.1 Timber

Forestry is the leading employer in south Arkansas, which includes the SCAWRPR. Forestry contributes to a number of economic sectors including manufacturing, health and social service, retail trade, wholesale trade, real estate, and transportation and warehousing (U of A Divison of Agriculture 2012).

Arkansas is the fourth-largest producer of saw logs in the South (U of A Divison of Agriculture 2012). Of the state softwood (i.e., pine) roundwood timber product output, 68% is produced in the counties of the SCAWRPR (Table 4.5). The majority of the timber processing capacity of the state is also located in this planning region (Brandeis et al. 2011). The total revenue from forestry reported for 2007 in the counties of the SCAWRPR was over $5.0 million (Table 4.5).

Table 4.5. Timber industry metrics for the counties within the SCAWRPR.

| County | 2009 Roundwood Timber Product Output (thousand cubic feet) [a] | | Value of Forest Product Sales (thousand dollars) | |
|---|---|---|---|---|
| | Softwood | Hardwood | 1987[b] | 2007[c] |
| Ashley[d] | 21,593 | 8,810 | $96 | $295 |
| Bradley | 28,334 | 3,558 | $122 | $126 |
| Calhoun | 12,882 | 2,537 | $18 | –[e] |
| Clark | 13,266 | 10,843 | $295 | $838 |
| Cleveland | 16,777 | 3,236 | $376 | $352 |
| Columbia[d] | 6,108 | 3,397 | $137 | $319 |
| Dallas | 19,849 | 3,892 | $153 | $153 |
| Drew[d] | 132 | 1,904 | –[e] | $379 |
| Garland | 8,344 | 590 | $171 | $62 |
| Grant | 13,518 | 2,212 | $238 | $32 |
| Hempstead[d] | 6,276 | 2,383 | $878 | $642 |
| Hot Spring | 9,388 | 1,860 | $346 | $355 |
| Jefferson[d] | 4,876 | 1,567 | –[e] | $100 |
| Montgomery | 2,429 | 1,806 | $187 | $145 |
| Nevada[d] | 9,554 | 2,004 | $512 | $361 |
| Ouachita | 8,775 | 5,077 | $156 | $313 |
| Pike | 21,125 | 3,012 | $402 | –[e] |

Table 4.5. Timber Industry metrics for the counties within the SCAWRPR (continued).

| County | 2009 Roundwood Timber Product Output (thousand cubic feet) [a] | | Value of Forest Product Sales (thousand dollars) | |
|---|---|---|---|---|
| | Softwood | Hardwood | 1987[b] | 2007[c] |
| Polk[d] | 11,185 | 2,170 | $203 | $268 |
| Pulaski[d] | 1,931 | 855 | $86 | $23 |
| Saline | 8,211 | 1,322 | $60 | $179 |
| Union | 22,923 | 5,489 | $219 | $120 |
| **Total** | **247,476** | **68,524** | **$4,655** | **$5,062** |

Notes:
a. Brandeis et al. 2011.
b. US Census Bureau 1989.
c. USDA National Agricultural Statistics Service 2009.
d. Part of this county is in another planning region.
e. Data withheld to protect privacy.

Water use in the timber industry is primarily during processing. Timberlands are not generally irrigated. Timberlands can impact water quality through erosion of forest roads, stream crossings, and harvested areas; and runoff of chemicals used in timber management.

#### 4.3.1.2 Tourism

Tourism is the second largest industry in Arkansas. Tourism, including water-based recreation, is a significant contributor to the economy of the SCAWRPR. According to the 2012 Annual Report Summary from the Arkansas Department of Parks and Tourism, tourism in the counties of the planning region generated over $3 billion dollars in revenue and taxes. The Hot Springs area in Garland County contributes significantly to the tourism economy of the planning region (Table 4.6).

Recreation on lakes in the SCAWRPR, including the USACE reservoirs and the Ouachita River navigation system, contribute to the economy of the region. USACE has estimated economic impacts of recreation at the reservoirs located in the planning region. Overall, the USACE reservoirs in the planning region generate over 1,000 jobs, and over $1 billion in revenue, wages, and taxes (Table 4.7). There are at least six other public lakes in the planning region for swimming, fishing, and boating.

Table 4.6. Tourism revenues for the counties of the SCAWRPR (Arkansas Department of Parks and Tourism 2012a).

| County | Visitors | | Travel Expenditures | | Payroll | | Employment | | Tax Revenue | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2012 | 1990 | 2012 | 1990 | 2012 | 1990 | 2012 | 1990 | 2012 |
| Ashley* | 77,060 | 121,243 | $10,797,773 | $27,910,389 | $1,954,397 | $5,322,679 | 225 | 322 | $637,068 | $2,270,411 |
| Bradley | 18,289 | 35,776 | $2,610,480 | $9,630,143 | $472,497 | $1,482,995 | 54 | 78 | $154,019 | $883,240 |
| Calhoun | 4,604 | 7,072 | $556,552 | $2,732,776 | $100,736 | $291,027 | 12 | 11 | $32,837 | $263,420 |
| Clark | 247,983 | 209,930 | $33,948,243 | $48,118,665 | $6,144,632 | $9,359,532 | 706 | 536 | $2,002,946 | $3,814,780 |
| Cleveland | 6,308 | 10,228 | $846,511 | $3,457,373 | $153,218 | $433,329 | 18 | 27 | $49,944 | $298,111 |
| Columbia* | 86,583 | 99,512 | $12,062,964 | $23,830,162 | $2,183,396 | $4,236,833 | 251 | 275 | $711,351 | $1,932,859 |
| Dallas | 23,760 | 48,890 | $3,443,388 | $11,516,911 | $623,253 | $1,633,769 | 72 | 97 | $203,160 | $1,001,091 |
| Drew* | 70,154 | 95,329 | $10,159,056 | $22,235,266 | $1,838,789 | $4,236,627 | 211 | 282 | $599,385 | $1,770,561 |
| Garland | 1,691,749 | 2,476,332 | $239,245,485 | $601,682,105 | $43,303,433 | $107,176,941 | 4,977 | 6,911 | $14,115,484 | $47,240,510 |
| Grant | 11,760 | 21,433 | $1,511,339 | $5,126,670 | $273,552 | $642,145 | 31 | 47 | $89,169 | $421,203 |
| Hempstead* | 152,629 | 197,347 | $20,644,723 | $47,579,879 | $3,736,695 | $8,936,209 | 430 | 518 | $1,218,039 | $4,051,871 |
| Hot Spring | 51,785 | 14,585 | $7,126,421 | $3,282,714 | $1,289,882 | $404,822 | 148 | 21 | $120,459 | $274,263 |
| Jefferson* | 357,784 | 442,069 | $49,703,500 | $110,788,911 | $8,996,334 | $20,900,407 | 1,034 | 1,308 | $2,932,507 | $8,416,041 |
| Montgomery | 83,859 | 95,644 | $11,342,494 | $25,763,286 | $2,052,991 | $4,139,224 | 236 | 240 | $669,207 | $2,361,240 |
| Nevada* | 36,629 | 57,386 | $5,109,778 | $20,652,272 | $924,870 | $3,706,355 | 106 | 154 | $301,477 | $1,200,779 |
| Ouachita | 149,342 | 114,857 | $21,786,680 | $24,993,279 | $3,943,389 | $4,568,327 | 453 | 292 | $1,285,414 | $1,985,510 |
| Pike | 54,006 | 62,018 | $7,565,143 | $14,808,135 | $1,369,291 | $2,651,871 | 157 | 178 | $446,344 | $1,221,991 |
| Polk* | 80,967 | 82,515 | $11,252,278 | $20,362,835 | $2,036,662 | $3,713,437 | 234 | 232 | $663,884 | $1,674,082 |
| Pulaski* | 2,889,431 | 5,653,505 | $488,766,742 | $1,612,013,724 | $88,466,780 | $335,126,264 | 10,169 | 12,972 | $28,837,238 | $90,739,999 |
| Saline | 91,623 | 213,803 | $13,735,657 | $50,387,070 | $2,486,154 | $9,418,933 | 286 | 597 | $810,404 | $3,988,427 |
| Union | 228,030 | 394,914 | $31,752,668 | $104,064,813 | $5,747,233 | $11,799,530 | 661 | 850 | $1,873,407 | $6,785,781 |
| Total | 6,414,335 | 10,456,400 | $983,967,875 | $2,790,939,390 | $178,098,184 | $540,183,268 | 20,471 | 25,948 | $57,753,743 | $182,598,182 |

*Part of this county is included in another planning region.

Table 4.7. Economic benefits from USACE reservoirs in the SCAWRPR in 2010 (USACE 2011).

| Reservoir | Total Sales | Jobs | Payroll | Value Added* |
|---|---|---|---|---|
| DeGray | $19,227,014 | 309 | $7,411,709 | $11,761,953 |
| Greeson | $9,039,560 | 173 | $3,345,358 | $5,289,211 |
| Ouachita | $27,015,112 | 433 | $10,558,006 | $16,692,389 |
| Felsenthal Pool | $5,064,129 | 78 | $1,772,866 | $2,784,299 |
| Calion Pool | $888,244 | 15 | $307,255 | $486,108 |
| **Total** | **$61,234,059** | **1,008** | **$23,395,194** | **$37,013,960** |

*Includes wages, salaries, payroll benefits, profits, rents, and indirect business taxes.

Hunting, fishing, and wildlife watching associated with the lakes, rivers, and wetlands of the planning region, contribute to the economy of the SCAWRPR. In 2011, Arkansas ranked seventh in the nation in hunting-related sales, and more mallard ducks were harvested in Arkansas than any other state (AGFC 2013b). The wetlands, rice, and bean fields along the Ouachita River make it a major flyway for ducks and geese (Gore 2009). Economic contributions from wildlife recreation in Arkansas are summarized in Table 4.8. Regional data are not available.

Table 4.8. Economic contributions from wildlife recreation in Arkansas.

| Activity | Total Expenditures (million dollars) | | 2011 Retail Sales (million dollars)[c] | 2011 State/Local Tax Revenue (million dollars) | 2011 Federal Tax Revenue (million dollars) |
|---|---|---|---|---|---|
| | 1991[a] | 2011[b] | | | |
| All Hunting | $85.0 | $1,018.8 | $877.4 | $99.2 | $99.5 |
| Waterfowl Hunting | NR | $288.0 | $236.7 | $29.1 | $23.9 |
| Sport Fishing | $216.9 | $495.6 | $508.0 | $49.4 | $49.8 |
| Wildlife Watching | NR | $216.1 | NR | NR | NR |

Notes:
a. USFWS, US Census Bureau 1993.
b. USFWS, US Census Bureau 2013.
c. AGFC 2013b.
NR=Not Reported

Streams in the SCAWRPR are also important to the tourism and recreation economy of the planning region. ADEQ has designated Lake DeGray, Lake Ouachita, and 634 miles of streams in the planning region as Extraordinary Resource Waterbodies for “scenic beauty, aesthetics, …broad scope recreation potential, and intangible social values” (Figure 4.6) (APCEC 2011). Over 213 miles of streams in the planning region are designated as Natural and Scenic Waterways (Figure 4.6). The Little Missouri River is a designated National Wild and Scenic River, and the Saline River is a designated Arkansas Natural and Scenic River.

#### 4.3.1.3 Agriculture

Agriculture is also a major economic driver in the SCAWRPR. This includes cattle production, poultry and egg production, swine, some row crop agriculture (including vegetables and melons), and some tree fruit and berries.

Arkansas is second in the nation broiler production, which are produced in the SCAWRPR. Livestock sales accounted for the majority (80%) of the 2007 revenues from sale of agricultural products in the counties in the planning region. The total value for sale of livestock produced in these counties during 2007 was over $1 million (Table 4.9). In most counties, the value of poultry sales was greater than the value of cattle sales (USDA National Agricultural Statistics Service 2009).

The total value for sale of crops produced in the counties of the SCAWRPR during 2007 was over $260 million (Table 4.9). Bradley County in the planning region is the state tomato-raising capital (Association of Arkansas Counties 2013).

#### 4.3.1.4 Resource Extraction

A number of economically important minerals occur in the SCAWRPR, making resource extraction another important economic driver in the planning region. Bromine, natural gas and petroleum are the top three minerals produced in Arkansas (Table 4.10). Bromine is produced in Columbia and Union counties (Hill 2010). In these counties, this industry in a major employer and influence on the economy (Cottingham 2012). Oil is produced in Ashley, Bradley, Calhoun, Columbia, Hempstead, Nevada, Ouachita, and Union counties in the planning region.

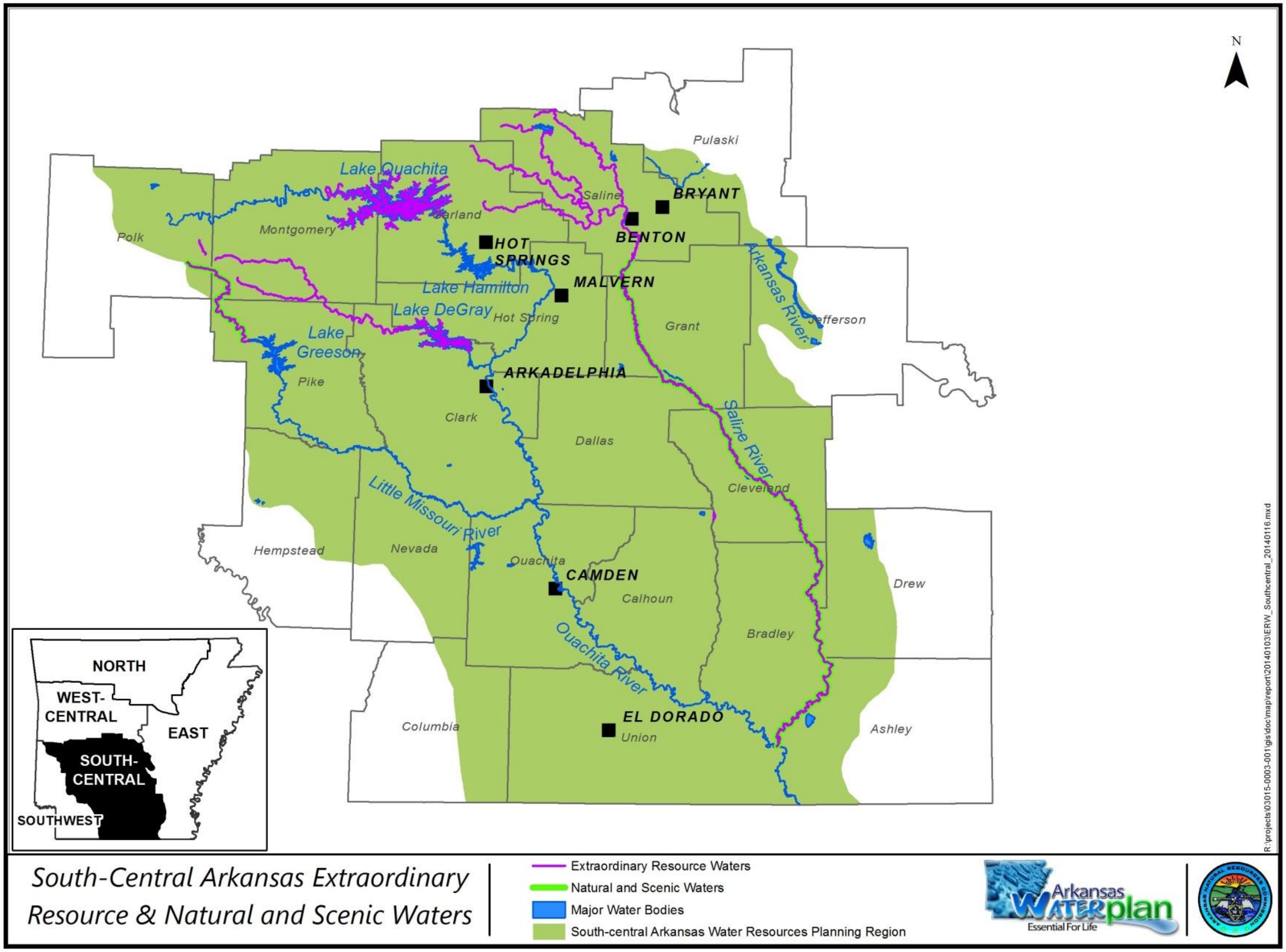


Figure 4.6. Designated Extraordinary Resource Waters and Natural and Scenic Waterways in the SCAWRPR (APCEC 2011).

Table 4.9. Value of agricultural sales (dollars) in counties of the SCAWRPR (US Census Bureau 1989, USDA National Agricultural Statistics Service 2009).

| County | Value of Crop Sales | | Value of Livestock, Poultry, & Products Sales | |
|---|---|---|---|---|
| | 1987 | 2007 | 1987 | 2007 |
| Ashley* | 30,127 | 55,231 | 2,386 | 9,482 |
| Bradley | 2,781 | 3,526 | 6,783 | 26,329 |
| Calhoun | 99 | D | 959 | D |
| Clark | 3,094 | 2,258 | 5,940 | 14,620 |
| Cleveland | 289 | 363 | 26,110 | 147,698 |
| Columbia* | 1,994 | 9,772 | 17,789 | 35,369 |
| Dallas | 156 | D | 836 | D |
| Drew* | 12,739 | 35,925 | 2,685 | 21,413 |
| Garland | 755 | 2,379 | 11,115 | 9,863 |
| Grant | 319 | 955 | 4,182 | 18,249 |
| Hempstead* | 2,543 | 5,000 | 105,071 | 162,118 |
| Hot Spring | 871 | 1,496 | 6,628 | 14,675 |
| Jefferson* | 53,245 | 117,532 | 3,614 | 182,252 |
| Montgomery | 187 | 1,127 | 26,862 | 18,401 |
| Nevada* | 839 | 1,266 | 25,883 | 47,122 |
| Ouachita | 404 | 1,514 | 7,610 | 47,224 |
| Pike | 596 | 750 | 30,519 | 15,154 |
| Polk* | 228 | 1,687 | 63,589 | 92,148 |
| Pulaski* | 10,862 | 18,618 | 4,694 | 133,842 |
| Saline | 1,012 | 2,822 | 2,644 | 8,797 |
| Union | 309 | 921 | 31,018 | 2,772 |
| **Total** | **123,449** | **263,142** | **386,917** | **1,080,749** |
| **Partial counties excluded** | | **18,111** | | |

Notes: * Part of this county is in another planning region., D = Data withheld to protect privacy.

Table 4.10. Oil and gas production in counties of the SCAWRPR in 2012 (Arkansas Geological Survey 2013).

| County | Oil Production (barrels) | Gas Production (million cubic feet) | Bromine Brine (barrels) |
|---|---|---|---|
| Ashley* | 8,161 | 0 | 0 |
| Bradley | 20,283 | 0 | 0 |
| Calhoun | 11,055 | 0 | 0 |
| Columbia* | 36,079 | 0 | 128,086,440 |
| Hempstead* | 2,484 | 0 | 0 |
| Nevada* | 246,943 | 734 | 0 |
| Ouachita | 415,727 | 5,537 | 0 |
| Union | 2,701,418 | 83,539 | 137,240,212 |
| **Total** | **3,442,150** | **89,810** | **265,326,632** |

*Part of this county is in another planning region.

Oil companies are one of the leading employers in the planning region (Bridges 2011). Other nonfuel minerals produced in the planning region include crushed stone, sand and gravel, diamonds and other gemstones, metals, and abrasives (USGS 2013a). Lignite is mined in Ashley and Bradley counties (Arkansas Geological Survey 2012a). Mineral extraction and processing in the planning region do not generally require large quantities of water. They do tend to have the potential to impact water quality, however (see Section 5.3.2).

In 2009, the value of nonfuel mineral production in Arkansas was $636 million (USGS 2013a). The market value of crude oil produced in Arkansas in 2008 was $413 million (U of A Sam Walton College of Business 2009).

Spring water is another natural resource of the SCAWRPR that contributes to the regional economy. There are six companies that bottle spring water in the planning region, in Garland, Montgomery, and Polk counties (see Table 2.2).

#### 4.3.1.5 Waterborne Commodity Transport

Waterborne transportation of commodities directly and indirectly contributes to the economic growth of the state, and the SCAWRPR, through economic value, employment, and earnings (Nachtmann 2002). A recent study determined that the total economic impact of river transportation of commodities on the Arkansas economy is $811 million annually (Arkansas Waterways Commission 2013). The Ouachita River in the SCAWRPR is used to transport commodities into and out of the region, and the state. There are two public ports located on the Ouachita River within the planning region (Figure 2.2).

Transportation of commodities reported at the Felsenthal and H.K. Thatcher locks in the SCAWRPR are listed in Table 4.11. In 2010, over 60 thousand short tons of goods and materials passed through the Felsenthal lock and dam near the Louisiana border. The majority of these materials consisted of chemicals and petroleum products. Information on the value of these shipments was not located.

Table 4.11. Commodities (in tons) transported through the Ouachita River locks in the SCAWRPR during 2012 (USACE Institute for Water Resources n.d.).

| Commodity Category | Felsenthal Lock and Dam | H.K. Thatcher Lock and Dam |
|---|---|---|
| Petroleum and Petroleum Products | 28,100 | 27,700 |
| Chemicals and Related Products | 26,300 | 0 |
| Waste Material | 5,800 | 0 |
| Manufactured Equipment and Machinery | 0 | 200 |

### 4.3.2 Comparison to 1990 Regional Economy

Figure 4.4 shows the value of sales and receipts reported in the 1992 economic census. Note that the 1992 economic census reported values by county only for the manufacturing, services, retail trade, and wholesale trade sectors. The 2007 value for services shown on Figure 4.4 is a summation of values for economic sectors that were reportedly included in the 1992 value for services (US Census Bureau 2011b). It appears that all of the sectors have experienced expansion.

Employment data from the 1990 census and 1992 economic census are included on Figure 4.5. The industrial categories used to report employment are slightly different for the two sources and the different time periods shown on Figure 4.5. While these differences make direct comparisons uncertain, using the information from different sources during similar time periods allows us to have greater confidence when identifying changes over time. There appears to have been a decline in employment in the manufacturing and retail trade sectors. It also appears that there may have been an increase in the number of people employed in the health and education economic sectors since 1990.

#### 4.3.2.1 Timber

Table 4.5 includes information on value of forestry products from the 1987 Census of Agriculture. Overall, the value of forestry product sales in 1987 was slightly lower than in 2007. Several counties in the planning region had lower forest product sales in 2007 than in 1987.

As today, in the 1990s, forestry was an important economic driver in the state, contributing over $4 billion annually to the state economy (Gray 1993). Lumber and wood products companies dominated the manufacturing sector of the state economy during this period (Advameg, Inc. 2010). Timber production and timber product output in Arkansas expanded between 1987 and 2005. Between 2005 and 2009, timber product output declined to a level below what it was in 1987 (Brandeis et al. 2011, May 1990). However, in comparing the value of forest product sales in 1987 and 2007, it appears that 2007 production was greater in several of the counties in the planning region (Table 4.5).

#### 4.3.2.2 Agriculture

Table 4.9 includes information on the value of crops and livestock from the 1987 Census of Agriculture, which were lower than in 2007. The area of cropland in the counties of the planning region has increased by 40% since 1987, suggesting expansion of crop agriculture in the planning region. Comparison of inventories from the 1987 and 2007 census of agriculture indicates that there have been moderate increases in the numbers of livestock and poultry in the region (Table 4.12).

#### 4.3.2.3 Tourism

Overall, the economic contribution of tourism in the SCAWRPR was greater in 2012 than in 1990 (Table 4.6). Declines in visitors and employment occurred in Clark, Hot Spring, and Ouachita counties. Only in Hot Spring County did this translate into lower expenditures and payroll. The 2012 numbers were higher than 1990 for the rest of the counties. Tax revenues from tourism were higher in 2012 than in 1990 in all counties. The economic contribution of hunting and fishing in the state has increased since 1990 (Table 4.7).

#### 4.3.2.4 Resource Extraction

Oil and natural gas production in south Arkansas was greater in 1990 than in 2012. Brine production in south Arkansas was slightly less in 1990 than in 2012. There have been 15 oil/gas/brine reservoirs discovered and developed in the planning region since 1990, and 24 that have been abandoned (Arkansas Geological Survey 2013).

Table 4.12. Livestock inventories in the counties of the SCAWRPR (US Census Bureau 1989, USDA National Agricultural Statistics Service 2009).

| County | Cattle and Calves | | Swine | | Poultry | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 1987 | | 2007 | |
| | 1987 | 2007 | 1987 | 2007 | Layers | Broilers | Layers | Broilers |
| Ashley* | 4,360 | 3,818 | 745 | 163 | 778 | 28 | 824 | D |
| Bradley | 4,648 | 4,209 | 678 | 29 | 56,694 | 577661 | 317,755 | 1,239,320 |
| Calhoun | 3,650 | 1,631 | 5 | 22 | D | 0 | D | 0 |
| Clark | 14,959 | 12,853 | 967 | D | D | D | 225,450 | 350,090 |
| Cleveland | 8,148 | 5,607 | 1,072 | 41 | 175,774 | 2818298 | 360,353 | 7,619,780 |
| Columbia* | 13,634 | 11,828 | 593 | 56 | (b) | 1391077 | 190,191 | 2,241,500 |
| Dallas | 3,396 | 2,334 | 461 | 131 | 154 | D | 66 | 0 |
| Drew* | 8,091 | 8,200 | 1,411 | 117 | 219 | D | 165,503 | 738,400 |
| Garland | 8,466 | 6,170 | 289 | 1,091 | D | D | 122,786 | 53 |
| Grant | 8,256 | 19,051 | D | 53 | D | 206,264 | 637 | 726,610 |
| Hempstead* | 38,737 | 62,759 | 3,452 | 4,870 | 3,925,295 | 5,573,081 | 231,135 | 8,806,490 |
| Hot Spring | 15,042 | 15,346 | 823 | 86 | D | D | 411,164 | D |
| Jefferson* | 4,498 | 3,152 | 628 | 272 | D | 323,435 | D | 1,382,360 |
| Montgomery | 16,356 | 17,442 | 11,814 | 12,030 | 466,048 | 2,020,853 | 490,020 | 1,401,800 |
| Nevada* | 20,654 | 17,042 | 531 | D | 495,769 | 1,829,236 | 276,210 | 2,305,218 |
| Ouachita | 5,404 | 9,229 | 1,608 | 104 | 34,653 | 567,006 | D | 1,031,509 |
| Pike | 17,303 | 42,852 | 10,156 | 26,738 | 433,054 | 3,127,264 | 664,375 | 2,025,030 |
| Polk* | 29,707 | 45,060 | 14,067 | 17,133 | 457,840 | 5,276,442 | 302,159 | 6,225,614 |
| Pulaski* | 11,102 | 8,080 | 1,092 | 204 | 652 | 150 | 855 | 428,000 |
| Saline | 9,696 | 7,292 | 1,091 | 60 | 1,081 | D | 906 | 0 |
| Union | 6,521 | 7,198 | 275 | 64 | 238,283 | 1,889,300 | 42,534 | 4,349,469 |
| **Total** | **252,628** | **311,153** | **51,758** | **63,264** | **6,286,294** | **25,600,095** | **3,802,923** | **40,871,243** |

Notes: *Part of this county is in another planning region. D = Data withheld to protect privacy.

## 4.4 Waste Generation and Disposal

Industries and communities in the SCAWRPR produce wastes that must be properly managed to protect water quality, which contributes to water availability for the water users of the SCAWRPR. ADEQ is the state agency responsible for regulating solid waste, hazardous waste, and wastewater. These three waste streams are managed through separate permitting programs overseen by EPA. Waste management in the SCAWRPR is quantified below, along with changes in waste management that have occurred since the 1990 AWP update.

### 4.4.1 Solid Waste

All or part of six Regional Solid Waste Management Districts (RSWMDs) are within the SCAWRPR (Figure 4.7). Information on solid waste generation and disposal for each of these districts for 2010 is summarized in Table 4.13. For the most part, the RSWMDs report that their solid waste disposal facilities and collection services are sufficient to meet demand. However, illegal dumping that occurs in the districts could pose local threats to water quality.

Table 4.13. 2010 solid waste generation and disposal information for RSWMDs in the SCAWRPR.

| RSWMD Name | Number of Counties in RSWMD | Counties in Planning Region | Number Of Landfills In Planning Region | Solid Waste Generated In-District (tons) | Solid Waste Disposed In-District (tons) | Number Illegal Dump Sites Identified[g] |
|---|---|---|---|---|---|---|
| Upper Southwest[a] | 9 | 2 + 2 partial | 2 Class IV | 128,824 | 139,332 | 8 |
| Southwest[b] | 6 | 4 + 1 partial | 1 Class I, 3 Class IV | 94,673 | 67,418 | 2 |
| Southwest Central[c] | 3 | 3 | 2 Class IV | 194,360 | 91,398 | 2 |
| Saline[d] | 1 | 1 | 1 Class I, 1 Class IV | 83,999 | 83,999 | 2 |
| Pulaski[e] | 1 | Partial | 2 Class I, 1 Class IV, 1 combined | 901,037 | 910,037 | 0 |
| Southeast Arkansas[f] | 10 | 3 + 3 partial | 1 Class I, 1 Class IV | 350,000[h] | 340,000[i] | 12 |

Notes:
a. Terracon 2013.
b. Southwest Arkansas Planning and Development District 2013.
c. West Central Arkansas Planning & Development District, Inc. 2011.
d. Grappe 2011.
e. Pulaski County Regional Solid Waste Management District 2011.
f. Southeast Arkansas Regional Solid Waste Management District 2011.
g. ADEQ 2013b.
h. Estimated annual projection.
i. 8,634 tons reportedly hauled out of district annually.

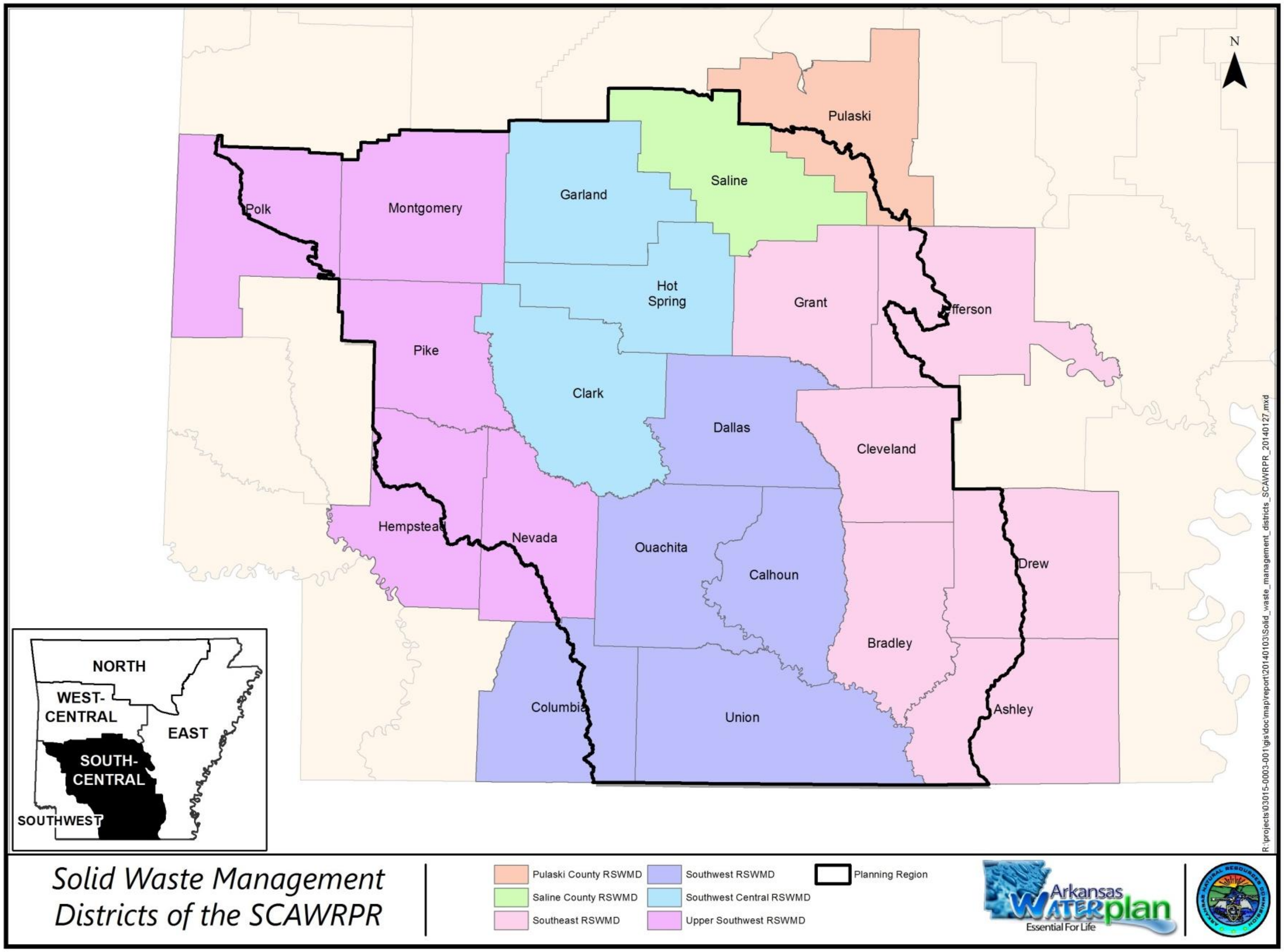


Figure 4.7. RSWMDs of the SCAWRPR (ADEQ 2011b).

There have been significant changes in the solid waste arena since 1990, driven by the need to protect water quality. In 1991, federal regulations changed, requiring improvements in the way landfills were constructed in order to protect groundwater quality. In addition, the new regulations required monitoring of groundwater quality around landfills (EPA 2012a, ADEQ 2011a). At the same time, state regulations set up programs to fund cleanup of groundwater contamination from landfills, and for collection and recycling of batteries and waste oil, both of which pose risks to surface and groundwater quality when disposed of improperly. Around 1995, the Arkansas General Assembly established a policy to eliminate illegal dumping, another threat to surface and groundwater quality. State legislation to implement this policy was passed in 1997. In 2005, state legislation was passed that resulted in the development and implementation of a comprehensive mercury minimization program for the state. Mercury is a surface water quality issue throughout the state (ADEQ 2011a). State programs initiated since 1990 for the collection and recycling of electronics, and collection of household hazardous wastes also protect water quality.

### 4.4.2 Hazardous Waste

There are 204 permitted hazardous waste generators in the counties within the SCAWRPR (Table 4.14). Eighty-one of these facilities are classified as large quantity generators, meaning they generate at least 1,000 kilograms of hazardous waste per month (EPA 2012b). One hundred twenty-three of the facilities are classified as small quantity generators, meaning they generate between 100 and 1,000 kilograms of hazardous waste per month (EPA 2012c). There are also nine hazardous waste treatment/storage/disposal facilities in the region; four in Camden, three in El Dorado, and two in Benton (ADEQ n.d.).

Table 4.14. Permitted hazardous waste generators in counties within the SCAWRPR (ADEQ 2014b).

| County | Large Quantity | Small Quantity |
|---|---|---|
| Ashley* | 3 | 2 |
| Bradley | 1 | 0 |
| Calhoun | 3 | 1 |
| Clark | 5 | 3 |
| Cleveland | 1 | 1 |
| Columbia* | 6 | 6 |
| Dallas | 0 | 0 |
| Drew* | 2 | 2 |
| Garland | 3 | 8 |
| Grant | 1 | 2 |
| Hempstead* | 0 | 3 |
| Hot Spring | 0 | 5 |
| Jefferson* | 5 | 10 |
| Montgomery | 0 | 1 |
| Nevada* | 2 | 0 |
| Ouachita | 8 | 8 |
| Pike | 0 | 0 |
| Polk* | 3 | 5 |
| Pulaski* | 24 | 56 |
| Saline | 3 | 6 |
| Union | 11 | 4 |
| **Total** | **81** | **123** |

*Part of this county is in another planning region.

Hazardous waste generation data are compiled annually, but this program was not implemented in Arkansas until after 1990. Information from 1990 on the number of hazardous waste generators is also not readily available. Therefore, a comparison with 1990 conditions is not made in this document.

### 4.4.3 Wastewater and Stormwater

As of January 2014, there are 2,650 point sources permitted to discharge wastewater and stormwater in the SCAWRPR (Table 4.15). These discharges are permitted by ADEQ through the federal National Pollutant Discharge Elimination System (NPDES) program. Industrial, municipal, and domestic wastewater discharges are permitted through NPDES as well as discharges of stormwater and runoff associated with industrial sites, municipalities (MS4s), and temporary construction sites. See Section 6 for more details on wastewater regulations and permitting in Arkansas.

Table 4.15. NPDES-permitted discharges in the SCAWRPR (ADEQ 2014a, ADEQ 2014e, ADEQ 2014c, ADEQ 2014d).

| County | NPDES Industrial | NPDES Municipal | NPDES Domestic | NPDES Large MS4 | NPDES Small MS4 | NPDES Construction Stormwater[(a)] | NPDES Industrial Stormwater | NPDES Other[(b)] | Total |
|---|---|---|---|---|---|---|---|---|---|
| Ashley[(c)] | 5 | 6 | 1 | 0 | 0 | 3 | 13 | 5 | 33 |
| Bradley | 6 | 3 | 1 | 0 | 0 | 27 | 13 | 0 | 50 |
| Calhoun | 9 | 5 | 1 | 0 | 0 | 14 | 5 | 1 | 35 |
| Clark | 15 | 5 | 15 | 0 | 0 | 50 | 18 | 3 | 106 |
| Cleveland | 2 | 2 | 1 | 0 | 0 | 23 | 5 | 3 | 36 |
| Columbia[(c)] | 20 | 5 | 3 | 0 | 0 | 4 | 18 | 5 | 55 |
| Dallas | 10 | 3 | 1 | 0 | 0 | 20 | 17 | 1 | 52 |
| Drew[(c)] | 6 | 2 | 1 | 0 | 0 | 2 | 12 | 1 | 24 |
| Garland | 37 | 6 | 19 | 0 | 2 | 210 | 80 | 4 | 358 |
| Grant | 12 | 2 | 3 | 0 | 0 | 37 | 23 | 3 | 80 |
| Hempstead[(c)] | 16 | 6 | 4 | 0 | 0 | 10 | 27 | 4 | 67 |
| Hot Spring | 18 | 3 | 11 | 0 | 0 | 61 | 52 | 6 | 151 |
| Jefferson[(c)] | 26 | 7 | 6 | 0 | 4 | 23 | 60 | 11 | 137 |
| Montgomery | 5 | 2 | 7 | 0 | 0 | 12 | 7 | 4 | 37 |
| Nevada[(c)] | 4 | 2 | 5 | 0 | 0 | 2 | 3 | 2 | 18 |
| Ouachita | 17 | 4 | 5 | 0 | 0 | 29 | 34 | 3 | 92 |
| Pike | 9 | 3 | 4 | 0 | 0 | 15 | 13 | 2 | 46 |
| Polk[(c)] | 8 | 3 | 3 | 0 | 0 | 3 | 14 | 2 | 33 |
| Pulaski[(c)] | 123 | 16 | 69 | 1 | 8 | 151 | 212 | 25 | 605 |
| Saline | 14 | 7 | 31 | 0 | 5 | 293 | 54 | 8 | 412 |
| Union | 33 | 11 | 19 | 0 | 0 | 80 | 73 | 7 | 223 |
| **Total** | **395** | **103** | **210** | **1** | **19** | **1,069** | **753** | **100** | **2,650** |

Notes:
a. Construction stormwater permits are temporary.
b. Includes filter backwash, process water, cooling water, and other discharges.
c. Part of this county is in another planning region.

Over 100 surface waterbodies in the planning region receive discharges from NPDES-permitted entities. A number of these waterbodies receive discharges from more than one NPDES-permitted point source (ADEQ 2012a).

ADEQ also issues water discharge permits through state regulatory programs. In January 2014, 647 state water permits are active in the counties within the SCAWRPR (Table 4.16). The majority of these permits (over 400) are for brine operations, the majority of which are in Union County. The counties with the largest numbers of facilities with state water permits are Union, Columbia, and Ouachita.

Table 4.16. State water permits (ADEQ 2014a).

| County | Industrial | Municipal | Domestic | Brine (includes commercial) | Reserve Pits-B17 Rule | Underground Injection | Total |
|---|---|---|---|---|---|---|---|
| Ashley* | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Bradley | 0 | 0 | 0 | 4 | 0 | 0 | 4 |
| Calhoun | 0 | 0 | 0 | 5 | 0 | 0 | 5 |
| Clark | 3 | 1 | 0 | 0 | 0 | 0 | 4 |
| Cleveland | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Columbia* | 8 | 0 | 0 | 56 | 49 | 2 | 115 |
| Dallas | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Drew* | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Garland | 4 | 1 | 0 | 0 | 0 | 0 | 5 |
| Grant | 1 | 2 | 0 | 0 | 0 | 0 | 3 |
| Hempstead* | 3 | 1 | 0 | 1 | 1 | 0 | 6 |
| Hot Spring | 5 | 1 | 0 | 0 | 0 | 0 | 6 |
| Jefferson* | 7 | 0 | 0 | 0 | 0 | 0 | 7 |
| Montgomery | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| Nevada* | 0 | 0 | 0 | 22 | 2 | 0 | 24 |
| Ouachita | 2 | 1 | 0 | 102 | 35 | 0 | 140 |
| Pike | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| Polk* | 3 | 1 | 0 | 0 | 0 | 0 | 4 |
| Pulaski* | 14 | 2 | 0 | 0 | 0 | 0 | 16 |
| Saline | 8 | 0 | 0 | 0 | 0 | 0 | 8 |
| Union | 12 | 0 | 1 | 218 | 58 | 4 | 293 |
| **Total** | **76** | **10** | **1** | **409** | **145** | **6** | **647** |

*Part of this county is in another planning region.

Table 4.17 compares the number of NPDES permits for municipal, domestic, and industrial wastewater reported for the SCAWRPR in the 1990 state-wide water quality assessment with the current numbers for the same categories of NPDES permits. Overall, the number of permitted wastewater discharges in the SCAWRPR has increased by over 300% since the 1990 AWP update. The majority of this increase is in the number of industrial and domestic permits. Note that the state-wide water quality assessment reports do not include permits for municipal, industrial, or construction stormwater runoff. The first industrial and construction stormwater runoff NPDES permits were issued by ADEQ in 1992 (ADEQ 2014c, ADEQ

2014d). ADEQ did not issue permits for stormwater runoff from small municipalities until 2004 (ADEQ 2014e).

Table 4.17. Numbers of NPDES wastewater permits reported for the SCAWRPR in 1990 and 2014 (ADPCE 1990, ADEQ 2014a).

| Permit Type | 1990 | 2014 | Change |
|---|---|---|---|
| Industrial | 42 | 395 | +253 |
| Municipal | 60 | 103 | +43 |
| Domestic | 68 | 210 | +142 |
| Cooling Water | 4 | 2 | -2 |
| Filter Backwash | 2 | 32 | +30 |
| Process Water | 1 | 12 | +11 |
| Agricultural | 0 | 0 | 0 |
| Other | 8 | 13 | +5 |
| Toxic | 2 | 0 | -2 |
| **Total** | **187** | **767** | **+580** |

# 5.0 WATER RESOURCES ISSUES

Water resources issues in the SCAWRPR include concerns about the amount of water that is available, how the water is used, and the chemical and biological quality of water resources. In addition, there are concerns in the region about how water is managed in terms of flood control, water supply infrastructure, and wastewater treatment infrastructure. These issues are discussed and, to some extent, quantified below. Changes in regional water resources issues since the 1990 AWP update are also discussed.

## 5.1 Flooding

Parts of the SCAWRPR have been known to experience recurring flood problems. The Ouachita River has historically had issues with flooding, leading to studies performed by the US government in the 1870s. Several significant flood events occurred on the river, notably the floods in May 1923 and March 1945. With the Flood Control Act of 1944, funding became available that would lead to the construction of Blakely Mountain Dam, forming Lake Ouachita and helping to decreasing flooding issues on the river (Branyan 2013, lakeouachita.org 2013).

Significant flood events have occurred in more recent years in the planning region. Heavy rainfall in May 1990 caused severe flooding in and around Hot Springs, Arkansas. The Ouachita River and several tributaries between Blakely Mountain Dam and Malvern, Arkansas, experienced flooding that led to significant property damage and one fatality. Both Lake Hamilton and Lake Catherine experienced flood stages near the 100-year event level. Several gage stations along the Ouachita River and its tributaries showed peak discharges that exceeded the 100-year event (Southard 1992).

A second significant flood event occurred on June 11, 2010, along the Little Missouri River. A flash flood occurred in the early morning due to a high-intensity rainstorm, with more than 5.3 inches of rain falling in 6 hours, causing an average flood depth of 7 feet to occur in the floodplain. USGS has estimated this storm to have a recurrence interval of less than 1% (100-year event). The flood killed 20 people and caused severe property damage (Holmes and Wagner 2011).

Columbia County, which is partially in the SCAWRPR, was listed as one of the six counties in Arkansas with the most federal disaster declarations. Eighty percent of these declarations were with regard to flooding (Branyan 2013).

## 5.2 Water Supply

Population growth, as well as expansion of water-intensive industries in this region, such as irrigated agriculture and aquaculture, has resulted in concern over whether there is sufficient water available to supply current and future demands in the SCAWRPR.

### 5.2.1 Groundwater

There are 12 recognized aquifers within the planning region, however, only some of these are considered sustaining aquifers. Other aquifers can supply only limited domestic use. There is concern about water level declines in several of the aquifers in the planning region. This is a somewhat localized issue as water use and groundwater recharge rates for these aquifers vary throughout the planning region.

#### 5.2.1.1 Groundwater Level Monitoring

ANRC sponsors monitoring of water levels of the Sparta aquifer in Ashley, Bradley, Calhoun, Columbia, Dallas, Drew, Ouachita, and Union counties (Figure 5.1). This water-level monitoring program is a cooperative effort between ANRC, USGS, the USDA Natural Resources Conservation Service (NRCS), and local water-resources agencies. Each spring, water level measurements are collected from approximately 80 wells in the Sparta-Memphis aquifer within the planning region (ANRC 2012b). Results of the monitoring program are published in the annual Arkansas Groundwater Protection and Management Report on the ANRC website.

USGS also conducts water-level monitoring independently as part of the National Water Information System (NWIS). Since 2007, USGS has operated continuous groundwater-level recorders at 15 real-time stations in the planning region (Figure 5.1). These data provide a valuable dataset for improved understanding of water resources of the state. USGS also collects water level data for seven aquifers from 21 additional wells in the planning region (USGS 2014).

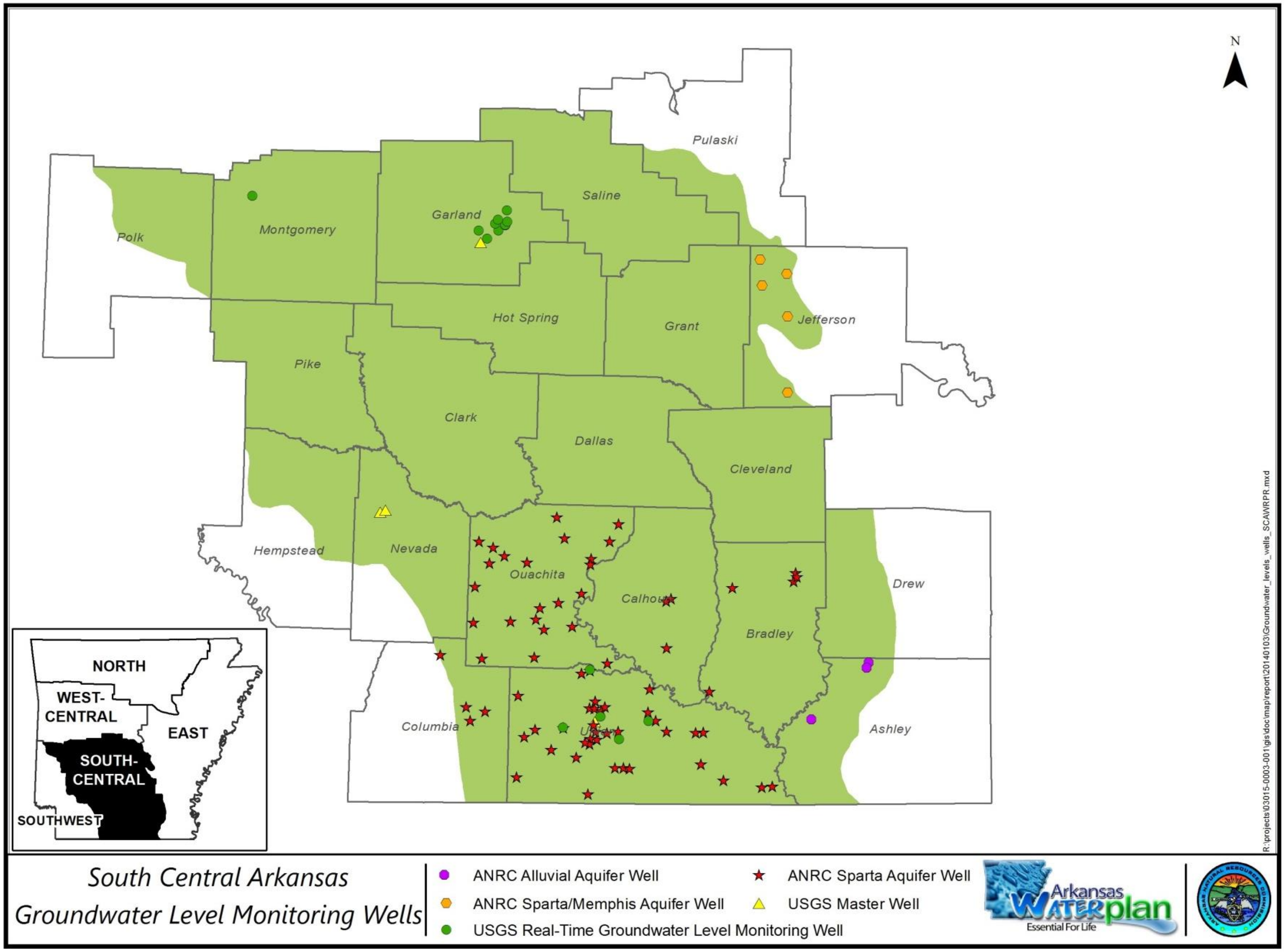


Figure 5.1. Groundwater level monitoring sites in the SCAWRPR.

Data from these programs may be retrieved at the NWIS website. USGS also works with its partners to prepare water level reports for aquifers associated with the SCAWRPR (USGS n.d.).

#### 5.2.1.2 Ouachita-Saline Alluvial Aquifer

Locally, the alluvium of the Ouachita and Saline rivers provides readily available groundwater. Although the aquifer is thin in the area of Clark, Cleveland, and Dallas counties, (Plebuch and Hines 1969) this aquifer has been a historical source of water for these counties and other counties within the planning region. In 2010, Union County reported a use of 0.05 million gallons per day (mgd) and Grant County reported usage of 3.39 mgd from this aquifer, used largely for irrigation (Kresse et al. 2013).

#### 5.2.1.3 The Jackson Group

Groundwater use from the Jackson Group was confined almost solely to a large area of exposed deposits south of the Arkansas River along the eastern border of the planning region. Because of the extensive clay content of sediments constituting the Jackson Group, yields were low and sufficient for only domestic and livestock supply in the past. Plebuch and Hines (1969) reported that the aquifer yielded small amounts for domestic use only. Halberg et al. (1968) similarly reported low yields throughout much of the extent of the Jackson Group and stated that where larger supplies were needed, wells would have to be drilled into the underlying Cockfield or Sparta Formations. Kresse and Fazio (2002) reported that, prior to 1960, a minimum of 90 wells in Drew and Lincoln counties and 6 wells in Jefferson County were using groundwater from the Jackson Group as a source for farm and domestic supply. Municipal water-supply sources have replaced use of groundwater from the Jackson Group, and remaining operational wells located in 1999 and 2000 by Kresse and Fazio (2002) were used solely for watering gardens and other ancillary purposes.

#### 5.2.1.4 Cockfield Aquifer

The Cockfield aquifer is an important groundwater resource throughout eastern and southern Arkansas. Public supply accounted for 17% of water pumped from the Cockfield aquifer in 2010, and the aquifer ranks as the sixth-highest used aquifer for public supply in Arkansas (Kresse et al. 2013). Domestic use of the Cockfield aquifer is important in the planning region, but in some areas yields are high enough to support municipal and industrial supply. From 2000 to 2010, Ashley County was the largest user of the Cockfield aquifer for both public and industrial supply. Use of the Cockfield aquifer here increased from less than 4 mgd to approximately 10 mgd between 1990 and 2010 (Kresse et al. 2013).

As a result of sustained and intense pumping of the Cockfield aquifer in the planning region, water level declines have led to cones of depression in western Drew County, southwestern Calhoun County, and southeastern Lincoln County, but no regionally extensive declines in water levels have been observed in the Cockfield aquifer (Kresse et al. 2013). With growing population and water demands over time, some municipalities (e.g., Kingsland, El Dorado) in the planning region have switched their primary water supply from the Cockfield aquifer to the Sparta aquifer (Kresse et al. 2013).

#### 5.2.1.5 Sparta Aquifer

The Sparta aquifer is an extremely important aquifer in Arkansas, generally providing water of excellent quality, with wells often yielding hundreds to thousands of gallons per minute. The Sparta aquifer provided approximately 197 mgd in 2010 with 700 wells reported in use (Kresse et al. 2013). Within the SCAWRPR, the Sparta aquifer is the best source for industrial use (primarily for oil and gas processing and development, chemical industry, and the lumber and paper industries) and public supply. Most counties within the planning region used the Sparta aquifer as a source of water supply in 2010, but the principal areas for groundwater withdrawal from the Sparta aquifer are in Union County and Jefferson County. Jefferson County, especially the Pine Bluff area within the SCAWRPR has been the largest user of the Sparta aquifer in the state.

The Sparta aquifer ranks first in groundwater used for public supply in Arkansas, with municipalities withdrawing 57.4 mgd from the Sparta aquifer in 2010 (Kresse et al. 2013). The Sparta aquifer has been the sole public supply source for El Dorado since the later 1940s (Baker et al. 1948). The Sparta aquifer has many municipal users in other areas within the planning region, including Carthage, Fordyce (both in Dallas County), and Rison (Cleveland County) (Plebuch and Hines 1969). Albin (1964) reported that the Sparta aquifer at Camden (Ouachita County) was nearing maximum sustainable yield in the mid-1960s, but Camden now gets their water from the Ouachita River. Use of the Sparta aquifer in Union County in 2010 was 7.59 mgd. Industrial water use of the Sparta aquifer by Union County was 3.98 mgd in 2010, or 52% of the total use. Use of the Sparta aquifer in Jefferson County in 2010 was 45.5 mgd. Industrial water use from the Sparta aquifer in Jefferson County was 31.79 mgd in 2010, or 69.9% of the total use (Kresse et al. 2013).

Water-level declines in the Sparta aquifer are a major concern for users in Arkansas and have been noted throughout the Sparta aquifer in Arkansas. Severe water-level declines were noted in southern and east-central Arkansas since development of the Sparta aquifer for primarily municipal and industrial uses in these areas. The reader is referred to Kresse and others (2013) for a discussion of the historical use of the Sparta and a general overview of changing water levels over time and development of cones of depression throughout the extent of the Sparta aquifer in Arkansas. Within the planning region, significant water level declines have been observed around Pine Bluff (Jefferson County) and El Dorado (Union County), with lesser declines observed in northern Cleveland County, northeastern Bradley County, eastern Calhoun County, northern Ashley County, and in Camden (Ouachita County). Minor cones of depression have developed in these latter areas since publication of the 1990 AWP.

#### 5.2.1.6 Cane River Aquifer

Although present in many areas of southern Arkansas, water quality concerns have restricted use of the Cane River aquifer to primarily southwest Arkansas. Historically, the Cane River aquifer was a source of domestic supply and public supply for Sparkman (Dallas County) (Plebuch and Hines 1969). In the mid-2000s, Sparkman switched from the Cane River aquifer to the Ouachita River. Wells capable of producing smaller yields were present in Union County, north of El Dorado (Baker et al. 1948, Tait et al. 1953). Ouachita County had a reported use of 0.08 mgd in 2010 (Kresse et al. 2013).

Although hydrologic characteristics were deemed the most favorable for future development in south-central Arkansas (Hosman et al. 1968), abundant groundwater from overlying formations supply water needs within the planning region. Ludwig (1973) indicated that water levels in the aquifer have not been affected by pumping.

#### 5.2.1.7 Carrizo Aquifer

The Carrizo aquifer serves only as a minor aquifer in Arkansas, mainly used for domestic supply within 5 to 10 miles of its outcrop (Albin 1964, Terry et al. 1986). Hosman et al. (1968) noted that in south-central Arkansas, where the hydrology of the Carrizo Sand was most favorable for future development, the unit was untapped. Older reports state that the aquifer was not commonly utilized, due perhaps to limited information available on the aquifer's extent and water availability and/or high iron contents (Halberg et al. 1968, Plebuch and Hines 1969). Most withdrawals from the Carrizo aquifer were domestic users. Published water use data for the Carrizo aquifer only is available from 1965 to 1980. In 1980, a total of 0.31 mgd was withdrawn from the Carrizo aquifer in Hempstead, Hot Spring, Nevada, and Ouachita counties (Kresse et al. 2013). No use has been reported for this aquifer within the planning region since 1980.

#### 5.2.1.8 Wilcox Aquifer

In southern and southwestern Arkansas, which includes the planning region, total water use from the Wilcox aquifer is less than that in northeastern Arkansas. However, the Wilcox aquifer is very important in the planning region for domestic supply near its outcrop area. Many residences have wells completed in the Wilcox aquifer and depend on it for drinking water; schools and small businesses are also reported to use water from the Wilcox aquifer in this area (Counts et al. 1955, Onellion and Criner 1955, Albin 1964, Halberg and Stephens 1966, Plebuch and Hines 1969, Ludwig 1972, Terry et al. 1986). Domestic use has declined in recent years as more residents convert to municipal water supplies; however, small amounts still are assumed to be withdrawn for domestic supply by users in Nevada County. Rosston (Nevada County), the only town in the planning region using the Wilcox aquifer for public supply, installed a well in

1928, pumped 0.03 mgd from 1945 to 1965, and as of 2010, pumped 0.06 mgd (Kresse et al. 2013).

In the planning region, two cones of depression were noted in the 2006 Wilcox aquifer surface, in Nevada County near Rosston and southeastern Clark County (Schrader 2007a). The cone of depression in Nevada County is centered near a single well. From 2003 to 2009, water levels in this well dropped 17.7 feet, which was the largest decline in the southern area of the Wilcox aquifer (Pugh 2010). Previous work in the 1970s had reported the lowest water levels of the Wilcox aquifer in the south part of the state near the Rosston public supply well (Ludwig 1972); however, the lowest levels of the Wilcox aquifer were recorded in 2009 at the depression in southeastern Clark County (Pugh 2010).

#### 5.2.1.9 Nacatoch Aquifer

Use of the Nacatoch aquifer is found in areas near its outcrop within the planning region. Poor water quality has restricted the aquifer's use farther away from its outcrop in southwestern Arkansas (Terry et al. 1986). Primary use of the aquifer has been public and industrial supply. Hempstead County has generally had the most use of the Nacatoch aquifer. Other counties within the planning region that have historically used the aquifer as a water supply include Clark, Ouachita, Nevada, and Hot Spring Counties. Users pumped the most water in 1980 (6.46 mgd). Water-use rates for the Nacatoch aquifer has decreased since 1980 to a reported level of 1.66 mgd in 2010 with wells located in Clark, Hempstead, Ouachita, and Nevada counties (Kresse et al. 2013).

Prescott (Nevada County) formerly had two wells in the Nacatoch aquifer, tapped in 1925 and 1948 (Hale et al. 1947, Counts et al. 1955), but now solely draws from the Little Missouri River. Other smaller communities in the area including Gurdon (Clark County) and Emmet (Nevada County) tap the Nacatoch aquifer for public supply.

Industrial use of water from the Nacatoch aquifer occurs in Clark and Hempstead counties. Lumber-processing facilities currently depend on Nacatoch aquifer wells in Clark County. Ice companies and Arkansas Louisiana Gas were also recorded users of the Nacatoch aquifer in Clark County. The current (2010) largest single use of the aquifer is for cooling water at a power plant in Hempstead County.

In the planning region, recent water-level contours have shown that water levels gradually decrease from the aquifer's outcrop north to south (Schrader and Blackstock 2010). In Prescott, water levels declined greater than 30 feet from the mid-1950s to the mid-1970s, but dramatic rises (up to approximately 70 feet) were recorded later in this well from 1985 to 1990, when the drinking water supply of Prescott was switched from groundwater to the Little Missouri River (Schrader and Blackstock 2010). Groundwater levels in the Nacatoch have been stable in this area since the early 1990s. In 2011, cones of depression were noted in southern Clark and north-central Hempstead counties (Kresse et al. 2013).

#### 5.2.1.10 Ozan Aquifer

Wells completed in the Ozan aquifer are found mainly in Clark County where other water sources are not available. Primary use of this aquifer has been for domestic supply; however, use has been restricted due to high chloride concentrations (Counts et al. 1955, Boswell et al. 1965). Pleubuch and Hines (1969) estimated that 0.13 mgd was withdrawn in Clark County from the Ozan aquifer in 1965. Published water use data for the Ozan aquifer only is available from 1965 to 1980, and no use has been reported for this aquifer after this period.

#### 5.2.1.11 Tokio Aquifer

The Tokio aquifer dominantly was used as a source of domestic water supply. Counts and others (1955) recorded 143 domestic wells into the Tokio aquifer in six counties in the SCAWRPR: Pike, Nevada, Clark, Hempstead (and Howard and Sevier in the Southwest AWRPR). Many of these wells originally were flowing artesian wells, and an estimated 66% of water was lost from the total 3 mgd that was withdrawn (Boswell et al. 1965). Use for domestic supply and livestock wells continued into the late 1960s and early 1970s in Clark County (Plebuch and Hines 1969, Ludwig 1972). Also, domestic wells are in use in Hempstead County.

Several towns in the planning region have used the Tokio aquifer for municipal supply. Several smaller communities in the area including Okolona (Clark County) and Blevins

(Hempstead County) tap the Tokio aquifer for public supply. Prescott (Nevada County) formerly had one well in the Tokio aquifer, completed in 1912 (Counts et al. 1955), but now solely draws from the Little Missouri River.

The Tokio aquifer has seen a small amount of industrial use in the past, including withdrawals for Arkansas Louisiana Gas Company near Prescott (Counts et al. 1955), but currently the aquifer is not used for industrial purposes within the planning region (Kresse et al. 2013).

Long-term ANRC and USGS cooperative monitoring has documented water-level changes in the Tokio aquifer (Schrader 1998, 1999, 2007b; Schrader and Scheiderer 2004; Schrader and Blackstock 2010; Schrader and Rodgers 2013). No appreciable changes in water levels were noted at the map scale between the 1996, 1999, and 2001 investigations (Schrader and Scheiderer 2004). Many reports cite the possibility of a cone of depression forming 5 miles northwest of Hope; however, not enough water-level data have been available in the southern part of the study area to confirm this situation (Schrader and Blackstock 2010). However, water levels in a well near the possible depression northwest of Hope (Hempstead County) have fallen with increasing use. A large drop was documented for this well between 1990 and 2000, when water use increased 215%, from 1.10 mgd to 3.46 mgd in Hempstead County. Water levels additionally appear to have slowly declined at Prescott.

#### 5.2.1.12 Trinity Aquifer

The Trinity aquifer is present in Pike County in the SCAWRPR. The Trinity aquifer has been used for domestic and public water supply, including the public supply well at Murfreesboro (Pike County). However, published water use data for the Trinity aquifer only is available from 1965 to 1980, and no use has been reported for this aquifer after this period.

#### 5.2.1.13 Ouachita Mountains Aquifer

Although Albin (1965) noted that wells in the Ouachita Mountains yielding greater than 10 gpm were considered “large-yield wells,” some wells commonly can yield between 10 and 50 gpm—yields more than sufficient for many community supply systems. A review of community supply wells from the Arkansas Department of Health resulted in 72 wells used by various entities including camps and other recreational areas, conference centers, rest areas, stores, and even sources of public supply. Five separate communities used wells completed in the Atoka, Bigfork Chert, Stanley Shale, and Arkansas Novaculite Formations for purpose of public supply, demonstrating that many formations constituting the Ouachita Mountains aquifer are capable of supplying volumes sufficient for small community supply sources of water (Kresse et al. 2013).

#### 5.2.1.14 Critical Groundwater Areas

The 1990 AWP update advocated sustainable, conjunctive use of groundwater and surface water resources in this region to meet water resources needs. A number of voluntary programs have been initiated to try to reduce the rate of groundwater depletion in areas where groundwater level declines are the greatest.

Portions of southwest Pulaski County and western Jefferson County lie within both the SCAWRPR and the Grand Prairie Critical Groundwater Area (Figure 5.2). Concerns about potential water-level declines from an increasing number of wells and increasing demands on the Sparta aquifer for agricultural use in additional to declines observed in the Mississippi River Valley alluvial aquifer led ANRC to designate the Grand Prairie as a Critical Groundwater Area in 1998 (ANRC 2010). Two surface-water diversion projects are planned for the Grand Prairie area to provide irrigation water and decrease dependence on the Mississippi River Valley alluvial and Sparta aquifers (Kresse et al. 2013).

Historically, the Sparta aquifer in south Arkansas provided abundant water of high quality; however, demand for water, particularly in Union County (and Columbia County in the Southwest WRPR), resulted in withdrawals that significantly exceeded recharge and water levels that were declining at rates greater than 1 foot per year through the 1980s and 1990s. Regional cones of depression centered on El Dorado and Monroe, Louisiana, coalesced by 1990. As water levels began to drop below the top of the formation, water users and managers alike began to question the ability of the aquifer to supply water of high quality for the long term and began to evaluate management approaches to protect the aquifer.

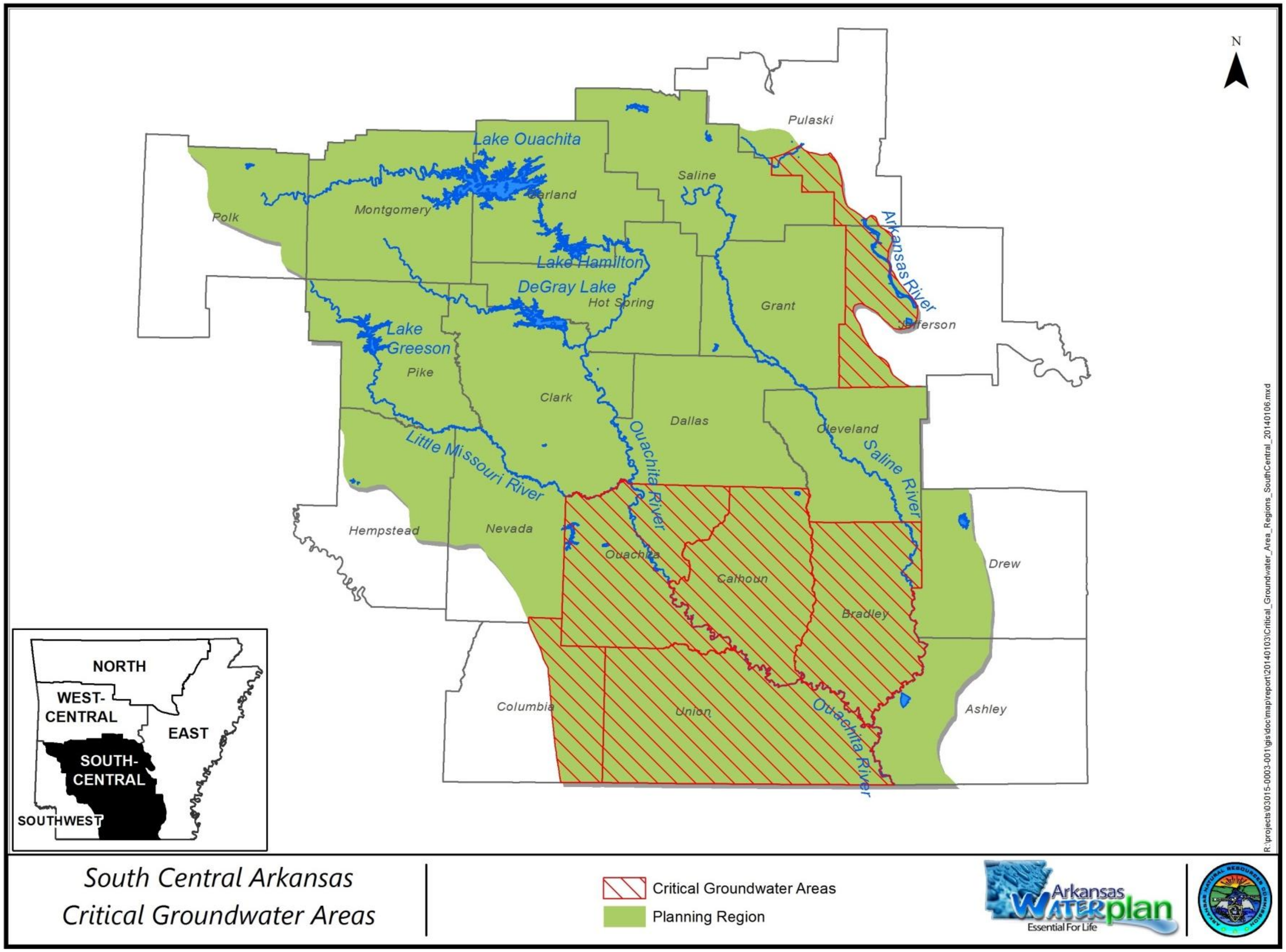


Figure 5.2. Critical groundwater areas within the SCAWRPR.

Water levels in Union County had been declining at rates greater than 1 foot per year for over a decade (Hays, Lovelace and and Reed 1998), and saltwater intrusion caused by intensive pumping increased near the cone of depression in Union County (Broom, Kraemer and and Bush 1984). Simulated results from Hays and others (1998) indicated that if pumping rates from the 1990s continued to 2027, water levels would approach or fall below the top of the Sparta aquifer at the major pumping centers in Arkansas and Louisiana. In 1996, the Sparta aquifer was declared a Critical Groundwater Area by ANRC in five counties: Ouachita, Calhoun, Bradley, Columbia, and Union (Figure 5.2). This action allowed counties within the designated area to establish local conservation boards with management, regulatory, and taxing authority to plan, guide, and implement management strategies targeting the achievement sustainable use of the aquifer.

The Union County Water Conservation Board (UCWCB) was formed and approved by ANRC in 1999. In an effort to conserve the aquifer, UCWCB instituted several water conservation measures, including (1) public education about water conservation practices, (2) industrial water reuse and sharing, and (3) reuse of reclaimed treated wastewater at local golf courses. Also, a temporary $0.01 sales tax was adopted in 2002 by the citizens of Union County for to help pay for a pumping facility on the Ouachita River to develop an alternative water source and supply surface water to local industry. This funding, in combination with a grant from EPA, were used to construct a pumping station and pipeline from the Ouachita River to major industrial groundwater users in the El Dorado area. The river intake, pumping facility, and 5 miles of 48-inch pipeline were completed in 2004. The facility is capable of producing 65 mgd. Also, funding allowed for the installation of eight real-time water-level monitors (Scheiderer and and Freiwald 2006). In recent developments, the Louisiana Department of Natural Resources (LDNR) has offered to share Sparta aquifer recovery monitoring responsibilities through September 2015 (personal communication between UCWCB, LDNR, and USGS Louisiana, August 7-8, 2013). More information can be found on the UCWCB website (http://www.ucwcb.org/).

From 2005 to 2010, use in Union County declined over 50% due to conservation efforts, and the efforts undertaken to reduce groundwater use led to rising water levels and a smaller cone of depression (Kresse et al. 2013). Groundwater models have been developed and are used to help manage water needs in the planning region with the goal of achieving and maintaining sustainable use of the Sparta aquifer.

### 5.2.2 Surface Water

Lakes and rivers in the SCAWRPR are important sources for water supply to cities, industry, and water utilities. Concerns about groundwater in the planning region have increased the demand for surface water as industry and water utilities switch from groundwater to surface water to supply their needs (e.g., the Union County Water Conservation Board described in Section 5.2.1.2). Surface water sources in the SCAWRPR are listed below (ADH n.d.):

- Caddo River,
- DeGray Lake,
- Ouachita River,
- Irons Fork Lake,
- Lake Columbia,
- Lake Lago,
- Middle Fork Saline River,
- Lake Nichols,
- Lake Ouachita,
- Lake Winona/Lake Maumelle,
- Lake Hamilton,
- Ricks Lake,
- Dillon Lake,
- Sanderson Lake,
- Little Missouri River,
- Little River, and
- Saline River.

Though the Little River is not located in this planning region, it is a source of water to utilities in the region, and is therefore listed.

Hot Springs Waterworks currently treats water from lakes Hamilton, Sanderson, Ricks, and Dillon. The city has two treatment plants: Lakeside Plant and Ouachita Plant. The Lakeside Plant treats water from lakes Ricks and Dillon, while the Ouachita Plant treats water from lakes Hamilton and Sanderson. Future plans for the city are to abandon the Lakeside Plant and build another with a new water source. A 2013 study found that choices for the acceptable new source would be either Lake DeGray or Lake Ouachita. Projected demands show an approximate 1% per year increase in need. Therefore, a suggested increase of 15 mgd from the new plant would allow for demands to be met and reassessed in the year 2030 (Crist Engineers, Inc. 2013). In October 2013, a deal between Hot Springs and Central Arkansas Water (CAW) was brokered, with CAW selling a portion of its future water rights to Lake DeGray to the City of Hot Springs. This deal has caused issue with some users of CAW water, who feel that the future water rights should have been saved (Petrimoulx 2013).

Some problems have arisen in the SCAWRPR due to surface water use. For example, the 2005-2009 NPS [Nonpoint Source] Management Program Update stated that water withdrawals along the Middle Fork of the Saline River have led to degradation of aquatic resources (ADEQ 2005). This was not mentioned in the 2011-2016 update, however. In 1995 there was an effort to make the Upper Saline River part of the Arkansas Natural and Scenic Rivers System, which would have disallowed its use as a water source. This effort was unsuccessful due to the fact that Saline County communities, including Benton, were suffering from a chronic water shortage at the time (Williams 1995). A 2002 study performed by a water study task force at the University of Arkansas at Little Rock stated that most sources in Saline County were sufficient for the next 5 to 20 years, but that further needs should be researched (Brenton et al. 2002).

Reallocation of storage from Ouachita Lake was considered to meet projected water supply needs for the communities of the Mid-Arkansas Water Alliance during the period from 2004 through 2009 (USACE Little Rock District 2009). Several communities in the planning region in Garland, Pulaski, and Saline counties are members of this alliance (Central Arkansas Water 2010).

## 5.3 Water Quality Issues

Federal law requires states to assess the water quality of the waters of the state (both surface water and groundwater) and prepare a comprehensive report documenting the water quality, which is to be submitted to EPA every 2 years. ADEQ is the agency in Arkansas responsible for enforcing the water quality standards and preparing the comprehensive report for submittal to EPA. This section discusses surface water and groundwater quality issues that have been identified in the SCAWRPR. These issues include non-attainment of surface water quality standards, non-attainment of drinking water standards and water quality guidelines in groundwater, fish consumption advisories, nonpoint source pollution of surface water and groundwater, and contaminants of emerging concern.

### 5.3.1 Water Quality Monitoring

To assess water quality, it is necessary to collect water quality data through monitoring programs. Monitoring of water quality in the SCAWRPR occurs under a range of programs, including routine ambient, special project, and research-oriented monitoring. Multiple agencies are responsible for the various water quality monitoring programs, and numerous entities assist with monitoring activities. Surface water and groundwater monitoring programs in the planning region are outlined below.

#### 5.3.1.1 Surface Water

ADEQ monitors water quality of surface waters through several programs. The ambient water quality monitoring network includes 30 sites on rivers and streams in the SCAWRPR that are sampled monthly for chemical analysis. The roving water quality monitoring network includes 16 stream sites in the planning region. Roving monitoring sites are divided into four regional groups. The groups of roving sites are sampled for chemical and bacterial analysis on a rotating basis, bimonthly over a 2-year period. Each roving site group is monitored every 6 years (ADEQ 2008, ADEQ 2012a, ADEQ 2013c). ADEQ surface water quality monitoring stations are shown on Figure 5.3.

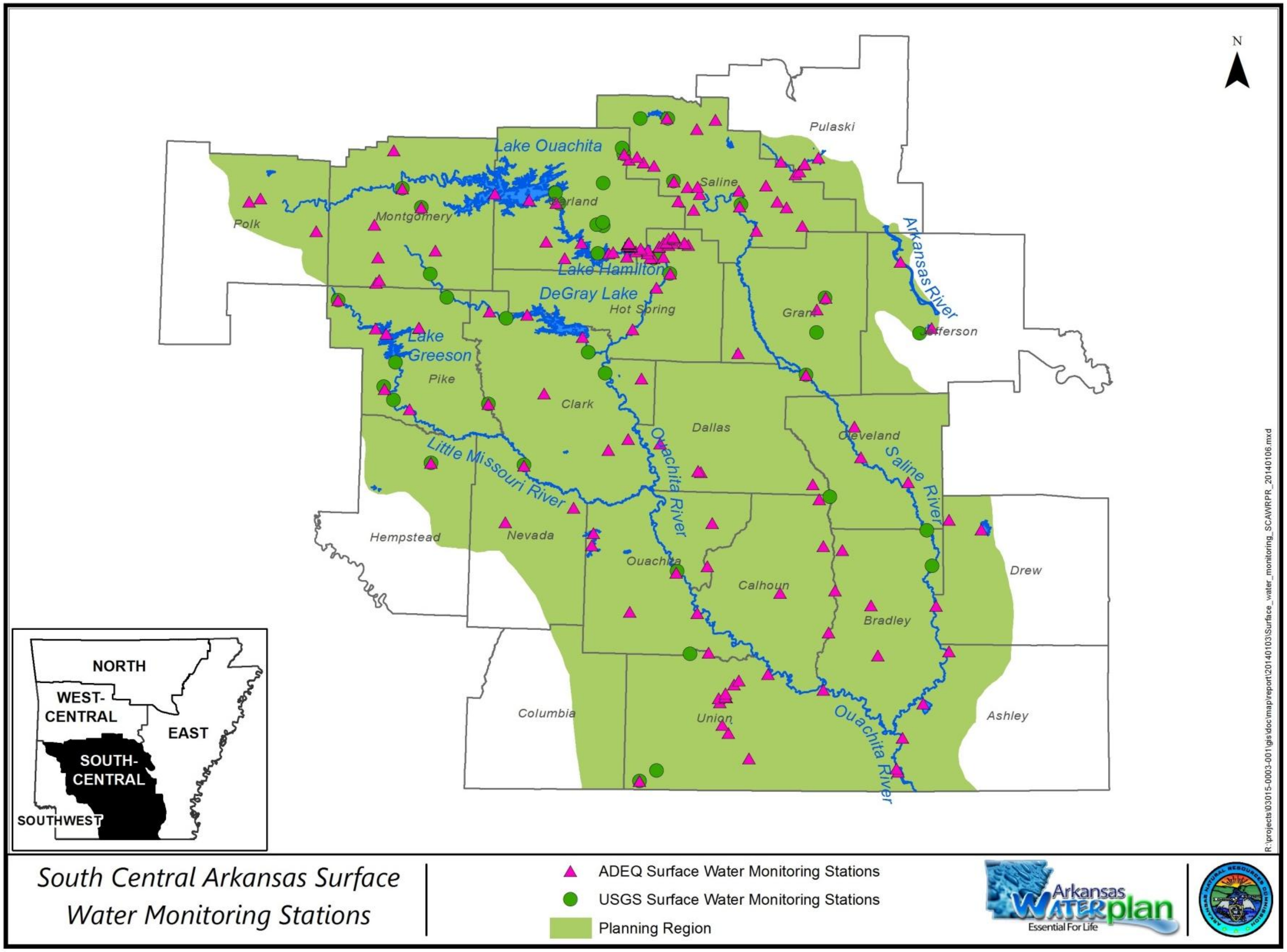


Figure 5.3. Surface water quality monitoring sites in the SCAWRPR.

Bacterial analysis is also performed on samples from the ambient water quality monitoring network within the active region of the roving water quality monitoring network. In addition, ADEQ conducts water quality monitoring during “intensive surveys.” These surveys can involve water sampling for chemical and bacterial analysis, as well as biological sampling to evaluate water quality. Intensive surveys are conducted for a variety of purposes, including determination of total maximum daily loads (TMDLs), and to augment water quality information from the routine water quality monitoring networks for more accurate assessment of designated use support. ADEQ also routinely monitors water quality in 18 significant publicly owned lakes within the planning region (ADEQ 2008, ADEQ 2012a, ADEQ 2013c).

Through its nonpoint source (NPS) management program, ANRC oversees water quality monitoring programs in 10 NPS priority watersheds. Two of these watersheds, Lower Ouachita Smackover and Upper Saline, are located in the SCAWRPR. These programs involve universities, contractors, and nonprofit organizations. Parameters monitored by these programs typically include nutrients and sediment, turbidity, and/or total suspended solids (TSS).

The monitoring and reporting requirements for surface water used for human consumption are authorized by both federal and state regulations. A summary of these requirements can be found in Chapter 5 of *Arkansas Public Water System Compliance Summary*, “Microbial Disinfection By-Products Rules” (ADH 2012). There are over 70 public water supply systems in the SCAWRPR that use surface water (ADH n.d.). Depending on the treatment methods used and the number of customers served by the public water supply utilizing surface water, the monitoring requirements for the raw surface water, or source water, will vary and may include turbidity, *Escherichia coli* (*E. coli*), cryptosporidium, total organic carbon (TOC), and alkalinity.

USGS also routinely monitors surface water quality data in the SCAWRPR. Data from USGS monitoring stations (Figure 5.3) may also be used in the biennial assessment. There are five active USGS water quality monitoring stations in the SCAWRPR. Samples are collected at these stations monthly, bi-weekly, or quarterly. There are five continuous USGS water quality monitoring stations in the SCAWRPR and 190 locations that have at least one sampling occurrence. Of these locations, 18 are in lakes and the remainder are in streams (USGS 2014).

#### 5.3.1.2 Groundwater

In the SCAWRPR, groundwater quality monitoring is performed on many levels ranging from ambient to research-oriented and mandated monitoring. Multiple agencies are responsible for the various groundwater monitoring programs, and numerous entities assist with monitoring activities. Divisions of ADEQ administer mandated groundwater monitoring programs at various sites that are regulated by state and federal programs. The purpose of this monitoring is to evaluate potential and actual impacts to groundwater resulting from human activities and natural phenomenon (ADEQ 2012a). For example there are three Superfund sites located within the planning region where groundwater monitoring is currently performed. Within the planning region are three active properties in the state's Brownfields program that are currently being evaluated; six sites that are on the state Priority List that are monitored; one active site in the Elective Cleanup program; one Class I solid waste landfill; and a number of hazardous constituent sites and leaking underground storage tank sites that are being evaluated or monitored through other regulatory mechanisms. These sites may have contaminated groundwater with numerous organic chemicals exceeding safe drinking water standards, but the aerial extent of the plume may be limited with no offsite migration and no known groundwater users at risk.

ADEQ developed the Arkansas Ambient Ground Water Monitoring Program in 1986, which currently consists of 11 monitoring areas and approximately 250 wells and springs throughout the state (Kresse et al. 2013). ADEQ's Athens Plateau, Ouachita, El Dorado, and Pine Bluff areas are in whole or partially located within the planning region (Figure 5.4). Samples are collected from wells (Ouachita Mountains aquifer and Cretaceous aquifers) in the Athens Plateau (Pike and Howard counties) to develop baseline conditions and monitor potential impacts of the agricultural industry on groundwater. The El Dorado (Union County) area monitoring is performed in the Cockfield and Upper (Greensand) and Lower (El Dorado) Sparta aquifer to monitor the effects of this highly industrialized area (i.e., oil and gas production; bromine extraction, production and refining; light manufacturing; and food processing) on groundwater quality. The Ouachita (Ouachita County) area near Camden is monitored because it is the recharge area for the Sparta and Cockfield aquifers.

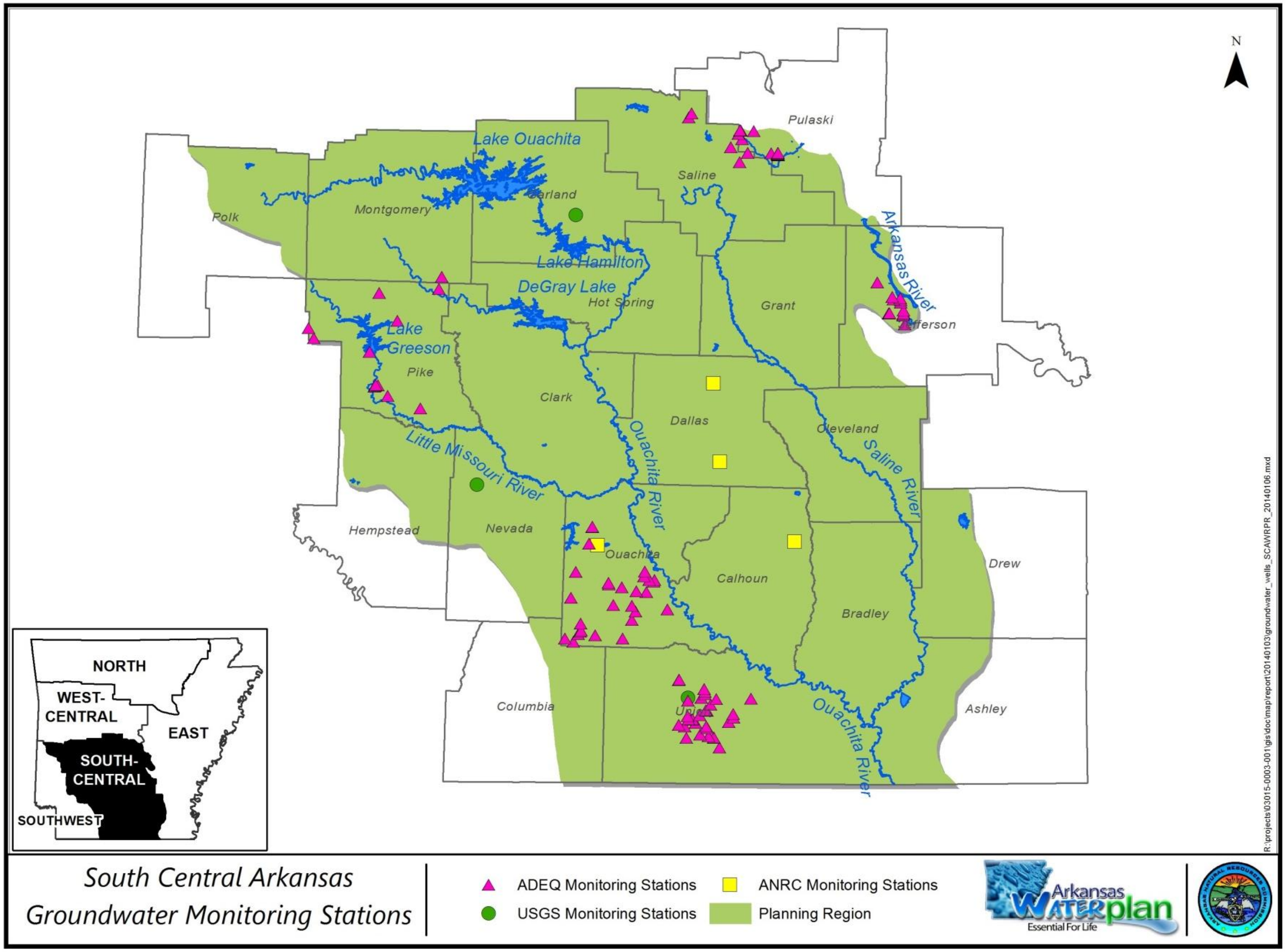


Figure 5.4. Routine groundwater quality monitoring sites in the SCAWRPR.

The Pine Bluff area straddles the SCAWRPR and East Arkansas WRPR, and is monitored because the alluvial aquifer and Cockfield and Sparta aquifers are the only sources of water to the Pine Bluff community. Data are presented in various ADEQ publications available on their website and in the EPA STORET database (ADEQ 2008).

The University of Arkansas (U of A) has conducted a significant amount of groundwater research that has resulted in scientific data and information necessary to understand, manage, and protect water resources within the state (Kresse et al. 2013). Hard-copy or digital reports, theses, dissertations, and journal articles are available at U of A's Mullins Library, Arkansas Water Resources Center technical library, or through various online sources.

The Arkansas Department of Health (ADH) is the primary agency for the federal Safe Drinking Water Act (SDWA) and is responsible for monitoring public water-supply wells. ADH maintains a statewide database that consists of 1,300 wells (Kresse et al. 2013). Every 3 years, these wells are sampled for inorganic, organic (including pesticides, herbicides, synthetic organic compounds, and volatile organic compounds), and radiochemical contaminants. The Total Coliform Rule of the SDWA requires sampling on monthly basis, where the number of samples required is dependent upon the population size. Nitrate monitoring is performed on a yearly basis unless a sample greater than or equal to 50% of the maximum contaminant level (MCL) is detected and prompts the need for increased frequency. Additionally, the Disinfection Byproduct Rule of the SDWA requires monitoring of trihalomethanes and haloacetic acids (byproducts of chlorine and other disinfectants used to treat drinking water) on a quarterly or annual basis. While all of the programs above collect samples from treated drinking water, ADH also collects samples from untreated water sources (surface and groundwater) that include bacteria, particulates, algae, organics, pathogens, total organic carbon on a weekly or monthly basis as required by the SDWA (ADEQ 2008).

Several routine ambient groundwater quality monitoring programs exist that involve cooperative efforts among USGS, ANRC, and ADEQ. Figure 5.4 shows the locations where ambient groundwater monitoring is performed in the SCAWRPR. Groundwater-quality monitoring activities are primarily funded by EPA grants under Section 106 and Section 319 of the Clean Water Act (CWA).

USGS has 24 master groundwater monitoring sites scattered throughout the state, with four of these sites located in the planning region (Figure 5.4). Samples are collected at these sites on a 5-year rotational basis for a variety of constituents to include nutrients, metals, organics, radioactivity, and selected primary and secondary drinking water standards (Kresse et al. 2013). In addition, USGS samples many other wells and springs for purposes of water quality and quantity investigations or as part of other monitoring programs, such as the National Water Information System. Data from these investigations and monitoring programs are presented in reports or available for download online at the Arkansas Water Science Center (http://ar.water.usgs.gov/) or similar USGS websites (ADEQ 2008; Kresse et al. 2013).

ANRC collects groundwater data statewide in areas where water-level declines or water-quality degradation have been historically observed (Kresse et al. 2013). In the SCAWRPR, ANRC performs groundwater monitoring at locations within the Sparta aquifer (four sites). These wells were installed as part of the Section 319 Core Program Monitoring Enhancement Wells program to establish long-term water quality trends and assist with the development of water quality standards. Samples are collected for the analysis of major water quality parameters and metals (Jay Johnston, ANRC, personal communication, 2013). When samples are collected, data are published in the annual Arkansas Groundwater Protection and Management Report available on the ANRC website (ANRC 2012b).

### 5.3.2 Non-Attainment of Surface Water Quality Standards

In 2008, approximately 1,920 miles of the 2,084 miles of streams within the SCAWRPR were assessed. Of the miles assessed, about 754 miles did not meet numeric water quality criteria or did not support all of their designated uses. Metals were the primary causes of impaired water quality in the majority of the stream miles assessed (Table 5.1) (ADEQ 2008). Mercury and beryllium were the sources of impairment for lakes in the SCAWRPR (Table 5.1). Figures 5.5 through 5.9 show locations of impaired waterbodies in the SCAWRPR. Resource extraction and industrial point sources are the most frequently identified sources of pollutants causing water quality impairments in the SCAWRPR, including metals, minerals, sediment, and low pH

(ADEQ 2009). A detailed listing of water quality impairments in the planning region identified in the 2008 303(d) list is included as Appendix A.

Table 5.1. Summary of impaired waters in the SCAWRPR (ADEQ 2008, ADEQ 2009).

| Pollutant | Miles of Impaired Stream | Acres of Impaired Lakes |
|---|---|---|
| Sediment/Siltation | 236.5 | 0 |
| Low dissolved oxygen | 53.9 | 0 |
| Chloride | 32.5 | 0 |
| TDS | 214.0 | 0 |
| Pathogens | 22.5 | 0 |
| Zinc | 449.1 | 0 |
| Sulfate | 135.2 | 0 |
| Nitrate | 85 | 0 |
| Mercury | 319.6 | 16,845+ |
| Beryllium | 158.0 | 53,300 |
| Lead | 188.6 | 0 |
| pH | 79.7 | 0 |
| Copper | 269.5 | 0 |
| Cadmium | 47.3 | 0 |
| Ammonia | 8.5 | 0 |
| Unknown | 0 | 300 |

It should be noted that while a waterbody may be impaired due to sediment, there is no numeric water quality standard for sediment/siltation. Arkansas has a numeric water quality standard for turbidity but not TSS; thus turbidity is the chemical parameter that is assessed to determine if a sediment impairment exists. There is currently no other method that is consistently used by EPA or ADEQ to measure sediment or siltation in water.

TMDL reports have been prepared for a number of waterbodies in the SCAWRPR addressing water quality issues such as turbidity, mercury contamination, low dissolved oxygen (DO), high TDS, high metal concentrations, and high mineral concentrations (Table 5.2).

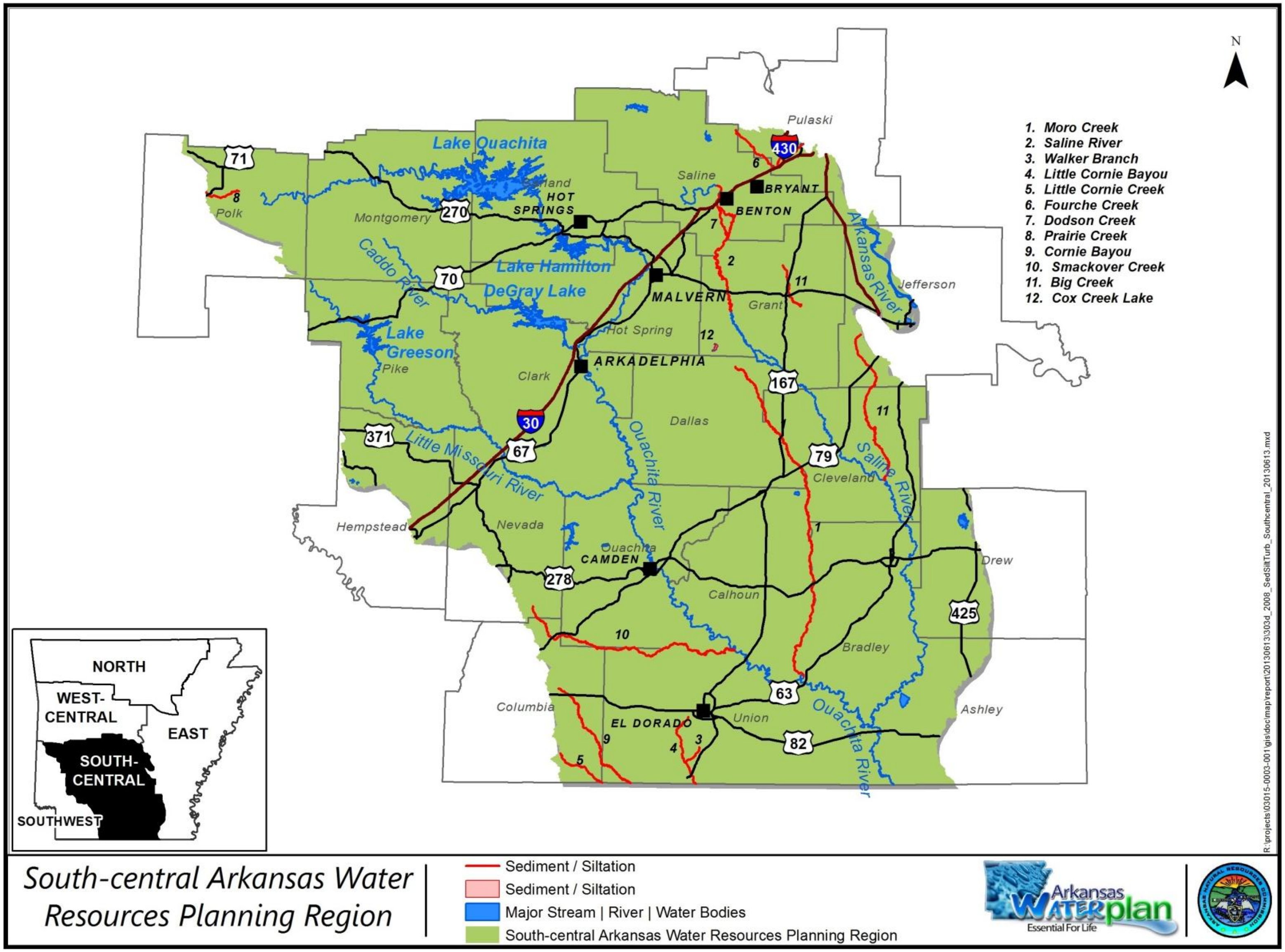


Figure 5.5. Waterbodies in the SCAWRPR with sediment/siltation listed as a cause of water quality impairment (ADEQ 2008, 2009).

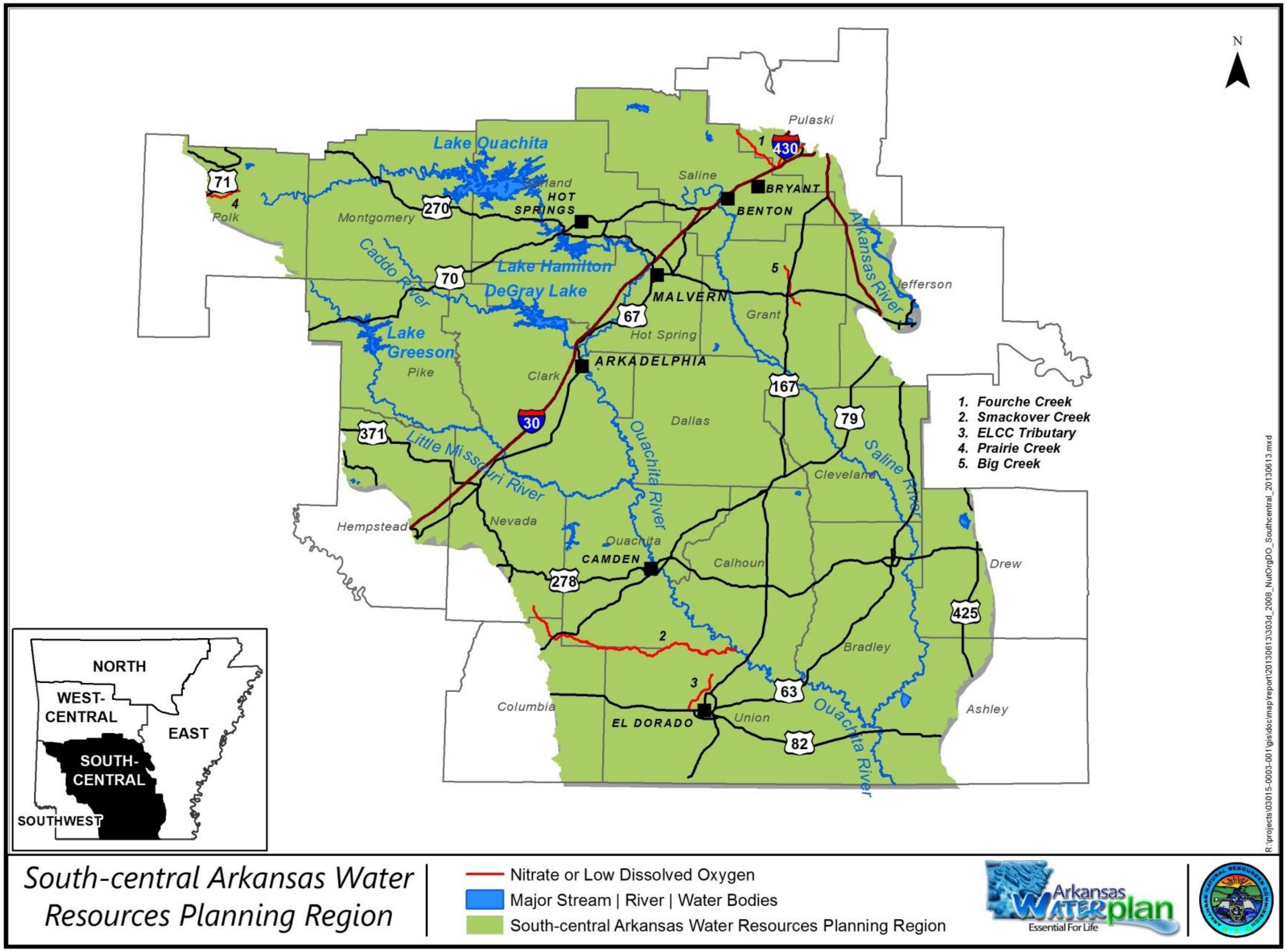


Figure 5.6. Waterbodies in the SCAWRPR with nutrients/organic enrichment/low DO listed as a cause of water quality impairment (ADEQ 2008, 2009).

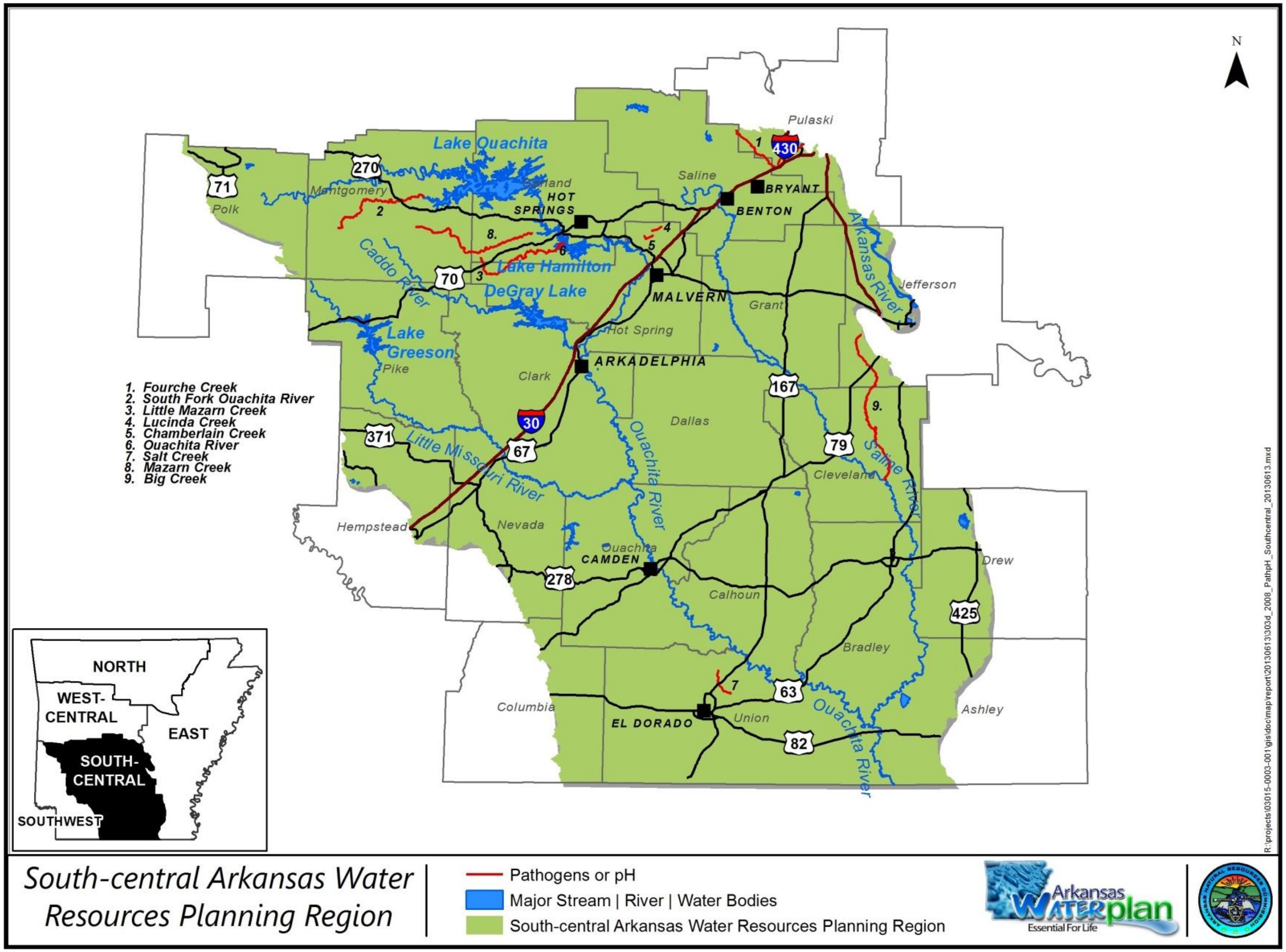


Figure 5.7. Waterbodies in the SCAWRPR with pathogens and/or low pH listed as a cause of water quality impairment(ADEQ 2008, 2009).

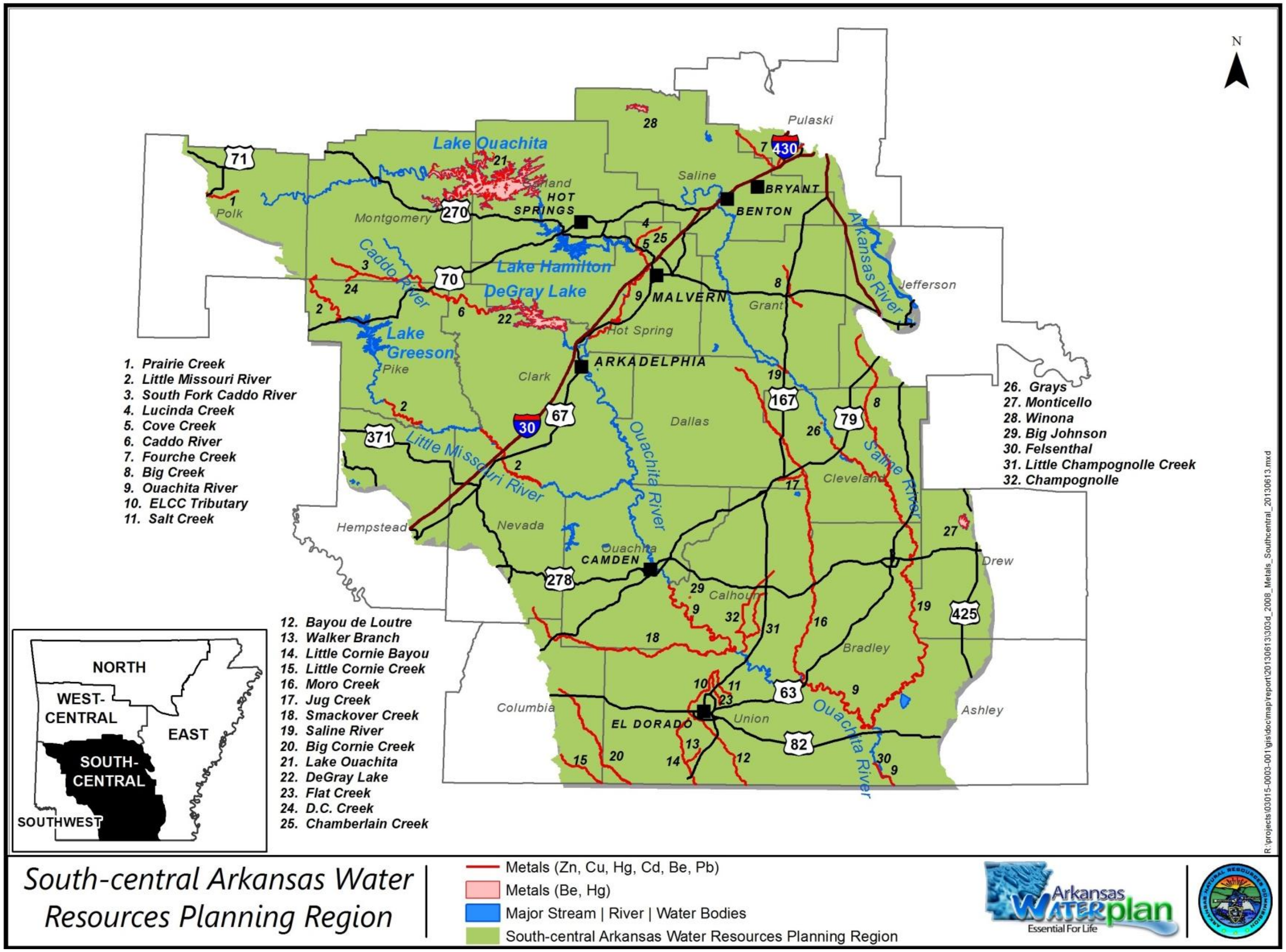


Figure 5.8. Waterbodies in the SCAWRPR with metals listed as a cause of water quality impairment (ADEQ 2008, 2009).

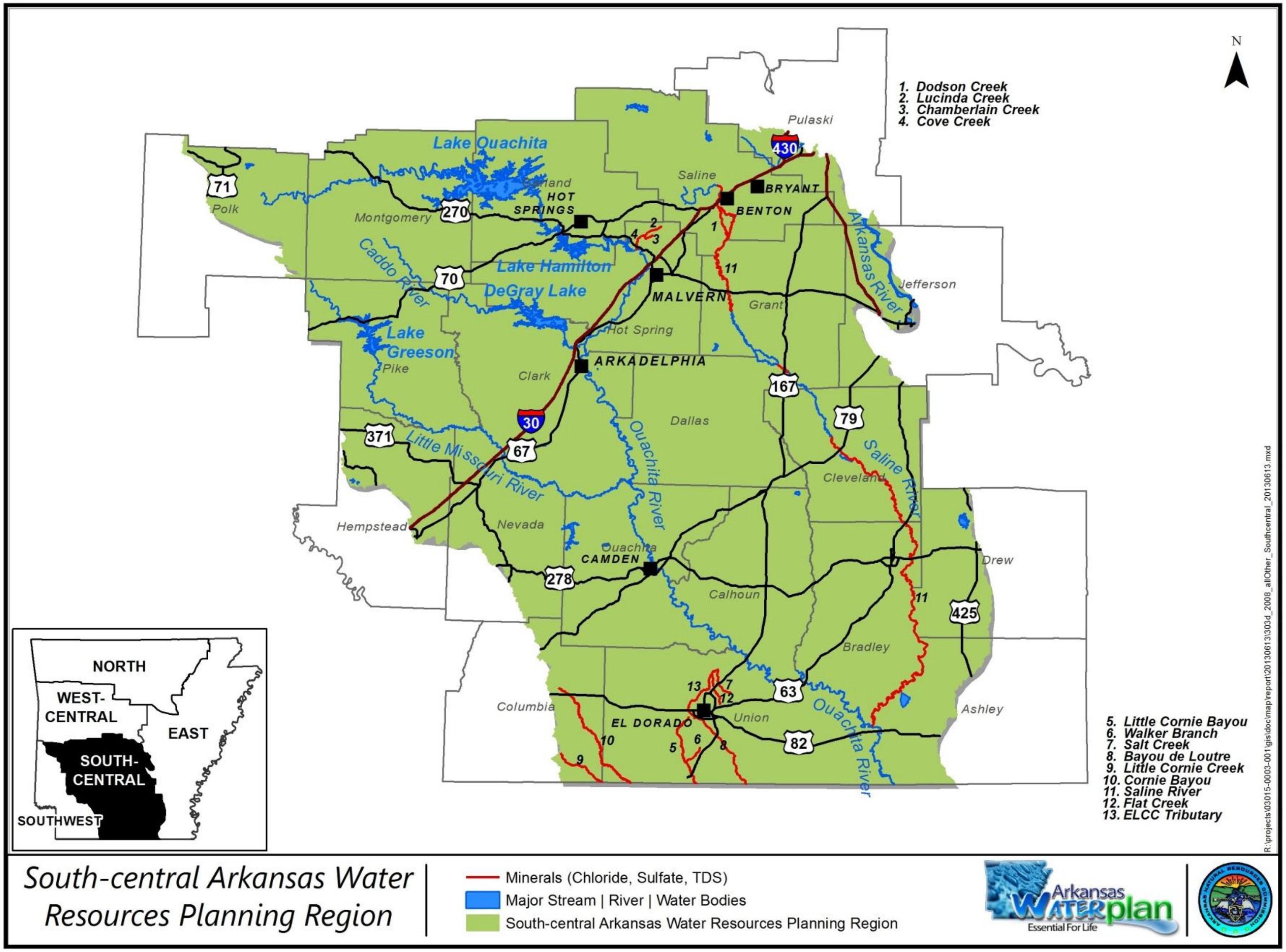


Figure 5.9. Waterbodies in the SCAWRPR with minerals listed as a cause of water quality impairment (ADEQ 2008, 2009).

Table 5.2. TMDLs for waterbodies in the SCAWRPR (ADEQ 2012b).

| Waterbody | Impaired Uses | Pollutants | Completed |
|---|---|---|---|
| Big Creek | Aquatic Life | Turbidity | 03/27/2008 |
| Big Creek near Sheridan | Aquatic Life | DO | 01/16/2007 |
| Big Creek near Sheridan | Aquatic Life | Lead, Turbidity | 03/21/2008 |
| Grays Lake | Fish Consumption | Mercury | 11/20/2003 |
| Lake Monticello | Fish Consumption | Mercury | 11/20/2003 |
| Lake Sylvia | Fish Consumption | Mercury | 09/17/2002 |
| Lake Winona | Fish Consumption | Mercury | 09/17/2002 |
| Saline River | | TDS | 01/08/2011 |
| Big Johnson Lake | Fish Consumption | Mercury | 11/20/2003 |
| Champagnolle Creek | Fish Consumption | Mercury | 05/30/2002 |
| ELCC Tributary | Aquatic Life, Water Supply | Chloride, Sulfate, TDS, Ammonia | 10/03/2002 |
| Felsenthal National Wildlife Refuge | Fish Consumption | Mercury | 05/30/2002 |
| Flat Creek | Aquatic Life, Water Supply | Chloride, Sulfate, TDS | 10/08/2003 |
| Little Champagnolle | Fish Consumption | Mercury | 05/30/2002 |
| Moro Creek | Fish Consumption | Mercury | 05/30/2002 |
| Moro Creek | Aquatic Life | Turbidity | 03/27/2008 |
| Ouachita River | Fish Consumption | Mercury | 05/30/2002 |
| Ouachita River Oxbow Lakes below Camden | Fish Consumption | Mercury | 05/30/2002 |
| Saline River | Fish Consumption | Mercury | 05/30/2002 |
| Salt Creek | Aquatic Life, Water Supply | Chloride, TDS | 10/08/2003 |
| Caddo River | Aquatic Life | Copper, Zinc | 03/21/2008 |
| Prairie Creek | Aquatic Life | Turbidity | 03/27/2008 |
| South Fork Caddo River | Aquatic Life | Copper, Zinc | 03/21/2008 |

### 5.3.3 Non-Attainment of Drinking Water Quality Standards and Water Quality Guidelines by Groundwater

No groundwater quality standards have been set by state agencies in Arkansas; although there are state regulations to protect groundwater quality (see Section 6). However, groundwater used as a drinking water source is required to meet state and federal drinking water quality standards. Other groundwater users, such as farmers and industries, have developed guidelines that they use to determine if groundwater quality is suitable for their uses. Where shallower aquifers have been heavily pumped, saltwater intrusion has locally contaminated groundwater.

#### 5.3.3.1 Ouachita-Saline Rivers Alluvial Aquifer

Kresse and others (2013) report on water quality within the alluvial deposits (including Pleistocene alluvial deposits) west of the divide between the Mississippi Alluvial Plain and the West Gulf Coastal Plain area as the Ouachita-Saline rivers alluvial aquifer without discriminating between these deposits. In general, groundwater quality of the Ouachita-Saline rivers alluvial aquifer is good when compared to EPA primary drinking water standards. However, numerous wells completed in the Ouachita-Saline rivers alluvial aquifer had nitrate concentrations greater than 10 mg/L, particularly in Calhoun and Bradley counties. Because most of the wells sampled in this area had well depths less than 30 feet, they possibly are shallow domestic wells, which are more vulnerable to surface sources of nitrate (for example, septic systems), and the nitrate has not been reduced, as happens in groundwater from the deeper parts of the aquifer (Kresse et al. 2013).

#### 5.3.3.2 The Jackson Group

Groundwater from the Jackson Group has some of the poorest water quality of any aquifer system in the state with naturally elevated chloride (greater than 800 mg/L), sulfate (greater than 3,000 mg/L) and TDS concentrations (greater than 5,000 mg/L). Nitrate concentrations revealed an inverse correlation with well depth, indicating vulnerability to surface sources of nitrate contamination (Kresse et al. 2013).

#### 5.3.3.3 Cockfield Aquifer

The Cockfield aquifer contains groundwater that is typically of high quality and is used throughout southeastern Arkansas. However, isolated areas of the aquifer contain elevated sulfate (primarily Jefferson and Drew counties) as a result of mixing with water of poor quality in underlying formations, and elevated iron concentrations (Grant and Jefferson counties) that are possibly the result of infiltration of high-iron content groundwater from overlying formations (Kresse et al. 2013).

#### 5.3.3.4 Sparta Aquifer

The quality of groundwater from the Sparta aquifer throughout the SCAWRPR is very good. Elevated iron and nitrate groundwater concentrations are found dominantly in the outcrop area of the Sparta Sand, with lower concentrations in the downgradient direction of flow. Areas of high salinity are noted in isolated areas of the Sparta aquifer, predominantly as a result of inferred upwelling from high-salinity groundwater in underlying formations (Kresse et al. 2013).

#### 5.3.3.5 Cane River Aquifer

Water quality from the Cane River aquifer is good with respect to federal drinking water standards. Salinity increases downdip of the outcrop area, and chloride concentrations can exceed the federal secondary drinking water regulation of 250 mg/L in some areas (Kresse et al. 2013).

#### 5.3.3.6 Wilcox Aquifer

The Wilcox aquifer within the planning region is a viable groundwater supply only in the outcrop area; the water becomes brackish or saline within a short distance downdip of the outcrop and is unfit for most purposes (Ludwig 1972, Plebuch and Hines 1969, Terry et al. 1986). Plebuch and Hines (1969) describe groundwater from the Wilcox aquifer in Clark, Cleveland, and Dallas counties as a sodium-bicarbonate type, with water increasing in dissolved-solids content and becoming a sodium-chloride type downdip. Broom and others (1984) noted that the Wilcox and Carrizo aquifers are indistinguishable in Union County, are hydraulically connected, and used solely for injection of brine. Hewitt and others (1949) noted abundant saltwater at depths of 1,000 feet in Ashley County. Ludwig (1972) described groundwater from the Wilcox aquifer as a soft to moderately hard, sodium-bicarbonate type for most of Hempstead, Lafayette, Miller, and Nevada counties. The southern extent of fresh water coincided with a fault system extending through central Miller, Lafayette, and Nevada counties, and groundwater south of the fault zone contained more than 1,000 mg/L dissolved solids based on electric logs (Ludwig 1972). Halberg and others (1968) reported that groundwater from the Wilcox aquifer in Hot Spring and Grant counties was a soft, sodium-bicarbonate type, although iron concentrations could be high and that groundwater from shallow wells was slightly acidic. Hosman and others

(1968) noted that water type varied with dissolved-solids content: where dissolved-solids concentrations were low, water was either a calcium-magnesium-bicarbonate or sodium-bicarbonate type; increases in dissolved solids up to 400 mg/L were attributed to predominantly sodium and bicarbonate; and above 400 mg/L, the increase was attributed to sodium, bicarbonate, and chloride (Kresse et al. 2013).

#### 5.3.3.7 Nacatoch Aquifer

Groundwater from the Nacatoch aquifer is most important in the southwestern part of the state, although it is also an available and good-quality source of water in the extreme northeastern part of the state. In the southwestern extent, fresh water mainly is obtained from areas in or near to the area of outcrop, especially for the eastern (Clark County) and western parts (Little River and Miller counties) of the outcrop area, and salinity increases in a downgradient direction from the outcrop area to a point where the groundwater is not suitable for most uses. Gradients of increasing chloride concentration are sharpest in the western and eastern parts of the outcrop, with a larger area of fresh water downgradient of the outcrop area in the central part of the aquifer (Hempstead County and Nevada counties). Concentrations of sulfate, iron, and nitrate generally are very low throughout the extent of the Nacatoch aquifer, where water quality data were available from producing wells (Kresse et al. 2013).

#### 5.3.3.8 Ozan Aquifer

Groundwater from the Ozan aquifer represents some of the least used and poorer quality water of any aquifer in the state. Several historical reports mentioned that aquifer was used as a domestic source because in many areas no other water source was available. High chloride concentrations can occur in groundwater within the outcrop area of the Ozan aquifer, which is atypical of most Cretaceous and Tertiary aquifers of the Coastal Plain. Chloride concentrations exceeding the federal secondary drinking water regulation 250 mg/L (EPA 2009) occur mainly in central Clark County. The highest median sulfate concentrations of any aquifer in the state are found in the Ozan aquifer. Sulfate concentrations can exceed 500 mg/L (the federal secondary drinking water regulation is 250 mg/L)(Kresse et al. 2013).

#### 5.3.3.9 Tokio Aquifer

Good quality water is obtained from the Tokio aquifer throughout much of its outcrop area. Sharp increases in salinity are noted in the extreme southwestern (Sevier County) and northeastern (Clark County) parts of the aquifer, limiting use at distances greater than approximately 5 miles downdip of the outcrop area. Sulfate concentrations approach 400 mg/L and chloride concentrations are greater than 1,200 mg/L near the western and eastern extent of the outcrop area. These concentrations exceed the federal secondary drinking water standard of 250 mg/L. In the central part of the aquifer, salinity increases are more gradual (with concentrations in the aquifer at less than 300 mg/L as far as 20 miles from the outcrop area), affording a larger area of low-salinity, high-quality water for multiple uses. In the southwestern part of the aquifer, sulfate is the dominant anion in the aquifer. Dedolimitization is a likely process that may account the high-sulfate, low-bicarbonate groundwater in this area of the aquifer; however, this theory requires further analysis to achieve greater confidence (Kresse et al. 2013).

#### 5.3.3.10 Trinity Aquifer

Similar to other Cretaceous aquifers in southwestern Arkansas, use of the Trinity is limited to the outcrop areas. Wells for which water-quality data were available were located only in Sevier and Howard counties (in the Southwest Arkansas WRPR). Generally, water quality from the Trinity aquifer is good. Chloride and sulfate can be somewhat elevated in certain parts of the aquifer, although concentrations were less than the 250 mg/L secondary drinking water standard. All chloride concentrations, except one, were less than 15 mg/L at distances as great as 15 miles from the outcrop area, demonstrating the low overall salinity in the aquifer (Kresse et al. 2013).

#### 5.3.3.11 Ouachita Mountains Aquifer

Groundwater quality in the Ouachita Mountains aquifer is good with respect to federal primary drinking water standards. Problems in regard to taste, staining, and other aesthetic properties are related to elevated levels of iron, which is a common complaint among domestic users. Sulfate and chloride concentrations tend to be elevated in some areas for groundwater from shale formations. No spatial relation was noted, however, for the distribution of iron concentrations, and high and low concentrations occurred in shale and quartz formations. Iron is abundant in numerous mineral forms in sedimentary rocks throughout Arkansas, and elevated iron in the Ouachita Mountain aquifer were attributed to microbially mediated processes (Kresse et al. 2013).

### 5.3.4 Fish Consumption Advisories

There are active fish consumption advisories due to mercury for several waterbodies in the SCAWRPR. Details of these advisories are given in Table 5.3. The locations of these waterbodies are shown on Figure 5.10.

Table 5.3. Fish consumption advisories in the SCAWRPR (ADH, AGFC, & ADEQ 2011, ADEQ 2012a).

| Waterbody | Affected Length or Area | Pollutant of Concern | Restrictions for High-Risk Groups* | Restrictions for General Public |
|---|---|---|---|---|
| **Felsenthal NWR** – Saline River to Stillions Bridge | 14,000 acres | Mercury | Should not eat largemouth bass (13 inches or longer, flathead or blue catfish, pickerel, gar, bowfin, or drum. | Should not eat flathead catfish, gar, bowfin, drum, pickerel, or largemouth bass (16 inches or longer). No more than two meals per month of blue catfish and largemouth bass (13-16 inches). |
| **Ouachita River** from Camden to north border of Felsenthal NWR to include all oxbow lakes, backwater, and overflow lakes and barrow ditches | 25 miles | Mercury | Should not eat largemouth bass, flathead catfish, pickerel, gar or bowfin. | Should not eat largemouth bass, flathead catfish, pickerel, gar or bowfin. |

Table 5.3. Fish consumption advisories in the SCAWRPR (continued).

| Waterbody | Affected Length or Area | Pollutant of Concern | Restrictions for High-Risk Groups* | Restrictions for General Public |
|---|---|---|---|---|
| **Saline River** from highway 79 in Cleveland County to Stillions Bridge | 89.4 miles | Mercury | Should not eat blue catfish, flathead catfish, gar, bowfin, drum, pickerel, or largemouth bass (13 inches or longer) or redhorse (20 inches or longer). | Should not eat blue catfish, flathead catfish, gar, bowfin, drum, pickerel, or largemouth bass (16 inches or longer) or redhorse (20 inches or longer). No more than two meals per month of largemouth bass (13-16 inches). |
| **Lake Columbia** | 2,950 acres | Mercury | Should not eat pickerel, flathead catfish, gar, bownfin, or largemouth bass (16 inches or longer). | Should not eat flathead catfish, gar, pickerel, or bowfin. No more than two meals a month of largemouth bass (16 inches or longer). |
| **Grays Lake** | 36 acres | Mercury | Should not eat flathead catfish (26 inches or longer), largemouth bass (13 inches or longer), gar, bowfin, or pickerel. | Should not eat largemouth bass over 16 inches in length. No more than two meals per month of gar, bowfin, pickerel, flathead catfish (26 inches or longer) or largemouth bass (13-16 inches in length). |
| **Moro Bay Creek** from Highway 160 to Ouachita River | 54.4 miles | Mercury | Should not eat any fish from this creek. | Should not eat largemouth bass, catfish, crappie, gar, pickerel, or bowfin. No more than two meals per month of bream, drum, buffalo, redhorse, and suckers. |
| **Champagnolle Creek** from Highway 4 to Ouachita River | 20 miles | Mercury | Should not eat flathead catfish, gar, bowfin, drum, pickerel, or largemouth bass (13 inches or longer). | Eat no more than two meals per month of flathead catfish, gar, pickerel, bowfin, or largemouth bass (13 inches or longer). |
| **Lake Winona** | 1,240 acres | Mercury | Should not eat black bass (16 inches or longer). | Eat no more than two meals per month of black bass (16 inches or longer). |
| **Lake Monticello** | 1,520 acres | Mercury | Should not eat flathead catfish, blue catfish, or largemouth bass (12 inches or longer). | Should not eat flathead catfish or blue catfish (over 15 inches). No more than two meals per month of largemouth bass (16 inches or less). Should not eat largemouth bass (over 16 inches). |

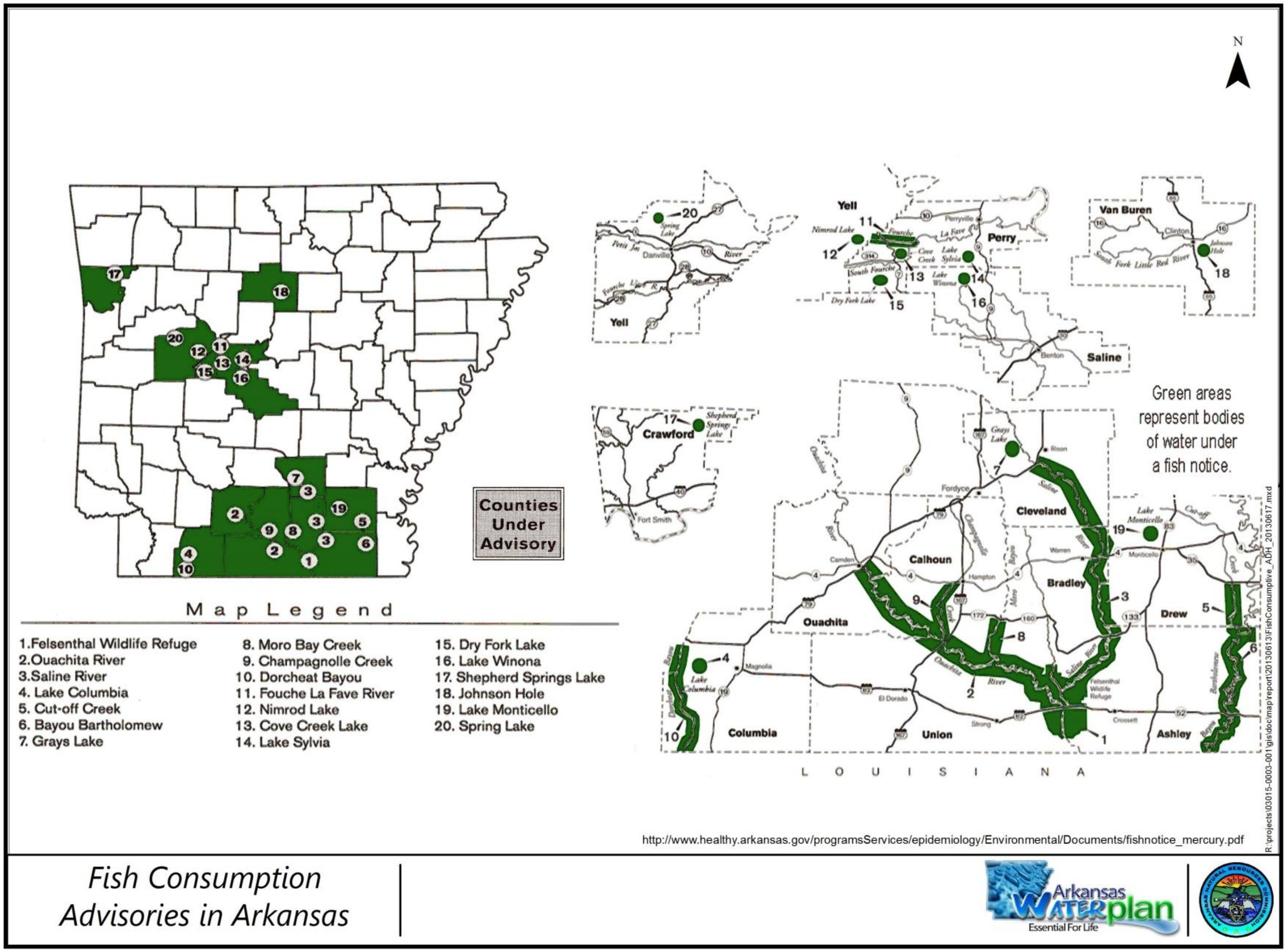


Figure 5.10. Waterbodies in the SCAWRPR for which fish consumption advisories have been issued (ADH, AGFC, & ADEQ 2011).

### 5.3.5 Nonpoint Source Pollution

Nonpoint source pollution was identified as a water resources issue in the 1990 AWP (ASWCC 1990). Nonpoint source pollution still contributes significantly to surface water and groundwater quality issues in Arkansas; it is the most frequently cited source of pollutants causing non-attainment of surface water quality standards (ADEQ 2012a).

In the 2011 – 2016 NPS Pollution Management Plan, two watersheds within the SCAWRPR have been identified as priority watersheds for nonpoint source pollution issues; Upper Saline River and Lower Ouachita – Smackover (Figure 5.11). This program primarily addresses nutrients and sediment in runoff. In these priority watersheds, the targeted source of nutrients is animal agriculture. The targeted sources of sediment are animal agriculture and timber production (ANRC 2012a).

There are two hazardous waste sites in the SCAWRPR that have been included on the National Priority List (i.e., Superfund sites). These sites are located in Ouachita and Union counties. Table 5.4 summarizes the information about these sites. At these sites, hazardous wastes contaminated the groundwater.

Table 5.4. Superfund sites in the SCAWRPR (EPA 2012d).

| Site Name | EPA ID | Site Location | Pollutants of Concern | Remediation Status |
|---|---|---|---|---|
| Ouachita-Nevada Wood Treaters | ARD042755231 | Ouachita County | Phencyclidine (PCP), arsenic | Ongoing |
| Popile, Inc. | ARD008052508 | Union County | PCP, creosote | Ongoing |

There are also several sites in the planning region that have been identified as a state priority for hazardous waste cleanup. Both surface water and groundwater contamination are issues at these sites (ADEQ 2013a). Information about these sites is summarized in Table 5.5.

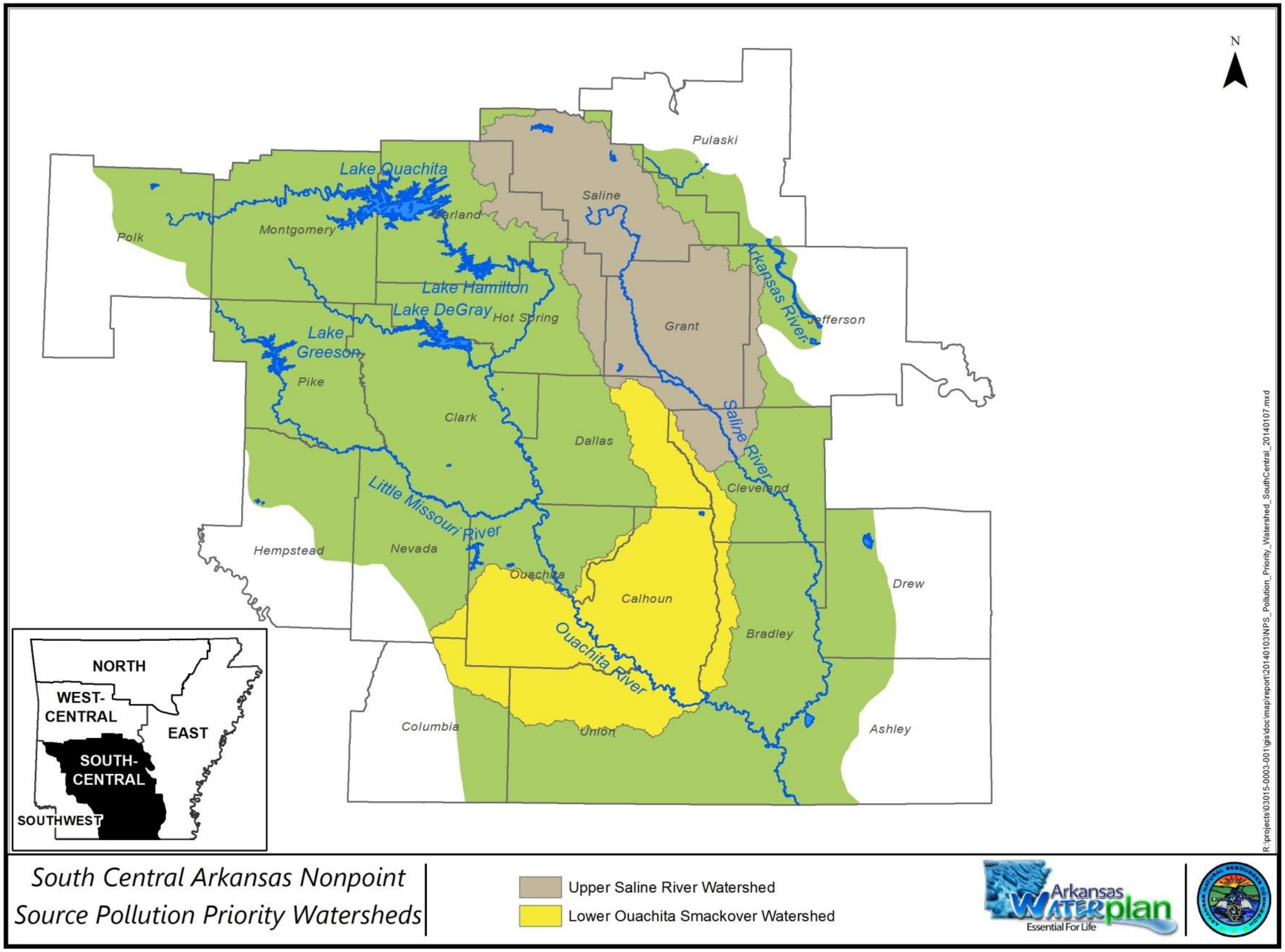


Figure 5.11. Priority NPS watersheds in the SCAWRPR (ANRC 2012a).

Table 5.5. State priority hazardous waste sites in the SCAWRPR with water quality issues (ADEQ 2013a).

| Site Name | EPA ID | County | Pollutants of Concern | Contaminated Water Resources | Remediation Complete |
|---|---|---|---|---|---|
| BEI Defense Systems, Inc. | ARD980583470 | Calhoun | Benzene, other volatile organic compounds (VOCs) | Groundwater | Ongoing |
| General Dynamics | ARD990661050 | Ouachita | Trichloroethene (TCE), trichloroethane (TCA), 1,2-dichloroethene (1,2-DCE), trichloromethane | Groundwater | Ongoing |
| Griffing Railway Repair | ARD981055494 | Union | Paint, wastewater treatment sludge, hazardous cleaners | Groundwater | Ongoing |
| Norphlet Chemical, Inc. Facility | ARD008049207 | Union | Anhydrous hydrogen fluoride (AHF), AHF mixtures, several contaminants of potential concern (COPCs) | Massey Creek, groundwater | Ongoing |
| Utility Services, Inc. | AR0000100859 | Jefferson | Polychlorinated biphenyls (PCBs), PCP, perchloroethylene (PCE) | Groundwater | Ongoing |
| Value Line Company (701 S. 3rd St.) | AR0000000331 | Clark | Several hazardous materials, including acetone, alcohols, methyl ethyl ketone (MEK), and many others | Groundwater | Ongoing |
| Amity Lacquer, Paint, and Chemical Company | ARD983286337 | Clark | MEK, acetone, lead | Groundwater | June 2013 |
| Benton Salvage | ARD980812846 | Saline | Lead, PCBs | Willow Creek, groundwater | June 2010 |
| Minton Property | ARR000011106 | Saline | Dichlorodiphenyldichloroethane (DDD), dichlorodiphenyltricholoroethane (DDT) | Private pond, groundwater | August 2012 |
| Valspar Corporation | ARD059634659 | Pulaski | Acetone, benzene, MEK, 1,2-DCE, several others | Groundwater | June 2010 |
| Value Line Company (1205 N. 10th St.) | AR0000000331 | Clark | General hazardous waste | Groundwater | August 2012 |
| Walgreens Store #03425 | ARR000011106 | Garland | PCE, PCBs | Groundwater | August 2012 |
| Garland County Industrial Park Landfill | ARD980748594 | Garland | PCBs, metal-laded leachate | Lake Catherine (potential) | January 2009 |
| Mid-South Reclamation Industries | N/A | Union | Toxic metals, cyanide | Surface waters | January 2009 |

### 5.3.6 Contaminants of Emerging Concern

There is growing interest, nationally and in Arkansas, in the occurrence of a group of chemicals called contaminants of emerging concern, which include pharmaceuticals, personal care products (e.g., soap and shampoo), natural and synthetic hormones, surfactants, pesticides, fire retardants, and plasticizers primarily in surface waters, but also starting to be measured in groundwater across the nation. The risks to human health and the environment from the majority of these chemicals are unknown, which is why they are referred to as “contaminants of emerging concern.” Contaminants of emerging concern have been detected in surface waters in Arkansas (Galloway et al. 2005). Detection, however, does not indicate there is an effect.

## 5.4 Water Infrastructure

Communities throughout the state struggle to maintain drinking water and wastewater infrastructure, including treatment plants and distribution lines. A few communities in the SCAWRPR are experiencing growth that is requiring expansion of water supply and wastewater capacity (see Section 5.2.2). In other areas within the planning region, maintaining aging infrastructure with limited financial resources is more likely an issue.

Of particular concern is the recent increased focus on nutrients in wastewater discharges. Historically, permitted point source discharges in Arkansas were not limited with regard to the amount of nutrients that can be in the wastewater they discharge. Current regulations require that all point source discharges in watersheds of waterbodies included on the Arkansas list of impaired waters due to phosphorus, be limited in the amount of phosphorus that can be present in their discharge (Arkansas Pollution Control and Ecology Commission [APCEC] Regulation No. 2, §2.509). While there are no phosphorus-impaired waterbodies in the SCAWRPR (Table 5.1), several municipalities in the planning region have wastewater treatment plants that are currently required to monitor total phosphorus and nitrate levels in their wastewater discharge (ADEQ 2014a). Substantial upgrades to existing wastewater facilities may be required to meet discharge nutrient limits.

There have been issues with two of the dams in the SCAWRPR. During routine inspection of Blakely Mountain Dam in 2005, it was determined that an element of the structure intended to aid normal seepage under the dam had been incorrectly installed. There has been no indication that this has affected the safety of Blakely Mountain Dam. A system was installed in 2009 to monitor the seepage (Worley 2013). Damage to the water control structure of Lower White Oak Lake was identified in 2012. The lake was drained in September 2012 and repairs initiated. The repairs were completed in February 2013 and the lake refilled (McNeill 2013).

## 5.5 Loss of Aquatic Biological Diversity

In a 2002 report, NatureServe ranked Arkansas 13$^{th}$ in the nation for the level of reportedly extinct species (NatureServe 2002). In 2005, 369 animal species of greatest conservation need (SGCN) were identified for Arkansas by a team of specialists (Anderson 2006). These species of greatest conservation need include 130 species associated with aquatic and semi-aquatic habitats that occur in the SCAWRPR (see Figure 3.4). Figures 5.12 through 5.15 show the numbers of aquatic species of greatest conservation need present in watersheds within the SCAWRPR. The greater the number of aquatic species of greatest conservation need present in a watershed, the more important it is to protect and restore water resources and their aquatic habitats in the watershed. The condition of aquatic habitats depend on characteristics such as water levels, flow volumes, and seasonal variability in both. High numbers of species of greatest conservation need are present in the Ouachita River and its tributaries, notably the Little Missouri and Saline rivers (Figure 5.15).

In addition to the animals of greatest conservation need, the Arkansas Natural Heritage Commission has identified 119 species of rare aquatic and semi-aquatic plants that occur in the SCAWRPR. Ten aquatic and semi-aquatic species present in the planning region are on the federal list of threatened and endangered species (Table 5.6). Five semi-aquatic plant species present in the planning region are on the state threatened and endangered plant species list (Table 5.7). Many of the species of concern, particularly species of mussels, fish, and plants, are affected by water quality, water levels, flow rates, and/or seasonal changes in water levels or flow.

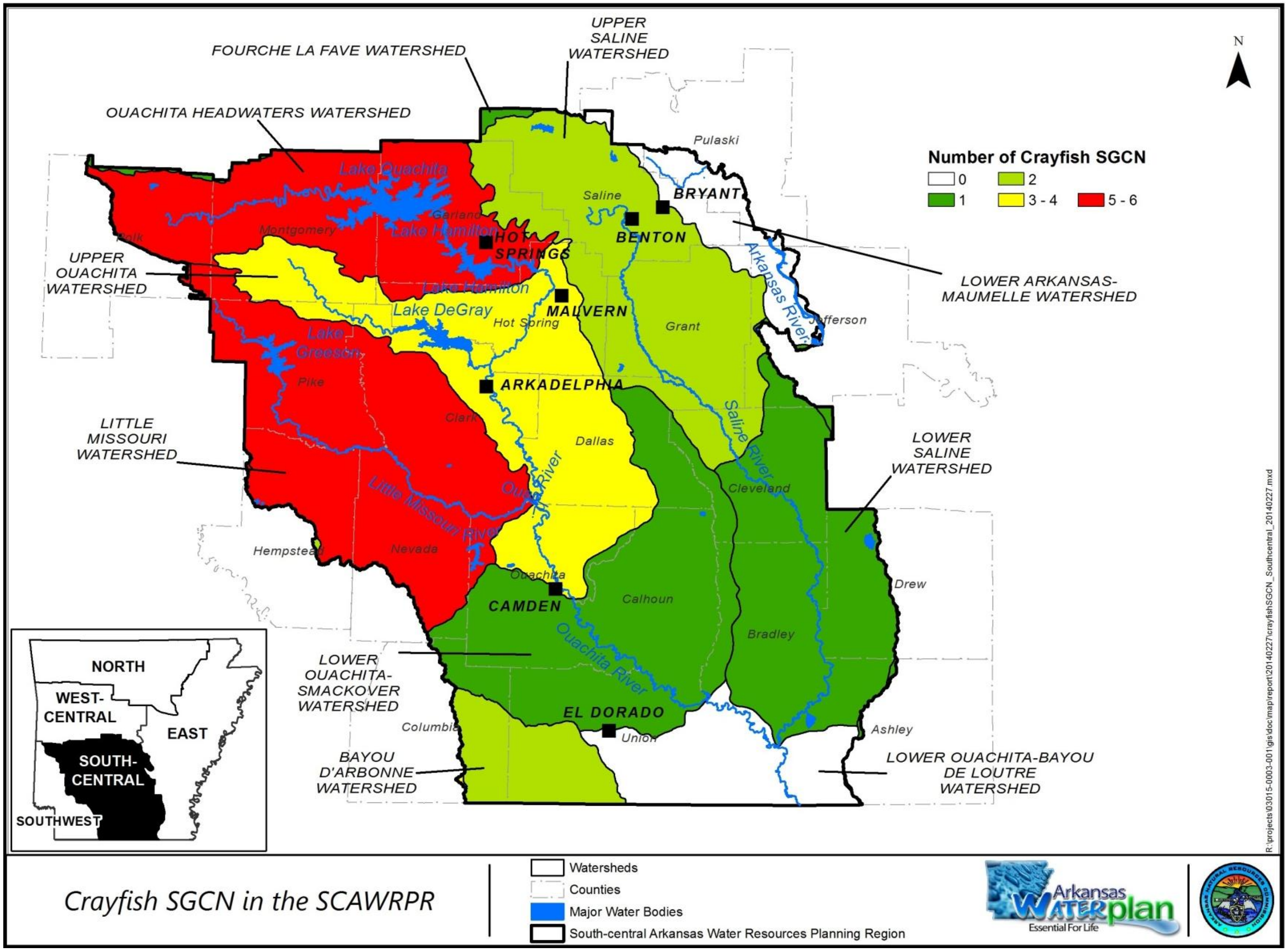


Figure 5.12. Numbers of crayfish SGCN in watersheds of the SCAWRPR.

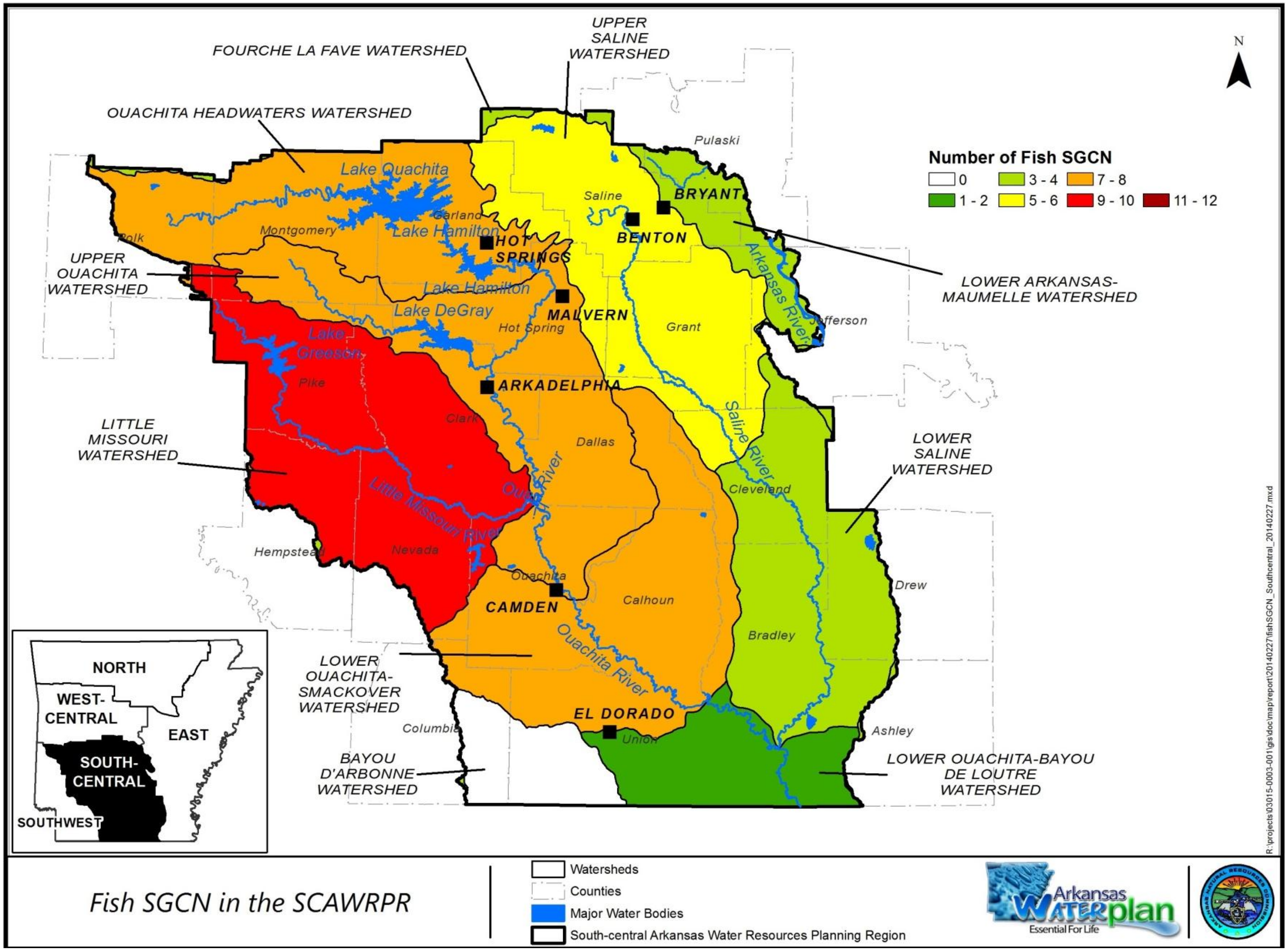


Figure 5.13. Numbers of fish SGCN in watersheds of the SCAWRPR.

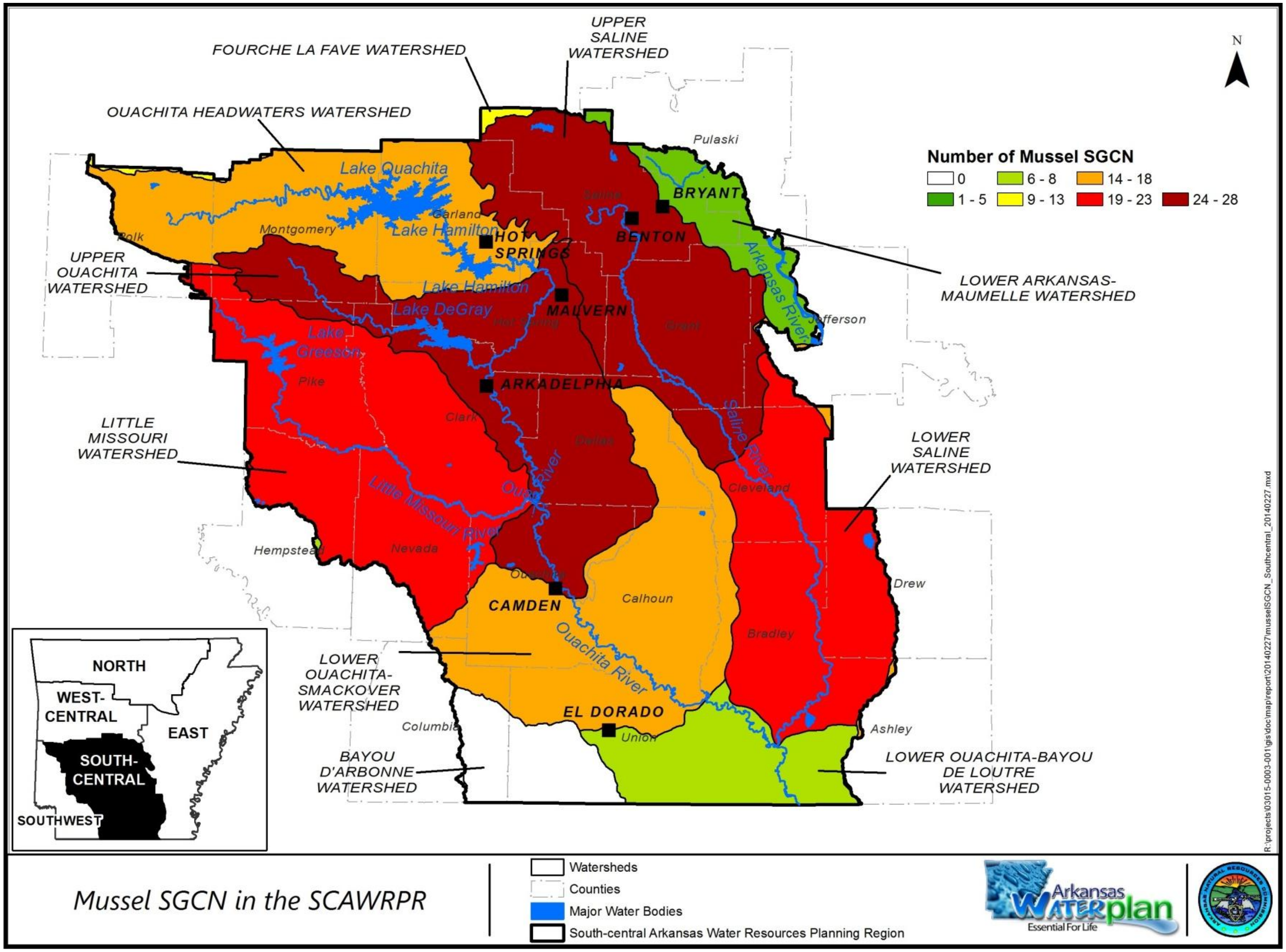


Figure 5.14. Numbers of mussel SGCN in the watersheds of the SCAWRPR.

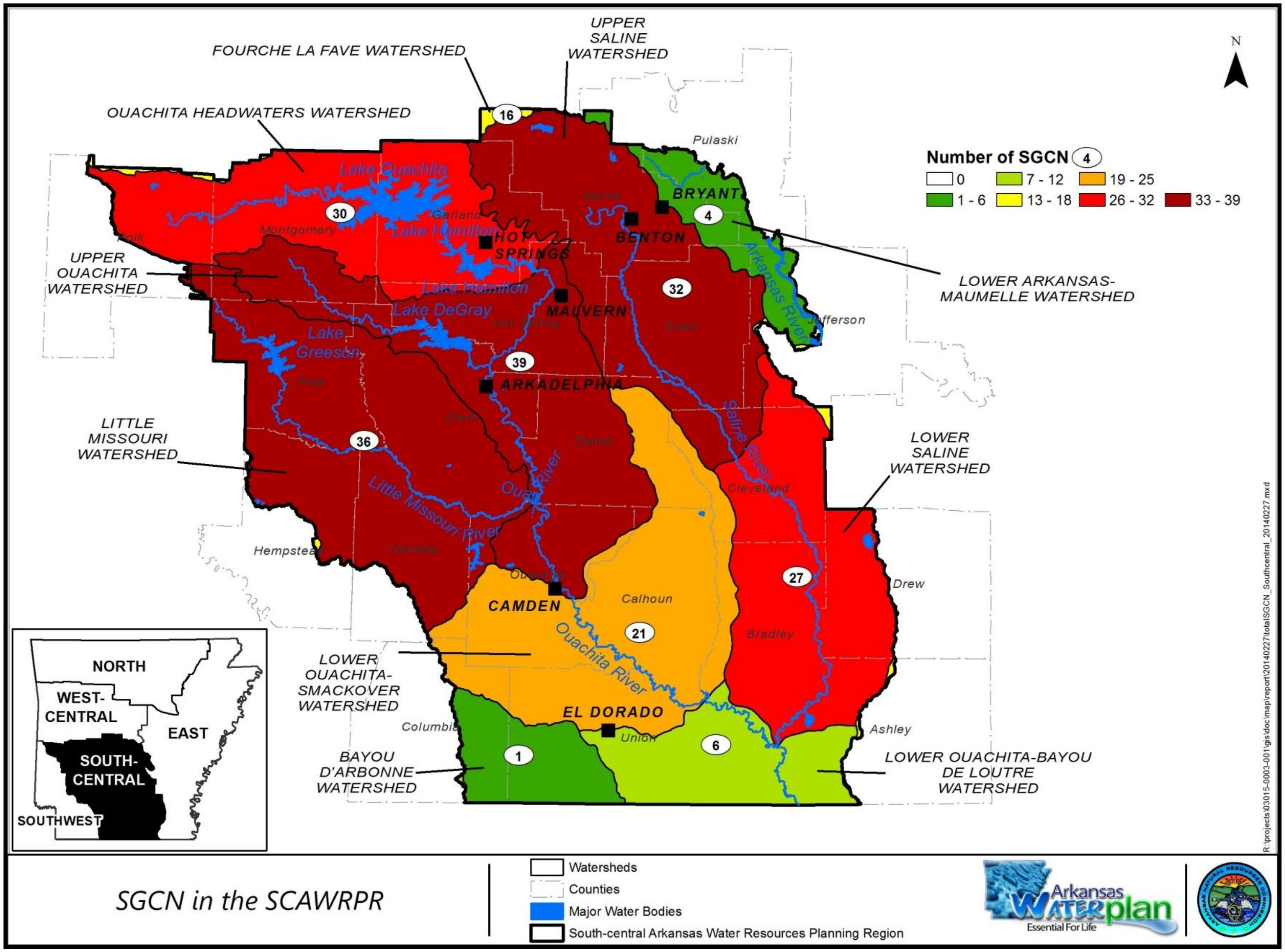


Figure 5.15. Total numbers of crayfish, fish, and mussel SGCN in the watersheds of the SCAWRPR.

Table 5.6. Federally listed threatened and endangered species occurring in aquatic and semi-aquatic habitats in the SCAWRPR (ANHC 2013, AGFC 2013c).

| Common Name | Species Name | Status | SCAWRPR Habitat |
|---|---|---|---|
| Pondberry | *Lindera melissifolia* | Endangered | Ashley County |
| Lousiana pearlshell | *Margaritifera* | Threatened | Columbia County |
| Leopard darter | *Percina panterina* | Threatened | Hempstead County – southern Ouachita Mountains |
| Harperella | *Ptilimnium nodosum* | Endangered | Garland, Montgomery, and Polk counties |
| Scaleshell | *Leptodea leptodon* | Endangered | Several counties in the SCAWRPR |
| Ouachita rock pocketbook | *Arkansia wheeleri* | Endangered; declining | Formerly occurred in Ouachita River near Arkadelphia |
| Pink mucket | *Lampsilis abrupta* | Endangered; stable | Ouachita River system |
| Winged mapleleaf | *Quadrula fragosa* | Endangered; stable | Several counties in the SCAWRPR |
| Spectaclecase | *Cumberlandia monodonta* | Proposed endangered | Several counties in the SCAWRPR |
| Rabbitsfoot | *Quadrula cylindrica* | Proposed endangered/ proposed critical habitat | Several counties in the SCAWRPR |
| Arkansas fatmucket | *Lampsilis powellii* | Threatened; declining | Saline, Caddo, and upper Ouachita rivers |
| Interior Least Tern | *Sterna antillarum athalassos* | Endangered | Hempstead, Jefferson, and Pulaski counties |

Table 5.7. State-listed threatened and endangered plant species occurring in aquatic and semi-aquatic habitats in the SCAWRPR (ANHC 2013).

| Common Name | Species Name | Status | SCAWRPR Counties |
|---|---|---|---|
| Winterberry | *Ilex verticillata* | Threatened | Ashley, Hot Spring, Saline |
| Swamp thistle | *Cirsium muticum* | Threatened | Garland, Montgomery |
| Slender rose-gentian | *Sabatia campanulata* | Endangered | Calhoun, Hot Spring, Pulaski, Saline |
| Pondberry | *Lindera melissifolia* | Endangered | Ashley |
| Texas sunnybell | *Schoenolirion wrightii* | Threatened | Ashley, Bradley, Calhoun, Cleveland, Drew |
| Sedge | *Carex opaca* | Endangered | Saline |
| White-top sedge | *Rhynchospora colorata* | Endangered | Bradley, Pulaski |
| Few-flower beaksedge | *Rhynchospora rariflora* | Threatened | Bradley, Calhoun, Saline |
| Whorled nut-rush | *Scleria verticillata* | Threatened | Clark, Saline |
| Small-head pipewort | *Eriocaulon koernickianum* | Endangered | Calhoun, Montgomery, Pulaski, Saline |
| Loesel's twayplade | *Liparis loeselii* | Threatened | Garland |
| Southern tubercled orchid | *Platanthera flava* | Threatened | Ashley, Columbia, Montgomery, Pulaski, Union |
| Purple fringeless orchid | *Platanthera peramoena* | Threatened | Pulaski, Saline |
| Rose pogonia | *Pogonia ophioglossoides* | Threatened | Calhoun, Jefferson, Saline |
| Baldwin's yellow-eyed grass | *Xyris baldwiniana* | Threatened | Calhoun |

In some cases, the presence of non-native aquatic species is believed to affect aquatic biodiversity. There are 26 non-native aquatic animal species known to occur in the SCAWRPR (Table 5.8). The majority of the non-native fish species present in the region are sportfish species that have been introduced purposely and are regularly stocked. The impact of many of these species on native species is unknown. Some species, such as carp, are suspected to affect native species as a result of modifying aquatic habitats, e.g., removing vegetative cover and increasing turbidity. Other species, such as non-native sportfish and exotic clams, are suspected to affect native species by competing with them for food and/or habitat (USGS 2013b). There are also 10 species of invasive aquatic plants known to occur in the planning region Table 5.8.

## 5.6 Operation and Maintenance of the Ouachita-Black Rivers Navigation System

Reduced federal funding is resulting in reductions in operation and maintenance of the federal navigation system on the Ouachita River in Arkansas. In 2012, USACE reduced the hours of operation of the Felsenthal and H.K. Thatcher locks on the Ouachita River from 24 to 16 hours a day. Monitoring of river traffic by the Ouachita River Valley Association indicates that the reduction in hours of operation of the locks is having an economic impact as a result of increased shipping times, and a 50% to 60% reduction in lockage of recreational boats. Reduced federal funding has also resulted in reduced dredging and snagging to maintain the navigation channel and a backlog of lock and dam maintenance projects. The navigation channel between Camden and Crossett has not been dredged in over 3 years. Lack of maintenance also impacts commercial and recreational use of the navigation system (Ouachita River Valley Association 2013).

Table 5.8. Non-native aquatic animal and plant species known to occur in the SCAWRPR.

| Common Name | Scientific Name | Origin | Locations | Dates Identified | Method of Introduction | Impact |
|---|---|---|---|---|---|---|
| Freshwater jellyfish | *Craspedacusta sowerbyi* | China | Lake Greeson | 1999 | Accidental | Unclear |
| Waterflea | *Daphnia* lumholtzi | Asia | DeGray Lake, Wildcat Lake, Lake Georgia Pacific | 1995 | Accidental | Competition with natives |
| Inland silverside | *Menidia* beryllina | Mississippi River, Red River | Lake Greeson, Lake Hamilton, Ouachita River – Moro Bay | 1988, 1987 | Stocking | Competition with natives |
| Rock bass | *Ambloplites rupestris* | Northern US, east of Mississippi River | Caddo River, Ouachita River, Ten-mile Creek, Saline River, Little Missouri River | 1955, 1962, 1970, 1973, 1976, 1997 | Stocking | May compete with natives |
| Redbreast sunfish | *Lepomis* auritus | Atlantic drainage | Ouachita River | 2000 | Stocking | Competition & hybridization with natives |
| Red-bellied pacu | *Piaractus* brachypomus | South America | Hot Springs vicinity | 2005 | Aquarium release | Unknown |
| Oscar | *Astronotus* ocellatus | South America | Hot Springs vicinity | 2005 | Aquarium release | Potential competition with and predation of natives |
| Threadfin shad | *Dorosoma* petenense | Other basins in Arkansas | Lake Ouachita, Lake Hamilton, Lake Catherine | 1988 | Stocked | Competition with and predation on natives |
| Goldfish | *Carassius* auratus | Asia | DeGray Lake, Lake Hamilton, Saline River | 1988 | Accidental | Unknown |
| Grass carp | *Ctenopharyngodon idella* | Eastern Asia | White Oak Lake, Little Missouri drainage, Ouachita River, Lake Hamilton, Saline River, Lake Catherine, Lake Ouachita, Moro Creek | 1988 | Stocking | Habitat modification |
| Common carp | *Cyprinus* carpio | Eurasia | Throughout the region | 1980, 1985, 1988, 1991, 1998, 2003 | Stocking | Habitat modification |
| Silver carp | *Hypophthalmichthys molitrix* | Asia | Saline River, Ouachita River | 1988, 1981 | Accidental | Competition with natives |
| Bighead carp | *Hypophthalmichthys nobilis* | China | Saline River | 1988 | Accidental | Unknown |
| Fathead minnow | *Pimephales* promelas | US | DeGray Lake, Lake Catherine, Lake Ouachita, Lake Hamilton, Saline River | 1988, 1980 | Accidental | Unknown |
| Northern pike | *Esox lucius* | Northern US | DeGray Lake | 1988 | Stocked | Predation of natives |

Table 5.8. Non-native aquatic animal and plant species known to occur in the SCAWRPR (continued).

| Common Name | Scientific Name | Origin | Locations | Dates Identified | Method of Introduction | Impact |
|---|---|---|---|---|---|---|
| Muskellunge | *Esox* masquinongy | Northern and eastern US | DeGray Lake | 1988 | Stocked | Predation of natives |
| White catfish | *Ameiurus* catus | Atlantic drainage | Champagnolle Creek | 1988 | Stocked | Competition with natives |
| Brown bullhead | *Ameiurus* nebulosus | Northern US, Atlantic drainage | Lake Greeson, Lake Hamilton, White Oak Lake,L'Aigle Creek, Moro Creek, Ouachita River headwaters | 1988 | Stocked | Competition with natives |
| Blue catfish | *Ictalurus furcatus* | Mississippi River basin, Gulf coast drainage | Lake Ouachita, Lake Greeson, Ouachita River, DeGray Lake, Lake Catherine, Lake Hamilton, White Oak Lake, Bragg Lake | 1988, 1997 | Stocked | None |
| Wiper | *Morone chrysops x M. saxatilis* | None, artificial hybrid | DeGray Lake, Lake Greeson | 1975, 1992 | Stocked | Hybridize with native bass |
| Striped bass | *Morone* saxatilis | Atlantic & Gulf drainages | Lake Greeson, Ouachita River, Lake Ouachita, Lake Catherine, Lake Hamilton, Little Missouri | 1957, 1967, 1976, 1980, 1984, 1988, 1992, 1997 | Stocked | Can impact populations of small fishes |
| Sauger | *Sander* canadensis | Arkansas River basin | Lake Jack Lee | 1980 | Stocked | None known |
| Rainbow trout | *Oncorhynchus mykiss* | Pacific drainage | Little Missouri River, Lake Greeson, Ouachita River, Lake Catherine, Lake Ouachita, Lake Hamilton | 1976, 1988, 1992, 1997 | Stocked | Unknown |
| Brown trout | *Salmo trutta* | Europe, Africa, Asia | Little Missouri River | 1988 | Stocked | Competition with and predation of natives |
| Nutria | *Myocastor* coypus | South America | Throughout region | 1978 | Accidental | Over-grazing of wetlands |
| Asian clam | *Corbicula* fluminea | Asia | Ouachita River, Caddo River, Champagnole Creek | 1968, 1969, 1976, 1981, 2004 | Accidental | Competition with natives, biofouling |
| Alligator weed | *Alternanthera philoxeroides* | South America | Pike, Ouachita, Bradley, Ashley, Drew, Jefferson, Pulaski | 2006, 1988 | Accidental | Habitat modification |
| Brazillian waterweed | *Egeria densa* | South America | Hot Spring, Saline, Pulaski | 1988 | Accidental | Competition with natives, habitat modification |

Table 5.8. Non-native aquatic animal and plant species known to occur in the SCAWRPR (continued).

| Common Name | Scientific Name | Origin | Locations | Dates Identified | Method of Introduction | Impact |
|---|---|---|---|---|---|---|
| Water hyacinth | *Eichhornia crassipes* | South America | Clark, Jefferson, Pulaski, Hot Spring | 1999, 2006 | Accidental | Habitat modification |
| Hydrilla | *Hydrilla verticillata* | Asia | Clark, Garland, Hot Spring, Montgomery, Ouachita, Pulaski, Ashley | 2005, 2010 | Accidental | Competition with natives |
| Yellow iris | *Iris pseudacorus* | Asia, Africa, Europe | Bradley, Dallas, Drew, Jefferson, Pulaski | 1988, 1997 | Accidental | |
| European water clover | *Marsilea quadrifolia* | Europe, Asia | Pulaski | 2010 | | |
| Parrotfeather | *Myriophyllum aquaticum* | South America | Ashley, Bradley, Calhoun, Garland, Jefferson, Montgomery, Polk, Saline, Union | 1988, 1970 | Introduced | Competition with natives |
| Eurasian water milfoil | *Myriophyllum spicatum* | Europe, Asia, Africa | Pulaski | 2010 | Accidental | Habitat modification, displacement of natives |
| Watercress | *Nasturtium officinale* | Europe, Africa, Asia | Garland, Montgomery, Polk | 1988 | | |
| Water fern | *Salvinia minima* | Mexico, South America | Garland, Hot Spring, Jefferson, Montgomery, Pulaski | 2010 | | |
| Narrow-leaved cattail | *Typha angustifolia* | Eurasia | Garland | 1988 | | Habitat modification, displacement of natives* |

*USDA Forest Service 2006.

# 6.0 INSTITUTIONAL AND REGULATORY SETTING

This section provides a description of the regulatory and institutional framework for water resources management in SCAWRPR. It includes general descriptions of federal and state laws, regulations, and programs that deal with water resources management in the region, as well as a listing of federal, state, and local governmental and nonprofit institutions that are involved in water resources management in the region. In addition, the interrelationships between regulations and institutions at the federal, state, and local levels in the SCAWRPR are illustrated.

## 6.1 Legal Framework

The legal framework for management and use of water resources in Arkansas is based on court case law, laws enacted by the Arkansas General Assembly, and rules and regulations enacted by state agencies. Federal laws and regulations also influence the regulation of water resources in the state (ANRC 2011). The discussion below identifies and summarizes the laws and regulations and associated programs that guide water management in SCAWRPR, and summarizes changes that have occurred in this legal framework since the 1990 AWP update.

### 6.1.1 Federal Laws and Regulatory Programs

Federal policy recognizes that states have primary authority for regulation of water usage within their borders. Therefore, the federal laws, regulations, and associated programs that influence water resources management in the SCAWRPR primarily relate to water quality. Federal legislation and programs also deal with other aspects of management of water resources in the region such as conservation and protection of waterbodies, flood control, and navigation.

#### 6.1.1.1 Water Quality

The current federal laws and programs that guide management of water quality in the SCAWRPR are summarized in Table 6.1. The CWA of 1972 (most recently amended in 2002) and the SDWA of 1974 (most recently amended in 1996) are two important pieces of federal water quality legislation that authorize a number of federal water quality programs.

Table 6.1. Federal laws and regulatory programs that address SCAWRPR water quality.

| Federal Law | Federal Water Quality Regulatory Programs | Responsible Federal Agency |
|---|---|---|
| CWA | Ambient nutrient water quality standards | EPA |
| | Biosolids regulations | |
| | Impaired waters | |
| | Nonpoint source pollution management | |
| | NPDES point source permitting | |
| | NPDES stormwater permitting | |
| | NPDES pesticide application permitting | |
| | NPDES confined animal feeding operations permitting | |
| | State ambient water quality standards | |
| | State biennial water quality assessment | |
| | TMDLs | |
| | Dredge and fill permitting | USACE |
| SDWA | Source water protection | EPA |
| | Underground injection wells | |
| Underground storage tank regulations | Underground storage tank program | EPA |
| Resource Conservation and Recovery Act (RCRA) | Hazardous waste management | EPA |
| | Solid waste management | |
| | Subtitle D | |
| Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) | Hazardous waste site clean up | EPA |
| Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) | Endangered species protection program | EPA |
| | Labeling requirements | |
| | Registration | |
| Surface Mining Control and Reclamation Act | Mine reclamation | US Department of the Interior (USDI) |
| | Surface mining control | |
| Toxic Substances Control Act (TSCA) | PCB Program | EPA |
| Soil and Water Resources Conservation Act | Conservation Effects Assessment Program | USDA |
| Arkansas Wilderness Act | National forests | USFS |
| National Forest Management Act | | |
| Weeks Act | | |
| Oil Pollution Act | Oil spill response planning | EPA |
| Pollution Prevention Act | Pollution prevention planning | EPA |
| National Environmental Policy Act (NEPA) | Environmental impact analysis of federal projects, with mitigation | EPA, Council on Environmental Quality |

Note: Highlighted laws and programs were promulgated after the 1990 AWP update.

Legislation related to forest conservation, such as the Cooperative Forestry Assistance Act, is included here because forests can protect and improve water quality. EPA is responsible for administering themajority of these laws and programs; however, EPA has delegated some of this authority to state agencies such as ADEQ and ADH.

The CWA of 1972 established the NPDES program, which regulates point source discharges through a permit program. The NPDES program is managed by EPA, but ADEQ has been delegated authority to issue NPDES permits. NPDES permits are based on a combination of technology-based and water quality based standards. Technology-based standards are developed by EPA for certain categories based on the performance of pollution control technologies available to the industry without regard for the receiving waterbody. Water quality-based standards are developed after consideration of the designated uses of the receiving waterbody and the water quality criteria necessary to protect those uses. In 1987, Congress amended the CWA to include nonpoint sources of pollution such as stormwater runoff from industries, construction sites, and municipalities. NPDES permits for the SCAWRPR are summarized in Section 4.4.3. The 1987 amendments also addressed management of biosolids (sewage sludge). The CWA also requires permits for dredge and fill activities in wetlands, lakes, streams, rivers, and other waters of the US. These permits are issued by USACE.

The TMDL program was established by the CWA in 1972; however, TMDLs were rarely developed for waterbodies until the 1990s, after environmental groups began suing EPA over the lack of TMDLs being performed (EPA 2008). The CWA requires that a TMDL study be conducted for waterbodies identified as having impaired water quality. The TMDL study is conducted to determine the maximum amount of a pollutant that a waterbody can receive and still meet ambient water quality standards. This maximum load is split between point sources and nonpoint sources. These loads are then compared to the estimated existing point source and nonpoint source loads to determine the amount of reduction required for the waterbody to meet its water quality standards.

The first TMDLs for waterbodies in the SCAWRPR were completed in 2001. Prior to this, beginning in the 1980s, ADEQ routinely performed wasteload allocation studies as part of the NPDES permitting process to determine the amount of a pollutant that could be discharged to a waterbody. Since 2001, 17 TMDLs have been completed for waterbodies in the SCAWRPR (see Section 5).

In 1998, EPA initiated a program to develop ambient water quality criteria for nutrients, i.e., nitrogen and phosphorus. At the time, nutrients were identified as a leading cause of water quality issues across the nation, including such high profile events as the hypoxic zone in the Gulf of Mexico and algal blooms along the national seacoast. In 2001, EPA published recommended criteria development plans (EPA 2013c).

The drinking water source water protection program was initiated as a result of the 1996 amendment to the SWDA. The purpose of this program is to prevent the need for increased treatment of drinking water (resulting in increased treatment costs and costs to customers) due to water quality degradation, by protecting the quality of the drinking water source. In the majority of cases, the cost of protecting drinking water sources from pollution is far lower than the cost of upgrading water treatment to remove increased pollution. There are approximately 335 public water utilities in the SCAWRPR that are subject to SDWA regulations (ADH n.d.).

Subtitle D of the 1991 amendment of the Resource Conservation and Recovery Act (RCRA) introduced specifications for how landfills were to be constructed and managed to protect water quality. This led to sweeping changes in solid waste management across the country and in Arkansas (ADEQ 2011a).

#### 6.1.1.2 Water Resources Management

The federal regulations and programs that address non-water quality aspects of water resources management are summarized in Table 6.2. These include regulations and programs that address flood control, river navigation, wetlands tracking, or water-based recreation. Programs related to drinking water infrastructure are also included in Table 6.2 and discussed below. Some of the legislation and programs that address water quality also address other aspects of water resources management. For example, preservation of forest lands protects water quality and hydrology. As a result, there is some duplication in Tables 6.1 and 6.2. Federally appropriated water, such as the water required to maintain navigation on the McClellan-Kerr Arkansas River Navigation System, is not available for other uses. Federal water appropriations preempt other beneficial water uses, such as irrigation.

Table 6.2. Federal laws and regulatory programs that address aspects of SCAWRPR water resources other than water quality

| Federal Law | Federal Program | Responsible Federal Agency | Water Plan Relevance |
|---|---|---|---|
| CWA | Wetland and stream mitigation | USACE | Physical protection of waterbodies, including wetlands |
| SDWA | Consumer confidence reports | EPA | Protects/improves public water supply |
| | Finished water criteria | EPA | Protects human health |
| | Operator certification | EPA | Informs the public |
| Endangered Species Act | Freshwater species protection | USFWS | Mechanism for physical protection of waterbodies that are habitats for endangered species |
| | Waterfowl protection | | |
| Soil and Water Resources Conservation Act | Census of Agriculture | USDA | Irrigation and agriculture |
| | Conservation Effects Assessment Program | USDA | Water resources protection/improvement |
| | Natural Resources Inventory | USDA | Characterize water resources |
| NEPA | Environmental Impact Statements and Mitigation | EPA, Council on Environmental Quality | Water resources protection/mitigation |
| Flood Control Act/Water Resources Development Act (WRDA) | Dam safety | USACE | Water storage, water supply, flood reduction, flow management, restoration of physical aquatic habitat |
| | Flood control reservoirs | | |
| | Levees | | |
| | Navigation systems | | |
| Arkansas Wilderness Act | National forests | USFS | Well managed forestlands improve and protect water resources |
| National Forest Management Act | | | |
| Weeks Act | | | |
| Rivers and Harbors Act | Navigation | USACE | Federal navigation systems in Arkansas |
| | Section 10 | USACE | Protects waterbodies, including wetlands |
| Migratory Bird Hunting and Conservation Stamp Act | Small wetland acquisition program | USFWS | Protects wetlands |
| Emergency Wetlands Resources Act | National Wetlands Inventory | USFWS | Track wetland resources |
| Dam Safety and Security Act | National Dam Safety Program | Federal Emergency Management Agency (FEMA) | Protection of lives and property |
| National Parks Acts | National Parks | USDI National Park Service | Protection of water resources associated with national parks |

Table 6.2. Federal law and regulatory programs that address aspects of SCAWRPR water resources other than water quality (continued).

| Federal Law | Federal Program | Responsible Federal Agency | Water Plan Relevance |
|---|---|---|---|
| Migratory Bird Conservation Act | Acquisition of lands for wildlife refuges | Migratory Bird Conservation Commission | Preservation of water resources for bird habitat |
| National Wildlife Refuge System Improvement Act | National Wildlife Refuges | USFWS | Preservation of water resources for habitat |
| National Flood Insurance Act | National Flood Insurance Program | FEMA | Insurance against flood losses |
| | Floodplain management | FEMA | Reduction of flood damage |
| | Flood hazard mapping | FEMA | Identification of flood hazard areas |
| None | Climate monitoring | NOAA | Tracking precipitation and evaporation – water availability |
| | Climate prediction | NOAA | Future water availability |
| | Drought status | NOAA | Enactment of water shortage specific management |
| Wild and Scenic Rivers Act | National Wild and Scenic Rivers | USFS | Preservation of unregulated rivers and streams for recreation |

Note: Highlighted programs were initiated after the 1990 AWP update.

An important federal program for mitigating impacts to wetlands and streams is part of the dredge and fill permitting program of the CWA (Section 404), overseen by USACE. This mitigation program was initiated in 1990, when EPA and USACE signed a memorandum of agreement establishing a process for determining the need for mitigation of impacts to wetlands, streams, and other water resources under the CWA Dredge and Fill Permitting program. This program provides a means for dredge and fill permit applicants to compensate for unavoidable destruction of aquatic habitat by either restoring or creating similar habitat either on site or at another location (EPA 2013a). There is one site within the SCAWRPR that has been designated as a mitigation banks for CWA dredge and fill permitting; on the upper Saline River (USACE 2013). The program is a mechanism for implementing the federal policy of no-net-loss of wetlands (EPA 2013a). Revised regulations governing this mitigation program were issued in 2008.

The Endangered Species Act provides for protection and recovery of imperiled terrestrial, freshwater, and marine plant and animal species (except pest insects) (USFWS 2013b). The SCAWRPR contains aquatic and semi-aquatic habitat important for a number of endangered species (see Table 5.6).

The 1996 amendments to the SDWA directed EPA and the states to develop requirements for certification of water treatment system operators (EPA 2012e). These amendments also initiated a program that required public water suppliers that operate community water systems to provide annual reports to drinking water utility customers on the quality of their drinking water (EPA 2013b).

Under the National Flood Insurance Act, flood hazard maps have been completed for the entire SCAWRPR, and most of the mapping has been, or is in the process of being, modernized, within the last 8 years, with the exception of Polk, Montgomery, Grant, Pike, Nevada, Calhoun, and Bradley counties (Figure 6.1). Flood hazard maps for these counties are more than 25 years old. Modernized flood hazard maps typically include updated Special Flood Hazard Areas (SFHAs), and are created in a digital countywide format. For the communities participating in the National Flood Insurance Program (NFIP), the flood hazard maps identify the regulatory SFHA whereby the community floodplain administrator applies the locally adopted and enforced floodplain management ordinance. Participation in the NFIP is voluntary; however non-participation results in federal flood insurance not being available to residents and limits post-disaster financial assistance. All of the counties included in the SCAWRPR are participating in the program, as well as a large percentage of the communities.

Surface waters in the SCAWRPR that are under some degree of federal management include the Ouachita River at Lake Ouachita and in the Ouachita National Forest, the Caddo River at Lake DeGray, and the Little Missouri River at Lake Greeson. The Felsenthal NWR is a federally controlled area at the confluence of the Saline River and the Ouachita River. This area includes Lake Jack Lee, which is formed on the Ouachita River by Felsenthal Lock and Dam. Federal water requirements preempt other beneficial water uses, such as irrigation.

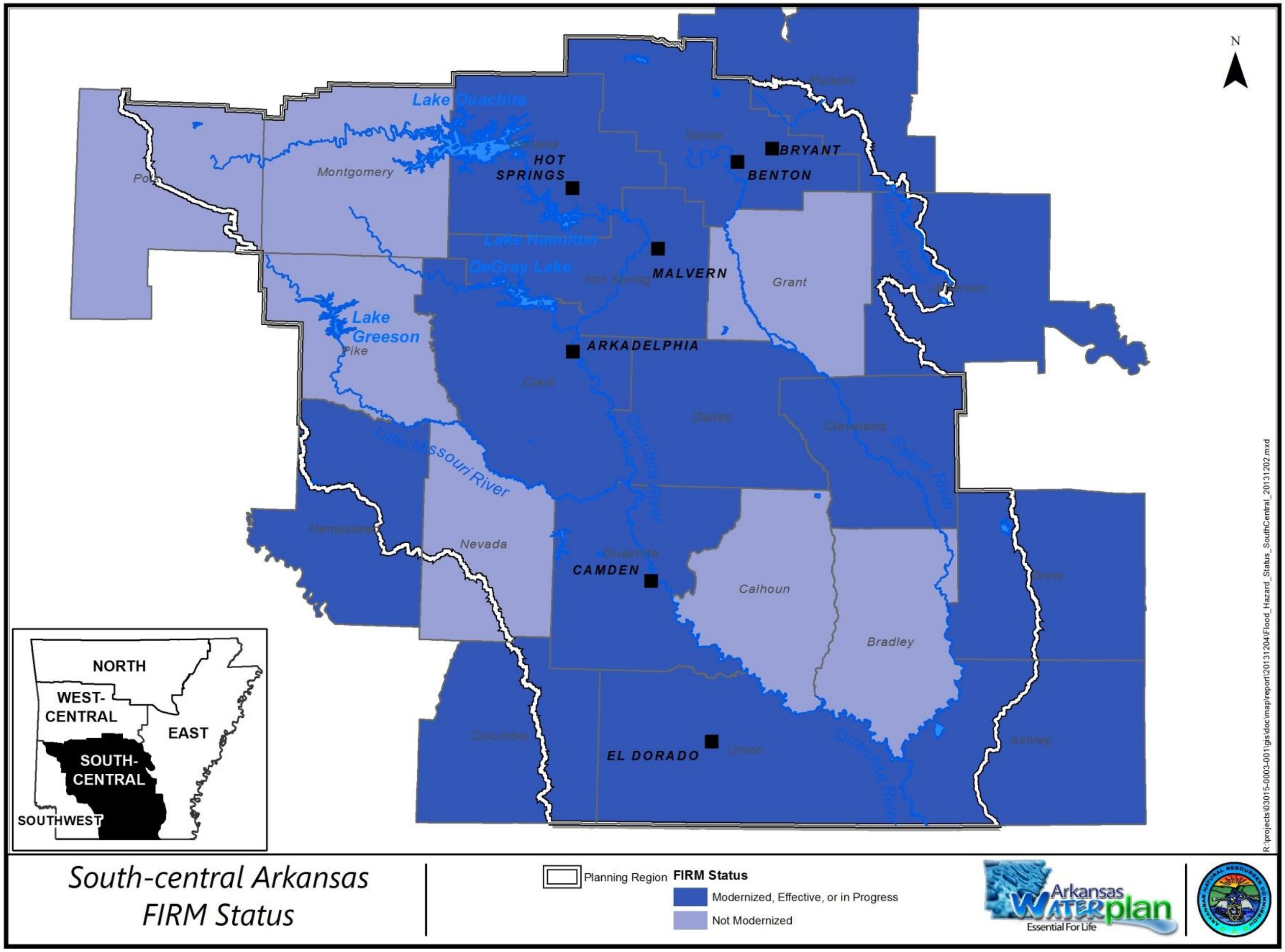


Figure 6.1. Status of flood hazard mapping in the SCAWRPR.

### 6.1.2 Federal Laws and Assistance Programs

Federal laws have also established a number of programs to provide technical and financial assistance for water resources management, that are available in Arkansas. Assistance programs for management of water quality and other aspects of water resources are discussed in the following sections.

#### 6.1.2.1 Water Quality

Table 6.3 summarizes current federal assistance programs available in the SCAWRPR and the associated federal laws. The majority of the federal assistance programs listed in Table 6.3 originated through the Farm Bill. The Farm Bill has been amended four times since 1990, most recently in 2013 (National Agricultural Law Center 2012). New conservation programs that are intended to assist farmers in protecting and restoring water quality have been added with each amendment (see Table 6.3). In 2012, over 103,801 acres in the counties of the SCAWRPR were enrolled in Farm Bill programs, and over $7.7 million in funding provided to those counties for water quality practices (Table 6.4) (NRCS 2012).

The CWA authorizes EPA to provide federal funding assistance to states and local entities through three funding programs. Through the Clean Water State Revolving Fund, federal funds are provided to ANRC to fund a low interest loan program for wastewater treatment, nonpoint source pollution control, and watershed management projects in the state. Grants for nonpoint source pollution control projects are authorized under Section 319 of the CWA. Finally, Section 106 of the CWA authorizes federal funding assistance to states and interstate agencies through grants for pollution control programs such as discharge permitting and water quality monitoring.

There are additional federal laws that authorize programs that provide assistance for community waste treatment and management to protect water quality. HUD grants for construction and upgrading of wastewater infrastructure were also authorized by the Housing and Community Development Act. Several programs to provide financial assistance for wastewater systems and solid waste programs in rural areas were authorized by the Consolidated Farm and Rural Development Act.

Table 6.3. Federal laws and assistance programs that affect the SCAWRPR water quality.

| Federal Law | Federal Water Quality Funding Assistance Programs | Responsible Federal Agency |
|---|---|---|
| CWA | Clean water state revolving fund | EPA |
| | Nonpoint source pollution management grants | |
| | Water pollution control program grants | |
| CERCLA | Hazardous waste site clean up | EPA |
| Cooperative Forestry Assistance Act | Forest Stewardship Program | USDA Forest Service |
| | Forest Legacy Program | |
| | Urban and Community Forestry Program | |
| Housing and Community Development Act | Community Development Block Grants | US Department Housing and Urban Development (HUD) |
| Farm Bill | Agricultural Water Enhancement Program | NRCS |
| | Conservation Reserve Program (CRP) | USDA Farm Services Agency |
| | Conservation Innovation Grants Program | NRCS |
| | Conservation Stewardship Program (CSP) | |
| | Cooperative Conservation Partnership Initiative | |
| | Environmental Quality Incentives Program (EQIP) | |
| | Farm and Ranch Land Protection Program | |
| | Grassland Reserve Program | |
| | Grazing Lands Conservation Initiative | |
| | Mississippi River Basin Healthy Watersheds Initiative | |
| | National Water Management Center | |
| | National Water Quality Initiative | |
| | Organic Initiative | |
| | Wetlands Reserve Program | |
| | Wildlife Habitat Incentives Program (WHIP) | |
| Consolidated Farm and Rural Development Act | Water and waste disposal systems for rural communities | USDA Rural Utilities Service |
| | Water and Waste Disposal Loans and Grants | USDA Rural Utilities Service |
| | Solid Waste Management Grants | |
| | Grant Program to Establish a Fund for Financing Water and Wastewater Projects | |
| American Recovery and Reinvestment Act | Funding for clean water state revolving fund and clean up of leaking underground storage tanks | Recovery Accountability and Transparency Board |
| Clean Vessel Act | Funding for pumpout stations and waste reception facilities for recreational boaters | USFWS |

Note: Highlighted laws and programs were promulgated after the 1990 AWP update.

Table 6.4. NRCS conservation programs summary for 2012 for counties of the SCAWRPR (NRCS 2012).

| County | CRP | | | EQIP | | | WHIP - Drought | | | Strike Force Initiative | | | Emergency Watershed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Contracts | Acres | Funds Obligated | Contracts | Acres | Funds Obligated | Contracts | Acres | Funds Obligated | Contracts | Acres | Funds Obligated | Funds Obligated |
| Ashley | 3 | 1,740 | $45,314 | 9 | 8,415.5 | $121,642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bradley | 0 | 0 | 0 | 7 | 291.5 | $64,316 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Calhoun | 1 | 107.3 | $1,991 | 4 | 803.4 | $45,444 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Clark | 0 | 0 | 0 | 2 | 240.9 | $22,019 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cleveland | 2 | 1,095.3 | $4,458 | 36 | 2,635.8 | $616,685 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Columbia* | 1 | 209.2 | $670 | 12 | 901.8 | $168,901 | 2 | 130 | $21,076 | 3 | 473.3 | $38,287 | 0 |
| Dallas | 0 | 0 | 0 | 8 | 674.0 | $62,095 | 2 | 60 | $5,357 | 0 | 0 | 0 | $570,364 |
| Drew | 3 | 4,870.4 | $160,949 | 22 | 14,158.2 | $404,132 | 0 | 0 | 0 | 6 | 490 | $300,703 | 0 |
| Garland | 1 | 1,400.0 | $5,675 | 10 | 687.3 | $119,216 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grant | 0 | 0 | 0 | 9 | 1,508.0 | $66,606 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hempstead* | 0 | 0 | 0 | 12 | 924.4 | $222,331 | 0 | 0 | 0 | 2 | 52.2 | $52,455 | 0 |
| Hot Spring | 0 | 0 | 0 | 9 | 555.0 | $72,507 | 1 | 116 | $11,142 | 0 | 0 | 0 | 0 |
| Jefferson | 34 | 36,081.1 | $1,251,011 | 43 | 15,082.2 | $2,258,878 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Montgomery | 0 | 0 | 0 | 12 | 1,962 | $229,838 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nevada* | 0 | 0 | 0 | 4 | 204.4 | $25,067 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ouachita | 0 | 0 | 0 | 9 | 417 | $92,337 | 0 | 0 | 0 | 1 | 3 | $18,483 | 0 |
| Pike | 0 | 0 | 0 | 5 | 189.3 | $70,208 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Polk* | 0 | 0 | 0 | 38 | 5374.2 | $531,347 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Saline | 0 | 0 | 0 | 4 | 308 | $24,093 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Union | 2 | 662.0 | $1,873 | 1 | 978.5 | $86,957 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Totals** | **47** | **46,165.3** | **$1,471,941** | **256** | **56,311.4** | **$5,304,619** | **5** | **306** | **$37,575** | **12** | **1,018.5** | **$409,928** | **$570,364** |

The American Recovery and Reinvestment Act was promulgated in 2009 to save and create jobs during the recession that began in 2008. This act initiated several programs that provide money to states for a range of activities, including improvements to wastewater treatment systems and clean up of leaking underground storage tanks and hazardous waste sites (EPA 2013e). Recovery money was awarded to the Arkansas State Clean Water Revolving Loan Fund, and the ADEQ Leaking Underground Storage Tank Program. Recovery money was awarded to one leaking underground storage tank remediation project in the planning region (EPA n.d.).

The Clean Vessel Act was promulgated in 1992. This act established a program to provide grants to states to pay for construction, maintenance, operation, or renovation of boat pumpout stations and waste reception facilities (US Congress 1992). Money from this program has been used to install and maintain pumpout facilities at the lakes and river ports in the SCAWRPR (USFWS 2013a).

Forestry assistance programs are included in Table 6.3 because forest improvement can improve water quality.

#### 6.1.2.2 Water Resources Management

The federal assistance programs that address non-water quality aspects of water resources management are summarized in Table 6.5. These include programs that address flood control, water conservation, water supply systems, fisheries, and aquatic habitat for wildlife. Some of the programs that provide assistance for addressing water quality also address other aspects of water resources management. For example, HUD Community Development Block Grants can be used to finance drinking water projects as well as wastewater projects. As a result, there is some duplication in Tables 6.3 and 6.5.

Table 6.5. Federal assistance programs for aspects of SCAWRPR water resources other than water quality.

| Federal Law | Federal Program | Responsible Federal Agency | Water Plan Relevance |
|---|---|---|---|
| SDWA | Drinking water state revolving fund | EPA | Protects human health |
| Farm Bill | Agricultural Water Enhancement Program | NRCS | Water conservation |
| | Cooperative Conservation Partnership Initiative | NRCS | Water conservation |
| | Conservation Innovation Grants Program | NRCS | Water conservation |
| | Emergency Watershed Protection | NRCS | Flooding reduction, recovery |
| | Groundwater Decline Initiative | NRCS | Water Conservation |
| | National Water Management Center | NRCS | Waterbody protection/restoration |
| | On-farm Energy Initiative | NRCS | Water conservation |
| | Watershed protection and flood prevention | NRCS | Flooding management |
| | Wetlands Reserve Program | NRCS | Physical waterbody protection/restoration |
| | WHIP | NRCS | Physical waterbody protection/restoration |
| Cooperative Forestry Assistance Act | Urban and Community Forestry Program | USFS | Trees in communities reduce stormwater runoff, improving hydrology |
| | Forest Stewardship Program | USFS | Well-managed forestlands improve and protect water resources |
| | Forest Legacy Program | | |
| Flood Control Act/WRDA | Habitat restoration | USACE | Water storage, water supply, flood reduction, flow management, restoration of physical aquatic habitat |
| | Basin studies | | |
| Housing and Community Development Act | Community development block grants programs | HUD | Protects/improves public water supply |
| American Recovery and Reinvestment Act | Funding for drinking water revolving fund | Recovery Accountability and Transparency Board | Protects/improves public water supply |

Table 6.5. Federal assistance programs for aspects of SCAWRPR water resources other than water quality (continued).

| Federal Law | Federal Program | Responsible Federal Agency | Water Plan Relevance |
|---|---|---|---|
| Consolidated Farm and Rural Development Act | Water and waste disposal systems for rural communities, Water and waste disposal loans and grants, Household water well system grant program, Grant program to establish a fund for financing water and wastewater projects, Emergency community water assistance grants | USDA Rural Development | Protects/improves public water supply |
| Land and Water Conservation Fund Act | Matching grants for acquisition and development of public recreation areas and facilities | USDI National Park Service | Preservation of water resources for recreation |
| Pittman-Robertson Wildlife Restoration Act | Wildlife restoration grant programs | USFWS | Preservation of water resources for fish and wildlife habitat |
| Sport Fish Restoration Act | Boating infrastructure grants | USFWS | Recreational boating and fishing |
| | Multistate conservation grants | USFWS | Aquatic habitat research and education |
| | Sports fish restoration grants | USFWS | Preservation of water resources for fish and wildlife habitat |

Note: Highlighted laws and programs were initiated after the 1990 AWP update.

The 1996 amendment of the Safe Drinking Water Act established the Drinking Water State Revolving Fund to assist drinking water utilities in financing infrastructure improvements. Using this fund, states can offer utilities low-cost loans and other types of assistance. Funds available through the American Recovery and Reinvestment Act were awarded to the Arkansas Drinking Water State Revolving Fund and used for two drinking water projects in the SCAWRPR (EPA n.d.).

Farm Bill amendments and associated assistance programs, as well as the Conservation Effects Assessment Program, the assistance programs associated with the Consolidated Farm and Rural Development Act, and the HUD Community Development Block Grant Program were discussed in Section 6.1.2.1. Farm Bill programs address water conservation (e.g., Groundwater

Decline Initiative), flood control (e.g., Watershed protection and Flood prevention), and conservation and restoration of aquatic habitat (e.g., Wetlands Reserve Program, WHIP). In 2012, over 103,801 acres in the counties of the SCAWRPR were enrolled in Farm Bill programs, and over $7.7 million in funding provided to those counties for water quality practices (Table 6.4) (NRCS 2012).

One project has been authorized under WRDA in the SCAWRPR since 1990, the Ouachita River watershed investigation in Arkansas and Louisiana. This project is ongoing; however, no funds were allocated for it in fiscal years 2012 and 2013 (USACE Vicksburg District 2013a, Ouachita River Valley Association 2011).

### 6.1.3 State Laws and Regulatory Programs

Arkansas has primary authority for regulation of water usage within the state. Many of the state laws and agency regulations related to water quality implement federal laws. The federal government has delegated authority to the state for a number of the regulatory administrative activities of both the CWA and the SWDA.

#### 6.1.3.1 Water Use Regulations

State water use law is based on a policy where riparian land owners, i.e., persons owning land that abuts a waterbody, have the right to reasonable use of the water within that waterbody. The reasonable use policy means that all landowners along a stream have the right to free and unrestricted use of the stream flow, provided that their use does not negatively affect the availability of water for other riparian users. Similarly, landowners have the right to reasonable use of groundwater under their property, as long as that use does not adversely affect the ability of other landowners to use the groundwater. In addition to water rights related to water withdrawals and consumptive use, Arkansas regulations address water rights related to public recreational uses of surface water such as boating and fishing (ANRC 2011).

In Arkansas, at the state level, regulations and programs authorized by the General Assembly that are related to water use are generally administered by ANRC. In addition, the Arkansas Water Well Construction Commission promulgates rules for construction of water supply wells, and the Arkansas Public Services Commission regulates private water utility fees. State incentive programs for water conservation, as well as funding for water resources development projects, have also been legislated. Table 6.6 summarizes selected Arkansas water use regulations and water conservation and development incentive programs that apply in the SCAWRPR.

Table 6.6. State regulations related to water use.

| State Water Use Regulations | Subjects Addressed by Regulations | Related State Legislation |
|---|---|---|
| Title 3: Rules for the Utilization of Surface Water[1] | Registration of surface water withdrawals | Arkansas Code §15-22-215 |
| | Minimum streamflows | Arkansas Code §15-22-222 |
| | Surface water transfers to non-riparian users | Arkansas Code §15-22-304 |
| | Regulation of dam construction | Arkansas Code §15-22-210 - 214 |
| | Allocation during periods of water shortage | Arkansas Code §15-22-217 |
| Title 4: Rules for the Protection and Management of Groundwater[1] | Registration of groundwater withdrawals | Arkansas Code §15-22-302 |
| | Groundwater protection program | Arkansas Groundwater Protection and Management Act (Arkansas Code §15-22-901 et seq.) |
| Arkansas Water Well Construction Commission Rules and Regulations[2] | Licensing of water well contractors<br>Construction requirements<br>Well reporting requirements | Arkansas Code §17-50-201 et seq. |
| Affiliate Transaction Rules[3] | Requirements for utility rates | Arkansas Code §23-2-101 et seq. |
| General Service Rules[3] | Standards of service for utilities | |
| Special Rules Water[3] | Standards of service for water utilities | |

Note: Highlighted legislation was promulgated after the 1990 AWP update.
1. Enforcement by ANRC.
2. Enforcement by Arkansas Water Well Construction Commission.
3. Enforcement by Arkansas Public Service Commission.

State law requires ANRC to "establish and enforce minimum stream flows for the protection of instream water needs" (Arkansas Code §15-22-222). Minimum streamflow is defined by Arkansas Code §15-22-202(6) as "…the quantity of water required to meet the largest of [specified] instream flow needs as determined on a case-by-case basis." The needs to be met that are specified in the statute are interstate compacts, navigation, fish and wildlife, water quality, and aquifer recharge. This definition is used to set minimum streamflows by rulemaking under Arkansas Code §15-22-222. Where no minimum flow is set by rule, these factors are used to make a case-by-case determination of minimum flow.

The minimum streamflow, set by rule or determined on a case-by-case basis, represents the trigger point for a "shortage" requiring allocation of water use. Because of the critical low flow conditions which may exist at the minimum streamflow level, the 1990 AWP recommended taking steps to reduce water withdrawals before water levels drop to minimum streamflow levels. The ANRC may allocate water among uses during a shortage.

Prior to adoption of Act 593 of 2013, minimum streamflows were classified as a "reserved" use when allocating water during a shortage, along with drinking water use and federal water rights. The legislation removed this reserved status and demoted minimum streamflows to a position below agriculture and industry in the allocation hierarchy, and ahead of hydropower and recreation. The intent was to ensure that agricultural and industrial surface water use is not curtailed during a shortage in an effort to protect instream flow needs (interstate compacts, navigation, fish and wildlife, water quality, and aquifer recharge). This change, especially as it applies a state law limitation on federal interests in navigation, interstate compacts and water quality, including wastewater discharge permits for sewer systems and industries, has not been tested.

In 1985, the Arkansas General Assembly adopted a departure from traditional riparian law by allowing transfer of water for use on non-riparian land. Prior to determining how much water is available to transfer, ANRC must first calculate the amount of water that must remain in the stream. The amount of water that must remain in the stream must be enough to cover: (1) existing riparian water rights as of June 28, 1985; (2) water needs of federal water projects as they existed on June 28, 1985; (3) firm yield of all reservoirs in existence on June 28, 1985; (4) maintenance of instream flows for fish and wildlife, water quality, aquifer recharge requirements, and navigation; and (5) future water needs of the basin of origin as projected in the AWP. The General Assembly limited the amount of excess surface water that may be permitted for non-riparian transfer to 25% of the average annual yield from the watershed after the greatest of the instream needs listed above is met. In the White River Basin, Arkansas

Code §15-22-304(e) further limits excess to an amount not to "exceed on a monthly basis an amount which is 50% of the monthly average of each individual month of excess surface water."

Minimum streamflow is often mistakenly equated with fish and wildlife flow requirements. Fish and wildlife flows are one of the five elements of minimum streamflow, which also includes interstate compacts, navigation, water quality, and aquifer recharge. Two different methods are used to calculate fish and wildlife flows for different situations. For case-by-case determinations of minimum flow for use in characterizing shortage and allocating water during a shortage, fish and wildlife flow requirements are estimated using a modified Tennant Method (ASWCC 1988). To calculate fish and wildlife flow requirements when determining the amount of excess water available for transfer to nonriparian users, the "Arkansas Method" (Filipek, Keith and Giese 1987) is used.

In 1991, the Arkansas Ground Water Protection and Management Act (Arkansas Code §15-22-901 et seq.) was signed into law, providing ANRC with authority to designate critical groundwater areas. As of 2013, two critical groundwater areas have been designated in the SCAWRPR (Figure 5.2). This law also mandated that ANRC evaluate the condition of the state's aquifers on a biennial basis, and make recommendations concerning safe yield and the designation of critical groundwater areas (ANRC 2011). ANRC publishes annual reports on the condition of the state's groundwater resources, including recommendations concerning aquifer safe yield and designation of critical groundwater areas.

Legislation passed in 2001 (Arkansas Code §15-22-915) requires the use of water meters on all non-domestic wells withdrawing water from sustaining aquifers, beginning in 2006. Designated sustaining aquifers in the SCAWRPR include the Cane River, Carrizo, Cockfield, Nacatoch, Ozan, Sparta, Trinity, Tokio, and Wilcox aquifers (Figure 3.20).

#### 6.1.3.2 Water Quality Regulations

Water quality regulations are promulgated by the General Assembly, APCEC, the State Board of Health, and ANRC. Table 6.7 identifies state regulations and laws, along with associated federal laws, that address water quality.

Table 6.7. State regulations that protect water quality.

| | Subjects/Programs | Related State Legislation | Related Federal Legislation |
|---|---|---|---|
| Regulation 1: Prevention of Pollution by Salt Water and Other Oil Field Wastes Produced by Wells in All Fields or Pools[(a)] | Environmental protection during oil drilling | Arkansas Water and Air Pollution Control Act (Arkansas Code §8-4-201 et seq.) | CWA |
| Regulation 2: Water Quality Standards for Surface Waters of the State of Arkansas[(a)] | Water quality standards (designated uses and numeric criteria) | Arkansas Water and Air Pollution Control Act (Arkansas Code §8-4-201 et seq.) | CWA |
| Regulation 3: Licensing of Wastewater Treatment Operators[(a)] | Licensing program for wastewater treatment operators | Arkansas Water and Air Pollution Control Act (Arkansas Code §8-4-201 et seq.) | CWA |
| Regulation 4: Disposal Permits for Real Estate Subdivisions in Proximity to Lakes and Streams[(a)] | State wastewater permit | Arkansas Water and Air Pollution Control Act (Arkansas Code §8-4-201 et seq.) | CWA |
| Regulation 5: Liquid Animal Waste Systems[(a)] | State wastewater permit | Arkansas Water and Air Pollution Control Act (Arkansas Code §8-4-201 et seq.) | CWA |
| Regulation 6: Regulations for State Administration of the NPDES Program[(a)] | Federal wastewater permits (NPDES) | Arkansas Water and Air Pollution Control Act (Arkansas Code §8-4-201 et seq.) | CWA |
| Regulation 12: Storage Tank Regulations[1] | Petroleum storage tank trust fund | Petroleum Storage Tank Trust Fund Act (Arkansas Code §8-7-901 et seq.) | CWA, Underground Storage Tank Regulations, including Energy Policy Act of 2005 |
| Regulation 15: Open-Cut Mining and Land Reclamation Code[(a)] | Environmental protection during non-coal mining activities, restoration of non-coal mining sites | Arkansas Open Cut Land Reclamation Act (Arkansas Code §15-57-301 et seq.) Arkansas Quarry Operation, Reclamation, and Safe Closure Act (Arkansas Code §15-57-401 et seq.) | None |
| Regulation 17: Underground Injection Control Code[(a)] | Underground injection of wastewater | Arkansas Water and Air Pollution Control Act (Arkansas Code §8-4-201 et seq.) | SDWA |

Table 6.7. State regulations that protect water quality (continued).

| | Subjects/Programs | Related State Legislation | Related Federal Legislation |
|---|---|---|---|
| Regulation 22: Solid Waste Management[a] | Landfill construction specifications, acceptable materials for landfill disposal, regional solid waste management districts, pollution prevention | Arkansas Solid Waste Management Act (Arkansas Code §8-6-201 et seq.), Arkansas Pollution Prevention Act (Arkansas Code §8-10-201 et seq.) | RCRA, Pollution Prevention Act |
| Regulation 23: Hazardous Waste Management[a] | Hazardous waste management, pollution prevention | Arkansas Hazardous Waste Act (Arkansas Code §8-7-201 et seq.), Arkansas Hazardous Materials Transportation Act (Arkansas Code §27-2-101 et seq.), Arkansas Pollution Prevention Act (Arkansas Code §8-10-201 et seq.) | RCRA, Pollution Prevention Act |
| Regulation 27: Licensing of Landfill Operators and Illegal Dumps Control Officers[a] | Licensing of landfill operators, licensing of illegal dumps control officers | Arkansas Code §8-6-901 et seq., Illegal Dump Eradication and Corrective Action Program Act (Arkansas Code §8-6-501 et seq.) | RCRA |
| Regulation 29: Brownfields Redevelopment[a] | Clean-up and redevelopment of contaminated sites | Arkansas Hazardous Waste Act (Arkansas Code §8-7-201 et seq.), Remedial Action Trust Fund Act, Arkansas Voluntary Clean-up Act (Arkansas Code §8-7-1101 et seq.) | CERCLA |
| Regulation 32: Environmental Professional Certification[a] | Certification program for professionals involved in clean-up of contaminated sites | Phase I Environmental Site Assessment Consultant Act (Arkansas Code §8-7-1301 et seq.) | CERCLA |
| Regulation 34: State water permit regulation[a] | Regulation of systems with the potential to pollute water resources, that are not otherwise regulated | Arkansas Water and Air Pollution Control Act (Arkansas Code §8-4-201 et seq.) | CWA |
| Rules and regulations pertaining to general sanitation[b] | Groundwater pollution, surface water pollution, sewage treatment | Arkansas Sewage Disposal Systems Act (Arkansas Code §14-236-101 et seq.) | CWA |
| Rules and regulations pertaining to public water systems[b] | Safety of drinking water supplied by public water systems | Arkansas Code §20-7-101 et seq. | SDWA |
| Rules and regulations pertaining to semi-public water systems[b] | Safety of drinking water supplied by semi-public water systems | Arkansas Code §20-7-101 et seq. | SDWA |

Table 6.7. State regulations that protect water quality (continued).

| | **Subjects/Programs** | **Related State Legislation** | **Related Federal Legislation** |
|---|---|---|---|
| Rules and regulations pertaining to water operator licensing[b] | Licensing for drinking water treatment systems | Arkansas Code §17-51-101 et seq. | SDWA |
| Rules and regulations pertaining to onsite wastewater systems, designated representative, and installers[b] | Permitting of onsite wastewater treatment systems (septic systems), licensing of designated representatives for onsite wastewater treatment systems, licensing of installers of onsite wastewater treatment systems | Arkansas Sewage Disposal Systems Act (Arkansas Code §14-236-101 et seq.) | CWA |
| Rules and regulations pertaining to mobile home and recreational vehicle parks[b] | Water supply, wastewater disposal, solid waste management | Arkansas Code §17-51-101 et seq. | CWA, SDWA, RCRA |
| Arkansas regulations on pesticide classification[c] | Pesticide classification | Arkansas Pesticide Control Act (Arkansas Code §2-16-401 et seq.), Arkansas Pesticide Use and Application Act (Arkansas Code §20-20-201 et seq.) | FIFRA |
| Arkansas regulations on pesticide applicator licensing[c] | Licensing of pesticide applicators | Arkansas Pesticide Use and Application Act (Arkansas Code §20-20-201 et seq.) | FIFRA |
| Arkansas Water Well Construction Commission Rules and Regulations | Specifications for construction of water wells to provide safe drinking water | Water Well Construction Act (Arkansas Code §17-50-101 et seq.) | SDWA |
| Rules and Regulations pertaining to outdoor bathing places[b] | Swim beach water quality | Arkansas Code §20-7-101 et seq. | CWA |
| Marine sanitation[b] | Marine sanitation | Arkansas Code §27-101-401 et seq. | Clean Vessel Act |

Notes: Highlighted regulations, programs, and legislation were promulgated after the 1990 AWP update.

a. Responsible state agency is ADEQ.

b. Responsible state agency is Arkansas Department of Health.

c. Responsible state agency is Arkansas State Plant Board.

Table 6.7 illustrates that there are myriad state regulations, covering a range of activities, that address water quality. The most basic of these are the regulations that set criteria for the quality of state surface waters and groundwater. These regulations identify the uses that state waterbodies should support, and specify narrative and numeric criteria for water quality to ensure the identified uses can be supported. In Arkansas, numeric water quality criteria for DO, turbidity, temperature, and minerals are ecoregion-based (APCEC 2011). Arkansas is in the process of developing numeric criteria for nutrients in surface water to meet federal requirements (ADEQ 2012c). State numeric water quality criteria for groundwater are in development.

A summary of the designated uses assigned to surface waterbodies in the SCAWRPR under APCEC Regulation No. 2 is provided in Table 6.8. Ouachita Mountain and Gulf Coastal ecoregion numeric surface water quality criteria apply in the SCAWRPR. Numeric surface water quality criteria for the waterbodies in the planning region are listed in Tables 6.9 through 6.11. Figure 6.2 shows the ADEQ water quality planning segments that are located in the planning region.

To protect surface water and groundwater quality, there are state regulations and laws that regulate discharge of wastewater, discharge of stormwater, underground storage tanks, underground injection of fluids, management of livestock, and disposal of solid waste.

The state source water and wellhead protection programs address protection of the quality of surface waters and aquifers used as public drinking water supplies. There are approximately 140 active public water supply utilities in the SCAWRPR. Half of these utilities use groundwater from their own wells, and are subject to the state wellhead protection program. Approximately 15 of the water utilities in the planning region use surface water and are subject to the state source water protection program. The remainder of the water utilities in the planning region purchase groundwater and/or surface water to supply to their customers (ADH n.d.).

Table 6.8. State designated uses for surface waters in the SCAWRPR (APCEC 2011).

| Designated Use | Waterbodies |
| --- | --- |
| Extraordinary Resource Waters | • Lake Ouachita<br>• DeGray Reservoir<br>• Saline River<br>• Caddo River above DeGray reservoir<br>• South Fork Caddo River<br>• Little Missouri River above Lake Greeson |
| Ecologically Sensitive Waterbodies | • Ouachita River above Lake Ouachita<br>• Ouachita River near Arkadelphia<br>• South Fork Ouachita River<br>• Caddo River and tributaries above DeGray Reservoir<br>• Saline River including Alum, Middle, North, and South Forks<br>• Tenmile Creek<br>• Little Missouri River above Lake Greeson<br>• Missouri River<br>• Mayberry Creek |
| Natural and Scenic Waterway | • Little Missouri River above Lake Greeson<br>• Saline River |
| Streams with substantial spring water influence | • L'Eau Frais<br>• Cypress Creek<br>• East and West Forks Tulip Creek |
| Primary Contact Recreation | All streams with watersheds > 10 square miles, and all lakes and reservoirs except:<br>○ Unnamed tributary to Smackover Creek<br>○ Unnamed tributary to Flat Creek<br>○ Coffee Creek<br>○ Mossy Lake |
| Secondary Contact Recreation | All waters except:<br>○ Unnamed tributary to Smackover Creek<br>○ Unnamed tributary to Flat Creek<br>○ Coffee Creek<br>○ Mossy Lake |
| Domestic Water Supply | All waters except:<br>○ Bluff Creek and unnamed tributary<br>○ Coffee Creek<br>○ Mossy Lake<br>○ Town Creek below Acme tributary<br>○ Unnamed tributary from Acme<br>○ Bayou de Loutre from Gum Creek to state line<br>○ Gum Creek<br>○ Walker Branch<br>○ Little Cornie Bayou from Walker Branch to state line<br>○ Alcoa unnamed tributary to Hurricane Creek<br>○ Hurricane Creek<br>○ Holly Creek<br>○ Dry Lost Creek and tributaries |

Table 6.8. State designated uses for surface waters in the SCAWRPR (continued).

| Designated Use | Waterbodies |
|---|---|
| Domestic Water Supply (cont.) | o Lost Creek<br>o Albemarle unnamed tributary to Horsehead Creek<br>o Horsehead Creek from unnamed tributary to mouth<br>o Dismukes Creek<br>o Big Creek<br>o Boggy Creek from confluence of tributary from Clean Harbors to Bayou de Loutre<br>o Unnamed tributary to Flat Creek from EDCC outfall to confluence with unnamed tributary A<br>o Unnamed tributary A to Flat Creek from EDCC ditch to mouth<br>o Flat Creek from unnamed tributary A to Haynes Creek<br>o Haynes Creek from Flat Creek to Smackover Creek |
| Industrial and Agricultural Water Supply | All waters |
| Trout Fishery | • Lake Ouachita<br>• Ouachita River from Blakely Mountain Dam to highway 270 bridge<br>• Little Missouri River from Narrows Dam to confluence with Muddy Fork |
| Seasonal Fishery | All streams with watersheds < 10 square miles |
| Perennial Fishery | Lakes and reservoirs, all streams with watersheds of 10 square miles or larger except:<br>o Unnamed tributary to Smackover Creek<br>o Unnamed tributary to Flat Creek<br>o Coffee Creek<br>o Mossy Lake |

Table 6.9. Temperature and turbidity numeric criteria in the SCAWRPR (APCEC 2011).

| Waterbody | Temperature (°F) | Base Flow Turbidity (NTUs) | All Flows Turbidity (NTUs) |
|---|---|---|---|
| Ouachita Mountain streams | 86.0 | 10 | 18 |
| Gulf Coastal streams | 86.0 | 21 | 32 |
| Trout waters | 68.0 | 10 | 18 |
| Lakes and reservoirs | 89.6 | 25 | 45 |
| Ouachita River from Little Missouri River to state line | 89.6 | 21 | 32 |
| Spring water streams | 86.0 | 21 | 32 |
| Bayou de Loutre from Chemtura outfall to Loutre Creek | 96.0 | 21 | 32 |

Table 6.10. Dissolved oxygen numeric water quality criteria in the SCAWRPR (APCEC 2011).

| Waterbody | Primary DO (mg/L) | Critical DO (mg/L) |
|---|---|---|
| Ouachita Mountain streams with watershed < 10 square miles | 6 | 2 |
| Ouachita Mountain streams with watershed ≥10 square miles | 6 | 6 |
| Trout waters | 6 | 6 |
| Gulf Coastal streams with watershed < 10 square miles<br>Loutre Creek from railroad bridge to mouth | 5 | 2 |
| Gulf Coastal streams with watershed 10 – 100 square miles<br>Dodson Creek, Loutre Creek from headwaters to railroad bridge, Jug Creek | 5 | 3 |
| Gulf Coastal streams with watershed > 100 square miles | 5 | 5 |
| Lakes and reservoirs | 5 | N/A |
| Prairie Creek from headwater to Briar Creek | 6 | 4 |
| Unnamed tributary to Smackover Creek, unnamed tributary to Flat Creek | 2 | 2 |
| Ouachita River from mile 223 to state line | 5 | 3 (June & July), 4.5 (August), or naturally occurring value |
| All streams when water temperature ≤ 10 ºC, or when streamflow is 15 cubic feet per second (cfs) or greater during March through May | 6.5 | Not applicable |

Table 6.11. Numeric water quality criteria for minerals in the SCAWRPR (APCEC 2011).

| Waterbody | Chloride (mg/L) | Sulfate (mg/L) | TDS (mg/L) |
|---|---|---|---|
| Big Cornie Creek | 230 | 30 | 500 |
| Little Cornie Creek | 200 | 10 | 400 |
| Three Creeks | 250 | 10 | 500 |
| Little Cornie Bayou above unnamed tributary | 200 | 20 | 500 |
| Unnamed tributary to Little Cornie Bayou from GLCC outfall 003 | 538* | 35* | 519* |
| Unnamed tributary to Little Cornie Bayou | 305* | ER(41.3) | 325* |
| Little Cornie Bayou from unnamed tributary to state line | 215* | 25* | 500* |
| Walker Branch | 180* | ER(41.3) | 970* |
| Gum Creek | 104* | ER(41.3) | 311* |
| Bayou de Loutre above Gum Creek | 250 | 90 | 500 |
| Bayou de Loutre below Gum Creek | 250 | 90 | 750 |
| Ouachita River Camden to state line | 160 | 40 | 350 |
| Saline River | 20 | 40 | 120 |
| Saline River east bifurcation at Holly Creek | ER(15) | 250 | 500 |
| Hurricane Creek above Hurricane Lake dam | 20 | 250 | 500 |
| Hurricane Creek from Hurricane Lake dam to Ben Ball bridge | 125 | 730 | 1,210 |
| Hurricane Creek from Ben Ball bridge to Highway 270 | 125 | 700 | 1,200 |
| Hurricane Creek from Highway 270 to mouth | 100 | 500 | 1,000 |

Table 6.11. Numeric water quality criteria for minerals in the SCAWRPR (continued).

| Waterbody | Chloride (mg/L) | Sulfate (mg/L) | TDS (mg/L) |
|---|---|---|---|
| Alcoa unnamed tributaries to Hurricane Creek | 125 | 700 | 1,100 |
| Dry Lost Creek and tributaries | ER(15) | 560 | 880 |
| Lost Creek to Little Lost Creek | ER(15) | 510 | 820 |
| Lost Creek below Little Lost Creek | ER(15) | 300 | 550 |
| Holly Creek | 30 | 860 | 1,600 |
| Moro Creek | 30 | 20 | 500 |
| Smackover Creek | 250 | 30 | 500 |
| Unnamed tributary A to Flat Creek from EDCC 001 ditch to mouth | 16* | 80* | 315* |
| Confluence with unnamed tributary A to Flat Creek | 23* | 125* | 475* |
| Bayou de Loutre above Loutre Creek | 180 | ER(41.3) | 970 |
| UT004 to Bayou de Loutre | 14* | ER(41.3) | 311* |
| UT002 to Bayou de Loutre | 278* | 90* | 500* |
| Loutre Creek from Highway 15 to mouth | 256* | 997* | 1,756* |
| Bayou de Loutre from Loutre Creek to the discharge of City of El Dorado South facility | 264* | 635* | 1,236* |
| Bayou de Loutre from discharge of the City of El Dorado South facility to Gum Creek | 250* | 431* | 966* |
| Bayou de Loutre from Gum Creek to Boggy Creek | 250* | 345* | 780* |
| Boggy Creek from discharge of Clean Harbors El Dorado to mouth | 631* | 63* | 1,360* |
| Bayou de Loutre from Boggy Creek to Hibank Creek | 250* | 296* | 750* |
| Bayou de Loutre from Hibank Creek to Mill Creek | 250* | 263* | 750* |
| Bayou de Loutre from Mill Creek to Buckaloo Branch | 250* | 237* | 750* |
| Bayou de Loutre from Buckaloo Branch to Bear Creek | 250* | 216* | 750* |
| Bayou de Loutre from Bear Creek to final segment | 250* | 198* | 750* |
| Bayou de Loutre final segment | 250* | 171* | 750* |
| Ouachita River Carpenter Dam to Camden | 50 | 40 | 150 |
| Town Creek below Acme tributary | ER(18.7) | 200 | 700 |
| Unnamed tributary from Acme | ER(18.7) | 330 | 830 |
| Little Missouri River | 10 | 90 | 180 |
| Muddy Fork Little Missouri River | ER(15) | 250 | 500 |
| Bluff Creek and unnamed tributary | ER(15) | 651* | 1,033* |
| Garland Creek | 250 | 250 | 500 |
| South Fork Caddo | ER(15) | 60 | 128 |
| Back Valley Creek | ER(15) | 250 | 500 |
| Wilson Creek from UMETCO property line to mouth | 56 | 250 | 500 |
| Ouachita River and tributaries from headwaters to Blakely Mountain Dam (including reservoir) | 10 | 10 | 100 |

*Based on ecoregion background flow of 4 cfs; ER = ecoregion criterion

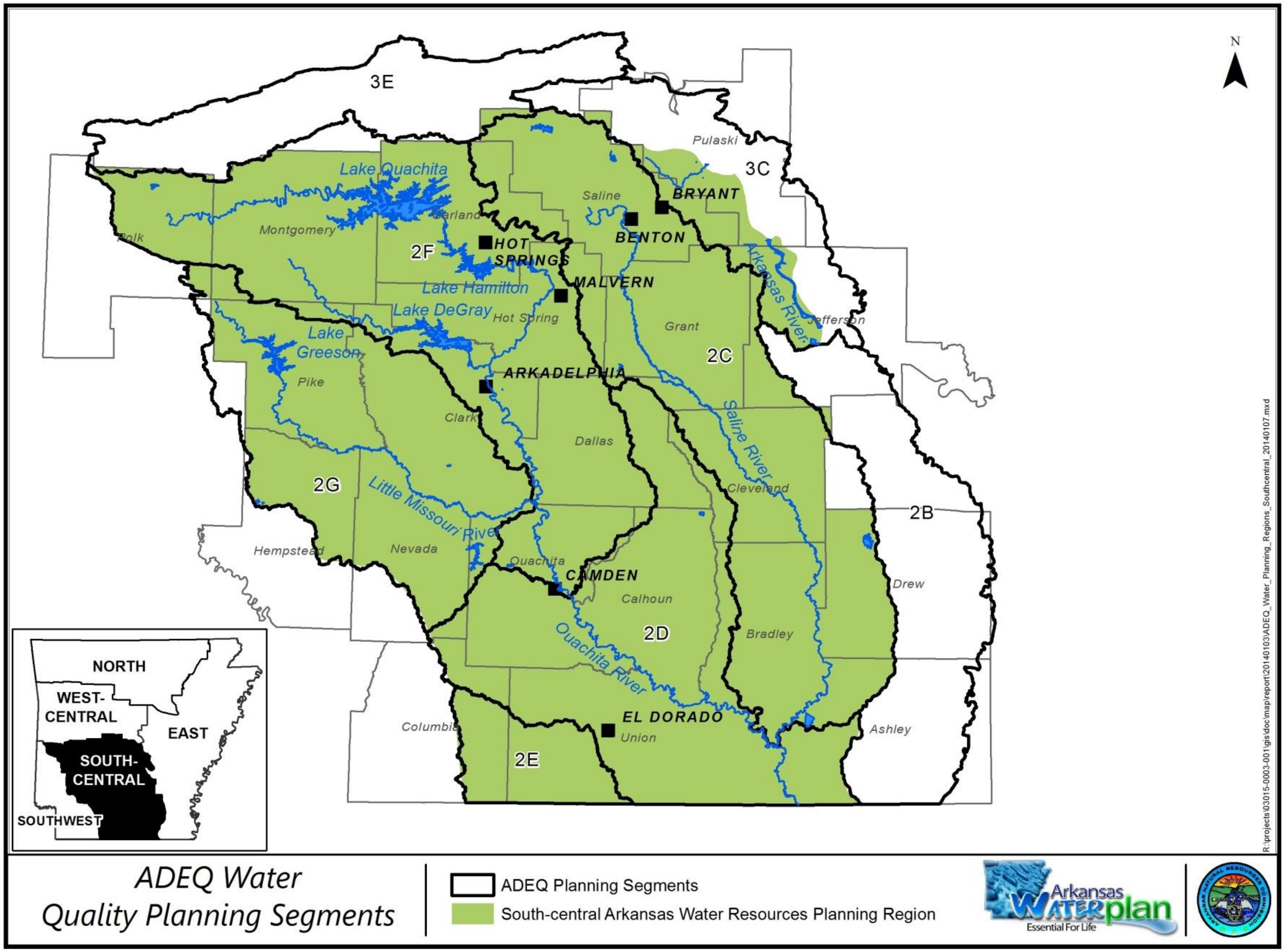


Figure 6.2. ADEQ water quality planning segments included in the SCAWRPR.

#### 6.1.3.3 Floodplain Management Regulations

Arkansas Code provides that it is the policy of the state to encourage and support actions to prevent and lessen flood hazards and losses. The state has the authority to adopt measures that will discourage development in flood-prone land, assist in reducing damage caused by floods, and improve long-range land management in flood-prone areas (Arkansas Code §14-268-101 et seq.).

Arkansas statute also requires each county, city, or town that is participating in the NFIP to designate a "person to serve as the floodplain administrator to administer and implement the ordinance and any local codes and regulations relating to the management of flood-prone areas" (Arkansas Code §14-268-106[a]). The designated floodplain administrator must also be accredited by ANRC under the commission's authority regarding flood control. State accreditation of floodplain administrators is regulated under ANRC Title 18 rules. Continuing education for the floodplain administrator is an especially important component of the state's accreditation program (Arkansas Code §14-268-106, §15-24-102, and §15-24-109).

#### 6.1.3.4 Water Management Regulations

Other state regulations and programs address additional aspects of water resources and their management. Table 6.12 summarizes these regulations, and the associated federal legislation. Highlighted regulations, programs, and legislation were promulgated after the 1990 AWP update.

The Arkansas Wetland Mitigation Banking Program (Arkansas Code §15-22-1002), authorized in 1995, is a state-sponsored initiative that promotes, in cooperation with federal, state, non-profit, and other interested entities, the restoration, creation, enhancement, and conservation of aquatic resources, including wetlands, streams, and deep-water aquatic habitat. This legislation authorizes ANRC to operate wetland and stream mitigation banks and to sell mitigation "credits" to private, nonprofit, and public entities required to provide mitigation for dredge and fill activities under the CWA. The "credits" represent the accrual or attainment of aquatic resource function at the mitigation bank site which results from restoration, creation, enhancement, or conservation efforts. The state wetland mitigation bank provides a costeffective alternative for mitigating impacts. USACE regulates both public and private mitigation banking and is responsible for approving the number of “credits” available within any individual bank. When an individual or entity is required to provide compensatory mitigation for unavoidable loss of function, USACE can approve the purchase of “credits” from the state mitigation bank to satisfy all regulatory mitigation requirements. In 2013, there are no state-sponsored wetland mitigation banks in the SCAWRPR (USACE 2013).

Table 6.12. State regulations relating to water management.

| Water Resources Regulation | Subjects/Programs | Related State Legislation | Related Federal Legislation |
|---|---|---|---|
| Title 6: Water plan compliance review procedures[1] | AWP | Arkansas Code §15-22-503 and 504 | None |
| Title 7: Rules governing design and operation of dams[1] | Dam safety | Arkansas Code §15-22-201 et seq. | WRDA/Dam Safety and Security Act |
| Title 12: Rules governing the Arkansas wetland mitigation program | Wetland mitigation bank | Arkansas Wetland Mitigation Bank Act (Arkansas Code §15-22-1001 et seq.) | CWA, Rivers and Harbors Act |
| Rules and regulations of the Arkansas Natural Heritage Commission | Arkansas Natural and Scenic Rivers System | Arkansas Natural and Scenic Rivers System Act (Arkansas Code §15-23-301 et seq.) | Wild and Scenic Rivers Act |
| Arkansas Wildlife Resources Regulations[2] | Allowance for fish passage at dams. | Arkansas Code §15-44-110 | |
| | Screens required on surface water intakes to protect fish | Arkansas Code §15-44-111 | |

Notes:
1. Enforcement by ANRC.
2. Enforcement by Arkansas Game and Fish Commission.

### 6.1.4 State Financial Assistance Programs

Arkansas has several state programs that provide financial incentives and assistance for water resources management. The federal government has delegated authority to the state to administer federal assistance programs of the CWA, the SDWA, and the Housing and Community Development Act.

#### 6.1.4.1 Assistance for Public Water and Wastewater Projects

ANRC is responsible for managing and distributing monies from several federal assistance programs intended to assist communities in constructing and maintaining drinking water and wastewater systems (Table 6.13). There are also state-funded programs that provide financial assistance to water supply and wastewater systems (Table 6.14). Programs shown in both Tables 6.13 and 6.14 utilize both federal and state funds.

Table 6.13. Federal water supply assistance programs managed by ANRC.

| Federal Program | Federal Funding Source | State Program |
|---|---|---|
| Community Development Block Grant Program | HUD | Arkansas Community and Economic Development Program |
| Safe drinking water state revolving fund, clean water state revolving fund | EPA | Water resources cost-share revolving fund program, construction assistance revolving loan fund |

Table 6.14. State programs for public water system assistance (administered by ANRC).

| State Water Use Regulations | State Assistance Programs | Related State Legislation |
|---|---|---|
| Title 5: Administrative rules and regulations for financial assistance | Water resources development general obligation bond fund; Water development fund program; Water resources cost-share revolving fund program; Water, sewer, and solid waste management system program; and Water, waste disposal, and pollution abatement facilities general obligation loan fund program | Arkansas Water Resources Cost Share Finance Act (Arkansas Code §15-22-801 et seq.), Arkansas Water, Waste Disposal, and Pollution Abatement Facilities Financing Act (Arkansas Code §15-20-1301 et seq.) |
| Title 15: Rules governing loans from the safe drinking water revolving loan fund | Safe drinking water revolving loan fund program, Construction assistance revolving loan fund | Arkansas Code §15-22-1101 et seq. |
| Title 16: Rules governing the Arkansas clean water revolving loan fund program | Clean water revolving loan fund program, Construction assistance revolving loan fund | Arkansas Code §15-5-901 et seq. |
| Title 23: Rules governing water and wastewater project funding through the Arkansas community and economic development program | Funding for construction or improvement of community treatment facilities for drinking water | Arkansas Code §15-5-901 et seq. |

#### 6.1.4.2 State Financial Incentive and Assistance Programs for Promoting Water Quality and Water Resources Management

ADEQ and ANRC administer a number of incentive and assistance programs related to water resources management (Table 6.15). These include programs to assist with clean-up of hazardous waste contamination, reduction of nonpoint source pollution, and management of solid wastes to protect water quality. In addition, there are state programs to encourage water conservation and preservation of wetlands. All but one of the programs listed in Table 6.15 are funded by state sources. The state nonpoint source pollution management grant program is federally funded under the authority of the Clean Water Act Section 319.

Table 6.15. State incentive and assistance programs that protect water quality.

| State Regulation | State Assistance Programs | Related State Legislation | Related Federal Legislation |
|---|---|---|---|
| Regulation 11: Solid Waste Disposal Fees, Landfill Post-Closure Trust Fund, and Recycling Grants Programs[a] | Recycling fund | Solid Waste Management Recycling Fund Act (Arkansas Code §8-6-601 et seq.) | RCRA |
| Regulation 12: Storage Tank Regulations[a] | Petroleum storage tank trust fund | Petroleum Storage Tank Trust Fund Act (Arkansas Code §8-7-901 et seq.) | CWA, Underground Storage Tank Regulations, including Energy Policy Act of 2005 |
| Regulation 29: Brownfields Redevelopment[a] | Clean-up funding | Arkansas Hazardous Waste Management Act (Arkansas Code §8-7-201 et seq.), Remedial Action Trust Fund Act (Arkansas Code §8-7-501 et seq.) | CERCLA |
| Regulation 30: Remedial Action Trust Fund, Site Priority List[a] | Clean-up funding, prioritization of contaminated sites for clean-up | Remedial Action Trust Fund Act (Arkansas Code §8-7-501 et seq.) | CERCLA |
| Title 5: Administrative rules and regulations for financial assistance[b] | Sewer and solid waste management systems program; Waste disposal and pollution abatement facilities general obligation bond program; Water, waste disposal, and pollution abatement facilities general obligation loan fund program | Arkansas Code §14-230-101 et seq., §15-22-601 et seq., §15-22-701 et seq. | None |

Table 6.15. State incentive and assistance programs that protect water quality (continued).

| State Regulation | State Assistance Programs | Related State Legislation | Related Federal Legislation |
|---|---|---|---|
| Title 10: Rules governing the Arkansas water resource agricultural cost-share program[(b)] | Arkansas water resources agricultural cost-share program | Arkansas Code §15-22-913 through 914, §15-22-507 | |
| Title 13: Rules governing the tax credit program for the creation and restoration of private wetland and riparian zones[(b)] | Wetlands and Riparian Zone Tax Credit Program | Arkansas Private Wetland Riparian Zone Creation and Restoration Incentive Act (Arkansas Code §26-51-1501 et seq.) | None |
| Title 14: Rules for implementing the Water Resources Conservation and Development Incentives Act[(b)] | Groundwater conservation tax incentives | Water Resource Conservation and Development Incentives Act (Arkansas Code §26-51-1001 et seq.) | |
| Title 23: Rules governing water and wastewater project funding through the Arkansas community and economic development program[(b)] | Funding for construction or improvement of community treatment facilities for wastewater | None | Housing and Community Development Act |
| None | Nonpoint source pollution grant program[2] | None | CWA (Section 319) |

Notes: Highlighted regulations, programs, and legislation were promulgated after the 1990 AWP update.

a. Responsible state agency is ADEQ.

b. Responsible state agency is ANRC.

### 6.1.5 Non-Regulatory State Water Management Programs

There are state agency programs for natural resources protection and management that apply to water resources. These include planning, guidance, and incentive programs. These programs do not necessarily have regulations associated with them. However, they guide the activities of state agencies related to water resources. The AWP is one such program. Others are described below.

#### 6.1.5.1 Arkansas Nonpoint Source Pollution Management Plan

ANRC regularly prepares a state nonpoint source pollution management plan. The purpose of this plan to provide a guide and focus for public agencies, nonprofit organizations, interest groups, and other stakeholders to work together to “develop, coordinate, and implement programs to reduce, manage or abate” nonpoint source pollution. The plan is updated every 5 years. The current plan was updated in 2010.

#### 6.1.5.2 Arkansas Forestry Best Management Practices

The Arkansas Forestry Commission has prepared a booklet of approved guidelines for conducting forest management practices in a way that minimizes water quality impacts. Implementation of these best management practices is voluntary. These management practices are applicable to commercial and private timber operations on public or private land.

#### 6.1.5.3 State Wildlife Action Plan

A state wildlife action plan was prepared by AGFC and approved by USFWS in 2007. This plan prioritizes activities to protect species of greatest conservation need and their habitats throughout the state. This plan addresses amphibians, birds, fish, crayfish, insects, mammals, mussels, and reptiles. There are over 70 species of greatest conservation need identified in this plan that are found in the aquatic habitats in the SCAWRPR. The most highly recommended conservation activities for the ecoregions in this planning region are habitat restoration and protection (Anderson 2006).

#### 6.1.5.4 State Wetland Strategy

A state wetland strategy was developed in 1995 by a team of Arkansas agencies. This strategy consisted of 10 elements that addressed conservation and restoration of wetlands, and improving understanding of wetlands, both by the scientific and natural resources community and by the public. Implementation of this strategy resulted in legislation that created the Arkansas Mitigation Banking Program, and the Arkansas Riparian Zone and Wetland Creation Tax Credit Program (Arkansas Multi-agency Wetlands Planning Team 1995).

### 6.1.6 Regional Water Resources Management Programs

Several agencies and organizations have developed water resources management or restoration programs for areas within the SCAWRPR. The purpose of some of these programs is to implement a state or federal regulation or policy, such as ambient water quality standards, no net loss of wetlands, or conservation of wildlife. These programs constitute a framework that provides opportunities for leveraging resources (personnel and funding) to accomplish water resources management goals. Examples of these regional water resources management programs are described below.

#### 6.1.6.1 Nine-Element Watershed Plans

Watershed plans are required by the CWA to guide activities for reducing pollution in waterbodies for which TMDLs have been developed. EPA has prepared guidance describing the nine elements that should be included in watershed plans to achieve TMDLs calculated for impaired waterbodies. A nine-element watershed plan must be completed and approved by EPA before restoration projects in the watershed can receive funding from the CWA NPS Program (Section 319 funding). The Upper Saline River in the planning region has an updated NPS pollution management plan that addresses nutrient enrichment in the stream from both point and nonpoint sources (ANRC 2012a). Development of a nine-element watershed plan is a priority activity in priority watersheds designated by ANRC (see Section 5.3.5 for information on priority watersheds in the planning region).

#### 6.1.6.2 Nonprofit Organizations

There are several nonprofit organizations that have active water resources programs within the SCAWRPR. These include The Nature Conservancy, Audubon Society, Ouachita River Valley Association, and Ducks Unlimited. Many of the water resources programs of these organizations involve state and federal agencies and their programs, along with public support.

The Nature Conservancy manages a natural area in the SCAWRPR where water resources are an important element of the ecology, Simpson Preserve at Trap Mountain. The

Nature Conservancy Ouachita Rivers Program and Conservation Forestry Program also protect and restore water resources in the planning region.

The Audubon Society has identified aquatic important bird areas in the SCAWRPR. These include a small island in Lake Ouachita, and the Felsenthal National Wildlife Refuge. These areas are important for supporting both resident and migrating waterfowl.

Ducks Unlimited has waterfowl habitat restoration projects in four counties in the SCAWRPR: Cleveland, Dallas, Hempstead, and Hot Spring.

The Ouachita River Valley Association promotes development of land and water resources in the Ouachita River basin in both Arkansas and Louisiana. The primary focus of this organization is the Ouachita-Black Rivers Navigation Project and its use for navigation, recreation, water supply, wildlife habitat, and flood control.

### 6.1.7 Local Regulations

There are also local regulations that influence management of water resources. These can include zoning laws; regulations promulgated by municipalities, counties, water and wastewater utilities; and regulations promulgated by irrigation, drainage, water, and sewer districts.

### 6.1.8 Interstate Compact

Arkansas is part of the Red River Compact, an interstate compact agreement among the states of Arkansas, Oklahoma, Texas, and Louisiana. One purpose of the compact is to promote the equitable apportionment and development of the water in the river basin among the participating states. According to Article II, Section 2.01 of the Red River Compact, each member state may use the water allocated to it by the compact in any manner deemed beneficial by that state. Each state may freely administer water rights and uses in accordance with the laws of that state, but such uses shall be subject to availability of water in accordance with the apportionments made by the compact.

There are five defined reaches in the Red River Basin covered by the compact (Figure 6.3). The SCAWRPR is included in Reach IV of the Red River. Guaranteed minimum flows are not set for the Ouachita River, nor other planning region streams in the compact. However, a flow criterion of 780 cfs is defined for the Ouachita River at the state line. When this flow is reached, Arkansas agrees to manage diversions from the Ouachita River to ensure an equitable portion of flow passes into Louisiana (Red River Compact Commission 1978).

## 6.2 Institutional Framework

Governmental responsibility for water resources management in the SCAWRPR is split among many agencies on three levels (federal, state, and local). As a result, management of water resources in the SCAWRPR can require coordination among a number of government entities. In addition, there are a number of non-governmental organizations that participate in water resources management in the planning region.

### 6.2.1 Federal Agencies

There are 17 federal agencies involved in water resources management in the SCAWRPR. These federal agencies are listed in Table 6.16, along with their respective activities in this planning region.

### 6.2.2 Arkansas Agencies

There are over 20 Arkansas agencies involved in water resources management in the SCAWRPR. These state agencies are listed in Table 6.17, along with a description of their water resources management responsibilities within the planning region.

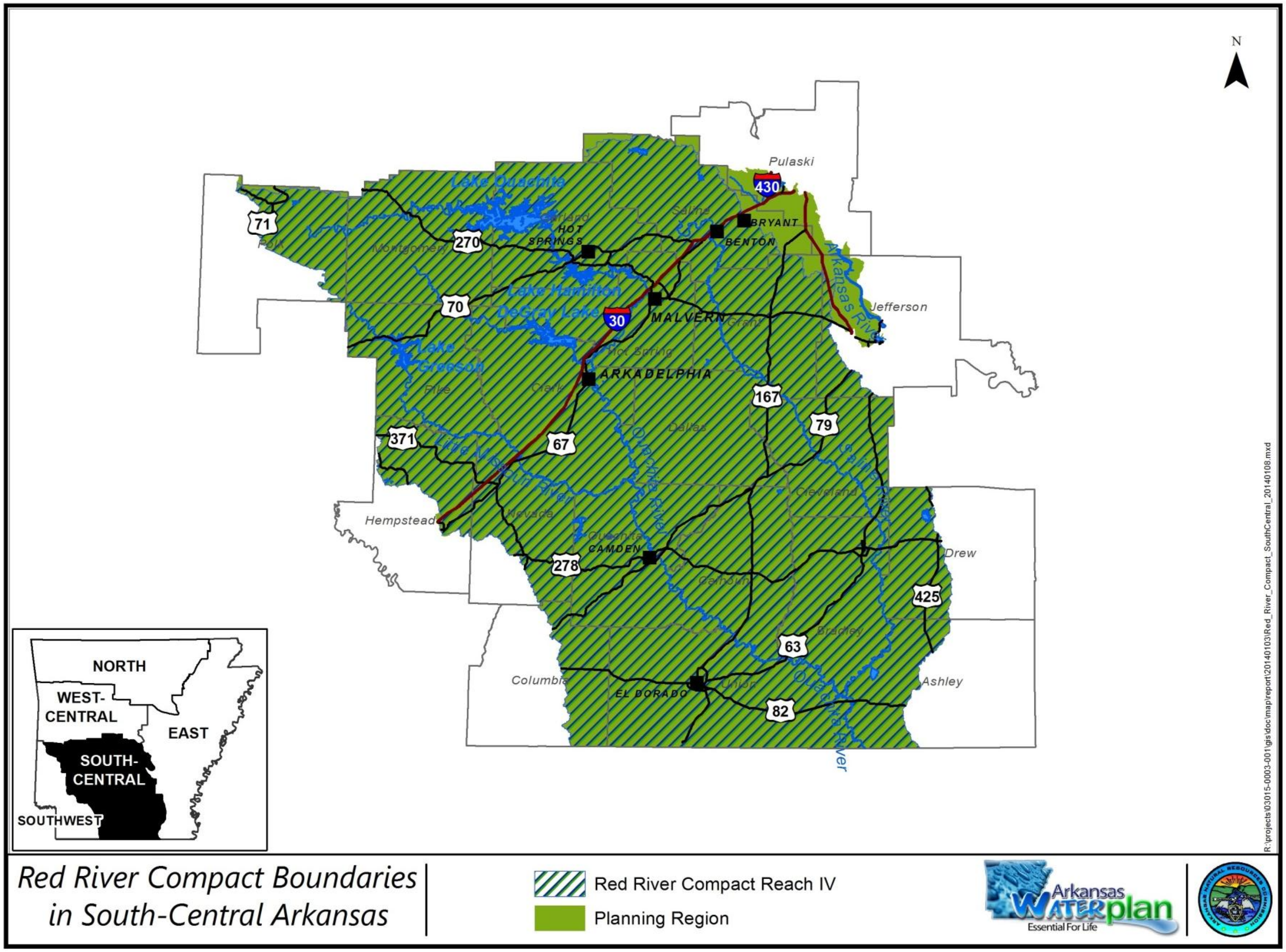


Figure 6.3. Red River Compact boundary within the SCAWRPR.

Table 6.16. Federal agencies with water resources-related responsibilities in the SCAWRPR.

| Federal Agency | Responsibility in Arkansas |
|---|---|
| EPA | • Oversees state agencies in implementation of management and funding programs under:<br>o CWA<br>o SDWA<br>o RCRA,<br>o Superfund (CERCLA),<br>o FIFRA, and<br>o Surface Mining Control and Reclamation Act.<br>• Conducts TMDL studies and other water quality studies in the state.<br>• Implements programs under TSCA. |
| Federal Energy Regulatory Commission | • Oversees environmental matters related to natural gas and hydropower projects in the planning region. |
| FEMA | • Prepares flood hazard maps for the state and encourages state and local governments to guide development decisions away from defined flood hazard risk areas through participation in the NFIP. |
| HUD | • Provides funding for water and wastewater infrastructure improvements. |
| NOAA | • Participates in monitoring precipitation and climate in the planning region. |
| NRCS | • Implements over 20 Farm Bill erosion control and habitat restoration funding and technical assistance programs in the planning region.<br>• Appraises the status and trends of soil, water, and related resources on non-federal land in the state and assesses their capability to meet present and future demands. |
| NRCS National Water Management Center | • Located in Little Rock.<br>• Serves as a water resources information exchange.<br>• Provides support and training related to:<br>o Environmental compliance,<br>o Hydrology and hydraulics,<br>o Stream geomorphology and restoration,<br>o Water quality and quantity,<br>o Watershed and dam rehabilitation, and<br>o Technology outreach. |
| Southwestern Power Administration | • Markets and delivers hydroelectric power produced at USACE hydropower projects in the planning region. |
| USACE | • Manages federal water, navigation, flood control, and hydropower projects in the planning region.<br>• Implements sections of the CWA related to impacts to navigable waters and wetlands.<br>• Constructs flood control, water supply projects, and conducts water resources studies authorized by the WRDA.<br>• Oversees conducts water resources studies, dam safety for federal dams. |

Table 6.16. Federal agencies with water resources-related responsibilities in the SCAWRPR (continued).

| Federal Agency | Responsibility in Arkansas |
|---|---|
| USDA | • Conducts the Census of Agriculture.<br>• Conducts the Natural Resources Inventory.<br>• Manages Conservation Effects Assessment Projects (watershed and regional). |
| USDA Farm Services Agency | • Implements the CRP for erosion control and habitat restoration in the planning region. |
| USDA Rural Development | • Implements USDA rural utilities financial assistance programs |
| USDI National Park Service | • Manages one national park and associated water resources within the planning region.<br>• Provides funds for land and water conservation projects. |
| USFS | • Manages the Ouachita National Forest and associated surface waters.<br>• Forest management incentive programs.<br>• Participates in forest inventory.<br>• Manages Urban and Community Forestry Program. |
| USFWS | • Implements the Endangered Species Act and programs to:<br>o Promote management of ecosystems,<br>o Promote conservation of migratory birds,<br>o Promote preservation of wildlife habitat,<br>o Promote restoration of fisheries,<br>o Combat invasive species, and<br>o Promote international wildlife conservation.<br>• Manages Felsenthal NWR in the planning region.<br>• Implements the Partners For Wildlife Program for restoration of bottomland hardwood forests.<br>• Conducts the National Wetland Inventory.<br>• Oversees state wildlife planning through the State Wildlife Grant Program. |
| USGS | • Flow and stage monitoring of rivers and streams.<br>• Groundwater level monitoring.<br>• Water quality monitoring.<br>• Groundwater modeling.<br>• Water quality modeling.<br>• Water data storage and management. |
| US Army | • Manages water resources associated with Pine Bluff Arsenal. |

Table 6.17. State agencies and entities with responsibilities related to water resources in the SCAWRPR.

| State Agency | Responsibility |
|---|---|
| ADEQ | • Implements state water quality policy and the NPDES program.<br>• Develops and enforces water quality standards.<br>• Investigates citizen complaints regarding water pollution.<br>• Oversees solid waste management.<br>• Operates the hazardous waste management program.<br>• Manages contaminated site clean-up and redevelopment programs.<br>• Develops and enforces mining and mine site reclamation regulations.<br>• Manages the storage tank regulation program.<br>• Permits no-discharge facilities and underground injection operations.<br>• Water quality monitoring and assessment. |
| ANRC | • Regulates, permits, and tracks water use and dam construction.<br>• Monitors climate.<br>• Administers federal water resources funding programs.<br>• Prepares water resources and nonpoint source pollution management plans.<br>• Develops and maintains mitigation banking and restoration incentive programs for aquatic resources.<br>• Supports conservation districts.<br>• Registers poultry feeding operations.<br>• Certifies nutrient management planners and applicators.<br>• Promotes public health and safety and minimize flood losses through:<br>o Training,<br>o Education,<br>o Technical assistance in floodplain management, and<br>o Accrediting floodplain administrators. |
| ADH | • Regulates public water supply systems.<br>• Implements the SDWA source water protection programs.<br>• Issues fish consumption advisories.<br>• Implements state health rules and regulations that apply to water resources.<br>• Regulates septic tanks and licenses septic tank cleaners.<br>• outdoor bathing and swimming.<br>• Implements state marine sanitation program. |
| Arkansas Department of Parks and Tourism | • Manages the 11 state parks and associated water resources in the planning region.<br>• Prepares comprehensive outdoor recreation plan.<br>• Manages outdoor recreation grant program. |
| Arkansas Forestry Commission | • Provides guidelines for protection of water resources in forestry operations.<br>• Monitors use of forestry BMPs.<br>• Participates in forest inventory.<br>• Implements forest management incentive programs.<br>• Implements Urban and Community Forestry program.<br>• Designates and manages state forests for a variety of purposes, including:<br>o Watershed protection, and<br>o Erosion and flood control. |

Table 6.17. State agencies and entities with responsibilities related to water resources in the SCAWRPR (continued).

| State Agency | Responsibility |
|---|---|
| AGFC | • Manages protection, conservation and preservation of fish and wildlife in the planning region through:<br>o Habitat management,<br>o Wildlife management areas,<br>o Fish stocking,<br>o Hunting and fishing regulations, and<br>o Education and outreach programs.<br>• Prepares state Wildlife Action Plan.<br>• Implements conservation grant programs.<br>• Manages over 5,000 acres of public waters in the planning region. |
| Arkansas Geological Survey | • Participates in research of, and provides information and education about, state water resources.<br>• Performs mapping.<br>• Maintains water well construction records. |
| Arkansas Livestock and Poultry Commission | • Regulates disposal of livestock carcasses. |
| Arkansas Multi-agency Wetland Planning Team | • Developed the state wetland strategy and is the lead for developing state numeric nutrient criteria for wetlands. |
| ANHC | • Surveys and conducts research on natural communities in the state.<br>• Acquires natural areas for preservation.<br>• Manages the Arkansas Natural and Scenic Rivers system. |
| Arkansas Oil and Gas Commission | • Provides technical assistance related to protection of water resources from wastes associated with production of the following:<br>o Oil,<br>o Natural gas, and<br>o Brine.<br>• Issues permits for drilling and operation of the following:<br>o Oil, natural gas, and brine production wells, and<br>o Injection and disposal wells. |
| APCEC | • Environmental policy-making body for the state. |
| Arkansas Public Service Commission | • Regulates rates and services of private water utilities, as well as utilities water crossings. |
| Arkansas State Board of Health | • Promulgates health rules and regulations for the state. |
| Arkansas State Highway and Transportation Department (AHTD) | • Issues hazardous waste transportation permits.<br>• Provides stormwater management.<br>• Develops and implements construction BMPs. |

Table 6.17. State agencies and entities with responsibilities related to water resources in the SCAWRPR (continued).

| State Agency | Responsibility |
|---|---|
| Arkansas State Plant Board | • Implements Insecticide, Fungicide, and Rodenticide Act programs, including:<br>o Pesticide registration,<br>o User and applicator training, and<br>o Dealer licensing.<br>• Implements state pesticide management plan for groundwater protection.<br>• Provides groundwater quality monitoring, and<br>• Provides climate/weather monitoring |
| Arkansas Water Well Construction Commission | • Regulates development of groundwater for drinking water through licensing water well contractors and registering drillers and pump installers.<br>• Regulates specifications for construction of water wells.<br>• Maintains water well construction records. |
| Arkansas Waterways Commission | • Studies and promotes navigable waterways for transportation and economic development. |
| U of A Cooperative Extension Service | • Provides technical assistance to Arkansans related to water conservation, and protection and restoration of water quality. |
| U of A Water Resources Center | • Participates in research related to water resources, and in water resources management projects. |

### 6.2.3 Federal-State Organizations

There are at least three federal-state organizations involved in water resources management in the SCAWRPR:

- Red River Compact Commission,
- Arkansas Conservation Partnership, and
- Arkansas Watershed Advisory Group.

The Red River Compact Commission administers the Red River Compact, which applies to the entire planning region (see Section 6.1.6). The commission is made up of one representative from the water agency of each of the member states (ANRC in Arkansas), a resident from each state chosen by the governor, and a federal representative appointed by the US president (Oklahoma Water Resources Board n.d.).

The Arkansas Conservation Partnership supports locally led natural resources conservation through coordination of education, financial, and technical assistance to landowners. Water resources and implementation of Farm Bill programs are two of the six natural resource issues that are the focus of the partnership. Members of the partnership include NRCS, other federal agencies, as well as ANRC, Arkansas Association of Conservation Districts, U of A Cooperative Extension, U of A at Pine Bluff, and Arkansas Forestry Commission. This partnership was formed in 1992 (ANRC 2012c, Cooperative Conservation America n.d.).

The Arkansas Watershed Advisory Group (AWAG) provides technical assistance to form local watershed groups, hosts an annual water quality conference, and facilitates quarterly discussions of voluntary water quality management approaches. AWAG is a consortium of federal and state agencies with private citizens (ANRC 2012c).

### 6.2.4 Regional and Local Entities

There are numerous regional and local entities in the SCAWRPR that are involved in activities related to water resources management. Examples of the types of local and regional entities present in this planning region are shown in Table 6.18, along with descriptions of their activities related to water resources management.

Table 6.18. Some of the regional and local government entities involved in water resources management in the SCAWRPR.

| Regional or Local Entity | Water Resources Involvement |
|---|---|
| Local Conservation Districts | • Work with state and federal agencies to implement measures for the control of erosion and flooding, and conservation of soil and water resources. |
| County Government | • Responsible for unincorporated areas, sometimes including floodplain management and zoning. |
| Drainage Districts | • Plan, construct, and maintain a system to drain lands; usually created by circuit court order. |
| Improvement Districts | • Implement federal projects for improvement of any river, tributary, or stream bordering the state.<br>• Created by circuit court order. |
| Irrigation Districts | • Distribute water resources.<br>• Created by circuit court order. |

Table 6.18. Some of the regional and local government entities involved in water resources management in the SCAWRPR (continued).

| Regional or Local Entity | Water Resources Involvement |
|---|---|
| Levee Districts | • Provide for the construction and maintenance of levees for flood protection. |
| Red River Compact Commission | • Administers the Red River Compact. |
| Regional Planning and Economic Development Districts | • Improve water supply and wastewater infrastructure.<br>• Assist Regional Solid Waste Management Districts. |
| Regional Solid Waste Management Districts | • Manage collection, disposal, and recycling of solid waste. |
| Regional Water Distribution Districts | • Public nonprofit organizations for distribution of water from USACE water projects. |
| Southeast Arkansas Regional Planning Commission | • Provides stormwater management education and outreach. |
| Universities | • Perform water resources and management research, education, and outreach. |
| Water districts and associations | • Water supply planning and management.<br>• Supply water and wastewater services. |

### 6.2.5 Nonprofit Groups

There are several nonprofit interest groups that conduct activities in the SCAWRPR that are related to water resources management. Some of these organizations are listed in Table 6.19 with a description of their water resources-related activities in the planning region.

### 6.2.6 Institutional Interactions in Water Resources Management

As noted at the beginning of this section, water resources management in the SCAWRPR involves numerous entities at multiple scales. Examples of the interactions among federal, state, and local entities that occur in water resources management in the SCAWRPR are presented in Table 6.20.

Table 6.19. Examples of nonprofit groups involved in water resources management in the SCAWRPR.

| Nonprofit | Water Resources Involvement |
|---|---|
| Arkansas Farm Bureau | • Advocates for agriculture. |
| Arkansas Waterways Association | • Promotes and protects Arkansas inland transportation waterways. |
| Arkansas Wildlife Federation | • Promotes conservation of aquatic habitat for fish and wildlife. |
| Audubon Arkansas | • Promotes three aquatic Important Bird Areas in the planning region. |
| Ducks Unlimited | • Promotes conservation and restoration of aquatic habitat for waterfowl at several sites in the planning region. |
| Stream teams | • Provides water quality monitoring, stream bank rehabilitation, and restoration of fish habitat. |
| The Nature Conservancy | • Provides/implements the following:<br>o Ouachita Rivers Program.<br>o Bauxite Natural Areas.<br>o Lorance Creek Natural Area.<br>o Ouachita River Nature Preserve.<br>o Simpson Preserve. |
| Ouachita River Valley Association | • Oversees Ouachita-Black Rivers Navigation Project. |
| Arkansas Water Works and Water Environment Association | • Support of water and wastewater utilities. |
| Arkansas Rural Water Association | • Support of rural water and wastewater utilities. |
| Arkansas Environmental Federation | • Advocates for industry. |

Table 6.20. Examples of interactions of federal, state, and local entities in water resources management within the SCAWRPR.

| State Water Resources Responsibility/Program | Involves: | | |
|---|---|---|---|
| | **Federal Entities** | **State Entities** | **Regional or Local Entities** |
| Water use registration | USGS (houses registration database) | ANRC (program lead) | Water utilities, irrigation districts, industry (water withdrawers) |
| Dam safety | USACE (federal dams)<br>FEMA (oversight) | ANRC (program lead), AGFC (dam builder), Arkansas Department of Parks and Tourism (dam builder) | Water and electric utilities, municipalities, counties (dam builders) |
| State climate monitoring | NOAA National Weather Service, NOAA National Climatic Data Center, USGS (precipitation monitoring), USACE (climate monitoring) | ANRC (State Climatologist), Arkansas State Plant Board (monitoring) | Community Collaborative Rain, Hail & Snow Network |
| Safe Drinking Water Act funding | EPA (funding) | ANRC (program lead) | Water utilities, municipalities/ communities, water districts |

Table 6.20. Examples of interactions of federal, state, and local entities in water resources management within the SCAWRPR (continued).

| State Water Resources Responsibility/Program | Involves: | | |
|---|---|---|---|
| | Federal Entities | State Entities | Regional or Local Entities |
| Interstate water compacts | NRCS, USGS, USACE | ANRC (state representative) | Red River Compact Commission |
| Water Resources Conservation Tax Incentives | NRCS | ANRC (program lead), U of A Cooperative Extension Service | Conservation districts |
| Conservation district grants program | None | ANRC (program lead) | Conservation districts |
| Community development block water and wastewater grants | HUD (funding) | ANRC (program lead), Arkansas Economic Development Commission | Water utilities, wastewater utilities, water districts, sewer districts |
| Floodplain management | FEMA | ANRC (certification) | Levee districts, counties, and municipalities |
| Nonpoint source pollution management | EPA (funding), NRCS (conservation programs), USFS (BMPs), The Nature Conservancy (projects), USDA Farm Services Agency (conservation program) | ANRC (program lead), Universities, Arkansas Water Resources Center, Audubon Arkansas, U of A Cooperative Extension Service, Arkansas Farm Bureau, ADEQ (TMDLs) | Watershed organizations, conservation districts, water districts, stream teams |
| Clean Water Act funding program (including nonpoint source and clean water revolving fund) | EPA (funding) | ANRC (program lead) | Watershed organizations, sewer districts, municipalities, land owners, nonprofit organizations |
| Groundwater protection and management – critical groundwater areas | USGS, USACE (water projects) | ANRC (program lead), Water Well Construction Commission | Counties, irrigation districts (water projects) |
| Wetland and riparian zone tax credit program | None | ANRC (program lead) | Watershed organizations, land owners, communities |
| Wetland and stream mitigation | USACE (lead) | ANRC (program lead), AHTD, AGFC, ADEQ, ANHC | Land owners/developers |
| Non-riparian water use certification | None | ANRC (program lead) | Water utilities |
| Arkansas Recovery Act water and wastewater funding | Recovery Accountability and Transparency Board | ANRC (program lead) | Water utilities, wastewater utilities, water districts, sewer districts |
| State water utility funding | None | ANRC (program lead) | Water utilities, water districts |
| State wastewater utility funding | None | ANRC (program lead) | Wastewater utilities, sewer districts |
| NPDES discharge permits | EPA (oversight, guidance) | ADEQ (program lead) | Dischargers |
| Underground injection control | EPA | ADEQ (program lead), Arkansas Oil and Gas Commission (program lead) | Dischargers |
| Wastewater pretreatment program | EPA | ADEQ (program lead) | Dischargers |

Table 6.20. Examples of interactions of federal, state, and local entities in water resources management within the SCAWRPR (continued).

| State Water Resources Responsibility/Program | Involves: | | |
|---|---|---|---|
| | **Federal Entities** | **State Entities** | **Regional or Local Entities** |
| Water quality standards | EPA | APCEC (regulations), ADEQ (implementation, enforcement), ANRC (groundwater standards), Multi-agency Wetland Planning Team (nutrient criteria for wetlands) | Local governments, regulated entities, interest groups |
| Water quality assessment | EPA (oversight, guidance), USGS (data), USACE (data) | ADEQ (implementation), ANRC (data) | None |
| TMDLs | EPA (oversight, guidance), USGS (data), USACE (data) | ADEQ (program lead) | None |
| Storage tank regulation | EPA | ADEQ (program lead) | Tank owners |
| Solid waste management | EPA (oversight) | ADEQ (program lead) | Regional solid waste management districts |
| Landfill post-closure trust fund | None | ADEQ (program lead) | Regional solid waste management districts |
| Hazardous waste management | EPA | ADEQ (program lead), AHTD (transport) | Interest groups |
| Remedial action trust fund | None | ADEQ | Interest groups |
| Brownfields | EPA | ADEQ | Municipalities |
| Superfund | EPA | ADEQ | Interest groups |
| Mining reclamation | USDI | ADEQ | Interest groups, mining companies |
| Water quality monitoring | EPA (oversight, studies), USGS (monitoring, studies), USACE (monitoring, studies) | ADEQ, ANRC, U of A Arkansas Water Resources Center (studies), AGFC (stream teams), Arkansas State Plant Board (groundwater monitoring), ANRC, universities | Stream teams (monitoring), water utilities (monitoring) |
| Fish tissue sampling | EPA (mercury), US Food and Drug Administration (guidelines) | ADEQ (program lead), ADH (consumption advisories), AGFC (sampling) | None |
| Stormwater management | EPA | ADEQ, U of A Cooperative Extension Service | Counties, municipalities |
| Spill prevention | EPA | ADEQ | Industry |
| Finished drinking water criteria | EPA | ADH | Water utilities, water districts |
| Source Water Protection | EPA | ADH, Arkansas Water Well Construction Commission | Water utilities (planning) |
| Drinking Water Consumer Information | EPA | ADH | Water utilities |
| Regulation of drinking water utilities | EPA | ADH, Arkansas Public Service Commission | Water utilities |

Table 6.20. Examples of interactions of federal, state, and local entities in water resources management within the SCAWRPR (continued).

| State Water Resources Responsibility/Program | Involves: Federal Entities | State Entities | Regional or Local Entities |
|---|---|---|---|
| Pesticide registration, labeling and classification | EPA | Arkansas State Plant Board | Pesticide distributors and users |
| Community Forestry | USFS | Arkansas Forestry Commission, Arkansas Urban Forestry Council | Municipalities |
| Forest stewardship | USFS, USDA Farm Services Agency, NRCS | Arkansas Forestry Commission, AGFC, ANRC, Arkansas Historic Preservation Program, U of A Cooperative Extension Service, ANHC | Landowners |
| Forest Legacy | USFS (funding), Land Trust Alliance | Arkansas Forestry Commission | Landowners |
| State parks | USACE, National Park Service (funding) | Arkansas Department of Parks and Tourism | Interest groups |
| Stream teams | None | AGFC | Stream teams |
| Wildlife management areas, refuges | USFWS | AGFC | Nonprofit organizations |
| Fishing and boating programs | USACE, USFWS | AGFC, Arkansas Department of Parks and Tourism | None |
| Pollution prevention program | EPA | ADEQ | Industry |
| Commercial navigation | USACE Memphis and Little Rock Districts | Arkansas Waterways Commission | Ouachita River Valley Association |
| Wild/Natural and scenic river systems | USFS | Arkansas Natural and Scenic Rivers Commission, ANHC, ADEQ | Watershed organizations |

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# APPENDIX A

## 2008 303(d) List of Impaired Waterbodies in the SCAWRPR

| ADEQ Planning Segment | Total miles | Stream miles assessed | Designated uses impaired | Stream miles impaired | Pollutant | Stream miles | Source |
|---|---|---|---|---|---|---|---|
| 2C – Saline River & tributaries | 576.3 | 527.2 | Aquatic life | 140.9 | Sediment/siltation | 68.7 | Erosion |
| | | | | | Copper | 72.2 | Unknown |
| | | | | | Lead | 63 | unknown |
| | | | | | pH | 28.9 | Unknown |
| | | | Drinking water supply | 95.7 | beryllium | 95.7 | unknown |
| | | | Agriculture & industrial water supply | 119.5 | TDS | 119.5 | unknown |
| | | | Fish Consumption | 89.9 | Mercury | 89.9 | |
| | | | Total | 158.4 | | | |
| 2D – Lower Ouachita River & tributaries | 394.2 | 345.6 | Agriculture & industrial water supply | 49.9 | TDS, sulfate | 49.9 | Resource extraction, industrial point source |
| | | | Aquatic life | 271.3 | Copper | 148.6 | Industrial point source, municipal WWTP |
| | | | | | DO | 43.9 | Unknown |
| | | | | | Lead | 77.9 | Unknown, municipal WWTP |
| | | | | | Sediment/siltation | 113.8 | Erosion |
| | | | | | Zinc | 255.3 | Unknown, resource extraction, industrial point source |
| | | | | | pH | 8 | Industrial point source |
| | | | Drinking water supply | 8.5 | Nitrate | 8.5 | Industrial point source |
| | | | Aquatic life & drinking water | 32.5 | Ammonia | 8.5 | Industrial point source |
| | | | | | Chloride & TDS | 32.5 | Industrial point source |
| | | | | | Sulfate | 24.5 | Industrial point source |
| | | | Fish Consumption | 229.7 | Mercury | 229.7 | |
| | | | Total | 345.6 | | | |

| ADEQ Planning Segment | Total miles | Stream miles assessed | Designated uses impaired | Stream miles impaired | Pollutant | Stream miles | Source |
|---|---|---|---|---|---|---|---|
| 2E – Upper Cornie Bayou & tributaries | 44 | 44 | Aquatic life | 44 | Sediment/siltation | 44 | Resource extraction |
| | | | | | Zinc | 44 | Resource extraction |
| | | | Agriculture & industrial water supply | 44 | Sulfate | 44 | Resource extraction |
| | | | | | beryllium | 15 | unknown |
| | | | total | 44 | | | |
| 2F – Ouachita River & tributaries: headwaters to Two Bayou | 642.2 | 576 | Aquatic life | 116.4 | Zinc | 68.3 | Resource extraction, unknown |
| | | | | | Sediment/siltation | 10 | Erosion |
| | | | | | pH | 42.8 | Resource extraction, unknown |
| | | | | | Cadmium | 2.5 | Resource extraction |
| | | | | | Copper | 29.1 | Resource extraction, unknown |
| | | | | | DO | 10 | Unknown |
| | | | Primary contact | 22.5 | Pathogens | 22.5 | Unknown |
| | | | Drinking water supply | 19.5 | beryllium | 47.3 | Resource extraction |
| | | | | | Sulfate | 2.5 | Resource extraction |
| | | | | | Zinc | 19.5 | Resource extraction |
| | | | Agriculture & industrial water supply | 12.5 | Sulfate | 14.3 | Resource extraction |
| | | | | | TDS | 12.1 | Resource extraction |
| | | | Total | 158.4 | | | |
| 2G – Little Missouri and Antoine River | 427.5 | 427.5 | Aquatic life | 47.7 | Copper | 19.6 | Unknown |
| | | | | | Lead | 10.5 | Unknown |
| | | | | | Zinc | 47.7 | Unknown |

| ADEQ Planning Segment | Total miles | Stream miles assessed | Designated uses impaired | Stream miles impaired | Pollutant | Stream miles | Source |
|---|---|---|---|---|---|---|---|
| Total | 2084.2 | 1920.3 | | 754.1 | | | |