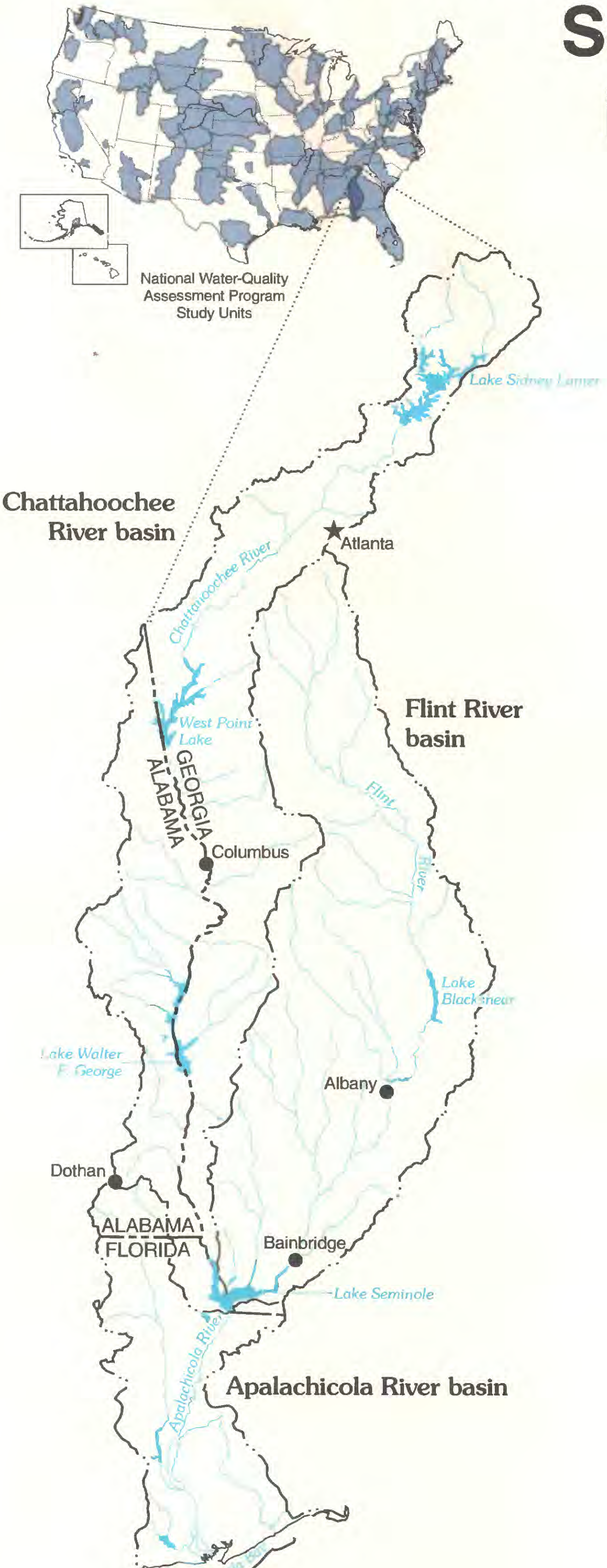
Influences of Environmental Settings on Aquatic Ecosystems in the Apalachicola–Chattahoochee–Flint River Basin



U.S. Geological Survey

Water-Resources Investigations Report 95-4278

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Cover: Photograph by Elizabeth A. Frick showing the view of the Apalachicola River at Alum Bluff in the Apalachicola Bluffs and Ravines Reserve, The Nature Conservancy, near Bristol, Florida.

INFLUENCES OF ENVIRONMENTAL SETTINGS ON AQUATIC ECOSYSTEMS IN THE APALACHICOLA-CHATTAHOOCHEE-FLINT RIVER BASIN

By Carol A. Couch, Evelyn H. Hopkins, and P. Suzanne Hardy

U.S. GEOLOGICAL SURVEY

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FOREWORD

The mission of the U.S. Geological Survey (USGS) is to assess the quantity and quality of the earth resources of the Nation and to provide information that will assist resource managers and policymakers at Federal, State, and local levels in making sound decisions. Assessment of water-quality conditions and trends is an important part of this overall mission.

One of the greatest challenges faced by water-resources scientists is acquiring reliable information that will guide the use and protection of the Nation's water resources. That challenge is being addressed by Federal, State, interstate, and local water-resource agencies and by many academic institutions. These organizations are collecting water-quality data for a host of purposes that include: compliance with permits and water-supply standards; development of remediation plans for a specific contamination problem; operational decisions on industrial, wastewater, or water-supply facilities; and research on factors that affect water quality. An additional need for water-quality information is to provide a basis on which regional and national-level policy decisions can be based. Wise decisions must be based on sound information. As a society, we need to know whether certain types of water-quality problems are isolated or ubiquitous, whether there are significant differences in conditions among regions, whether the conditions are changing over time, and why these conditions change from place to place and over time. The information can be used to help determine the efficacy of existing water-quality policies and to help analysts determine the need for, and likely consequences, of new policies.

To address these needs, the Congress appropriated funds in 1986 for the USGS to begin a pilot program in seven project areas to develop and refine the National Water-Quality Assessment (NAWQA) Program. In 1991, the USGS began full implementation of the program. The NAWQA Program builds upon an existing base of water-quality studies of the USGS, as well as those of other Federal, State, and local agencies. The objectives of the NAWQA Program are to:

- describe current water-quality conditions for a large part of the Nation's freshwater streams, rivers, and aquifers;
- describe how water quality is changing over time; and
- improve understanding of primary natural and human factors that affect water-quality conditions.

This information will help support the development and evaluation of management, regulatory, and monitoring decisions by other Federal, State, and local agencies to protect, use, and enhance water resources.

The goals of the NAWQA Program are being achieved through ongoing and proposed investigations of 60 of the Nation's most important river basins and aquifer systems, which are referred to as study units. These study units are distributed throughout the Nation and cover a diversity of hydrogeologic settings. More than two-thirds of the Nation's freshwater use occurs within the 60 study units and more than two-thirds of the people served by public water-supply systems live within their boundaries.

National synthesis of data analysis, based on aggregation of comparable information obtained from the study units, is a major component of the program. This effort focuses on selected water-quality topics using nationally consistent information. Comparative studies will explain differences and similarities in observed water-quality conditions among study areas and will identify changes and trends and their causes. The first topics addressed by the national synthesis are pesticides, nutrients, volatile organic compounds, and aquatic biology. Discussions on these and other water-quality topics will be published in periodic summaries of the quality of the Nation's ground and surface water as the information becomes available.

This report is an element of the comprehensive body of information developed as part of the NAWQA Program. The program depends heavily on the advice, cooperation, and information from many Federal, State, interstate, Tribal, and local agencies and the public. The assistance and suggestions of all are greatly appreciated.

Information regarding the NAWQA Program is available on the Internet via the World Wide Web. You may connect to the NAWQA Home Page using the Universal Resources Locator (URL) at:

<URL:http://wwwrvares.er.usgs.gov/nawqa/nawqa_home.html>

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by

Carol A. Couch, Evelyn H. Hopkins, and P. Suzanne Hardy

ABSTRACT

The watershed boundary of the Apalachicola-Chattahoochee-Flint (ACF) River basin defines an aquatic ecosystem whose water quality is the result of complex interactions of natural and human influences on land and water resources. Topics relating to the basin's environmental setting—its physical, biological, and cultural characteristics—are summarized to provide an understanding of factors that influence water quality and the health of aquatic ecosystems.

The ACF River basin lies partly in southwestern Georgia, southeastern Alabama, and northwestern Florida and covers 19,800 square miles in the Blue Ridge, the Piedmont, and the Coastal Plain Provinces. The basin includes the drainages of the Chattahoochee River and the Flint River, which meet to form the Apalachicola River. The Apalachicola River flows into the Gulf of Mexico at Apalachicola Bay. Basin hydrology and water quality are influenced by 16 mainstem reservoirs, 13 of which are on the Chattahoochee River. Ground water in the basin is contained in six aquifers—the surficial aquifer system, the Floridan aquifer system, the Claiborne aquifer, the Clayton aquifer, the Providence aquifer, and the crystalline-rock aquifer.

Physiography, climate, and hydrology of the ACF River basin provide natural conditions that support a rich and abundant diversity of plants and animals. Although most of the ACF River basin has been altered by human activities, the basin's environment is noteworthy for its remaining biological diversity and the role it plays in sustaining biological productivity in Apalachicola Bay. The Bay produces 90 percent of Florida's and 13 percent of the Nation's oyster harvest; and functions as a nursery for penaeid shrimp, blue crabs, and a variety of fin fish. The diversity of the basin's aquatic fauna is noteworthy because the basin is home to (1) the largest number of fish species among Gulf Coast drainages east of the Mississippi River, (2) the largest assemblage of freshwater fish in Florida, (3) the largest number of mollusc species among western Florida drainages, and (4) the highest species density of amphibians and reptiles on the continent north of Mexico.

Population of the ACF River basin in 1990 was estimated at 2.6 million. Nearly 90 percent of the total population lived in Georgia, and nearly 60 percent lived in the Metropolitan Atlanta area. The 1990 basin population is projected to increase by 15 percent to 3.0 million by the year 2000, and by 30 percent to 3.4 million by 2010. The largest increases in population are projected for the Metropolitan Atlanta area.

In 1972-76, approximately 59 percent of the basin was covered by forest, 29 percent was agricultural, 5 percent was wetland, 4 percent was urban, and 3 percent was water or barren land. Most of the original land cover of the basin has been transformed by human activity. Timber is the basin's largest cash crop, and most forests consist of second-growth stands or large acreages of planted pine. The dominant agricultural land use in the Piedmont Province is pasture and confined feeding for dairy, livestock, and poultry production. Row-crop agriculture, orchards, and silviculture are most common in the Coastal Plain Province. The top five crops in order from most to least acres harvested in 1990 were peanuts, corn, soybeans, wheat, and cotton.

The water in the basin is used for public and industrial supply, irrigation, power generation, navigation, and recreation. Although most public-supply withdrawals in the Blue Ridge and Piedmont Provinces are from surface-water sources, with the exception of counties near or immediately below the Fall Line, all publicly supplied water in the Coastal Plain is withdrawn from ground-water sources. Ground water supplied 18 percent of the basin's population served by public supply. Total water withdrawn in the ACF River basin in 1990 was 2,098 million gallons per day (Mgal/d), of which Georgia withdrew 82 percent, and Florida and Alabama each withdrew 9 percent. Power generation is the single largest water use. Sixteen of the basin's 22 power generating plants are located along the mainstem of the Chattahoochee River. The U.S. Army Corps of Engineers maintains a navigation channel from the mouth of the Apalachicola River to Columbus, Ga., on the Chattahoochee River and to Bainbridge, Ga., on the Flint River.

Water quality in the basin is influenced by the operation of 137 municipal wastewater-treatment facilities. In 1990, 354 Mgal/d of municipal wastewater was discharged within the ACF River basin. Eighty-eight percent of the wastewater was discharged into the Chattahoochee River basin, 10.6 percent into the Flint River basin, and 1.4 percent into the Apalachicola River basin.

Two-thirds of the 938 stream miles in the Georgia portion of the ACF River basin having water quality that does not meet or only partially meets the designated-use criteria in the Chattahoochee River basin. The Chattahoochee River is the most heavily-used water resource both in the ACF River basin and in Georgia. Urban runoff or unknown nonpoint sources are cited as the causes of water-quality regulations in 72 percent of violations. The remaining causes primarily are combined sewer overflows in the Atlanta area, and discharges from municipal or industrial treatment facilities with inadequate treatment capabilities or operational deficiencies.

INTRODUCTION

The National Water-Quality Assessment (NAWQA) Program of the U.S. Geological Survey (USGS) is designed to describe the status and trends in the quality of the Nation's ground- and surface-water resources and to provide a sound understanding of the natural and human factors that affect the quality of these resources (Leahy and others, 1990). Because much of the public concern over water quality stems from a desire to protect both human health and aquatic life, the NAWQA Program will, in addition to measuring physical and chemical indicators of water-quality, assess the status of aquatic life through surveys of fish, invertebrates, and benthic algae, and habitat conditions (National Research Council, 1990). As an integrated assessment of water quality incorporating physical, chemical, and biological components, the NAWQA Program is ecological in approach.

In 1991, the Apalachicola-Chattahoochee-Flint (ACF) River basin was selected for investigation in the NAWQA Program. The watershed boundary of the ACF River basin defines an ecosystem in which the quality of the water is a result of the complex interaction of natural and human influences on land and water resources.

The purposes of this report are to describe the environmental setting and the influence of this setting on aquatic ecosystems of the ACF River basin. The environmental setting includes physical, biological, and cultural characteristics of the ACF River basin. The physical setting includes physiographic, soil, climatic, and hydrologic factors. The biological setting summarizes historical and current (1992) information on habitats and aquatic biota within the basin. The cultural setting describes how the human population uses land and water resources within the basin.

Available literature and reports from Federal, State, and local agencies are used to describe the environmental setting of the ACF River basin. Whereas many of these reports deal with topics of limited scope and geographic extent, it is the objective of this report to provide a broad synthesis of topics relevant to understanding determinants of the health of the aquatic ecosystem and water-quality conditions in the ACF River basin.

Although the basinwide scope of NAWQA's ACF River basin study is unprecedented, water-quality assessments of regional scope have been conducted previously in parts of the basin. The USGS conducted two earlier regional water-quality studies, one in the Apalachicola River basin (Elder and others, 1988), and another in the upper Chattahoochee River basin (Cherry and others, 1980).

In 1971, the Georgia Water Quality Control Board (predecessor to the Georgia Department of Natural Resources, Environmental Protection Division) published a water-quality assessment of the Chattahoochee River from its headwaters to Lake Seminole, and an assessment of the Flint River from Fulton County to near Griffin, Ga., (Georgia Water Quality Control Board, 1971a,b). Another water-quality study of regional scope was conducted on West Point Lake by the USGS for the U.S. Army Corps of Engineers (USACOE) (Radtke and others, 1984).

PHYSICAL SETTING

The physical setting of the ACF River basin includes its location, physiography, soils, climate, surface- and ground-water hydrology, and its natural water quality. These physical factors provide the natural template that influences the basin's biological habitats and diversity, and the way in which humans use the basin's land and water resources.

Location

The Apalachicola-Chattahoochee-Flint (ACF) River basin (fig. 1) drains about 19,800 square miles (mi^2) in the southeastern United States in parts of southeastern Alabama (2,772 mi^2); the panhandle of Florida (2,574 mi^2); and central and western Georgia (14,454 mi^2) (U.S. Army Corps of Engineers, 1985). The ACF River basin includes the Chattahoochee River and the Flint River drainages that meet at Lake Seminole to form the Apalachicola River. The Apalachicola River flows into the Gulf of Mexico at Apalachicola Bay. Although the New River basin (569 mi^2) is included in the study boundaries of NAWQA's ACF River basin study, it is not considered in this report.

Near West Point Lake (fig. 1), the Chattahoochee River defines the state boundaries between Alabama and Georgia. The Flint River basin is contained entirely within Georgia. Except for the upper reaches of the Chipola River in Alabama, the Apalachicola River basin is contained within the panhandle of Florida.

Physiography

The ACF River basin contains parts of the Blue Ridge, Piedmont, and Coastal Plain physiographic provinces that extend throughout the southeastern United States (fig. 2). Similar to much of the Southeast, the basin's physiography reflects a geologic history of mountain building in the Appalachian Mountains, and long periods of repeated land submergence in the Coastal Plain Province. Glaciers, which influenced the physiography of much of North America, never extended to the southeastern United States. Physiography within the major provinces is not homogeneous and has been subdivided by the States of Alabama, Florida, and Georgia into the districts shown in figure 2. Although similar physiography may extend across state boundaries, districts may be assigned different names by state geologists in each state.

The northernmost part of the ACF River basin is within the Blue Ridge Province where headwaters of the Chattahoochee River arise. Less than one percent of the basin lies within the Blue Ridge Province. The Blue Ridge Province is dominated by rugged mountains and ridges that range in altitude from 3,000 to 3,500 feet (ft). The boundary between the Blue Ridge and the Piedmont is defined by a sharp change in slope at an altitude of approximately 1,700 ft. The Blue Ridge and Piedmont Provinces are underlain by mostly Precambrian and older Paleozoic crystalline rocks that include mica schist, felsic gneiss and schist, and granite and granite gneiss. Less extensive outcrops of quartzites are also present (fig. 3).

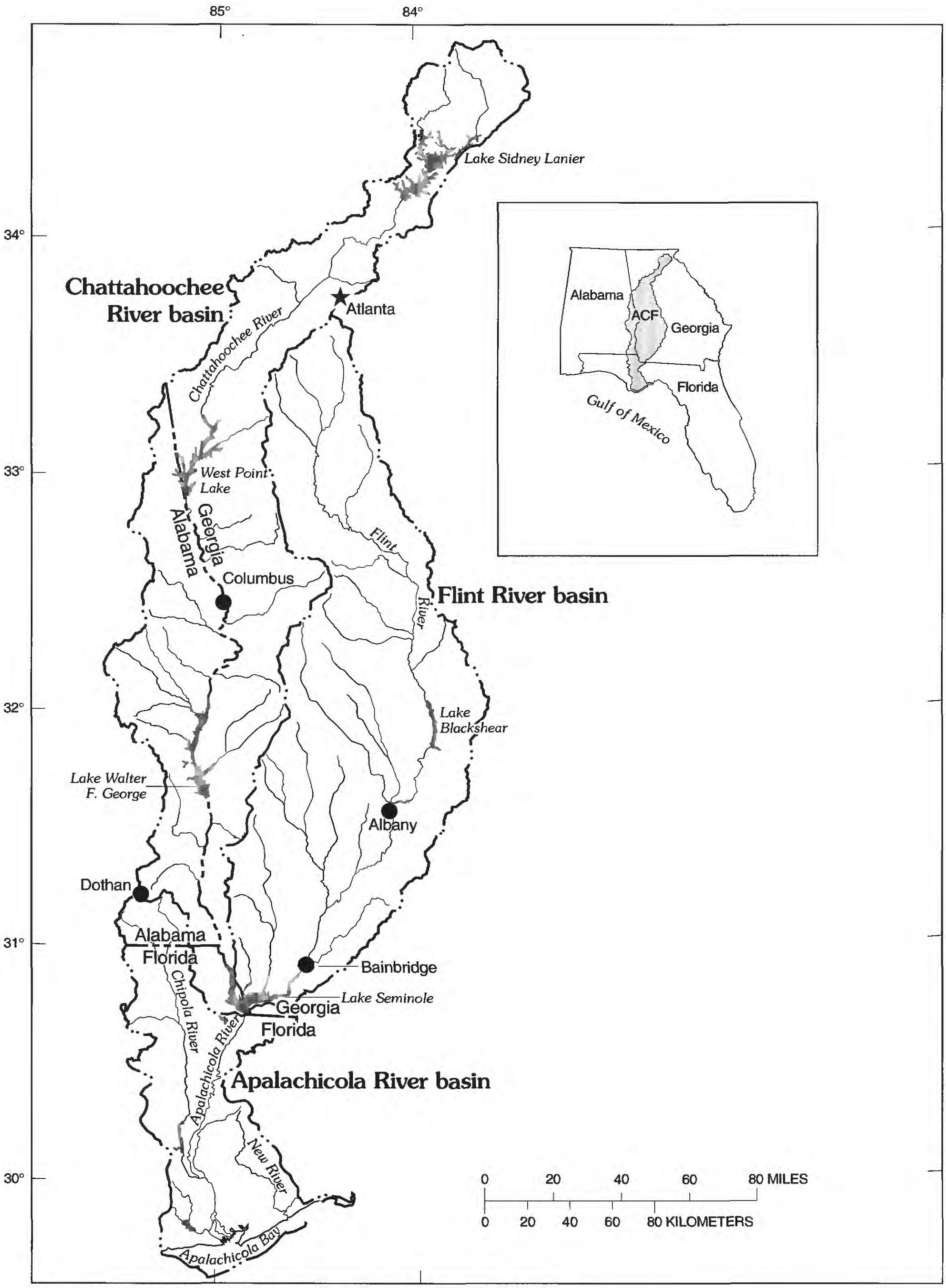
The part of the ACF River basin within the Piedmont Province in Georgia contains parts of seven physiographic districts—the Dahlonega Upland, the Hightower-Jasper Ridges, the Central Uplands, the Gainesville Ridges, Winder Slope, the Greenville Slope, and the Pine Mountain Districts (Clark and Zisa, 1976). In the Piedmont Province within Alabama, the ACF River basin lies in the Piedmont Upland District (Copeland, 1968).

The northeast trending linear-ridge structure of the Hightower-Jasper Ridges, the Central Uplands and Gainesville Ridges Districts strongly control the course of the upper Chattahoochee River and its tributaries. In particular, highly fractured faults in the Gainesville Ridges District forces the Chattahoochee River and its tributaries into a rectangular drainage pattern. Within these three ridge districts, altitudes range from about 1,500 ft in the northeast and to about 1,000 ft in the southwest. Relief, the distance between minimum and maximum altitudes, varies from approximately 500 ft in the northeast to 100-200 ft in the southwest (Clark and Zisa, 1976).

The Greenville Slope District in Georgia and the Piedmont Upland District in Alabama are both characterized by rolling topography with altitudes ranging from 1,000 ft in the Greenville Slope to 500-800 ft in the Piedmont Upland (Clark and Zisa, 1976; Copeland, 1968). Streams occupy broad, shallow valleys separated by broad, rounded divides and have dendritic drainage patterns.

The Pine Mountain District in Georgia rises abruptly from the Greenville Slope District to altitudes of 1,200-1,300 feet. The Pine Mountain District is dominated by Pine Oak Mountain, which is capped by quartzite. This district is notable for the presence of natural, warm-water springs flowing from fractured quartzite. Watersheds on the southern face of this west-to-east trending mountain ridge have rectangular drainage patterns (Clark and Zisa, 1976).

The Fall Line is the boundary between the Piedmont and Coastal Plain Provinces. This boundary approximately follows the contact between crystalline rocks of the Piedmont Province and the unconsolidated Cretaceous and Tertiary sediments of the Coastal Plain Province. As implied by the name, streams flowing across the Fall Line can undergo abrupt changes in gradient which are marked by the presence of rapids and shoals. Geomorphic characteristics of streams differ between the Piedmont and Coastal Plain Provinces. In the Coastal Plain, streams typically lack the riffles and shoals common to streams in the Piedmont, and exhibit greater floodplain development and increased sinuosity (Wharton, 1978).



Base modified from U.S. Geological Survey digital files

Figure 1. Location of the Apalachicola-Chattahoochee-Flint (ACF) River basin.

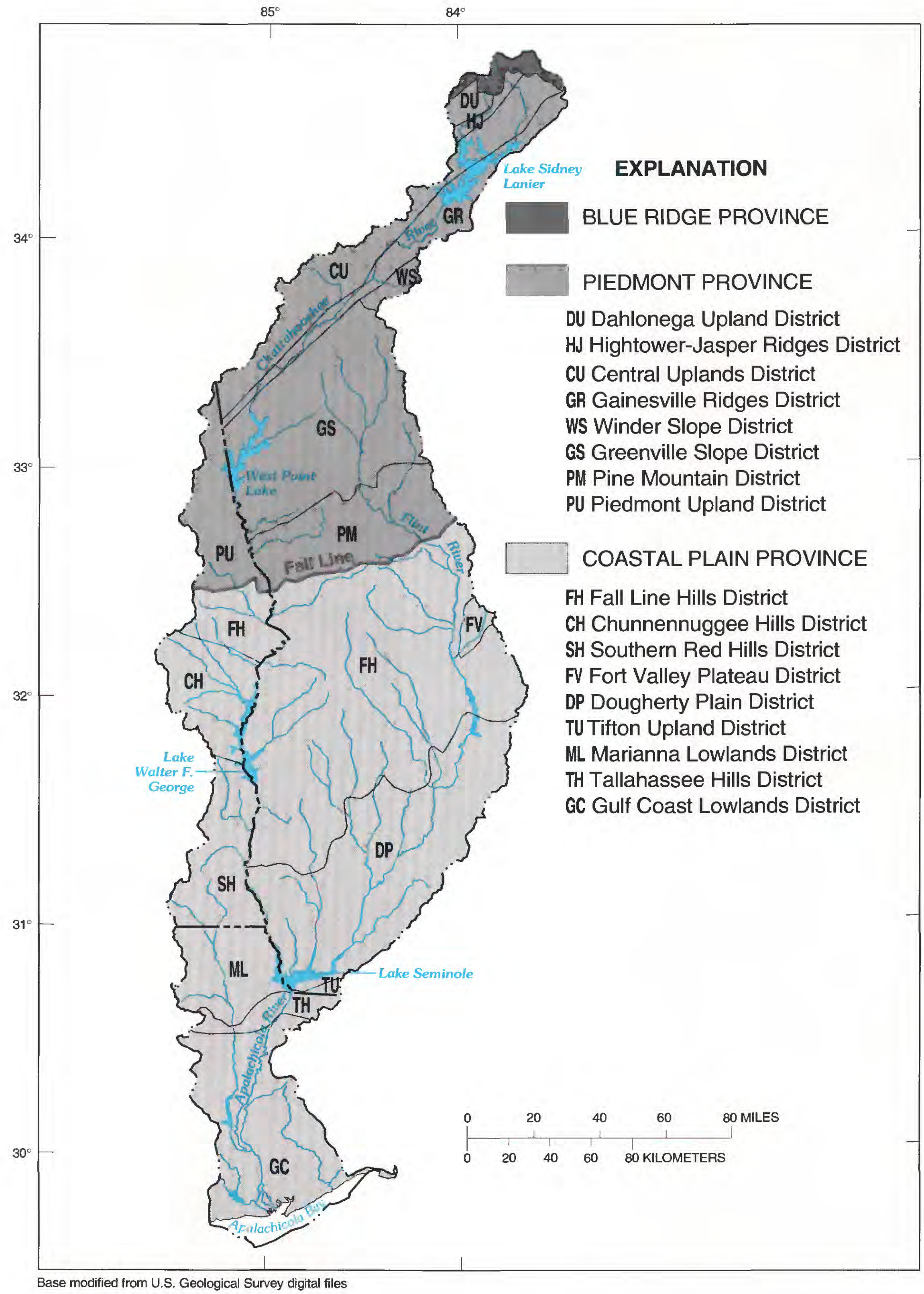


Figure 2. Physiographic provinces and districts of the Apalachicola-Chattahoochee-Flint River basin (modified from Copeland, 1968; Clark and Zisa, 1976; Lietman and others, 1983).

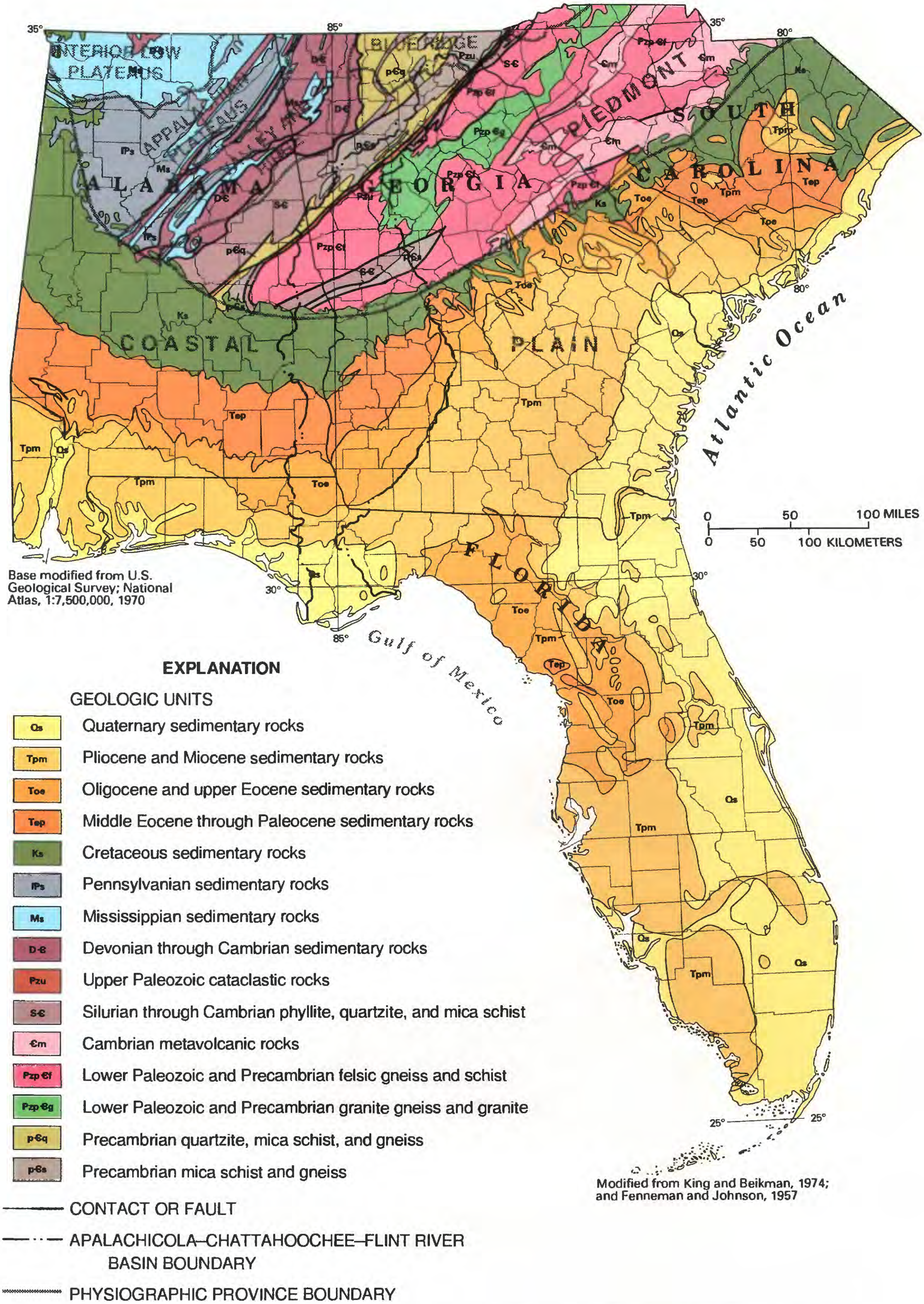


Figure 3. Geology of the Apalachicola–Chattahoochee–Flint River basin and adjacent areas.

The Coastal Plain Province contains three distinct regions—a hilly region immediately below the Fall Line; a region of karst topography; and a low-lying coastal region. The Fall Line Hills District in Georgia and Alabama, and the Chunnennuggee and Southern Red Hills Districts in Alabama are highly dissected with relief ranging 50-250 ft. Cretaceous sediments lie in a band immediately below the Fall Line and crop out into younger Eocene-Paleocene sediments of the low-lying Dougherty Plain District.

The Dougherty Plain and the Mariana Lowlands Districts are characterized by outcrops of the Ocala and Suwannee Limestones that result in a karst topography. The Dougherty Plain slopes southwestward with altitudes of 300 ft in the northeast to less than 100 ft near Lake Seminole. The flat to very gently rolling topography contains numerous sinkholes and associated marshes and ponds. Small streams in the Dougherty Plain District are frequently intermittent during the summer. The eastern boundary of the ACF River basin includes a small portion of the Tifton Upland District where the boundary with the Dougherty Plain is defined by the steeply sloping Pelham Escarpment. This solution escarpment continues to the northeast, forming the surface-water divide between the Flint River basin and the Ochlockonee River basin to the east.

A detailed description of physiography in the Apalachicola River basin is contained in Leitman and others (1983). The upper part of the basin lies within the Tallahassee Hills, Grand Ridge, New Hope Ridge, and Marianna Lowlands Districts. As it flows through the Tallahassee Hills District, the Apalachicola River is bordered on the east side by steep bluffs. The Tallahassee Hills District has altitudes as high as 325 ft, and is bounded on the south by the Cody Scarp, where elevations drop 15 to 20 ft to the Gulf Coast Lowlands. The Marianna Lowlands is a karst plain drained by the Chipola River, the largest tributary within the Apalachicola River basin.

The Gulf Coast Lowlands lie south of the Tallahassee Hills, Grand Ridge and New Hope Ridge Districts and extend to the Gulf of Mexico. This flat, sandy lowland was shaped by waves and currents during inundation by Pleistocene seas. This district is less than 100 ft in elevation. As the Apalachicola River flows southward through the Gulf Coast Lowlands, its floodplain broadens in width from 3 to 5 miles (mi).

Soils

Three major soil orders—ultisols, entisols, and spodosols, and more than 50 soil series—are present in the ACF River basin (Hajek and others, 1975; Perkins and Shaffer, 1977; Caldwell and Johnson, 1982). Ultisols are characterized by sandy or loamy surface horizons and loamy or clayey subsurface horizons. These deeply weathered soils are derived from underlying acid crystalline and metamorphic rock. Entisols are young soils with little or no change from parent material and with poorly developed subhorizons. These soils are frequently infertile and droughty because they are deep, sandy, well-drained, and subject to active erosion. Spodosols are characterized by a thin sandy subhorizon underlaying the A horizon. This sandy subhorizon is cemented by organic matter and aluminum. The ACF River basin is similar to much of the southeastern coastal plain in the dominance of ultisols. Entisols are found at and below the Fall Line and in the Dougherty Plain; and spodosols are found in the Gulf Coast Lowlands.

Soils of the ACF River basin are divided into six major land-resource areas (formerly called soil provinces, fig. 4). The Southern Piedmont, Georgia Sand Hills, Southern Coastal Plain, and Eastern Gulf Coast Flatwoods land-resource areas cover 97 percent of the ACF River basin. The Southern Piedmont land-resource area is dominated by ultisols. Piedmont ultisol soils are acid, low in nitrogen and phosphorus, and generally lack the original topsoil. Topsoil erosion began with intensive cultivation of cotton in the 1800's (Wharton, 1978).

Soils in the Southern Coastal Plain and the Georgia Sand Hills land-resource areas are derived from marine and fluvial sediments eroded from the Appalachian and Piedmont Plateaus. Ultisols are found throughout the Southern Coastal Plain, with the exception of some areas in the Georgia Sand Hills and Dougherty Plain where entisols locally are present.

The Eastern Gulf Coast Flatwoods land-resource area, which composes much of the Apalachicola River basin, is dominated by spodosols. Spodosols of the low-lying Eastern Gulf Coast Flatwoods are poorly-to-very poorly drained.

Basinwide patterns in soil leaching and runoff potential provide information on areas that may be susceptible to greater contaminant transport through infiltration or runoff. Maps of soil leaching and runoff potential were constructed for soils in the ACF River basin (figs. 5 and 6) using data from the digital State Soil Geographic Database (STATSGO) of the U.S. Department of Agriculture, Natural Resources Conservation Service (formerly called the Soil Conservation Service). Figure 5 shows the percent of soil series in each STATSGO soil-mapping unit with high leaching rates. A high leaching rate is assigned to soils with a permeability of 6.0 inches per hour or more (Brown and others, 1991). Soils with high leaching rates are concentrated in the sandy Cretaceous sediments below the Fall Line and in the sandy surficial sediments of the East Gulf Coast Flatwoods.

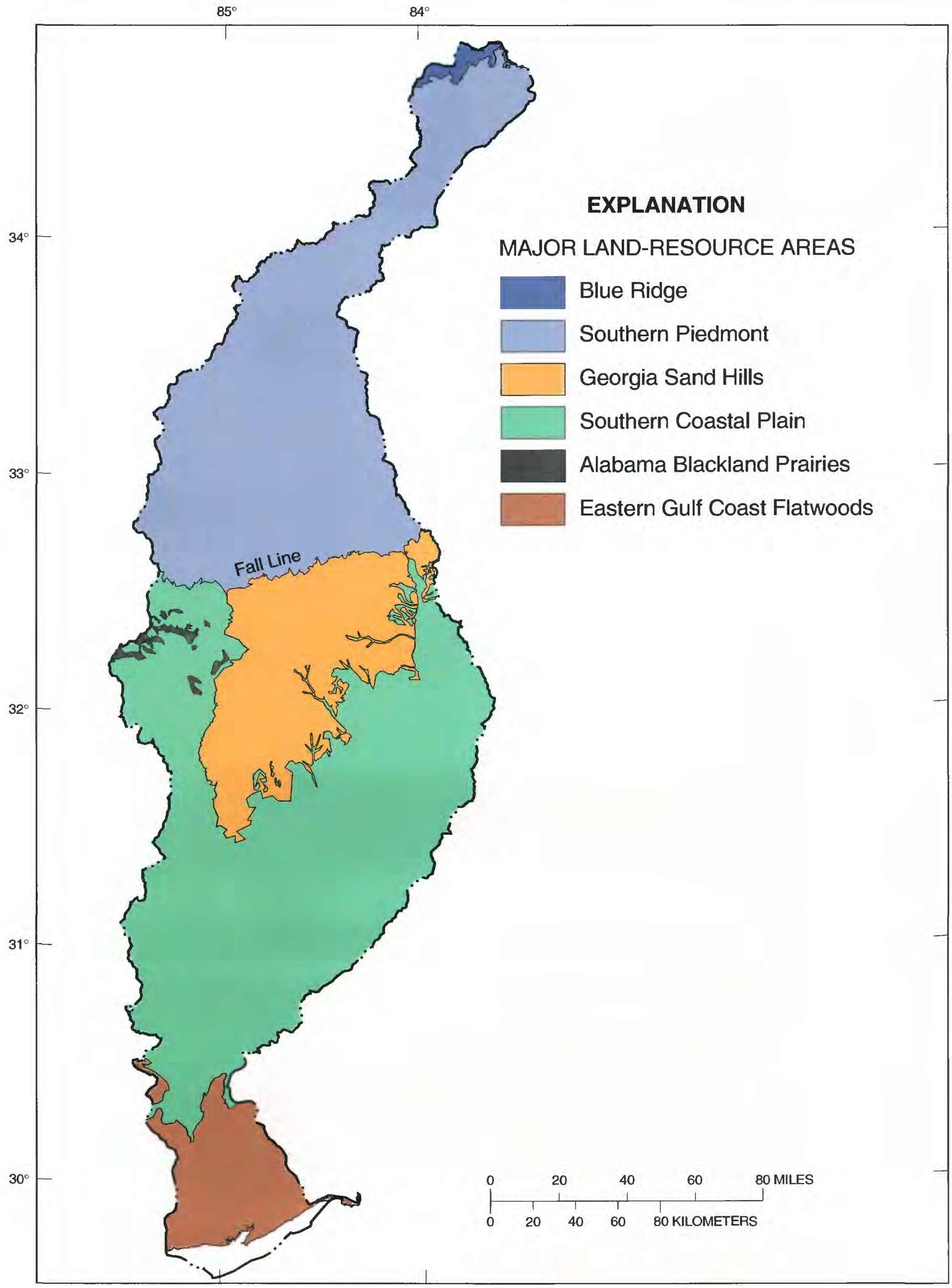


Figure 4. Major land-resource areas in the Apalachicola-Chattahoochee-Flint River basin (data from State Soil Geographic Database [STATSGO], Soil Conservation Service, and U.S. Department of Agriculture).

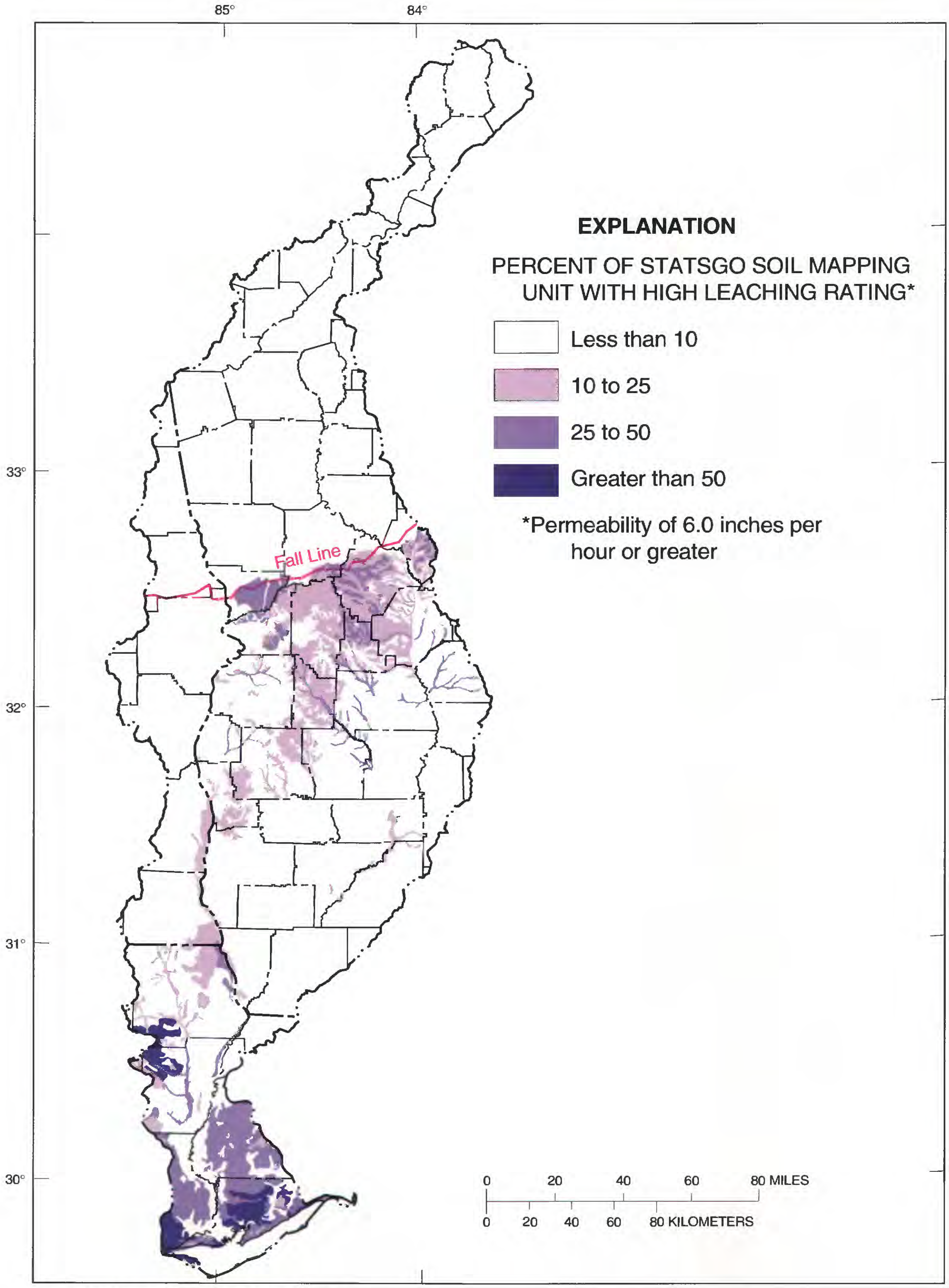


Figure 5. Soil mapping units with a high leaching rating in the Apalachicola-Chattahoochee-Flint River basin (data from State Soil Geographic Database [STATSGO], Soil Conservation Service, and U.S. Department of Agriculture). County names shown in Figure 22.

Runoff ratings are based on the inherent capacity of bare soil to permit infiltration, and consider slope, frequency of flooding during the growing season, and permeability (Brown and others, 1991). Soils with high runoff ratings are distributed throughout the basin, but are concentrated in areas having low permeability, steep slopes; or where flooding is frequent or the water table is near the surface, such as in floodplains and other low-lying areas. In the ACF River basin, soils with the highest runoff rate are present on steep slopes in the Blue Ridge, several areas in the Piedmont Province, the Fall Line Hills District, and in the lower Apalachicola River basin where soils commonly remain saturated (fig. 6).

Climate

The ACF River basin is characterized by a warm and humid, temperate climate. Major factors influencing climate variability in the basin are latitude, altitude, and proximity to the Gulf of Mexico.

Because the ACF River basin spans about 5 degrees of latitude, it has a sharp gradient in growing seasons. Average annual temperature ranges from about 60 °F in the north to 70 °F in the south. Average daily temperatures in the basin for January range from about 40 °F to 55 °F, and for July from 75 °F to 80 °F. In the winter, cold winds from the northwest cause the minimum temperature to dip below freezing for only short periods. Summer temperatures commonly range from the 70's to the 90's.

Precipitation is greatest either in the mountains as a result of their orographic effect or near the Gulf of Mexico as a result of the availability of moist air (fig. 7). Average annual precipitation in the basin, primarily as rainfall, is about 55 inches (in.), but ranges from a low of 45 in. in the east-central part of the basin to a high of 60 in. in the Florida panhandle (U.S. Geological Survey, 1986).

Evapotranspiration generally increases from north to south and ranges from about 32 to 42 in. per year. In the east-central part of the basin, precipitation and evapotranspiration are about equal. Average annual runoff ranges from 15 to 40 in. Areal distribution of average annual runoff from 1951-80 reflects basinwide patterns in precipitation and soil-runoff potential (fig. 8). Runoff is greatest in the Blue Ridge Mountains and near the Gulf coast (Gebert and others, 1987).

Surface-Water Hydrology

The Chattahoochee and Flint River basins in Georgia contain most of the headwater watersheds for surface waters that flow into or are used by the Florida and Alabama parts of the basin. This section describes the hydrology of the Chattahoochee, Flint, and Apalachicola River basins. Throughout the ACF River basin, low flows usually occur from September to November and peak flows usually occur from January to April when rainfall is high and evapotranspiration is low.

Chattahoochee River Basin

The Chattahoochee River—whose name is derived from Creek Indian words meaning painted rock—drains an area of 8,770 mi^2 and is the most heavily used water resource in Georgia. The Chattahoochee River arises as a cold-water mountain stream in the Blue Ridge Province at altitudes above 3,000 ft and flows 430 mi to its confluence with the Flint River. The discharge of the Chattahoochee River based on median daily flows near Columbia, Ala., (fig. 9) during water years 1977-92 was 8,250 cubic feet per second (ft^3/s). Median daily discharge ranged from a low of 498 ft^3/s in 1989 to a high of 191,000 ft^3/s in 1990 (fig. 10).

Thirteen of 16 dams on mainstem locations in the ACF River basin are on the Chattahoochee River (table 1, fig. 11). Dam construction in the basin began in the early 1800's on the Chattahoochee River above the Fall Line at Columbus, Ga., to take advantage of natural gradients for power production. Annual flow has not been appreciably altered by the system of dams, although storage is used to augment flows during periods of low flow; and daily fluctuations below some reservoirs can be dramatic. Pronounced decreases in the frequency of high and low flows have occurred since the start of operation of Buford Dam that forms Lake Sidney Lanier. Lake Sidney Lanier, West Point Lake, and Lake Walter F. George provide most water storage available to regulate flows in the basin. Lake Sidney Lanier alone provides 65 percent of conservation storage, although it drains only 5 percent of the ACF River basin. In addition, West Point Lake and Lake Walter F. George provide 18 and 14 percent, respectively, of the basin's conservation storage (Leitman and others, 1991).

Over most of its length, the flow of the Chattahoochee River is controlled by hydroelectric plants releasing water for production of hydropower. These hydroelectric plants use hydropeaking operations to augment power supply during peak periods of electric demand. At Cornelia, Ga. (site 1, fig. 9; fig. 12a), the Chattahoochee River is free flowing; however, throughout the remainder of its length, the river's hydrograph shows the influence of hydropeaking operation (figs. 12b,c,d). Hydropeaking operations can result in daily stage fluctuations of 4 ft or more.

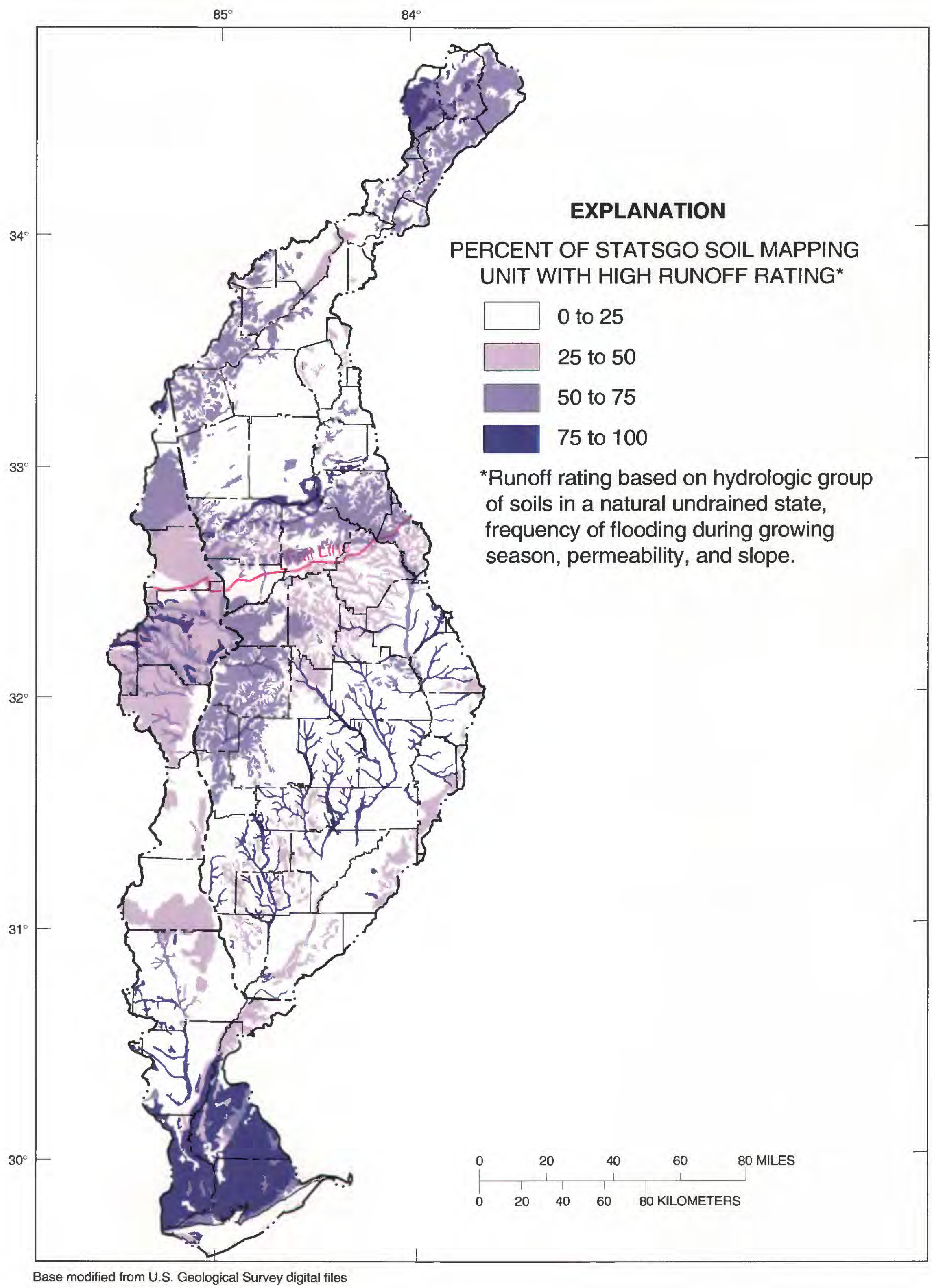


Figure 6. Soil mapping units with a high runoff rating in the Apalachicola-Chattahoochee-Flint River basin (data from State Soil Geographic Database [STATSGO], Soil Conservation Service, and U.S. Department of Agriculture). County names shown in Figure 22.

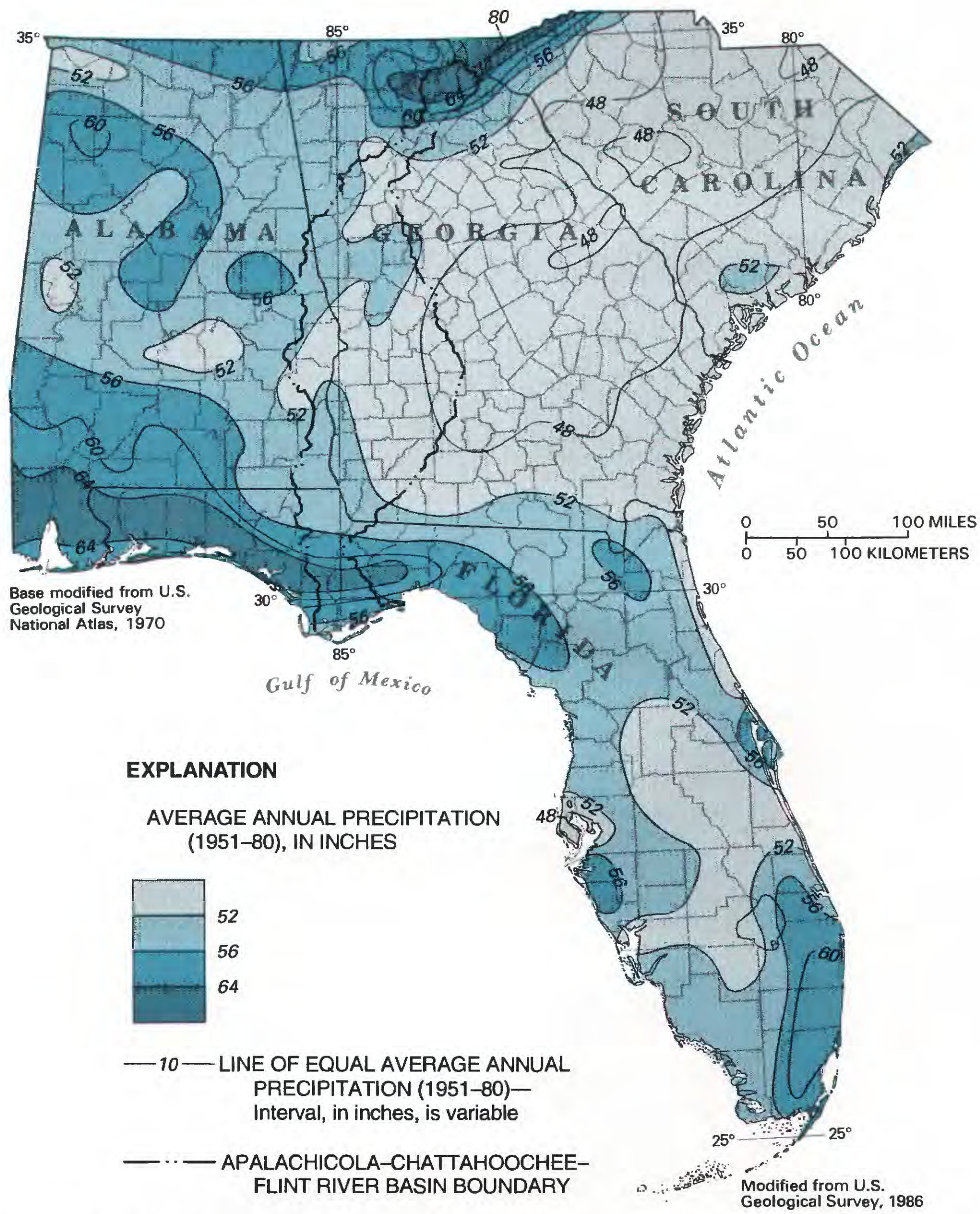


Figure 7. Average annual precipitation (1951–80) in the Apalachicola–Chattahoochee–Flint River basin and adjacent areas.

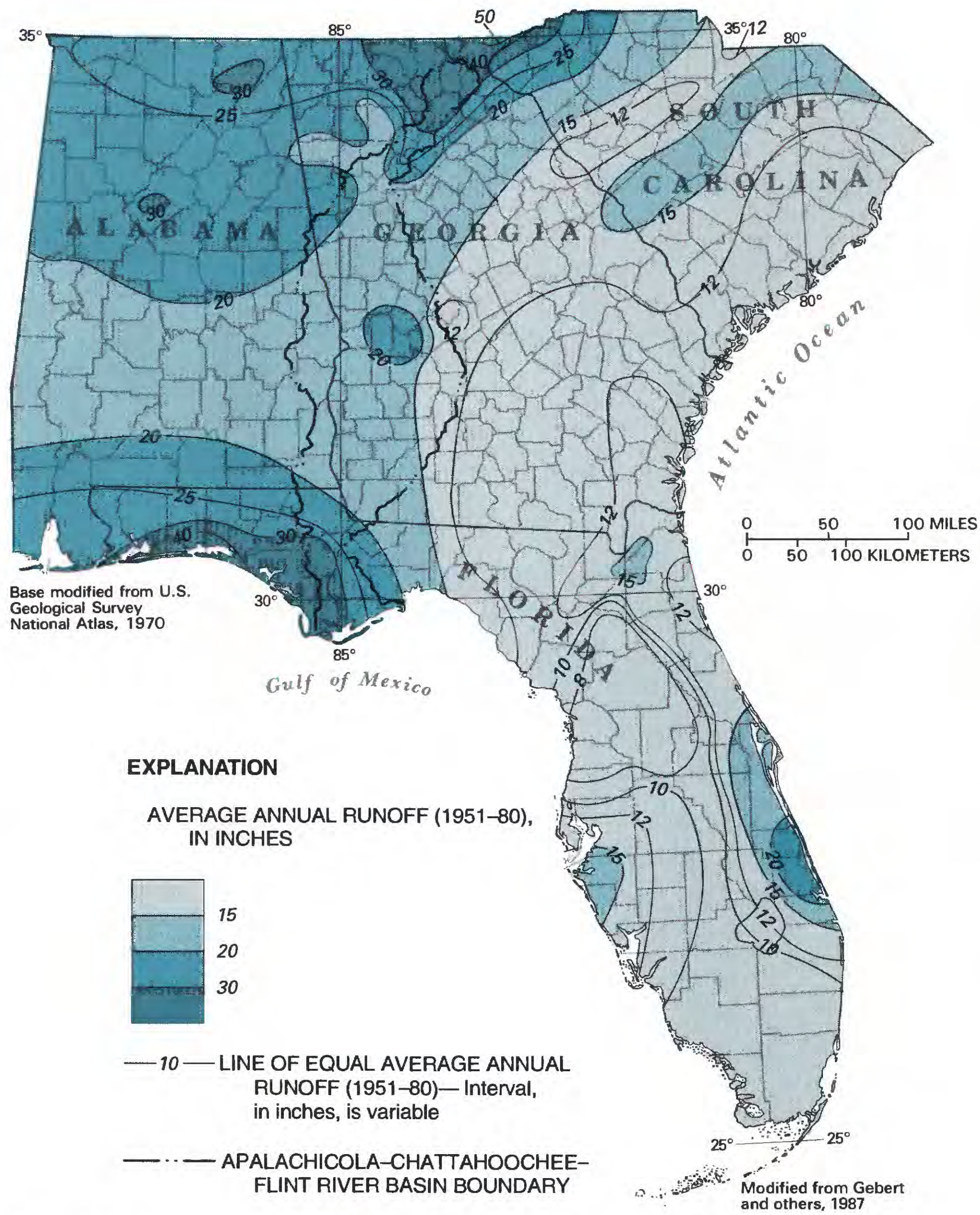
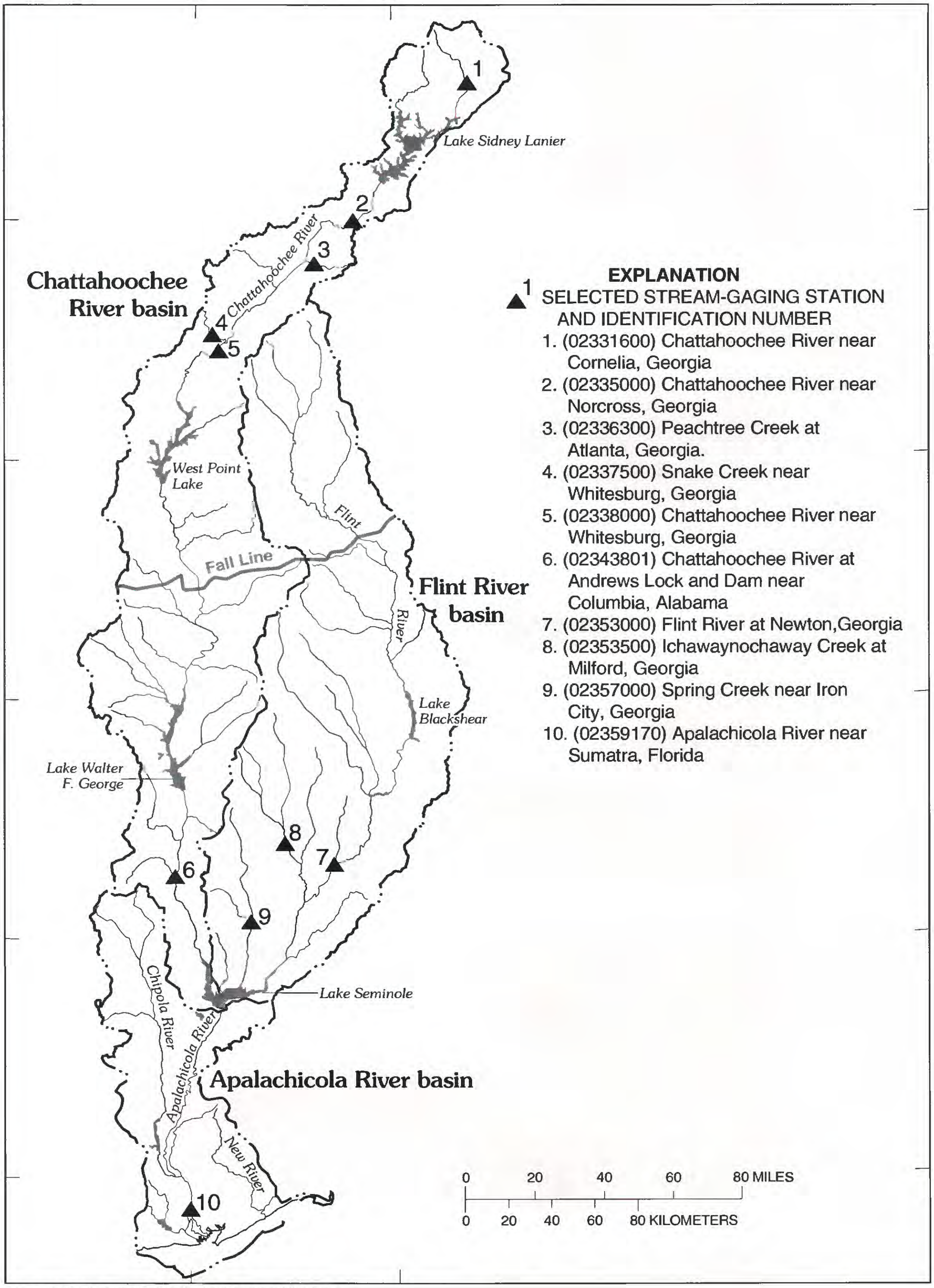


Figure 8. Average annual runoff (1951–80) in the Apalachicola–Chattahoochee–Flint River basin and adjacent areas.



Base modified from U.S. Geological Survey digital files

Figure 9. Major basin boundaries and location of selected stream-gaging stations in the Apalachicola-Chattahoochee-Flint River basin.

Table 1: Dams and associated impoundments in the Apalachicola-Chattahoochee-Flint River basin

[mi^2, square miles; --, data not available; FC, Flood Control; N, Navigation; P, Power; WS, Water Supply; WQ, Water Quality; FW, Fish and Wildlife; R, Recreation; modified from U.S. Army Corps of Engineers, 1984]

Name of dam	Associated impoundment	Owner	Date constructed or operational	Principal use	River mile	Total drainage area (mi^2)	Full power or normal pool data	
							Surface area (acres)	Storage capacity (acre-feet)
Chattahoochee River								
Buford	Lake Sidney Lanier	U.S. Army Corps of Engineers	1959	FC,N,P,R, WS,FW	384.2	1,040	[1/]38,024	[1/]1,917,000
Morgan Falls	Bull Sluice Lake	Georgia Power		P,WQ	312.6	1,340	700	run-of-river
West Point	West Point Lake	U.S. Army Corps of Engineers	1975	FC,N,P,R, FW	201.4	3,440	[1/]25,864	[1/]604,527
Langdale	unnamed	Georgia Power	[2/]1860	P	191.9	3,630	[1/]152	run-of-river
Riverview	unnamed	Georgia Power	[2/]1902	P	190.6	3,660	350	run-of-river
Bartletts Ferry	Lake Harding	Georgia Power	[2/]1926	P,WS	178.0	4,240	4,940	run-of-river
Goat Rock	unnamed	Georgia Power	[2/]1912	P,WS	172.3	4,520	1,000	run-of-river
Oliver	Lake Oliver	Georgia Power	1962	P,WS	163.2	4,630	--	run-of-river
North Highlands	unnamed	Georgia Power	[2/]1900	P	162.5	4,630	200	run-of-river
City Mills	unnamed	City Mills	[2/]1906	P[3/]	161.2	4,650	70	run-of-river
Eagle-Phenix	unnamed	Eagle and Phemix Mill	[1/]1834	P	160.4	4,670	220	run-of-river
Walter F. George Lock and Dam	Lake Walter F. George	U.S. Army Corps of Engineers	1963	N,P,FW,R	75.0	7,460	[1/]45,181	[1/]934,400
George W. Andrews Lock and Dam	unnamed	U.S. Army Corps of Engineers	1963	N,R	46.5	8,213	[1/]1,540	[1/]18,100
Flint River								
Warwick	Lake Blackshear	Crisp County, Ga.	1930	P	134.8	3,764	--	5,700
Flint River	Lake Worth	Georgia Power	1920	P	104.1	5,200	1,600	--
Apalachicola River								
Jim Woodruff Lock and Dam	Lake Seminole	U.S. Army Corps of Engineers	1957	N,P,FW,R	107.6	17,230	37,500	--

[1/] Full pool.
[2/] Date constructed.
[3/] Not operational.

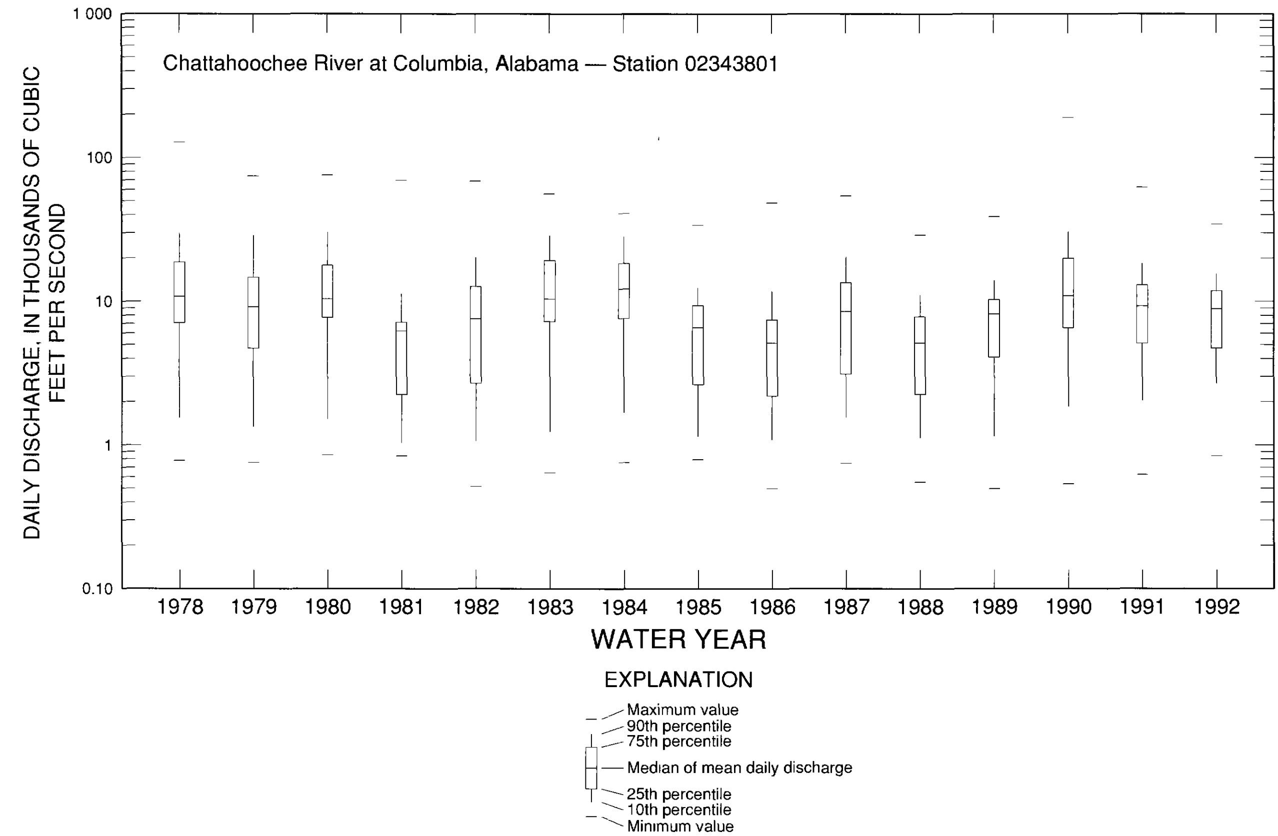


Figure 10. Discharge for water years 1978-92 for the Chattahoochee River at Columbia, Alabama. Location shown in Figure 9.

In contrast to the mainstem Chattahoochee River, many tributaries remain free flowing. Flows of tributaries in forested basins are represented by Snake Creek (fig. 13) that drains 35.5 mi^2 above streamflow-gaging station 02337500. Flows typical of urban basins are represented by Peachtree Creek (fig. 14). Above streamflow-gaging station 02336300, Peachtree Creek drains a 86.8-mi^2 urban basin in Metropolitan Atlanta. Similar to most Piedmont streams, both streams have higher sustained flows during winter months, and show responses to storm events throughout the year. However, sharper peaks in the hydrograph of Peachtree Creek reflect the greater influence of impervious land cover in this urban basin.

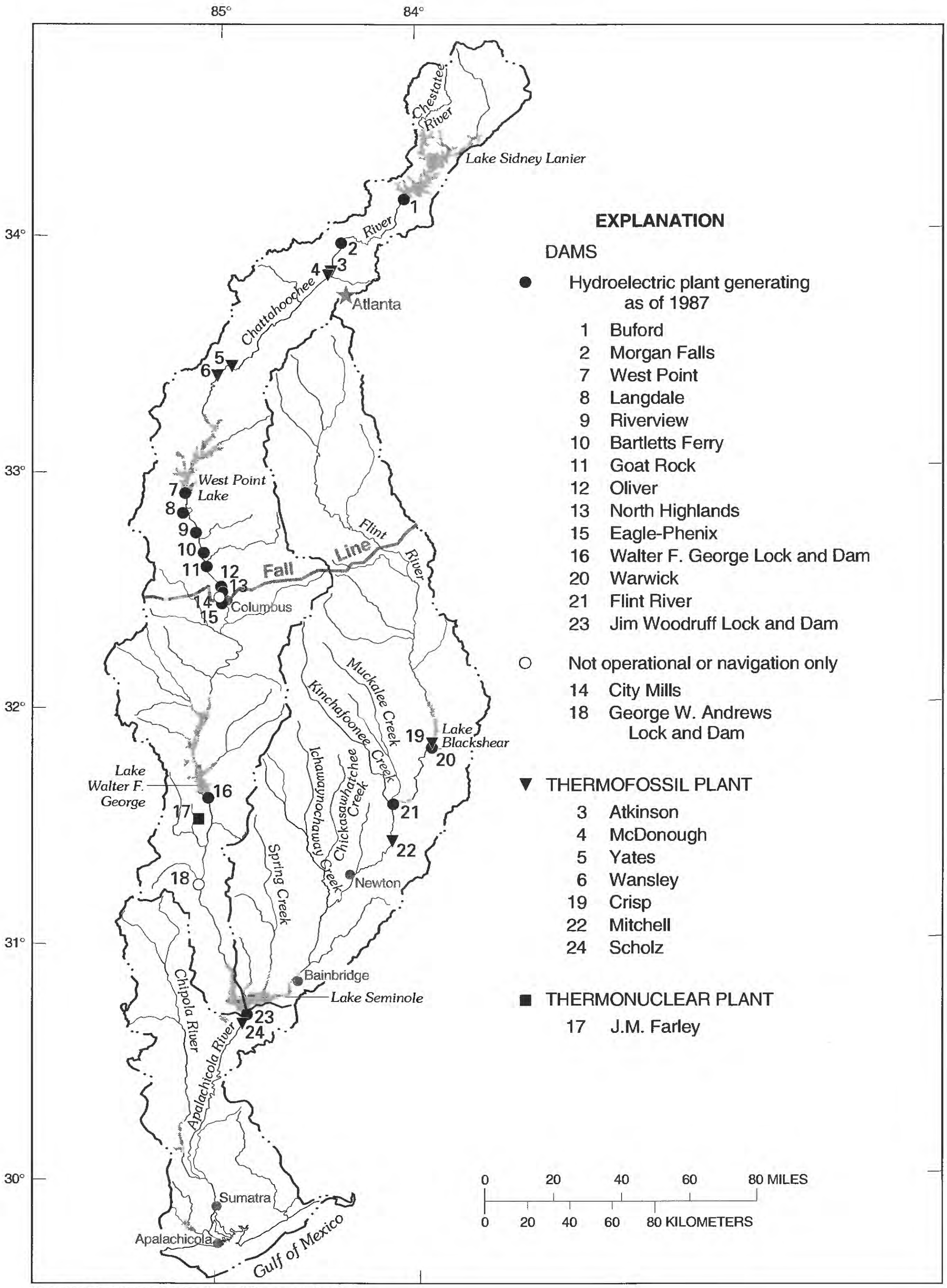
Flint River Basin

The Flint River is about 350 mi long and drains an area of 8,460 mi^2. Most of the larger tributaries in the ACF River basin are located in the Coastal Plain Province part of the Flint River basin. These tributaries—with their Creek Indian meaning in parentheses—include Ichawaynochaway Creek (buck sleeping place), Chickasawhatchee Creek (council house creek), Kinchafoonee Creek (mortar bone or pounding block creek), and Muckalee Creek (pour-upon-me creek) (Utley and Hemperley, 1975).

Spring Creek, formerly a Flint River tributary that now discharges directly into Lake Seminole, drains 585 mi^2 in a region of karst topography. As implied by its name, flow in Spring Creek is dominated by ground-water discharge directly into its limestone bed.

From 1977-92, the discharge of the Flint River based on mean daily flows at Newton, Ga., was 4,030 ft^3/s. Mean daily discharge ranged from 922 ft^3/s in 1991 to 47,000 ft^3/s in 1990 (fig. 15). Two hydropower dams located on the Flint River (table 1, fig. 11) impound run-of-the-river reservoirs and do not appreciably influence the flow of the Flint River. The Flint River has one of only 42 free-flowing river reaches longer than 125 mi remaining in the contiguous 48 states (Benke, 1990).

Higher flows during winter months are evident in the annual hydrographs of the Flint River, Ichawaynochaway Creek, and Spring Creek (figs. 16a,b,c). During winter months, Coastal Plain streams, such as Ichawaynochaway and Spring Creeks, flow for sustained periods through their floodplains.



Base modified from U.S. Geological Survey digital files

Figure 11. Location of mainstem dams and power-generating plants in the Apalachicola–Chattahoochee–Flint River basin (source for Georgia: Fanning and others, 1991).

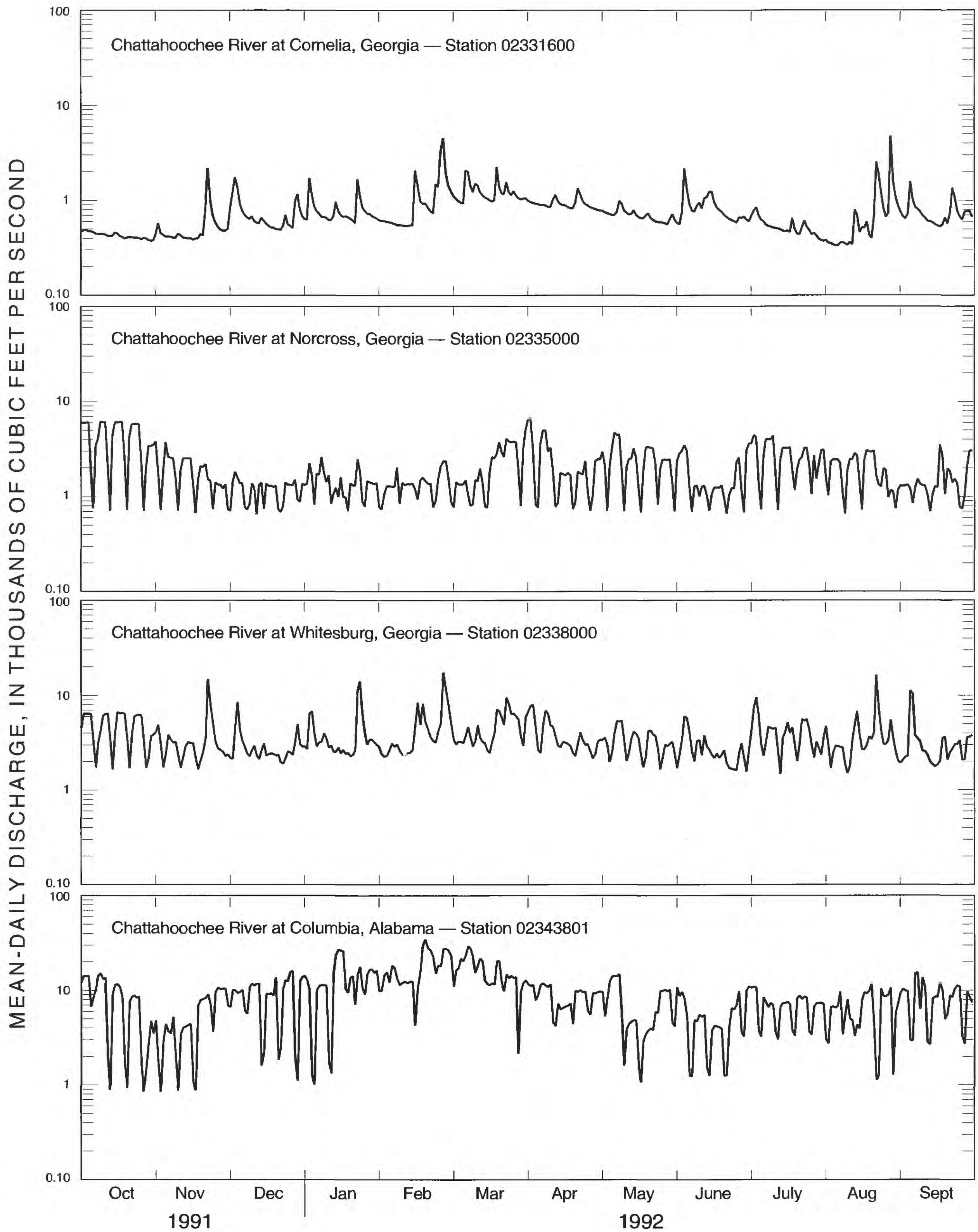


Figure 12. Annual hydrographs for Chattahoochee River at Cornelia, Georgia, Chattahoochee River at Norcross, Georgia, Chattahoochee River at Whitesburg, Georgia, and Chattahoochee River at Columbia, Alabama. Location shown in Figure 9.

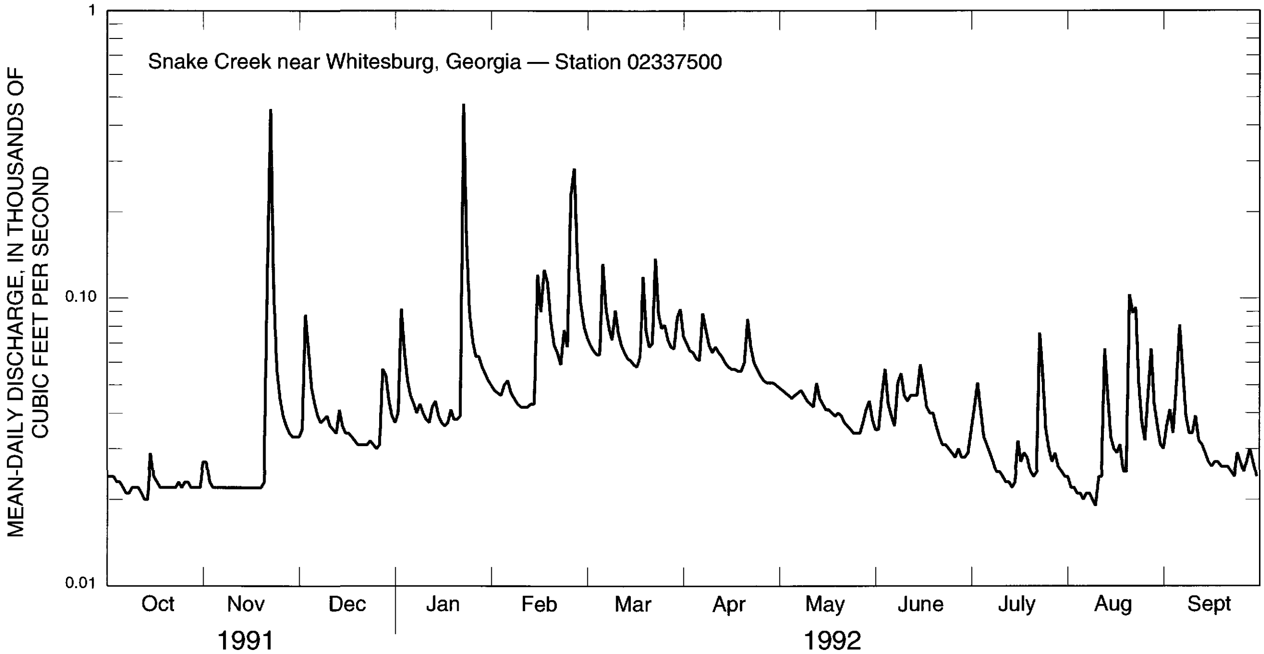


Figure 13. Annual hydrograph for Snake Creek near Whitesburg, Georgia. Location shown in Figure 9.

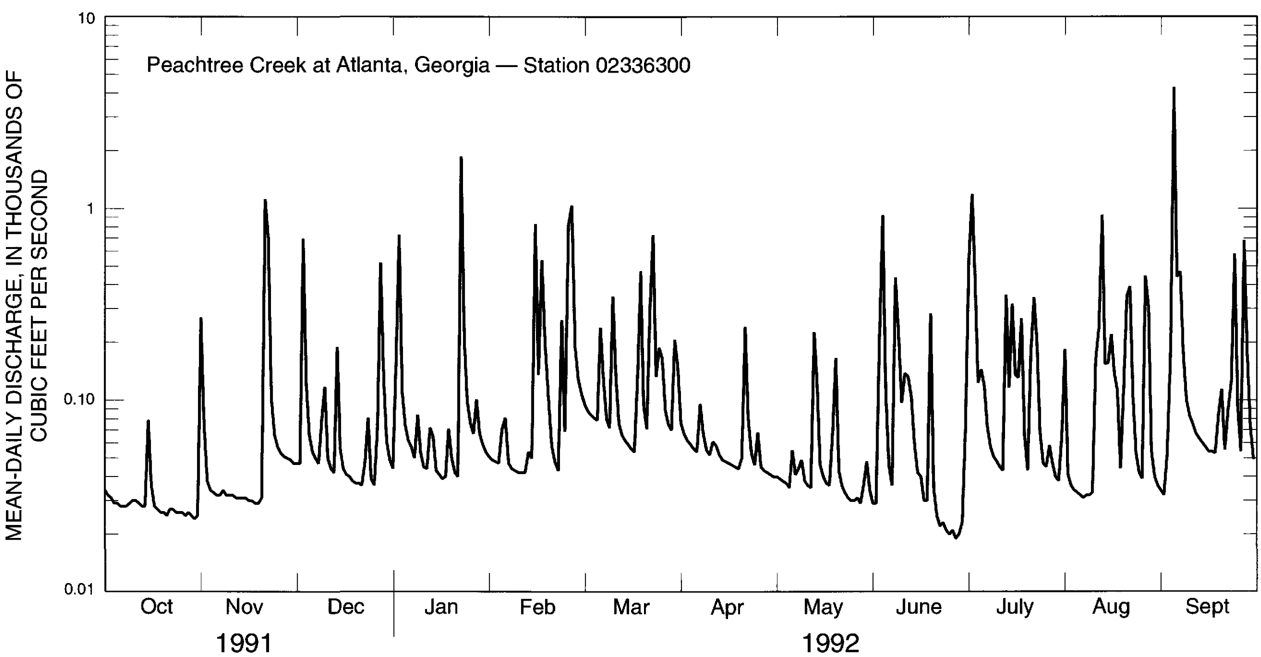


Figure 14. Annual hydrograph for Peachtree Creek at Atlanta, Georgia. Location shown in Figure 9.

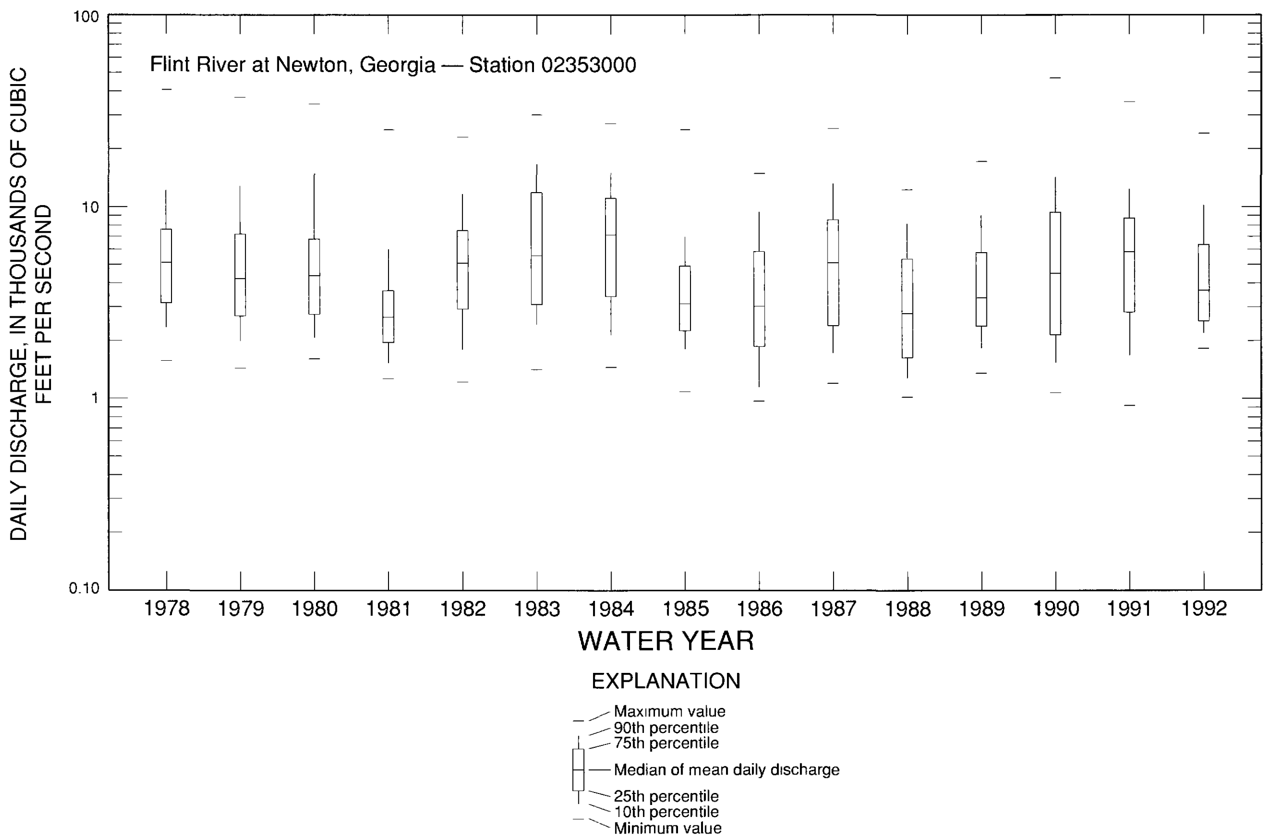


Figure 15. Discharge for water years 1978-92 for the Flint River at Newton, Georgia. Location shown in Figure 9.

Apalachicola River Basin

The Apalachicola River flows unimpeded for 106 mi from Jim Woodruff Lock and Dam to the Gulf of Mexico. The river drains about 2,600 mi^2 and its shallow estuary covers about 208 mi^2. Tidal influences do not extend beyond 25 mi upstream from the river's mouth. The Apalachicola River falls 40 ft as it flows through the Gulf Coast Lowlands. The width of the river ranges from several hundred feet when confined to its banks to nearly 4-1/2 mi during high flows. The discharge of the Apalachicola River is 21st in magnitude among the rivers of the conterminous United States, and is the largest in Florida, accounting for 35 percent of freshwater flow on the western coast of Florida (Livingston, 1992). During 1977-92, the discharge of the Apalachicola River based on mean daily discharge at Sumatra, Fla., was 19,602 ft^3/s (fig. 17). Mean daily discharge at Sumatra ranged from 5,800 ft^3/s in 1981 to 178,000 ft^3/s in 1990 (fig. 18). As described later in this report, the large seasonal fluctuations in flow in the Apalachicola River are important to the ecological function of the river and its estuary.

Eighty percent of the Apalachicola River flow is contributed by the Chattahoochee and Flint Rivers, 11 percent from the Chipola River, and less than 10 percent from ground water and overland flow (Elder and others, 1988). The Chipola River—Apalachicola River's largest tributary—drains one-half of the Apalachicola River basin. The Chipola River is classified as a spring-fed river with baseflow derived principally from aquifers.

Because of rainfall-distribution patterns, the average annual runoff from the Chattahoochee River exceeds that of the Flint River. The Chattahoochee River makes a greater contribution to peak flows in the Apalachicola River than the Flint River. However, during extreme dry periods, the greater flow contribution in the Apalachicola River comes from the Flint River, where baseflow is sustained by ground-water discharges (Elder and others, 1988).

Leitman and others (1983) studied stage and discharge records from 1929-79 to determine if significant hydrologic changes occurred in the Apalachicola River as a result of dam-flow regulation. Dams have had little effect on the magnitude of high flows or seasonal distribution of discharge over an annual cycle. Dam regulation did reduce the amount of time that flow was at low extremes. Water stages in the river within the first 30 mi downstream of Jim Woodruff Lock and Dam have lowered due to scouring of the river bottom.

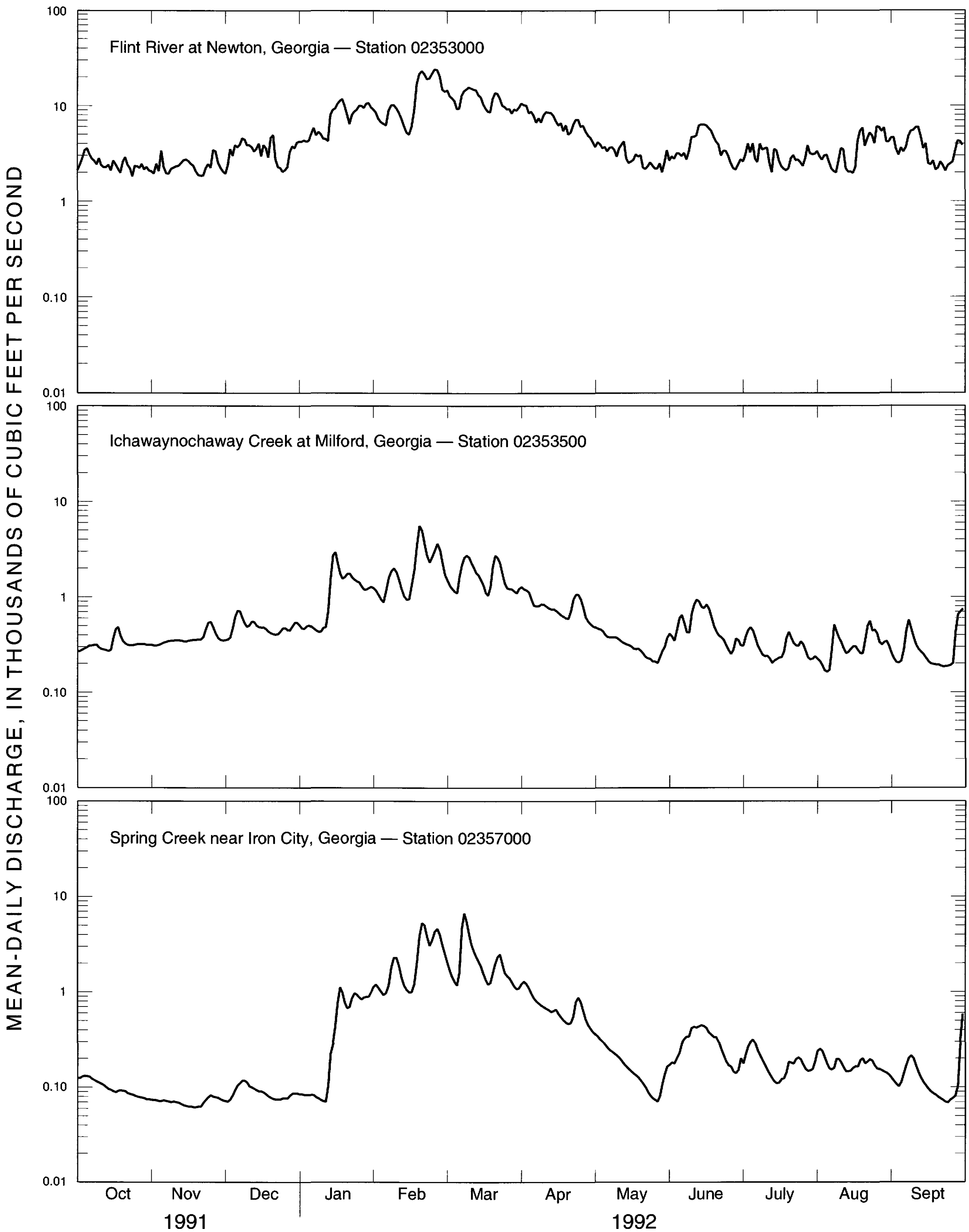


Figure 16. Annual hydrographs for Flint River at Newton, Georgia, Ichawaynochaway Creek at Milford, Georgia, and Spring Creek near Iron City, Georgia. Location shown in Figure 9.

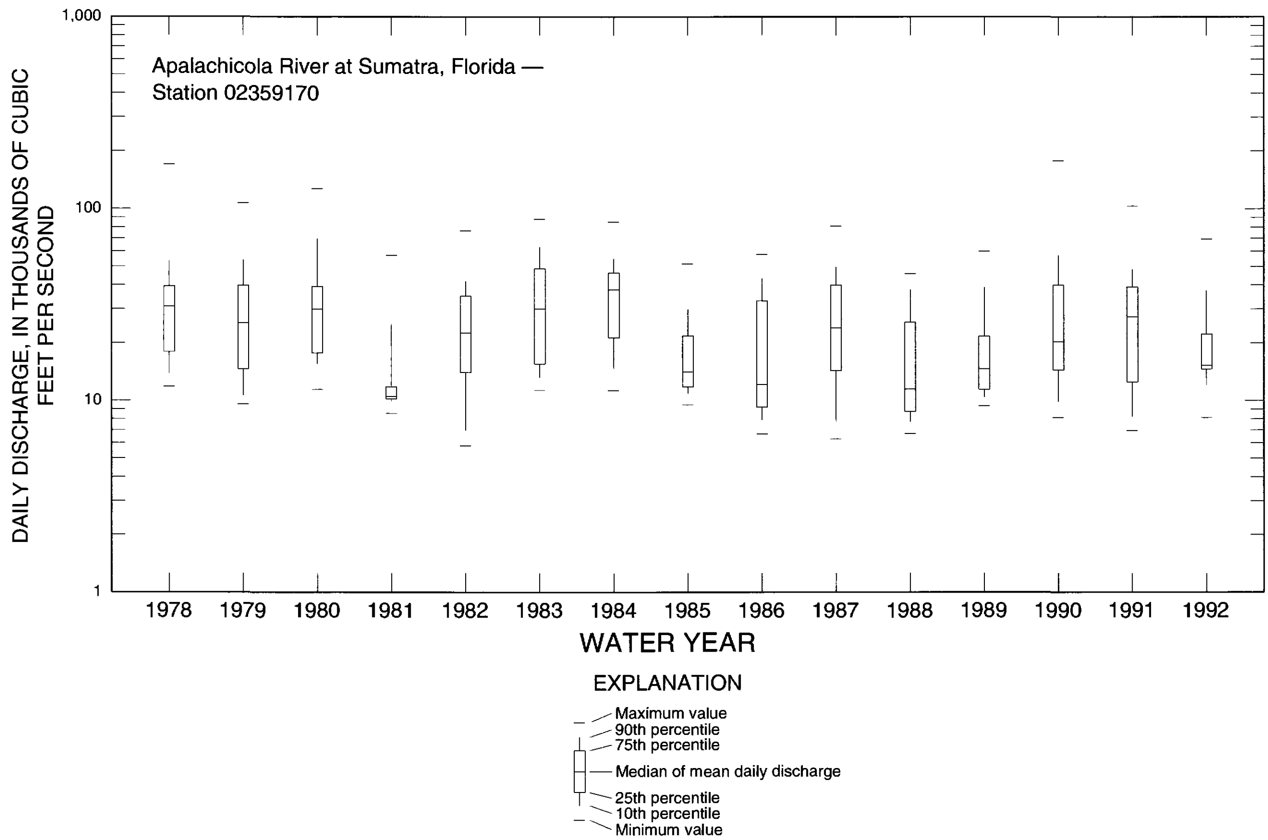


Figure 17. Discharge for water years 1978-92 for the Apalachicola River at Sumatra, Florida. Location shown in Figure 9.

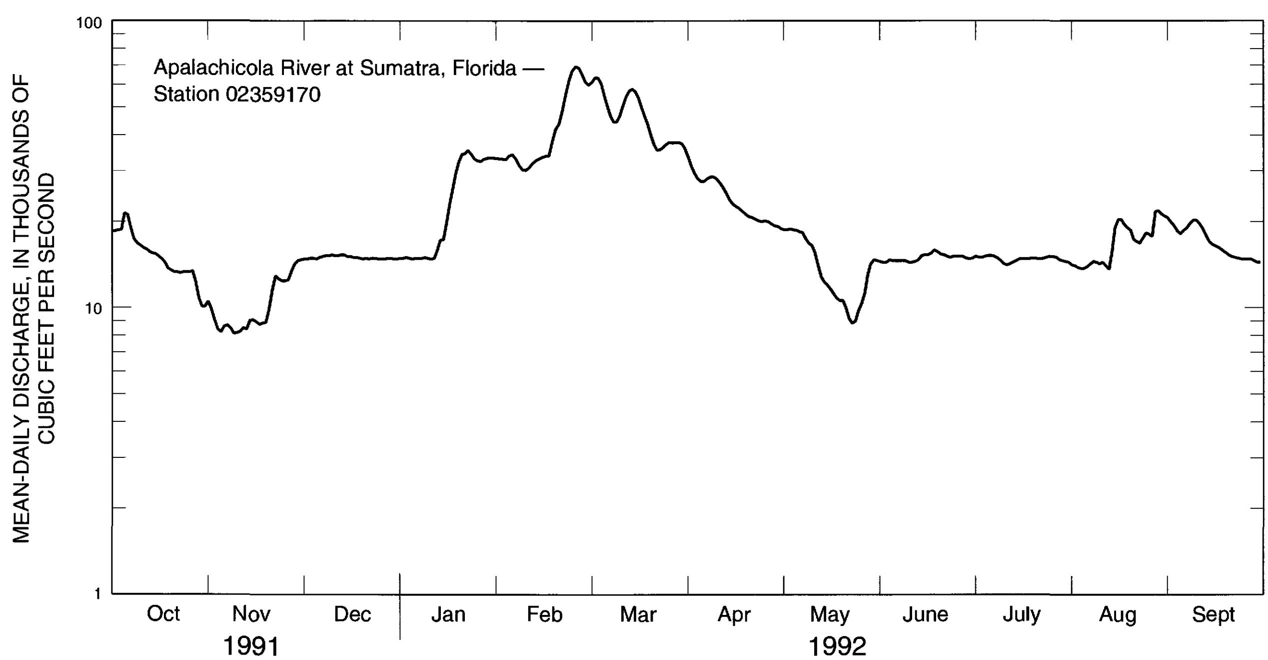


Figure 18. Annual hydrograph for Apalachicola River at Sumatra, Florida. Location shown in Figure 9.

Ground-Water Hydrology

Six major aquifers underlie the ACF River basin. These aquifers, listed in descending order, are the surficial aquifer system, the Floridan aquifer system, the Claiborne aquifer, the Clayton aquifer, the Providence aquifer, and the crystalline-rock aquifer. Generalized outcrop areas and stratigraphy of aquifers underlying the Coastal Plain Province are shown in figures 19 and 20; these aquifers generally are separated by confining units.

Aquifers in the Coastal Plain Province consist of alternating units of sand, clay, sandstone, dolomite, and limestone that dip gently and thicken to the southeast. Confining units between these aquifers are mostly silt and clay. From the Fall Line to the Gulf of Mexico, progressively younger sediments crop out and overlie older sediments. The complex interbedded clastic rocks and sediments of Coastal Plain aquifers range in age from Quaternary to Cretaceous. Because of gradational changes in hydrologic properties, aquifer and stratigraphic boundaries are not always coincident.

The surficial aquifer system is a shallow, mostly unconfined water-table aquifer consisting of cross-bedded sand, gravel and clay with undifferentiated alluvium near rivers. Surficial deposits are associated with all outcrop areas shown in figure 19. However, only in the southern part of the ACF River basin do these deposits contain ground water whose use warrants mapping as a single aquifer (Miller, 1990). Isolated domestic wells withdraw water from the surficial aquifer system.

The Floridan aquifer system, one of the most productive aquifers worldwide, underlies about 100,000 mi^2 in Florida, southern Alabama, southern Georgia, and southern South Carolina. The Floridan aquifer system comprises of a thick sequence of carbonate rocks that are of Tertiary age and are hydraulically connected in varying degrees (Miller, 1986). The Ocala Limestone is one of the thickest and most productive formations that crops out in the Dougherty Plain and gives rise to a karst topography riddled with sinkholes. The complex hydrogeology of the Floridan aquifer system is reflected by highly variable transmissivities that range from 2,000 to 1,300,000 feet squared per day (ft^2/d). Range in transmissivities in the Ocala Limestone is caused by the variable, fractured nature, and the dissolution of limestone that creates conduits and solution openings (Miller, 1986).

The Tallahatta Formation of Eocene age is the principal water-bearing formation of the Claiborne aquifer (McFadden and Perriello, 1983). The Clayton Formation of Paleocene age is the water-bearing formation of the Clayton aquifer. Cretaceous units crop out immediately below the Fall Line. The principal water-bearing formation is the Providence Sand of Late Cretaceous age (McFadden and Perriello, 1983). Older Cretaceous strata generally are too deep to be economically developed.

Aquifers in the Piedmont and Blue Ridge Provinces are in crystalline rocks that crop out in the northern part of the basin and extend to the Fall Line (fig. 3). These crystalline rocks have similar hydraulic characteristics and are mapped as one aquifer. The metamorphic and igneous crystalline rocks of the crystalline aquifer are overlain by pockets of regolith (weathered, unconsolidated rock debris) of varying thicknesses. The greatest thicknesses of regolith, as much as about 100 ft, are in draws and valleys. Because the crystalline rocks have few primary pore spaces, ground water is obtained primarily from the regolith and from fractures in the rock. Reported yields of wells completed in these rocks range from zero to 471 gallons per minute (gal/m), but are commonly less than 50 gal/m (Cressler and others, 1983; Chapman and others, 1993).

The regional direction of ground-water flow is from north to south; however, local flow directions vary, especially in the vicinity of streams and areas having large ground-water withdrawals. Rivers and streams in the Coastal Plain Province commonly are deeply incised into underlying aquifers and receive substantial amounts of ground-water discharge. Strata associated with the Floridan aquifer system are exposed along sections of the Apalachicola, Chattahoochee, and Flint Rivers; and Spring Creek (Maslia and Hayes, 1988). As a result of the hydraulic connection between the Floridan aquifer system and the Flint River, ground-water discharge contributes more significantly to baseflow in the Flint River than in the Chattahoochee River. Aquifer discharge to the Chattahoochee River is estimated to be one-fifth of the amount that discharges to the Flint River (Torak and others, 1991).

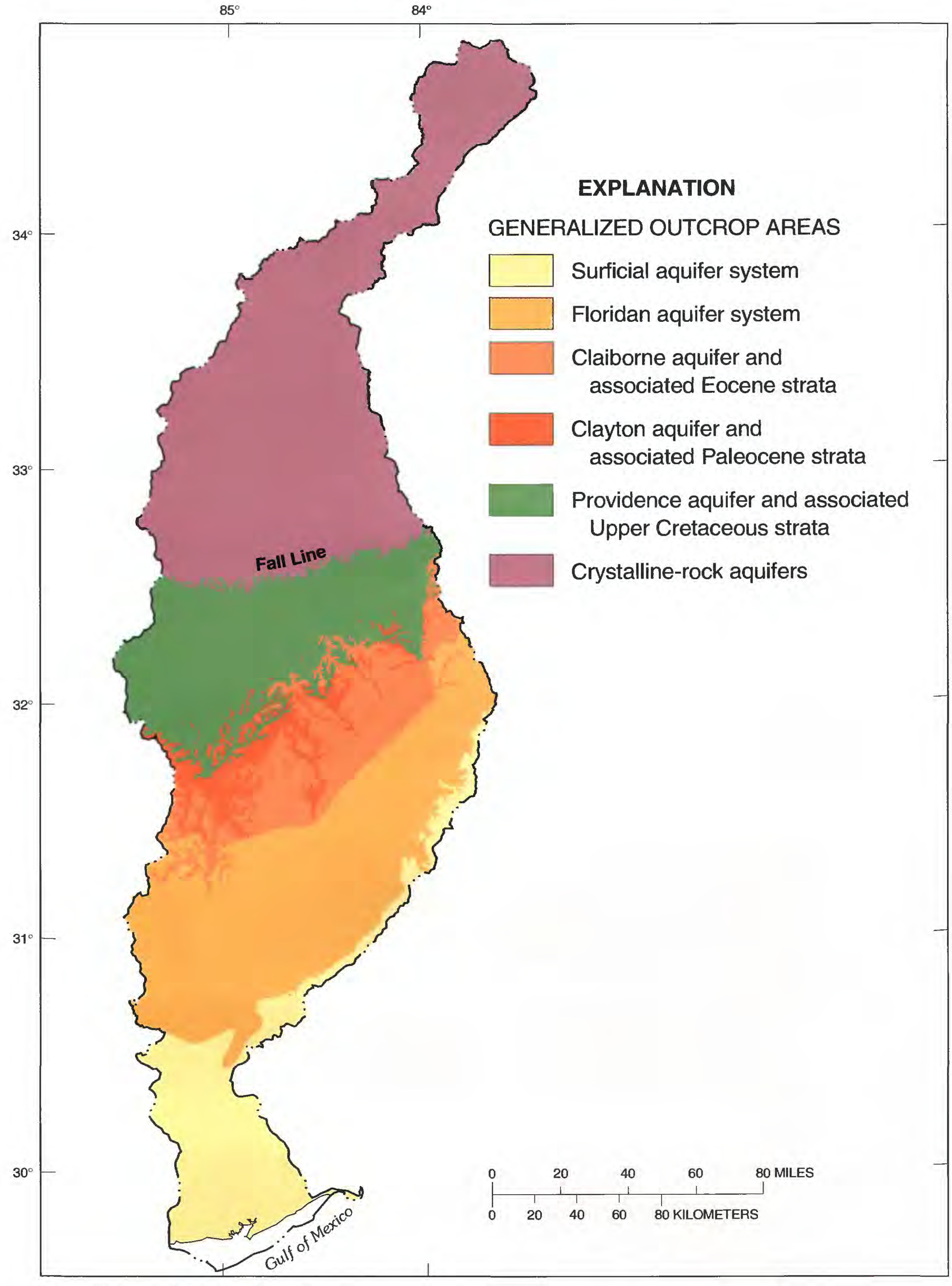


Figure 19. Generalized outcrop areas for geologic and hydrogeologic units underlying the Apalachicola–Chattahoochee–Flint River basin (modified from Georgia Geologic Survey, 1976; Miller, 1986; and Geological Survey of Alabama, 1989).

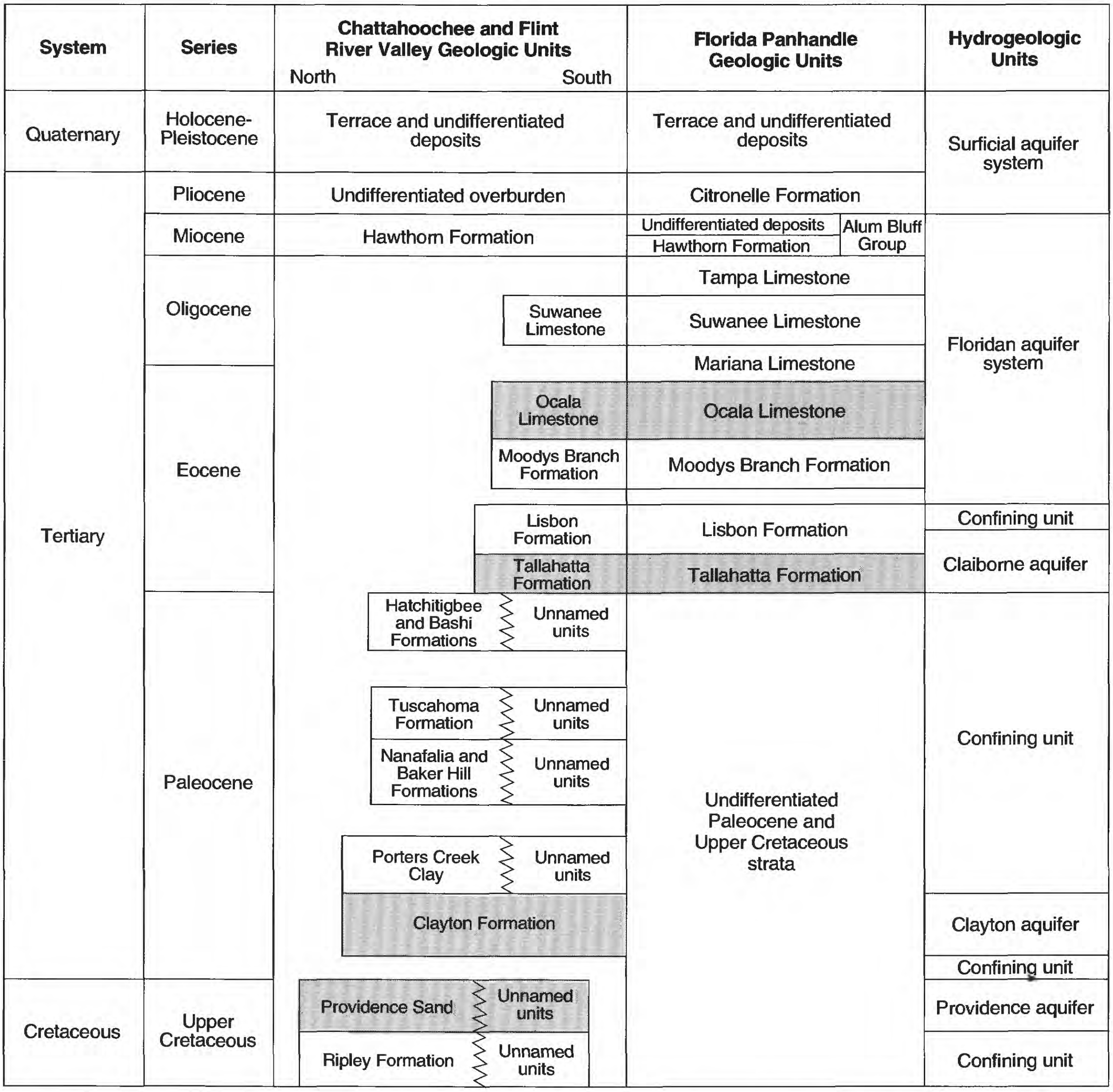


Figure 20. Generalized geologic and hydrogeologic units in the Coastal Plain of the Apalachicola–Chattahoochee–Flint River basin. Gray area represents principle water-bearing strata; blank area represents missing strata (modified from Wagner and Allen,1984; Faye and Mayer, 1996; and Georgia Geologic Survey, written communication, 1996).

Natural Water Quality

Assessment of the effect of human activity on water quality must first begin with an understanding of natural variations in water quality. Large-scale patterns in surface-water chemistry in the Chattahoochee and Flint River basins were summarized by Cherry (1961, 1963). Surface-water chemistry naturally is different in the Blue Ridge, the Piedmont Province, and in differing areas of the Coastal Plain Province. Surface water in the Blue Ridge and Piedmont Provinces and parts of the Coastal Plain Province, is siliceous with specific conductance typically less than 50 microsiemens per centimeter (µs/cm) and pH ranging from 5.6 to 6.9. Surface waters in the Blue Ridge Province and in the sandy Cretaceous outcrop immediately below the Fall Line in west-central Georgia are very soft with low concentrations of dissolved ions. Carbonate water is present in the Dougherty Plain District of the Coastal Plain Province where specific conductance is typically greater than 150 µs/cm and pH exceeds 7.0. The Dougherty Plain has soft to moderately hard water, with soft water present in the remainder of the Coastal Plain and the Piedmont.

Ground-water quality is related to the geologic character of the aquifers through which it moves. General chemical characteristics of water in the major aquifers of the ACF River basin are shown in table 2.

Water from the unconfined cystalline-rock aquifer of the Blue Ridge and Piedmont Provinces is slightly acidic and soft to moderately hard. Unconfined water in the shallow regolith and rock fractures is at greater risk of contamination in urban and industrial settings than in rural settings. Traces of volatile organic compounds have been detected in a few wells in Fulton County, Ga. (Davis, 1990).

Major differences in ground-water quality between the crystalline rock aquifer and aquifers underlying the Coastal Plain Province reflect the presence of limestone and greater agricultural land use in the Coastal Plain Province. Coastal Plain aquifers have more bicarbonate, calcium, nitrite, and nitrate, and less manganese than the crystalline aquifer.

The feldspathic sand and coquinoid limestone of the Late Cretaceous Providence formation yields a sodium bicarbonate type water. Water from the Providence Sand aquifer is basic and soft to moderately hard with higher sodium concentrations than water in other aquifers underlying the lower ACF River basin. The sodium content of water in the Clayton aquifer also is influenced by feldspathic sands. Ground water from the Clayton aquifer is soft to moderately hard and ranges from a sodium bicarbonate to a calcium bicarbonate type. Water obtained from the Claiborne aquifer is a calcium bicarbonate type and is moderately hard to hard (Davis, 1990).

The Ocala Limestone is the principal water-bearing stratum of the Floridan aquifer system in the lower ACF River basin. The water in the Ocala Limestone is a calcium bicarbonate type, moderately hard to hard, and slightly alkaline. Sulfate concentrations generally increase in the part of the Floridan aquifer system near the coast (Davis, 1990).

The natural quality of water from all aquifers in the ACF River basin is acceptable for public supply. However, the extent of localized contamination by volatile organic compounds in urban settings, and upward trends in nitrite and nitrate concentrations in agricultural settings, are concerns. Nitrite and nitrate concentrations in the areas of karst topography in the ACF River basin are generally within drinking-water standards, but are somewhat higher than levels found in other areas of Georgia (Davis, 1990). In a recent survey of nitrate concentrations in shallow domestic wells in Georgia, U.S. Environmental Protection Agency (EPA) safe drinking water-standards of 10 parts per million (ppm) nitrate was exceeded in only a few isolated wells (Stuart and others, 1995).

Table 2. Water-quality concentration data, by aquifer, in Georgia portion of the Apalachicola-Chattahoochee-Flint River basin, 1988

[Data are mean values; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; modified from Davis, 1990]

Aquifer name	Physiographic province	Number of analyses	Physical property, in units	Major inorganic constituents, in units							Trace elements, in units	
			pH (in standard units)	Calcium, dissolved, (in mg/L)	Chloride, dissolved, (in mg/L)	N, as nitrite and nitrate, dissolved (in mg/L)	Magnesium, dissolved (in mg/L)	Sodium, dissolved (in mg/L)	Potassium, dissolved (in mg/L)	Sulfate, dissolved (in mg/L)	Iron, dissolved (in mg/L)	Manganese, dissolved (in mg/L)
Floridan aquifer system	Coastal Plain	57	7.7	43	7.0	1.0	6.0	6.0	1.0	26	29	6.0
Claiborne	Coastal Plain	7	6.1	23	4.0	2.0	3.0	3.6	1.0	<2.0	274	92
Clayton	Coastal Plain	7	7.3	46	3.8	1.0	4.6	10	2.0	19	1,186	28
Providence	Coastal Plain	3	7.1	16	7.0	.3	1.3	34	1.6	10	44	8.0
Crystalline rock	Piedmont	21	6.7	14	7.0	.4	4.0	10	2.5	13	1,348	100
Crystalline rock	Blue Ridge	4	6.8	15	4.0	0.04	2.1	8.0	1.8	8.0	221	113

BIOLOGICAL SETTING

One objective of the NAWQA Program is to provide an improved understanding of relations among physical, chemical, and biological characteristics of streams as an integral part of interpreting water-quality status and trends (Gurtz, 1994). Biotic communities may exist in states of degradation or recovery in response to historical or continuing disturbances of land and water resources. An assessment of current characteristics of aquatic biotic communities needs to include an understanding of antecedent disturbances. The biological setting includes a description of current information on terrestrial and aquatic habitats and biota, and historical human alterations of these habitats.

Most of the ACF River basin has been altered and transformed by human activities; and yet, the basin's environment is noteworthy for its remaining unique biological diversity and the role it plays in sustaining biological production in the Apalachicola Bay. Apalachicola Bay produces 90 percent of Florida's and 13 percent of the Nations's oyster harvest, and functions as a nursery for penaeid shrimp, blue crabs, and a variety of fin fish (Livingston, 1992). The Bay is designated by the United Nations as an International Biosphere Reserve and is the location of the largest National Estuarine Research Reserve. The Apalachicola River and Bay have been declared an Outstanding Florida Water by the State of Florida.

The uniqueness of the basin's environment and biological diversity is a consequence of the basin's relation to regional ecological and zoogeographic patterns. The ACF River basin contains parts of the Blue Ridge Mountains, Southeastern Plains, and Southern Coastal Plain Ecoregions (Omernik, 1987). The Blue Ridge Ecoregion is contained within the part of the basin in the Blue Ridge Province. The Southeastern Plains Ecoregion encompasses all of the ACF River basin in the Piedmont and Coastal Plain Provinces with the exception of most of the Apalachicola River basin. In the Apalachicola River basin, the Southern Coastal Plain Ecoregion is coincident with the Gulf Coast Lowlands District. These ecoregions are intended to identify areas of relatively homogeneous ecological systems and are partially based on the distribution of terrestrial biota.

Terrestrial Habitats

The health of aquatic ecosystems is linked to the health of terrestrial ecosystems. All parts of the ACF River basin have been subject to varying degrees of forest-cover alteration. Small-scale disturbance of native forests began with American Indians who used fire to manage pinelands and create fields for cultivation. Forest disturbance was greatly accelerated by European settlers who logged throughout the basin and extensively cleared land for agriculture in the Piedmont and Coastal Plain. Between 1868 and approximately 1940, hydraulic mining of gold in the Blue Ridge resulted in extensive deforestation of land (Leigh, 1994).

Prior to European settlement, the ACF River basin was mostly forested. Historically, the Blue Ridge Province was covered by oak-chestnut-hickory forests, with hemlock in moist coves and white pine in drier ridges. Chestnut was extirpated from these forests as a result of the Chestnut Blight. Native forests in the Piedmont Province were dominantly deciduous hardwoods and mixed stands of pine and hardwoods. The Coastal Plain supported oak-sweetgum-pine forests, with gum-cypress in floodplain forests. Parts of the lower Coastal Plain were vegetated by open savannahs of wiregrass and longleaf pine (Wharton, 1978).

Although land cover in the Blue Ridge Province historically has been dominated by forest, forest-species composition. and age structure have been altered by mining, logging, and disease. Deforestation caused by mining and logging resulted in localized severe erosion and thick sediment deposits in floodplains in the Blue Ridge. As much as 5 ft of sediment has been deposited in floodplains of the Chestatee River in the upper Chattahoochee River basin as a result of hydraulic mining of gold (Leigh, 1994).

The Piedmont Province experienced three phases of land abandonment—after the Civil War, during the agricultural depression of the late 1880's, and after the boll weevil infestation in the 1920's. Cotton production in the Piedmont Province left the land relatively infertile and almost devoid of topsoil. Almost all topsoil in the Piedmont had been eroded by 1935 (Wharton, 1978). Abandoned agricultural lands were replaced by the secondary forests that cover most of the Piedmont today.

Forest cover probably reached a low between 1910 and 1919 basinwide when agriculture was at a peak. By the 1920's, about 87 percent of the Piedmont had been cultivated (Plummer, 1975). By the mid-1970's, approximately 59 percent of the land cover in the entire ACF River basin was forests of second growth stands and large acreages of planted pine (U.S. Geological Survey, 1972-78).

Although logging has occurred throughout most of the Apalachicola River basin, certain areas, such as wet savannahs in the pine flatwoods of the lower basin and bluffs and ravines, remain unique botanical areas inhabited by a large number of rare and endangered species. There are 116 noteworthy species of plants in the Apalachicola River basin of which 17 are endangered, 28 threatened, and 30 are rare; and 9 plant species are narrowly endemic (Clewell 1977). This unusual diversity is attributable to the variability of the basin's physical environment and geographical location, which allows the basin to receive floral and faunal influences from five distinct physiographic districts (Leitman and others, 1991).

Wetland Habitats and Aquatic Vegetation

Wetlands are lands transitional between terrestrial and deep-water habitats where the water table is at or near land surface or the land is covered by shallow water (Cowardin and others, 1979). Most wetlands in the ACF River basin are forested wetlands located in floodplains of streams and rivers. Forested-floodplain wetlands are maintained by the natural flooding regime of rivers and streams, and in turn, influence the water and habitat quality of riverine ecosystems.

Estimates of wetland acreage within the ACF River basin vary because of differences in methods used to classify and inventory wetlands. However, approximately five percent (633,600 acres) of the basin was wetlands in the 1970's (U.S. Geological Survey, 1972-78). Because of the hilly topography, wetlands in the Blue Ridge and Piedmont Provinces are small and scattered. Most wetlands of significant size are in the Coastal Plain Province in the Flint River and the Apalachicola River basins (fig. 21). Approximately 90,000 acres are in the forested floodplain of the Flint River basin and floodplain and swamps associated with Chickasawhatchee and Spring Creeks (U.S. Fish and Wildlife Service, 1992). The Apalachicola River basin contains about 27,000 acres of wetlands in the Chipola River floodplain, and 130,000 acres of wetlands in the floodplain and tidal marshes of the Apalachicola River (Wharton and others, 1977; Leitman, 1984).

The Apalachicola River floodplain forests are among the most productive in warm, temperate regions (Elder and Cairns, 1982), and riverine inputs of nutrients and detritus derived from the floodplain sustain the productivity of the Apalachicola Bay (Mattraw and Elder, 1984). Biological organization of the Bay is controlled largely by riverine influences on the Bay's salinity, turbidity, and sedimentation rates (Livingston 1991).

The Apalachicola River floodplain is a vast wetland of bottomland hardwood forests and tupelo-cypress swamps. Disturbances have been limited primarily to logging which began during the lumber boom of 1870-1925 and continued at a lower level to the present. Forty-seven tree species grow in this floodplain, and the 10 dominant trees, in decreasing order of relative basal area, are water tupelo, Ogeechee tupelo, Baldycypress, Carolina ash, swamp tupelo, sweetgum, overcup oak, planertree, breen ash and water hickory (Leitman and others, 1983). The species composition of the floodplain forest is dependent on flood characteristics of the Apalachicola River. If the flooding cycle is significantly and permanently altered, the floodplain forest will change in species composition and age structure.

Aquatic vegetation and algae exhibit uncontrolled or noxious growth in response to changes in water quality such as nutrient enrichment or altered hydraulic conditions. These problems occur frequently in reservoirs in the Coastal Plain Province, where stable water levels, shallow depths, sedimentation, excessive nutrient inputs, and a mild climate provide conditions favorable to the proliferation of aquatic vegetation, particularly introduced species. In the ACF River basin, Lakes Blackshear and Seminole have experienced noxious growths of aquatic plants. The problem is severe in Lake Seminole, where as much as 80 percent of the lake's surface area has been covered by aquatic plants. Noxious growth of aquatic plants in Lake Seminole began in 1955 at the time water began to be impounded (Gholson, 1984). In 1973, an aquatic plant survey of Lake Seminole identified more than 400 species, of which 70 were classified as noxious or potentially noxious plants. Several introduced species have established themselves, including Eurasian milfoil (*Myriophyllum spicatum*), giant cutgrass (*Zizaniopxis miliacea*), water hyacinth (*Eichorina crassipes*) and Hydrillae (*Hydrilla verticillata*).

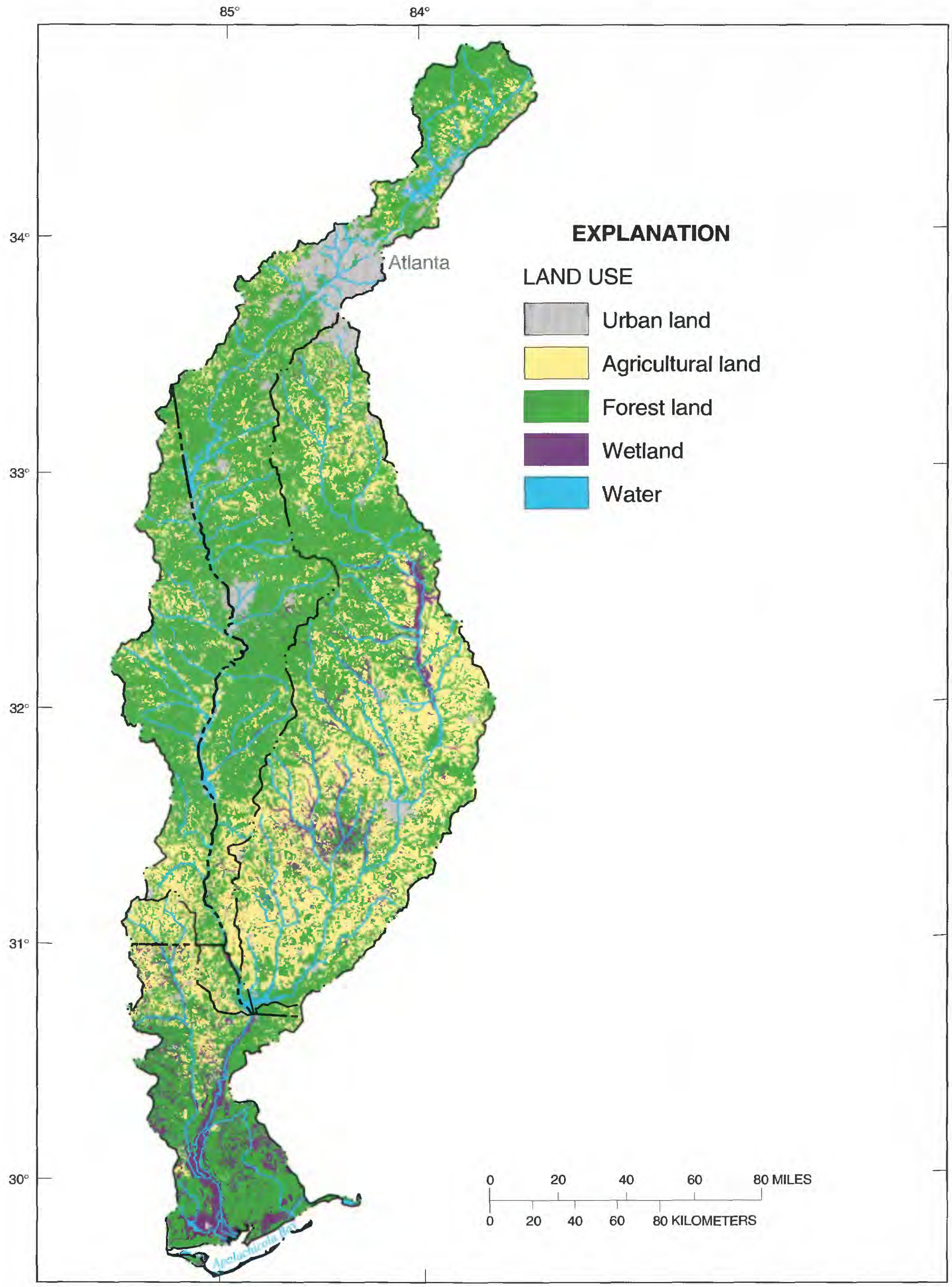
The U.S. Army Corps of Engineers uses several methods in attempting to control plant growth in Lake Seminole, including aerial application of herbicides and mechanical harvesting, and recently tested biological control methods using the Hydrillae fly (*Hydrillae pakistani*).

Aquatic Fauna

This section focuses on aquatic or wetland species including fishes, amphibians, aquatic reptiles, and aquatic invertebrates. However, the ACF River basin is rich in many other fauna that rely on the water resources of the basin, including 99 species of breeding birds and 52 species of mammals (Means, 1977). Although a description of these bird and mammal species is beyond the scope of this report, the water needs of these species, such as migratory water fowl, should be considered in water-resource planning and management.

Fish Fauna

The ACF River basin has the largest diversity of fish fauna among the Gulf Coast river drainages east of the Mississippi River (Dahlberg and Scott, 1971). The diverse fish fauna of the ACF River basin includes 122 extant species representing 23 families (table 3). The Apalachicola River basin has the largest assemblage of freshwater fish species in Florida. Sixteen fish species have been listed for protection by Federal or State agencies (table 6). The largest number of species (33) are in the minnow family Cyprinidae. Centrachidae, the sunfish family, has the next largest number of species (20). Seventeen fish species have been introduced in the ACF River basin by humans. Introduced species include the rainbow and the brown trout, white catfish, flathead catfish, black bullhead, goldfish, carp, rough shiner, red shiner, white bass, spotted bass, rock bassappie, yellow perch, sauger, and walleye.



Base modified from U.S. Geological Survey digital files

Figure 21. Landuse in the Apalachicola-Chattahoochee-Flint River basin. Barren land (120 square miles) and range land (9 square miles) are not visible at this scale (modified from U.S. Geological Survey land use and land cover digitial data, 1972–78; urban areas expanded based on U.S. Bureau of the Census 1990 population data).

Table 3. Fishes of the Apalachicola-Flint-Chattahoochee River basin, excluding estuarine species

[X denotes presence; --, not reported]

Common and *scientific* names	Distribution of fish, by river basin and physiographic province				
	Apalachicola River basin	Chattahoochee River basin		Flint River basin	
	Coastal Plain Province	Coastal Plain Province	Piedmont Province	Coastal Plain Province	Piedmont Province
PETROMYZONTIDAE					
Southern brook lamprey *(Icthyomyzon gagei)*	X[1/,2/,3//]	X[4/,5/]	X[4,5/]	X[1,3,4/]	X
ACIPENSERIDAE					
Gulf of Mexico sturgeon *(Acipenser oxyrhynchus desotoi)*	X[2,3/]	--	--	--	--
LEPISOSTEIDAE					
Spotted gar *(Lepisosteus oculatus)*	X[1,2,3/]	X[1,3,4,5//]	--	X[1,3,4/]	--
Longnose gar *(Lepisosteus osseus)*	X[1,2,3/]	X[1,3,4,5/]	--	X[1,3,4/]	--
AMIIDAE					
Bowfin *(Amia calva)*	X[1,2,3/]	X[1,3,4,5/]	--	X[1,3,4/]	--
ANGUILLIDAE					
American eel *(Anguilla rostrata)*	X[1,2/]	X[1,3,4,5/]	--	X[1,3,4/]	--
CLUPEIDAE					
Alabama shad *(Alosa alabamae)*	X[1,2,3/]	X[1,3,4/]	X[1,3,4/]	X[3/]	X[3/]
Skipjack herring *(Alosa chrysochloris)*	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[3/]	X[3/]
Gizzard shad *(Dorosoma cepedianum)*	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[1,3,4/]	X[1,3,4/]
Threadfin shad *(Dorosoma petenense)*	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[1,3,4/]	X[1,3,4/]
SALMONIDAE[6/]					
Brook trout *(Salvelinus fontinalis)*	--	--	X[1,2,4/]	--	--
Brown trout *(Salmo trutta)*	--	--	X[1,2,4/]	--	--
Rainbow trout *(Oncorhyrnchur mykiss)*	--	--	X[1,2,4/]	--	--
CYPRINIDAE					
Bluefin stoneroller *(Campostoma pauciradii)*	--	X[1,4,/]	X[1,4,/]	X[1,4/]	X[1,4/]
Goldfish *(Carassius auratus)*	--	X[1,4,5/]	X[1,4,5/]	--	--
Bluestripe shiner *(Cyprinella[7/] callitaneia)*	X[1,2/]	X[1,4,8/]	X[1,4,5/]	X[1,4/]	X[1,4/]
Bannerfin shiner *(Cyprinella[7/] leedsi)*	X[3/]	--	--	--	--
Red shiner *(Cyprinella[7/], lutrensis)*	--	--	X	--	--
Blacktail shiner *(Cyprinella [7/]venusta)*	X[1,3/]	X[1,3,4,5,8/]	X[1,3,4,5,8/]	X[1,3,4/]	X[1,3,4/]
Common carp *(Cyprinus carpio)*	X[1,2/]	X[1,4,5/]	X[1,4,5/]	X	--

Table 3. Fishes of the Apalachicola-Flint-Chattahoochee River basin, excluding estuarine species—Continued

Common and *scientific* names	Distribution of fish, by river basin and physiographic province				
	Apalachicola River basin	Chattahoochee River basin		Flint River basin	
	Coastal Plain Province	Coastal Plain Province	Piedmont Province	Coastal Plain Province	Piedmont Province
CYPRINIDAE—Continued					
Silverjaw minnow *(Ericymba buccata)*	X[1,2/]	X[1,4,5,8/]	X[1,4,5,8/]	--	X[1,4/]
Clear chub *(Hybopsis winchelli)*	X[1,2,3/]	X[1,3,5/]	X[1,3,5/]	X[1,3/]	X[1,3/]
Bandfin shiner *(Luxilus[7/] zonistius)*	X[1,2,3/]	X[1,3,4,5,8/]	X[1,3,4,5,8/]	X[1,3,4/]	X[1,3,4/]
Blacktip shiner *(Lythrurus[7/] atrapiculus)*	--	X[1,3/]	X[1,3/]	--	--
Bluehead chub *(Nocomis leptocephalus)*	--	X[3,4,5/]	X[3,4,5/]	--	X[3/]
Golden shiner *(Notemigonus crysoleucas)*	X[3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[3,4]	X[3,4/]
Rough shiner *(Notropis baileyi)*	--	X[1,3,4,5/]	X[1,3,4,5]	--	--
Ironcolor shiner *(Notropis chalybaeus)*	X[1,2,3/]	X[2/]	--	X[1,4/]	--
Dusky shiner *(Notropis cummingsae)*	X[1,2,3/]	X[1,4,5/]	X[1,4,5/]	--	--
Redeye chub *(Notropis harperi)*	X[1,2,3/]	X[1,3,4,5/]	--	X[1,3,4,5/]	--
Spottail shiner *(Notropis hudsonius)*	--	X[1,3,4/]	X[1,3,4/]	--	--
Highscale shiner *(Notropis hypsilepis)*	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[1,3,4/]	X[1,3,4/]
Longnose shiner *(Notropis longirostris)*	X[1,2/]	X[1,4,5/]	X[1,4,5/]	X[1,4/]	X[1,4/]
Yellowfin shiner *(Notropis lutipinnis)*	--	--	X[1,4,8/]	--	--
Taillight shiner *(Notropis maculatus)*	X[1,2,3/]	X[1,3,4,5/]	--	X[1,3,4/]	--
Coastal shiner *(Notropis petersoni)*	X[1,2,3/]	X[8/]	X[8/]	X[1,3,4/]	--
Weed shiner *(Notropis texanus)*	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[1,3,4,5/]	X[1,3,4,5/]
Coosa shiner *(Notropis xaenocephalus)*	--	--	X[1,4,8/]	--	--
Pugnose minnow *(Opsopoeodus emiliae)*	X[1,2,3/]	X[1,3,4,5/]	--	X[1,3,4,5/]	--
Fathead minnow *(Pimephales promelas)*	--	--	X	X[3/]	X[3/]
Broadstripe shiner *(Pteronotropis[7/] euryzonus)*	--	X[1,3,4,5/]	--	X[3/]	--
Sailfin shiner *(Pteronotropis[7/] hypselopterus)*	X[1,2,3/]	X[1,3,4,5/]	--	X[1,3,4/]	--
Flagfin shiner *(Pteronotropis[7/] signipinnus)*	X[1,2,3/]	--	--	--	--

Table 3. Fishes of the Apalachicola-Flint-Chattahoochee River basin, excluding estuarine species—Continued

Common and *scientific* names	Distribution of fish, by river basin and physiographic province				
	Apalachicola River basin	Chattahoochee River basin		Flint River basin	
	Coastal Plain Province	Coastal Plain Province	Piedmont Province	Coastal Plain Province	Piedmont Province
CYPRINIDAE—Continued					
Bluenose shiner (*Pteronotropis*[7/] *welaka*)	X[1,3,5/]	X[1,3,5/]	--	X[1,3/]	--
Creek chub (*Semotilus atromaculatus*)	X[1,2,3/]	--	X[1,3,4,5,8/]	--	X[1,3,4,5,8/]
Dixie chub (*Semotilus thoreauianus*)	--	--	X	--	--
CATASTOMIDAE					
Quillback (*Carpiodes cyprinus*)	X[1,2,3,4/]	X[1,3,4,5/]	--	X[3/]	--
White sucker (*Catostomus commersoni*)	--	--	X	--	--
Creek chubsucker (*Erimyzon oblongus*)	X[2/]	X[1,3,4,5/]	X[1,3,4,5/]	X[1,3,4/]	X[1,3,4/]
Lake chubsucker (*Erimyzon succeta*)	X[1,2,3/]	X[1,3,4,5/]	--	X[1,3,4,5/]	-
Alabama hogsucker (*Hypentelium etowanum*)	--	X[1,4,5,8/]	X[1,4,5,8/]	--	--
Spotted sucker (*Minytrema melanops*)	X[1,2,3/]	X[1,3,4,5,8/]	X[1,3,4,5,8/]	X[1,3,4/]	X[1,3,4/]
Grayfin redhorse (*Moxostoma sp. cf. poecilurum*)	X[1,3/]	X[1,3,4,5,8/]	X[1,3,4,5,8/]	X[1,3,4/]	X[1,3,4/]
Greater jumprock (*Scartomyzon*[9/] *lachneri*)	--	X[1,3,4,5]	X[1,3,4,5]	X[1,3,4]	X[1,3,4/]
Striped jumprock (*Scartomyzon*[9/] *rupiscartes*)	--	--	X[1,4,8/]	--	X[3/]
ICTALURIDAE					
Snail bullhead (*Ameiurus*[10/] *brunneus*)	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[1,3,4/]	X[1,3,4/]
White catfish (*Ameiurus*[10/] *catus*)	X[1,2/]	X[1,4,5/]	--	X[3,4/]	--
Black bullhead (*Ameiurus*[10/] *melas*)	--	--	X	--	--
Yellow bullhead (*Ameiurus*[10/] *natalis*)	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[1,3,4/]	X[1,3,4/]
Brown bullhead (*Ameiurus*[10/] *nebulosus*)	X[1,2,3/]	X[1,3,4,5,8/]	X[1,3,4,5,8/]	X[1,3,4/]	X[1,3,4/]
Spotted bullhead (*Ameiurus*[10/] *serracanthus*)	X[1,2,3/]	X[1,3,4/]	--	X[1,3,4/]	--
Channel catfish (*Ictalurus punctatus*)	X[1,2,3/]	X[1,3,4,5,8/]	X[1,3,4,5,8/]	X[1,3,4/]	X[1,3,4/]
Tadpole madtom (*Noturus gyrinus*)	X[1,2,3/]	X[1,3,4,5,8/]	X[1,3,4,5,8/]	X[1,3,4/]	X[1,3,4/]
Black madtom (*Noturus funebris*)	X[1,2,3/]	--	--	--	--

Table 3. Fishes of the Apalachicola-Flint-Chattahoochee River basin, excluding estuarine species—Continued

Common and *scientific* names	Distribution of fish, by river basin and physiographic province				
	Apalachicola River basin	Chattahoochee River basin		Flint River basin	
	Coastal Plain Province	Coastal Plain Province	Piedmont Province	Coastal Plain Province	Piedmont Province
ICTALURIDAE—Continued					
Speckled madtom *(Noturus leptacanthus)*	X[1,2,3/]	X[1,3,4,5,8/]	X[1,3,4,5,8/]	X[1,3,4/]	X[1,3,4/]
Flathead catfish *(Pylodictis olivaris)*	X[2/]	X[3,4,8/]	X[3,4,8/]	X[1,3,4/]	X[1,3,4/]
ESOCIDAE					
Redfin pickerel *(Esox americanus)*	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[1,3,4/]	X[1,3,4/]
Chain pickerel *(Esox niger)*	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4/]	X[1,3,4/]	X[1,3,4/]
APHREDODERIDAE					
Pirate perch *(Aphredoderus sayanus)*	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[1,3,4/]	--
BELONIDAE					
Atlantic needlefish *(Strongylura marina)*	--X[1,2/]	--X[1,4,5/]	--	--	--
FUNDULIDAE					
Golden topminnow *(Fundulus chrysotus)*	X[1,3,4/]	--	--	X[1,3,4/]	--
Banded topminnow *(Fundulus aurogutattus)*[11/]	X[1,2,3/]	--	--	--	-
Eastern starhead minnow *(Fundulus escambiaei)*	X	--	--	X[/]	--
Blackspotted topminnow *(Fundulus olivaceus)*	X[2/]	X[1,3,4,5,8/]	X[1,3,4,5,8/]	--	--
Southern studfish *(Fundulus stellifer)*	--	X[1,3,4,8/]	X[1,3,4,8/]	--	--
Pygmy killifish *(Leptolucania ommata)*	X[1,2,3/]	--	--	--	--
Bluefin killifish *(Lucania goodei)*	X[1,2,3/]	--	--	--	--
POECILIIDAE					
Mosquitofish *(Gambusia* sp. cf. *affinis)*	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[1,3,4/]	X[1,3,4/]
Least killifish *(Heterandria formosa)*	X[1,2,3/]	X[1,3/]	--	X[1,3/]	--
Sailfin molly *(Poecilia latipinna)*	X[3/]	--	--	--	--
ATHERINIDAE					
Brook silverside *(Labidesthes sicculus)*	X[1,2,3/]	X[1,3,4,5/]	--	X[1,3,4/]	--
COTTIDAE					
Mottled sculpin *(Cottus bairdi)*	--	--	X[1,3,4,8/]	--	--
Banded sculpin *(Cottus carolinae)*	--	--	X[1,3,4,8/]	--	--

Table 3. Fishes of the Apalachicola-Flint-Chattahoochee River basin, excluding estuarine species—Continued

Common and *scientific* names	Distribution of fish, by river basin and physiographic province				
	Apalachicola River basin	Chattahoochee River basin		Flint River basin	
	Coastal Plain Province	Coastal Plain Province	Piedmont Province	Coastal Plain Province	Piedmont Province
MORONIDAE					
White bass (*Morone chrysops*)	X[1,2,3]	X[1,3,4,5]	X[1,3,4,5]	X[1,3,4]	X[1,3,4]
Striped bass (*Morone saxatilis*)	X[1,2,3]	X[1,3,4]	X[1,3,4]	X[1,3,4]	X[1,3,4]
Sunshine bass (*Morone chrysops* X *saxatilis*)	X[3]	X[3]	X[3]	X[3]	X[3]
ELASSOMATIDAE					
Everglades pygmy sun fish (*Elassoma evergladei*)	X[1,2,3]	--	--	X[1,3,4]	--
Okefenokee pygmy sun fish (*Elassoma okefenokeee*)	X[1,2,3]	--	--	--	--
Banded pygmy sunfish (*Elassoma zonatum*)	X[1,2,3]	X[1,3,4,5]	--	X[1,3,4]	--
CENTRARCHIDAE					
Shadow bass (*Ambloplites ariommus*)	X[2]	X[1,3,4]	X[1,3,4]	X[1,3,4]	X[1,3,4]
Flier (*Centrarchus macropterus*)	X[1,2,3]	X[1,3,4,5]	X[1,3,4,5]	X[1,3,4]	--
Bluespotted sunfish (*Enneacanthus glorious*)	X[1,2,3]	--	--	X[1,2,3]	--
Banded sunfish (*Enneacanthus obesus*)	X[1,2,3]	--	--	X[1,3,4]	--
Redbreast sunfish (*Lepomis auritus*)	X[1,2,3]	X[1,3,4,5]	X[1,3,4,5]	X[1,3,4]	X[1,3,4]
Green sunfish (*Lepomis cyanellus*)	X[1,2,3]	X[1,3,4,5]	X[1,3,4,5]	X[3]	X[3]
Warmouth (*Lepomis gulosus*)	X[1,2,3]	X[1,3,4,5]	X[1,3,4,5]	X[1,3,4]	X[1,3,4]
Orangespotted sunfish (*Lepomis humilis*)	X[1,2,3]	X[1,4,5]	--	X[3]	--
Bluegill (*Lepomis macrochirus*)	X[1,2,3]	X[1,3,4,5]	X[1,3,4,5]	X[1,3,4]	X[1,3,4]
Dollar sunfish (*Lepomis marginatus*)	X[1,2,3]	X[1,3,4,5]	--	X[1,3,4]	--
Longear sunfish (*Lepomis megalotis*)	X[3]	X[1,3,4,5]	X[1,3,4,5]	--	--
Redear sunfish (*Lepomis microlophus*)	X[1,2,3]	X[1,3,4,5]	X[1,3,4,5]	X[1,3,4]	X[1,3,4]

Table 3. Fishes of the Apalachicola-Flint-Chattahoochee River basin, excluding estuarine species—Continued

Common and *scientific* names	Distribution of fish, by river basin and physiographic province				
	Apalachicola River basin	Chattahoochee River basin		Flint River basin	
	Coastal Plain Province	Coastal Plain Province	Piedmont Province	Coastal Plain Province	Piedmont Province
CENTRARCHIDAE—Continued					
Spotted sunfish intergrade *(Lepomis mineatus* X *L. punctatus)*	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[1,3,4/]	X[1,3,4/]
Redeye bass *(Micropterus coosae)*	--	X[1,3,4,5,8/]	X[1,3,4,5,8/]	X[1,3,4/]	X[1,3,4/]
Shoal bass *(Micropterus* sp. cf. *coosae)*	X[1,2,3/]	X[1,3,4/]	X[1,3,4/]	X[1,3,4/]	X[1,3,4/]
Smallmouth bass *(Micropterus dolomieu)*	--	X[1,3,4,5/]	X[1,3,4,5/]	--	--
Spotted bass *(Micropterus punctatus)*	X[1,2,3/]	X[1,3,4,5,8/]	X[1,3,4,5,8/]	--	--
Largemouth bass *(Micropterus salmoides)*	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[1,3,4/]	X[1,3,4/]
White crappie *(Pomoxis annularis)*	X[3/]	X[1,3,4/]	X[1,3,4/]	X[1,3,4/]	X[1,3,4/]
Black crappie *(Pomoxis nigromaculatus)*	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[1,3,4/]	X[1,3,4/]
PERCIDAE					
Florida sand darter *(Ammocry pta bifasicata)*	X[1,2,3/]	--	--	--	--
Brown darter *(Etheostoma edwini)*	X[1,2,3/]	X[1,3,4,5/]	--	X[1,3,4/]	--
Swamp darter *(Etheostoma fusiforme)*	X[1,2,3/]	X[1,3,4,5/]	--	X[1,3,4/]	--
Goldstripe darter *(Etheostoma parvipinne)*	X[1,2,3/]	X[1,3,4,5/]	--	X[1,3,4/]	--
Gulf darter *(Etheostoma swaini)*	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[1,3,4/]	X[1,3,4/]
Yellow perch *(Perca flavescens)*	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[3/]	X[3/]
Blackbanded darter *(Percina nigrofasciata)*	X[1,2,3/]	X[1,3,4,5/]	X[1,3,4,5/]	X[1,3,4/]	X[1,3,4]
Sauger *(Stizostedion canadense)*	X[1,2,3/]	X[1,3,4/]	X[1,3,4/]	--	--
Walleye *(Stizostedion vitreum)*	--	X[1,3,4/]	X[1,3,4/]	--	--

Table 3. Fishes of the Apalachicola-Flint-Chattahoochee River basin, excluding estuarine species—Continued

Common and *scientific* names	Distribution of fish, by river basin and physiographic province				
	Apalachicola River basin	Chattahoochee River basin		Flint River basin	
	Coastal Plain Province	Coastal Plain Province	Piedmont Province	Coastal Plain Province	Piedmont Province
MUGILIDAE					
Mountain mullet *(Agnostomus monticola)*	X[1,2,3/]	--	--	--	--
Striped mullet *(Mugil cephalus)*	X[2/]	--	--	--	--
White mullet *(Mugil curema)*	X[1,2,3/]	--	--	X[3/]	--
SOLEIDAE					
Hogchoker *(Trinectes maculatus)*	X[1,2,3/]	X[4/]	X[8/]	X[4/]	--

1/ From Yerger, 1988.
2/ From Edmiston and Tuck, 1988.
3/ From Barkaloo and others, 1988.
4/ From Dalhberg and Scott, 1981.
5/ From Gilbert, 1969.
6/ Predominately found in Blue Ridge Province, but also stocked in upper Piedmont Province.
7/ Formerly *Notropis*, Mayden, 1989; Page, and Johnston, 1981.
8/ From Satterfield, 1961.
9/ *Scartomyzon* formerly *Moxostoma*, Jenkins and Burkhead, 1993.
10/ *Ameiurus* formerly *Ictalurus*, Lundberg, 1992.
11/ From Gilbert and others, 1992.

The distributional ranges of seven species are limited exclusively to the ACF River basin. These endemic species include the grayfin redhorse, greater jumprock, bluestripe shiner, broadstrip shiner, highscale shiner, bandfin shiner, and the shoal bass.

There are eight diadromous species in the ACF River basin. Anadromous species are the Gulf sturgeon, striped bass, Alabama shad, skipjack herring, and Atlantic needlefish. Catadromous species are the American eel, hogchoker, and mountain mullet.

Although most fish species are distributed throughout the ACF River basin and occur in relation to their preferred habitats, two natural characteristics of the basin influence broad-scale patterns in distribution of some species. These characteristics are the differences in water temperatures between the Blue Ridge and Piedmont Provinces, and in stream gradients across the Fall Line.

With the exception of the uppermost Chattahoochee River basin in the Blue Ridge and Piedmont Provinces above Lake Sidney Lanier, the basin is dominated by a warm-water fishery. Fish species limited in distribution to the cooler water of the uppermost Chattahoochee River basin are rainbow, brown, and brook trout. Within the ACF River basin, banded and mottled sculpin are found only in the upper Piedmont and Blue Ridge parts of the Chattahoochee River. The release of cool, hypolimnetic waters from Lake Sidney Lanier has resulted in the development of a secondary trout fishery downstream from Lake Sidney Lanier above Metropolitan Atlanta.

Some fish species are more commonly found in or limited to the lower gradient, low-velocity waters below the Fall Line in the Coastal Plain Province. These species include pirate perch, spotted gar, Florida gar, sailfin shiner, coastal shiner, white mullet, striped mullet, mountain mullet, hogchoker, lined topminnow, golden topminnow, pygmy killifish, bluefin killifish, freshwater goby, Everglades pygmy sunfish, banded pygmy sunfish, bluespotted sunfish, longear sunfish, brown darter, swamp darter, goldstripe darter, gulf darter, and Florida sand darter.

Warm-water species of recreational importance include largemouth bass, white bass, the hybrid sunshine bass, redeye bass, shoal bass, spotted bass, crappie, yellow perch, pickerel, channel catfish and several varieties of sunfish and suckers. Cold-water trout fisheries are of significant recreational and economic value. Trout are stocked by the Georgia Department of Natural Resources and are managed primarily as a "put-and-take" fishery.

Amphibians and Reptiles

In addition to the diversity of fish fauna, the ACF River basin is noteworthy for its diversity of amphibians and reptiles. The upper part of the Apalachicola River basin has the highest species density of amphibians and reptiles on the continent north of Mexico (Kiester, 1971). Means (1977) provides a checklist of amphibian and reptile species in the Apalachicola River basin, and Martof (1956) provides a checklist with distributional notes for species in Georgia. These checklists indicate that the ACF River basin is inhabited by 16 species of freshwater aquatic turtles, 21 species of salamanders, 26 species of frogs, and the American alligator. All require freshwater to complete or sustain their lifecycles. In addition, numerous species of snakes and lizards inhabit streams and wetlands.

Fifteen species of amphibians or reptiles are noteworthy because of their rarity or protected status (table 4). Two species are designated as threatened and five species are designated as candidate species under the Federal Endangered Species Act (U.S. Fish and Wildlife Service, 1994). The American alligator, whose population has increased in recent years, is designated as threatened because of its similarity to another species of concern, the American crocodile. The alligator snapping turtle, the world's largest freshwater turtle, is designated as threatened as a result of commercial overharvesting for its meat.

Barbour's map turtle, a Federal candidate species under the Endangered Species Act, is endemic to the Coastal Plain part of the ACF River basin. The natural range of the turtle was decreased by the formation of Lake Seminole causing a decline in population, and its population then further declined because of harvesting for meat.

Aquatic Invertebrate Fauna

With the exception of perhaps mollusc (Heard, 1977) and crayfish species (Hobbs, 1942, 1981), knowledge of the number and distribution of aquatic-invertebrate species that inhabit the ACF River basin is limited. Perhaps the largest diversity of macrofaunal-aquatic organisms occurs among the insects. However, information on the occurrence of aquatic insect species is limited to checklists relevant only to selected taxa and only in portions of the ACF River basin.

Hobbs (1942, 1981) lists 30 species of crayfish that occur in the ACF River basin. Fifteen of those species occur in the Apalachicola River basin and 20 occur in the Chattahoochee or Flint River basins. Six species are endemic to the Chattahoochee River basin and another six species are endemic to the Flint River basin.

The southeastern United States has more freshwater mussel species than any other region of the world (Burch, 1973). Of the western Florida river drainages, the Apalachicola River basin had the largest number of species of freshwater gastropods and bivalves, the most endemic species, and the greatest proportion of endemics to the total mollusc fauna (Johnson, 1972). Historically, as many as 45 unionid mussel species have been collected in the ACF River basin. Two snail species and seven mussel species are currently listed as candidate species under the Endangered Species Act (table 4). The two candidate snail species are endemic to the ACF River basin.

CULTURAL SETTING

The cultural setting describes how the human population uses the basin's land and water resources. Topics included in this section are population, land cover and use, water use, and municipal wastewater discharge. A more comprehensive analysis of human influences on water quality is planned to be included in other NAWQA publications.

Population

The ACF River basin is located in the heart of the Nation's "sunbelt" region. Metropolitan Atlanta, the largest metropolitan area in the southeastern United States, is partly within the ACF River basin. Seventy-nine counties are wholly or partly contained in the ACF River basin (fig. 22).

Population of the ACF River basin was estimated at 2.6 million people in 1990 (U.S. Bureau of Census, 1991 a,b,c). Nearly 90 percent (2.3 million) of the basin population lived in Georgia with nearly 60 percent (1.4 million) of that population in the Atlanta metropolitan area (fig. 23). About 7 percent (182,000) of the basin population lived in Alabama; and about 3 percent (78,000) of the basin population lived in Florida. Thirty-six percent of Georgia's population resided in the ACF River basin. Less than 5 percent of Alabama's population, and less than one percent of Florida's population resided within the basin. Population distribution in the basin is shown in figure 24.

Population centers outside the Metropolitan Atlanta area include the Columbus, Ga., and Phenix City, Ala., area (210,000 population), Albany, Ga. (85,000), and Dothan, Ala. (54,000), which is only partially in the basin. Most other population centers, such as Bainbridge, Ga., have fewer than 50,000 people, and generally are in the range of 5,000 to 10,000 people.

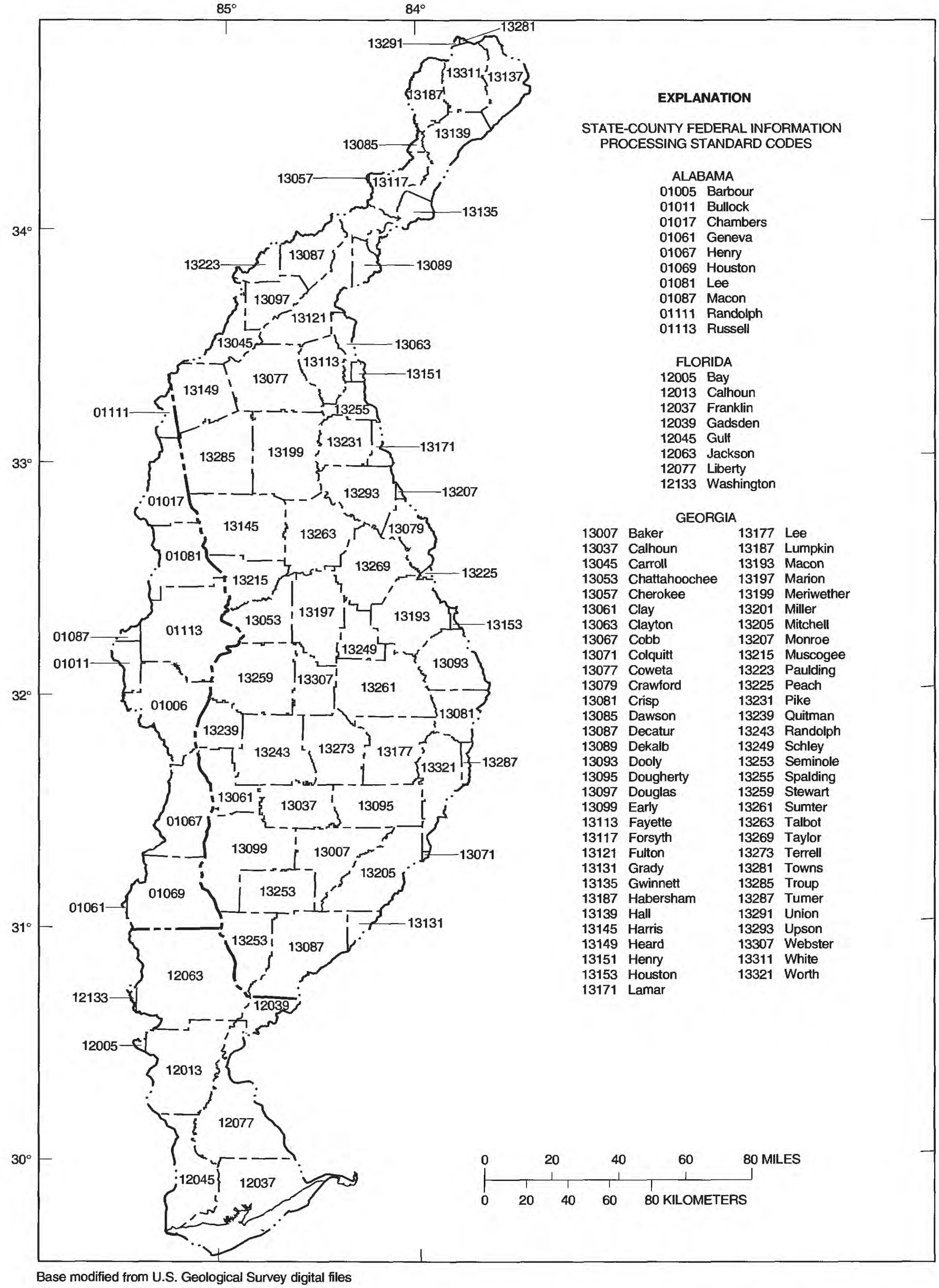
Between 1970-90, the population in the ACF River basin increased 37 percent. Basin population is projected to increase by 15 percent to 3.0 million by 2000, and by 30 percent to 3.4 million by 2010. The largest increases in population are projected for the Metropolitan Atlanta area. The predominantly rural counties of the southern part of the basin are projected to have stable or slightly declining populations (Paul Lycett, Georgia Department of Community Affairs, written commun., October 1992; Carolyn Trent, University of Alabama Center for Business and Economic Research, written commun., December 1992; University of Florida, 1992).

Table 4. Federal and state listed fish, amphibians, aquatic reptiles, and molluscs in the Apalachicola-Chattahoochee-Flint River basin, 1992

[--, no listed status; E, endangered; T, threatened; T(S/A), theatened due to similarity in appearance to other species; SP, species of special concern; R, rare; U, unusual; EX, extirpated; C2, candidate category 2 listing for Federal listing as E ot T, but for which adequate data are not available]

Common name	Scientific name	Status			
		Federal[1]	Alabama[2]	Florida[3]	Georgia[4]
	FISH				
Gulf Coast sturgeon	*Acipenser oxyrhynchus desoti*	T	--	SP	EX
Alabama shad	*Alosa alabamae*	--	--	--	U
Grayfin redhorse	*Moxostoma* sp. cf. *poecilurum*	--	--	T	--
Spotted bullhead	*Ameiurus serracanthus*	--	--	--	R
Black madtom	*Noturus funebris*	--	--	--	R
Bigeye chub	*Hybopsis amblops*	--	--	--	R
Bluestripe shiner	*Cyprinella callitaenia*	C2	--	T	T
Broadstripe shiner	*Pteronotropis euryzonus*	--	--	--	R
Highscale shiner	*Notropis hypsilepis*	--	--	--	T
Bluenose shiner	*Notropis welaka*	--	--	--	R
Bandfin shiner	*Luxilus zonistus*	--	--	R	--
Blacktip shiner	*Notropis atrapiculus*	--	--	R	
Mountain mullet	*Agnostomus monticola*	--	--	R	--
Banded topminnow	*Fundulus auroguttatus*	--	--	--	R
Shoal bass	*Micropterus* sp. cf. *coosae*	--	--	T	--
Goldstripe darter	*Etheostoma parvipinne*	--	--	--	R
	AMPHIBIANS				
One-toed amphiuma	*Amphiuma pholeter*	--	--	--	R
Apalachicola dusky slamander	*Desmognathus apalachicolae*	--	--	SP	--
Flatwoods salamander	*Ambystoma cingulatum*	C2	SP		R
Green salamander	*Aneides aeneus*	C2	SP	--	--
Hellbender	*Cryobranchus alleganiensis*	C2	--	--	R
Georgia blind salamander	*Haideotriton wallacei*	--	--	--	T
Striped newt	*Notophthalmus perstriatus*	--	--	--	R
Pigeon Mountain salamander	*Plethodon petraues*	--	--	--	R
	REPTILES				
American alligator	*Alligator mississippiensis*	T(S/A)	SP	--	--
Barbour's map turtle	*Gramptemys barbouri*	C2	T	SP	T
Alabama map turtle	*Gramptemys geographica*	--	--	--	R
Common snapping turtle	*Chelydia serpentina*	--	SP	--	--
Alligator snapping turtle	*Macrolemys temmincki*	T	SP	SP	T
Suwannee cooter	*Chrysemys concinna suwanniensis*	--	--	SP	--
Florida gopher frog	*Rana areolata aseous*	C2	--	SP	--
	MOLLUSCA				
Black-crested elimia snail	*Elimia albanyensis*	C2	--	--	--
Flaxen elimia snail	*Elimia boykiniana*	C2	--	--	--
Fat three-ridge mussel	*Amblema neislerii*	C2	--	--	--
Winged spike mussel	*Elliptio nigella*	C2	--	--	--
Purple bankclimber mussel	*Elliptoideus sloatianus*	C2	--	--	--
Lined pocketbook mussel	*Lampsilis binominata*	C2	--	--	--
Shiny-rayed pocketbook mussel	*Lampsilis subangulata*	C2	--	--	--
Oval pigtoe mussel	*Pleurobema pyriforme*	C2	--	--	--
Beaver pond mussel	*Pyrulopsis castor*	C2	--	--	--

1/ U.S. Fish and Wildlife Service, 1994.
2/ Alabama Conservation and Natural Resources, 1992.
3/ Florida Game and Fish Commission, 1993.
4/ Georgia Department of Natural Resources, 1992 a,b.



Base modified from U.S. Geological Survey digital files

Figure 22. Location of the counties in the Apalachicola–Chattahoochee–Flint River basin.

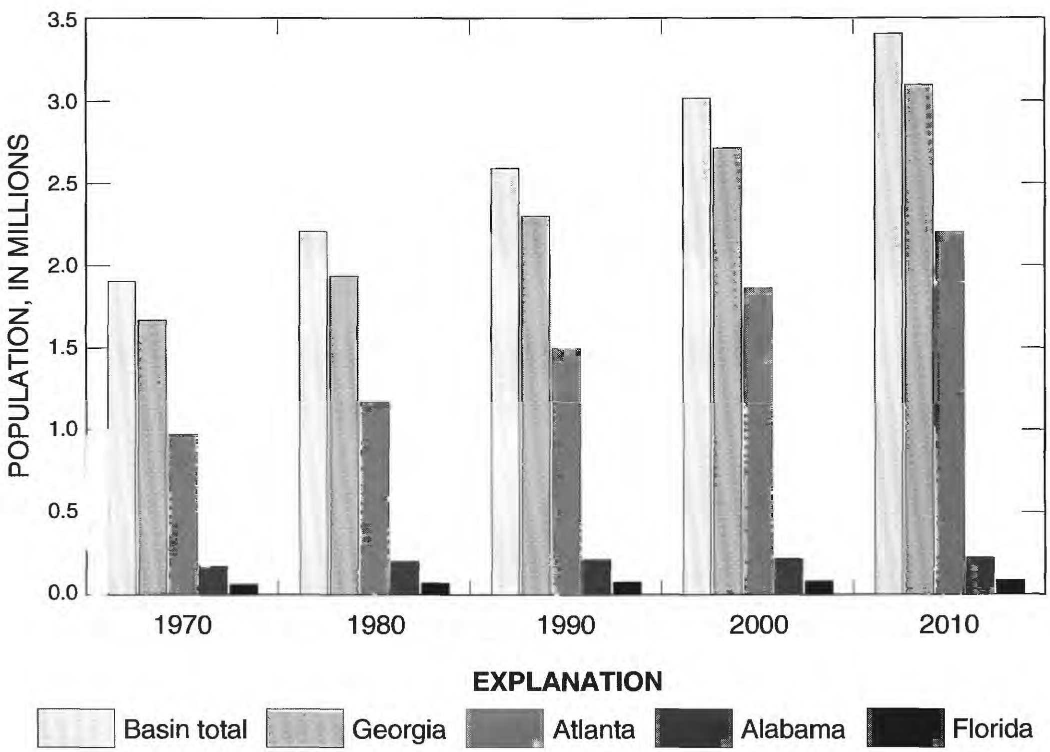


Figure 23. Historical and projected population in the Apalachicola-Chattahoochee-Flint River basin, 1970-2010 (data sources: for 1970-1990, U.S. Bureau of the Census; for 2000 and 2010, Paul Lycett, Georgia Department of Community Affairs, written communication, October, 1992; Carolyn Trent, University of Alabama Center for Business and Economic Research, written communication, December, 1992; University of Florida, 1992).

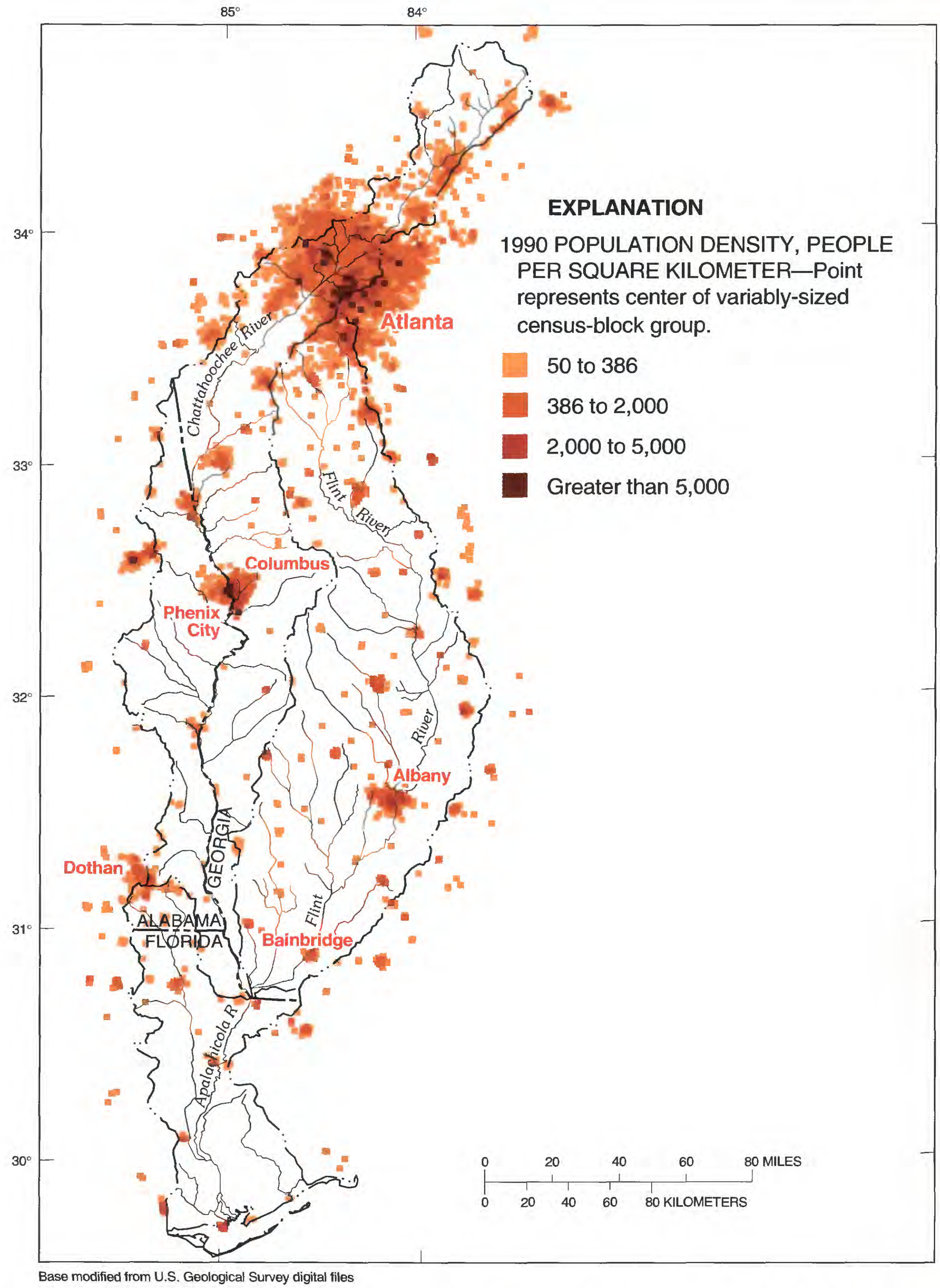


Figure 24. Population density (1990) in the Apalachicola–Chattahoochee–Flint River basin (modified from U.S. Bureau of Census, 1991a, b, c).

Land Cover and Use

Land-cover classification has been determined for the entire ACF River basin based on high-altitude aerial photography for 1972-76 (U.S. Geological Survey, 1972-78). This classification indicates that 59 percent of the basin land cover was forest, 29 percent was agriculture, 5 percent was wetlands, and 4 percent was land cover (fig. 21). In contrast to the Piedmont Province, agriculture comprised a larger percentage of land cover in the Coastal Plain, especially in the lower Flint River basin. Urban land cover was concentrated in the upper part of the Chattahoochee and Flint River basins in the Metropolitan Atlanta area.

The basin's forest cover consists chiefly of second-growth hardwoods and planted pine. Timber is the leading cash crop in the basin, and approximately 25 percent of the forest is timberlands owned by companies or individuals involved in manufacturing wood products. This silvicultural land use is concentrated in the Apalachicola River basin, in the Piedmont Province south of Atlanta, and in the Coastal Plain just below the Fall Line (fig. 25). Florida contains the Nation's second largest acreage of corporate tree farms for pulp production, virtually all of which is in northern Florida (Fernald, 1981).

Agricultural land use is a mix of cropland, pasture, orchards, and areas of confined feeding for poultry, livestock, and dairy production. Agricultural land use is concentrated in the Coastal Plain Province of the ACF River basin (fig. 26). Row crops and orchards dominate agricultural land use in the Coastal Plain Province. The dominant agricultural land use in the Piedmont Province is pasture and confined feeding for poultry and livestock production.

Total farmland in the ACF River basin decreased every agricultural census year from 1974 to 1987 (fig. 27, U.S. Bureau of the Census, 1981a,b,c; 1989a,b,c). However, poultry production has been increasing during that same period. In 1990, approximately 250 million broiler chickens, 500 thousand cattle, and 225 thousand swine were produced in the basin. Most poultry production is concentrated in the upper part of the Chattahoochee River basin above Lake Sidney Lanier in Hall, White, and Habersham Counties, Ga.

Crops with the largest harvested acreage include peanuts, corn, soybeans, and cotton (fig. 28). Other important crops include wheat, hay, vegetables, and tobacco. In 1987, 80,000 acres were planted in orchards. The orchard crop with most acres is pecans. Peaches are also grown in the basin. The ranking of harvested acres among these crops varies from year to year in response to market conditions, government subsidy programs, and the weather.

Water Use

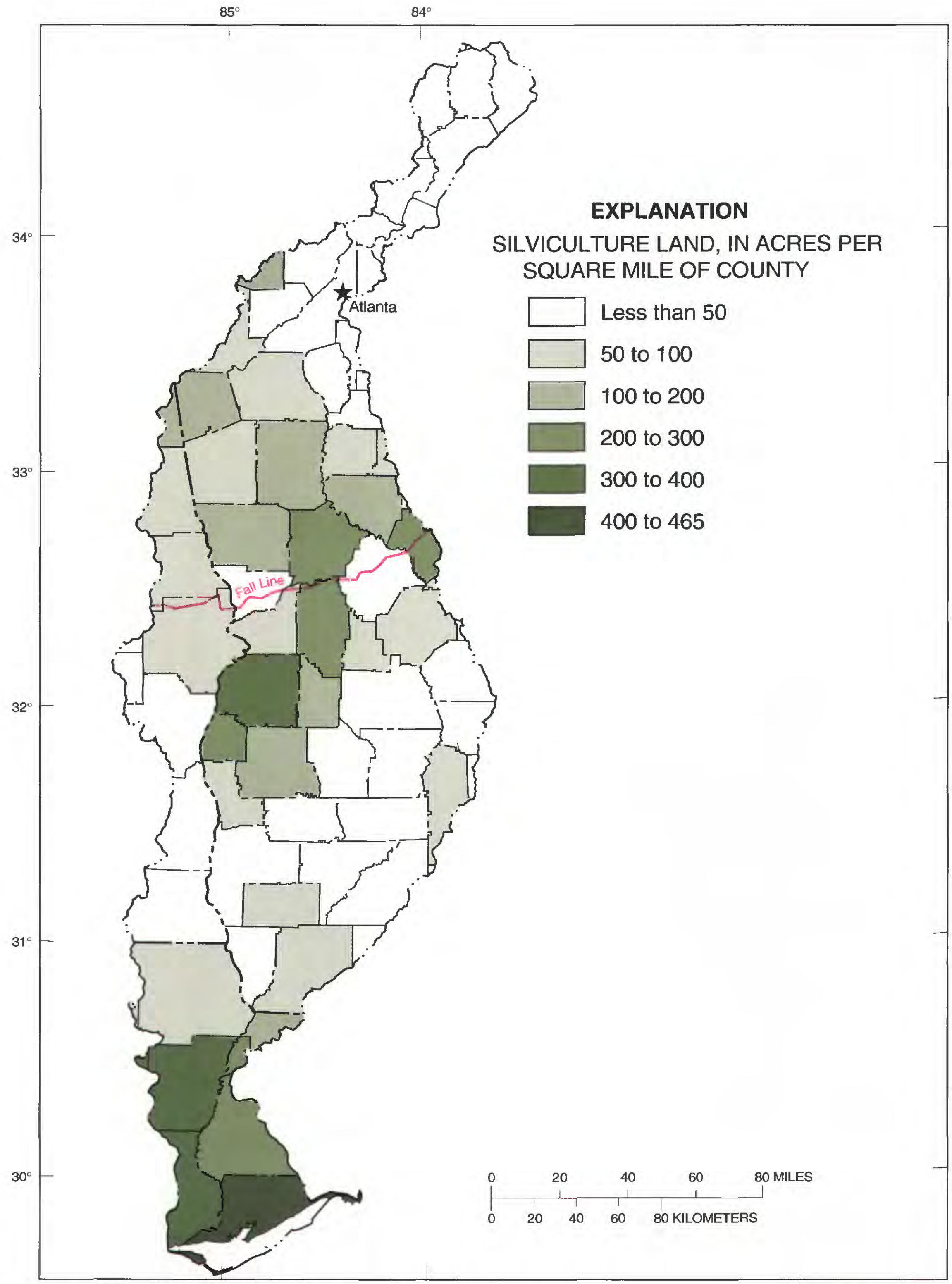
Water use in the ACF River basin is measured by estimates of freshwater withdrawn from ground- and surface-water sources. Saline water is not used in the basin. Unless otherwise noted, all data presented in this section are derived from a report of estimated water use in the ACF River basin by Marella and others (1993). Total water withdrawals were 2,098 million gallons per day (Mgal/d) in the ACF River basin in 1990, of which Georgia withdrew 82 percent; and Florida and Alabama withdrawals were 9 percent, respectively. About 20 percent of total water withdrawals in 1990 was not returned to surface- or ground-water sources. In 1990, an estimated 150 Mgal/d were exported from the basin and 36 Mgal/d were imported into the basin.

Surface-water sources supplied 86 percent (1,795 Mgal/d) and ground-water sources supplied 14 percent (303 Mgal/d) of water used in 1990 (fig. 29). Surface water is the primary water source in the Piedmont Province of the ACF River basin because ground-water yields from crystalline rock aquifers are low. Sixty-three percent of surface-water withdrawals occur in the Piedmont Province part of the Chattahoochee River basin. Sixty-one percent of ground-water withdrawals occur in the Coastal Plain Province part of the Flint River basin.

Total water withdrawals increased by 42 percent between 1970 and 1990. During this period, total surface-water withdrawals increased by 29 percent; however, ground-water withdrawals increased by 240 percent. Large increases occurred in agricultural and public-supply withdrawals between 1970 and 1990 (fig. 30). Increased withdrawals for irrigation caused agricultural water use to increase 1,137 percent between 1970 and 1990. During this same period, public-supply water withdrawals increased by 248 percent, outpacing the 37 percent growth in population in this period.

Public-supplied water withdrawals are by public or private suppliers and are delivered for domestic, industrial, and commercial use. Public-supply withdrawals totaled 20 percent of surface-water withdrawals, and 42 percent of total withdrawals in 1990, exclusive of power-generation withdrawals. Thermoelectric-power generation accounted for 51 percent of total withdrawals in 1990. Nearly 87 percent of the basin's population (2,287,000 people) relied on public-water supplies for drinking water. Ground water supplied 18 percent (418,000 people) of the basin's population served by public supply. Estimated public-supply water use *per capita* was 173 gal/d in the ACF River basin during 1990.

Thirteen percent of total water withdrawals in 1990 was for self-supplied domestic, commercial, or industrial use. Water for self-supplied domestic use is assumed to be solely from ground-water sources. Commercial and industrial self-supplied water is withdrawn from surface- and ground-water sources. In 1990, approximately 341,000 people, residing mostly in the middle and southern part of the basin, used self-supplied water. From 1970-90, withdrawals for self-supplied domestic use remained relatively constant; and commercial and industrial self-supplied withdrawals increased by 53 percent.



Base modified from U.S. Geological Survey digital files

Figure 25. Silviculture land in the Apalachicola–Chattahoochee–Flint River basin, 1987, 1989, and 1990 (modified from Brown,1987; Thompson, 1989; and Vissage and Miller, 1991).

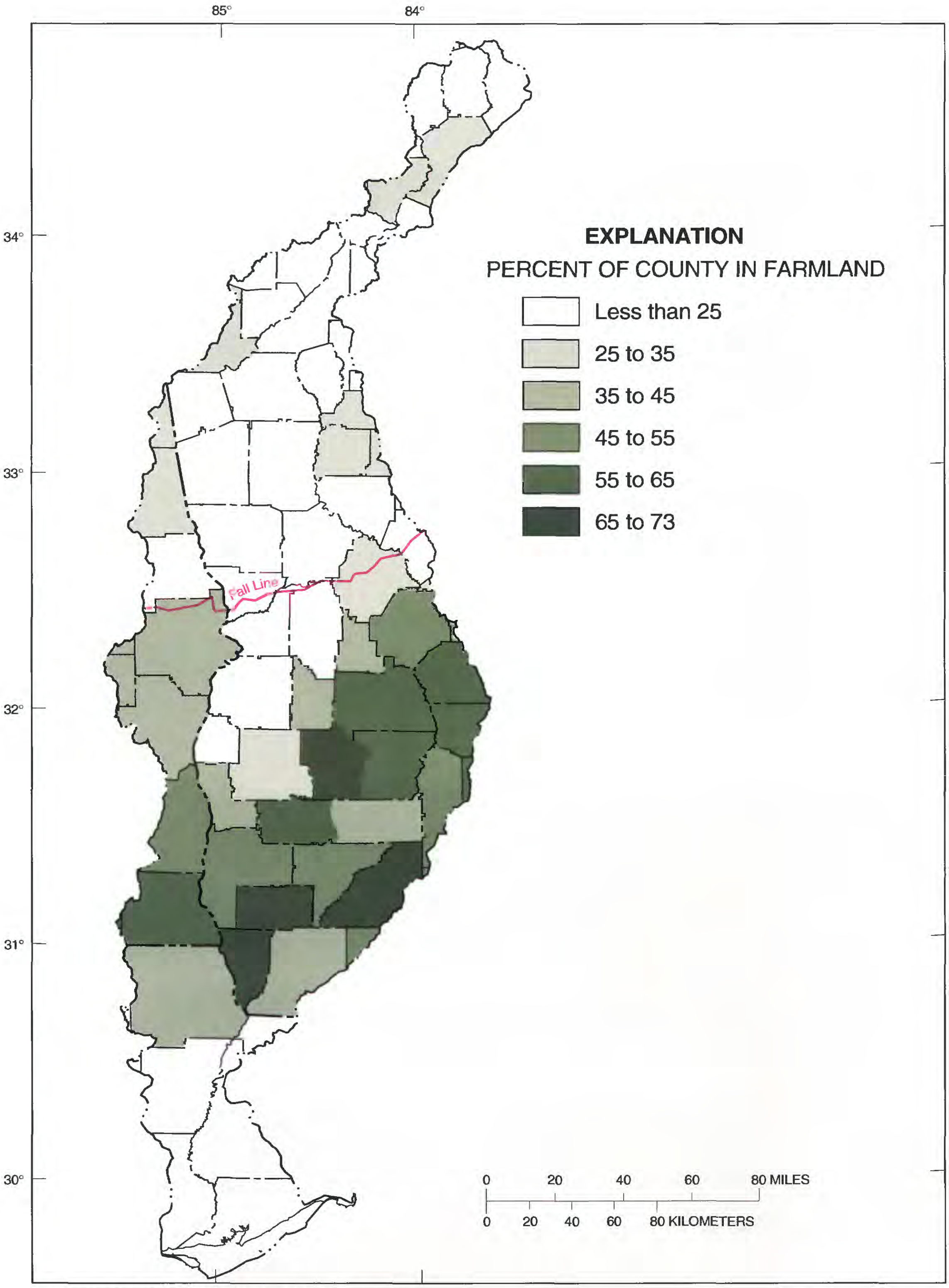


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Figure 26. Percent of county in farmland in the Apalachicola–Chattahoochee–Flint River basin, 1987 (data from U.S. Bureau of the Census, 1989a, b, c).

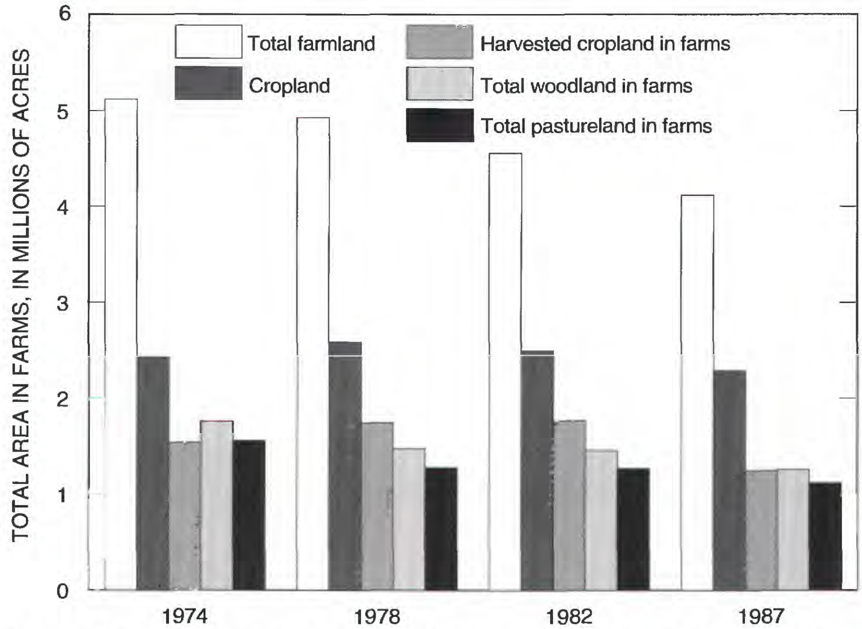


Figure 27. Total areas in farms; and selected categories of cropland, harvested cropland, woodland, and pastureland in farms in the Apalachicola-Chattahoochee-Flint River basin (data from U.S. Bureau of the Census, 1981a, b, c; and 1989a, b, c).

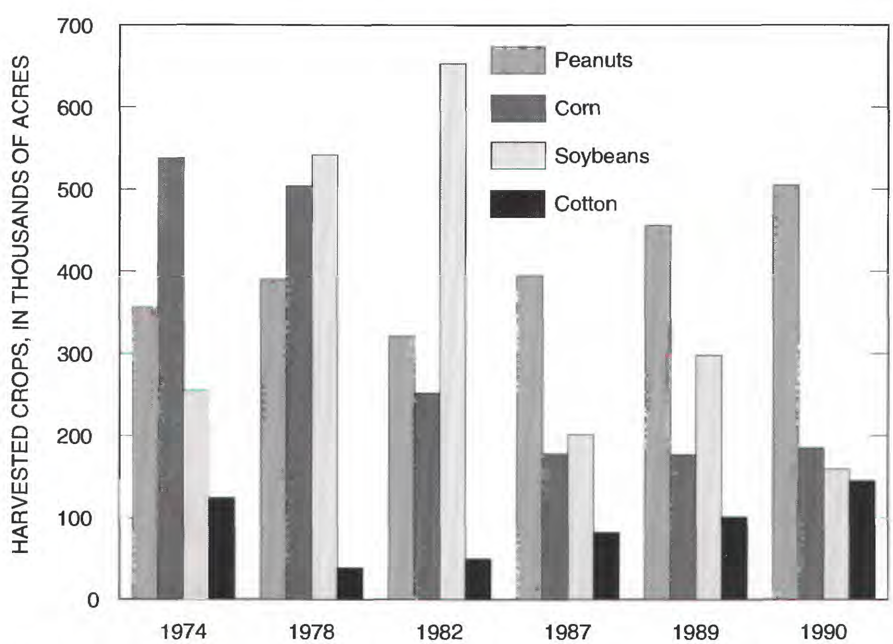


Figure 28. Harvested acres of peanuts, corn, soybeans, and cotton in the Apalachicola-Chattahoochee-Flint River basin (data from U.S. Bureau of the Census 1981a, b, c; and 1989a, b, c).

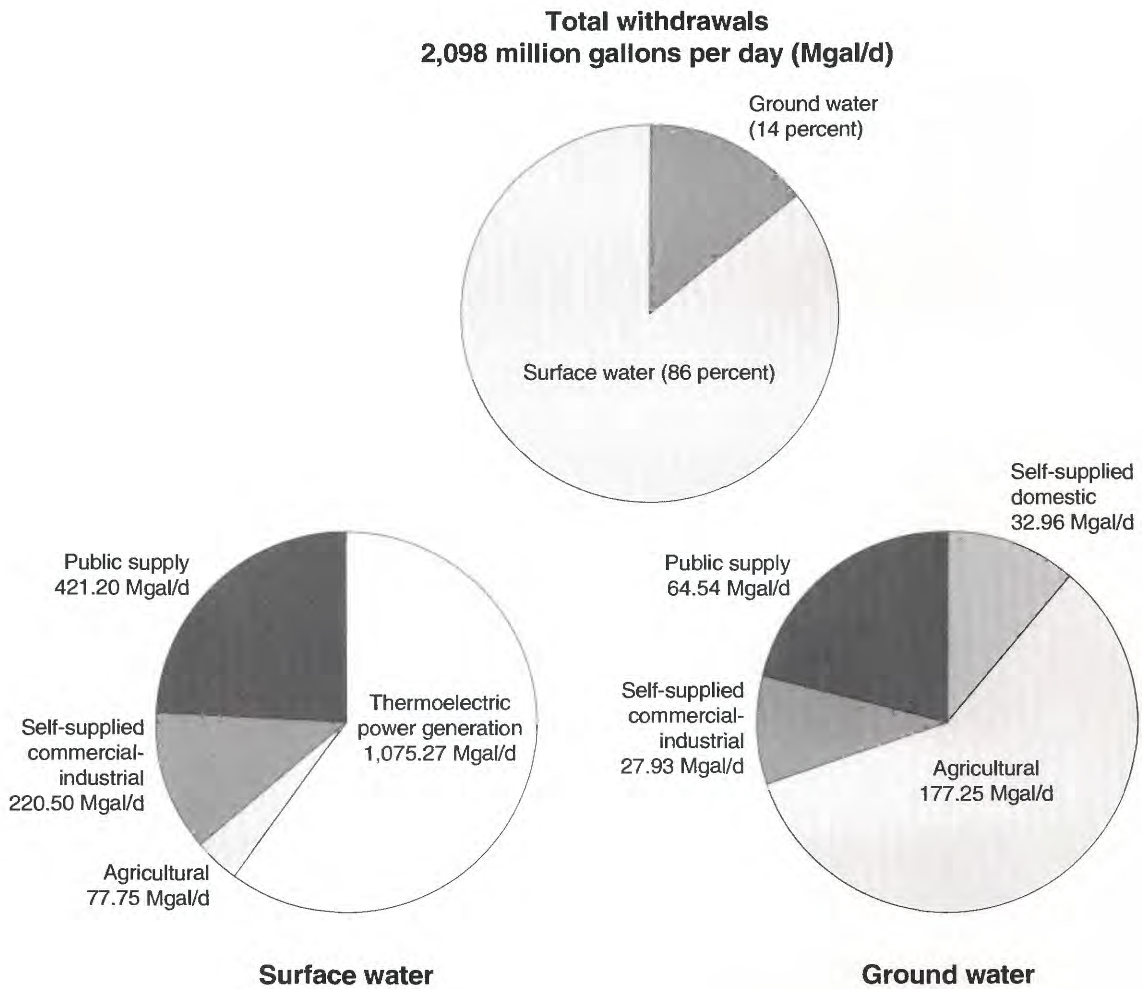


Figure 29. Ground- and surface-water withdrawals by principal water-use categories in the Apalachicola-Chattahoochee-Flint River basin, 1990 (data from Marella and others, 1993).

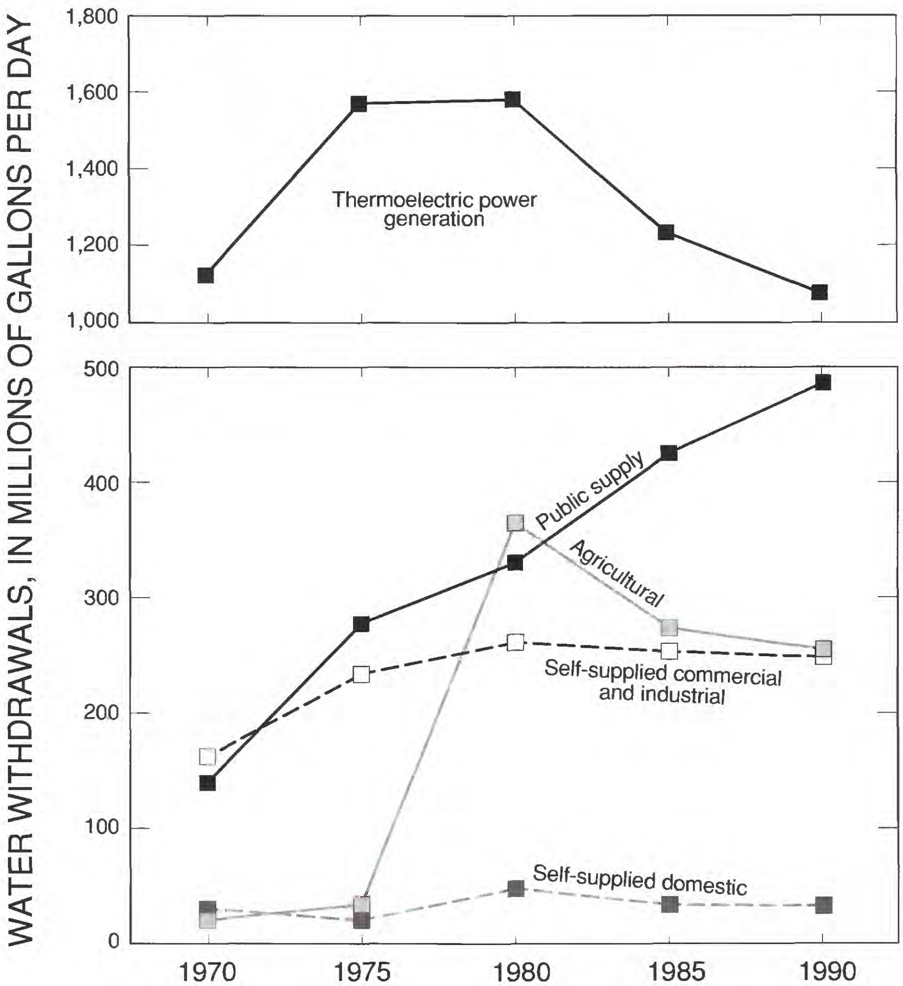
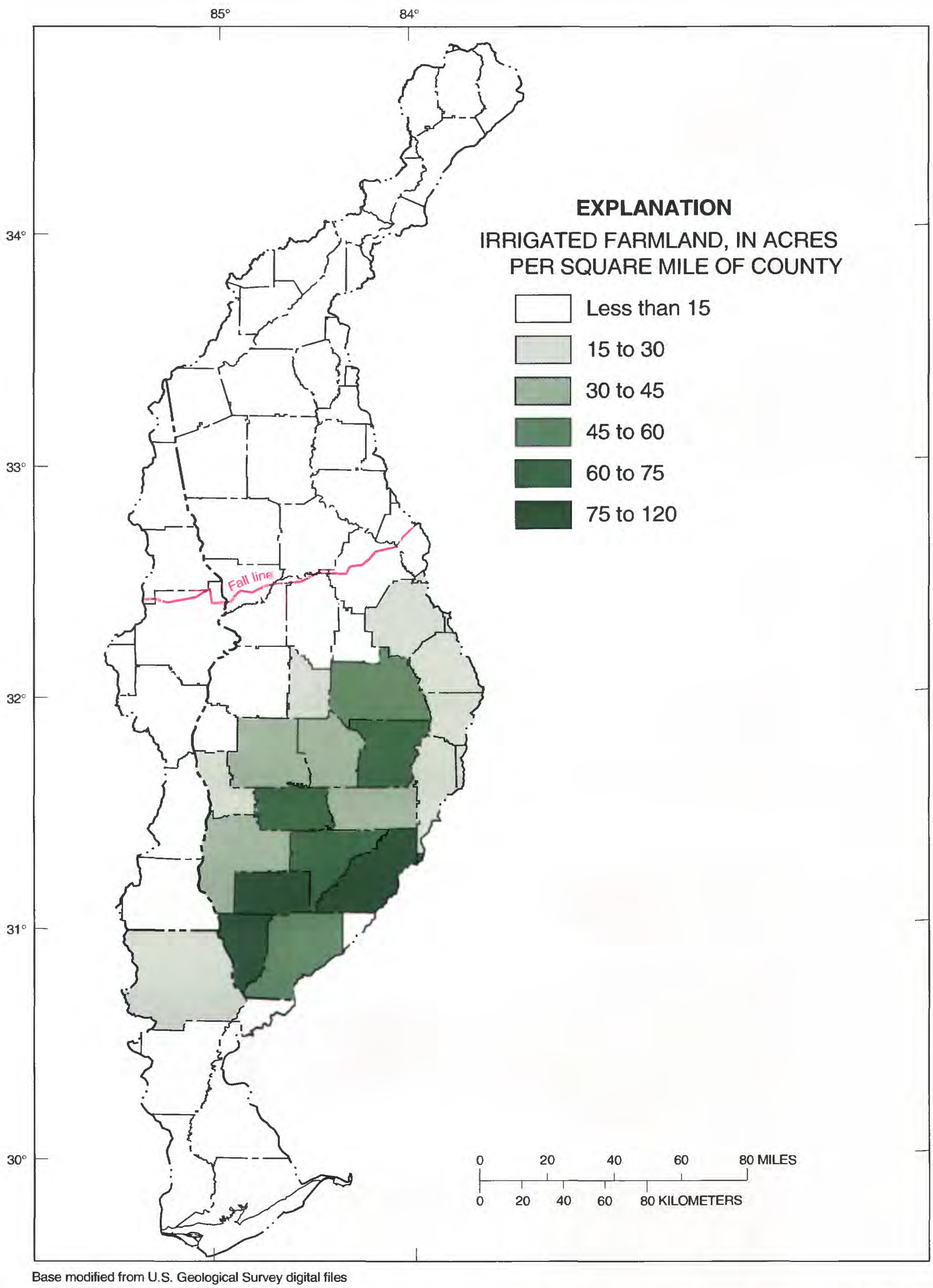


Figure 30. Water withdrawals by principal water-use categories in the Apalachicola-Chattahoochee-Flint River basin, 1970-90 (modified from Marella and others, 1993).

Agricultural water use (255 Mgal/d) accounted for nearly 13 percent of total water withdrawals in 1990. In 1990, 58 percent of total ground-water withdrawals was for agricultural uses, and ground-water sources supplied 70 percent of agricultural uses. Most of the increase in ground-water withdrawals occurring between 1970 and 1980 resulted from the introduction of new irrigation technologies, such as the center pivot and other self-propelled irrigation equipment (Pierce and Barber, 1984). However, since 1980, the rapid increase in agricultural ground-water withdrawals stabilized as irrigation efficiencies improved.

Most ground-water withdrawals occur in counties in the Coastal Plain with the largest acreages of irrigated farmland. In 1990, five counties in the karst Dougherty Plain of the Flint River basin in Georgia (Decatur, Seminole, Miller, Mitchell, and Baker Counties) collectively withdrew 66 percent of all ground-water withdrawals for agricultural use (figs. 22, 31).

Although most public-supply withdrawals in the Piedmont Province are from surface-water sources, with the exception of counties near or immediately below the Fall Line, all public-supply water in the Coastal Plain comes from ground-water sources. The Floridan aquifer system supplied most of the ground water used in the basin in 1990, followed by the Claiborne, Clayton, crystalline-rock, and the Providence aquifers.



Base modified from U.S. Geological Survey digital files

Figure 31. Irrigated farmland in the Apalachicola–Chattahoochee–Flint River basin, 1987 (data from U.S. Bureau of the Census, 1987a, b, c).

Power Generation

Twenty-two power-generating plants located along the mainstem Chattahoochee and Flint Rivers use the water resources of the basin (fig. 11). In 1990, eight thermoelectric plants in the ACF River basin withdrew 60 percent of total surface-water withdrawals. Instream-water use by 14 hydroelectric plants totaled nearly 39,000 Mgal/d in the basin in 1990.

Of the 16 mainstem dams in the basin, George W. Andrews Lock and Dam and City Mills are not operated for hydroelectric power production. The first power-generating dam was the Eagle-Phenix Dam, which was originally constructed in 1834 and reconstructed in 1865 to provide hydropower to the Eagle and Phenix Mill. Eight dams are located on the Chattahoochee River north of Columbus, Ga., to take advantage of the natural gradient at the Fall Line (fig. 11). The total hydroelectric generation capacity is 699,720 kilowatts in the ACF River basin (Fanning and others, 1991).

Water used for thermoelectric-power generation is considered an offstream use of water, and generally is non-consumptive. Thermoelectric power is generated at seven fossil-fuel plants and one nuclear power plant located in the ACF River basin. Power generated at these plants totaled 33,460 gigawatts per hour and withdrew about 1,076 Mgal/d. Eighty-seven percent of water withdrawals were returned to the river. Surface-water withdrawals for thermoelectric power generation decreased 505 Mgal/d from 1980 to 1990 because of increased recirculation of cooling water.

Navigation

Navigation has been an historical use of the waterways of the ACF River basin from Apalachicola Bay to the Fall Line. Before the Civil War, the city of Apalachicola, Fla., was a major cotton port. Between 1828-60, 130 steamboats operated on the Chattahoochee, Flint, and Apalachicola River (Owens, 1969). During the Civil War, the Apalachicola and Chattahoochee Rivers were of strategic significance to the Confederacy and several Civil War naval battles occurred on the Chattahoochee River (Turner, 1988).

Federal support for navigation dates back to 1824, when the U.S. Army Corps of Engineers was authorized by Congress to maintain a navigational channel. The U.S. Rivers and Harbor Act of 1946 authorized the maintenance of a 9-foot deep and 100-foot wide channel from the mouth the Apalachicola River to Columbus, Ga., on the Chattahoochee River and to Bainbridge, Ga., on the Flint River.

A series of three navigation locks and dams are operated by the U.S. Army Corps of Engineers (table 1). Walter F. George Lock and Dam and George W. Andrews Lock and Dam are on the Chattahoochee River in the Coastal Plain Province, respectively. The Jim Woodruff Lock and Dam is located at the beginning of the Apalachicola River (fig. 11). Maintenance of the navigational channel in the Apalachicola River has required periodic dredging and alterations including 7 cutoffs to straighten bends and 29 sets of groins to produce channel scouring. Despite these alterations, the Apalachicola River remains undammed and is one of the last major Coastal Plain rivers in a relatively natural condition.

Average annual tonnage transported by barge was 697,800 tons for the period 1987-91. Tonnage decreased by 34 percent from 882,000 tons in 1987 to 584,000 tons in 1991 (U.S. Army Corps of Engineers, 1992). Major commodities transported by barge are clay, sand, and gravel (41.6 percent); fertilizers (15.9 percent); fuels and oils (15.9 percent); chemicals (11.5 percent); coal, ore, and asphalt (6.8 percent); agricultural products (5.5 percent); and miscellaneous commodities (2.8 percent). Fertilizers are the largest tonnage transported upstream; whereas clay, sand, and gravel are the largest tonnage transported downstream.

Recreation

Because of proximity to the largest metropolitan area in the Southeast, the reservoirs, rivers, and streams of the ACF River basin are heavily used for recreation. The upper part of the ACF River basin contains several heavily used reservoirs, national forests, and national and state parks. For example, Lake Sidney Lanier, located north of Atlanta, has more than 16 million visitors annually and the highest visitation rate among U.S. Army Corps of Engineers reservoirs nationwide (U.S. Army Corps of Engineers, 1989).

The headwaters of the Chattahoochee River rise in the scenic mountains of northern Georgia and flow southwestward. Northern Georgia contains parts of the Chattahoochee National Forest, several State parks, and resort communities which are favorite weekend and vacation destinations. Within Metropolitan Atlanta, the Chattahoochee River National Recreation Area of the National Park Service has improved access to the river by providing parks and boat ramps along the river corridor. Tubing, rafting, and fly fishing are popular activities upstream of the confluence of Peachtree Creek and the Chattahoochee River.

Recreational fisheries of the ACF River basin consist of a cold-water trout fishery in the Chattahoochee River basin in the mountains above Lake Sidney Lanier and in the river below Buford Dam, where hypolimnetic releases provide cold water necessary for trout habitat. The 49-mi reach of the Chattahoochee River from Buford Dam to Peachtree Creek has been managed by the Georgia Game and Fish Division since 1960 as a trout fishery.

Warm-water recreational fisheries exist in the remainder of the Chattahoochee River basin and in the Flint and Apalachicola River basins for various species of bass, catfish, and sunfish. West Point Lake, Lake Walter F. George, and Lake Seminole have local, economically significant businesses and services supporting recreational fishing, including bait and tackle shops, guide services, tournaments, hotels, and restaurants.

Wastewater Discharge

Human activities that influence water quality in the ACF River basin include point sources such as municipal and industrial wastewater-treatment facilities. Industrial wastewater-treatment facilities are not described in this report.

In 1990, there were 137 municipal wastewater-treatment facilities in the ACF River basin (fig. 32). At that time, 354 Mgal/d of municipal wastewater was discharged within the ACF River basin. Seven Alabama facilities discharged about 14 Mgal/d, and 12 Florida facilities discharged about 4 Mgal/d and the remaining 336 Mgal/d was discharged by Georgia facilities (modified from Marella and others, 1993).

In 1990, 30 plants discharged 93 percent of total effluents and 7 of these plants located in larger cities discharged 72 percent of effluent. Eighty-eight percent of wastewater was discharged into the Chattahoochee River basin, 10.6 percent into the Flint River basin, and 1.4 percent into the Apalachicola River basin. Eleven municipal wastewater-treatment facilities applied wastewater to land surfaces, instead of or in addition to discharging directly to surface-water bodies (E.A. Frick, U.S. Geological Survey, written commun., 1995).

INFLUENCES OF ENVIRONMENTAL SETTINGS ON AQUATIC ECOSYSTEMS

Interacting natural and anthropogenic factors in the ACF River basin have created many unique contrasts in the patterns of land and water use that influence the ACF River basin's aquatic ecosystem. The basin's physiography, climate, and hydrology provide natural conditions that have supported a rich and abundant diversity of plants and animals. Superimposed on these natural conditions are human influences that vary in relation to the distribution of the basin's population, and to the population's use of land and water resources. Metropolitan Atlanta, the largest and fastest growing metropolitan area in the southeast, is in the basin's headwaters. The basin's growing population presents challenges to balancing human and ecosystem needs for water of sufficient quantity and quality. At the basin's terminus, the Apalachicola River and Bay are regionally and globally significant for their biological productivity and diversity.

The Apalachicola, Chattahoochee, and Flint River basins differ in the extent and type of dominant of anthropogenic influences. Of these basins, the Chattahoochee River basin is most influenced by urban and suburban land uses, and has the most heavily-used water resources both in the ACF River basin and in the State of Georgia. The Chattahoochee River basin contains the largest population centers and receives the majority of the ACF River basin's municipal wastewater discharges. Although the headwaters of the Flint River are in Metropolitan Atlanta, its water quality is less influenced by wastewater discharge because of the diversion of effluent from two Metropolitan Atlanta municipal wastewater facilities after 1985 from the Flint River to the Chattahoochee River. However, the Flint River is influenced by wastewater discharges from Albany, Ga., and other smaller communities.

The quality of wastewater effluent has improved since the 1980's as a result of treatment facility improvements and the recent phosphate-detergent ban by the Georgia Legislature. Since the mid-1970's, water quality of municipal-wastewater effluent has greatly improved with the construction of advanced wastewater-treatment facilities. Prior to the 1970's, large quantities of raw industrial and sewage wastewater were released into the Chattahoochee and Flint Rivers. Downstream from Atlanta, the Chattahoochee River was classified as grossly polluted, with high biochemical-oxygen demands, low dissolved-oxygen concentrations, exceedingly high fecal-coliform counts, and biota dominated by worms and the bacterium *Sphaerotilus* (Georgia Water Quality Control Board, 1971a,b).

In 1990, the Georgia Legislature adopted a Statewide phosphate-detergent ban. Wastewater dischargers in the Atlanta Metropolitan area were directed by the Georgia Department of Environmental Protection to reduce phosphorus effluent to 0.75 mg/L by 1992. Restricted use of phosphate detergents and upgraded wastewater-treatment facilities resulted in an 83-percent decrease in phosphorus load between 1988-93 from the six largest wastewater-treatment facilities in Metropolitan Atlanta (Wangsness and others, 1994).

Water-quality conditions in the Chattahoochee River below Atlanta are placed in a national context in the USEPA's National Study of Chemical Residues in Fish. Fish tissue was tested for a total of 60 different chemicals in the National Study. Fish tissue was collected at sites near potential point and nonpoint sources of contamination and at background sites expected to have little or no contamination. Eleven of 388 sites in this study are in the ACF River basin. At three sites on the Chattahoochee River, fish tissues contained chemical concentrations that were among the highest in the Nation. One or more of these three sites ranked in the top five for chemicals concentrations, including four dioxin or furan compounds; pentachloranisole; 1,2,3 trichlorobenzene; chlordane; five chlordane congeners; chlorpyrifos; and methoxychlor (U.S. Environmental Protection Agency, 1991).

Reports prepared by the states of Alabama, Florida, and Georgia to meet the requirements of Section 305(b) of the Clean Water Act (PL 92-500) provide information on the extent to which waters in the ACF River basin support designated water-use classifications. Water bodies are evaluated against existing water-quality standards for designated uses, including standards for drinking-water supplies, fishing, swimming, and aquatic life.

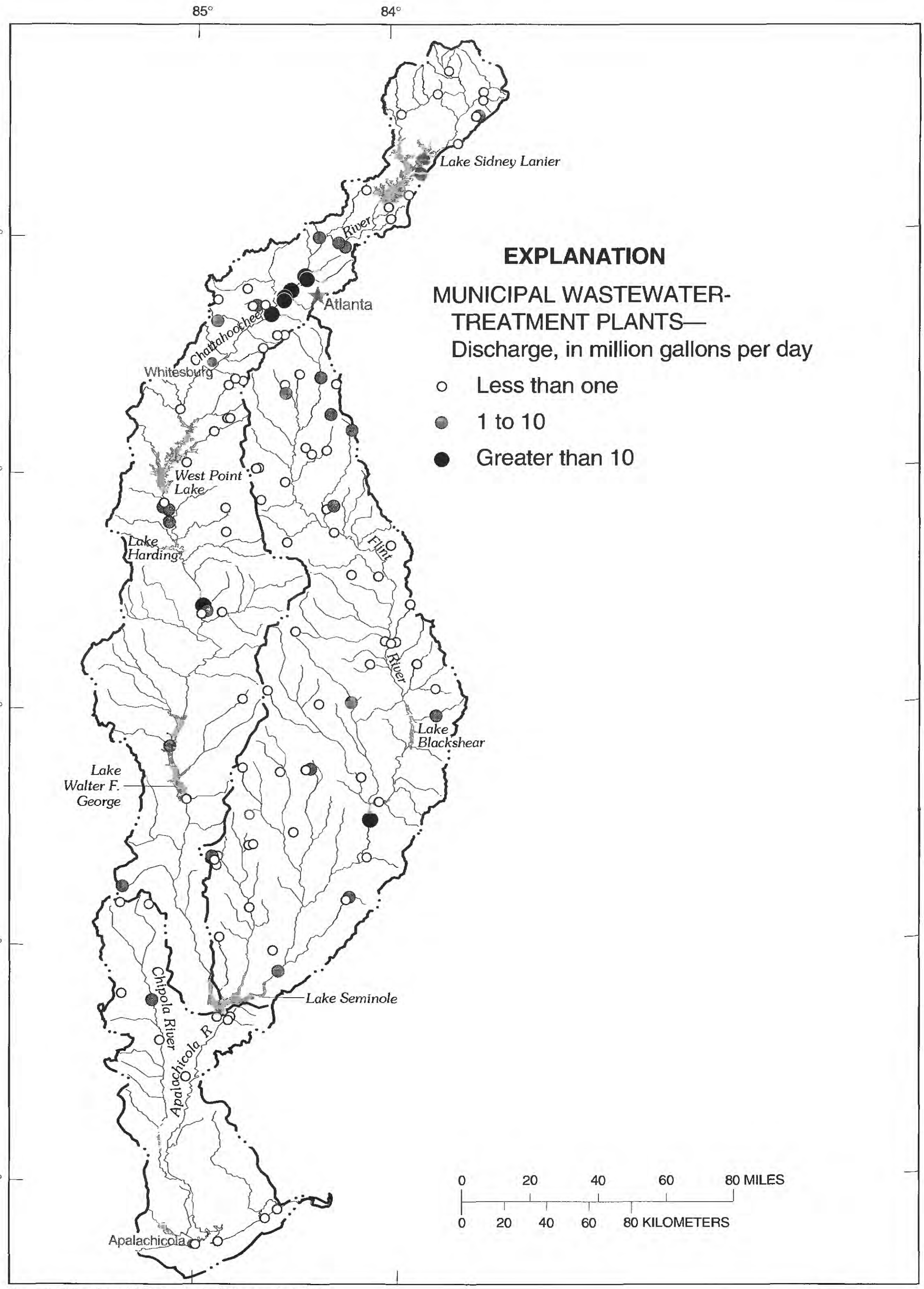


Figure 32. Location and discharges of municipal wastewater-treatment plants in the Apalachicola–Chattahoochee–Flint River basin.

Thirty miles of streams in the Alabama part of the Chattahoochee River basin do not support designated uses, and 114 mi only partially support designated uses. The primary causes cited for failure to meet use designations are nutrient concentrations, organic enrichment, and low dissolved oxygen. West Point Lake and Lake Harding (fig. 32) are classified as eutrophic. Alabama has issued a fish-consumption advisory for catfish caught in these two lakes and the intervening stretch of the Chattahoochee River because of chlordane contamination (Alabama Department of Environmental Management, 1992).

In the Apalachicola River basin, Florida has identified South Mosquito, Sutton, and Scipio Creeks as only partially meeting designated uses (Florida Department of Environmental Regulation, 1992). South Mosquito Creek and Sutton Creek receive wastewater discharge; Scipio Creek is affected by industrial runoff from a marina. All other streams in the Apalachicola River basin meet designated uses.

In the Chattahoochee and Flint River basins in Georgia, 539 mi of streams do not support designated uses, and 399 mi only partially meet designated uses. Thirty-four percent of total Georgia stream miles not supporting designated uses and 31 percent partially meeting designated uses are located in the ACF River basin (Georgia Department of Natural Resources, 1992). Water-quality criteria violations for metals (50 percent of total violations) and fecal coliform bacteria (39 percent of total violations) are the most frequently cited reasons for not fully meeting use designations. In 72 percent of water-quality violations, urban runoff or unknown nonpoint sources are given as the causes for not meeting designated uses. The remaining causes primarily are combined sewer overflows in the Atlanta area, and municipal or industrial wastewater-treatment facilities having limited capabilities or operational deficiencies.

Most reservoirs in the Georgia part of the ACF River basin are classified as eutrophic. In 1991, Lake Blackshear had the highest value statewide for the trophic state index, and seven basin lakes fell in the top 10 of 27 lakes rated statewide. Despite their eutrophic condition, most lakes in the ACF River basin supported designated uses; however, parts of Lake Sidney Lanier and all of West Point Lake were designated as partially supporting uses. Two embayments in Lake Sidney Lanier have been affected by municipal wastewater discharge, and West Point Lake has been affected by accelerated eutrophication, and is currently under a fish-consumption advisory because of chlordane concentrations in fish. The advisory issued by the Georgia Department of Natural Resources is for catfish, carp, and hybrid bass caught between State Highway 92 bridge to West Point Dam.

Two-thirds of the 938 stream miles not meeting or partially meeting designated uses in the Georgia portion of the ACF River basin are located in the Chattahoochee River basin. Water-quality problems are frequently associated with non-point sources such as urban runoff. Fishing is the use designation not met in greater than 80 percent of impaired stream miles. In the reach of the Chattahoochee River from Atlanta to Whitesburg, Ga., non-point source loads for most constituents are greater than point-source loads, and constituent yields generally increase with increasing urbanization (Stamer, 1979).

Outside of urban centers, most of the landscape of the ACF River basin is used to produce silvicultural or agricultural products. Silvicultural and agricultural activities can influence aquatic ecosystems primarily through non-point source inputs of pesticides, nutrients, and sediment, and by physical alteration of riparian and stream margin habitats. The cumulative effect of these activities on aquatic ecosystems in the ACF River basin, particularly the smaller tributaries and streams which are most at risk, has not been systematically evaluated.

Potential effects of silvicultural management on aquatic ecosystems are primarily alterations in physical habitat such as increased temperature due to loss of shade from riparian vegetation, and increased sedimentation. For example, timber harvesting in the upper Chattahoochee River basin which disturbed relatively small areas (1 to 2 mi^2) increased sheet erosion by several orders of magnitude (Faye and others, 1980).

Agricultural influences on aquatic ecosystems differ with the type of agriculture. Confined feeding for poultry and livestock production dominate in the Piedmont Province, and row-crop agriculture dominates in the Coastal Plain. Potential effects on aquatic ecosystems in the Piedmont Province primarily are nutrient enrichment from manure disposal and riparian degradation and stream-bank erosion caused by livestock trampling and grazing. Aquatic ecosystems in areas of row-crop agriculture are at risk of receiving inputs of pesticides and chemical fertilizers. In 1987, the approximately 3 1/2-million acres of agricultural lands in the basin received 2-million acre treatments of pesticides, and 1.3-million acre treatments of chemical fertilizers (U.S. Bureau of Census, 1989 a,b,c). Radtke and others (1980) studied the effects of agriculture on stream quality in the Spring Creek basin in southwestern Georgia. Pesticides were detected in surface water collected during active farming periods. However, concentrations and yields of total nitrogen and phosphorus were found to be low, even during periods of storm runoff.

In addition to anthropogenic influences on water quality, aquatic ecosystems of the ACF River basin are influenced by hydrologic alterations resulting from hydropower operations and the maintenance of navigation channels. In contrast to the Flint and Apalachicola Rivers, the hydrology of the Chattahoochee River is highly regulated by the operation of 13 dams. Although Warwick and Crisp Dams are located on the lower Flint River, the upper

Flint River is one of only 42 unregulated river reaches of at least 125 mi in length remaining in the conterminous United States, and the two dams are run-of-the-river with little storage capacity. The 107-mi Apalachicola River remains free-flowing without impoundments; however, much of the river has been physically altered by navigation-channel maintenance including the removal of shoals, dredging, and snag removal. Such activities decreased the quality of important fish habitat in the Apalachicola River (Ager and others, 1986).

Prior to the construction of dams, the basin supported important commercial freshwater fisheries. Construction of dams, particularly Jim Woodruff Dam, adversely affected a once-thriving commercial sturgeon fishery by limiting range and access to important spawning grounds. Sturgeon have not been caught commercially since 1970 (Leitman and others, 1991). Most economic value is derived from recreational fishing for trout in the upper basin and warm-water fish primarily in the reservoirs.

The striped bass, also an important commercial and game fish in the ACF River basin, is believed to be a race distinct from the Atlantic populations of the bass (Crateau, 1983). Construction of dams in the ACF River basin has contributed to the decline in the commercial fishing for striped bass. With the construction of Jim Woodruff Dam, the distribution of the striped-bass population is restricted to 17 percent of its previous spawning grounds in the ACF River basin. Recreational fishing of the striped bass is supported by a stocking program of the Georgia Department of Natural Resources.

Chemical and organic pollution are commonly perceived as the greatest threats to aquatic fauna, and are of primary concern to human-health and water-quality monitoring programs. However, a recent international study determined that habitat loss and degradation, and overharvesting are the most significant factors contributing to species population declines and extinctions (Allan and Flecker, 1990). These same factors appear to be the primary causes resulting in the listing of ACF River basin aquatic fauna under the Federal Endangered Species Act. For example, the American alligator, alligator snapping turtle, and Barbour's map turtle are endangered as a consequence of overharvesting. The basin's fish and mussel species are threatened primarily as a result of habitat loss due to reservoir construction and sedimentation. The Jim Woodruff Dam and the series of impoundments on the Chattahoochee River have severely restricted access of anadromus fish, such as the gulf sturgeon and striped bass, to spawning grounds and may influence unionid mussel populations by limiting the ranges of host fish required by their parasitic larvae. A 1993 survey by the U.S. Fish and Wildlife Service found nearly all unionid mussel species to be extirpated in the mainstem of the Chattahoochee River, and declining populations in the Flint River (Williams and Brim-Box, 1993).

Although degraded water quality and contaminants are not direct causes for listing of the basin's aquatic fauna under the Federal Endangered Species Act, these factors have contributed to declines of biological communities in some reaches of the Chattahoochee River. The fishing-use designation is not met in 80 percent of impaired stream miles in Georgia; however, the influence of degraded water-quality conditions on fish populations has been assessed only in limited areas. For example, the fish community present in the Chattahoochee River below Atlanta from the confluence of Peachtree Creek to Whitesburg, Ga., is substandard to that found in similar Georgia streams (Mauldin and McCollum, 1992). The biotic integrity of the fish community in this river reach ranged from 37 percent to 53 percent of normal, with carp (an introduced species) comprising approximately 75 percent of biomass. In addition, portions of the reach are under fish-consumption advisories due to chlordane contamination in fish tissue (Georgia Department of Natural Resources, 1992). Suggested factors contributing to lowered biotic integrity include loss of habitat due to the deposition of silt, the presence of contaminants at levels below detection limits, and chronic fish kills in tributary streams (Mauldin and McCollum, 1992).

Water-quality conditions have adversely affected fishing on West Point Lake. Pollution of West Point Lake and the contamination of the lake's fish by chlordane have resulted in the cancellation of fishing tournaments and reduction in recreational use. Fishing has decreased by 60 percent, resulting in sales losses to local businesses (Alabama Department of Environmental Management, 1992).

Fish-community surveys also have been conducted on parts of the mainstem Flint River and Apalachicola River. A 1984 survey of the Upper Flint River near Upson, Talbot, and Taylor Counties found a diverse fish community that had changed little since the early 1970's (Ellis and Clark, 1984). Periodic assessments of the fish populations in the Apalachicola River have documented declines in productivity resulting from loss of productive near-shore habitat and snags due to dredge spoil disposal and desnagging (Ager and others, 1986). However, in recent years, the U.S. Army Corps of Engineers has altered spoil disposal and desnagging to alleviate such habitat loss.

NAWQA's water-quality assessment in the ACF River basin will consider the effects of variations in natural and anthropogenic influences that have been described in this report. In the northern part of the basin lying in the Piedmont Province, human activity in the growing Atlanta Metropolitan area, poultry production above Lake Sidney Lanier, and silviculture influence water quality. In the Coastal Plain Province, intensive row-crop agriculture may be a dominant influence on water quality. NAWQA's ACF River basin study design will attempt to assess these various influences and their cumulative effects on the basin's aquatic ecosystems.

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