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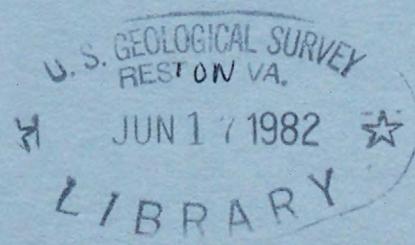
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WETLAND HYDROLOGY AND TREE DISTRIBUTION OF THE APALACHICOLA RIVER FLOOD PLAIN, FLORIDA

OPEN-FILE REPORT 82-251



✓ T. W. and J.



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WETLAND HYDROLOGY AND TREE DISTRIBUTION
OF THE APALACHICOLA RIVER FLOOD
PLAIN, FLORIDA

By Helen M. Leitman, James E. Sohm, and Marvin A. Franklin

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GEOLOGICAL SURVEY

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LIST OF COMMON AND SCIENTIFIC PLANT NAMES USED

[Nomenclature follows Kurz and Godfrey (1962),
unless otherwise indicated]

ash, Carolina	<u>Fraxinus caroliniana</u> Mill.
green	<u>Fraxinus pennsylvanica</u> Marsh.
pumpkin	<u>Fraxinus profunda</u> (Bush.) Bush.
baldcypress	<u>Taxodium distichum</u> (L.) Rich.
birch, river	<u>Betula nigra</u> L.
boxelder	<u>Acer negundo</u> L.
bumelia, buckthorn	<u>Bumelia lycioides</u> (L.) Pers.
buttonbush	<u>Cephalanthus occidentalis</u> L.
chinaberry	<u>Melia azedarach</u> L.
cottonwood, swamp	<u>Populus heterophylla</u> L.
cypress	see baldcypress
dogwood, stiffcornel	<u>Cornus foemina</u> Mill.
(swamp dogwood ²)	(<u>Cornus stricta</u> Lam.)
elm, American	<u>Ulmus americana</u> L.
slippery	<u>Ulmus rubra</u> Muhl.
winged	<u>Ulmus alata</u> Michx.
grape	<u>Vitis</u> spp. ³
haw, green	<u>Crataegus viridis</u> L.
parsley	<u>Crataegus marshallii</u> Egglest.
hickory, water	<u>Carya aquatica</u> (Michx. f.) Nutt.
hornbeam, American	<u>Carpinus caroliniana</u> Walt.
locust, water	<u>Gleditsia aquatica</u> Marsh.
maple, red	<u>Acer rubrum</u> L.
mulberry, red	<u>Morus rubra</u> L.
oak, cherrybark	<u>Quercus falcata</u> Michx., var. <pagodaefolia< u=""> Ell.</pagodaefolia<>
diamond-leaf	<u>Quercus laurifolia</u> Michx.
laurel	<u>Quercus hemisphaerica</u> Bartr. (Quercus laurifolia Michx. ⁴)
overcup	<u>Quercus lyrata</u> Walt.
swamp chestnut	<u>Quercus prinus</u> L. ² (Quercus michauxii Nutt.)
water	<u>Quercus nigra</u> L.
palmetto, cabbage	<u>Sabal palmetto</u> (Walt.) Lodd.
persimmon, common	<u>Diospyros virginiana</u> L.
pine, loblolly	<u>Pinus taeda</u> L.
spruce	<u>Pinus glabra</u> Walt.
planertree (water-elm ²)	<u>Planera aquatica</u> Gmel.
possumhaw	<u>Ilex decidua</u> Walt.
silverbell, little	<u>Halesia tetraptera</u> Ellis. (Halesia parviflora Michx. ²)

See footnotes at end of table.

LIST OF COMMON AND SCIENTIFIC PLANT NAMES USED--Continued

sugarberry (hackberry)	<u>Celtis laevigata</u> Willd.
swamp-privet	<u>Forestiera acuminata</u> (Michx.) Poir.
sweetbay	<u>Magnolia virginiana</u> L.
sweetgum	<u>Liquidambar styraciflua</u> L.
sycamore, American	<u>Platanus occidentalis</u> L.
titi	<u>Cyrilla racemiflora</u> L.
tupelo, Ogeechee	<u>Nyssa ogeche</u> Bartram ex Marsh
water	<u>Nyssa aquatica</u> L.
swamp (blackgum)	<u>Nyssa biflora</u> Walt. [<u>Nyssa</u> <u>sylvatica</u> var. ² <u>biflora</u> (Walt.) Sarg.]
black (sourgum)	<u>Nyssa sylvatica</u> Marsh. (<u>Nyssa</u> <u>sylvatica</u> ² Marsh. var. <u>sylvatica</u>)
viburnum, witherod	<u>Viburnum cassinoides</u> L.
walnut, black	<u>Juglans nigra</u> L.
willow, black	<u>Salix nigra</u> Marsh.

¹ Introduced exotic species.

² According to Little (1979).

³ Radford and others (1968).

⁴ Little (1979) does not recognize Quercus hemisphaerica as a separate species.

CONVERSION FACTORS

The metric (SI) units used in this report may be converted to inch-pound units by the following conversion factors:

<u>Multiply</u>	<u>By</u>	<u>To obtain</u>
millimeter (mm)	0.03937	inch
meter (m)	3.281	foot
kilometer (km)	0.6214	mile
square meter (m^2)	10.76	square foot
hectare (ha)	2.471	acre
square kilometer (km^2)	0.3861	square mile
cubic meter (m^3)	35.31 1.308	cubic foot cubic yard
cubic hectometer (hm^3)	810.7	acre-foot
meter per second (m/s)	3.281	foot per second
cubic meter per second (m^3/s)	35.31	cubic foot per second
square meter per hectare (m^2/ha)	4.355	square foot per acre
trees per hectare (trees/ha)	0.4047	trees per acre

$$^{\circ}\text{C} = 5/9(^{\circ}\text{F}) - 32$$

$$^{\circ}\text{F} = 9/5(^{\circ}\text{C}) + 32$$

CONVERSION FACTORS--Continued

Locations on the river are marked with prominent signs giving navigation miles. Conversions from kilometers to navigation miles are given below for all river locations used in this report.

<u>Kilometer</u>	<u>Navigation mile</u>	<u>Kilometer</u>	<u>Navigation mile</u>
0	0	98.0	60.9
10.5	6.5	100	62
20.1	12.5	116.5	72.4
32.3	20.1	120	75
34	21	127	79
37	23	138.1	85.8
40	25	140	87
45	28	150.1	93.3
50	31	158	98
60	37	160	99.5
68.4	42.5	168.5	104.7
78.5	48.8	171	106
80	50		

National Geodetic Vertical Datum of 1929 (NGVD of 1929) is a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "mean sea level." NGVD of 1929 is referred to as sea level in this report. Altitude is defined as distance above or below NGVD of 1929.

WETLAND HYDROLOGY AND TREE DISTRIBUTION OF
THE APALACHICOLA RIVER FLOOD PLAIN, FLORIDA

By Helen M. Leitman, James E. Sohm, and Marvin A. Franklin

ABSTRACT

The Apalachicola River in northwest Florida is part of a three-state drainage basin encompassing 50,800 square kilometers in Alabama, Georgia, and Florida. The river is formed by the confluence of the Chattahoochee and Flint Rivers at Jim Woodruff Dam from which it flows 171 kilometers to Apalachicola Bay in the Gulf of Mexico. Its average annual discharge at Chattahoochee, Florida, is 690 cubic meters per second (1958-80) with annual high flows averaging nearly 3,000 cubic meters per second. Its flood plain supports 450 square kilometers of bottom-land hardwood and tupelo-cypress forests.

The Apalachicola River Quality Assessment focuses on the hydrology and productivity of the flood-plain forest. The purpose of this part of the assessment is to address river and flood-plain hydrology, flood-plain tree species and forest types, and water and tree relations. Seasonal stage fluctuations in the upper river are three times greater than in the lower river. Analysis of long-term streamflow record revealed that 1958-79 average annual and monthly flows and flow durations were significantly greater than those of 1929-57, probably because of climatic changes. However, stage durations for the later period were equal to or less than those of the earlier period. Height of natural riverbank levees and the size and distribution of breaks in the levees have a major controlling effect on flood-plain hydrology. Thirty-two kilometers upstream of the bay, a flood-plain stream called the Brothers River was commonly under tidal influence during times of low flow in the 1980 water year. At the same distance upstream of the bay, the Apalachicola River was not under tidal influence during the 1980 water year.

Of the 47 species of trees sampled, the five most common were wet-site species constituting 62 percent of the total basal area. In order of abundance, they were water tupelo, Ogeechee tupelo, baldcypress, Carolina ash, and swamp tupelo. Other very common species were sweetgum, overcup oak, planertree, green ash, water hickory, sugarberry, and diamond-leaf oak. Five forest types were defined based on species predominance by basal area. Biomass increased downstream and was greatest in forests growing on permanently saturated soils.

Depth of water, duration of inundation and saturation, and water-level fluctuation, but not water velocity, were very highly correlated with forest types. Most forest types dominated by tupelo and bald-cypress grew on permanently saturated soils with inundation by flood waters 50 to 90 per cent of the time, or an average of 75 to 225 consecutive days during the growing season from 1958 to 1980. Most forest types dominated by other species grew in areas that were saturated or inundated 5 to 25 percent of the time, or an average of 5 to 40 consecutive days during the growing season from 1958 to 1980. Water and tree relations varied with river location because range in water-level fluctuation and topographic relief in the flood plain diminished downstream.

INTRODUCTION

Forested wetlands are complex transitional systems between terrestrial and aquatic environments. Natural energy is used in wetlands to manage water quantity and maintain water quality. They provide unique and essential habitat for a diverse assortment of plants and animals (Wharton and others, 1977, p. 335-346). Development pressure in forested flood plains is high and management controversies are common. The needed scientific study of forested wetlands is hampered by their complexity and by the limited applicability of conventional limnological or terrestrial ecological techniques.

Purpose and Scope

The Apalachicola River Quality Assessment was initiated in 1978 as part of a national river quality assessment program of the U.S. Geological Survey. The broad objectives and development of the national program were (Greeson, 1978):

1. To define the character, interrelationships, and apparent cause of existing river-quality problems; and
2. To devise and demonstrate the analytical approaches and the tools and methodologies needed for developing water-quality information that will provide a sound technical basis for planners and managers to use in assessing river-quality problems and evaluating management alternatives.

The specific goals of the Apalachicola River Quality Assessment conformed to these overall program objectives with the modification that the investigation was process oriented rather than problem oriented. The Apalachicola River system supports largely undisturbed forested wetlands on the flood plain and highly productive estuaries at its mouth (Apalachicola Bay). The primary purpose of this assessment was to investigate river-wetland relations and controlling factors which influence the yield of nutrients and detritus to the bay. Emphasis was

given to processes which influence nutrient and detritus flow, rather than to problems involving environmental disturbance or pollution. Special attention was given to methods development because ecological studies of large river-wetland systems have been rare and few methods particularly applicable to this type of study have been described. The specific goals of the Apalachicola River Quality Assessment were to (Mattraw and Elder, 1980):

1. Determine the extent to which potentially toxic trace elements and organic substances accumulate in benthic organisms and sediments.
2. Describe how tree distribution is related to hydrologic conditions in the flood plain.
3. Assess the importance of leaf production and decomposition on the flood plain to detritus and nutrient yields.
4. Identify major sources of nutrients to the river system and quantify transport of nutrients and organic detritus in various parts of the system.

The description of tree distribution and its relation to hydrologic conditions on the Apalachicola River flood plain is the purpose of this report. Three major objectives of this assessment component were to:

1. Observe hydrologic conditions in the forested flood plain and relate them to long-term river-stage record.
2. Estimate species composition and define the major forest types for the flood plain.
3. Relate long-term hydrologic conditions in the flood plain to tree distribution.

Geographically, the Apalachicola River Quality Assessment is limited to the Apalachicola River and its forested flood plain from the confluence of the Chattahoochee and Flint Rivers at Jim Woodruff Dam, downstream to Apalachicola Bay. Data collection began in August 1979 and continued through November 1980.

Acknowledgments are extended to Ann Redmond of Northwest Florida Water Management District for assistance in botanical field work in the fall of 1979, and James Lucas of EROS Data Center for his efforts to interpret hydrologic conditions from satellite images. Acknowledgements are also extended to the following employees of the U.S. Geological Survey: Linda Geiger for assistance in data interpretation, Gilbert Hughes for analysis of hydrologic record, Sherron Flagg for editing and manuscript preparation, Edwin Malin for illustrations, and numerous other individuals for hydrologic measurements in the flood of March and April 1980 and other technical support.

Physiography

The Apalachicola River is formed by the confluence of the Chattahoochee and Flint Rivers (fig. 1). The three rivers drain 50,800 km² in Georgia, Alabama, and Florida. The Chattahoochee flows about 700 kilometers from its source in north Georgia to Lake Seminole at the Florida-Georgia State line. The Flint River originates south of Atlanta, Ga., and flows about 600 kilometers before it joins the Chattahoochee River. The Apalachicola River is 171 kilometers long and falls about 12 meters from its head at Jim Woodruff Dam near Chattahoochee, Fla., to the Apalachicola Bay in the Gulf of Mexico (fig. 2). The Apalachicola River downstream from Jim Woodruff Dam drains 6,200 km², 50 percent of which is drained by its major tributary, the Chipola River.

The kilometer designations shown in figure 2 are used in this report to indicate locations on the river. They range from kilometer 0 at the U.S. Highway 98 bridge, at the city of Apalachicola, to kilometer 171 at Jim Woodruff Dam near Chattahoochee. Kilometers were determined from "navigation miles" established by the U.S. Army Corps of Engineers using the conversion factor of 1.609 kilometers per mile. Locations on the river are marked with prominent signs giving navigation miles. For the convenience of readers, miles are shown in addition to kilometers in figure 2; and conversions from kilometers to navigation miles for each specific river location mentioned are provided in the conversion factors in the front of this report.

Figure 3, modified from Puri and Vernon (1964, fig. 5), shows the detailed physiographic regions in the Apalachicola River area. They fall into two broad physiographic categories according to the U.S. Geological Survey (1970, p. 61). The Marianna Lowlands, New Hope Ridge, Greenhead Slope, Fountain Slope, Grand Ridge, Tallahassee Hills, and Beacon Slope are considered part of the Gulf-Atlantic Rolling Plain. The Coastal Lowlands are part of the Gulf-Atlantic Coastal Flats.

Flood-plain soil has a wide range of textures and colors because it is made up of a variety of sediments that were washed from many different soils. At two locations near Blountstown and Wewahitchka, Leitman (1978) found flood-plain soils to be predominantly clay with some silty clay and minor clay loam. Sands on point bars were predominantly fine and very fine sands and were of the micaceous type whereas most Florida sands are siliceous. Cation exchange capacity and organic carbon content were higher than most Florida soils except peats and mucks. The soil pH was acid but not as acid as most Florida soils.

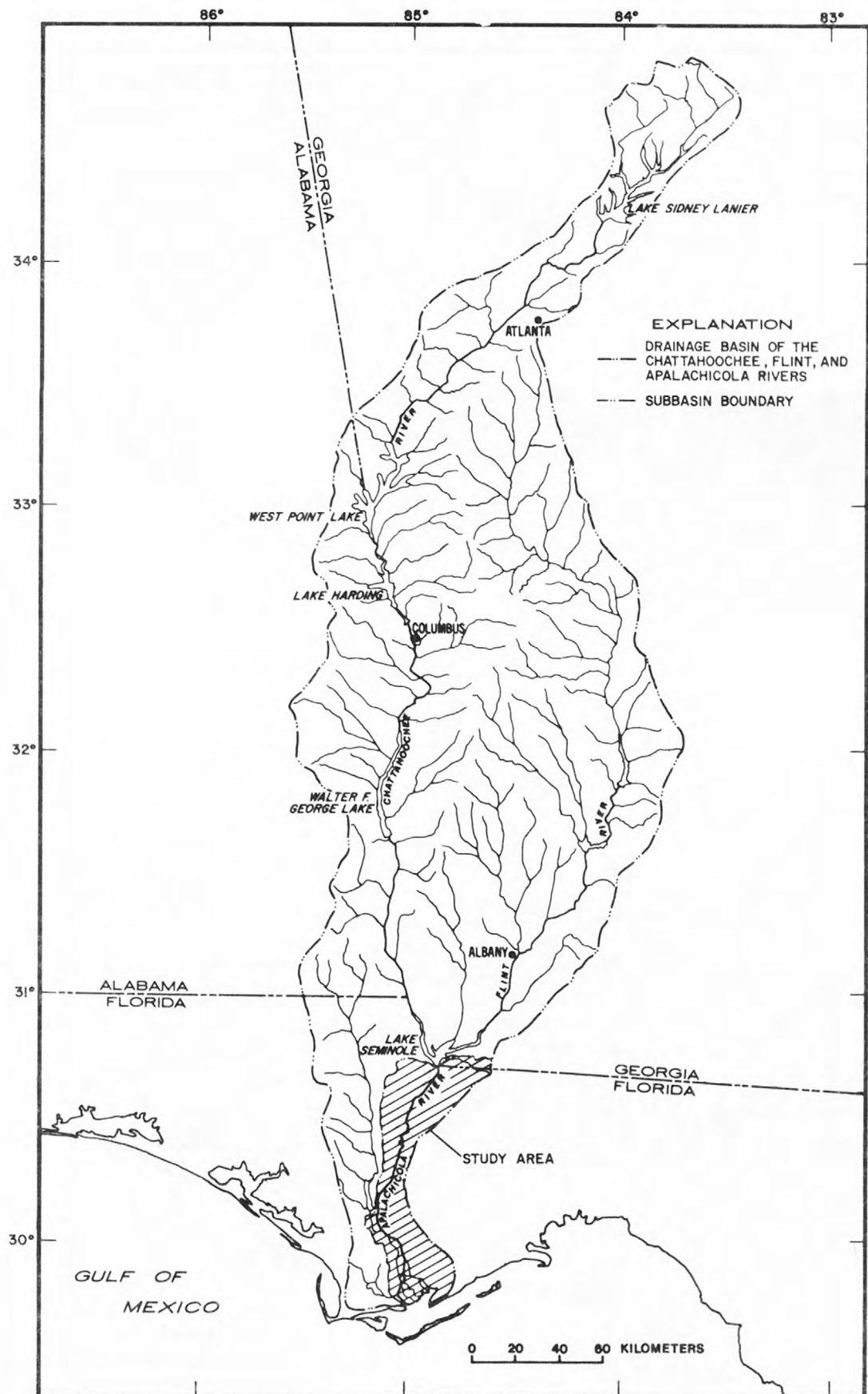


Figure 1.--Drainage basin of the Apalachicola, Chattahoochee, and Flint Rivers in Florida, Georgia, and Alabama.

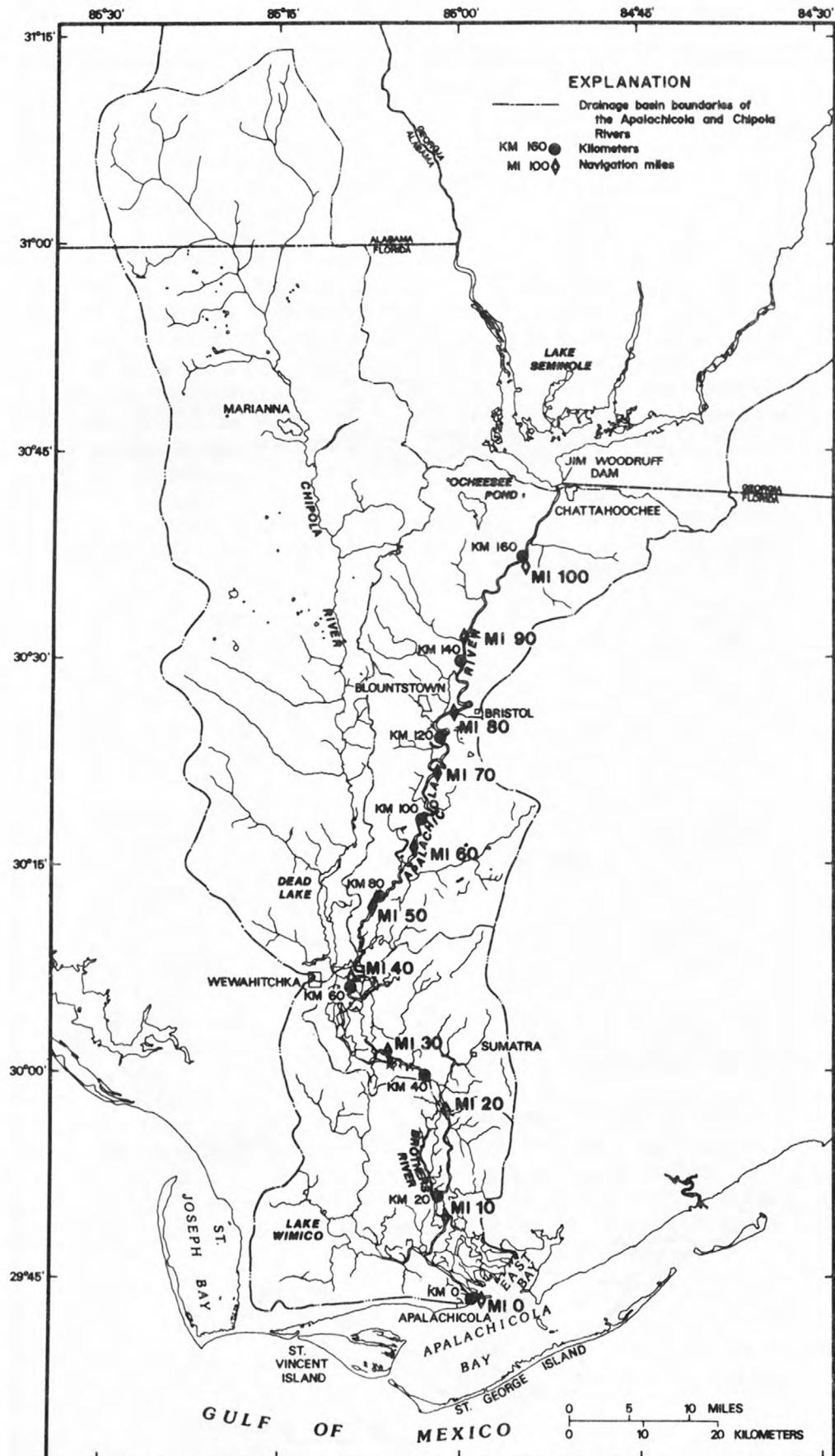


Figure 2.--Drainage basin of the Apalachicola River in Florida and the Chipola River in Florida and Alabama.

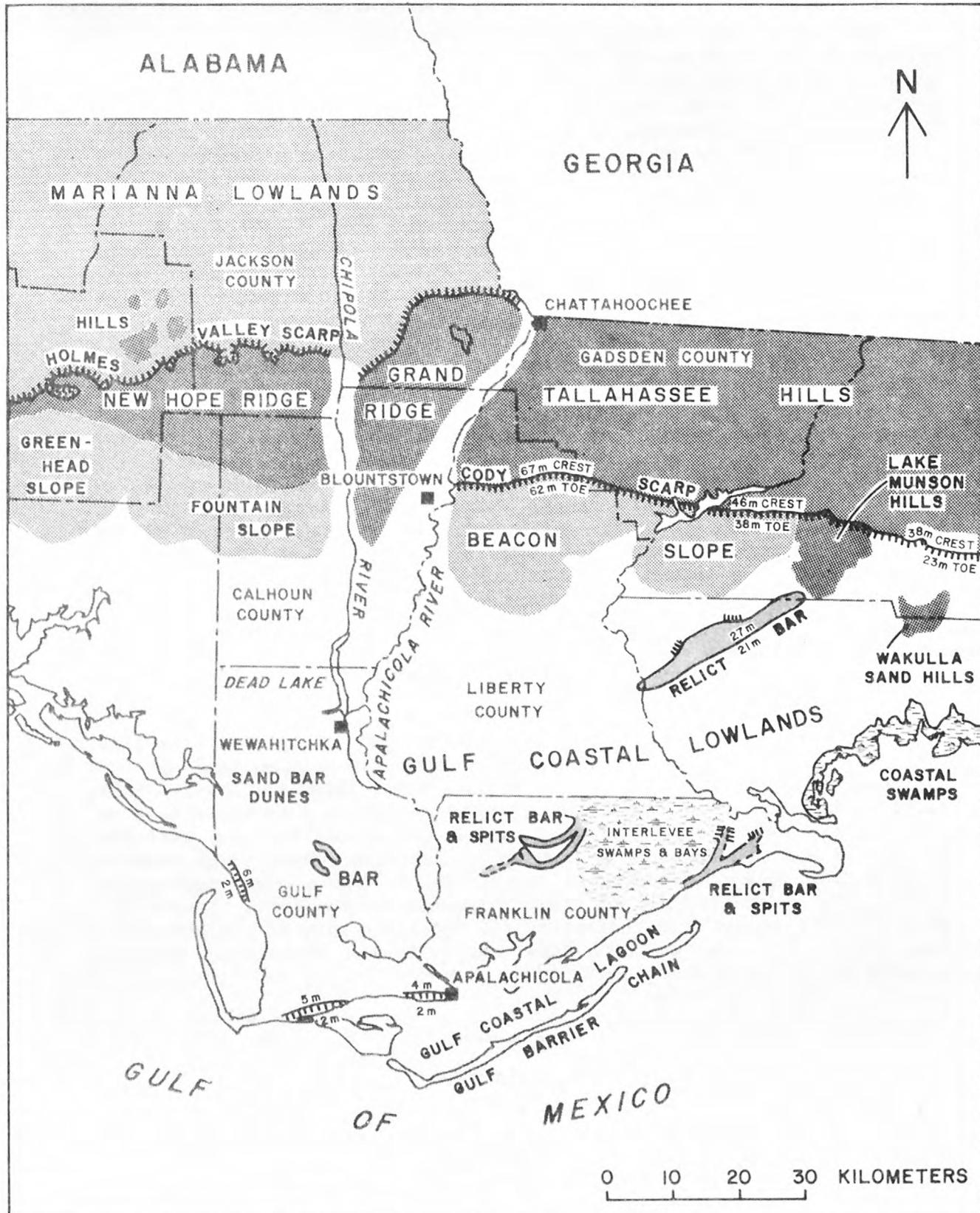


Figure 3.--Physiography of the Apalachicola River area. [Modified from Puri and Vernon (1964, fig. 5).]

The upper river corridor from Chattahoochee to Blountstown cuts through sediments of Miocene age. Steep bluffs on the east side of the upper river form the western boundary of the Tallahassee Hills physiographic province (fig. 3), where altitudes are as high as 99 meters. The land west of the upper river is gently rolling and rises gradually from the flood plain to the Grand Ridge region where altitudes are as high as 38 meters. West of the Grand Ridge area, the land drops slightly to the Marianna Lowlands, a karst plain drained by the Chipola River, the major tributary of the Apalachicola. The flood plain of the upper river is 1.5 to 3 kilometers wide, and the river itself has long, straight reaches and wide, gentle bends. Natural riverbank levees range from 120 to 180 meters wide and can be as much as 4.5 meters higher than the remainder of the flood plain.

The middle river from Blountstown to Wewahitchka lies in Holocene and Pleistocene deposits. For the first few kilometers, it is bounded on the east by the Beacon Slope physiographic region, where altitudes are as high as 45 meters. The Gulf Coastal Lowlands, which are below 30 meters in altitude, lie to the south and west of the Beacon Slope. The flood plain, wider than that of the upper river, is 3 to 5 kilometers across. The river channel meanders with large loops in the Beacon Slope area and with many small tight bends further south. Natural riverbank levees range from 60 to 120 meters wide and 2.5 to 4 meters higher than the remainder of the flood plain. Dead Lake, just north of Wewahitchka, was formed when natural levees of the Apalachicola River impounded the Chipola River. According to Vernon (1942), formation of this lake was due to a much greater sediment load and a more rapid rate of alluviation in the Apalachicola than in the Chipola.

The lower river from Wewahitchka to the city of Apalachicola lies completely in the Gulf Coastal Lowlands with surrounding land-surface altitudes less than 15 meters. The Chipola River joins the Apalachicola River at kilometer 45. The flood plain is widest in this section, 4 to 7 kilometers across, and the river is characterized by long straight reaches with a few small bends. Natural riverbank levees range from 15 to 45 meters wide and rise 0.5 to 2.5 meters above the flood-plain floor. The upstream limit of tidal influence in the flood plain probably does not extend above kilometer 40. Near the city of Apalachicola, the tidal river empties into bays and estuaries bounded by barrier islands and spits (fig. 3).

Hydrology and Climate

The Apalachicola River is 21st in magnitude of the rivers of the conterminous United States and is the largest river in Florida. The mean annual flow at Chattahoochee from 1958 to 1980 was $690 \text{ m}^3/\text{s}$. The mean annual high was $2,970 \text{ m}^3/\text{s}$ and the mean annual low was $256 \text{ m}^3/\text{s}$. Seasonal fluctuations in stage (water level in river) and discharge are large. Peak floods are most likely to occur in January, February, March, or April of each year. Low flow generally occurs in September, October, and November. Flood patterns vary greatly from year to year and may not conform to these seasonal trends in any given year.

Fluctuations in stage vary greatly from upper to lower river. Figure 4 shows hydrographs for the 1980 water year at the four long-term gaging stations on the river. At the most upstream station, near the town of Chattahoochee, the stage fell 7.3 meters from the peak on March 31, to the low for the year at the end of September, while the stage at the most downstream station, near Sumatra, ranged 2.4 meters from the peak to the low.

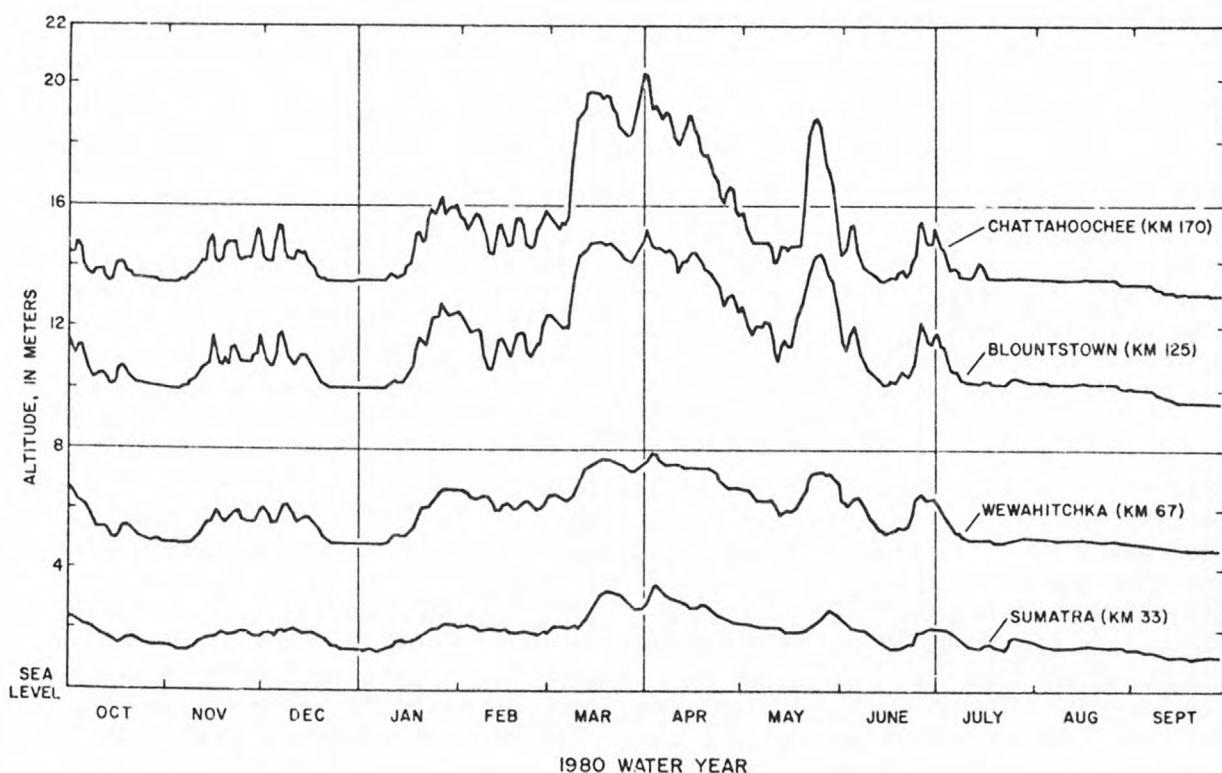
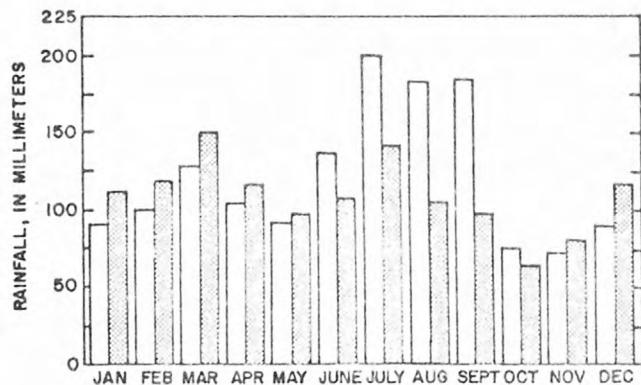


Figure 4.--River stage at four gaging stations on the Apalachicola River for water year 1980.

Georgia rainfall has a greater influence on Apalachicola River flows than Florida rainfall because only 11 percent of the basin of the Apalachicola, Chattahoochee, and Flint Rivers is in Florida (fig. 1). However, flows in the lower river can be substantially increased by Florida rainfall because of input from the Chipola River near kilometer 45. Flow from the Chipola River averaged 10 percent of the Apalachicola River flow at the Sumatra gage during the 1979 and 1980 water years. Local rainfall can also increase soil saturation or cause inundation on the flood plain during low or medium river stages, especially in depressions or flat areas having soils with a high percentage of clay.

Average annual rainfall in the Apalachicola River basin in Florida is 1,470 millimeters (1941-70), and mean annual potential evapotranspiration is between 990 and 1,140 millimeters (U.S. Department of Agriculture, 1969). Average annual rainfall in the basin of the Chattahoochee and Flint Rivers in Georgia is 1,320 millimeters. Basin rainfall in Georgia is shown with basin rainfall in Florida in figure 5. Georgia rainfall is slightly higher in the winter but much lower in the summer than Florida rainfall. The two states have similar amounts of rainfall in the spring and both have the least rainfall in October and November (U.S. Department of Commerce, 1973a; 1979a; 1979b).



EXPLANATION

- Average rainfall in the Apalachicola River basin in Florida. Rainfall is an average of 30-year normals for 1941-70 for Blountstown and city of Apalachicola.
- Average rainfall in the basin of the Chattahoochee and Flint Rivers in Georgia. Rainfall is an average of the 30-year normals for the southwest, west central, and north central divisions. These three divisions contain most of the drainage basin of the Chattahoochee and Flint Rivers.

Figure 5.--Average rainfall in the Apalachicola River basin in Florida compared with that in the basin of the Chattahoochee and Flint Rivers in Georgia. [Data from U.S. Department of Commerce (1973a, 1979b).]

Mean annual temperature in the Apalachicola River basin in Florida is 19°C (degrees Celsius). Mean January temperature is 11°C and mean July temperature is 27°C (U.S. Department of Commerce, 1973a). The growing season is from the mean (50 percent probability) date of the last 0°C frost in the spring to the mean date of the first 0°C frost in the fall. The length of the average growing season ranges from 255 days (March 5 to November 15) at the Florida-Georgia State line near Chattahoochee to 280 days (February 23 to November 30) at the Gulf Coast near Apalachicola (J. R. Gallup, National Weather Service, Auburn, Alabama, oral commun., 1980).

Dendrology

The forested flood plain of the Apalachicola River is the largest in Florida. It is 114 kilometers long and covers approximately 450 km² (Wharton and others, 1977, p. 70). Of the 211 different species of trees growing in the north Florida area, about 60 are found on the Apalachicola River flood plain. It is dominated by the general forest type, oak-gum-cypress, defined by the U.S. Forest Service as bottom-land forest in which 50 percent or more of the stand is tupelo, blackgum, sweetgum, oak, and cypress, singly or in combination (U.S. Department of Agriculture, 1969, p. 9). The oak-gum-cypress type is very common on the flood plains of southeastern alluvial rivers; however, this general forest type has been divided into numerous specific types that differ from river to river (Leitman, 1978, p. 6-12).

The first quantitative description of tree associations on the Apalachicola River flood plain was made from the pilot house of a steamboat traveling on the lower river (Harper, 1911). In the upper river, Kurz (1938) related tree species to various topographic features in the flood plain. Clewell (1977) described the botany and physiography of the Apalachicola River region, and Leitman (1978) studied flood-plain trees in relation to water levels, elevation, and soils at two locations near Blountstown and Wewahitchka.

Water in the flood plain influences the distribution of trees because the availability of oxygen is severely restricted in saturated and inundated soils. Water-logging tolerance varies with each species and with environmental conditions and increases with the age of the plant (Whitlow and Harris, 1979). In constantly saturated soils, the only trees that will survive are those that have developed numerous anatomical and physiological adaptations to grow in a soil environment low in oxygen. Flooding during the dormant season has little or no effect because the oxygen requirements of plants are very low, but as little as 3 days of flooding during the growing season can affect seedlings of certain intolerant species such as yellow poplar (Southeastern Forest Experiment Station, 1958). Seedlings of many species can survive soil saturation without standing water for much longer periods than complete inundation (Hosner, 1960; Hosner and Boyce, 1962).

The presence or absence of water is not the only factor affecting tree distribution. Patterns of seed dispersal, seed predation by animals, type of soil, availability of nutrients, competition, temperature, salinity, fire, the activities of man, and other factors affect tree distribution. However, many of these factors are directly affected by hydrologic conditions. Timber harvesting directly affects forest composition, but no description of logging practices and activities in the study area has been summarized in the literature. Fire is probably not an important factor in the flood plain. Occasionally, one finds charred snags (remnants of trunks) in the flood plain. Their occurrence is infrequent and isolated, suggesting that fire was probably restricted to individual trees. These charred snags are probably the result of lightning or being burned out by racoon hunters (C. H. Wharton, oral commun., 1980).

Dams and Navigational Improvements

Jim Woodruff Lock and Dam, which impounds Lake Seminole, is 171 kilometers upstream of Apalachicola Bay. At a stage of 23.5 meters above sea level, Lake Seminole has an area of 152 km², contains 475 hm³ of water, inundates 76 kilometers of the Chattahoochee River and 76 kilometers of the Flint River, and has 386 kilometers of shoreline. Dam construction began in 1950, and filling of the reservoir was accomplished in several stages from May 1954 to February 1957. The primary use of the dam is to improve navigation for barge traffic, with power generation as a secondary benefit.

Including Jim Woodruff Dam, 16 dams are on the Chattahoochee and Flint Rivers (fig. 6). Table 1 gives locations, construction dates, operators, uses, and capacities of the five largest dams in terms of reservoir capacity. These five largest dams influence seasonal, weekly, or daily river flows. The 11 smallest dam-reservoir systems have no effect on seasonal or weekly flows and little or no effect on daily flows. Most were built by local or private organizations for power generation. The oldest dam, Eagle and Phenix, was built in 1834. Most of the remaining small dams were built around the turn of the century.

The original congressional authorization for navigational improvements by the U.S. Army Corps of Engineers on the Apalachicola River was made on June 23, 1874, for a channel 30 meters wide and 1.8 meters deep. The current project authorizes the Corps to maintain a channel 30 meters wide and 2.7 meters deep. Dredging for the 2.7-meter depth began in 1956 in preparation for the completion of Jim Woodruff Dam. Average annual volume of dredging since 1956 has been 800,000 cubic meters per year. In the past, dredged material was placed at 131 locations along the river, many of which were undiked flood-plain disposal sites used on a one-time basis. Most of the 151 disposal sites currently in use are between the banks of the river rather than on the flood plain (Harry Peterson, U.S. Army Corps of Engineers, Panama City, Fla., oral commun., 1980).

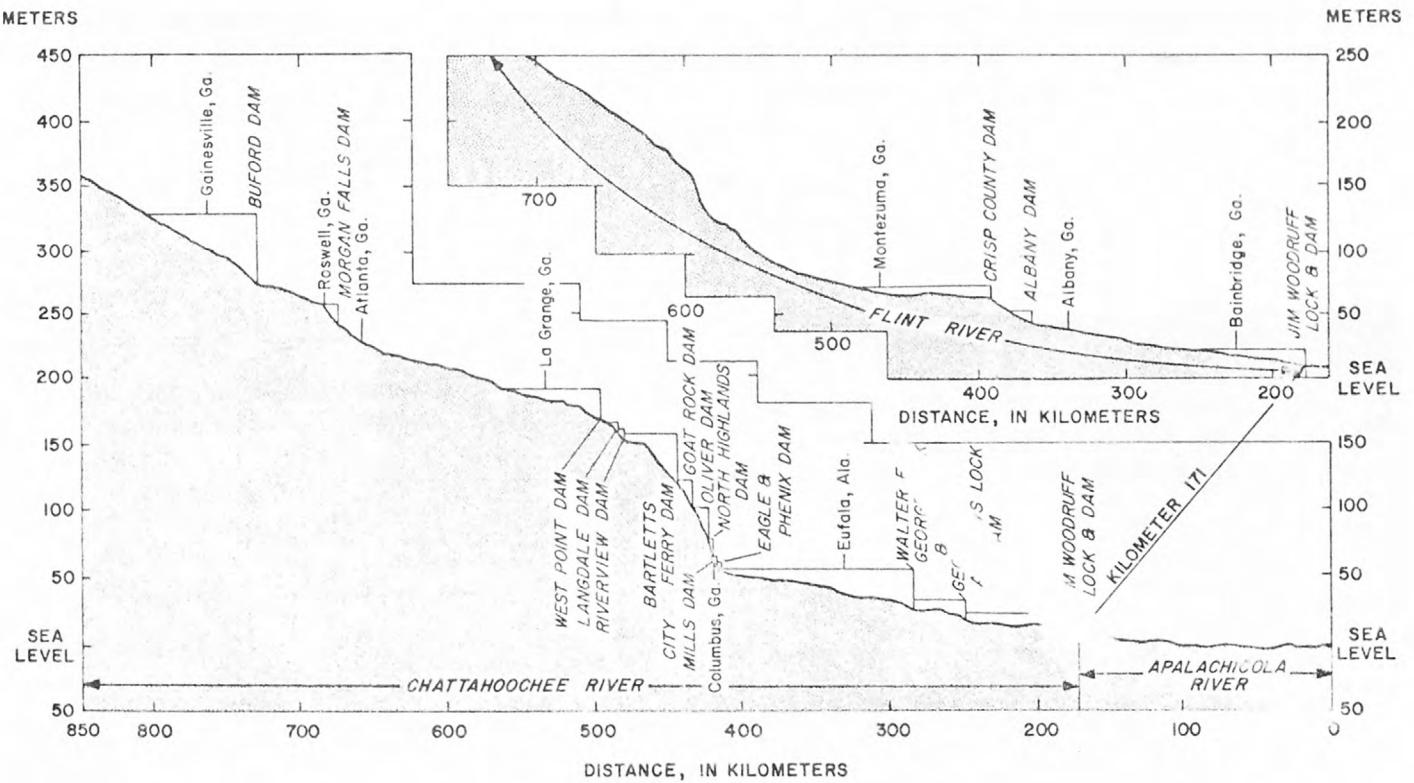


Figure 6.--Altitudes and locations of the 16 dams on the Apalachicola, Chattahoochee, and Flint Rivers (modified from U.S. Army Corps of Engineers, 1980).

Table 1.--The five largest dams in terms of reservoir capacity on the Apalachicola, Chattahoochee, and Flint Rivers

[Data from U.S. Geological Survey, 1977, and U.S. Army Corps of Engineers, 1980]

[Bartlett's Ferry Dam operated by Georgia Power Company, all other dams operated by U.S. Army Corps of Engineers]

Dam	Reservoir	Dis- tance up- stream of bay, in km	Filling of pool com- pleted	Useable reservoir capacity in hm ³	Purpose
Buford	Sidney Lanier	732	June 1957	2,079	Flood control, power, recreation, drinking water
West Point	West Point	497	June 1975	379	Flood control, power
Bartlett's Ferry	Harding	457	1926	168	Power
Walter F. George	Walter F. George	291	March 1963	301	Navigation, power, flood control
Jim Woodruff	Seminole	171	Feb. 1957	45	Navigation, power

In a study of 11 dredged material disposal sites from kilometer 10.5 to kilometer 68.4, Eichholz and others (1979) found that deposition on the flood-plain forest averaged 1.6 hectares per disposal site and caused mortality of most trees within the deposition area. Dredged material was deposited most often in the mixed bottom-land hardwood forest of the riverbank levee and frequently blocked flood-plain sloughs and creeks. In only one instance was dredged material placed in the tupelo-cypress forest behind the riverbank levee. Depth of deposition ranged from less than 1 meter to over 10 meters. Clewell and McAninch (1977) found that tree vigor was reduced when only 0.04 to 0.12 meters of fill were deposited on Apalachicola River flood-plain trees. Most trees were killed by 0.8 meters or more of fill.

Groins are placed in rivers to improve navigability by creating scour in the channel area of the river (fig. 7). Twenty-nine sets of groins made of wooden pilings or stone were installed from 1963 to 1970, most of which are in the upper river. Most locations have four groins in a set, but they may have as few as two or as many as eight in a set (Harry Peterson, oral commun., 1980).

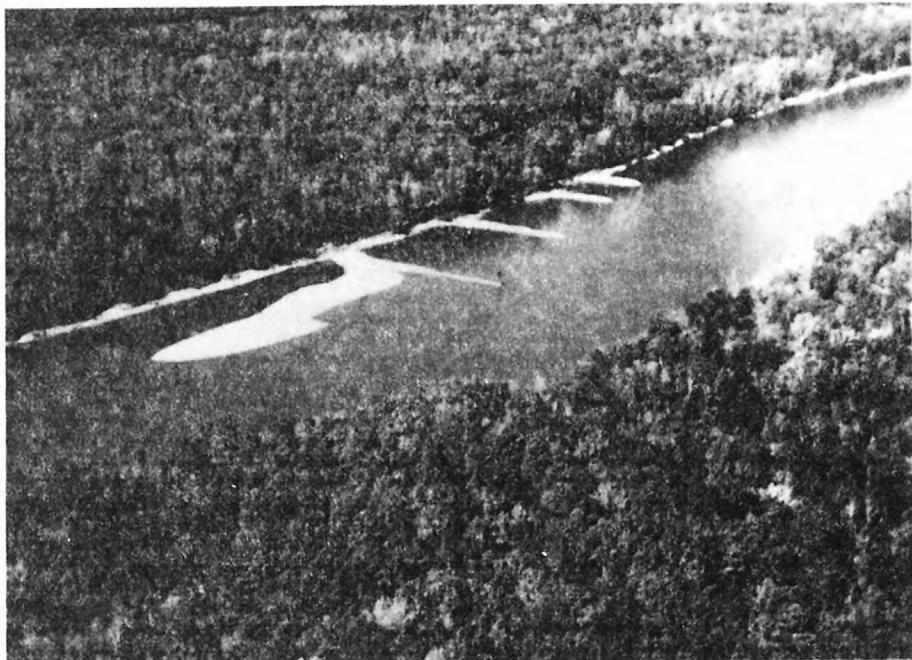


Figure 7.--Channel control groins at kilometer 160 on the Apalachicola River. Groins are 30 to 100 meters in length.

The U.S. Army Corps of Engineers made four cutoffs in 1956-57 and three more in 1968-69 to straighten bends in the river that were particularly difficult for barges to navigate. The cutoffs shortened the total length of the river about 3 kilometers (Harry Peterson, oral commun., 1980). Figure 8 shows the cutoff of a meander, Battle Bend, above the confluence of the Chipola and Apalachicola Rivers.

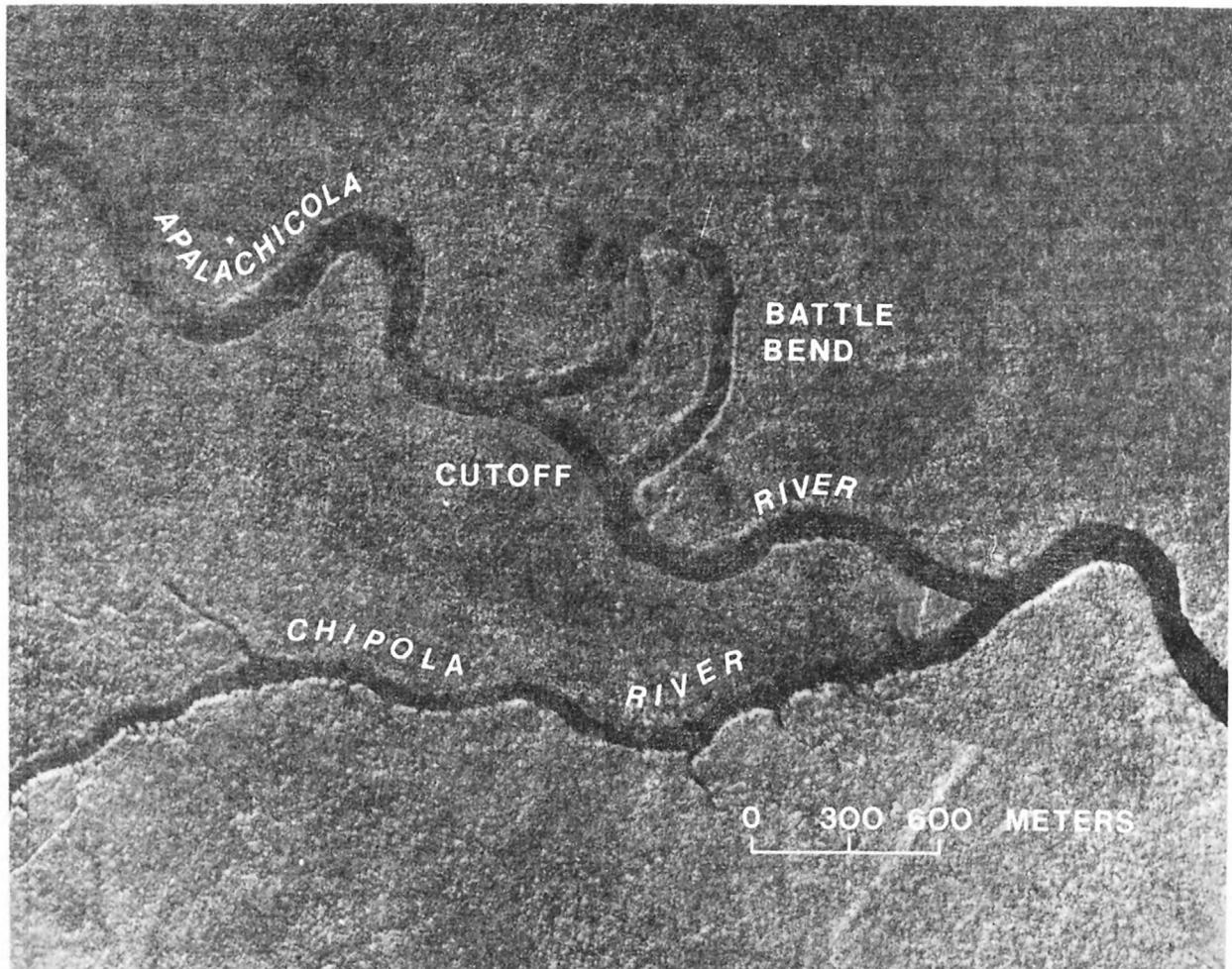


Figure 8.--Cutoff of a meander on the Apalachicola River above its confluence with the Chipola River.

Land Use

The major land use in the flood plain is forestry. Most areas were first cut between 1870 and 1925 (Clewel, 1977, p. 11) and have been logged once or twice since that time. Regrowth has been rapid and much of the flood plain has the general aspect of a mature forest. Other extensive uses are beekeeping for tupelo honey production, commercial and sport fishing, and hunting. A few areas on the flood plain have been cleared for agriculture (row crops and improved pasture) and residential developments. Population and development in the area are relatively sparse.

Most of the flood plain is owned by lumber and paper companies and is managed for timber harvesting. A large part of the flood plain in the lower reaches of the river is publicly owned. In 1977-78, the State of Florida Environmentally Endangered Lands Program purchased 113 km² of flood plain from about kilometer 34 to Apalachicola Bay. According to Florida statutes, land below the "ordinary high water line" of the river is owned by the State.

METHODS OF INVESTIGATION

Transects

Cruise Transects

Eight transects were established across the Apalachicola River flood plain to collect data on water depth, duration, and velocity, and tree cover and density. They were located perpendicular to the flood-plain corridor at approximately equally spaced intervals from the dam at Chattahoochee to the south end of Forbes Island in the lower river. Transect and long-term gage locations are shown in figure 9.

Cruise-transect points were established at 90-meter intervals across each transect. Limited amounts of water and tree data were collected at these points, once in the autumn of 1979 and once in the spring of 1980. The methods by which these data were collected are called "cruise transect" methods because they are similar to timber cruising methods used by foresters. Specific tree-sampling and hydrologic methods are described in subsequent sections. Cruise transect names, locations, altitudes, and sampling distances are given in table 2. The transects did not extend the full width of the flood plain due to unclear flood-plain boundaries, alterations by man, and project time constraints. Supplementary Data I describes the end points of each transect.

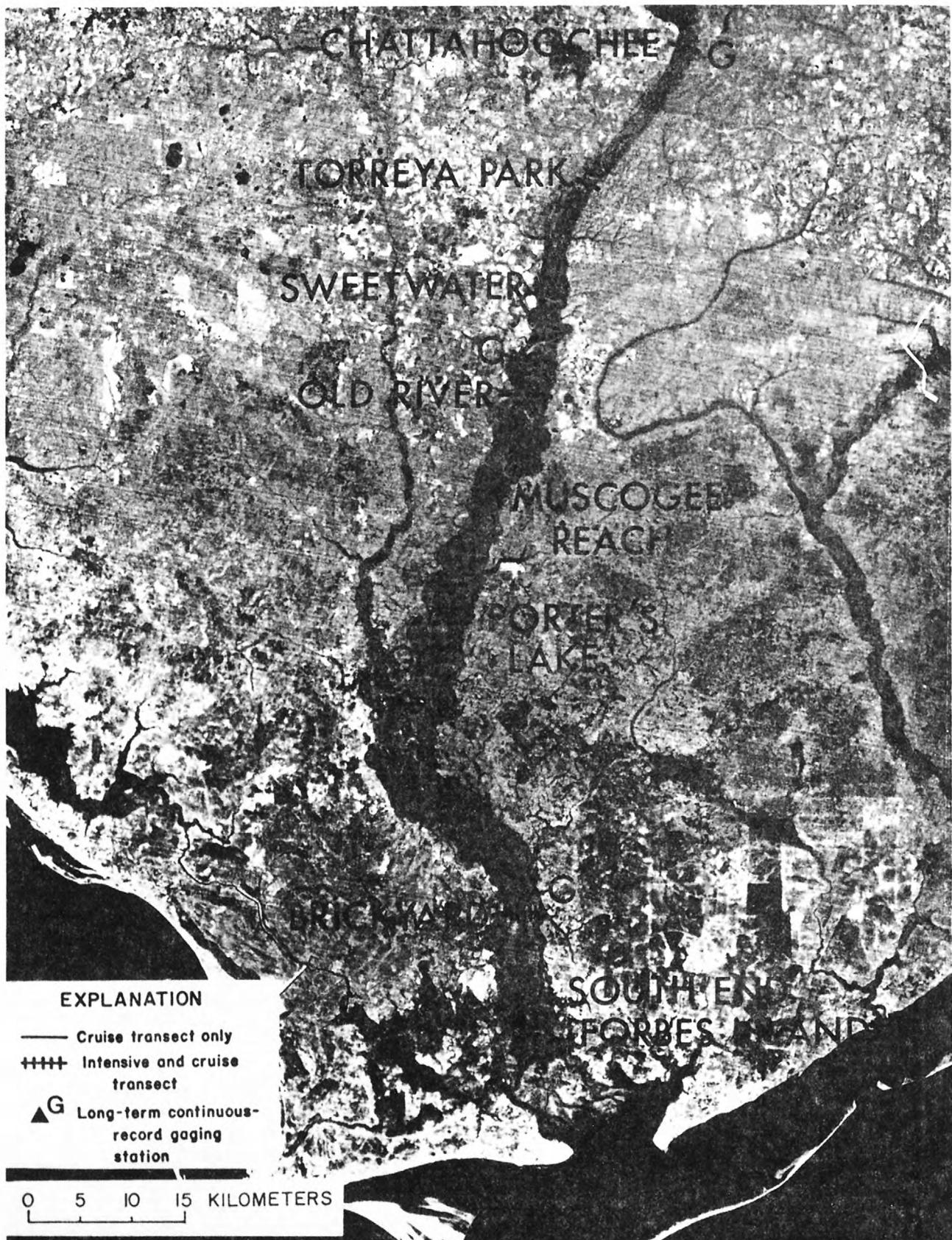


Figure 9.--Apalachicola River showing locations of transects and long-term gaging stations.

Table 2.--Cruise-transect names, locations, altitudes, and sampling distances

Transect name	River location in km	Altitude in meters Minimum, excluding stream-beds	Maximum	Number of sampling points	Length of transect in meters
<u>Upper river</u>					
Chattahoochee	168.5	15.5	20.1	20	1,800
Torreya Park	150.1	14.3	17.9	12	1,100
Sweetwater ^{1/}	138.1	13.5	18.1	27	^{2/} 2,400
<u>Middle river</u>					
Old River	116.5	10.8	15.1	36	3,200
Muscogee Reach	98.0	7.7	11.3	28	2,500
Porter Lake	78.5	5.5	9.5	16	^{3/} 1,500
<u>Lower river</u>					
Brickyard ^{1/}	32.3	0.3	3.5	45	4,100
South end of Forbes Island	20.1	0.5	2.3	39	^{4/} 3,500
Total				223	20,100

^{1/}Sampled by intensive-transect methods also.

^{2/}Water depths and velocities were taken for an additional 730 meters to the west.

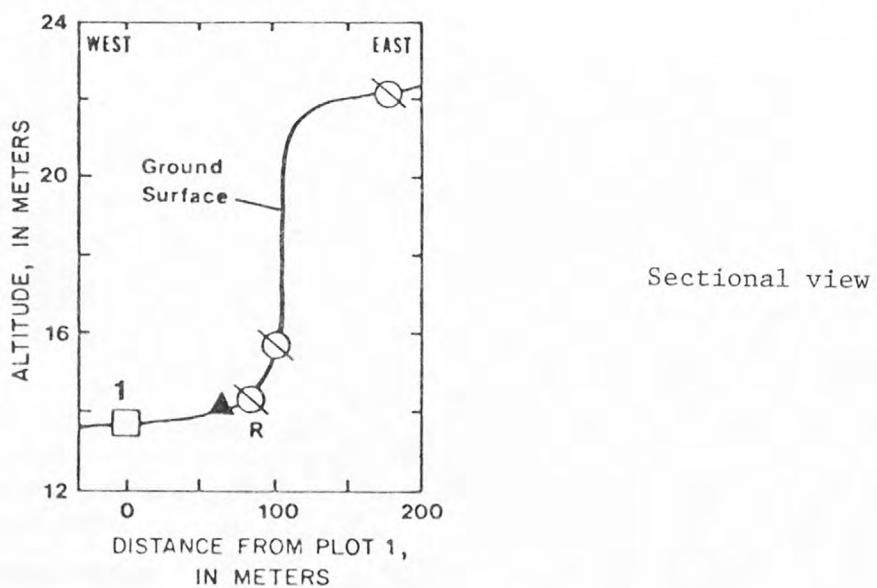
^{3/}An additional 3,300 meters on the east side not sampled due to recent logging.

^{4/}Water depths and velocities were taken for an additional 2,100 meters to the east.

Intensive Transects

At the Sweetwater and Brickyard cruise transects, many additional water and tree observations were made during the 2-year period of investigation. The methods by which these additional data were collected are called "intensive transect" methods because the variety of data and frequency of collection were much greater than those of the cruise-transect methods. Intensive transects were located as close as possible to the long-term gaging stations at Blountstown and Sumatra. Tree and water observations were made at 16 sampling plots of 500 square meters each (7 at Sweetwater and 9 at Brickyard) in addition to the numerous cruise-transect sampling points listed in table 2. Sampling plot design, tree-sampling and hydrologic methods for the intensive transects are described in subsequent sections.

The Sweetwater intensive transect is located about 10.5 kilometers upstream of U.S. Highway 20 bridge near Blountstown. Figure 10 shows the location of sampling plots and hydrologic measuring sites. Immediately east of plot 1, there is a steep bluff rising 45 meters higher than the flood plain. This is part of a continuous steep bluff and ravine system on the east side of the flood plain from Chattahoochee to Bristol. The flood plain from plot 1 to plot 2 is very flat with soft organic mud that is always covered with about a half meter of water. West of this ponded area, the land rises to a high natural levee of firm, sandy loam at plot 4. There are no well defined streams on the east flood plain.



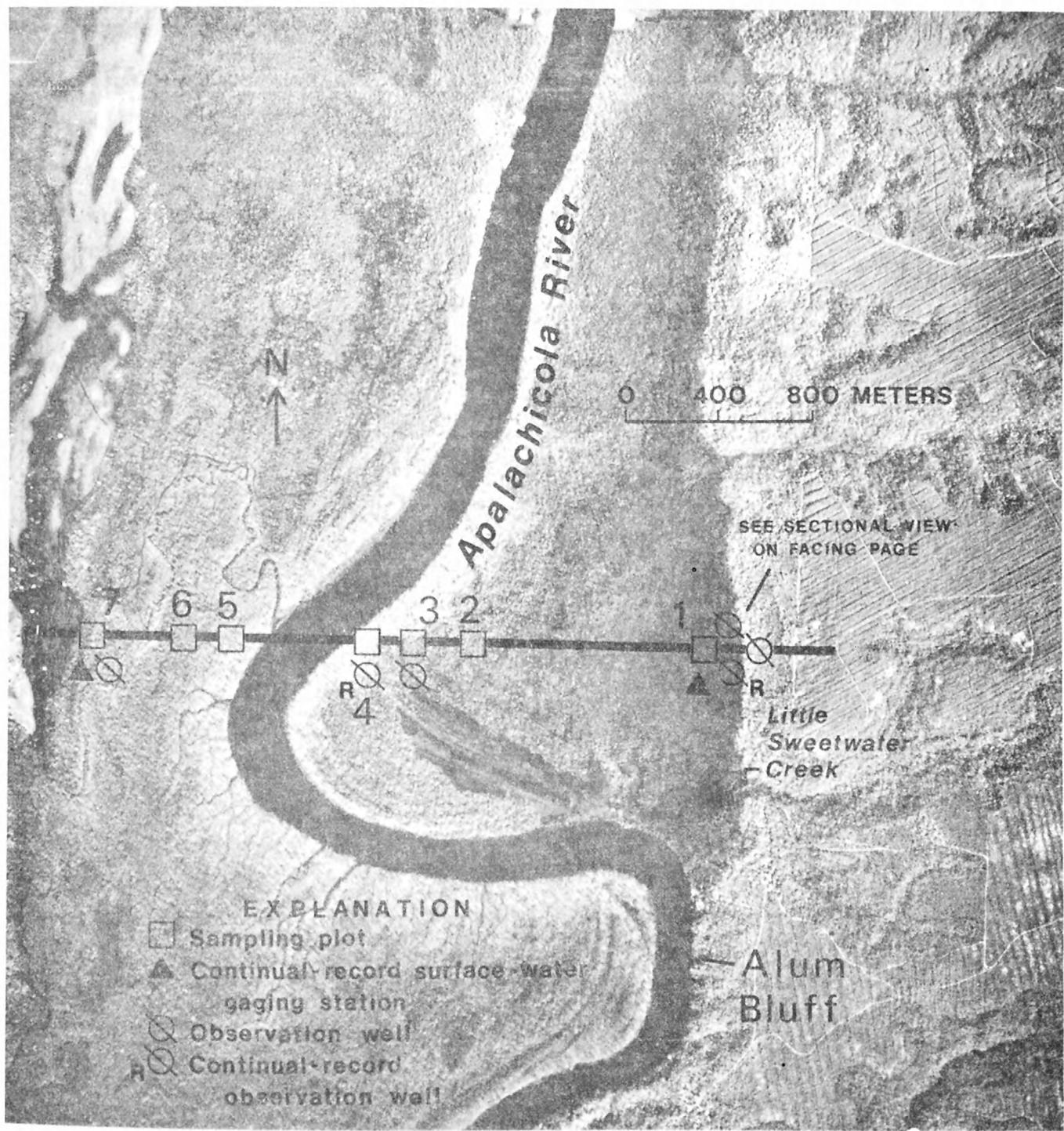


Figure 10.--Sweetwater intensive transect with locations of sampling plots and hydrologic measuring sites.

A stream on the west flood plain begins near the transect at the river bank, flows north, returns to the south and crosses the transect line at plot 7. Plots 5 and 6 have firm, loamy clay soils that are infrequently flooded. Plot 7 is on a low silty stream bank that is frequently flooded. Immediately to the west of plot 7 is a recently cleared brushy area which gradually rises westward to a road that is less than 3 meters above the west flood plain. No plots were located in this area because of the lack of trees; however, discharge measurements were made here during the March and April 1980 flood. The upland region for 3 kilometers west of the transect is 3 to 9 meters higher than the west flood plain.

Figure 11 shows the location of sampling plots and hydrologic measuring sites at the Brickyard intensive transect. The upland to the east ranges from 2 to 4 meters higher than the flood plain. There is no flood plain east of the river. The transect lies parallel to, and about 100 meters south of, the Florida Power Corporation powerline crossing. During powerline construction, trees were cleared from the crossing area but use of earth-moving equipment was limited. Consequently, ground levels in the powerline clearing are not significantly different than the surrounding area and effects of the powerline or its construction on water movement in the flood plain were undetectable.

Brickyard Cutoff and the Brothers River divide this transect into three areas. Sample plots 11, 12, 13, and 14 are between the Apalachicola River and Brickyard Cutoff on Forbes Island. Plots 11 and 14 lie on narrow natural levees surrounding a very large, flat, and muddy area of saturated clays. Between Brickyard Cutoff and the Brothers River the land rises to a firm hummock around nearly every tree or group of trees (fig. 12). The land between hummocks is riddled with shallow sloughs having soupy mud bottoms. Plot 15 is on the east side of a deeper slough 1.2 meters deep during low water) that connects to the Brothers River about 300 meters north of the powerline. The flood plain west of the Brothers River (plots 18 and 19) is mostly flat with clayey muds. The transect ends at a manmade levee. For 5 kilometers west of this levee, ground levels range from 0 to 2 meters higher than the flood plain.

Hydrologic Methods

Surface Water

Gages

Four long-term gages (fig. 9) and four project gages (figs. 10 and 11) within the area of investigation provided stage and discharge information for this report. The gages are listed in table 3 with station name and number, period of record, type of data, and location. Figure 13 shows the project gage in the flood plain at plot 12 of the Brickyard transect during and after the March and April 1980 flood.

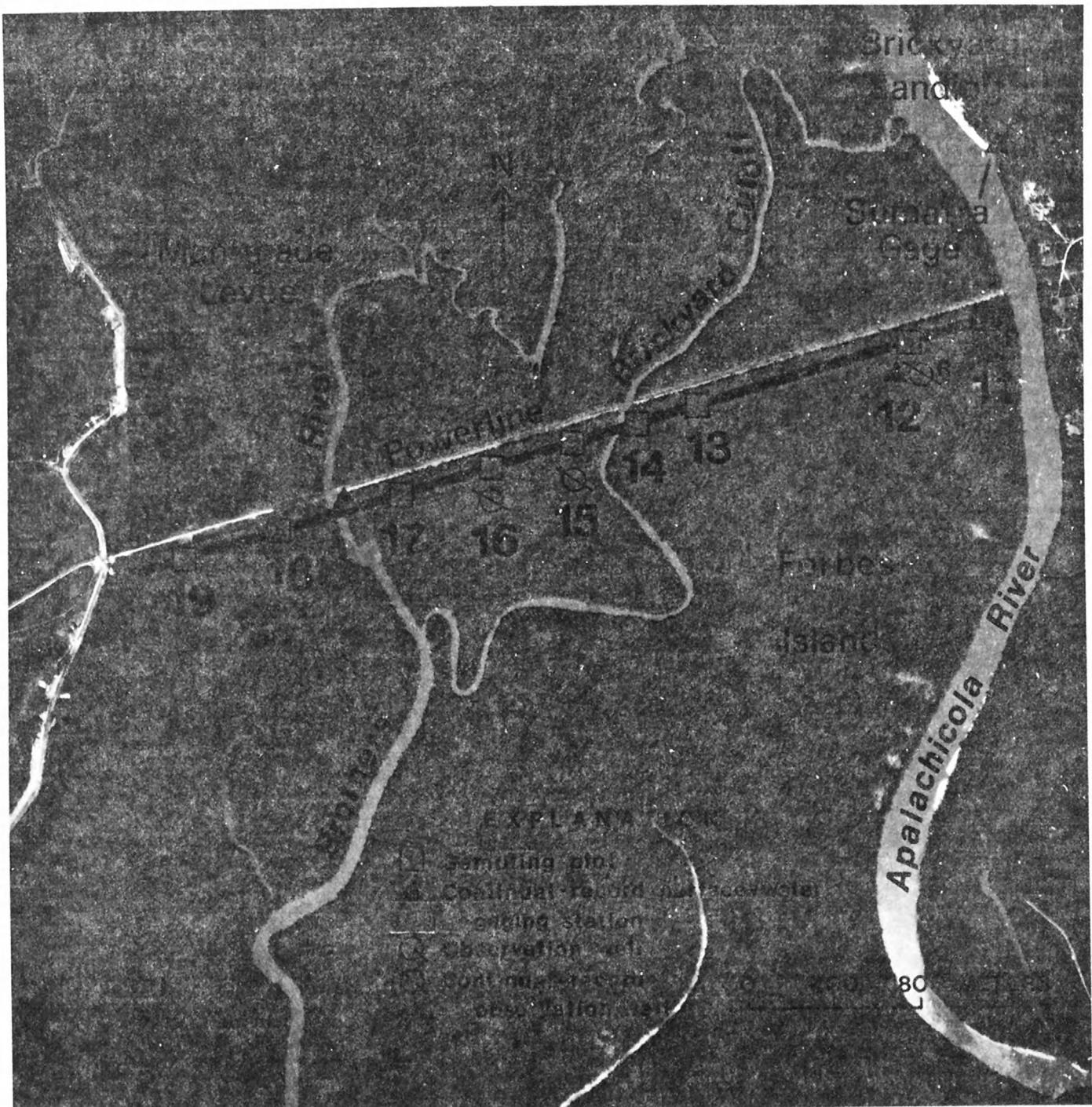


Figure 11.--Brickyard intensive transect with locations of sampling plots and hydrologic measuring sites.



Figure 12.--Clump of trees on a hummock at the
Brickyard transect between Brickyard Cutoff
and Brothers River. This hummock rises about
1 meter above the water surface.

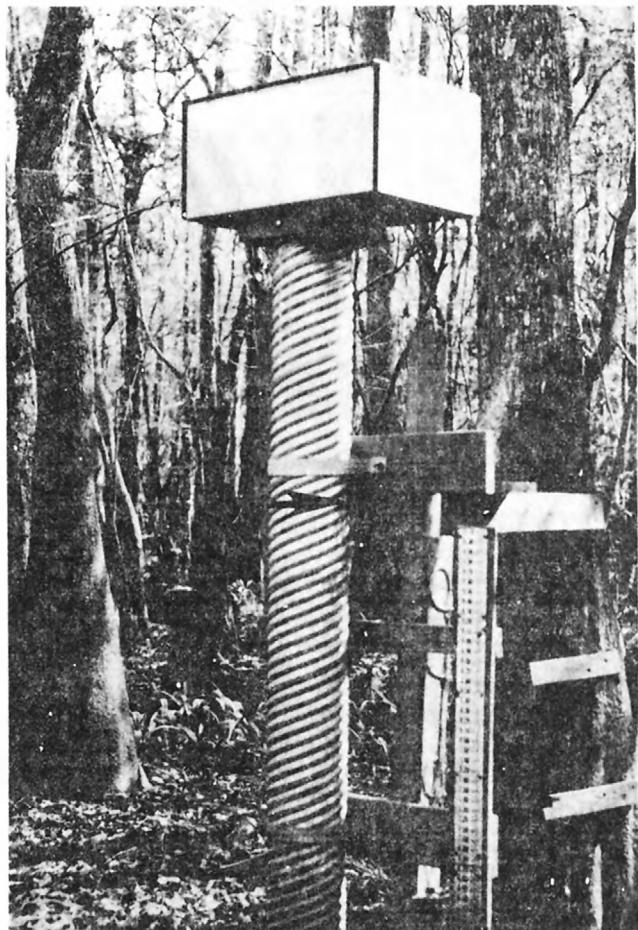
Table 3.--Surface-water gaging stations in investigation area

Station name ¹ and number	Location	Period of record	Type of record
Apalachicola River at Chattahoochee, 02358000	On downstream side of right main pier on U.S. Highway 90, 1.0 km downstream from Jim Woodruff Dam, and 1.6 km west of Chattahoochee.	1928-80	Mean daily discharge
Sweetwater plot 1, 302851084590500	In flood plain near east end of the Sweetwater intensive transect 10.5 km north of Bristol.	09/20/79 to 09/30/80	Mean daily stage
Sweetwater plot 7, 302849085004200	In flood plain near west end of the Sweetwater intensive transect 10.5 km north of Bristol.	10/10/79 to 09/30/80	Mean daily stage
Apalachicola River near Blountstown, 02358700	On the right bank 152 m upstream from Neal Lumber Company Landing, 2.4 km southeast of Blountstown.	1920-57 1958-80	Once daily stage and occasional discharge
Apalachicola River near Wewahitchka, 02358754	On the right bank just above the Chipola Cutoff, 5.5 km east of Wewahitchka.	1965-80	Mean daily stage and occasional discharge
Apalachicola River near Sumatra, 02359170	On left bank at Brickyard Landing, 3.9 km west of Fort Gadsden and 8.5 km southwest of Sumatra.	1950-59 09/09/77 to 09/30/80	Mean daily stage and occasional discharge
Brickyard plot 12, 295621085011500	In flood plain, between Apalach- icola River and Brickyard Cutoff at Brickyard intensive transect.	10/05/79 to 09/30/80	Mean daily stage
Brothers River, 295610085024500	On the left bank of Brothers River about 61 m north of the Brickyard intensive transect.	10/01/79 to 09/30/80	Mean daily stage

¹ Station identification number.



A



B

Figure 13.--Continual-record surface-water gage in the flood plain at plot 12 of the Brickyard transect (a) during the flood of March and April 1980 and (b) during a dry fall season in December 1980. Arrow in photograph B indicates water level during the flood in photograph A.

An effort was made to fill in periods of incomplete or missing record at the long-term gages. Daily discharge for the period 1922-57, at Blountstown, was computed by developing a stage-discharge relation from miscellaneous discharge measurements. The relation is well defined from discharge measurements between 150 and 2,800 m^3/s , and is extended above 2,800 m^3/s using the stage-discharge relation for the period 1958-80. The stage-discharge relation at Wewahitchka is good within bank-full stage. This relation was extrapolated to high flow by step-backwater analysis. From this relation, daily discharge was computed for the period 1965-80. The stage-discharge relation at Sumatra was used to compute the daily discharge for the period 1950-59. For 1959-77, the daily discharge was estimated by adding the daily discharge from the Apalachicola River near Blountstown and the Chipola River near Altha and lagging the total by 3 days. When compared to periods of actual record, daily discharge estimated by this method indicated a correlation coefficient of 0.92.

Flood measurements

During the March and April 1980 flood, repeated discharge measurements were made across the Sweetwater and Brickyard transects. Particular attention was devoted to the sample plots, with detailed visual observations to note any changes in the physical surroundings. Water depth and velocity were measured once during the flood at 90-meter intervals in the flood plain at each cruise transect.

Step-backwater analysis

Stage-discharge relations were available at the four long-term gaging stations on the Apalachicola River before the March flood. During the flood, a partial rating for the Sweetwater transect was developed. In order to develop a rating at the cruise transects, a step-backwater analysis was performed (Shearman, 1976, fig. 2).

The U.S. Geological Survey gage near Sumatra provided the known stage-discharge relation. The U.S. Army Corps of Engineers furnished cross sections for the main channel. Gee and Jenson Engineers, Inc., furnished several flood-plain cross sections in Gulf, Franklin, and part of Liberty Counties. The Florida Department of Transportation furnished cross sections at road crossings. Cross sections for the cruise transects were determined during the flood by measuring from the known water surface to the ground at previously established points. All cross sections were plotted and the distance between each was determined. The roughness coefficient (Mannings "n") was estimated from field observations and aerial photographs.

The step-backwater analysis used to generate the water-surface profiles, employs measured values with the exception of Mannings "n". Estimated "n" values were calibrated by comparing stage-discharge relations for Wewahitchka, Blountstown, and Chattahoochee to the computed profiles (fig. 14). Distribution of flow in the flood plain was checked by comparing velocity observations made in the flood plain during the March flood to the velocities computed by step-backwater analysis in each subarea for which observed velocities were available (fig. 15). The analysis was used to generate stage-discharge and stage velocity relations at the transects. Figure 16 is the final stage-discharge relation for each of the transects after the "n" values were calibrated.

Ground Water

In order to study the relation of ground water and surface water within the intensive transects of the study area, a network of ground-water observation wells was constructed (table 4, fig. 10, fig. 11). Two wells at each intensive transect provided a continual record of water-table fluctuations in response to river-stage changes. Monthly measurements of the water table were made at several additional wells both in and out of the flood plain at both transects.

Tree Sampling

An accurate characterization of tree species at each intensive-transect plot was necessary to correlate with the detailed hydrologic information collected. To determine the appropriate plot size, a nested-plot test was conducted at each transect. The purpose of a nested-plot test was to determine the smallest area on which the species composition of the forest type in question was adequately represented (Mueller-Dombois and Ellenberg, 1974, p. 47-50). As a result of these tests, 500 square meters was estimated as the optimum plot size. Forest types apparent on aerial photographs were located and checked in the field. At least one 500-square-meter plot was located in each forest type and plot boundaries were marked with string. Seven plots were located at the Sweetwater transect and nine at the Brickyard transect (figs. 10 and 11). The genus, species, diameter, and crown class of each tree, 75 millimeters or greater in diameter, were recorded for each plot. Nomenclature follows Kurz and Godfrey (1962). Diameters were measured at breast height, 1.4 meters above ground. Buttressed, forked, or deformed trees were measured according to Avery (1967, p. 74). Trees less than 75 millimeters in diameter were not measured because they did not meet the minimum dimensions of a tree according to Kurz and Godfrey (1962, p. XIV). Four crown classes (dominant, codominant, intermediate, and overtopped) were used as defined by Avery (1967, p. 212).

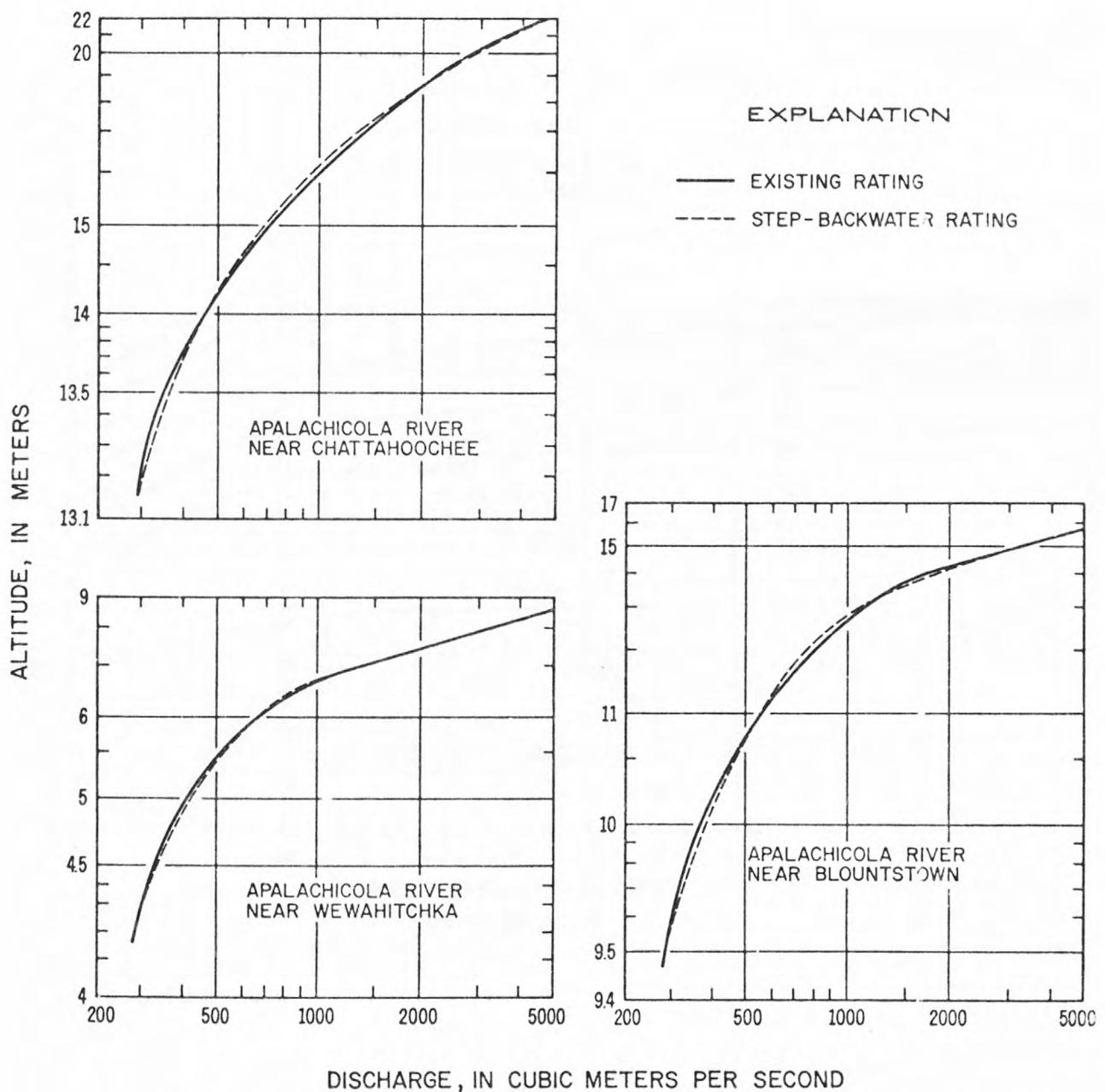


Figure 14.--Relation between step-backwater rating and current-meter rating at Chattahoochee, Blountstown, and Wewahitchka.

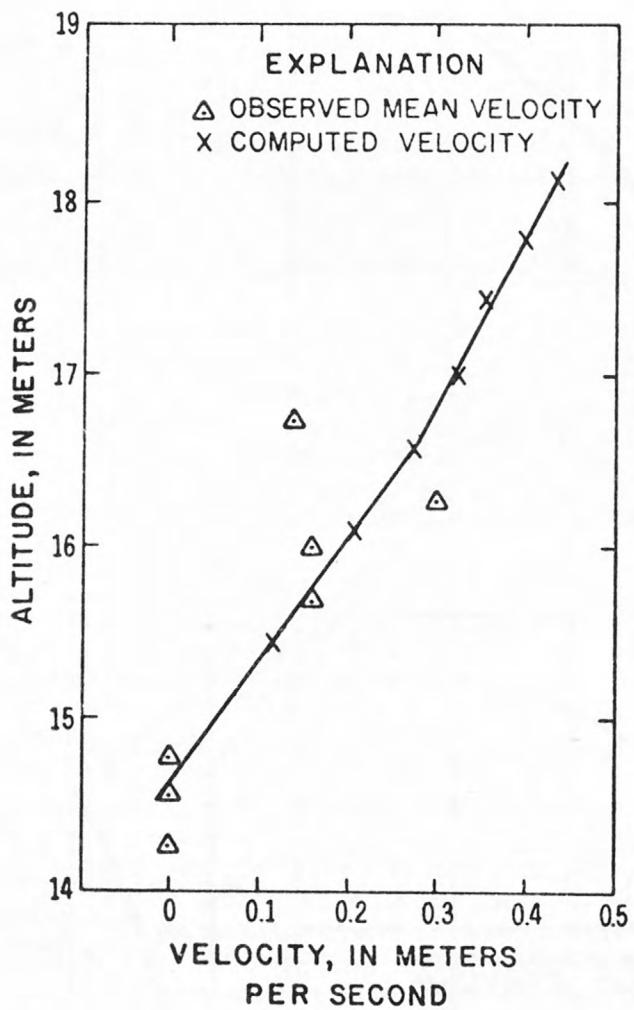


Figure 15.--Typical relation between computed and observed flood-plain velocities. Measurements shown were taken on the west flood plain of the Sweetwater transect.

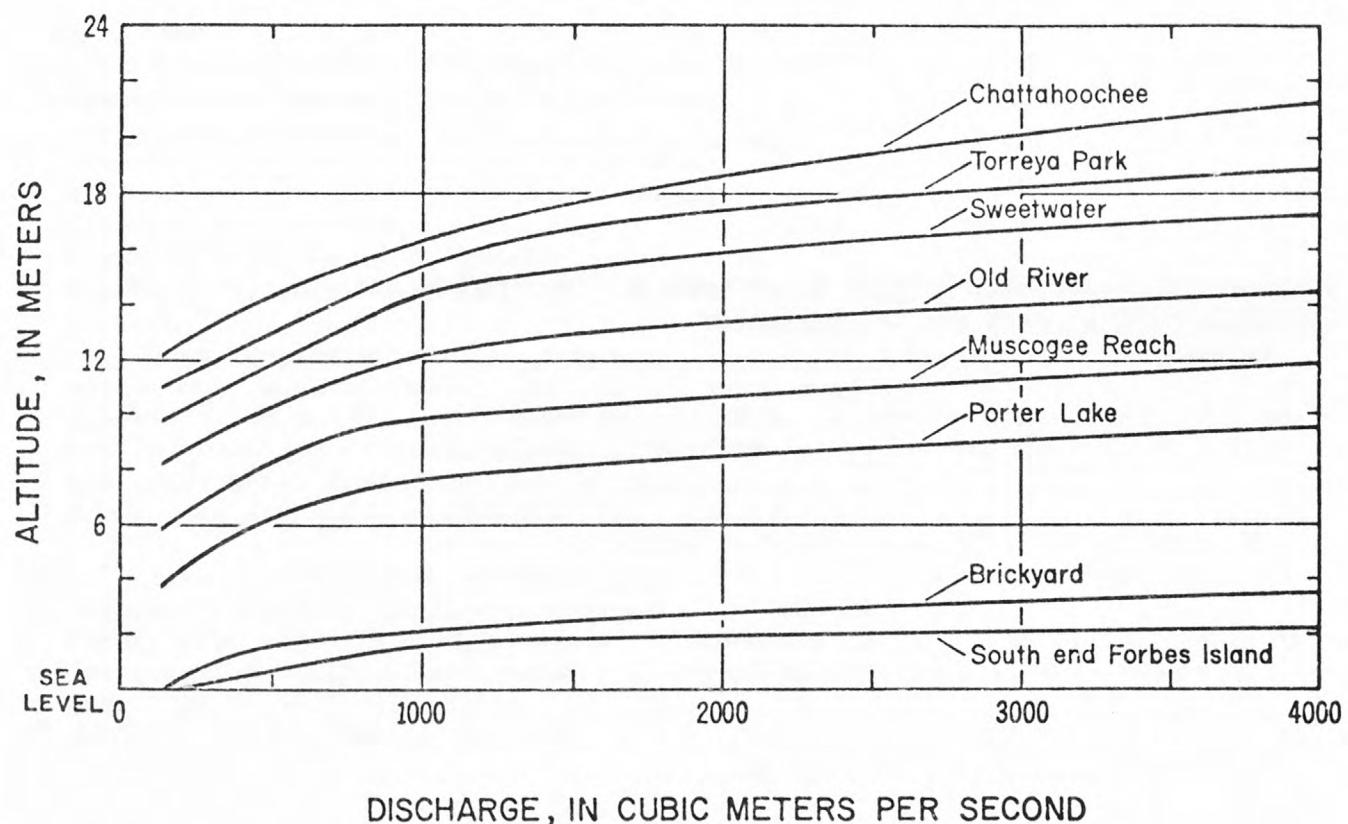


Figure 16.--Stage-discharge relations at the cruise transects.

Table 4.--Ground-water wells at the intensive transects during the 1980 water year

Location	Type of record	Altitude of land surface, in meters	Depth of well below land surface, in meters
About 170 meters east of plot 1, on upland at east end of Sweetwater transect.	Monthly	22	4.6
About 100 meters east of plot 1, at base of steep bank at east end of Sweetwater transect.	Monthly	16	0.5
About 80 meters east of plot 1, in flood plain at east end of Sweetwater transect.	Mean daily	14	4.0
At plot 3 on Sweetwater transect, about 30 meters west of permanent pond covering most of the east flood plain.	Monthly	15	2.7
At plot 4 on Sweetwater transect, about 120 meters east of Apalachicola River.	Mean daily	15	4.6
At plot 7 on west end of Sweetwater transect, in a flood-plain stream.	Monthly	14	2.4
At Brickyard Landing, about 60 meters east of Apalachicola River and 15 meters north of landing road.	Monthly	4.3	4.3
Near plot 11 on Brickyard transect, on the natural riverbank levee about 30 meters west of the Apalachicola River.	Mean daily	1.7	1.8
At plot 12 on Brickyard transect, in the interior of Forbes Island.	Mean daily	1.1	2.4
At plot 15 on Brickyard transect, near a slough between Brickyard Cutoff and Brothers River.	Monthly	0.6	3.7
At plot 16 on Brickyard transect, between Brickyard Cutoff and Brothers River about 300 meters west of plot 15.	Monthly	0.9	3.7

Cruise transects were sampled at 90-meter intervals by the point-sampling method. Distances were measured by pacing and a compass was used to determine direction. The tree nearest each point was marked with double flagging and the transect line between each point was marked with single flagging. Sampling at each point was done with a glass wedge prism (Avery, 1967, p. 165-183; Kulow, 1965). Prism sampling is more efficient than plot sampling when characterizing the significant species over a very large area because the largest trees and most frequently occurring trees are sampled much more than the small and uncommon trees. Genus, species, diameter, and crown class were recorded for each tree. One important difference between the plot and point methods was the minimum diameter. Plot sampling measured only those trees 75 millimeters or greater in diameter. No minimum diameter limit was used for point sampling.

Upon completion of tree sampling, basal area (cross-sectional stem area) and density (number of trees) were calculated for each tree species at each plot and point (Avery, 1967). Relative basal area and density were also calculated. Relative basal area is the percentage of the total basal area comprised by each species. Relative density is the percentage of total density comprised by each species.

Tree species were grouped into five forest types designated A through E based on species predominance by basal area, using a method of classifying vegetation that is similar to the tabular comparison method described by Mueller-Dombois and Ellenberg (1974, p. 177-210). "Forest Cover Types of United States and Canada" (Eyre, 1980) was used as a guide for naming the types.

Water and Tree Relations

For each of the 223 cruise-transect points, nine hydrologic parameters in three general categories were quantified (table 5). Depth of water was measured during both dry and flooded conditions. Duration of inundation and saturation in the flood plain was estimated with six different parameters. Velocity was measured only during flooded conditions. Water parameters at each cruise-transect point were grouped by forest type to determine the relation between tree communities and water regimes.

Table 5.--The nine water parameters and the general hydrologic factors with which each is associated

Water parameter	General hydrologic factor
Fall-season depth	Depth of water Flood depth
Percent inundation estimated from river stage record	Duration of inundation and saturation (amount of time, in percent or number of consecutive days, that the soil is inundated or saturated.)
Observed percent inundation	
Percent saturation	
Consecutive days of inundation estimated from river stage record	
Observed consecutive days of inundation	
Consecutive days of saturation	
Velocity	Velocity

Depth of Water

Fall-season depth

Fall-season depth is the water present at each cruise-transect point during the low-water or drier period of the year. If standing water was present, the water depth was reported as a negative number (that is, $-1.0 = 1$ meter deep). If no standing water was present, soil moisture was judged by appearance on the surface as dry, damp, or saturated. According to Frevert and others (1955, p. 90-92), when the soil appears saturated, all pore space is filled with water and the soil moisture potential is zero. Damp soils are between field capacity and wilting point. Soils that appear dry have reached or surpassed the wilting point. Fall-season depth at each site was observed in November and early December 1979. Rainfall was negligible during that period, but minor flooding was a problem in late November and early December in the lower river. Therefore, fall-season depth observations were repeated at some locations in the fall of 1980.

Flood depth

Flood depth is the depth of water at each cruise-transect point during the 2-year (0.5 probability), 1-day high (1958-80). The 2-year, 1-day high was used because it is the average annual flood. Water depths are reported as negative numbers. If a point remained dry during

the 2-year, 1-day high, the distance of the ground above the water level of the 2-year, 1-day high is reported as a positive number. The following steps were taken to obtain these depths. Water depths at each point were taken on various dates during the March and April 1980 flood when river stage was high enough to assume a level water surface across the flood plain. Distance to the water surface was measured from one reference point at each transect on the same day that depths were taken. Altitude of the reference point was determined by surveying from benchmarks. Water depths were then subtracted from the altitude of the water surface to obtain the altitude of the ground at each point. Frequency analyses were performed on long-term gage record (1958-80) to determine the discharge of the 2-year, 1-day high. Rating curves developed by the step-backwater analysis were used to determine the altitude of the 2-year, 1-day high at each transect. Altitudes of the ground at each point were subtracted from altitudes of the 2-year, 1-day high at each transect to obtain flood depths.

Duration of Inundation and Saturation

Percentage of inundation and saturation

Percentage of inundation estimated from river-stage record--Percentage of inundation estimated from river-stage record is the total percentage of time from 1958 to 1980 that river stage equaled or exceeded the ground level of each cruise transect point. This parameter is derived from stage-duration curves at the cruise transects which were interpolated from 1958-80 flow-duration curves at Chattahoochee, Blountstown, and Sumatra and from 1965-80 curves at Wewahitchka through the use of stage-discharge rating curves. This parameter is known to be unrepresentative at some locations because of differences in stage between the river and flood plain where flow between the two is retarded by natural levees or other features. Duration of inundation in the flood plain, therefore, may be shorter or longer than the duration of flooding above a given stage in the river. Despite its inadequacies, river-stage record is the only information available on most rivers for estimating duration of inundation in the flood plain. Therefore, estimates based on river-stage record are presented in this report, along with more accurate estimates, to illustrate their varying usefulness in different situations in the flood plain and to allow possible applications of the results of this report to other southeastern rivers.

Observed percentage of inundation--This is the estimated percentage of time from 1958 to 1980 that the water level in the flood plain equaled or exceeded the ground level of each cruise transect point. It more closely approximates actual flood-plain inundation than

the estimate from river-stage record. To obtain this estimate, percentage of inundation estimated from river-stage record was adjusted based on the following assumptions and observations:

1. At the Sweetwater and Brickyard transects, daily and monthly hydrographs for the 1980 water year comparing river stage and flood-plain water levels were used to estimate long-term duration of inundation in the flood plain. Daily hydrographs were constructed from continual record at the project gage locations (figs. 10 and 11). Monthly hydrographs were constructed from monthly observations at all sampling plots without gages.
2. Field notes in both the autumn and the spring indicated that the river-stage and flood-plain water-level relations found at the intensive transects also existed at many other cruise transect locations.
3. Fall-season depths at every point were used as an indicator of duration. It was assumed that if water was present during the dry period of the year, it was present all the time (1958-80).
4. If topographic maps showed many sloughs or creeks connecting directly to the river, it was assumed that water-level fluctuations in that well-drained area of the flood plain closely approximated river-stage fluctuations.

Percentage of saturation.--This is the estimated percentage of time from 1958 to 1980 that the soil at each cruise transect point was saturated. To obtain this estimate, the observed percentage of inundation was raised or left the same based primarily on fall-season depth observations. It was assumed that if the soil was saturated during the dry period of the year, it was saturated all the time.

Days of inundation and saturation

The three remaining duration parameters specify the number of consecutive days that water stands at or above the ground level of each cruise-transect point. These parameters were derived from a frequency analysis of discharge that departed from established methods. The standard method of frequency analysis of stream discharge for various time intervals relies on the annual maximum (or minimum) mean discharge for a specified number of consecutive days. With this method, discharges for individual days during the period fall above and below the mean. This is not satisfactory for the purpose at hand because if water levels fall below the ground level of a cruise-transect point, the soil can dry out and allow oxygenation of tree roots.

Consequently, in this report frequency analyses are related to "threshold" discharges which are equaled or exceeded for the specified periods. "Threshold discharge" is defined as the minimum discharge occurring during a specified period of consecutive days. This concept allows one to define a discharge which is equaled or exceeded on all days during the consecutive-day period. For example, the "30-day threshold discharge" would be the minimum discharge occurring during a period of 30 consecutive days, or the discharge which was equaled or exceeded on all days of the 30-day period. By examining all possible 30-day periods during a year, the largest 30-day threshold discharge can be determined, and this discharge is defined as the "30-day maximum threshold discharge." This discharge represents the largest discharge which was equaled or exceeded for 30 consecutive days during the year. Similarly, this concept can be applied to any other consecutive day period, such as a 3-day, 7-day, or 15-day period. The maximum threshold discharge can be converted to a water level by using a stage-discharge relation.

The 30-day maximum threshold discharge is compared to the 30-day maximum mean discharge at Blountstown during the 1980 water year (fig. 17). The 30-day maximum mean discharge is $2,300 \text{ m}^3/\text{s}$, whereas the 30-day maximum threshold discharge of $1,800 \text{ m}^3/\text{s}$ is the highest discharge that was equaled or exceeded for 30 consecutive days during the 1980 water year.

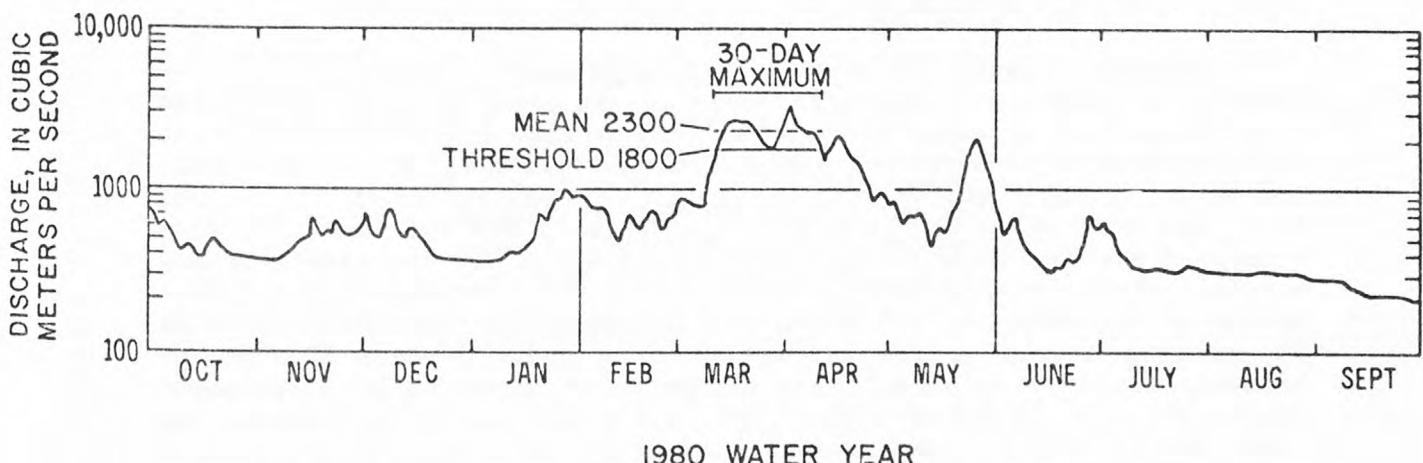


Figure 17.--Thirty-day maximum mean discharge and 30-day threshold discharge for 1980 water year at Blountstown.

The maximum threshold discharge for various time intervals (1, 7, 30, 60, 90, 120, 183, and 365 consecutive days) was determined from hydrographs for each of the water years 1958-80 at the Chattahoochee, Blountstown, and Sumatra gages and 1965-80 at the Wewahitchka gage. A log-Pearson Type III frequency analysis (U.S. Water Resources Council, 1977) was performed for each of the time intervals. From this array of frequency curves a relation between discharge and time intervals was established for a 2-year recurrence interval (0.5 probability) for each of the long-term gages. By interpolation of the long-term gage data, similar relations were established for each transect. Stage-discharge relations developed by the step-backwater process were available for converting the discharge-time interval relation to a river stage-time interval relation for the 2-year recurrence interval for each transect.

Flooding during the dormant season usually has no effect on trees (Hall and Smith, 1955, p. 283-284; McAlpine, 1961, p. 567; Yelenosky, 1964, p. 140). The average growing season for the Apalachicola River is approximately 265 days from March 1 through November 21 (J. R. Gallup, National Weather Service, Auburn, Ala.; oral commun., 1980); therefore, days of flooding from November 22 to February 28 are not important to tree growth and survival. Consequently, maximum threshold discharges and stage-time interval relations were determined for each transect for the growing season in the manner previously described for complete water years. The stage-time interval relation for the 2-year recurrence interval at Sweetwater transect is shown in figure 18 for both the complete water year and the 265-day growing season. Water parameters following in this section use only the growing season relations.

Consecutive days of inundation estimated from river-stage record.-- This is the number of consecutive days in the growing season that river stage equaled or exceeded the ground level of each cruise-transect point on an average of once every 2 years from 1958 to 1980. To estimate this parameter at each cruise-transect point, the altitude of the ground level was located on the left axis in figure 18 and the number of days inundated was read from the growing season curve. In the example shown by the dashed lines, a cruise-transect point at the Sweetwater transect having an altitude of 14.6 meters was inundated 20 consecutive days in the growing season on the average of once every 2 years (0.5 probability) from 1958 to 1980. This parameter is known to be unrepresentative at some locations because of differences in stage between the river and flood plain where flow between the two is retarded by natural levees or other features. Days of inundation in the flood plain, therefore, may be more or less than the days of flooding above a given stage in the river.

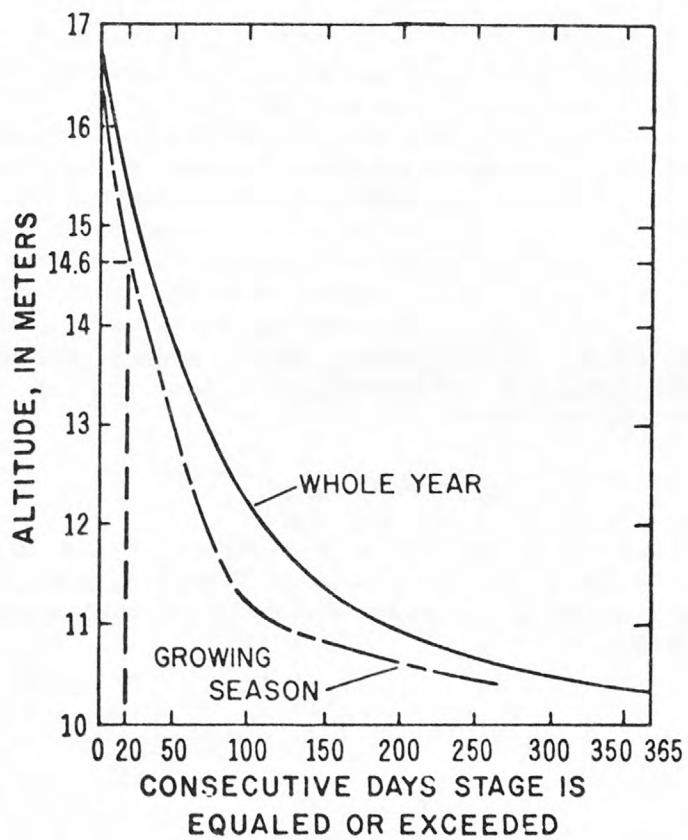


Figure 18.--Relation between stage and time intervals for whole year and growing season for 2-year recurrence interval at Sweetwater transect.

Observed consecutive days of inundation.--This is the estimated number of consecutive days in the growing season that the water level in the flood plain equaled or exceeded the ground level of each cruise-transect point on an average of once every 2 years from 1958 to 1980. It more closely approximates consecutive days of inundation at each point than the river-stage estimate just described. To obtain this value, consecutive days of inundation estimated from river-stage record were adjusted based on combinations of the four assumptions and observations described for "observed percent inundation."

Consecutive days of saturation.--This is the estimated number of consecutive days in the growing season that the soil at each cruise-transect point was saturated on an average of once every 2 years from 1958 to 1980. To obtain this estimate, the observed consecutive days of inundation were increased or left the same based primarily on fall-season-depth observations.

Velocity

Velocity is the mean velocity at the 2-year, 1-day high (1958-80), for the subsection in which each cruise-transect point falls. This parameter was derived from the stage-velocity relations produced by the step-backwater analysis.

RESULTS AND DISCUSSION

Hydrology

Surface Water

Analysis of long-term record

Stage and discharge records from 1929 to 1979 at the Chattahoochee gage were studied to determine if there had been any significant hydrologic changes as a result of regulation by dams. Although the 16 dams on the Apalachicola, Chattahoochee, and Flint Rivers (fig. 6) were constructed at various times from 1834 to 1975, filling of both the largest reservoir, Lake Sidney Lanier, and the reservoir closest to the area of investigation, Lake Seminole, was completed in 1957 (table 1). The second and third largest reservoirs were filled in 1975 and 1963, respectively. Thus, 1929 to 1957 and 1958 to 1979 were the periods of record chosen for comparison.

Average annual flow at Chattahoochee from 1958 to 1979 was 15 percent greater than from 1929 to 1957. Mean daily discharges for the two periods were different at a 0.01 level of significance. Average annual

flow of several other rivers in Florida, Georgia, and Alabama compared to Chattahoochee flow (table 6) indicates that the increase in flow is probably due to greater rainfall over the three-state area during the later period. Average flow was higher in 1958-78 than in 1937-57 for all streams investigated, the increase ranging from 6 percent for the Choctawhatchee River on the west side of the Apalachicola River basin to 38 percent for the combined flow of the Suwannee, Withlacoochee, and Alapaha Rivers to the east. Increases of the Apalachicola, Chattahoochee, and Flint Rivers were between these two extremes, ranging from 13 percent for the Flint River at Albany to 18 percent for the Chattahoochee River at Columbus.

Table 6.--Mean annual discharge of several rivers in Florida, Georgia, and Alabama, 1937-57 and 1958-78

Gaging station	Size of drainage basin, in km ²	Mean annual discharge, in m ³ /s	1937-57	1958-78	Difference, in percent
Chattahoochee River at Atlanta, Ga.	3,760	67.6	79		+17
Chattahoochee River at Columbus, Ga.	12,100	177	209		+18
Flint River at Albany, Ga.	13,800	167	189		+13
Apalachicola River at Chattahoochee, Fla.	44,500	591	692		+17
Escambia River at Century, Fla.	9,890	171	186		+ 9
Choctawhatchee River at Caryville, Fla.	9,060	155	164		+ 6
Suwannee River at White Springs, Fla.	6,290	44.5	64.1		+44
Suwannee River at ¹ Ellaville, Fla.	18,100	156	216		+38

¹Majority of flow is from the Withlacoochee and Alapaha Rivers.

At Chattahoochee, the distribution of average annual flow of the 1929-57 and 1958-79 periods was similar throughout the year, as shown by the average monthly flows in figure 19. The flow of the more recent period was appreciably higher in all months except July. Effects of seasonal regulation by dams upstream of Jim Woodruff Dam (storing flood waters in the spring and releasing them in the fall) were not apparent in this analysis of average monthly flows.

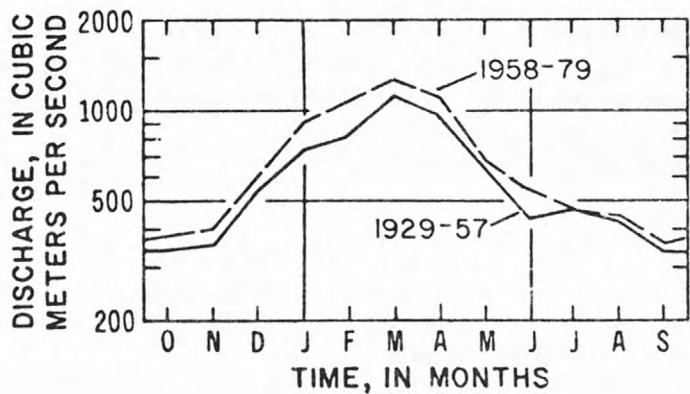


Figure 19.--Average monthly flows at Chattahoochee, 1929-57 and 1958-79.

Flow and stage-duration curves at Chattahoochee are shown in figure 20. The flow-duration curve is somewhat flatter for the period 1958-80, possibly indicating the effects of regulation by dams. Although flow in the latter period is higher, stages in the latter period are lower than in the earlier period due to physical changes in the channel. Analyses at the Blountstown gage indicate that the 1958-80 flow duration curve is flatter and higher than that of 1922-57, similar to the curves at Chattahoochee in figure 20. However, physical changes in the channel at Blountstown are probably not as pronounced as at Chattahoochee because there is very little difference in the stage duration curves for the two periods at Blountstown. Stage duration is used almost exclusively in analyses of water and tree relations in this report.

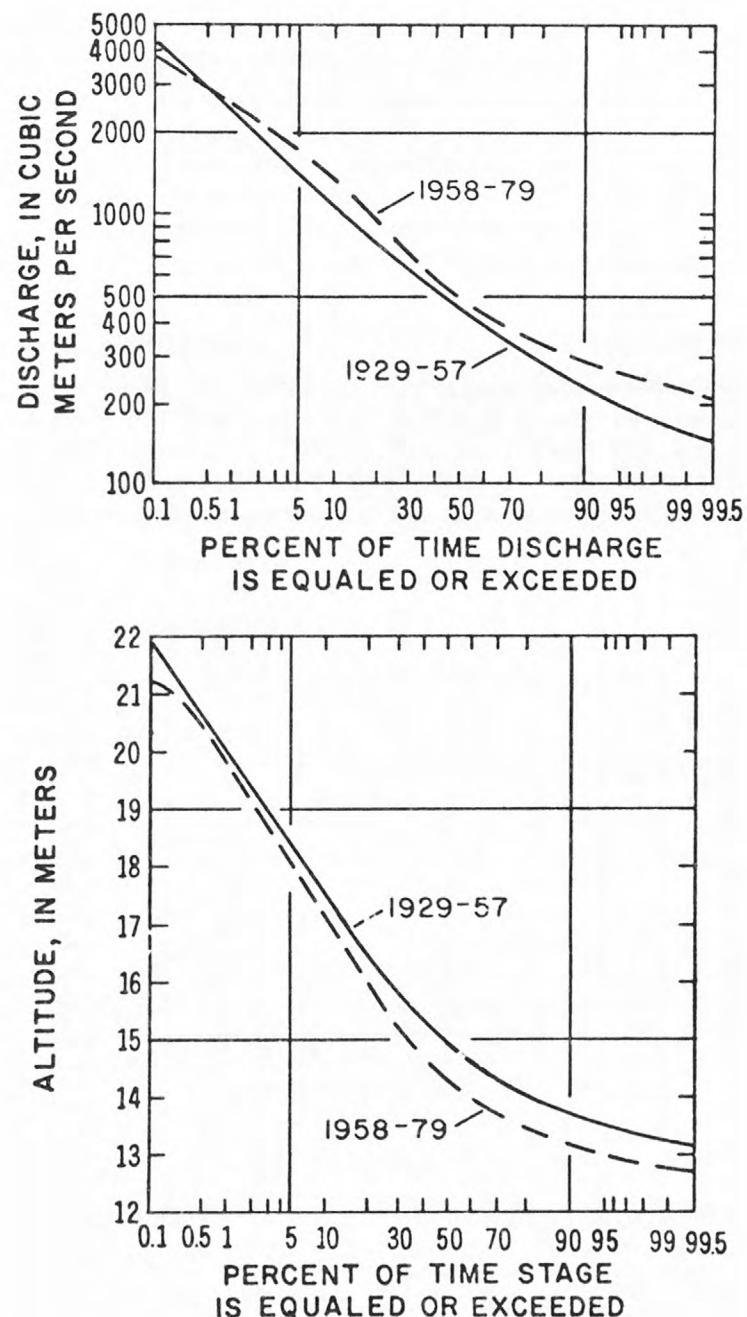


Figure 20.--Flow and stage duration at Chattahoochee, 1929-57 and 1958-79.

To describe long-term hydrologic conditions at the cruise transects, it was necessary to extrapolate between long-term gaging stations with similar periods of record. Inadequate record at the Wewahitchka and Sumatra gages prior to 1958 precluded the use of pre-1958 record for this investigation. A 23-year period of record from 1958 to 1980 at Chattahoochee, Blountstown, and Sumatra gages and a 16-year period of record from 1965 to 1980 at the Wewahitchka gage were chosen to develop depth, duration, and velocity parameters for relating to forest types. Since stage durations for 1922-57 and 1958-80 are very similar at the Blountstown gage, differences between the two periods with respect to tree growth are probably insignificant.

The 1980 water year

The total flow of the Apalachicola River at Blountstown during the 1980 water year was slightly greater than the average for 1958-80. The 1980 flow averaged $759 \text{ m}^3/\text{s}$ compared to $700 \text{ m}^3/\text{s}$ for 1958-80. However, the seasonal distribution of the 1980 flow differed considerably from the pattern of the long-term average as shown in figure 21.

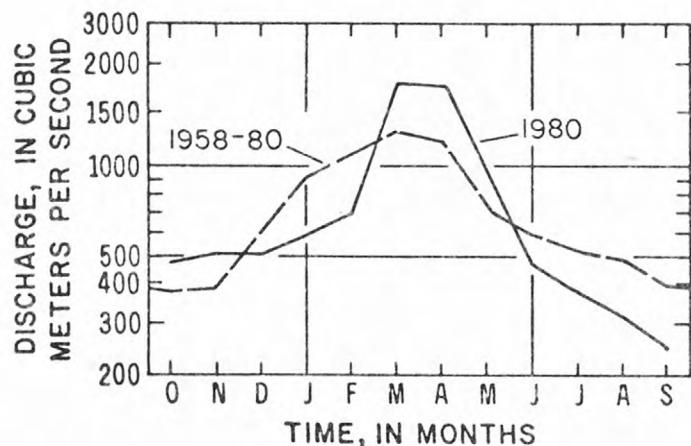


Figure 21.--Mean monthly flows of the 1980 water year compared with that of 1958-80 record at Blountstown.

Table 7 shows that for time periods ranging from 1 to 365 days, recurrence intervals of maximum mean discharges of the 1980 water year were consistently greater than 2 years (0.5 probability). Recurrence intervals of 1980 discharges ranged from 4 to 10 years for all the selected time periods except 30 days. The 25-year recurrence interval for the 30-day maximum mean discharge resulted from the prolonged high flood of March and April 1980. The concentration of flow in the high range is also evident by the stage-duration curve for 1980 when it is compared with the curve for 1958-80 as shown in figure 22.

Table 7.--Maximum mean discharge of Apalachicola River at Blountstown for specified time periods of 1980 water year, with approximate recurrence intervals

Number of consecutive days	1980 maximum mean discharge in m^3/s	Approximate recurrence interval in years
1	3,460	4
15	2,430	5
30	2,410	25
60	1,860	10
90	1,560	7
183	1,070	4
365	759	4

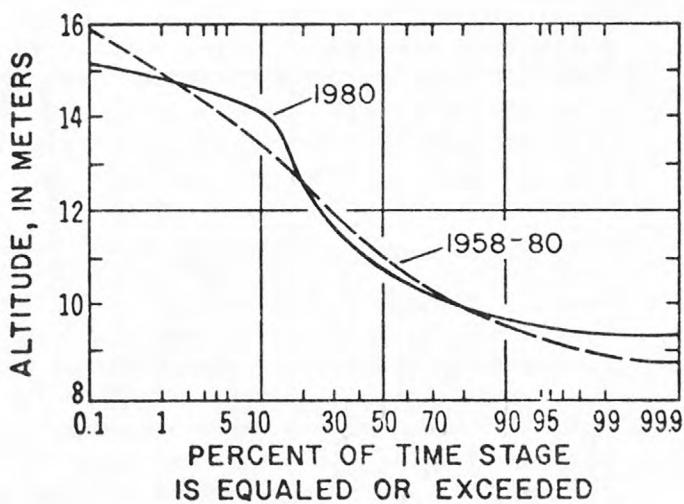


Figure 22.--Percent stage duration for the 1980 water year compared with that of 1958-80 record at Blountstown.

River and flood-plain relations at the intensive transects

At both the Sweetwater and Brickyard transects, river and flood-plain hydrographs reflect the influence of the natural riverbank levees. The effects of the levees vary with each location. At Sweetwater plot 1, the levees help to pond water in the flood plain. At Brickyard plot 12, the levees keep water from the main channel out of the flood plain until they are overtopped by high stages.

The hydrographs in figure 23 compare surface-water levels at Sweetwater plots 1 and 7 to river stage at the Sweetwater intensive transect. The plot 1 gage is located on the eastern edge of a large permanent pond on the east side of the flood plain with water standing at an altitude of about 14 meters. This part of the flood plain is not affected by flooding until the river stage reaches at least 14 meters in altitude. Above this altitude, flood-plain water levels react much the same as river stage.

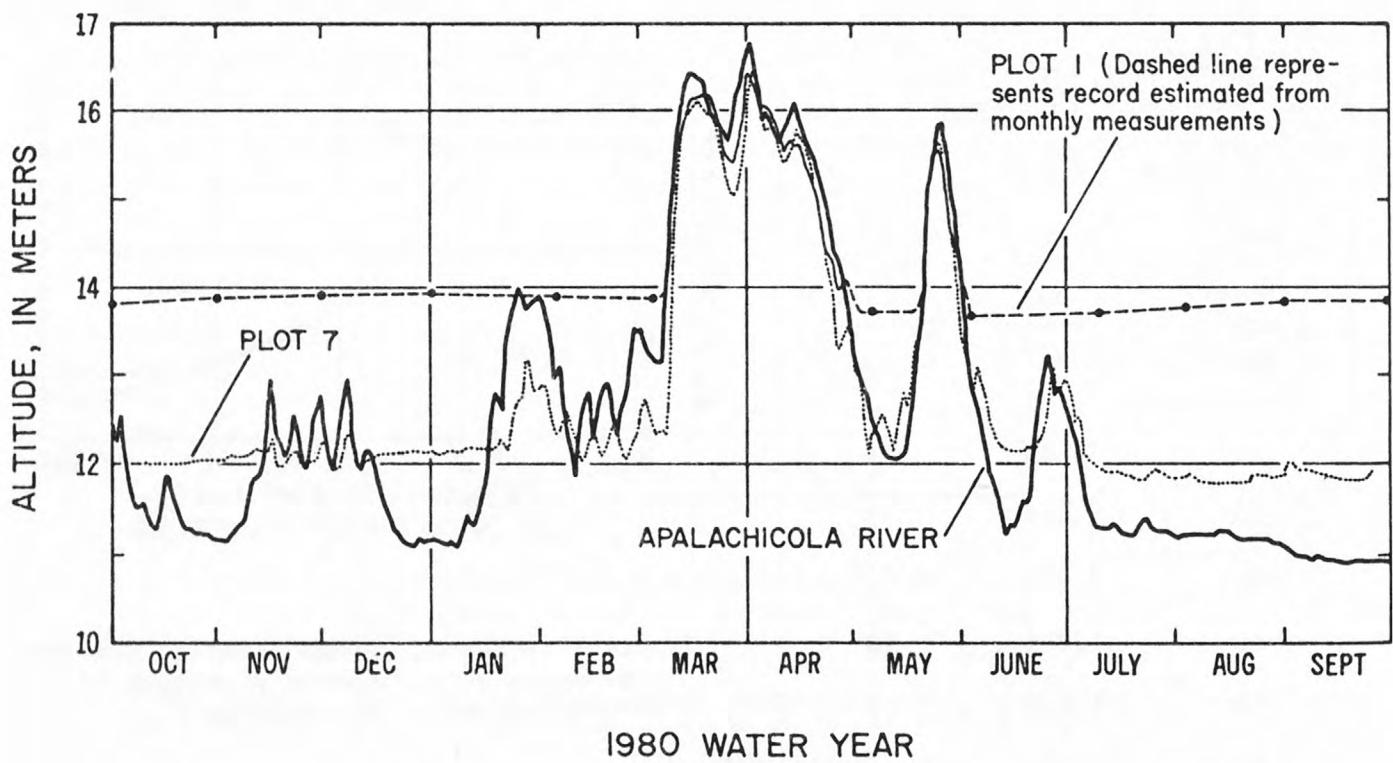


Figure 23.--River stage and flood-plain water levels for the 1980 water year at Sweetwater transect.

The plot 7 gage is on the west side of the flood plain and the site is well-drained by established channels. The area between plot 7 and the Apalachicola River is fairly high with only a few depressions. The plot 7 hydrograph follows the river-stage hydrograph during the peak flooding period in March and April. The west bank levee was inundated in this flood but the peaks do not match because plot 7 is located slightly downstream of the reference point for the river. The effects of the levee are evident at lower stages on short-duration peaks. During minor flood peaks in late November and early December, and again in January and February, the damming effect of the levee prevented water levels in the flood plain from reaching an equilibrium with the river. During low water in July, August, and September, water was ponded at a level almost 1 meter above river stage and fluctuated slightly in response to local rainfall.

The hydrographs in figure 24 show the relation between the main river stage at Sumatra and flood-plain water levels at plot 12 and Brothers River at the Brickyard intensive transect. The peaks do not match exactly because the Sumatra gage is 760 meters upstream of the transect. At most river stages, the levees cause river stage to be higher than the flood-plain ground level with no standing water present on the flood-plain floor. As the flood waters rise, the levees are overtopped, with the result that the water surface is uniform across the entire flood corridor. As the flood wave passes and the water levels start to recede, the recession is about the same until most of the levee altitudes are reached. On the recession of large flood peaks, the water levels at Brothers River and at plot 12 fall more rapidly than the Apalachicola River stage. At those times, conveyance of water by the Brothers River is more efficient because its path downstream to its confluence with the Apalachicola River is more direct than the corresponding reach of the Apalachicola River.

An inspection of the hourly record at the Brothers River and Sumatra gages indicated some tidal influence at both sites. Tidal fluctuations at the Brothers River gage generally occurred when stages fell below an altitude of 0.9 meter. Fifty-five percent of the time during the period from October 1979 through September 1980, stages at the Brothers River gage were below an altitude of 0.9 meter. The amplitude of diurnal fluctuations varied greatly with both river stages and tidal cycles. The maximum diurnal fluctuation recorded at the Brothers River gage during the 1980 water year was 0.3 meter. Tidal fluctuations at the Sumatra gage on the main river generally occurred when river stages fell below an altitude of 0.9 meter. The river did not fall below 0.9 meter in altitude at any time during the 1980 water year, but 5 percent of the time from 1958 to 1980, stages at the Sumatra gage were below 0.9 meter in altitude. Range of tidal fluctuations at the Sumatra gage is undetermined.

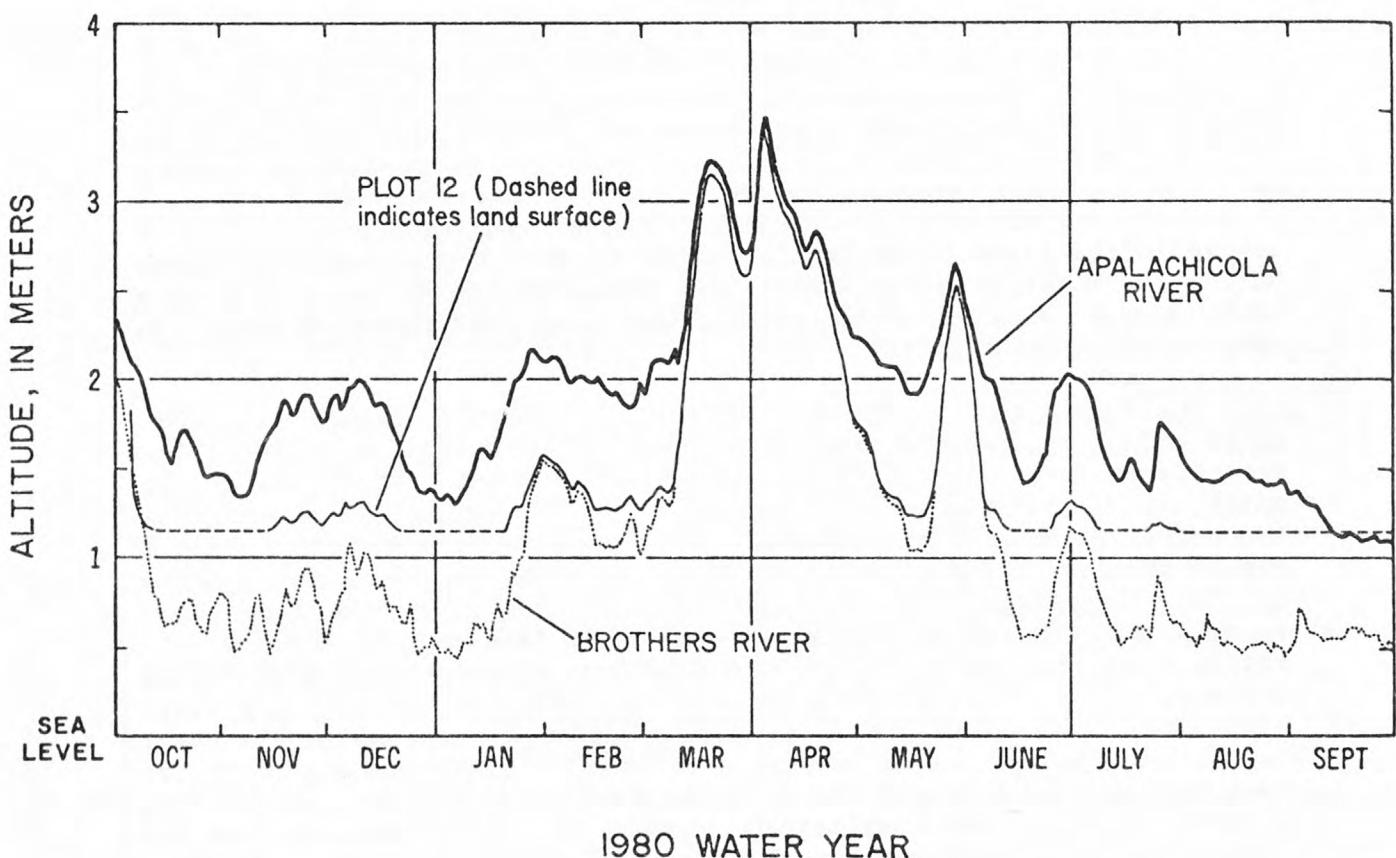


Figure 24.--River stage and flood-plain water levels for the 1980 water year at Brickyard transect.

The instantaneous water levels across the flood plain varied during floods at the Sweetwater and Brickyard transects, depending on the magnitude and duration of the flood wave, the height of the levees, and the size and distribution of the breaks in the levees. A series of current-meter discharge measurements at different flood atages were made at Sweetwater and Brickyard transects during the period March 9 to April 28, 1980. The distribution of flow and velocity of two of the measurements for each transect are shown in figures 25 and 26.

An analysis of the flow patterns at the Sweetwater intensive transect on March 11 and 18, 1980, shows that instantaneous water levels vary considerably across the flood plain at a medium flood stage but are nearly uniform at a high flood stage (fig. 25). The flood plain carried 10 percent of the flow on March 11 and carried 26.6 percent of the flow at a higher stage on March 18. Velocities increased in the main channel and the east flood plain but decreased in the west flood plain with higher stage.

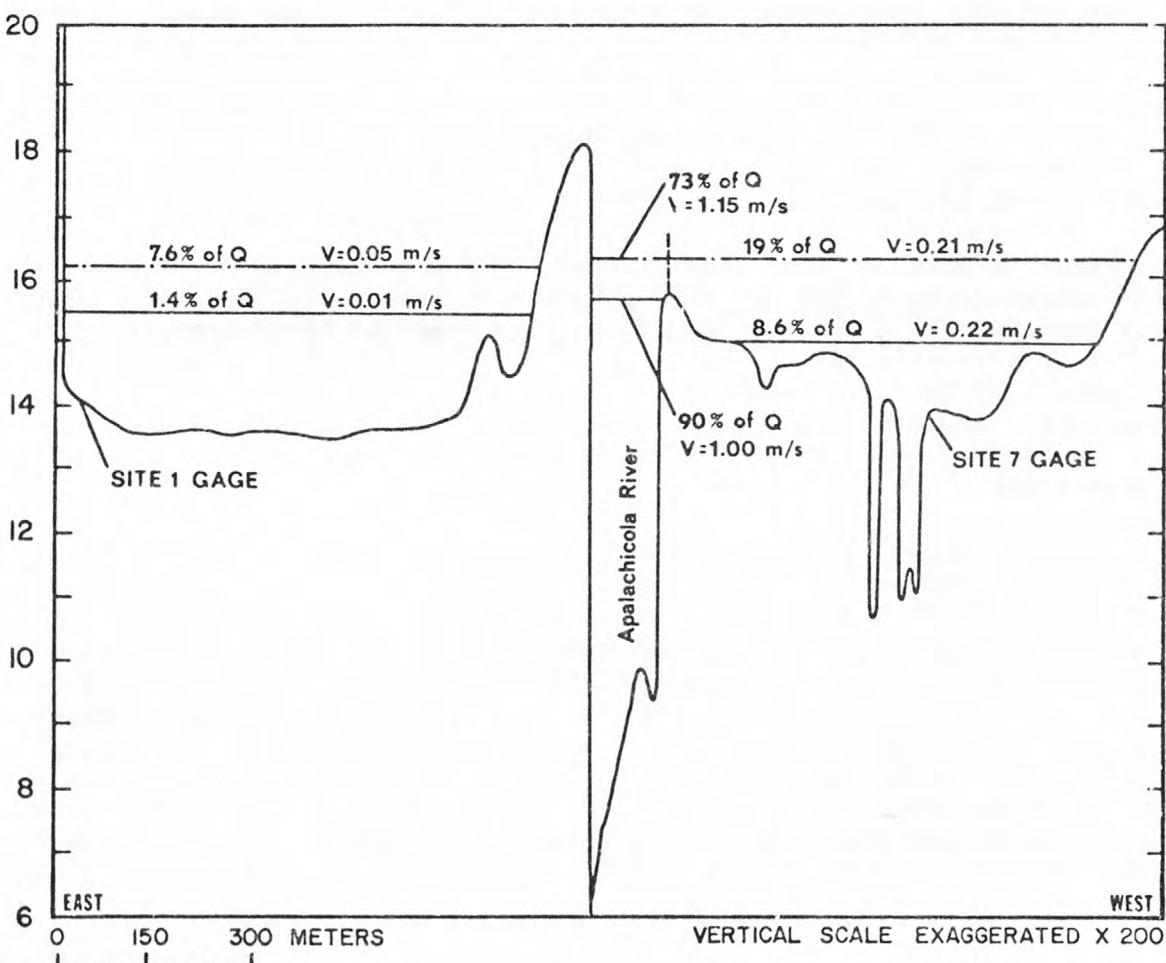
Flow patterns at the Brickyard transect on March 14 and 19, 1980, show that instantaneous water levels are fairly uniform across the flow corridor at both medium and high flood stages (fig. 26). The flood plain at this site has two major channels, Brickyard Cutoff and Brothers River, which convey a high percentage of flow during flooding, especially at lower flood levels. Those two flood-plain channels carried 27.7 and 24.1 percent of the total flow on March 14 and 19, respectively. The remainder of the flood plain, excluding Brickyard Cutoff and Brothers River, carried 35.0 and 44.3 percent of the total flow during the medium and high flood stages, respectively. Velocities were higher in most sections of the flood plain at the higher stage.

Ground Water

Relations between water-table fluctuations in the flood plain and river stage are illustrated for Sweetwater plot 4 in figure 27 and for Brickyard plot 11 in figure 28. Ground-water measurements from a system of observation wells at several other plots across each transect were also examined. The water table at both transects is dependent upon river stage, with fluctuations damped by movement of water through the flood-plain soils.

At Sweetwater, the water-table gradient is generally toward the river at low stages and away from the river at high stages; but superficial seepage from the bluff at the east end of the Sweetwater transect indicates that ground-water discharge onto the flood plain from the adjacent upland is continuous. At Brickyard, the water-table gradient is generally away from the river at low and medium stages and essentially the same as the river at high stages, depending upon the rate of rise or fall of river stage. The gradient at Brickyard may be towards the river at extremely low stages, but this condition did not occur during the period of investigation.

METERS

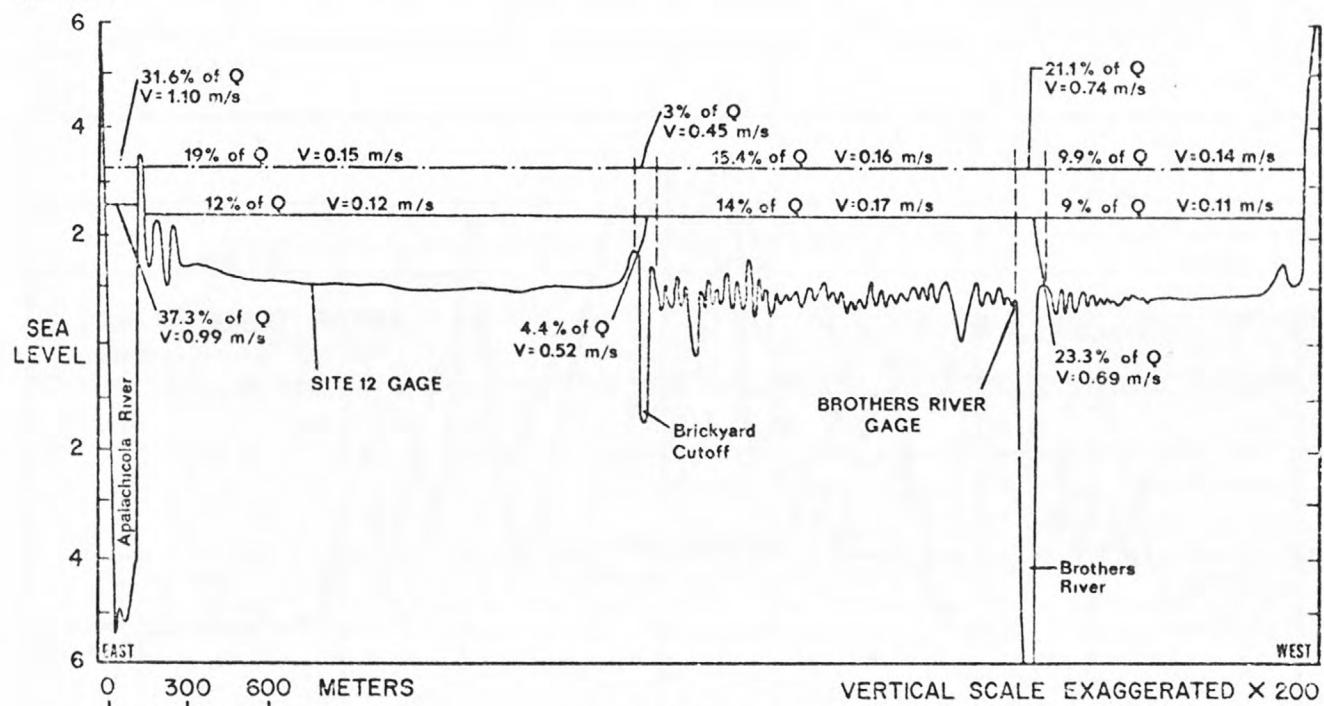


EXPLANATION

- Q Mean daily discharge
- V Mean daily velocity
- Water level on March 18, 1980.
Total Q = 2490 m³/s
- Water level on March 11, 1980.
Total Q = 1640 m³/s

Figure 25.--Flow and velocity distribution at a medium and high flood stage at the Sweetwater transect.

METERS



EXPLANATION

Q Mean daily discharge

V Mean daily velocity

— Water level on March 19, 1980.

Total Q = 2920 m³/s

— Water level on March 14, 1980.

Total Q = 1980 m³/s

Figure 26.--Flow and velocity distribution at a medium and high flood stage at the Brickyard transect.

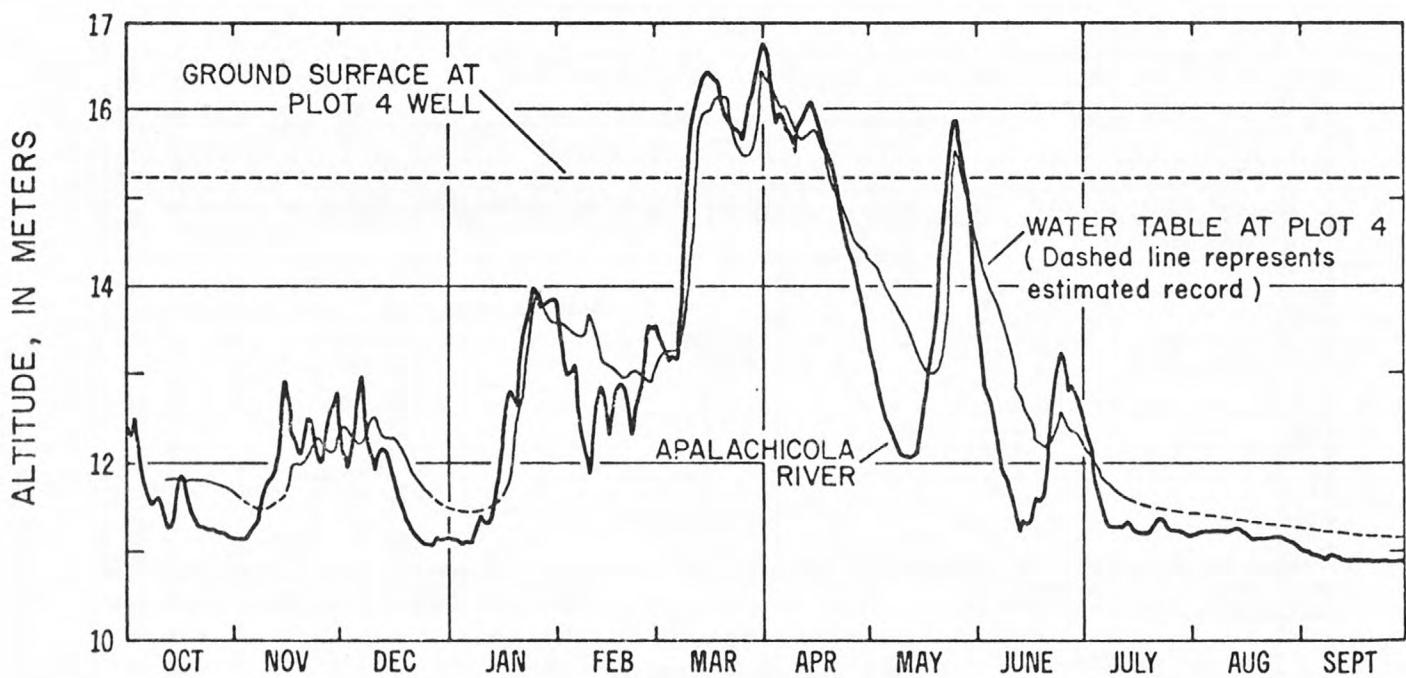


Figure 27.--Water table and river stage for the 1980 water year at the Sweetwater transect. The water table was measured about 120 meters east of the river behind the natural riverbank levee.

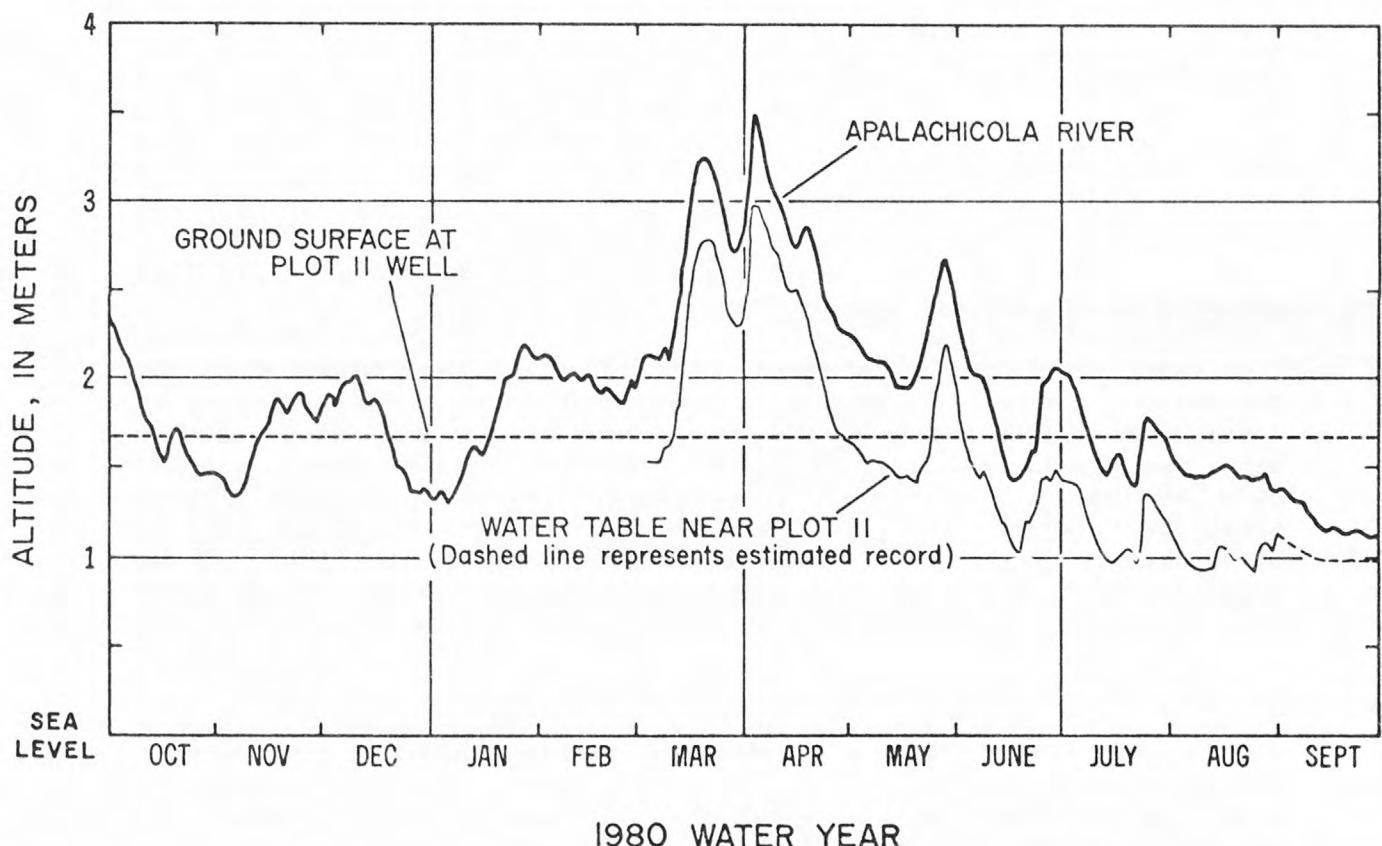


Figure 28.--Water table and river stage for the 1980 water year at the Brickyard transect. The water table was measured about 30 meters west of the river on the natural riverbank levee.

Trees

Species Composition

The cruise transects were designed to provide an estimate of the species composition of the whole flood plain. Results from point sampling methods on the intensive transects gave mean basal areas and densities (of all species) that were roughly 10 percent smaller than plot sampling values. Others have compared plot and point sampling and found insignificant differences in the results of the two methods (Grosenbaugh and Stover, 1957). Further data, such as more sampling transects or a forest map, would be needed to test or improve on this estimate of flood-plain composition.

Forty-seven species of trees were identified and measured during the study. Table 8 lists the 25 most significant species ranked by basal area. Water tupelo is the most common tree in the flood plain in both basal area and density. Six wet-site species (water tupelo, Ogeechee tupelo, baldcypress, Carolina ash, swamp tupelo, and planer-tree) dominate the flood plain with a combined relative basal area of 64.8 percent. Their combined relative density is 47.8 percent. Of the remaining 39 species, sweetgum stands out with 4.8 percent of the basal area and possumhaw (a deciduous holly) with 10.5 percent of the density.

Several species were notable with regard to their range of distribution. Swamp tupelo was observed only in the two lower river transects with a few minor exceptions. Sweetbay, cabbage palmetto, and pumpkin ash were found exclusively in the lower river. Ogeechee tupelo was relatively uncommon in the upper river. Sugarberry, possumhaw, and American hornbeam were rare or absent in the lower river. Sweetgum was found most commonly on the higher flats and terraces of the upper and middle river, but could also be found occasionally in permanently saturated soils of the lower river. The upper river had the greatest variety of species, probably because of the greater range in elevations and hydrologic fluctuations. Of 47 species sampled, 35 were found in the upper river, and 27 were found in the lower river.

Forest Types

Five forest types were defined using the cruise-transect data (fig. 29, table 9). Relative basal areas and densities of tree species in each forest type are given in tables 10 and 11. Each cruise-transect point was identified as one of the five types. Fourteen of the 223 points could not be classified because they did not meet any of the forest type definitions in table 9. Unclassified points had species compositions intermediate between two or three forest types, dominant pioneer or early successional species, or no trees.

Table 8.--Relative importance of tree species on the Apalachicola
River flood plain based on cruise-transect data

[Absolute basal area and density upon which these percentages are based are 46.2 m²/ha (square meters per hectare) and 1,540 trees/ha (trees per hectare), respectively.]

Species	Relative basal area in percent	Relative density in percent	Species	Relative basal area in percent	Relative density in percent
Water tupelo	29.9	12.8	American hornbeam	2.0	4.7
Ogeechee	11.0	6.6	Pumpkin ash ¹	1.9	4.4
Baldcypress	10.6	5.5	Water oak	1.8	0.5
Carolina ash	5.4	11.5	Red maple	1.5	4.8
Swamp tupelo	5.0	2.0	Sweetbay	1.0	0.5
Sweetgum	4.8	3.2	River birch	0.8	0.7
Overcup oak	3.2	2.0	Possumhaw	0.8	10.5
Planertree	2.9	9.4	American sycamore	0.6	0.3
Green ash	2.9	2.7	Swamp cottonwood	0.4	0.4
Water hickory	2.9	0.8	Black willow	0.4	0.4
Sugarberry	2.8	2.1	Swamp chestnut oak	0.3	0.1
Diamond-leaf oak	2.5	1.4	Boxelder	0.3	0.8
American elm	2.4	1.2	22 other species ²	2.0	10.7

¹Some trees identified as pumpkin ash may have been Carolina ash or green ash. Samaras (winged seeds) had dropped from the trees and seeds of all three species were mixed on the ground beneath the trees.

²Green haw, cabbage palmetto, water locust, red mulberry, swamp-privet, winged elm, slippery elm, cherrybark oak, stiffcornel dogwood, chinaberry, black tupelo, buttonbush, spruce pine, loblolly pine, laurel oak, buckthorn bumelia, parsley haw, common persimmon, black walnut, titi, witherod viburnum, and little silverbell.

Grape vines were also counted at several sampling points.

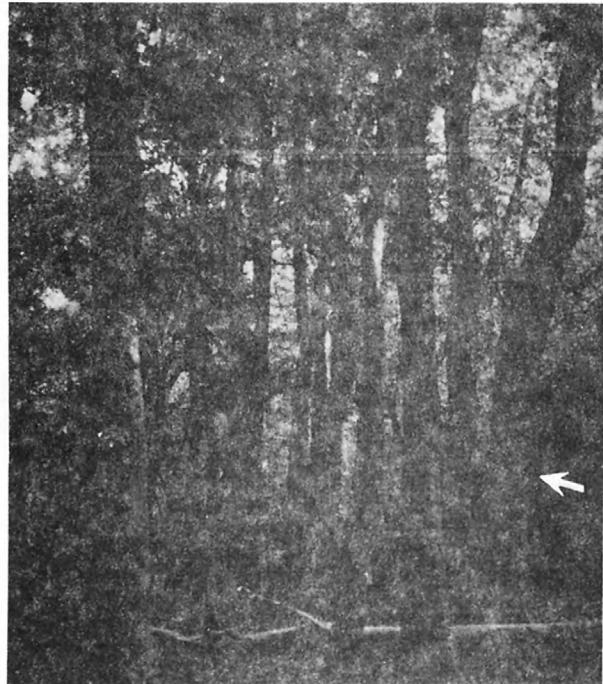


Type A, near kilometer 158, showing abundant vines and undergrowth.



Type E, near kilometer 37, with water tupelo predominant.

Type E, near kilometer 20, with baldcypress in foreground. 



Type B, near kilometer 127, showing silt deposition from flooding on tree trunks about 2 meters above ground (at arrow).



Figure 29.--Forest types A, B, and E.

Table 9.--Forest types defined at the cruise transects

[Predominant: comprising 50 percent or more in terms of basal area.
 Pure: comprising 95 percent or more in terms of basal area.]

Name	Definition	Chief associates	Common associates	SAF ¹ type
Type A Sweetgum-sugarberry-water oak	Sweetgum, sugarberry, water oak, American hornbeam, possumhaw are predominant.	Diamond-leaf oak, green ash	American elm, American sycamore, water hickory	92
Type B. Water hickory-green ash-overcup oak-diamond-leaf oak	Water hickory, green ash, overcup oak, diamond-leaf oak, sweetgum, American elm are predominant.	Sugarberry, red maple	Water oak, possumhaw, American hornbeam, water tupelo, Ogeechee tupelo, baldcypress	93 96
Type C. Water tupelo-Ogeechee tupelo-baldcypress	Water tupelo, Ogeechee tupelo, baldcypress, swamp tupelo, Carolina ash, planertree are predominant but not pure.	Overcup oak, pump-kin ash, red maple	Water hickory, American elm, green ash, diamond-leaf oak, sweetbay	102 103
Type D. Water tupelo-swamp tupelo	Water tupelo, swamp tupelo, Ogeechee tupelo, baldcypress, Carolina ash, pumpkin ash, planertree, sweetbay are pure.			103
Type E. Water tupelo-baldcypress	Water tupelo, baldcypress, Ogeechee tupelo, Carolina ash, planertree are pure.			102 or 103

¹ Society of American Foresters (Eyre, 1980).

² Swamp tupelo, pumpkin ash, or sweetbay serve as indicator species to distinguish this type from type E.

Table 10.--Relative basal areas of tree species of each forest type, derived from cruise-transect data

[Absolute basal areas upon which these percentages are based are 28.5 m²/ha for forest type A, 32.8 m²/ha for B, 53.6 m²/ha for C, 66.1 m²/ha for D, and 59.2 m²/ha for E. Due to rounding, percentages given will not necessarily total 100. Species from 14 of the 223 cruise-transect points are not included because those points could not be classified into any of the five types defined in table 9.]

Species	Relative basal area (in percent)				
	Type A	Type B	Type C	Type D	Type E
Loblolly pine	0.2				
Spruce pine	.4				
Cherrybark oak	.4				
Chinaberry	.2				
Buckthorn bumelia	.2				
Parsley haw	.2				
Red mulberry	.9				
Winged elm	.8				
Black tupelo	.4	0.3			
Boxelder	.9	.5			
Swamp chestnut oak	1.8	.5			
Possumhaw	4.8	1.3			
Water oak	11.7	1.4			
Sugarberry	16.7	3.3			
Sweetgum	25.9	9.8	0.5		
American hornbeam	12.0	2.4	.3		
American sycamore	2.7	1.2	.1		
Swamp-privet	1.1		.1		
Green haw	.4	.8			
Green ash	4.3	15.8	1.9		
American elm	3.6	11.4	1.7		
Water hickory	2.4	15.8	1.3		
Stiffcornel dogwood		.3			
Laurel oak		.3			
Diamond-leaf oak	3.8	10.9	2.2		

Table 10.--Relative basal areas of tree species of each forest type, derived from cruise-transect data--Continued

Species	Relative basal area (in percent)				
	Type A	Type B	Type C	Type D	Type E
Overcup oak	1.1	14.7	4.8		
Red maple	1.1	2.8	3.7		
Water locust	.2	.3	.4		
Cabbage palmetto	.4		.7		
River birch			1.2		
Slippery elm			.2		
Black willow			.9		
Swamp cottonwood			.7		
Pumpkin ash ¹			4.4	5.4	
Sweetbay			2.1	3.2	
Swamp tupelo	.4	.3	6.8	20.0	
Buttonbush			.2		0.1
Planer tree		.4	6.6	3.0	2.3
Carolina ash	.2	1.7	9.8	2.1	7.1
Ogeechee tupelo		1.3	14.2	20.7	12.4
Water tupelo	.2	.9	24.8	34.5	58.4
Baldcypress	.2	1.0	10.2	11.0	19.8

¹Some trees identified as pumpkin ash may have been Carolina or green ash. Samaras (winged seeds) had dropped from the trees and seeds of all three species were mixed on the ground beneath the trees.

Table 11.--Relative densities of tree species of each forest type,
derived from cruise-transect data

[Absolute densities upon which these percentages are based are 1,340 trees/ha for forest type A; 1,360 trees/ha for B; 2,210 trees/ha for C; 2,050 trees/ha for D; and 1,120 trees/ha for E. Densities of some of the understory species may appear relatively high because no minimum diameter limit was used during sampling. Due to rounding percentages given will not necessarily total 100. Species from 14 of the 223 cruise-transect points are not included because those points could not be classified into any of the five types defined in table 9.]

Species	Relative density (in percent)				
	Type A	Type B	Type C	Type D	Type E
Loblolly pine	0.1				
Spruce pine	.1				
Cherrybark oak	.1				
Chinaberry	.3				
Buckthorn bumelia	.2				
Parsley haw	3.8				
Red mulberry	.3				
Winged elm	.3				
Black tupelo	.1	0.1			
Boxelder	2.9	.3			
Swamp chestnut oak	.3	.1			
Possumhaw	37.8	25.1			
Water oak	2.3	.3			
Sugarberry	7.9	3.6			
Sweetgum	8.1	9.3	0.8		
American hornbeam	22.0	2.7	.3		
American sycamore	1.1	.3	.1		
Swamp-privet	4.1		.3		
Green haw	.5	.7			
Green ash	.6	11.5	3.3		
American elm	.9	4.7	1.1		
Water hickory	.7	3.7	.3		
Stiffcornel dogwood		4.9			

Table 11.--Relative densities of tree species of each forest type,
derived from cruise-transect data--Continued

Species	Relative density (in percent)				
	Type A	Type B	Type C	Type D	Type E
Laurel oak		0.1			
Diamond-leaf oak	3.2	2.3	1.4		
Overcup oak	.8	8.1	2.4		
Red maple	.9	16.9	6.9		
Water locust	.1	.1	1.8		
Cabbage palmetto	.1		.3		
River birch		.7	.9		
Slippery elm			.2		
Black willow			1.1		
Swamp cottonwood			.5		
Pumpkin ash ¹			4.5	21.4	
Sweetbay			1.1	1.2	
Swamp tupelo	.2	.1	2.7	8.2	
Buttonbush			7.7		0.3
Planertree		.1	17.6	22.0	6.8
Carolina ash	.1	1.9	18.2	11.5	25.0
Ogeechee tupelo		.1	10.1	6.8	15.6
Water tupelo	.1	.6	10.3	24.2	35.6
Baldcypress	.1	1.8	5.9	4.5	16.6

¹ Some trees identified as pumpkin ash may have been Carolina or green ash. Samaras (winged seeds) had dropped from the trees and seeds of all three species were mixed on the ground beneath the trees.

D and E could be considered the same forest type, but the conspicuous presence of swamp tupelo in the lower river suggested a division between the two types. Swamp tupelo sites are characterized by shallower flooding according to Eyre (1980, p. 69).

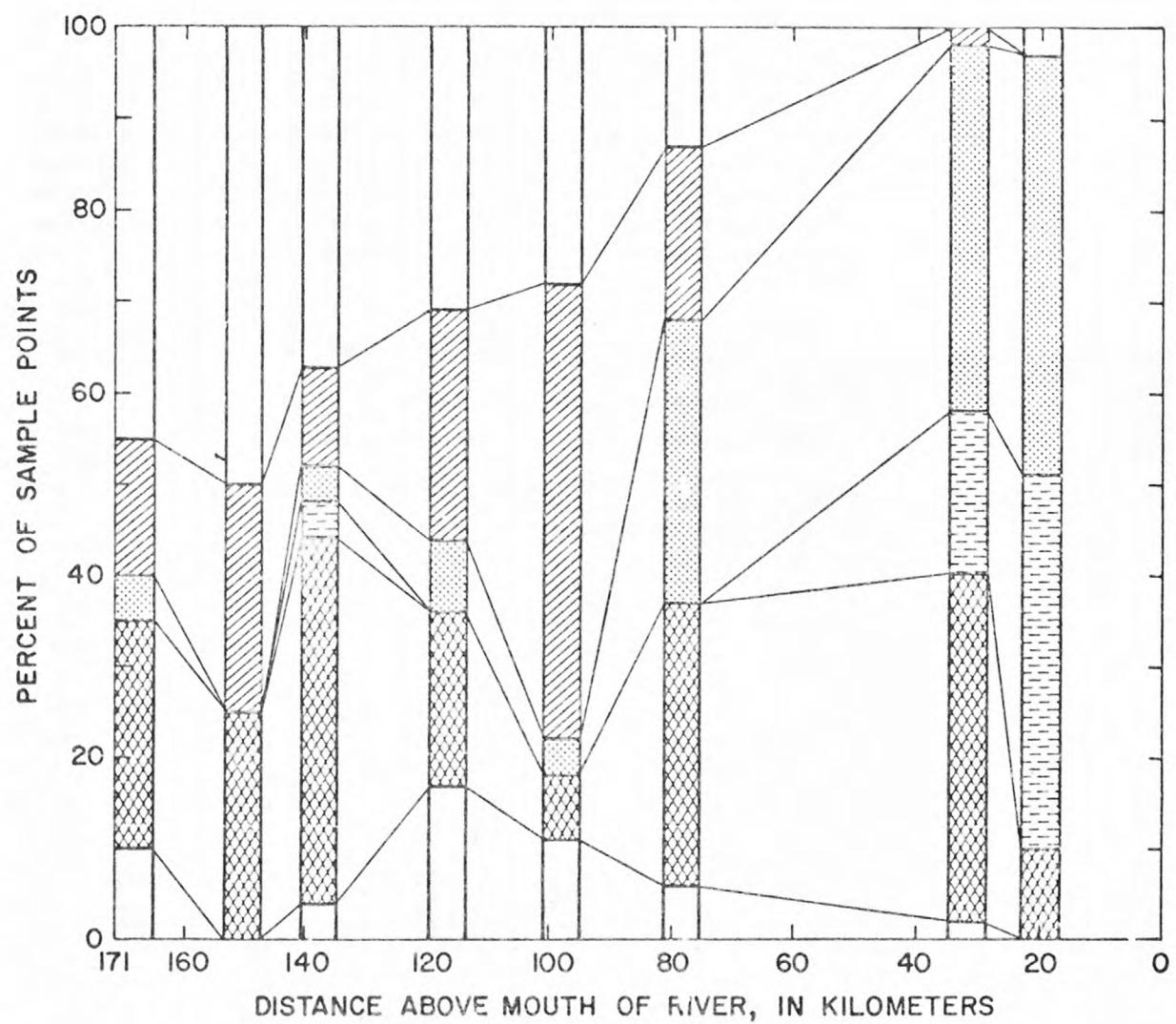
There is another forest type on the Apalachicola River not sampled by the cruise transects. Black willow is usually pure or predominant [Society of American Foresters type 95 (Eyre, 1980)]. Swamp cottonwood, river birch, and American sycamore are chief associates. This is a pioneer type characteristically found on the new land formed by point bars. Although it is very common along the river margins, usually on the inside of each bend in the river, this willow zone is quite narrow and occupies a very small part of the total area of the flood-plain forest.

A very common Mississippi River flood-plain community type, overcup oak-water hickory, was occasionally found in limited areas. Results of sampling did not indicate that it was consistent or extensive enough to be categorized as a separate forest type.

The most common single forest type is E (table 12). The three forest types dominated by tupelo and other wet-site species, C, D, and E, constitute a total of 56 percent of all sample points. The change in abundance of different forest types from upper to lower river is shown in figure 30. Type A decreases downstream and type B, well represented in the upper and middle river, is almost completely absent in the lower river. Type C is concentrated at the three downstream transects. Type D occurs almost exclusively at the two lower river transects. Type E is the only type present at all eight transects.

Table 12.--Abundance of forest types at all cruise transects

Forest type	Number of sample points	Percent of total sample points (rounded)
A	47	21
B	36	16
C	47	21
D	25	11
E	54	24
Unclassified	14	6
Total	223	



EXPLANATION

FOREST TYPES

- A
- B
- C
- D
- E
- Unclassified

CRUISE TRANSECT NAMES

- KM 169 - Chattahoochee
- KM 150 - Torreya Park
- KM 138 - Sweetwater
- KM 117 - Old River
- KM 98 - Muscogee Reach
- KM 79 - Porter Lake
- KM 32 - Brickyard
- KM 20 - South end of Forbes Island

Figure 30.--Abundance of forest types at each cruise transect.

Mean basal area in m^2/ha of all tree species are below average at sites identified as types A and B, and above average at sites belonging to types C, D, and E (fig. 31). Mean densities in trees/ha show a similar trend except for type E. Some of this difference in basal area and density may be due to the enlarged bases of tupelo and cypress trees that dominate types C, D, and E, although tree trunks were sampled above the swelled buttresses whenever possible. This higher basal area and density of types C, D, and E, in combination with a downstream increase in abundance of the three types (fig. 30), explains the downstream increase in basal area and density shown in figure 32.

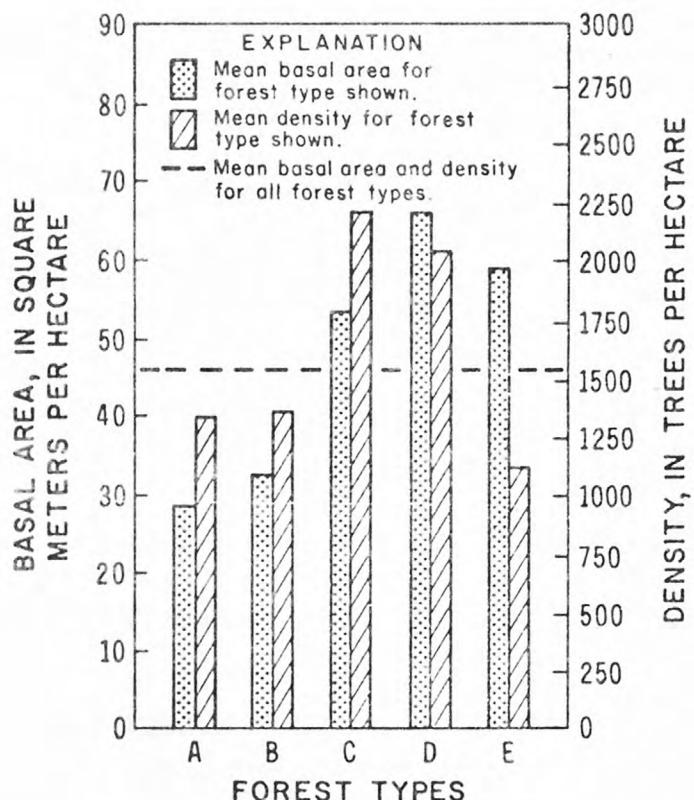


Figure 31.--Mean basal area and density of trees of each forest type.

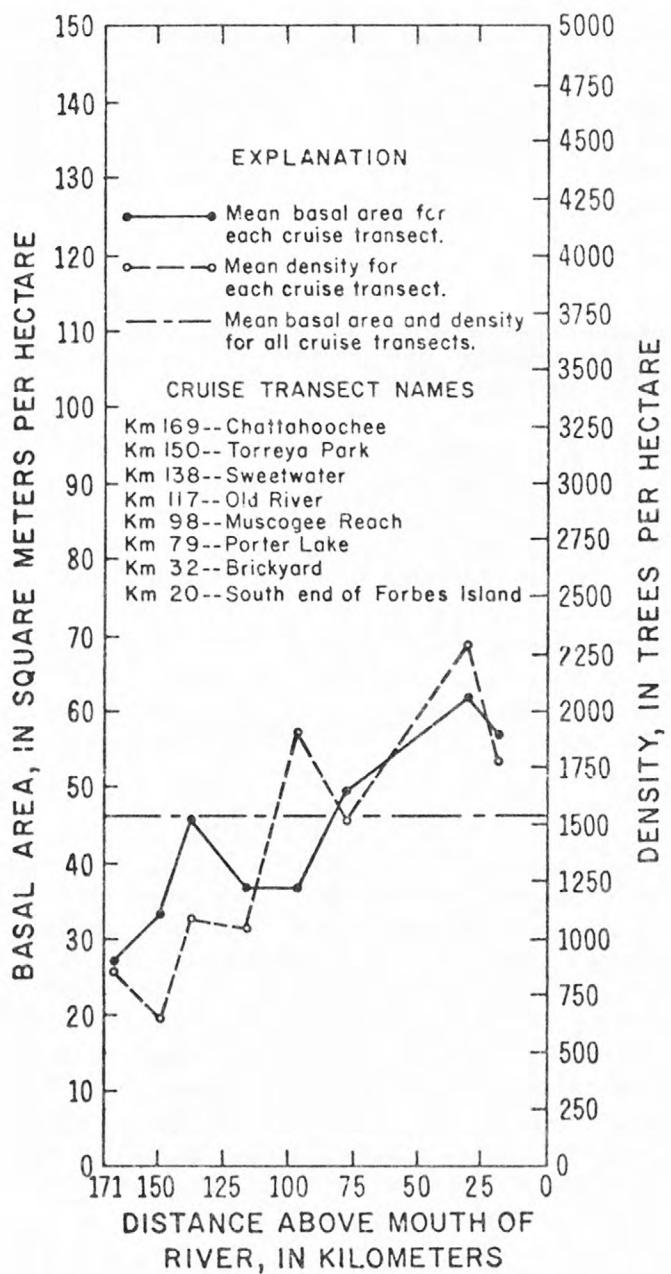


Figure 32.--Mean basal area and density of trees at each cruise transect.

Water and Tree Relations

The Kruskal-Wallis test (Hollander and Wolfe, 1973, p. 117) was used to test differences among forest types with respect to the nine water parameters. For each water parameter, values were assigned rankings and an analysis of variance was performed on the ranked values rather than the actual values. The F-value (model mean square/error mean square) was tested for significance at a 0.0001 level of significance. With respect to eight of the nine water parameters, differences existed among forest types at a significance probability of 0.0001. The only parameter that did not show this relation to forest types was velocity. At a significance probability of 0.01, however, it was also shown to vary among forest types. River location was tested in addition to the nine water parameters and showed differences among forest types at a significance probability of 0.0001.

Some of the water parameters were derived directly from others or from the same basic data. Correlation coefficients of each of the nine water parameters with each other and river location were calculated to determine the degree of interdependency among parameters (table 13). Correlation coefficients and significance probabilities were calculated by the Pearson product-moment method. The six parameters measuring duration of inundation and saturation all have highly significant correlations with each other. Kilometers, fall-season depths, and flood depths are strongly correlated with most of the duration parameters. Velocities have the weakest correlations with the other parameters.

Each of the nine water parameters was compared to the five forest types at all sites (209 cruise-transect points). The combining of all sites in making a comparison, however, frequently masks patterns of water and tree relations that change from upper to lower river. To illustrate how relations change at different locations on the river, most parameters are presented not only for all sites but are also presented for 53 cruise-transect points in the upper river and for 81 points in the lower river. The remaining points in the middle river are not shown separately because conditions there are generally between those of the two extreme locations in the upper and lower river. Upper river graphs compare only A, B, and E forest types because C and D types are rare in the upper river. Lower river graphs show only C, D, and E types because A and B types are rare in the lower river (see fig. 30).

Table 13.--Significant correlation coefficients of nine water parameters with each other and river location

L9

	Percent saturation	Consecutive days of saturation	Observed percent inundation	Observed consecutive days of inundation	Fall-season depth	Percent inundation estimated from river stage	Consecutive days of inundation estimated from river stage	Kilometers	Flood depth	Velocity
Consecutive days of saturation	0.99									
Observed percent inundation	.85	0.82								
Observed consecutive days of inundation	.73	.72	0.96							
Fall-season depth	.86	.84	.85	0.79						
Percent inundation estimated from river stage	.62	.56	.50	.29	0.57					
Consecutive days of inundation estimated from river stage	.50	.44	.40	.21	.50	0.97				
Kilometers	-.49	-.45	-.27	NS	-.36	-.78	-0.70			
Flood depth	-.45	.40	.59	.60	.49	.20	NS	0.29		
Velocity	NS	NS	NS	NS	NS	.23	.18	-.37	NS	

[Levels of significance are: 0.0001 for correlation coefficients of 0.26 to 0.99; 0.001 for correlation coefficients of 0.22 to 0.25; and 0.01 for correlation coefficients of 0.17 to 0.21. NS = not significant.]

Depth of Water

Fall-season depth

Figure 33 shows the 1979 fall-season depths for each forest type. Types A and B were generally dry. Types C, D, and E were generally wet, although the range of C overlapped that of A and B.

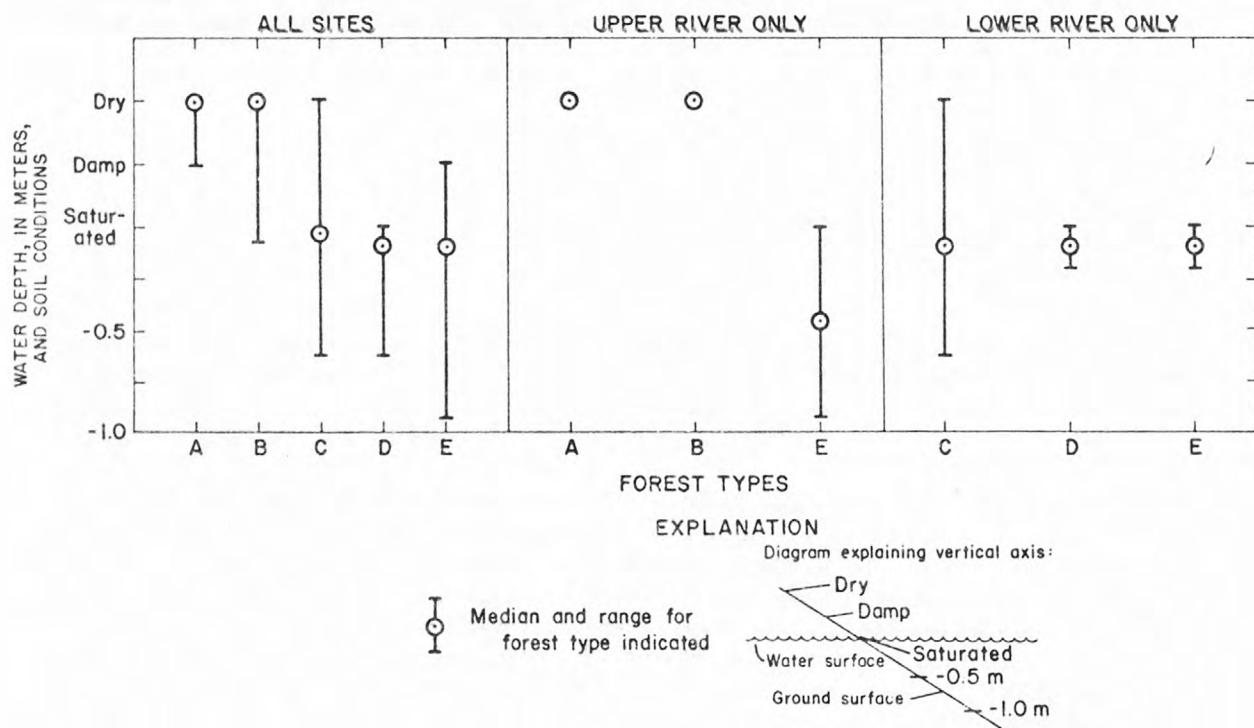


Figure 33.--Relations between 1979 fall-season water depth and forest type.

Upper river types fell into two very distinct categories: dry (A and B), and saturated or inundated (E). Lower river types were generally inundated with 0.1 meter of water and showed little differences in median depths; however, type C was much more variable than D and E, ranging from dry to 0.6 meter deep in the fall.

Flood depth

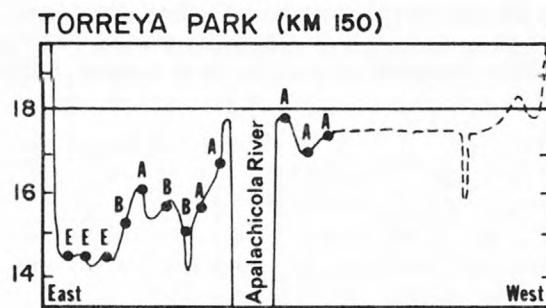
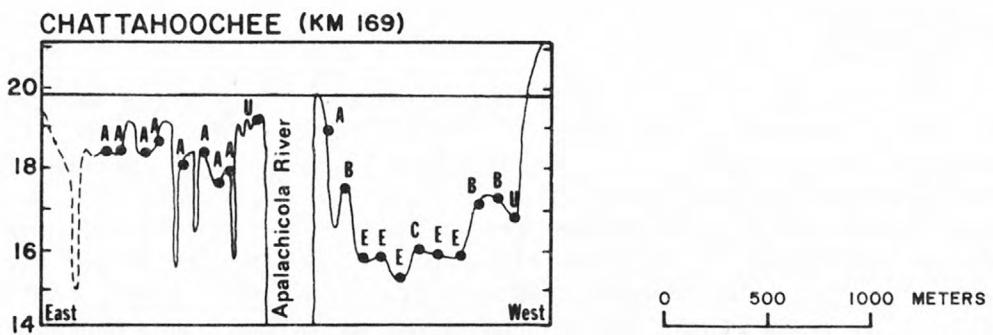
Flood depth is a relative measure of elevation corrected to a standard reference--the 2-year, 1-day high. This parameter allows relative elevational comparisons among forest types at transects which differ greatly in land-surface altitude. Altitude; 2-year, 1-day high; and forest type of each cruise-transect point are shown on cross sections in figure 34. Large elevation differences between forest types are characteristic of the upper river. The lower river flood plain is very flat with little or no elevation difference between forest types. This geographic difference can be explained by the decrease in water fluctuation from upper to lower river. Higher flood stages create higher levees in the upper river than in the lower river. Upper river levees are 3 to 6 meters higher than low and medium river stages, whereas lower river levees are 0.6 to 1.8 meters higher than these same river stages. Although duration of flooding may be equal for levees at the two locations, more xeric (drier) species will be able to grow on the upper river levee due to the distance from the water table. Thus the greater range in water fluctuation in the upper river creates larger elevational differences allowing wider variations in forest types than in the lower river.

Figure 35 shows flood depths for each forest type. When all sites are considered together, median flood depths for all forest types are between 1.2 and 2.7 meters, and ranges show much overlap. However, considering only the upper river, the flood depths in type E forests were much greater, ranging from 2.7 to 4.6 meters deep, than in type A and B forests. In the lower river, flood depths are shallower and less variable than in the upper river. Median flood depths for all lower river forest types were between 1.2 and 2.1 meters, and total range of flood depths was less than one-third of that in the upper river.

Elevational differences among forest types in the lower river are of greater importance than implied by the results in figure 35 because ground levels were measured in such a way that microrelief was not taken into account. Microrelief in the hummocky land between Brickyard Cutoff and Brothers River is probably the primary factor influencing tree growth there. Hummocks only a few meters in diameter rise above the average level of the flood plain allowing tree roots to obtain plenty of oxygen in a permanently inundated environment.

Flood depths for one forest type, E, are shown in figure 36 at every transect. Depths gradually and consistently decrease from upper to lower river.

ALTITUDE, IN METERS



EXPLANATION

- 2 YEAR, 1 DAY HIGH (1958-80)
- A CRUISE-TRANSECT POINTS.
- LETTERS REPRESENT FOREST TYPE (U=UNCLASSIFIED).
- 6 INTENSIVE-TRANSECT PLOTS
- SOLID LINES REPRESENT MEASURED ALTITUDES. DASHED LINE REPRESENTS APPROXIMATE ALTITUDES ESTIMATED FROM TOPOGRAPHIC MAPS.

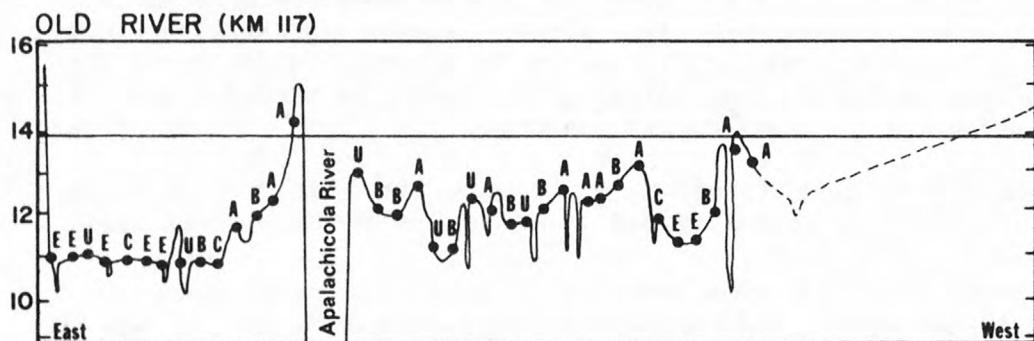
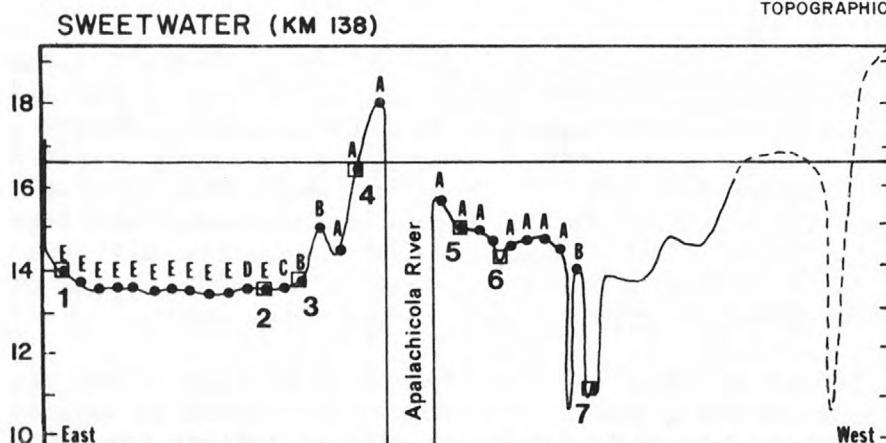


Figure 34.--Altitude; 2-year, 1-day high (1958-80); and forest type for each cruise-transect point.

ALTITUDE, IN METERS

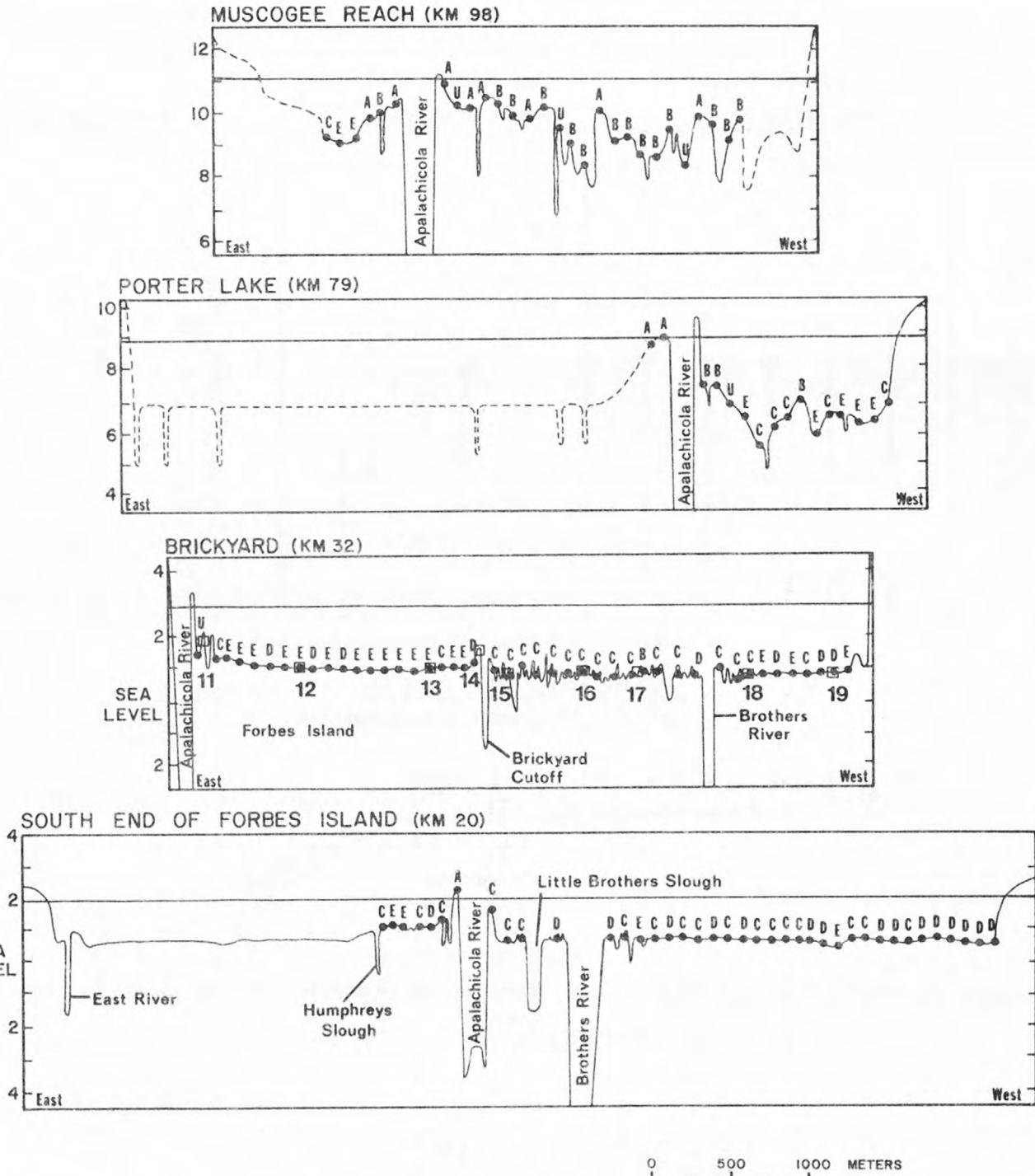
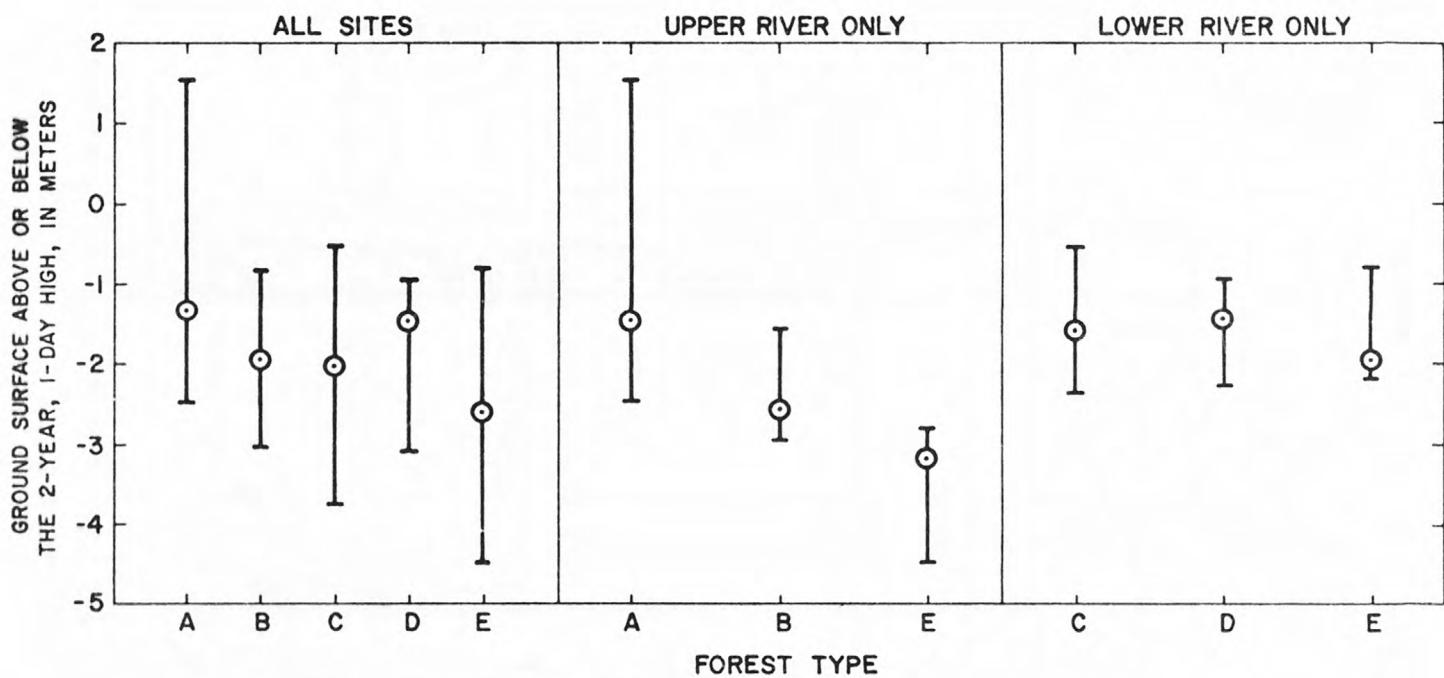


Figure 34.--Altitude; 2-year, 1-day high (1958-80); and forest type for each cruise-transect point--Continued.



EXPLANATION

Diagram explaining vertical axis:

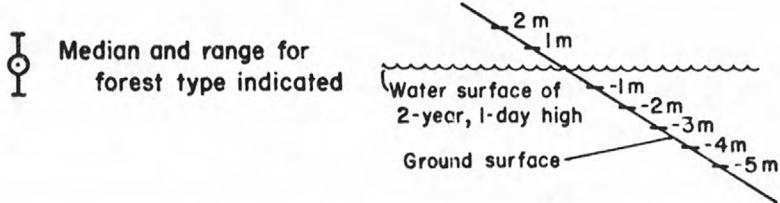
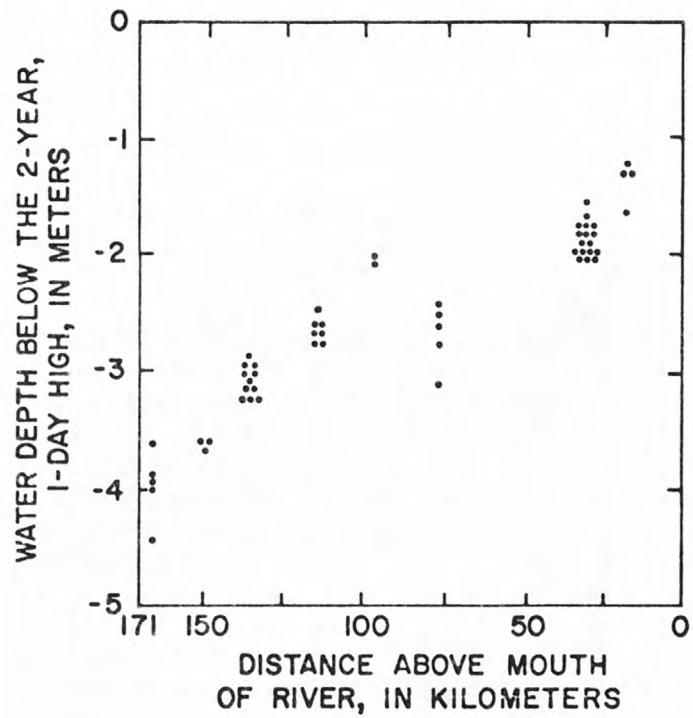


Figure 35.--Relations between 2-year, 1-day high (1958-80) flood depth and forest type.



EXPLANATION TRANSECT NAMES

- Km 169 - Chattahoochee
- Km 150 - Torreya Park
- Km 158 - Sweetwater
- Km 117 - Old River
- Km 98 - Muscogee Reach
- Km 79 - Porter Lake
- Km 32 - Brickyard
- Km 20 - South end of Forbes Island

Figure 36.--Two-year, 1-day high (1958-80) flood depths at type E forests at each transect.

Duration of Inundation and Saturation

Supplementary Data II summarizes the hydrologic observations and assumptions at each transect that were used to estimate values for four of the six duration parameters, observed percentage of inundation, percentage of saturation, observed consecutive days of inundation, and consecutive days of saturation.

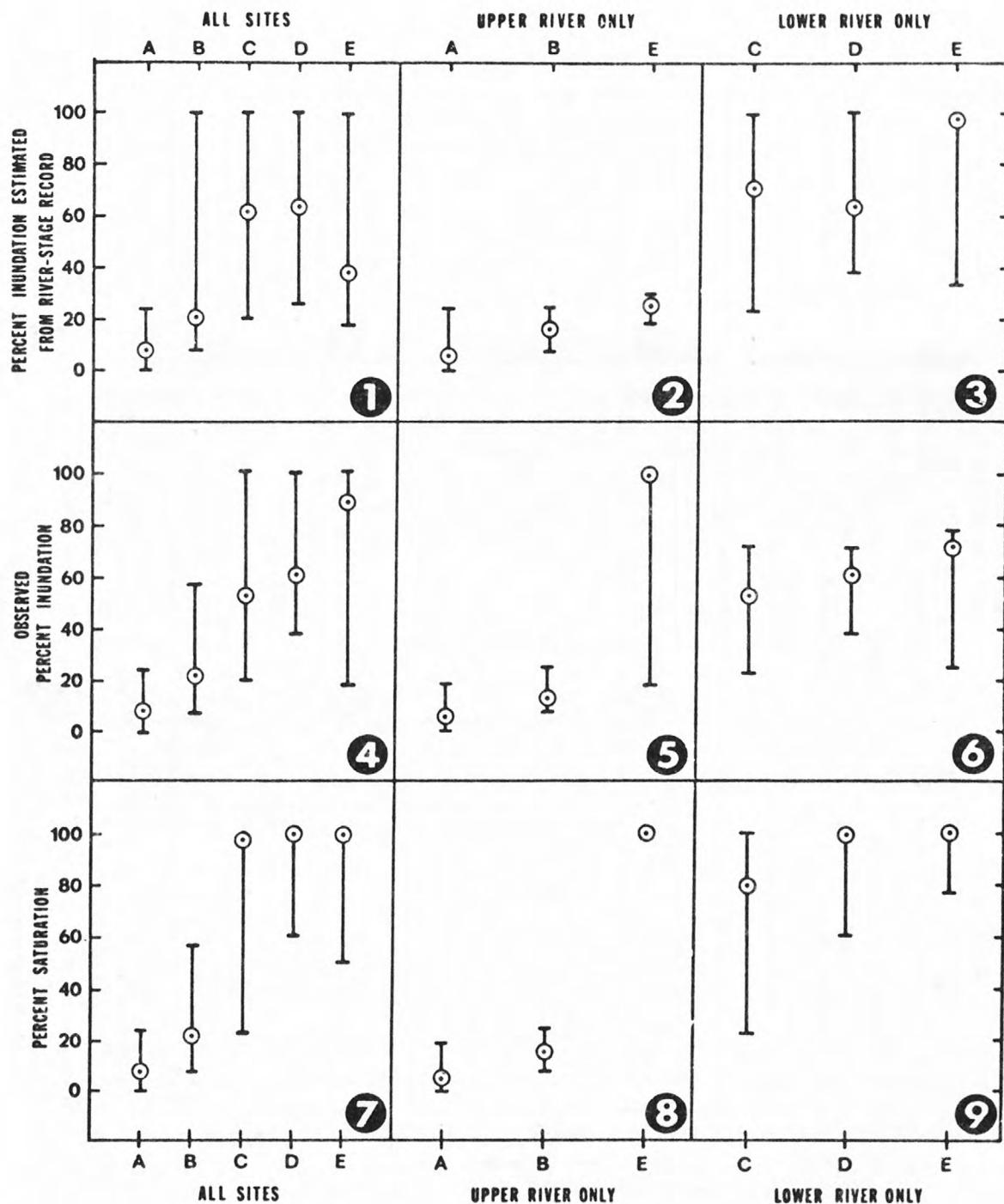
The nine numbered graphs in figure 37 show various estimates of percentage of inundation and saturation for each forest type. Figure 38 shows estimates of consecutive days of inundation and saturation in the growing season for each forest type in the same format as figure 37. In the following paragraphs, references to individual graphs apply to both figures.

For types A and B, median time of inundation estimated from river-stage record (graph 1), observed time of inundation (graph 4), and estimated time of saturation (graph 7), are quite similar. Types A and B were generally found on levees, ridges, slopes, or high flats with hydrologic fluctuations that matched river stage. Time of inundation estimated from river-stage record was determined to be a good measure of the actual inundation and saturation conditions in the flood plain for those forest types. (See figure 34 and Supplementary Data II for details at each transect.)

Graphs 1, 4, and 7 show that for types C, D, and E, time of inundation estimated from river-stage record is much less reliable as a measure of actual inundation conditions in the flood plain and is almost completely useless as an indicator of actual saturation conditions in the flood plain. Types C, D, and E were commonly found in low, permanently saturated flat areas with poor drainage connections to the river.

Graphs 5 and 8 show that forest types in the upper river fall into two very distinct hydrologic groups. Median time of inundation and saturation is less than 20 percent (fig. 37) or 25 consecutive days in the growing season (fig. 38) for types A and B and 100 percent or 265 days (the entire growing season) for type E. Graphs 6 and 9 show that hydrologic distinctions between forest types in the lower river are much less clear than in the upper river. Median time of inundation and saturation in the lower river is less for type C but still greater than 50 percent or 80 consecutive days in the growing season for all three forest types.

In general, types C, D, and E are commonly found on permanently saturated soil, whereas types A and B are not. When the differences in basal area and density among forest types (fig. 31) are considered, it appears that biomass is greater in forests growing on permanently saturated soils. A possible explanation is that drier sites have been subjected to more frequent logging because of easier access, so that trees there are younger and of lower biomass. In the absence of any detailed history of logging practices, this cannot be confirmed.

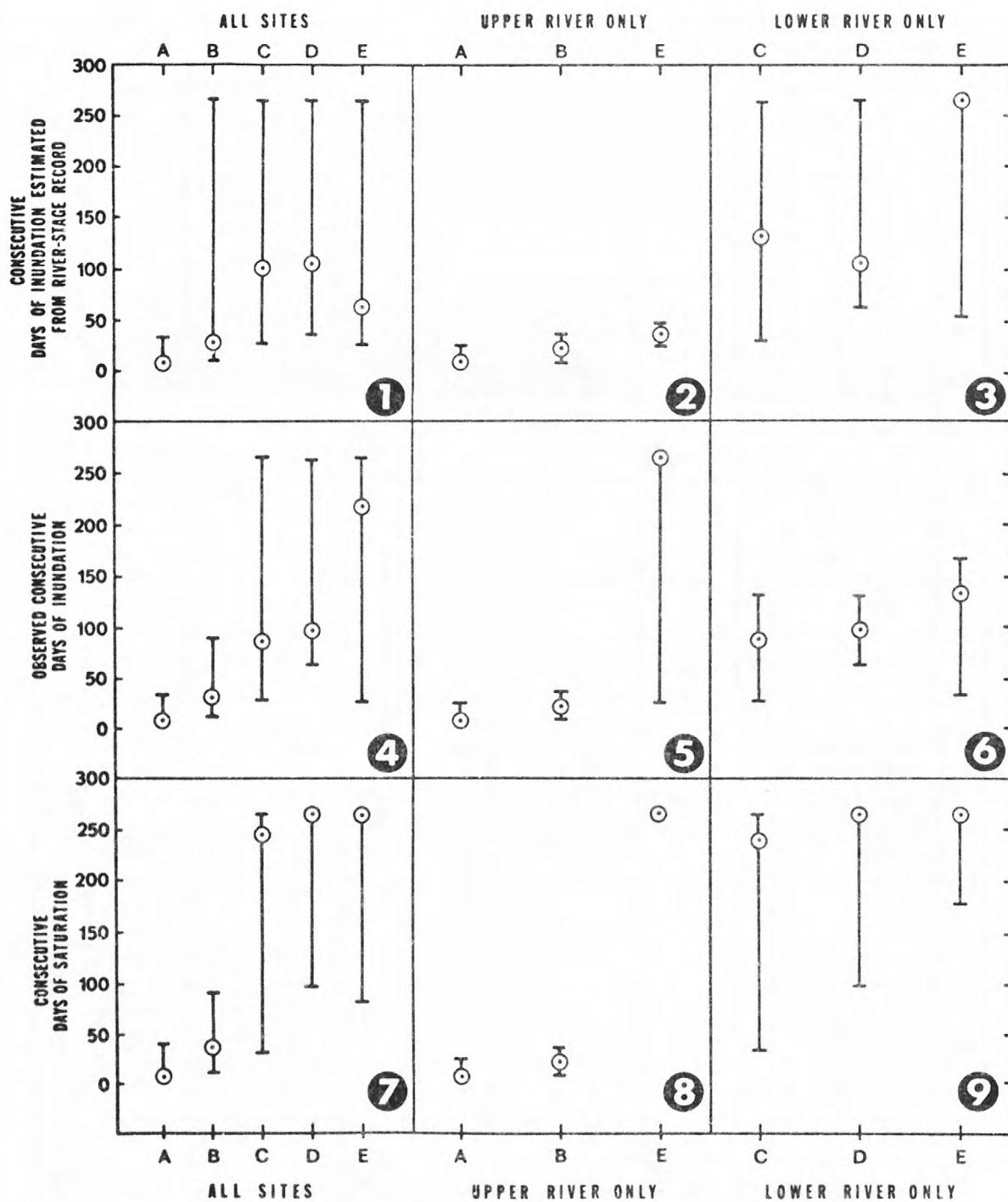


EXPLANATION

— MEDIAN AND RANGE FOR FOREST TYPES INDICATED

LETTERS ON HORIZONTAL AXIS REPRESENT FOREST TYPES.

Figure 37.--Relations between percentage of inundation and saturation (1958-80) and forest type.



EXPLANATION

- MEDIAN AND RANGE FOR FOREST TYPES INDICATED. 265 DAYS IS THE LENGTH OF THE GROWING SEASON AND IS THEREFORE THE MAXIMUM NUMBER OF DAYS SHOWN.
- LETTERS ON HORIZONTAL AXIS REPRESENT FOREST TYPES.

Figure 38.--Relations between consecutive days of inundation and saturation in the growing season (1958-80) and forest type.

In a comparison of estimated time of saturation with individual species, sweetgum and sugarberry were present most often at cruise-transect points saturated 10 to 15 percent of the time (about 3 consecutive weeks in the growing season). The median time of saturation was 22 percent (5 consecutive weeks in the growing season) for green ash, diamond-leaf oak, and water hickory, and 42 percent (more than 8 consecutive weeks in the growing season) for overcup oak. Baldcypress, water tupelo, Ogeechee tupelo, Carolina ash, swamp tupelo, and planertree occurred most often at points saturated 100 percent of the time. Table 14 compares relative tolerance to inundation and saturation of the 12 major species in this investigation to that of the same species in various field and greenhouse studies in the eastern United States.

Velocity

Average velocities in the flood plain during the 2-year, 1-day high (1958-80) range from 0 to 0.27 m/s (fig. 39). Most sites, regardless of forest type, have velocities between 0.1 and 0.2 m/s, and ranges for each forest type show much overlap. Most sites in the upper river, regardless of forest type, have velocities less than 0.06 m/s. Middle and lower river velocities are higher, most of them falling between 0.1 and 0.2 m/s.

Velocities showed no obvious differences with respect to forest types except at one location. At the Brickyard transect, velocities were generally higher in type C forests than type E. Type C forests were found on the hummocky land between Brickyard Cutoff and the Brothers River. The hummocks may be a velocity feature or created by roots as an adaptation to permanent inundation. Velocities at all other transects were so variable that it would be difficult to draw firm conclusions from this isolated case.

SUMMARY

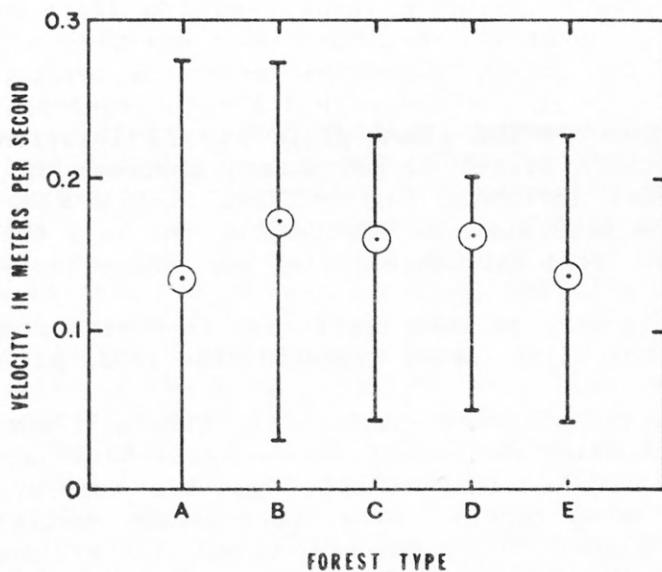
The first major objective of this investigation was to observe hydrologic conditions in the forested flood plain and relate them to long-term river-stage record.

Analysis of long-term record for the Apalachicola River at Chattahoochee indicated that 1958-79 average annual and monthly flows, and flow durations were significantly greater than those of 1929-57. Higher flows for the later period at stations on several other southeastern rivers indicated that climatic changes were probably responsible for the increased flow. However, due to physical changes in the channel, stages for the later periods were lower at Chattahoochee and the same at Blountstown compared to those of the earlier period.

Table 14.--Comparison of relative tolerance of 12 flood-plain species to inundation and saturation in this investigation to that found under various field and greenhouse situations in the eastern United States

[Grouped species have equivalent tolerances]

Relative tolerance	This investigation	Lower White River Arkansas (Bedinger, 1971)	Dewatering project on a Kentucky reservoir (Hall and Smith, 1955)	Summary of literature on lower Mississippi Valley (Whitlow and Harris, 1979)	Seedlings in greenhouse study in southern Illinois (Hosner and Boyce, 1962)
	Sweetgum, sugarberry	Sweetgum, ash	Sugarberry, swamp tupelo	Sugarberry, sweetgum	Sweetgum
	Diamond-leaf oak, water		Sweetgum		
	hickory, green ash				
		Sugarberry, overcup oak, water	Water tupelo, ash		Sugarberry
		hickory			
	Overcup oak		Overcup oak		Water tupelo
	Baldcypress, water	Planertree, baldcypress	Planertree	Green ash, water	Green ash
	tupelo, swamp			hickory, overcup oak, water	
	tupelo, Ogeechee			tupelo, baldcypress, planertree	
	tupelo, Carolina				
	ash, planertree				



EXPLANATION

— MEDIAN AND RANGE FOR
FOREST TYPES INDICATED

Figure 39.--Relation between average velocities during the 2-year, 1-day high (1958-80) and forest type.

Observations of hydrologic conditions in the flood plain during the 1980 water year were extrapolated to approximate long-term (1958-80) conditions. Hydrologic relations between the river and flood plain varied with each location. Natural levees on river and stream banks, and high ridges within the flood plain were inundated only when the river reached relatively high stages. Water quickly drained away from these areas as soon as river stages fell. Low flat areas in the flood plain were almost always permanently saturated and at some locations in the upper river appeared to be permanently inundated. Flood-plain areas of intermediate elevation between levees and low flats were generally inundated for longer durations than the levees but were rarely saturated for prolonged periods. Height of natural riverbank levees, and size and distribution of breaks in the levees had a major controlling effect on hydrologic conditions in the flood plain at all locations. A flood-plain stream, Brothers River, 32 kilometers upstream of the bay, was commonly under tidal influence during times of low flow in the 1980 water year. At the same distance upstream of the bay, the Apalachicola River was not under tidal influence during the 1980 water year.

The second objective of this report was to estimate species composition and define the major forest types for the flood plain.

Of the 47 species of trees sampled, the five most common were wet-site species constituting 62 percent of the total basal area. In order of abundance, they were water tupelo, Ogeechee tupelo, baldcypress, Carolina ash, and swamp tupelo. Other very common species were sweetgum, overcup oak, planertree, green ash, water hickory, sugarberry, and diamond-leaf oak. Average basal area and density for all forest areas sampled were $46.2 \text{ m}^2/\text{ha}$ and 1,540 trees/ha, respectively.

Several species were notable with regard to their range of distribution. Swamp tupelo was observed only in the two lower river transects with a few minor exceptions. Sweetbay, cabbage palmetto, and pumpkin ash were found exclusively in the lower river. Ogeechee tupelo was relatively uncommon in the upper river. Sugarberry, possumhaw, and American hornbeam were rare or absent in the lower river. Sweetgum was found most commonly on the higher flats and terraces of the upper and middle river, but could also be found occasionally in permanently saturated soils of the lower river. The upper river had the greatest variety of species.

Five forest types were defined based on species predominance by basal area. They were type A, sweetgum-sugarberry-water oak; type B, water hickory-green ash-overcup oak-diamond-leaf oak; type C, water tupelo-Ogeechee tupelo-baldcypress; type D, water tupelo-swamp tupelo; and type E, water tupelo-baldcypress. Biomass increased downstream and was greatest with forest types C, D, and E.

The third objective was to relate long-term hydrologic conditions in the flood plain to tree distribution.

Depth of water, duration of inundation and saturation, and water-level fluctuation, but not water velocity, were very highly correlated with forest types. Forest types C, D, and E were generally found at sites having permanent soil saturation with inundation by flood waters 50 to 90 percent of the time or 75 to 225 consecutive days of each growing season from 1958 to 1980. Forest types A and B were found at sites that were saturated or inundated 5 to 25 percent of the time or 5 to 40 consecutive days of each growing season from 1958 to 1980.

Water and tree relations varied with river location because range in water-level fluctuation and topographic relief in the flood plain diminished downstream. River stage in the upper river fluctuated an average of 7.3 meters. Ground surface varied 4.6 meters across the upper river flood plain. As a result, forest types in the upper river included a wide variety of species growing among many different hydrologic conditions. Low flats occupied by forest type E experienced prolonged inundation with 0.5 meter or more of standing water or permanent soil saturation. Relatively infrequent flooding occurred on levees and high ridges occupied by forest type A. Intermediate hydrologic conditions existed for sites occupied by forest type B. Ground surface in the flood plain of the lower river was very flat, usually varying no more than 0.6 meters across the entire width of the flood plain at any one location. The range of river-stage fluctuation in the lower river was about one-third that of the upper river. Narrow levees, covering 6 to 8 percent of the flood-plain width, provided the greatest topographic relief in the lower river. These levees were as much as 2.4 meters above the flood-plain floor. Interior flood-plain soils were permanently saturated, except on tree hummocks. With few exceptions, lower river forests were dominated by water tupelo, Ogeechee tupelo, bald-cypress, Carolina ash, and swamp tupelo (forest types C, D, and E).

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SUPPLEMENTARY DATA I--TRANSECT END POINTS

Transect	Transect end points
Chattahoochee	
east	Upland vegetation continued indefinitely up an upland creek swamp, no obvious elevation changes.
west	Change to upland vegetation, rapid rise in elevation.
Torreya Park	
east	Change to upland vegetation, rapid rise in elevation.
west	Loblolly pines joined flood-plain forest, no obvious elevation changes.
Sweetwater	
east	Change to upland vegetation, rapid rise in elevation.
west	Overgrown fields with no mature trees, no obvious elevation changes.
Old River	
east	Change to upland vegetation, rapid rise in elevation.
west	Loblolly pines joined flood-plain forest, no obvious elevation changes.
Muscogee Reach	
east	Change to upland vegetation, rapid rise in elevation.
west	Overgrown fields with no mature trees, no obvious elevation changes.
Porter Lake	
east	Impassable due to recent timber cutting.
west	Change to upland vegetation, rapid rise in elevation.
Brickyard	
east	Change to upland vegetation, rapid rise in elevation.
west	High manmade levee.
South end Forbes	
Island	
east	Uncompleted due to project time constraints.
west	Change to upland vegetation, rapid rise in elevation.

SUPPLEMENTARY DATA II--DESCRIPTION OF INUNDATION AND SATURATION CONDITIONS AT EACH TRANSECT

Numerous hydrologic observations and assumptions were used in estimating duration of inundation and saturation at each cruise-transect point. This information is summarized here, from east to west across each transect. The two intensive transects are reported first because the detailed hydrologic data collected there were helpful in making estimates at the other six transects. Descriptions of hydrologic subsections can be easily followed by referring to the appropriate cross section of each transect in figure 34.

In this supplement, the term "river-stage estimates" is used to represent the two water parameters, percentage of inundation estimated from river-stage record, and consecutive days of inundation estimated from river-stage record. The term "flood-plain estimates" is used to represent the four water parameters, observed percentage of inundation, percentage of saturation, observed consecutive days of inundation, and consecutive days of saturation.

Sweetwater Transect

The first 1,250 meters of the Sweetwater transect, which includes plots 1 and 2, were permanently inundated to a minimum depth of 0.3 meter over the entire area. Water levels were very stable except during the flood of March and April 1980, when rise and fall of flood-plain water levels matched river-stage fluctuations (fig. 23). The remainder of the transect, including the last 400 meters on the east side and all of the west side excluding streams, was not inundated or saturated except during the March and April flood. Flood-plain estimates were the same as river-stage estimates in this subsection. Ground levels of all the cruise-transect points on the west side were well above average annual river stage.

Brickyard Transect

At the Brickyard transect, the levee on the west bank of the Apalachicola River is high and continuous enough to have a major controlling effect on the hydrology of the flood plain behind it. Ground levels for the entire length of the transect behind the riverbank levee fall well below the level of average annual river stage. However, flood-plain water levels do not rise to match river stage until the river stage rises above an altitude of approximately 2.1 meters. Figure 24 shows 1980 water-level fluctuations of the Apalachicola River and the flood plain at plot 12 and Brothers River, that illustrate the hydrologic conditions at this transect.

The first 1,890 meters of the Brickyard transect is Forbes Island, bounded on both sides by natural levees. The levees are dry except when the river level is above an altitude of approximately 2.1 meters. The very flat flood plain between the levees is flooded to shallow depths (less than 0.5 meter) when the river stage rises above an altitude of about 1.5 meters and is deeply flooded (1 meter and more) when the river stage rises above an altitude of about 2.1 meters. There is little or no standing water at other times when the river is below an altitude of about 1.5 meters. However, 16 monthly observations during the fall seasons of 1979 and 1980 indicate that the soil is permanently saturated, regardless of the river stage or the time elapsed since it was last flooded.

The middle part of the Brickyard transect is also an island (unnamed); but unlike Forbes Island, it is not flat or bounded by levees. Hummocks, mounds of land at the bases of clumps of trees, are as high as 1.2 meters above surrounding land (fig. 12). Land between hummocks is riddled with shallow sloughs 25 to 50 millimeters deep that never dry out. The network of sloughs around the hummocks is connected to the Brothers River and probably fluctuates daily from tidal influence at low river stage. At those times the hummocks are dry and cracked, allowing tree roots to get plenty of oxygen, despite standing water a few meters away in the shallow sloughs. The area is considered dry at those times for the flood-plain estimates. At medium stages (between altitudes of approximately 1.5 and 2.1 meters in the river), water rises in the shallow sloughs, partially inundating the hummocks. At high stages (above an altitude of approximately 2.1 meters in the river), water covers all of the flood plain to a depth of 1.2 meters or more.

The first 250 meters of the transect west of Brothers River is similar to the hummocky land just described. Hummocks gradually disappear to the west, and the last 640 meters of the transect is very flat. Monthly observations indicate this last section is permanently saturated and is inundated only when the river stage is above an altitude of about 1.5 meters.

Chattahoochee Transect

In the fall of 1979, soil on the east side of the Chattahoochee transect was firm and dry. Several small but steep-sided streams are connected directly to the river, breeching the natural riverbank levee nearby to both the north and south. Flood-plain estimates correspond to river-stage estimates in this section. Behind the natural riverbank levee on the west side, water was ponded almost 1 meter deep in the fall of 1979. Aerial observations in the fall of 1980 indicated that it was still ponded. Sites on the west side that were inundated or saturated in the fall of 1979 are judged to be permanently inundated or saturated. Flood-plain estimates for dry sites that were above the level of the ponded water are the same as river-stage estimates.

Torreya Park Transect

The first 275 meters of the Torreya Park transect was saturated in the fall of 1979 and probably remains permanently saturated due to ground-water seepage from steep adjacent bluffs. The remainder of the transect on the east and west sides was firm and dry in the fall and is probably flooded directly by river-stage fluctuations.

Old River Transect

At the Old River transect, standing water 25 to 50 millimeters deep covered the first 610 meters in the fall of 1979 and permanent inundation is assumed. A low ridge separates this section from the remainder of the east side transect. West of the ridge, soils were noticeably firmer and most sites were dry. Observations during the flood of March and April 1980 indicated that this section drains more quickly than the river, probably by way of a flood-plain slough (Outside Lake) to the south. Flood-plain estimates west of the ridge correspond to river-stage estimates.

On the west side of the Old River transect, three low areas approximately 460, 820, and 1,680 meters west of the riverbank were inundated, saturated, or immediately adjacent to standing water in the fall of 1979. The numerous depressions, sloughs with no downstream outlets, and ponded water observed in both the fall dry period and spring floods indicated strong similarities to a site 10.5 kilometers upstream studied by Leitman (1978). In that study, flood waters were found to be retained by numerous depressions and sloughs in the interior of the flood plain several weeks after flood waters had receded. For low and medium elevation sites on the west side of the Old River transect, flood-plain estimates were greater than river-stage estimates. For high elevation sites throughout the transect, flood-plain estimates were the same as river-stage estimates.

Muscogee Reach Transect

In the fall of 1979, water was ponded 0.5 meter deep on the first 210 meters of the Muscogee Reach transect and permanent inundation is assumed. For the remaining areas of this transect (east and west sides) that were dry in the fall, flood-plain estimates match river-stage estimates. Five low areas on the west side of the transect were damp, but not saturated, in the fall. Flood-plain estimates are slightly greater than river-stage estimates at these sites.

Porter Lake Transect

The two sites on the east riverbank levee of the Porter Lake transect were firm and dry in the fall of 1979. Flood-plain estimates match river-stage estimates at those sites. In the first 460 meters of the west side there is a depression with no outlet during low water. Soils were saturated at two sites within this depression during the fall. Flood-plain estimates are greater than river-stage estimates at those sites. The last 580 meters of this transect lie west of a dividing ridge. Flood waters west of this ridge have a direct outlet to the river by way of Porter Lake. For all sites not inundated or saturated in the fall, flood-plain estimates match river-stage estimates. Permanent inundation or saturation were assumed at wet sites.

South End of Forbes Island Transect

At the south end of Forbes Island transect, observations began 520 meters east of the Apalachicola River at Humphreys Slough, which is connected to the Apalachicola River to the north and the St. Marks River to the south. Flood-plain estimates for inundation match river-stage estimates in the section from Humphreys Slough to the Apalachicola River. Observations in the fall of 1979 and 1980 indicate that saturation is permanent in this section, except for the two east riverbank levee sites. The high levee on the west bank of the Apalachicola was dry in the fall. All remaining sites were saturated in the fall. Since Brothers River levees are not present to impound flood waters on or hold flood waters out of the flood plain, flood-plain estimates for inundation correspond to river-stage estimates. Saturation, however, is permanent probably because the land is very flat and altitudes are close to sea level.

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