80-51 NUTRIENT YIELD OF THE APALACHICOLA RIVER FLOOD PLAIN, FLORIDA: RIVER-QUALITY ASSESSMENT PLAN 80-51

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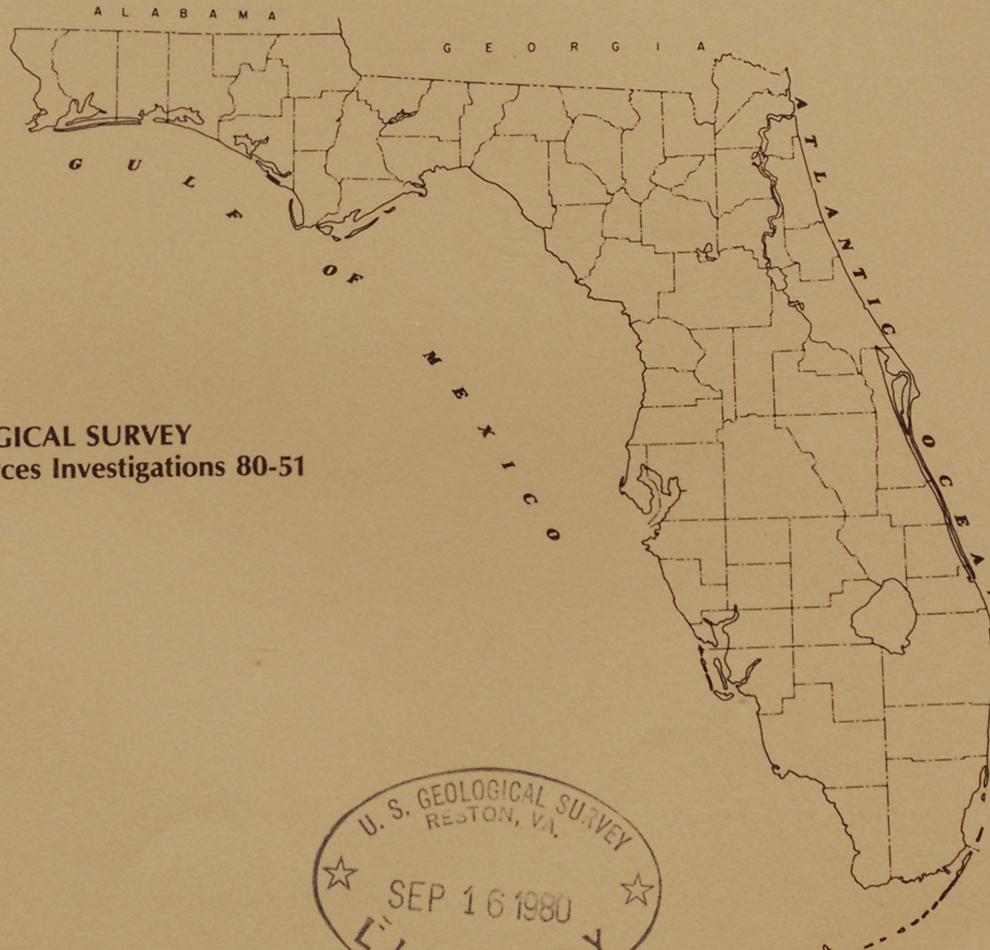

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By Harold C. Mattraw, Jr. and John F. Elder

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Water-Resources Investigations 80-51

1980

UNITED STATES DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS

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

Multiply inch-pound unit	By	To obtain metric (SI) unit
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square feet (ft^2)	0.0929	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)
acre	0.4047	hectare (ha)
cubic feet per second (ft^3/s)	0.02832	cubic meters per second (m^3/s)

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ABSTRACT

The Apalachicola River in northwestern Florida is the location of one of four current U.S. Geological Survey National River Quality Assessments. The investigation of the Apalachicola River and flood plain is designed to quantify the organic detritus and nutrient yield to the productive, estuarine Apalachicola Bay. The extensive riverine flood plain is subject to seasonal flooding which transports large quantities of accumulated, decaying leaf litter from the flood plain into the river and ultimately into Apalachicola Bay.

The Apalachicola River Quality Assessment has four major objectives:

1. Determine the accumulation of organic substances and trace elements in benthic organisms and fine-grained sediments.

2. Describe the distribution of the major tree communities on the flood plain and its relation to long-term flooding patterns.

3. Assess the role of leaf fall and decomposition in determining nutrient yield.

4. Identify and quantify major sources and pathways of nutrients to the river.

Special emphasis is given to investigative approaches and techniques that will increase transfer value in relation to assessments of similar wetland ecosystems. Four reports conveying the methods, techniques, and results of the assessment will be approved for publication by March 1981.

INTRODUCTION

The Apalachicola River in northwest Florida is formed by the confluence of the Chattahoochee and Flint Rivers and has a 19,280-square mile drainage system encompassing parts of three states (fig. 1). With an average discharge of 24,700 ft^3/s at Chattahoochee, Fla., the Apalachicola is the largest river in Florida and ranks 21st in magnitude of discharge in the conterminous United States. The river falls 40 feet in its 107-mile course from Lake Seminole, at the Florida-Georgia state line, to Apalachicola Bay in the Gulf of Mexico. Each winter and spring its rising waters flood the adjacent wetlands for 3 to 5 months. The flood plain, which broadens downstream from 1 mile wide just below Lake Seminole to over 5 miles wide near the mouth, is thickly forested with cypress, tupelo, and mixed hardwood trees, which thrive on the periodic inundation. At the end of its course, the river empties into the Apalachicola Bay, which is one of the most productive shellfish regions in the United States.

The Apalachicola River basin south of Lake Seminole, excluding the Chipola River (fig. 2), has a drainage area of 1,061-square miles, of which nearly one-fifth is inundated during all or part of the year. The river and its flood plain support a dense and diverse wetland vegetative community. It has been assumed that the vegetation yields organic matter which is transported downstream and provides the primary source of nutrients for the estuarine food web. There is, however, a definite need for further quantification to assess the contribution of the wetlands to nutrient and detritus flow in the river system. The Apalachicola River Quality Assessment Project addresses that need.

Wetlands are complex transitional systems between terrestrial and aquatic environments. They are among the most controversial natural resources because they are often ideally suited for industrial or agricultural development which may threaten the continued existence of wetlands in an undisturbed state. There is an urgent need for thorough scientific study of wetlands, but such study is hampered by the complexity of the systems and the limited applicability of conventional limnological or terrestrial ecological techniques.

Previous Studies

A number of studies have begun to bridge the information gaps relating to wetlands. Many of these have been presented in recent symposia. The proceedings of a 1977 symposium, edited by Good and others (1978), dealt with primary production, decomposition processes, nutrient dynamics, and management potential of freshwater wetlands. Another collection of papers, edited by Drew (1978) focused on the use of wetlands as waste treatment areas. One of the main themes that emerges from the various wetland studies is that hydrology is critical and must be well understood before other aspects such as nutrient cycling and primary production can be described. Important relations between hydrology and wetland vegetation were demonstrated by Robertson and others (1978) and Carter and others (1977). The Apalachicola River

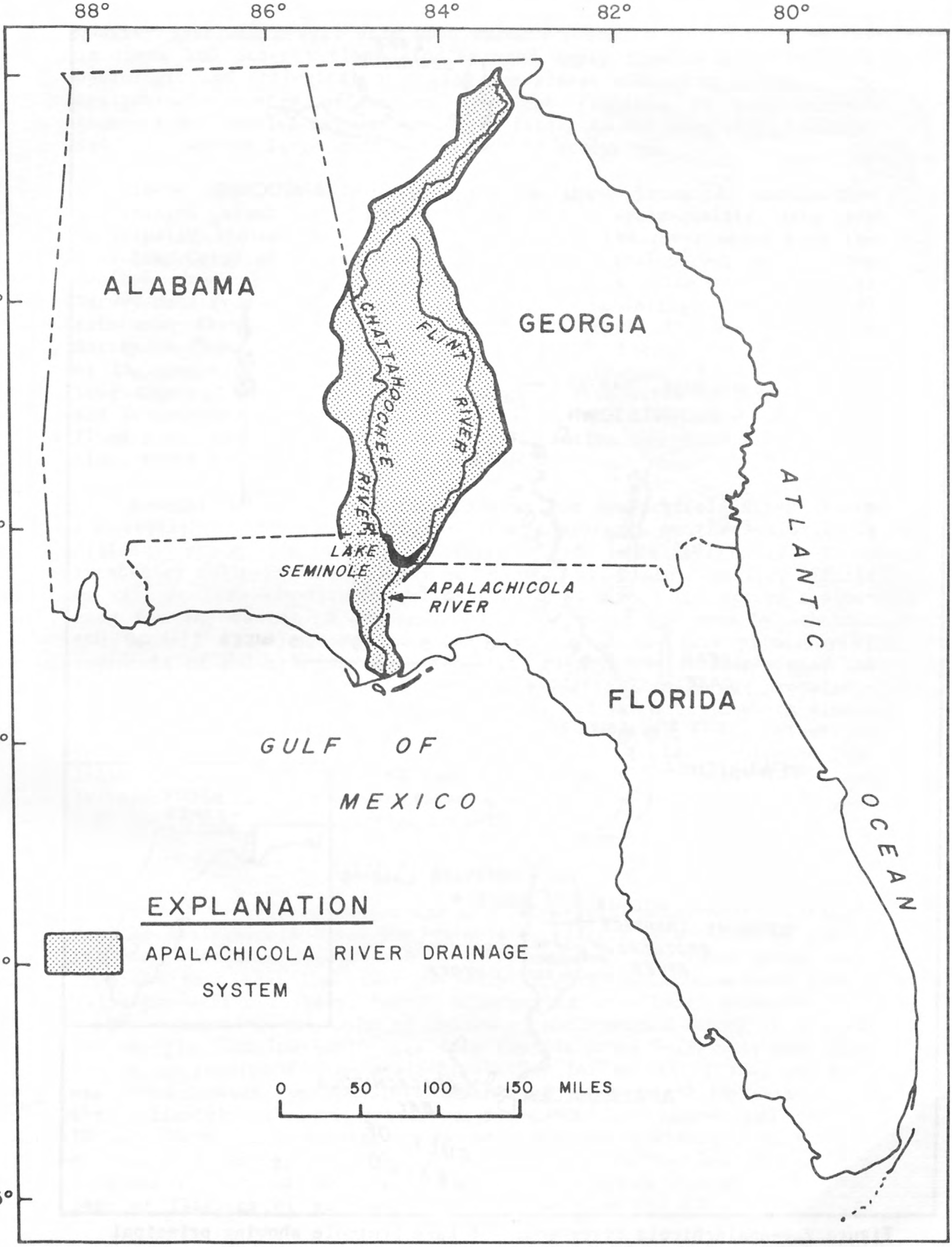

Figure 1.--Apalachicola River drainage system in the southeastern United States.

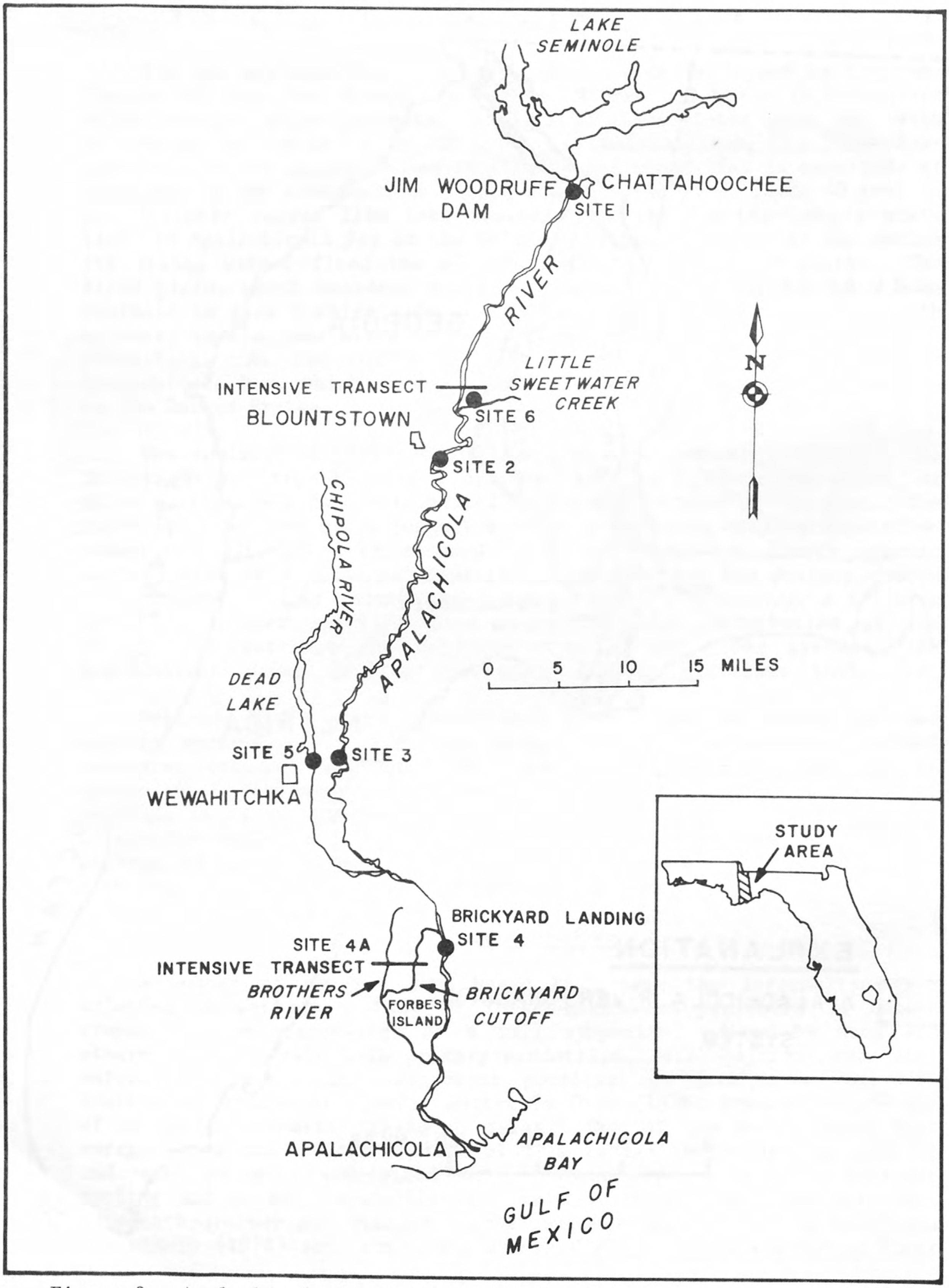

Figure 2.--Apalachicola River south of Lake Seminole showing principal sampling sites.

Quality Assessment will draw upon information and techniques developed in these and other wetland studies, and apply them to a system whose hydrologic and ecological processes are almost unknown at present. The Apalachicola system offers an excellent crucible to test current theories and develop new methodology relating to the chemistry, biology, and hydrology of large undisturbed wetland ecosystems.

There have been few studies which have produced quantitative information about the Apalachicola River. Water-quality data are principally limited to the upper 5 miles of the river where both the U.S. Army Corps of Engineers and the U.S. Geological Survey periodically monitor chemical and biological characteristics. The U.S. Geological Survey data from the National Stream Quality Accounting Network (NASQAN) site near Chattahoochee are published annually by the U.S. Geological Survey in "Water Resources Data for Florida." A report on the results of the Corps of Engineers study is in preparation. A correlation of tree communities with water levels at 1-hectare sites near Blountstown and Wewahitchka was done by Leitman (1978). She identified three major flood-plain tree communities whose distribution was related to elevation, river stage height, and soil type.

Several descriptive publications on the Apalachicola River system are available. The proceedings of the conference on the Apalachicola drainage system, edited by Livingston and Joyce (1977), report on freshwater mollusks, terrestrial vertebrates, fish and wildlife, effects of fill on tree vitality, legal aspects of damming, and economic planning for the basin. A geological description of the area by Schnable and Goodell (1968) shows that the river basin consists primarily of sediments of Holocene age with some late Pleistocene sediments near the mouth of the river. The U.S. Fish and Wildlife Service has produced a 1:100,000-scale "Wetland Map" (1978) of part of the area in which almost the entire river flood plain has been classified as a palustrine forested wetland. The U.S. Geological Survey has published two 1:250,000-scale land use and land cover maps of the area (1979a and 1979b). Most of the river flood plain has been classified by the U.S. Geological Survey as forested wetland.

River Management Conflicts

Recent controversy about the most beneficial management strategies for the Apalachicola River has stimulated efforts by a number of institutions to acquire more knowledge of the system. The controversy stems from the fact that the river not only supports a large wetland forest and a productive fishery, but it also serves as a barge transportation system connecting the Gulf of Mexico with industrial areas in Alabama and Georgia. Marine ecologists from Florida State University have been active in studies of the Apalachicola Bay for several years, and have expressed concern over possible impacts of navigational improvements on the delicately-balanced estuarine food web (Livingston and others, 1974). Maintenance of the river as a navigable channel, whether by extensive dredging, channelization, or dam construction, might mean disruption of the natural flooding cycle and subsequent reduction in the rate of flushing of nutrients and detritus from the flood plain. The operation and maintenance of the tririver system as authorized by the U.S. Congress was described by the U.S. Army Corps of Engineers (1976). Again in 1978 the Corps released a document describing potential benefits and impacts of various alternatives for navigational improvements. Three alternatives were considered: (1) continuation of present maintenance dredging, (2) open-river regulation involving construction of cut-off channels, and (3) construction of a dam near Blountstown. The U.S. Fish and Wildlife Service (1979) reviewed the impact statement and described several potential environmental impacts of the various alternatives. An alternative suggested by the U.S. Fish and Wildlife Service as the most acceptable was complete railroad transport of commodities, eliminating the necessity for barge traffic.

OBJECTIVES

The U.S. Geological Survey's National River Quality Assessment Program (RQAP), of which the Apalachicola investigation is a part, was initiated in 1972 with two stated objectives (Greeson and others, 1977):

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 project conform to these overall program objectives with the modification that the investigation is process-oriented rather than problem-oriented. The interrelations of wetland processes and variables are to be emphasized, whether or not they represent water-quality problems. A primary objective of the project is to develop approaches and methods for wetland investigations. Special emphasis is given to procedures for assessing the role of hydrodynamics in wetland ecology and measuring the flow of detritus through the system.

Application of these methods to studies of flood-plain hydrology, plant ecology, and transport of nutrients and detritus in the Apalachicola should develop a better understanding of the particular river-wetland system. The methods could have transfer potential to similar studies in other regions.

The specific objectives of the Apalachicola River Quality Assessment are:

1. To determine the extent of accumulation of potentially toxic trace elements and organic substances in benthic organisms and sediments.

2. To describe how tree distribution on the flood plain is related to the pattern of inundation (duration, level, and frequency).

3. To assess the importance of leaf production and decomposition on the flood plain to detritus and nutrient yields.

4. To identify major sources of nutrients to the river system and quantify transport of nutrients and organic detritus in various parts of the system.

The last three objectives address the processes whose net effect is the export of nutrients and organic detritus to Apalachicola Bay. The first objective is not directly related but provides baseline data which is presently lacking.

Although an analysis of nutrient recycling within the flood plain would be a desirable part of the Apalachicola River Quality Assessment, a thorough analysis of nutrient recycling would require additional studies of migration of soluble nutrient phases through the soil and ground-water system. Such an analysis would include at least the following: (1) absorption; (2) adsorption; (3) complexation; (4) chemical precipitation; (5) reutilization by the vegetative community; and (6) atmospheric diffusion. Although an evaluation of nutrient recycling has several tangible management and planning benefits for the Apalachicola River Basin, it is not included as an objective of the present assessment.

Scope

Geographically, the study is limited to the Apalachicola River and its flood plain from the Jim Woodruff Dam, which impounds Lake Seminole, downstream to the northernmost extent of tidal influence, some 20 miles from Apalachicola Bay. This broad areal scope is achieved by collecting data at representative locations and extrapolating results to describe the entire basin. Water-quality samples are to be collected monthly with more frequent collections during flooding. Two detailed vegetative transects will be supplemented with eight tree survey transects across the flood plain distributed throughout the length of the river. Most field activities will be completed by August 1980.

Flooding occurs on the Apalachicola River in the winter and early spring. It is expected that the high water during flood season will produce the maximum transport of nutrients and detritus from the flood plain to the bay. Data collection began in February 1979 and will continue through August 1980. This schedule offers the opportunity to experiment with various sampling techniques during the 1979 flood season, followed by regular monitoring the remainder of the year. The assessment will be well underway by the winter of 1979-80, and should thereby achieve full coverage of the 1980 floods.

THEORETICAL CONSIDERATIONS

Figure 3 illustrates the probable interaction between hydrologic and biological factors which results in nutrient and detritus yield to the estuary. The central variable in the entire sequence is flooding, which is caused by abundant winter rainfall in Georgia. Discharges of 40 to 50 thousand ft^3/s raise the river stage sufficiently to flood extensive areas of bottom-land hardwoods. An unknown fraction of the leaf drop from the prior autumn is carried off the flood plain and ultimately into Apalachicola Bay. Flood waters remain on the flood plain for variable periods of time depending on land elevation, proximity to the numerous small streams, summer rainfall, and the soil type in low-lying areas. The extent and the duration of standing water are believed to control the particular species of trees that grow in the various habitats. The bottom-land hardwood forest has at least 30 common species of trees indicating the complexity that is characteristic of this area. The type and density of the various trees control the type, amount, and timing of leaf fall. Little is known about the relative decomposition rates of the different tree leaves. The leaves decompose to produce organic detritus with variable quantities of carbon, nitrogen, and phosphorus. When flooding occurs each year some fraction of the residue is either dissolved or eroded and transported to the bay.

From this general scenario, there have emerged a number of hypotheses which are to be tested in this assessment. The hypotheses are enumerated below:

1. The distribution of tree species growing on the flood plain is dependent on the long-term flooding pattern.

> There are unquestionable differences among tree species with respect to flooding tolerance (Robertson and others, 1978; Bedinger, 1971). For any section of flood plain, the extent and duration of mean annual inundation will determine the kinds of trees it supports.

2. The decomposition rate of leaf litter is dependent, in the short term, on the extent and duration of flooding.

> This is based on the premise that leaves decompose in a wet environment at a rate different than that in a dry environment (Nykvist, 1963). As decomposition rate changes, so will the availability of organic detritus and nutrients for transport out of the system. Hence flooding influences net nutrient and detritus transport indirectly by affecting decomposition rates (short-term basis), and tree species distribution (long-term basis).

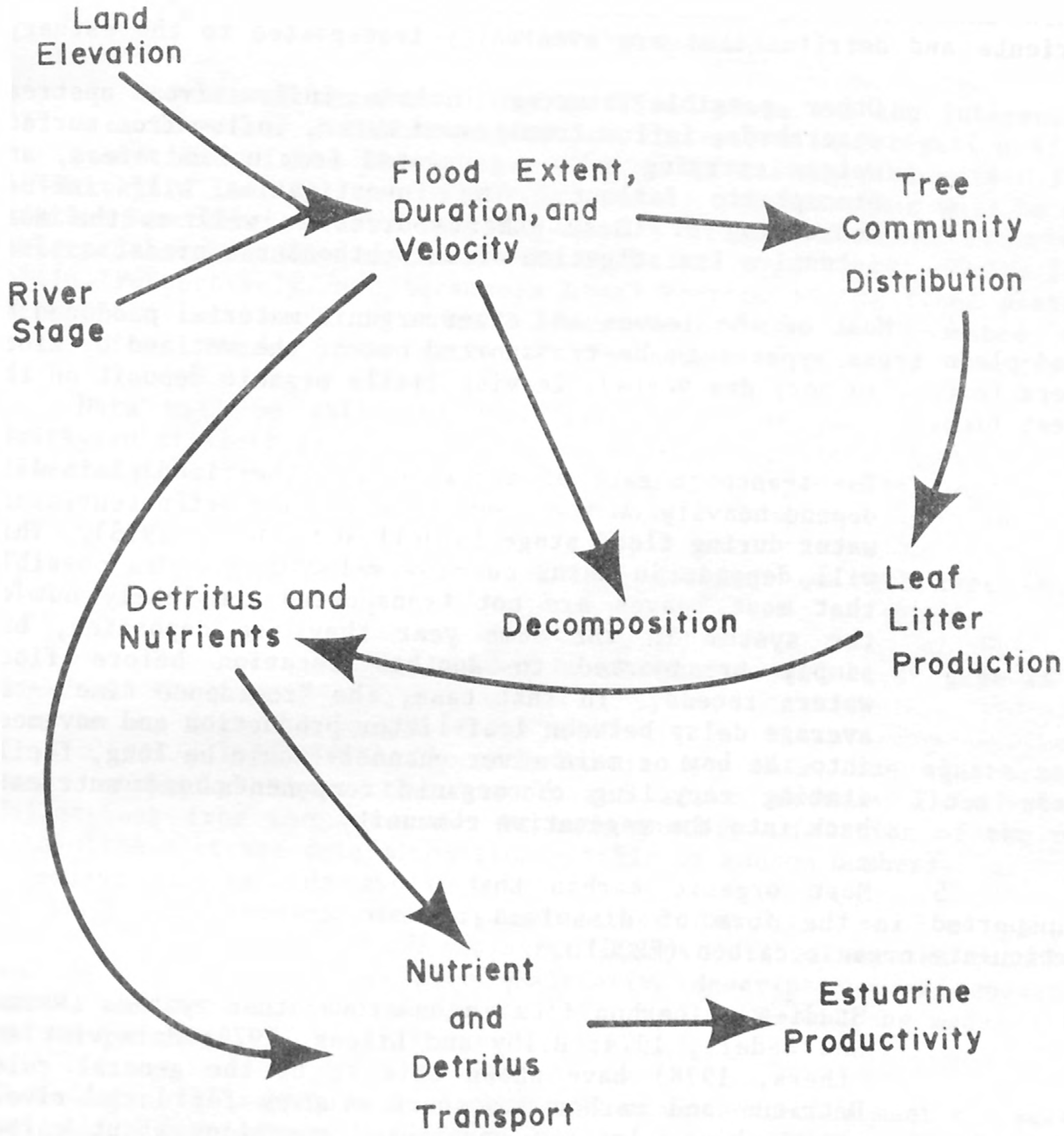

Figure 3.--Hydrologic and biologic interactions influencing nutrient and detritus yield.

3. The autochthonous organic matter (that which is produced within the river and flood-plain system) is the principal source of nutrients and detritus that are eventually transported to the estuary.

> Other possible sources include inflow from upstream watersheds, inflow from ground water, inflow from surface waters carrying matter generated from upland areas, and atmospheric fallout. The investigation will include monitoring of these other sources as well as the more intensive investigation of autochthonous sources.

4. Most of the leaves and other organic material produced by flood-plain trees appears to be transported out of the wetland by flood waters (except in very dry years), leaving little organic deposit on the forest floor.

> The transport rate of debris out of the flood plain will depend heavily on the scouring and transport potential of water during flood stage (Sedell and others, 1978). This will depend, in turn, on flow velocity. It is possible that most leaves are not transported completely out of the system in the same year they are deposited, but simply transported to another location before flood waters recede. In that case, the "residence time"--the average delay between leaf-litter production and movement into the bay or main river channel--would be long, facilitating recycling of organic components and nutrients back into the vegetative community.

5. Most organic carbon that flows through the system is transported in the form of dissolved organic carbon (DOC) and fine particulate organic carbon (FPOC).

> Studies of carbon flux in numerous other systems (Naiman and Sedell, 1979; Bilby and Likens, 1979; Malmqvist and others, 1978) have shown this to be the general rule. Detritus and carbon transport studies for large rivers are lacking, leaving unanswered questions about carbon flow mechanisms.

6. Medium and coarse particulate detritus (>62-μm particle size) is transported primarily along the bottom of the river channel. Fine particulate organic matter and dissolved organic matter, on the other hand, are distributed homogeneously throughout the flowing water.

> This hypothesis has important implications for sampling techniques. It will be tested by using variations in sampling times, locations, and procedures.

WORK ELEMENTS

Flood-plain Investigations

As a means of characterizing the flood plain and the interactions of water flow and detritus production, intensive investigation of two cross sections of the flood plain will be undertaken. One site will be at Brickyard Landing, near sampling site 4, and the other will be near Little Sweetwater Creek, sampling site 6 (fig. 2). These sites were selected because they represent the lower and upper parts of the flood plain, respectively, and because a broad section of the flood plain is accessible at each location. Because of the concentrated data collection, these cross sections are termed "intensive transects."

Data will be collected from sixteen 500-m^2 plots, nine at the Brickyard transect and seven at the Sweetwater transect. The plots were selected to represent different tree community types that exist in the transect. The type of data to be collected from each plot includes:

1. Species and breast-height diameter of each tree in the plot.

2. Water stage measured by staff gage and crest gage in the center of the plot.

3. Leaf litter accumulated in two nets, one square meter each, suspended above the ground and above maximum flood stage. Collections from the nets will be made monthly. Location of the nets within the plot are determined from a table of random numbers.

4. Sediment and organic matter deposited on 1 m^2 plastic sheets at ground level. The plastic sheets will be located randomly. Monthly observations will give qualitative descriptions of deposition rates, and measurements of the total accumulation will be made at the end of one year.

These data will supply much of the information needed to meet the second and third project objectives. The relation between flooding and tree-species distribution will be examined using data elements 1 and 2. Leaf-litter production rates and its variability with time, tree species, and location may be assessed using data element 3. Data element 4 should indicate if, when, and how much material is being transported from the floor of the flood plain.

In addition to the two intensive transects, other cross sections of the flood plain will be examined to provide more complete coverage of the entire flood plain. In these "cruise transects," the data collected will be limited to tree species and diameters, using standard forest measurement procedures. Aerial photography will be used to locate each cruise transect. Accessible sites that are representative of the flood plain will be chosen. Two of these will be at the intensive transect sites; the others will be evenly distributed along the 95 miles of river from Jim Woodruff Dam to the lower end of Forbes Island. The more transects sampled, the more accurately the data will represent the distribution of species on the entire flood plain, although the information return per additional transects decreases after a number of critical transects are completed. The number of transects examined will be determined by ongoing evaluation of the species, size, and density of trees.

Cruise transect results will yield information about: (1) composition of major tree-community types, (2) percentage and total area of the community types in the entire flood plain, (3) tree basal area per hectare for each species and each community type, and (4) density of trees per hectare for each species and each community type. This characterization of the entire flood plain provides a means of extrapolating data from intensive transects and leaf decomposition investigations to the entire flood plain.

River Sampling

The transport of nutrients and detritus in the river will be monitored at four principal collection locations indicated in figure 2. Three additional sites, off the main river channel, will be sampled for nutrients only. Site 1 near Chattahoochee is a NASQAN sampling site with good nutrient data from 1971 to present (1980). Site 2 is at the Corps of Engineers' discharge station near Blountstown. The 27-mile river segment between sites 1 and 2 has a relatively narrow flood plain dominated by various hardwood species. Site 3 is a new daily discharge station above the Chipola River cutoff near Wewahitchka. The 35-mile long segment of the river between sites 2 and 3 has a broad flood plain and numerous small streams draining adjacent swamps. Site 4 is at Brickyard Landing which was established in 1977 as a daily-discharge station. This is the last downriver site accessible overland that is not influenced appreciably by tidal fluctuations. The 24-mile segment of river between sites 3 and 4 drains forested flood plain. Site 5 is located on the Chipola River below Dead Lake. It is used to monitor the contribution from this major tributary. Site 6 is located on a small tributary stream, Little Sweetwater Creek, and represents lateral input to the river from the drainage basin. It drains an area of considerable relief and runs through a relatively narrow pass, where discharge measurement is possible, before entering the flood plain. Continuous discharge stations are being established at sites 5 and 6. The seventh site (site 4A) is a companion to site 4; it is a flood-plain composite at the point of the Brickyard Landing sampling site and intensive transect. Samples at this site are collected as a composite of water from Brickyard Cutoff, and Brothers River. Additional samples from the flood plain are included in this composite sample during flooding.

Samples will be collected monthly during low-flow periods and twice monthly during flood season. At peak flows, sampling is to be more frequent and timed with the floods. A 3-4 day delay between rainstorms in Georgia and flood crests on the river allows some preparation time. Sampling began in late February 1979 and will continue through June 1980.

The purpose of the river sampling is to acquire actual measurements of nutrient and detritus transport in different segments of the river. These will be compared with data from the flood plain to estimate the extent of transport of potentially-available autochthonous material. Water samples are collected as depth-integrated, cross-sectional composites from each site. They are analyzed for various suspended and dissolved fractions of carbon, nitrogen, and phosphorus, including nitrate plus nitrite, ammonia, organic nitrogen, orthophosphate, total phosphorus, suspended and total organic carbon, and inorganic carbon. Chloride concentration is analyzed to include a conservative unreactive ion. Bulk precipitation samples from collectors located near the four main-channel sampling sites (sites 1-4) are analyzed for the same nutrients.

Measurement techniques of detritus flow in large rivers are relatively untested. Two different sampling procedures are currently being used for the two fractions of transported organic matter. That which is suspended in the main body of flowing water is sampled by pumping water through a hose and nested set of sieves of 1-mm and 62-mm mesh size. This seive selection permits separation of large debris (>1-mm particle size), coarse particulate organic matter (CPOM, 62 μm - 1.0 mm), and fine particulate organic matter (FPOM, 0.45 μm - 62 μm). The FPOM fraction passes through the seives and is analyzed separately for suspended organic carbon on 0.45-μm silver filters. The dissolved carbon fraction is analyzed from filtered water. The pumping and sieving sampling procedure has the advantage that a relatively large amount of water may be sampled from any depth and any location desired (or any composite of depths and locations) and separated into size fractions. A much greater volume of water can be sampled with a suspended net, but size fractioning and depth sampling are more difficult. Both methods will be tested and compared during the project.

The other principal type of transported organic matter is that which moves along the river bottom. To sample this material, a net is suspended at one place in the main river channel for a fixed period of time, then retrieved and emptied. Periodic measures of cross-sectional distribution of coarse detritus will permit estimates of total bottom load. The net is of large mesh size (1 mm) since it is intended to collect debris which is large enough to settle and be pushed along by the current (as differentiated from small particles which remain suspended). Collection methods for bottom-channeled material have not been developed for large fast-flowing rivers, and little information is available about this potentially important transport mechanism. Refinement of the method is one of the principal methods-oriented work elements of the project. Large floating debris such as branches and logs are not accounted for by any of the sampling procedures. The total biomass transported by this means is typically negligible in rivers, however.

Trace Elements and Pesticides

Available NASQAN data from site 1 indicate that pesticides and metals are absent or nearly absent in Apalachicola River water. This condition is not expected to vary downstream since no major point source of pollutants exists in the Apalachicola watershed. Recent studies in Apalachicola Bay (Livingston and others, 1978), and at two sites in the river (W. W. Johnson, U.S. Fish and Wildlife Service, oral commun., 1979) have shown, however, that concentrations of toxic substances in some local aquatic organisms are relatively high for an "unpolluted system." In other aquatic systems, significant impacts upon aquatic flora and fauna have been observed at very low concentrations of toxic metals (LeLand and others, 1978). The significance of toxicants may be amplified by biomagnification in the food web, often manifested by accumulations in certain species of benthic invertebrates, fish, or birds. An inventory of existing levels of metals and pesticides may be done relatively easily. It will at least provide baseline data which will be important for future evaluation of potential sources, and it may reveal some existing sources.

Samples of fine-grained sediments, bottom-load detritus, and fresh-water clams will be collected at the main river sampling sites (1-4), at least once during low-flow and once during high-flow. Sediments will be separated, by sieving and sedimentation-decantation, into particle-size fractions. The clay fraction (<20-μm particle size) will be used for heavy metal analysis. The clams to be used are Corbicula manilensis, that are widespread throughout the river. Clam and bedload samples will be analyzed to determine concentrations of the following substances:

Heavy Metals	Herbicides	Organophosphorus Insecticides
As	2,4-D	Diazinon
Cd	2,4-DP	Ethion
Cr	2,4,6-T	Malathion
Cu	Silvex	Methyl parathion
Pb		Methyl trithion
Mn		Parathion
Hg		Trithion
Zn		

Leaf Decomposition

The leaf decomposition process converts the leaf fall into fine particulate detritus and dissolved organic compounds. The five most abundant tree species in the flood plain have been selected to document the rate of decay and release of carbon, nitrogen, and phosphorus during the decay process. The five species, table 1, represent a variety of leaf morphologies which may play an important role in the decomposition process.

Table 1.--Tree species and leaf morphology

Common name	Scientific name	Leaf morphology	Leaf dimensions
Bald cypress	Taxodium distichum	Needlelike on a slender stem	0.5 - 1.2 cm long.
Sweet gum	Liquidambar styraciflua	Thin, pliable, starshaped	12 - 18 cm long, 10 - 12 cm broad.
Water tupelo	Nyssa aquatica	Thin, pliable, simple shape	12 - 18 (sometimes 30) cm long.
Diamond-leaf oak	Quercus laurifolia	Stiff, leathery, simple shape	5 - 12 cm long, 1 - 5 cm broad.
Water hickory	Carya aquatica	Thin, pliable, multiple leaflets on a stalk.	7 - 15 leaflets per leaf, 20 - 40 cm long overall.

Leaves for each species will be collected at abscission during the peak fall for that species as determined by their presence in the accumulation nets. These leaves will then be air dried and placed in nylon bags of 2.5 mm mesh. A sufficient number of bags will then be placed both in the river and on the flood plain to allow four replicates for each sample time. Sampling will be done twice weekly for 6 months or until the decay process is essentially complete. In addition, six locations representing a variety of flood-plain conditions were chosen for decomposition experiments with a composite sample representing indigenous leaves caught by the accumulation nets. Bags are placed on the flood plain at the six collection sites and collected monthly. Upon retrieval each sample will be chemically analyzed to measure the loss of nutrients versus time and the rate of decay as determined by the percentage weight loss.

Associated experiments with each of the five species will be designed to determine the organisms involved in the decay process and interactions among the organisms. Initially this will be done by using a smaller mesh bag (0.5 mm) to exclude the larger detritivores (shredders and grazers). Determinations will then be made of microbial biomass and the differences in rate of decay within the two mesh sizes used.

The time and amount of leaf fall and the rate of decomposition will determine the nutrient and detritus pool available for transmission from the flood plain to the river. The actual transport of the decayed leaf material to the river system will be largely dependent on the hydrodynamics of the flood plain during high water periods.

Discharge Measurements

Instantaneous discharge rates in the main channel, the Chipola River and Little Sweetwater Creek, are determined from rating curves and stage records for the permanent stage recording stations at the six locations. Records exist for many years at the Apalachicola River near Chattahoochee, dating as far back as 1929. Discharge measurements will be made during the course of the investigation to refine the rating curves and detect any stage-discharge shifts that may occur.

Flood-plain velocities will be measured at the Brickyard Landing and Little Sweetwater Creek transects. These velocity measurements during flood stage will be used to establish rating curves for the four flood-plain, continuous-record, stage gages, two at each of the transect locations. Ground elevations in the transects will also be surveyed. The record of stage will thus provide flood depth, duration and estimated velocity, and discharge for the flood plain. The depth and duration record will be compared with the distribution of tree communities. The velocity measurements will be compared with the erosion and transport of decaying leaf matter. The discharge computations will be utilized to compute loads of detritus moving across the flood plain and into the river system. The flood-plain stage records will provide additional information on the chronology of flooding and recession when compared with stage records from the main river channel.

Collection of nutrients and detritus at four locations of discharge measurement down the main river channel will provide an estimate of the gain of materials for three major segments of the river and flood-plain system. Gains per acre of flood plain in each of the three segments will indicate the importance of flood-plain morphology on detritus transport. If the flood plain acts as a sink instead of a nutrient and detritus source, there may be a net loss of transported material.

Major winter-spring flooding on the Apalachicola is primarily dependent upon rainfall in the Chattahoochee and Flint River watersheds. In the summer and fall, however, smaller but significant floods can result from local rainstorms. Such occurrences during the current project will be monitored carefully so that the importance of local summer-fall rain may be evaluated. This may be interpreted further by examination of local weather records to attain historical analysis of late-season flushing. The impact of Jim Woodruff Dam will also be examined using stage records from before and after completion of the dam in 1957.

Ground-water Levels

Ground-water level records will be collected at the Brickyard Landing and Little Sweetwater Creek intensive transect areas. Two major objectives will be investigated: (1) the degree of lateral connection between the shallow water table and the river, and (2) the relative importance of ground-water discharge to the flood plain and river.

Large reaches of the river bank have natural levees that restrict surface transport of water onto and off the flood plain. If the ground-water table has a good connection with the river, initial flooding in some areas may result from a rising water table. If the interconnection between river and ground-water table is poor, large low-lying areas may not be flooded until river stage exceeds the natural levee elevation. With a poor interconnection these same areas may remain flooded for long periods following river subsidence. Since trees are affected by the duration of flooding, the interconnection of the river and ground-water table may influence the distribution of tree communities.

Several recent investigations have described wetlands that were areas of ground-water discharge. The relative importance of ground-water discharge in the Apalachicola flood plain has never been tested. Regional ground-water flow toward the river at Brickyard Landing and Sweetwater Creek is probably very different because of the difference in relief. A few well-placed ground-water level recorder stations will furnish data to evaluate any differences and establish the relative importance of ground-water discharge to the river and flood-plain water balance.

Mapping of Vegetation and Inundation

The Apalachicola River Quality Assessment intends to describe the constitution and function of the river basin as a whole. This will require extrapolation of data collected at the specific flood-plain transects and river sampling sites to a basin-wide framework. The basin may be characterized most effectively by the use of maps to illustrate distribution of different vegetative communities and the inundation patterns.

Remotely-sensed data have been used previously to determine areas of inundation (Moore and North, 1974) and to map forested wetland vegetation (Carter and Stewart, 1975; deSteiguer, 1977; Gammon and Carter, 1979). Attempts will be made to make similar use of Landsat imagery and low-level color infrared photography available for the Apalachicola basin. Application for flood-mapping, however, will be limited due to masking by the dense forest canopy during most of the year. For vegetative mapping, Landsat imagery has considerable potential. Data gathered at the intensive and cruise transects will be used to analyze Landsat data throughout the basin. Variation in reflected signals from surfaces of the ground, water, and vegetation should be distinguishable to permit mapping of different vegetative communities. If such vegetation maps prove reliable, quantitative estimates of the extent of various trees or tree communities can be made and used for basin-wide leaf production estimates.

PUBLICATION PLANS

Four interpretive reports documenting the methods, techniques and results of the four major objectives of the Apalachicola River Quality Assessment will be prepared for publication as U.S. Geological Survey Water Supply Papers. The tentative titles are:

1. "Occurrence of trace elements and organic substances in sediment and bivalve *Corbicula manilensis* in the Apalachicola River, Florida."

2. "Flood patterns and tree distribution on the Apalachicola River flood plain."

3. "Production and decomposition of leaf litter on the Apalachicola River flood plain."

4. "Nutrient and detritus transport in the Apalachicola River."

The fourth report will draw heavily on data from the other three and serve to summarize the entire Apalachicola River Quality Assessment.

SUMMARY

The Apalachicola River basin in Florida is a large complex ecosystem which is characterized by an extensive bottom-land hardwood tree community. The flood-plain vegetation has been cited as the source of the detritus and nutrients which sustain the abundant estuarine production in Apalachicola Bay.

The Apalachicola River Quality Assessment will employ a variety of techniques and methods to:

1. Identify the major tree communities that occupy the flood plain.

2. Relate the location of tree communities to the long-term flooding patterns.

3. Measure the annual tree-leaf production for the major tree communities.

4. Investigate the decomposition of leaf litter into detritus and nutrients.

5. Describe the erosion and transport of the litter from the flood-plain floor into the river.

6. Quantify the yield of nutrients and detritus from the study area.

7. Ascertain the relative role of bulk precipitation and ground-water discharge to the nutrient yield.

8. Characterize the hydrodynamics of the flooding process and the role of the river.

9. Survey trace elements and organic substances in fine-grained sediment, bedload detritus, and clams.

10. Evaluate and publish descriptions of techniques, results, and conclusions by March 1981.

The broad scope and specialized disciplines required in the assessment dictated a multidiscipline background for the investigative team and the collaboration of the U.S. Geological Survey technical steering committee. Additional advice has been offered from a broad cross-section of specialists, especially Joseph Larson, University of Massachusetts; Robert Livingston, Florida State University; James Lucas, EROS Data Center; and James C. Brice, U.S. Geological Survey.

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