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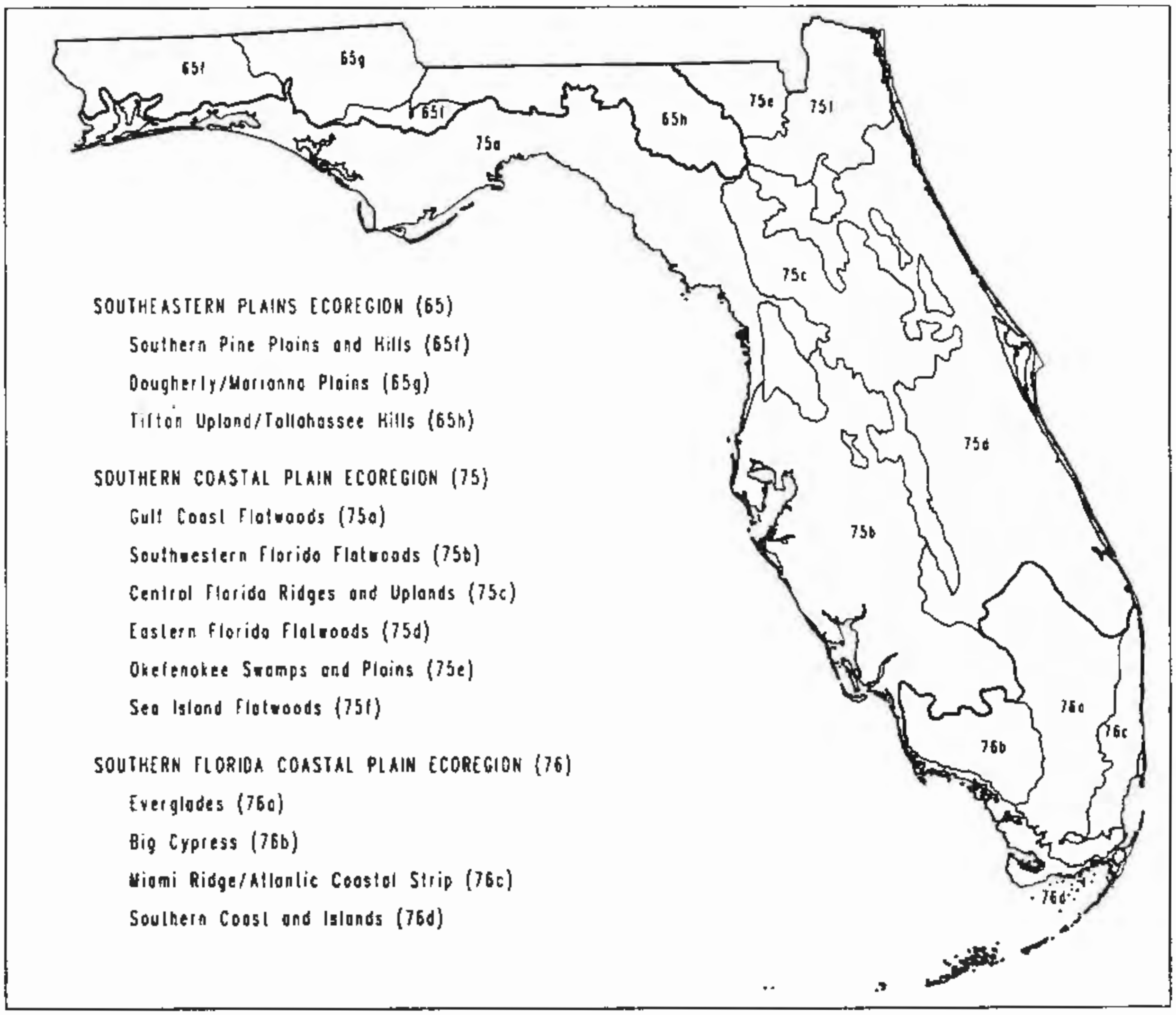
FLORIDA REGIONALIZATION PROJECT



FLORIDA REGIONALIZATION PROJECT

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ABSTRACT

Ecoregion frameworks are valuable tools for environmental resource inventory and assessment, for setting resource management goals, and for developing biological criteria and water quality standards. In a cooperative project with the Florida Department of Environmental Protection, the U.S. Environmental Protection Agency and other interested agencies, we have defined ecological regions and subregions of Florida, and have selected sets of stream reference sites within most of the subregions. The ecoregions and reference sites can be used to better understand regional variations in stream quality, to assess attainable conditions and to structure aquatic resource regulatory programs. In conjunction with this effort we have reviewed aquatic classifications of Florida, and have analyzed fish species distribution patterns.

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SECTION 1
ECOREGION/SUBREGION FRAMEWORK

1.1 INTRODUCTION

Spatial frameworks are important for structuring the research, assessment, monitoring, and management of environmental resources. Ecological regions, defined in general terms as regions of relative homogeneity in ecological systems and relationships between organisms and their environments, have been developed in the the United States (Bailey 1976; Omernik 1987), Canada (Wiken 1986), New Zealand (Biggs et al. 1990) and other countries for these organizational purposes. Ecoregions are usually defined by patterns of homogeneity in a combination of factors such as climate, physiography, geology, soils, and vegetation. These regions also define areas within which there are different patterns in human stresses on the environment and different patterns in the existing and attainable quality of environmental resources. Ecoregion classifications are effective for national and regional environmental resource inventory and assessment, for setting regional resource management goals, and for developing biological criteria and water quality standards (Gallant et al., 1989; Hughes et al., 1990; Hughes 1989; Environment Canada 1989; U.S. Environmental Protection Agency, Science Advisory Board 1991; Warry and Hanau 1993).

The development of ecoregions in North America has evolved considerably in recent years (Bailey et al. 1985; Omernik and Gallant 1990). The first compilation of ecoregions of the conterminous United States by the U.S. Environmental Protection Agency (EPA) was performed at a relatively cursory scale, 1:3,168,000, and was published at a smaller scale, 1:7,500,000 (Omernik 1987). The approach recognized that the combination and relative importance of characteristics that explain ecosystem regionality vary from one place to another and from one hierarchical level to another. This is similar to the approach used by Environment Canada (Wiken 1986). In describing ecoregionalization in Canada, Wiken (1986) stated:

> "Ecological land classification is a process of delineating and classifying ecologically distinctive areas of the earth's surface. Each area can be viewed as a discrete system which has resulted from the mesh and interplay of the geologic, landform, soil, vegetative, climatic, wildlife, water and human factors which may be present. The dominance of any one or a number of these factors varies with the given ecological land unit. This holistic approach to land classification can be applied incrementally on a scale-related basis from very site-specific ecosystems to very broad ecosystems."

The ecoregions defined by Omernik (1987) were shown to be useful for stratifying streams in Arkansas (Rohm et al. 1987), Nebraska (Bazata 1991), Ohio (Larsen et al. 1986), Oregon (Hughes et al. 1987; Whittier et al. 1988), Washington (Plotnikoff 1992), and

Wisconsin (Lyons 1989). Arkansas, Minnesota, and Ohio have used the 1987 ecoregion map to set water quality standards (Arkansas Department of Pollution Control and Ecology 1988), lake management goals (Heiskary and Wilson 1989), and to develop biological criteria (Ohio EPA 1988). Many state agencies, however, have found the resolution of the regions in the 1:7,500,000 scale map to be of insufficient detail to meet their needs. This has led to several collaborative projects, with states, EPA regional offices, and EPA's Environmental Research Laboratory in Corvallis, OR (ERL-C), to refine ecoregions and define subregions at a larger (1:250,000) scale. In addition to Florida, these projects cover Iowa, Massachusetts, the Coast Range and Columbia Plateau of Oregon and Washington, and parts of Mississippi, Alabama, Pennsylvania, Virginia, Maryland and West Virginia.

Sets of regional reference sites within an ecoregion or subregion can give managers and scientists a better understanding of attainable water body conditions. The biota and physical and chemical habitats characteristic of these regional reference sites serve as benchmarks for comparison to more disturbed streams, lakes, and wetlands in the same region (Hughes et al., 1986; Hughes et al. 1993; Hughes in press). These sites indicate the range of conditions that could reasonably be expected in an ecoregion or subregion, given natural limits and present or possible land use practices.

In a cooperative project with the Florida Department of Environmental Protection (DEP), the U.S. EPA, and other interested parties, we have refined aquatic ecoregions and defined subregions, and have selected candidate stream reference sites. In this section we discuss the method and materials used to define subregions of the Southeastern Plains Ecoregion, the Southern Coastal Plain Ecoregion and the Southern Florida Coastal Plain Ecoregion and provide descriptions of the significant characteristics in each subregion.

It is important to note that the regions and subregions defined are general ecological regions and not special purpose regions. During the planning stages of the project, a question was posed to the Florida DEP personnel regarding the type of regional framework they desired. Did they want special purpose regions reflecting spatial patterns in the attainable quality of ecosystem components such as macroinvertebrates or fish, or did they want a more holistic framework that would not address any single component perfectly, but would instead be generally useful for many environmental resources? The answer was that their immediate needs were for the more general, multi-purpose ecoregion framework.

1.2 METHODS

In brief, the procedures used to accomplish the regionalization process include compiling and reviewing relevant materials, maps, and data; outlining the regional characteristics; drafting the regional and subregional boundaries; digitizing the boundary lines, creating digital coverages, and producing cartographic products; and revising as needed after review by state managers and scientists. In our regionalization process we employ primarily qualitative methods. That is, expert judgement is applied throughout the selection, analysis, and classification of data to form the regions, basing judgments on the quantity and quality of reference data and on interpretation of the relationships between the data and other environmental factors. More detailed descriptions on methods, materials, rationale, and philosophy for regionalization can be found in Omernik (1987), Gallant et al., (1989), and Omernik and Gallant (1990).

Maps of environmental characteristics and other documents were collected from the state of Florida and from ERL-C. The most important of these are listed in the References section. The most useful map types for our ecoregion delineation are usually physiography or land-surface form, geology, soils, climate, vegetation, and land use. Physiographic and land surface-form information were gathered from many sources including Brooks (1981b; 1982), White (1970), Puri and Vernon (1964), Clark and Zisa (1976), Sapp and Emplaincourt (1975), Fenneman (1938), and Hammond (1970). Geology maps included the 1:250,000-scale Environmental Geology Series from the Florida Bureau of Geology, state scale maps (Brooks 1981a; Vernon and Puri 1964; Osborne et al., 1989; Lawton 1977) and national scale maps such as Hunt (1979) and King and Biekman (1974). Soils information was obtained from the Florida Agricultural Experiment Stations and U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) (1962), Caldwell and Johnson (1982), USDA-SCS (1984), USDA (1973), Perkins and Shaffer (1977) and preliminary 1:250,000-scale SCS State Soil Geographic Data Base (STATSGO) soil maps. Additional soils information was obtained for some areas from the USDA's county-level soil survey publications. Climate information was collected from Bradley (1974), Fernald (1981), and Jordan (1984). For land use/land cover we used primarily the 1:250,000-scale U.S. Geological Survey (USGS) maps, 1:500,000-scale maps for adjacent states (Lineback and Weaver, 1985), as well as the general classification of Anderson (1970). The vegetation and forest cover maps we used included Davis (1943, 1967), those in the state atlases (Fernald 1981; U.S. Army Corps of Engineers, 1981) and the national atlas (Kuchler, 1970; U.S. Forest Service, 1970), and a recent vegetation classification of Landsat Thematic Mapper imagery (1985-1989) developed by the Florida Game and Fresh Water Fish Commission. In addition, a map produced from composited multi-temporal Advanced Very High Resolution Radiometer (AVHRR) satellite data was also used to assess boundaries and regional differences. This AVHRR data is currently being used by the USGS EROS Data Center to characterize land cover of the conterminous United States (Loveland et al., 1991).

We used USGS 1:250,000-scale topographic maps as the base for delineating the ecoregion and subregion boundaries. Although some maps in this series are old, it does provide quality in terms of the relative consistency and comparability of the series across Florida, in the accuracy of the topographic information portrayed, and in the locational control. It is also a very convenient scale. Fifteen of these maps give complete coverage of the state.

The following section describes the revised ecoregions and proposed subregions in Florida (Figure 1). Although these subregions still retain some heterogeneity in factors that can affect water quality and biotic characteristics, the framework is an improvement on the earlier national-scale ecoregions, and provides more homogeneous units for inventorying, monitoring, and assessing surface waters than commonly used hydrologic unit frameworks or generalized physiographic districts.

1.3 REGIONAL DESCRIPTIONS

"Of course, no classification system fits the real situation perfectly. There are always plots of land, or water, that don't fit any category, or seem to fit two categories equally well," (Simons 1989, p.58).

SOUTHEASTERN PLAINS ECOREGION (#65)

Subregions:	States:
- Southern Pine Plains and Hills	AL, FL, GA, MS
- Dougherty/Marianna Plains	AL, FL, GA
- Tifton Upland/Tallahassee Hills	FL, GA

In north Florida, the Southeastern Plains Ecoregion occupies the hilly, pine and mixed hardwood forest area along the borders with Alabama and Georgia. The rolling hills of this area include Florida's highest elevation point, 345 feet, in northwest Walton County. The ecoregion has been characterized as containing smooth to irregular plains; oak/hickory/pine and southern mixed forests; a mosaic of cropland, pasture, woodland and forest; and mostly ultisol soils (Omernik 1987).

The southern boundary of this ecoregion has some heterogeneous characteristics, but the weight of mapped evidence supports the placement of our line. General soils and Major Land Resource Area (MLRA) maps, physiography maps, geology maps, relief maps, vegetation maps and regional maps show relatively close agreement for the division. Areas of uncertainty do exist however. In the western panhandle, the new ecoregion line has been moved slightly further south than the boundary shown by Omernik (1987). In Okaloosa and Walton counties, much of the Eglin Ridge area was previously in the Southern Coastal Plain Ecoregion (#75). Many of the physiographic, geologic, soils and vegetation maps show this area having similar characteristics with the Florida area to the north in the Southeastern Plains Ecoregion (#65). The AVHRR imagery, however, shows the Eglin area within a more southerly region. The break between the clay-rich Miocene deposits to the north and the sandy Plio-/Pleistocene deposits is not always apparent, but there are clayhill/sandhill vegetative differences (Myers 1990).

There is some uncertainty about where the eastern and southeastern boundary of the Southeastern Plains Ecoregion should be placed in Florida. Omernik's 1987 boundary on the east extends from Union County north to Lake City and Jasper and into Georgia. This line occurs at an obvious break in the land use mosaic and follows closely the physiographic division boundary of Brooks (1981b), and the North Central Florida Ridge MLRA boundary (USDA-SCS 1981). The boundary between the Central Florida Ridge MLRA and the Southern Coastal Plain MLRA is drawn near Madison in Madison county, and Hammond's (1970) land form class boundary separating irregular plains from flat plains occurs further west, roughly between the Aucilla River and Monticello in Jefferson County. Either of these lines seem suitable for enclosing the more hilly areas. The areas to the east of Madison and around Live Oak are plains of less relief and internal drainage and resemble areas to the south more than the hilly region to the west. While the division between Florida's Northern Highlands and Central Highlands is not prominent (White 1970), Omernik's 1987 ecoregion boundary is similar to the MLRA's (USDA-SCS 1981), and both occur at a soil temperature line dividing thermic from hyperthermic soil temperature regimes (Caldwell and Johnson 1982). The Suwanee River forms the eastern boundary of the panhandle, according to Clewel (1985), and forms a significant phytogeographic boundary. Many species of the panhandle occur no further east, and many other species of peninsular Florida occur no further west (Clewell 1985).

Southern Pine Plains and Hills Subregion (65f)

Called the Pine Hills or Piney Woods in Mississippi and Southern Pine Hills in Alabama, this subregion in Florida includes the Western Highlands or what Brooks (1982) refers to as the Blackwater Hills and Escambia Terraced Lands. In Alabama and Mississippi there is a slightly different mix of vegetation and land use in these southern plains compared to the Southeastern Plains and Hills subregion to the north, and streams tend to be darker and more acidic as one moves south toward the Florida border. The oak-hickory-loblolly/shortleaf pine forest of the north is replaced by the Southern mixed forest of beech-sweetgum-magnolia-longleaf/slash pine-oak forest in this subregion. Elevations are generally 200-550 feet, 100-300 feet in the Florida portion, with relief of 100-200 feet between hill and stream bottoms. The hill summits and higher elevations are composed of the Citronelle formation, generally sandy, gravelly, and porous, and more resistent to erosion than the older underlying Miocene sandstones. Most of this subregion is woodland and forest with some cropland and pasture (photo 1). This area of the Panhandle receives some of the highest mean annual precipitation totals (generally 60-75 inches) and the coolest mean minimum and mean maximum temperatures in the state (Bradley 1972; Fernald 1981).

In Florida, the main section of this subregion is confined to Escambia, Santa Rosa, Okaloosa, and Walton counties. As recommended by the DEP district biologist (Don Ray, DEP-Pensacola, personal communication), we have added an extension of this subregion across Bay, Calhoun, and Liberty counties. Although this could be considered a transitional

Photo 1

Photos 1 and 2. Forest land use/land cover predominates in the Southern Pine Plains and Hills, although some areas have a forest and agricultural land use mosaic. Pine plantations generally receive intensive management practices and significant ecosystem alterations.

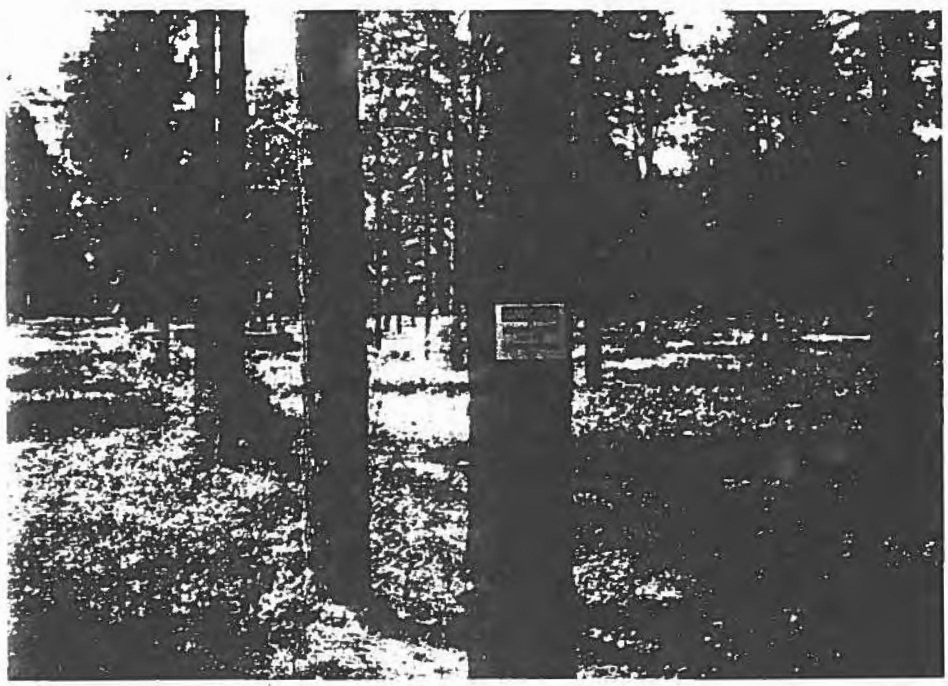

Photo 2

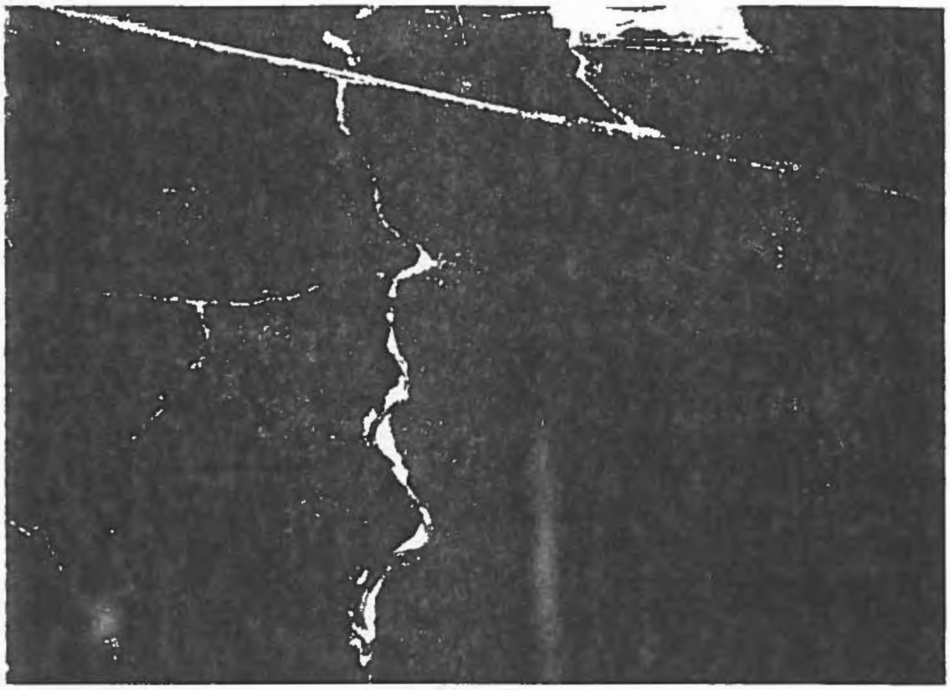

Photo 3

Photos 3 and 4. Sandy-bottomed, blackwater streams such as East Fork Big Coldwater Creek (above) and the Blackwater River (below) are common in this subregion. The tea-colored waters are often high in organic acids, tannins, and lignins leached from decomposing plant litter.

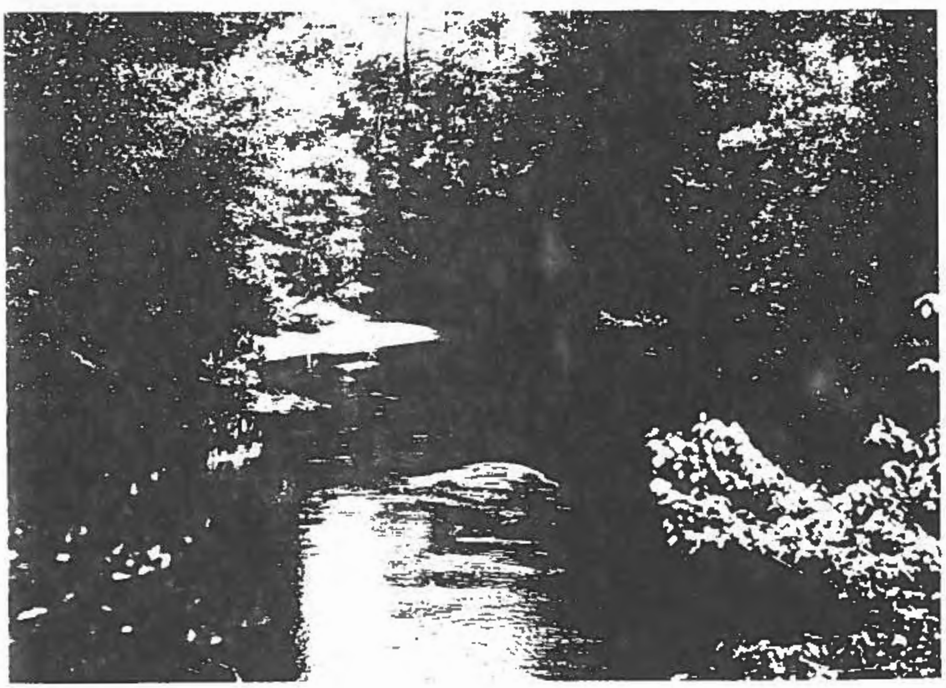

Photo 4

area. It was felt that the soils, surficial materials, stream substrate and velocity, made the surface waters here more typical of subregion 65f rather than the coastal flatwoods region.

Photo 5. Clear, sandy-bottom streams are also found in this region, such as Rocky Creek in Walton County.

Dougherty/Marianna Plains Subregion (65g)

Most of Jackson County, FL and surrounding counties are influenced by the near-surface limestone region that Brooks (1981b) calls the Dougherty Karst District and Harper (1914) called the Lime Sink Region. The subregion extends well into Alabama and Georgia, but not all of it has the distinct karst type features as found in Florida. Although called plains, the subregion also has some rolling low hills. It is, however, generally more flat than surrounding areas and has more intensive agriculture (photos 6 and 7). Portions of the subregion contain relatively few small surface streams (photo 8). The general soils and vegetation maps do not always distinguish this subregion, but the geologic and physiographic maps do. Clewell (1985) states that some northern plant species found in the Marianna lowlands are found nowhere else in Florida.

Photo 6

Photos 6 and 7. The Dougherty/Marianna Plains is a region of more intensive agriculture than other parts of the Panhandle. Note the sinkholes and bay swamps (above) in Jackson County. Red clay soils are typical in many areas of this region.

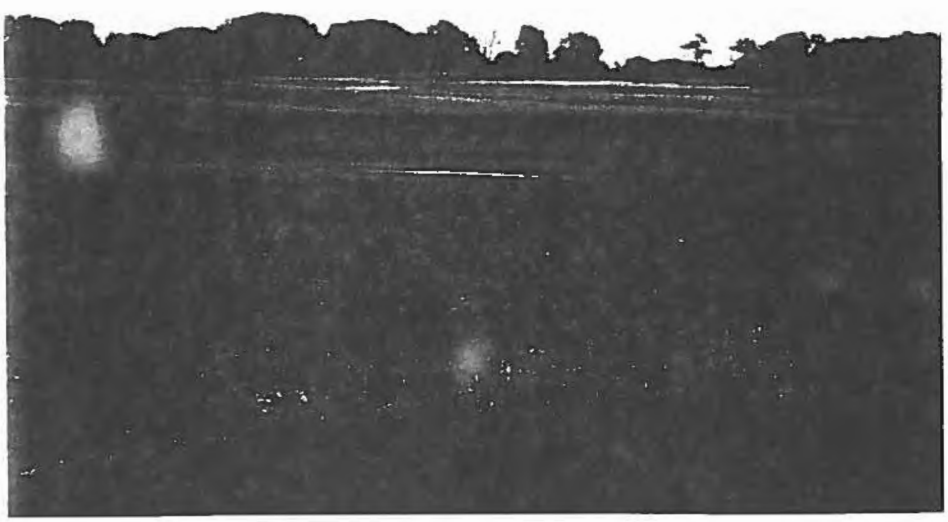

Photo 7

Photo 8. Econfina Creek west of Betts, Bay County

There is a question of how far south to extend this subregion into Florida. The Marianna Lowlands meet a belt of high sand hills just south of Dry Creek in Jackson County. Called the Compass Lake Highlands (Brooks 1982) or the New Hope Ridge (Puri and Vernon 1964), this area does appear to belong in the Southeastern Plains Ecoregion (#65). The lake area in southern Washington County, the Crystal Lake Karst or Greenhead Slope, was within Omernik's (1987) Southern Coastal Plain Ecoregion (#75), however that boundary has been adjusted to the south, allowing these karst lakes to be included within the Southeastern Plains Ecoregion (#65). Whether this lake area should be included in the Dougherty/Marianna Plains subregion, due to the obvious limestone/karst landscape, or in the Southern Pine Plains and Hills subregion because of its more hilly nature, or in the Southern Coastal Plain ecoregion because of its slightly different more recent geologic formation could be debated. On the physiography map by Wolfe et al., (1988) these more hilly lake areas are considered part of the Northern Highlands rather than the Marianna Lowlands. Brooks (1981b) includes them all in his Dougherty Karst District. Wolfe et al., (1988) also note that the karst lakes of the Panhandle fit the Florida Natural Area Inventory's (1990) Sandhill Upland Lake category better than their Sinkhole Lake type. We include this lake area in the Dougherty/Marianna Plains subregion, but one could also consider it a region within the region.

The western boundary of this subregion, for lack of better evidence, could follow the physiographic district line of Brooks (1981) in north central Walton County, where one does see surface water differences between the karst features to the east and the more dissected hilly area to the west. This line also crosses into Alabama near the Covington County/Geneva County line where Hodgkins et al., (1976) drew their Wiregrass Plains boundary.

Tifton Upland/Tallahassee Hills Subregion (65h)

This subregion combines some heterogeneous hilly and upland areas, and it has some geologic similarities to highland areas further west. Pine/hardwood forests are extensive on both clay and sandy soils, and some agriculture is found throughout, especially to the east. At the western end, the biotically distinctive area of the Appalachicola Bluffs and Ravines grades into the Quincy Hills and the Tallahassee Hills. Towards the east, the relief diminishes substantially with more rolling hills, solution basins and lower swampy areas. This eastern area is a transition, with characteristics similar to the upland areas to the south. The boundary with the Okefenokee subregion is fairly evident, but the southern boundary is not easily determined.

The eastern portion of this subregion could easily be defined as a separate region, and its character is not described by the subregion name of Tifton Upland/Tallahassee Hills. From just east of Monticello in Jefferson County up to Valdosta, GA and then south past

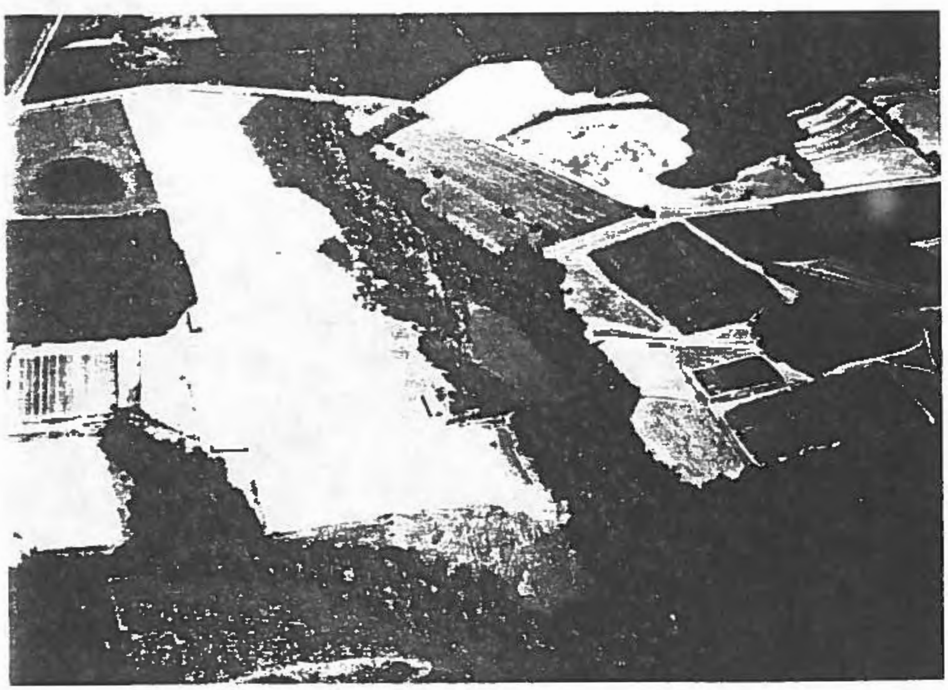

Photo 9. Typical mixed land use of the Tifton Upland, Gadsden County.

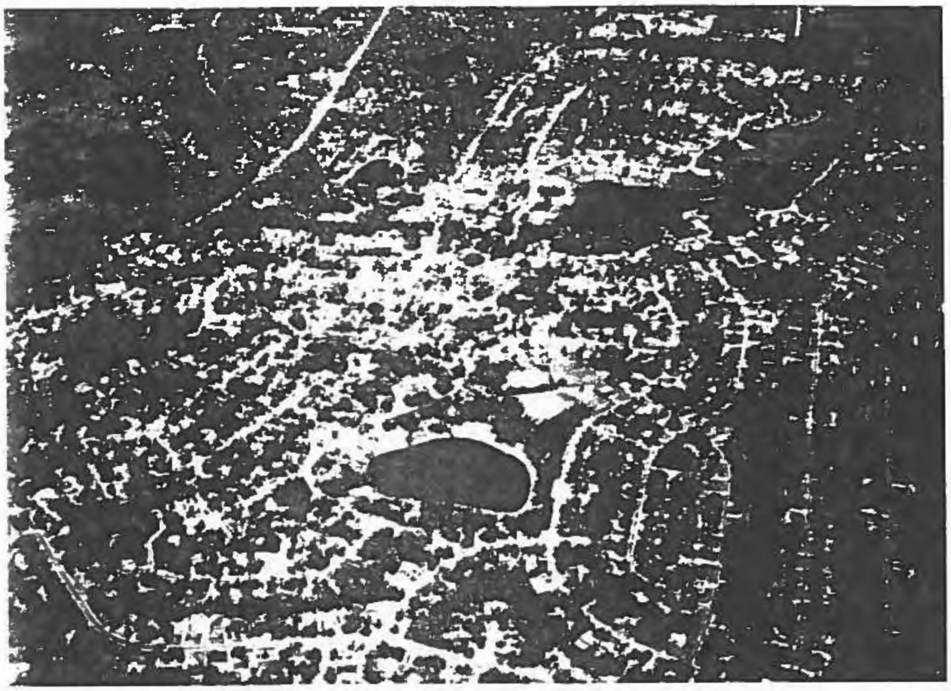

Photo 10. Suburban karst near Tallahassee, Leon County

Photo 11. Cropland/pasture and riparian corridor, Hamilton/Suwannee counties.

Lake City, it is generally a low rolling karst plain with few streams present. There is a gradual transition in the State Line Hills, and Brooks (1981b) notes that the Greenville Islands and Swamps area in Madison County is similar to the Tallahassee Red Hills to the west. The hills become more isolated, however, as one moves east toward the more flat karst plains, and some regional schemes show a distinctive lime-sink area extending up toward Valdosta (Harper 1914; Wharton 1978). Although the topic of dividing this subregion was discussed, the Florida DEP participants in this project were disinclined to make such a division.

Table 1-1. General characteristics of subregions of the Southeastern Plains Ecoregion (65) in Florida.

Subregion	Landform	Potential natural vegetation	Land use/ land cover	Soils
Southern Pine Plains and Hills (65f)	Irregular plains, 50-75% of gentle slope is on upland. Elevation 100-300ft. Relief 100-200ft.	Mixed hardwood and pines forest, longleaf pine and xerophytic oaks	Evergreen forest, mixed forest, cropland and pasture	Ultisols, Entisols
Dougherty/ Marianna Plains (65g)	Flat plains to irregular plains. Elevation 75-200ft. Relief 50-100ft.	Mixed hardwood and pines forest, longleaf pine and xerophytic oaks	Cropland and pasture, mixed forest, evergreen forest	Ultisols
Tifton Upland/ Tallahassee Hills (65h)	Irregular plains, flat sandy plains. Elevation 75-300ft. Relief 50-200ft.	Mixed hardwood and pines forest, longleaf pine and xerophytic oaks	Evergreen forest, cropland and pasture, mixed forest	Ultisols, Entisols

SOUTHERN COASTAL PLAIN ECOREGION (#75)

Subregions:	States:
- Gulf Coast Flatwoods	AL, FL, MS
- Southwestern Florida Flatwoods	FL
- Central Florida Ridges and Uplands	FL
- Eastern Florida Flatwoods	FL
- Okefenokee Swamps and Plains	FL, GA
- Sea Island Flatwoods	FL, GA

Within the state, the Southern Coastal Plain Ecoregion covers parts of northern Florida and all of central Florida. It is a region of some heterogeneity, including swampy lowlands along the Gulf and Atlantic coasts as well as an area of discontinuous highlands that include numerous lakes. From the national scale, Omernik (1987) characterized the ecoregion as flat plains (10-50% covered by standing water); southern mixed forest (beech, sweetgum, magnolia, pine, oak) and southern floodplain forest (oak, tupelo, baldcypress); land uses of forest and woodland grazed, woodland and forest with some cropland and pasture, and swamp; and wet soils (aquods, aquents, aquepts, aquults).

Gulf Coast Flatwoods Subregion (75a)

This subregion stretches from coastal Mississippi into western Pasco County, Florida. There are heterogeneous areas and habitats within the subregion, including coastal lagoons and mangrove; swamp and marsh; the clastic, non-karst terraces and deltas of the Appalachicola; limestone plains and rocklands; and paleo sand dune areas. Along the coast, the coastal strand and pine scrub vegetation found on dunes, spits and barrier islands of the Panhandle, changes to mangrove and coastal marshes from Wakulla to Pasco counties. In general, pine flatwoods mixed with some hardwood forest and swamp vegetation characterize the inland region. The Appalachicola National Forest and private pine plantations cover a large part of this subregion in Florida.

Southwestern Florida Flatwoods Subregion (75b)

This flatwoods subregion includes barrier islands and peninsulas, Gulf coastal lowlands and valleys, as well as higher elevation areas such as the De Soto Plain and the Polk or Bone Valley Upland. This subregion contains most of the forested Green Swamp area, extensive areas of pasture and rangeland, spreading urbanization, disturbed lands from phosphate mining, and citrus groves to the south.

South of the Caloosahatchie valley the flatwoods grade into the Big Cypress area. Davis (1943 p.47) notes the difficulty of defining a southern boundary for this region as it nears the Big Cypress. He suggested his "western flatlands" region would be divided into a northern and southern part by the Caloosahatchie valley, with the southern part being less well drained, with thin sand soils over marl and limestone or calcareous sandstone. These conditions give rise to "cabbage palm hammocks and other plants that prefer near-neutral

Photo 12. Pensacola Bay, Gulf Breeze peninsula, Santa Rosa Sound and barrier island. Santa Rosa and Escambia counties. Gulf Coast Flatwoods subregion.

Photo 13. Bottomland hardwoods, Chipola River near Honeyville, Gulf County, Gulf Coast Flatwoods subregion.

Photo 14. Apalachicola National Forest management practices. Gulf Coast Flatwoods subregion.

Photo 15. Sandy Creek at tidal influence. Bay County, Gulf Coast Flatwoods subregion.

Photo 16. Little Manatee River riparian area. Hillsborough County, Southwestern Florida Flatwoods subregion.

Photo 17. Charlie Creek. Hardee County. Southwestern Florida Flatwoods subregion.

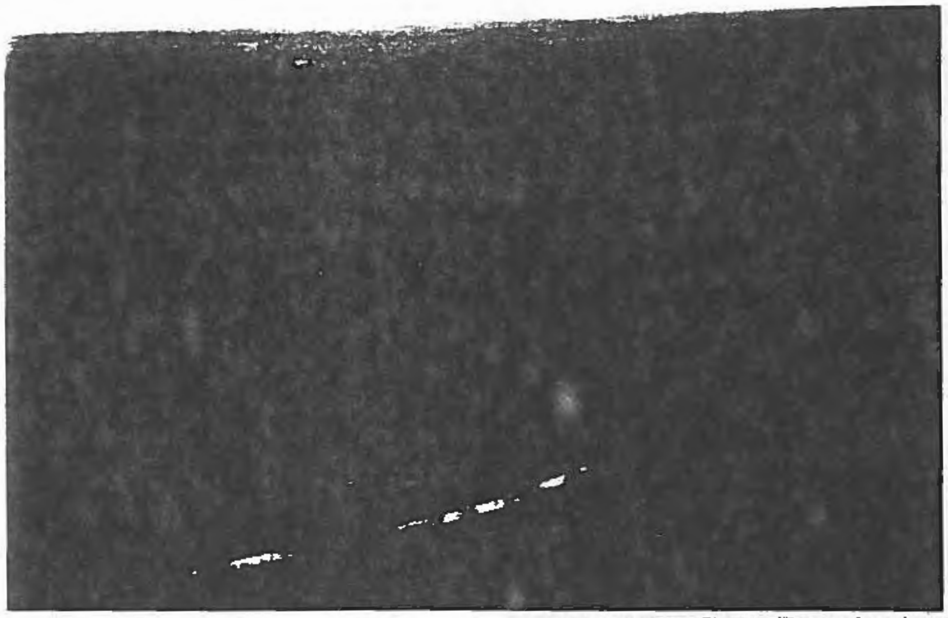

Photo 18. The Green Swamp area, Polk/Sumter counties, Southwestern Florida Flatwoods subregion.

Photo 19. Cypress swamp, Charlie Bowlegs Creek, Highland Hammock State Park, Highlands/Hardee counties, Southwestern Florida Flatwoods subregion.

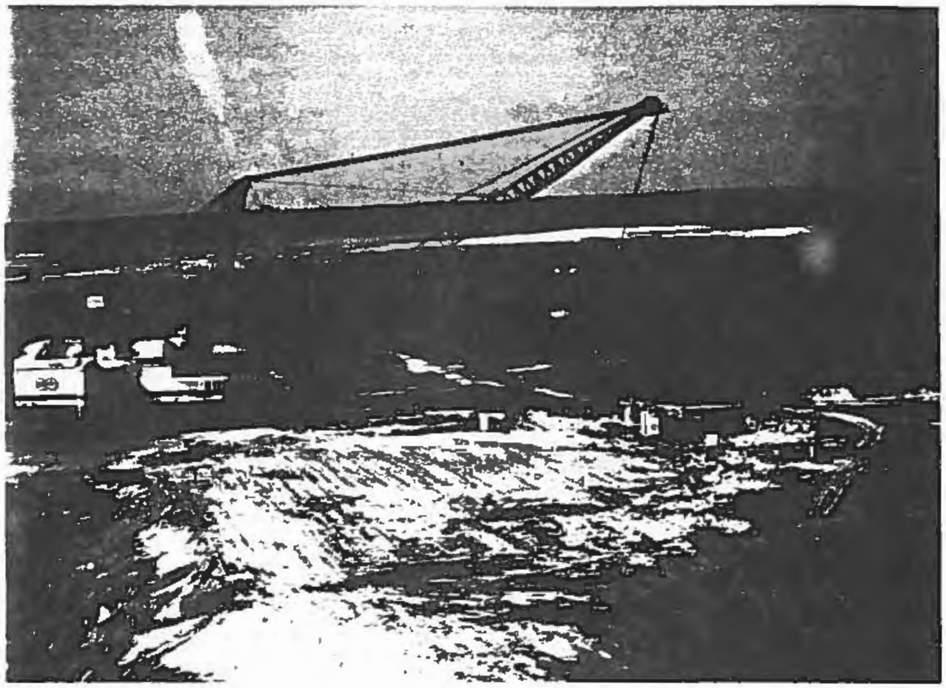

Photo 20

Photos 20 and 21. Typical land disturbances in the Southwestern Florida Flatwoods subregion include phosphate mining (above, Polk County), land clearance for citrus groves (below, Charlotte County), as well as creation of pasture for grazing cattle.

Photo 21

or alkaline soil conditions." (Davis 1943). The southern section was also characterized by Davis as having a great number of marsh, swamp, and open water depressions.

Central Florida Ridges and Uplands Subregion (75c)

The area from the Lake Wales Ridge/Intraridge Valley in the south, through the highland dune area of Ocala National Forest, and into the Trail Ridge area in the north, may comprise the longest smooth line of genetically associated lakes in the United States, according to White (1970). The sand hill karst area characterized by xeric hills and solution basins is the principle recharge area of the Floridan aquifer. The soils tend to be thick, acidic, sandy, and excessively to moderately drained. The natural vegetation consisted of forests of longleaf pine, turkey oak and wiregrass (Davis 1967), and the current land cover includes citrus orchards, herbaceous rangeland, cropland and pasture, and urban/built-up land.

In delineating this area, several questions were raised about the dominant characteristics and proper areas to include in the subregion. It was debated whether to define one central ridge/uplands subregion, several disjunct units of the same subregion, or several upland subregions. As White (1970) notes and the USDA-SCS MLRA is drawn, the general area also encloses large lowlands. One could define a subregion of the most prominant ridges and highlands, and another that covers the lower sandy uplands. When does a highland or ridge become a lowland? For example, in the Brooksville/Weeki Wachee

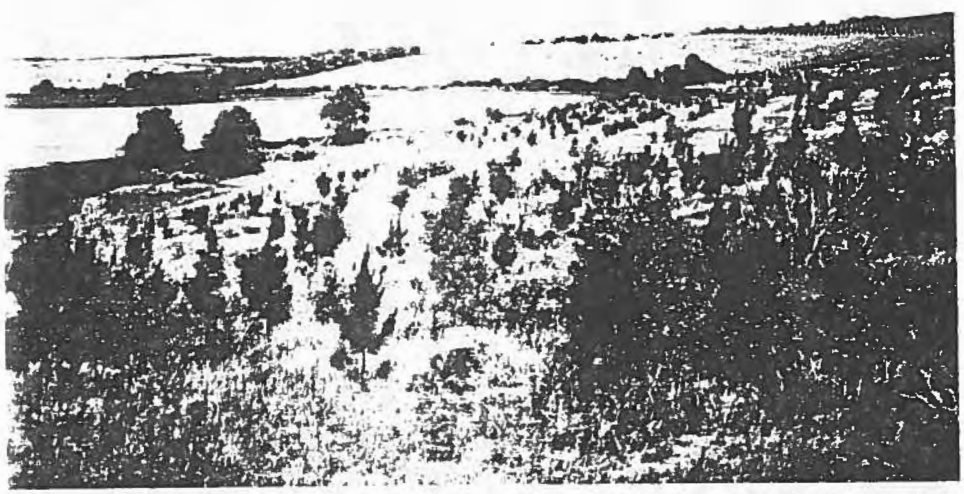

Photo 22. Rolling upland with conversion from citrus to pine, near Clermont, Lake County, Central Florida Ridges and Uplands subregion

Photo 23

Photos 23 and 24. Increasing urban/suburbanization occasionally meets geologic hazards such as sinkholes. Polk County, Central Florida Ridges and Uplands.

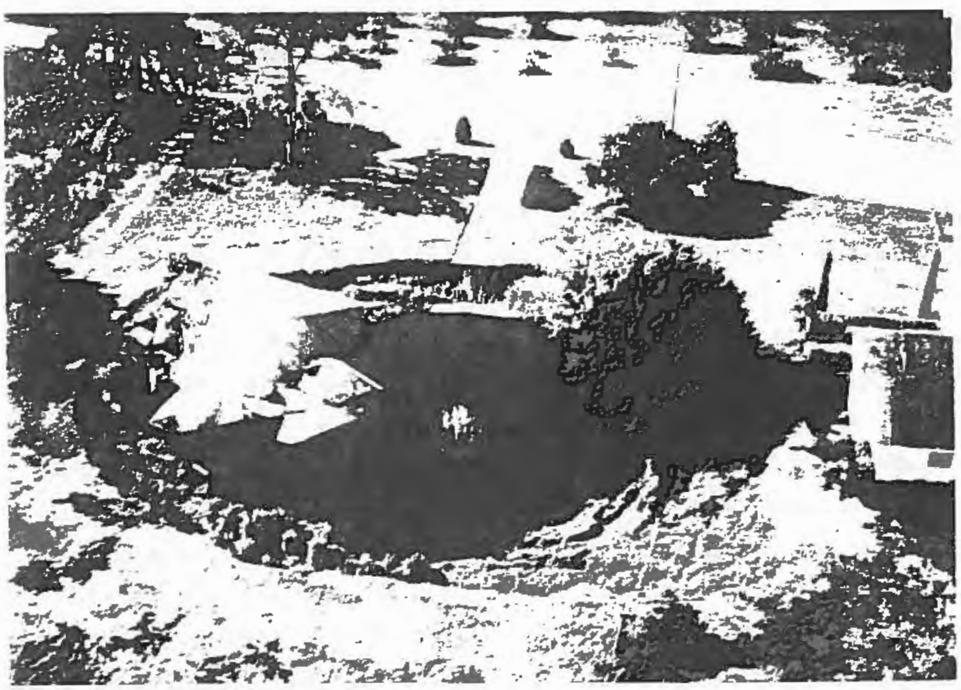

Photo 24

area in Hernando County and down into Pasco County there are sandy areas with karst features, longleaf pine/turkey oak vegetation like the highlands, but elevations are less than 75 feet. How do the ridges differ from one another? While there is heterogeneity in all the subregions, are the various highland ridge lake areas that different from one another? Davis' (1967) natural vegetation map shows a difference between the Lake District areas (longleaf pine and xerophytic oak) and the upland areas (e.g., Sumter Upland, classified as hardwood forests). Near Gainesville and the Western Valley or Haile Limestone Plain, there are karst plains with low hills, originally with hardwood forests. Should this be included in the Ridges and Uplands subregion, and what would be considered upland vs. lowland in this area?

These questions and others like them were not always answered easily, highlighting the fact that there are heterogeneous characteristics and subtle gradations within a central ridge and upland subregion. When one generalizes, either/or decisions (upland or lowland) are made that always leave room for debate, but the attempt for this subregion was to include most all of the upland xeric, sandy well drained areas and prominant ridges. The STATSGO soils maps, county soil surveys, and physiographic maps were useful in this effort.

Eastern Florida Flatwoods Subregion (75d)

Originating from sequences of barrier islands and lagoons in Pliocene and Pleistocene time, the subregion is ribbed by sand ridges and some intervening swampy lowlands. Sand, silt and clay soils are mostly of poor drainage, but it is a diverse area of coastal strips, valleys, ridges, and plains. Land uses include cropland and pasture, pine plantations, non-forested wetlands, and urban/suburban. On our first draft map we delineated a St. Johns marsh area containing characteristics from both ecoregion 75 and 76. While historically this area had similar features such as muck soils and sawgrass marshes as found in the Everglades area, much of the area has been transformed, and the DEP district biologists suggested that it not be defined as a separate area from the flatwoods subregion.

There is no strong evidence for a well-defined boundary between the Southwestern Florida Flatwoods and the Eastern Florida Flatwoods subregions in the Glades County area. Our first draft map had a boundary similar to Brooks' (1981) physiographic division across the northeastern part of Glades County, and similar to where Davis (1943) drew the western boundary of his Istokpoga-Indian Prairie Basin. DEP biologists suggested that the streams in Hendry and Glades counties resembled streams in the Eastern Florida Flatwoods more than the Southwestern Florida Flatwoods, and that the boundary should be moved further west. Much of this area is described as prairie, including the palm savanna and freshwater marsh Indian Prairie reported by Harper (1927) and the wet and dry prairies depicted by Davis (1943, 1967). Our revised boundary is drawn to include most of

Photo 25. St Johns River, Volusia/Seminole counties. Eastern Florida Flatwoods subregion.

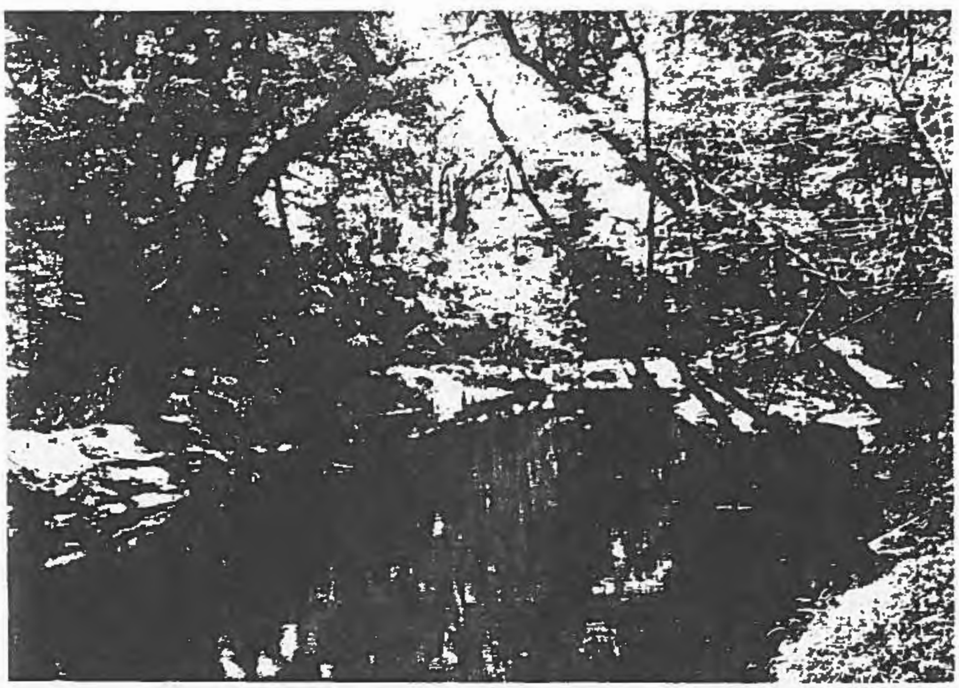

Photo 26. Econlockhatchee River, Orange County, Eastern Florida Flatwoods subregion.

Photo 27

Photos 27 and 28. Only a few coastal areas of the Eastern Florida Flatwoods subregion remain relatively undisturbed by human development. Above, Merritt Island National Wildlife Refuge, Brevard County; below, Canaveral National Seashore, Volusia County.

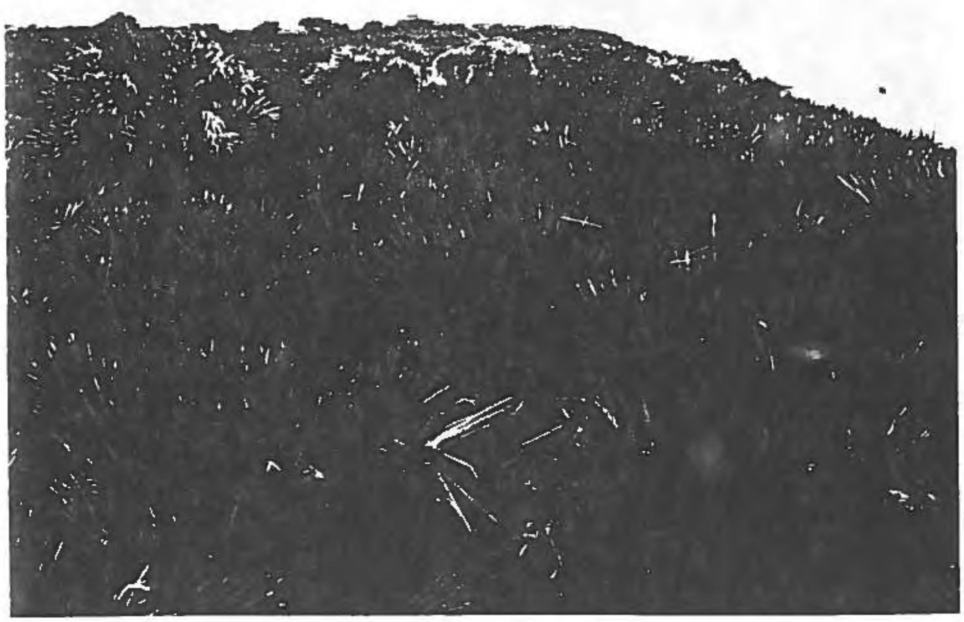

Photo 28

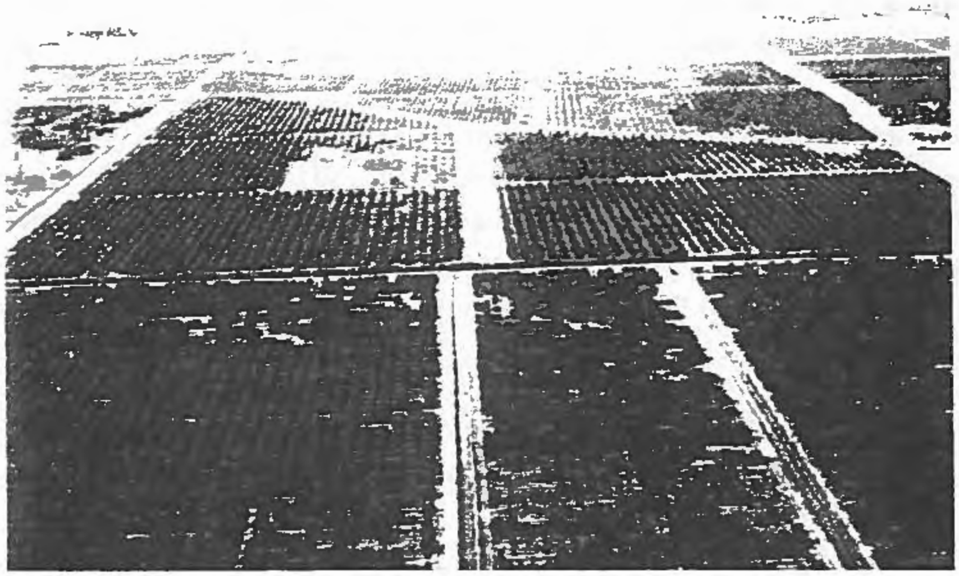

Photo 29

Photos 29 and 30. The southern portion of the Eastern Florida Flatwoods has been transformed to citrus groves and grazing land, with extensive canalization. St. Lucie County (above). Kissimmee River canal, Okeechobee/Highlands counties (below).

Photo 30

the prairie areas in the Eastern Florida Flatwoods. Although this boundary placement is not as far to the west and southwest as some biologists recommended (Rick Cantrell, DEP-Tallahassee, personal communication), it at least puts Fisheating Creek and Gator Slough in the Eastern Florida Flatwoods.

Okefenokee Plains and Swamps Subregion (75e)

Containing the headwaters of the Suwannee and St. Marys Rivers, this region contains plains or terraces and basins of peat and muck deposits with marsh and swamp forests. Although not recognized on several types of maps (MLRA, and some physiographic region maps), this area has different topography, soils, mosaic of land use, and vegetation than surrounding subregions. The swampy areas grade into poorly drained flatwoods. The subregion in Florida is not substantial in size; it includes the Pinhook Swamp area, the Osceola National Forest, and extends south near Lake City in Columbia County and the Baker County/Union County line. The boundary is similar to the one defined by Brooks (1981b) down to the Lake City Ridge, and the southern boundary can be determined from the STATSGO soils maps. For Georgia, it is a larger and more important subregion. Although our region in Georgia would generally be confined to the more hydric bog swamp Okefenoke area, Veatch and Stephenson's (1911) physiographic map of the Georgia coastal plain shows an Okefenokee Plain region extending from Florida to the South Carolina border.

Sea Island Flatwoods Subregion (75f)

In Georgia and part of Florida, this is an area mostly of clastic sediments where fluvial processes of eastward-flowing streams and rivers help shape the landscape. Broad coastal barrier islands, salt marshes, plains, and ridges create some ecological habitat diversity. This flatwoods subregion includes Trail Ridge, which differs in character from north to south. Differences in drainage and soils create flatwoods on the northern part of Trail Ridge and longleaf pine/turkey oak to the south. The subregion also contains upland plains of flatwoods with marshes, swamps, and lakes. The soils in this area are characterized generally as poorly drained spodosols.

The boundary between the Sea Island Flatwoods and the Eastern Florida Flatwoods to the south is vague and uncertain. Brooks' (1981b) physiographic district boundary is slightly further to the south than the division indicated by the soils maps. The DEP district biologist (Lee Banks, DEP-Jacksonville, personal communication) recommended a more northerly boundary line and our division tends to follow the break indicated by soils.

Photo 31. The extensive Pinhook Swamp, Baker County, Okefenokee Swamps and Plains subregion.

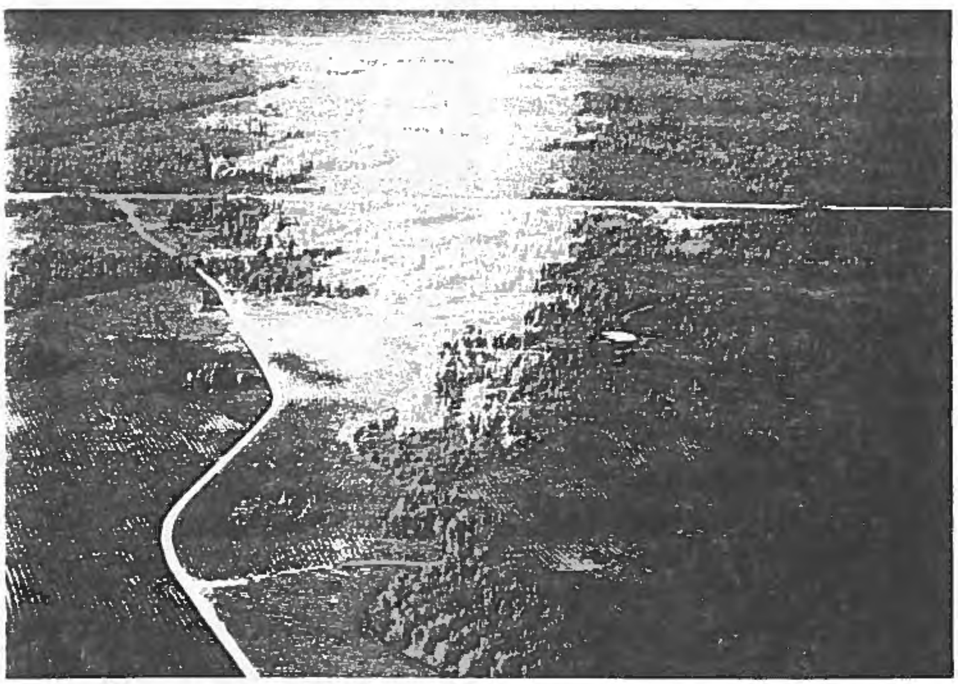

Photo 32. Pine plantation, Hamilton County, Okefenokee Swamps and Plains subregion.

Photo 33

Photos 33 and 34. Pigeon Creek and watershed, Nassau County, Sea Island Flatwoods subregion.

Photo 34

Photo 35. Amelia Island, Nassau County, Sea Island Flatwoods subregion.

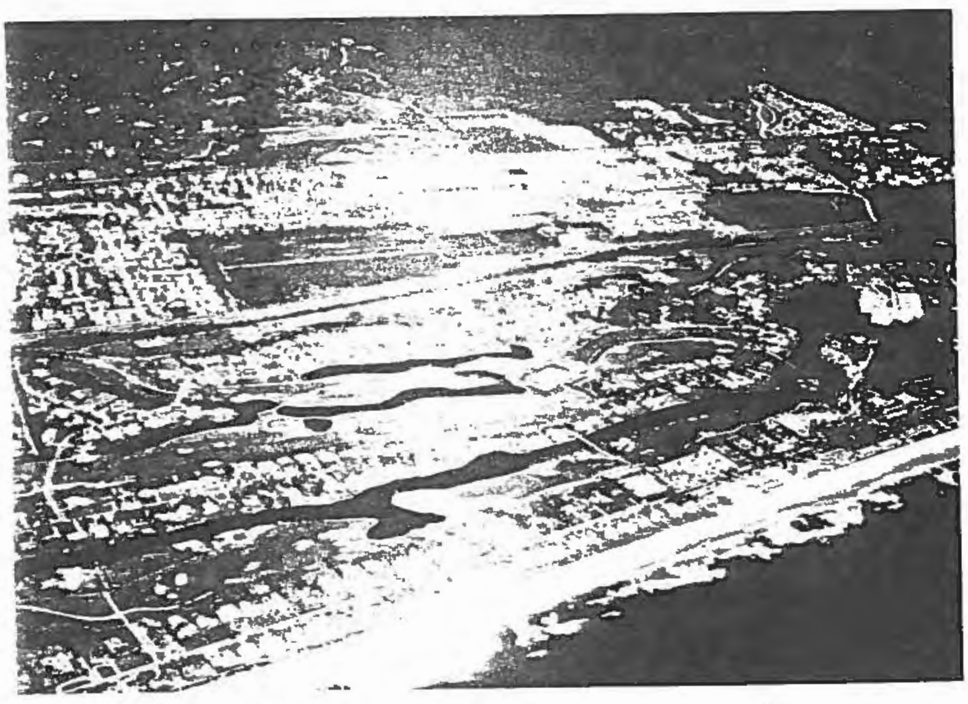

Photo 36. Ponte Vedra Beach, St. Johns County, Sea Island Flatwoods subregion.

Table 1-2. General characteristics of subregions of the Southern Coastal Plain Ecoregion (75) in Florida.

Subregion	Landform	Potential natural vegetation	Land use/ land cover	Soils
Gulf Coast Flatwoods (75a)	Flat plain, 10-50% and >50% covered by standing water. Elevation 0-120ft. Relief 0-100ft.	Pine flatwoods, swamp forests	Evergreen forest, forested wetland, mixed forest land, cropland and pasture	Spodosols, Ultisols
Southwestern Florida Flatwoods (75b)	Flat plain, 10-50% and >50% covered by standing water. Elevation 0-200ft. Relief 0-100ft.	Pine flatwoods, grasslands of prairie type	Cropland and pasture, herbaceous rangeland, orchards and groves	Spodosols, Entisols
Central Florida Ridges and Uplands (75c)	Generally flat plains or rolling plains with sandy highlands and ridges. Elevation 50-200ft. Relief 20-100ft.	Longleaf pine forests and xerophytic oaks	Orchards and groves, cropland and pasture, evergreen forest, urban/built up	Entisols, Alfisols
Eastern Florida Flatwoods (75d)	Flat plain, 10-50% and >50% covered by standing water. Elevation 0-150ft. Relief 0-75ft.	Pine flatwoods, grasslands of prairie type, freshwater marshes, swamp forests	Cropland and pasture, herbaceous rangeland, evergreen forest, forested and nonforested wetland, orchard/groves	Spodosols, Entisols, Histosols
Okefenokee Swamps and Plains (75e)	Flat plain, >50% covered by standing water. Elevation 100-175ft. Relief 0-50ft.	Swamp forest, pine flatwoods	Forested wetland, evergreen forest	Inceptisols, Spodosols
Sea Island Flatwoods (75f)	Flat plain, 10-50% covered by standing water. Elevation 0-250ft. Relief 0-100ft.	Pine flatwoods	Evergreen forest, forested wetland, cropland and pasture	Spodosols, Ultisols, Inceptisols, Entisols

SOUTHERN FLORIDA COASTAL PLAIN ECOREGION (#76)

Subregions:
- Everglades
- Big Cypress
- Miami Ridge and Atlantic Coastal Strip
- Southern Coast and Islands

The Southern Florida Coastal Plain Ecoregion has been characterized generally as flat plains with wet soils, marshland and swamp land cover with everglades and palmetto prairie vegetation types (Omernik 1987). Southern Florida contains some distinctive ecological subregions, however, and relatively slight differences in elevation and landform have important consequences for vegetation and the diversity of habitat types. The climate is considered subtropical to tropical with a pronounced summer wet season. It is also a region where humans have caused extensive hydrological and biological alterations (e.g., McPherson et al., 1976; Wilson and Porras 1983).

In addition to the usual thematic component maps, there are several general regional schemes of south Florida that tend to reinforce the group of subregions listed above. Harper's map (1927 p.32) captures these general regions, though not all boundaries were shown "...because too little known at present." Davis (1943) includes a more precise map, and McPherson et al., (1976), Snyder et al., (1990) and Craig (1991) follow the same general regional breakdown.

The Southern Florida Coastal Plain ecoregion boundary (Omernik 1987) has been moved further south, closer to Lake Okeechobee, and is similar to the MLRA boundary. Omernik's 1987 ecoregion line followed closely Hammond's (1970) landform class ("more than 50% covered by standing water"), extending up the Eastern Valley. However, Omernik's (1987) ecoregion line appears to divide some distinct regions such as the prairie areas north of Lake Okeechobee (Harper 1927), or the flatwoods areas [i.e., western flatlands and eastern flatlands of Davis (1943), the flatwoods regions of Harper (1927), the Eastern and Southwestern physiographic districts of Brooks (1981), and the flatlands physiographic regions shown in McPherson et al (1976)]. The more dramatic changes one sees in moving from central Florida into southern Florida generally occur at or below Lake Okeechobee. The evidence, in addition to the sources cited above, also include the vegetation maps of Kuchler (1966) and Davis (1943), the AVHRR-NDVI data, the soils and MLRA map of Caldwell and Johnson (1982), and certain thematic maps in the Atlas of Florida (Fernald 1981). An examination of U.S. elevation data (USGS EROS Data Center 1990) shows an elevation class boundary similar to our boundary for the Southern Florida Coastal Plain Ecoregion. (The elevation map also shows a close correlation and partial explanation for the ecoregion/subregion divisions throughout EPA Region 4). There is also 6 evidence from several mapped characteristics of similarities between the St. Johns Marsh area and the Everglades to the south. As White (1970) notes it is a transition area, and it makes for a broad fuzzy ecoregion boundary.

Everglades Subregion (76a)

This subregion includes Lake Okeechobee, the Everglades Agricultural Area, the water conservation areas, and the sawgrass and sloughs of the national park. For some water quality studies, one would want to further divide this subregion. The Everglades Agricultural Area would be an important cultural overlay because land use and water quality are different from the rest of the Everglades.

There is also a question about the characteristics to use in determining the eastern boundary of the Everglades along the Atlantic coastal strip/Miami ridge: current land use and hydrologic realities or presettlement conditions? Our line tends to follow the land use and hydrologic canalization influences but is somewhat rounded and generalized especially in a few places where the wetter less developed areas occur at the western edge of the built-up urban/suburban and agriculture area.

The Everglades is an important and unique ecosystem, with the park designated as an International Biosphere Reserve and a World Heritage Site, but its integrity is threatened by the processes of agriculture and urbanization that surround the "River of Grass."

Big Cypress Subregion (76b)

Boundaries of the Big Cypress subregion are not easily determined. Davis (1943, p.48) noted that, "No one has definitely defined or circumscribed this region," and (p. 47) that "...it is difficult to define the exact northern boundary of the Big Cypress region," so that "only an arbitrary line" between the area and the western flatlands could be drawn. There is also some fuzziness in the eastern boundary, and the mix of vegetation along the boundary has changed in recent decades as shown by mapped evidence. "The eastern boundary of the Big Cypress extends over into the Everglades basin, but these cypress forest areas, even if in the Everglades basin, are not considered a part of the Everglades," (Davis 1943, p.48). The SCS Soil Survey of Hendry County notes that the boundary between the Everglades and adjacent physiographic provinces has been defined using vegetation and is placed where the characteristic sedges of the Everglades, including sawgrass, are replaced by true grasses, pines, or cypress. It is interesting to note the changes in areas of green tint ("woodland" or "woods-brushwood") from the 1956 edition of the Miami 1:250,000 USGS topographic map to the 1988 edition along this eastern boundary, or the change from the 1956 West Palm Beach 1:250,000 map to the 1985 Ft. Lauderdale 1:100,000 map. The woodland/nonwoodland interface has generally moved several miles to the west on the newer maps. The SCS, in developing their STATSGO soil map, followed the 1956 green tint/white tint interface almost exactly to separate association 208 from 213.

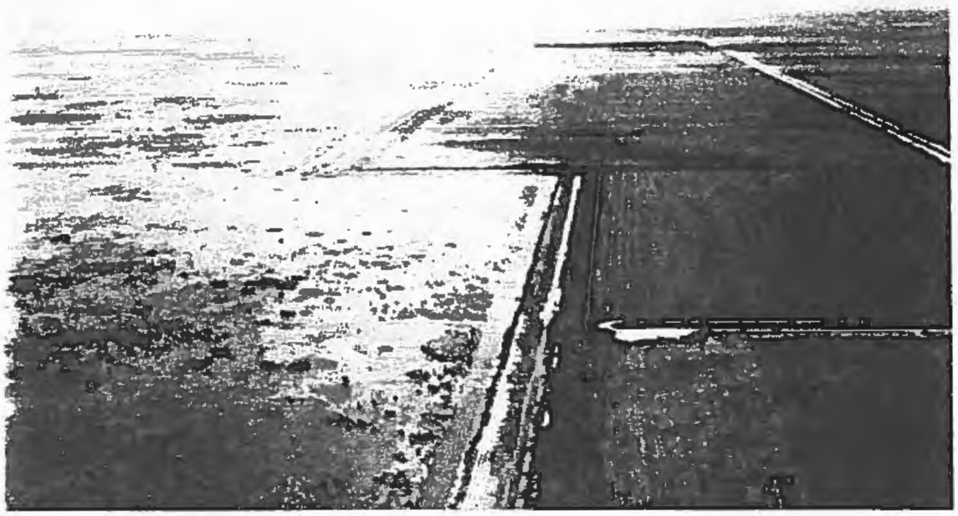

Photo 37. Edge of Everglades Agricultural Area, Palm Beach County, Everglades subregion.

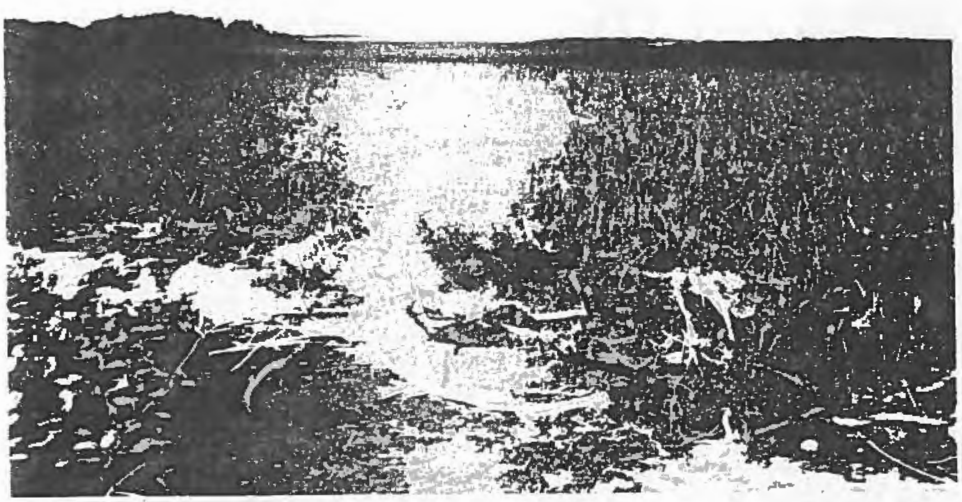

Photo 38. Freshwater marl prairie, Dade County, Everglades subregion.

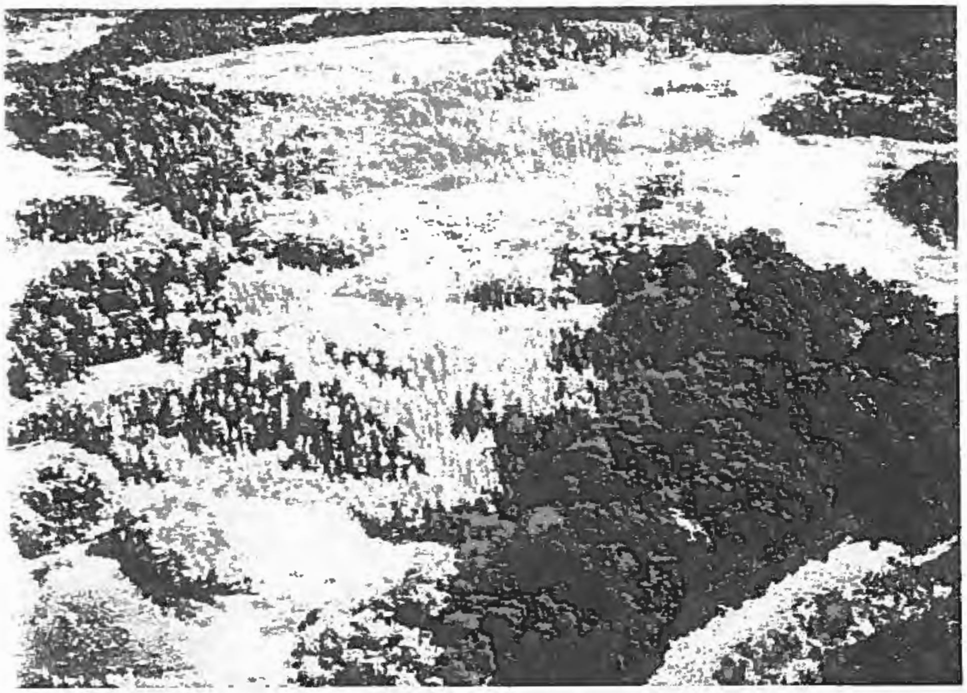

Photo 39

Photos 39 and 40. Big Cypress Swamp, Collier County, Big Cypress subregion.

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Maps by Craig (1991) and Brooks (1981) recognize Devil's Garden, Immokalee Rise, and Corkscrew Swamp to the north of the Big Cypress, while Snyder et al., (1990), has a more northerly Big Cypress Swamp. All three areas have some cypress swamp, wet prairie and flatwoods. Davis (1943) extends his Western Flatwoods into the northern part of Collier County. Harper (1927) shows a very vague (no) boundary between the flatwoods and Big Cypress. One could consider a Big Cypress subregion, with some heterogeneous characteristics, extending almost to the Caloosahatchee Valley. Even on the USGS 1;250,000 topographic maps, this area is labeled as Everglades and one could include this in Ecoregion 76. The headwaters of the Big Cypress watershed (Drew and Schomer 1984) are different from the areas to the south, however, and there are some similarities between the Immokalee Rise and the De Soto plain across the Caloosahatchie.

The western boundary of the Big Cypress subregion trends due south near Estero Bay, generally staying three to seven miles inland from the coast down toward Naples. This is supported by somewhat similar regional boundaries shown by Craig (1991), McPherson (1976), Davis (1943), and Snyder et al., (1990), as well as other thematic maps. DEP biologists have also suggested that the streams such as the Estero, Imperial, and Cocohatchee Rivers are different from the freshwaters found in the Big Cypress to the east (Richard Cantrell, DEP-Tallahassee; Ford Walton, DEP-Punta Gorda, personal communications).

Miami Ridge/Atlantic Coastal Strip Subregion (76c)

At 27 degrees latitude, where the Florida Atlantic coast starts to trend from the northwest to due south, the convergence of boundaries of the Southern Coastal Plain Ecoregion (#76), the Atlantic Coastal Strip subregion and the Eastern Flatwoods subregion creates some uncertainty about where the lines should cross the coastal ridges. Brooks' (1981) physiographic district boundary skirts the east side of the Loxahatchee Slough and extends to the ocean near Juno, just north of Lake Worth. The Atlantic Coastal Ridge region shown by Craig (1991) ends just below Jupiter Inlet. Soils and vegetation maps tend to support the Eastern Flatwoods extending south to near Ft. Lauderdale. The Miami Rock Ridge is somewhat different from the Atlantic Coastal Strip, however the proliferation of pavement from South Miami to West Palm Beach (80+ miles) tends to create a more homogeneous area. Snyder et al., (1990) provides an informative discussion of the South Florida Rockland, which includes limestone outcrop areas outside of this subregion.

The western boundary area of this subregion, especially west and northwest of Miami, was previously more characteristic of the Everglades subregion with wet to dry prairie marshes on marl and rockland, and sawgrass marshes (Davis 1967). Much of it is now in agriculture and pasture with advancing suburbanization.

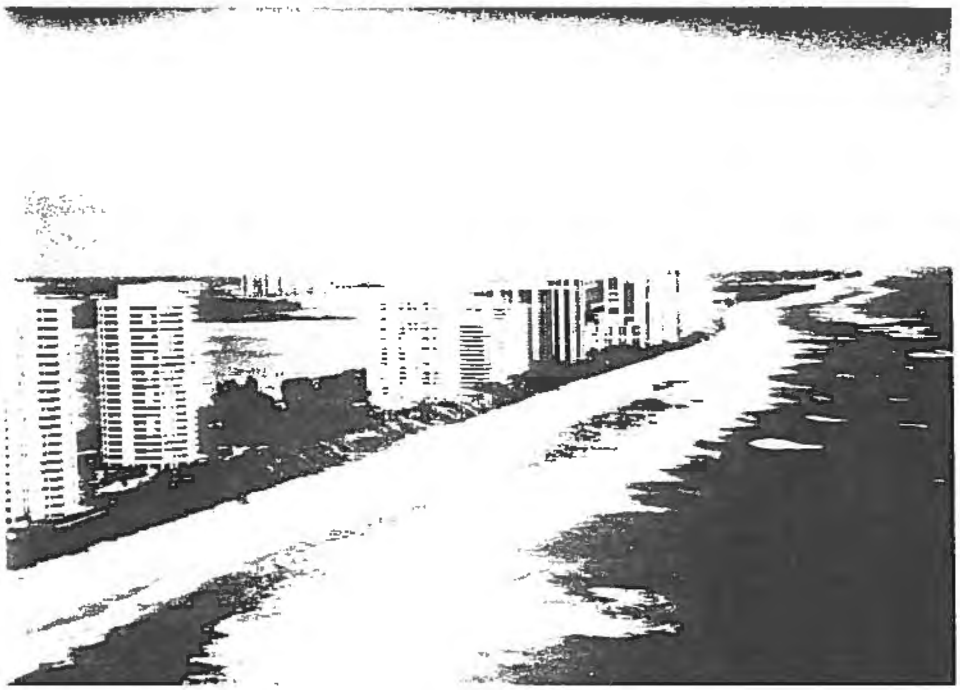


Photo 41. The urban coast, Palm [illegible] Miami Ridge/Atlantic Coastal Strip subregion.

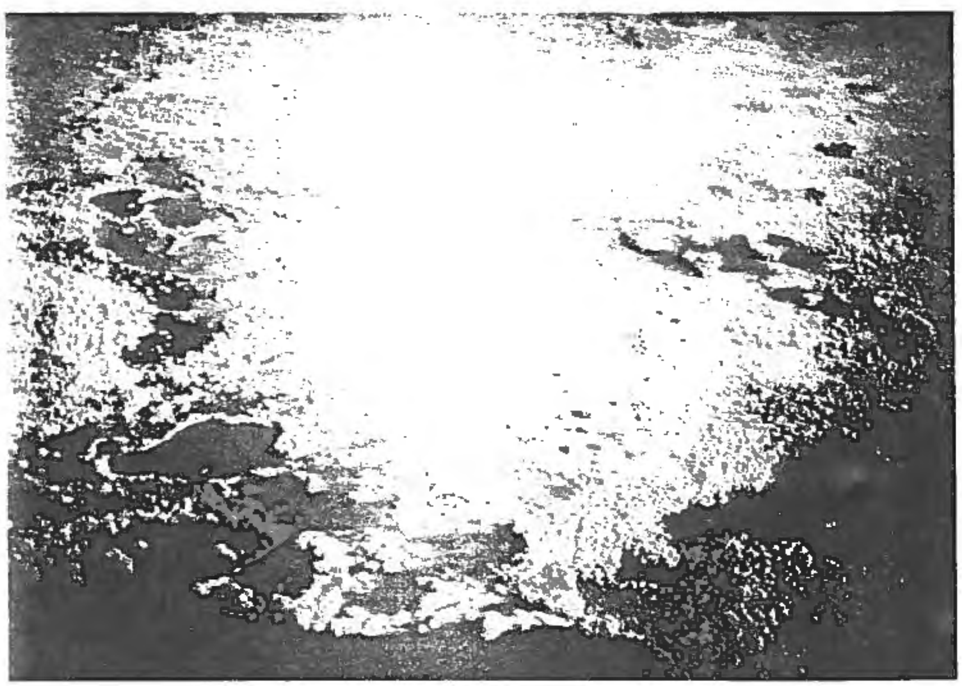


Photo 42. Mangroves and islands [illegible] Collier County, Southern Coast and Islands subregion.

Southern Coast and Islands Subregion (76d)

This subregion includes the low coastal areas of the Ten Thousand Islands and Cape Sable, the islands of Florida Bay, and the Florida Keys. Fresh surface water habitats are generally limited or non-existent in this subregion. There are differences between the various types of keys and islands, but in considering general regions for a state as large as Florida, this inclusion still keeps the region sufficiently homogeneous. The diversity of island types relates mainly to origin and structure, such as the coral reefs of the Keys, the vermetid reefs of the Ten Thousand Islands, and the low non-rocky sediment-trapped islands in Florida Bay. The subregion has the greatest areal extent of mangroves in the state and several large areas of saltwater marsh.

Table 1-3. General characteristics of subregions of the Southern Florida Coastal Plain Ecoregion (76).

Subregion	Landform	Potential natural vegetation	Land use/ land cover	Soils
Everglades (76a)	Flat plain, >50% covered by standing water. Elevation 0-25ft. Relief 0-10ft.	Saw-grass marshes, marsh prairies	Nonforested wetland, forested wetland, cropland	Histosols
Big Cypress (76b)	Flat plain, >50% covered by standing water. Elevation 5-80ft. Relief 0-10ft.	Pine flatwoods, open scrub cypress, prairie type grasslands, marl/rockland prairie marsh	Nonforested wetland, forested wetland	Entisols, Spodosols
Miami Ridge/ Atlantic Coastal Strip (76c)	Flat plain, 10-50% covered by standing water. Elevation 0-20ft. Relief 0-15ft.	Southern slash pine forests, pine flatwoods, coastal strand	Urban/built-up, cropland and pasture, some evergreen forest	Entisols, Spodosols
Southern Coast and Islands (76d)	Flat plain, >50% covered by standing water, tidal sloughs, open lagoons, low beach ridge deposits, coral reefs and islands. Elevation <6ft. Relief <6ft.	Mangrove swamp forests and coastal marshes, coastal strand	Forested wetlands	Tidal marsh and tidal swamp, rock outcrop-tidal marsh

SECTION 2
AQUATIC CLASSIFICATIONS OF FLORIDA

"A classification should be designed for a specific purpose: it will rarely serve two different purposes equally well," (Grigg 1965).

2.1 INTRODUCTION

One goal of this project is to stratify the considerable biological variability of Florida through the use of a hierarchical set of ecological regions and water body types. Water body types are usually classified using physical, chemical, or biological criteria or some combination of the three. The classification of Florida water body types is a challenging task due to the complexity and uniqueness of the state's hydrologic systems. One must approach such a task cautiously and humbly, because our collective knowledge of the processes and distributions of natural features is fragmentary, and because the complexity, diversity and subtle gradations of these systems can make even a seemingly good classification ineffective and less useful. We also need respect for and an understanding of previous classification attempts, thus this short review of aquatic classifications in Florida might be useful.

Comprehensive classifications that attempt to cover all the water body types can be found from several sources. Berner and Pescador's (1988) classification was used to describe mayfly habitats (Table 2.1). The Florida Natural Areas Inventory's hierarchical classification of natural communities (Natural Community Categories, Groups, and Types) has three Categories, based on hydrology and vegetation, that cover water body types: Palustrine, Riverine and Lacustrine (Table 2.2). The Florida Museum of Natural History is using seventeen freshwater types for their fish database (Table 2.3). A Florida Department of Environmental Regulation biologist (Frydenborg 1991) uses a classification of aquatic systems for development of an "eco-unit concept" (Table 2.4). Layfield and Barbour (1991) proposed a stream and lake classification for their community bioassessment project (Table 2.5).

2.2 STREAMS

For streams, Beck (1965) aimed "to propose a uniform classification of the lotic habitats of Florida." He reviewed similar previous classifications (ie., Rogers 1933; Carr 1940; Hobbs 1942; Berner 1950; and Herring 1951) and defined "five chemically, physically, and biologically distinct stream types." These are:

Sand-bottomed stream
Calcareous stream
Larger rivers
Swamp and bog stream
Canals

Table 2-1. Aquatic (mayfly) habitats (Berner and Pescador 1988)

- **Intermittent Creeks**
- **Permanent Creeks**
  - Sand-bottomed creeks with little vegetation
  - Sand-bottomed creeks choked with vegetation
  - Silt-bottomed creeks with little vegetation
  - Silt-bottomed creeks choked with vegetation
- **Rivers**
  - Stagnant rivers
  - Slow-flowing deep rivers
  - Larger calcareous streams
- **Ditches and Pools**
  - Roadside ditches
  - Pools (transitory)
- **Ponds**
  - Sinkhole ponds
  - Fluctuating ponds
  - Temporary woods ponds
  - Sporadic ponds
  - Jerome sink
- **Lakes**
  - Sand-bottomed lakes
  - Silt-bottomed lakes
  - Disappearing lakes
- **Marshes**
- **Everglades**
- **Swamps**
  - Cypress swamps
  - Bayheads
- **Springs**

Table 2-2. Water-related natural community categories, groups and types (Florida Natural Areas Inventory 1990)

- LACUSTRINE
  - Clastic Upland Lake
  - Coastal Dune Lake
  - Coastal Rockland Lake
  - Flatwoods/Prairie/Marsh Lake
  - River Floodplain Lake and Swamp Lake
  - Sandhill Upland Lake
  - Sinkhole Lake
- RIVERINE
  - Alluvial Stream
  - Blackwater Stream
  - Seepage Stream
  - Spring-run Stream
- PALUSTRINE
  - WET FLATLANDS
    - Hydric Hammock
    - Marl Prairie
    - Wet Flatwoods
    - Wet Prairie
  - SEEPAGE WETLANDS
    - Baygall
    - Seepage Slope
  - FLOODPLAIN WETLANDS
    - Bottomland Forest
    - Floodplain Forest
    - Floodplain Marsh
    - Floodplain Swamp
    - Freshwater Tidal Swamp
    - Slough
    - Strand Swamp
    - Swale
  - BASIN WETLANDS
    - Basin Marsh
    - Basin Swamp
    - Bog
    - Depression Marsh
    - Dome Swamp

Table 2-3. A classification of Florida freshwaters (Steve Walsh, Florida Museum of Natural History)

- LAKES
  - Streams flowing into lake
  - Streams flowing out of lake
  - Streams flowing in and out of lake
  - Landlocked lake
  - Riverine lake (St. Johns River)
  - Impounded lake
- RIVERS AND STREAMS
  - Heavy flow (>150 cfs) with sediment bottom
  - Large flow (20-150 cfs) with sediment bottom
  - Moderate flow (1-19.9 cfs) with sediment bottom
  - Low flow (<1 cfs) with sediment bottom
  - Heavy flow (>150 cfs) with calcareous bottom
  - Large flow (20-150 cfs) with calcareous bottom
  - Moderate flow (1-19.9 cfs) with calcareous bottom
  - Low flow (<1 cfs) with calcareous bottom
- LARGE MARSHES
  - Everglades-Big Cypress
- SUBTROPICAL PERIPHERAL
  - Florida Keys
- ESTUARINE
  - Brackish

Table 2-4. A classification of Florida's aquatic systems (Frydenborg 1991)

- LENTIC
  - Karst solution lake
  - Relict estuary lake
  - Stream-capture lake
  - Perched aquifer lake
  - Others
    - Marsh
    - Swamp
    - Temporary pond
    - Coastal dune pond
- LOTIC
  - Alluvial river
  - Blackwater stream
    - Bog-fed stream
  - Floridan aquifer-fed stream
  - Surficial aquifer-fed stream
- ESTUARINE
  - *Spartina* marsh
  - Mangrove forest
  - Mud flats
  - Oyster bars
  - *Thalassia* beds

Table 2-5. Classification of streams, rivers and lakes (Layfield and Barbour 1991)

- LAKES
  - Karst
  - Tectonic
  - Dystrophic
  - Reservoir
  - Riverform
- STREAMS AND RIVERS
  - Tannic
    - Sand bottom
    - Sand bottom with spring influence
    - Swamp and bog
  - Alluvial
  - Calcareous and spring
  - Miscellaneous

Clewell (1991) maintains there has been no concerted effort to categorize Florida's diverse streams, and criticized Beck's classification for being inconsistent in the use of characteristics to distinquish stream types. "Two stream types were based on the nature of bottom sediments (sand-bottomed streams and swamp-and-bog streams), one on dissolved solids (calcareous streams), one on size (larger rivers), and one on channel origin (canals)," (Clewell 1991). Doubting that a consistent, multipurpose classification could be devised, Clewell instead offers a characterization of contrasting stream types for attaining an appreciation of Florida streams. The four contrasting stream types he describes are:

Blackwater streams
Spring runs
Alluvial rivers
Tidal rivers.

For panhandle blackwater streams, Wolfe et al., (1988) combined Beck's sand-bottomed stream with the swamp and bog stream, "because the latter is merely a slower moving, lower volume version of the former; the swamp and bog stream ... grades downstream into a sand-bottomed stream if the drainage system is large enough." Their text goes on, however, to explain how the two stream types differ.

That Beck was inconsistent in the use of characteristics to distinquish stream types is of less concern than the ultimate utility of the classification. Similar to defining regions where the determining characteristics and their relative importance may vary from one area to another, the criteria to classify streams may be different to get the most useful seperation of stream types. This idea may be difficult to accept by a strict taxonomist. For resource managers, however, that have a good understanding of the nature and variability of these aquatic systems and realize there are many shades of gray, it may be acceptable to use different characteristics and careful identification to obtain a more meaningful classification.

Nordlie (1990) discussed Florida stream classification efforts, concluding that Beck's was the most widely used. He believed that the Florida Natural Areas Inventory scheme suffered from the same disadvantages that other systems do and offered no additional advantages. One of Nordlie's concerns was the difficulty of giving a single classification to a stream because there may be several sources of inflow along its course that changes its character. Some rivers originate from artesian springs and then become brown and acidic from swamp discharge and surface runoff, e.g., the Aucilla River. Others originate as acidic brownwater streams but receive spring input in their midreaches, e.g., the Suwannee and Waccasassa. Others may be extensively altered by engineering or pollution. Nordlie went on to classify thirty-three major Florida waterways using Beck's system. Although he recognized that different sections of a river should have different classifications, he did not attempt to do so.

Estevez et al., (1984) divided Florida rivers into alluvial, spring-fed, and blackwater types, but also noted that many rivers (e.g., the Suwannee) show characteristics of all three types in different reaches or at different times of the year.

One can see some similarity in the different stream classifications devised for Florida. Initial group discussions with the DEP district biologists and other personnel, however, did not lead to any consensus on an appropriate stream classification for the regionalization/reference site project. Some efforts are underway to develop a more site-specific classification that includes factors such as stream size, velocity, substrate, energy source and pH. In the interim, a relatively simple scheme such as sand bottom, sand bottom with spring influence, swamp and bog, alluvial, and miscellaneous will be considered.

2.3 LAKES

In the Water Resources Atlas of Florida, Estevez et al., (1984, p. 96) classifies lakes simply as acid clear, acid colored, or alkaline clear. Also in the Atlas, Palmer (1984, p.62) discusses the lake types as impoundments, solution lakes (two basic types), lakes in relict sea bottom depressions, and lakes formed by erosion and sedimentation processes in rivers. He also shows the percentage of total lakes classified by stream connection, ie., no inlets and outlets, inlets and outlets, outlets only, inlets only. The Florida Museum of Natural History used this common straightforward hydrologic classification (Table 3) but at least 70% of Florida's 7800+ lakes are of the "landlocked" type (no inlet or outlet). A more useful classification would require subdividing this one class. Berner and Pescador (1988) used bottom type, sand or silt, for their lakes and several criteria for ponds, but did not make a clear distinction between a lake and a pond.

Huber et al., (1982) undertook a trophic state index classification of Florida's lakes in response to the requirements of the EPA's Clean Lakes Program. Lakes were first classified as nitrogen limited, phosphorus limited, or nutrient balanced. 573 lakes were classified by an average trophic state index (TSI) as well as by several subindices. Hydrologic lake types (inflow, outflow, inflow-outflow, seepage, unspecified) were found to not be a major factor influencing TSI values.

Myers and Edmiston's (1983) Florida lake classification project grouped lakes into "poor" or "fair to good" classes using trophic state index. They then prioritized lakes for restoration using a quantitative scheme based on the trophic state, recreational use, public interest, impaired use, nutrient loading, and the importance as a public water body. They listed the top 50 lakes in Florida in need of restoration. Most all occurred in central Florida and were affected by cultural eutrophication. Myers and Edmiston also formulated a ranking scheme for the top 50 lakes in Florida most deserving protection and preservation (i.e., those with good quality, public interest, recreation use, importance as water body), and these were located throughout the state.

2.4 SPRINGS

Springs have been categorized by Whitford (1956).

Soft freshwater
Hard freshwater
Oligohaline
Mesohaline
Sulfide
Salt sulfide

Slack and Rosenau (1979) divided first magnitude springs (average flow >100 cubic feet per second) from second magnitude springs (average flow 10-100 cubic feet per socond) and mapped the chemical types of Florida springs as calcium-magnesium-bicarbonate, sodium chloride, mixed, and calcium sulfate. Rosenau et al., (1977) provides the most detailed state publication on the springs of Florida.

2.5 MARSHES

Marshes of Florida have been summarized comprehensively by Kushlan (1990). He has categorized the freshwater marshes into five major groups based on factors that "vary from one physiographic region to the next." The distribution of marshes may be explained through a combination of local and regional topography, rainfall, evaporation and geology. The major groups from higher to lower elevation are:

Highland marshes
Flatwoods marshes
Kissimmee marsh complex
St. Johns marshes
Everglades

Kushlan further divides marshes into "six major categories" or predominant plant associations: water lily marsh, submersed marsh, cattail marsh, flag marsh, saw grass marsh and wet prairie. He also discusses invertebrates, fish, and other marsh animals.

2.6 SWAMPS

In classifying surface waters, consideration of forested wetlands, or swamps, highlights the difficulty of distinquishing between land and water in Florida. One cannot understand the biological integrity of a water body without considering closely integrated adjacent swamp ecosystems. Ewel (1990) summarizes the current knowledge of swamp ecosystems in Florida, and uses two broad divisions of a classification based on the National Wetlands Inventory: River Swamps (whitewater floodplain forest, blackwater floodplain forest, spring run swamp) and Stillwater Swamps (bay swamp, cypress pond, cypress savanna, cypress strand, gum pond, hydric hammock, lake fringe swamp, malaleuca swamp, mixed hardwood swamp, shrub bog).

SECTION 3
STREAM REFERENCE SITE SELECTION

To develop biological criteria and evaluate impaired water bodies, it is important to establish reference conditions that are suitable for comparison. A key function of an ecoregion framework is its use in selecting regional reference sites and facilitating the assessment of regionally attainable conditions. Ideally, control sites for estimating attainable conditions should be as minimally disturbed as possible yet representative of the streams for which they are to be controls (Hughes, et al., 1986). Although no two streams are alike, we hypothesize that streams within an ecoregion or subregion will have generally similar characteristics as compared to all streams within a state or larger area. Because of the variety of stream types, extent of karst topography and relative lack of elevational differences in Florida, as compared to much of the conterminous United States, it is also important to classify stream types and to consider groundwater influences. Different stream types can occur in each subregion and groundwater influences may tend to mask regional differences. Additional classifications or hierarchical levels may be needed to sort out differing stream segments and habitat types.

General guidelines for selecting reference sites have been given in Hughes et al., (1986) and by Gallant et al., (1989). The process, however, is being refined as experience is gained in current and ongoing ecoregion/reference site projects (e.g., Alabama/Mississippi, Iowa, and EPA Region III). For any given project it may be necessary to modify or expand general procedures; due to varying characteristics or objectives in different areas, it is difficult to follow strictly a detailed rule-based approach that will be applicable to all regions. Our process of selecting candidate reference sites in Florida is outlined below:

1). We defined regions and subregions within which there is apparent homogeneity in a combination of geographic characteristics that are likely to be associated with resource quality, quantity, and types of stresses.

2). We generally characterized disturbance (such as areal or nonpoint source pollution, and local or point sources of pollution) in each ecoregion and subregion and analyzed geographic characteristics to better understand representative or typical conditions. What comprises disturbance may vary considerably from one region to another. In regions with nutrient-rich soils, poor drainage, but great agricultural potential, all streams may have been channelized at one time or another, and all watersheds may have a high percentage of agricultural land use. Reference streams in such a region comprise those with few if any point sources, lack of recent channelization activity, and riparian zones with a relatively large percentage of woody vegetation. Regions with nutrient-poor soils, lacking agricultural potential, and containing a different set of identifying landscape characteristics such as coniferous forests and clear streams and lakes, are likely to be affected by different types of stressors. Relative lack of silvicultural activities or heavy recreational usage may be important criteria in selecting minimally-impacted, representative reference streams in these regions.

3). A set of stream sites with approximated surface watersheds that appear relatively undisturbed and completely within the ecoregion or subregion was chosen. The actual number of sites/watersheds selected was a function of the apparent homogeneity or heterogeneity of the region, the size of the region, hydrologic characteristics, and simply how many stream sites/watersheds were available for selection. The point of diminishing returns, regarding the number of streams necessary to address regional attainable quality and within-region variability, may be reached with only a few sites in regions that are relatively homogeneous and/or small. Complex regions, on the other hand, are likely to require a large number of sites. Another consideration was access, ie., do roads get the biologists near enough to the stream section for sampling? Disturbance and typicalness were interpreted from information shown on 1:250,000-scale and 1:100,000-scale USGS topographic maps, land use and soils maps, and Landsat imagery. The existence of populated areas, industry, agricultural land use, forestry, mining, catfish ponds, fish hatcheries, transportation routes, etc., were all interpreted from mapped information. The 1988 and 1990 Florida Water Quality Assessment 305(b) reports were also consulted for each potential site to assess water chemistry/quality, and point- or non-point source pollution impacts. The number of preliminary candidate sites per subregion varied, ranging from only eight in subregion 75C, the Central Florida Ridges and Uplands where relatively few streams are found, to twenty sites in subregion 75D, the Eastern Florida Flatwoods. A list of the candidate sites was developed that included the subregion, site number, stream name and location, major basin, county, 1:100,000-scale map name, DEP district, estimated watershed area (if determinable), and additional comments. This was given to the state biologists along with photocopies of the exact site locations.

4). Each set of sites was reviewed by state biologists, and sites were visited during ground reconnaissance to get a sense for the usefulness of the regions, the characteristics that comprise reference sites in each region, the range of characteristics and types of disturbances in each region, and how site characteristics and stream types vary between regions. In this process, sites that were found unsuitable were dropped (because of disturbances not apparent on the maps or due to anomalous situations) and other sites could be added.

5) Aerial reconnaissance was conducted to identify disturbances not observable from the ground, to get a better sense for the spatial patterns of disturbances and geographic characteristics in each region, and to photograph typical characteristics, site locations, or disturbances for use in briefings and publications.

It should be remembered that all of the reference sites have some level of disturbance. There are no pristine, unimpacted watersheds in Florida, or, considering atmospheric deposition of contaminants, anywhere else in the U.S. The least or minimally impacted sites were looked for, but levels of impact are relative on a regional basis. The characteristics of appropriate reference sites will be different in different ecoregions and subregions and for different waterbody and habitat types. It is desirable, therefore, to have a large number of candidate reference sites for each region to help define the different types of streams, to illustrate the natural variability within similar stream types, and to clarify the factors that characterize the best sites from factors present in the lower quality sites.

SECTION 4
FISH SPECIES DISTRIBUTION ANALYSIS

4.1 INTRODUCTION

The natural regions delineated for the state of Florida characterize areas of similarity with respect to environmental factors that affect aquatic resources. Specifically, the regions subsume broad scale differences in the physical-chemical environment that influence the types of fishes found. Differences in factors such as gradient, clarity, productivity, temperature and dissolved oxygen affect the suitability of waters for various fishes and tend to be integrated and represented by the delineated regions. Water body type and watershed area will also influence the distribution of particular types of fishes.

As part of the regionalization project, we used information on the distribution of fish species collected throughout the state (Burgess and Walsh 1991) to examine differences in fish assemblages and the degree to which the differences corresponded to the delineated regions. We did not attempt to delineate fish faunal regions. Such an endeavor would require incorporation of additional background information beyond the scope of this study (e.g., present and historical connections between drainage basins, species introductions, changes in sea level, and community dynamics like competition and predation). Our purpose was to focus on the characteristics of the current physical-chemical environment that vary regionally and affect the suitability of fish habitats.

4.2 METHODS

Catalogued material from the Florida Museum of Natural History fish collection was used to characterize the fish assemblages throughout the state. Written descriptions of sampling sites were used by museum personnel to identify water body types (Table 4-1) and site locations on 1:250,000-scale USGS maps. Locations were digitized by ERL-C personnel to provide exact latitude and longitude coordinates and subregion classification.

Sampling methods and the degree to which methods were documented for the samples in the collection were not consistent. For this reason the fish assemblages were characterized in terms of fish species presence or absence rather than actual abundances. A more quantitative analysis would be inappropriate given the lack of uniformity in sampling methods. In many instances, more than one sample was collected at a particular site. The number of samples was tabulated and data were combined to characterize the fishes at each site.

A master database was designed with one record for each site. The fish species occurring at that site were flagged. All data were double entered and verified prior to production of site-by-species matrices for statistical manipulation.

Table 4-1. Classification of Florida Freshwaters: the water body types used to classify each sampling site in the Florida Museum of Natural History database.

LAKES
(1) Streams flowing into a lake
(2) Streams flowing out of a lake
(3) Streams flowing in and out of a lake
(4) Landlocked lake
(5) Riverine lake (St. Johns River)
(6) Impounded lake

RIVERS AND STREAMS
(7) Heavy flow (>150 cfs) with sediment bottom
(8) Large flow (20-150 cfs) with sediment bottom
(9) Moderate flow (1-19.9 cfs) with sediment bottom
(10) Low flow (<1 cfs) with sediment bottom
(11) Heavy flow (>150 cfs) with calcareous bottom
(12) Large flow (20-150 cfs) with calcareous bottom
(13) Moderate flow (1-19.9 cfs) with calcareous bottom
(14) Low flow (<1 cfs) with calcareous bottom

LARGE MARSHES
(15) Everglades-Big Cypress

SUBTROPICAL PERIPHERAL
(16) Florida Keys

ESTUARINE
(17) Brackish

Several types of multivariate statistical methods have been shown particularly effective in depicting regional differences in fish assemblages. We employed two basic statistical approaches. The first was to display sites in multi-dimensional space, based on the similarity of the fish species present, and compare site groupings with groupings based on subregion membership. We used clustering and ordination techniques for this purpose and color-coded the sites in the resulting plots by subregion membership. Correspondence between similar species groupings and subregion membership were then evaluated.

The other basic approach employed was to classify sites a priori, by subregion, and evaluate subregional differences in characteristics of the fish assemblages. We constructed ordered tables of dominant species ("species signatures") and box-plots of species richness for each subregion and then evaluated differences between the subregions.

It should be noted that species richness will vary, regardless of subregional differences, in proportion to both sampling intensity and watershed size. For this reason, plots were drafted using only sites sampled more than once (generally 2-4 times) and sites were pooled based on major water body types sampled (as a crude surrogate for watershed area; see Table 4-1).

4.3 SELECTED RESULTS AND DISCUSSION

Extensive detrended correspondence analyses of the database, partitioned both geographically and by water body type, indicated some subregional differences. Analysis of all of the low flow sites sampled more than once throughout the state yields a representative summary of these analyses (Figure 2). Sites from subregion 65f, the Southern Pine Plains and Hills, appear the most tightly clustered (similar in terms of fish species composition), followed by those from subregion 75e, Okefenokee Swamps and Plains. Sites from the Southeastern Plains Ecoregion (65) generally appear to the left of sites from the Southern Coastal Plain Ecoregion (75) with the exceptions of subregions 75a (Gulf Coast Flatwoods) and 65h (Tifton Upland/Tallahasee Hills) which overlap the sites of the opposite ecoregion significantly.

Cluster analysis of the Panhandle portion of the database, the portion which had revealed the clearest subregional separation, yielded a large number of distinct clusters. The degree of separation by subregion was analogous to that of the detrended correspondence analysis with a slightly stronger separation of the clusters of sites from the Southern Pine Plains and Hills subregion (65f).

The ordered table of characteristic species illustrated that while there are some species generally common to most subregions, there are definite shifts in the characteristic species from one subregion to the next (Table 4-2). In order to achieve this level of distinctiveness, the criterion for inclusion in the table was adjusted to species found at greater than 16% of the sites in the subregion.

Preliminary analyses of species richness, by subregion, had indicated that distinct differences might exist between regions. After sites were partitioned to correct for potentially confounding effects of sampling intensity and watershed size, box plots by subregion did reveal differences (Figure 3). Most noticeable is the fact that the most frequently sampled water body types differ by subregion. It remains to be determined whether these differences in water body type are truly representative of waters within the regions or merely artifacts of the way in which sampling sites were chosen. Regardless, it appears that fish assemblages in low flow sites in the Southeastern Plains Ecoregion (65) seem most diverse, contrasted with low flow sites in the Southern Coastal Plain Ecoregion (75). Species richness was low in the sampled sites of the Southern Florida Coastal Plain Ecoregion (76), particularly in subregion 76d.

In summary, our analysis of the fish collection of the Florida Museum of Natural History indicates that there are some regional differences in the types of fishes found throughout the state of Florida. Differences are most evident between sites of the Southeastern Plains Ecoregion (65) and the rest of the state. Variation in species composition among sites within the same subregion is quite high. A large amount of this variation is suspected to result from the lack of controlled site selection and sampling processes; the museum fish database contains whatever specimens were of interest to investigators for a variety of reasons. It is expected that standardized survey techniques employed to sample sites selected as truly representative of those in each subregion would yield more pronounced regional differences.

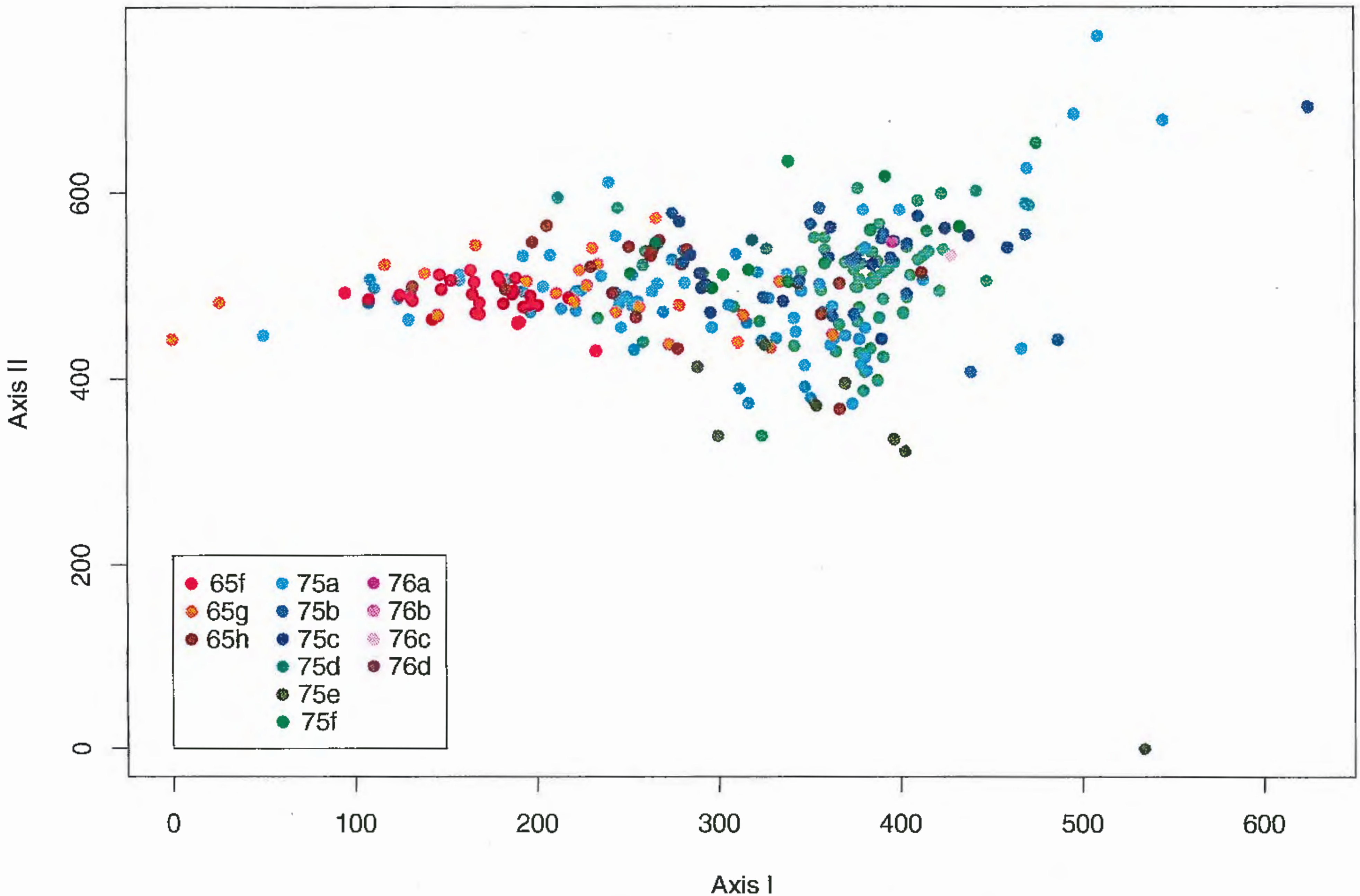


Figure 2. Detrended correspondence analysis of fish species composition at low flow sites in Florida sampled more than once (minus three outliers).

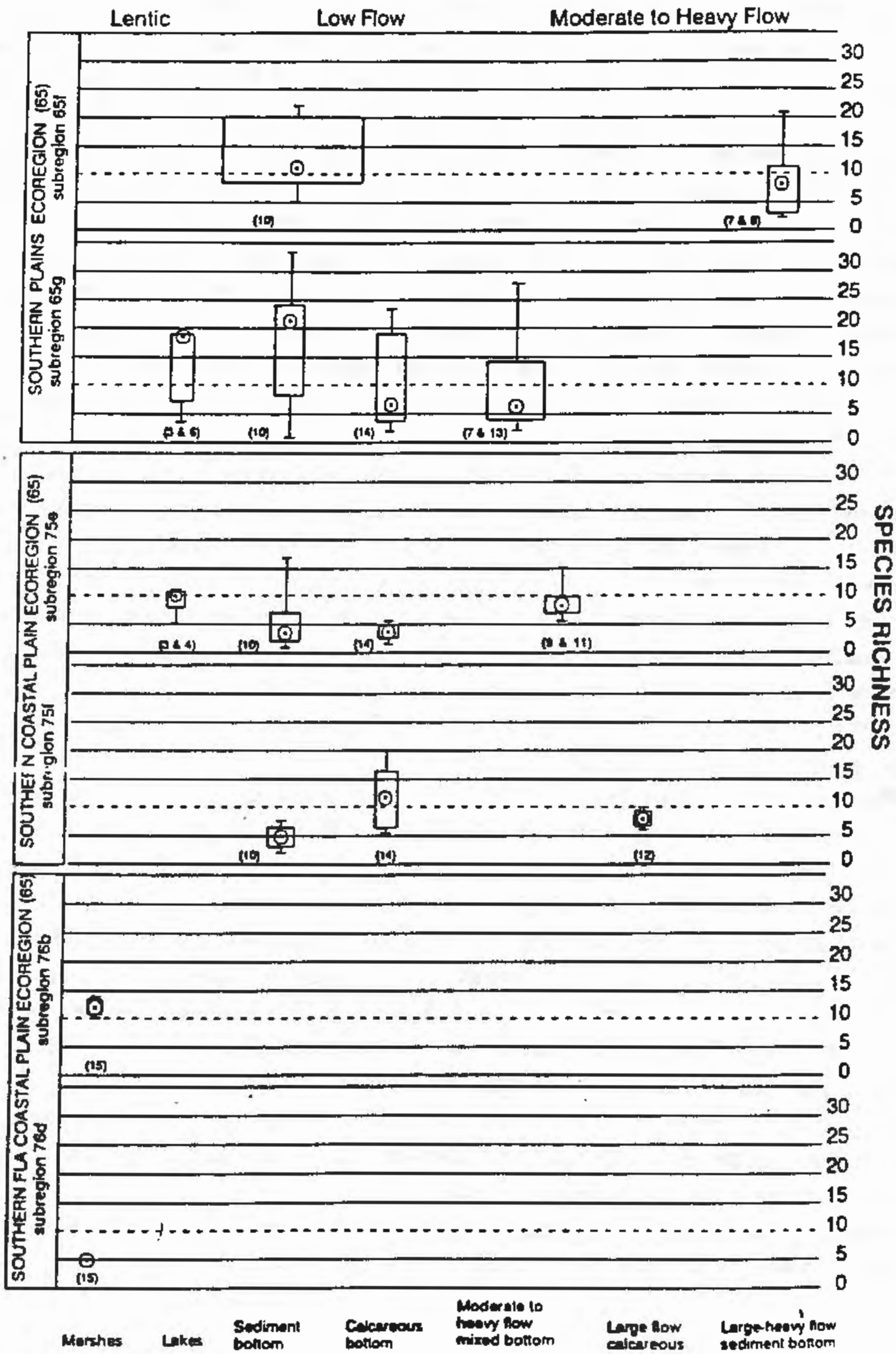
Table 4-2. List of "signature fishes" or those species appearing in more than 16% of the samples taken from each subregion. Numbers indicate actual percentage of sites in the subregion at which the species was collected.

	65F	65G	65H	75A	75B	75C	75D	75E	75F	76A	76B	76C	76D
PTERON2	46.1												
ETHEOS12	33.3												
FUNDUL9	33.3												
NOTURU1	26.2												
ERIMYZ2	26.2												
ICHGAG	23.4												
NOTROP5	22.7												
LEPOMI5	20.6												
ERIBUC	17.7												
CYPRIN3	24.3	21.4											
ETHEOS3	24.1	22.3											
NOTROP4		23.2											
ETHEOS1			17.6										
NOTURU3	52.5		23.2										
FUNDUL5	18.4	30.4		16.9									
NOTROP9	56.7	32.1	23.2										
PTERON1	66.6	26.8	22.5	16.6									
PERCIN1	70.9	28.6	35.2	16.0					23.3				
APRSAY	26.2	26.8	25.3	23.3				34.6	21.0				
ESSOX1	22.7	35.7	17.6	22.8				34.6					
LEPOMI1			34.5						24.4				
CENMAC		22.3	19.0					34.6					
ELASSO1				17.6	20.7			42.3					
LEPOMI4		29.5			27.6				18.6	37.1			
LEPOMI6			21.1		16.4		16.7			30.6			
NOTROP8			17.6	16.7	19.8				18.6				
ENNEAC2			17.6			16.0	16.2	21.2		21.0			
ERIMYZ1	16.3	22.3		17.6	17.2		16.2		17.4	16.1			
ETHEOS4		18.8		16.4	24.1	16.0	16.7	19.2		19.4			
GAMBUS1	34.0	50.9	42.3	42.1	50.0	40.7	39.2	36.5	43.0	65.5	69.2	27.9	31.3
LABSIC		38.4	35.9	23.0	31.9	21.3	29.6	25.0	34.9	21.0			
LEPOMI2		27.7	29.6	21.3	36.2	21.3	24.8	25.0	22.1	54.8	46.2	19.1	
LEPOMI3		40.2	41.5	21.5	31.9	34.7	27.3	17.3	22.1	37.1	23.1		
LEPOMI7	42.6	28.6	18.3	26.4	28.4		19.2		26.7	58.1	30.8		
MICROP4	21.3	33.9	31.0	28.0	23.3	26.0	21.3	17.3	27.9	37.1			
NOTCRY		24.1	29.6		20.7	15.3	21.5		17.4	32.3	23.1		
HETFOR				16.0	37.1	17.3	25.1			54.8	46.2		
JORFLO					28.4					45.2	53.8		
FUNDUL2					31.0	21.3	19.0			43.5	53.8		
FUNDUL8						16.0		28.8					
FUNDUL11						19.0	19.2						
ACAPOM								19.2					
NOTURU2								17.3					
LEPOMM								25.0					
ENNEAC3								32.7					
NOTROP2									21.0				
POELAT					36.2		27.6			53.2	46.2	20.6	29.2
LUCIAN1					23.3	18.7	26.8			48.4	53.8	20.6	
AMEIUR3								17.3		33.9	23.1		
FUNDUL3										12.9	30.8		20.8
LEPISO3										30.6			
LUCIAN2													29.2
CYPVAR													22.9
MENIDI1													20.8
FUNDUL6													18.8
MENIDI2													16.7

Table 4-2 (cont.) KEY TO SPECIES ACRONYMS:

PTERON2	Pteronotropis signipinnis	flagfin shiner
ETHEOS12	Etheostoma (Ulocentra) n. sp.	
FUNDUL9	Fundulus olivaceus	blackspotted topminnow
NOTURU1	Noturus funebris	black madtom
ERIMYZ2	Erimyzon tenuis	sharpfin chubsucker
ICHGAG	Ichthyomyzon gagei	southern brook lamprey
NOTROP5	Notropis longirostris	longnose shiner
LEPOMI5	Lepomis megalotis	longear sunfish
ERIBUC	Ericymba buccata	silverjaw minnow
CYPRIN3	Cyprinella venusta	blacktail shiner
ETHEOS3	Etheostoma edwini	brown darter
NOTROP4	Notropis harperi	redeye chub
ETHEOS1	Etheostoma bifacia	Florida sand darter
NOTURU3	Noturus leptacanthus	speckled madtom
FUNDUL5	Fundulus escambiae	russetfin topminnow
NOTROP9	Notropis texanus	weed shiner
PTERON1	Pteronotropis hypselopterus	sailfin shiner
PERCIN1	Percina nigrofasciata	blackbanded darter
APRSAY	Aphredoderus sayanus	pirate perch
ESOX1	Esox americanus	redfin pickerel
LEPOMI1	Lepomis auritus	redbreast sunfish
CENMAC	Centrarchus macropterus	flier
ELASSO1	Elassoma evergladei	Everglades pygmy sunfish
LEPOMI4	Lepomis marginatus	dollar sunfish
LEPOMI6	Lepomis microlophus	redear sunfish
NOTROP8	Notropis petersoni	coastal shiner
ENNEAC2	Enneacanthus gloriosus	bluespotted sunfish
ERIMYZ1	Erimyzon sucetta	lake chubsucker
ETHEOS4	Etheostoma fusiforme	swamp darter
GAMBUS1	Gambusia holbrooki	eastern mosquitofish
LABSIC	Labidesthes sicculus	brook silverside
LEPOMI2	Lepomis gulosus	warmouth
LEPOMI3	Lepomis macrochirus	bluegill
LEPOMI7	Lepomis punctatus	spotted sunfish
MICROP4	Micropterus salmoides	largemouth bass
NOTCRY	Notemigonus crysoleucas	golden shiner
HETFOR	Heterandria formosa	least killifish
JORFLO	Jordanella floridae	flag fish
FUNDUL2	Fundulus chrysotus	golden topminnow
FUNDUL8	Fundulus lineolatus	lined topminnow
FUNDUL11	Fundulus seminolis	Seminole killifish
ACAPOM	Acantharchus pomotis	mud sunfish
NOTURU2	Noturus gyrinus	tadpole madtom
LEPOMM	Leptolucania ommata	pygmy killifish
ENNEAC3	Enneacanthus obesus	banded sunfish
NOTROP2	Notropis chalybaeus	ironcolor shiner
POELAT	Poecilia latipinna	sailfin molly
LUCIAN1	Lucania goodei	bluefin killifish
AMEIUR3	Ameiurus natalis	yellow bullhead
FUNDUL3	Fundulus confluentus	marsh killifish
LEPISO3	Lepisosteus platyrhincus	Florida gar
LUCIAN2	Lucania parva	rainwater killifish
CYPVAR	Cyprinodon variegatus	sheepshead minnow
MENIDI1	Menidia beryllina	inland silverside
FUNDUL6	Fundulus grandis	gulf killifish
MENIDI2	Menidia peninsulae	tidewater silverside

Figure 3. Box plots of fish species richness at sites sampled 2-4 times in each water body type for two subregions per ecoregion. Water body types displayed indicate those most frequently sampled in each subregion. Water body codes are as in Table 4-1.



SECTION 5
CONCLUSIONS AND RECOMMENDATIONS

The definition of an ecoregion framework for Florida was not a simple task, due in part to the complex mosaic of landscape characteristics and the subtle changes in this mosaic from one place to another, relative to other areas of the United States. Compared to other states, however, Florida does seem to have a rich collection of maps, books, documents and databases describing its physical features and biotic distributions. This abundance of material provided some confidence in our decisions for regional delineations. Despite the volumes of written material, the multitude of maps and graphs, and the gigabytes of government agency data, the spatial distributions and variations in quality of terrestrial and aquatic habitats and associated biota are not as well known or documented as is needed for effective management or regulatory practices. With increasing population growth and landscape alteration, there may be uncertainty about just what is being lost; hence, it becomes imperative to find appropriate areas or biotic communities to use for comparisons of resource quality.

Our ecoregion framework for Florida is a general framework for the state to be used for environmental resource assessment and management. Because regions are mental constructs and boundaries are defined with certain purposes in mind, the interest in such a framework should not be in its absolute truth but in its utility. Does it provide a mechanism to better understand spatial variations in ecosystem potential or in the nature and quality of environmental resources? We believe that the framework along with the selection of stream reference sites can help build the foundation for a better understanding of regional differences. The ecoregion map is a hypothesis, a potentially useful framework to be debated, tested, and improved.

One need this project helped to highlight, but failed to completely reconcile, was the development of a useful classification of streams. While this report included a review of aquatic classifications used in Florida, and several group discussions about stream types were held with DEP district biologists and others, a consensus could not be reached on classes of streams that had relevance across the state yet were reflective of local conditions and processes. For the sake of agreement and to begin assessment of reference site data, a general classification was adopted (EA Engineering, Science, and Technology and Tetra Tech, Inc. 1994). The need for comparison and extrapolation may show that this general stream typing is not adequate to represent certain stream characteristics. Because the topic was not easily resolved, there may be some reluctance to revisit the issue, but DEP staff should continue to discuss and develop the classification if there are obvious shortcomings with the one currently adopted.

Although the mapping of water body types was one of the original tasks for this project, it became clear that what could be mapped with the data available was not very useful to the biologists and water quality managers. We did convert some of the lake data bases, such as the Florida Lake Gazetteer and Huber's (1982) Classification of Florida Lakes, to ARC/INFO files and produced draft maps of some of the physical feature types, but for stream types, data on the geographic extent is scarce. Once the DEP biologists reach a consensus on an effective classification scheme for characterization and typing of the reference streams, an effort should be made extend this work to other stream reaches. This must be viewed as a long-term project, but much of this information may already reside in the minds of the district biologists, and it should be relatively straight-forward to mark reaches on an agreed scale of map for later digitization.

Along with the classification of reference sites, more effort should be made to assess their representativeness. This is difficult in a state like Florida, where regional patterns are often composed of complex mosaics and many systems appear unique. Because classic topographic watersheds have little meaning in much of Florida, more work needs to be done in characterizing land patterns and hydrologic flows that affect the reference sites and would influence comparisons with other streams. There also should be more analysis and evaluation of the larger river biological station reference sites that were chosen by a different process than the other stream reference sites (Layfield and Barbour 1991). Until more is known about these sites and the relative contributions of multiple regional influences, we recommend that these reference site data bases be kept separate.

In addition to the use of reference sites for assessing attainable water quality, the ecoregion framework could also be used to organize and analyze the current status of surface water conditions. Current status could be determined by sampling a random selection of streams within the regions. The EMAP grid could be used to select these sites, and, if sampled regularly, the values could be compared to those of the reference sites to help assess cumulative impacts and temporal trends. Although the amount and distribution of least-impacted and most-impacted surface water varies from one region to another, a logical scheme for inventorying the extent of surface water resources and their quality (relative degradation) would couple an ecoregion reference site framework with a systematic EMAP grid. Data from sets of regional reference sites representing least- and most-impacted conditions (selected qualitatively) would be compared and grouped with data from randomly selected sets of EMAP grid sites.

To make conclusions about this regionalization project does not imply that the work is completed. The hypothesis that a regional framework and sets of regional reference sites can give managers and scientists a better understanding of the spatial variations in the chemical, physical and biological components of streams in Florida is intuitive but must be tested. Significant time and effort is required for the collection and analysis of data to more fully understand attainable surface water quality. To use that knowledge to actually improve the quality of waterbodies across the state will be a continuing challenge in overcoming narrow interests and institutional barriers.

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Florida Streams
Potential Candidate Reference Sites
Ecoregion #65

65F Southern Pine Plains and Hills

Stream Name/Location	Approx. Size	Comments
65F01 McDavid Creek at Hwy. 99 Perdido Basin Escambia County Bay Minette 1:100,000 Northwest District	24 mi^2	Agricultural headwaters may raise coliform counts. WQI=21.
65F02 E. Fork Big Coldwater Creek Blackwater Basin Santa Rosa County Crestview 1:100,000 Northwest District	50 mi^2	Near state forest bdy. or upstream at Hwy. 4.
65F03 Big Juniper Creek Blackwater Basin Santa Rosa County Crestview 1:100,000 Northwest District	35 mi^2	At Hwy. 191 or could be combined with 65F4 and sampled below Sweet-water Cr.
65F04 Sweetwater Creek Blackwater Basin Santa Rosa County Crestview 1:100,000 Northwest District	30 mi^2	Above Cedar Creek. May want to move downstream for larger watershed at Hwy. 4 or next road down south of Munson.
65F05 Panther Creek Blackwater Basin Okaloosa County Crestview 1:100,000 Northwest District	29 mi^2	Some agricultural land use, primarily in headwaters.
65F06 Big Creek Yellow River Basin Okaloosa County Crestview 1:100,000 Northwest District	23 mi^2	Some agriculture. Laurel Hill ?
65F07 Turkey Gobbler Creek Yellow River Basin Okaloosa County Crestview 1:100,000 Northwest District	10 mi^2	Need some representation of sandy Eglin Ridge streams. Which ones are least disturbed? Air Force base access?

65F08 Little Alaqua Creek Choctawhatchee Bay Basin Walton County Crestview 1:100,000 Northwest District	24 mi^2	Eglin AFB access?
65F09 Rocky Creek ab. Little Rocky Choctawhatchee Bay Basin Walton County Crestview 1:100,000 Northwest District	38 mi^2	District addtion. Eglin AFB. What is non- forested area in upper reaches? Shrub and brushland?
65F10 Mitchell Creek Escambia River Basin Escambia County Bay Minette 1:100,000 Northwest District	10mi^2	District addition.

* Big Pine Barren Creek and Canoe Creek in Escambia County should also be considered although they include significantly more agricultural activities. Some representation of the agricultural areas might be desired. Canoe Creek has had reported fish declines, sediment, turbidity and pesticide problems, but has some ongoing SCS watershed projects. The size of Big Pine Barren and human impacts in the upper reaches indicate some likely problems, but the lower reaches and tributaries appear mostly forested.

65G Dougherty/Marianna Plains

Stream Name/Location	Approx. Size	Comments
65G01 Sandy Creek ab. W. Sandy Choctawhatchee River Basin Walton County Crestview 1:100,000 Northwest District	24 mi^2	Most all sites in this subregion have agricultural land use in the watersheds.
65G02 Parrot Creek Choctawhatchee River Basin Holmes County Marianna 1:100,000 Northwest District	15 mi^2	
65G03 West Pittman Creek Choctawhatchee River Basin Holmes County Marianna 1:100,000 Northwest District	30 mi^2	
65G04 Reedy Creek Choctawhatchee River Basin Holmes County Marianna 1:100,000 Northwest District	20 mi^2	Crossed by powerline, railroad, and interstate.
65G05 Limestone Creek Choctawhatchee River Basin Holmes County Marianna 1:100,000 Northwest District	4 mi^2	How significant are these small calcareous streams? WQI=17. Catfish Branch and Paul Branch to the west may be less impacted. How small should we go for reference sites?
65G06 Hard Labor Creek Choctawhatchee River Basin Washington County Marianna 1:100,000 Northwest District	60 mi^2	Sedimentation from roads and site preparation reported for Flat Creek. Cumulative impacts may require search for least impacted reaches.
65G07 Econfina Creek St. Andrews Bay Basin Washington/Bay Counties PanamaCity/Marianna 1:100,000 Northwest District	> 90 mi^2	Fina wata. Hwy 20 or above.

65G08 Wrights Creek east of Noma Choctawhatchee River Basin Holmes County Marianna/Dothan 1:100,000 Northwest District	35 mi²	Check with Vicki Bauer, AL. DEM.
65G09 Spring Branch Chipola River Basin Jackson County Marianna 1:100,000 Northwest District	12 mi²	At Hwy 2
65G10 Pelt Creek Chipola River Basin Jackson County Marianna 1:100,000 Northwest District	4 mi²	Above confluence with Dry Creek. New Hope Ridge.
65G11 Tenmile Creek Chipola River Basin Calhoun County Marianna 1:100,000 Northwest District	30 mi²	At Road 274 west of Chason. New Hope Ridge.
65G12 Ocheesee Creek Apalachicola River Basin Calhoun/Jackson County Bainbridge/Marianna 1:100,000 Northwest District	25 mi²	

65H Tifton Upland/Tallahassee Hills

Stream Name/Location	Approx. Size	Comments
65H01 Crooked Creek Apalachicola River Basin Gadsden County Bainbridge 1:100,000 Northwest District	16 mi^2	Apalachicola Bluffs area may be too unique, not representative of subregion. Flat Creek has Interstate thru the length of watershed.
65H02 Sweetwater Creek Apalachicola River Basin Liberty County Bainbridge 1:100,000 Northwest District	13 mi^2	Unique?
65H03 Mule Creek at Hwy 12 Ochlockonee River Basin Liberty County Bainbridge 1:100,000 Northwest District	11 mi^2	More typical soils than Bluff sites.
65H04 Rocky Comfort Creek Ochlockonee River Basin Gadsden County Tallahassee/Bainbridge 1:100,000's Northwest District	30 mi^2	Agricultural area but appears to have good riparian cover. Spring may be located above Turkey Creek and Road 65b bridge.
65H05 Black Creek St. Marks River Basin Leon County Bainbridge/Tallahassee 1:100,000's Northwest District	11 mi^2	Flows into unnamed creek then disappears into Copeland Sink. Questionable.
65H06 Welaunee Creek Aucilla River Basin Jefferson County Perry 1:100,000 Northeast District?	10 mi^2	West of Lake Iamonia.

Florida Streams
Potential Candidate Reference Sites
Ecoregion #75

75A Gulf Coast Flatwoods

Stream Name/Location	Approx. Size	Comments
75A01 Black Creek Choctawhatchee Bay Walton County Fort Walton Beach/Panama City/Marianna 1:100,000's Northwest District	37 mi^2 (26 mi^2 above Camp Cr.)	Is this a reasonable substitute for Lafayette Cr. which may have agric. impacts, and includes some areas in 65F? (Lafayette deleted by district).
75A02 Big Crooked Creek St. Andrews Bay Bay County Panama City 1:100,000 Northwest District	20 mi^2	At Hwy 388. Pine plantation impacts?
75A03 Sandy Creek St. Andrews Bay Bay County Panama City 1:100,000 Northwest District	20 mi^2	Above Mule Creek. May be marginal.
75A04 Kennedy Creek Apalachicola River Basin Liberty County Panama City 1:100,000 Northwest District	20 mi^2	At Cotton Landing Recreation Site.
75A05 New River New River Basin Liberty County Tallahassee 1:100,000 Northwest District	16+ mi^2 at Vilas, 50+mi^2 below Bay Creek.	May be less disturbed above Vilas at Hwy 65. "One of the blackest of the blackwater streams."
75A06 Sopchoppy River Ochlockonee River Basin Wakulla County Tallahassee 1:100,000 Northwest District	48 mi^2 (USGS) at FS road 7.9mi nw of Arran.	Either crossing above Monkey Creek. OFW waterbody.

75A07 Juniper Creek ab. New River New River Basin Liberty County Tallahassee 1:100,000 Northwest District	35 mi^2	
75A08 Econfina River Steinhatchee River Basin Taylor County Perry 1:100,000 Northeast District	198 mi^2 (USGS)at crossing above Hwy 98.	May want to move upstream depending on silviculture impacts. Adverse wq trends reported.
75A09 Spring Warrior at Rd 361 Steinhatchee River Basin Taylor County Cross City 1:100,000 Northeast District	30+mi^2	Some elevated levels of nutrients, chlorophyl-a and bacteria reported.
75A10 Eightmile Creek Steinhatchee River Basin Dixie County Cross City 1:100,000 Northeast District	30+mi^2	WQI only fair. Some high bacteria counts. Is this typical of area? What are small square ponds on map?
75A11 Rocky Creek ab Gulf of Mexico Steinhatchee River Basin Dixie County Cross City 1:100,000 Northeast District	?	Small coastal stream at Road 361.
75A12 Waccasassa River at Hwy 24 Waccasassa River Basin Levy County Ocala 1:100,000 Northeast District?	?	Some silviculture activities.
75A13 Wekiva River at Rd 326 Waccasassa River Basin Levy County Ocala 1:100,000 Northeast District?	?	"

75B Southwestern Florida Flatwoods

Stream Name/Location	Approx. Size	Comments
75B01 Little Withlacoochee River Withlacoochee River Basin Sumter/Hernando Counties Inverness 1:100,000 Southwest District	?	At Hwy. 50 or above. Silviculture and agriculture impacts, low DO.
75B02 Withlacoochee River, Hwy.471 Withlacoochee River Basin Pasco/Sumter/Polk Counties Tarpon Springs/Kissimmee 1:100,000's Southwest District	?	Land use impacts, weed problems, plus naturally "poor" water quality.
75B03 Pithlachascotee River east of Moon Lake Crystal River to St. Petersburg Beach Basin Pasco County Tarpon Springs 1:100,000 Southwest District	>150 mi^2 (USGS)	Swamp or river? Includes 75C? Questionable site.
75B04 Anclote River on private road 3.2mi. nw of Odessa Crystal R.-St.Pete.Bch. Basin Pasco County Tarpon Springs 1:100,000 Southwest District	68.1 mi^2 (USGS)	Multiple impacts. May want to move upstream of South Branch.

*

[Would upper Hillsborough River above Crystal Springs (and preferably above the airport tributary) be a suitable and comparable swamp-and-bog type reference stream? Access?]

Stream Name/Location	Approx. Size	Comments
75B05 Little Manatee River ab.S.Fk. Little Manatee River Basin Hillsborough County St. Petersburg 1:100,000 Southwest District	88 mi^2	Elevated bacteria and nutrients. Any new phosphate mining?
75B06 South Fork Little Manatee R. Little Manatee River Basin Manatee/Hillsborough Counties St. Petersburg 1:100,000 Southwest District	35 mi^2	

75B07 Charlie Creek above Little Charley Bowlegs Cr., Hwy 64 Peace River Basin Hardee County Bartow 1:100,000 Southwest District	?	Better downstream?
75B08 Oak Creek ab. Charlie Creek Peace River Basin Hardee County Arcadia 1:100,000 Southwest District	55 mi^2	Agriculture impacts.
75B09 Manatee River at Hwy 64 Manatee River Basin Manatee County Sarasota/St. Petersburg 1:000,000's Southwest District	60 mi^2	May have too many impacts. Phosphate mining in North Fork headwaters? May want to delete.
75B10 Myakka River ab Myakka City Myakka River Basin Manatee County Sarasota 1:100,000 Southwest District	60 mi^2	Sluggish, marshy blackwater. No flow here?
75B11 Horse Creek at Hwy 70 Peace River Basin De Soto/Hardee Counties Arcadia 1:100,000 Southwest District	140 mi^2	Status of proposed phosphate mining?
75B12 Joshua Creek at Hwy 31 Peace River Basin De Soto County Arcadia 1:100,000 Southwest District	>70 mi^2	Agriculture and cattle.
75B13 Prairie Creek at Hwy 31 Peace River Basin De Soto County Arcadia 1:100,000 Southwest District	233 mi^2 (USGS)	Better quality downstream?
75B14 Shell Creek above Prairie Cr. Peace River Basin Charlotte County Fort Myers 1:100,000 South District	?	Affected by impoundment?

75C Central Florida Ridges and Uplands

(A characteristic of this subregion is that there are few streams. There are some short lake inlets or outlets, and also a few spring runs. The sites below may be some of the better streams in the subregion, however the uniqueness of several of them raises the question of comparability.)

Stream Name/Location	Approx. Size	Comments
75C01 Cabbage Creek ab.L.Orange Cr. Oklawaha River Basin Putnam County Saint Augustine 1:100,000 Northeast District	15 mi^2	
75C02 Deep Creek ab.Gum Cr. Hwy 315 Oklawaha River Basin Putnam County Saint Augustine 1:100,000 Northeast District	6 mi^2	
75C03 Acosta Crk. Hwy 309 n. Welaka Lower St. Johns River Basin Putnam County Saint Augustine 1:100,000 Northeast District	6 mi^2	May be marginal.
75C04 Juniper Creek (Ocala N.F.) Upper St. Johns River Basin Marion County Daytona Beach 1:100,000 Central District	?	Spring run.
75C05 Alexander Sp. Cr.(Ocala N.F.) Upper St. Johns River Basin Lake County Daytona Beach 1:100,000 Central District	?	Where to sample?
75C06 Black Water Creek at Hwy 44A Upper St. Johns River Basin Lake County Orlando 1:100,000 Central District	?	
75C07 Tiger Cr. ab Lake Weohyakapka Kissimmee River Basin Polk County Bartow 1:100,000 Central District	?	

75C08 Livingston Cr. ab Lk.Arbuckle
Kissimmee River Basin
Polk County
Bartow 1:100,000
Southwest District

75D Eastern Florida Flatwoods

Stream Name/Location	Approx.Size	Comments
75D01 Rocky Creek e. of La Crosse Santa Fe River Basin Alachua County Gainesville 1:100,000 Northeast District	22 mi^2	Agricultural NPS impacts?
75D02 Hatchet Creek at Hwy 26 Oklawaha River Basin Alachua County Gainesville 1:100,000 Northeast District	30 mi^2	Landfill? Channelization? Fairbanks and Waldo development. WQI=20's.

*

[Need discussion about Orange Creek, Cabbage Creek, Little Orange Creek in Oklawaha basin. High quality waters but flow through two different subregions].

Stream Name/Location	Approx.Size	Comments
75D03 Silver River Oklawaha River Basin Marion County Daytona B./Ocala 1:100,000's Central District	NA	One of a kind in 75D? Tourist springs in 75C.
75D04 Daisy Creek Oklawaha River Basin Marion County Daytona Beach 1:100,000 Central District	14 mi^2	Probably small flow. Turf farm along Hwy 315 may impact quality.
75D05 Simms Creek ab. Etonia Cr. Lower St. Johns River Basin Putnam County Saint Augustine 1:100,000 Northeast District	35 mi^2	Upstream titanium mining? How does poor water quality downstream in Etonia & Rice Creeks affect biota in Simms Creek?

75D06 Moses Creek w.of Crescent Bch Upper East Coast Basin St. Johns County Saint Augustine 1:100,000 Northeast District	9 mi^2	
75D07 Pellicer Creek Upper East Coast Basin St. Johns/Flagler Counties Saint Augustine 1:100,000 Northeast District	40+mi^2 at Hwy 1	OFW waterbody.
75D08 Upper Middle Haw Creek near Relay Lower St. Johns River Basin Flagler/Volusia Counties Daytona Beach 1:100,000 Northeast/Central Districts	45+ mi^2	Some cattle. Swampy. Naturally low ph, DO.
75D09 Bulow Creek blw. st.monument Upper East Coast Basin Volusia County Daytona Beach 1:100,000 Central District	?	Questionable, though appears less disturbed than Spruce Creek south of Daytona.
75D10 Cow Creek ab. Deep Creek Upper St. Johns River Basin Volusia County Orlando 1:100,000 Central District	12+mi^2	Not an encouraging name.
75D11 Tootoosahatchee Creek at road 2 mi. s. of Hwy 50. Upper St. Johns River Basin Orange County Titusville/Kissimmee1:100,000 Central District	14 mi^2	Low DO, high color. Metals?
75D12 Jim Creek at rd e. of Hwy 520 Upper St. Johns River Basin Orange County Cape Canaveral/Kissimmee 1:100,000's Central District	25 mi^2	Low DO, high color. High inorganic toxics?
75D13 Wolf Creek, rd e. of Hwy 419 Upper St. Johns River Basin Osceola County Cape Canaveral 1:100,000 Central District	?	Agricultural area. Canalization.

75D14 Bull Creek at Hwy 441 Upper St. Johns River Basin Osceola County Kissimmee/Bartow/Vero Beach/ Cape Canaveral 1:100,000's Central District	?	Downstream access?
75D15 Blue Cypress Creek above Cow Log Creek Upper St. Johns River Basin Osceola County Vero Beach 1:100,000 Central District	?	At rd. east of Hwy 441. Is this one of the better agricultural streams in this area? A typical impacted stream?
75D16 Padget Branch at Hwy 60 Upper St. Johns River Basin Indian River County Vero Beach 1:100,000 Central District	23 mi^2	Little Gumhead Marsh?

*

[Are there any small streams, sloughs, canals in the Kissimmee Basin that should be considered as reference sites? If so, are there systems that would be comparable to them?]

75D17 South Fork St. Lucie River Southeast Florida Basin Martin County Fort Pierce 1:100,000 Southeast District	?	Impacted, but perhaps slightly less than North Fork. Estuarine influence?
75D18 North Fork Loxahatchee River Southeast Florida Basin Martin County Fort Pierce/West Palm Beach 1:100,000's Southeast District	?	Too small? Jonathan Dickinson State Park.
75D19 Northwest Fork Loxahatchee R. Southeast Florida Basin Martin/Palm Beach Counties West Palm Beach 1:100,000 Southeast District	?	
75D20 Econlockhatchee R. at Hwy 420 Upper St. Johns River Basin Orange County Orlando/Kissimmee 1:100,000's Central District	?	Where does Orange Co. Easterly WWTP effluent enter? Move upstream?

75E Okefenokee Swamps and Plains

Stream Name/Location	Approx. Size	Comments
75E01 Rocky Creek Upper Suwannee Basin Hamilton County Okefenokee Swamp 1:100,000 Northeast District	20+mi²	Cypress Cr. WMA(?)
75E02 Deep Creek Upper Suwannee Basin Columbia County Lake City 1:100,000 Northeast District	35+mi²	
75E03 Robinson Creek/Branch Upper Suwannee Basin Columbia County Lake City 1:100,000 Northeast District	22+mi²	Some cropland/pasture.
75E04 Little Suwannee Creek Upper Suwannee Basin Columbia County Okefenokee Swamp 1:100,000 Northeast District	?	Perhaps better for Georgians to sample near Hwy. 441/90.
75E05 Moccasin Creek St. Marys Basin Baker County Okefenokee Swamp 1:100,000 Northeast District	>40 mi²	Or for larger basin sample North Prong St. Marys at Hwy. 2/94.
75E06 Calkins Creek at Rd. 127 St. Marys Basin Baker County Lake City 1:100,000 Northeast District	15 mi²	Too small?

75F Sea Island Flatwoods

Stream Name/Location	Approx. Size	Comments
75F01 Pigeon Creek at Hwy 1/23 St. Marys River Basin Nassau County Fernandina Beach 1:100,000 Northeast District	6 mi^2	WQI=22 (1988 305b). Hampton Lake on lower reach may make it atypical. Powerline and railroad cross watershed.
75F02 Cabbage Creek at Rd. 121A St. Marys River Basin Nassau County Fernandina Beach 1:100,000 Northeast District	12 mi^2	Might be more swamp than creek.
75F03 Little Dunn Creek at Rd.121 St. Marys River Basin Nassau County Okefenokee Swamp/Fernandina Beach 1:100,000's Northeast District	8 mi^2	
75F04 Deep Creek at Hwy 108 St. Marys River Basin Nassau County Fernandina Beach/Okefenokee Swamp 1:100,000's Northwest District	11 mi^2	The most northerly of the three Deep Creeks flowing into the St. Marys in Nassau County.
75F05 Lofton Creek at Hwy A1A/200 Nassau River Basin Nassau County Fernandina Beach 1:100,000 Northeast District	?	May be too impacted. Where is landfill? Silviculture NPS. Would Plummer Creek be better?
75F06 Alligator Creek ab. New R. Santa Fe River Basin Bradford County Lake City 1:100,000 Northeast District	17 mi^2	Probably too impacted. Is New River ab. Alligator Cr. still cattle-trampled?
75F07 N.Fk.Black Cr ab. Boggy Br. Lower St. Johns River Basin Clay County Jacksonville/St. Augustine/Lake City 1:100,000's Northeast District	25 mi^2	At road up from Hwy 218. Development impacts. Mine tailings effects from Trail Ridge? Flow from Kingsley Lake? Questionable site.

75F08 Big Branch ab.N.Fk.Black Cr — $11\ mi^2$ — Road access may be marginal.
Lower St. Johns River Basin
Clay County
Jacksonville 1:100,000
Northeast District

75F09 Ates Creek ab.S.Fk.Black Cr — $34\ mi^2$
Lower St. Johns River Basin
Clay County
Saint Augustine 1:100,000
Northeast District

75F10 Greens Cr. ab.S.Fk.Black Cr — $35\ mi^2$
Lower St. Johns River Basin
Clay County
Saint Augustine 1:100,000
Northeast District

75F11 Fivemile Creek ab. New R. — $16\ mi^2$
Santa Fe River Basin
Union County
Gainesville 1:100,000
Northeast District

APPENDIX B

Florida Stream Reference Site Status - October 1992

* sampled in '92
\+ added candidate site

NORTHWEST DISTRICT (PENSACOLA)

*65F01 McDavid Creek at Hwy 99	- Sampled summer '92.
65F02 E. Fk. Big Coldwater Cr.	- Deleted. Poor habitat.
65F03 Big Juniper Creek	- OK site. Won't be sampled in '92.
65F04 Sweetwater Creek	- OK site. Won't be sampled in '92.
*65F05 Panther Creek	- Sampled summer '92.
65F06 Big Creek	- OK site. Won't be sampled in '92.
65F07 Turkey Gobbler Creek	- OK site. Won't be sampled in '92.
*65F08 (Substitute) Alaqua Cr. ab Davis	- Sampled summer '92.
65F09 Rocky Cr. ab. Little Rocky Cr.	- OK site. Won't be sampled in '92.
*65F10 Mitchell Creek	- Sampled summer '92.
+*65F11 Big Horse Creek at Hwy 2	- Sampled summer '92.
+*65F12 Pine Log Creek at Hwy 2	- Sampled summer '92.
*65G01 Sandy Cr. ab. W. Sandy Cr.	- Sampled summer '92.
65G02 Parrot Creek	- Deleted.
65G03 West Pittman Creek	- Deleted.
65G04 Reedy Creek	- Deleted.
65G05 Limestone Creek	- Deleted. Too small.
65G06 Hard Labor Creek	- Deleted. Clear cuts.
*65G07 Econfina Creek	- Sampled summer '92.
65G08 Wrights Creek e. of Noma	- Deleted. Agric. & cows.
65G09 Spring Branch	- Deleted. Dammed up.
65G10 Pelt Creek	- Deleted.
*65G11 Tenmile Creek at Hwy 73	- Sampled summer '92.
65G12 Ocheesee Creek	- OK site. Won't be sampled in '92.
+*65G13 Bridge Creek at Hwy 71	- Sampled summer '92.
+65G14 Farley Creek	- OK site. Won't be sampled in '92.
*65H01 Crooked Creek	- Sampled summer '92.
*65H02 Sweetwater Creek	- Sampled summer '92.
*65H03 Mule Creek at Hwy 12	- Sampled summer '92.
65H04 Rocky Comfort Creek	- OK site. Won't be sampled in '92.
65H05 Black Creek	- Deleted.
65H06 Welaunee Creek	- Sampled summer '92.
+*65H07 Lloyd Creek	- Sampled summer '92.
+*65H08 Flat Creek	- Sampled summer '92.
*75A01 Black Creek	- Sampled summer '92.
75A02 Big Crooked Creek	- Deleted. Clear cuts.
*75A03 Sandy Creek	- Sampled summer '92.
75A04 Kennedy Creek	- Deleted. Swamp/no flow.
75A05 New River	- Deleted.
*75A06 Sopchoppy River blw. Monkey Cr.	- Sampled summer '92.
75A07 Juniper Creek ab. New R.	- Deleted.
+*75A14 Little Crooked Creek at Hwy 79	- Sampled summer '92.

+*75A15 S. Fk. Bear Creek - Sampled summer '92.
+*75A16 Dean Creek - Sampled summer '92.
+*75A McBride Slough - Sampled summer '92.

NORTHEAST DISTRICT (JACKSONVILLE)

*75A08 Econfina River - Sampled summer '92.
75A09 Spring Warrior at Rd.361 - Deleted. No water.
75A10 Eightmile Creek - Deleted. Clear cut.
75A11 Rocky Creek ab. Gulf - Deleted. Tidal.
*75A12 Waccasassa River at Hwy 98 - Sampled summer '92.
75A13 Wekiva River at Rd.326 - OK site. Won't be sampled in '92.

75C01 Cabbage Creek ab. L.Orange Cr. - Deleted. Mining impact.
75C02 Deep Creek ab. Gum Cr. Hwy 315 - Deleted. Mining.
75C03 Acosta Creek at Hwy 309 - Deleted. Access problem.

*75D01 Rocky Creek e. of La Crosse - Sampled summer '92.
75D02 Hatchet Creek at Hwy 26 - Deleted.
75D05 Simms Creek ab. Etonia Creek - Deleted. Mining.
75D06 Moses Creek w. of Crescent Bch. - Deleted. Tidal.
75D07 Pellicer Creek - Deleted. Tidal.
*75D08 Upper Middle Haw Cr. near Relay - Sampled summer '92.

75E01 Rocky Creek - Deleted. Need boat.
*75E02 Deep Creek - Sampled summer '92.
*75E03 Robinson Creek/Branch - Sampled summer '92.
75E04 Little Suwannee Creek - Deleted. Locked gate.
*75E05 Substitute North Prong at Hwy 2 - Sampled summer '92.
75E06 Calkins Creek at Rd. 127 - Deleted.

*75F01 Pigeon Creek at Hwy 1/23 - Sampled summer '92.
75F02 Cabbage Creek at Rd. 121A - Deleted.
75F03 Little Dunn Cr. at Rd. 121 - Deleted.
75F04 Deep Creek at Hwy. 108 - Deleted. Access problem.
75F05 Lofton Creek at Hwy A1A/200 - Deleted. Tidal at rd. above A1A.
75F06 Alligator Creek ab. New R. - Deleted. Impacted.
75F07 N.Fk. Black Cr. ab. Boggy Br. - Deleted. Atypical.
75F08 Big Branch ab.N.Fk.Black Cr. - Not sampled. Access problem.
75F09 Ates Creek ab. S. Fk. Black Cr. - Deleted.
*75F10 Greens Cr. ab. S. Fk. Black Cr. - Sampled summer '92.
*75F11 Fivemile Creek ab. New River - Sampled summer '92. Future mining?

PLUS BIOLOGICAL SITES
4 sites on Suwannee River
2 sites on Santa Fe River
1 site on Aucilla River

CENTRAL DISTRICT (ORLANDO)

*75C04	Juniper Creek (Ocala N.F.)	- Sampled summer '92.
75C05	Alexander Sp. Cr. (Ocala N.F.)	- Deleted. Access. Redundant.
*75C06	Black Water Creek at Hwy 44A	- Sampled summer '92.
*75C07	Tiger Cr. ab. Lake Weohyakapka	- Sampled summer '92.
*75C08	Livingston Cr. ab Lake Arbuckle	- Sampled summer '92.
*75D03	Silver River	- Sampled summer '92.
75D04	Daisy Creek	- Deleted. Impacted.
75D09	Bulow Creek	- Deleted. Replace with Tomoka R.
75D10	Cow Creek above Deep Creek	- OK site. Won't be sampled in '92.
75D11	Tootoosahatchee Cr.	- OK site. Won't be sampled in '92.
*75D12	Jim Creek at rd. e. of Hwy 520	- Sampled summer '92.
75D13	Wolf Creek, rd e. of Hwy 419	- Deleted. Agriculture impacts.
75D14	Bull Creek at Hwy 441	- OK site. Won't be sampled in '92.
75D15	Blue Cypress Cr. ab Cow Log Cr.	- Deleted.
75D16	Padget Branch at Hwy 60	- Deleted. Agriculture impacts.
*75D20	Econlockhatchee River, Hwy 420	- Sampled summer '92.
*75D21	Tomoka River at 11th St.	- To be sampled summer '92.
*75D22	Orange Creek ab. Little Orange	- Sampled summer '92.
75Dxx	Wekiva River at Wekiva Landing	- Won't be sampled summer '92.

PLUS BIOLOGICAL SITES

St. Johns River at Astor
St. Johns River at Lake Washington
Ocklawaha River at Eureka

SOUTHWEST DISTRICT (TAMPA)

*75B01	Little Withlacoochee River	- Sampled summer '92.
*75B02	Withlacoochee River	- Sampled summer '92 (two sites).
*75B03	Pithlachascotee River	- Sampled summer '92.
75B04	Anclote River	- Deleted.
*75B05	Little Manatee R. ab. S. Fk.	- Sampled summer '92.
75B06	South Fork Little Manatee River	- Deleted.
*75B07	Charlie Cr. blw Oak Cr. Hwy 634	- Sampled summer '92.
*75B08	Oak Creek nr Sweetwater, Hwy 634	- Sampled summer '92.
*75B09	Manatee River at Hwy 64	- Sampled summer '92.
*75B10	Myakka River ab Myakka City	- Sampled summer '92.
*75B11	Horse Creek at Hwy 72	- Sampled summer '92. (Ford Walton)
75B12	Joshua Creek at Hwy 31	- Deleted. Agriculture impacts.
*75B17	Hillsborough River	- Sampled summer '92 (two sites).

SOUTH DISTRICT (PUNTA GORDA)

75B13 Prairie Cr. at Hwy 31 or below	- Won't be sampled summer '92.
75B14 Shell Creek above Prairie Cr.	- Won't be sampled summer '92.
*75B15 Orange River above Buckingham	- Sampled summer '92.
*75B16 Telegraph Creek	- Sampled summer '92.
*75D23 Fisheating Creek	- Sampled summer '92.

SOUTHEAST DISTRICT (PORT ST. LUCIE)

*75D17 South Fork St. Lucie River	- Sampled summer '92.
*75D18 North Fork Loxahatchee River	- Sampled summer '92.
*75D19 Northwest Fork Loxahatchee R.	- Sampled summer '92.
75Dxx Blakesly Creek	- Deleted.

DRAFT ECOREGIONS/SUBREGIONS OF FLORIDA

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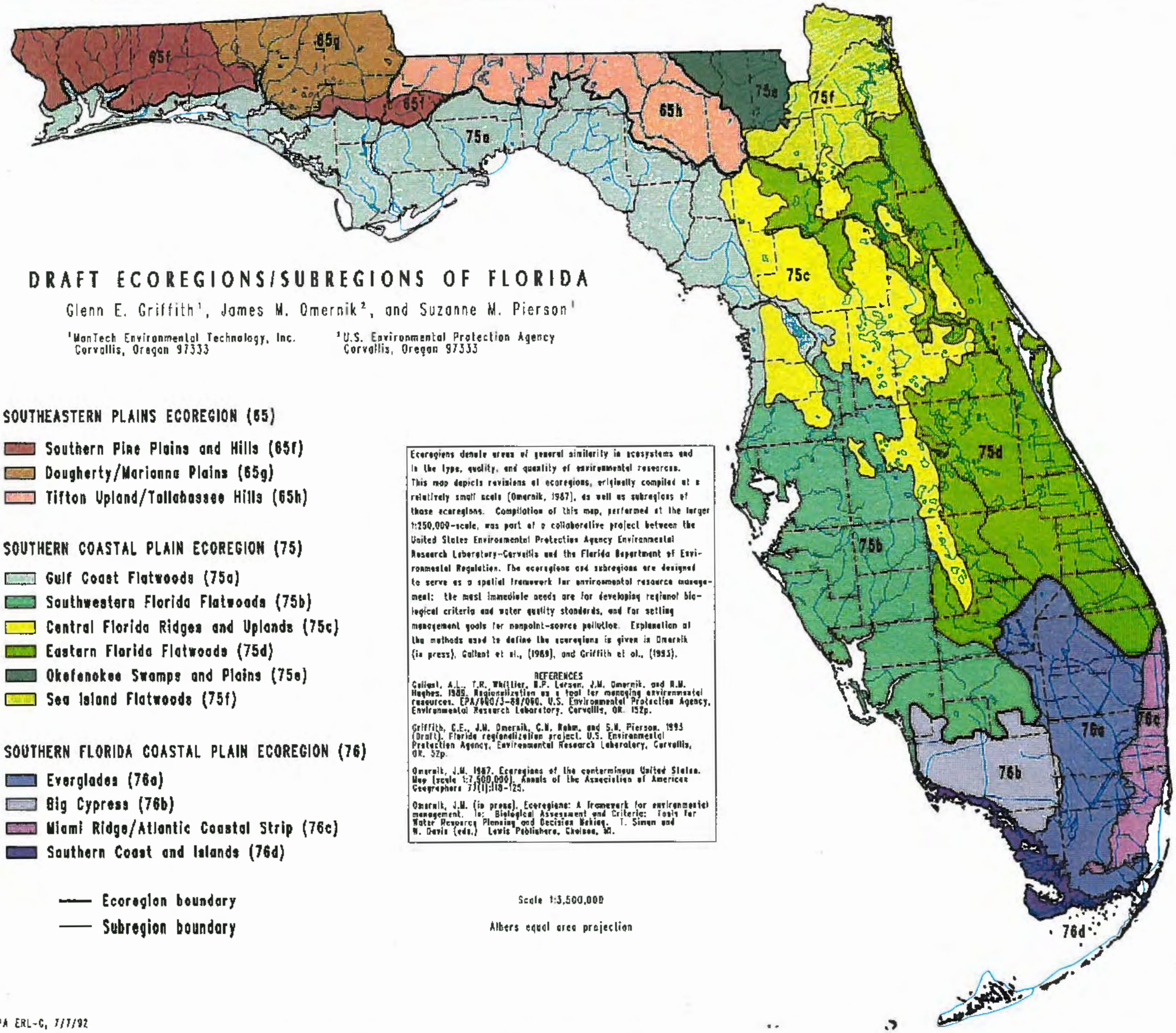

SOUTHEASTERN PLAINS ECOREGION (65)

- Southern Pine Plains and Hills (65f)
- Dougherty/Marianna Plains (65g)
- Tifton Upland/Tallahassee Hills (65h)

SOUTHERN COASTAL PLAIN ECOREGION (75)

- Gulf Coast Flatwoods (75a)
- Southwestern Florida Flatwoods (75b)
- Central Florida Ridges and Uplands (75c)
- Eastern Florida Flatwoods (75d)
- Okefenokee Swamps and Plains (75e)
- Sea Island Flatwoods (75f)

SOUTHERN FLORIDA COASTAL PLAIN ECOREGION (76)

- Everglades (76a)
- Big Cypress (76b)
- Miami Ridge/Atlantic Coastal Strip (76c)
- Southern Coast and Islands (76d)

—— Ecoregion boundary
—— Subregion boundary

Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. This map depicts revisions of ecoregions, originally compiled at a relatively small scale (Omernik, 1987), as well as subregions of those ecoregions. Compilation of this map, performed at the larger 1:250,000-scale, was part of a collaborative project between the United States Environmental Protection Agency Environmental Research Laboratory-Corvallis and the Florida Department of Environmental Regulation. The ecoregions and subregions are designed to serve as a spatial framework for environmental resource management; the most immediate needs are for developing regional biological criteria and water quality standards, and for setting management goals for nonpoint-source pollution. Explanation of the methods used to define the ecoregions is given in Omernik (in press), Gallant et al., (1989), and Griffith et al., (1993).

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Scale 1:3,500,000

Albers equal area projection

US EPA ERL-C, 7/7/92
Digital production, R. Nelson