Florida
Wetland Resources

Wetlands covered more than one-half of Florida, approximately 20.3 million acres, in predevelopment times. Although only about one-half of the original wetlands remain, Florida still has more wetlands than any of the other 47 conterminous States (Dahl, 1990). Wetlands in Florida are diverse and include types that are rare in other States, such as mangrove swamps and hydric hammocks. Associations of warm-temperate and subtropical wetlands not found elsewhere are common in Florida, a prime example being the unique complex of extensive sawgrass marshes and other wetlands known as The Everglades (fig. 1).

Florida's wetlands have considerable economic and environmental value. In river basins, flood-plain wetlands reduce downstream flood damages by retaining overflows in backwater ponds and depressions. Organic soils in many wetlands can store large quantities of water and release it slowly to plants during drought. Wetlands can filter out and accumulate pollutants from surface water—some cypress depressions in Florida have been used specifically for wastewater treatment (Dierberg and Brezonik, 1984). Many rare or endangered plant and animal species, such as the insectivorous white-top pitcherplant and the snail kite, live in Florida wetlands. Wetlands provide breeding and feeding grounds for resident and migratory birds. Coastal wetlands such as salt marshes, mangrove swamps, and seagrass beds are nursery areas for sea turtles and economically important species such as shrimp, blue crab, oyster, mullet, spotted seatrout, and red drum (Tiner, 1984; Palik and Kunneke, 1984).

Figure 1. Sawgrass marsh and tree islands in the Everglades–Big Cypress region of southern Florida. *(Photograph courtesy of Florida State Archives.)*

In the past, wetlands were considered obstacles to the development of the State. Widespread destruction and degradation of wetlands, however, resulted in drastic losses of wildlife, water shortages, and water-quality problems (Frayer and Hefner, 1991). Today, Florida's wetlands are considered important resources and are protected by laws that preserve their esthetic and ecological value.

TYPES AND DISTRIBUTION

Wetlands are lands transitional between terrestrial and deepwater habitats where the water table usually is at or near the land surface or the land is covered by shallow water (Cowardin and others, 1979). The distribution of wetlands and deepwater habitats in Florida is shown in figure 2*A*; only wetlands are discussed herein.

Wetlands can be vegetated or nonvegetated and are classified on the basis of their hydrology, vegetation, and substrate. In this summary, wetlands are classified according to the system proposed by Cowardin and others (1979), which is used by the U.S. Fish and Wildlife Service (FWS) to map and inventory the Nation's wetlands. At the most general level of the classification system, wetlands are grouped into five ecological systems: Palustrine, Lacustrine, Riverine, Estuarine, and Marine. The Palustrine System includes only wetlands, whereas the other systems comprise wetlands and deepwater habitats. Wetlands of the systems that occur in Florida are described below.

System	Wetland description
Palustrine	Nontidal and tidal-freshwater wetlands in which vegetation is predominantly trees (forested wetlands); shrubs (scrub-shrub wetlands); persistent or nonpersistent emergent, erect, rooted herbaceous plants (persistent- and nonpersistent-emergent wetlands); or submersed and (or) floating plants (aquatic beds). Also, intermittently to permanently flooded open-water bodies of less than 20 acres in which water is less than 6.6 feet deep.
Lacustrine	Nontidal and tidal-freshwater wetlands within an intermittently to permanently flooded lake or reservoir larger than 20 acres and (or) deeper than 6.6 feet. Vegetation, when present, is predominantly nonpersistent emergent plants (nonpersistent-emergent wetlands), or submersed and (or) floating plants (aquatic beds), or both.
Riverine	Nontidal and tidal-freshwater wetlands within a channel. Vegetation, when present, is same as in the Lacustrine System.
Estuarine	Tidal wetlands in low-wave-energy environments where the salinity of the water is greater than 0.5 part per thousand (ppt) and is variable owing to evaporation and the mixing of seawater and freshwater.
Marine	Tidal wetlands that are exposed to waves and currents of the open ocean and to water having a salinity greater than 30 ppt.

Lacustrine and riverine wetlands are not addressed in this report. They constitute a relatively small part of Florida's wetlands and were not distinguished from deepwater habitats by the FWS National Wetlands Inventory (Frayer and Hefner, 1991).

Palustrine System.—Eighty-seven percent of Florida's wetlands are in the Palustrine System. Palustrine forested wetlands cover 5.5

million acres, nearly one-half the acreage of all Florida wetlands (Frayer and Hefner, 1991). These wetlands, which are widely distributed throughout the State, fringe rivers and lakes, line small drainages and sloughs, form in small depressions and ponds, and cover wet flatwoods. The predominant trees can be pines, hardwoods, or cypress.

Pine flatwoods, the most common ecological community in Florida, are distributed statewide. These communities are on flat land and have poorly drained, acidic, sandy soils that commonly are underlain by a clay or organic hardpan. Pine flatwoods can be a mixture of both wetland and upland communities that are difficult to delineate. Discrepancies between present-day estimates of 8.2 and 11.0 million acres of remaining wetlands in Florida (Frayer and Hefner, 1991; Kautz, 1991) might be due primarily to difficulties inherent in distinguishing wet from dry flatwoods. Wet flatwoods can grade into dry flatwoods with imperceptible changes in elevation. In many areas, numerous seasonal ponds, small streams, and other wetlands are embedded within the larger pine-flatwoods matrix. In wet flatwoods, soils can remain saturated through much of the rainy season, and there can be standing water for 1 to 2 months every year. During the dry season, however, high evapotranspiration from sandy soils and an impermeable hardpan preventing upward movement of ground water result in dry conditions that can persist for months (Abrahamson and Hartnett, 1990).

Palustrine forested wetlands in which mixed hardwoods predominate cover about 2 million acres of Florida (Kautz, 1991) and comprise many wetland types. Bottom-land hardwood forests on river flood plains are most common in the northern part of the State, reaching their greatest extent in the alluvial flood plains of the panhandle (Wharton and others, 1977). Tree diversity can be high in alluvial flood plains: a study of the flood-plain forest bordering the Apalachicola River (Leitman and others, 1984) recorded 47 tree

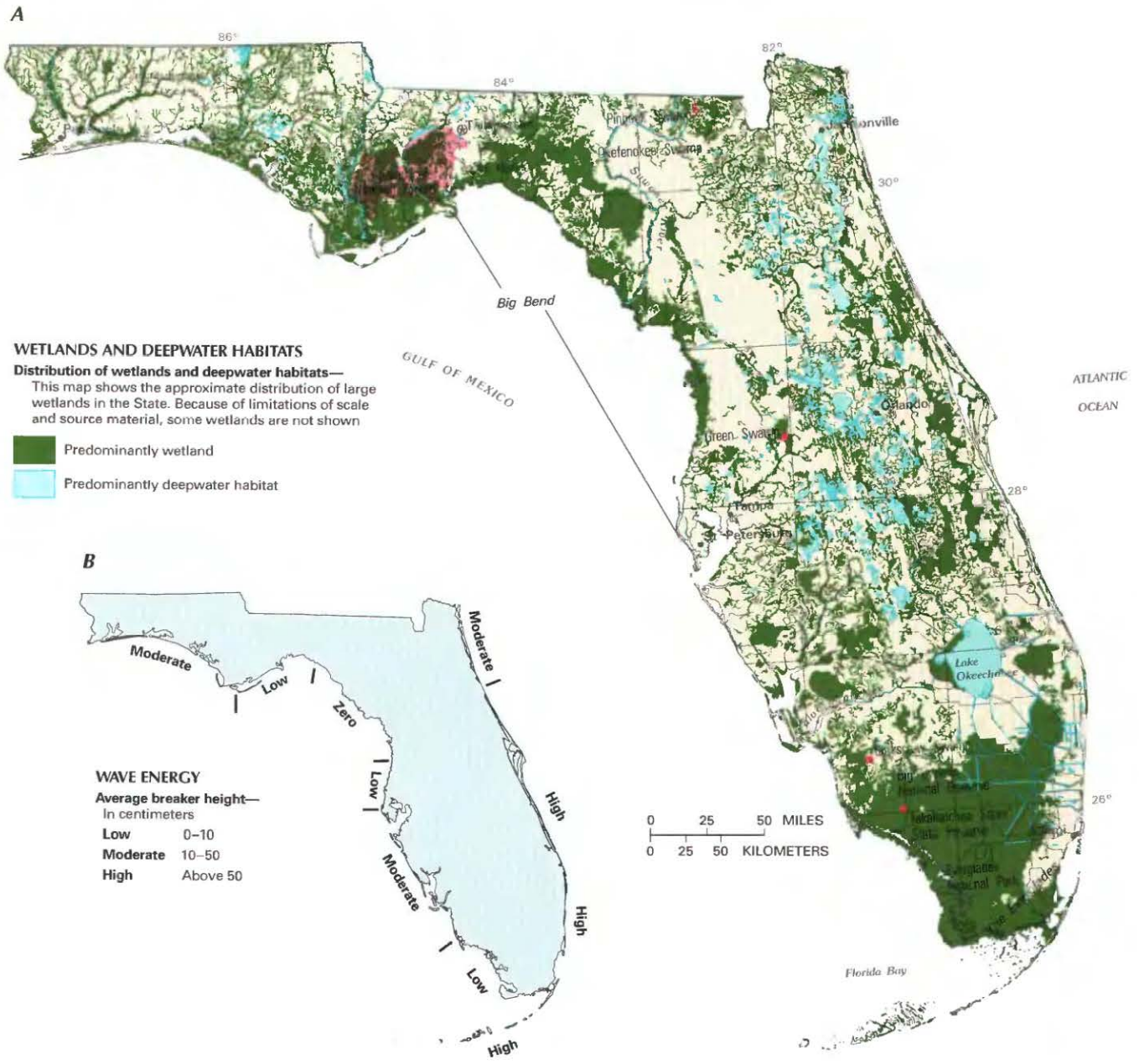

Figure 2. Distribution of wetlands and deepwater habitats in Florida and physical and climatological features that control wetland distribution in the State. ***A***, Distribution of wetlands and deepwater habitats. ***B***, Wave height along the Florida coast. *(Sources: A, T.E. Dahl, U.S. Fish and Wildlife Service, unpub. data, 1991. B, Carlton, 1977.)*

species and 5 major tree communities. Blackwater streams, which are common in Florida, are dark colored owing to the presence of organic acids from decaying vegetation. The Suwannee River, which has characteristics of both blackwater and spring-fed streams, has an extensive flood-plain forest in its lower reaches. Bay swamps, black gum swamps, and other mixed-hardwood wetlands that form in depressions are common throughout Florida. These forested wetlands often are mixed with shrub bogs (scrub-shrub wetlands) as in the Apalachicola National Forest and in Pinhook Swamp, the southern extension of the Okefenokee Swamp in Florida (Wharton and others, 1977). Shrub bogs are depressional wetlands that have acidic, organic soils and that typically are dominated by titi, gallberry, fetterbush, and other evergreen shrubs (U.S. Soil Conservation Service, 1989). Hydric hammocks, which form on poorly drained soils or soils saturated by near-surface water tables and in which evergreen oaks such as live oak and swamp laurel oak predominate, are rare outside Florida (Vince and others, 1989). Exotic tree species such as melaleuca have invaded wetlands in southern Florida to such an extent that some authors consider wetlands in which they are the predominant vegetation to belong to a distinct forested-wetland type (Wharton and others, 1977; Ewel, 1990).

Palustrine forested wetlands in which cypress predominates cover about 1.6 million acres in Florida (Kautz, 1991). Cypress domes are small, isolated, depressional wetlands that have convex silhouettes when viewed from a distance. They are acidic, stillwater swamps that have standing water at least part of the year, and many have a permanent central pond. The Green Swamp in west-central Florida has a high density of cypress domes in a pine-flatwoods matrix (McPherson, 1979). Large swamps in which cypress predominates commonly ring lakes or line watercourses. Cypress strands are linear cypress swamps along watercourses. Fakahatchee Strand State Preserve in southwestern Florida contains an outstanding example of a cypress strand; the wetland harbors rare orchids, palms, and the endangered Florida panther (Grow, 1989). Cypress scrub is a drier community of stunted cypress found primarily in southern Florida on nutrient-poor, calcium-carbonate-rich soils or shallow sand over limestone. Big Cypress National Preserve has large areas of cypress scrub in which mature cypress trees usually are less than 20 feet tall.

Palustrine emergent wetlands such as freshwater marshes and wet prairies cover 2.9 million acres of Florida (Frayer and Hefner, 1991). Freshwater marshes are concentrated in southern Florida, where about 1.6 million acres remained in 1973, including 624,000 acres of sawgrass marshes (Odum and Brown, 1977). Other major marsh systems include those in the Kissimmee and St. Johns River flood plains (Kushlan, 1990). Freshwater marshes are inundated most of the year, have thick accumulations of organic materials, and burn infrequently. Wet prairies usually are inundated for less than one-half of the year, have less organic accumulation, and burn more frequently—every 1–3 years if fuel is sufficient. Fires maintain both wetland types by limiting the invasion of woody vegetation and retarding the accumulation of organic matter (Kushlan, 1990).

Estuarine and Marine Systems.—Florida has about 1.4 million acres of estuarine and marine intertidal wetlands along 1,200 miles of coastline. About 12 percent of Florida's wetlands are estuarine, and less than 1 percent are marine. Tides cycle terrestrial sediments, nutrients, and detritus through coastal wetlands, making them highly productive ecological communities (Florida Natural Areas Inventory and Division of State Lands, 1990). The most common coastal wetlands are salt marshes, mangrove swamps, and seagrass beds.

Salt marshes are emergent wetlands that develop along low-wave-energy coastlines and in estuaries. Wave energy (fig. 2*B*), salinity, frequency of inundation, and tidal range vary along the coasts, resulting in substantial differences in the areal extent and plant-species composition of these marshes. The most extensive

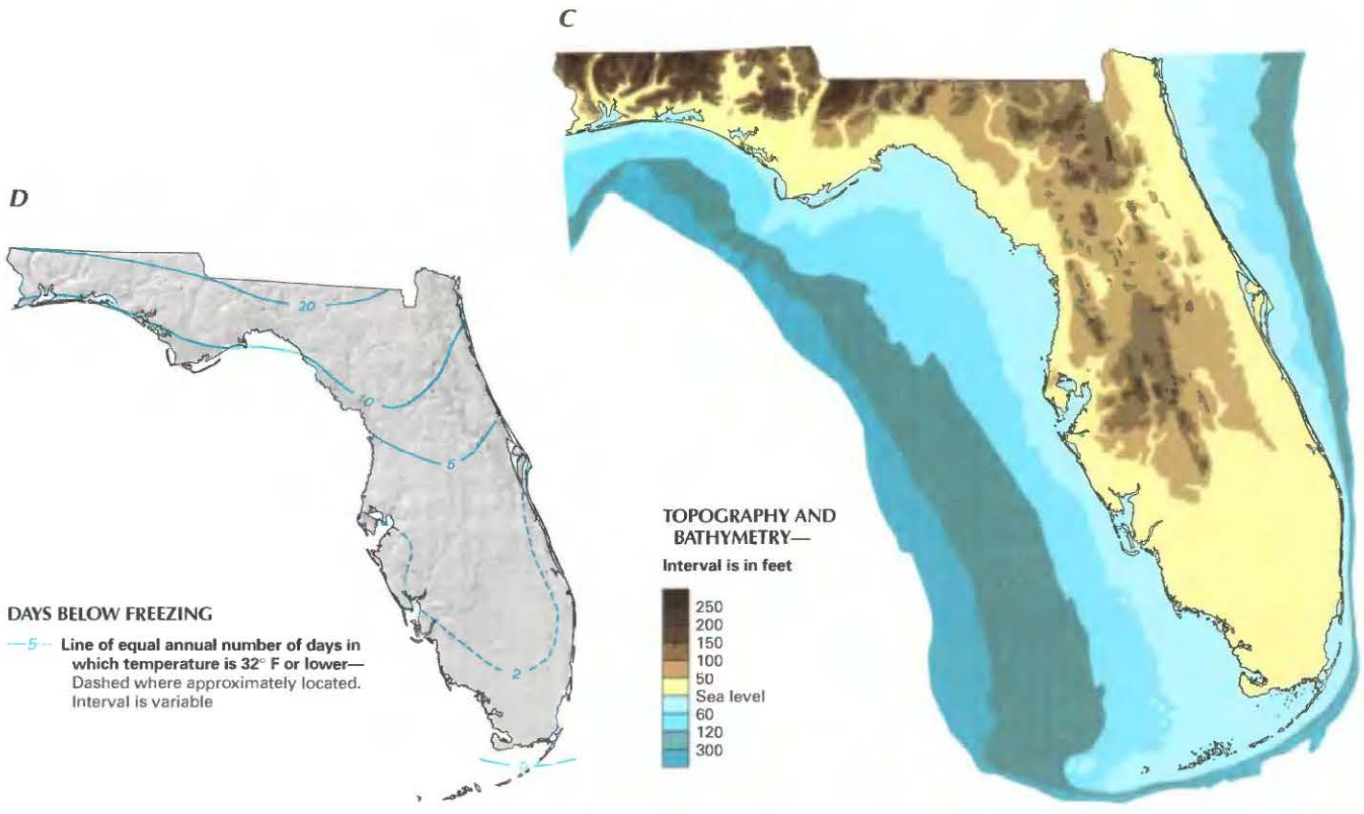

Figure 2. Continued. Distribution of wetlands and deepwater habitats in Florida and physical and climatological features that control wetland distribution in the State. ***C***, Topography of Florida and bathymetry of adjacent offshore waters. ***D***, Average annual number of days in which temperature is 32°F or lower. *(Sources: C, Fernald, 1981. D, Conway and Liston, 1990.)*

development of salt marshes occurs in the Big Bend region of the gulf coast (fig. 2*A*).

Mangrove swamps replace salt marshes along southern coastal areas that generally are subject to low-energy waves. Mangroves are salt-tolerant trees that colonize shallow, subtropical marine and estuarine waters. Tropical storms commonly damage or destroy mangroves before they reach their maximum height (Odum and McIvor, 1990), and most mangrove swamps are classified as scrub-shrub wetlands because the trees typically are less than 20 feet tall.

Seagrass beds are colonies of several species of rooted vascular plants that typically live totally submersed in saltwater. Most of Florida's seagrass beds are in Florida Bay at the southern tip of the State and in the Gulf of Mexico offshore from the Big Bend. In this report, only the shallowest zone of seagrass communities, in which shoal grass predominates, are considered to be wetlands; extensive seagrass beds below the intertidal zone are considered to be in deep-water habitats.

HYDROLOGIC SETTING

Many factors contribute to the abundance of wetlands in Florida, the most important of which are the low, flat terrain and plentiful rainfall. Most of the State's wetlands are in flat areas below 50 feet above sea level that extend from the coast inland for many miles (fig. 2*A* and 2*C*). Runoff and drainage in these wetlands are slow as a result of the low relief. The flat landscape and the impermeable strata underlying wetland soils commonly result in lateral flow of water on or near the land surface. Some wetlands are drained by low-gradient stream systems, as in the upper St. Johns River basin, which has extensive freshwater marshes and where the average velocity of the river is only 0.3 foot per second (Heath and Conover, 1981). Near the coast, water levels in freshwater wetlands along these streams are affected by tidal fluctuations. Close to the mouth of the streams, the transition from freshwater to saltwater causes major changes in the structure and composition of estuarine wetlands (Florida Department of Natural Resources, 1988).

Except along the southeastern coast, the land slopes gradually into the Gulf of Mexico and Atlantic Ocean. The shallow water offshore diminishes the energy of incoming waves, resulting in small, low-energy breakers onshore. Two areas on the gulf coast receive low-wave energy favorable to the development of tidal marshes, seagrass beds, and mangrove swamps (fig. 2*B*). The near-zero wave-energy coastline from north of Tampa to St. Marks is a result of the shallow offshore waters and a protected location in Florida's Big Bend. One of few coastal areas in the world subject to so little wave action, this part of the coast has the second-largest area of seagrass beds in the Gulf of Mexico (Zieman and Zieman, 1989), large areas of coastal marsh, and extensive hydric hammocks just landward of coastal salt marshes (Vince and others, 1989).

Rainfall in Florida averages 53 inches per year and is greatest during the warm season from June through September. Southern Florida has a subtropical climate characterized by two seasons—dry and rainy—rather than by the four seasons typical of temperate climates to the north. As a result, wetlands in southern Florida are affected by greater extremes of hydrologic conditions than those in the rest of the State. Wet prairies, wet pine flatwoods, and scrub cypress forests that are saturated or inundated in the rainy season can be severely dehydrated in the dry season in late winter and early spring when rainfall is relatively low and temperatures and evapotranspiration rates remain relatively high (Jordan, 1984).

Opposite conditions exist in northern Florida, where flooding and replenishment of water in swamps and flood plains is greatest in the late winter and early spring. Winter evapotranspiration is substantially lower than that in southern Florida because temperatures are near or below freezing on many days and much of the vegetation is dormant. Summer rainfall exceeds winter rainfall in northern Florida, but the difference is not as great as in southern Florida because of a secondary rainfall peak in February and March. In adjacent States to the north, this secondary winter-spring peak is more pronounced and in some areas is the primary peak. Most of the drainage basins of the larger northern Florida rivers such as the Apalachicola, Choctawhatchee, Escambia, and Suwannee are in Georgia and Alabama. Therefore, rainfall patterns in those States have a significant effect on the hydrology of these rivers and their flood-plain wetlands. The broad flood plains of these rivers have topographic features and tree communities that have been shaped by wide fluctuations in river levels. During the annual flooding in late winter and early spring, water depths on the flood plain of 15–20 feet are not unusual. However, in the rest of the year, these flood plains are mostly dry except for ponds, depressions, and sloughs that retain water year round.

Southern Florida has a nearly freeze-free climate (fig. 2*D*). Wetlands along the southern coasts support plant species that generally do not thrive in the cooler climate of northern Florida coasts (Odum and others, 1982). For example, mangroves are killed back by freezes, which are more common in northern Florida, and some seagrass species are better adapted to the warm waters of the southern coasts. Wetlands in southern Florida commonly are invaded by nonnative tropical species that alter native-species associations; two such nonnative species, melaleuca and Brazilian pepper, have become predominant in many southern Florida wetlands. The near absence of frost in southern Florida that enables some tropical species to thrive also limits the distribution of some temperate wetland species. Pond pine, several hollies, titis, some of the tupelos, many bottom-land hardwood tree species, and several species of marsh plants grow only in the central and northern regions of the State.

Early travelers to southern Florida encountered a vast freshwater marsh that covered most of the peninsula from Lake Okeechobee south. This wetland, now known as The Everglades, covered about 2.9 million acres and was predominantly peatland covered by tall sawgrass growing in shallow water. Associated plant communities included pond apple swamps south of the lake, sloughs with aquatic vegetation, wet prairies, tree islands, and mangrove swamps bordering Florida Bay. The Everglades was part of the larger Kissimmee–Lake Okeechobee–Everglades Basin, which extended as a single drainage basin from present-day Orlando to Florida Bay, about two-thirds the length of the Florida peninsula (fig. 3*A*). The Kissimmee River meandered across a 2-mile-wide flood plain south to Lake Okeechobee, a shallow water body of 470,000 acres. When the lake was full, water sometimes overflowed the southern rim into The Everglades. Water in The Everglades moved slowly to the south by sheet flow in what Douglas (1947) called the River of Grass. Much of the land was inundated during the rainy season in normal years, and, during years of heavy rains, all but the highest tree islands were flooded. During floods, water moved with enough force to cause tree islands to develop an alignment pattern parallel to the lines of surface-water flow (Parker, 1974). During the dry season, ground-water levels generally were close to the land surface, but during some years, severe drought lowered water levels well below the land surface and fires swept over the land, burning vegetation and peat. Seasonally varying flows of freshwater from The Everglades into Florida Bay had an important influence on the salinity of the bay and contributed to the productivity of coastal wetlands and fisheries.

Significant drainage of The Everglades began in the early 1880's and continued through the 1960's. By the late 1920's, five canals connected Lake Okeechobee to the Atlantic Ocean. During the hurricanes of 1926 and 1928, Lake Okeechobee overflowed, killing thousands of people and destroying crops. In response to these disasters, a 38-foot-high dike was constructed around the southern shore of the lake, and canals were enlarged to increase drainage (Blake, 1980). The Central and Southern Florida Flood

Control Project of 1948 authorized construction of a complex drainage and water-management system comprising canals, levees, pumps, and control structures. Lake Okeechobee and three water-conservation areas (WCA's; fig. 3*B*) became reservoirs for flood protection during the wet season and for agricultural irrigation and recharge of ground water in urban wellfields during the dry season (Klein and others, 1975). Most of the 800,000 acres of the Everglades Agricultural Area was drained to grow sugar cane and other crops. About 50 percent of the original Everglades was eliminated by the early 1990's. The remaining 50 percent is preserved in WCA–1 (Loxahatchee National Wildlife Refuge), WCA–2, WCA–3, and Everglades National Park, which was established in 1947 on 1.4 million acres at the southwestern end of the drainage basin.

Alterations of The Everglades by drainage and development have had severe environmental consequences. About 40 percent of the water that originally flowed southward from Lake Okeechobee into The Everglades is now diverted westward to the Gulf of Mexico by the Caloosahatchee Canal and eastward to the Atlantic Ocean by the St. Lucie Canal (fig. 3*B*). Seawater intrusion into the surficial aquifer has occurred as far as 6 miles inland in some areas (VanArman and others, 1984). Lowered water tables have resulted in oxidation of drained peat and damaging peat fires that have low-

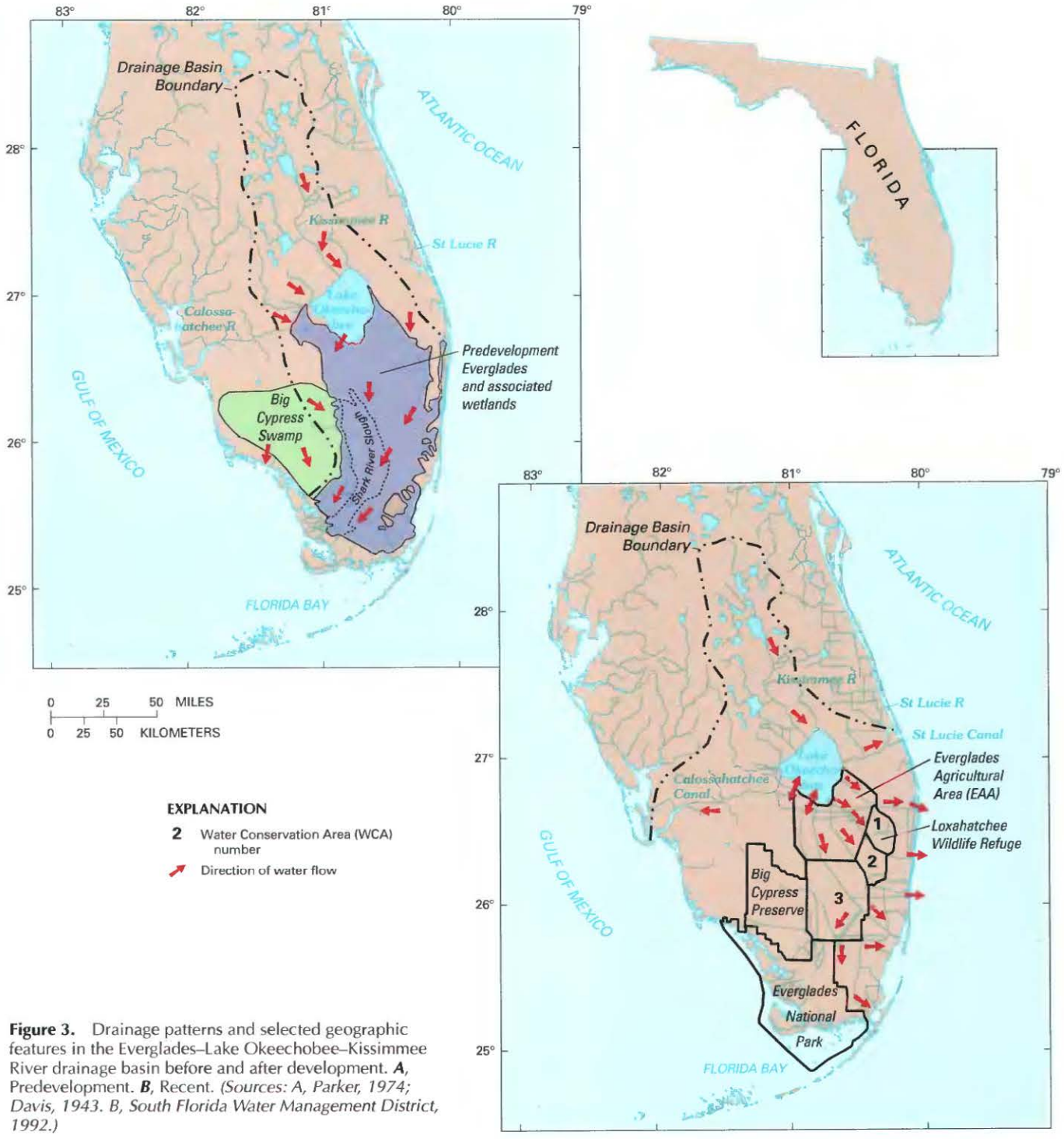

Figure 3. Drainage patterns and selected geographic features in the Everglades–Lake Okeechobee–Kissimmee River drainage basin before and after development. ***A***, Predevelopment. ***B***, Recent. *(Sources: A, Parker, 1974; Davis, 1943. B, South Florida Water Management District, 1992.)*

ered the land surface more than 5 feet in some agricultural areas (Davis, 1943; Duplaix, 1990). Using the WCA's as reservoirs has resulted in conditions that are often too dry or too wet to maintain natural communities (McPherson, 1973). South of Lake Okeechobee, populations of wood storks and other wading birds decreased by almost 95 percent from 1870 to 1973 as a direct result of hydrologic alterations (Crowder, 1974; Kushlan and others, 1975). Drainage and land clearing have increased opportunities for exotic plants such as melaleuca to become established in dense stands that exclude native species. Water pumped into canals from agricultural lands can have high levels of phosphorus and other nutrients. As a result, sawgrass, which is adapted to a low-nutrient environment (Davis, 1991), is being replaced by cattails in the northern Everglades, particularly in WCA–2, where nutrient loading is a problem (South Florida Water Management District, 1992).

The magnitude of environmental alterations of The Everglades has produced public concern and countermeasures to protect this significant wetland. The 570,000-acre Big Cypress National Preserve adjacent to Everglades National Park was established in 1974. The Everglades was designated a "Wetland of International Importance" by the Federal Government. State and Federal agencies working cooperatively have developed plans that call for acquisition of parts of Shark River Slough and the remaining Everglades east of Everglades National Park and reestablishment of water flows along historic flow paths. Preliminary plans also have been made to restore the once-meandering Kissimmee River, which was reduced from 90 to 52 miles in length by channelization in the 1960's. The State, as part of the settlement of a lawsuit filed by the Federal Government, has agreed to enforce a plan to greatly reduce nutrient loading from the Everglades Agricultural Area. Federal legislation has assured minimum flows to Everglades National Park, and attempts are being made to distribute water based on historic seasonal-flow models. However, as water-demand patterns in southern Florida become more complex, difficulties in providing water of the proper quantity and quality at the proper time to remaining natural areas of The Everglades will increase. Because of the extensive water-control system, water-management decisions have replaced natural events as the driving force controlling the function and evolution of The Everglades.

TRENDS

Wetlands covered more than one-half of Florida before development began (Hampson, 1984; Dahl, 1990). The Swamp Land Acts of the mid-1800's transferred 20.3 million acres of "swamp and overflowed" lands from Federal to State ownership (Shaw and Fredine, 1956), and that was the acreage assumed by the FWS National Wetlands Inventory for Florida's predevelopment (1780's) wetlands (Dahl, 1990). In 1906, the U.S. Department of Agriculture conducted the first inventory of the Nation's wetlands. The survey reported 19.8 million acres of wetlands in Florida excluding coastal lands overflowed by tidewater, indicating that wetland losses in Florida probably were minimal before the 1900's (Shaw and Fredine, 1956).

Wetland losses were greater in the early 1900's than in the period between 1930 and the mid-1950's owing to the lack of funds available for drainage projects during the Great Depression and World War II. By the mid-1950's, 15.3 million acres of wetlands remained (Shaw and Fredine, 1956). Most of the losses were due to agricultural drainage in the St. Johns River valley, on the lower east coast, in the Kissimmee River and Everglades region around Lake Okeechobee, and scattered in the west-central peninsula (Gray and others, 1924; U.S. Bureau of the Census, 1952; Blake, 1980). Between the mid-1950's and mid-1970's, wetland losses were extensive in The Everglades, where 1.5 million acres of primarily wet prairies and freshwater marshes were drained for agriculture and real estate development (Odum and Brown, 1977). Moderate drainage was conducted from the mid- to late 1950's in northern Florida to enhance pine timber production. The rate of wetland losses for all of Florida slowed to 26,000 acres annually between the mid-1970's and mid-1980's; losses due to agriculture still were greatest, and losses to urbanization were second in importance (Frayer and Hefner, 1991).

Recent estimates of the wetland acreage remaining in Florida differ by almost 3 million acres; most of the difference is in the forested-wetland category. Wetlands delineated in figure 2*A* and reported by the FWS total 11 million acres (Frayer and Hefner, 1991). The Florida Game and Fresh Water Fish Commission, using 1985–89 Landsat Thematic Mapper imagery, estimated that about 8.2 million acres of wetlands remain (Kautz, 1991). Hampson (1984) estimated that about 8.3 million acres of wetlands existed in Florida in 1973. These two estimates are lower than the FWS estimate probably because they exclude most of Florida's wet pine flatwoods, one of the most common natural communities in the State. The Game and Fresh Water Fish Commission estimate also excluded some mixed-hardwood wetlands in areas where they could not be easily distinguished from upland hardwoods (J.M. Hefner, U.S. Fish and Wildlife Service, written commun., 1993).

Wetlands regulations and legislation in effect today generally allow wetlands destruction only when mitigated by wetlands enhancement, preservation, or creation. The effectiveness of these measures in slowing wetland loss is currently under evaluation (Frayer and Hefner, 1991). A recent report on the success of mitigation indicated that the ecological success rate for completed projects was low—for one-third of all permitted projects, the required mitigation had never been attempted (Florida Department of Environmental Regulation, 1991).

CONSERVATION

Many government agencies and private organizations participate in wetlands conservation in Florida. The most active agencies and organizations and some of their activities are listed in table 1.

Federal wetland activities.—Development activities in Florida wetlands are regulated by several Federal statutory prohibitions and incentives that are intended to slow wetland losses. Some of the more important of these are contained in the 1899 Rivers and Harbors Act; the 1972 Clean Water Act and amendments; the 1985 Food Security Act; the 1990 Food, Agriculture, Conservation, and Trade Act; the 1986 Emergency Wetlands Resources Act; and the 1972 Coastal Zone Management Act.

Section 10 of the Rivers and Harbors Act gives the U.S. Army Corps of Engineers (Corps) authority to regulate certain activities in navigable waters. Regulated activities include diking, deepening, filling, excavating, and placing of structures. The related section 404 of the Clean Water Act is the most often-used Federal legislation protecting wetlands. Under section 404 provisions, the Corps issues permits regulating the discharge of dredged or fill material into wetlands. Permits are subject to review and possible veto by the U.S. Environmental Protection Agency (EPA), and the FWS has review and advisory roles. Section 401 of the Clean Water Act grants to States and eligible Indian Tribes the authority to approve, apply conditions to, or deny section 404 permit applications on the basis of a proposed activity's probable effects on the water quality of a wetland.

Most farming, ranching, and silviculture activities are not subject to section 404 regulation. However, the "Swampbuster" provision of the 1985 Food Security Act and amendments in the 1990 Food, Agriculture, Conservation, and Trade Act discourage (through financial disincentives) the draining, filling, or other alteration of wetlands for agricultural use. The law allows exemptions from penalties in some cases, especially if the farmer agrees to restore the altered wetland or other wetlands that have been converted to agricultural use. The Wetlands Reserve Program of the 1990 Food, Agriculture, Conservation, and Trade Act authorizes the Federal Government to purchase conservation easements from landowners who agree to protect or restore wetlands. The Consolidated Farm

Service Agency (formerly the Agricultural Stabilization and Conservation Service) administers the Swampbuster provisions and Wetlands Reserve Program. The Natural Resources Conservation Service (formerly the Soil Conservation Service) determines compliance with Swampbuster provisions and assists farmers in the identification of wetlands and in the development of wetland protection, restoration, or creation plans.

The 1986 Emergency Wetlands Resources Act and the 1972 Coastal Zone Management Act and amendments encourage wetland protection through funding incentives. The Emergency Wetland Resources Act requires States to address wetland protection in their Statewide Comprehensive Outdoor Recreation Plans to qualify for Federal funding for State recreational land; the National Park Service provides guidance to States in developing the wetland component of their plans. Coastal States that adopt coastal-zone management programs and plans approved by the National Oceanic and Atmospheric Administration are eligible for Federal funding and technical assistance through the Coastal Zone Management Act.

State wetland activities.—The Department of Environmental Protection is the principal State agency that issues permits for development activities in wetlands. The Henderson Wetlands Act of 1984 gave the Department of Environmental Regulation (now called the Department of Environmental Protection) expanded jurisdiction over the issuance of permits for dredge-and-fill activities affecting wetlands. The Department of Environmental Protection evaluates the potential effects on wetlands before granting permits and seeks mitigation of unavoidable losses by enhancement, preservation of unaffected wetlands, or wetlands creation. Pursuant to section 305(b) of the Clean Water Act, the Department of Environmental Protection submits to the EPA and the U.S. Congress a biennial assessment of the State's surface-water quality, including that of wetlands. The Department of Environmental Protection has general oversight authority for the five water-management districts, which have authority to levy local taxes and regulatory authority over isolated wetlands within district boundaries. Authorization to use wetlands that are part of sovereign submerged lands is required from the Department of Environmental Protection. These lands, which lie under navigable waters, are held in trust for all the citizens of Florida. The Department of Enviornmental Protection has designated portions of these submerged lands as aquatic preserves, which are carefully managed.

Since 1963, the State of Florida has administered land-acquisition programs that have preserved many wetlands and areas adjacent to water bodies. Much of the land purchased for preservation, as well as parks and other State-owned properties, is managed by the Department of Environmental Protection; however, a substantial amount of publicly owned wetlands are managed by the water-management districts, the Game and Fresh Water Fish Commission, and the Division of Forestry. Historically, land-management programs were designed for recreation, to develop specific resources such as timber, or to favor a few important game animals or endangered species. Partly as a result of citizen input and involvement, ecosystem-management techniques such as prescribed burning are now widely used to maintain the natural character of wetlands and other ecological communities. Since the early 1970's, ecosystem maintenance as a land-management goal has gained favor in Florida as the best strategy to ensure long-term protection of plant and animal species as well as sustainable resources for people.

Regional, county, and local wetland activities.—Florida's Comprehensive Planning Act of 1985, administered by the Department of Community Affairs, requires local governments to produce long-range plans for the development and conservation of resources. Policies for wetlands protection are required elements of all plans. Some city and county governments have strong regulatory or land-acquisition programs that provide wetlands protection beyond that which is required by the State. Others, particularly in the largely rural northern part of the State, are less able to develop strong local protection programs owing to funding limitations; thus, the State and water-management districts have the largest roles in wetland protection in those areas.

Private wetland activities.—Private organizations in Florida have important roles as advocates of wetland conservation and protection. Florida has many private-interest groups that keep the public informed on wetland issues, organize citizen networks, and lobby for wetland-protection measures. The National Audubon Society, The Nature Conservancy, and the Trust for Public Lands have purchased wetlands in Florida for preservation. Some of these lands have been transferred to State or Federal ownership; others are preserved in private ownership, such as Corkscrew Swamp, an Audubon sanctuary. Other groups, such as the Florida Wildlife Federation and the Sierra Club, conduct wetland-protection activities that include programs to educate the public about wetland issues.

Table 1. Selected wetland-related activities of government agencies and private organizations in Florida, 1993

[Source: Classification of activities is generalized from information provided by agencies and organizations. •, agency or organization participates in wetland-related activity; ..., agency or organization does not participate in wetland-related activity. MAN, management; REG, regulation; R&C, restoration and creation; LAN, land acquisition; R&D, research and data collection; D&I, delineation and inventory]

Agency or organization	MAN	REG	R&C	LAN	R&D	D&I
FEDERAL						
Department of Agriculture						
Consolidated Farm Service Agency	...	•	...	...	...	...
Forest Service	•	...	•	•	•	•
Natural Resources Conservation Service	...	•	•	...	•	•
Department of Commerce						
National Oceanic and Atmospheric Administration	•	•	...	...	•	...
Department of Defense						
Army Corps of Engineers	•	•	•	•	•	•
Military reservations	•	...	...	...	...	...
Department of the Interior						
Fish and Wildlife Service	•	...	•	•	•	•
Geological Survey	...	...	...	...	•	...
National Biological Service	...	...	...	...	•	...
National Park Service	•	...	•	•	•	•
Environmental Protection Agency	...	•	...	...	•	•
STATE						
Department of Agriculture and Consumer Services						
Division of Forestry	•	...	...	...	...	...
Department of Community Affairs	...	•	...	...	...	...
Department of Environmental Protection	•	•	•	•	•	•
Game and Fresh Water Fish Commission	•	•	...	...	•	•
University of Florida Center for Wetlands	...	...	...	...	•	...
Other State university programs	...	...	...	...	•	...
REGIONAL, COUNTY, AND LOCAL						
Water Management Districts	•	•	•	•	•	•
Regional Planning Councils	...	•	...	...	...	...
Some County and City Governments	•	•	•	...	...	...
PRIVATE ORGANIZATIONS						
National Audubon Society	•	...	...	...	•	...
The Nature Conservancy	•	...	...	•	...	...
Trust for Public Lands	...	...	...	•	...	...

References Cited

Abrahamson, W.G., and Hartnett, D.C., 1990, Pine flatwoods and dry prairies, *in* Myers, R.L., and Ewel, J.J., eds., Ecosystems of Florida: Orlando, University of Central Florida Press, p. 103–149.

Blake, N.M., 1980, Land into water, water into land—A history of water management in Florida: Tallahassee, University Presses of Florida, 344 p.

Carlton, J.M., 1977, A survey of selected coastal vegetation communities of Florida: Florida Department of Natural Resources, Florida Marine Research Publication 30, 40 p.

Conway, McKinley, and Liston, L.L., eds., 1990, The weather handbook: Norcross, Ga., Conway Data, Inc., 548 p.

Cowardin, L.M., Carter, Virginia, Golet, F.C., and LaRoe, E.T., 1979, Classification of wetlands and deepwater habitats of the United States: U.S. Fish and Wildlife Service Report FWS/OBS–79/31, 131 p.

Crowder, J.P., 1974, Some perspectives on the status of aquatic wading birds in South Florida: U.S. Bureau of Sport Fisheries and Wildlife Report PB–231 216, 12 p.

Dahl, T.E., 1990, Wetlands—Losses in the United States, 1780's to 1980's: Washington, D.C., U.S. Fish and Wildlife Service Report to Congress, 13 p.

Davis, J.H., 1943, The natural features of southern Florida: The Florida Geological Survey Bulletin 25, 311 p.

Davis, S.M., 1991, Sawgrass and cattail nutrient flux—Leaf turnover, decomposition, and nutrient flux of sawgrass and cattail in the Everglades: Aquatic Botany, v. 40, p. 203–224.

Dierberg, F.E., and Brezonik, P.L., 1984, The effect of wastewater on the surface water and groundwater quality of cypress domes, *in* Ewel, K.C., and Odum, J.T., eds., Cypress Swamps: Gainesville, University Presses of Florida, p. 83–101.

Douglas, M.S., 1947, The Everglades—River of grass: New York, Rinehart, 406 p.

Duplaix, Nicole, 1990, South Florida water—Paying the price: National Geographic, v. 178, no. 1, p. 89–113.

Ewel, K.C., 1990, Swamps, *in* Myers, R.L., and Ewel, J.J., eds., Ecosystems of Florida: Orlando, University of Central Florida Press, p. 281–322.

Fernald, E.A., ed., 1981, Atlas of Florida: Tallahassee, The Florida State University Foundation, Inc., 276 p.

Florida Department of Environmental Regulation, 1991, Report on the effectiveness of permitted mitigation: Tallahassee, Florida Department of Environmental Regulation, 59 p.

Florida Department of Natural Resources, 1988, Wetlands in Florida—An addendum to Florida's Comprehensive Outdoor Recreation Plan: Tallahassee, Florida Department of Natural Resources, 91 p.

Florida Natural Areas Inventory and Division of State Lands, 1990, Guide to the natural communities of Florida: Tallahassee, Florida Department of Natural Resources, 111 p.

Frayer, W.E., and Hefner, J.M., 1991, Florida wetlands—Status and trends, 1970's to 1980's: Atlanta, U.S. Fish and Wildlife Service, 31 p.

Gray, L.C., Baker, O.E., Marschner, F.J., and Weitz, B.O., 1924, The utilization of our lands for crops, pasture and forests, *in* U.S. Department of Agriculture, Agriculture yearbook—1923: Washington, D.C., U.S. Government Printing Office, 1,284 p.

Grow, Gerald, 1989, Florida parks—A guide to camping in nature (4th ed.): Tallahassee, Fla., Longleaf Publications, 260 p.

Hampson, P.S., 1984, Wetlands in Florida: Tallahassee, Florida Bureau of Geology Map Series 109, scale 1:2,000,000.

Heath, R.C., and Conover, C.S., 1981, Hydrologic almanac of Florida: U.S. Geological Survey Open-File Report 81–1107, 239 p.

Jordan, C.L., 1984, Florida's weather and climate—Implications for water, *in* Fernald, E.A., and Patton, D.J., eds., Water resources atlas of Florida: Tallahassee, Florida State University, p. 18–35.

Kautz, R.S., 1991, Space age habitat mapping: Florida Wildlife, v. 45, no. 73, p. 30–33.

Klein, Howard, Armbruster, J.T., McPherson, B.F., and Freiberger, J.J., 1975, Water and the south Florida environment: U.S. Geological Survey Water-Resources Investigations 24–75, 165 p.

Kushlan, J.A., 1990, Freshwater marshes, *in* Myers, R.L., and Ewel, J.J., Ecosystems of Florida: Orlando, University of Central Florida Press, p. 324–363.

Kushlan, J.A., Ogden, J.C., and Higer, A.L., 1975, Relation of water level and fish availability to wood stork reproduction in southern Everglades, Florida: U.S. Geological Survey Open-File Report 75–434, 56 p.

Leitman, H.M., Sohm, J.E., and Franklin, M.A., 1984, Wetland hydrology and tree distribution of the Apalachicola River flood plain, Florida: U.S. Geological Survey Water-Supply Paper 2196, 52 p.

McPherson, B.F., 1973, Vegetation in relation to water depth in Conservation Area 3, Florida: U.S. Geological Survey Open-File Report 73–0173, 60 p.

_____1979, Land cover map of the Green Swamp area, Central Florida: U.S. Geological Survey Miscellaneous Investigations Series Map I–1134, scale 1:63,360.

Odum, H.T., and Brown, Mark, eds., 1977, Carrying capacity for man and nature in South Florida: Gainesville, Fla., National Park Service and University of Florida Center for Wetlands cooperative publication, 886 p.

Odum, W.E., and McIvor, C.C., 1990, Mangroves, *in* Myers, R.L., and Ewel, J.J., Ecosystems of Florida: Orlando, University of Central Florida Press, p. 517–548.

Odum, W.E., McIvor, C.C., and Smith, T.J., III, 1982, The ecology of the mangroves of South Florida—A community profile: U.S. Fish and Wildlife Service Report FWS/OBS–81/24, 144 p.

Palik, T.F., and Kunneke, J.T., 1984, Northwestern Florida ecological characterization—An ecological atlas: U.S. Fish and Wildlife Service Report FWS/OBS–82/47.1, 302 p.

Parker, G.G., 1974, Hydrology of the pre-drainage system of the Everglades in South Florida, *in* Gleason, P.J., ed., Environments of South Florida—Present and past: Miami, Fla., Miami Geological Society, Memoir 2, p. 718–727.

Shaw, S.P., and Fredine, C.G., 1956, Wetlands of the United States—Their extent and their value to waterfowl and other wildlife: U.S. Fish and Wildlife Service Circular 39, 67 p., 1 map.

South Florida Water Management District, 1992, Surface water improvement and management plan for the Everglades: West Palm Beach, South Florida Water Management District Support Information Document, 472 p.

Tiner, R.W., Jr., 1984, Wetlands of the United States—Current status and recent trends: Washington, D.C., U.S. Fish and Wildlife Service, 59 p.

U.S. Bureau of the Census, 1952, United States census of agriculture, 1950, v. 4—Drainage of agricultural lands: Washington, D.C., U.S. Government Printing Office, 307 p.

U.S. Soil Conservation Service, 1989, Twenty-six ecological communities of Florida (revised ed.): Gainesville, Florida Chapter Soil and Water Conservation Society, 286 p.

VanArman, Joel; Nealon, Dennis; Burns, Scott; Jones, Brad; Smith, Lisa; MacVicar, Thomas; Yamsura, Margaret; Federico, Anthony; Bucca, Jane; Knapp, Michael; and Gleason, Patrick, 1984, South Florida Water Management District, *in* Fernald, E.A., and Patton, D.J., eds., Water resources atlas of Florida: Tallahassee, Florida State University, p. 138–157.

Vince, S.W., Humphrey, S.R., and Simons, R.W., 1989, The ecology of hydric hammocks—A community profile: U.S. Fish and Wildlife Service Biological Report 85(7.26), 81 p.

Wharton, C.H.; Odum, H.T.; Ewel, K.C.; Duever, M.J.; Lugo, Ariel; Boyt, Rene; Bartholemew, J.; DeBellevue, E.B.; Brown, S.; Brown, M.; and Duever, L.C., 1977, Forested wetlands of Florida—Their management and use: Gainesville, University of Florida, 348 p.

Zieman, J.C., and Zieman, R.T., 1989, The ecology of the seagrass meadows of the west coast of Florida—A community profile: U.S. Fish and Wildlife Service Biological Report 85(7.25), 155 p.

FOR ADDITIONAL INFORMATION: District Chief, U.S. Geological Survey, 227 N. Bronough St., Suite 3015, Tallahassee, FL 32301; Regional Wetland Coordinator, U.S. Fish and Wildlife Service, 1875 Century Building, Suite 200, Atlanta, GA 30345

Prepared by

Melanie R. Darst, Helen M. Light, and Benjamin F. McPherson, U.S. Geological Survey