# EARTH SYSTEMS:

## THE FOUNDATION OF FLORIDA'S ECOSYSTEMS


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## INTRODUCTION

**ECOLOGY** is the study of the relationship between organisms and their environment, including the study of communities, patterns of life, natural cycles, relationships to each other, biogeography, and population changes.

An **ECOSYSTEM** is a community of organisms, including humans, interacting with one another and the environment in which they live.

**ECOSYSTEMS EXIST IN AN INFINITE VARIETY,** and on many scales, from the microscopic to planet-wide. Therefore, an ecosystem's boundaries depend on the scope of the study. Most ecosystems have a diversity of animals and plants, all of which have a range of living requirements. Because of this, there is overlap among adjacent ecosystems.

**ECOSYSTEMS ARE NOT STATIC.** They change in time and space, due to both natural and human influences. Shallow lakes, for example, tend to fill in over time with sediment and plant material; human activities can accelerate the process. Plant and animal communities also change as part of the life cycle of an ecosystem.

**A knowledge of EARTH SYSTEMS is necessary to understand how biological and non-biological components interact to create and sustain ecosystems.** The solid earth aspects of earth systems are included in the science of geology, the atmospheric components reside with meteorology, and hydrogeology and hydrology cover the aqueous parts of our physical earth system.

Basic geologic knowledge of the physical characteristics of rocks and geologic processes has direct relevance to ecosystems. **ROCKS ARE THE ULTIMATE SOURCE OF MOST NUTRIENTS IN FOOD CHAINS.** Weathering processes break down rocks into their constituent minerals and chemical components, forming soils and nutrients. Erosion and sediment transport processes then make them available to the biosphere. Most nutrients are recycled many times through an ecosystem before losing their usefulness to the system.

**The GEOLOGIC STRUCTURE of the stratigraphic formations of an area's rocks is a major factor in determining the landforms, or geomorphology, of that area.** The structure and stratigraphy also influence surface and ground-water conditions, such as flow, recharge and discharge areas, and location and depth of aquifers and ambient water chemistry. Some geomorphic features can create very localized microclimates and restricted ecosystems; steephead ravines and sinkholes are two examples.

The accompanying block diagrams are generalized composites that have been constructed to illustrate the most important topographic and geologic features of broad areas of the state. They do not represent all features that occur in specific areas. Vegetation has been omitted to accentuate the main geomorphic features.

Florida's climate ranges from temperate and sub-tropical in the north to tropical in the south. This climatic range results in intermingled plant and animal environments and numerous overlapping ecosystems.

### CENOZOIC ROCKS

Florida is underlain by thousands-of-feet of rocks of Precambrian, Paleozoic, Mesozoic, and Cenozoic age. However, only rocks of Cenozoic age either crop out at the surface or occur at relatively shallow depths. Figures 1 and 2 show these relationships. Since these are the only rocks involved in creating and sustaining Florida's ecosystems, only they will be discussed here.

Cenozoic sediments began to be laid down about 65 million years ago. Figure 1 shows the geological units comprising the Cenozoic stratigraphic column in Florida. In general, carbonate rocks (limestone and dolomite) predominate in the older sediments of the Paleogene, while siliciclastics (clays, sands, gravels) predominate in the younger sediments of the Neogene-Quaternary.

Florida's present landscape is the product of sea level fluctuations and associated marine related processes, erosion and depositional processes. Over the past 2 to 3 million years, as a result of the repeated growth and melting of continental glaciers, sea levels have fluctuated from several hundred feet above present level to several hundred feet below present sea level. The most recent fluctuation is a slow rise in sea level, causing a retreat of shorelines in many parts of the state. Siliciclastic sediments were eroded from the Appalachian Mountains to the north, blanketing the state. Rivers, waves, and currents created ancient deltas, shorelines, estuaries, dunes and sand ridges. Subsequent mechanical and chemical erosion and re-deposition produced Florida's present geomorphology. The more prominent of the geomorphic features are shown on Figure 3.

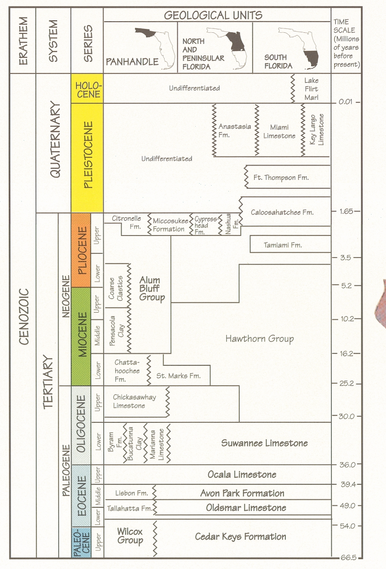



FIGURE 1: Florida stratigraphic column.

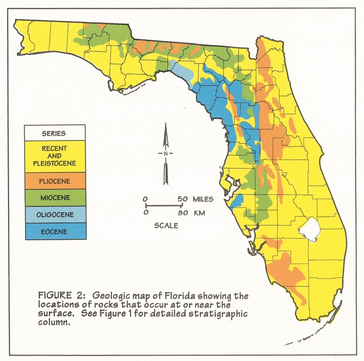



FIGURE 2: Geologic map of Florida showing the locations of rocks that occur at or near the surface. See Figure 1 for detailed stratigraphic column.

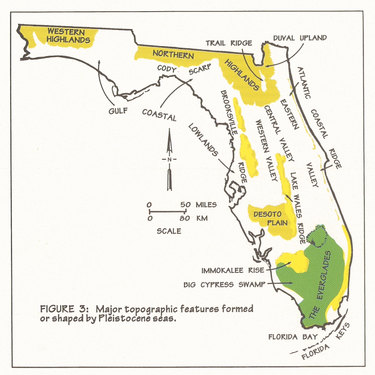
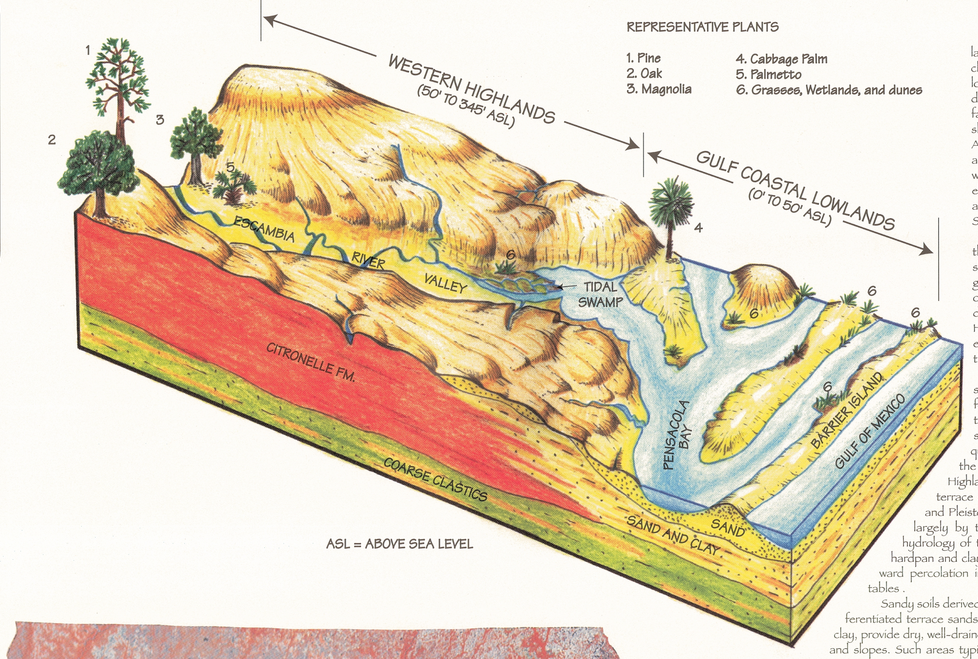



FIGURE 3: Major topographic features formed or shaped by Pliocene-Recent seas.

## WESTERN PANHANDLE




The Western Florida panhandle is underlain by thick Miocene to Recent sands and clays. Carbonates, which are common at shallow depth elsewhere in Florida, generally lie at depths in excess of 400 feet below land surface. Clays in the thick overburden sediments shield this limestone from extensive dissolution. As a result, karst features, such as sinkholes, are rare to absent in the four counties of the western panhandle. The thick sands and gravelly sands also form the primary drinking water aquifer, which due to its lithology, is named the Sand-and-Gravel aquifer.

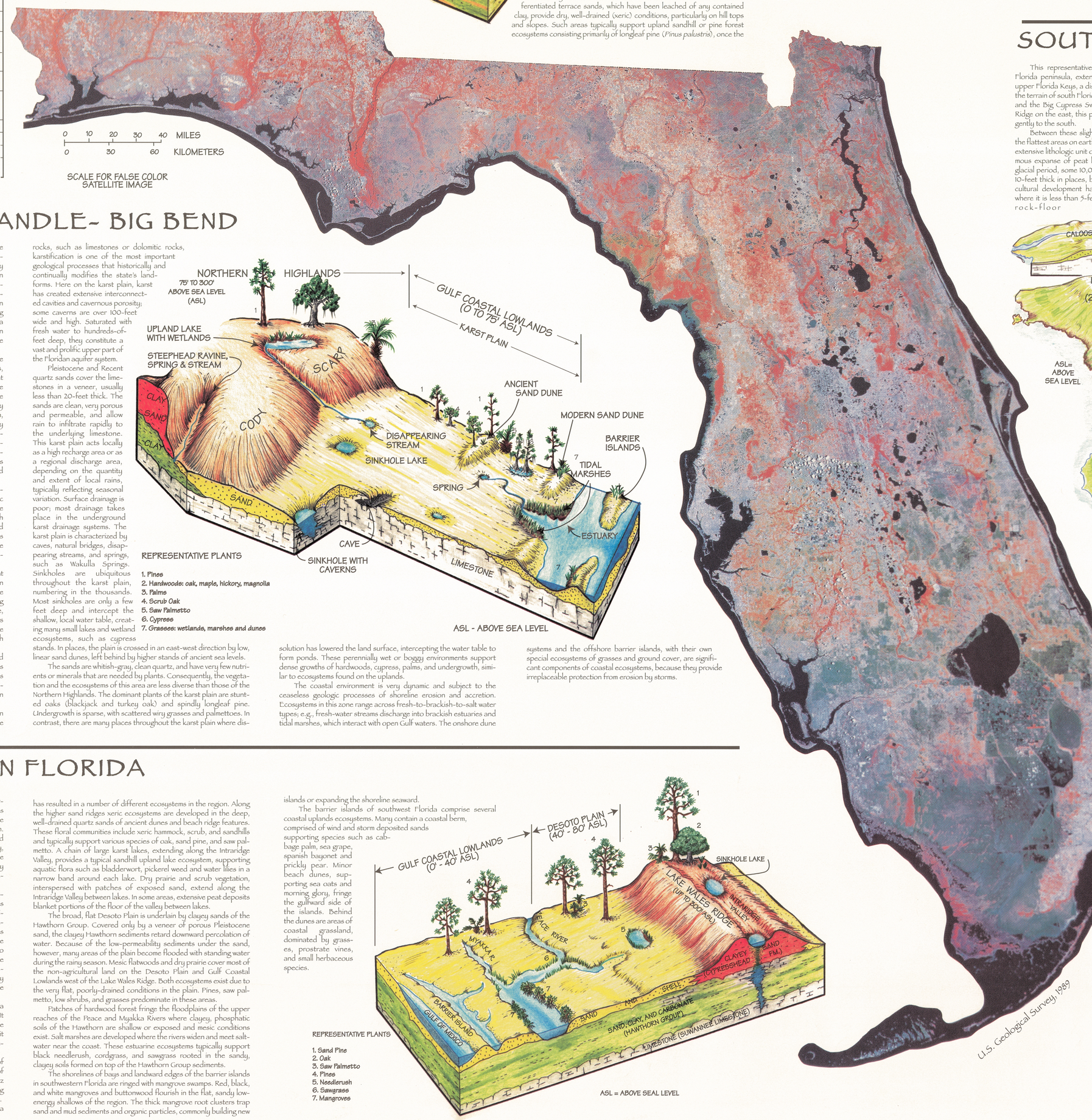
Extending approximately 50 miles from the Alabama border on the north to the Gulf shoreline, the region is divided into two major geomorphic zones. Skirting the northern edge of the western panhandle is a broad, stream-dissected upland named the Western Highlands. South of these highlands is a gently flat and elevationally lower zone named the Gulf Coastal Lowlands.

The Western Highlands consist of clayey-sand hills, which attain elevations up to 345 feet above sea level (ASL). Surface water features consist primarily of deeply-incised streams. Plio-Pleistocene clayey, gravelly, quartz sands of the Citronelle Formation form the core of the hills. Blanketing the Western Highlands is a relict, variably thick veneer of marine terrace sands, deposited by high-standing Pliocene and Pleistocene seas. Local ecosystems are controlled largely by the topography and by the lithology and hydrology of the underlying geologic formations. Limonite hardpan and clay beds, for example, commonly retard downward percolation in many areas, causing high standing water tables .

Sandy soils derived from the Citronelle Formation and the undifferentiated terrace sands, which have been leached of any contained clay, provide dry, well-drained (xeric) conditions, particularly on hill tops and slopes. Such areas typically support upland sandhill or pine forest ecosystems consisting primarily of longleaf pine (*Pinus palustris*), once the principal upland tree species in prehistoric times, along with other pine species, oaks, wiregrasses, herbs, and low woody shrubs.

Interspersed with the sandhill ecosystem on the rolling topography of the Western Highlands, particularly along the smaller stream courses, are upland hardwood forests and upland mixed forests. Clayey, organic, sandy soils, developed from the shallow-lying Alum Bluff Group and Citronelle Formation, retain more moisture than the deep sand regions and support a decidedly mesic (moist) community. In these regions the common flora includes magnolia, oak, hickory, beech, and various pine species. Bottomland hardwood forests and floodplain forests are developed along the major alluvial stream courses of the region, where higher water tables and high soil clay and organic content provide mesic conditions. Moisture dependent forests of water and live oak, sweetgum, magnolia, beech, palmetto and river birch extend along the upper reaches of the Escambia River Valley. Freshwater tidal swamp occupies the lower, seaward portion of the valley. The southern boundary of the Western Highlands is marked by a relict marine escarpment which forms a topographic break between the elevationally higher uplands to the north and the lower, generally flat Gulf Coastal Lowlands zone to the south.

The Gulf Coastal Lowlands comprise a sandy, gently-seaward sloping plain extending from the southern edge of the Western Highlands south to the Gulf of Mexico. Elevations rise from sea level at the Gulf coast to about 50 feet ASL at the toe of the Western Highlands. The Gulf Coastal Lowlands are characterized by numerous relict sand beach ridges, dunes and swales formed by high-standing Pleistocene seas. This sandy topography is underlain by generally clean quartz sands, creating moderate to poorly-drained mesic conditions. Pine flatwoods occupy much of the inland portions of the lowlands. Near the coast, maritime hammock flora of live oak, cabbage palm, and redbay occur in discontinuous forests, rooted in the thick quartz sands of old coastal dunes. Well developed dunes along the modern coast support a beach dune ecosystem including sea oats, cordgrass, sand spur, and morning glory. Behind the dunes, especially on the barrier islands, is a coastal grassland ecosystem. This flat, treeless ecosystem is developed on clean sands and typically supports only grasses, prostrate vines and other maritime herbaceous flora.




## EASTERN PANHANDLE- BIG BEND

The distance from the Georgia-Florida border in the north to the Gulf of Mexico in the south is about 50 miles. This landscape is naturally divided into two distinct areas by the east-west oriented Cody Scarp, an ancient shoreline feature which stretches from the western panhandle almost to Jacksonville. The Cody Scarp is a prominent feature that can rise as much as 150 feet in elevation over a mile of horizontal distance. The higher, rolling hills north of the Cody Scarp are in the Northern Highlands geomorphic province, with elevations ranging from about 300 feet above sea level (ASL) near the Georgia/Florida border to about 75 feet ASL at the toe of the scarp. The flat region that gradually slopes down from the toe of the scarp to sea level at the Gulf is the Gulf Coastal Lowlands.

The Northern Highlands are underlain by sediments of the Miocene Hawthorn Group, composed of interbedded quartz sands, clays, and carbonates. Except for a few areas where they crop out at the surface, these sediments usually underlie the younger Pliocene siliciclastic sediments of the Miccosukee Formation (reddish-orange clays, silts, and sands). These heterogeneous sediments form loamy soils that are rich in nutrients. They support lush, natural vegetation, and make good farming soils. The rolling hills have been dissected by stream erosion, creating steep-walled channels in the weakly clay-cemented, sandy sediments. Steepheads are distinctive erosional features that result from spring-fed streams eroding headward and etching narrow, steep ravines. These ravines form isolated environments that have specialized ecosystems of ferns, other sensitive plants, and amphibians.

Many large lake basins are the result of dissolution of buried limestone, which has caused slight subsidence of the overlying siliciclastic sediments. These lakes are only a few feet deep and usually have extensive marshes or wetlands associated with them. Due to the high clay content and the thickness of the Hawthorn Group and Miccosukee Formation sediments, which act as confining units, this region has low potential for recharge to the groundwater aquifer, the Floridan aquifer system, which is developed in the underlying limestones.

The upland ecosystems are based on the plant communities that are supported by the nutrient-rich sediments, and are dependent on the local stratigraphy and hydrogeology. Important elements in these ecosystems are the mixed hardwood and conifer forests, containing both temperate and subtropical species. Extensive stands of large, mature hardwoods (oak, maple, beech, hickory, magnolia), conifers (pine, cedar, cypress), and palms form the foundation and protective canopy for lush undergrowth. Together, these elements create rich and varied ecosystems.

The Gulf Coastal Lowlands of the eastern panhandle-Big Bend area are underlain by thick sections of near-surface carbonate rocks of Oligocene age (Suwannee Limestone) and Miocene age (St. Marks Formation). These limestones have been deeply weathered by dissolution. These limestones also extend to the north under the Northern Highlands.

Karstification is largely a chemical erosion process that occurs in carbonate rocks. Because most of Florida is underlain by carbonate rocks, such as limestones or dolomitic rocks, karstification is one of the most important geological processes that historically and continually modifies the state's landforms. Here on the karst plain, karst has created extensive interconnected cavities and cavernous porosity; some caverns are over 100-feet wide and high. Saturated with fresh water to hundreds-of-feet deep, they constitute a vast and prolific upper part of the Floridan aquifer system.




Pleistocene and Recent quartz sands cover the limestones in a veneer, usually less than 20-feet thick. The sands are clean, very porous and permeable, and allow rain to infiltrate rapidly to the underlying limestone. This karst plain acts locally as a high recharge area or as a regional discharge area, depending on the quantity and extent of local rains, typically reflecting seasonal variation. Surface drainage is poor; most drainage takes place in the underground karst drainage systems. The karst plain is characterized by caves, natural bridges, disappearing streams, and springs, such as Wakulla Springs. Sinkholes are ubiquitous throughout the karst plain, numbering in the thousands. Most sinkholes are only a few feet deep and intercept the shallow, local water table, creating many small lakes and wetland ecosystems, such as cypress stands. In places, the plain is crossed in an east-west direction by low, linear sand dunes, left behind by higher stands of ancient sea levels.

The sands are whitish-gray, clean quartz, and have very few nutrients or minerals that are needed by plants. Consequently, the vegetation and the ecosystems of this area are less diverse than those of the Northern Highlands. The dominant plants of the karst plain are stunted oaks (blackjack and turkey oak) and spindly longleaf pine. Undergrowth is sparse, with scattered wiry grasses and palmettoes. In contrast, there are many places throughout the karst plain where dissolution has lowered the land surface, intercepting the water table to form ponds. These perennially wet or boggy environments support dense growths of hardwoods, cypress, palms, and undergrowth, similar to ecosystems found on the uplands.

The coastal environment is very dynamic and subject to the ceaseless geologic processes of shoreline erosion and accretion. Ecosystems in this zone range across fresh-to-brackish-to-salt water types; e.g., fresh-water streams discharge into brackish estuaries and tidal marshes, which interact with open Gulf waters. The onshore dune systems and the offshore barrier islands, with their own special ecosystems of grasses and ground cover, are significant components of coastal ecosystems, because they provide irreplaceable protection from erosion by storms.

## SOUTHWESTERN FLORIDA

Southwestern Florida is underlain by Oligocene to Recent carbonates, sands, clays, and mollusk shell beds. The deeper carbonates are comprised of porous Suwannee Limestone. Locally, the Suwannee Limestone is the uppermost rock unit of the Floridan aquifer system. Overlying the Suwannee are carbonates and interbedded sands and clays of the Hawthorn Group. At the eastern edge of the area, clayey, gravelly quartz sands of the Pliocene Cypresshead Formation overlie the Hawthorn Group and form the foundation for the elevationally higher central ridges. Shallow sediments are variably-thick undifferentiated Plio-Pleistocene sands and shell beds.

In general, the region is comprised of flat-lying, sandy terrain broken only by the higher elevations of relict, marine-eroded inland ridges running parallel to the axis of the peninsula. Locally, the most prominent of these ridges is named the Lake Wales Ridge, which attains elevations of 300 feet above sea level (ASL). The core of the Lake Wales Ridge is comprised of clayey, gravelly, coarse quartz sands of the Pliocene Cypresshead Formation. These, in turn, rest on Oligocene to Pliocene siliciclastics and carbonates of the Hawthorn Group. The Lake Wales Ridge is split along much of its length by a steep-walled axial valley, referred to as the Intraridge Valley. This valley probably formed by karst dissolution of the underlying limestone. Numerous large sinkhole lakes extend along the axis of the Intraridge Valley.

Extending westward from the toe of the Lake Wales Ridge is a broad, flat, sandy, relict submarine plain named the DeSoto Plain. It ranges in elevation from about 80 feet ASL at the toe of the Lake Wales Ridge to about 40 feet ASL at its western boundary, where it adjoins the Gulf Coastal Lowlands zone. Surface sediments are composed largely of marine sands and interbedded shell beds.

The Gulf Coastal Lowlands extend from the western boundary of the Desoto Plain approximately 25 miles to the Gulf shoreline. Most of this flat-lying region is less than 40 feet ASL. Relict marine quartz sands and shell beds, reworked and deposited by high-standing Pliocene and Pleistocene seas, comprise the near-surface sediments.

The varying geology and hydrogeology of southwestern Florida has resulted in a number of different ecosystems in the region. Along the higher sand ridges xeric ecosystems are developed in the deep, well-drained quartz sands of ancient dunes and beach ridge features. These floral communities include xeric hammock, scrub, and sandhills and typically support various species of oak, sand pine, and saw palmetto. A chain of large karst lakes, extending along the Intraridge Valley, provides a typical sandhill upland lake ecosystem, supporting aquatic flora such as bladderwort, pickerel weed and water lilies in a narrow band around each lake. Dry prairie and scrub vegetation, interspersed with patches of exposed sand, extend along the Intraridge Valley between lakes. In some areas, extensive peat deposits blanket portions of the floor of the valley between lakes.

The broad, flat Desoto Plain is underlain by clayey sands of the Hawthorn Group. Covered only by a veneer of porous Pleistocene sand, the clayey Hawthorn sediments retard downward percolation of water. Because of the low-permeability sediments under the sand, however, many areas of the plain become flooded with standing water during the rainy season. Mesic flatwoods and dry prairie cover most of the non-agricultural land on the Desoto Plain and Gulf Coastal Lowlands west of the Lake Wales Ridge. Both ecosystems exist due to the very flat, poorly-drained conditions in the plain. Pines, saw palmetto, low shrubs, and grasses predominate in these areas.

Patches of hardwood forest fringe the floodplains of the upper reaches of the Peace and Myakka Rivers where clayey, phosphatic soils of the Hawthorn are shallow or exposed and mesic conditions exist. Salt marshes are developed where the rivers widen and meet salt-water near the coast. These estuarine ecosystems typically support black needlerush, cordgrass, and sawgrass rooted in the sandy, clayey soils formed on top of the Hawthorn Group sediments.

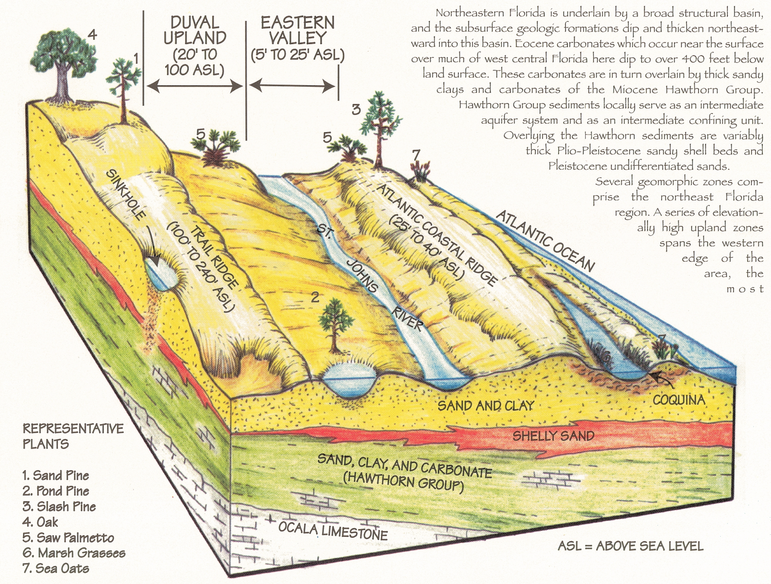
The shorelines of bays and landward edges of the barrier islands in southwestern Florida are ringed with mangrove swamps. Red, black, and white mangroves and buttonwood flourish in the flat, sandy, low-energy shallows of the region. The thick mangrove root clusters trap sand and mud sediments and organic particles, commonly building new islands or expanding the shoreline seaward.

The barrier islands of southwest Florida comprise several coastal uplands ecosystems. Many contain a coastal berm, comprised of wind and storm deposited sands supporting species such as cabbage palm, sea grape, spanish bayonet and prickly pear. Minor beach dunes, supporting sea oats and morning glory, fringe the gulfward side of the islands. Behind the dunes are areas of coastal grassland, dominated by grasses, prostrate vines, and small herbaceous species.




U.S. Geological Survey, 1989

## NORTHEASTERN FLORIDA




Northeastern Florida is underlain by a broad structural basin, and the subsurface geologic formations dip and thicken northeastward into this basin. Eocene carbonates which occur near the surface over much of west central Florida here dip to over 900 feet below land surface. These carbonates are in turn overlain by thick sandy clays and carbonates of the Miocene Hawthorn Group. Hawthorn Group sediments locally serve as an intermediate aquifer system and as an intermediate confining unit. Overlying the Hawthorn sediments are variably thick Plio-Pleistocene sandy shell beds and Pleistocene undifferentiated sands.

Several geomorphic zones comprise the northeast Florida region. A series of elevationally high upland zones spans the western edge of the area, the most prominent being a relict marine region of sand hills named the Trail Ridge. Elevations of nearly 240 feet above sea level (ASL) are typical along the crest of the ridge. The clean, well-drained quartz sand hills of the Trail Ridge support xeric sandhill and scrub ecosystems. The nutrient poor, relict marine Pleistocene quartz sands support a flora of sand and longleaf pines, various oaks, low hardwood shrubs such as rosemary, and grasses and ground-cover lichens.

Extending eastward from the Trail Ridge towards the St. Johns River is a broad, flat plain named the Duval Upland. Lower in elevation than the Trail Ridge, the Duval Upland is underlain by poorly-to-moderately drained, Plio-Pleistocene relict marine, quartz sands and silts. These sediments, deposited in shallow, high-standing Pleistocene seas, are typically acidic and are leached of moisture-and-nutrient-holding clay. The water table is variable, and some areas contain standing water during the rainy season. Much of the upland is forested in pine flatwoods, with various species of pine, with saw palmetto, gallberry and wiregrass understory. Longleaf pine dominates in the better drained areas, while pond pine and slash pine generally occupy wetter sites.

The Duval Upland is bounded on the east by a broad lowland valley, named the Eastern Valley, which contains the St. Johns River. Like the Duval Upland, the terrain within the Eastern Valley is flat, sandy, and only moderately to poorly drained. Most non-agricultural areas within this zone are populated by pine flatwoods.

East of the St. Johns River, the Eastern Valley is dotted with relict marine beach ridge features. It is bounded on the east by the Atlantic Coastal Ridge, an ancient shoreline feature formed by high-standing Pleistocene seas. The ridge is comprised of shelly sands and Anastasia Formation sediments, which support xeric beach dune flora, including sea oats, beach cordgrass, sandspur and morning glory.

A series of coast-parallel lagoons border the east coast, separating the sandy barrier islands from the mainland. Extensive coastal saltmarshes, comprised primarily of *Juncus* and *Spartina* grasses, are developed along the shores of these lagoons.

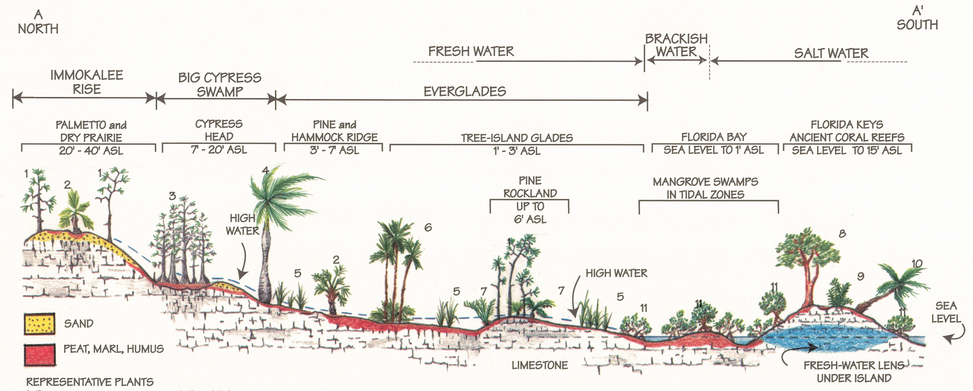
Along the coast, sandy barrier islands with large, well-developed dunes, face the Atlantic Ocean. These islands support xeric beach dune flora, including sea oats, beach cordgrass, sandspur and morning glory.

## SOUTH FLORIDA

This representative section includes the southern tip of the Florida peninsula, extending from Lake Okeechobee south to the upper Florida Keys, a distance of about 150 miles. Flatness describes the terrain of south Florida. With the exceptions of the Immokalee Rise and the Big Cypress Swamp on the west, and the Atlantic Coastal Ridge on the east, this part of Florida is a flat plain that slopes very gently to the south.

Between these slightly higher areas lies the Everglades, one of the flattest areas on earth, covering over 5,000 square miles. The most extensive lithologic unit of this area is the Everglades peat. This enormous expanse of peat has been forming since the end of the last glacial period, some 10,000 years ago. The peat may have been over 10-feet thick in places, but canalization, drainage projects, and agricultural development have depleted the peat to the point where it is less than 5-feet thick. The rock-floor upon which the peat deposits have accumulated forms a shallow, elongated, bowl-like trough that is composed of sandy, shelly, karstic limestones, calcareous sandstones, or marls, all of which were deposited during the Pleistocene epoch. The northern boundary of the trough is Lake Okeechobee, which has a bottom elevation of about present sea level. The Everglades is covered with shallow water that moves southward in sluggish sheet flow, as indicated by arrows in the diagram. From the northern edge of the open Everglades to the southwestern tip of the peninsula, where the fresh water flows into the Gulf, a distance of about 100 miles, the slope of the water surface may be only one to two inches per mile. This is so flat that rainstorms can reverse the gradient of the local water surface. Here, elevation differences of a few inches can determine environmental and ecosystem boundaries. This is a vast, fresh-water prairie whose main ecosystem components are sawgrass and sedges. Within this prairie are small, scattered areas where the limestone bedrock is one or two feet higher in elevation, called tree-island glades or rock ridges. This slightly higher elevation allows these glades to support stands of cypress, willows, palms, pines, and palmettoes.




The Atlantic Coastal Ridge forms the eastern rim of the Everglades trough. This narrow, gently rolling limestone ridge, from 5 to 5-miles wide, has a thin covering of quartz sand. Higher elevations are on the steeper eastern side, with a gentle slope to the west into the Everglades trough. Maximum elevations are between 20 and 25 feet above sea level (ASL) in the Miami area; usual crest elevations gradually decrease to the south, down to 5 feet or less at the western end of the Pine Rocklands, where the ridge eventually merges into the Everglades' topography. The higher, northern segments of the ridge have thicker, better drained, sandy soils than the southern segments, which have thin, marly, peaty soils interspersed with frequently exposed, pitted limestone. Pine Rocklands, scrub oaks, palms and palmetto prairies are the predominant ecosystems developed on these geological foundations. This rock-rim controls the flow of Everglades water by directing it to the south and then deflecting it to the southwest.

The western boundary of the Everglades trough consists of two areas of slightly higher elevations, the Immokalee Rise and the Big Cypress Swamp. The boundaries among these three areas are ill-defined because they merge and intermingle across zones that can be several miles wide. There are significant differences in the types of soils over each of the areas, resulting in different types of vegetation that occur in each. The Everglades is covered by thick layers of peaty soils. Some parts of the Immokalee Rise and the Big Cypress Swamp also have peaty soils, but mostly they are covered by sandy soils and muds or they have Pleistocene limestone exposed at the surface.

The Immokalee Rise is roughly oval in outline, ranging from 20 to 40-feet elevation ASL. It is covered by thin deposits of nutrient-poor, quartz sand, with the underlying limestone exposed in some areas. The surface is pocked by many small, circular, shallow, karst depressions that are seasonally wet and which accumulate organic deposits. These geologic conditions result in pine flatwoods and saw palmetto prairies ecosystems.

The Big Cypress Swamp, covering more than 1,000 square miles south of the Immokalee Rise, with elevations between 7 and 20-feet ASL, is a transition zone between the Everglades and the Immokalee Rise. Thin deposits of quartz sand and sandy peat cover much of the area, with exposed, karstified limestone common. Perennially wet conditions that flood the many shallow, karst depressions and sloughs create ideal conditions for bald cypress strands. Some strands occur in depressions situated on the higher rock ridges and are commonly surrounded by tropical hardwood hammock ecosystems. During times of high water, runoff occurs as sheet flow to the southeast, south, and southwest, contributing to the fresh-water flow of the Everglades to the Gulf.

Mangroves border the shorelines of southwest Florida, Florida Bay, and the Keys. Along the mainland coast and the Keys, in the zone where the water varies from salt-to-brackish-to-fresh, they often form impenetrable thickets with their high, interwined prop roots. Some of the mangrove swamps are developed on rocky coasts; others grow on unconsolidated sandy, peaty, or lime-mud substrates. Florida Bay is very shallow, with depths varying from 1 to 6 feet and channels up to 9-feet deep. Its bottom is loose lime mud, with occasional outcrops of hard limestone. Mangroves and sea grasses trap this loose mud, forming countless shoals and islands, with elevations usually less than 3-feet ASL. This ecosystem is vital as a breeding-nursery ground for many marine animals. Also, in this part of Florida the mangrove swamps provide the first line of defense in coastal protection against shoreline erosion and storm floodwaters.

The upper Florida Keys, from Miami to Big Pine Key, are comprised of the Key Largo Limestone, the remains of ancient coral reefs. The coral reefs grew in periods of higher-than-present sea levels during the Pleistocene Epoch, and were exposed and killed when sea level dropped the last time. The lower Keys, including Big Pine Key to Key West, are made of Miami Limestone, the emergent remnants of a Pleistocene, oolitic limestone bar. Elevations over most of the Keys are less than 10 feet, although Key Largo and Key West have small areas that are slightly higher than 15-feet ASL. The islands gradually slope upwards from the sea to gently rounded tops. Local relief seldom exceeds 2 feet. Solution depressions are ubiquitous and usually filled with organic sediments, where vegetation preferentially takes root. Paradoxically, although the Keys have a tropical climate, they have some of the lowest annual rainfalls in Florida. This fact, combined with having practically no topsoil, and the continual saltspray in the air, means that the Keys are a very stressful environment for plants. Any plant growing in the Keys must be salt-tolerant and be able to live with little fresh water. Mangroves thrive in this type of environment, and they are the most important biological constructional agent throughout the Keys. Other important tropical trees include palms, gumbo-limbo, poisontree, West Indies mahogany, mastic, pigeon plum, Jamaica dogwood, strangler fig, and the lignumvitae. During times of sufficient rainfall some of the Keys may have shallow subsurface lenses of fresh-water that float on top of brackish or salt water, but most water supplies on the islands now come from desalinization plants.





FURTHER READING

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