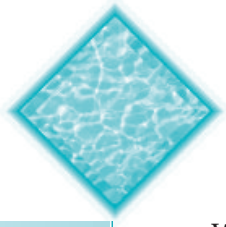
Chapter 4

Water and Life: Natural Systems



"Florida is a complex living creature, and subtlety is its most endearing quality."
— Clay Henderson, President, Florida Audubon Society

KEY IDEAS

- Water is the link connecting all of Florida's natural communities.
- Water is the major defining feature of Florida's natural communities.
- Hydrology and soils determine the kinds of plants that grow.
- Plants in turn attract and support various kinds of animals.
- Healthy uplands are critical for maintaining healthy aquatic ecosystems.
- Florida is a global hot spot of biodiversity and has many rare communities, as well as more endangered plants and animals than any other state except Hawaii and California.
- Human disruption of natural processes affects natural communities.

VOCABULARY

Coral reefs
Dry prairies
Ecosystem
Endemic
Entisols
Hardwood hammock
Histosols
Hydrogenase
Hydrology
Hydroperiod
Insectivorous plants
Limnologist
Mangroves
Marsh
Microbes
Natural community
Pine flatwoods
Pleistocene
Prescribed burns
Scrub
Seagrass beds
Slough
Steepheads
Strand
Swamp
Symbiotic
Uplands

Water and its antithesis, fire, account for much of the subtlety we see in Florida's natural communities. The Florida Natural Areas Inventory, a project of The Nature Conservancy and the Florida Department of Environmental Protection, recognizes 81 distinct natural communities in Florida. No state east of the Mississippi can rival Florida in its abundance and diversity of plants and animals. Florida also has more endangered and threatened plants and animals than any other state except California and Hawaii (U.S. Fish and Wildlife Service 2000).

The state was colonized over many thousands of years by species from continental areas to the north and tropical Caribbean areas to the south. Some species, such as the American beech and the white oak, reach the southern limits of their ranges in the Florida Panhandle. Others, such as gumbo limbo and Bahama lysiloma, reach the northern limits of their ranges in southern Florida. Semi-isolation by ocean on three sides has contributed to a high percentage (8 percent) of **endemics** in Florida (plant, fish, amphibian, reptile, bird and mammal species native to nowhere else in the world) (Governor's Office 1999).

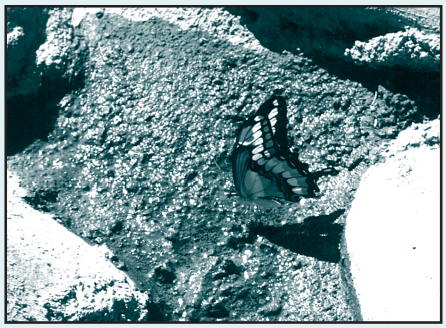
Ancient Origins

During the **Pleistocene** Epoch (from about 1.8 million to 10,000 years ago), massive ice sheets formed over the northern latitudes in at least four separate events, and sea levels around the world fell by as much as 400 feet. During the warmer interglacial periods, sea levels rose as high as 150 feet above their current level, leaving only the highest land

areas of Florida, such as the central highlands, exposed as islands. The Appalachian Mountains eroded and marine currents carried a steady supply of sand south to portions of Florida, then below sea level. A blanket of sand was deposited over the underlying limestone, infilling the irregular rock surface and forming a relatively featureless sea bottom. As sea level fell, these flat, shallow sea bottoms eventually emerged from the sea to become today's pineland ecosystems. Sand dunes and sand ridges formed along the coastlines as sea level varied. Many of these once-coastal regions are the sites of today's scrub and sandhill ecosystems.

IN DEFENSE OF MUD

A spoonful of soil contains more microorganisms than the number of people on Earth.



Species diversity in soil: 30,000 species of bacteria, 1.5 million species of fungi, 60,000 species of algae and 100,000 species of protozoa.

Over 30 years ago, Edward S. Deevey, Jr., delivered a statement to the National Water Commission entitled "In Defense of Mud." Deevey, a distinguished **limnologist** (one who studies inland waters) argued that mud, as the habitat of essential microorganisms, is as important as water to the health of this planet. Mud is not all the same, and different kinds of microorganisms require different kinds of muddy water. By conserving different kinds of mud, we conserve different, yet essential microorganisms, as well as different types of water resources. Lakes, swamps, marshes and estuaries all have different kinds of mud and associated microorganisms.

Deevey is concerned with a common yet "dangerous misapprehension: the idea that balanced living systems consist of animals plus plants. As long as the sun shines and the plants are green, it seems to follow that animals and people have nothing to worry about. The truth, of course, is that no living system is ever balanced without microbes" (1970:7).

Microorganisms that live only in mud produce **hydrogenase**, a catalyst for recycling natural materials. Hydrogenase breaks down nitrogen and sulfur in dead matter to forms that can be used by plants to grow new tissue. These microorganisms also help reduce pollution by breaking down harmful compounds and contributing oxygen to the atmosphere. Hydrogenase-producing microorganisms are found in the mud of lakes, swamps, marshes and estuaries.

Deevey concludes that the most valuable inhabitants of wetlands are sulfate-reducing bacteria. Destruction of wetlands has reduced these bacteria and their habitat by half, but the amount of airborne sulfur they need to process has more than doubled as a result of industrial pollution. "To the last generation of conservationists, the haunts of coot and heron seemed to need no reasoned defense from anybody. Henceforth, I believe, the 'new conservation' can take a more worldly stand. Its basis is that hydrogenase, like water and oxygen, is no longer a 'free good,' but a commodity more precious than we know" (1970:8).

The next time you watch a sunset over the endless expanse of saw grass in the Everglades, fish on a lake or hear an osprey call as you paddle a canoe down a river, think of the mud beneath the water. Without it, there would be no saw grass or fish or birds.

Before the Pleistocene, naturally acidic rain and ground water flowed through and dissolved the limestone rock of the Florida land form, forming a web of underground caverns and conduits. During low sea level periods in Pleistocene times, these conduits often collapsed, creating many of the sinkholes, springs and lakes that punctuate the modern Florida landscape. In the central portion of the peninsula, dissolution and collapse of the underlying limestone created lakes and large valleys, such as Lake Apopka in the Central Valley.

Ecosystems

Water is the thread connecting all ecosystems on Earth, as well as the sculptor of ancient and modern land forms. In Florida, water flows from upland ecosystems through rivers, swamps and freshwater marshes, and eventually to salt marshes, mangroves, seagrass beds and coral reefs along the coast.

An **ecosystem** is a community of **microbes**, plants and animals, including humans, interacting with one another and with the physical environment where they live. The term ***natural community*** is frequently used interchangeably with the term ecosystem, although ecosystems may encompass more than one natural community. The physical environment includes soils, water and nutrients, as well as human-made structures and alterations. In a healthy ecosystem, living and nonliving components provide a framework through which solar energy is transferred and within which nutrients such as nitrogen and phosphorus circulate. English botanist Sir Arthur Tansley coined the word *ecosystem* in 1935 from the Greek root *oikos,* meaning house. Ecosystems are place and life functioning together.

An ecosystem can be as small as a community of bacteria, insects and microscopic plants living in rainwater collected in the crook of a tree, or larger than the Kissimmee River-Lake Okeechobee-Everglades-Florida Bay ecosystem. The Earth itself is one huge ecosystem. The size of an ecosystem, and often its boundaries, are arbitrary and depend on the needs and interests of the investigator. Sometimes the observer can clearly see boundaries between ecosystems. In other instances, ecosystems blend gradually one into another. In Florida, changes in moisture, soil fertility, fire frequency and human alteration often occur over very short distances and result in clear and striking changes in the landscape: a scrub community adjoins a cypress pond, a tropical hammock stands out from surrounding pineland (Myers and Ewel 1990).

Scientists do not agree on any one way to classify ecosystems. Most ecosystem classifications are based on vegetation, the physical landscape and environmental factors. In Florida, one key defining factor is water. **Hydrology**, combined with type of soil, determines the kinds of plants that grow. Plants in turn attract and support various kinds of animals. Although animals are critical components of ecosystems, many animals use more than one ecosystem, especially during different times of their life cycles. Thus it is far easier to define ecosystems by plant than by animal life.

In Florida, ecosystems may be divided into **uplands** (pinelands, scrub, dry prairies and hardwood hammocks), swamps (river swamps, cypress swamps), marshes (freshwater marshes, salt marshes), lakes, rivers and coastal systems (seagrass beds, mangroves and coral reefs). Healthy uplands are critical for maintaining healthy aquatic ecosystems. The type and condition of uplands influence the amount and

the quality of water reaching lakes, streams and estuaries. Plants in uplands slow runoff and prevent soil from eroding. Many uplands are also groundwater recharge areas.

Much of Florida is a subtle mosaic of uplands and lowlands. Within an expanse of cypress swamp or marsh, slash pines will grow on the slightly higher and drier ground. In Florida, a few inches difference in elevation is all that separates lowlands from uplands.

Prior to European settlement, pine flatwoods, interspersed with cypress swamps, bay swamps and herbaceous wetlands, were the most extensive vegetation type, covering 35.3 percent of Florida. The second most abundant type was longleaf pine/xeric oak, which covered 20 percent of Florida.

Modern Florida is dominated by pine forests, cropland and rangeland, urban and barren lands and old fields. Pine forests still dominate in the Panhandle and northern third of the peninsula, although these are more likely to be managed timber plantations than natural pinelands (Kautz et al. 1998). Cropland and pastureland dominate in the south-central portion of the peninsula. Urban development is most common in coastal areas, along the I-4 corridor and around Jacksonville. Today in Florida, freshwater marshes and wet prairies are most abundant, dominating the Everglades of south Florida and the upper St. Johns River valley. Upland hardwood forests are also abundant, occurring largely along river bluffs, in coastal areas, and as small, scattered patches in north Florida. Mixed hardwood swamps are most common along the floodplains of Panhandle rivers, in the floodplain of the Wekiva River, and in the extensive wetlands systems of Dixie County. Cypress swamps are most abundant in the Big Cypress Swamp in south Florida, Green Swamp in central Florida and the Pinhook Swamp region of north Florida. Dry prairies are found scattered throughout the south-central portion of the peninsula.

STEEPHEADS: FLORIDA'S MOUNTAINS

Photo credit: ©The Nature Conservancy 1994

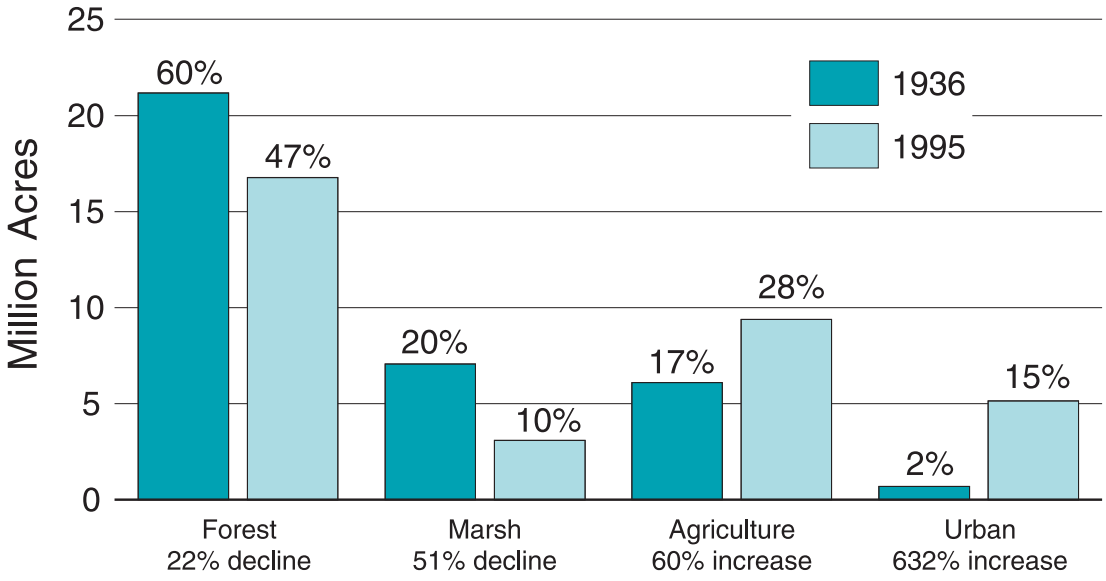
Ashe's magnolia, an endangered plant of steephead forests

Steepheads are a distinct type of slope forest found in northern Florida. A steephead forms when ground water leaks through porous sand onto a sloping surface at the head of a stream. The ground water removes sand from the bottom of the slope, causing the sand above to slump down and to be carried away by the flowing ground water. Heads of steephead streams are low in relation to their mouths: they erode from the bottom up (Means 1981). Other streams develop from gully erosion. Surface runoff from rainfall washes sediments off the ground's surface gradually, eroding land from the top down. Gully-eroded streams depend on rainfall for their flow, whereas steephead streams have a steady flow of constant-temperature spring water. Steephead forests contain many endemics, as well as rare northern plants. The endangered Okaloosa darter is found exclusively in steephead streams.

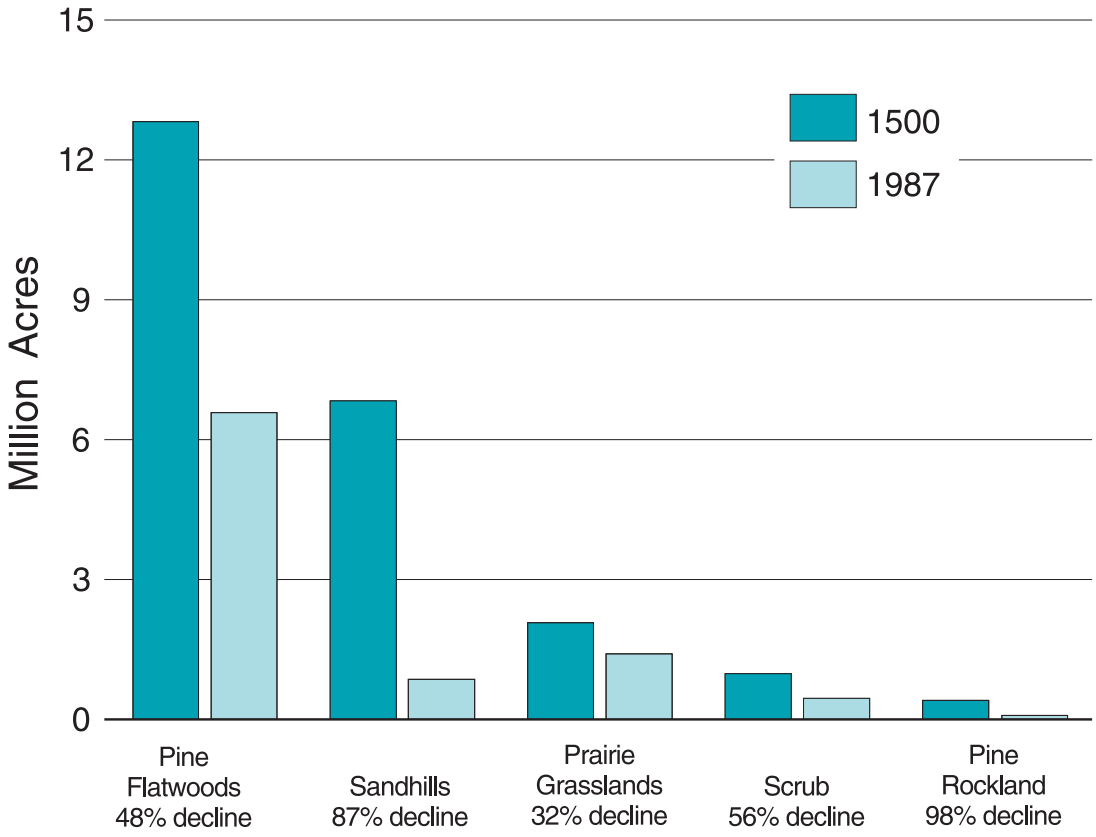
SOILS

Florida's soils are generally sandy and low in fertility. Well-drained loamy soils occur only in the western highlands, which extend approximately 30 miles south of the Alabama and Georgia borders. Deep and excessively drained sands, **Entisols**, often referred to as sandhills, occur in the western highlands of the Panhandle and on the central ridge from the vicinity of the Suwannee River in north-central Florida south to

Change in Florida Land Cover



Declines in Florida Natural Communities



Source: Kautz et al. 1998

south-central Florida. These areas are important for groundwater recharge. Poorly drained sandy soils are the most common soils in the state, occurring in pine flatwoods. Poorly drained organic soils underlain by limestone or marl (**Histosols**) occur on flat lands primarily in the Everglades and in the upper Ocklawaha River.

ECOSYSTEM PROCESSES: WATER AND FIRE

Floods, fires from lightning and droughts are common in Florida and often occur in quick succession. Plants, animals and natural communities have evolved a variety of adaptations to deal with these stresses and changes. Pond cypress, for example, survive better than bald cypress in nutrient-poor, still waters. Longleaf pine's ability to withstand fire, even in its "grass" seedling stage, is well known. Fire also produces minerals necessary for longleaf pine germination (Abrahamson and Hartnett 1990).

Hydroperiod, the duration of standing water, plays a strong role in determining the location of the various wetland communities. Forested wetlands along floodplains of major rivers are typically inundated for one to six months each year. In hammocks where limestone is near the surface, the ground is frequently damp from groundwater seepage. Freshwater marshes typically have shallow standing water (less than 12 inches deep) from 7 to 12 months each year (Kautz et al. 1998).

In southern Florida, water levels varied greatly between wet and dry seasons and from year to year. Naturalist and adventurer A. W. Dimock describes a canoe trip he took in 1908: "We began the trip in canoes, but ended in an oxcart. We paddled and wallowed through two hundred miles of flower-clad lakes and boggy, moccasin-infested trails, zigzagging from border to border of the Florida Everglades and were hauled for 5 days on pine-covered strands of sand….Last year we crossed the 'Glades from west to east, in a power boat, over the deepest water known for a decade. This year, from Cape Sable to Lake Okeechobee, we could seldom find water to float a canoe" (Tebeau 1966:15).

Naturally occurring wildfires, as well as water, have played a defining role in shaping Florida's natural communities. Florida has one of the highest frequencies of lightning strikes of any region in the United States and more thunderstorm days than anywhere in the country (Abrahamson and Hartnett 1990). As a result of thousands of years of frequent lightning-set wildfires, many natural communities in Florida have come to depend on fire. Pinelands, prairies, scrubs and marshes all require regularly occurring fire. Without fire, hardwoods will invade a site and, over time, a hardwood forest will replace the original vegetation.

Today, roads, fire lanes and the need to protect lives and property have limited naturally occurring wildfires. Many fire-maintained communities are no longer able to sustain themselves without help. Forests must now be burned under **prescribed** conditions in order to reduce fuel and to eliminate hardwoods.

Natural Communities

Pine flatwoods: The most common plant community in Florida, **pine flatwoods** have acidic sandy soil with some peat and often a clay layer one to three feet below the surface. They are usually moist during the rainy season and sometimes even flood. Fire is required to prevent their transformation to hardwood forests. Vegetation density varies from nearly closed to open and

THE KISSIMMEE PRAIRIE

Dry prairies are very rare communities. Their diversity distinguishes them from vast grasslands, also called prairies, such as the Great Plains of North America and the steppes of Asia. Dry prairies are becoming even scarcer because they are highly desirable for farming and development.

Dry prairies are nearly level, treeless expanses of saw palmetto, drought-tolerant grasses and small shrubs interspersed with oak and cabbage-palm hammocks, marshes and ponds. The term "dry prairie" is somewhat of a misnomer, as these areas may have water at or above ground surface for a month or more during the summer wet season. They are only dry when compared to other treeless communities of central Florida — wet prairies and marshes.

The Kissimmee Prairie, most of which is protected in public ownership, is a prime example of the dry prairie. The Kissimmee River State Preserve, north of Lake Okeechobee in south-central Florida, offers great opportunities for wildlife observation, particularly in the winter months during bird migration periods when visitors can usually see several distinctive and rare birds, including the crested caracara, the burrowing owl, the sandhill crane, the Florida grasshopper sparrow and the snail kite.

The Kissimmee Prairie was Florida's early cattle country. "Cow-hunters" once drove cattle across the open range of the Kissimmee Prairie to the west coast of Florida for export to Cuba. In Florida, cattlemen were not called cowboys, for the work was too rugged for mere "boys." Here, the cow-hunter used the powerful and very loud cow whip to drive cattle, hunt and communicate across the vast land. According to oral history, "Florida Cracker" referred originally to those who used these whips.

almost savanna-like (Alden et al. 1998). Thickets of saw palmetto are frequently present. Pine flatwoods are home to the endangered red-cockaded woodpecker and the threatened eastern indigo snake.

Scrub: Florida **scrub** is a series of desert-like islands in a sea of marshes, swamps and pine flatwoods (Ripple 1997). Thousands of years ago, arid scrub land stretched from the western United States through the southern United States east to the Atlantic Ocean. The climate changed, and all that now remains of scrub in the southern United States are a few patches on ancient sand dunes in Florida. Although scrub receives as much rain as nearby areas, rain passes rapidly through the thick layer of well-drained sand to the underlying aquifer. Like desert plants, scrub plants have evolved ways of efficiently gathering and retaining moisture. Plants and animals are also able to survive relatively infrequent yet intense fires. The most common scrub plants are sand pine, rosemary and several species of dwarfed, gnarled evergreen scrub oak.

Dry prairies: Open grasslands with scattered saw palmettos and oak/cabbage-palm hammocks once stretched north and west of Lake Okeechobee and along the Kissimmee River. Most of Florida's **dry prairies** have been converted to ranch land. Remaining dry prairies are important habitat for the threatened crested caracara and the burrowing owl. Dry prairies occasionally flood for short

periods during the rainy season. Fires every one to four years maintain their grassy landscapes dominated by wiregrass and broomsedge.

Hardwood hammocks: Florida has no vast forests of hardwoods. Instead, it has small (usually less than 20 hectares, or 49 acres) islands of hardwoods found on ground that's slightly higher than the surrounding landscape. **Hardwood hammocks** have rich organic soil, acidic sandy loam with dissolved limestone or clay over limestone. Hammocks rarely flood or burn. Vegetation is thick and more than 150 species of trees and plants, including beautiful and rare orchids and bromeliads, are found here. In south Florida, hardwood hammocks provide critical habitat for the endangered Florida panther.

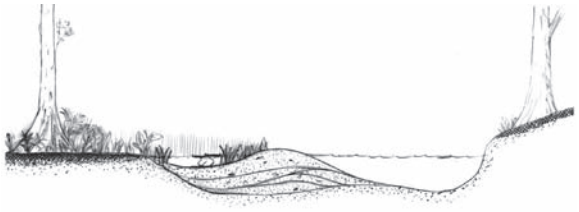
Swamps: Florida has a remarkable diversity of **swamps**. Hardwood swamps occur along rivers in north Florida and in **strands** along sloughs in south Florida. **Sloughs** are broad shallow channels of flowing water corresponding to linear depressions in underlying limestone. The most common type of swamp in Florida is the cypress swamp, which occurs in all parts of Florida except the Keys. Cypress belong to the same family as redwoods and sequoias. Two types are recognized: the bald cypress and the pond cypress. Bald cypress is most easily distinguished at maturity from pond cypress by its feather-like leaves (Nelson 1994). Because cypress seeds cannot germinate underwater, they require land that is dry for part of the year. They are typically wet 200–300 days out of the year. Cypress swamps are favored nesting spots for the endangered wood stork.

Marshes: Florida has expansive freshwater **marshes**, salt marshes and even bogs. The largest freshwater marsh in the state is the Everglades, where saw grass stretches as far as the eye can see, interrupted only by an occasional tropical hardwood hammock or cypress head. Saw grass is a sedge, not a true grass, and its sharp teeth can tear clothes and cut skin. Soils in freshwater marshes are wet about 250 days each year. Natural ground fires are ignited by lightning in the dry season and prevent bushes and trees from growing. Freshwater marshes support flocks of wading birds, as well as alligators and fish.

Vast salt marshes can still be seen along much of Florida's coast, even in areas where coastal development has been intense. Salt marshes have characteristics of both terrestrial and marine ecosystems and support many visiting, as well as resident, animals. Vegetation must tolerate at least periodic inundation by salt water keyed to tides and is commonly dominated by smooth cordgrass and black needlerush. Several hundred species of benthic microalgae and phytoplankton are found in salt marshes. Salt marshes are nursery grounds for many fish and shellfish of commercial and recreational importance and are the exclusive home of three birds — clapper rails, long-billed marsh wrens and seaside sparrows (Montague and Weigert 1990).

The coastal lowlands of Mississippi, Alabama and Florida were once a nearly continuous bog and habitat for one of North America's most unusual assemblages of plants and animals, including **insectivorous plants**. The leaves of one of these — the pitcher plant — are so distinctive that these wetlands are often called pitcher plant bogs (see picture, page 33). Over 90 percent of the bogs have been lost to development. Bogs develop on acidic water-saturated, nutrient-poor, sandy soil that rarely floods. The soil lies on top of an impermeable layer of rock or clay that prevents water from draining. Pine Barrens tree frogs, ribbon snakes and cottonmouths are common in bogs. Endemic plants include violet flowered butterwort, tropical waxweed, Harper's beauty and white birds-in-a-nest.

Lakes: Most of Florida's 7,800 lakes were formed by dissolution of underlying limestone, collapse of the overlying land surface and flow of ground water into the resulting cavity. Most Florida lakes are small, shallow and in the peninsula's central sandy ridge. These sandhill lakes are naturally very clear, are nutrient-poor and usually have closed basins (that is, no streams flow either in or out). These lakes are typically surrounded by emergent vegetation and frequently support submersed grasses, such as maidencane. Many Florida lakes are polluted by the discharge of nutrients, other pollutants and siltation from human development. Increase in lake nutrients has contributed to the explosion of invasive exotic plants such as water hyacinth and hydrilla. Twenty-one established exotic fish species also compete with native fish (Kautz et al. 1998).



Rivers: Florida has three main types of rivers: alluvial rivers, spring-fed rivers and blackwater rivers. Floodplains along alluvial rivers contain a wide variety of hardwoods, shrubs and woody plants. The rivers themselves contain 100 to 152 species of fish. The Apalachicola River system encompasses more rare and endangered species of plants and animals than any other river system in Florida. In spring-fed rivers, submerged vegetation is abundant because of water clarity. Spring-fed rivers also support abundant populations of mussels and snails, which in turn support mussel- and snail-eating turtles and fish. One small spring along the Ichetucknee River is the only place in the world where the sand grain snail is found. The federally endangered Gulf sturgeon travels from a coastal estuary up the spring-fed Suwannee River to spawn. Blackwater rivers drain pinelands and swamps. Submerged vegetation is limited because the water is dark and acidic from the tannin and humic acids produced in the pinelands and swamps. Blackwater rivers have lower fish and invertebrate species diversity than spring-fed or alluvial rivers, due in part to the high acidity of the water. The three-lined salamander, the southern dusky salamander and the mud salamander are commonly found in blackwater rivers.

Dunes and Maritime Forests: Grasses such as sea oats grow on dunes closest to the water's edge, and a

variety of forest vegetation (maritime forests) grows on the more stable dunes inland from the coastline. Going south from Cape Canaveral on the east coast and from Tampa on the west coast, vegetation gradually changes from a dominance of temperate species to a dominance of tropical species. At least 22 species of endemic plants are found on dunes and in maritime forests in Florida. Atlantic and gulf beaches themselves are the most important nesting site for loggerhead turtles in the Western Hemisphere, as well as for several species of shore birds, including the endangered snowy plover. Exotic plants such as Australian pine and Brazilian pepper are a serious problem along many of Florida's beaches.

Mangroves: **Mangroves** are limited by temperature to the tropics and subtropics and are established along low wave-energy coastlines in those parts of the state. Mangrove forests grow in zones of red, black and white mangroves with buttonwoods (not a true mangrove) on the upland fringe. Water fluctuations are important to mangrove forest development. Fluctuating water levels, waterlogged sediments and salt water exclude most other plants. Mangroves have specially adapted roots that allow them to grow and propagate in water. Mangroves and buttonwoods also have a variety of means of dealing with fluctuations in salinity. Red mangroves, for example, filter fresh water from seawater at the root surface, whereas black and white mangroves and buttonwoods excrete excess salt via salt glands at the leaf surface (Odum and McIvor 1990). Mangrove forests are valuable habitat for a wide range of invertebrates, fish, amphibians, reptiles, birds and mammals, including the endangered American crocodile, the endangered hawksbill sea turtle, the endangered Atlantic ridley sea turtle, the endangered Florida manatee and the threatened Atlantic salt marsh snake. Mangroves are important nursery areas for sport and commercial fish and shellfish, including spiny lobster, pink shrimp, mullet, tarpon, snook and mangrove snapper. Mangroves are easily destroyed by oil spills and herbicides.

Seagrass beds: Seven species of seagrass are found in Florida's coastal waters. The most common are turtle, shoal and manatee grasses. **Seagrass beds** are excellent habitat for many fishes, crustaceans and shellfish, and are critical nursery areas for young marine animals. Bay scallops, blue crabs and spotted sea trout are examples of species that depend on seagrass beds. Seagrasses are also a major part of the diets of manatees and sea turtles and are substrate for epiphytic (attached) algae, a critical component of the marine food web.

Coral Reefs: **Coral reefs** are among Florida's most spectacular and beautiful natural communities. Found in the shallow

waters off southeast Florida and the Florida Keys, coral reefs require transparent, warm and relatively nutrient-poor waters. Only the surface layers of coral reefs are alive. The reef's limestone base is composed of skeletal deposits of dead corals and algae. Microscopic algae live **symbiotically** in the outer parts of the coral polyp. Over 100 species and subspecies of coral and algae are found in Florida's coral reefs, as well as numerous other species of recreational and commercial value, including spiny lobster, grouper, snapper, parrot fish and butterfly fish. Many reef species live in narrow niches and have specialized food requirements and complex life cycles.

Conclusion

People have been part of the ecosystems of Florida for more than 10,000 years. For most of this time, human population was relatively low and human use of natural resources did not cause any significant decrease in the ability of the environment to maintain clean air and water, as well as productive, biologically diverse ecosystems. In the past 200 years, however, human uses have had enormous impacts. Deforestation in the north, wetland drainage in the south, agriculture in the center and urbanization along the coasts and the I-4 corridor have caused massive losses of natural ecosystem diversity and productivity. In Florida, the major challenge of the next century will be to create an environmentally, as well as economically, sustainable way of living (Kautz et al. 1998).