Florida's Water Resources

"Florida is blessed with water. Water makes the difference between desert and flourishing green plants, as much of the land around the earth at the same latitude is desert."

— Peggy Lantz, The Florida Water Story

KEY IDEAS

- Most of Florida's water is ground water.
- No rocks. No water.
- Ground water is replenished by rainfall.
- Surface water in the form of rivers, lakes, bays and wetlands is abundant.
- Much of Florida has a karst terrain with sinkholes, underground caverns and an active interchange between surface water and ground water.
- Pollution on the land's surface may end up in drinking water.
- Wetlands perform many valuable functions and are protected by law from development.
- Estuaries are nursery areas for many sport and commercial fish and shellfish.

VOCABULARY

Alluvial river
Aquaculture
Aquifer
Blackwater river
Brackish
Discharge
Drainage basin
Estuary
Fill
First-magnitude springs
Karst
Recharge
Runoff
Sheetflow
Sinkhole
Spring
Spring-fed river
Streamflow
Tributary
Watershed
Wetland

Florida is, indeed, blessed with water. Yet you cannot see most of Florida's fresh water: it seeps beneath the ground through sand and gravel and flows through cracks and channels in underlying limestone. The amount of ground water under Florida's forests, pastures, cities, marshes, roads, schools and suburbs is mind-boggling: more than a quadrillion gallons. This is equivalent to about one-fifth of the water in all five of the Great Lakes, 100 times as much water as in Lake Meade on the Colorado River, and 30,000 times the daily flow to the sea of Florida's 13 major rivers (Conover 1973). In fact, Florida has more available ground water in aquifers than any other state.

Florida also has abundant surface water in springs, rivers, lakes, bays and wetlands. Of the 84 **first-magnitude springs** (those that discharge water at a rate of 100 cubic feet per second or more) in the United States, 33 are in Florida — more than in any other state. Within Florida's boundaries are approximately 16,000 kilometers (10,000 miles) of rivers and streams and 7,800 lakes (Kautz et al. 1998). Although more than half of Florida's original wetlands have been drained or developed (Noss and Peters 1995), the state still has vast and diverse wetlands. The Florida Everglades and Big Cypress Swamp cover much of southern Florida, and some Florida wetland communities, such as mangrove swamps and hydric (wet) hammocks, rarely occur in other states.

In Florida, ground water and surface water are connected, often in complicated and changing ways that are invisible at the land's surface. Lakes may disappear into sinkholes, springs may bubble up through new breaks in underlying rocks, and water may flow one way at the land's surface and quite a different way underground. This is because much of Florida has what geologists term a **karst** landscape.

Karst landscapes are underlain by limestone (mostly calcium carbonate), a soluble rock composed of shell fragments, limey mud and sand. Limestone is easily dissolved by water charged with carbon dioxide (CO_2). As rain falls, it mixes with CO_2 in the air. As it soaks through the ground's surface, the water gathers more CO_2 from decaying plants. Water charged with CO_2 forms a weak acid (carbonic acid) that reacts with limestone to dissolve it.

In many parts of the world, land slopes gradually to the sea. "One can always walk downhill, arriving eventually at a stream that can be followed to a river, which can be followed to the ocean. A characteristic feature of karst landscapes is that the land usually slopes down into closed depressions from which the only exit is underground" (White 1988:19–20).

The name *karst* derives from the Slovenian *kars,* meaning rock, and was first used by the Germans to describe a high plateau in Slovenia with numerous caves and disappearing streams. Karst is now used to describe similar areas around the world. Well-developed karst features may also be found in south-central Kentucky, the Yucatan peninsula, parts of Cuba and Puerto Rico, southern China and western Malaysia, as well as in Florida. Rivers and streams are few and even absent in most karst areas of the world. Because Florida has high water tables and flat terrain, karst areas in Florida have more rivers and streams than karst areas elsewhere.

Photo credit: Joann Mossa

Limestone banks, Suwannee River

Watersheds

Today, rather than looking at land and water resources as separate, unrelated parts, water managers consider the connections within a watershed or **drainage basin**. Every part of the Earth's land surface is within a watershed. Divides (ridges, peaks or areas of high ground) separate watersheds. Because water flows downhill, rain falling on these divides may flow in opposite directions, becoming part of different watersheds. For example, from the Great Divide in North America the continent's river systems flow in opposite directions.

A **watershed** is the land area that contributes runoff, or surface water flow, to a water body. The water resources within a watershed are affected primarily by what happens on the land within that watershed. Anything on the land within the watershed, however far from the water body, can eventually reach and impact that water resource. Some examples of contaminants that may be picked up by water in the watershed are soil particles (suspended materials) and chemicals (dissolved materials), such as nutrients, pesticides, oils and gasoline residues.

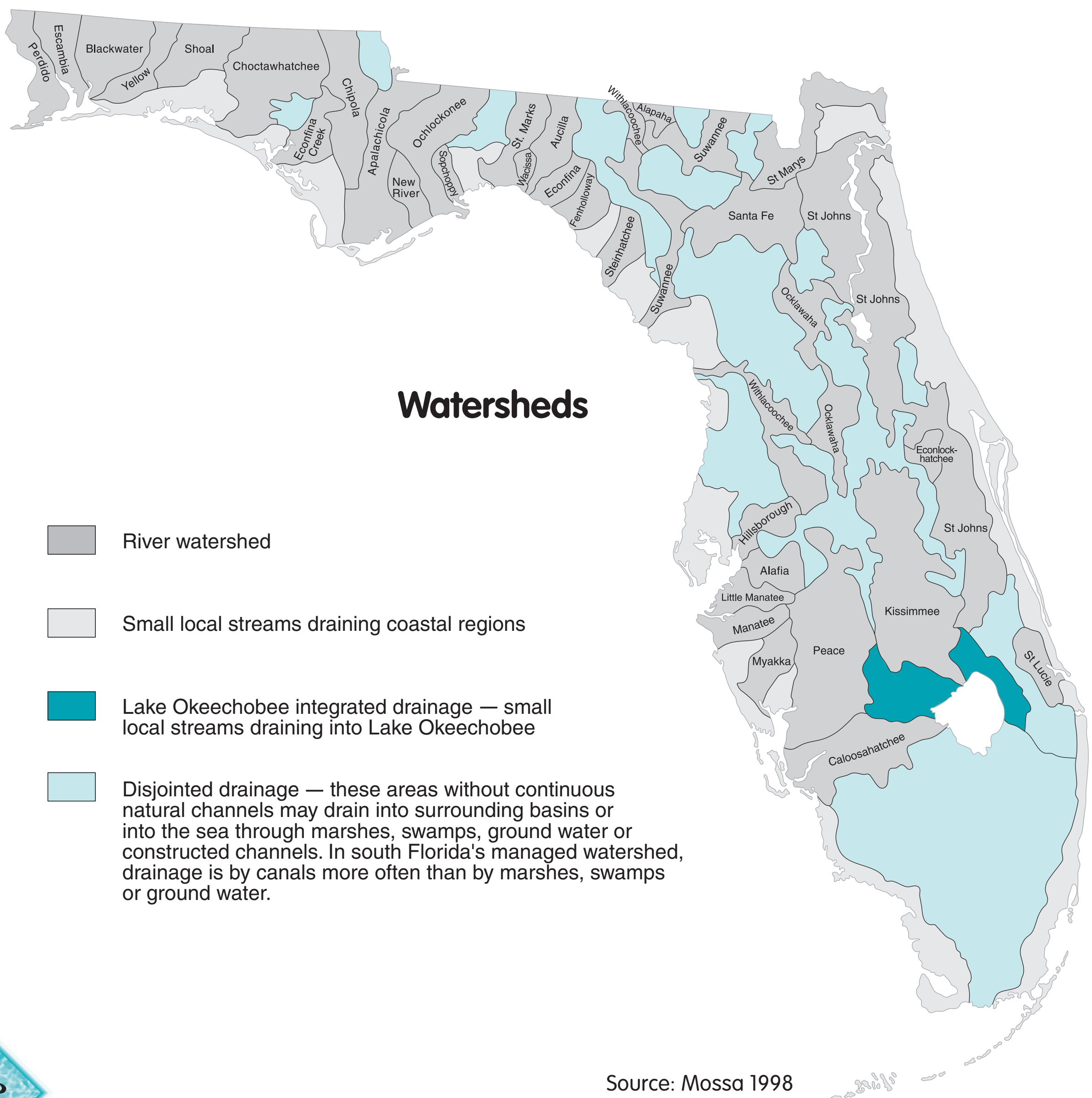
The shape of the land defines a watershed. Water flows both above and below the ground from points of higher elevation to points of lower elevation through the force of gravity. Rainfall that is not absorbed by the soil but flows to a larger body of water is known as **runoff**; runoff collects in channels such as streams, rivers and canals. The small channels, in turn, flow to larger channels and eventually flow to the sea. These channels or streams are also known as **tributaries**. The slope of the land, as well as

Surface Water Drainage

Source: Mossa 1998

the amount and type of vegetation and soil and the type of land use, determine the rate and amount of runoff that enters a water body. More water soaks through sandy soils than through clay soils; gentle slopes allow more time for rain to soak into the ground or to evaporate than do steep slopes; and natural areas generally allow more water to enter the ground than areas that are covered with houses or pavement. Vegetation also absorbs water and slows its movement.

Florida's karst terrain and flat topography sometimes make determining watershed boundaries difficult. In some places the drainage pattern is best described as "disjointed" because streams and rivers do not form continuous channels on the land surface (Mossa 1998) — they may disappear underground in sinks or depressions. Large rivers may form from springs issuing from the aquifer, and surface water watersheds may be quite different from groundwater watersheds. Some portions of Florida are poorly drained (Mossa 1998). There are few or no streams or channels in these areas, and water flows across the surface through extensive swamps or marshes. This is known as **sheetflow**.



Source: Mossa 1998

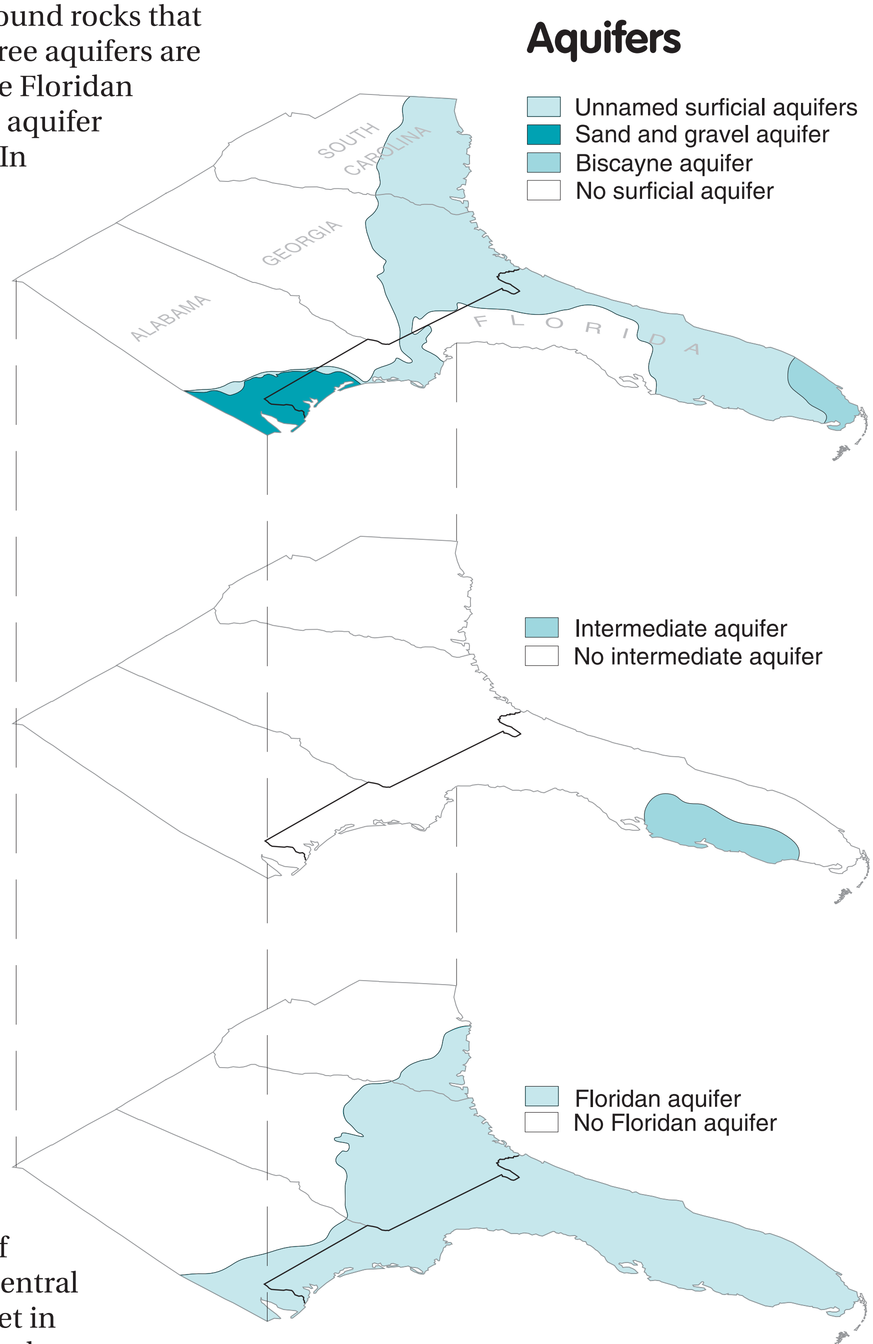
In much of south Florida, the natural landscape has been altered with huge public works projects, making the region a managed watershed. Canals, pumping stations and water-control structures, such as dikes and weirs, have altered the watershed. The historic swamps, marshes and associated sheetflow are greatly altered or are replaced by urban development and agriculture and drained by canals. Public and private entities are responsible for water movement, especially the discharge of floodwater.

Ground Water

AQUIFERS

Aquifers are underground rocks that hold water. In Florida, three aquifers are used for water supply: the Floridan aquifer, the intermediate aquifer and the surficial aquifer. In northwest Florida, the surficial aquifer is called the sand and gravel aquifer, and in southeast Florida it is called the Biscayne aquifer.

The Floridan aquifer has been called Florida's rain barrel (Parker 1951) and is one of the most productive aquifers in the world. Each day Floridians use about 2.5 billion gallons of water from the Floridan aquifer. It underlies 250,000 square kilometers (100,000 square miles) in southern Alabama, southeastern Georgia, southern South Carolina and all of Florida. Over most of Florida, the Floridan aquifer is covered by sand, clay or limestone that ranges in thickness from a few feet in parts of west-central and north-central Florida to hundreds of feet in southeastern Georgia, northeastern Florida, southeastern Florida and the

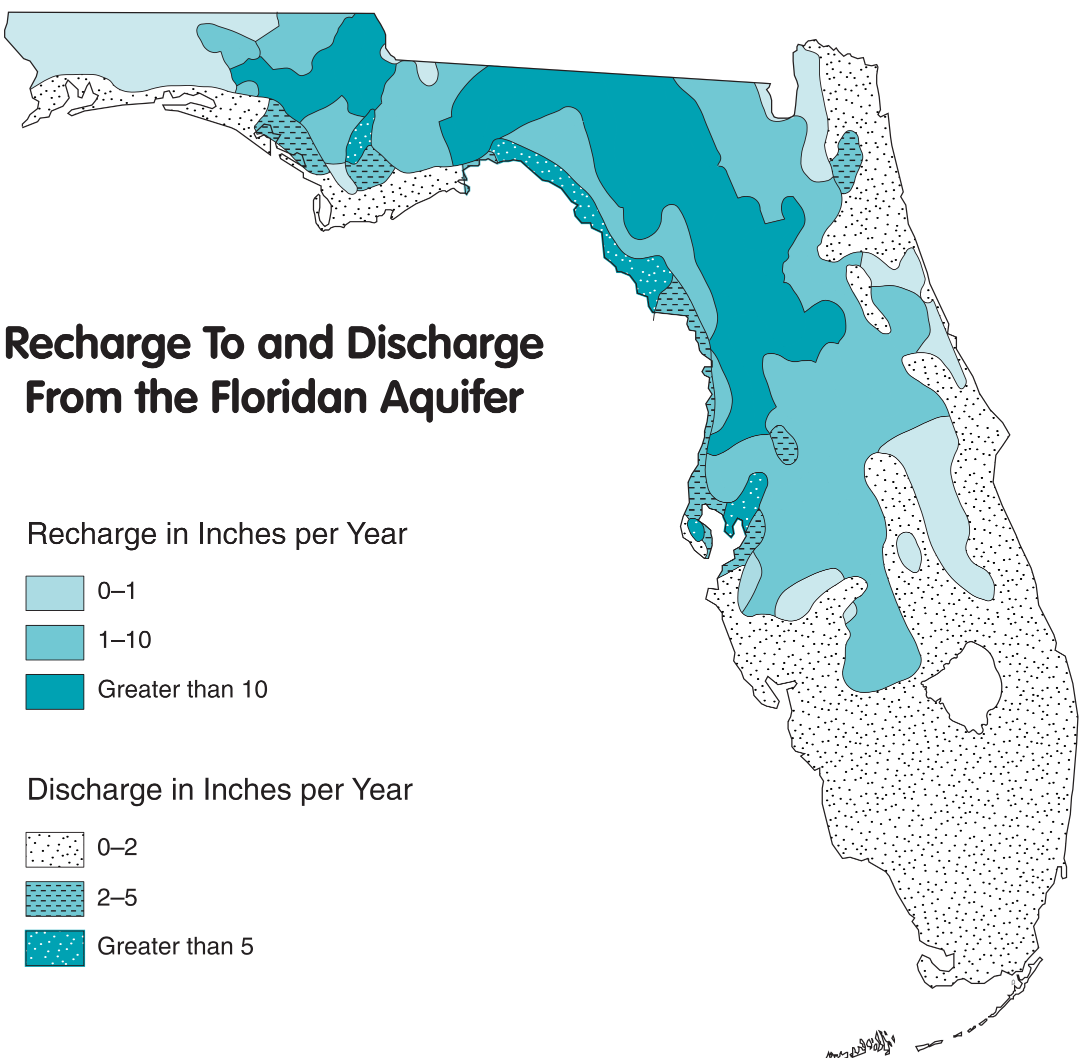


Source: Berndt 1998

westernmost Panhandle. Within the aquifer, water may travel quickly or very slowly. In parts of the aquifer with caves and large conduits, water may travel several miles in only a few hours. Where water-filled spaces are small and underground routes convoluted, it may take days, weeks or even years for water to travel the same distance.

In the past several decades, increased pumping of ground water has lowered water levels in the Floridan aquifer in several places in Florida and Georgia, including the Panhandle, northeastern and southwestern Florida, and southeastern and coastal Georgia (Berndt et al. 1998).

Water is replaced in the Floridan aquifer by rainfall that soaks into the ground. This is referred to as **recharge**. Recharge does not occur everywhere. In some places (mostly along the coasts and south of Lake Okeechobee) water flows out of, rather than into, the aquifer. This is referred to as **discharge**. In other areas, thick clay covers the aquifer and slows or stops the downward flow of water. Areas of high recharge only occur in about 15 percent of the state and include the well-drained sand ridges of central and west-central Florida. Sand is porous, which means water can easily flow through it. Limiting intensive development in high



Recharge To and Discharge From the Floridan Aquifer

Source: Berndt 1998

recharge areas is critical for maintaining water supplies: water cannot soak through pavement.

In some parts of Florida, the Floridan aquifer is not a suitable or drinkable source of fresh water. In some places, it is too far below the surface; in other places, the water is salty. The surficial sand and gravel aquifer is the major source of fresh water in Escambia and Okaloosa counties in northwest Florida, and the surficial Biscayne aquifer is the major source of fresh water in Dade and Broward counties in southeast Florida. Between the surficial aquifers and the Floridan aquifer in some parts of the state is the intermediate aquifer. This aquifer is an important source of fresh water in Sarasota, Charlotte and Glades counties. The remainder of the state uses the Floridan aquifer as its main source of drinking water.

SINKHOLES

Sinkholes are dramatic testimony to the fragile nature of the limestone underlying the state. A **sinkhole** is a depression in the land surface caused when rainwater dissolves limestone near the ground surface or when the roofs of underground channels and caverns collapse. Under natural conditions, solution sinkholes form slowly and expand by the gradual erosion of subsurface limestone caused by rainwater. Dredging, constructing reservoirs, diverting surface water and pumping large amounts of ground water may result in the abrupt formation of collapse-type sinkholes (Berndt et al. 1998). Loss of water from underground cavities, compounded by drought, may cause the overlying rock and earth to collapse. Weight on the top of the caverns caused by heavy rains or construction may also result in collapse.

SINKHOLE PHENOMENON

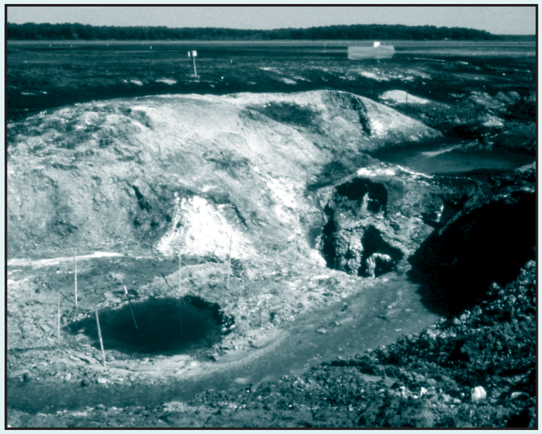
In early March 1998, as a drilling company was drilling an irrigation well for a future golf course in western Pasco County, a massive sinkhole opened up and threatened to swallow the entire drilling rig. Although the driver got the rig out in time, a crane had to retrieve a truck from the 150-foot-wide, 15-foot-deep sinkhole. Shortly after this event, nearly 700 sinkholes, most only a few feet wide, appeared in the surrounding area.

While sinkholes are common in the area, “this event was unique,” according to Mark Stewart, chairman of the Geology Department at the University of South Florida. “I know of no other recent event in Florida that opened so many sinkholes in one small area.”

According to Tony Gilboy, hydrogeologist for the Southwest Florida Water Management District, the phenomenon began when the contractor drilled a hole into the Floridan aquifer for an irrigation well. As he cleaned out the hole using compressed air, a common development practice, a large underground cavity collapsed, resulting in the large sinkhole near the drill rig. The force of several tons of dirt falling into the cavity caused a massive pressure wave through the aquifer, producing the nearly 700 smaller sinkholes on the surrounding property. Heavy rains, which the area had been experiencing, may also have contributed by putting pressure on the underground cavities, causing them to collapse.

DISAPPEARING WATERS

The Indians called Lake Jackson in Leon County *Okeeheepkee*, meaning "disappearing waters." Between September 13 and 16, 1999, that is precisely what the lake did as approximately 30 million gallons of water drained out of the southern portion of the lake through Porter Hole Sink into the vast underlying Floridan aquifer, like bathwater out of a tub. In a few short days about half of the popular 4,000-acre lake had gone dry. Water depth in the lake had been steadily dropping during the long dry summer from a norm of 8 feet to only 2–3 feet. Water levels in the aquifer also dropped. At this point, either a plug blocking the sinkhole washed out, taking the lake with it, or once the lake level dropped below a certain level, the remainder drained into the partially opened sinkhole. With the water gone, all that was visible at the land surface was a canyon cut by the water and a hole 26 feet deep and 8 feet wide in the Torreya Formation underlying the lake. As the local confining unit for the Floridan aquifer, the Torreya Formation is a combination of clays, sands and some carbonates with relatively low permeability. Exploring the hole, Florida Geological Survey geologist Dr. Tom Scott found a passage to the northwest about 20 feet into the Floridan aquifer. Several months later two passages were visible, the one to the northwest that had expanded to 30 feet and one to the east running about 30 feet. In the spring of 2000, the remainder of the lake, the northern portion, drained through Lime Sink.



Lake Jackson Photo credit: Tom Scott

Although some homeowners may not be happy with the loss of their lakefront property, and fishermen will have to go elsewhere, natural drainage can be healthy for a lake. Pollutants and sediments from runoff and nutrients from fertilizer and dead vegetation build up in the water and on the lake bottom. When the lake is dry, the sediment is hardened and compacted by air and sunlight. Exposure to the air also oxidizes some of the nutrients. The Northwest Florida Water Management District, Leon County, the Florida Department of Environmental Protection and the Florida Fish and Wildlife Conservation Commission opted to help nature along by removing some of the nutrient-rich sediments from the dry lake bed. When the lake refills, its water quality and its ecology will be improved.

Lake Jackson is a closed basin — no water enters or leaves the lake through streams or rivers. Nor does ground water enter the lake through major springs. The lake is totally dependent on rainfall. A return to normal rainfall amounts should cause the lake to refill by replenishing the aquifer and possibly plugging the sinkhole with the sediments that run off the dry lake bottom.

Lake Jackson has gone dry several other times during the twentieth century — in 1907, 1909, 1932, 1935, 1936, 1957 and 1982. According to geologist Scott, when the Spanish arrived in the 1500s they chronicled a prairie, not a lake. In 1716, Spaniard Diego de Peña also found a vast prairie where he reported seeing over 300 buffalo and a few cows. In 1959, another sinkhole in the lake bottom, Lime Sink, was plugged with cement and various objects as people tried to help nature along. After draining, the lake can stay dry for years, but in 1982 the lake refilled in only three months.

SPRINGS

Springs are a "window" into the aquifer from which they flow. Cool in the summer and warm in the winter, they are among the most sought-after of all the state's natural and scenic resources. Most of Florida's springs are found in the northern half of the state and flow from the Floridan aquifer. As rainwater enters and recharges the aquifer, pressure is exerted on the water already in the aquifer. This pressure causes the water to move through cracks and tunnels in the aquifer. Sometimes this water flows out naturally to the land surface at places called **springs**. When the openings are large, spring flow may become the source of rivers. The Ichetucknee is an example of a river created by a spring. Springs also make substantial contributions to the flow of other rivers. Manatee, Fanning, Troy and Blue springs contribute nearly 368 million gallons each day to the Suwannee River.

For thousands of years, Native Americans settled near springs and fished in spring-fed streams. Spanish explorer Ponce de Leon came to Florida seeking a Fountain of Youth, as well as gold and other treasures. Travelling in Florida in 1774, botanist William Bartram described water issuing from one of the springs along the St. Johns River as "perfectly diaphanous," with fish appearing "as plain as lying on a table before your eyes, although many feet deep in water" (Van Doren 1955:135). Today, springs are popular with both tourists and residents. Many of Florida's largest springs have been incorporated into state parks, including Manatee, Homosassa, Silver, Wakulla and Ichetucknee. Wakulla and Silver springs have been popular locations for movies. Majorie Kinnan Rawlings' *The Yearling,* as well as more than 100 episodes of the popular TV series *Sea Hunt,* were filmed at Silver Springs. The *Creature from the Black Lagoon* and some of the Tarzan movies were shot at Wakulla Springs.

Rain falling onto nearby recharge areas and entering the aquifer is the source of most of Florida's ground water, including water that flows from springs. Contrary to popular belief, underground rivers do not carry water into Florida from other states (Spechler and Schiffer 1995). Caverns in the aquifer are sometimes large and interconnected and may transmit water underground for several miles, but there are no underground rivers. The 320 known springs in the state discharge nearly 8 billion gallons of water each day, more than all the fresh water used in the state each day (Spechler and Schiffer 1995).

Large withdrawals of water from wells near a spring can cause the flow of the spring to stop. Silt or sediments building up in the spring can also cause loss of flow. The only large spring in Florida known to have ceased flowing is Kissengen Spring, about 4 miles southeast of Bartow (Berndt et al. 1998). The spring stopped flowing in 1950 (Rosenau et al. 1976).

Surface Water

RIVERS

Florida's largest rivers are in the northern part of the state. Portions of the watersheds of many of these rivers are in Georgia and Alabama. Even the largest rivers in Florida — the Apalachicola, the Suwannee and the St. Johns — have only a fraction of the flow of the continent's and the world's largest rivers.

In the Panhandle, rivers flow south to the gulf; along the west coast, rivers flow west to the gulf. In the central portion of the peninsula, streamflow is south. In the lower southeastern portions of the peninsula, rivers flow east to the Atlantic. In the northeastern and east-central portions of the peninsula, the St. Johns River flows north to the Atlantic and other rivers flow east to the Atlantic. The only major river that does not flow to the gulf or to the Atlantic is the Kissimmee River, which flows south and discharges to Lake Okeechobee (Nordlie 1990).

WHAT IS STREAMFLOW?

Streamflow, also known as discharge, is the volume of water passing a point in a certain amount of time. The slope of the watershed surrounding the stream or river, the permeability and water storage capacity of the surrounding soils, and the rainfall pattern all affect streamflow. Current or velocity measures the distance traveled by the water during a certain length of time. Velocity depends on the depth of the stream or river, the slope and friction due to the texture of the bottom and the shape of the river or stream channel. Velocity is highest just under the water's surface because the friction between water and air is slight. Faster currents are found at the outside of a bend. The stream's force erodes the outer edges. Slower water is found on the inside of a turn and is often where soils will be deposited, forming sandbars.

Bottom type is closely related to the velocity of streamflow. Fast water has more energy and scours or carries away all but the largest particles of soil, sand or rock. So the bottoms of fast-flowing rivers and streams are rock, rubble and gravel. These are generally found in the upper stretches of a river system. Slower water allows fine particles (sand, silt and clay) to be deposited, resulting in sandy or mucky bottoms.

In the United States, river discharge is most commonly measured in cubic feet per second. In her book *Fresh Water*, British Columbian naturalist E. C. Pielou outlines a method for measuring flow in a small stream. (Be sure to select a stream that is safe to wade.)

Materials: rope marked at equal intervals, measuring stick, stop watch, oranges

1. Select a straight area in a stream and stretch a rope across it. The rope should have marks at equal intervals. Four or five intervals should be sufficient. Secure the rope across the stream. One way to do so is to tie it around trees.

2. Wade in and measure the depth of the water below each of the interval marks. Calculate the area of the cross section by averaging the depth and multiplying by the width of the stream. OR, measure depth in three places across the stream in a straight line, then divide the total by four to get the average depth of the stream. The reason you take three depth measurements and divide by four is to take into account the shallow areas of the stream.

3. Select a length of stream to measure the velocity and mark each end with an object such as a rock. A distance two or three times the width of the stream is usually enough.

4. Measure the velocity by putting a float in the stream and using a stopwatch to measure the amount of time it takes for the float to travel from the upstream marker to the downstream marker. An orange or an orange peel may be used as a float. Repeat until you have recorded velocities below each marked interval on the rope. Average the velocities and multiply by 0.85 (this number corrects for the fact that velocity has only been measured at the surface).

5. Calculate streamflow by multiplying the corrected average velocity by the area of the cross section.

Professional hydrologists use special instruments called current meters to measure streamflow.

Florida's rivers may be classified as predominantly alluvial, blackwater or spring-fed. **Alluvial rivers**, such as the great Mississippi, have large, well-defined drainage basins, carry high sediment loads and have large forested floodplains. These rivers typically flood each year (usually in the winter in Florida), depositing a rich load of sediment. All of Florida's alluvial rivers are in the Panhandle. The Apalachicola, Choctawhatchee, Escambia and Ochlockonee are examples.

Blackwater rivers have dark, stained waters from decomposing plant materials. Typically they drain pine flatwoods and cypress swamps. Many of Florida's rivers are blackwater types, including New River in northwest Florida, which drains Tates Hell Swamp, and the Withlacoochee, Hillsborough and Peace rivers in central Florida, which begin in the Green Swamp (Clewell 1991).

Spring-fed rivers are most common in the karst regions of north-central Florida where limestone is close to the ground surface. Spring water is cool year-round, and clear. The Wakulla, Silver, Weekiwachee, Rainbow and Crystal rivers are spring runs issuing from five of Florida's 33 first-magnitude springs. The Chipola, St. Marks, Aucilla, Santa Fe, Ocklawaha and Homosassa are also spring-fed rivers (Clewell 1991).

Many Florida rivers are a mixture of these types. For example, the Suwannee begins as a blackwater river draining the Okefenokee Swamp. As it travels south, it becomes a spring-fed river, as many springs contribute to its flow. As it approaches the gulf, it has a low-forested floodplain characteristic of alluvial rivers (Kautz et al. 1998).

LAKES

Florida has thousands of lakes, large and small. By far the largest (1,890 square kilometers or 730 square miles) is Lake Okeechobee, which extends into Glades, Hendry, Martin, Okeechobee and Palm Beach counties. Lake Okeechobee, the second largest lake wholly within the United States, has an average depth of 2.6 meters (8.6 feet) (VanArman et al. 1998). Most of Florida's other lakes are also shallow (between 2 and 9 meters, or 6.5 and 29.5 feet, deep), although a few sinkhole lakes are hundreds of feet deep (Heath and Conover 1981). Over one-third of the lakes in Florida are found in four central Florida counties (Osceola, Orange, Lake and Polk).

Most of Florida's lakes were formed in the same manner as sinkholes. Ground water dissolved limestone, forming underground cavities; the roof of these cavities collapsed, forming a depression, which then filled with ground water and rainwater. Other lakes were once depressions in the sea bottom, and still others were carved out by rivers.

According to Thomas Scott, many theories exist for the origin of Lake Okeechobee, including meteorite impact, compaction of underlying rock deposits and faulting along the northern part of an ancient lagoon (pers. com). Dr. Scott, a geologist with the Florida Geological Survey, thinks the lake developed from a large lagoon that existed at the northern end of the Everglades.

In addition to natural lakes, Florida abounds in constructed lakes and ponds created by digging into the shallow water table for **fill** (sand and rock), for irrigation, mining or **aquaculture** (commercially growing fish or other water species). Lakes and ponds are also designed and created to manage stormwater runoff from developed areas or to serve as reservoirs.

WETLANDS

Wetlands is a general term for portions of land periodically covered by fresh water or salt water. Over the past 400 years numerous words have been used to describe these areas including *swamp*, *tidal swamp*, *coastal swamp*, *marsh*, *tidal marsh*, *salt marsh*, *salt meadow*, *bog*, *fen*, *morass*, *overflowed land* and *quagmire* (Moss 1980). Terminology has changed as people's perceptions of the value of these lands have changed. The term *wetlands* began to appear in the 1950s, along with a concern for the preservation of these lands as wildlife habitat (Moss 1980). In 1953, the U.S. Fish and Wildlife Service defined wetlands as "lowlands covered with shallow and sometimes temporary or intermittent waters….and holding water long enough to grow moist-soil plants" (quoted in Moss 1980:200). The wetlands definition found in Florida law today (Chapter 373.019, *FS*) is based on vegetation and soil, as well as on the hydrologic conditions. Topography is no longer considered part of the definition. Some wetlands actually have higher elevation than surrounding land.

Wetlands are often classified as swamps or marshes, depending on

FLORIDA'S LEGAL DEFINITION OF WETLANDS

In Florida, when a proposed land use potentially affects a wetland, a permit is required. The permitting criteria first attempt to ensure that the wetland will be preserved. When some impact to the wetland is unavoidable, the permit conditions may require restoration or mitigation at another site. Wetland mitigation usually means that more wetlands than those impacted will be preserved, protected or restored either at the impacted site or at another site.

In order to protect wetlands and their valuable functions, it is necessary to understand exactly what they are. As defined in subsection 373.019 (22), *F.S.*, wetlands are those areas

> inundated or saturated by surface water or ground water at a frequency and a duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils. Soils present in wetlands generally are classified as hydric or alluvial, or possess characteristics that are associated with reducing soil conditions. The prevalent vegetation in wetlands generally consists of facultative or obligate hydrophytic macrophytes that are typically adapted to areas having soil conditions described above. These species, due to morphological, physiological, or reproductive adaptations, have the ability to grow, reproduce, or persist in aquatic environments or anaerobic soil conditions. Florida wetlands generally include swamps, marshes, bayheads, bogs, cypress domes and strands, sloughs, wet prairies, riverine swamps and marshes, hydric seepage slopes, tidal marshes, mangrove swamps and other similar areas. Florida wetlands generally do not include longleaf or slash pine flatwoods with an understory dominated by saw palmetto.

Even with such a long and specific definition, identifying wetlands and determining their boundaries is not easy. Wetland determination is based on three factors — hydrology, soil and plants. Identification and delineation are based on applied science and require field tests. Throughout Florida, all government agencies now use the same method to identify wetlands. The methods are Florida-specific rather than national or global. The complete methodology is set forth in the *Florida Administrative Code*, Chapter 17-340. Simply stated, wetlands must have at least two out of the following three conditions:

The hydrology — Wetlands are affected by the frequency and duration of water upon the land. There are thirteen hydrologic indicators of wetlands, such as water marks, algal mats and aquatic plants and animals.

The soil — Wetland soils are saturated or ponded long enough to develop anaerobic, or low oxygen, conditions in the upper part of the soil. There are twelve hydric (wet) soil indicators, such as a sulfur odor, dark color and muck or peat.

The plants — Wetlands have more plants that grow, reproduce or persist in saturated or wet conditions than uplands. These are called obligate or facultative-wet plants. Common examples are cypress trees, willow, bull rush and cattails.

You should contact your water management district before doing work in, on or around a wetland.

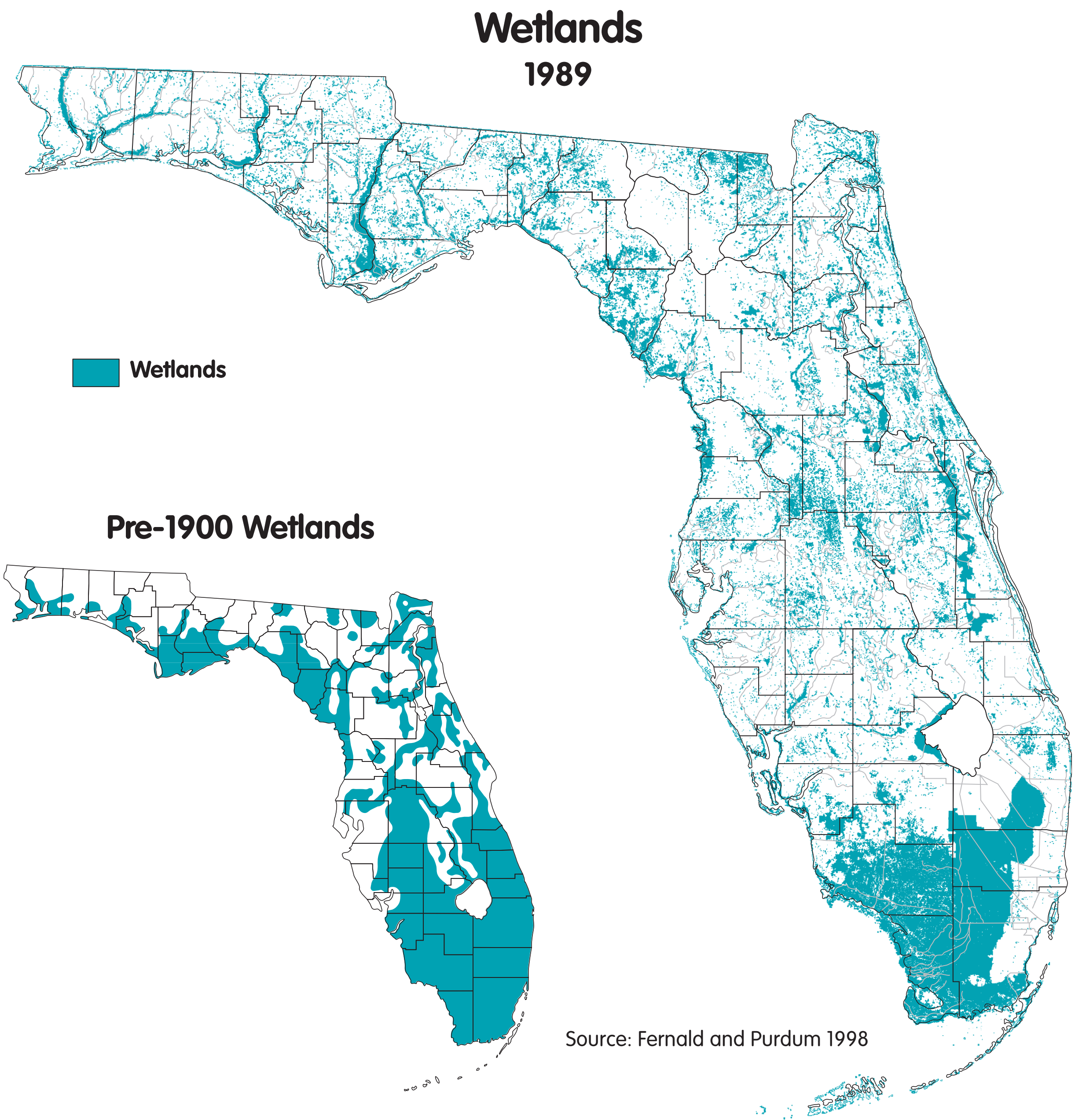
Source: Southwest Florida Water Management District

Wetland boundaries appear clearly demarcated by vegetation in this picture. When this is not the case, scientists rely on hydrologic indicators and soil analysis.

whether the vegetation is dominated by trees (swamps) or by grasses (marshes). Cypress ponds, strands, prairies, river swamps, floodplains, freshwater marshes, wet prairies, salt marshes and mangrove swamps are all wetlands.

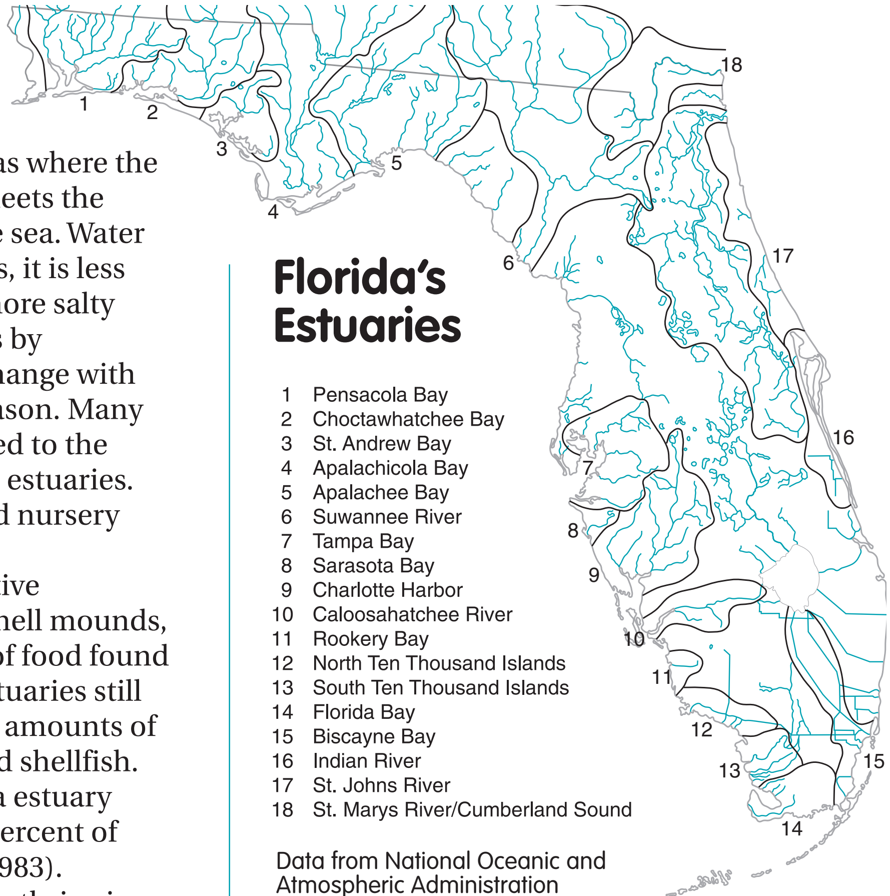
Wetlands perform many valuable functions. They provide vital habitats for fish and wildlife. They improve water quality by trapping nutrients such as nitrogen and phosphorus, toxic substances and disease-causing microorganisms. They slow and intercept runoff, protect shorelines and banks from erosion, and protect upland areas from floods.

Wetlands once covered half of Florida. Over one-half of these wetlands have been drained for agriculture, flood control and residential development. Extensive areas of remaining wetlands include the Everglades and Big Cypress Swamp in southern Florida, Green Swamp in central Florida, Okefenokee Swamp near the Florida-Georgia border, and Tates Hell Swamp in northwest Florida.



Source: Fernald and Purdum 1998

ESTUARIES



The word ***estuary*** is derived from the Latin *aestuarium*, meaning boiling tide. Estuaries are coastal areas where the freshwater current of rivers meets the incoming saltwater tide of the sea. Water in estuaries is **brackish**; that is, it is less salty than the seawater and more salty than the river water. Estuaries by definition are unstable and change with the tide as well as with the season. Many plants and animals are adapted to the changing conditions found in estuaries. Estuaries are the breeding and nursery areas for most sea life.

Along Florida's coasts, Native Americans left behind huge shell mounds, testament to the abundance of food found in estuaries. Today, Florida estuaries still produce many kinds and vast amounts of sport and commercial fish and shellfish. For example, the Apalachicola estuary provides between 80 and 90 percent of Florida's oysters (Livingston 1983).

Florida's estuaries vary greatly in size and shape. Some estuaries such as tidal creeks and spring-fed streams entering the Gulf of Mexico are only a few acres in area, whereas the mangrove forests and brackish portions of the Florida Everglades are 1,000 square miles. On the gulf coast many of the estuaries end in bays. On the Atlantic coast many of the estuaries are long and narrow and bordered by barrier islands.

The health of an estuary depends on frequent but gradual changes in the amount of fresh water and nutrients it receives. This in turn depends on the health of wetlands. Forested river swamps and freshwater marshes produce nutrients to feed plants and animals in estuaries; they slow floodwaters so that estuaries do not receive too much fresh water too quickly; and they help keep soil from eroding and clogging estuaries with sediment.

Conclusion

The health of all of Florida's vast water resources depends on us. Choices we make in one place or regarding one type of water resource may have unforeseen and undesirable consequences elsewhere. Nutrients and pesticides applied to land many kilometers away from a pristine river may seep into the aquifer and end up in the river through spring discharge. Clear-cutting forested floodplains may harm fish and shellfish by decreasing nutrients and increasing sediment. Excessive pumping of ground water may result in saltwater intrusion or drying of wetlands.

Yes, Florida is blessed with water. It's up to us to use it wisely.