EVERGLADES

An American Treasure

2010-2011 Edition

"There are no other Everglades in the world. They are, they always have been, one of the unique regions of the earth, remote, never wholly known. Nothing anywhere else is like them: their vast glittering openness, wider than the enormous visible round of the horizon, the racing free saltness and sweetness of their massive winds under the dazzling blue heights of space."

Marjory Stoneman Douglas

— *"THE EVERGLADES: RIVER OF GRASS,"* 1947

EARTHECHO INTERNATIONAL
www.earthecho.org

THE SCHOOL DISTRICT OF PALM BEACH COUNTY

U.S. Army Corps of Engineers

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
sfwmd.gov

Journey Through the Everglades – An American Treasure

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Acknowledgements

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- *The Palm Beach Post*
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Everglades: An American Treasure

Teacher Training Workshops

Learn about current issues impacting the Everglades & earn In-Service credits

A Training Workshop for secondary teachers developed to focus on skills students need to succeed with FCAT.

- **Full Day Workshops at the Arthur R. Marshall Loxahatchee National Wildlife Refuge, Boynton Beach**

Find out about upcoming workshops and register at: www.ces.fau.edu/education/teachers

Bring the Everglades into your classroom!

For more information contact: Rebecca Stanek at (561) 682-2865 or rstanek@sfwmd.gov
This workshop is coordinated by Florida Atlantic University's Center for Environmental Studies and is sponsored by the South Florida Water Management District.

Everglades on the Road to Recovery

The Florida Everglades was once a vibrant, free-flowing wetland. Known as the River of Grass, it covered 4,000 square miles in Central and South Florida, stretching from the Kissimmee Chain of Lakes to Florida Bay.

Over the last century, drainage and development reduced the Everglades to half its size. Birds, wildlife and native plants lost vital habitat, and freshwater no longer flowed across much of the wetland.

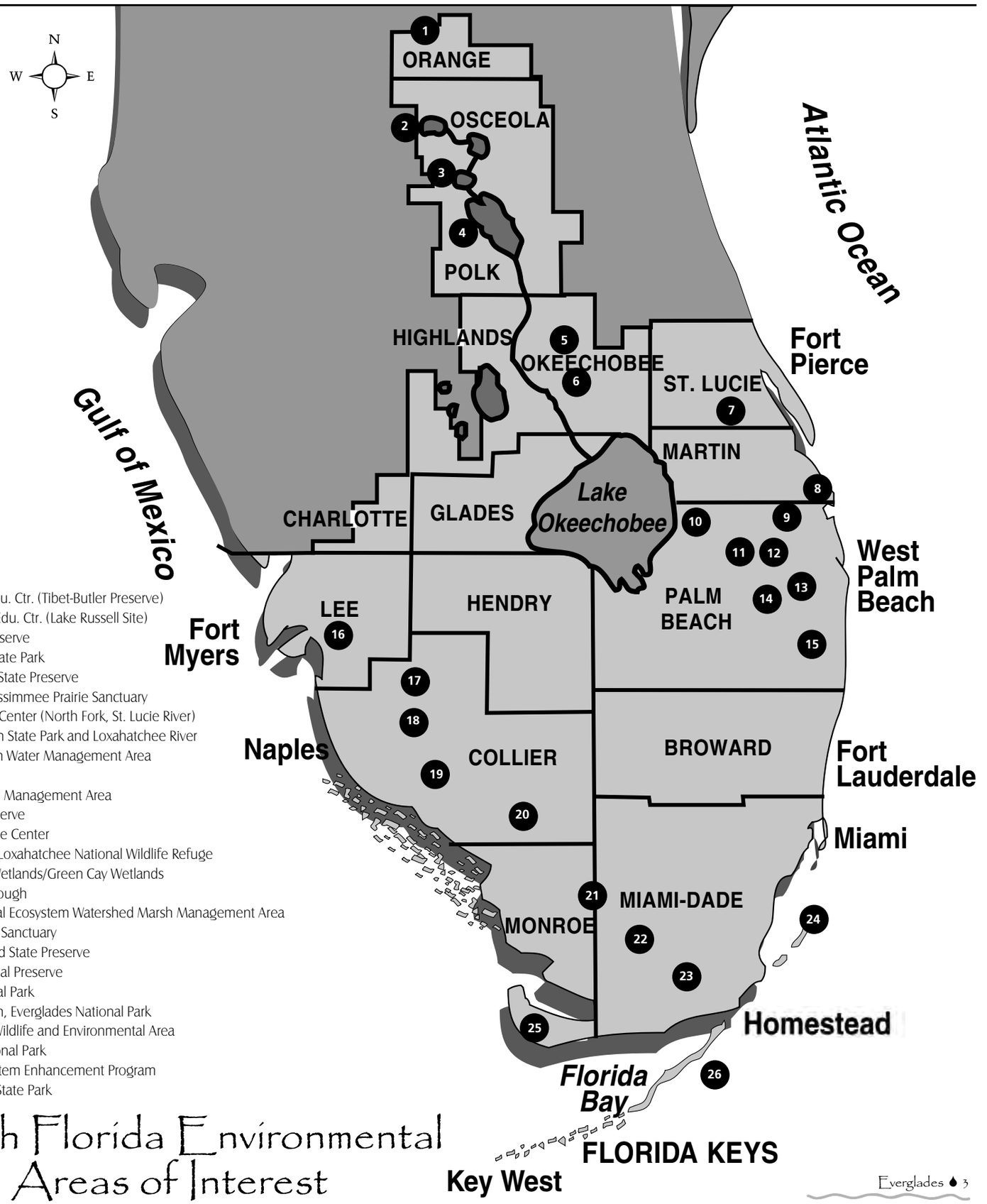
The remaining Everglades is a national treasure – yet this natural resource is still at risk. But thanks to federal, state and local organizations, the famed River of Grass is on the road to recovery. The Comprehensive Everglades Restoration Plan (CERP) is an $10.9 billion partnership that will restore freshwater flow and provide for ecosystem recovery.

Florida has already invested 1.8 billion in water quality improvements alone and is expediting other key restoration projects to benefit the Everglades ecosystem. Progress is well under way! We invite you to turn the pages and learn more.

Excellent Everglades Web Sites

SFWMD and U.S. Army Corps of Engineers	www.evergladesplan.org
South Florida Water Management District	www.sfwmd.gov
Everglades National Park	www.nps.gov/ever
Big Cypress National Preserve	www.nps.gov/bicy
Florida Earth Foundation	www.floridaearth.org
U.S. Fish and Wildlife Service	www.fws.gov
USFWS – South Florida Ecological Services	www.fws.gov/verobeach
U.S. Geological Survey	www.usgs.gov
A.R.M. Loxahatchee NWR	www.fws.gov/loxahatchee
South Florida Information Access	www.sofia.usgs.gov

Where to Experience the Everglades



1. Vera Carter Env. Edu. Ctr. (Tibet-Butler Preserve)
2. Osceola Cty. Env. Edu. Ctr. (Lake Russell Site)
3. Disney Wildlife Preserve
4. Lake Kissimmee State Park
5. Kissimmee Prairie State Preserve
6. Ordway-Whittell Kissimmee Prairie Sanctuary
7. Oxbow Ecological Center (North Fork, St. Lucie River)
8. Jonathan Dickinson State Park and Loxahatchee River
9. Hungryland Slough Water Management Area
10. DuPuis Reserve
11. J.W. Corbett Water Management Area
12. Grassy Waters Preserve
13. Okeeheelee Nature Center
14. Arthur R. Marshall Loxahatchee National Wildlife Refuge
15. Wakodahatchee Wetlands/Green Cay Wetlands
16. Six-Mile Cypress Slough
17. Corkscrew Regional Ecosystem Watershed Marsh Management Area
18. Corkscrew Swamp Sanctuary
19. Fakahatchee Strand State Preserve
20. Big Cypress National Preserve
21. Everglades National Park
22. Shark Valley Slough, Everglades National Park
23. Southern Glades Wildlife and Environmental Area
24. Biscayne Bay National Park
25. Cape Sable Ecosystem Enhancement Program
26. John Pennekamp State Park

South Florida Environmental Areas of Interest

Understanding the System

The Everglades is a place, a marsh, a region, a watershed, an ecosystem. It is the mirrored glint of sunlight on shallow water that is moving slowly, below a great sweep of sawgrass, toward the sea. The Everglades is a "river of grass."

The Everglades is much more than the nature preserve at the tip of the Florida peninsula. Before any people lived here, the land had already been carved out by nature. There were droughts and fires, hurricanes and floods, and each played its role in modifying the land that was here when the first people arrived.

South Florida is flat. The land along both coasts and most of the land south of Lake Okeechobee is less than 25 feet above sea level, and elevations throughout South Florida at the highest point are no more than 50 feet above sea level. Consequently, much of the area was a combination of part land and part seawater or freshwater that flowed very, very slowly.

Before people arrived, and even still today, there were three major features to South Florida's water picture. The upper portion of the South Florida **ecosystem** is made up of a number of lakes and the Kissimmee River. In the middle is Lake Okeechobee. The lower portion is the Everglades.

The landscape of the Everglades **system** used to store water naturally. An eastern coastal ridge and a western inland ridge together form a broad, shallow valley, sloping ever so slightly from north to south. South Florida has always been a naturally wet place, and the valley retained most rainfall within the Everglades.

We know that the three major characteristics that defined the historic Everglades were: how the water flowed, its large size, and the variety of **habitats**.

Water connected the system from top to bottom. The pace at which the sheet-like flow of water moved across the historic Everglades varied, from months to years. Water that moved down the flat and level landscape flowed so slowly that, in effect, it was stored during one season for use in another. The Everglades' all-important long periods of natural flooding depended more on the ability to store water, and on its slow movement, than on the immediate effects of rainfall. Because of the storage and slow flow in the natural system, summer rains kept **wetlands** flooded and maintained freshwater flows to coastal **estuaries** well into the dry winter season. The enormous amount of storage made wetlands and estuaries less vulnerable to rainfall, which varies dramatically in time and place throughout South Florida.

The large area of the ecosystem provided a variety of wildlife habitats. In the mid-1800s, the wetlands of Southern Florida covered an area of almost 9 million acres. This was vast enough to support animals that had large feeding ranges or very special habitat needs. It produced an abundance of aquatic life; supported larger animals such as the Florida panther; and was big enough to recover repeatedly from the effects of hurricanes, fires and other natural disturbances.

The Everglades' plants grew in a diverse mosaic of landscapes and seascapes. The Everglades was a complex system of plant life, linked by water, that included expansive areas of tree islands, **sawgrass ridges** plus **water lily sloughs**, wet prairies, cypress swamps, mangrove swamps, and coastal lagoons and bays. This mosaic of habitats, and the Everglades' unique water patterns, supported the continuing survival of animals under a wide range of seasonal and annual conditions.

Alligator

White ibis

Florida panther

White water lily

Read About It • **Look through the newspaper for different kinds of freshwater environments, either pictured or mentioned.**

Think About It • **Why are wetlands important to an environment?**

Read About It • **Find examples in the newspaper of actions taken during the process of development. This includes building roads, cutting trees, constructing new homes, etc.**

Think About It • **Discuss the consequences of such actions. Are natural resources being used? Is business or government involved? What is the profit, and loss, of progress?**

Vocabulary for pages 4-5

- **Ecosystem** – a community of organisms and its chemical and physical environment
- **Estuaries** – an area where freshwater runoff from the land mixes with seawater to produce brackish water
- **Habitat** – the place or environment where a plant or animal lives and grows
- **Ridges and sloughs** – a linear pattern of higher sawgrass ridges, separated by deeper water lily sloughs
- **System** – a group of interacting natural bodies that, together, perform one or more vital functions
- **Watershed** – a region or area bounded peripherally by a divide, and draining ultimately to a particular watercourse or body of water, e.g., the Kissimmee-Okeechobee-Everglades Watershed
- **Wetlands** – areas where the water table is at, near or above the land surface for a significant part of most years

Journey Through the KOE Watershed

"The Everglades." When you hear those words, what comes to mind? You are going to travel through the KOE (Kissimmee–Okeechobee–Everglades) **Watershed**. There will be many places to stop and learn along the way. For the next few minutes, relax and imagine that you are a drop of water. Are you ready? Then, let's go ... and experience what makes the Everglades such an interesting place!

1. Your journey as a drop of water begins in the northernmost reaches of the Everglades watershed. This lake, named **Turkey Lake**, is just west of **Orlando**. From here, you travel south, toward the **Kissimmee Chain of Lakes**, and finally into **Lake Kissimmee**, the last of the **Kissimmee Chain of Lakes**.

2. From here, you are swept directly southward, down the **Kissimmee River**. Historically, the **Kissimmee River** meandered about 103 miles from **Lake Kissimmee** to **Lake Okeechobee**. The river was channelized between 1962 and 1971 to prevent catastrophic flooding, and two-thirds of the historical flood plain was drained. Restoration has begun to restore an estimated 40 square miles of river/flood-plain ecosystems. You will be traveling for a few days to make it to your next resting place, **Lake Okeechobee**.

3. Well, you've made it to **Lake Okeechobee,** where you'll get to bask in the sunlight and support the productivity of this shallow, 730-square-mile lake. Along the western side of the lake, you flow through marshes. Today, if you flow too far west, you might get swept down the dredged **Caloosahatchee River** and out into the **Gulf of Mexico**. There, you would mix with your salty cousins in **San Carlos Bay**. On the other hand, if you drift to the far east side of the lake, you may get pulled into the canal to the **St. Lucie River**, and swept to the **Atlantic Ocean**.

4. Eventually, you leave **Lake Okeechobee** through the **Palm Beach Canal**, at the southeast edge of the lake. As you pass through a "gate" and enter a canal, you pass by the **Herbert Hoover Dike**, a wall of soil about 34 feet high. It was built around the entire lake to help protect surrounding lands from floods.

5. As you travel down the canal, on your venture to **Florida Bay**, you pass through the **Everglades Agricultural Area**, or EAA. The EAA is 700,000 acres of former Everglades, where sugar cane and other food crops are now grown.

6. From the **Palm Beach Canal**, you move into the northern tip of **Water Conservation 1**, better known as the **Arthur R. Marshall Loxahatchee National Wildlife Refuge**. You first meander around cattails that have replaced the historical sawgrass marsh, but you eventually make your way south, into dense stands of sharp sawgrass that look just like the Everglades of yesteryear.

7. You have two final obstacles to overcome as you continue to flow south through two more **water conservation areas**. You see what looks like a major obstacle ahead. It is **Alligator Alley**, a four-lane highway that connects the East and West coasts of Florida, with a canal on its north side. You follow the flow of this canal to the west, pass through a culvert, and find you're in the center of **Water Conservation Area 3**.

8. Now you're slowly drifting through a shallow marsh area and past tree islands. You catch a glimpse of "chickees" built by Miccosukee Indians. You're pulled toward them and then into a culvert that carries you under another major east-west road, **Tamiami Trail**. Whew! You made it past the final barrier. Now you get to take the long, last trip down **Shark River Slough**.

9. You are traveling very slowly through **Shark River Slough** because the land drops only a few inches each mile. You have the chance to go along the linear sawgrass ridges and water lily sloughs. You pass through an alligator hole or two. The last leg of the trip is just ahead. You notice that the type of plants along the shore are changing. These plants have roots hanging down into the slough in which you are traveling. You are starting to mix with your salty cousins from nearby **Florida Bay**.

10. Continuing on, you reach the edge of the bay. Here, another force is pulling on you – the outgoing tide. It is carrying you out into **Florida Bay**. In the bay, you drift toward the south, mingling with the turtle grass that covers the sandy bottom. Once in a while, you are carried up into shallow water. These are the edges of mud banks found throughout **Florida Bay**.

11. Continuing your movement south through the bay, you feel as if you are riding on a roller coaster. Over and over again, you are swept up to the top of a mud bank and then down into a deeper basin. Your travel companions are becoming more and more salty. Eventually, you reach the islands that make up the **Florida Keys**. With the tide, you are carried into one of the channels between the islands. Looking up, you realize that you're passing directly under **U.S. 1**, the only highway connecting the main islands in the Keys.

12. Finally, you're on the southeast side of the Keys and entering **Hawk Channel**. The water is salty. While in Hawk Channel, you see huge mounds of rocks that appear to be waving at you with thousands of little arms. These corals form patch reefs along both sides of Hawk Channel. The beautiful colors amaze you.

Kissimmee — Okeechobee — Everglades

The Florida Water Story

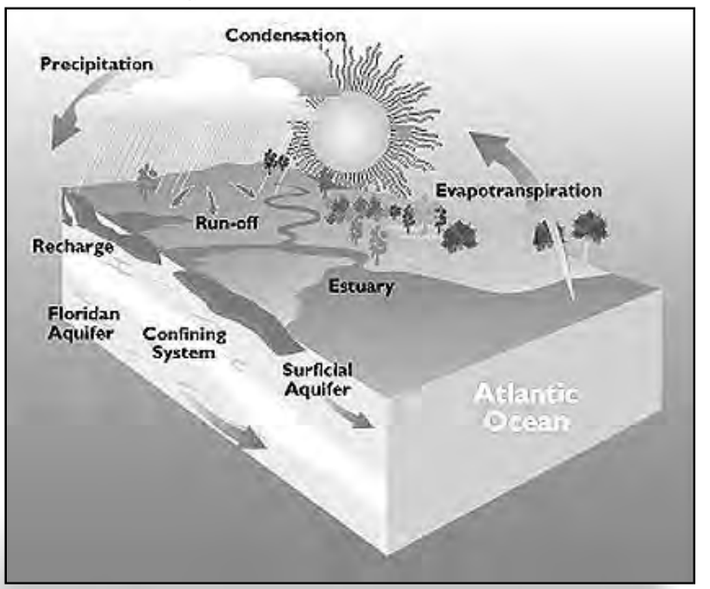
From Wet to Dry and Back Again

The hydrologic cycle is essentially a closed system with regard to water. Water cycles endlessly through its different phases, moving from sea to atmosphere to land and back to the sea. In a sense, the water of the Everglades is the offspring of the clouds, delivered back to the earth and sea as rain.

In Southern Florida, the average rainfall is about 50 to 60 inches per year; most of that occurs during the summer months. Sometimes, more than half comes in less than two months in late summer. Much of that rain is put back into the cycle by evaporation and **transpiration**, a process known as **evapotranspiration**.

But that is not the whole story. Unlike the four-part cycle of seasonal changes in other parts of the country, there are two distinct climatic seasons in Southern Florida. One is the hot, humid and wet summer, with frequent afternoon thunderstorms; the other is the cooler, drier winter.

Because of the rain and flat terrain, many places in South Florida where people live today were, in the past, under water for at least part of the year.



The hydrologic cycle in Southern Florida

Vocabulary for pages 6-7

Aquifer - the underground formation of rock or sand that stores water; people with wells pump water from aquifers

Evapotranspiration - the loss of water to the atmosphere by evaporation from land and water surface, and by transpiration from plants

Groundwater - water that is found in underground formations of sand or rock, called aquifers; in contrast to surface water, found standing in ponds, lakes, streams and other wetlands

Percolation - the downward movement of water through rock and soil toward the water table

Recharge - when water is added to an aquifer

Sustainable - continued indefinitely

Transpiration - a process in which water absorbed by plant roots is lost from pores in the leaves

Water table - the point where one can find standing groundwater beneath the soil; the water table rises and falls, depending on the amount of rainfall, human consumption and other factors

Read About It • **Rainfall is the main source of freshwater for South and Central Florida. Each day, the newspaper reports the weather conditions. Locate where this is found in the newspaper. Check the newspaper for several days. Is the report always in the same place?**

Think About It • **Sometimes, the information found in the newspaper is presented in chart or graph form. At other times, symbols are used to communicate information. Determine how many different ways information about the weather is presented to the reader.**

Read About It • **Find examples in the newspaper of how weather impacts people.**

2001 drought

Graphing Average Monthly Rainfall

Use the data below to create a line graph that displays South Florida's average monthly rainfall

MONTH	AVERAGE RAINFALL PER MONTH (inches) (1971-2000)
January	2.27
February	2.23
March	2.81
April	2.45
May	4.32
June	7.95
July	6.98
August	7.35
September	6.67
October	3.81
November	2.66
December	1.89
Total Rainfall	**51.39**

Source: SFWMD

Water From Rock or Sand Aquifers

The rocky foundation of Southern Florida is porous and permeable, which means it can store large amounts of water that can move through it fairly easily. Rainfall that doesn't collect on the surface or flow off into rivers, streams or canals moves quickly underground into these rocky or sandy underground aquifers. The surface of this underground reservoir is called the **water table**; the water below it, **groundwater**.

The layer of sand or rock in which this water is stored is called an **aquifer**. The aquifers of Southern Florida act like large sponges, holding water in their spaces. Throughout most of the Kissimmee-Okeechobee-Everglades Watershed, a shallow, close-to-the-surface aquifer intercepts water as it **percolates** downward. This aquifer is made up of sediments covered by sand and other materials that have not yet hardened into rock.

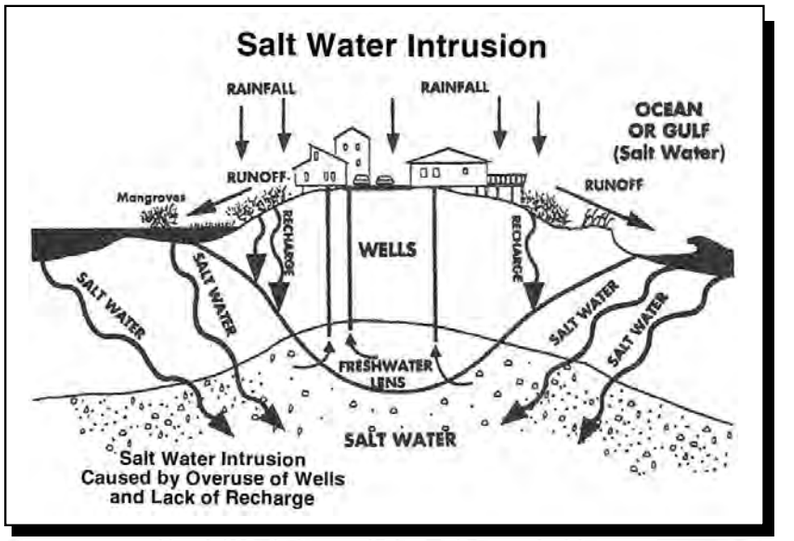
One of the most permeable shallow aquifers in the world, the Biscayne Aquifer, is just south of Boynton Beach in Palm Beach County and stretches to the southern tip of Florida. It draws in water over its entire surface, which makes it an excellent source of water. Ninety percent of Southern Florida relies on the water stored in aquifers for drinking.

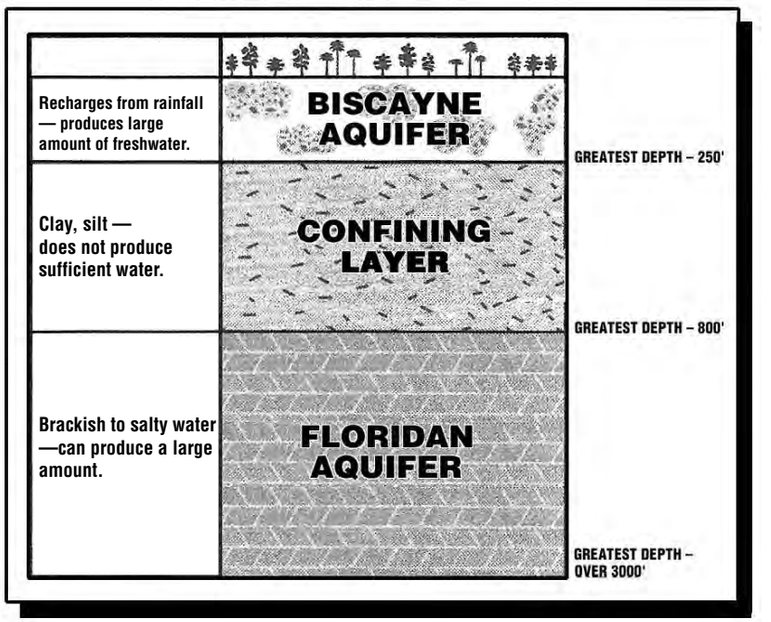
Many wellfields tap the aquifer in Southern Florida for the water supply of our ever-growing population. Cities, homeowners and businesses drill wells and pump water from the ground to draw water from the aquifer. A single large pump can bring up more than 1 million gallons each day.

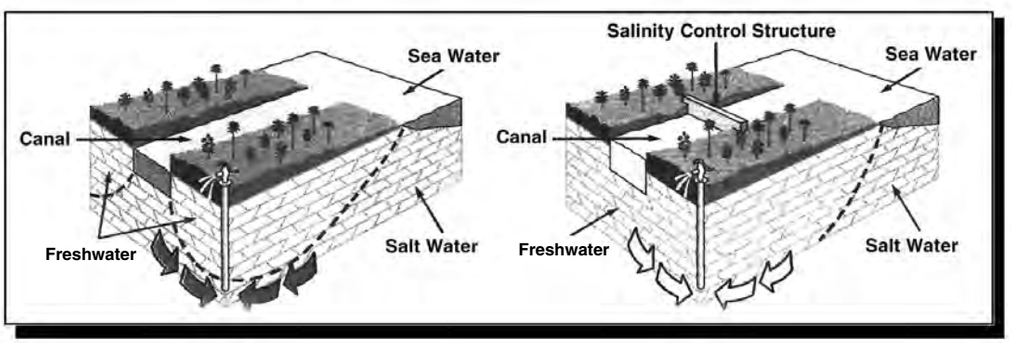
How does the aquifer continue to have so much water? The Biscayne Aquifer is **recharged,** primarily from rainfall that seeps or percolates directly down from the surface. Not all rainfall, however, is stored in the aquifer as groundwater. Some of it is stored in rivers and lakes. Some may flow naturally, or may be redirected, to the Atlantic Ocean or out to the Gulf of Mexico. Some is returned to the atmosphere through **evapotranspiration** in the hydrologic cycle.

For humans to use water in a **sustainable** manner, the amount of water pumped from the aquifers for human use would be equal to or less than the amount of water that seeps into or recharges the aquifer. However, this balance does not always happen. The increased need for water by our growing population, and the ever-dwindling wetland areas that allow water to recharge the aquifer, has upset this delicate balance. The increasing human demand for water, coupled with the drainage of wetlands, has led to major threats to both the quantity and quality of Southern Florida's water.

Along the coastal areas of Florida, groundwater often meets saltwater from the ocean, which also can move into and through the porous rock layers underground. Under normal conditions, the level of underground freshwater equals the level of underground saltwater directly along the coast. However, as freshwater is removed, saltwater moves in and replaces it. This is called "saltwater intrusion." It has become a major threat to the quality of freshwater available for people to use.







Salinity control structures help hold back saltwater. When groundwater levels are low, water from Lake Okeechobee is released into canals to further combat saltwater intrusion.

Florida's Water Timeline

1881
Hamilton Disston begins drainage of Southern Florida wetlands, with a promise from the state of 1 million acres for 25 cents per acre if he succeeds.

1880-1900
Steamboats ferry passengers and cargo from Fort Myers through Lake Okeechobee to Kissimmee, and on the Indian River from Jupiter to the Cape Canaveral area. Key West serves as a hub of steamship routes to the Gulf of Mexico, Cuba and the Northeast.

1912
Henry Flagler's railroad to Key West opens: Southern Florida is connected economically to the East Coast and the rest of the nation.

1924-1925
The real estate boom reaches its height in Southern Florida.

1926
A major hurricane hits Miami, killing about 390 people; the real estate crash begins.

1928
A major hurricane strikes Lake Okeechobee and breaches 22 miles of muck dike. An estimated 3,000 people drown. The goals of water management in South Florida change to include flood protection and drainage of the land for development.

1930s
The economy of Florida, which is heavily based on land speculation, crumbles with the Great Depression that is sweeping the rest of the country.

1935
The Labor Day Hurricane kills 409 people and destroys the railroad through the Florida Keys.

1942-1945
Many military personnel train in Southern Florida for World War II. After the war, many of these people return; this is believed to be one of the reasons for Florida's post-war boom.

1947
Everglades National Park is established.

1949
The Central and Southern Florida Flood Control District is created as the local sponsor of the U.S. Army Corps of Engineers' Central and Southern Florida Project.

1951
The Arthur R. Marshall Loxahatchee National Wildlife Refuge is established.

The Everglades of Yesterday

Historically, rainwater from the Kissimmee Valley flowed south to Lake Okeechobee. The lake would periodically overflow its southern shoreline, and water would continue its slow journey across a 60-mile-wide, very shallow "river" flowing over the flat and level grasslands of the Everglades, eventually emptying into Florida Bay. Only a few small rivers flowed eastward through the coastal ridge.

Why talk about the Everglades of 100 years ago? To find ways to restore the Everglades, we need to understand how the Everglades functioned before the area was drained and developed, beginning in the late 1800s. Of course, it's impossible to return the entire Everglades to pre-development condition, but understanding how the Everglades has been modified by people helps us understand the current problems and possible solutions.

Today: Restoring a Troubled Ecosystem

There is hope for the Everglades. Thanks to a historic partnership among federal, state, local and tribal leaders, a plan has been developed to restore the Everglades. Over a period of six years (during the 1990s), a team of more than 150 ecologists, hydrologists, engineers, planners and other professionals worked together with the public to craft a system-wide solution to the problems experienced by the Everglades. The Comprehensive Everglades Restoration Plan (CERP) is made up of a series of water-system and environmental improvements that will be conducted over the next 30 years. With an estimated cost of $10.9 billion, CERP is the most ambitious restoration project ever undertaken in North America.

The Comprehensive Everglades Restoration Plan, which includes a suite of state-expedited projects, will provide a sustainable volume and timing of water flow to the Everglades. By capturing and storing much of the freshwater that now flows unused to the coasts, most of the pre-drainage flow to Everglades National Park will be restored. The plan also will enhance flows to surrounding conservation areas and wildlife refuges. CERP will also reduce the extreme highs and lows of Lake Okeechobee, allowing the lake's ecology to rebound. Damaging freshwater releases to estuaries will be reduced, alleviating stress on fish, oyster beds and seagrasses. The Everglades will enjoy a more natural timing, flow and quantity of water, resulting in a diverse and natural habitat for plants and animals. Flood protection will be maintained and, in some cases, might improve. Urban and agricultural water users will have reliable water supplies.

Stepping Up the Pace!

More than half of the nearly 400,000 acres of lands needed to implement CERP are now in public ownership, including all of the land needed to construct the expedited projects. Design and/or construction of projects to increase storage, improve water quality and reestablish more historic flow patterns and hydrologic characteristics are also under way – including 45,000 acres of constructed wetlands that use "green technology" to remove excess nutrients.

A Troubled Ecosystem

- 90 to 95 percent reduction in wading-bird populations
- 68 plant and animal species are threatened or endangered
- High-nutrient water environment/thick cattail growth
- Decreased biodiversity
- 1 million acres of the ecosystem under health advisories for mercury contamination
- Indicator-species populations decline
- Over 1.5 million acres infested with invasive, exotic plants
- Declining population levels of important fish species
- Defoliation of seagrasses; fish kills and deformed fish
- Continued reduction in number of birds initiating breeding in South Florida
- Unnatural water shortages and saltwater intrusion

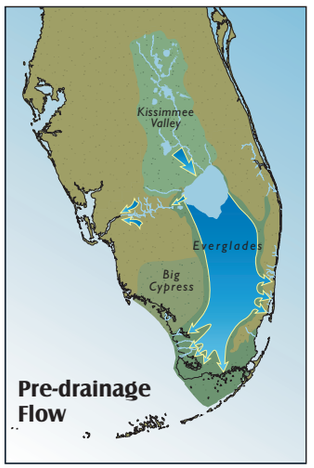
A Restored Ecosystem

- Wetland functions that mimic pre-drainage conditions
- Significant increases in animal populations at all levels of the aquatic food chain
- Low-nutrient water
- Increased biodiversity
- Return of large nesting rookeries of wading birds
- Recovery of a number of endangered species
- Indicator-species populations increase
- Quality of water discharged to natural areas improves
- Improved health of Lake Okeechobee fishery
- Freshwater flows to bays and estuaries are more natural; increased flows to Florida Bay and decreased harmful discharges to the St. Lucie and the Caloosahatchee estuaries
- Improved health of seagrasses and other submerged aquatic vegetation

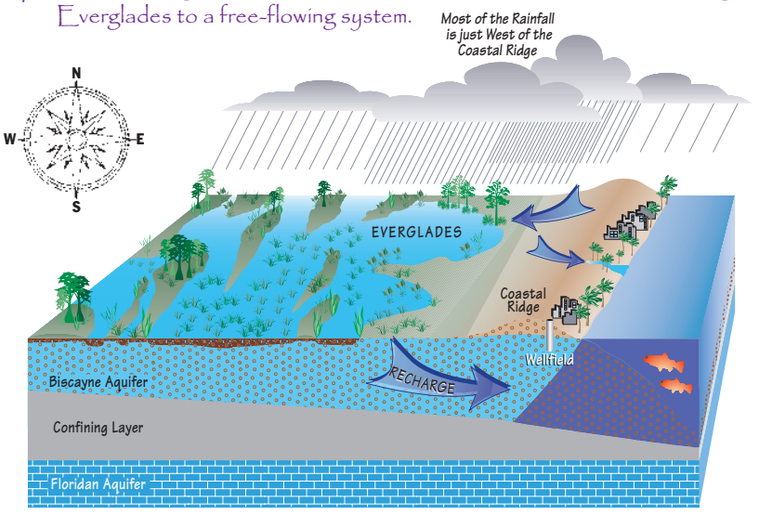
Read About It • **Look through the newspaper for examples of people, groups or organizations that are working to protect the environment. Make a list of those involved and the actions they are taking.**

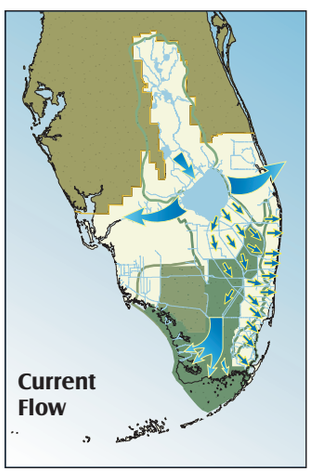
Think About It • **What actions could you take to protect the environment? Share your ideas with others. What are their responses to your ideas?**

Water once freely flowed from the southern rim of Lake Okeechobee through the Everglades to Florida Bay and the Gulf of Mexico. Today, the free-flowing Everglades has been altered by a system of canals and levees. Once implemented, the Comprehensive Everglades Restoration Plan will return much of the remaining Everglades to a free-flowing system.

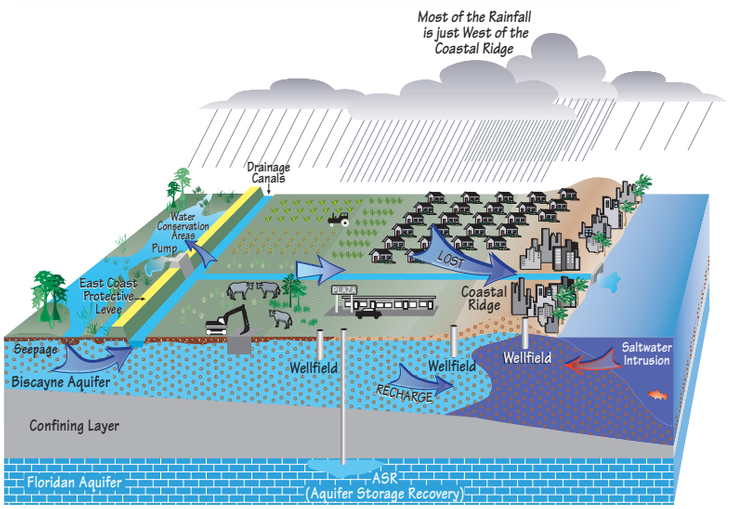


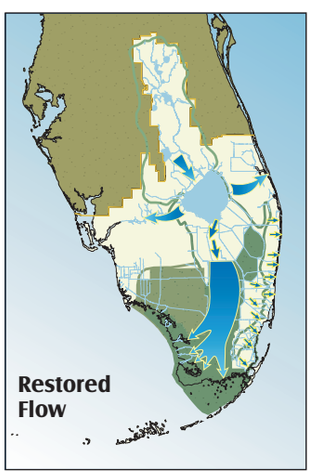
Pre-drainage Flow



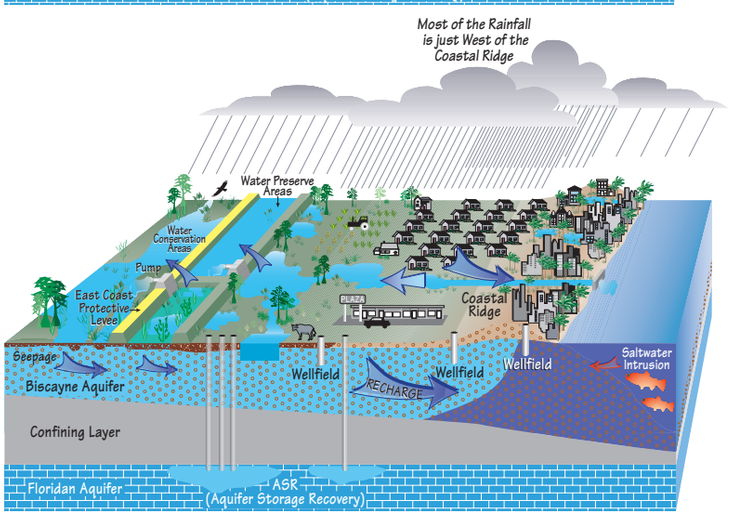


Current Flow





Restored Flow



Read About It • **Scan the newspaper for articles, to share with your class, showing how people have changed or controlled the environment.**

Think About It • **Discuss as a class whether you think that people are the only living beings that can control or change their environment.**

Florida's Water Timeline

1971
Disney World opens in Orlando and brings to the watershed not only millions of visitors but also many new permanent residents. Channelization of the Kissimmee River occurs.

1972
The Florida Legislature passes the Water Resources Act. The Florida Water Resources Act creates five regional water management districts based on hydrologic boundaries, and establishes a permit system for allocating water. The Central and Southern Florida Flood Control District becomes the South Florida Water Management District.

1973
The U.S. Congress passes the Endangered Species Act to identify and list endangered species.

1976
Florida citizens adopt a constitutional amendment giving water management districts taxing authority.

1980
More than 120,000 Cuban people come into Southern Florida through the Mariel boatlift.

1992
Hurricane Andrew strikes southern Miami-Dade County; damages approach $16 billion.

1994
The Everglades Forever Act sets forth the plan and the funding mechanism to improve Everglades water quality as well as the amount, timing and flow of water to the Everglades; and to eradicate and control exotic plants in the Everglades.

1996
Legislation is set forth in which water management districts must set minimum flows and levels that will not harm the environment.

1999
The U.S. Congress approves the Comprehensive Everglades Restoration Plan, a joint federal-state plan to restore the Everglades and provide water for people and the environment. Congress authorizes the first 10 projects in the plan.

2003
Groundbreaking on first construction project to restore America's Everglades – Picayune Strand.

2004
Governor Jeb Bush unveils an ambitious plan to accelerate the restoration of America's Everglades by stepping up the pace to complete critical environmental projects more than a decade ahead of schedule. Construction is now under way.

Biological Diversity

The range of organisms present in a given ecological community or ecosystem

Tricolored heron

Our Unique Ecosystem

Few places in the world are as biologically rich as the Everglades ecosystem. Nearly 45 species of mammals, including about 10 marine forms, frequent the Everglades and related bays, sounds, coastal estuaries and offshore waters. Hundreds of species of fish and thousands of species of marine, estuarine, and freshwater invertebrates live in the waters of this ecosystem. More than 50 kinds of reptiles, including the legendary alligator, lend truth to the perception that the Everglades is home to an array of wildlife. Nearly 20 species of salamanders, frogs and toads live in or near alligator holes, sloughs and marshes in the watershed. Aside from insect species – which number in the thousands – perhaps no other animals represent the area's biological diversity and wealth better than birds. Almost 350 species of birds, both temperate and tropical, have been recorded.

In Southern Florida, temperate and **subtropical** zones merge to form one of the largest and most complex ecosystems in North America. The Kissimmee-Okeechobee-Everglades ecosystem is composed of more than a dozen plant communities, hundreds of distinctive habitats, and thousands of ecological **niches**, all of which fit together like pieces of a jigsaw puzzle. Most of the Everglades' continental plants and animals in the past came south, from portions of the northern and central peninsula, as these areas remained above water even when much of the southern peninsula was submerged by the rising sea. Today, much colonization occurs with the help of humans from the south, from Cuba and the Bahamas. Most tropical components of the Everglades watershed are plants. The seeds of plants are adapted for easy dispersal. Some have made the passage to the Florida peninsula on ocean currents and winds. Others have been carried temporarily on the bodies of, or in the intestinal tracts of, animals. Together, the permanent and migratory inhabitants of the Everglades watershed make it one of the most biologically diverse ecosystems in the world.

A complex interaction occurs at the margins of habitats. Regardless of the size of their organizational unit (a biome, an ecosystem, a community, etc.), individuals and species from each area mix when two or more habitats come together. This phenomenon is known as the **edge effect**, and the place where it occurs is called the **ecotone**. The edge effect results in a greater abundance and diversity of plants and animals in the ecotone.

Certain animals have a special importance to the overall health and integrity of an ecosystem. These are called **keystone species**. They affect other organisms in critical ways. For example, the alligator excavates holes that become dry-season refuges for many other animals. And the apple snail serves as an exclusive food source to the endangered snail kites.

Alligator and great egrets in an alligator hole

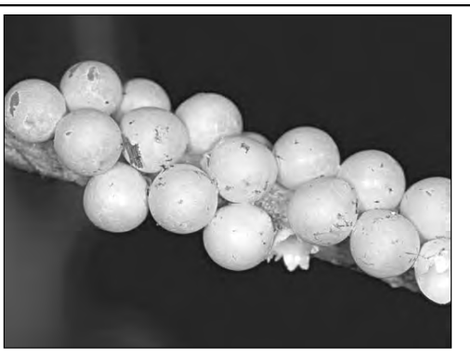
Florida panther

The Apple Snail

The apple snail is an aquatic invertebrate. Due to the size of its shell, it is the largest and most visible snail native to Florida. To survive, it needs marsh areas that have standing water for long periods (long **hydroperiods**). It can breathe air through **gills** and through a type of lung. It is a source of food for a variety of reptiles (turtles, alligators); amphibians (bullfrogs); fish, birds (limpkins, grackles); and mammals (river otters).

The snail kite, an endangered hawk, is an extremely specialized eater. While it might, on occasion, feed on crayfish and small turtles, its primary food is the apple snail. The feeding habits of the snail kite make the apple snail very important to the kite's survival. As a result, the kite is restricted to marshes with long hydroperiods that provide the best conditions for apple-snail survival.

The quality of habitat for the apple snail will determine whether the snail kite will survive. The snail kite and the apple snail are two dependent links in the Everglades food chain. Today, fewer than 2,000 of these birds remain.



Apple snail eggs

Snail kites

Hydrophytic Plants

Hydrophytic plants have adapted to thrive in wetlands, despite the dangers and stresses of an **anaerobic** and flooded environment. Most upland plants take in oxygen through root systems and distribute it through their stems and leaves. To survive in their **hydrated** environment, rooted wetland plants must employ alternative strategies to obtain and transfer oxygen.

These adaptations might appear as:

- "knees" in a tree's root system that jut out of the ground and extend above the high-water mark (thought to help absorb oxygen)
- shallow or exposed roots that pick up oxygen from surface, aerobic soil layers
- hollow tubes or air spaces that transport oxygen to the roots
- swollen and/or buttressed tree trunks that are usually thickened to the height of deepest water inundation (thought to decrease the chance of plants being uprooted)

Wood stork

Cardinal wild pine

Vocabulary for pages 10-11

Anaerobic - living in the absence of oxygen
Dormant - inactive
Drought - a prolonged period with no rain
Ecotone - transitional area in which two ecosystems merge
Edge effect - existence of larger number/greater diversity of species in ecotone than in either bordering habitat
Gills - respiratory organs in aquatic animals
Hydrated - supplied with water
Hydroperiod - number of months a year the area has standing water
Keystone species - species that plays role that affects many other species in an ecosystem
Niche - role played by a particular species in its environment
Periphyton - algae mats that live on rocks and higher plants
Subsist - to exist or be
Subtropical - zones of the Earth immediately north and south of the two tropic zones; air temperature usually does not go below freezing (0° C)
Torpor - state of inactivity

Cypress knees

White water lily

Adaptations

As the water level changes from drought to flood, two critical adaptive behaviors are essential to the survival of Everglades watershed creatures: the capacity to live through floods and **droughts**, and the ability to spread rapidly and recolonize and reproduce when the rains return.

Gambusia (mosquitofish) and other killifish, such as golden top minnows, flagfish, least mosquitofish, and lucanias, are adapted to "breathe" the oxygen-rich surface layers of shrinking ponds of water long after other fish such as bass and bream have succumbed. Their heads are flat on top, and their mouths are angled upward so that they can take in oxygen from surface water.

The structural adaptation of the gambusia has considerable significance to the wood stork. This adaptation enables large numbers of the fish to survive in basins of shrinking water during the time that adult birds are searching these areas for food for their young. The modified mouth structure of the mosquitofish enables it to survive under marginal conditions.

Other organisms have interesting structural and behavioral adaptations that help them cope with the lack of water. Tree snails become **dormant** behind a seal of mucous during the winter. Apple snails, crayfish, frogs and turtles dig down to moist soil and enter a state of **torpor**, a resting state similar to hibernation. Birds migrate to moister places. Land mammals range farther abroad in search of water, and carnivores and omnivores **subsist** on other animals that have succumbed. Garfish and bowfins have primitive "lungs" that enable them to survive at least short periods completely out of water; the bowfin even burrows into moist ground on the bottoms of drying ponds and manages to survive. During the dry season, alligators often dig holes down to the water table, where they live on stored fat, largely ignoring the other tenants of the gator hole.

Bromeliads and other air plants trap and hold water in their upturned leaf bases. Other plants have thick, succulent leaves, or body parts that conserve water. The algal mat of **periphyton** holds eggs, cysts, larvae of insects, and other creatures in its moist interior, enabling them to survive the dry season.

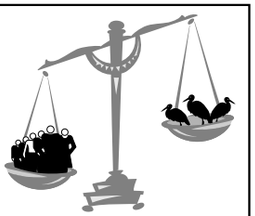
A Changing Population – and a Changing Everglades

South Florida 1930 - 2009 Population by County

	1930	2005	2009
Broward County	20,094	1,623,018	1,744,922
Charlotte County	4,013	141,627	165,455
Collier County	2,883	251,377	333,032
Glades County	2,762	10,576	11,311
Hendry County	3,492	36,210	41,320
Highlands County	9,192	87,366	99,713
Lee County	14,990	440,888	615,124
Martin County	5,111	126,731	143,856
Miami-Dade County	142,955	2,253,362	2,472,344
Monroe County	13,624	79,589	77,925
Okeechobee County	4,129	35,910	39,703
Orange County	49,737	896,344	1,108,882
Osceola County	10,699	172,493	272,788
Palm Beach County	61,781	1,131,184	1,287,344
Polk County	72,291	483,924	584,343
St. Lucie County	7,057	192,695	272,864

Ref: Bureau of Economic and Business research (BEBR), University of Florida – April 2009

Fewer than 10 percent of the wading birds that once populated Southern Florida inhabit the Everglades. Forty years ago, 2,500 wood storks were breeding in this vast wetland, but by 1990, their numbers had dwindled to several hundred. Thanks to environmental restoration, wood storks are making a comeback, now numbering more than 1,000.



As recently as 1870, when only a few hundred people lived along the coast of Southeastern Florida, an estimated 2 million wading birds inhabited the Everglades. During the last century, many more people have moved to the area, and this vibrant Florida ecosystem has been altered to accommodate their needs. The Everglades area has shrunk, and many of the bird-species numbers are so reduced that they are threatened. Today, the results of controlling the Everglades' water flow are all too apparent. The great sheets of water that once moved slowly across the expanse of the original Everglades, recharging the water table and providing flow to streams and rivers, are now harnessed in canals. The natural timing of water ebbing and flowing as it crisscrossed the lower peninsula is now manipulated. It rushes through canals or stands behind flood-control structures. Canals quickly drain into natural water bodies and are conduits for residential and agricultural runoff that pollutes lakes, rivers and estuaries. Most of the expansive Everglades is divided into managed "water conservation areas" that supply water to the people of the East Coast of Southern Florida. The natural overland sheet flow, so important to the ecosystem, has been interrupted. The Everglades is not the only natural system in distress.

Lake Okeechobee suffers from high-nutrient water and water that stays high too long. Estuaries suffer from inundation of high-nutrient freshwater during storm seasons and very little freshwater in times of drought. In addition to its environmental woes, the whole of Southern Florida has outgrown population projections made in the 1940s and '50s. Considered very generous at the time, the projection for the new millennium was 2 million people. Today, almost 7.5 million call Southern Florida home. The population is expected to double in the next 50 years. We have a limited supply of usable freshwater. Will the Comprehensive Everglades Restoration Plan be able to provide for all of the people? Will there be enough water left over to restore the Everglades? These questions are continually reviewed and debated by experts. The CERP will face many challenges.

Roseate spoonbill

Activity

READ
THINK
EXPLAIN

Population Explosion

1) Use the key provided to determine how many counties in 1930 had a population between 10,000 and 50,000.

2) How much did the population increase from 1930 to 2006 in your county?

3) The population growth of South Florida has had a dramatic impact on the Everglades. According to the reading, explain three ways the Everglades has changed since 1870.

_____

_____

_____

_____

_____

Vocabulary for pages 13-15

Carnivores - flesh eating animal

Carrying capacity - maximum population of a species a specific environment can support

CERP - Comprehensive Everglades Restoration Plan

Endangered species - species that could soon become extinct

Exotic species - non-native species

Fragmentation - breaking into pieces

Herbivore - organism that eats plants

Invasive - capable of spreading

Non-native - plants or animals originating in a part of the world other than where they are growing

Organism - form of life

Perennial - lasting or active through the year or through many years

Trophic level - organisms' position in the food chain

What's It Worth?

People share the Everglades with nature. They harvest sugar cane and rice, tomatoes and grapefruit. They produce dairy products. Like giant water striders, they skim about on airboats, searching for fun and frogs. In distant Florida Bay, an angler's line snaps tight as a sea trout takes the bait, while in Lake Okeechobee's shallows, someone else lands a bass. Thousands of vacationers crowd the beaches of the Sun Coast, on Florida's West Coast, while sails fly with the offshore wind like colorful vertical wings. A scientist studies a bird rookery, while another predicts movements of weather fronts. In the cities, millions of people go about their daily business, often unaware of the complex and fragile aquatic system that sustains them.

The cost of human development and use of this natural system has been high. Our cities draw heavily on resources from the Everglades system. On an average day, each human being in Southern Florida uses 190 gallons of water – twice the national average. Each day, more than 900 people move to Florida, most to Southern Florida. The southern part of Florida (Orlando to the Keys) is home to almost 7.5 million people. An estimated 10 million people will live here by 2010. These figures do not include the approximately 30 million visitors that South Florida gets each year. In an ecosystem built on water, the needs of so many have enormous significance.

Too often, too easily, we have asked, "Of what value is a place like the Everglades unless it is drained?" Wetlands are good for alligators, wood storks, palmetto bugs and eagles; sawgrass, periphyton, and resurrection ferns; snakes, orchids and shrimp; dolphins, tarpon and turtle grass. Wetlands are havens for many species nearing extinction. They also are incredibly efficient "water-treatment plants." A single acre of wetland peat can absorb 300,000 gallons of water. Wetlands are buffers against damage by storm, tidal surge and flood. Wetlands are oxygen factories. They produce proteins, carbohydrates and fats, assembly-line style. In addition, wetlands store water for human use, recharge surficial aquifers, and manage timing and delivery of water to estuaries and bays.

Why Preserved Areas Are Important

The national parks and wildlife refuges found in South Florida represent a rich diversity of both natural and cultural history. Today, however, it is clear that natural areas cannot be preserved forever by simply drawing national park and refuge boundaries. They are greatly impacted by what happens outside their borders. The Comprehensive Everglades Restoration Plan will help restore water-flow patterns and give life back to a once deprived system. The health of the national parks and wildlife refuges will also be positively impacted.

Everglades National Park is the only subtropical preserve in North America. It is the only park to be named an International Biosphere Reserve, World Heritage Site, and a Wetland of International Importance. It is known for its rich bird life and is the only place in the world where alligators and crocodiles exist side by side. Biscayne National Park, established more than 30 years ago, protects a nationally significant ecosystem with mangrove shorelines, a shallow bay, undeveloped islands and living coral reefs. It is also home to many threatened and endangered species. Big Cypress National Preserve is a multi-use area dominated by wet prairies, cypress sloughs and pinelands. The preserve is home to the Miccosukee and Seminole Indians. The clear waters from the preserve flow into the mangrove estuary of Everglades National Park, giving sustenance to the marine creatures that live there. Dry Tortugas National Park is characterized by turquoise-blue waters, coral reefs, nesting birds and a massive 19th-century coastal fort. Located 68 miles west of Key West, the park consists of seven small islands and expanses of open water.

Arthur R. Marshall Loxahatchee National Wildlife Refuge is a 143,874 acre refuge protecting a remaining portion of the unique Everglades. The refuge protects endangered species such as the snail kite, wood stork, and tropical curly grass fern as well as alligators and red-bellied turtles. The .8 mile Marsh Trail is an open levee trail that's a bird watcher's paradise where wading birds, shorebirds, and migratory waterfowl can be seen.

Reduction of Wetlands

Roughly 50 percent of the historic Everglades wetland area has been lost to human use and development. Loss of this wetland area significantly reduces biological diversity and rates of survival for vertebrate species that require large areas. Wading birds, snail kites and panthers have become increasingly stressed by the **fragmentation** and loss of their habitat. Wading-bird populations have dropped to under 10 percent of their former sizes. This correlation suggests that the lost wetlands may have been especially critical to the wading birds' feeding and nesting success. The remaining wetlands are so diminished in quality that their **carrying capacity** for birds is only a fraction of former levels.

The decrease in Southern Florida wetlands has reduced the area over which sunlight can be transformed into food and oxygen by aquatic plants. The decrease in wetland area has meant a loss of wetland function, including the loss of gator holes and other refuges. By any measure of species richness, there has been a drastic erosion of biodiversity in Southern Florida.

Environmental restoration focuses on restoring the remaining Everglades wetlands. By expediting key projects, environmental benefits will be achieved sooner rather than later.

Read About It • **Read the editorials in the newspaper for several days. Pay particular attention to how an editorial is written. What do you think are the key elements of an editorial?**

Think About It • **Write an editorial that you could send to your local newspaper, expressing your opinion on what might happen if Florida's wetlands continue to vanish.**

Read About It • **Find newspaper articles about natural disasters, such as volcanoes, floods, tornadoes, earthquakes, etc.**

Think About It • **Determine the causes that led to the disaster you researched and whether the disaster might have been prevented.**

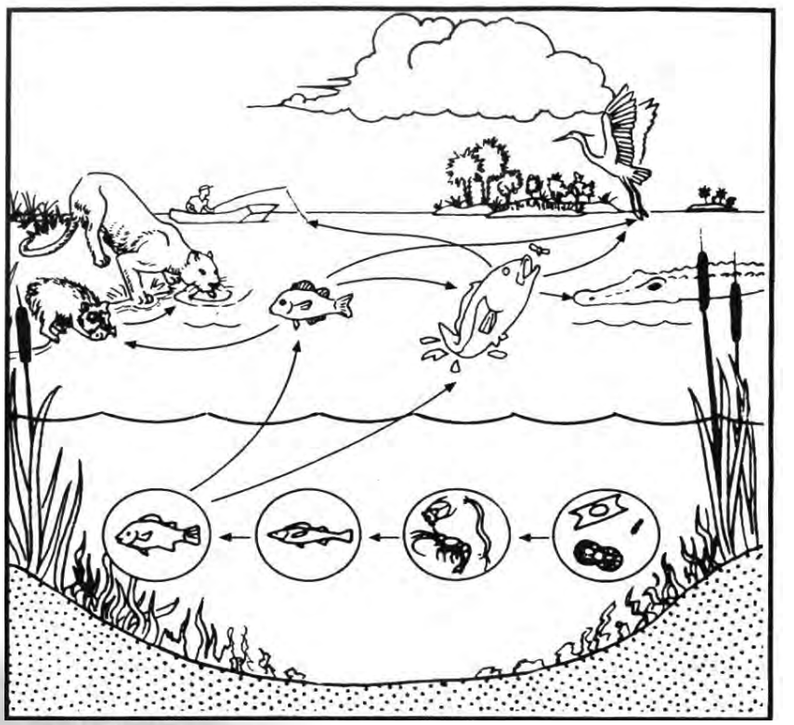
The Web of Life

The sun energizes the entire Everglades ecosystem. Producers (primarily plants), using solar energy, combine carbon dioxide and water to make food. This process is called photosynthesis. Some animals are primary consumers. They eat, digest, reorganize and incorporate, into their own bodies, the materials made by producers. Decomposers are the link between death and new life. In a way, each **organism** in this flow of energy "eats" a little bit of the sun, since the primary energy source for producers is light, required for photosynthesis.

The term "food web" describes the complex interactions in a natural system. A food web is a composite of several food chains, or sequences of production and consumption, of life and death. Each level or link in a food web is called a **trophic level**. Primary consumers, such as marsh rabbits, eat plants and are called **herbivores**. Secondary consumers eat marsh rabbits and are called **carnivores**. At each level, energy in the system is used and lost; therefore, energy available for the next level is decreased.

A grazing food chain starts with producers. A typical grazing food chain in the Everglades could include periphyton (producers), which are fed on by mosquito larvae, which in turn are eaten by sunfish. The sunfish becomes food for the largemouth bass, which is then eaten by a river otter.

A detrital food chain is one in which consumers "eat" dead matter. Some microbes, including fungi and bacteria, are part of food chains in which organic matter is consumed. Detrital food chains are especially common in natural systems like the Everglades, where less than 10 percent of the primary production is grazed. In such a rich system, substantial and complex buildups of biomass can occur, increasing energy storage in the system. A typical detrital food chain in the watershed could begin with dead plant material "eaten" by bacteria and fungi, which are consumed by single-cell animals. The protozoans are then eaten by worms and insects,



which are consumed by birds. Mangrove systems, such as those in Rookery Bay near Naples, are classic examples of detrital food chains.

Nutrients, elements and inorganic compounds that are essential to life are circulated through the watershed in what are called "material cycles." Among the elements that are repeatedly moved through the ecosystem in large quantities are nitrogen, phosphorus, sulfur and carbon.

Mosquitoes

The mosquito is one member of the wetland communities that never goes unnoticed. Florida has 67 species of mosquitoes. Their life cycles, habits and behaviors vary. Some bite only at night; others bite only during the day; a few don't bite at all. If a mosquito bites you, it is a female that requires one or more meals of blood before she can lay her eggs.

Glades mosquitoes lay their eggs in mud and detritus, from May through August. The eggs "keep" until the rains begin. As soon as the eggs are flooded, they hatch into the larval stage, and after four to 10 days, they become pupae. The adult mosquito develops from the pupa in two to four days. Adults generally live two to four weeks.

As irritating as the mosquitoes of the Glades can be, they are critical to the food webs in the watershed. Many kinds of insects and other creatures depend on the large food mass of mosquito larvae. Mosquitofish prey on the larvae and, in turn, become food for other animals such as frogs, snakes and birds. These animals are fed upon by otters, raccoons, alligators and other larger predators.

Urban areas frequently experience swarms of mosquitoes from wetlands. Often, mosquitoes are controlled by aerial spraying of insecticides designed to kill the adult form. A **perennial** issue arises when we try to balance our desire for comfort with the fact that mosquitoes represent a critical food source for many watershed animals. Additionally, insecticides might cause health problems for humans and other animals. Maintaining a healthy balance of natural predators can remedy the mosquito over-population problem.

Read About It	• **Look through the newspaper for examples of how Florida is changing. Clip out your examples, and be prepared to share them with your class.**
Think About It	• **How do the changes in Florida influence its water? How might these problems affect you?**
Read About It	• **Identify a particularly controversial subject in your community or state. Collect articles, pictures and editorials from the newspaper related to the subject.**
Think About It	• **Determine from your clippings: What are the opposing views; who is for and against the issue; why is the issue controversial; when/how will the issue be resolved?**

Endangered Species

In 1973, the United States Congress passed the Endangered Species Act. The act authorizes the U.S. Fish and Wildlife Service (USFWS; Department of the Interior) and the National Marine Fisheries Service (NMFS; Department of Commerce) to identify and list **endangered species**. An endangered species is one that is in severe danger of becoming extinct; gone forever. A threatened species is one that is still abundant in parts of its range but has declined in total numbers. The NMFS is responsible for identifying all plant and marine species that are endangered or threatened in the United States.

The decision by either agency to add or remove a species from the list must be based solely on biological grounds, without economic consideration. The act also calls for recovery plans to be developed for listed species. It prohibits the killing, collecting or hunting of all protected species and makes it illegal for any person or agency in the United States to trade in products that are made from a listed species, except under very special circumstances.

The Everglades ecosystem is home to 68 federally listed endangered and threatened species. This includes 35 species of plants and 33 species of animals. Listed animal species include the Florida panther, West Indian manatee, American crocodile, Eastern indigo snake, Atlantic saltmarsh snake, snail kite, wood stork, roseate tern, and Cape Sable seaside sparrow.

The Florida panther is endangered. You have a better chance of seeing a Florida panther at the Palm Beach Zoo than in the Everglades. The cats used to range from Texas to Florida. Today, between 80 and 100 are left, roaming the ever-shrinking wilderness of South Florida. As many as 22 panthers wear radio collars that monitor their movements.

The drainage and development of much of the Southern Florida wetland system have introduced contaminants into remaining wetlands. A shrinking gene pool, lack of habitat and threat of mercury poisoning led experts to predict that panthers could become extinct in 25 to 40 years. However, to prevent this, the USFWS initiated a captive-breeding program and successfully introduced Texas cougars to increase the vigor of the population.

These programs have since been discontinued as their goals were met. Today, intraspecific aggression, habitat loss and vehicular mortality are the primary causes of panther death.

Florida panther

Seaside sparrow

Introduction of Non-Native Species

Indigenous, or native, species have adapted to each other and their habitats over long periods of time. Predator-prey relationships, reproductive life cycles, selective consumption of resources and other ecological processes help to maintain balance to the ecosystem. When a new species invades, these long-lasting relationships might be upset.

Often, introduced species are not suited to the Florida environment, so they quickly die out. But sometimes the new ecosystem lacks the predators or other enemies that controlled the introduced species' growth in its natural habitat. If the new arrival can tolerate the new conditions, has few nutrient limitations, and/or reproduces quickly and in large numbers, there may be no bounds to its consumption of resources or reproduction rate. These introduced species, or **non-native** species, might be **invasive**. They may out-compete native species.

Introduction of non-native species can happen accidentally or deliberately. Species may be inadvertently transported here on ships, or packaged in imported goods, or escape from zoos or arboretums. Purposeful introductions occur when people bring in species for aesthetic reasons, to provide new game wildlife populations, for pest control, or when unwanted pets are released. In some cases, the introduced species can be beneficial to the ecosystem; however, too often, their impact is devastating.

Melaleuca forest – introduced to dry up wetlands

Some South Florida Non-native Species

Plants		Animals	
Lygodium (climbing fern)	Melaleuca	Burmese python	Blue tilapia
Hydrilla	Australian pine	Walking catfish	Oscars
Water hyacinth	Brazilian pepper	Feral pig	Cichlids
Earleaf acacia	Carrotwood	Eurasian collared dove	Carp
Air potato	Water lettuce	Bromeliad weevil	Asian eel

Complete the table below to better understand the competition between native and non-native species.	**Native** Cypress tree (cones)	**Non-native** Melaleuca tree (pods)
Cones/pods per branch	6 - 8	100
Seeds per cone/pod	15 - 20	200 - 300
Seeds per branch		
No. of reproductive cycles per year	1	At least 3
Seeds per branch per Year		
No. of branches per tree	20 - 30	20 - 30
Seeds per tree per year		

Careers Related to the Everglades

Restoration Works!

Everglades restoration is under way! More than 60 projects make up the Comprehensive Everglades Restoration Plan (CERP), a state-federal partnership that will restore this South Florida ecosystem.

Restoring America's Everglades is a massive, landmark effort. The state of Florida has already invested $1.8 billion in water quality improvements alone.

Scientists working in wetlands ecology, estuarine science, hydrogeology and other disciplines provide vital knowledge and direction for these efforts. Their primary goal is to "get the water right."

Join Us!

A diverse workforce is needed to achieve these goals. Consider just some of the careers shown here. Your skills and expertise will be needed in the years ahead to ensure the Everglades' future. Continue your education. America's treasure, the Florida Everglades, is in your hands!