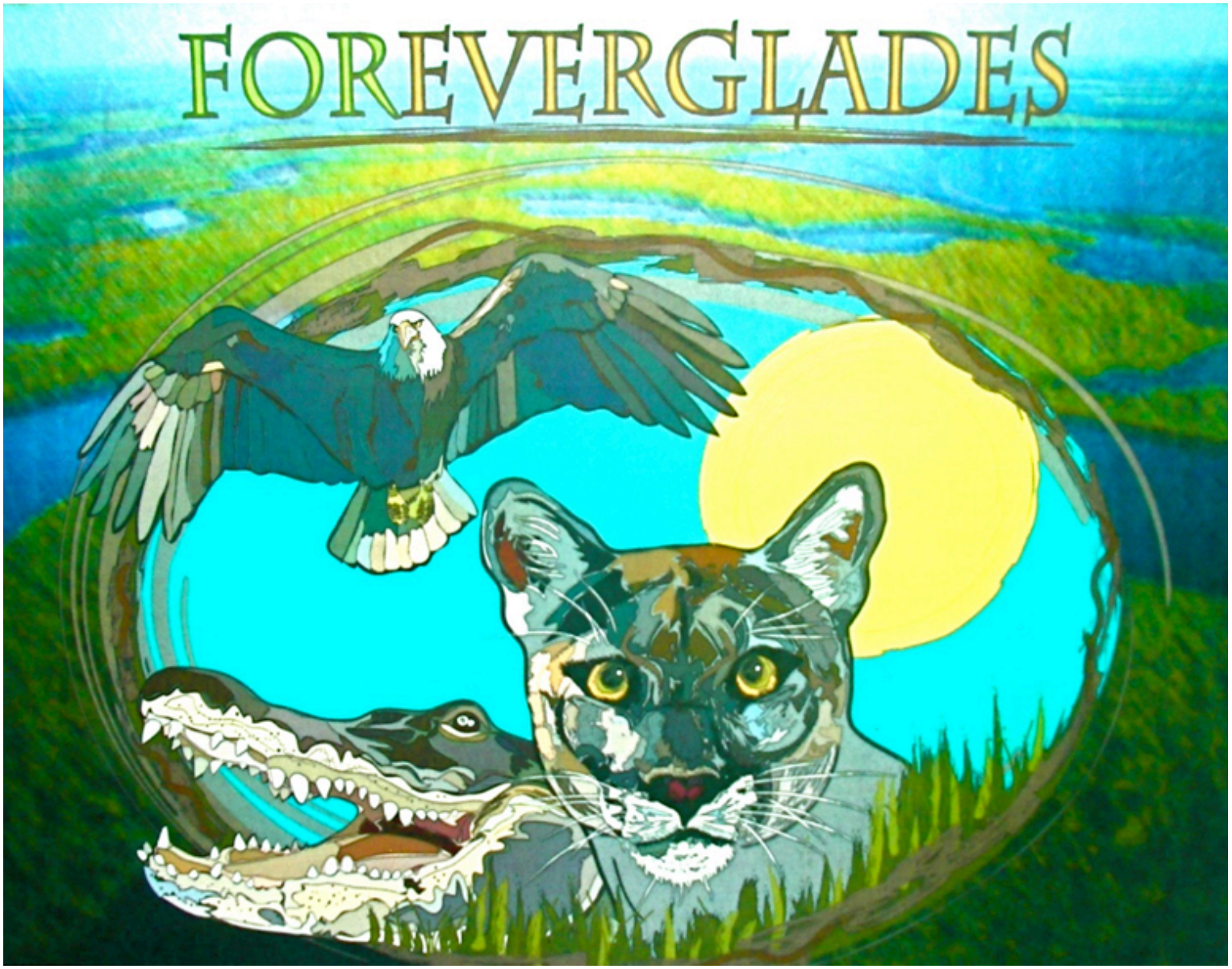
Rhythms of the Refuge

A Guide for Educators



Arthur R. Marshall Loxahatchee National Wildlife Refuge

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U.S. Fish & Wildlife Service

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Dedication
To the Tomorrow of our Boys and Girls

"There is no other Everglades in the world. They are, 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."

"The Everglades: River of Grass"

By: Marjory Stoneman Douglas 1947

Welcome Educators

Thank you for choosing to use the environmental education services provided by the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge), managed by the U.S. Fish and Wildlife Service. We are delighted that you are taking the opportunity to enhance your group's learning experiences at the Refuge!

The *Rhythms of the Refuge: A Guide for Educators* is designed to assist your students' learning, discovery, and enjoyment of the environment in the hopes that they will become informed citizens and responsible land stewards who protect habitats and wildlife. Refuge staff also welcomes formal partnerships with schools and school districts and will be happy to assist you in these efforts.

This guide contains information about the Refuge's history and habitats; tips for organizing field experiences to the Refuge; a variety of educational activities and lesson plans for before and after your visit correlated to the Next Generation Florida Sunshine State Standards; Discovery Trunk Inventories that educators can check out to use off-site from the Refuge; service learning opportunities; glossary of terms, and appendices with additional resource information – of which, all are adaptable to every grade level and discipline. The bold aqua words are all defined in the glossary to enhance your student's knowledge.

If this guide fulfills its purposes, your field experience will result in big grins, wind-blown hair, dirty hands, happy memories, and a new and better understanding of the Refuge, its wildlife, and habitats.

We greatly look forward to seeing you at the Refuge soon! Call 561/732 3684 and ask for the Education Department.

As a result of using *Rhythms of the Refuge: A Guide for Educators*, students will be able to:

- Describe the unique contribution to conservation both historically and presently of Arthur R. Marshall Loxahatchee National Wildlife Refuge in the local area, surrounding region, and National Wildlife Refuge System.
- Use scientific methodology in order to explore the environment: ask questions, hypothesize, collect data, analyze data, form conclusions.
- Describe and apply basic ecological concepts, such as energy flow, community, diversity, change, interrelationships, cycles, and adaptation.
- Describe the components and functions of a given habitat by observing, counting, and describing the animals and plants in that habitat.
- Explain the role of the National Wildlife Refuge System in wildlife and habitat conservation.
- Make a land use and/or land management decision in a role play situation and examine the consequences of that decision.
- Show how individuals can affect the earth through their behaviors and attitudes.

Acknowledgements

Special thanks to the following individuals who contributed their time and expertise toward improving environmental education at the Refuge.

- The Refuge staff who contributed to the various drafts and reviews of chapters of *Rhythms of the Refuge: A Guide for Educators*,

  Faye Pelosi (Palm Beach County Educator),

  Cindy Bhebe (Santaluces High School) and

  Wendy Casperson (Seminole Trails Elementary School)

  for their extensive work on this guide and "pulling it all together" correlating *Rhythms of the Refuge: A Guide for Educators* to the Florida Next Generation Standards and making the manual a cohesive guidebook.

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- Credit for the photographs and images are courtesy of

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  Charles Slavens,

  Lance Warley,

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  and the U.S. Fish and Wildlife Service Image Library.

  Other charts, maps, and photographs are credited as noted, and the writers of this manual sincerely thank them.

- The graphic art on the cover was designed in 2010 "The Year of the Everglades" by 12th grade South Tech Academy student, Kenneth Henry. He submitted his art to the Palm Beach County Cultural Council – Everglades Art Contest.

  Mr. Henry's art was chosen to be one of the 30 pieces chosen from all grade levels in Palm Beach County to represent the best at the 25th Annual Everglades Coalition - the 30 student winners/representatives/ambassadors were shown around the county and the Refuge was the first display stop. Thank you again, Ken Henry for allowing your art to set the stage for Refuge field trips of the future!

- Compiled by Interpretive Specialist Serena Rinker, Arthur R. Marshall Loxahatchee National Wildlife Refuge, U.S. Fish and Wildlife Service.

Chapter I

Introduction to Established Conservation Systems

The U.S. Fish and Wildlife Service
In the United States, Federal agencies play an important role in conservation. There are a number of Federal government agencies involved in protecting the environment including the U.S. Fish and Wildlife Service (Service). Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) is part of this agency. Other agencies and private groups also work to conserve fish, wildlife, plants, and habitats, but the (Service) is the only **Federal** agency whose **primary** responsibility relates to fish, wildlife, plants, and their habitats.

- The mission of the U.S. Fish and Wildlife Service (Service) is:

Working with others to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.

- To accomplish this mission, the Service has a number of programs and activities. Some of these programs and activities are:

1. **National Wildlife Refuge System**
   The Service manages more than 565 National Wildlife Refuges and more than 3,000 waterfowl production areas across the United States and its territories. As the land-base of the Service, the Refuge System includes over 150 million acres of lands and waters, and provides prime habitat for fish, wildlife, and plants across the country.

2. **Migratory Bird Conservation**
   Migratory birds cross state lines and international borders regularly, the only effective way to conserve these **populations** is through cooperation at a large scale. For this reason, the Service is the lead Federal agency for managing migratory birds in the United States.

3. **Fish Conservation and Restoration**
   The Service helps restore fish populations that have been depleted due to over-fishing, pollution, or other habitat damage. A network of national fish hatcheries, fish technology centers, fish health centers, and fish and wildlife management assistance offices aid in fishery conservation.

4. **Endangered Species Recovery**
   The Service works to conserve and restore endangered and threatened species and the ecosystems upon which they depend. After identifying a particular species as threatened or endangered, Service staff develop recovery plans for those species, and sets up processes as dictated by the **Endangered Species Act** (1973).

5. **International Work**
   The Service is also involved in working on international treaties and agreements to promote long-term conservation of **natural resources**. The treaties provide sound biological advice as to how to implement these laws and treaties by providing international leadership on conservation issues.

6. **Law Enforcement**
   In its law enforcement role, Service staff investigate violations of national laws and international treaties related to wildlife, regulating wildlife trade, and help Americans understand and obey wildlife protection laws.

The National Wildlife Refuge System

The National Wildlife Refuge System is truly unique because it is the world's largest and most diverse collection of lands set aside specifically for wildlife. Today, there are more than 563 National Wildlife Refuges (NWR), covering over 150 million acres. There is a least one refuge in every state, American Samoa, Puerto Rico, the Virgin Islands, the Johnson Atoll, the Midway Atoll, and several other Pacific islands (www.fws.gov).

U.S. Fish & Wildlife Service

The U.S. Fish and Wildlife Service and the National Wildlife Refuge System in Florida

The U.S. Fish and Wildlife Service areas in Florida include: the National Wildlife Refuge System, Fish Hatchery in Welaka; Law Enforcement Offices in Miami, Ft. Myers, Vero Beach, Groveland, Tampa, Jacksonville, Tallahassee; Ecological Services Offices in Vero Beach, Panama City, Jacksonville; a Realty Office in Jacksonville, and at Ding Darling NWR; a Fish Resource Coordination Office in Panama City; and Partner Program offices in Jacksonville, Naples, and Panama City.

Key

ES - Ecological Services Office

LE - Law Enforcement Office

RE - Realty Office

- Fish Resource Coordination Office

- Fish Hatchery

- National Wildlife Refuge

History

Several people were influential in the development of the Refuge System, which began in 1903, when **President Theodore Roosevelt** (left) established the four-acre Pelican Island in Florida as a Federal Bird Reservation. Pelican Island was the first Federal land set aside specifically to protect wildlife. In 1912, the National Elk Refuge was established in Wyoming; it was the first unit to be called a "refuge." From its modest beginnings in Florida, the National Wildlife Refuge System has continued to grow.

While the Refuge System officially began in 1903, the foundations for protecting wildlife and land resources began long before this date. In the mid-1800s, certain groups became more aware of the importance of fish, wildlife, and land resources. Scientists began to see evidence of depleted natural resources, as did hunters and anglers. These groups began to lobby Congress for protection of the Nation's resources. Interest increased in saving our Nation's wild lands.

The so-called "Duck Committee" formed by President Franklin Roosevelt in 1934 had great impact in redirecting Refuge resources toward the protection of migratory birds. One of the committee members, J.N. "Ding" Darling (above) went on to became Chief of the Biological Survey which oversaw Refuges that same year. In 1935, J. Clark Salyer II was sent around the United States to select new refuge areas. Salyer is considered by most to be "the father of the Refuge System." For 31 years, he oversaw Refuge administration and management and defended the integrity of Refuges and the wildlife that inhabited them.

J.N. "Ding" Darling was a political cartoonist who created the Blue Goose symbol which is now the logo for the National Wildlife Refuge System. Darling was also the creator of the Federal Duck Stamp which can be purchased by anyone but especially hunters over the age of 16 and the money raised is used to purchase wetlands for the protection of wildlife habitat. Since 1934 over $670 million has been raised and 5.2million acres have been purchased for wildlife.

Aldo Leopold (left) was appointed as the first Professor of Game Management at the University of Wisconsin-Madison (this was the first such appointment). Leopold, by the late 1930's was the nation's foremost expert on wildlife management and advocated for the scientific use of wildlife habitats by both public and private areas. Leopold's philosophy was that wildlife management was a technique for restoring and maintaining the environmental diversity of an area rather than creating an abundance for hunters.

John Clark Salyer II (left) was recruited by J.N."Ding" Darling to oversee the management of the National Wildlife Refuges. Salyer was given a car to drive since he was afraid to fly and in the first six weeks of being on the job he had driven over 16,000 miles and had drawn up plans for over 600,000 acres of new refuge lands. He was given the title "Father of the National Wildlife Refuge System" for all of his contributions. Under his direction the Refuge System increased in size from 1.5 million acres in the mid 1930's to almost 29 million acres upon his retirement in 1961.

Thomas H Beck (left), editor of Collier's Magazine, was appointed the chairman of the Wildlife Restoration committee by Roosevelt along with "Ding" Darling and Aldo Leopold. The purpose of this committee was to acquire lands for waterfowl, upland game, mammals, and song, insectivorous, and ornamental birds. They prepared a report recommending that $50 million be earmarked for the acquisition of such lands and for habitat restoration. The committee also was under the direction of the Secretaries of Agriculture, Interior, and Commerce.

Mission

The mission of the National **Wildlife Refuge** *System is: to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources of the United States for the benefit of present and future generations of Americans.*

According to the U.S. Fish and Wildlife Service website (www.fws.gov) most Refuges were established for the protection of migratory birds, especially **waterfowl** and are aligned along the four major migratory bird flyways including the Pacific, Rocky Mountain, Mississippi, and Atlantic. A smaller number of

Refuges were established for special reasons, such as protecting a particular species including the National Elk Refuge in Wyoming and Florida Panther National Wildlife Refuge in Florida. However, the purpose of these refuges usually broadens to include the **conservation** of the many other wildlife and plant species found in the refuge habitats.

Waterfowl Production Areas

Waterfowl Production Areas (WPAs) provide **critical habitat** for waterfowl as well as other wildlife. WPAs became a part of the Refuge System in 1966. There are over 3,000 WPAs in the United States, covering 668,000 acres. Most WPAs (almost 95 percent of them) are located in North Dakota, South Dakota, Minnesota, Wisconsin, and Montana. Many WPAs are in prairie wetlands called **prairie potholes** (prairie potholes region is an area of the northern Great Plains with mid and tall-grass prairies that contain thousands of shallow **wetlands** known as potholes). These wetlands are often temporary and may not be wet throughout the year, but they provide critical habitat for wildlife on the prairie landscape.

The passage of the Migratory Bird Hunting and Conservation Stamp Act ("Duck Stamp" Act) in 1934 helped provide the money needed to buy land for Refuges; ninety-eight cents of every dollar are used to purchase wetlands. One third of America's **threatened** species make refuges their home. Under this act, duck hunters are required to buy the Federal Duck Stamp, thereby supporting the Refuge System through the acquisition of land. The act also opened up parts of the Refuge System for hunting. In the same year, the passage of the Fish and Wildlife Coordination Act authorized federal water resources agencies to acquire land in order to protect and enhance fish and wildlife.

Wildlife Management

National Wildlife Refuges are managed by staff using a variety of management tools. These tools vary according to the management goals, but can include prescribed burning, mowing, water management, exotic plant and animal control, hunting, grazing, and agriculture. These tools help to restore, maintain, and enhance fish, wildlife, and plant resources.

Recreation

Most Refuges are open to the public for wildlife-dependent recreation, as long as the recreation is compatible with the wildlife conservation mission and purpose of the Refuge. Activities can include hunting, fishing, wildlife observation, wildlife photography, environmental education, and interpretation. Also, many Refuges now have handicapped accessible facilities. The availability of these recreational activities allows visitors to enjoy and appreciate National Wildlife Refuges and understand their importance to conservation.

Blue Goose Symbol of National Wildlife Refuges

The blue goose is the symbol of the National Wildlife Refuge System. If you see the blue goose, then you're near a vital refuge.

Rachel Carson was a scientist and chief editor for the U.S. Fish and Wildlife Service from 1939-1952. She wrote the following essay in 1948 as an introduction to the series, "Conservation in Action," a collection of narratives about refuges and the Refuge System:

If you travel much in the wilder sections of our country, sooner or later you are likely to meet the sign of the flying goose – the emblem of the National Wildlife

Refuges. You may meet it by the side of a road crossing miles of flat prairie in the Middle West, or in the hot deserts of the Southwest. You may meet it by some mountain lake, or as you push your boat through the winding salty creeks of a coastal marsh. Whenever you meet this sign, respect it. It means that the land behind the sign has been dedicated by the American people to preserving, for themselves and their children, as much of our native wildlife as can be retained along with our modern civilization.Wild creatures, like men, must have a place to live. As civilization creates cities, builds highways, and drains marshes, it takes away, little by little, the land that is suitable for their space for living dwindles, the wildlife populations themselves decline. Refuges resist this trend by saving some areas from encroachment, and by preserving in them, or restoring where necessary, the conditions that wild things need in order to live.

National Wildlife Refuge System Timeline

1869	Congress designates the Pribilof Islands in Alaska as a national reservation for the protection of fur seals; authority was placed with the Department of Treasury.
1871	Congress established the US Commission on Fish and Fisheries with Spencer Fullerton Baird as the Commissioner. This commission was the first to become concerned with the natural resources conservation and was affiliated with the Smithsonian. This Committee was directed to study the decline of food fish of the seacoasts and lakes of the U.S.
1872	Yellowstone National Park was created by an Act of Congress. The Secretary of the Interior was responsible for the managing of the park and the prevention of the wanton destruction and commercial taking of wildlife and fish.
1885	George Bird Grinnell proposed an organization for the protection of birds called, The Audubon Society.
1887	Boone and Crocket Club is founded by Theodore Roosevelt, George Bird Grinnell and others to help stop the loss of the U.S.'s natural resources and protect and conserve wildlife habitat.
1899	Industrialist Edward H Harriman invited scientists on an all-expense paid trip to Alaska to study wildlife and habitat. Many of these areas became National Wildlife Refuges 80 years later.
1900	The Lacey Act became the first Federal law that protected game prohibited interstate shipment of illegally taken wildlife and the importation of species.
1903	Beginning of the National Wildlife Refuge System - President Theodore Roosevelt established Pelican Island (Florida) as the first bird sanctuary. During his term, he created 51 bird reservations and four big game preserves.
1918	The Migratory Bird Treaty Act between the U.S. and Great Britain (Canada) became the foundation for future legislation; greatly expands the System.
1934	President Franklin D. Roosevelt convened a committee to determine how to save waterfowl during the Dust Bowl era. Conservationist Aldo Leopold, cartoonist J.N. "Ding" Darling, and publisher Thomas Beck suggested a "Duck Stamp" act to raise funds for acquiring wetland habitat. Congress passed the Migratory Bird Hunting and Conservation Stamp Act ("Duck Stamp" Act).
1935-1936	"Ding" Darling, head of the U.S. Biological Survey (the predecessor of the U.S. Fish and Wildlife Service) sent biologist J. Clark Salyer II to locate prime wetlands nationwide. The 600,000 acres that were eventually purchased became more than 50 Refuges, including Red Rock Lake (Montana) for trumpeter swans and Agassiz (Minnesota) for waterfowl.
1940	U.S. Fish and Wildlife Service formed as part of Department of the Interior.
1951	Loxahatchee National Wildlife Refuge established on June 8th the 216th NWR.
1962	In the early 1960's, United States citizens were becoming more interested in outdoor recreation. The Refuge Recreation Act opened up Refuges for more recreational uses, including education. The major stipulation of this act was that recreation could not interfere with the primary goals of the Refuge.
1966	The National Wildlife Refuge System Act was passed. It included measures to preserve ecosystems for endangered species, perpetuate migratory bird species, preserve natural diversity, and create public appreciation for wildlife protection.
1980	Alaska National Interest Lands Conservation Act adds almost 54 million acres to the Refuge System in that state.
1986	With Public Law 99-615 President Ronald Reagan renamed the Loxahatchee National Wildlife Refuge to Arthur R. Marshall Loxahatchee National Wildlife Refuge.
1997	National Wildlife Refuge Improvement Act legally establishes the conservation of fish, wildlife, and plants as the mission of the Refuge System. As established by the act, the mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources of the United States for the benefit of present and future generations of Americans. The act also gives priority to certain wildlife-dependent recreational uses on Refuges so long as they are compatible with the purposes of the refuge and the mission of the Refuge System. These uses are hunting, fishing, wildlife observation, wildlife photography, environmental education, and interpretation.
2003	NWR System celebrates its centennial.

U.S. Fish & Wildlife Service

Standards

Math
I can investigate patterns of association.

English Language Arts (ELA)
I can determine the main idea or essential message through inferring, paraphrasing, summarizing, and identifying relevant details.

Science
I can recognize that scientists who make contributions to scientific knowledge come from all kinds of backgrounds and possess varied talents, interests, and goals.

History and Civics
I can utilize timelines to identify the time sequence of historical data. I can analyze how images, symbols, objects, cartoons, graphs, charts, maps, and artwork may be used to interpret the significance of time periods and events from the past.

Art
I can identify examples in which artists have created works based on cultural and life experiences.

Activities/Lessons

*National Wildlife Refuge System Timeline Matchup from **Okefenokee NWR** curriculum (for students grades 3 and up)*

Materials: Timeline from Chapter I or example timeline below. Scissors, envelopes.

Activity: This will take about 1 class period. Prior to class, cut the timeline into strips and cut the date off of each fact (keep an uncompromised copy as your reference.) Put the date in one envelope and the fact in another. Hand each student an envelope. Students must match their fact with the appropriate date. Once they have linked into these groups of two, students must then arrange themselves into chronological order as per the timeline. At the end of the activity. Each pair reads their date and fact and students are moved to the correct places in the timeline as needed. If using example timeline, make sure content is taught so students have an understanding of specifics.

Example of Timeline

1872	**First National Park established** Yellowstone National Park was established.
1891	**First National Forest established** The Yellowstone Timberland Reserve (now part of Shoshone and Teton National Forests) was established by Benjamin Harrison.
1903	**First National Wildlife Refuge established** President Theodore Roosevelt establishes Pelican Island as the first National Wildlife Refuge. During his term, he created 51 bird reservations and four big game preserves.
1905-1912	**Refuges for big game animals were established** First refuges for big game animals were Wichita Mountains (OK)-1905; National Bison Range (MT)-1908; National Elk Refuge (WY)-1912.
1918	**Migratory Bird Treaty Act** The Migratory Bird Act between the U.S. and Great Britain (for Canada) became the foundation for the legislation that would greatly expand the refuge system.
1924	**Upper Mississippi National Wildlife Refuge established** First refuge designated for wildlife and fish; also the first to allow hunting. Izaak Walton League Founder Will Dilg was instrumental in the effort, after his son drowned in the river.
1929	**Migratory Bird Conservation Act** The Migratory Bird Conservation Act authorized the Interior Secretary to acquire areas for migratory birds with approval by the Migratory Bird Commission.
1934	**Migratory Bird Hunting and Conservation Stamp Act** President Franklin D. Roosevelt convened a committee to determine how to save waterfowl during the Dust Bowl era. Aldo Leopold, JN "Ding" Darling and publisher Thomas Beck suggested a "duck stamp" to raise funds for acquiring funds for wetland habitat.
1936	**J. Clark Salyer identifies prime wetlands for acquisition** "Ding" Darling assigned Salyer to identify prime wetlands nationwide. The 600,000 acres he purchased became over 50 refuges, including Red Rock Lakes (MT) for Trumpeter Swans and Agassiz (MN) for waterfowl.
1940	**Conservation in Action Booklets** Service scientist Rachel Carson wrote a series of Conservation in Action booklets examining wildlife and habitats on refuges.
1939-1945	**Refuge lands open to oil and gas drilling** Interior Secretary opened refuge lands to oil and gas drilling and allowed the Department of Defense to use Refuge lands for bombing practice.
1951	**Loxahatchee Wildlife Refuge established** Under the authority of the Migratory Bird Conservation Act of 1929, Loxahatchee National Wildlife Refuge was established on June 8, 1951 in a license lease agreement with the Central and Southern Florida Flood Control Project (now called the South Florida Water Management District).
1958	**Acquisition of Waterfowl Production Areas authorized** The Duck Stamp Act was amended to authorize acquisition of small wetland "potholes" as Waterfowl Production Areas. The Service has acquired more than two million acres of wetland and grassland habitat from 28,000 landowners in eight north-central states.
1962	**Refuge Recreation Act** The Refuge Recreation Act (amended 1966) permitted "secondary recreational uses" on refuges where such activities do not conflict with refuges primary purposes, when there is money to administer them.

U.S. Fish and Wildlife Service Emblem Design Contest
from Faye Pelosi (all grades)

Materials: Chapter I information. Students may use any medium to produce this creation.

Activity: This can be used as extra credit or a class assignment. Have students create a new design to illustrate the U.S. Fish and Wildlife Service emblem, representing the agency. It should be an original idea much like the Blue Goose emblem was "Ding" Darling's original creation. Student's product can be referenced for art contests with Arthur R Marshall Loxahatchee National Wildlife Refuge among others (see appendix resources for information on the Duck Stamp Art Contest).

Conservation Jeopardy
from Faye Pelosi (grades 2 through adult)

Materials: Individual white boards (which can be borrowed from the Refuge, The Marsh Trail Classroom Trunk) and markers or plenty of blank paper and any writing utensil, large white board.

Activity: This will take two class periods.
Class period 1:
In small groups, students read the chapter and mark the text while they create (who, what, when, where, why, and how) questions and answers provided from information within the chapter and/or from researched materials. The teacher compiles the best and most rigorous questions and answers from each group and puts them into categories that represent each sub-heading in the chapter.

Class period 2:
Before students arrive, the teacher creates a Jeopardy board on the master white board (see sample Jeopardy board at right), students get into groups that are different from the ones they were in during the previous period; each group gets a small white board and marker (or paper and writing utensil).

Example of Timeline - continued

1964	**Land and Water Conservation Fund Act** The Land and Water Conservation Act authorized funds from off-shore oil leases to acquire wildlife habitat.
1964	**National Wildlife Refuge System Administration Act** The National Wildlife Refuge System Refuge System Administration Act created the "compatibility" standard that secondary uses must be consistent with the major purposes for which refuges are established.
1966	**National Wildlife Refuge System Act** The National Wildlife Refuge System Act included measures to preserve ecosystems for endangered species, perpetuate migratory bird species, preserve natural diversity, and create public appreciation for wildlife.
1969	**Hobe Sound National Wildlife Refuge established** Hobe Sound National Wildlife Refuge was established September 30, 1969 through the generosity of conservation minded Jupiter Island residents to protect the diminishing manatee and green sea turtle populations found in the Intracoastal Waterway in Hobe Sound.
1974	**U.S. Fish and Wildlife Service created** The U.S. Bureau of Sport Fisheries responsibilities were reassigned to the newly created U.S. Fish and Wildlife Service.
1980	**Alaska National Interest Lands Conservation Act** This act added almost 54 million acres to the Refuge System in Alaska.
1986	**Loxahatchee National Wildlife Refuge name changed** Loxahatchee NWR name was changed to the Arthur Raymond Marshall Loxahatchee National Wildlife Refuge on November 6, 1986 by a law signed by President Ronald Reagan.
1994	**500th National Wildlife Refuge established** Canaan Valley National Wildlife Refuge in West Virginia was established – it is the highest valley east of the Rocky Mountains.

The teacher determines which group goes first by any method. The first group to go chooses a category and numerical points; the teacher reads aloud the question associated with that category and level of rigor, all groups write (as fast as they can) the answer and hold up their board QUIETLY; whichever group is first and correct then gets the points and also gets to choose the next category and numerical points to incite the next question. Teachers can make a bonus column offering lots of points and can use any information from the chapter for bonus questions, definitions, etc…

Example of Jeopardy

U.S. Fish and Wildlife Service	National Wildlife Refuge System	The Blue Goose	Wildlife Management
5	5	5	5
10	10	10	10
15	15	15	15
20	20	20	20

U.S. Fish & Wildlife Service

Chapter 2
Arthur R. Marshall Loxahatchee National Wildlife Refuge

The Refuge was originally named Loxahatchee National Wildlife Refuge because it was physiographically connected to the **Loxahatchee River** via the Loxahatchee **Slough**. The connection has since been **dredged**, filled, and developed. Loxahatchee's (the name for "turtle" in the Mvskoke language is Loca. The correct spelling for "Turtle River" is Loca Hvtce. The **Seminole** and Mvskoke people speak the same language supposedly) name was changed in 1986.

Then President Ronald Reagan renamed the Refuge the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) to honor Arthur R. Marshall, Jr. (1919-1985), an influential conservationist in South Florida. Marshall was a marine **fisheries** biologist for the U.S. Fish and Wildlife Service for 15 years, taught at two Florida universities, and served as a Governing Board member for the South Florida Wildlife Management District. He was instrumental in securing protection for the Big Cypress National Preserve, Biscayne National Park, and Pelican Island National Wildlife Refuge. Since the Refuge is the Everglades, it encompasses all ecological systems of the Everglades: Cypress Swamp, Sawgrass Communities, Tree Islands, Wet Prairies, and Sloughs – all of which will be discussed at great length in Chapter III. It has also been subject to the same historical influences as the entire Everglades.

Everglades History

Evidence shows that the first people lived and thrived in Florida about 12,000 years ago when the last Ice Age ended. They lived on the rich plant life and on the wide variety of animals that are still around today. In addition to the small mammals that we see now there were also large **mammals** that are now extinct like the saber tooth tiger, mastodon, giant armadillo and the camel. Much of the first people's existence has been found through the discovery of their garbage mounds which have been found across Florida and through the Everglades.

"In 1513, Spanish explorer **Ponce de Leon** names North America's most familiar appendage La Florida, or "land of flowers." He finds no streets of gold, only the fierce and proud **Calusa Indians**, who mortally wound him on a subsequent visit. In 1545, thirteen-year-old **Hernando d'Escalante Fonaneda**, shipwrecked en route from Spain to Colombia, spends 17 years as a Calusa Indian captive. Although Fonaneda writes that the Indians have "no gold, less silver, and less clothing," they have nevertheless fashioned a high prehistoric culture along the edge of the Everglades building oyster-shell islands and digging canals.

In 1823, the word **Everglades** is coined from the old English "glyde" or "glaed," which means "opening in the forest." On May 28, 1844, the first snail kite was collected in the Everglades for scientific purposes; it was shot near the headwaters of the Miami River, now present day Miami International Airport. Florida became the 27th state in the Union with a population of 70,000 in 1845." (Audubon magazine, 8/2001)

Historical Dates Affecting the Refuge

1881	First drainage began in the Everglades
1907	Everglades Drainage District created by Florida Legislature
1917	Four canals dug: West Palm Beach, Hillsboro, New River, Miami (1750 miles)
1926	Hurricane killed an estimated 400 people around Lake Okeechobee
1928	Hurricane killed an estimated 2000 people around Lake Okeechobee
1929	Florida Legislature established Okeechobee Flood Control District
1930	Army Corps of Engineers and the state began enlarging levees around Lake Okeechobee
1934	Sugar Act created price supports
1947-48	Hurricanes cause massive flooding (108 inches for the year total)
1949	Central and South Florida Flood Control District (C&SF) established
1951	Loxahatchee National Wildlife Refuge established
1952-54	Eastern perimeter levee constructed 100 miles long (including L-40); S5A pump built
1954-59	Many more levees constructed including L-7; S-6 pump built
1960-63	Conservation areas made; L-39 enclosed refuge; Gates S-10A, C, and D built
1970s	Significant shift to cattails showing along perimeter
1972	C&SF became South Florida Water Management District
1978	Refuge designated as **Outstanding Florida Waters**
1986	With Public Law 99-615, President Ronald Reagan changed the Loxahatchee NWR name to Arthur R. Marshall Loxahatchee National Wildlife Refuge
1987	SWIM Act passed by Florida Legislation
1988	U.S. attorney filed suit in Federal court against the state of Florida for polluting Arthur R Marshall Loxahatchee National Wildlife Refuge and Everglades National Park
1991	Federal and State governments made a Settlement Agreement
1992	Settlement Agreement signed in court as Consent Decree
1993	Statement of Principles signed; Technical mediation group met
1994	Everglades Forever Act signed (May 3); Everglades Nutrient Removal project began operation (August 18)
1994	Construction began on STA 1E
1995	Modification to Consent Decree recommended by all signing parties
1997	Construction began on STA 1W
2002	License agreement renewed for another 50 years
2003	Loxahatchee Impoundment Landscape Assessment project inaugurated in Management Compartment C impoundments 3 and 4

"The Everglades is a **freshwater** marsh that originally covered an area of about nine million acres. Now the Everglades are an area of about 1.92 million acres. Lake Okeechobee, with its floor near sea level, occupies a 467,200 acre basin that is almost centered between the east and west coast at the northern end of the Everglades system. The Everglades was created by the sheet flow of water from the lake through a marsh that very gradually covered the **limestone** bottom with a layer of peat." (Lodge, 2004)

Beginning with the Swampland Act of 1845, and later the 1907 Everglades Drainage Act, excessive drainage activities occurred in the Everglades to pave the way for agriculture and development. To meet the ever-increasing water needs of agriculture and population expansion, three water storage areas called **Water Conservation Areas 1, 2, and 3** were constructed by the U.S. Army Corps of Engineers in the 1940s. Bounded by **levees** and connected by a series of canals, these areas were placed under the jurisdiction of what is now the South Florida Water Management District, a regional governmental agency of the State of Florida.

In 1951, a license agreement between the Central and South Florida Flood Control District (now called the South Florida Water Management District) and the U.S. Fish and Wildlife Service, under the authority of the Migratory Bird Conservation Act, enabled the establishment of the 141,324-acre Loxahatchee National Wildlife Refuge. The Refuge is the only remnant of the northern Everglades in Palm Beach County, Florida. Most of the Refuge is encompassed by Water Conservation Area 1, which is owned by the State of Florida and the South Florida Water Management District (District) and is leased to the U.S. Fish and Wildlife Service.

In addition to the lands leased from the District, the U.S. Fish and Wildlife Service owns 2,550 acres to the east and west of the Refuge interior. This acreage

is sub-divided into four management compartments — A, B, C, Strazzulla Marsh, and the Cypress Swamp. In total, the Refuge currently includes 143,954 acres of northern Everglades' habitat.

Culture and Archeology

There are no known human settlements on Refuge lands. There was however, significant archaeological and cultural use on the lands surrounding the Refuge so it stands to reason that the Indians used the land as a way to cross the state and for hunting purposes.

The first settlers in what is now Palm Beach County and South Florida were Indian tribes such as the **Tequesta** (or **Tekesta** lived in present day Palm Beach, Broward and Miami-Dade Counties), **Jaega/Jobe** (lived between the Indian River and Southern Palm Beach County), **Mayaimis** (from the southwest side of Lake Okeechobee Basin), **Ais** (from Jupiter Inlet), and Calusa (from the Caloosahatchee River Region). The unique confluence of culture and circumstance which would become today's Seminole Tribe of Florida can be traced back at least 12,000 years, say researchers. There is ample evidence that the Seminole people of today are cultural descendants of Native Americans who were living in the southeastern United States at least that long ago. By the time the Spaniards "discovered" Florida (1513), this large territory held, perhaps, 200,000 Seminole ancestors in hundreds of tribes, all members of the Maskókî linguistic family.

When the Maskókî tribes in Alabama, whom English speakers erroneously called "Creeks," rose up against the white settlers in the Creek War of 1813-14, the brutal repression and disastrous treaty forced upon them by General Andrew Jackson sent thousands of the most determined warriors and their families migrating southward to take refuge in Spanish Florida. There, they joined the descendants of many other tribes whose members had lived all across the Florida forests for thousands of years. The Indians who constituted the nucleus of

A map of Florida's Lost Tribes, courtesy of Theodore Morris, www.floridalosttribes.com

this Florida group thought of themselves as yat'siminoli or "free people," because for centuries their ancestors had resisted the attempts of the Spaniards to conquer and convert them, as well as the attempts of the English to take their lands and use them as military pawns. Soon, white Americans would begin to call all of the Indians in Florida by that name: "Seminoles." "Seminole" is a Creek word for a renegade or a runaway. The Creeks called them this because they ran away and hid in the Everglades. Not in a derogatory sense, just descriptive.

But Spain could not afford enough soldiers to patrol the long frontiers of Florida. Its choice lands were openly coveted by white settlers who regularly moved across its borders. English war ships anchored off its Gulf coast and English agents encouraged the Seminoles, Creeks, and Mikisúkî to resist U.S. settlement openly. U.S. officials, angry that the Spaniards could not oust the English or control the Indians, were particularly incensed by the protection and shelter the Seminoles offered to African slaves. These freedom seekers had been finding refuge in Spanish Florida for over a century, but the new U.S. government was determined to stop this practice. In the late 1700s and early 1800s, conflicts, skirmishes, and ambushes erupted and racial hatred flared into violence more and more frequently on the new frontier.

When the military and political opportunist, General Andrew Jackson, brazenly marched across Florida's international boundaries to settle the "Indian problem," he created an international furor. Over a period of several tumultuous years, he burned Indian towns, captured Africans, and

hanged one Maskókî medicine man, Francis, as well as two Englishmen whom he suspected of inciting the Indians. This series of events, which took place between 1814 and 1818, is known as the First Seminole War.

And the conflicts did not end there; they only escalated. Through the Treaty of Moultrie Creek (1823), the Treaty of Payne's Landing (1832), and numerous "talks" and meetings, U.S. Indian Agents sought to convince the Florida Indians to sell their cattle and pigs to the U.S. government, return runaway slaves to their "rightful owners," leave their ancient homelands in Florida, and move west of the Mississippi River to Arkansas Territory. In 1830, soon after Jackson the Indian fighter became Andrew Jackson, the president of the United States, he pushed through Congress an Indian Removal Act. With this Act, the determination of the government to move Indians out of the Southeast and open the land for white settlement became the official policy of the U.S., and the willingness of the government to spend monies in support of military enforcement of this policy increased.

The clash that inevitably resulted from this policy finally began in 1835, and the seven years that it lasted frame the last, the greatest, and arguably the most tragic years in the history of U.S.-Indian relations east of the Mississippi River. Known to history as the Second Seminole War, the U.S. government committed almost $40,000,000 to the forced removal of slightly more than 3,000 Maskókî men, women, and children from Florida to Oklahoma. This was the only Indian war in U.S. history in which not only the U.S. army but also the U.S. Navy and Marine Corps participated. Together with the desultory Third Seminole War, a series of skirmishes that took place between 1856 and 1858, the United States spent much of the first half of the 19th century in trying, unsuccessfully, to dislodge about 5,000 Seminoles from Florida.

The so-called "Trail of Tears" was not just a removal of the Cherokees, but all of the so-called "five civilized tribes." In 1838, the removal of the Muskogee Creeks and the Seminole had started 20 years earlier and lasted longer. These 20 years were awful, for the Muskogee Creeks who not only suffered through it, but also those who fought against cultural genocide in the Creek War of 1813 – 1814, which led up to the Removal. From 1825, when the first McIntosh party left through 1834, the Creeks still literally fought against the Removal itself. During this time they had their land, homes and food stores stolen from them; rape, murder, every evil that the white Americans could do was done to them. It took over two more years (through 1836) to complete the removal of over 20,000 Muskogee (Creek) people. Just like that other event, however, the toll in human suffering was profound and the stain on the honor of a great nation, the United States, can never be erased. The Seminole people - men, women, and children, were hunted with bloodhounds, rounded up like cattle, and forced onto ships that carried them to New Orleans and up the Mississippi. Together with several hundred of the African ex-slaves who had fought with them, they were then sent overland to Fort Gibson (Arkansas), and on to strange and inhospitable new lands where they were attacked by other tribes, in a fierce competition for the scarce resources that they all needed to survive.

In addition to "Old Hickory," as Jackson had come to be known, an impressive list of U.S. military figures eventually joined the fight to remove the Seminoles from Florida. Edmund P. Gaines, Zachary Taylor, Oliver O. Howard ("the Christian General"), Richard Keith Call, and Thomas S. Jesup, among many others, would nearly ruin their reputations trying to fight the Seminoles in a place that was cold and wet in winter, and hot and wet in summer; where only the Seminoles, alligators, snakes, and mosquitoes knew how to survive; and where dysentery and malaria were the primary rewards for Herculean efforts. One white soldier wrote home that, "If the Devil owned both Hell and Florida, he would rent out Florida and live in Hell!"

William S. Harney, — who would later tell western tribes "The Great White Father has sent me here to punish you!"— learned his vicious Indian-fighting tactics in Florida. Winfield Scott, the only commander of U.S. troops in Florida to emerge with his reputation intact, went on to reorganize the entire U.S. military establishment on the "open field" tactics that evolved from the Seminole Wars. Today, students at U.S. military academies still study the hit-and-run tactics of the Seminoles. This was the first time in its history that U.S. soldiers fought a "guerrilla" war, one in which the old "linear" tactics of the European military system were almost useless against warriors who moved in flexible formations, attacked and disappeared, and used the very terrain as a weapon against their enemies. The U.S. would not fight another such war until its troops entered the tiny Southeast Asian nation of Vietnam, more than a century later.

By May 10, 1842, when a frustrated President John Tyler ordered the end of military actions against the Seminoles, over $20 million had been spent, 1500 American soldiers had died and still no formal peace treaty had been signed. At that time, it marked the most costly military campaign in the young country's history. And it wasn't over yet. Thirteen years later, a U.S. Army survey party - seeking the whereabouts of Abiaka and other Seminole groups - was attacked by Seminole warriors under the command of the colorful Billy Bowlegs. The nation invested its entire reserve into the apprehension of the ambushers.

The eventual capture and deportation of Bowlegs ended aggressions between the Seminoles and the United States. Unlike their dealings with other Indian tribes, however, the U.S. government could not force surrender from the Florida Seminoles. Historians estimate there may have been only a few hundred unconquered Seminole men, women and children left - all hiding in the swamps and Everglades of South Florida. No chicanery, no offer of cattle, land, liquor or God, nothing could lure the last few

U.S. Fish & Wildlife Service

Photo: Wendy J. Casperson

from their perches of ambush deep in the wilderness. The U.S. declared the war ended - though no peace treaty was ever signed - and gave up.

The Florida survivors comprised at least two main factions: Maskoki speakers who lived near Lake Okeechobee and those who spoke the linguistically-related Hitchiti tongue (also called Miccosukee or Seminole) and lived to the south. In the remote environs of such uncharted Florida wilderness, the Seminoles remained, living in small traditional camps of cypress frame/palmetto-thatch chickees, isolated from Florida society and the rest of the world until well into the 20th century . . . long after most tribes had experienced assimilation, religious conversion and cultural annihilation.

The descendants of these last few Indian resistors are the members of today's Seminole Tribe of Florida, the Miccosukee Tribe of Indians of Florida and the unaffiliated Independent or Traditional Seminoles. (Seminole Tribe at semtribe.com)

The next settlers arrived in 1860 when the Jupiter Lighthouse was built to aid sailors navigating the Atlantic Ocean. (www.pbcgov.com)

Homesteading began in the late 1800's, with the majority of the settlers coming to the area to set up a family farm. According to The Florida Homestead Act of 1862 Congress provided the transfer of 160 acres of unoccupied land to each homesteader upon payment of a nominal fee after five years of residence. Early farmers found the soil to be highly productive and earned most of their income by growing vegetables for the northern winter market.

"During the 1870's many northern sportsmen, hunting in the Kissimmee River and Lake Okeechobee country, met the Seminoles and found them courteous but wary and non-cooperative. About this time they also appeared regularly at villages such as Miami, Fort Myers, Fort Lauderdale, and Everglades to trade hides and plumes for guns, powder, dry goods, and grocery staples." (FWC, 1974)

The late 1800's also marked the beginning of the tourism industry. Transportation improvements, particularly to the railroad system by Henry Flagler provided easier access to the area. Hotels to serve tourists were constructed, along with the first winter homes for seasonal residents.

In 1850, Congress passes the Swamplands Act, which authorized the transfer of 20.3 million acres to the state of Florida for the purpose of drainage and reclamation. Out of the thirteen states that were part of the Swamplands Act, Florida had the most land. Much later, with the passages of the Everglades Drainage Act of 1907, excessive drainage activities occurred in the Everglades, paving the way for agriculture and development.

In 1892, **Henry Flagler** visited Palm Beach and decided to build a large resort hotel, the Royal Poinciana, and extend the Florida East Coast Railroad to West Palm Beach from Jacksonville. These developments made Palm Beach the nation's premier winter resort. Flagler considered the mainland area a perfect satellite location to service his resort and a good place for his workers to live. This area was incorporated as West Palm Beach in 1894.

Other towns, such as Linton and Boynton Beach, were established soon after West Palm Beach. The town of Linton was founded in 1894 by **William S. Linton**, the postmaster of Saginaw, Michigan. He and a friend purchased 160 acres of land and sold it in five-acre tracts through ads in Michigan newspapers. In 1901, they renamed the town Delray Beach, after a Detroit suburb.

Boynton Beach was founded in 1895 when Civil War officer **Major Nathan S. Boynton** built a 50-room resort hotel on the beach. One year later the railroad came through on its way to Miami which increased the population in the area. (www.pbcgov.com)

South Florida's three Water Conservation Areas (WCAs) are vast tracts of remnant Everglades sawgrass marsh located adjacent to Everglades National Park. Spanning 846,387 acres, the WCAs serve multiple water resource and environmental purposes, including flood control, water supply and habitat for South Florida's plant and animal communities. Construction of the three Water Conservation Areas was authorized by the U.S. Congress in 1948

as part of legislation creating the massive public works system that provides flood control and water supply for South Florida. A series of levees, along with associated water control structures, separate the wetlands in the WCAs from agricultural and urban areas of South Florida. Managing water levels in this vast area — 58 times larger than the island of Manhattan — is a responsibility of the U.S. Army Corps of Engineers.

Influences

Location

The Refuge is located in **Palm Beach County**, Florida. Located on the southeast coast, Palm Beach County is the largest of Florida's sixty-seven counties. The county's 2,268 square miles include 245 square miles of surface water, making it the largest county east of the Mississippi River. The Refuge lies west of U.S. Highway 441/State Road 7 and south of U.S. Highway 80/Southern Blvd, 15 miles west of the Atlantic Ocean.

The area east of the Refuge is a mosaic of winter vegetable farms known as the East Coast Buffer Area and housing developments; further to the east are the Palm Beaches and an unbroken chain of communities extending southward to Miami. The Everglades Agricultural Area (EAA), which includes large sugar cane plantations, winter vegetable, sod farms, and cattle ranches, is to the west and northwest of the Refuge. To the south and southwest of the Refuge lie Water Conservation Areas 2 and 3, and Everglades National Park. The Florida Everglades represent the largest contiguous freshwater marsh in the entire world. (Riley) (See page 23 in this chapter for a map of the Refuge.)

Geology

"It could be called an accident of geography that the Florida peninsula extends from North America's **temperate** climate to the edge of the Caribbean tropics. The predecessors of the modern continents of Africa and South America were connected as parts of the supercontinent called **Gondwanaland** by geologists, joined below what is now Africa's west bulge. A map of ancient North America would have lacked a prominent modern feature: Florida. The land features that would have become Florida, was then the bulge of the African Coast of Gondwanaland. (Lodge, pg 21).

In the millions of years that followed, North America slowly approached Gondwanaland, narrowing the **Iapetus Ocean** (the ocean that was between the continents) until the land masses collided about 300 million years ago. The collision created the **Appalachian Mountains** as it fused North America's east coast with Africa's west bulge, just north of South America's position, and locked Florida's terrain deep in the interior of the giant continent that was formed. Geologists called that supercontinent **Pangaea**. (Lodge, pg 21).

After a long period of quiet, Pangaea began to tremble with volcanic activity that centered near Florida. Volcanic eruptions added massive igneous rock, transforming Florida's earlier sedimentary terrain. The upheaval continued, and about 180 million years ago (**Jurassic period**) it began forcing North America to rift from Pangaea, giving violent birth to the **North Atlantic Ocean**, **the Caribbean Sea**, and **the Gulf of Mexico**. In the new configuration, however, the shallow marine terrain of Florida, the Bahamas, and parts of southern Georgia and Alabama was welded to the North American continent. (Lodge, pg 22).

The shallow marine environment of the youthful Florida platform produced **sediments** rapidly. The sediments later formed thick sequences of different types of limestone rocks and related carbonate rocks. It is about 135 million years old (**lower Cretaceous time**) and now lies 11,000 feet beneath the **Big Cypress Swamp** and western Everglades.

As a result of its long submerged history, the Florida peninsula is now a broad platform (**Floridan Plateau**) built of stable sedimentary rocks (primarily limestones ranging from ancient to very recent age), layered over the ancient basement of African origin. To the east, the plateau drops off abruptly into the Atlantic. Southward, it slopes gently to a "rim" occupied by the **Florida Keys** and then also drops off quickly into the deep trough known as the **Straits of Florida**, which is located between Cuba and Florida and carries the Florida Current (otherwise known at the Gulf Stream, or simply "the Stream.") To the west, the plateau slopes gradually far out into the Gulf of Mexico before receding into deep water. South of Lake Okeechobee, this plateau is so flat that only the direction of water flow can indicate which way is downhill.

Climate and Weather

Located in the **subtropical** region of south Florida, the Refuge's climate is hot and humid most of the year and the winters are mild. In general, there are two seasons — wet and dry. The **wet season** occurs from late May to late October. The Refuge receives some of the highest amounts of rainfall in South Florida (Gleason et al., 1975). While annual rainfall ranges from 40 to 83 inches, about 60 inches is typical. More than one-half of the rainfall for the year occurs between June and September in the form of thunderstorms. Hurricane Irene's (1999) and Hurricane Wilma's (2005) path have come directly over the Refuge, however, numerous hurricanes and tropical storms have skirted it. Large rainfall events occur primarily during the months of August to November.

During the **dry season**, November to May, rain falls during the cold fronts which average about seven per month from December through March, but the amount is significantly less than during the wet season. Winds prevail out of the southeast and the average relative humidity is 75 percent. While air temperatures at the Refuge have ranged from 20°F to 101°F, the mean summer temperature and mean winter temperature are 56°F and 89°F, respectively. The combination of humidity and temperature causes heat indices to range from 105°- 110°F in the summer.

Since the eastern edge of the Refuge is located within 12 miles of the Atlantic Ocean, temperatures are moderated. The temperatures also are moderated by the surface water of the Everglades. (Lox CCP, pg 19).

The following Historical Climate Data 1971-2006 for the City of West Palm Beach weather station is provided by the Southeast Regional Climate Center:

Annual Normal Maximum Temperature	83.2 Fahrenheit
Annual Normal Minimum Temperature	67.4 Fahrenheit
Hottest Year	1942: 106 Fahrenheit
Coldest Year	1942: 5 Fahrenheit
Coldest Month	January
Hottest Month	July
Annual Normal Precipitation	61.39 inches
Highest Precipitation Month	September: 8.35 inches
Average Yearly Precipitation	62.33 inches
Wettest month	September
Driest month	February

Arthur R. Marshall Loxahatchee National Wildlife Refuge has maintained its own **weather** station since 1990 and sends its daily data to the National Weather Service in Miami.

Management

The Refuge plays an important role in conservation on multiple geographic levels. At 143,954 acres in size, the Refuge is an important part of the overall Everglades **ecosystem**. Everglades National Park which lies directly southwest of the Refuge has been recognized as a Wetland of International Importance by the **Ramsar Convention**, the only international treaty dedicated to the protection of an ecosystem.

Everglades National Park and the Refuge contain wetlands which provide important feeding, **roosting** and nesting habitats for many birds, mammals, **reptiles** and **amphibians**. There are at least 63 imperiled species (per CCP) known to occur or could occur on the Refuge. These species are listed as Federal or State threatened and endangered species, species of special concern, species of management concern, or listed by the Convention of International Trade in Endangered Species (CITIES) and will be discussed in Chapter V. The Service has primary responsibility for federally listed species. However, in many cases many of the animals and plants occupy the same or similar habitat. In managing federally listed species, state and other listed species benefit as well.

Environmental and Wildlife Management

A variety of management programs enhance wildlife habitats at the Refuge. There are four major concerns that Refuge staff has in with respect to habitat - degraded **hydropattern**, poor water quality, exotic plants, exotic animals, urban development in adjacent areas - any one of which could compromise the future of the Refuge.

Hydropattern refers to the depth of the water, the distribution of the water, the seasonal timing of water, and the flow of water. Good water quality is critical to achieving Refuge objectives and those of the Everglade's ecosystem **restoration**. To achieve effective water management, the Refuge relies upon developing progressive partnerships with the National Park Service, Army Corps of Engineers, and the South Florida Water Management District.

Another management effort is controlling invasive **exotic** plants. Serious threats to native plant communities and wildlife habitats (entire South Florida ecosystem) include the invasive exotic plants, such as **melaleuca** (*Melaleuca quinquenervis*), old world climbing fern (*Lygodium microphyllium*), Brazilian pepper (*Shinus terebinthifolius*), and Australian pine (*Casuarina equisetifolia*). These alien plants, lacking natural **predators** and insects to keep them in check, rapidly expand, forming dense forests or thickets which are undesirable to humans and wildlife.

Adjacent proposed development is a potential threat to the ecological communities of the Refuge. Examples of **adjacent development** that have been proposed including mining in the Everglades Agricultural Area (EAA), power plants, wind farm, a landfill, a golf course, an amphitheater, and a housing development. The potential negative impacts to the Refuge differ depending on the nature of the proposed development.

Human Management

Approximately 300,000 people visit the Refuge annually. Priority recreational opportunities include hunting, fishing, wildlife observation, nature photography, interpretation, and environmental education. Visitors enjoy a number of facilities including the visitor center, Marsh Trail, Cypress Swamp Boardwalk, fishing pier, canoe/kayak trail, bike trail, viewing areas, platforms, kiosks, and more.

Visitors often ask why most of the Refuge is "closed." Roughly, 30,000 acres is open to public access. It is important to understand that wild animals need wild places to live that are undisturbed by humans, and the Refuge provides such a **sanctuary**. As a result, an abundance and **diversity** of wildlife is found here, in particular species which are sensitive to human disturbance, including nesting Everglades snail kites and nesting bald eagles. If the Refuge were completely open to recreation, there would be damage to the many species that call the Refuge home and the viewing would be limited.

Fire

Prior to the arrival of European settlers, large scale **wildfires** were common occurrences throughout Florida's peninsula especially during drought years. These wildfires, usually started by lightning, helped to form the vegetative

communities throughout Florida, both inland, the 'Glades, and coastal such as the **pine flatwoods** and **sand pine** and **oak scrub**. The mangrove community was the exception and rarely, if ever, burned. Plants and animals became adapted to natural fire occurrence.

The combination of fire and flow of water helped create the unique mosaic habitat found in the Everglades. Vast expanses of sawgrass burned with great intensity while higher elevated habitats surrounded by water, such as bayheads and **tree islands**, under all but extremely dry conditions, survived these wildfires. Deeper water areas such as wet prairies and sloughs typically did not carry fire and when they did, they burned with much lower intensity as they usually remained somewhat wet. Under extremely dry conditions, the soil, also known as **peat** or muck, would inevitably burn. This would have probably led to the formation of inland pools or ponds, as fires burned through to the underlying limestone, which would have benefitted alligators, fish, wading birds, and waterfowl.

When European settlers first penetrated the South Florida wilderness, they encountered Native Americans using fire for a variety of purposes and they would later adopt some of the same practices. Native Americans used fire to burn away dense vegetation and to drive game during a hunt. They also noted that '**game**' was more plentiful and healthier after a fire event. Prior to and before there was game enforcement, early **'Gladesmen'** often used the practice of night burning to drive and flush the white-tailed deer for hunting.

Large scale settlement, drainage and manipulation of water levels in the Everglades that occurred in the early 20th century adversely affected fire occurrence in South Florida. Humans have **fragmented**, developed, and over drained the Everglades. This led to a significant accumulation of fuels over time, which allowed wildfires to become more intense and destructive. Fires near the **urban**

interface (where human population and property abut wild or protected lands) can and do result in the loss of personal property due to the amount of underbrush that is present and not cleared from around homes as a buffer.

Mans' thoughtless introduction of invasive, exotic plants, such as melaleuca and **old world climbing fern**, has had a detrimental effect on when or where fires can be used as a resource management tool. Melaleuca leaves contain oils which are extremely volatile which increases fire behavior and intensity. The resultant fire kills native vegetation and prepares the soil bed for the rapid spread of melaleuca seeds and the replacement of native vegetation.

Old world climbing fern can carry fires into the crowns of native pines and cypress causing significant damage and pieces of the fern can break off and drift with thermals increasing the potential for spot fires. Drainage of the 'Glades has increased the potential for damaging muck fires. Dry muck or peat can be fully consumed during extreme fire conditions, which can burn for weeks; this can lead to changes in the Everglades vegetative community. Tree islands, normally protected from fire because they are usually surrounded by water, may in turn be susceptible to damaging wildfires and may take years to fully recover. In addition, they may be subject to invasion by exotic plants.

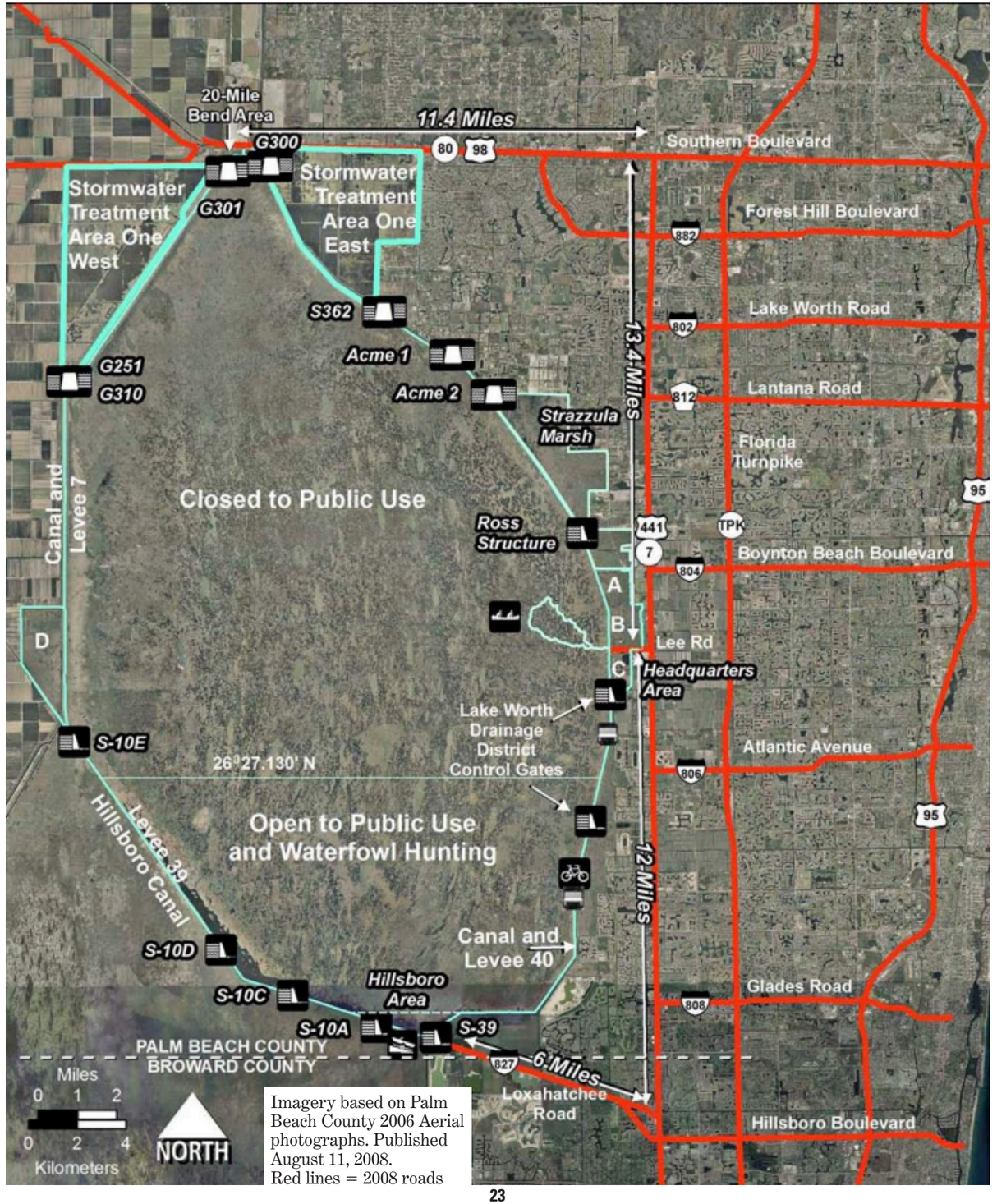
Today, natural area resource managers and wildlife biologists have adopted the use of "**prescribed fire**" as a key management tool to manipulate vegetative communities and benefit wildlife species dependent upon fire-adapted communities. Some wildlife may be killed in prescribed burns, but several factors combine to limit losses when compared to uncontrolled wildfires. Prescribed burns are usually small, less intense, slower spreading, and generally create a **mosaic pattern** of burned and unburned fuels.

Unburned areas serve as **refugia** for slower moving wildlife such as small rodents and reptiles. Birds can simply just fly to a more desirable location. Factors such as wind speed and direction, relative humidity, **temperature**, fuel moisture and fuel type, and drought index are all important factors to address prior to conducting a prescribed burn. Fire is an integral part of Florida; without fire, unique plants and animals associated with these ecosystems maintained by fire are lost forever.

Benefits of prescribed fire management include the following:
Restores and maintains fire-dependent communities; reduces chances of destructive wildfires; reduces invasion by hardwood species; perpetuates fire-adapted **flora** and **fauna**; cycles nutrients; controls disease; opens scenic vistas; protect the urban interface and private landowner from destructive wildfires; target hazardous fuel loadings to lessen the potential for wildfire, or may aim at habitat restoration for endangered or threatened species such as restoring an early **successional** habitats and vegetative community in sand pine or oak scrub to benefit eastern indigo and diamondback rattle snakes, gopher tortoises, as well as a multitude of other indigenous species that are live in and around the Refuge.

U.S. Fish & Wildlife Service

Arthur R. Marshall Loxahatchee National Wildlife Refuge Public Use and Refuge Area Map



Imagery based on Palm Beach County 2006 Aerial photographs. Published August 11, 2008.
Red lines = 2008 roads

Environmental Education
Environmental Education (EE) is a crucial tool in modern **natural resource** management, improving people's understanding of ecological systems and U.S. Fish and Wildlife Service conservation efforts. The importance of environmental education in the Refuge System is underscored by the fact that it is one of the priority wildlife-dependent recreational activities supported by the National Wildlife Refuge Improvement Act of 1997. To provide guidance to Service staff on EE, national policy is currently being developed on environmental education:

…a process designed to develop a ***citizenry*** *that has the awareness, concerns, knowledge, attitudes, skills, motivation, and commitment to work toward solutions of current environmental problems and the prevention of new ones. Environmental education within the National Wildlife Refuge System incorporates on-site, off-site, and distance learning materials, activities, programs, and products, that address the audience's course of study, the Refuge System's mission, and the management purposes of the refuge. (FWS policy, 2004)*

Environmental understanding develops as people are presented with opportunities to learn throughout their lifetime. As people learn about the environment, they often progress through different stages of understanding: awareness, knowledge, skills, values, and participation. *Rhythms of the Refuge: A Guide for Educators* seeks to help build an aware, knowledgeable, skilled, and active Everglades citizenry that values and protects the Refuge.

Photo: Wendy Casperson - Students from Banyan Creek Elementary

The Theme and each Topic, Objectives, and Methodology are correlated to the Next Generation Florida's Sunshine State Standards

Theme
The theme encompasses teaching an understanding and appreciation of the Everglades ecosystem, the Comprehensive Everglades Restoration Program (**CERP**), Refuge **ecology**, and the human influence on ecosystems of the Everglades. This theme was developed by Refuge staff and its partners to be incorporated into all aspects of Visitor Services and academic programs.

Topics
- **Water:**
  This message addresses information on water quality, water quantity, water distribution and water timing, including the amount of water entering the Refuge, the locations to which the water flows when it enters the Refuge, and the seasonality of water flow.

- **Endangered and Invasive Species:**
  The Refuge offers protection for many of the species that are considered imperiled, Federal or state threatened, species of concern and endangered on the Refuge by offering areas for roosting, nesting, feeding areas and habitat for them to live. There are at least 63 imperiled species listed that make or could make the Refuge home.

  Invasive (exotic, non-native) plants and animals are a tremendous threat to the ecosystem and its water supply. The Refuge has been actively battling the worst invasive exotic plant problem in all of South Florida- and among the worst in the National Wildlife Refuge System.

- **Everglades Habitats:**
  Each of the Refuge's five habitat ecosystems will be discussed along with the flora and fauna of each ecosystem. Wildlife management tools such as inventory and monitoring, prescribed fire, and enhancing the native **biodiversity** and integrity of the Refuge will also be highlighted.

- **Everglades History and the Arthur R. Marshall Loxahatchee NWR:**
  The Social Science connection to the cultural and political history of the Everglades and the Refuge is vital in understanding our human connection, problems and solutions, to our Earth.

Objectives
As a result of using *Rhythms of the Refuge: A Guide for Educators*, students will be able to:

- Describe the unique contribution to conservation both historically and presently of the Refuge in the local area, surrounding region, and National Wildlife Refuge System.

- Use scientific methodology in order to explore the environment: ask questions, hypothesize, collect data, analyze data, form conclusions.

- Describe and apply basic ecological concepts, such as **energy** flow, community, diversity, change, **interrelationships**, cycles, and adaptation.

- Describe the components and functions of a given habitat by observing, counting, and describing the animals and plants in that habitat.

- Explain the role of the National Wildlife Refuge System in wildlife and habitat conservation.

- Make a land use and/or land management decision in a role plan situation and examine the consequences of that decision.

- Show how individuals can affect the earth through their behaviors and attitudes.

Methodology
The messages and general objectives expressed in the framework above are best supported by a combination of instructional methods including outdoor investigations, indoor demonstrations, outdoor demonstrations, presentations, teacher-guided research, individual reflection, and service learning projects. Indoor presentations can currently include distance education opportunities offered in partnership with the National Conservation Training Center.

Standards

Math
I can describe and compare measureable attributes.

ELA
I can plan and develop a topic: organize ideas, concepts, and information using strategies such as definition, classification, comparison/contrast, and cause/effect; including formatting, graphs, and multimedia when useful to aiding comprehension.

Science
I can discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.

History and Civics
I can examine key elements and peoples in Florida history as they relate to United States history.

Art
I can use critical-thinking skills for various contexts to develop, refine, and reflect on a theme.

Lessons/Activities

Fire Adaptations from Fire in Southern Ecosystems curriculum (grades 3-12)
Materials: The influences: fire section of Chapter II Arthur R. Marshall Loxahatchee National Wildlife Refuge and plants and wildlife section of each Chapter IV Everglades Ecosystem in addition to any supplemental resources needed (some included within this guide's appendices). Paper and writing utensil.

Activity: Students list plants and animals that live in the Everglades while teacher records on the board. Students help teacher label which plants and animals would survive in fire and next to each, write how they would survive (what is their adaptation?) Teachers can also add in comparison/contrast to ask students which animals would not be able to survive or escape during fire and why (adaptations they lack). Lastly, students confirm or disprove their category list choices – the teacher gives each student one of the plants or animals on the board to look up in this manual or supplemental resource (including the internet). The following class period, students present their findings that confirm or disprove the list from the previous class period. Extend this activity to discuss survival of the most well-adapted in students' own lives, their own adaptations to hardships or "fires."

Background Reading
Fire Adaptations
All living things have developed traits in response to their environments. These traits are called adaptations. Adaptations are physical features or behaviors that help a plant or animal survive and make the most of its habitat. Plants and animals that live in a fire dependent ecosystem have adaptations that allow them to survive and recover after a fire has passed.

Plants Can't Run
In the face of fire, plants can't run, fly, creep, or crawl away. Because plants are rooted in place, they must have special **adaptations** to help them survive fire. One way for a plant to survive a fire is to insulate itself from the heat of the flames. This insulation is especially important for big trees, because they can't afford to burn down to the ground and start growing all over again like smaller plants. The bark of fire-adapted pine trees such as longleaf pine, slash pine, and loblolly pine — is thicker than the bark of pine trees not adapted to survive fires. This adaptation of thick bark protects southern pines from the heat of most fires. Small woody shrubs have thin bark, and herbaceous plants such as grasses and wildflowers have no bark at all. Instead of depending on thick bark for protection, these plants use the soil to insulate their roots from the fire. The upper parts of these shrubs and plants may burn up completely in a fire, but the underground parts survive below the soil. These plants send up new green growth, called shoots, from underground roots, bulbs, or rhizomes after the fire has passed.

Some plants protect their buds with layers of foliage as an adaptive strategy to survive a fire. Longleaf pines have this adaptive strategy—a thick cluster of juicy green pine needles, which is important to protect the buds of the young longleaf pine for future tree growth.

Another strategy of plants is to produce seeds after a fire. Because fire clears out undergrowth in the forest, plants that produce seeds right after a fire have an advantage of growing with more sun, more nutrients from the fresh ash left behind by the fire, and less competition from other plants. For example, only a couple of months after a fire, wiregrass can cover the forest floor with new shoots and tall, wheat-like flowers! Wiregrass is a tall sandhill grass that responds especially well to spring fires, the time of year that lightning naturally started fires in the past. Some types of pines have pine cones that open after a fire. These serotinous cones are held closed by a sticky resin that melts at high temperatures. The heat of a fire opens the cones and allows the seeds to escape. Sand pines and pond pines are two types of southern pines that have serotinous cones.

Where Do Animals Go?
Animals have many behaviors that help them avoid getting burned in a fire. For example, animals can hide from a fire in many different kinds of places. Larger animals such as deer, bear, and fox will walk or run away from a fire. Wildfires in southern pine forests usually move slowly, so most animals can simply walk away, though some wildfires can move very quickly.

Most prescribed fires (also called controlled burns) that are set by land managers' move even more slowly across the landscape than wildfires. The average human walks faster than the speed of a prescribed fire moving across the forest floor and even most small animals can easily escape slow-moving prescribed burns.

Animals that are not able to walk fast enough to escape a fire sometimes hide in underground burrows or in low, moist places. Insects will hide under the leaf litter or duff at the top of the soil or under the bark of a pine tree. Since the heat from a fire rises upward, temperatures are not intensely hot just a centimeter under the soil. Some insects and birds go up high in trees to escape the flames. Mice, rats, snake, and lizards also escape in the relatively cool soil. Many reptiles and small mammals hide in the burrow of the gopher tortoise, who is sometimes called the "innkeeper" of the pine forest. The burrows often reach 10 or more feet underground and can be 40 feet long, so they are insulated by earth and remain cool during a fire. Wetland creatures such as turtles and amphibians will seek shelter under water. Birds can fly away from the fire, though some birds are attracted to the fire to feed on insects as they escape the flames!

Sometimes young birds and other small animals may not be able to escape a fire. Many studies have been done about this because people are concerned about animals. Even though some small animals may die, scientists have shown that fire improves the habitat and the remaining animals will thrive and make new nests. Even though a few individuals are lost, the **habitat** as a whole is better off after the fire so the animal populations will grow.

Fires reduce the numbers of many pest insects, such as ticks, chiggers, and pine beetles. Some insects, however, seem to thrive after a fire. Ant populations are more numerous in burned areas than in unburned areas, probably because the increase sunlight on the ground means more food for the ants. Ants are known to play an important role in pine forest ecosystems and are a major food source for the endangered red-cockaded woodpecker.

Fire and the Carbon Cycle from Fire in Southern Ecosystems curriculum
Materials: The fire section in Chapter II, internet or library resources, school textbook. (Grades 6-12)

Activity:
Step 1: Through a combination of class discussion and background reading, make sure the students have a basic conceptual understanding of the carbon cycle and of the process in which they will participate.

Step 2: Explain that each student will play the role of a carbon atom and walk through the carbon cycle between the reservoirs. Hand one starter card to each student. For the ocean and forest reservoirs, divide the starter cards as evenly as you can among the students. Students will move to the appropriate station based on the card they receive. The starter cards designate the status of each carbon atom at each station at the beginning of the activity only.

Step 3: Tell students to discard their starter cards, draw a process card from the stack at the station, and then read and follow its instructions (either stay in place or move to one of the other stations). To keep the activity orderly, follow these two instructions:

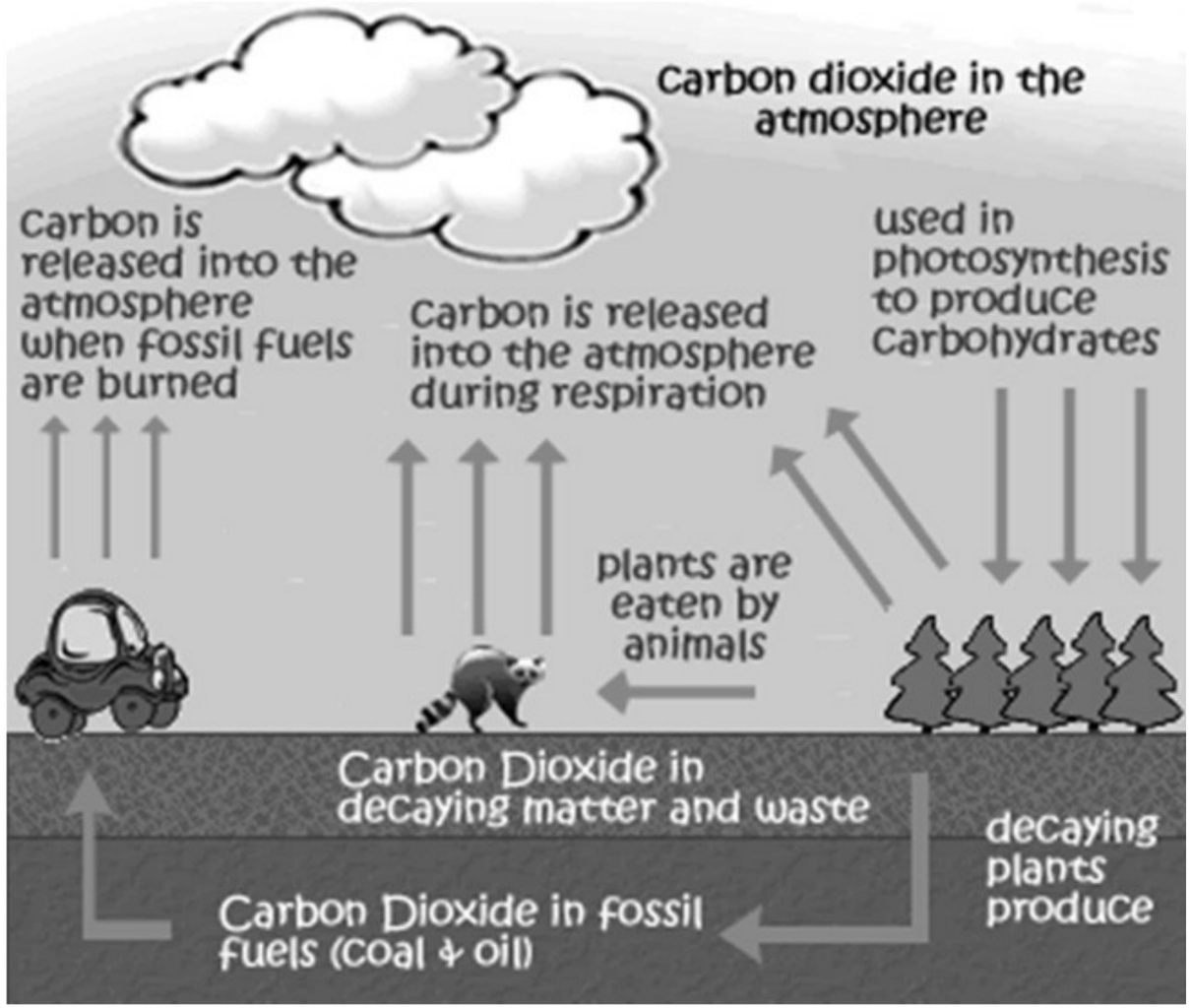
1. Students should place their process cards at the bottom of the stack before they move.

2. Students should only move when given an agreed-upon signal so that everyone moves at the same time.

Step 4: Make sure all students are in the appropriate place at the end of the first round before announcing that each student should draw a card and go again. In other words, repeat Step 3.

Step 5: Repeat Step 3 three to five times until you are comfortable that the students understand the following points:

- The total amount of carbon on earth is finite.
- Carbon moves through different phases of its cycle, always remaining as a form of carbon.
- Reservoirs represent carbon stores within the cycle.
- Fossil fuels, when removed from the ground and burned, put carbon from the ground into the air as carbon dioxide, thus increasing the amount of CO2 in the atmosphere.



Source: Dickinson College COP15 Course Student Blog

- As the world population increases, it is expected that more fossil fuels will be burned resulting in more CO2 in the atmosphere.

Hold a brief class discussion on these points before moving on to the next part of the activity.

Background:
Carbon is the basic building block of life. All living organisms need carbon to create the molecules that form their bodies (proteins, carbohydrates, fats, etc.). The total amount of carbon on earth remains constant and is exchanged between living and nonliving things through the carbon cycle.

In the carbon cycle, there is a regular exchange of carbon between plants, animals, the ocean, and the atmosphere. Plants absorb carbon as carbon dioxide from the atmosphere and transform it into plant food through the process of **photosynthesis**. Animals absorb carbon into their bodies by eating plants or other animals for energy and growth. Both plants and animals release carbon dioxide into the atmosphere through respiration (also known as breathing in animals).

Carbon dioxide is a greenhouse gas (one of the gases that helps trap heat within our atmosphere). Greenhouse gases are important because they keep the planet warm enough to sustain life on earth. However, an increase in greenhouse gases can trap additional heat in the atmosphere resulting in increased temperatures.

When plants and animals die, decomposition usually releases the carbon held in their bodies back into the atmosphere. Sometimes decomposition cannot occur due to a lack of oxygen (e.g., something is buried in mud), which causes carbon to remain in the ground and become fossil fuel (e.g., coal or oil) over many millions of years. In the carbon cycle, as in other cycles, there are **reservoirs** where carbon is held. Carbon moves between these reservoirs. The major reservoirs are the atmosphere, the

ocean, some rock formations, and large expanses of forests. When a reservoir is disturbed, carbon is released into the atmosphere as carbon dioxide. Burning fossil fuels (e.g., coal and oil) takes carbon from the ground and puts it into the atmosphere.

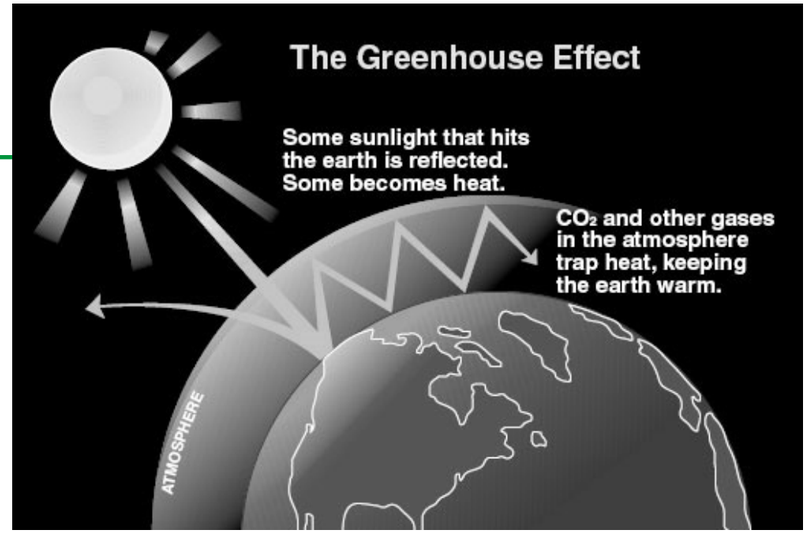
Forest fires do the same thing, since the wood in trees represents a large store of carbon. When a forest burns, carbon is released from the plant material in the form of ash and carbon dioxide.

Background Reading
What is the Role of Fire in the Carbon Cycle?

Everything on earth is composed of almost 100 naturally occurring elements. About 30 of these elements are important to the existence of life as we know it. All elements exist in one of three interchangeable states: solid, liquid, and gas. As elements change state and combine or separate into different molecules, they behave in a cyclic fashion. In other words, they change in a predictable way that repeats itself over and over again. There is a finite amount of each of these elements that has remained constant since the earth first formed.

Carbon is one of the elements that is essential to life and has a cycle that we can easily describe. Fire plays a pivotal role in this cycle. As a solid, carbon forms the molecular backbone of organic molecules (e.g., proteins, carbohydrates, and fats), which are the primary building blocks of living organisms. In its gaseous state, carbon can bond with oxygen to form carbon dioxide, also known as CO2 (two atoms of oxygen and one atom of carbon).

Carbon dioxide is what all living things exhale and is a naturally occurring gas in our atmosphere. Carbon dioxide can also dissolve in water (it is used to make soda) allowing carbon to also exist in a liquid state. Trees and other forest plants are largely made up of molecules containing carbon, oxygen, and hydrogen atoms. As



Source: State of Washington, Department of Ecology

forests grow, the plants transform carbon dioxide from the air into plant material through the process of photosynthesis. The carbon atoms that become part of the plant stay within the plant until the plant dies.

For this reason, forests are often considered reservoirs or sinks for carbon, because they can absorb large amounts of carbon from the atmosphere and hold it for long periods of time. When the plants die, their carbon content is released back into the atmosphere by the actions of insects, fungi, and bacteria. When oxygen is not available to these decomposers, the plant material can become trapped in the earth and, over millions of years, it forms fossil fuels such as coal, oil, and natural gas (also considered carbon reservoirs). Deforestation and large forest fires are two ways that forest plants die and release carbon dioxide back into the atmosphere.

When a forest burns, carbon is released from the plant material in the form of ash and carbon dioxide. Carbon dioxide is a greenhouse gas because it is one of the gases that helps trap heat within our atmosphere. Greenhouse gases are important as they keep the planet warm enough to sustain life on earth. An increase in greenhouse gases, however, can trap additional heat in the atmosphere resulting in increased temperatures. This is called global warming.

Scientists believe that increased temperatures may also have additional climatic impacts around the globe such as changes in wind and rain patterns. Scientists who study climate change examine the potential sources and impacts of increased greenhouse gases in the atmosphere. In the southeastern United States, many areas were once vegetated by the southern pine ecosystem that was dominated by longleaf pine and wiregrass. This ecosystem burned every 1–3 years. Under natural conditions, these fires would normally be caused by lightning during the growing season between March and June of each year.

Pines, grasses, wildflowers, saw palmetto, and various oaks are important components of these communities. When fires occur at natural intervals, dead vegetation (such as pine needles, branches, and wood) is burned, but larger plants and trees are able to survive. The fire essentially cleans up the forest of fuel. When fire regularly occurs, the dead debris does not have a chance to build up.

Due to people's fear of fire, fire suppression became the dominant policy in the United States in the 1940s and lasted well into the 1990s. When fire is suppressed in fire-adapted ecosystems, fuels build up (examples are pine needles, dense growth of shrubs, and fallen trees and dead wood). Then, when a fire does happen, it can be very severe, killing trees, other plants, and wildlife.

This occurred in 1998 in Florida when there were thousands of out-of-control catastrophic wildfires. The intense heat from a catastrophic wildfire can damage the ecosystem by cooking the upper layers of the soil and by slowing down healthy regrowth of the forest after the fire.

Today, fire is seen by land managers and many others as a positive force, and is encouraged under controlled conditions with highly trained personnel in a process called prescribed (or controlled) burning. Prescribed burns are used to maintain the health of a fire-dependent ecosystem and to restore a natural fire cycle to areas where fire has been suppressed. Prescribed burns are implemented by teams of highly trained staff to mimic the natural fire regime of a plant community. For example, about two million acres in Florida are treated with prescribed fire each year. Each of the three different types of wildland fires release carbon into the atmosphere: prescribed fire, wildfire, and wildland fire use.

However, prescribed fires and wildland fire use provide benefits to fire-adapted ecosystems and are less intense, which allows trees and many plants to survive. After these fires, there is rapid regrowth of grasses, flowers, low-growing shrubs, and pine tree seedlings. The new plants quickly begin reabsorbing carbon back from the atmosphere.

On the other hand, wildfires are difficult to control and difficult for ecosystems to recover from—trees are killed and regrowth of the forest is much slower. Forests with heavy fuel loads contribute to the occurrence of catastrophic wildfires and store a large quantity of carbon, which is sent into the atmosphere by a fire. Catastrophic wildfires are viewed as contributors to climate change. When considering the impact of forest fires on the level of carbon dioxide in the atmosphere, it is important to weigh the benefits and impacts that fires have on ecosystems and the atmosphere. Southern pine ecosystems are naturally very flammable, so it is not a question of if a fire will happen, but when. Catastrophic wildfires, particularly in areas where there are heavy fuel buildups, are usually damaging to the ecosystem and can contribute large quantities of carbon dioxide to the atmosphere. Prescribed fire, on the other hand, mimics a natural fire regime, is carefully planned and conducted to minimize impacts to ecosystems, produces much less smoke than a wildfire, and helps to maintain wildlife-friendly and healthy forests. In short, prescribed fire is safer, cheaper, and better for the ecosystem than the alternative, wildfire.

Activity Cards

Fossil Fuel Reservoir Coal	**Atmosphere Reservoir Carbon Dioxide in the Air**
Ocean Reservoir Phytoplankton	**Forest Reservoir Plant—Tree or Shrub**
Ocean Reservoir Animal—Herbivore or Carnivore	**Forest Reservoir Animal—Herbivore or Carnivore**
Ocean Reservoir Decomposer	**Forest Reservoir Decomposer**

Activity Cards
Starting Cards for Activity Part 1: The Carbon Cycle
Print enough cards so that each student has one to start the activity. Hand one card to each student. Students will move to the appropriate reservoir station based on the card they receive.

Process Cards for Activity 1: The Carbon Cycle
Print and cut out 16 cards (two sheets of each) for each reservoir station. For example, place all of the cards that say atmosphere as a mixed stack at the atmosphere station.

Process Cards

Atmosphere Your carbon atom is taken up from the atmosphere by a tree, shrub, or wildflower through the process of photosynthesis. Go to the forest.	**Atmosphere** Your carbon atom is taken up from the atmosphere by a tree, shrub, or wildflower through the process of photosynthesis. Go to the forest.	**Atmosphere** Your carbon atom is taken up from the atmosphere by a tree, shrub, or wildflower through the process of photosynthesis.Go to the forest.
Atmosphere Your carbon atom is taken up from the atmosphere by a tree, shrub, or wildflower through the process of photosynthesis. Go to the forest.	**Atmosphere** Your carbon atom is taken up from the atmosphere by phytoplankton in the ocean through the process of photosynthesis. Go to the ocean.	**Atmosphere** Your carbon atom is taken up from the atmosphere by phytoplankton in the ocean through the process of photosynthesis. Go to the ocean.
Atmosphere Your carbon atom is taken up from the atmosphere by phytoplankton in the ocean through the process of photosynthesis. Go to the ocean.	**Atmosphere** Your carbon atom is taken up from the atmosphere by phytoplankton in the ocean through the process of photosynthesis. Go to the ocean.	**Forest** Your carbon atom is in a plant or animal that has died and is taken up by a forest decomposer (fungi or bacteria). Remain in the forest as a decomposer.
Forest Your carbon atom is in a plant, animal, or decomposer that has died and is buried through sedimentation to become coal (a fossil fuel). Go to fossil fuels.	**Forest** Your carbon atom is respired back to the atmosphere by a plant, animal, or decomposer. Go to the atmosphere.	**Forest** Your carbon atom is respired back to the atmosphere by a plant, animal, or decomposer. Go to the atmosphere.
Forest Your carbon atom is eaten by an animal (an herbivore eats a plant or a carnivore eats another animal). Remain in the forest as an herbivore.	**Forest** Your carbon atom is eaten by an animal (an herbivore eats a plant or a carnivore eats another animal). Remain in the forest as an herbivore.	**Forest** Your carbon atom is in a plant, animal, or decomposer and is used for its growth. Remain in the forest.
Forest Your carbon atom is in a plant, animal, or decomposer and is used for its growth. Remain in the forest.	**Fossil Fuels** You are burned as coal (after millions of years) and go to the atmosphere.	**Fossil Fuels** You are burned as coal (after millions of years) and go to the atmosphere.
Fossil Fuels Remain as coal in the fossil fuels. (Fossil fuels can remain in the ground for millions of years.)	**Fossil Fuels** Remain as coal in the fossil fuels. (Fossil fuels can remain in the ground for millions of years.)	**Fossil Fuels** Remain as coal in the fossil fuels. (Fossil fuels can remain in the ground for millions of years.)
Fossil Fuels You are burned as coal (after millions of years) and go to the atmosphere.	**Ocean** Your carbon atom is in a plant or animal that has died and is taken up by an ocean decomposer (fungi or bacteria). Remain in the ocean as a decomposer.	**Ocean** Your carbon atom is in an ocean plant or animal that has died and is buried through sedimentation to become coal (a fossil fuel). Go to fossil fuels.

Ocean Your carbon atom is respired back to the atmosphere by phytoplankton. Go to the atmosphere.
Ocean Your carbon atom is respired back to the atmosphere by phytoplankton. Go to the atmosphere.
Ocean Your carbon atom is eaten by an animal (an herbivore eats a plant or a carnivore eats another animal). Remain in the ocean as an herbivore.
Ocean Your carbon atom is eaten by an animal (an herbivore eats a plant or a carnivore eats another animal). Remain in the ocean as an herbivore.
Ocean Your carbon atom is in a phytoplankton and is used for its growth. Remain in the ocean.
Ocean Your carbon atom is in a phytoplankton and is used for its growth. Remain in the ocean.

Photo: USFWS

Using Art to show understanding of how fire helps the Everglades:
Materials: The fire section in Chapter II, internet or library resources, school textbook (grades K-12), one piece large white drawing paper and crayons or colored pencils (older students might want to try colored chalks).

Activity: This will take two-three class periods depending on the speed of your students. Give students the large white paper folded into four sections evenly across page (so that they are tall and thin). Label each section (A. Before fire; B. During fire; C. Right after fire; D. Six months after fire). On back students can explain in own words how the fire changed the environment.

Chapter III

Water is Our Treasure to the Balance of Life

Water distribution and water timing, including the amount of water entering the Refuge, the locations in the Refuge to which the water flows, when the water enters the Refuge, and the seasonality of water flow is vital to the balance of the Everglades ecosystem.

Water and the Refuge

At the northern end of the Everglades lays the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge), the largest and most pristine remaining part of the Northern Everglades. The Refuge is comprised of 143, 954 acres of Everglades' habitat. The 400-acre cypress swamp, located in the Headquarters Area, is the largest remaining section of the strand that once stretched from Lake Okeechobee to Ft. Lauderdale.

Typical Everglades' vegetation of tree islands ranging in size from less than one acre to over 300 acres comprises approximately 85 percent of the Refuge. The other 15 percent of the habitats include wet prairies, sloughs, and sawgrass marshes. The tree islands are one of the features that best characterize the Refuge. South and Southwest of the Refuge are the other large remaining portions of Everglades: Water Conservation Areas 2 and 3, Big Cypress National Preserve, Miccosukee Indian Reservation, and Everglades National Park. Northwest of the Refuge is the 700,000-acre Everglades Agricultural Area (EAA), which includes large sugar cane farms, winter vegetables and sod farms, and cattle ranches. Immediately east of the Refuge lies a conglomerate of urban communities.

The Refuge is part of a large freshwater storage area connected by a series of canals and levees built by the U.S. Army Corps of Engineers (COE). An agreement between South Florida Water Management District (SFWMD) and the U.S. Fish and Wildlife Service (USFWS) in 1951 enabled the establishment of the Refuge under the Migratory Bird Conservation Act of 1929 for the purpose of protecting and managing the unique Northern Everglades habitat and all

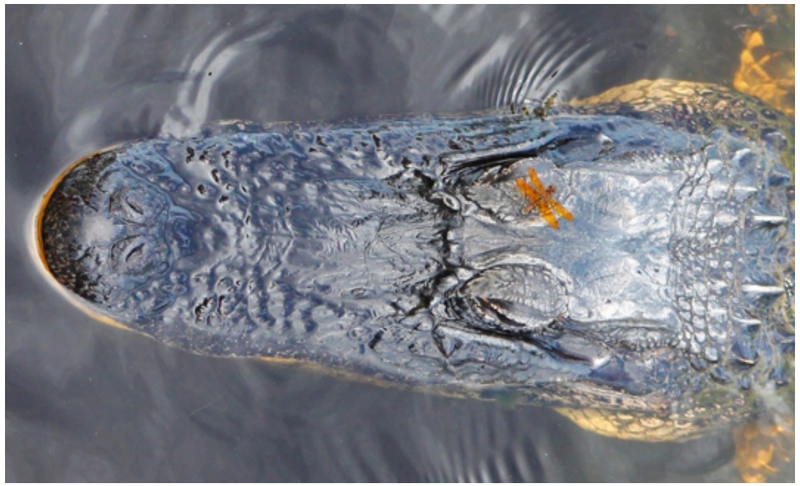


Photo: Wendy Casperson

of its associated flora and fauna. As a result, the Refuge shares a footprint with the 141,324-acre Water Conservation Area 1 (WCA 1), which is defined by a 57-mile levee and associated inside borrow canal. The Refuge additionally consists of approximately 2,550 acres in fee title, owned by the USFWS, which is subdivided into five compartments that can be managed separately: A, B, C, and the cypress swamp units are located on the east side of the Refuge in the Headquarters Area; D is on the western boundary, just north of the confluence of the L-7 and L-39 canals.

The limestone bottom of the vast freshwater marsh that makes up the Refuge interior is covered with a layer of peat varying from 7 to 12 feet thick. The underlying aquifer provides water to nearby coastal communities. The L-40 canal and levee defines the perimeter of the Refuge (and WCA 1).

The two major sources of water for WCA 1 are rainfall (58 percent), and the S-5A, G-251, G-310 and G-6 pump station at Twenty-Mile Bend (40 percent) (CCP). Refuge water sources other than rainfall originate from drained agricultural and/or urban lands.

Water Quality

Although the Refuge was designated an *Outstanding Florida Water* in 1978, which affords it greater water quality protection, the surrounding land use makes it a challenge to protect the water quality of the Refuge. Water levels in WCA 1 are managed following a schedule developed by the COE and managed in coordination with the SFWMD.

The schedule was designed to achieve the following objectives: (1) maintain water storage capacity on the Refuge during the hurricane season; (2) store water for irrigating nearby cropland during the fall, winter, and early spring; (3) prevent **saltwater intrusion** into the **Biscayne aquifer** by storing water for release into coastal canal systems during the fall, winter, and spring; (4) maintain the health of Refuge vegetation types by flooding all wetlands during the summer and fall; and (5) enhance feeding opportunities for waterfowl and **wading birds** by lowering water levels in the spring so that water is concentrated in sloughs and shallow ponds during the nesting season. Historically, such fish as tarpon and mullet used the area, but the presence of water control structures has long since restricted this access.

U.S. Fish & Wildlife Service

The Water Quality Problem

High nutrient runoff from urban and agricultural lands is one of the most serious issues facing the Refuge. This water allows undesirable imbalances in the ecosystem and will be addressed in detail below. Mercury is also a major water quality issue that has been well-documented in the Everglades system. The primary source of mercury in the Greater Everglades is **atmospheric deposition**. However, sulfur originating in the EAA is a known factor in mercury bioavailability. The impacts and sources of sulfur and mercury are being investigated by multiple agencies including SFWMD, United States Geological Survey (USGS), United States Environmental Protection Agency (USEPA), Florida Department Environmental Protection (FDEP), as well as independent/contracted researchers at institutions such as Louisiana State University. Yet another issue is **pesticides** in agricultural runoff, although little is known about their effects specifically on **aquatic** organisms in the Refuge and remaining Everglades.

In the late 1970's, managers at the Refuge began to notice a change in the vegetation around the canals that they associated with water quality; cattails were growing densely in large areas that should have been mostly sawgrass. In the natural Everglades, cattails (Typha spp.) are native, but they grow in small clumps around concentrations of natural nutrient inputs, such as **alligator holes** and bird roosts. A large dense stand of cattail causes many problems to the naturally-occurring wildlife and plants.

For instance, it is too dense for waterfowl, otters, fish, and other animals to maneuver through. It also prevents sunlight from penetrating in the water, where the aquatic plants need it for photosynthesis. In addition, it has about one-fifth the lifespan of sawgrass, so it dies faster, leaving a mass of rotting vegetation. The lack of photosynthesis and the rotting cattail create a disastrous lack of **dissolved oxygen**, which fish and aquatic **invertebrates** require. The density of the vegetation also impedes sheet flow, which is a natural part of the Everglades. There are more complex repercussions as well such as the exotic plants and animals that move in and thrive in our tropical climate.

After much investigation, scientists concluded that the cattail expansion was primarily caused by excess phosphorus entering the Refuge via the pump inputs of phosphorus-laden water from the agricultural lands to the north via the S-5A pump station, agricultural lands to the west via the S-6 pump station, and urban areas to the east via the Acme 1 and Acme 2 pump stations. Due to the high level of connectivity between the water in the perimeter canals and the water in the interior marsh, these phosphorus inputs were able to flow deep into the Refuge promoting the spread and dominance of cattail. The most recent vegetative survey, completed in 2004, revealed that cattail now covers over 13,500 acres in the Refuge.

Cattails are the most visible effect of the nutrient imbalance. However, many detrimental changes in the abundance and diversity of algae, diatoms, desmids, and other microorganisms have already occurred by the time the cattail problem is evident. Changes such as these – starting at the bottom of the food chain – eventually work their way up to effects at higher trophic levels.

A healthy Everglades system supports a wide variety of aquatic algae. Many of these algal species form communities collectively known as **periphyton**. These communities can grow in various forms including surface or benthic mats or 'sweaters' that coat submerged stems and plants. These assemblages both feed and shelter small fish and invertebrates that are crucial **prey** species of the Everglades food web. Unlike the better-known pond scum scenario of polluted ponds and lakes, periphyton is essential for the health of the Everglades. However, periphyton communities typical of the historical Everglades can only thrive in low nutrient, or **oligotrophic** conditions.

The natural Everglades were a balanced ecosystem that required little in the way of **nutrients** to keep it healthy. Low growth rates, low primary productivity, and high dissolved oxygen levels characterize the historic oligotrophic Everglades. When excess nutrients are added, such as phosphorus and nitrogen, the growth rates of some plants are accelerated, primary productivity increases, dissolved oxygen levels decrease, and the system becomes eutrophic. **Eutrophication** is a sign of aging in many aquatic systems – increased rates of eutrophication signal speeded-up aging. The Everglades is a young system, formed only 5,000 years ago. Yet the aging process is occurring too fast. The nutrient that is causing the significant damage is phosphorous, because this element is a **limiting factor** – that is, it is the nutrient normally found in such small amounts that it governs how the system grows. Nitrogen is naturally abundant and does not normally limit the system.

In the natural system (pre-drainage), the nutrients entered into the system primarily from upstream runoff during high water events and wildlife inputs. Now, however, the canals transport high nutrient runoff water from the farmlands but as it navigates through the canals its potency is diminished but still makes an impact.

The Solution

The Federal government sued the State of Florida in 1988 for violation of the federal **Clean Water Act** and various intergovernmental agreements. This lawsuit was based on the expanding front of nutrient enrichment and cattail dominance in natural areas downstream of agricultural and urban discharges. A **Settlement Agreement** was reached in this case in 1991 and a **Consent Decree** was issued in 1992, putting the Settlement Agreement terms into a court order. The State of Florida passed the Everglades Forever Act in 1994, which put the terms of the Consent Decree into state law.

The parties to the Settlement Agreement include the Refuge, Everglades National Park managed by the National Park Service (NPS), COE, SFWMD, and the FDEP. The plaintiff (the United States) is represented by the United States Department of Justice. There are many interested parties in the case, including agricultural entities, environmental groups, local governments, and the Miccosukee Tribe of Indians of Florida. The case is currently active in the Court of Chief U.S. District Judge Federico Moreno, who appointed a Special Master John M. Barkett to assist with the complex technical and legal issues of the litigation. Among other requirements, the Consent Decree (amended in 2001) required the State of Florida to construct and operate 345,000 acres of constructed wetlands (**Stormwater Treatment Areas** or STAs) to remove nutrients from agricultural runoff and implement a **best management practices** (BPM) program in the EAA.

BMPs are agricultural and urban management practices that aim to reduce excess nutrients and other pollutants from entering vulnerable water bodies. These practices include guidelines on the storage, application, and disposal of pesticides and fertilizers. Farmers in the EAA are required by the Consent Decree to reduce phosphorus discharges from agricultural lands by at least 25 percent. Data collected to date show that this target is currently being achieved.

Currently, two STAs (STA 1East and STA 1West) treat agricultural and urban discharges before water enters the Refuge. A portion of STA 1W began discharging into the Refuge in 1994 (then called the Everglades Nutrient Removal Project) and the facility became fully operational in the latter half of 2000. STA 1W contains approximately 6,544 acres of effective treatment area arranged in a total of eight cells in three flow-ways. In 2014, the total phosphorus **flow-weighted mean concentration** and total phosphorus load discharged to the Refuge from STA 1W were approximately seven times lower than the concentration and load delivered to STA 1W. Although STA 1W loads are being reduced, most of the total phosphorus flow-weighted mean concentrations discharged to the Refuge in 2014 were above concentrations identified to be protective of the Refuge.

In September 2004, STA 1E was brought on-line to treat a portion of the water originally directed to STA 1W as well as new urban **stormwater runoff** from the C 51 basin. STA 1E contains approximately 4,994 acres of effective treatment area arranged in a total of eight cells in three flow-ways, discharging into the L 40 Canal through pump station S 362. In 2014, the **total phosphorus** flow weighted mean concentration and total phosphorus load discharged to the Refuge from STA 1E was lower than the concentration and load delivered to STA 1E. Although STA 1E loads are being reduced, as in STA 1W the total phosphorus flow-weighted mean concentrations discharged to the Refuge in 2014 were above discharge concentrations identified to be protective of the Refuge.

What Can You Do To Help?

You have made an important step by reading this and seeking out information on the water quality problems of the Refuge and the entire Florida Everglades Ecosystem. Besides a national treasure, the Everglades supply much of the drinking water for South Floridians. Please help by:

- Conserving and reusing water (rain barrels...).
- Refrain from using toxic household materials that leach into the surface and **ground water**.
- Use natural cleaning products for reducing the pest population and use biodegradable soaps.
- Contact local, state, and Federal legislators by email/mail about the need to protect the waters of the Everglades for the benefit of current and future generations of people and wildlife.
- Support farmers' efforts to practice more than the required Best Management Practices.
- Purchase locally grown fruits and vegetables to support our farmers in area where you live.
- Compost your kitchen waste and use it for your plants instead of fertilizer.
- Pick up your animals waste so it doesn't go into the water drainage system.

What the Future Holds

In spite of the efforts being made by the construction of the STAs, in reduced water **pollution** to the Refuge, it will take many more years to see the results of the improved water quality. In the interim, tons of phosphorus will enter the Refuge. Refuge staff will continue to make every effort to protect the water entering the Refuge by supporting the Settlement Agreement and other laws.

Standards

Math
I can create equations that describe numbers or relationships.

ELA
I can analysis cause and effect relationships.

Science
I can analysis and explain the parts of the energy/**water cycle**. I can understand the concept of adaptation/diversity.

History/Civics
I can understand the judicial process as seen through a federal vs. state lawsuit.

Art
I can investigate the use of technology and other resources to inspire art-making decisions.

Lessons/Activities

Water Quality Testing from Backpacklab.com by Hanna
Materials: Test kits, paper and writing utensils. (Water test kits provided by the Refuge can be borrowed for any water quality testing lessons conducted within Refuge boundaries. Refuge water test kits come with complete instructions for use). You can also visit a water treatment plant.

Activity: Find out where your local water comes from. Find the local water quality report, which comes out annually through the local municipality. Test your school retention pond, water fountains, etc… Record what is found in the quality of the water and list why each element is there (intentional vs. unintentional or naturally occurring), the effects each element has on plants and animals, including humans, and compare these findings to the water quality report provided by your local municipality.

Background Information: Good water quality is essential for the survival of organisms living in an aquatic habitat. It is also vital for human consumption and safe water recreation. Various elements are tested to ensure the safety of the aquatic environment. These include pH, temperature, dissolved oxygen, salinity, turbidity and other nutrient components.

pH: the concentration of hydrogen ions in solution. The pH is measured on a scale from 0 to 14. On the scale from 0 to 6 is acidic and from 8 to 14 is basic. In the center of the scale, 7, is neutral. The pH is an important factor in the survival of many aquatic organisms.

Temperature: Temperature is not a relevant gauge for water quality in the Refuge. But, temperature can be important to a variety of wildlife and plants. Discharges of heated waters from water treatment plants and other manufacturing facilities can increase the temperature and change the types of organisms that flourish in a particular body of water.

Dissolved Oxygen: Dissolved oxygen is necessary to many forms of life including fish, invertebrates, bacteria and plants. These organisms use oxygen in respiration, similar to organisms on land. Fish and **crustaceans** obtain oxygen for respiration through their gills, while plant life and phytoplankton require dissolved oxygen for respiration when there is no light for photosynthesis. The amount of dissolved oxygen needed varies from creature to creature. Dissolved oxygen enters water through the air or as a plant byproduct. From the air, oxygen can slowly diffuse across the water's surface from the surrounding atmosphere, or be mixed in quickly through aeration, whether natural or man-made. The aeration of water can be caused by wind (creating waves), rapids, waterfalls, ground water discharge or other forms of running water. Man-made causes of aeration vary from an aquarium air pump to a hand-turned waterwheel to a large dam. (fondriest/environmental measurements website).

Salinity: Salinity, the amount of salts dissolved in water, is crucial to the existence of organisms that exist in either a freshwater or saltwater habitat. Where a freshwater river meets seawater can be defined as an estuary but also as **brackish water**. Some of the organisms that live in an estuary are extremely sensitive to a change in salinity of their water environment. Since the Refuge is a freshwater marsh there is very little salinity in the water.

Turbidity: Turbidity is the cloudiness of the water. It determines how much sunlight from the sun can filter through to the aquatic plants and microorganisms underneath the surface that capture the sun's energy and conduct photosynthesis. A byproduct of photosynthesis is oxygen released into the atmosphere that humans and other organisms need for life.

Plants vs. Pollutants "Run-Off" Race from the Wonder of Wetlands Curriculum
Materials: Chapter IV Everglades Ecosystem and Chapter III Water is Our Treasure to Balance Life, celery (pre-cut lengthwise), 1qt glass jars with food coloring, water, a plank of wood, an old fake grass doormat, and something to prop the doormat up at an angle, and two tin pans the size of the doormat.

Activity: This will take at least two class periods. Have students investigate which Everglades plants would, due to their adaptations, be best at treating water for quality. Label each jar with the name of the specific Everglades plant great for water filtering. Fill jars ½ way with water and maximum four drops of food coloring, place the celery into the colored water over night (explain to students how plants absorb pollutants with the water they drink – capillary action). Let students investigate the cross-section cut of the celery for colored dots indicating the water-filled channels.

**This can also be done with a carnation. You can split the stem from the bottom to the flower into four parts with each part of the stem in a different color of food coloring. The flower will end up four different colors. Or, place a coffee stirrer across the rim of a plastic cup filled 1/2 full of water. Tape a strip of filter paper to the stirrer marked with an ink line (from a washable black marker). Tip of filter paper should just barely touch the water. Observe the progression of water climbing up filter paper. This also shows capillary action.

Now that the water is clean, the second part of this will develop student understanding of plant and water functioning together for flow. Set up the wooden plank and fake grass mat at an angle with the tin pans underneath to catch water flow. (Discuss with students what the grass and wood represent, predict how the water will flow differently and why – healthy vs. unhealthy wetlands). Students take the leftover water from celery jars – one in front of each wetland, and pour the water down to see which flows faster (discuss significance of water flow speed and reference the Kissimmee River channeling and the current restoration project undoing that damage). Lastly, have students state which plants they would use to slow water flow in the unhealthy wetland.

Background Information: The following is a list of dominant plants in a healthy wetland:
Common water hyacinth, giant leather fern, alligator weed, Florida **bladderwort,** common duckweed, maiden cane, southern cattail

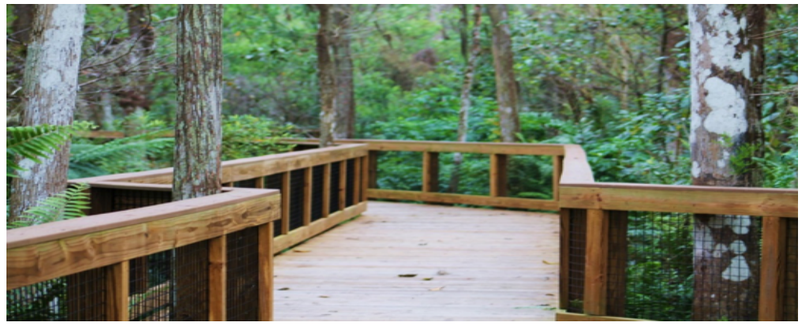
Extension: (Grades 3-12) Students discuss what characteristics would make a plant successful in slowing the water flow in a healthy wetland. Students then research the plants on the list and discuss in small groups which three they would recommend to plant in a healthy wetland.

Chapter IV

Everglades Ecosystem

The Everglades is an ecosystem that is a delicate, interconnected tapestry of various habitats. Each habitat depends on the pristine **preservation** of the land, creatures, and water in order to sustain such a rich substantial, yet fragile treasure of North America. The Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) is the only unspoiled portion of Florida's northern Everglades.

Swamps are like no other landscape. All swamps are wetlands, but not all wetlands are swamps. Swamps don't necessarily have huge mountains or vistas that stretch out for miles. In their own subtle way, swamps are their own special place (Richardson 34). For the purposes of this chapter, we are talking specifically about the cypress swamp at the Refuge.



Cypress Boardwalk at Arthur R. Marshall Loxahatchee Wildlife Refuge
Photo: Wendy Casperson

What is a Swamp?

Swamp is a word that resists precise definition. Sometimes defined as a tree-studded wetland and other times as a tract of wet, spongy land saturated and often partially or intermittently covered with water, a swamp is not always easily separated from a marsh. Seasonal flooding and the presence of trees, therefore, are two of the best clues in distinguishing a swamp from a marsh (Dennis).

On the eastern edge of the Refuge is a 400-acre cypress swamp community which is composed of **pond cypress** trees, pond apple, myrsine, **lichens** and ferns such as giant leather, sword, shield, strap, royal, resurrection and swamp ferns. The moist **microclimate** of the cypress swamp also provides for a profusion of epiphytes (air plants), such as cardinal, giant reflexed, and twisted wild pine and Spanish moss. This cypress swamp is the largest remaining remnant of the community on the east side of the Everglades. This cypress swamp's former **range** extended from Lake Okeechobee through Palm Beach and northern Broward counties, south to Fort Lauderdale (Lodge 1994). The cypress swamp in the Refuge includes 20 species of trees and shrubs, 20 species of herbs, nine species of vines, one type of sedge, 14 species of ferns, seven species of **bromeliads**, and three species of lichens (CCP, Appendix K).

Why is it called a Cypress Swamp?

One should not lose sight of the tree that gives the cypress swamp its name. The **cypress tree** is a **deciduous** conifer. One of its closest relatives is the California redwood or Giant sequoia. Cypress is not only old in the sense that the wood is long lasting, but it has a fossil history dating back thousands of years (Dennis).

Bald cypress (*Taxodium distichum*) is a dominant **canopy** species. This species needs water, not necessarily to germinate new **seedlings**, but to reduce **competition** from other trees that can't tolerate much standing water. Whether Bald and Pond Cypress' (*Taxodium ascendens*) are separate species or merely different varieties of Bald Cypress remains a hot topic among **taxonomists**, but there are enough differences in branch structure, foliage, bark, and seedlings to fuel the debate for some time to come.

Generally pond cypress can be distinguished from bald cypress by their needles, which are scale-like and point upward, unlike those of the bald cypress, which are feather-like and lie flat on the plane of the branches. Both mature bald and pond cypress develops buttresses of various sizes and shapes (Ripple).

Cypress seedlings rely on a complex set of circumstances to germinate and mature. Male and female cones appear on the same tree and mature from December through March, a period that coincides with Florida's **dry season** and the subsequent lowering of water levels throughout various cypress swamps in South Florida, including the Refuge cypress swamp. Ideally, when a cypress seed falls, there will be enough water so that the seed can remain immersed from one to three months, thereby allowing water to penetrate its thick outer coating (Ripple 26). Cypress seeds can float and remain alive underwater for up to a year; however, they cannot germinate underwater and so must eventually settle into moist soil. After a seedling has poked its way up through the peat and soggy mat of decaying leaves and needles, it must grow quickly to prevent being flooded when water levels rise during the raining season (Ripple 28). Cypress seedlings won't survive if they are too dry or too wet, but once they have matured they will survive both flooding and droughts.

In regards to the Cypress, the question concerning the function of **knees** has intrigued people for many years. There have been many speculations as to their function or functions. Knees were first thought to act as breathing organs to secure oxygen for the root system. Correlation of the height of knees to the flooding regime, including the question of

gas exchange, has been introduced as a function. It has been suggested that they assist in trapping soil and debris around the root system. A proposed function was that the knees add strength to the root system. Storage of starch has been attributed as another function of these structures. In addition, many researchers believe the knees may support the trees and aerate their root system. Bald and Pond Cypress' appear to grow well without knees as with them (Ripple).

History and Conservation

In the 1890's, lumber barons from the North started moving into the South and began exploring the swamps for timber resources. Cypress is a rot-resistant wood and was highly prized for use in the furniture and building trade. Early on many people felt that swamps were a place of danger and very unhealthy, but that view changed toward the beginning of the 19th century when Americans began to see these wetlands as places to see wildlife and enjoy some form of recreation. Americans used their voices to help save their cypress swamps but there was much resistance from the lumber industry. Some of the biggest and the best swamps were saved; others unfortunately were flooded by dams, filled in, cut, channelized, or drained (Dennis). This is why the Refuge is a **second growth** Cypress Swamp – the only **first growth** Cypress Swamp near Palm Beach County is Barley Barber Swamp in Martin County, which is owned by FPL.

Plants of the Cypress Swamp

The cypress swamp is an ideal location to study how plants grow and respond to stimuli in the environment. A response to stimuli by plants is called a **tropism**, which comes from the Greek word meaning "turn." Plant tropisms that are easy to observe include **heliotropism** (response to the sun), **geotropism** or **gravitropism** (response to gravity) and **thigmatropism** (response to touch). Different parts of plants can respond to touch. Some leaves, like those of the sensitive plant (Mimosa pudica) located as a ground cover in front of the visitor center will close when you touch them.

Roots use touch sensitivity to find their way downward through the soil, moving away from objects like stones in their path. This is called negative thigmatropism, since they move away from the object that touches them. Climbing vines with tendrils actually reach out and grow toward the touch of a pole or string, their tendrils eventually coiling around the object and using it as a support to grow on. This is called positive thigmatropism. The coiling is caused by the sides of the tendril growing at different rates. (National Gardening Association)

As has already been discussed, most plants and trees (vegetation) in a cypress swamp are the types that don't mind having wet feet. Many of these species are also competing with the cypress trees for space, sunlight, and nutrients (food). In the Refuge's cypress swamp, the other trees include pond apple and red maple.

Pond apple

(*Annona glabra*) also known as custard apple (*Annona reticulate*) is a small evergreen native to American Tropics and South Florida, usually growing to between 12 and 20 feet tall, sometimes reaching 40 feet, the trunk is short with a swollen base. The leaves are four to six inches long, bright green, smooth, leathery, oval shaped with a pointed tip and a rounded base. Flowers borne in spring are creamy white or greenish-white with red markings and very thick petals. Fruit is ripe in late summer, edible but not very tasty (like cotton), smooth, four to five inches green/yellow skinned (looking like a hard apple), ripe when it is the color of a nectarine or peach with brown bean-like seeds imbedded in the pulp.

Red maple

(*Acer rubrum*) is a deciduous, fast growing tree with the widest north to south range of any tree native to the East coast of the USA. It can reach 50 feet tall. Its leaves are three to five inches with three prominent lobes; two lesser lobes may occur. The **leaf** margins lack teeth. The flowers occur in the spring and are tiny and red. The fruit is only found on female trees and is red, winged and it matures to a light brown.

Elderberry

(*Sambucus canadensis*) is a shrub or small tree reaching nine to 26 feet tall; it has white foliage; the fruit is dark purple to black and produces in grouping clusters during the fall. The fruit is edible and can be made into jelly, dye, and wine. The leaves and inner bark can be used as an insecticide. However, other parts of the plant are poisonous, including the unripe fruit.

Giant leather fern

(*Acrostichum danaeaefolium*) This fern is the largest of the ferns in the swamp with its leaves reaching 12 feet long. When the fern reproduces, the underside of the leaves are covered with brown spores that feel like leather or suede making it easy to understand how the plant got its name.

Sword fern

(*Nephrolepis exaltata*) This fern's spores (sori) are in a round case on the outer edge of the underside of this lightly fringed leaf (pinnule). The leaflets are alternate on the stem and a light green color.

Royal fern

(*Osmunda regalis*) From a distance, this common large fern looks like a fern, but up close, its widely spaced, oblong leaflets (fronds) make it look like a locust tree. It can grow to six feet or more. It is pale green and has its spores on single stem with separate branches above the leaves. Very regal indeed.

Swamp fern

(*Blechnum serrulatum*) The spores (sori) form two brown lines down the center midrib of the underside of the leaf. These leaflets (pinnules) are very pointy at the tip. The leaflets (pinnules) are opposite on each side of the main stem and a medium to darker green color.

Strap fern

(*Campyloneurum phyllitidis*) The long swordlike leaves of this fern do not seem to qualify it for the fern family. It grows in clumps on logs and trees to as much as 36 inches long. The upper side of the leaf (frond) is scattered with small bumps in a mirror image of the sori (spore) pattern on the underneath side. The spores (sori) appear as small dots in two rows between each major vein scattered throughout the underside of the frond.

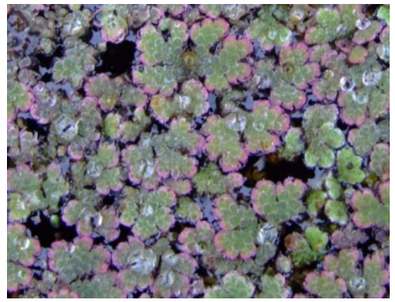
Hottentot fern

(*Thelypteris interrupta*) Leaves (fronds) are shiny on top and dark green never dull and never with hairs. They are spaced distinctly and are tough. The fronds can reach 30 to 50 inches tall and are usually ⅜ inch to ½ inch wide, leaflets (pinnules) are widely lobed and pointed tips on leaflet (pinna) especially noticeable on the tail at the top of the frond. Spores (sori) form a continuous meandering line along the edge of the leaflet and much closer to the margins then to the midvein.

Resurrection fern

(*Polypodium polypodioides*) This fern is an airplant and gets its name because it can survive long periods of drought by curling up and appearing dead. When just a little water is present, the fern will uncurl and reopen, appearing to resurrect. Thus this fern comes to life. The leathery evergreen leaves (fronds) are between four and 12 inches long. The leaves (fronds) are made of small, rounded, oblong blades. The spores (sori)

are on the underneath side of the leaflet (pinnule) in a pattern of a line of one rounded case on the outer edge of the oblong blade.



Water fern

(*Salvinia minima*) If you look in the water, you will see this fern. It is the larger of the two ferns that make its home in the water. The fern leaf is round in shape and several fern leaves are clumped together to form a strand of fern leaves. There are tiny hairs that stick up on the top of the leaf. The size of the leaf is about ½ inch in diameter.

Duckweed

(*Lemna minor*) Duckweed is the smallest flowering plant known to man. This angiosperm has three small leaflets that combine to form a three sided leaf. There are between one and two tendrils hanging down into the water that keep this angiosperm afloat. Each plant is approximately ¼ inch in size.

Air plants

(*Epiphytes*) Air plants grow on the trunks and branches of trees. Sometimes these plants make the trees look like they are full of bird nests. Each air plant is a tiny self- contained habitat. These plants use their host for support only, catching their own water from the rain and debris (from the wind) for food.

Cardinal wild pine

(*Tillandsia fasciculata*) This air plant is a member of the bromeliad family. Many air plants, like the cardinal wild pine, look like pineapple tops and are, in fact, related to pineapples. Wild pines sit on the side of the tree, usually in the crook of where a branch and the trunk meet. Its leaves may exceed three feet long and the bracts are usually bright red with the conspicuous small flower that is purple, yellow or sometimes white in color.

Reflexed wild pine

(*Tillandsia balbisiana*) This air plant is much smaller than its cousin, the Cardinal wild pine, listed above. Having just a few leaflets bending back on itself with one small red-colored bract, it has the same flower of purple, yellow, or sometimes white in color.

Spanish moss

(*Tillandsia usneoides*) This moss has an unusual growth form and is actually in the air plant bromeliad family. So, it's not Spanish, nor a moss. It is typically gray to green gray in color and has a string of small plants attached by a stem. The flowers appear very small and white in the crook of the stem. Look up into the canopy of the cypress trees to see this plant hanging from the tree branches.

Lichens

Most of the trees in the cypress swamp look like someone used a spray can of paint on their trunks. Dabs and splotches, some peeling, of gray, white, even light red are found on nearly every trunk or branch. They are lichens (pronounced likens), a **symbiotic** association between **alga** and **fungus**.

Lichens are compound organisms, sometimes called tiny ecosystems, made up of two, or even three, very different partners, none of which are plants. The dominant partner is fungus, living symbiotically with a colony of alga or **cyanobacterium** – sometimes both. The alga and/or the cyanobacterium supply food, by photosynthesis to the fungus, while the fungus supplies moisture, minerals, and protection to its partners. (The alga photosynthesizes and provides some nutrients to the fungus, which in turn provides skeletal protection and a water-trapper for the alga.)

Lichens are the first organism to appear on rock surfaces where they begin the formation of soil and pave the way for plants to grow. It is said that there are over 30,000 kinds of lichens. They range in color from gray to green, red, pink, yellow, orange, and black. They are used for dyes, perfume stabilizers, and they furnish the food for caribou in the arctic region.

The role of lichens in plant succession and the colonization of the earth is dramatic and of great importance. They have invaded all parts of the world, from the warm tropics (like the cypress swamp) to the Arctic and Antarctic, and from sea level to the highest mountain tops. They grow most abundantly where rainwater washes over stone. **Crustose** or crusty lichens grow flat and grow close to the surface of rocks and close to the barks of trees. **Foliose** or leafy lichens have broad lobes and grow on rocks, trees, and the ground (even on desert sands). **Fruticose** or shrubby lichen are slender and branched. They are often seen hanging from trees.

Baton rouge (or red stick)

(*Cryptothecia rubrocincta*) This crustose lichen is pale red lichen seen scattered on the trunks of the cypress trees. It sometimes has a white ring around it. The red color comes from its symbiont; instead of a green alga, it is a photosynthetic purple bacterium.

Common greenshield

(*Flavoparmelia caperata*) This is one of the most common of foliose lichens, these have leafy lobes, which spread out in a horizontal layer over the surface. The structure of foliose lichen would show a sandwich of fungal layer with an algal mat in the middle. Small rootlets called rhizines attach the lichen to the substrate.

Old man's beard

(*Usnea strigosa*) This fruticose or shrubby lichen is green in color and grows on the sides of trees in clumps. It is very delicate in nature and looks extremely fragile. It is wispy and looks like an old man's beard.

Wildlife of the Cypress Swamp

Vertebrates

This term refers to animals that possess a backbone, such as humans. Mammals, birds, snakes, fish, and lizards are all animals that fit in this category. All of the following animals have been seen in the cypress swamp at the Refuge. Various conditions will make it more or less likely that you will see these animals in the swamp at any given time on any given day. A couple of the conditions include: **nocturnal** (active at night) vs. **diurnal** (active during the day) and the amount of water in the swamp at any given time. Each visit to the swamp will be a different experience and sometimes observational skills in spotting evidence of wildlife presence are a tremendous teaching tool.

U.S. Fish & Wildlife Service

River otter

(*Lutra canadensis*) Otters are mammals that live the majority of their life under water. They do come onto dry land, but are more comfortable in the water where they find their food, socialize, and play. They can hold their breath for up to four minutes of underwater swimming. Their fur is so thick that they really don't get wet to the skin.

Eastern gray squirrel

(*Sciurus carolinensis*) With their big bushy tails the Eastern gray squirrel is a common resident in the swamp. They also have longer ears, shorter tails than their northern counterparts and silver-tipped fur. They are important to the habitat in the swamp because they bury nuts and Florida Oak acorns in the dirt and can retrieve them by smell. Many a new tree or forest has re-sprouted because the squirrel forgot where they left their food from a couple months or a year ago.

Nine-banded armadillo

(*Dasypus novemcinctus*) The nine-banded long-nosed armadillo (and colloquially as the poor man's pig or poverty pig), extensive burrowers, weigh 12 to 22 pounds. Head and body length is 15 to 23 inches, which combined with the five to 19 inch tail for a total length of 20 to 42 inches and stands six to 10 inches tall. The outer shell is composed of ossified dermal scutes covered by non-overlapping, keratinized epidermal scales, which are connected by flexible bands of skin. It is an insectivorous animal, feeding chiefly on ants, termites, and other small invertebrates. Nine-banded armadillos are solitary, largely nocturnal animals that come out to forage around dusk.

Pileated woodpecker

(*Dryocopus pileatus*) This is the largest woodpecker in North America. It has a red crest and black body with a white stripe on its face and down its neck. It was the inspiration for Woody Woodpecker. The knocking on trees and the loud ringing calls give this bird away.

Carolina wren

(*Thryothorus ludovicianus*) This small bird has a huge voice, and you may never see him or her, but you will hear them. It is cinnamon-red in color and has a large collection of songs similar to a Mockingbird (Florida's state bird). They can be found year round in dense, thick brush covered places, like the Refuge cypress swamp. Wrens love insects for dinner and have a bill shaped just right to capture their prey.

Water moccasin (Florida Cottonmouth)

(*Agkistrodon piscivorus*) This is probably the most feared snake in the cypress swamp. It is a venomous (meaning a toxic sting or bite) snake and has a triangle-shaped head with a dark colored eye line through its eyes. As they age, they get darker in color. It gets its name from the interior of its mouth, which looks like cotton. While swimming in the water, cottonmouths keep their head up high.

Everglades rat snake

(*Elaphe obsolete rossalleni*) This snake matures to be the size of four to six feet long, sometimes seven feet in length, making it one of the longest snakes in North America. Hatchlings have gray blotches on them and as they mature the color changes from orange to red. They are good climbers and may be found coiled in the treetops. They are active when the temperature suits their activities. They are good swimmers, but only venture into the water when necessary.

Southeastern five-lined skink

(*Eumeces inexpectatus*) This moderately large lizard measures between five to 8.5 inches long and has short legs and a streamlined body. Coloring is generally gray, brown, and black background with five white or yellowish stripes (two on each side and one down the center of the back). The skink is often found underneath logs or under tree bark. It is often referred to as "scorpions" not due to a sting but scientists speculate that it tastes bad to predators (http://srelherp.uga.edu)

Green anole

(*Anolis carolinensis*) This native anole is approximately six to seven inches long of which is about ½ tail. The color is most often lime green but can turn to brown but take a while to switch color so are not true chameleons. Their throat fan (dewlap) is bright pink in color.

Green treefrog

(*Hyla cinerea*) This frog reaches a bit more than two inches in length and can change color from bright green to dull green. It is one of the noisier frogs in the rain frog category because it mostly sings in inclement weather. They have blobby, sticky toes that help them cling to the underside of leaves.

Cuban treefrog

(*Osteopilus septentrionalis*) This frog is an amphibian native to the Caribbean region of the Western Hemisphere. Its wide diet and ability to thrive amongst humans has made it a highly invasive species with established colonies in the Everglades. They range in size from three to 5.5 inches and vary in color from olive-brown and bronze to gray or grayish-white and typically don't have sticky toes. A nocturnal, tree-dwelling frog, it is known to eat almost anything that will fit in its mouth and can mate year-round. This frog is taking over the native range of the green treefrog and is competing for a niche in the swamp.

Mosquitofish

(*Gambusia holbrooki*) **Mosquitofish** are native to southern and eastern portions of the United States. They were originally introduced into California in 1922 and have been the most effective non-insecticidal or non-chemical method of controlling mosquitoes in over 80 years. They breed throughout the summer and give birth to live young that are ready to eat mosquito **larvae** within minutes. They get to approximately three inches

in size and can eat mosquito larvae as fast as the larvae hatches from eggs, as many as 100 a day. This fish can live two to three years.

Sailfin molly

(*Poecilia latipinna*) Commonly found in shallow surface waters or can be found under floating vegetation. This fish is tolerant to low levels of oxygen as it can exploit the thin film of oxygen rich surface water with its upturned mouth, and so is able to survive in oxygen depleted habitats. This fish is oblong with a small head and the dorsal fin flattened with a small, upturned mouth. The body is light gray with several rows of spots along the sides and back. Sailfin mollys can reach five inches long.

Invertebrates

This term refers to animals without a backbone, such as **insects**. Earthworms and spiders are also invertebrates. The following animals have been documented to have been seen in the cypress swamp at the Refuge.

Cicadas

(*Tibicen linnei*) These insects have large eyes that are wide apart on the head. Their wings are usually transparent and well-veined. They live in temperate to tropical climates. They are one of the most recognized insects due to their acoustic talents and in fact the name cicada means "buzzer" in Latin. They achieve this noise by rubbing their large wings back and forth on top of their back.

Spiny Orb-weaver spider

(*Gasteracantha cancriformis*) This spider is the most colorful and recognizable spiders in Florida. The dorsum (back) of the abdomen is white with black spots and large red spines on the margins. The webs of these spiders typically contain tufts of silk, which may prevent birds from flying into the webs.

Common green darner

(*Anax junius*) This dragonfly is so named after its resemblance to a darning-needle. The Green Darner is one of the most common and abundant dragonfly species throughout North America. It is well known for its great **migration** distance from the northern United States south into Texas and Mexico. It is one of the largest dragonflies in existence. Males grow to three inches in length with a wingspan of up to 3.1 inches. Females oviposit (to deposit or lay eggs, especially by means of an ovipositor which in certain female insects is an organ at the end of the abdomen, which eggs are deposited.) in aquatic vegetation, eggs laid beneath the water surface. **Nymphs** are aquatic **carnivores**, feeding on insects, tadpoles, and small fish. Adult darners catch insects on the wing, including ant royalty, moths, mosquitoes, and flies.

Sawgrass Communities

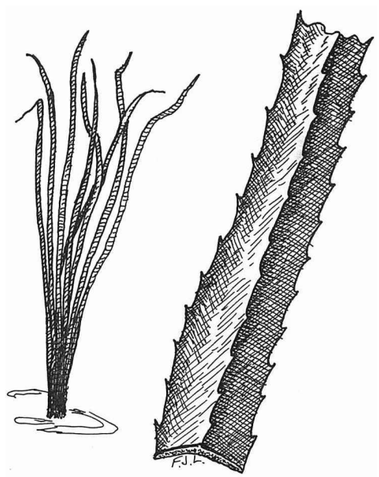
What is Sawgrass?

Sawgrass is so named because it has spiny, **serrated leaf** blades that resemble a saw. The **sawgrass** community (25 percent land coverage) is characterized by the saw-edged sedge that dominates this type of habitat. Yes, sawgrass (*Cladium jamaicense*) is not a grass, but a **sedge**. It is named for the sharp, upward pointing teeth that line each edge of the leaf's stiff V cross section. Sedges have edges, as the saying explains.

Sawgrass may grow in solid stands, mosaics or interspersed with other species such as wax myrtle and dahoon holly. Sawgrass areas often border tree islands, separating them from the wet prairie. Once its highly perishable seedlings become established, sawgrass is a very tough plant, well adapted to the rigors of the Everglades, and most of its subsequent reproduction is by lateral spread of its prolific root-like rhizomes that spread underground and can form a thick often impenetrable concentration. This plant can grow to heights of nine feet. The flowers are found on tall, rusty-brown spikes (stems) that are up to three feet long and tower above the leaves. Its principal enemies are soil fire during drought, multi-year flooding deeper

than about a foot, and fire followed by rising water. The last of these conditions eliminates the oxygen supply to the roots, causing suffocation. As each sawgrass **clum** matures, the older outer leaves die, and their conducting tissues become air tubes – tiny straws – that carry oxygen to the roots, which live in an oxygen-deprived environment when the soil is flooded. While sawgrass is recovering in the month or so after a burn, the roots are dependent on this oxygen supply, which would be cut off by flooding over the dead leaves. The implication to water-level management is obvious for dealing with too much or too little sawgrass.

On its tougher side, essentially nothing eats sawgrass, although the abundant, late summer seeds are an important food for ducks (Lodge).



How Does the Sawgrass Community Develop?

Sawgrass communities are areas overwhelmingly dominated by sawgrass, with little other conspicuous vegetation. Spacing of the plants grades from sparse to dense. Dense tall sawgrass originally covered most to the northern Everglades in an unbroken expanse called the "sawgrass plain." There it grew to over nine feet tall in deep, peat soils. Most of the sawgrass plain area is now in agriculture, mainly sugarcane, but some tall sawgrass remains in northern Everglades conservation areas, like the Refuge. In the central and southern Everglades, sawgrass communities typically occurs in patches; its stature is not so tall (usually three to five feet), and several other marsh species may occur together with the sawgrass.

The average **hydroperiod** for sawgrass communities are about ten months, but ranges from less than six months to nearly continuous flooding, and typical wet-season depths range from one to one-and-a-half feet. The deeper water and longer hydroperiod support taller, denser sawgrass, with the drier end of the range supporting more open, sparse growths. Dense sawgrass, especially, harbors little animal life, but is one of the habitats where alligators build their nests (Lodge).

Plants of the Sawgrass Communities

In addition to sawgrass (a sedge) other plants that occur in the sawgrass community are swamp ferns and sword ferns (see Cypress Swamp for description). As was mentioned in the narrative, two main tree species might be found in the sawgrass community (marsh).

Wax myrtle

(*Myrica cerifera*) This tree is also referred to as southern bayberry. It is a fairly hardy evergreen tree growing to 40 feet tall, usually shrubby, trunk up to one feet in diameter, often growing in a leaning position. Smooth, silver-gray bark is marked with small corky splotches. The wax from the berries is used in the manufacture of fragrant bayberry candles. The leaves are about four inches long, two inches wide at the center with margin coarsely notched from the widest part to the pointed tip, lower margin smooth to a tapering base, aromatic when crushed, bright green, stiff, thin but leathery with orange spots on underside. The flowers are small, yellowish-green catkins borne in spring, male and female blossoms always are on separate trees. The fruit is in clusters of bluish-gray wax covered berries that form along the stem in the winter.

Dahoon holly

(*Ilex cassine*) This is a small evergreen tree growing to 30 feet tall. It has a smooth bark that is grayish white. The leaves are narrow, glossy, leathery, two to four inches long, frequently, but not always toothed and downy on the underside. Flowers occur in the spring and are white. The fruit on female trees are small, one seeded, red berry clusters that are visible in the fall. The berries are attractive to birds. This is the true Florida holly and is often confused with the invasive, non-native Brazilian pepper.

Flat sedge

(*Cyperus odoratus*) Flat sedge grows from four to 30 inches tall. It may have only a few leaves rising from the base, and a few loose sheaths. Leaves are about ½ inch wide and may be as long as the plant. The base of the inflorescence (a group or cluster of flowers arranged on a stem or specifically the part of the shoot or seed plants where flowers are formed) has three to ten conspicuous leaf-like bracts. The bracts are about ½ inch wide and can be much longer than the inflorescence. The inflorescence may be from one to eighteen inches long. It has several small bottlebrush-like clusters of spikelets.

Wildlife of the Sawgrass Communities

Vertebrates

In the previous Cypress Swamp section, vertebrate and invertebrate animals were discussed. Please refer to those definitions while discussing sawgrass communities' wildlife with your students. The following are all in the vertebrate category, but there are many invertebrates that are found in this habitat such as dragonflies, cicadas, spiders, mosquitos, banded mystery snails, bromeliad beetles, European honeybees, crayfish, giant ramshorn snails, red fire ants, love bugs, Mexican elongate twig ants, **apple snails** and velvet ants.

Marsh rice rat

(*Oryzomys palustris*) This rat is a semi aquatic North American rodent. It weighs between 1.4 to 2.8 ounces and is a medium sized rodent (length can be between 8.9 inches to 12 inches long and with the tail length between 4.3 inches to 6.1 inches long) that resembles a common brown or black rat. The upper parts are generally gray-brown, but reddish in many Florida populations. Their fur is thick and short. The feet show several specializations for life in the water. When rice rats swim, air is trapped in the fur, which increases buoyancy and reduces heat loss. The skull is large and flattened and is short at the front. This rat is nocturnal (active at night) and nests in sawgrass and has a diverse diet of plants, fungi and a variety of animals. It in turn becomes prey for animals such as the barn owl.

Least bittern

(*Ixobrychus exilis*) This secretive marsh bird stands 11 inches to 14 inches tall and is very small, thin, and furtive and straddles reeds. There is a large buff wing patch that is lacking in rails. There is also a very rare dark chestnut color patch. The voice is a **song** that is low, muted coo-coo-coo and can be heard in the marsh.

Sora

(*Porzana carolina*) This little secretive marsh bird stands only between eight to 9¾ inches tall. The adult is a small plump gray-brown rail with a black patch on the face and throat. This bird also has a short yellow bill. The short cocked tail reveals white or buff undertail. The voice is a long, high, squealing whinny descending and slowing at the end KO-WEEeee-e-e-e-e-e, ee, ee given by both sexes; high clear, sharp whistled kooEE (Sibley).

Everglades racer

(*Coluber constrictor paludicola*) The Everglades racer differs from the brown-chinned racer primarily in coloration. Look for it along canals, at pond edge and in shrubby fields. Average adult size is 20 to 56 inches long. Adult color typically is slate gray, but many specimens are brownish-gray, bluish, or greenish. The chin and throat are white. The belly is grayish to uniform black. The body is slender and the scales are smooth, and there are 17 dorsal scale rows at midbody. The pupil is round. Juvenile color is gray with distinct reddish brown blotches fading into a solid-colored tail.

Striped crayfish snake

(*Regina alleni*) Average adult size is 14 to 20 inches long, record is 26 inches. Adults are glossy brown with three inconspicuous darker stripes, one along the center and one on each side of the back. The lower sides are yellowish-tan. The belly is normally uniform yellowish, but can be reddish-orange with a darker smudge to a well-defined row of spots. The head appears small relative to the body. The scales are smooth, but keeled above the cloaca. There are 19 dorsal scale rows at mid-body. The pupil is round. Juveniles are similar to adults. The striped crayfish snake is highly aquatic and inhabits areas with dense vegetation where it lives within the submerged roots. Here it finds its favorite prey, crayfish. This snake does not constrict its prey like many other species do, but rather it uses coils of its body to hold the prey while swallowing it alive. Juveniles may also feed on aquatic invertebrates such as dragonfly larvae. Breeding occurs in the spring; the young are born alive.

Golden shiner

(*Notemigonus crysoleucas*) is in the carp family of fish and is native to eastern North America. It can grow from three to five inches long. The body is deep-bodied. The back is dark green or olive in color and the belly is silvery white. The sides are golden in larger fish but silver in smaller ones. The anal fin is large and has eight to 19 rays, while the dorsal fin has eight rays. The mouth is small and upturned. Golden shiners prefer quiet waters and do better in clear water with dense mats of vegetation.

Marsh killifish

(*Fundulus confluentus*) This freshwater fish has distinct dark bands on the side (dark bands for females and juveniles, light bands for males). It has a rounded caudal fin. The fish has a large black spot on the end of the dorsal fin. The dorsal fin starts directly above the start of the anal fin. All fins are speckled. This fish is important in the control of mosquitoes.

Invertebrates

Halloween pennant

(*Celithemis eponina*) This dragonfly has been described as looking very similar to a butterfly. Its wings are orange-yellow in color, though its markings are dark brown, not black as is commonly believed; the entirely orange-yellow wings with dark brown bands are what has given it its Halloween common name and its typical position of being perched at the tip of a weed stalk, waving in the breeze like a pennant contributes to the remainder of its common name. The young has yellow markings, including a stripe on its back, and adult males develop pale red markings, particularly on the face, though females will occasionally get these red markings too. Halloween pennants are approximately 1.5 inches in size. They feed on other insects and they are able to fly in rain and strong wind. On hot days, it will often shade its thorax using its wings.

Tree Islands

What Comprises a Tree Island?

The northern portion of the Refuge is characterized by thousands of tree islands that range from less than one acre to more than 300 acres. There is approximately 20 percent of the Refuge interior covered with tree islands. The term tree island is often used to depict the island-like appearance of a patch of forest in an Everglades marsh. The island part of the term is its superficial resemblance. Several forested plant communities occur as tree islands in the Everglades. Wetland shrubs and trees found throughout the region's swamps occur on all Everglades tree islands. In addition, those tree islands having ground

rising above ordinary flooding elevation support upland tree species that only survive in **aerobic** (unsaturated) soils. Most of the wetland vegetation species are temperate, North American origin, and are common in swamps throughout the southeast (Lodge).

Tree islands occur both in peatlands of the Everglades mainstream and in **peripheral marl prairies** of the southern and southeastern Everglades. Those in the peatlands are the most numerous and have received the most attention. Today, most peatland tree islands are in the Northeastern Everglades (the Refuge) and in the Shark River Slough (in Everglades National Park). In both areas, the tree islands are part of the **ridge-and-slough** landscape. However, ridge-and-slough landscape was historically contiguous between Arthur R. Marshall Loxahatchee National Wildlife Refuge and Shark River Slough. Damaging hydrology, both too wet and too dry with attendant soil fires, have caused a major loss of tree islands in the Everglades (Lodge).

For most people familiar with the Everglades, the different kinds of tree islands are recognized for their appearance, related to the kinds of tree that dominate them regardless of how they were formed. Many of the tree islands at the Refuge are referred to as "bayheads." Bayheads are by far the most common type of tree islands. They are named for swamp bay (widely called red bay) but may often contain other species that superficially resemble swamp bay, such as sweetbay. In fact, swamp bay many not even dominate a bayhead. A good example is the strand type tree island at the Refuge, which are typically composed of an overstory of redbay and dahoon holly with wax myrtle, buttonbush and cocoplum comprising a dense midstory and numerous ferns in the understory (Lodge).

Why are Tree Islands Significant?

In the Everglades, tree islands provide **nesting sites** for turtles and alligators, protective cover for wildlife such as deer

and otters, and roosting and nesting locations for many birds, notably Everglades snail kites, anhingas, and wading birds. Abundant evidence also shows that Native Americans used the high ground on tree islands through a long history (see Chapter II). Without tree islands, marsh habitat would have far less value to an ecosystem, especially where they support wading bird **rookeries** and colonies along with other wildlife.

Their survival depends on a balance between fire and water levels, and alligator activity may also be important. During drought conditions, alligators wallow out circular deep water refugia, called alligator holes. Wind-blown herbaceous seeds germinate on the exposed peat and eventually woody vegetation grows on the edges and creates a tree island with a doughnut shape. Alligator holes are very important aquatic refugia during the dry season and are sources for fish and other aquatic organisms' population reestablishment after summer rain rehydrates the ecosystem (Lodge).

How did Tree Islands Begin?

In its early history the Everglades was nearly devoid of tree islands. Tree islands of the Everglades peatlands have mainly formed by three processes.

They may form on a:

- **"fixed"** high point of rock
- peat **"pop-up"**
- sawgrass **"strand"**

Once established, generations of tree islands can produce many layers of roots, twigs, branches, and leaves and become a woody peat, called Gandy peat. This type of peat is more resistant and less prone to decay and thus, tree islands elevations stay above the surrounding marsh as more peat accumulates (Lodge).

The formation process of tree islands at the Arthur R. Marshall Loxahatchee National Wildlife Refuge has only recently been discovered. Certain tree islands in the Refuge are huge compared to the rounded pop-up tree islands. Strand islands are relatively narrow but generally elongated. Their configuration is similar to large sawgrass ridges (sometimes called "strands") in ridge-and-slough areas. While they are fixed in location, they do not have the characteristic teardrop shape of fixed tree islands. The layers of peat in strand islands are Gandy peat with a layer of sawgrass peat (Everglades peat), with no relationship to the topography of the underlying rock surface, which is covered by seven to eleven feet of peat. Thus, it is apparent that they evolved from sawgrass strands by shrub invasion. The abundance of slough habitat at the Refuge helps protect them from fire, which would inhibit or eliminate shrub invasion. Several hundred of these low, wet, strand tree islands exist in the Refuge, the only part of the Everglades where they occur. Like pop-up tree islands, strand islands are thought to be much younger than the Everglades (Lodge).

Plants of Tree Islands

As stated earlier, tree islands at the Refuge are typically composed of an overstory of red bay and dahoon holly with wax myrtle, buttonbush and cocoplum comprising a dense midstory and numerous ferns in the understory. Since dahoon holly and Southern bayberry (wax myrtle) have been described in previous habitats, Red Bay will be introduced here.

Red bay

(*Persea borbonia*) This tree with its evergreen aromatic leathery leaves, dark blue fruit hanging on into winter, and reddish bark is a jewel among trees. This tree can be expected to grow to reach 45 feet tall, but can reach a maximum of 75 feet tall. The average stem diameter is one to 2.5 feet with four feet in diameter maximum. Redbay is moderately tolerant of salt and intolerant of fire. But, fire does help stimulate seed germination.

Strangler fig

(*Ficus aurea*) This is a common name for a number of tropical plant species, including some banyans. They all share a common "strangling" growth habit that is found in many species, specifically ficus. This growth habit is an adaptation for growing in dark forests, where light competition is intense. The strangler fig starts life as a air plant (epiphyte) when their seeds are bird-dispensed and grow their roots downward and envelope the host tree, while also growing up to reach sunlight.

Buttonbush, credit Paul Cooper

(Cephalanthus occidentalis) This is a somewhat course deciduous shrub that reaches from six to 12 feet tall and four to eight feet for the diameter of its spread. It blooms in June and the flowers are tiny, tubular, five lobed, fragrant white in color. The flowers appear in dense, spherical, long-stalked flower heads. Long projecting styles give the flower heads a distinctively pincushion-like appearance. Ping pong size flower heads are attractive to bees and butterflies. The buttonbush can grow in water or moist soil.

Moonflower vine

(*Ipomoea alba*) This flower is sometimes just called moonflower or moon vine, is a species of night-blooming morning glory. It is a perennial herbaceous vine growing to a height of 16 ½ feet to 98 ½ feet tall with twining stems. The leaves are entire or three-lobed 1 1/3 inches to 5 1/3 inches long with a 1 1/3 inch to 7 7/8 inch long stem. The flowers are fragrant, white or pink and large (3 1/3 to 5 1/8 inches) diameter. The flowers open quickly in the evening and last through the night, remaining open until touched by the morning sun.

Morning glory

(*Ipomoea sagittate*) Most morning glory flowers curl up and close during the warm parts of the day, and are fully open in the morning, thus their name. It is a fast growing annual vine that can grow up to 15 feet tall and cover a wide area very quickly. The pure blue bell-shaped flower is the most common and the flowers live for one day only. It is closely related to sweet potato.

Golden polypody

Golden Polypody (*Phlebodium aureum*), this epiphytic fern native to tropical and subtropical regions of the Americas extends north to Florida, where it grows in swamps. It is a rhizomatous fern, with the creeping rhizome 5/16 inch to 5/8 inch (rarely 1 3/16 inches) in diameter, densely covered in the golden-brown scales that give the species its name. The fronds are large and pinnatifid (deeply lobed), from 11 – 51 inches long and 4 – 19 inches broad, with up to 35 pinnae; they vary in color from bright green to glaucous green and have undulate margins. Several round sori run along each side of the pinna midrib, and the minute spores are wind-dispersed. The fronds are semi-evergreen or briefly deciduous in areas with a marked dry season.

Widespread maiden fern

(*Thelypteris kunthii*) This is the common name for Southern shield fern, is a deciduous perennial fern growing to a height of 24 to 36 inches. The fronds are long arching, trianguler, bright sea green fronds; pinnate pinnatified blade; very hairy on upper and lower surface; sori have rounded indusial and are borne along the midvein of pinna lobes.

Southern needleleaf

(*Tillandsia setacea*) This perennial and epiphytic wetland plant is found in marshes and swamps in central and south Florida. It blooms in the summer and has stiff tufts of clustered silverly-scaled, very long, narrow needle-like leaves and is an evergreen. The flowers are reddish spikes which form six inch masses. It flowers from June to September.

Wildlife of Tree Islands

Vertebrates

In the Cypress Swamp section, vertebrate and invertebrate animals were discussed. Please refer to those definitions while discussing tree island wildlife with your students. The following are all in the vertebrate category, but there are many invertebrates that are found in this habitat.

Marsh rabbit

(*Sylvilagus palustris*) The marsh rabbit is a small cottontail rabbit found in sandy islands, marshes and swamps. Adults from the Florida peninsula typically weigh around 2.2 to 2.6 pounds with a total length up to 17 inches displaying darker and redder colors (cinnamon-rufous). A strong swimmer found only near regions of water, they feed on leaves and bulbs of marsh plants including cattails, rushes, and grasses.

Bobcat

(*Lynx rufus*) Bobcats have a gray to brown coat, whiskered face, black-tufted ears, and resembles the other species of the mid-sized Lynx genus. It has distinctive black bars on its forelegs and a black-tipped, stubby tail, from which it derives its name. Though the bobcat prefers rabbits and hares, it will hunt anything from insects and small rodents to deer. They are territorial and largely solitary, although there is some overlap in home ranges. Adult males range from 20 to 30 pounds; females range about 13 to 21 pounds. The bobcat is crepuscular: it keeps on the move from three hours before sunset until about midnight and then again from before dawn until three hours after sunrise.

White-tailed deer

(*Odocoileus virginianus*) This mammal, also known as the whitetail, is a medium-sized deer native to the United States. The deer's coat is a reddish-brown in the spring and summer and turns to a grey-brown throughout the fall and

winter. The deer can be recognized by the characteristic white underside to its tail. It will raise its tail when it is alarmed to flag the other deer. The average size is larger further away from the Equator. White-tailed deer from the tropics and the Florida Keys are markedly smaller-bodied than temperate populations, averaging 77 to 110 pounds, with an occasional adult female as small as 55 pounds.

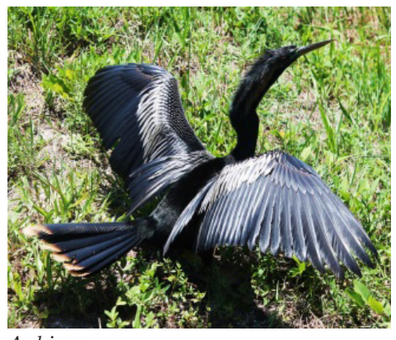
Great blue heron

(*Ardea herodias*) This is a large wading bird common near the shores of open water and in wetlands with a head-to-tail length of 36 to 55 inches, a wingspan of 66 to 79 inches, and a weight of 4.4 to 8 pounds. Notable features include slaty flight feathers, red-brown thighs, and a paired red-brown and black stripe up the flanks; the neck is rusty-gray, with black and white streaking down the front; the head is paler, with a nearly white face, and a pair of black plumes running from just above the eye to the back of the head. Primary food is small fish, though it is also known to opportunistically feed on a wide range of shrimp, crabs, aquatic insects, rodents, other small mammals, amphibians, reptiles, and small birds. Herons locate their food by sight and usually swallow it whole.

Little blue heron

(*Egretta caerulea*) This is a small heron, about 24 inches long, with a 40 inch wingspan, and weighs 0.72 pounds. It is a medium-large, long-legged, heron with a long pointed blue or grayish bill with a black tip. Breeding adult birds have blue-grey **plumage** except for the head and neck, which are purplish and have long blue filamentous plumes (located on the back of the head as seen in the picture). The Little blue heron legs and feet are dark blue. This heron stalks its prey methodically in shallow water, often running as it does so. It eats fish, frogs, crustaceans, small rodents and insects.

White ibis



Anhinga

(*Eudocimus albus*) Adults are 25 ½ inches tall with a 37 1/3 inch wingspan. They have all-white plumage except for black wingtips (visible in flight) and reddish bills and legs. The red bill blends into the face of breeding birds; non-breeding birds show a pink to red face. It occurs in marshy wetlands and pools near the coast. Its diet consists of various fish, frogs and other water creatures, as well as insects and small reptiles.

(*Anhinga anhinga*) Sometimes called snakebird, darter, American darter, or water turkey, is a water bird of the warmer parts of the Americas. The word "anhinga" comes from the Brazilian Tupi language and means devil bird or snake bird. This bird resembles the cormorant with an average body length of 35 inches, a wingspan of 45 inches, and a weight of 48 ounces. It is a dark-plumaged piscivore with a very long neck, and often swims with only the neck above water.

Florida snapping turtle

(*Chelydra serpentina osceola*) This territorial turtle is related to the common snapping turtle with jaws strong enough to **bite off a finger**. It is only found in Florida and Georgia, can grow to 17 inches long and weigh 45 pounds. Its tail is almost as long as his shell and it has saw-edges along the top of the tail. The shell also has rough points down the middle. The shell is tan to dark brown and may have green algae growing on it. They eat water bugs, fish, lizards, small birds, mice, plants, and even dead animals and live in ponds under the shadows. They don't like to rest in the sun like most turtles, they dig into the mud on the bottom of the pond with only their eyes and nose showing.

Dusky pygmy rattlesnake

(*Sisturus miliarius barbouri*) The most common venomous snake in Florida, and is responsible for more human snakebite than any other snake. Known as the ground rattler, the snake is grey in color with black blotches all over its body, including the underside. There is a series of nearly circular black markings on the middle of the back, with a dotted brick-red to orange line running right down the center of the back, between each black blotch. These snakes only attain a length of 2½ feet, but average around a foot in length. Their small size and moderately mild venom keeps them from being a serious threat to human life, but the bite is still extremely painful. The rattle sounds like an insect buzzing. They eat lizards, amphibians, and rodents.

Southern black racer

(*Coluber constrictor priapus*) One of the more common subspecies of non-venomous snakes in the Southern U.S., these snakes are quite active during the day, which increases the chance of sightings. Usually thin with a jet black dorsal side with a grey belly and white chin. They are quite fast, giving rise to the name racer. When cornered it will fight—its tiny sharp teeth can deliver a painful but non-venomous bite. Adult racers are solid black but juveniles are a blotched gray and reddish brown. Most racers are 24 to 55 inches in length and rarely exceed 70 inches. They will eat almost any animal they can overpower, including, rodents, frogs, toads, and lizards.

Pig frog

(*Rana grylio*) This frog is green or grey-green in color, with brown or black blotching. They have fully webbed feet, a sharply pointed nose, and a large ear tympanum. They are easily mistaken for various other species of the genus Rana which they share geographic range with, including the bullfrog (*Rana catesbeiana*). They grow to a length of 3.25 to 5.5 inches. This species gets its common name from the call that males use to attract females, which sounds somewhat like a pig's grunt. Its pig-like grunt can be heard during the warm months of the year. Almost entirely aquatic, they are found predominantly on the edges of lakes, or in cypress swamps and marshes heavy with vegetation. They feed nocturnally on crayfish, but like most frogs, they will consume almost anything they can swallow, including insects, fish, and other frogs.

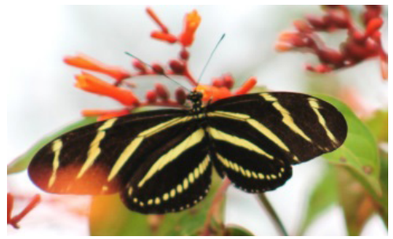
Southern leopard frog

(*Rana sphenocephala*) Mostly aquatic, it is generally green or light brown in color, with dark brown or black blotching (that is the origin of their common name). They grow to 3½ inches in length and have a pointed snout. They are excellent jumpers, and typically escape predation by leaping into the water and swimming to the bottom. They are mostly nocturnal, and carnivorous, consuming almost any kind of insect they can catch and fit in their mouth, as well as earthworms, spiders and centipedes.

Invertebrates

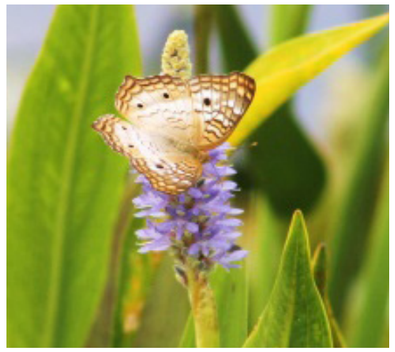
Giant swallowtail

(*Papilio cresphontes*) With a wingspan of about 3.9 to 6.3 inches, it is the largest butterfly in Canada and the United States. The body and wings are dark brown to black with yellow bands. There is a yellow eye in each wing tail. The abdomen has bands of yellow along with the previously mentioned brown. The mature caterpillar resembles bird droppings to deter predators, if that doesn't work they use their red osmeterium (a protrusible glandular process of swallowtail larvae that emits a disagreeable odor for defensive purposes). Older instars take on the appearance of a small snake with a fake head and eyes; it is mostly seen in deciduous forest and citrus orchards where they are considered pests.



Zebra

(*Heliconius charitonius*) Zebra heliconian, is a species of butterfly and was declared the official butterfly for the state of Florida in the United States in 1996. The caterpillar feeds on Yellow Passionflower (*Passiflora lutea*), Corky-stemmed Passionflower (*Passiflora suberosa*), and Two-flower Passionflower (*Passiflora biflora*). The adults are unusual among butterflies in that they eat pollen as well as sip nectar. Adults roost in groups of up to 70, and return to the same roost each evening.



White peacock

(*Anartia jatrophae guantanamo*) This butterfly has a wing span of two to 2 3/4 inches. Males patrol and occasionally perch to find females. Eggs are laid singly near the host plant or under its leaves. Eggs are pale yellow, laid on various host plants including ruellia and water hyssop. Caterpillars are black and spiny, with silver spots. Chrysalis is green, and darkens with age. The white peacock flies year-round except in very cold weather. It lives in open fields near swampy areas, ponds and streams and feeds on Spanish needle.

Wet Prairies

What is a Wet Prairie?

In contrast to sloughs, **wet prairies** have shallower water levels and are characterized by short emergent plants other than sawgrass, such as **beakrushes** and **spikerushes**. They only superficially resemble prairie habitats of the Great Plains. The term wet prairie is not standardized in the Everglades literature and has been applied to two distinct communities.

In general, the term wet prairie has been used in such a wide range of contexts as to lead to confusion by non-experts. The simplest solution is to follow the definition of wet prairie used by Olmsted and Loope (1984) and recognize that wetlands with shorter hydroperiods (typically one to three months but could be up to six months) and shallower maximum levels of flooding (saturated soils up to about 11.8 inches) are wet prairies. In common, these communities have lower and less dense vegetation than sawgrass communities, providing more open water for aquatic animals.

Two Types of Wet Prairies

The first type of wet prairie is the **marl prairie** and is further south in the Everglades ecosystem than the Refuge. The second type of wet prairie is a deeper-water marsh community that occurs on peat soil and has a long hydroperiod and lower plant diversity. Maidencane, Tracy's beaksedge or spikerush usually dominate. Wet prairies are the most prevalent vegetative community (approximately 50 percent land coverage) in much of the central and eastern portions of the Refuge and generally found between sawgrass marshes and sloughs. This important vegetative community type provides prey for wading birds and the Everglades snail kite in the form of fish, aquatic invertebrates, such as prawns, and apple snails which require permanent water. (Lodge, 1994 and 2004)

What Are the Holes in Wet Prairies?

One early describer of the wet prairie said they had more holes than solid ground (Dade County 1979). These numerous **solution holes** are in direct contact with the underlying **aquifer** and serve as vital refugia for aquatic and semi-aquatic species during seasonal drying down of water levels. These refugia became concentrated with fish, amphibians, reptiles, and invertebrates, and are preferred foraging areas for a wide range of wading birds as water levels are dropping.

Inundated beakrush

Plants of Wet Prairies

(*Rhynchospora inundata*) Inundated beakrush, perennial sedge of oligotrophic wetland habitats with fluctuating water levels, requires periods of both inundation and drawdown to maintain population health. It flowers and spreads when flooded, but the seeds germinate only in a dry environment. Its stem is triangular in cross-section and reaches as tall as 39 inches though usually not more than 23 inches. Leaves are slender, erect, and flat or slightly rolled inward and the major ones originate at the base of the stem. The flower is diffusely branched and can be 4 to 9 inches. It has a distinctively open appearance because the spikelets grow in small, loose clusters of 2 to 6 or are occasionally solitary. Its seeds are eaten by ducks.

Spikerush

(*Eleocharis Spp*) In general, spikerushes are small perennial plants (although some reach heights of four feet) and are often confused with the smaller species of rushes, grasses, or sedges. Slender spike rush can grow completely underwater and appear as a submerged plant. Stems are unbranched with sheaths around the base but can be round, square, or flattened depending on the species. All spike rushes have small fruiting spikes at the tips of the stem. Submerged portions of all aquatic plants provide habitats for many micro and macro invertebrates. These invertebrates in turn are used as food by fish and other wildlife species (e.g. amphibians, reptiles, ducks, etc.). After aquatic plants die, their decomposition by bacteria and fungi provides food (called **detritus**) for many aquatic invertebrates.

Pickerelweed

(*Pontederia cordata*) Pickerelweed typically grows to about two to three feet tall. Its leaves are large, up to five inches wide, and are usually twice as long. Leaf shapes are variable, but are usually lance-shaped. The easiest way to recognize pickerelweed is by its spike of violet-blue flowers. Sometimes the flowers are white. It is a prolific grower that can cover large areas. Pontederia cordata blooms from spring to summer.

Whisk-fern

(*Psilotum nudum*) A whisk fern has water and food conducting tissues but lacks true leaves and roots. Photosynthesis occurs in the aerial stems, and water and mineral absorption occurs in the horizontal underground rootlike stems (rhizomes), which receive water and nutrients from fungi through a mycorrhizal association. There are two phases in the life cycle of a whisk fern. The large asexual plants (sporophytes) produce spores that develop into

very small colorless sexual plants (gametophytes), which are similar to rhizomes in overall appearance. Eggs and sperm are produced in special structures on their surfaces. Union of these gametes initiates the second sporophyte phase. In nature, the plants mostly grow as epiphytes (living on other plants).

Wildlife of Wet Prairies
Vertebrates

Florida mottled duck

(*Anas fulvigula*) The mottled duck is a non-migratory, close relative of the mallard (*Anas platyrhynchos*). Mottled ducks are large and brown in color but appear very dark when viewed at a distance. Mottled ducks are darker than female mallards, but slightly lighter in color than black ducks. Approximately 40 percent of the mottled duck's diet consists of animal matter such as insects, snails, mollusks, crayfish and small fish. The remainder of its diet is composed of grass seeds, stems, roots, seeds of other marsh plants, and bayberries.

Black-necked Stilt

(*Himantopus mexicanus*) The black-necked stilt is a locally abundant shorebird of American wetlands and coastlines. Adults have long pink legs and a long thin black bill. They are white below and have black wings and backs. The tail is white with some grey banding. A continuous area of black extends from the back along the hindneck to the head. There, it forms a cap covering the entire head from the top to just below eye-level, with the exception of the areas surrounding the bill and a small white spot above the eye. Males have a greenish gloss to the back and wings, particularly in the breeding season. This is less pronounced or absent in females, which have a brown tinge to these areas instead. Otherwise, the sexes look alike. The black-necked stilt forages by probing and gleaning primarily in mudflats and lakeshores, but also in very shallow waters near shores. It seeks out a range of aquatic invertebrates – mainly crustaceans and other arthropods, mollusks, small fish and tadpoles.

Everglades snail kite

(*Rostrhamus sociabilis*) The Everglades snail kite is an endangered species. Snail kites can grow up to 18 inches long with a 47 inch wingspan. They have long, broad, rounded wings. It is short-tailed, with a white rump and undertail coverts. The dark, deeply hooked beak is an adaptation to its diet. The adult male has dark blue-gray plumage with darker flight feathers. The legs and **cere** are red. The adult female has dark brown upperparts and heavily streaked pale underparts. She has a whitish face with darker areas behind and above the eye. The legs and cere are yellow or orange. The immature is similar to adult female, but the crown is streaked. It flies slowly with its head facing downwards, looking for its main food, the large apple snails. For this reason, it is considered a molluscivore. It nests in a bush or on the ground, laying three to four eggs.

Fulvous whistling duck

(*Dendrocygna bicolor*) The Fulvous whistling duck is 19 to 21 inches long. It has a long grey bill, long head and longish legs, buff head and under parts, a dark crown, and dark grey back and wings. The tail and wing patches are chestnut, and there is a white crescent on the upper tail which is visible in flight. All plumages are similar, except that juveniles have less contrasted flank and tail coloration.

Florida mud turtle

(*Kinosternon subrubrum steindachneri*) The shell of the Florida mud turtle is usually smooth and dark brown or olive. Mud turtles are easily distinguishable from similar musk turtles by looking at the underside of the **plastron**. Mud turtles have a large plastron with two moveable hinges. The head of the Florida mud turtle is often spotted but lacks the yellow or white stripes of the striped mud turtles and common musk turtle. Young mud turtles tend to be darker than the older individuals and hatchlings have reddish or orange blotches on the plastron. This turtle is semi-aquatic and hence spends more time on land than many other turtles. Any shallow waterway serves as an ideal environment, including streams, rivers, lakes, ponds and marshes; they have a distinct tolerance to brackish water. Mud turtles are even found in temporary wetlands, burrowing into the mud when the wetland dries. Typically found in the intertidal zone at the water's edge at a mean distance from sea level of 112 feet. Mud turtles feed on a wide variety of aquatic organisms and also eat aquatic plants.

Florida softshell

(*Apalone ferox*) The Florida softshell turtle is a species of softshell turtle native to the eastern United States and typically has a dark brown to olive green, leathery carapace with a white or cream colored underside, which provides the turtle with effective protection from some predators. They have a long neck, an elongated head, with a long snorkel-like nose. Juveniles have dark blotching, which fades as they age. They grow to a large size, from 6 to 30 inches, the largest of all the species in the genus Apalone. Females are larger with males only reaching about 14 inches. The juveniles are olive-yellow with grey spots and a yellow lined carapace. Juveniles also have yellow and orange markings on the head and a gray plastron. These marking disappear as it ages, although adults sometimes show traces of the markings. The Florida softshell is highly carnivorous, consuming fish, frogs and other amphibians, insects, duck hatchlings and crustaceans.

Florida green water snake

(*Nerodia cyclopion floridana*) Adults average from 30 to 55 inches, record 74 inches. Adults are thick bodied and may be greenish, brownish, or orangish, with no real distinctive markings other than dark speckling. The belly is unpatterned but light-colored, with a faint pattern beneath the tail. The head is large, with a scale between the eye and the scales on the upper lip. Like all other water snakes, the Florida green water snake is commonly mistaken for the venomous cottonmouth. The cottonmouth is usually darker and will typically open its mouth as a warning display, showing the bright white interior of its mouth. The Florida green water snake feeds on frogs, tadpoles, salamanders, and fish.

Brown water snake

(*Nerodia taxispilota*) Average adult size is 30 to 55 inches, record is 69.5 inches. Adults are light tan with darker squarish brown blotches on the back. Dark squarish markings extend upwards from the belly onto the sides of the body between the dorsal blotches. The belly is light-colored with darker blotches and half moons. It feeds on fish, frogs, and carrion. It is live-bearing, with up to 60 young being recorded. The seven to 11 inch newborns emerge from June-October.

Giant marine toad

(*Bufo marinus*) Giant marine toad, also known as the giant neotropical toad or cane toad, is a large, terrestrial true toad. Adults average 3.9 to 5.9 inches in length; the largest recorded specimen weighed 5.8 pounds with a length of 15 inches from snout to vent. The Giant marine toad has poison glands, and the tadpoles are highly toxic to most animals if ingested. It has a diet of both living and dead matter. As a result of its voracious appetite, the Giant marine toad has been introduced to many regions of the Pacific and the Caribbean islands as a method of agricultural pest control. These toads are considered an exotic species as they are taking the place of our native toads and frogs.

Oak toad

(*Bufo quercicus*) Oak toads range in size from 3/4 to 1 5/16 inches. Ground color varies from light gray to almost black. These tiny toads may be very dark when they are cold, but become brightly colored and well patterned with paired, light-edged dark dorsal spots when warm. The distinguishing character for Oak toads (no matter what color they are) is a light middorsal stripe that may be white, cream, yellow, or orange. There are also generally 4 or 5 pairs of black or brown spots on the back of the toad.

Invertebrates

Regal darner

(*Coryphaeschna ingens*) The Regal darner dragonfly is a member of the family Aeschnidae. Darners are among the largest and fastest-flying North American dragonflies, 2 ¼ to 4 ¾ inches long. These brilliant blue, green, or brown insects have large, clear wings spanning up to 5 7/8 inches. Their hemispherical compound eyes meet on top of the head. The larva of this dragonfly is 2 ½ inches long, has a very flat lower lip, with no grasping bristles on the side, and relatively short legs.

Eastern lubber grasshopper

(*Romalea microptera*) This is the most distinctive grasshopper species in the southeastern United States. It is well known both for its size and its unique coloration. They start as newborns the size of a pinky nail and grow to four inches long. The wings offer little help with mobility for they are rarely more than half the length of the abdomen. This species is incapable of flight and can jump only short distances. The lubber is quite clumsy and slow in movement and travels by feebly walking and crawling over land. In Latin, the word means clumsy. They exist throughout the year in Florida with their numbers dwindling during the fall and winter period.

Four-spotted pennant

(*Brachymesia gravida*) This dragonfly species perches conspicuously on tips of twigs in true pennant fashion. Looks like a slaty skimmer with a black spot in each wing and white stigmas. Sporadically reported from Cape May and Cumberland counties along the coast; it also occurs across Delaware Bay in brackish marshes. Look not only for the four brown wing spots, but also for the white pterostigma (a cell in the outer wing of insects which is often thickened or colored and stands out from other cells) on each wing. Legs in this species are black.

Bowfin

(*Amia calva*) Bowfins are an order of primitive ray-finned fish. The most distinctive characteristic of the Bowfin is its very long dorsal fin consisting of 145 to 250 rays, and running from mid-back to the base of the tail. The caudal fin is a single lobe, though double lobed. They can grow up to 43 inches in length, and weigh 21.5 pounds. The bowfin is

an indiscriminate predator that readily preys on a broad variety of arthropod and vertebrate prey, from insects, crawfish, fish and frogs. Bowfins are found throughout eastern North America, typically in slow-moving backwaters, canals and ox-bow lakes. When the oxygen level is low (as often happens in still waters), the bowfin can rise to the surface and gulp air into its swim bladder, which is lined with blood vessels and can serve as a lung.

Seminole killifish

(*Fundulus seminolis*) Seminole killifish are an endemic Florida species. Seminole killifish are small, olive green, cylindrical fish with a rounded caudal fin. They have faint vertical bars on their sides and small longitudinal streaks. They can grow up to 8 inches long. Killifish spawn in April or May, but spawning may continue throughout the summer. They feed primarily on small insects and crustaceans, and tend to inhabit near the bottom. They are important forage fish and are valued in the bait fish industry.

Sheepshead minnow

(*Cyprinodon variegatus*) Sheepshead minnows are generally about 1.8 inches long, the longest on record was 3.7 inches. Their distinguishing characteristics include silver, tubby bodies, one dorsal (back) and one anal fin (fin closest to tail), and no lateral line. This fish can live in water so shallow that it may be the only species there. They can survive in water that has been deprived of oxygen by gulping air at the water's surface. Sheepshead minnows can be found in freshwater as well as saltwater. Sheepshead minnows are an important link in the coastal **food chain**. Their diet consists of plant material, algae, detritus (decomposing dead/animal matter), mosquitoes and smaller fish.

Swamp darter

(*Etheostoma fusiforme*) Swamp darters are small torpedo shaped fish with a split dorsal fin and flat caudal fin. They are green to brown in color with three or four black spots across the caudal fin. They can grow to about 3.5 inches in total length. They spawn in the early spring. They are predacious fish feeding on live animals, primarily small aquatic insects and crustaceans.

Sloughs

What is a Slough?

Sloughs (pronounced SLOOs) are the deepest of the natural marsh communities in the Everglades. They are the main avenues of water flow through the Everglades. The current remains leisurely, moving about 100' a day. During the rainy season, water depths in sloughs may exceed three feet, with the annual average depth about one foot. The hydro period is approximately 11 months, making it ideal habitat for aquatic plants. Like the longer hydro period type of the wet prairie, sloughs occur over peat soil and support an abundance of fish and aquatic invertebrates.

The dominant vegetation includes submerged and floating aquatic plants such as blatterwort, white water lily, floating heart, and spatterdock. Because of their long hydro period and scarce fuel (little standing vegetation), sloughs seldom if ever burn, and thus act as natural firebreaks in the Everglades. Some areas of slough vegetation originate where soil fires reduced elevations, forming patches that have a long hydro period (Lodge).

What Does a Slough Look Like?

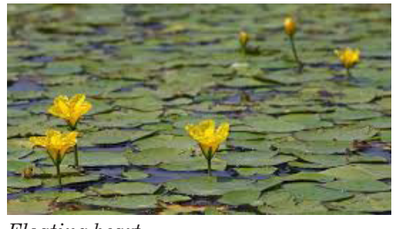
Where sloughs are extensive, the landscape is typically dotted with tree islands and contains patches of sawgrass marsh, often as elongated strips. This configuration is called ridge-and-slough landscape, with sawgrass on elevated "ridges" (relative to the foot-deep sloughs). Tree islands are on yet higher ground. Sloughs have deeper water and hold water longer than other Everglades habitats discussed above. The slough may vary in depth from a few inches to two feet or more. Along with alligator holes, the deeper sloughs provide an important source of water during the dry season. As you have seen, each habitat has a distinct group of plants which distinguishes it from the others. The slough is characterized more by a lack of plants. White water lily and floating heart are found here but little other vegetation can be seen above the water's surface (Lodge).

Plants of the Slough

White water lily

(*Nymphaea odorata*) The white water lily is a perennial plant that often forms dense colonies. The leaves arise on flexible stalks from large thick rhizomes. The leaves are more round than heart-shaped, bright green, 6 to 12 inches in diameter with the slit about 1/3 the length of the leaf. Leaves usually float on the water's surface. Flowers arise on separate stalks; have brilliant white petals (25 or more per flower) with yellow centers. The flowers may float or stick above the water and each opens in the morning and closes in the afternoon. The flowers are very fragrant. White water lily can spread from seeds or the rhizomes.

Submerged portions of all aquatic plants provide habitats for many micro and macro invertebrates. These invertebrates in turn are used as food by fish and other wildlife species (e.g. amphibians, reptiles, ducks, etc). After aquatic plants die, their decompostion by bacteria and fungi provides food (called "detritus") for many aquatic invertebrates. Deer, muskrat, nutria and other rodents will consume the leaves and rhizomes of white water lily, while the seeds are eaten by ducks.



Floating heart

(*Nymphoides peltata*) Yellow floating heart was introduced as an ornamental aquatic plant from Eastern Asia. It is a floating-leaved plant and is generally somewhat larger than America's native floating hearts. Its flower is yellow. It has adventitious roots along an underwater stem.

Spatterdock

(*Nuphar lutea*) Spatterdock (or yellow pond lily) is a large plant whose leaves are often floating; however, submersed and immersed leaves are common. Spatterdock commonly occurs in ponds, lakes and sluggish streams and blooms from spring to summer. Spatterdock has large heart-shaped leaves, usually with wavy margins. Spatterdock floating leaves are attached to long, stout stems which arise from large, spongy rhizomes. Spatterdock submersed leaves are very thin, attached at the bottom rhizomes. Spatterdock flowers are yellow and "half-opened" at or above the water surface. Flowers are attached to thick round stems that are often 6 feet long. Spatterdock may be confused with white water lily, Nymphaea species.

Blatterwort

(*Utricularia Spp*) The bladderworts received this name because of tiny bladder-like structures on their branched underwater leaves. (The wort part of the name comes from old English, when wort meant plant). These bladders are actually small vacuum traps which catch tiny aquatic animals. The tiny traps are oval, with a membranous door at one end. Small trigger hairs surround the door that secretes a sweet lure; when an animal comes near the trigger hairs, the door snaps open for a fraction of a second, sucking the animal inside the bladder. Once trapped inside, the plant absorbs the animal's nutrients using digestive juices. Due to their ability to 'eat' animals, bladderworts can live in nutrient poor, rather acidic, boggy conditions. Bladderworts are free-floating plants, but usually go unnoticed due to their habit of hanging out near the bottom in shallow areas. They usually attract attention in spring and summer when they float to the surface to send up shoots of small, attractive, yellow snapdragon like flowers.

Fanwort or chara

(*Cabomba caroliniana*) Fanwort is a multi-branched submerged perennial plant except for a few small (½ – 1¼ inches long) alternately arranged elongated floating leaves. The submerged leaves are opposite, attached by a single petiole, but above the petiole form a finely divided "fan-shaped" leaf. Fanwort has a small (½ to ¾ inch diameter) white to pink flower which arises from the tip of the stem and stands slightly above the water's surface. Submerged

portions of all aquatic plants provide habitats for many micro and macro invertebrates. These invertebrates in turn are used as food by fish and other wildlife species (e.g. amphibians, reptiles, ducks, etc.). After aquatic plants die, their decomposition by bacteria and fungi provides food (called "detritus") for many aquatic invertebrates. Fanwort has little known direct food value to wildlife. (http://aquaplant.tamu.edu)

Wildlife of the Slough

Wood storks

(*Mycteria americana*) The wood stork is on the threatened species list and a species of special concern in Florida. The adult is a large bird 33–45 inches tall and 58 to 71 inch wingspan. Males typically weigh 5.5 to 7.3 pounds; females weigh 4.4 to 6.2 pounds, although large birds are up to 10 pounds. It appears all white on the ground, with blackish-gray legs and pink feet. In flight, the trailing edge of the wings is black. The head is dark brown with a bald, black face, and the thick down curved bill is dusky yellow. Juvenile birds are a duller version of the adult, generally browner on the neck, and with a paler bill. Walking slowly and steadily in shallow water up to its belly; it seeks prey, which, like that of most of its relatives, consists of fish, frogs and large insects. It catches fish by holding its bill open in the water until a fish is detected.

Osprey

(*Pandion haliaetus*) The osprey sometimes known as the sea hawk or fish eagle is a diurnal, fish-eating bird of prey. It is a large raptor, reaching 24 inches in length with a 6.5 foot wingspan. It is brown on the upperparts and predominantly grayish on the head and under parts, with a black eye patch and wings.

The Osprey is particularly well adapted to this diet, with reversible outer toes, sharp spicules on the underside of the toes, closable nostrils to keep out water during dives, and backwards-facing scales on the talons which act as barbs to help hold its catch. Occasionally, the Osprey may prey on rodents, rabbits, snakes, amphibians, other birds, and small reptiles. It has evolved specialized physical characteristics and exhibits unique behavior to assist in hunting and catching prey. Despite its propensity to nest near water, the Osprey is not a sea-eagle. Fish make up 99% of the Osprey's diet. It typically takes fish weighing five to 10 ounces and about 10 to 14 inches in length, but the weight can range from two to 68 ounces. Ospreys have vision that is well adapted to detecting underwater objects from the air. Prey is first sighted when the Osprey is 32 to 130 feet above the water, after which the bird hovers momentarily then plunges feet first into the water.

Red-shouldered hawk

(*Buteo lineatus*) The Red-shouldered hawk is a medium-sized hawk. Males are 17 to 23 inches long, weigh about 1.2 pounds and have a wingspan of 38 inches. Females are slightly larger at 19 to 24 inches in length, a weight of about 1.5 pounds and a wingspan of about 42 inches. Adults have a brownish head, a reddish chest, and a pale belly with reddish bars. Their tail, which is quite long by **buteo** standards, is marked with narrow white bars. The red shoulder is visible when the bird is perched as seen in the image above. These hawks' upper areas are dark with pale spots and they have long yellow legs. Western birds may appear redder while Florida birds are generally paler. The wings of adults are more heavily barred on the upper side.

Juvenile Red-shouldered hawks are most likely to be confused with juvenile Broad-winged hawks, but can be distinguished by their long tail, crescent-like wing markings, and a more flapping, **accipiter**-like flight style. This bird is often confused with the Red-tailed hawk, another species of hawk. Prey can include amphibians, reptiles (especially small snakes), small birds, and large insects. During winters, they sometimes prey on birds commonly found at bird feeders.

American alligator

(*Alligator mississippiensis*) The American alligator has a large, slightly rounded body, with thick limbs, a broad head, and a very powerful tail. Adult alligators generally have a green, olive, brown, gray, or nearly black color with a creamy white underside. Algae-laden waters produce greener skin, while tannic acid from overhanging trees can often produce darker skin. Juvenile alligators have a striped pattern for **camouflage** that they lose as they mature. Adult male alligators are typically 11.2 to 14.5 feet in length, though rarely exceeding 14 feet, while adult females average 8.2 to 9.8 feet. Average body weights are reported from 270 to 800 pounds, with the larger old males exceeding 1,000 pounds.

American alligators have the strongest bite of any living animal, measured at up to 2,125 (pound force) in laboratory conditions.

American alligators are less susceptible to cold than American crocodiles. Unlike the American crocodile, which would quickly succumb to the cold and drown in water of 45 °F, an alligator can survive in such temperatures for some time without apparent discomfort. Alligators eat fish, birds, turtles, snakes, mammals, and amphibians. Some adult alligators take a larger variety of prey ranging from a snake or turtle to a bird and moderate sized mammals like a raccoon or deer. The **gizzards** (stomachs) of alligators often contain **gastroliths**. The function of these stones is to grind up food in the stomach and help with digestion.

Peninsula cooter

(*Pseudemys floridana peninsularis*) They grow up to 15 inches. The full dark spots on the underside of the marginal help to distinguish it from Pseudemys floridana floridana, which has spots with light colored centers. The cooter is mainly herbivorous and inhabits lakes, sloughs, ponds, slow-flowing streams, and other still bodies of water with soft bottoms and abundant aquatic vegetation. However, it can be found in high densities in some Florida spring runs, usually in heavily vegetated areas with little flow. This species is active year-round and spends a large portion of the day basking on logs.

Florida banded water snake

(*Nerodia fasciata pictiventris*) Adults average from 24 to 42 inches. The record is 62.5 inches. Stout bodied snake with broad black, brown, or red crossbands over most of its body. The lighter narrower bands are tan, gray, or reddish and may contain a dark spot on the side. The light bands may be broken by a black strip down the middle of the back. Crossbands may be obscured as snake darkens with age. Their belly is creamy yellow with wormlike red or black markings. Scales are keeled and there are 23 to 27 dorsal scale rows at midbody. The pupil is round. A dark stripe extends from the eye to the angle of the jaw. Juveniles have very clear red or black crossbands on light background.

Largemouth bass

(*Micropterus salmoides floridanus*) The largemouth is the largest member of the sunfish family. It generally has light greenish to brownish sides with a dark lateral line which tends to break into blotches towards the tail. Often confused with smallmouth and spotted bass, it is easily distinguishable because the upper jaw extends beyond the rear edge of the eye. Also, its first and second dorsal fins are almost separated by an obvious deep dip, and there are no scales on the soft-rayed second dorsal fin or on the anal fin. Two are recognized: the northern largemouth (*M. s. salmoides*) and the Florida largemouth (*M. s. floridanus*). The two look much the same, but the Florida largemouth has 69 to 73 scales along the lateral line compared to the northern largemouth's 59 to 65 scales. Florida bass grow to trophy size more readily than northern largemouth in warm waters. Originally, the Florida largemouth was found only in peninsular Florida, but they have been stocked in several other states including Texas and California. Males seldom exceed 16 inches, while females frequently surpass 22 inches.

Longnose gar

(*Lepisosteus osseus*) The longnose gar ranges in length from 24 to 72 inches and weighs 1.1 to 7.7 pounds; the world record is 50.31 pounds, caught in Trinity River, Texas in 1954; Fish Base reports a maximum size of 6.6 feet. Average life span is 17 to 20 years. The snout is elongated into a narrow beak containing many large teeth. The gar has a long body that is shaped like a cylinder, and is covered with diamond-shape scales. It has a long black streak across the body. They usually are found near vegetation and occasionally in brackish waters. Young fish mainly feed on zooplankton while larger ones feed on small fish, frogs and crustaceans. They feed by stalking their prey or lying in wait for it to come within striking distance.

Bluegill

(*Lepomis macrochirus*) The bluegill is a species of freshwater fish sometimes referred to as bream, brim, or copper nose. Of the many types of sunfish body shapes, the bluegill's most notable feature is the blue or black "ear." Its name, however comes from the bright blue edging visible on its gill rakers. It can be distinguished from similar species by the (not always pronounced) vertical bars along its flanks. The bluegill grows to a maximum overall length of approximately 16 inches.

Black crappie

(*Pomoxis nigromaculatus*) The black crappie is a silvery-green to yellowish fish with large dorsal and anal fins of almost identical shape and size. The sides are marked with black blotches which become more intense towards the back. The dorsal, anal, and caudal fins also are marked with rows of dark spots. Crappies have compressed bodies, small heads and arched backs. It has a large mouth with an upper jaw extending under the eye. Primary food items are crustaceans, aquatic insects and small fish. Adults mainly eat small fish, particularly open-water forage fish, like threadfin shad.

Activities/Lessons

Wetland Metaphors from Project WILD (grades 2-12)

Materials: Chapter IV Everglades Ecosystems, bag filled with – sponge, pillow, bar soap, egg beater, sieve, paper coffee filter, antacid (TUMS) tablets, box of cereal, bottle of water, baby rattle (bag with all of contents can be borrowed from Arthur R. Marshall Loxahatchee National Wildlife Refuge), paper and writing utensil.

Activity: This takes about 30 minutes. Begin by confirming student background knowledge of the definition of a metaphor. Have one student be the recorder. Allow students to pick an element from the bag, think about what they have, and write a brainstorm list of how this element metaphorically relates to the function of a wetland using knowledge gained from this chapter. As students share, the recorder makes a chart showing the element and its metaphorical function as connected to wetlands (an example of this is that an egg beater could be a tornado/hurricane that comes through the wetlands or a sponge is the peat that soaks up the water but still holds it in the wetland). Students then confirm or disprove their ideas, recorder writes the correct information next to the students' claims.

An extension of this is to have students write Haiku poems with visuals of their element and what each represents in wetlands.

Animal Olympics from U.S. Fish and Wildlife Service (K-12)

Materials: Must take place outdoors. Since this can be adapted to the schoolyard as well as the Refuge (animal cards should refer to fauna found where the activity is taking place), pictures, markers, and paper. Teacher can make groups or individuals, students just cannot have the same animal. (Refuge has 11 signs with Refuge animals which can be borrowed for this activity. Please call education department for a score sheet for the Refuge Animal Olympics.)

Activity: This should take two class periods to coordinate. The teacher should have students make game cards with information and visuals about an animal and its physical body movements on one page– this animal should be researched from information within this chapter and supplemental resources (teacher can allow students to choose their animal or assign students an animal – it must be related to the habitat of the activity).

Teacher assigns a recorder to track how many students have the same physical capabilities as the animals. Begin in alphabetical order. For example, the student with the alligator goes first, holds up his/her paper showing the picture and physical capability fact of the animal (the high walk), the student then attempts to mimic the capability and the rest of the class tries one by one as well while the recorder tracks how many students' abilities can compare to the animals'.

Even children with disabilities can have an animal; the teacher should be sensitive to the child's feelings and abilities. At the end, the top three students who physically match the same capabilities as the animals win the Gold, Silver, and Bronze metals.

Great blue heron Balance Beam: Great blue herons can walk in a straight nine inch stride.

White-tail Deer High Jump: White-tailed deer can jump 8½ feet straight into the air.

Everglades snail kite Aerobatics: Male kites swoop, glide and dive to attract a mate. Can a student perform a similar aerobatic performance?

American alligator High Walk: American alligators keep their legs directly underneath themselves to walk. How many feet can a student high walk.

Osprey Dance: Male ospreys 'sky dance' to attract a mate. Can a student sky dance for five minutes?

Florida panther Long Jump: Florida panthers can long jump up to 15 feet vertically and 45 feet horizontally.

Anhinga Still Pose: Anhingas spread their wings to thermoregulate their body temperature. Can a student spread their arms and hold the pose for two minutes?

Marsh rabbit Run: Marsh rabbits run in a zig zag pattern.

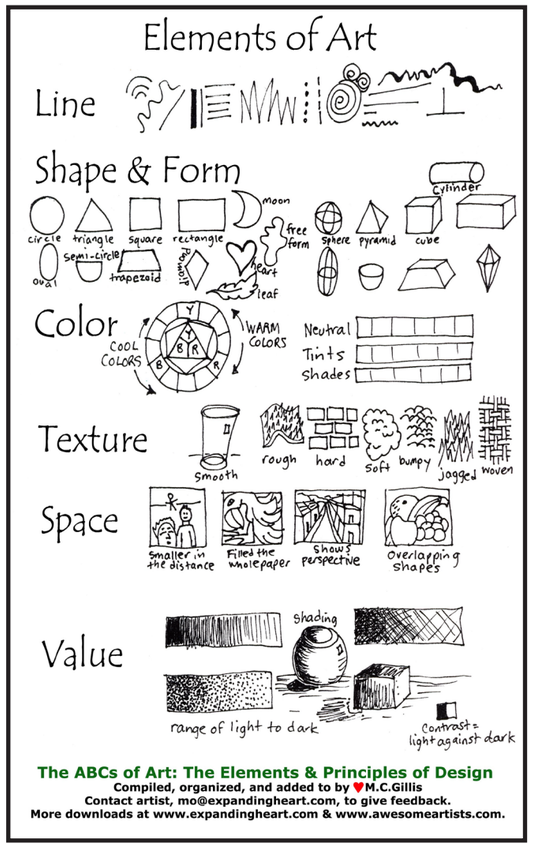
Red-shoulder hawk Distance Spit: Red-shoulder hawk babies send their feces over the nest at a few days old. How far can a student spit?

River otter Gymnastics: River otters spin or twist while on the grass or in the water.

Florida box turtle Curl: Florida box turtles curl up in a ball at the sign of a threat. Can a student hold this pose for two minutes?

Extend this by discussing – are these students and animals the fittest? Do they have the best chance at survival?

Extend this into a discussion on bullying students with disabilities or children who are different from themselves!!!



Patterns in Nature, Can you Guess Who? from Emily Guerrieri (grades 3-12)

Materials: camera, camera phone, or drawing materials (teachers can use small digital cameras and students can pair up or they can borrow cameras from the school). This activity must take place outdoors.

Activity: Students are shown photos of various types of patterns on man-made objects, or patterns made by man and take notes on the different types of patterns. Students are then to find examples of each in nature – take a photo or draw it as a close-up, then present their findings to the class and the class must categorize the type of pattern, connect it to something man-made, and guess what the close-up is of. Use the template of patterns from www.expandingheart.com

Chapter V

Endangered Species

This chapter is designed to introduce students and teachers to endangered and threatened species that live in the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) and the Southeastern United States and will hopefully encourage further research and discussions about other problems and issues in this country and around the world.

What Does it Mean to be Endangered?

A plant or animal is endangered if it is in serious danger of becoming extinct throughout all or much of its range. A threatened species is likely to become endangered in the near future. A species is listed as endangered or threatened through a formal legal process that examines scientific evidence of the plant or animal's habitat and the numbers of which are present from year to year. Once listed, a species receives Federal protection from all activities that destroy it or its habitat, and a plan is made for helping the species recover.

Many students will be surprised to learn that endangered and threatened species may live and **migrate** close to their homes. Visit the following three websites for a list of the threatened and endangered species:

- http://www.freshfromflorida.com/Divisions-Offices/Florida-Forest-Service/Our-Forests/Forest-Health/Florida-Statewide-Endangered-and-Threatened-Plant-Conservation-Program/Florida-s-Federally-Listed-Plant-Species
- http://www.nmfs.noaa.gov/pr/species/esa/listed.htm
- http://www.fws.gov/endangered

Have your students learn about one or more species being threatened by extinction and report on these species during class. Individual awareness and action on a local level is important to the survival of all the animals in this chapter.

Federal Endangered and Threatened Species Listing

Group	Endangered	Threatened
Plants	720	156
Mammals	71	20
Birds	81	18
Reptiles and Amphibians	35	37
Fish	83	71
Insects and **Arachnids**	60	10
Total	1,050	312

U.S. Department of the Interior, U.S. Fish and Wildlife Service, Endangered Species – Environmental Conservation Online System http://ecos.fws.gov/tess_public/pub/boxscore.do

Numerical Summary of Species

Listed by the State of Florida as Federally-designated Endangered (FE)

Federally-designated Threatened (FT)

Federally-designated Threatened because of similarity of appearance [FT(S/A)]

Federal non-essential experimental population (FXN)

State-designated Threatened (ST)

State Species of Special Concern (SSC)

Charts and information provided by Florida Fish and Wildlife Conservation Commission 2011

In October 2013, the U.S. Fish and Wildlife Service had 1,362 plant and animal species listed as endangered and threatened in the United States. That number is up from 581 in 1990. Unfortunately, this number increases each year. Even though **extinction** is a natural process, man has accelerated the rate at which it occurs due to our need for land and its resources in which the plants and animals need to live. Scientists estimate that the number of species lost each year will climb at a rate far exceeding any in the last 65 million years. Even though we have had great success with the American bald eagle, wood stork and the American alligator there are always species that are being added and subtracted to the threatened and endangered list every year (http://www.fws.gov/endangered/species/us-species.html).

For the most current Florida Fish and Wildlife Conservation Commission Endangered and Threatened Official Species List please see (http://myfwc.com/media/1515251/threatened_endangered_species.pdf).

Endangered and Threatened Species Specific to Arthur R. Marshall Loxahatchee National Wildlife Refuge

There are at least 63 imperiled species known to occur or could occur on the Refuge. These species are listed as Federal or state threatened and endangered species, species of special concern, species of management concern, or listed by the Convention of International Trade in Endangered

Status Designation	Fish	Amphibians	Reptiles	Birds	Mammals	Invertebrates	Total
FE	3	1	4	9	22	8	47
FT	2	1	6	4	1	6	20
FT(S/A)	0	0	1	0	0	3	4
FXN	0	0	0	1	0	0	1
ST	3	0	7	5	3	1	19
SSC	6	4	6	16	6	4	42
Total	14	6	24	35	32	22	133

Species (CITES). The Service has primary responsibility for federally listed species. By managing for federally listed species, state and other listed species benefit as well.

Several species that fall under the endangered species, threatened species, or species of special concern are discussed below:

Reddish egret

(*Egretta rufescena*) This bird has been rarely observed on the Refuge. The reddish egret has been known to nest in the Boynton Beach area. The reddish egret is a state species of special concern.

Everglades snail kite

(*Rostrhamus sociabilis*) in 2013, volunteers observed the impoundments and levee's surrounding the Refuge for snail kite activity. To request a complete summary of their observations, please see the Refuge Interpretive Specialist Serena Rinker.

Surveys were performed by University of Florida researchers in the interior, impoundments, and Lake Worth Drainage District canal. One nest was initiated in the Refuge for the 2013 year; however it was not successful due to rapid changes in the water regulation schedule contributing to poor foraging conditions. The Everglades snail kite is a federally endangered species.

Bald eagle

(*Haliaeetus leucocephalus*) there are two pairs of nesting bald eagles in the Refuge. These majestic birds were taken off of the Department of Interior's endangered species list on June 28, 2007, but are still on the federally threatened list. These birds mate for life.

American alligator

(*Alligator mississippiensis*) appears to be doing well on the Refuge. In 1999, a long term survey was initiated to determine the abundance, nesting success, and health of this species. Alligators of all sizes were observed in both survey routes, with larger alligators observed in the canal survey. Many pods of young of several size classes were observed along the interior survey route indicating that alligator nesting is occurring on a regular basis in the interior. Nests were located, opened, and the eggs measured, counted, and evaluated for viability. Tending females were captured, marked, and measurements were taken. Early indications are that alligators in and around the Refuge appear to be in good condition. The American alligator is listed as a species of least concern.

Tropical curly-grass fern

(*Schizaea germanii*) was found in 1972 by Taylor Alexander on tree islands near the airboat trail, but is now found in the Cypress Swamp near rotten tree stumps and decomposing litter. It likes areas that are wet/marshy areas and that are shady. The tropical curly grass fern is an endangered species.

Factors of Species Endangerment

Humans

Causes

Today, most species become endangered because of things people do that jeopardize the survival of a species such as:

- Turning habitat into farms, factories, towns, roads, highways, dumps
- Poisoning habitats with pesticides and other pollutants
- Introducing foreign species (exotics) that compete with native ones for food or space
- Exploiting a species for commercial or recreational purposes

Solutions

- As stated by a Refuge biologist, "There is no substitute for getting children out in the wilds and letting them see and experience all that nature has to offer. This is what they will remember." Exposure and awareness is the main key to the success of life on the planet.
- A recovery plan is a guide for identifying and solving problems endangering a plant or animal. It might call for preserving or cleaning the habitat or it might require breeding an animal in captivity and releasing the young in areas where the species once lived.

What Can You Do to be a Part of the Solution?

Get Involved!

- Xeriscape, use Permaculture, Reduce, Reuse, Recycle
- Raise awareness of people around you about the plight of species and their habitats.
- Research Projects in Action – LILA (Loxahatchee Impoundment Landscape Assessment), the University of Florida, and Florida Atlantic University along with many other secondary and post-secondary institutions are conducting research experiments daily at the Refuge and you can be a part of any of them. For example: catching non-native tree frogs, eradicating invasive plant species, collecting water samples, etc…
- Join a Service Learning Project like YCC (Youth Conservation Corps)
- Write letters to lawmakers about habitat preservation

Wildlife Laws and What They Mean

The Federal government administers the national program for endangered species and is guided by laws that protect wildlife. The key legislation is the Endangered Species Act of 1973. This law provides for the listing of all classes of plants and animals that are close to extinction and gives them legal protection. The U.S. Fish and Wildlife Service is responsible for protecting and conserving endangered wildlife on land or in fresh water, while the National Marine Fisheries Service oversees marine species. These agencies work with other Federal and state government agencies, conservation organizations, businesses, and industry to try and ensure that endangered species recover and can be self-sustaining.

Endangered Species Act: (1973) this comprehensive law was passed to protect plants and animals that are in danger of becoming extinct. Species that are officially listed as "threatened" or "endangered" on the U.S. Fish and Wildlife Service list are not allowed to be imported or exported; hunted, collected, or harassed; transported across state or national lines for commerce; sold; or used in any way without an authorized permit from the U.S. Fish and Wildlife Service. Restrictions on trade and transport apply to live and dead animals and plants, their parts; and the products manufactured from them.

Protected species may be used only for the purposes of scientific research, public education, exhibition in zoos, or efforts that could help save the species. This includes help in reproduction and the transferring of animals between facilities (like zoos and aquariums) to keep the gene pool as diverse as possible. The FWS uses reintroduction of species into the animal's historically native regions from habitats that are not as suitable for the species.

For example: there were 100 red wolves that were reintroduced into eastern North Carolina to roam their native range over 20 years ago. The project is called the Red Wolf Recovery Program and counts are said to be between 90 – 110 red wolves as of today.

www.fws.gov/redwolf/redwolfrecovery.html

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES): (1975) this international treaty, which was designed to protect plants and animals affected by international trade, regulates the import and export of endangered and threatened plants and wildlife. Nations that sign the treaty agree to restrict the trade of certain species. (In 2011, 175 nations had signed) These restrictions depend on the appendix each species is listed under.

Appendix I includes species immediately threatened with extinction. All shipments of live and dead animals and plants, their parts, and any goods manufactured from them must have two permits – one from the exporting country and one from the importing country. These permits are granted only for educational or scientific purposes, and only if collection will not threaten the species.

Appendix II includes species that are not immediately threatened by extinction, but will be if their trade is not regulated. A permit from only the exporting country is required. It's legal to use these species in commercial trade, but only if it will not threaten the species.

Appendix III includes species that are not covered by Appendices I and II, but are endangered or threatened in a

country that needs international help to protect them. An export permit must be issued by the country where it is in trouble.

*Note: Nations belonging to CITES can take a "reservation" on certain species, which means they can exempt themselves from CITES requirements.

Lacy Act: (1900) This U.S. act prohibits the taking, selling, buying, importing, exporting, or transporting of any species (including rare plants and fish) that are protected by any Federal, tribal and state law. The act also makes it illegal to import any species into the United States that may be harmful to people, agriculture or wildlife. It requires that wildlife be transported humanely and be correctly identified. Its strict penalties (up to $20,000 fine and/or five years imprisonment) are often used to prosecute commercial traffickers.

Other Acts

Marine Mammal Protection Act: (1972) protects taking or harming marine mammals in U.S. waters, or importing their body parts and products. (Marine mammals include polar bears, sea otters, walruses, dugongs, manatees, whales, seals, and sea lions.)

Migratory Bird Treaty Act: (1918) protects migratory birds (including migratory and resident **songbirds**) and restricts trade of their body parts, feathers, nests, eggs and products made from them. Seasonal hunting is allowed for some ducks, geese, woodcocks, and other migratory birds.

Eagle Protection Act: (1940) was passed to protect bald eagles and amended in 1962 to include golden eagles.

Activities/Lessons

I Will Survive from U.S. Fish and Wildlife Service Region 4 EE Manual (grades 1-12)

Materials: Chapter V Endangered Species, construction paper or poster board, scissors, markers, colored pencils – older students could make a power point presentation or poster using their computer skills in Microsoft Publisher.

Activity: Students can work in teams or individually. This will take a class period. Create a T chart – to the left side, list species chosen from the Florida Fish and Wildlife Conservation Commission Threatened and Endangered Official Species List (one per group or one per student), write the causes next to the species, and then write solutions to the problem next to the cause.

Lastly, have students create an advertisement poster that persuades audiences to be aware of their animals' plight and take part in the solution presented. Students present these posters to the class.

And Then There were None from U.S. Fish and Wildlife Service Region 4 EE Manual (grades 3-12)

Materials: list of causes from "T chart" created from I Will Survive activity, Florida Fish and Wildlife Conservation Commission Threatened and Endangered Official Species List from Chapter V Endangered Species, tape, six slips of paper per student.

Activity: Each student makes an "I AM" card with the name of one species from the T chart. Students tape the "I AM" card to their shirt, and then get into a circle. Teacher distributes the six slips of paper to each student (explain that each slip represents the population of millions of organisms).

Teacher reads the causes from the T chart and says, "Each time I read a cause that limits or reduces your chances of survival, put one of your slips on the floor in front of you. Whenever I say, human population growth, everyone must turn in a slip." When students only have two slips left, they sit down and say, "I'm in big trouble." Graph the outcomes. Discuss who is left and why.

Bringing Art into the Classroom (grades 2-12)

Materials: large white poster board/foam board, items found in natures such as; leaves, pine cone parts, seeds, feathers, rocks, sand, sticks, etc. This project can be used as an at home project.

Activity: Assign the students a Florida "At risk, Threatened, or Endangered" animal – could be mammal, bird, reptile depending on what you are studying. The students are to draw the outline of the animal in pencil to fit the paper, making sure that they leave room for the animals name and basic facts about it. They are then to use the natural product to fill in the outline so that the animal looks like the animal in real life.

Extension: If you are working on another area of the world you can adapt this project to that area as well – for example: if you are working on Africa you could use animals like the Black Rhino, Cheetah, Leopard and the Mountain Zebra.

www.earthsendangered.com

Chapter VI

Exotics Invading South Florida and Arthur R. Marshall Loxahatchee National Wildlife Refuge

Over 40 new exotic species arrive into the United States monthly (www.myfwc.com), Florida being only second to Hawaii for the most invasive exotic species problems in the United States. With populations of exotic plants and animals increasing daily in Florida, coupled with habitat depletion, a significant threat is posed to the integrity and biodiversity of all of South Florida's ecosystems, including: pine flatwoods, sand pine scrub, mangrove communities, cypress swamps, the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) and the entire Everglades ecosystem.

Columbian boa surrendered at Florida Fish and Wildlife Conservation Commission Pet Amnesty Day

Flora and Fauna

Flora

Flora relates to all plant life. Thousands of exotic plants have been introduced to Florida since the **New World** was discovered. With its subtropical climate, South Florida provides an ideal situation for the growth and spread of these new invasive exotics. Without their native predators or controls, or diseases to keep their populations in check, some of these introduced species rapidly expand forming dense monotypic forests and thickets which are undesirable to wildlife throughout Florida.

Over 1,200 of these introduced plant species, 31% of all plant species documented in Florida, have become **naturalized** in Florida, meaning they are successfully reproducing on their own (Wunderlin). Of these, one to four per cent have become serious pests and are currently replacing native plant habitats such as those found in the Everglades ecosystem. This degraded habitat has been proven to support less species diversity than native plant habitats. In fact, the introduction of invasive exotic plants is the second greatest threat to biodiversity next to **habitat destruction**.

Category I

Plants are species that are currently invading and disrupting native plant communities in Florida. Sixty-seven percent (67%) of the Category I plants were introduced from the nursery industry, fifteen percent (15%) are of unknown origin or were introduced accidentally and the final eighteen percent (18%) were introduced as a help to the environment.

Category II

Plants are species that have shown a potential to disrupt native plant communities. Research by Bob Pemberton has shown that the longer a plant was available in the nursery trade the greater the chance it has of becoming invasive. Plants sold for more than 20 years have a 66% greater chance of becoming invasive (fleppc.org)

Characteristics

Invasive exotic pest plants that allow them to effectively out-compete native plants include:

- Rapid growth;
- Ability to produce seeds at an early age;
- Prolific and prodigious seed production;
- Their ability to survive stressful events such as fire, drought, temperature extremes, and herbicide treatments;
- Ease of seed dispersal;
- Ability to rapidly colonize both disturbed and relatively pristine sites such as the Refuge.

Melaleuca

(*Melaleuca quinquenervia*) was brought in to absorb and drain the water from the Everglades in order to create stable ground for building and reduce mosquito habitat with hopes of reducing malaria. Melaleuca invades all habitats found within the Refuge including saw grass marsh, tree islands, wet prairies, and sloughs, directly affecting the species which depend on these habitats for nesting and foraging.

Old World climbing fern

(*Lygodium miscrophyllum*) was introduced as an ornamental in the 1950s and is currently spreading across South Florida at an alarming rate. This fern is particularly destructive to native tree islands found in the Everglades and is also in the Refuge's 400 acre Cypress

Swamp. The fern effectively smothers native plants. It also has a nasty habit of ascending into the canopy of trees forming potential flame ladders which may carry fires into the crowns resulting in eventual tree death. Small pieces of fern material may break off during fires, drift with heat thermals, and start spot fires.

Australian Pine

(*Casuarinas equisetifolia*) A deciduous tree with a soft, wispy, pine-like appearance that can grow to 100 feet or more in height. It bears a superficial resemblance to the conifer genus Pinus because of its small, round, cone-like fruits and its branchlets of scale-like leaves that look like pine needles.

Australian pine is fast-growing (5 to 10 feet per year). Dense thickets of Australian pine displace native dune and beach vegetation, including mangroves and many other resident, beach-adapted species. The Australian pine's roots are capable of producing nitrogen through microbial associations; it can colonize nutrient-poor soils.

Once established, it radically alters the light, temperature, and soil chemistry regimes of beach habitats, as it outcompetes and displaces native plant species and destroys habitat for native insects and other wildlife. The ground below Australian pine trees becomes ecologically sterile and lacking in food value for native wildlife. Unlike native shrubbery, the thick, shallow roots of Australian pine make it much more susceptible to blow-over during high wind events, leading to increased beach and dune **erosion** and interference with the nesting activities of sea turtles. Australian pine was introduced to Florida in the late 1800's and planted widely for the purposes of ditch and canal stabilization, shade and lumber (NPS).

Brazilian Pepper

(*Schinus terebinthifolius*) An evergreen shrub or tree, it was imported as an ornamental in the 1840s. It forms dense thickets of tangled woody stems that completely shades out and displaces native vegetation as it produces certain allelopathic agents, suppressing the growth of other plants. Seeds spread by consumption and deposition of the fruit by wildlife; spread is enhanced by decorative use of branches and fruit. Brazilian pepper is estimated to occupy over 700,000 acres in central and south Florida.

http://www.fleppc.org/ID_book/Schinus%20terebinthifolius.pdf

Fauna

Fauna relates to all wildlife. Florida, specifically South Florida, next to Hawaii, California, and Louisiana, is home to more exotic wildlife species than any other region in the United States. Approximately 26% of all resident mammals, birds, reptiles, amphibians, and fish are non-native. In fact, South Florida harbors one of the largest exotic animal communities in the world, and these are represented by every animal phylum (SFWMD, 2000). These exotic invaders prey on native wildlife, therefore decreasing native numbers and the food source for native predators; destroy ecosystems, causing native species to lose vital space; they compete for food, water and shelter; introduce and spread diseases to which native species are not immune.

Examples:

- Cuban tree frog
- Swamp hens
- Sacred ibis
- Pythons and boas
- Feral hogs

How Exotics are Introduced into Non-Native Habitats

Since no ecosystem in South Florida is exempt from man's influence, the threat of exotic invader introduction by humans remains high. There are four general types of pathways by which exotic animals are introduced into South Florida environments: Intentional, Unintentional, Escapes, and Natural Range Expansion.

Intentional

Intentional introductions include stocking of sport fish (peacock bass), stocking of animals for ornamental reasons or hunting (Japanese koi or goldfish, exotic game mammals), dumping of live bait by fisherman; releases of unwanted pets by owners, or releases of unwanted animals by dealers; release of aquarium

organisms such as plants, fish, and invertebrates and release of research animals for science and medicine which includes release of exotic non-native insects, or animals to serve as biological control agents to control other exotic organisms (Goodyear, 2000). Some of these intentional introductions have been for beneficial purposes for the native environment; however, a few of these "beneficial, intentional introductions" reacted adversely and have had catastrophic affects.

Examples of Beneficial Intentional Introductions

Peacock bass

(*Cichia ocellaris*) The Peacock bass was released by the Florida Fish and Wildlife Conservation Commission in the early 1980s into select South Florida canals, which could provide sustainable populations. They provide an excellent alternative sport fishery to the native largemouth bass. Canals became over-populated with non-native forage fish such as the spotted tilapia, another exotic fish species that was illegally introduced for the aquarium trade. The peacock bass was stocked to help control and feed upon the spotted tilapia population. Peacock bass populations would in turn be controlled by water temperatures, in effect, limiting their populations to South Florida canals. The peacock bass fishery now provides millions of dollars to the local economy through purchases of licenses and associated fishing equipment. Research has shown that peacock bass feed on different prey and at different times of the day than native largemouth bass. In effect, the peacock bass are filling a vacant **niche**. Research has shown that bass populations are stable or increasing in areas where the peacock bass has been stocked.

Triploid grass carp

(*Ctenopharyngodon idella*) Triploid grass carp, a species of non-reproductive fish were intentionally introduced to help control the spread of the invasive exotic hydrilla plant in South Florida lakes and canals, and the program has achieved great success.

Melaleuca snout beetle

(*Oxyops vitiosa*) Melaleuca Snout Beetle, was intentionally released to help reduce the spread of the exotic Australian melaleuca tree only after research was conducted to show that it would pose no threat to native flora or agricultural cash crops.

Examples of Injurious Intentional Introductions

Giant cane toad

(*Rhinella marina*) Giant cane toad was released to control sugarcane beetles. This species has since spread to urban areas and is a potential danger to small children and pets if handled, or consumed. Its poison is fairly toxic.

Muscovy duck

(*Cairina moschata*) Muscovy ducks were intentionally released by the Florida Fish and Wildlife Conservation Commission in the late 1960s to provide a huntable resource. Established populations soon began to breed with the native populations and escaped domestic birds. They are now commonly seen in lakes in residential and retirement communities.

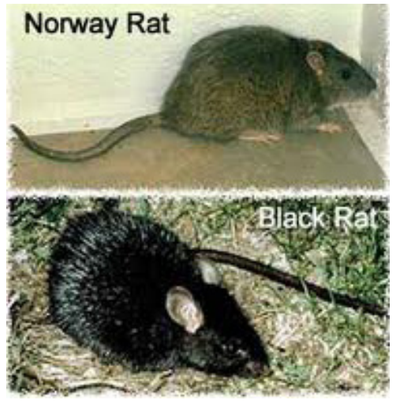
Unintentional

Unintentional introductions consist primarily of "hitchhikers," or those animals accidentally introduced with cargo shipments, ballast water releases, etc. International shipping has played a huge role in the introduction of exotic animals since the Spanish arrived in Florida in the 1500s. Since inspections of cargo at ports are minimal and generally involve searches for illegal contraband (drugs and guns) and illegal aliens rather than for exotic animal species, the U.S. Fish and Wildlife Service and U.S. Department of Agriculture inspectors are only able to check a fraction of incoming shipments.

Examples of Injurious Unintentional Introductions

Asian tiger mosquito

(*Aedes albopictus*) Asian tiger mosquito, a carrier and agent for the spread of the eastern equine encephalitis virus, arrived via a shipment of tires from Japan.



(*Rattus rattus* and *Rattus norvegicus*) Black rat and Norway rat were introduced to Florida via the shipping pathway. Both are considered as serious exotic pest problems.

Escapees

Importation of virtually all exotic animal species presents a risk for escape, and escapes indeed often occur from facilities where these species are supposed to be confined. Exotic animals escape from private residences, pet stores, aquaculture facilities, zoos, airports, entry ports, tourist attractions, and research facilities. The source of the majority of exotic bird and mammal species established in South Florida is believed to be from private collections, although many bird species, because of their flight capability, escaped from Port Everglades and Miami International Airport. South Florida is susceptible to tropical weather disturbances such as hurricanes, tornadoes, and tropical depressions. These catastrophic **natural disasters** can greatly accelerate the spread of non-indigenous animal species. Many non-native animal species inadvertently escaped captivity after their cages had been destroyed, or damaged. For instance, Hurricane Andrew freed from secure facilities hundreds of exotic animals species including fish, snakes, lizards, birds, and mammals such as primates.

Natural Range Expansion

Natural **immigration** of non-native fauna has occurred in South Florida but is not common. Excellent examples of natural range expansion include the love bug from Texas, the coyote from the northwestern U.S., and the cattle egret from Africa to South America in 1877 and spread to the U.S. in 1941 (www.allaboutbirds.org). Populations of white-winged doves, native to the southwest were released by the Florida Fish and Wildlife Conservation Commission in the early 1960s as an upland game species for hunters. Specimens were released from private aviaries in Dade County as well. Their populations however, may be enhanced by natural immigration of individuals from Texas. The armadillo was thought to have arrived by natural range expansion, but were later determined to be intentional releases.

Why Do Exotics Flourish in Florida?

Several factors that contribute to the successful establishment of exotic animals in Florida include:

- Ideal climate
- Steady source of animals
- Ease of dispersal
- Continuous disturbance of habitats

Subtropical Climate and Environment

South Florida is considered a **"habitat island"** (Goodyear, 2000) and is ideal for the spread and survival of exotic animal species. Maximum temperatures average in the low 80s, and minimum temperatures that average in the low 60s and receive on average nearly 60 inches of precipitation per year. South Florida's climate is very similar to environments that support most of the imported exotic animals so this factor enhances their ability to survive, and establish viable reproducing populations.

Extreme weather conditions, such as extended freezes, may wipe out entire exotic animal populations, or help to contain their spread. South Florida's climate is also moderated by water bodies to the north, east, and west which contribute to the nearly constant and favorable weather conditions. In fact, an imaginary line exists to the north of Lake Okeechobee which prevents the spread and existence of most exotic animal and plant species to the north, but effectively ensures their survival to the south. It has been debated that the issue of "global warming" may be contributing to the spread of exotic plants and animal species north of this line as the result of changes (warming) in temperatures.

Steady Supply of Animals

There is a continuous, daily supply of animals entering South Florida due to the aquarium, pet industry and exotic animal trade, and aquaculture through ports of entry like Miami International Airport and Port Everglades on flights and ships from around the world. This, along with an ideal climate, has encouraged wildlife importers and exotic animal breeders to locate in South Florida. This has spawned, and contributed to a thriving, catastrophic invasive industry, leading to endangerment of native species.

U.S. Fish & Wildlife Service

Prairie dog surrendered at Fish and Wildlife Conservation Commission Pet Amnesty Day

On average, 12,000 shipments of wildlife, of which 85% are live animals, enter through the airport and port annually. Tropical fish, reptiles, amphibians, birds, and mammals represent the majority of importations (Goodyear, 2000). Most exotic animals found in the Everglades can be traced to importation for the pet trade industry. The pet trade in South Florida is highly profitable and the number of permits for the importation, possession, and breeding of exotic animal species continues to skyrocket according to the Florida Fish and Wildlife Conservation Commission and can be directly linked to the State's ever-growing human population. The trade in illegal wildlife is second only to the trade in guns and drugs according to the U.S. Fish and Wildlife Service (Goodyear, 2000).

Florida's **aquaculture** industry is the largest in the United States, exporting nearly $170 million in tropical fish and aquatic plants annually (U.S. Congress OTA, 1993). Aquaculture is the fastest growing sector of Florida's agriculture industry. More exotic fish are established in, cultured in, and shipped to and from Florida than nearly any other region of the world (Goodyear, 2000). Most of the imported exotic fish species are destined for the pet or commercial trade industries. Many of the exotic fish species present in South Florida habitats can be specifically traced to releases, whether intentional or not, from **commercial fish trade** industries. Sixty-five percent of all exotic fish species now occurring throughout the United States can be traced to the aquarium trade industry. In addition, releases of exotic fish species into local water bodies occurs frequently when owners and individuals tire of caring for them.

Ease of Dispersal Due to Continuous Disturbance of Habitats

Habitat destruction from human habitation, agriculture and development, favors the establishment of **non-indigenous** animal species. South Florida's human population and resultant habitat destruction continues to expand at an exponential rate. The majority of the area bordering the historic Everglades has succumbed to **urbanization**. Many of the established exotic animal's species are located near human population centers where they find suitable shelter, food, and breeding sites. Most natural habitats in South Florida have been severely altered or fragmented, increasing the susceptibility by exotic animals. Disturbed sites in general usually become prime sites for colonization by exotic animal species. Many species are locally distributed while others are much more widespread.

Human modification of South Florida ecosystems:

- Land clearing
- Hydrological alterations – canals, lakes, levees
- Urbanization – drainage, dikes, and ditches

The vast, man-made network of inter-connected canals and lakes throughout South Florida can accelerate the establishment, spread, and threat of exotic fish species throughout the Everglades ecosystem. Beginning in the early 1900s, and culminating in the massive Everglades Central and South Florida Project of the 1940s, an expansive network of canals and levees were dredged in order to drain the Everglades for agriculture and human development by the Army Corps of Engineers. This intricate system of canals accelerated the influx of humans and development along the eastern corridor of the Everglades and resulted in the tremendous population growth in South Florida. The remaining fragmented habitats have been altered by drainage and the natural hydrology has been severely impacted. Exotic animal species thrive in these conditions and environmental stresses to native wildlife may make native wildlife populations more susceptible to invasion by these intruders.

Solutions and Management

An exotic **eradication** and management program will rely on an integrated exotic invader management program that utilizes all available tools to control invasive/exotic species. Although an extraordinary amount of money is being slated for the restoration of the Everglades and its water quality, this unique one-of-a-kind ecosystem may eventually be lost if the problem of invasive pest plant and wildlife management is not effectively and continuously addressed. Without continued treatment and increased funding directed towards **invasive plant** management, the Refuge and most of South Florida will continue to see native plant communities such as the Everglades become replaced by **monocultures** of one species of plant which will lead to habitat **degradation** and a decrease in biodiversity.

Plants: Over $5 billion per year is spent in the United States by local, state, and Federal agencies to control invasive exotic plants. In 2002, the License Agreement between the South Florida Water Management District (SFWMD) and the Refuge was renewed and included performance measures for the control of exotic vegetation. Under those performance measures, the Refuge's goal is to achieve maintenance control of melaleuca, Brazilian pepper, Australian pine, and old world climbing fern by 2017. In South Florida alone, local, state, and Federal agencies have spent over $35 million (http://pesticide.ifas.ufl.edu) in an effort to manage melaleuca since 1991.

No program currently exists in the United States to test if plants may eventually pose a severe risk to native plant habitats. New Zealand and Australia have successfully implemented exotic plant screening programs to investigate potential plant problems prior to their sale or release, which would be productive for the United States of America to adopt. Even though thousands of new plant species are arriving daily through ports along the Florida coast, little legislation exists to prevent their introduction. Currently, only a select few of these plants are prohibited from being grown or sold in Florida or have been listed on the Federal Noxious Weed List.

Monitoring

The root of the word monitoring means to warn, and an essential purpose of monitoring is to raise a warning flag that the current course of action is not working. The Bureau of Land Management in a document entitled Measuring and Monitoring Plant Population define monitoring as the collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting a management objective.

Monitoring is a key part of what has been termed adaptive management, in which monitoring measures progress toward or success at meeting an objective and provides the evidence for management change or continuation (Elzinga).
In order to combat the spread and introduction of exotic plants, the **Florida Exotic Pest Plant Council** (FLEPPC) was established in 1984 to support the management of invasive exotic plants in Florida's natural areas by providing a forum for the exchange of scientific, educational and technical information. The Florida Exotic Pest Plant Council is a non-profit organization and is not a regulatory agency.

Mapping

In the past, aerial **Systematic Reconnaissance Flights** (SRF) was the technology most widely used to monitor

and document coverage of exotic plant infestation throughout South Florida. The last SRF survey in August, 2015 indicated about 73 percent of the Refuge was infested with old world climbing fern and melaleuca. Brazilian pepper and Australian pine were interspersed throughout the Refuge to a lesser degree.

Since then, **Aerial Sketch Mapping** technology has emerged and provides more accurate data about the presence of these invasive plants. Sketch mapping is an aerial mapping technique that records species, density of cover, and number of acres per **species**. The method has produced a more accurate map showing where three of the top four species of concern are located, the number of acres infested, and the density of cover of those acres.

Due to the density of the vegetation which covers it, there is some level of inaccuracy in mapping old world climbing fern. The first aerial survey conducted by the South Florida Water Management District (SFWMD) in 1993 revealed that old world climbing fern covered an estimated 25,000 acres in South Florida. A 1997 survey revealed that the fern covered an estimated 107,000 acres, an increase of 328%. Fern populations at the Refuge were first noted in the late 1980s. This is particularly disturbing as only severe infestations can be documented during aerial surveillance and reconnaissance flights, and it is a fact that small populations occur throughout the Refuge that are undetected during these aerial plant surveys.

Treatment

Since 2002, the Service has been actively implementing treatment techniques to bring the four identified exotic plant species within maintenance control. Multiple treatments are required in a single area and include aerial and ground chemical application (pesticides), manual labor (using large machines, machetes-human power), prescribed burning, and biological control (the use of animals such as moths). In September, 2015, more than 407,314 acres have been treated. Brazilian pepper and Australian pine are currently under maintenance control.

- The former treatment strategy for old world climbing fern and melaleuca was to treat species individually and after one year for old world climbing fern and two years for melaleuca, revisit and retreat the area again if any new growth was evident. Prescribed burning and biological control were incorporated into the control of the four identified species. Chemical applications were followed by prescribed burning in certain areas with successful results in removing seedlings.

- In 2014, the Refuge adopted a multi-species simultaneous treatment approach and has treated a total of 8,000 acres combined old world climbing fern and melaleuca.

- Since 2010, roughly 67,000 total acres have been treated using the old and new approach.

What Can You Do to Help with Exotics?

- Spread the word about exotic invading plants and animals with the "Don't Let it Loose" campaign. www.nps.goc.ever.forteacher.dlil.html

- Wash your gear, bike, boat, shoes, anything that was in an area that, if not cleaned, may carry exotics into native habitats.

- Attend Pet Amnesty Day with Arthur R. Marshall Loxahatchee National Wildlife Refuge.

- Do not buy, breed, sell, or release any non-native plants or animals.

- Hunt exotic invaders: plant and animal eradication.

- Remove exotics from your yard.

- Volunteer to help remove exotics.

Impacts of Exotic Wildlife

Exotic wildlife, if they become established, can evolve into **injurious** environmental nightmares.

Injuries Due to Exotic Wildlife

Even though there are some benefits to exotic plants and animals, non-native wildlife most impacts native **biotic** communities in a harmful way, damaging natural ecosystems forever. Damages to native wildlife and habitats is often of a subtle nature with the exception of feral hogs, whose rooting and widespread damage to native plant communities is easily noticed.

The general public does not realize the injurious impacts that exotic wildlife have on natural ecosystems, which include:

- Habitat modification or alteration.

- Prey upon native plants and animals.

- Transmission of diseases to native plants and animals.

- Hybridizing with native wildlife species.

- Competing for the same food and shelter.

Habitat modification or alteration:
Introduced feral hogs have modified entire plant communities through their feeding habits and soil disturbance. Some habitats have been modified to support a single plant species, thereby, reducing species richness (Simberloff, 1997).

Preying upon native plants and animals:
Many ground-nesting bird species worldwide are extinct due to the intentional, and unintentional, release of feral hogs, cats, dogs, and rats. For example: to counter this impact, mongoose were released in Hawaii in the mid - 1900 century to help control rat populations in the sugar cane fields. However, since then, the mongoose population has grown to large numbers without controlling the nocturnal rat population and has greatly diminished the population of ground nesting birds. Releases exacerbated the problem as mongoose also began to prey upon native bird species eggs. (Wikipedia) The introduction of the brown tree snake via ocean shipping has also led to the extinction of many birds.

Transmission of disease to native plants and animals:

- Introductions of non-indigenous wildlife can have devastating impacts on native wildlife and plant populations. An accidental release of a mosquito species in the 1880's (www.parasiteandvectores.com), a carrier of avian malaria **parasite**, resulted in the death of many native bird species. However, many of the non-native bird species were resistant to the parasite which in turn increased their chance of survival and establishment of the species in the United States.

- Humans are susceptible to a bacteria Chlamydophila psittaci (a lethal intracellular bacterial species that may cause parrot fever in humans). It is transmitted both from handling pigeons but mostly from their droppings. Psittacosis is a serious disease but rarely fatal (less than 1%). Pigeons are also important vectors for different species of the bacteria Salmonella. (Wikipedia)

- Introduction of the chestnut blight virus with the Asian chestnut tree varieties in 1904 (www.acf.org) resulted in the decimation of nearly the entire population of American chestnut trees, which once composed much of the biomass of eastern hardwood forests, and are important as a food source for humans and native wildlife.

- First detected in Georgia in 2002, Laurel wilt is a deadly disease of redbay (Persea borbonia) and other tree species in the Laurel family (Lauraceae). The disease is caused by a fungus (Raffaelea lauricola) that is introduced into host trees by a non-native insect, the redbay ambrosia beetle (Xyleborus glabratus). The avocado is perhaps the most commercially valuable plant affected by laurel wilt.

Hybridization with native wildlife species:
Native wildlife species can be affected as the direct result of changes in the gene pool which can alter or affect changes in native wildlife populations. Weakening of the genetic viability of native animals can: affect habits; alter behavior, or fitness. Fitness as it relates to reproduction, mating and evolutionary theory. This leads to decreased survivability of native wildlife while increasing survivability and establishment of the non-indigenous species.

In Florida, and in areas adjacent to the Refuge, feral populations of domestic mallard ducks threaten to breed with native mottled ducks. The Florida Fish Wildlife Conservation Commission is concerned with losing the genetic viability of the mottled duck as a species so the Commission proposed legislation that prohibits the unauthorized or illegal release of captive-breed, feral, or free-ranging mallards on any state or Federal lands managed for wildlife strictly for biological reasons, particularly the spread of avian diseases. In July 2004, this ruling was passed as Florida code 68A-4.0052: possession and release of live mallards.

Competition for the same niche:
Non-indigenous wildlife may impact native populations indirectly by competing for the same niche. Intentional releases, for sentimental

purposes, of European starlings and the house (formerly English) sparrow have directly contributed to the decline of many native cavity-nesting bird species, namely woodpeckers and eastern bluebirds. The invaders are more aggressive and they easily displace native species. European starlings also impact native cavity nesters by leaving nest cavities in an unusable condition. Starlings are notorious poor housekeepers. Fecal sacs of young are often left in the nest hole, and the nesting material itself soon becomes infested with parasites, primarily mites. Starlings are hardier than native species, and their nest sanitation habits ensure future availability of nest holes. Starlings also feed and damage important agricultural crops and contribute, by feeding on the fruit, to the spread of invasive exotic plants such as Brazilian pepper.

Direct Impacts on the Arthur R. Marshall Loxahatchee National Wildlife Refuge

The majority of documentation of non-indigenous wildlife on the Refuge consists of **anecdotal** sightings and references in monthly and annual reports, i.e., presence on the Refuge. Photographs of many of the exotic animal species can be found in the Refuge computer image files.

Encroaching development along the Eastern edge of the Refuge will more than likely lead to an increase in exotic animal sightings. Public visitations to the Refuge currently total an estimated 300,000 per year, and this should proportionately increase with continued development.

Many of the documented exotic animal species are carelessly released on the Refuge when individuals tire of caring for them. Those documented animals include Cuban anole, Burmese pythons, Nile monitor lizard, Monk parakeets, Sacred ibis, Cane toad, Cuban tree frog, Lobate Lac Scale, Snakehead, Oscar, and Mayan cichlid. Unfortunately, most of the general public is unaware of the impacts that these exotic species pose to native plants and wildlife.

The Refuge currently does not have the biological staff to conduct comprehensive inventories or monitoring of exotic animal species. Most of the biological research and effort is being focused on issues pertaining to the overall restoration of the Everglades and implications to the Refuge, i.e., water quality, water timing and delivery, and invasive exotic plants. The impacts of invasive exotic plants are of grave concern to Refuge management as is the isolated, subtle impacts of exotic animal species.

Activities/Lessons

Plants on Trial – from Hoosier National Forest curriculum (grades 6-12)

Materials: Robe and props to represent the species within the chapter, and court appointments.

Activity: Teachers should make a team of prosecuting lawyers, defense lawyers, jury, defendant plants and animals, a judge, court reporter, bailiff, witnesses. Research facts about an exotic invader from the chapter and supplemental resources. Create a mock trial about a plant or animal invading a habitat, convict or acquit and sentence the invader. For example - Lygodium has been apprehended for strangling Cypress and is on trial for attempted murder/extinction. Lygodium is being prosecuted by the invasive species biologists at Arthur R. Marshall Loxahatchee National Wildlife Refuge; is being defended by a plant nursery, who introduced Lygodium as an ornamental in the 1950s, and the judge is Florida Fish and Wildlife Conservation Commission, witnesses are employees and visitors, contractors… This trial, can last a week including research, meetings, etc....

Mock Trial Case for Activity #1:
Extension: Give students the background information or have them research the information on the internet, along with the trial case simulation characters. Have students construct a script for the trial and include props (graphs, picture and valid evidence to support their points).

You may even be able to get a lawyer to come assist with the research and with the trial process.

Arthur R. Marshall Loxahatchee National Wildlife Refuge vs. Lygodium Charge: Lygodium for attempted murder in the first degree (by strangling) of cypress trees.

Crime Scene Location: N26º 32' 53.523", W 80º 18' 56.091" (latitude and longitude of Global Positioning System) interior of the Arthur R. Marshall Loxahatchee National Wildlife Refuge.

Plaintiff: Seaside Landscape Nursery of Delray Beach, Florida

Defendant: Lygodium miscrophyllum (a.k.a. Old World climbing fern).

Judge: Program Manager for the Florida Fish and Wildlife Conservation Commission.

Prosecuting Attorney representing: Invasive Species Biologist/Arthur R. Marshall Loxahatchee Wildlife Refuge

Jury: Classmates

Witnesses may include but are not limited to:

- Cypress boardwalk tour guide
- Environmental Protection Agency biologist
- Environmental Protection Agency invasive species specialist
- Canadian tourists
- Summer camp elementary students
- Carpenter contracted to repair boardwalk
- Interpretive specialist
- Native American from Seminole Indian Reservation

U.S. Fish & Wildlife Service

Oh Deer – from Project WILD (grades 2-12)

Materials: Nothing is needed, but you should be outside.

Activity: This game will happen over a process of four times to represent the seasons/growing periods to show limiting factors that contribute to population fluctuation. Ask students the four things needed to survive (food, water, shelter, space), divide the class equally in half and put them into a line facing away from one another 35 feet apart.

One line is the habitats, the other line is any native animal – students decide what they want to be (food, shelter, alligator, snail kite…) The habitat line makes symbols to represent what they are – food puts hands on stomach, shelter puts hands above head like a roof, water puts hands over mouth. The native animal line is told what to be (teacher secretly whispers to students which animals they are – first tell three to four students that they are an invasive; as the game progresses through seasons. Increase the number of students that represent invasives and decrease the number of students that represent natives so they can see competition for resources. Have the native animal line chose which habitat they need to hunt for (food, water, shelter, space). The teacher can limit the habitat line to reflect real-world problems like a drought.

To begin season 1, the habitat line makes their symbols and both lines turn to face one another and the animal line hunts for what they need and grabs it. Stop and show students how there are some animals who don't have what they needed, so they die (turn them into invasives).

To begin season 2, limit the habitat line again (make students into parking lots or contaminated water, or a freeze) and add more invasives to the animal line, creating more competition for the natives. Continue the game through four seasons and graph how the invasives, natural population growth of natives, and habitat limitations strangle native species.

Extension: Students can construct a flow chart or picture story to depict the sequential variations in population changes caused by limiting factors.

Students can write an essay to describe the changes in chronological order.

Students can create a timeline to show chronological order.

Chapter VII

Human Connection to Wetlands (Including our Everglades)

Symbiosis Defined

The interaction of different biological species in a close, often long-term relationship that is equally beneficial to each species (www.merriam-webster.com). We must live in symbiosis with our environment; otherwise, we will continue to see, with the degradation of the ecosystems' health, the degradation of human health as well.

Health Defined as a Relationship Between Humans and Environments

Health includes the relationship between: top functional performance of our body, mind, and spirit, the air we breathe, our water, our food and our surroundings. The World Health Organization defined health in its broader sense in 1946 as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." The definition of a healthy environment within the context of the Florida Everglades as is the same, connecting to human life as defined by the South Florida Water Management District in that: "recognizing that a healthy ecosystem is vital to a healthy economy."

How Do We Maintain Health?

The maintenance and promotion of health is achieved through different combinations of physical, mental, and social well-being, together sometimes referred to as the health triangle. Systematic activities to prevent or cure health problems and promote good health in humans are undertaken by health care providers. Applications with regard to animal health are covered by the veterinary sciences. The term healthy is also widely used in the context of many types of non-living organizations and their impacts for the benefit of humans, such as in the sense of healthy communities, cities, or environments. In addition to health care interventions and a person's surroundings, a number

of other factors are known to influence the health status of individuals, including their background, lifestyle, and economic and social conditions; these are referred to as determinants of health (Wikipedia).

Key Factors Influencing Health

- Income and societal status
- Social support networks
- Education and literacy
- Employment/working conditions
- Social environments
- Physical environments
- Personal health practices
- Healthy child development
- Biology and genetics
- Health care services
- Culture
- Gender

Is Environmental Degradation a Health Cost?

The environment is often cited as an important factor influencing the health status of individuals. This includes characteristics of the **natural environment**, the **built environment**, and the **social environment**. Factors such as clean water and air, adequate housing, and safe communities and roads all have been found to contribute to good health, especially to the health of infants and children. In the *Journal of Epidemiology and Community Health*, Dr. Jonas Bjork from the Lund University Hospital in Sweden study has shown that a lack of neighborhood recreational spaces including natural environment leads to lower levels of personal satisfaction and higher levels of obesity, linked to lower overall health and wellbeing. This suggests that the positive health benefits of natural space in urban neighborhoods should be taken into account in public policy and land use. (Wikipedia)

In the 1600's, over 220 million acres of wetlands existed in the lower 48 states (Dahl and Johnson 1991). Since then, extensive losses have occurred, with many of the original wetlands drained and converted to farmland. Today, less than half of the nation's original wetlands remain. Activities resulting in wetlands loss and degradation include: agriculture; commercial and residential development; road construction; impoundment; resource extraction; industrial siting, processes, and waste; dredge disposal; silviculture; and mosquito control (USEPA 1994b; USEPA 1993a). The primary pollutants causing degradation are sediment, nutrients, pesticides, salinity, heavy metals, weeds, low dissolved oxygen, pH, and selenium (USEPA 1994).

The Main Activities that Cause Wetland Impairment include:

- Hydrologic Alteration;
- Urbanization (including development);
- Marinas/Boats;
- Industry (including industrial development);
- Agriculture;
- Silviculture/Timber Harvest;
- Mining;
- Atmospheric Deposition.

http://www.water.ncsu.edu/watershedss/info/wetlands/wetloss.html

U.S. Fish & Wildlife Service

Land Development Affects Health

Evidence suggests that environmental problems can have a substantial impact on human health (for example: degradation of an environment). Wetlands are unique and critical habitats that serve fish, wildlife, and man in every connected way. They are characterized by water, special soils and a vastly different **plant community** in various ecosystems. Healthy wetlands provide habitat for a tremendous variety of fish and wildlife; their health is directly connected to that of humans. To further illustrate, **bottomland hardwoods** are a wetland ecosystem that depends on water fluctuations to maintain their integrity and function. They serve as buffer zones between uplands and aquatic systems by protecting water quality. They greatly reduce flooding and erosion by diminishing the rate and volume of runoff into streams and rivers. They trap silt and filter out pollution, further protecting waterways. They also support a myriad of life. A bottomland hardwood forest can support two to five times as many white-tailed deer as a nearby upland zone.

As an example of this, the Environmental Protection Agency (EPA) states: two hundred years ago, magnificent bottomland forests covered almost thirty million acres across the Southeastern United States. Today, only about forty percent of that area still supports these productive and unique ecosystems. It is estimated that losses of these swamps reached rates as high as 431,000 acres per year from 1965 to 1975, largely due to conversion to croplands, particularly for soybeans. In some regions of the lower Mississippi floodplain, only a very small percentage of original bottomland hardwood forests remain.

In 1849, 1850, and 1860 the United States Congress passed several acts that transferred 65 million Federal acres of swamp and over flow lands to 15 states, mostly in the Mississippi Valley. This land fell into the hands of **developers** who drained the water, cut the timber, and converted the land to farms and other uses. Naturally, floods followed, so then Congress passed laws to build flood control dams and levees to protect developers' investments. Today over half of our nation's 215 million acres of wetlands have been destroyed and our drinking water are compromised along with our access to natural spaces.

Many rivers and streams have been dug out and straightened to reduce floods. This process is called **channelization** and usually destroys streamside habitat and severely reduces the size and composition of adjacent wildlife communities. For example, nearly 40,772 acres or 78% of the Kissimmee River basin marshland in Florida was drained. Fish populations were severely reduced and water birds were reduced by 93% in the area.

Pollution Affects Health

Environmental degradation exerts significant pressure on human health. **Exposure** to air, water, and soil pollution, to chemicals in the environment, or to noise, causes: cancer, respiratory, cardiovascular, and communicable diseases, as well as poisoning and neuropsychiatric disorders in not only humans, but animals as well. (Sharma) Particularly vulnerable to environmental pollution is: children, pregnant women, the elderly and persons with pre-existing diseases.

Examples of impacts of environmental pollution on health include:

- cancer (e.g. skin cancer from exposure to UV radiation or leukemia resulting from exposure to pesticides while still in the womb)
- asthma (exacerbated by outdoor air pollution)
- birth defects (from drinking-water contaminants ingested by the pregnant mother)
- neurodevelopmental disorders (resulting from lead poisoning) (OECD)

Outdoor air pollution is estimated to be responsible each year for approximately 7,000,000 premature deaths. Health problems linked to air pollution range from minor eye irritation to upper respiratory symptoms, chronic respiratory diseases such as asthma, cardiovascular diseases, and lung cancer. Some of these require hospital treatment, and may be fatal. How badly air pollution affects individuals will depend on the pollutant's chemical composition, its concentration in the air, the length of exposure, the **synergy** with other air pollutants, as well as individual **susceptibility**. PM10 – tiny **particulate matter** (PM) small enough to be inhaled into the deepest part of the lung – is especially harmful to human health, as it can substantially reduce life expectancy. In 2030, premature deaths from lung cancer are projected to be multiplied by four, roughly 3.1 million. The OECD Environmental Outlook to 2030 also projects a six-fold increase in deaths attributable to the decrease in the **ozone layer** by 2030 (www.who.int).

Outdoor air pollution-caused deaths – breakdown by disease:

- 40% – ischemic heart disease
- 40% – stroke
- 11% – chronic obstructive pulmonary disease (COPD)
- 6% - lung cancer
- 3% – acute lower respiratory infections in children (World Health Org.)

Health problems due to exposure to harmful chemicals are well documented. For instance, concern has been raised about the link between exposure to chemicals such as **alkylphenols** (used in detergents and pesticides) and disruption of the hormonal system that regulates many of the body's functions. Effects on sperm motility, fetal growth rate, and neurological functions of offspring have been observed from human exposure

to **PCBs** (polychlorinated biphenyl) and epidemiological studies suggest exposure-related increases in cancers of the digestive system. PCBs were used in coolants, insulating fluids, PVC, and other products until their production was banned in most countries in the 1970's; even so they are still found in the environment.

Poor water supply, sanitation and hygiene (WSH). According to the Centers for Disease Control (CDC) there are many factors that relate to mortality of both children and adults. Improving the water quality and access to water for developing countries as well as improved sanitation requirements is helping to improve the lives of millions across the world. Please see boxes below for more CDC information on water supply, sanitation, and hygiene.

Ecological Psychology – Nature Deficit Disorder

As environmental health is degraded by the above mentioned damaging and destroying factors, human health degrades as well. Nature Deficit Disorder, as defined by Richard Louv in his groundbreaking 2005 book *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder* is "not a medical condition; it is a description of the human costs of alienation from nature. This alienation damages children and shapes adults, families, and communities. There are solutions, though, and they're right in our own backyards. Direct exposure to nature is essential for healthy childhood development – physical, emotional, and spiritual. What's more, nature is a potent therapy for depression, obesity, and attention deficit disorder (ADD). Environmental-based education dramatically improves standardized test scores and grade point average and develops skills in problem solving, critical thinking, and decision making. Even creativity is stimulated by childhood experiences in nature."

What Can You Do to Make a Positive Impact?

- Get informed and get involved!!!
- Read your local newspaper and find out about the environmental challenges in your neighborhood.
- Write your elected officials and attend public meetings about issues - you elect them!!
- Volunteer at a local nature center or facility that you feel passionate about and learn about the challenges that face that facility.

  The Refuge is blessed by dedicated **volunteers**. About 100 people per year generously donate their time and talents to make the Refuge a better place for people and wildlife. The Friends of the Arthur R. Marshall Loxahatchee National Wildlife Refuge, a non-profit citizen group, also supports the operations of the Refuge through their activities, fundraising, and outreach advocacy. You are encouraged to become a Friend!
- Use canvas bags at the grocery store instead of using plastic. Did you know it takes 500-1,000 years for a plastic bag to decompose?
- Reduce-Reuse-**Recycle**

Xeriscaping

Xeriscaping is defined in Wikipedia as landscaping and gardening in ways that reduce or eliminate the need for **supplemental** water from irrigation. Xeriscaping is promoted in regions that do not have easily accessible, plentiful, or reliable supplies of fresh water, and is gaining acceptance in other areas as climate patterns shift. Using xeriscaping lessens the use of chemicals and provides homes for native wildlife. If you love to garden and love those flowers in your yard, buy native plants from a nursery that specializes in native plants to South Florida.

Check out the Florida Native Plant Society website for the Palm Beach County chapter listing (http://palmbeach.fnpschapters.org/).

Permaculture

Permaculture is the ecological design and ecological engineering, which develops **sustainable** human settlements and self-maintained agriculture systems modeled from natural resources. Permaculture is a design system based on ethics and design **principles** to guide efforts towards a sustainable future.

Permaculture ethics are:

- Care of the Earth
- Fair Share
- Care of People

The twelve permaculture principles are:

- Observe and Interact
- Catch and Store Energy
- Obtain a Yield
- Apply Self-Regulation and Accept Feedback
- Use and Value Renewable Resources Services
- Produce No Waste
- Design from Patterns to Details
- Integrate Rather than Segregate
- Use Small and Slow Solutions
- Use and Value Diversity
- Use Edges and Value the Marginal
- Creatively Use and Respond to Change

As humans, we should leave the environment as close as possible to its natural form, therefore leaving it as a benefit to environmental and human health.

U.S. Fish & Wildlife Service

Access to WASH (Water, Sanitation and Hygiene)

- Worldwide, 780 million people do not have access to an improved water source
- An estimated 2.5 billion people lack access to improved sanitation (more than 35% of the world's population)
- According to the World Health Organization and UNICEF, regions with the lowest coverage of "improved" sanitation in 2006 were sub-Saharan Africa (31%), Southern Asia (33%) and Eastern Asia (65%)
- In 2006, 7 out of 10 people without access to improved sanitation were rural inhabitants
- According to the United Nations and UNICEF, one in five girls of primary-school age are not in school, compared to one in six boys. One factor accounting for this difference is the lack of sanitation facilities for girls reaching puberty. Girls are also more likely to be responsible for collecting water for their family, making it difficult for them to attend school during school hours. The installation of toilets and latrines may enable school children, especially menstruating girls, to further their education by remaining in the school system.

Disease and Death

- An estimated 801,000 children younger than 5 years of age perish from diarrhea each year, mostly in developing countries. This amounts to 11% of the 7.6 million deaths of children under the age of five and means that about 2,200 children are dying every day as a result of diarrheal diseases.
- Worldwide, millions of people are infected with neglected tropical diseases (NTDs), many of which are water and/or hygiene-related, such as Guinea Worm Disease, Buruli Ulcer, Trachoma, and Schistosomiasis. These diseases are most often found in places with unsafe drinking water, poor sanitation, and insufficient hygiene practices.
- Worldwide, soil-transmitted helminths infect more than one billion people due to a lack of adequate sanitation.
- Guinea Worm Disease (GWD) is an extremely painful parasitic infection spread through contaminated drinking water. GWD is characterized by spaghetti-like worms up to 1 meter in length slowly emerging from the human body through blisters on the skin anywhere on the body but usually on the lower legs or lower arms. Infection affects poor communities in remote parts of Africa that do not have safe water to drink. In 2012, 542 cases of Guinea Worm Disease were reported. Most of those cases were from Sudan (96%).
- Trachoma is the world's leading cause of preventable blindness and results from poor hygiene and sanitation. Approximately 41 million people suffer from active trachoma and nearly 10 million people are visually impaired or irreversibly blind as a result of trachoma. Trachoma infection can be prevented through increased facial cleanliness with soap and clean water, and improved sanitation.

Prevention

- Water, sanitation and hygiene has the potential to prevent at least 9.1% of the global disease burden and 6.3% of all deaths 1.The impact of clean water technologies on public health in the U.S. is estimated to have had a rate of return of 23 to 1 for investments in water filtration and chlorination during the first half of the 20th century.
- Water and sanitation interventions are cost effective across all world regions. These interventions were demonstrated to produce economic benefits ranging from US$ 5 to US$ 46 per US$ 1 invested.
- Improved water sources reduce diarrhea morbidity by 21%; improved sanitation reduces diarrhea morbidity by 37.5%; and the simple act of washing hands at critical times can reduce the number of diarrhea cases by as much as 35%. Improvement of drinking-water quality, such as point-of-use disinfection, would lead to a 45% reduction of diarrhea episodes.
- In order to meet the United Nations' Millennium Development Goal to halve the proportion of people without sustainable access to improved drinking water and basic sanitation by 2015:
  - An estimated 784 million people will need to gain access to an improved water source.
  - An estimated 173 million people on average per year will need to begin using improved sanitation facilities (accounting for expected population growth).
  - Even if the United Nations' Millennium Development Goal for improved drinking water and basic sanitation is reached by 2015, it will still leave:
  - An estimated 790 million people (11% of the world's population) without access to an improved water supply.
  - An estimated 1.8 billion people (25% of the world's population) without access to adequate sanitation.

http://www.cdc.gov/healthywater/global/wash_statistics.html

Policies and CERP

In 1948, Congress authorized the Central and Southern Florida Project for Flood Control and Other Purposes **(C&SF Project).** This authorization represented the birth of water management in the region. With implementation beginning in the mid 1950's, and the main features completed by the mid 1960's, the water management program proved highly beneficial to many human interests — agriculture, water supply, and flood control — but not to wildlife residing in the Everglades ecosystem.

The C&SF Project had three main components.

- It established a perimeter levee through the eastern portion of the Everglades, blocking sheet flow so that lands farther east would be protected from direct Everglades flooding. This levee severed the eastern 16% of the Everglades from its interior.
- The C&SF Project designed a large area of northern Everglades, south of Lake Okeechobee, to be managed for agriculture. Named the Everglades Agriculture Area (EAA), it encompassed about 27% of the historic Everglades and was a major factor in the economic justification of the C&SF Project.
- Water conservation became the primary designated use for most of the remaining Everglades between the EAA and Everglades National Park, limited on the east by the eastern perimeter levee and on the west by an incomplete levee bordering the Big Cypress Swamp.

The name of the Central and Southern Florida Project for Flood Control and Other Purposes (C&SF Project) was changed to the South Florida Water Management District in 1972 by the Florida legislature (https://nicholas.duke.edu/wetland/csf.htm)

The primary system includes about 1,000 miles of levees, 720 miles of canals, and almost 200 water control structures.

The Central and Southern Florida (C&SF) Project legislation that passed in 1948 was south Florida's existing water management system. The project provided water supply, water management and other benefits. Due to adverse effects the plan is now being modified under the Comprehensive Everglades Restoration Plan (CERP).

CERP provides a framework and guide to restore, protect and preserve the water resources of central and southern Florida, including the Everglades. It covers 16 counties over an 18,000-square-mile area and centers on an update of the Central & Southern Florida (C&SF) Project also known as the Restudy.

The Plan was approved in the fall of 2000. It includes more than 60 elements, will take more than 30 years to construct and the current estimate in Oct 2007 dollars is $11.9 billion for projects. Water Resources Development Act (WRDA 1992) provided the U.S. Army Corps of Engineers with the authority to re-evaluate the C&SF Project and to recommend improvements and modifications to the project in order to restore the ecosystem.

The goal of CERP is to capture fresh water that now flows unused to the Atlantic Ocean and the Gulf of Mexico and redirect it to areas that need it most. The majority of the water will be devoted to **environmental restoration**, reviving a dying ecosystem, the Everglades. The remaining water will benefit cities and farmers by enhancing water supplies for the south Florida economy.

Activities/Lessons

- Beach or neighborhood clean-up
- Native wildlife school garden
- In a current newspaper, take an environmentally relevant article and write letters to law makers
- Attend a town council meeting or city commissioners meeting

Glossary of Terms

Abiotic	Nonliving factor in an ecosystem, such as moisture, temperature, wind, sunlight, soil, and minerals.
Accipiter	A hawk of a group distinguished by short, broad wings and relatively long legs, adapted for fast flight in wooded country. Page 59
Adaptations	Inherited trait that is selected for over time because it allows organisms to better survive in their environment. Page 25
Adjacent development	Human development that is adjacent to natural spaces such as Refuges, National Parks, etc. Page 21
Aerial sketch mapping	Is the most efficient and economical method of detecting and appraising recognizable pest damage over large remote forest areas. Prior to the use of aircraft, forest pest surveys were conducted from vantage points such as ridges and mountain tops. Page 72
Aerobic	Process that requires oxygen to occur. Page 47
Air sacs	Air-filled space that connects to a bird's lungs, aiding in breathing.
Ais	The Ais, or Ays were a tribe of Native Americans who inhabited the Atlantic Coast of Florida. They ranged from present-day Cape Canaveral to the St. Lucie Inlet, in the present-day counties of Brevard, Indian River, St. Lucie and northernmost Martin. They lived in villages and towns along the shores of the great lagoon called Rio de Ais by the Spanish, and now called the Indian River. The name 'Ais' is derived from a great Indian cacique (chief). Little is known of the origins of the Ais, or of their language. The Ais language has been tentatively assigned by some scholars to the Muskogean language family. Page 17
Albumen	Egg white, or the protein contained in it.
Aldo Leopold	(January 11, 1887 – April 21, 1948) Aldo was an American author, scientist, ecologist, forester and environmentalist. Page 10
Algae	Chlorophyta or green algae (*Eukaryota*) (singular: alga) photosynthetic plantlike protists, tiny, non-seed bearing aquatic plant. Page 40
Alkylphenols	A derivative of phenol having one or more alkyl groups attached to the carbon ring. Page 77
Alligator hole	As the dry season approaches and water dries up from other areas within the Everglades, alligator holes retain water and become refuges to a variety of wildlife. Alligators prey on the animals that frequent gator holes in search of refuge, food, and water. Page 33
Altrical	(Of a young bird or other animal) hatched or born in an undeveloped state and requiring care and feeding by the parents.
Amphibian	Vertebrate that can live on land and in water. Page 21
Anecdotal	(Of an account) not necessarily true or reliable, because based on personal accounts rather than facts or research. Page 74
Anting	Is a self-anointing behavior during which birds rub insects, usually ants, on their feathers and skin.
Appalachian Mountains	Appalachian Mountains, often called the Appalachians, are a system of mountains in eastern North America. The mountain range elevation is 6,683' and the area covered by this mountain range is 737,000 square miles. Page 20
Apple snail	*Pomacea paludosa* (Ampullariidae) Family of large freshwater snails, aquatic gastropod mollusks with a gill and an operculum. This snail is the primary food of the Everglades Snail Kite. It lays its pearl-white eggs on the leaves of water plants. Page 45
Aquaculture	The rearing of aquatic animals or the cultivation of aquatic plants for food. Page 71
Aquatic	An aquatic plant or animal, typically one suitable for a pond. Page 33
Aquifer	A body of permeable rock that can contain or transmit groundwater. Page 53
Arachnid	Terrestrial chelicerate, such as a spider. Page 63
Atmospheric Deposition	The transfer of substances in air to surfaces, including soil, vegetation, surface water, or indoor surfaces, by dry or wet processes. Page 33
Bald Cypress	*Taxodium distichum* (Cupressaceae) A deciduous North American conifer with exposed buttress roots and ball-shaped cones, typically growing in swamps and on water margins. Page 36
Beakrushs	*Rhynchospora* (Cyperaceae) A sedge having a tubercle like a beak crowning the fruit Page 52

Beck, Thomas	Appointed by Franklin D. Roosevelt to work on the Committee on Wild-Life Restoration along with Ding Darling and Aldo Leopold to acquire land for habitat restoration. One of the recommendations of the Beck Committee was the establishment of the Migratory Bird Hunting and Conservation Stamp or the "Duck Stamp." Page 10
Benthic Zone	Lake or pond bottom, where little to no sunlight can reach.
Best Management Practices	Techniques, measures or structural controls used to manage the quantity and improve the quality of stormwater runoff. The goal is to reduce or eliminate the contaminants collected by stormwater as it moves into streams and rivers. Page 34
Big Cypress Swamp	The freshwaters of the Swamp, essential to the health of the neighboring Everglades, support the rich marine estuaries along Florida's southwest coast. This national preserve managed by the National Park Service protects over 729,000 acres. Page 20
Biodiversity	Variety of life within an area. Page 24
Biome	Regional or global community of organisms characterized by the climate conditions and plant communities that thrive there.
Biosphere	All organisms and the part of Earth where they exist.
Biotic	Living things, such as plants, animals, fungi, and bacteria. Page 73
Biscayne Aquifer	Biscayne Aquifer, named after Biscayne Bay, is a surficial aquifer. It is a shallow layer of highly permeable limestone under a portion of South Florida. The area it underlies includes Broward County, Miami-Dade County, Monroe County, and Palm Beach County, a total of about 4,000 square miles. Page 32
Bladderwort	*Utricularia* (Lentibulariaceae) An aquatic plant of north temperate regions with small air-filled bladders that keep the plant afloat and trap tiny animals that provide additional nutrients. Page 35
Bottomland Hardwoods	Are one of the many important riparian ecosystems in the United States. The term 'bottomland hardwoods' was first used to describe deciduous hardwood forests of the southeastern U.S. that occurred on river floodplains. Page 77

Boynton, Maj. N	(June 23, 1837-May 27, 1911) Major Boynton was a Michigan politician, inventor, hotel owner and a Civil War major who gave his name to the city of Boynton Beach. Page 19
Brackish Water	A mixing of fresh water and saltwater, this is water that has between 10 and 20 cups of salt in every 1,000 cups of water measured, referred to as 10 to 20 parts per 1,000. Page 35
Bromeliad	(Bromeliaceae) A family of plant native to tropical and subtropical America, typically having short stems with rosettes of stiff, usually spiny, leaves. Some kinds are epiphytic (An epiphyte is a plant that grows harmlessly upon another plant, and derives its moisture and nutrients from the air, rain, and sometimes from debris accumulating around it, instead of the structure to which it is fastened), and many are cultivated as houseplants. Page 36
Built Environment	Is a material, spatial and cultural product of human labor that combines physical elements and energy in forms for living, working and playing. It has been defined as "the human-made space in which people live, work, and recreate on a day-to-day basis." Page 76
Buteo	(Accipitridae) Any of the genus of hawks with broad rounded wings relatively short tails, and soaring flight. Page 59
Calusa Indians	Also called the Shell Indians, lived on the sandy shores of the southwest coast of Florida. These Indians controlled most of south Florida. They were the first Indians that the Spanish established communication with, in the sixteenth century until the culture was decimated in the second half of the eighteenth century. Page 15
Camouflage	Structural adaption that enables species to blend with their surroundings, allows a species to avoid detection by predators. Page 60
Candidate Species	Species that have been recommended for listing as threatened or endangered.
Canopy	Dense covering formed by the uppermost branches of trees. Page 36
Caribbean Sea	An arm of the western Atlantic Ocean bounded by the coasts of Central and South America and the West Indies. Page 20
Carnivore	Organism that obtains energy by eating only animals. Page 43
Carrying Capacity	The largest population that a particular environment can support.

Carson, Rachel	(May 27, 1907-April 14, 1964) Carson was an American marine biologist, U.S. Fish and Wildlife Service employee, and conservationist whose book *Silent Spring* and other writings are credited with advancing the global environmental movement. Page 11
Cattail	*Typha* (Typhaceae) A tall, reedlike marsh plant with straplike leaves and a dark brown, velvety cylindrical head of numerous tiny flowers. Page 33
Cere	A fleshy, membranous covering of the base of the upper mandible (beak) in some birds. Page 54
CERP	Comprehensive Everglades Restoration Plan provides a framework and guide to restore, protect and preserve the water resources of central and southern Florida, including the Everglades. It covers 16 counties over an 18,000-square-mile area. Page 24
Channelization	To straighten by means of a channel. The reconstruction of a natural waterway so as to flow in a different path; canalization. Page 77
Chlorophyll	Light-absorbing pigment molecule in photosynthetic organisms.
Citizenry	A whole body of citizens. Page 24
Clean Water Act	Is the primary federal law in the United States governing water pollution. It was established in 1972. Page 33
Climate	Average long-term weather pattern of a region. Page 20
Clum	A vertical stalk of leaves that a lay person might call an individual plant of grasses or sedges. Page 44
Commensalism	Ecological relationship in which one species receives a benefit but the other species is not affected one way or another.
Commercial Fish Trade	As fishing in which the fish harvested, either in whole or in part, are intended to enter commerce or enter commerce through sale, barter or trade. Page 71
Competition	Ecological relationship in which two organisms attempt to obtain the same resource. Page 36

Consent Decree	An agreement or settlement to resolve a dispute between two parties without admission of guilt (in a criminal case) or liability (in a civil case) and most often refers to such a type of settlement in the United States. Page 33
Conservation	The wise and careful use of our natural resources. Page 11
Consumer	Are organisms of an ecological food chain that receive energy by consuming other organisms. These organisms are formally referred to as heterotrophs, which include animals, bacteria and fungus.
Critical Habitat	A specific geographic area that contains features essential for the conservation of a threatened or endangered species and that may require special management and protection. Page 11
Crustaceans	(crustacea) Any of the aquatic arthropods, such as lobsters, crabs, and shrimps, that has a segmented body, an exoskeleton, and paired, jointed limbs. Page 35
Crustose	(Of a lichen or alga) forming or resembling a crust. Page 40
C & SF Project	The largest civil works project in the country. Construction began the next year and continued over 20 years as the U.S. Army Corps of Engineers built the massive flood control plumbing system stretching from just south of Orlando to Florida Bay. Page 80
Cyano-bacterium	(cyanobacterium) bacteria that can carry out photosynthesis. Page 40
Cypress Tree	(cupressaceae) An evergreen coniferous tree with small, rounded, woody cones and flattened shoots bearing small, scalelike leaves. Closest relative is California redwood. Page 36
Deciduous	Tree that has adapted to winter temperatures by dropping its leaves and going dormant during the cold season. Page 36
Decomposer	Detritivore that breaks down organic matter into simpler compounds, returning nutrients back into an ecosystem.
Degradation	The condition or process of degrading or being degraded. Page 71
Dendrology	The scientific study of trees.
Dependence	The state of requiring something else for individual survival.
Detritus	Organic matter produced by the decomposition of organisms. Page 53

Developers	A person or thing that develops something. Example: a property developer. Page 77
Ding Darling (JN)	(October 21, 1876 – February 12, 1962) was an American cartoonist who won two Pulitzer Prizes. Jay Norwood "Ding" penned some conservation cartoons and he was an important figure in the conservation movement. Page 10
Dissolved Oxygen	Microscopic bubbles of gaseous oxygen (O2) that are mixed in water and available to aquatic organisms for respiration—a critical process for almost all organisms. Primary sources of DO include the atmosphere and aquatic plants. Page 33
Diurnal	Occurring or active during the daytime rather than at night: diurnal animals. Page 40
Diversity	(Biological) the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. Page 21
Dredged	The process of digging up and removing material from wetlands or from the bottoms of waterways to clear them or make them deeper or wider. Page 15
Dry season	Yearly period of low rainfall in the tropics. The weather in the tropics is dominated by the tropical rain belt, which comes from the northern to the southern tropics over the course of the year. Page 36
Ecology	Study of the interactions among living things and their surroundings. Page 24
Ecosystem	Collection of organisms and non-living things, such as climate, soil, water, and rocks, in an area. Page 21
Ectotherm	Organism that regulates its body temperature by exchanging heat with its environment.
Egg-tooth	A hard white protuberance on the beak or jaw of an embryo bird or reptile that is used for breaking out of the shell and is later lost.
Endangered	Means a species is in danger of extinction.
Endangered Species Act	Of 1973 is a key legislation for both domestic and international conservation. The act aims to provide a framework to conserve and protect endangered and threatened species and their habitats. Page 7

Endoskeleton	Internal skeleton built of bone or cartilage.
Energy	The capacity for work. Or the ability to do work, or produce change. Page 25
Energy cycle	The energy cycle for life is fueled by the sun. The main end product for plants and animals is the production of highly energetic molecules. These molecules store enough immediately available energy to allow plants and animals to do their necessary work.
Environmental Education	Process that allows individuals to explore environmental issues, engage in problem solving, and take action to improve the environment. As a result, individuals develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions. Page 24
Environmental Restoration	Scientific study supporting the practice of ecological restoration, which is the practice of renewing and restoring degraded, damaged, or destroyed ecosystems and habitats in the environment by active human intervention and action. Page 80
Eradication	The complete destruction of something. Page 71
Erosion	Process of eroding or being eroded by wind, water, or other natural agents. Page 68
Eutrophication	Excessive richness of nutrients in a lake or other body of water, frequently due to runoff from the land, which causes a dense growth of plant life and death of animal life from lack of oxygen. Page 33
Everglades	A subtropical marshy region of Florida, south of Lake Okeechobee: contains the A.R.M. Loxahatchee National Wildlife Refuge and Everglades National Park established to preserve the flora and fauna of the swamps. The area is approximately 5,000 square miles. Page 15
Exoskeleton	Hard outer structure, such as the shell of an insect or crustacean, that provides protection and support for the organism.
Exotic	Plant or animal species introduced into an area where they do not occur. Page 21
Exposure	The state of being exposed to contact with something. Page 77
Extinction	Elimination of a species from Earth. Page 63
Fauna	The animals of a particular region, habitat, or geological period. Page 22

Federal	Having or relating to a system of government in which several states form a unity but remain independent in internal affairs. Page 7
Finfish	The strict biological definition of a fish, above, is sometimes called a true fish. True fish are also referred to as finfish or fin fish to distinguish them from other aquatic life harvested in fisheries or aquaculture.
First Growth	120 to 140 years of age in the interior of the tree where fire is a frequent and natural occurrence whereas the Second Growth is a forest or woodland area which has re-grown after a major disturbance such as fire, insect infestation, timber harvest or wind throw, until a long enough period has passed so that the effects of the disturbance are no longer evident. Page 37
Fisheries	Industry or occupation devoted to the catching, processing, or selling of fish, shellfish, or other aquatic animals. Page 15
Fixed	(as in Fixed Tree Island) An origin of a tree island involving a high spot of the rock base; a true island in the marsh. Page 47
Flagler, Henry	(January 2, 1830- May 20, 1913) Flagler was an American Industrialist and founder of Standard Oil. He was also a key in the development of the Atlantic coast of Florida and what became the Florida East Coast Railway. Page 19
Fledge	(Of a young bird) develop wing feathers that are large enough for flight.
Flora	Plants of a particular region, habitat, or geological period. Page 22
Florida Exotic Pest Plant Council	The mission is to support the management of invasive exotic plants in Florida's natural areas by providing a forum for the exchange of scientific, educational, and technical information. Page 72
Florida Keys	A string of tropical islands stretching about 120 miles off the state's southern tip, between the Atlantic Ocean and Gulf of Mexico. Page 20
Floridan Plateau	Florida peninsula is a porous plateau of karst limestone sitting atop bedrock known as the Florida Platform. Page 20

Flow-Weighted Mean Concentrations	(FWMC) represents the total load for the time period divided by the total discharge for the time period. The ratio of FWMC to time-weighted mean concentration (TWMC) indicates whether a pollutant tends to increase in concentration as flow increases. If the FWMC>TWMC, that pollutant, on average, increases with increasing flow. Page 34
Foliose	(Lichen) A foliose lichen is lichen with leafy body parts, and which generally have a "skin" on each side of the leafy lichen body part. Page 40
Fontaneda, Hernando de Escalante	He wrecked on Florida at age 13 and lived with the Calusa Indians for 17 years. His accounts of living with the Calusa were the first written about the Calusa Indians and how they lived. Page 15
Food Chain	Model that links organisms by their feeding relationships. Page 57
Fragmented	To cause to break into pieces or fragments. Page 22
Freshwater	Water that does not contain a large amount of salt. Inland water, as ponds, lakes, or streams, that is not salt. Origin of fresh water. Page 16
Fruticose	Are the most three-dimensional lichen. They're usually round in cross section (terete), and most are branched. They can be like little shrubs growing upward, or they can hang down in long strands. Page 40
Fungus	(singular is *Fungi*) Any of a diverse group of eukaryotic single-celled or multinucleate organisms that live by decomposing and absorbing the organic material in which they grow, comprising the mushrooms, molds, mildews, smuts, rusts, and yeasts, and classified in the kingdom Fungi. Page 40
Game	Animals pursued and taken by sportsmen, such as wild meats designed for or served at the table. Those species of animals. Page 22
Gatroliths	A small stone swallowed by a bird, reptile, or fish, to aid digestion in the gizzard. Page 60
Geotropism	The growth of the parts of plants with respect to the force of gravity. The upward growth of plant shoots is an instance of negative geotropism; the downward growth of roots is positive geotropism. Page 37

Gizzards	A muscular, thick-walled part of a bird or reptile's stomach for grinding food, typically with grit. Page 60
Gladesmen	Defined by FIU Professor Laura A. Ogden in Swamplife as poor rural whites whose ancestors settled in southern Florida in the mid-nineteenth century and who subsist largely through commercial hunting and fishing and through small-scale agriculture and their connections with the land, flora, and fauna of the Everglades. Page 22
Gondwanaland	Gondwanaland is the ancient supercontinent that incorporated present-day South America, Africa, Arabia, Madagascar, India, Australia, and Antarctica. Page 20
Gravitropism	Growth of plants in response to gravity; plant stems grow upward, against gravity, and roots grow toward the gravitational pull. Page 37
Ground Water	Found underground in the cracks and spaces in soil, sand and rock. It is stored in and moves slowly through geologic formations of soil, sand and rocks called aquifers. Page 34
Gulf of Mexico	An ocean basin largely surrounded by the North American continent. It is bounded on the northeast, north, and northwest by the Gulf Coast of the United States, on the southwest and south by Mexico, and on the southeast by Cuba. Page 20
Habitat	Combined biotic and abiotic factors found in the area where an organism lives. Page 26
Habitat Destruction	The process in which natural habitat is rendered functionally unable to support the species present. In this process, the organisms that previously used the site are displaced or destroyed, reducing biodiversity. Page 67
Habitat Island	Process by which part of an organism's preferred habitat range becomes inaccessible. This then creates an island or fragmentation of the habitat. Page 70
Heliotropism	The directional growth of a plant in response to sunlight. Page 37
Herbivore	Organism that eats only plants.
Homesteading	A lifestyle of self-sufficiency. It is characterized by subsistence agriculture, home preservation of foodstuffs, and it may or may not also involve the small scale production of textiles, clothing, and craftwork for household use or sale. Page 19

Humus	The organic component of soil, formed by the decomposition of leaves and other plant material by soil microorganisms.
Hydropattern	Refers to the depth of the water, the distribution of the water, the seasonal timing of water, and the flow of water. Page 21
Hydroperiod	The seasonal pattern of the water level that results from the combination of the water budget and the storage capacity of the wetland. The water budget is a term applied to the net of the inflows, all the water flowing into, and outflows, all the water flowing out of, a wetland. Page 44
Iapetus Ocean	An ocean that existed in the Neoproterozoic and Paleozoic eras of the geologic timescale. This ocean was situated in the southern hemisphere, between the paleocontinents of Laurentia, Baltica and Avalonia. Page 20
Immigration	Movement of individuals into a population. Page 70
Importation	Something that is imported from abroad: an imported commodity or article. Page 70
Indicator Species	Species whose presence in an ecosystem gives clues about the condition of that ecosystem.
Injurious	Causing or likely to cause damage or harm. Page 73
Innate	Behavior that is not learned through experience.
Insects	*Insecta* (Arthropods) A class of invertebrates that have an exoskeleton, a three-part body, three pairs of jointed legs, compound eyes and one pair of antennae. Page 43
Instinct	Inborn pattern of behavior that is characteristic of a species.
Interdependence	Inter means "between," so it's the dependence between plants and animals.
Inter-relationships	The way in which each of two or more things is related to the other or others. Page 25
Invasive Plant	Plant tending to spread prolifically and undesirably or harmfully. Page 71
Invertebrate	Animal without a backbone. Page 33

U.S. Fish & Wildlife Service

Jaega/Jobe Indians	(Also Jega, Xega, Jaece, Geiga) These Indians were a tribe that lived along the Florida coast near present day Martin and Palm Beach County at the time of initial European contact, and until the 18th century. The Jaegas were hunter/gatherers and their diets consisted mainly of fish, shellfish, sea turtles, deer and raccoon as well as wild plants. Page 17
Jurassic Period	The Jurassic Period (213 to 144 million years ago) is the second of three periods during the Mesozoic Era. It is preceded by the Triassic Period and it is followed by the Cretaceous Period. Page 20
Keystone Species	Organism that has an unusually large effect on its ecosystem. So named for the wedge-shaped piece at the summit of an arch, regarded as holding the other pieces in place.
Knees (Cypress)	A term used in the biology of trees to describe the distinctive structures forming above the roots of a cypress tree. Their function is unknown, but they are generally seen on trees growing in swamps. Page 36
Larvae	Distinct juvenile form many animals undergo before metamorphosis into adults. Animals with indirect development such as insects, amphibians, or cnidarians typically have a larval phase of their life cycle. Page 42
Leaf	A flattened structure of a higher plant, typically green and bladelike, that is attached to a stem directly or via a stalk. Leaves are the main organs of photosynthesis and transpiration. Page 37
Legislation	Laws, considered collectively. Page 65
Levee	An embankment built to prevent the overflow of a body of water. Page 16
Lichen	Fungus that grows symbiotically with algae, resulting in a composite organism that grows on rocks or tree trunks. Page 36
Limestone	A hard sedimentary rock, composed mainly of calcium carbonate or dolomite, used as building material and in the making of cement. Page 16
Limiting Factor	Environmental factor that limits the growth and size of a population. Page 33

Linton, William S.	(February 4, 1856-November 22, 1927) Linton was born and raised in Michigan where he was a politician. Linton and Swinton came to Florida looking for an opportunity to invest in what was the unsettled frontier. They purchased land and settled what is now the area of Delray and Boynton Beach. Page 19
Lower Cretaceous Period	The younger of two epochs into which this period is divided in the geologic timescale. The Cretaceous is named after the white limestone known as chalk which occurs widely in northern France and is seen in the white cliffs of south-eastern England, and which dates from this time. Page 20
Loxahatchee River	(Seminole for river of turtles) is a 7.6 mile river near the southeast coast of Florida. It is a National Wild and Scenic River, one of only two in the state, and received its federal designation on May 17, 1985. Page 15
Mammal	Endothermic organism that has hair, mammary glands, bones in the ear that allow for hearing, and a jaw for chewing food. Page 15
Marl Prairie	One type of wet prairie occurring on thin calcitic soil (marl) over limestone bedrock, which may be exposed as jagged, up to foot-tall projections called pinnacle rock or dissolved below the surface into pockets called solution holes. Page 53
Mayaimis	(Also referred to as Ais or Ays) A tribe of Native Americans who inhabited the Atlantic Coast of Florida. They ranged from present-day Cape Canaveral to the St. Lucie Inlet, in the present-day counties of Brevard, Indian River, St. Lucie and northernmost Martin. Page 17
Melaleuca	An Australian shrub or tree that bears spikes of flowers. Some kinds are a source of timber or medicinal oil. Page 21
Microclimate	Climate of a specific location within a larger area. Page 37
Migrate	(Of an animal, typically a bird or fish) Move from one region or habitat to another, especially regularly according to the seasons. Page 63
Mimicry	The close external resemblance of an animal or plant (or part of one) to another animal, plant, or inanimate object.
Migration	Seasonal movement of animals from one region to another. Page 43

Mobbing	(Of a group of birds or mammals) Surround and attack (a predator or other source of threat) in order to drive it off.
Molt	(Of an animal) Shed old feathers, hair, or skin, or an old shell, to make way for a new growth.
Monocultures	The cultivation of a single crop in a given area. Page 71
Mosaic Pattern	Fire is manipulated to create a mosaic of patches representative of a range of fire histories to generate differences across space and time. Page 22
Mosquitofish	*(Gambusia affinis)* Species of freshwater fish, also known commonly, if ambiguously, as simply mosquitofish or by its generic name. Page 42
Mutualism	Ecological relationship between two species in which each species gets a benefit from the interaction.
Natural Disasters	Natural event such as a flood, earthquake, or hurricane that causes great damage or loss of life. Page 70
Natural Environment	Means all living and non-living things that are naturally on Earth. In a narrow sense, it is an environment that is not influenced by people. Page 76
Natural Resource	Materials or substances such as minerals, forests, water, and fertile land that occur in nature and can be used for economic gain. Page 24
Naturalized	Establish (a plant or animal) so that it lives wild in a region where it is not indigenous. Page 67
Nesting Sites	Locations (of a bird or other animal) used to build a nest. Page 47
New World	One of the names used for the Western Hemisphere, specifically the Americas (including nearby islands such as those of the Caribbean and Bermuda). Page 67
Niche	Specific area where an organism inhabits. Page 69
Nocturnal	Done, occurring, or active at night. Page 40
Non-indigenous	Member(s) (i.e. individual, group, or population) of a species that enters an ecosystem outside of its historic or native range. Most of the non-indigenous introductions are a result of human activities since the European colonization of North America. Page 71
Non-renewable Resource	Natural resource that is used more quickly than it can be formed.
North Atlantic Ocean	The northern part of the Atlantic Ocean, extending from the equator to the Arctic Ocean. Page 20
Nutrients	Substance that provides nourishment essential for growth and the maintenance of life. Page 33
Nymphs	An immature form of an insect that does not change greatly as it grows, e.g., a dragonfly, mayfly, or locust. Page 43
Oak Scrub	Areas that have thick stands of evergreen oaks in small patches on shallow depressions or slight hills. These forests are distinct from their surrounding habitats, which are often dominated by longleaf pine. On mesic sites, common species are southern live oak (*Quercus virginiana*) Fagaceae, sand laurel oak (*Quercus hemisphaerica*) Fagaceae, and American persimmon (*Diospyros virginiana*) Ebenaceae. Page 22
Old World Climbing Fern	(*Lygodium microphyllum*) Lygodiaceae climbing fern originating in tropical Africa, South East Asia, Melanesia and Australia. It is an invasive weed in Florida and Alabama where it invades open forest and wetland areas. Page 22
Oligotrophic	An oligotroph is an organism that can live in an environment that offers very low levels of nutrients. Page 33
Omnivore	Organism that eats both plants and animals.
Ornithology	The scientific study of birds.
Outstanding Florida Waters (OFW)	Rivers, lakes and other water features designated by the Florida Department of Environmental Protection (DEP) under authority of Section 403.061 (27), Florida Statutes as worthy of special protection because of their natural attributes. OFW have special restrictions on any new activities that would lower water quality or otherwise degrade the body of water. OFW designation has been applied to all bodies of water in National Wildlife Refuges. Page 16
Ozone Layer	A layer in the earth's stratosphere at an altitude of about 6.2 miles (10 km) containing a high concentration of ozone, which absorbs most of the ultraviolet radiation reaching the earth from the sun. Page 77

Palmate Leaf	Resembling a hand with the fingers spread as in having lobes radiating from a common point.
Palm Beach County	A county located in the state of Florida. As of the 2010 census, the population was 1,320,134, making it the third-most populous county in Florida. The largest city and county seat is West Palm Beach. Page 20
Pangaea	Or "Pangea" was a supercontinent that existed during the late Paleozoic and early Mesozoic eras. It formed approximately 300 million years ago and then began to break apart after about 100 million years. Page 20
Parasite	An organism that lives in or on another organism (its host) and benefits by deriving nutrients at the host's expense. Page 73
Parasitism	Ecological relationship in which one organism benefits by harming another organism.
Particulate Matter	An air pollution term for a mixture of solid particles and liquid droplets found in the air. The pollutant comes in a variety of sizes and can be composed of many types of materials and chemicals. Page 77
PCBs	Polychlorinated biphenyls (PCBs) is a group of organic compounds used in the manufacture of plastics, as lubricants, and dielectric fluids in transformers, in protective coating for wood, metal and concrete, and in adhesives, wire coating and so forth. Page 78
Plant Community	Is a collection or association of plant species within a designated geographical unit, which forms a relatively uniform patch, distinguishable from neighboring patches of different vegetation types. Page 77
Peat	A highly organic material found in marshy or damp regions, composed of partially decayed vegetable matter. Page 22
Peripheral Marl Prairies	Outlying extensive, level or slightly undulating, mostly treeless tract of calcium carbonate or lime-rich mud or mudstone which contains variable amounts of clays and silt land. Page 47
Periphyton	A combination of algae microbes, and detritus that is a base of the food chain of the freshwater community in the Everglades. Page 33
Permaculture	The development of agricultural ecosystems intended to be sustainable and self-sufficient. Page 65
Pesticides	A substance used for destroying insects or other organisms harmful to cultivated plants or to animals. Page 33
Photosynthesis	Process by which light energy is converted to chemical energy, produces sugar and oxygen from carbon dioxide and water. Page 27
Pinate leaf	Resembling a feather in having parts or branches arranged on each side of a common axis.
Pine Flatwoods	A pine woodland in a low-lying region having little drainage. This is a moderately cold tolerant plant community. Page 22
Plastron	The underneath part of a turtle shell. Page 55
Plumage	A bird's feathers collectively. Page 50
Pollution	The presence in or introduction into the environment of a substance or thing that has harmful or poisonous effects. Page 34
Ponce de León, Juan	Was a Spanish explorer and conquistador. He became the first Governor of Puerto Rico by appointment of the Spanish crown. He led the first European expedition to Florida. Page 15
Pond Cypress	(*Taxodium ascendens*) Deciduous coniferous tree native to ponds and wetlands of the southeast United States, having scale-like leaves and roundish cones. Page 36
Pop-Up	Islands occurring in sloughs where lily roots and rhizomes forming peat fill with mostly methane gas and become buoyant, tears free and "pops up." Page 47
Populations	All of the individuals of a species that live in the same area. Page 7
Prairie Potholes	Is an area of the northern Great Plains and midgrass and tallgrass prairies that contains thousands of shallow wetlands known as potholes. Page 11
Precocial	(Of a young bird or other animal) hatched or born in an advanced state and able to feed itself almost immediately.
Predator	An animal that lives by capturing other animals for food. Page 21
Preen	(Of a bird) straighten and clean its feathers with its beak.
Preservation	A process of saving something in its natural state. Page 36

Prescribed Fire	Is the knowledgeable and controlled application of fire to a specific land area to accomplish planned resource management objectives. These fires are managed in such a way as to minimize the emission of smoke and maximize the benefits to the site. Page 22
Prey	An animal that is hunted and killed by another for food. Page 33
Primary	First or highest in rank or importance, chief, principal. Page 7
Principles	A fundamental truth or proposition that serves as the foundation for a system of belief or behavior or for a chain of reasoning. Page 78
Ramsar Convention	Wetland of International Importance, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. Page 21
Range	Distribution of a species is the geographical area within which that species can be found. Within that range, dispersion is variation in local density. Page 36
Recycle	Convert (waste) into reusable material. Page 78
Refugia	An area where special environmental circumstances have enabled a species or a community of species to survive after extinction in surrounding areas. Page 22
Reptile	Ectotherm that is covered with dry scales, breathes with lungs, and reproduces by laying eggs. Page 21
Restoration	The action of returning something to a former owner, place, or condition. Page 21
Ridge and Slough	A landscape is composed of a parallel arrangement of rather evenly spaced sawgrass ridges and open water sloughs characterized by aquatic vegetation and generally the year-round presence of water above the soil surface. Page 47
Rookies	Breeding colony of birds, typically seen as a collection of bird nests high in a clump of trees. Page 47

Roosevelt, President Theodore	(October 27, 1858- January 6, 1919) often referred to by his initials TR, was an American statesman, author, explorer, soldier, naturalist, and historian who served as the 26th President of the United States. He is remembered for his foreign policy, corporate reforms and ecological preservation. Roosevelt won the Nobel Peace Prize for his part in ending the Russo-Japanese War. Page 10
Roosting	(Of a bird or bat) settle or congregate for rest or sleep. Page 21
Roots	The part of a plant that attaches it to the ground or to a support, typically underground, conveying water and nourishment to the rest of the plant via numerous branches and fibers. Page 37
Sabal palm	(*Sabal palmetto*) Sabal is a genus of New World palms, many of the species being known as palmetto, a loanword from the Spanish language. It is Florida's state tree.
Saltwater Intrusion	Is the movement of saline water into freshwater aquifers, which can lead to contamination of drinking water sources and other consequences. Saltwater intrusion occurs naturally to some degree in most coastal aquifers, owing to the hydraulic connection between groundwater and seawater. Page 32
Salyer II, J. Clark	(August 16, 1902 – August 16, 1966) Salyer was an educator in Parsons, Kansas before taking a position with the Iowa Fish and Game Commission in 1933. He was later name "Father of the National Wildlife Refuge System" because under his direction the Refuge system grew from 1.5 million acres to 29 million acres over his tenure. Page 10
Sanctuary	A place of refuge or safety, i.e. a nature preserve. Page 21
Sand Pine	(*Pinus clausa*) A pine common along the coast of Florida and Alabama with smooth bark, leaves in pairs, and spiny-tipped cones. Page 22
Saprophyte	A plant, fungus, or microorganism that lives on dead or decaying organic matter.
Sawgrass	(*Cladium*) A sedge with spiny-edged leaves. Page 43
Scat	Wildlife feces.

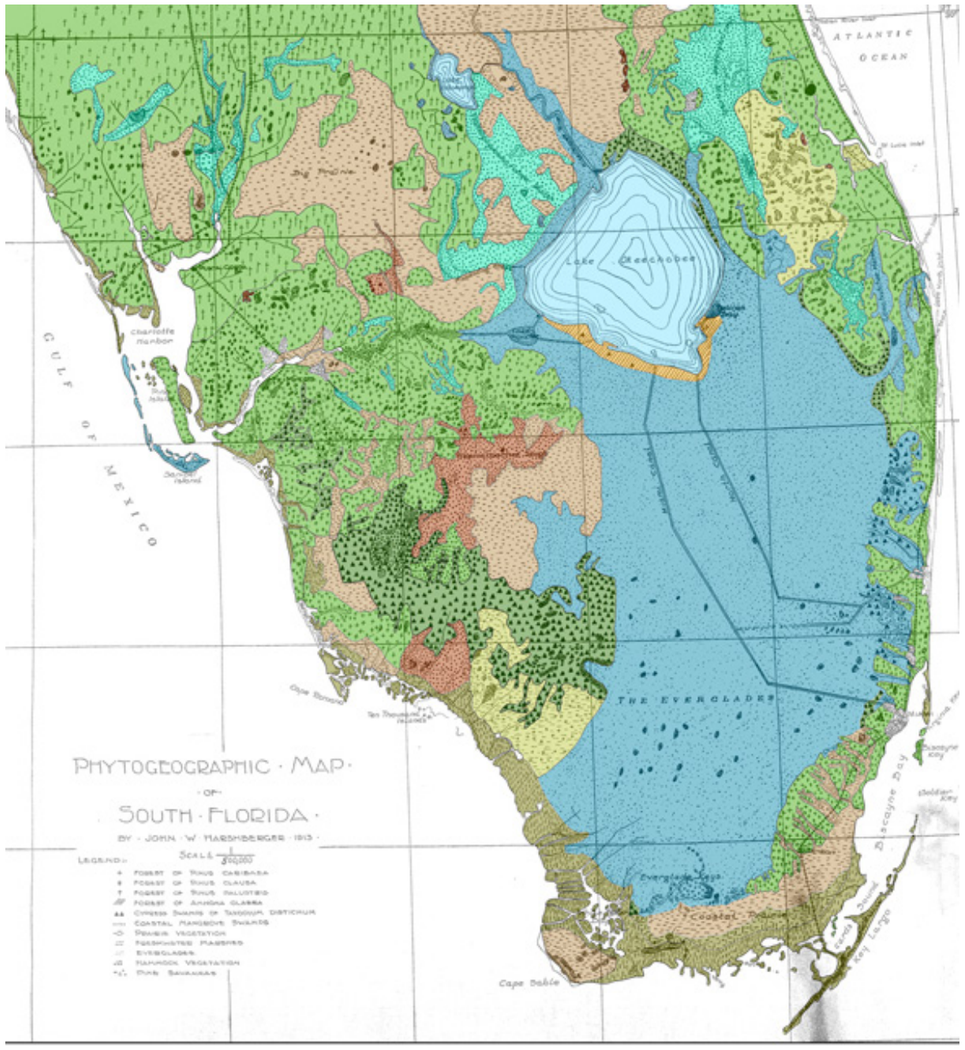
Second Growth	Woodland growth that replaces harvested or burned virgin forest. Page 37
Sedge	A grasslike plant with triangular stems and inconspicuous flowers, growing typically in wet ground. Sedges are widely distributed throughout temperate and cold regions. Page 43
Sediment	Matter that settles to the bottom of a liquid, dregs. Page 20
Seedlings	A young plant, especially one raised from seed and not from a cutting. Page 36
Seminole Indians	A member of any of the groups of American Indians that emigrated to Florida from Georgia and Alabama in the 18th and 19th centuries and that are now located in southern Florida and Oklahoma. Page 15
Serrated Leaf	Having or forming a row of small, sharp, projections resembling the teeth of a saw. Having a saw-toothed edge or margin notched with toothlike projections. Page 43
Settlement Agreement	This agreement contains a fundamental commitment by all parties to achieve the water quality and water quantity needed to preserve and restore the unique flora and fauna of the Park and Refuge. Thus, the Agreement broadly requires the SFWMD and DEP to take such action as is necessary to achieve all state water quality standards in the Park and Refuge. Page 33
Simple Leaf	A leaf whose blade is not divided to the midrib even though lobed — compare compound leaf.
Slough	An area of deepest water in the Everglades and provides an important source of water during the dry season. Page 15
Social Environment	Social context, sociocultural context, or milieu, refers to the immediate physical and social setting in which people live or in which something happens or develops. It includes the culture that the individual was educated or lives in, and the people and institutions with whom they interact. Page 76
Song	Typically a song is defined as a relatively structured vocalization produced while attracting a mate or defending a territory. Calls tend to be shorter, less rhythmic sounds used to communicate a nearby threat or an individual's location. Page 45
Songbirds	Is a member of the perching bird family. Page 66

Solution Holes	Rain water is less likely to erode the limestone to form solution holes—smaller versions of sinkholes that do not intersect with the water table. In this formation the beds are generally impermeable. Page 53
Species	A class of individuals having some common characteristics or qualities; distinct sort or kind. In biology the major subdivision of a genus or subgenus. Page 72
Spikerush	(*Eleocharis palustris*) Is a native, perennial, warm season sedge. Page 52
Stormwater Runoff	Is water from rain or melting show that "runs off" across the land instead of seeping into the ground. Generally speaking, stormwater is rain that washes off driveways, parking lots, roads, yards, rooftops, and other hard surfaces. Page 34
Stormwater Treatment Areas	Storm water treatment areas are constructed wetlands that remove excess nutrients. Page 34
Straits of Florida	Or Florida Straits is a strait located south-southeast of the North American mainland, generally accepted to be between the Gulf of Mexico and the Atlantic Ocean, and between the Florida Keys and Cuba. Page 20
Strand Tree Island	Are characterized by having a uniform plant community along the north-south axis; therefore lacking the zonation that characterizes fixed tree islands. Page 47
Subsidence	A natural process that involves sinking of the earth. In the marsh, land is sinking about one inch every three years.
Subtropical	Relating to the regions of the Earth bordering on the tropics, just north of the Tropic of Cancer or just south of the Tropic of Capricorn. Subtropical regions are the warmest parts of the two Temperate Zones. Page 20
Successional	Sequence of biotic changes that regenerate a damaged community or start a community in a previously uninhabited area. Page 22
Supplemental	Something added to complete a thing, make up for a deficiency, or extend or strengthen the whole. Page 78
Susceptibility	The state or fact of being likely or liable to be influenced or harmed by a particular thing. Page 77
Sustainable	Able to be maintained at a certain rate or level. Page 78

Swamp	This is a low, wet, forested area. Page 36
Symbiosis	Ecological relationship between members of at least two different species that live in direct contact with one another.
Symbiotic	Having an interdependent relationship. Page 40
Symbiotic Relationship	A close, prolonged association between two or more different organisms of different species that may, but does not necessarily, benefit each member.
Synergy	The interaction or cooperation of two or more organizations, substances, or other agents to produce a combined effect greater than the sum of their separate effects. Page 77
Systematic Reconnaissance Flights	A scientific method in wildlife survey for assessing the distribution and abundance of wild animals. The method involves systematic or random flight lines (transects) over the target area at a constant height above ground, with at least one observer recording wildlife in a calibrated strip on at least one side of the aircraft. Page 72
Taxonomists	A biologist who groups organisms into categories. Page 36
Temperate	Of, relating to, or denoting a region or climate characterized by mild temperatures. Page 20
Temperature	A temperature is a numerical measure of hot and cold. Its measurement is by detection of heat radiation, particle velocity, kinetic energy, or most commonly, by the bulk behavior of a thermometric material. Page 22
Tequesta Indians	Were a small peaceful tribe. They were one of the first tribes in South Florida and they settled near Biscayne Bay in present day Miami. The Tequesta Indians were hunter/gatherers and relied mainly on fish, shellfish, nuts, and berries for food. The men caught shark, sailfish, sea cows and porpoises in the local waters. Page 17
Thigmotropism	Is a movement in which a plant moves or grows in response to touch or contact stimuli. Page 37
Threatened	Species are those likely to become endangered within the "foreseeable future." Page 11
Total Phosphorus	(TP) is the form of analysis typically cited as an effluent parameter for municipal and industrial wastewater treatment plants. Page 34
Tree Islands	They range in size from a few square miles to 300 acres or more and rise as much as three feet above the surrounding marsh. They are a needed retreat from the watery and open environment of the Everglades. They provide food and shelter for wildlife. Page 22
Triassic Period	Is a geologic period and system that extends from roughly 252.17 to 0.2 million years ago, an interval of 51.04 million years. It is the first period of the Mesozoic Era, and lies between the Permian and Jurassic periods. Both the start and end of the period are marked by major extinction events.
Tropism	Movement or growth of a plant in response to an environmental stimulus. Page 37
Urban Interface	Refers to the zone of transition between unoccupied land and human development. Communities that are within 0.5 miles (0.80 km) of the zone may also be included. These lands and communities adjacent to and surrounded by wildlands are at risk of wildfires. Page 22
Urbanization	Is a word for becoming more like a city. When populations of people grow, the population of a place may spill over from city to nearby areas. This is called urbanization. Maybe tall apartment buildings spring up on what had been the outskirts of town, bringing more people there to live and work. Page 71
Vertebrate	Animal with an internal segmented backbone. Page 40
Volunteers	A person who freely offers to take part in an enterprise or undertake a task. Page 78
Wading Birds	A long-legged bird, such as a crane, heron, or stork, that frequents shallow water, especially in search of food. Page 32
Water Conservation Areas 1, 2, 3	South Florida's three (WCAs) are vast tracts of remnant Everglades sawgrass marsh located adjacent to Everglades National Park. Spanning 846,387 acres, the WCAs serve multiple water resource and environmental purposes, including flood control, water supply and habitat for South Florida's plant and animal communities. Renowned for their clean water, unique landscape and birds and wildlife, the WCAs are popular for recreational activities such as fishing, hunting and bird watching. Page 16

Water Cycle	The cycle of processes by which water circulates between the earth's oceans, atmosphere, and land, involving precipitation as rain and snow, drainage in streams and rivers, and return to the atmosphere by evaporation and transpiration. Page 34
Waterfowl	Ducks, geese, or other large aquatic birds, especially when regarded as game. Page 10
Weather	The state of the atmosphere at a place and time as regards heat, dryness, sunshine, wind, rain, etc. Page 21
Wet Dry Seasons	Florida experiences seasons that differ from most of the remainder of the country. Rather than the four seasons of winter, spring, summer and fall, Florida exhibits a distinct Wet (warm) Season and Dry (cooler) Season. This duality of seasons is similar to the Monsoon or Wet-Dry climates that other regions of the world experience. The Wet Season is typically considered to begin in the latter part of May and resembles "summer" across much of the remainder of the country. Though it does not rain every day during the summer, the frequency of rainfall usually begins to increase in late May. The Dry Season usually begins in October as the first synoptic scale cold front brings drier and slightly cooler air into the area. Tropical systems, additional fronts and gale centers can bring periods of heavy rain through November, but the frequency of rain almost always decreases after the first significant frontal passage. Page 20
Wetlands	Areas that, at least periodically, have waterlogged soils or are covered with a relatively shallow layer of water. Wetlands support plant and animals that are adapted to living in a watery environment. Bogs, freshwater marshes, freshwater swamps, and the Everglades are examples of wetlands. Page 11
Wet Prairie	Have shallower water levels and are characterized by short emergent plants other than sawgrass, such as beakrushes and spikerushes. Page 52
Wildfires	A large, destructive fire that spreads quickly over woodland or brush. Page 21
Wildlife Refuge	A place that provides food, shelter, and protection for the organisms that live or migrate there. Page 10
Xeriscape	Landscaping and gardening that reduces or eliminates the need for supplemental water. Page 65

Maps



Everglades
Freshwater marshes
Lake Okeechobee
Cypress Swamp
Forest
Coastal mangrove Swamps
Pine Savannas
Hammocks Vegetation
Prairie Vegetation
Annona glabra - Pond Apple

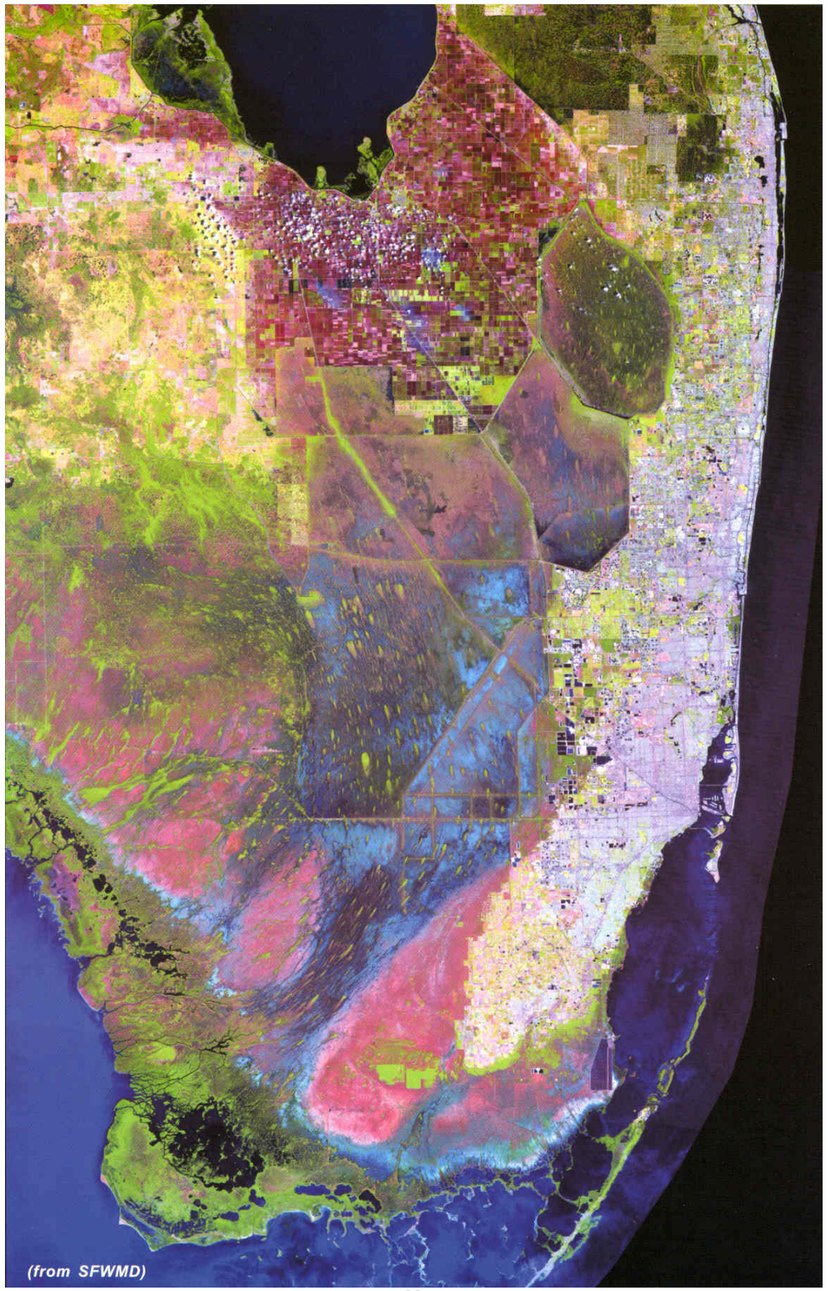
Phytogeographic Map
John Harshberger, 1913

0 5 10 20 Miles

Source: Digitized by
Noosha Mahmoudi, 2007

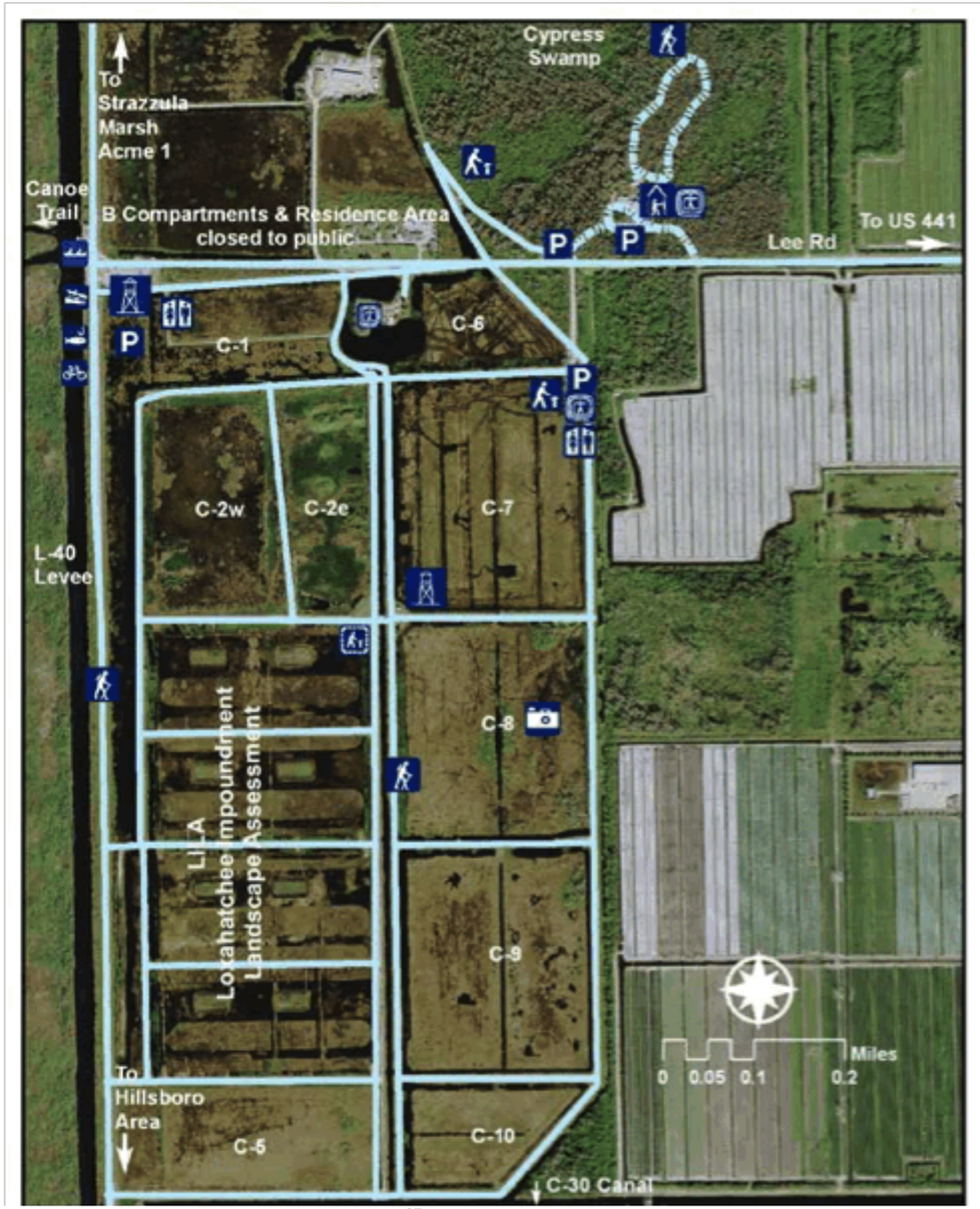
EVER GLADES FOUNDATION

U.S. Fish & Wildlife Service



U.S. Fish & Wildlife Service

Refuge Headquarters Area



Resources

Barley Barber Swamp — first growth Cypress Swamp www.barleybarber.org tours and school group by Treasured Lands Foundation 772/647 9074

An Activity Guide for Teachers: Everglades National Park, National Park Service

The Florida State Museum
Homestead, FL 33030

An Educator Guide to St. Mark's National Wildlife Refuge, St. Mark's NWR

http://permacultureprinciples.com

The South Florida Water Management District (District) and the U.S. Army Corps of Engineers (COE) are partners in the Comprehensive Everglades Restoration Program – the restoration program to clean up the Everglades. Read and learn on their website http://www.evergladesrestoration.org/.

Project WILD/Aquatic WILD
Council for Environmental Education
5555 Morningside, Suite 212
Houston, TX 77005
Phone: 713/520 1936
Email: info@councilforee.org

http://refuges.fws.gov

http://www.fws.gov/refuge/arm_Loxahatchee

http://raws.wrh.noaa.gov/roman/

http://gacc.nifc.gov/sacc/predictive/weather/weather.htm

http://www.cpc.ncep.noaa.gov/

The Friends of the Arthur R. Marshall Loxahatchee National Wildlife Refuge https://loxahatcheefriends.com/ has available for sale a number of excellent reference books on the Everglades and its native flora and fauna. These items may be purchased at the Refuge Visitor Center during operating hours. Funds generated through sales are used for educational programs and exhibits on the refuge. Many of the agencies listed below will provide additional resources and materials such as posters, coloring books, and additional resource material. Also, all states have a department of natural resources or a fish and game commission that will have materials available for that state. They are listed in the phone book under state governments.

Project Learning Tree
The American Forest Council
1250 Connecticut Avenue, NW
Washington, D.C. 20036

Project WILD/Aquatic WILD
Council for Environmental Education
5555 Morningside, Suite 212
Houston, TX 77005
713/520 1936 info@councilforee.org

Education Section Ecological Society of American Institute of Ecosystem Studies
P.O. Box AB
Millbrook, NY 12545

Florida Fish and Wildlife Conservation Commission
Nongame Education Program
620 South Meridian Street
Tallahassee, FL 32399-1600

Florida Urban Wildlife Extension Specialist Florida Department of Environmental Protection South East Florida Sub-District
400 N. Congress Avenue
West Palm Beach, FL 33401

Florida Parks and Monuments Association
10 Parachute Key #51
Homestead FL 33034-6735

A Guide to Environmental Education for National Wildlife Refuges and Fish Hatcheries in the Southeast Region, U.S. Fish and Wildlife Service, Region 4, Atlanta, GA 30303

Florida Native Plant Society
P.O. Box 278
Melbourne, FL 32902-0278
321/271 6702
info@FNPS.org

Project H.O.M.E.
New Hampshire Fish and Game
2 Hazen Drive
Concord, NH 03301

U.S. Fish and Wildlife Service
1875 Century Blvd.
Atlanta, GA 30345

U.S. Environmental Protection Agency
345 Courtland Street
Atlanta, GA 30303

National Park Service
75 Spring Street, SW Room 1094
Atlanta, GA 30303

U.S. Forest Service
1720 Peachtree Road
Atlanta, GA 30367

National Wildlife Refuge System
5275 Leesburg Pike
Falls Church, VA 22041-3803

Department of Wildlife and Range Services
118 Newins-Zeigler Hall
University of Florida
Gainesville, FL 32611

Florida Fish and Wildlife Conservation Commission
8535 Northlake Blvd.
West Palm Beach, FL 33412

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http://www.allaboutbirds.org. Cornell Lab of Ornithology. Cornell University. Copyright 2011

http://aquaplant.tamu.edu. Texas A & M University. 2015

http://www.fleppc.org. Florida Exotic Pest Plant Council. 2015

http://www.fleppc.org/ID_book/Schinus%20terebinthifolius.pdf., Center for Invasive Species and Ecosystem Health, University of Georgia, January 2015.

http://www.fondriest.com/environmental-measurements/
Fondriest Environmental Inc. 2015

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National Gardening Association. 2015

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Standards and Lessons/Activities

These additional lesson plans align all activities to each chapter and the national core disciplines, and the Next Generation Florida Sunshine State and Common Core standards. Each chapter and activity is adaptable to indoor, outdoor, field trip experiences and all grade levels. If you would like more activities and lessons or to have someone model the lessons/activities with you, or illustrate how to adapt the information and activities to a certain grade level/student group, please contact the ARM Loxahatchee NWR and ask for the education department.

Chapter I: Introduction to Established Conservation Systems

- Math: I can investigate patterns of association.
- ELA: I can determine the main idea or essential message through inferring, paraphrasing, summarizing, and identifying relevant details.
- Science: I can recognize that scientists who make contributions to scientific knowledge come from all kinds of backgrounds and possess varied talents, interests, and goals.
- History/Civics: I can utilize timelines to identify the time sequence of historical data. I can analyze how images, symbols, objects, cartoons, graphs, charts, maps, and artwork may be used to interpret the significance of time periods and events from the past.
- Art: I can identify examples in which artists have created works based on cultural and life experiences.

Chapter II: Arthur R. Marshall Loxahatchee NWR

- Math: I can describe and compare measurable attributes.
- ELA: I can plan and develop a topic; organize ideas, concepts, and information, using strategies such as definition, classification, comparison/contrast, and cause/effect; include formatting, graphics, and multimedia when useful to aiding comprehension.
- Science: Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.
- History/Civics: Examine key events and peoples in Florida history as they relate to United States history.
- Art: Use critical-thinking skills for various contexts to develop, refine, and reflect on a theme.

U.S. Fish & Wildlife Service

Lesson Title: Food Chain Lesson from the A.R.M. Loxahatchee NWR

Grade level: Grades Kindergarten and Up

Student Target Benchmark

SC.3.L.17.2 (Recognize that plants use energy from the sun, air, and water to make their own food.)

SC.4.L.17.2 (Explain that animals, including humans, cannot make their own food and that when animals eat plants or other animals, the energy stored in the food source is passed to them.)

SC.4.L.17.3 (Trace the flow of energy from the Sun as it is transferred along the food chain through the producers to the consumers.)

LAFS.3.RI.2.4 (Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area.)

LAFS.3.SL.1.2 (Determine the main ideas and supporting details of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.)

LAFS.3.SL.1.3 (Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.)

LAFS.3.SL.2.4 (Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.)

Lesson Objectives

After completing this activity, students will be able to:

1) Describe a simple food chain (A sequence of living organisms in an ecological community in which members of one level feed on those in the level below it and in turn are eaten by those in the level above them.)

2) Give an example of a simple food chain (clover->grasshoppers->frogs->snakes->hawks.)

3) Distinguish between Producers (plants—which use the sun's energy to produce food); Consumers (primary consumers—plant eating animals---secondary consumers—animals which eat the primary consumers, etc.), (or an organism that eats mostly flesh by catching other organisms or by eating particles or organic matter such as plants); and Decomposers (an organism that returns components of organic matter to ecological cycles by feeding on and breaking down dead plants and animals).

Materials for Pre & Post Lessons

- Vocabulary: food chain, producer, consumer, decomposer, photosynthesis, energy, humus, food web.
- Materials: pictures of animals and plants found on the Refuge, Observation sheet, Food Chain worksheet

Pre-visit Warm-up Lesson

(completed in classroom before visiting)

Overview: Food chains begin with plants that can make their own food through photosynthesis, using the sun's energy. Consumers in turn, eat these plants and then each other. The process continues until organisms break down the dead plants and animals at the top of the food chain by eating them. The latter, the decomposers, return it to the soil as humus. Humus contains nutrients that plants need to grow.

Background Information: Only plants can produce their own food with the help of the sun's energy. Plants are called producers, and they begin the food chain. Primary consumers are plant eating animals, and secondary consumers eat the primary consumers. Decomposers finish the cycle and return the dead materials to the soil. There can be many food chains happening at the same time so a food web displays these chains that are interconnected. Ask the students, using a KWL chart, what they know about how plants and animals depend on each other for what they eat. Using their answers, begin to explain the concepts of photosynthesis and food chains. (Photosynthesis—the process by which green plants convert carbon dioxide and water into simple sugar in the presence of chlorophyll).

Main Lesson

(completed during visit with Refuge educators)

Procedure/Activity: Review with the students that each plant or animal is connected in some way to other plants and animals. Show the students pictures of various plants and animals found on the Refuge. Divide the large group into smaller walk groups. Hand out the observation worksheet. After walking through one of the various habitats on the Refuge reassemble into a large group, but keep the smaller groups intact within the larger group. Hand out the Food Chain worksheet. Instruct each of the groups to come up with at least one food chain based on the plants and animals they either observed or saw pictures of in the Refuge.

Discussion:

Have the students in each group share their food chains with the larger group.

Post-visit Reflection Lesson

(completed in classroom after visiting)

- Have students add animal pictures to their food chains, cut them out and make mobiles from them.
- Have students investigate food chains from other habitats such as pine flatwoods or coastal communities.

Assessment

Review Objectives: Using the students' (corrected if necessary) food chain worksheets, have them label each plant/animal producer, consumer or decomposer.

Attachments

(Request from education department)

- Vocabulary List
- Organisms Graphic
- Food Chains of the Everglades Graphic
- Student Food Chains of the Everglades Graphic
- Food Web Graphic
- Observational Data Sheet

Chapter III: Water

- Math: Create equations that describe numbers or relationships
- ELA: I can analyze cause and effect relationships
- Science: I can analyze and explain the parts of the water cycle
- History/Civics: I can understand the judicial process as seen through a federal vs. state lawsuit
- Art: I can investigate the use of technology and other resources to inspire art-making decisions

Lesson Title: General Wetlands Lesson from the A.R.M. Loxahatchee NWR

Grade level: Grades 3 and Up

Student Target Benchmark

SC.3.L.14.1 (Describe structures in plants and their roles in food production, support, water and nutrient transport, and reproduction.)

SC.3.L.14.2 (Investigate and describe how plants respond to stimuli (heat, light, gravity), such as the way plant stems grow toward light and their roots grow downward in response to gravity.)

SC.4.N.1.2 (Compare the observations made by different groups using multiple tools and seek reasons to explain the differences across groups.)

LAFS.3.SL.1.1 (Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly.)

LAFS.3.SL.2.4 (Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.)

MAFS.3.MD.2.3 (Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs.)

Lesson Objectives

After completing this activity, students will be able to:

1) Define a wetland. (An area often flooded or soaked with water.)

2) Describe how wetlands are identified. (By the types of plants, trees, water in them.)

3) Explain the difference between a swamp and a marsh. (Swamp is forested, marsh has few trees.)

4) Identify why wetlands are important. (Fisheries, flood control, recreation, plants make up the bottom of the food chain, clean and remove chemicals from our drinking water.)

Materials for Pre & Post Lessons

- Vocabulary: Wetland, Marsh, Swamp, Food Chain, frequency, acre, nutrients, always/often
- Materials: Picture guide worksheets, clipboards, data worksheets, pencils, and binoculars.

Pre-visit Warm-up Lesson

(completed in classroom before visiting)

Overview: A little over 11 million acres of Florida are wetlands. They can be marshes, swamps, ponds, and wet prairies. Bodies of water, like rivers and lakes are not considered wetlands because they are always flooded. Florida contains 20% of all the remaining wetlands in the entire country. Plants have adapted or changed to grow in the wet/dry conditions found in a wetland.

Background Information: Using a large pad or whiteboard, the teacher will ask the students what they already know about wetlands and what wetlands do to keep our water clean, our habitat safe for fish, animals and plant life, and why that is important.

Main Lesson

(completed during visit with Refuge educators)

Procedure/Activity: Students will be split into small groups. Given clipboards, picture guide sheets, data sheets, and binoculars, students will walk through the Cypress Swamp or Marsh Trail. They will check off the presence and if possible, amounts of plant, animal or resource found. (Science, Mathematics)

Discussion:

After returning to the group area; students will choose a group spokesperson to report to the larger group on the results of their Wetlands Walk. Students will be asked to discuss how they chose to split up the activities necessary to work as a team in order to get and keep their data. (Spotters, Recorders.) Students will evaluate the success of their data collection and collaboration as part of their report.

Post-visit Reflection Lesson

(completed in classroom after visiting)

- Teachers can keep data sheets for students to graph and compare results. (Mathematics)
- Students can begin their own nature journals by classifying plants and animals that they saw and designing covers for their journals. (Science, Art)
- Students can build a food chain using the plants and animals observed on their walk. (Science)

Assessment

Review Objectives: Ask the students to review what plants and animals were predominate in the wetlands they observed. See if the students can describe the difference between a swamp and a marsh based on the animals and plants that they saw or heard about from the other students. With teacher prompts, if necessary, students can begin to answer the question of what functions wetlands serve for the animals and plants that they observed.

Attachments

(Request from education department)

- Vocabulary List
- Cypress Swamp Graphic
- Marsh Trail Graphic
- Data Collection Sheet

Lesson Title: KOE (Kissimmee-Okeechobee-Everglades) Lesson from the A.R.M. Loxahatchee NWR

Grade level: Grades 3 and Up

Student Target Benchmark

SC.4.E.6.3 (Recognize that humans need resources found on Earth and that these are either renewable or nonrenewable.)

SC.4.E.6.6 (Identify resources available in Florida (water, phosphate, oil, limestone, silicon, wind, and solar energy.)

SC.3.P.8.2 (Measure and compare the mass and volume of solids and liquids.)

CCSS.ELA.Literacy.5.RI.1 (Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.)

CCSS.ELA.Literacy.RI.6.2 (Determine a central idea of a text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments.)

CCSS.ELA.Literacy.RI.8.6 (Determine an author's point of view or purpose in a text and analyze how the author acknowledges and responds to conflicting evidence or viewpoints.)

CCSS.Math Content.6.NS.C.8 (Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.)

CCSS.Math Content.7.G.B.6 (Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.)

Lesson Objectives

After completing this activity, students will be able to:

1) List where the Everglades get its water. Describe the historical flow of water from the Kissimmee Chain of Lakes, Kissimmee River, through Lake Okeechobee and down to Florida Bay.

2) Name three other competitors for that water and to explain how water coming into the Everglades has been changed. Articulate some of the reasons why that flow has been interrupted (agriculture, development, population growth).

3) Explain why freshwater in South Florida is not an unlimited resource.

Materials for Pre & Post Lessons

- Vocabulary: Aquifer, limestone, Kissimmee Chain of Lakes, Lake Okeechobee, drought, periphyton.
- Materials: Chapter 1 - The Vital Essence from *Discover A Watershed: The Everglades* by South Florida Water Management District, Two large identical Sponges (preferably 8-10" long and 2" thick); Large container of water; Three pans to hold water; Two ID cards labeled, "Historic Everglades" and "Everglades Today"; Four ID cards labeled: "farmer," "developer," "population of South Florida," and "Everglades"; Masking tape; Map of South Florida; Piece of limestone or picture of limestone.

Pre-visit Warm-up Lesson

(completed in classroom before visiting)

Overview: The Everglades depends on water from rainfall and drainage from the Kissimmee River Basin and Lake Okeechobee. Before people settled in South Florida, the water that spilled over the lake's southern edge flowed southward through the Everglades. In the late 1800s, people began to build canals and levees to control this water flow for human needs. Now, the Everglades compete with humans for water.

Background Information

Have students read Chapter 1 - The Vital Essence from *Discover A Watershed: The Everglades* You may choose to have your students read individually or in teams. Or you may choose to read selected paragraphs from the chapter to the students. Have your students determine a central idea of a text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments.

Previous to the activity planned, explain to the students how the Everglades is supplied with water. Display the piece or picture of limestone for student observation, while explaining its water-bearing capabilities.

Use the map of South Florida to review the concept of the original water flow from the Kissimmee River Basin, to Lake Okeechobee, through the Everglades, into the Gulf of Mexico, and on to the coral reefs or Dry Tortugas. Compare this to the altered water flow due to humans. Using the map on page 14 of read Chapter 1 - The Vital Essence from *Discover A Watershed: The Everglades* by South Florida Water Management District have your students solve real-world and mathematical problems involving area, volume and surface area of the various water supply sources.

Main Lesson

(completed during visit with Refuge educators)

Procedure/Activity:

1. About a day or so before the activity, explain to your students how the Everglades are supplied with water. Display the piece of limestone for student observation, while explaining its water-bearing capabilities.

2. Use the map of south Florida to review original water flow from the Kissimmee Chain of Lakes to Lake Okeechobee to Florida Bay and the altered water flow due to man. Point out the four canals: West Palm Beach canal, Hillsboro canal, New River canal, and the Miami canal.

3. Appoint four volunteers to represent "the Everglades," "farming interests," "developers," and "the human population of South Florida."

4. Identify each volunteer with a label.

5. Immerse one sponge in one pan of water until it is saturated. Let it represent the original, unaltered Everglades in the wet season. Label that pan. It has received an uninterrupted flow of water. Ask the students where the water originates.

6. Ask the "Everglades" volunteer to squeeze the sponge over the pan to show how much water the Everglades can hold. Put the sponge back in the water.

7. Immerse the second sponge in a second pan of water until it is saturated.

8. Ask the students how the water flow has been changed by people and for what purposes water is diverted away from the Everglades. Tell students that they are going to take water from the Everglades, just as others do.

9. Let the "farmer" give one squeeze to the sponge, allowing some of the water to squeeze out into another pan. Pass the sponge to the "developer" and let him/her squeeze. What do they do with the water? They divert it, or drain it into the ocean to make the land dry enough for planting and developing.

10. Pass the sponge to the "population of south Florida" for a squeeze into another pan. What do people use the water for?

11. Let the "Everglades" give the last squeeze from the sponge into pan 2. The remaining water squeezed from the sponge into the second empty pan represents the water left for the Everglades after humans have diverted much of the water for their own use.

12. Compare the two pans of water. What is left for the Everglades?

Discussion:
Can the water be saved? Is there enough for everyone? What effect does reduced water have on Everglades plants and animals? Ask a student to read the last paragraph of Chapter 1 - The Vital Essence from *Discover A Watershed: The Everglades.* Hold a discussion on the concept of the last two sentences: "In the Everglades there is "water, water, everywhere…" but too many living things needing to 'drink' from the river. In this ecosystem, water is clearly the vital essence."

Post-visit Reflection Lesson
(completed in classroom after visiting)

- Have students investigate how to conserve water in their homes or school, and in their neighborhoods.
- Have students investigate what agencies in the State of Florida are charged with dealing with the current flow of water through the Everglades.
- Using the last paragraph of the first section of Chapter 1 - The Vital Essence from *Discover A Watershed: The Everglades*. On page 6 that begins with Florida is synonymous with…. have your students solve real-world and mathematical problems involving area, volume and surface area of the area mentioned in this paragraph.
- Using graph paper as a grid and the 1913 Phytogeographic Map of South Florida, have your students solve real-world and mathematical problems involving estimates of the surface area of each of the vegetative areas of the map.
- Using the section of Chapter 1 - The Vital Essence from *Discover A Watershed: The Everglades*. On page 10 called What's It Worth, have your students research current year totals for all the statistics listed in this section of the narrative. Have your students graph the statistics from 1996 (when this curriculum was published) and the current year and compare the changes. Discuss the changes.
- Hold a debate about current water issues related to the Everglades ecosystem.

Assessment
Review objectives from the beginning of the lesson. In writing or in discussion, have students demonstrate that they have met each objective.

Attachments
(Request from Refuge education department)

- Vocabulary list
- Chapter 1 - The Vital Essence from *Discover A Watershed: The Everglades* by South Florida Water Management District
- Map of 1913 Phytogeographic Map of South Florida
- Two large identical sponges
- Large container of water
- Three pans to hold water
- Masking tape
- Piece of limestone or a picture of limestone
- Map of the geologic story of South Florida
- Map of KOE system with major canals identified
- Placards for Historic Everglades, Everglades Today, Everglades, Farmer, Developer, Population of South Florida

Lesson Title: Adaptation Everywhere Lesson from the A.R.M. Loxahatchee NWR

Grade level: Grades 3 and Up

Student Target Benchmark
SC.5.L.15.1 (Describe how, when the environment changes, differences between individuals allow some plants and animals to survive and reproduce while others die or move to new locations)

SC.4.N.1.2 (Compare the observations made by different groups using multiple tools and seek reasons to explain the differences across groups)

SC.3.N.1.1 (Raise questions about the natural world, investigate them individually and in teams through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.)

SC.4.L.16.3 (Recognize that animal behaviors may be shaped by heredity and learning.)

SC.4.N.1.6 (Keep records that describe observations made, carefully distinguishing actual observations from ideas and inferences about the observations.)

LAFS.4.RI.2.4 (Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a grade 4 topic or subject area.)

LAFS.4.L.3.4 (Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 4 reading and content, choosing flexibly from a range of strategies.)

Lesson Objectives
After completing this activity, students will be able to:

1) Define and apply the terms adaptation, specialist, and generalist using examples of specific animals.

2) Use binoculars correctly.

3) Use field guides to identify organisms based on their observations.

4) Identify organisms correctly based on the descriptions of adaptations given by others.

Materials for Pre & Post Lessons
- Vocabulary: adaptation, amphibians, behavior, crustaceans, environment, habitat, hibernate, invertebrate, larvae, marsh, raptor, species, submerged vegetation, willow, coco plum, wax myrtle, pickerelweed, and duck potato.
- Copies of Student Page-"Adaptations Everywhere." Binoculars, magnifying glasses, field guides, clipboards, and pencils.

Pre-visit Warm-up Lesson
(completed in classroom before visiting)

Overview: An adaptation is defined as a trait or characteristic that helps a plant or animal survive in its habitat. An adaptation can relate to the behavior, anatomy, and/or physiology of an organism. Consequently, an adaptation could be viewed as a "tool" a plant or animal possesses that helps it survive and reproduce. The very fact that an adaptation helps an organism survive under certain environmental conditions means an adaptation is also a limitation. For example, a plant that is adapted to wet tropical conditions cannot survive in a desert. Specialists versus generalists: Some organisms are highly adapted to a specific environment while others are found in a variety of environments. An organism that is adapted to a specific and narrow set of conditions is considered a specialist. Other organisms are able to live in a variety of environments and are called generalists.

Background Information: Review the concept of Adaptations with the students. Consider these adaptations:

1) Birds that swim (ducks) often have webbed feet that they use as paddles in order to move through the water.

Raptors (hawks, eagles, falcons, accipiters, and owls) have strong feet and sharp talons to help them catch and kill prey.

Plants can also adapt to a particular environment. Cypress trees spend 3/4 of the year in water. Therefore, the buttress base stabilizes this tree. Wax myrtle trees give off a fragrance that native Americans said kept mosquitoes away.

Discuss the difference between specialists and generalists using the following examples of raptors found on the Refuge. Example of a specialist: The snail kite lives in freshwater marshes in warm climates. Its diet is almost exclusively apple snails (genus Pomacea). The kite's curved beak is pointed, which is used to extract the snail from its shell. Apple snails are most abundant in alkaline (basic) waters that have a good supply of submerged vegetation and dissolved oxygen.

Example of a generalist: The red-tailed hawk is found in almost all of North America. The red-tailed hawk has a wide tolerance for different habitats. Its diet includes birds, reptiles, amphibians, invertebrates, and small mammals.

Main Lesson
(completed during visit with Refuge educators)

Procedure/Activity: Students will be divided into teams of two. They will be given a worksheet, binoculars, and magnifying glasses. Provide each pair with a field guide appropriate for what they will be able to observe with their observation tool.

Explain to the students that they will be taking turns observing and recording. The student with the binoculars, or magnifying glass should locate a particular animal/plant with their observation tool. The observer should then describe the behavior and appearance of their animal/plant to their partner while their partner

records the information. For example, if they are describing a mallard, they might tell their partner that the animal is swimming in the water, has feathers on its body, webbed feet, a green head, etc. The observer should make at least five observations (see "Adaptations Everywhere" worksheet). When the observer thinks he/she has sufficiently described the animal/plant (or the animal has moved away), the observer and recorder should read through the descriptions and discuss why they think the listed aspects of appearance and behavior help an animal/plant survive. For example, a mallard's webbed feet help it to swim.

Older students may take this farther and explain that the webbed feet that help mallards swim also allow them to find food because their swimming ability gets them in another habitat type. Having discussed the animal's/plant's adaptations, they can use what they have learned to try to identify the species using a field guide. If they identify it, they can write their answer in the margin of the Student Page.

Discussion: Bring the pairs back together into the larger group. Have each team describe to the group the adaptations of one of the animals/plants they observed. The other students should try to guess the animal or plant from the descriptions of its adaptations.

Post-visit Reflection Lesson
(completed in classroom after visiting)

- Have students "design" a creature that is perfectly adapted for a certain habitat or is adapted to live in many different habitats. The creature could be a mammal, bird, fish, plant, insect, amphibian, reptile, or a new "type" of organism. Have them draw the creature or build a model of it.
- Describe the behavior and appearance of different animals to the students. Ask them to try to describe the characteristics of the habitat in which the animal lives. How is the animal adapted to that habitat?
- Have students write their own definition of the term adaptation and give examples of adaptations (animal or plant) that they have seen on the Refuge.
- Point out an animal to the students. Have them make basic observations about the animal and identify it using their field guides.

Assessment
Review Objectives from the beginning of the Lesson.

Attachments
(Request from Refuge education department)

- Vocabulary List
- Adaptations Everywhere page
- Adaptations Graphic
- Bird Adaptations Graphic

Chapter IV: Everglades Ecosystem

- Math: I can classify objects and create data about the objects within classifications.
- ELA: I can construct definitions and classifications through the use of figurative and descriptive language and explain how these strategies impact meaning.
- Science: Compare and contrast adaptations displayed by animals and plants that enable them to survive in different environments such as life cycles variations, animal behaviors and physical characteristics.
- History/Civics: I can analyze environmental impacts due to political, economic, and social changes.
- Art: Identify objects from everyday life that have been designed and created using artistic skills.

Lesson Title: Alligator Hole Ecodrama Lesson from the A.R.M. Loxahatchee NWR — Adapted from Everglades National Park Educator Materials

Grade level: Grades 2 and Up

Student Target Benchmark
SC.3.L.15.1 (Classify animals into major groups [mammals, birds, reptiles, amphibians, fish, arthropods, vertebrates and invertebrates, those having live births and those which lay eggs] according to their physical characteristics and behaviors.)

SC.5.E.7.5 (Recognize that some of the weather-related differences, such as temperature and humidity, are found among different environments, such as swamps, deserts, and mountains.)

SC.4.L.17.4 (Recognize ways plants and animals, including humans, can impact the environment.)

LAFS.5.SL.1.1 (Engage effectively in a range of collaborative discussions [one-on-one, in groups, and teacher-led] with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.)

TH.5.S.2.1 (Collaborate with others to create productions and solve challenges.)

DA.5.O.3.1 (Practice movements, steps, pantomime, and gestures as a means of communicating ideas or intent without using words.)

Lesson Objectives
After completing this activity, students will be able to:

1) Describe the wet/dry season of the Everglades/South Florida (more/less rain, dates).

2) Explain why alligators dig a "gator hole" during the dry season (need for water).

3) Explain why the alligator is sometimes called the "Keeper of the Everglades" (provides water for other animals).

Materials for Pre & Post Lessons

- Vocabulary: habitat, interrelationships, wet/dry season, adaptations, hydrology, symbiosis, mutualism, commensalism, and parasitism.
- Materials: cards illustrating Alligator, Fish, Birds, Snake, Frog, Otter, Bobcat, Deer.

Pre-visit Warm-up Lesson
(completed in classroom before visiting)

Overview: There are two hydrological seasons in South Florida: the wet and the dry season. During the wet season (May-November) rain falls almost every day and the surface water levels rise. Wildlife is found throughout the Everglades. During the dry season (December-April), there is less rain and the surface water levels fall. Wildlife becomes concentrated in areas where water remains.

Background Information: Alligator holes become one of the few remaining wet habitats for wildlife to use during the dry season. Alligators like all living things, need water to survive. The alligators powerful tail, jaws, and feet are used to keep a pool of water open throughout the dry season. Wildlife gathers at these "gator holes." The alligator will consume (eat) some of the animals while the remaining animals have gotten the water they need. An alligator hole is an example of an interrelationship. Introduce the concepts of Symbiosis—a relationship of mutual benefit or dependence. Mutualism—both organisms benefit. Commensalism—one organism benefits and the other is not affected in any manner. Parasitism—one organism benefits and the other is harmed.

Main Lesson
(completed during visit with Refuge educators)

Procedure/Activity: 1) Choose a volunteer to be the alligator. Assign about one third of the group to be fish and another one third to be birds. The remaining one third should include a snake, a frog, an otter, a deer, a bobcat and a panther. (Note: Some duplicate cards will need to be made to reach the number of cards required for the activity.) (Note: panthers have not been seen on the Arthur R. Marshall Loxahatchee National Wildlife Refuge in recent years but were historically found here.)

2) Ask the students to act out the following: During the dry season a huge alligator digs a hole to hold water using his/her strong tail and legs. She uproots grass and excavates mud, slashing with her powerful tail, digging with her legs, and carrying away debris in her mouth. The alligator continues to work on her hole while she lives there, deepening it, widening it and keeping it free of debris. Gator holes are often the only source of water for wildlife during the dry season. The first to seek out the water are fish who swim their way to the gator hole (FISH SWIM IN). The fish are happy now that they have found water, even though it is smaller and a gator is near. Although the alligator will eat some of the fish (have gator tag one or two who will die), it is their only hope for survival. Next the BIRDS FLY to the gator hole. Here they find fish to eat (choose a bird to eat a fish). REPTILES such as snakes, and AMPHIBIANS like frogs slither, hop, and swim to the gator hole. Finally, MAMMALS seek out the freshwater provided by the gator hole: otters slide in to drink and fish, deer eat grass nearby and come for a drink, bobcat and maybe even a lone panther hides in ambush nearby in search of a meal and then a visit to the gator hole for a drink. Now EVERYONE is in the gator hole. What does the alligator provide for wildlife? (Water) What does the wildlife provide for the gator? (Food)

Discussion:
Reassemble the groups of students. Ask the students why the alligator is called the "Keeper of the Everglades." Ask how this is an inter-relationship. Ask the students to explain why certain fish, bird, or frogs got eaten. (Too close to the predator, away from the pack, etc.) Can this be extrapolated into the real Everglades habitat? Ask why the Florida panther might not be seen in the Refuge in present day. Discuss how the concepts of symbiosis function in the gator hole.

Post-visit Reflection Lesson
(completed in classroom after visiting)

- Have students discuss the characteristics of Birds, Fish, Reptiles, Mammals and Amphibians. Then have them choose from picture cards or a list of specific animals. Let them identify which animal be-longs in which group.
- Have the students make food webs using at least one of the animals in the narrative game.

Assessment
Ask the students how the seasons of rain and dry are connected with an alligator digging an alligator hole. What does the name "Keeper of the Everglades" refer to?

Attachments
(Request from Refuge education department)

- Vocabulary List
- Cards illustrating Alligator, Fish, Birds, Snake, Frog, Otter, Bobcat, Deer

Lesson Title: Butterfly Watch Lesson from the A.R.M. Loxahatchee NWR

Grade level: Grades 2 and Up

Student Target Benchmark
SC.2.L.17.1 (Compare and contrast the basic needs that all living things, including humans, have for survival.)

SC.2.L.17.2 (Recognize and explain that living things are found all over Earth, but each is only able to live in habitats that meet its basic needs.)

SC.2.L.16.1 (Observe and describe major stages in the life cycles of plants and animals, including birds and butterflies.)

SC.4.L.17.2 (Explain that animals, including humans, cannot make their own food and that when animals eat plants or other animals, the energy stored in the food source is passed to them.)

LAFS.3.RI.2.4 (Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area.)

MAFS.3.MD.2.3 (Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs.)

VA.3.S.2.In.a (Follow sequential procedures and techniques to achieve an artistic goal.)

VA.3.S.2.Su.a (Use a variety of visual art tools and media.)

Lesson Objectives
After completing this activity, students will be able to:

1) List the body parts of a butterfly and the sequence of their life cycle.

2) Observe and take data on at least one butterfly and their food plants in the field.

3) Draw and accurately color the wing pattern of their assigned butterfly.

Materials for Pre & Post Lessons
- **Vocabulary:** habitat, food chain, pollinate, prey, life cycle, egg, larvae, caterpillar, chrysalis, wing, nectar.
- **Materials:** Pictures of the anatomy of the adult butterfly. Pictures of the life cycle stages of a butterfly. Pictures of various species of butterflies that will be studied in the field. Data sheets for recording data, pencils, and clipboards. (Students are not permitted to net butterflies on a USFWS Refuge. They will need to identify the butterfly by observation alone).

Pre-visit Warm-up Lesson
(completed in classroom before visiting)

Overview: Butterflies are extremely important for many reasons. They are an indicator species as to the health of an ecosystem. They are prey food for many birds, bats, and other animals making them a vital part of the food chain. They have aesthetic value contributing to the enjoyment and health of people. Butterflies have an economic role to play in terms of nature tourism and the pollination of our food supply.

Background Information: Students will be asked to share what they already know about butterflies. Teacher will use the KWL method to list what the students say. Teacher will pass out the Butterfly Life Cycle Sheet and pictures of the Anatomy of the Butterfly and have the students compare it with the information they already have on the KWL chart.

Main Lesson
(completed during visit with Refuge educators)

Procedure/Activity: Proceed to one of the Refuge Butterfly Gardens and divide the students into groups. Hand out the butterfly pictures, data sheets, clipboards, and pencils. Instruct the students on which data to collect. Some possibilities include the number of their butterfly seen or the number of different types of plants their butterfly stops to feed on. Students can identify the plants by the signs near them in the garden. If they are not labeled, students can sketch and describe them. Instruct the students to make a sketch of their butterfly and note the colors and wing patterns.

Review the following rules with the students before beginning the activity: Stay on the trails. Do not wildly chase the butterflies. Be careful of the plants and the other students. Do not touch the butterflies. After a specific period of time; bring the students together in one large group.

Discussion: Once students are again together in a large group, have them report their results for the type of data they collected. Ask what their experience in the field was including the ease or difficulty in collecting data and completing their sketch on the clipboard.

Post-visit Reflection Lesson
(completed in classroom after visiting)

- Students can transcribe their data onto clean data sheets and draw bar graphs comparing their data collection results with another student.
- Students can draw their butterfly wing pattern and color from memory and include it in their ongoing nature journals.
- Students can use a different art medium such as paints or pastels to draw their butterfly wing patterns.

Assessment
Review Objectives: Ask the students to review with the proper terminology and sequence the life cycle of the butterfly. Review the parts of the adult butterfly. Have them turn in their field sheets for review which should include both data requested and a sketch of the color and wing pattern of their assigned butterfly.

Attachments
(Request from Refuge education department)

- Vocabulary List
- Life Cycle of a Butterfly Sheet
- Butterfly Anatomy Sheet
- Butterfly Field Journal/Data Sheet
- Butterfly and Wildflower guides

Lesson Title: Lichens Lesson from the A.R.M. Loxahatchee NWR (Adapted from The Schoolyard Wildlife Activity Guide)

Grade level: Grades 3 and Up

Student Target Benchmark

SC.3.L.17.2 (Recognize that plants use energy from the Sun, air, and water to make their own food.)

SC.4.L.17.2 (Explain that animals, including humans, cannot make their own food and that when animals eat plants or other animals, the energy stored in the food source is passed to them.)

SC.5.N.1.6 (Recognize and explain the difference between personal opinion/ interpretation and verified observation.)

MAFS.5.MD.2 (Represent and interpret data.)

LAFS.5.RI.3.7 (Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.)

LAFS.5.RI.3.9 (Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.)

Lesson Objectives

After completing this activity, students will be able to:

1) Define the two organisms that make up a lichen.

2) Identify the three major lichens found in the Cypress Swamp, (Crustose—crusty, Fruticose—shrubby, and Foliose—leafy)

3) Identify the relationship that algae and fungi, as lichens, have with each other (mutualism—they benefit each other)

4) Identify and classify the environmental conditions that foster the growth of lichens

Materials for Pre & Post Lessons

- Vocabulary: algae, fungus, lichen, crustose, fruticose, foliose, mutualism, parasitism, commensalism.
- Materials: hand lenses, clipboards, pictures of typical foliose, crustose and fruticose lichens on worksheets, lichen field journal/data sheet, symbiotic relationship sheet

Pre-visit Warm-up Lesson

(completed in classroom before visiting)

Overview: Lichens can grow in a variety of different environmental conditions and on a wide range of living and non-living surfaces. They are most commonly found growing on rocks or wood. Many lichens are found in shady, moist areas, but most prefer lots of sunlight and moderate amounts of moisture. Although lichens can withstand a variety of extreme environmental conditions, leafy and shrubby lichens are very sensitive to pollution; especially sulfur dioxide from car exhaust and smoke. Hence, the number of lichens near a street is usually less than the number of lichens in less polluted areas.

Background Information: Lichen is really a combination of two different kinds of organisms living together. Lichens are composed of both fungi and algae and both types of organisms benefit from the presence of the other (mutualism). (To contrast the relationship of mutualism, give examples of both parasitism and commensalism). Fungi benefits from getting food from the algae. An alga, as a plant, synthesizes its sugars through photosynthesis. In turn, the algae get protection from the weather and a safer environment to grow in.

Main Lesson

(completed during visit with Refuge staff)

Procedure/Activity: Divide the students up into small groups. Give them the materials and review the worksheets. Have them note how many different types of lichens they can find. Remind students not to touch the lichens or remove them from the surfaces in which they find them. Have the groups go into at least two habitats in the Refuge.

Discussion: Have each group share their results with the larger group. Use the following questions to tabulate the results of the groups. What kinds of surfaces did the lichens appear to grow on? Did they grow on living or non-living surfaces? Did they seem to grow more in sunlight or in shade. Were they growing near to the ground or away from the ground. Did the lichens seem to grow more in moist areas or dry areas? How many different colors of lichens were found? What was the most common type? Was there a difference in the amount of lichens found near the road or parking lot and the amount of lichens found in more secluded areas?

Post-visit Reflection Lesson

(completed in classroom after visiting)

- Have the students graph the results of their lichen stroll using the data from their worksheets.
- Have students investigate if other habitats; such as pine flatwoods, their schoolyard, or coastal environments contain as many lichens and types of lichens as the same size as defined area they walked through at the Refuge.

Assessment

Review objectives from the beginning of the lesson. In writing or in discussion, or using lesson materials, have students demonstrate that they have met each objective.

Attachments

(Request from Refuge education department)

- Vocabulary List
- Pictures of Foliose, Crustose, Fruticose lichen
- Lichen field journal/data sheet
- Symbiotic relationship sheet

Lesson Title: Butterfly Habitat Lesson from the A.R.M. Loxahatchee NWR

Grade level: Grades 2 and Up

Student Target Benchmark

SC.2.L.16.1 (Observe and describe major stages in the life cycles of plants and animals, including beans and butterflies.)

SC.4.L.17.2 (Explain that animals, including humans, cannot make their own food and that when animals eat plants or other animals, the energy stored in the food source is passed to them.)

SC.3.L.15.Su.1 (Sort common animals by observable characteristics.)

SC.3.N.1.1 (Raise questions about the natural world, investigate them individually and in teams through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.)

LAFS.3.RI.2.4 (Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area.)

LAFS.3.SL.2.4 (Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.)

Lesson Objectives

After completing this activity, students will be able to:

1) List the body parts of a butterfly and the sequence of their life cycle. (Eggs, Larvae, Caterpillar, Chrysalis, Pupa, Proboscis, Emergence)

2) Define the word habitat. (A place in which individuals of a particular species can usually be found. A habitat contains all the things that are needed to survive)

3) List 3 things that make good butterfly habitat.

a. Lots of flowers

b. Other butterflies to mate with

c. Plants to lay their eggs on

4) List at least 2 reasons why butterflies are important and why it would be necessary to keep their habitats from being degraded. (Health value—enjoyment, physical exercise, economic value—tourism, ecosystem value—part of the food chain, prey for birds, indicators of a healthy environment, educational, migration.)

Materials for Pre & Post Lessons

- Vocabulary: habitat, eggs, larvae, caterpillar, pupa, chrysalis, proboscis, emergence.
- Materials: Butterfly Life Cycle sheet, Butterfly Anatomy Sheet, pictures of various different habitats, clipboards, pencils and paper, butterfly and wildflower identification guides.

Pre-visit Warm-up Lesson

(completed in classroom before visiting)

Overview: All living things need a place to live where they have water, shelter, food, the right climate and the ability to mate/reproduce. This is a habitat. Using butterflies, we can illustrate to students the importance of habitat and habitat maintenance.

Background Information: Using the KWL model, have the students share what they know about butterflies in general and their life cycle. After passing out both the Butterfly Life Cycle sheet and Butterfly Anatomy sheet return to the KWL chart to revise, if necessary. Discuss with the students the meaning of the word habitat. Compare different habitats and animals and discuss what their same and differing needs might be.

Main Lesson

(completed during visit with Refuge educators)

Procedure/Activity: Split the large group in at least three smaller groups. Explain to the students that they will be going to three different habitats (Marsh, Butterfly Garden, and Cypress Swamp). Ask students to note if any of these habitats would be considered prime butterfly habitats and if so, why. Students can be given clipboards, pencils and a worksheet along with butterfly identification guides to identify any butterflies that they come across.

Discussion: Have the small groups join together into one large group. Ask the students to share their field notes and findings. See if there was any difference in the richness of the different habitats in terms of the amount of butterflies seen in each area. If so, elicit ideas from the students as to why the differences may be found.

Post-visit Reflection Lesson

(completed in classroom after visiting)

- Contrast and compare the parts of a butterfly's body with those of a spider.
- Contrast and compare butterfly characteristics with those of a moth.
- Research the difference between a chrysalis and a cocoon.

Assessment

Review Objectives: Have the students fill out blank review sheets for butterfly body parts and life cycle. After participating in the activity, see if the students can come up with any new reasons for the importance of butterflies. Compare other animals and their habitat needs to butterflies.

Attachments

(Request from Refuge education department)

- Vocabulary List
- Life Cycle of a Butterfly Sheet
- Butterfly Anatomy Sheet
- Refuge Habitat Picture Sheet
- Butterfly and Wildflower Guides

Lesson Title: Cypress Swamp Lesson from the A.R.M. Loxahatchee NWR

Grade level: Grades 3 and Up

Student Target Benchmark

SC.5.L.17.1 (Compare and contrast adaptations displayed by animals and plants that enable them to survive in different environments such as life cycle variations, animal behaviors, and physical characteristics.)

LAFS.5.RI.3.7 (Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.)

LAFS.5.RI.3.9 (Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.)

LAFS.5.SL.2.4 (Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.)

VA.5.H.3 (Enduring Understanding 3: Connections among the arts and other disciplines strengthen learning and the ability to transfer knowledge and skills to and from other fields.)

Lesson Objectives

After completing this activity, students will be able to:

1) Describe what type of wetland a Cypress Swamp is. (forested).

2) Name the parts of a swamp/forest. (Canopy, Emergent, Swamp Floor, Understory).

3) Describe what kind adaptations the plants and animals have needed to make to live in the habitat of the cypress swamp. (The Swamp is a cool, shady, moist environment).

4) Name at least 2 types of trees and plants found in the Cypress Swamp. (ferns, air plants aka epiphytes, bromeliads, cypress trees, willows, etc.).

5) Name at least 2 types of animals found in the Cypress Swamp (bobcat, woodpeckers, owls, snakes, anoles).

6) Place different animals and plants in the area of the Cypress Swamp where they would most likely be found.

Materials for Pre & Post Lessons

- **Vocabulary:** wetland, swamp, marsh, forest, cypress, canopy, understory, shrub layer, forest floor, ferns, habitat, air plants, epiphytes, bromeliads, willow, adaptations.

- **Materials:** Plant/Animal Cypress Swamp Sheet, Observational Data Sheet, map of South Florida, Cypress Swamp Diagram Sheet, and one large poster of the layers, photos of 10-12 different animals and plants of the Cypress Swamp, binoculars, clipboards, pencils.

Pre-visit Warm-up Lesson

(completed in classroom before visiting)

Overview: At one time a huge strand of cypress swamp stood on the eastern edge of the Everglades extending from Lake Okeechobee south to Ft. Lauderdale. All that remains of this strand in Palm Beach County is a 400 acre stand in the Arthur R. Marshall Loxahatchee National Wildlife Refuge.

Background Information: Explain to the students the original extension of the cypress swamp. Ask the students what factors most likely led to the swamp being cut down. Review the parts of the swamp and the animals/plants most likely to be found there.

Main Lesson

(completed during visit with Refuge educators)

Procedure/Activity: Divide the large group of students into three small groups. Have each group of students walk to one of the three large areas on the boardwalk of the cypress swamp. Instruct the students to participate in 3 minutes of silence. Ask them to look and listen. Taking their Cypress Swamp sheet, make notes of how many plants/animals they can see which correspond to their worksheet. Ask if there are any questions. After the silent observation, have students share back some examples. Begin to point out plants/animals in the immediate area. Next have the students take out their forest division (Cypress Swamp Diagram) worksheet. Ask them to match the plants that they are now familiar with to the division on the worksheet.

Discussion:

Either in small groups or when the groups come together, have the students list as many descriptors as they can (dark, moist, smelly, etc.) to describe the Cypress Swamp.

Post-visit Reflection Lesson

(completed in classroom after visiting)

- Have the students further research a plant or animal they saw in the Cypress Swamp and present the information to the class as a whole.

- Have the students collect pictures of a plant or animal they observed in the Cypress Swamp. Make a class collage or have them begin a nature journal with the pictures.

Assessment

Review objectives from the beginning of the lesson. In writing or in discussion, or using lesson materials, have students demonstrate that they have met each objective.

Attachments

(Request from Refuge education department)

- Vocabulary List
- Plant/Animal Cypress Swamp Graphic Sheet
- Observational Data Sheet
- Map of South Florida
- Cypress Swamp Diagram Sheet

U.S. Fish & Wildlife Service

Chapter V:
Endangered Species

- Math: I can reason quantitatively and use units to solve problems.

- ELA: I can organize, synthesize, analyze, and evaluate the validity and reliability of information from multiple sources (including primary and secondary sources) to draw conclusions using a variety of techniques, and correctly used standardized citations.

- Science: Define a problem, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphs, analyze information, make predictions, and defend conclusions.

- History/Civics: I can identify ways citizens can make a positive contribution in their community.

- Art: Research and report technological developments to identify influences on society.

Chapter VI:
Exotics Invading South Florida and ARM Loxahatchee NWR

- Math: I can make inferences and justify conclusions from sample surveys, experiments, and observational studies.

- ELA: I can present claims and findings by sequencing ideas logically in a focused and coherent manner using pertinent descriptions, facts, and details to accentuate the main idea. I will use appropriate eye contact, adequate volume, and clear pronunciation.

- Science: Describe how, when the environment changes, differences between individuals allow some plants and animals to survive and reproduce while others die or move to new locations.

- History/Civics: Analyze the effects of transportation, trade, communication, science, and technology on the preservation and diffusion of culture.

- Art: Apply the critical-thinking and problem-solving skills used in various medium of art to develop creative solutions for real-life issues.

Chapter VII:
Human Connection

- Math: Use probability to evaluate outcomes of decisions.

- ELA: I can integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a question or solve a problem.

- Science: Identify and investigate the general functions of the major systems of the human body (digestive, respiratory, circulatory, reproductive, excretory, immune, nervous, and musculoskeletal) and describe ways these systems interact with each other to maintain homeostasis.

- History/Civics: I can identify group and individual actions of citizens that demonstrate civility, cooperation, volunteerism, and other civic virtues.

- Art: Create personally meaningful works of art to document and explain ideas about local and global communities.