Mangroves Mosquitoes and Man

by

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Marine Education

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D. Supplemental Information on the CD-ROM supplement to the curriculum

The Johnson Marine Education Center' has invested $3500 in the computer hardware and software including a Motorola Starmax 4000 computer (Macintosh clone) with 406e processor at 200Mhz and 2.5 gigabit Hard Drive; a 8x CD-ROM drive, 32 megabytes of Video Memory, 16-bit stereo playback, a10 base-T network adapter, a Sony Trinitron Multiscan 100SX Monitor and a Iomega Zip Drive. Software packages are Macromedia Director 5.0 and Adobe Photoshop 4.0.

CD-ROM products are appealing, engaging, fun to use and are better suited to the relatively short attention span of many students than textbooks and stand alone video. This type of multimedia can be easily structured to break information into short segments, requiring interactive attention by the user between sections. The medium also allows material to be organized in a hierarchical way that allows students to proceed at their own pace and explore topics that most interest them. In addition, students who learn via multiple sensory channels have been shown to retain more information for longer time periods. Finally, because students typically can move through the programs relatively independently and 'in-depth' material can be included for advanced students, so that teachers can be more effective.

In the "Indian River Jones" game, the layout is linear and builds upon itself with 3 progressive levels of involvement: an information gathering phase, an 'interview' phase and a decision making phase... This structure gives the student background information and skills before moving on to a more challenging level where players make decisions about management practices for a mosquito impoundment. Active involvement by the student will be required to maneuver through the game. At some points a tentative ear and eye are all that are required, while other sections require the use of a mouse and/or keyboard.

The first level provides basic facts about the Indian River Lagoon region including history, biology, geography, climate, and ecology and will be closely linked to the Mangrove, Mosquitoes and Man printed curriculum materials. In the second and third levels, "Indian River Jones' (and the student) conducts personal interviews with experts in the field and the game flows into a "choose your own adventure" section at the end. These interviews include telephone calls, on-site tours and informal meetings. People from many walks of life are interviewed (i.e. a person remembering times past, a recreation director, a building contractor, an environmental scientist, and a mosquito control director). Interviewees have a diversity of viewpoints about the IRL and how it should be managed. The final adventure module allows the student to choose from a range of management options and see the results of various decisions.

The CD-ROM includes sounds, descriptions, and visual images of the Indian River Lagoon. Images have been drawn from video obtained in 1996 with IRL license plate funding, digitized photographs from scientists who have worked in mangrove habitats (ie. Dr. Jorge Rey at the Florida Medical Entomology Laboratory) and still photographs from the HBOI Photography Department. Maps of impoundments and mangrove habitat along the shores of the Indian River lagoon in St. Lucie County are also included.

In the late summer and fall of 1997, the game will be reviewed by scientists and managers to eliminate factual or conceptual inaccuracies. Reviewers will be Dr. Jorge Rey (UF Medical Entomology Laboratory), Dr. Grant Gilmore (HBOI) and Mr. Jim David of the St. Lucie County Mosquito Control District.

This classroom resource will complement material in the Living Lagoon CD-ROM produced by HBOI's Multi-media Department in 1996. The Living Lagoon differs from the game in that it is aimed at the public and allows the user to view seven different topics about the Indian River Lagoon in any order.

The primary advantage of the game is that it allows teachers to be more efficient in their use of classroom time and more effective at reaching both ends of the student ability spectrum. Students who are working below grade-level in reading and quantitative skills (such as map reading) can 'play the game' with enthusiasm and interest while at the same time improving their language, problem solving and computer skills in a non-threatening environment. At the other end of the spectrum, students who are working above grade level can be assigned challenging, independent work that takes advantage of advanced features nested within the hierarchy of the product. This advanced exploration can occur while the teacher is focusing on fundamental concepts and skills with the rest of the class.

Acknowledgments

This project could not have been accomplished without the cooperation and effort of many individuals. Research and material for the background information was provided by Julie Lambert (Harbor Branch Summer Intern), Janet Merkt (Marine Resources Council), Jim David and David Mook (St. Lucie County Mosquito Control Commission). A special thanks to the expert knowledge of David Mook and Diane Barile (Marine Resources Council) for their editing for factual validity.

The support and patience of the classroom teachers allowing me to come into their classrooms once a week to try out the activities with their children was invaluable. These same teachers have helped in making the curriculum more "teacher friendly" with their comments and suggestions. The participating teachers and schools are: C.A. Moore Elementary - Mary Mosley, Principal; Marge Armstrong, Becky Contois, Carol Wetherington, Traci Jacobson, and from Fairlawn Elementary - Genelle Yost, Principal; Madeline Bell, Kerri Clark, Pat Priest, Ellie Baker, and Belinda Buckley. As an addition to the grant, the curriculum was also tested in Lawnwood Elementary - Michael Hitsman, Principal; Diane Young and Christine Berger. The same thanks to the nearly 250 students who were in the test classes.

The field trips were a highlight of the year with the kids. David Mook helped in making the first trip to the impoundment a memorable one. The second optional field trip was to Harbor Branch where students were a part of a mangrove replanting project administered through the Environmental Learning Center in Vero Beach. Thanks to Camile Sewell for all the materials and help.

Throughout the project I received much encouragement from Dr. Susan Cook, Director of Education, Harbor Branch Oceanographic and especially from my family, David and Dee Dee Vaughan.

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MANGROVES, MOSQUITOES AND MAN

Harbor Branch Oceanographic Institution, in partnership with the St. Lucie County Mosquito Commission, St. Lucie County Schools and the Marine Resource Council, is developing an innovative 4th grade program on Mangroves, Mosquitoes and Man. Students will be introduced to the Indian River Lagoon as a system. Using mosquito impoundments as their living laboratory, they will learn to look at all aspects of an issue and defend the issue as an informed decision maker. The goal of the program is not only to teach them about an environment close to home, but to see how this environment fits into their everyday lives as well as historically into the lives of others. This will set the foundation for them to be informed future voters who will be deciding the future of the environment in which they live.

UNIT I

Students will be introduced to the curriculum and the investigation techniques used by scientists. They will begin their mission of determining the best management practices for the existing mosquito impoundments along the Indian River Lagoon.

UNIT II

Students will focus their study of the Indian River Lagoon and Mosquito impoundments. After visiting an impoundment and becoming aware of how impoundments work, students will begin to look at the Indian River Lagoon as a system. They will see how all aspects of the system fit together and how man's presence has had major impacts on the Lagoon.

UNIT III

Students will focus their study on mosquitoes. Through the study of mosquitoes, students will begin to see how such a tiny animal can have such a profound effect on a large system. They will see the importance of mosquito control for Florida.

UNIT IV

Students will use their knowledge of the Indian River Lagoon ecosystem, the "players" who have an interest in the Lagoon, mosquito biology and impoundments to decide what should be done with mosquito impoundments.

Tips on Using the Curriculum

This curriculum is meant to be used in addition to your regular classroom materials. It has many activities which can be worked into math, writing (Florida Writes activities included), Florida History, and art. As such, it does not have to be taught in the order presented. Fit the activities in where most useful.

* This curriculum was written to be used in a 4th Grade classroom or above. You will want to read through the information before using it in your classroom. You may find that you need to scale up or down, depending on the group of students.

* The use of overheads for the Masters is very useful.

* You may find the vocabulary lists difficult for some students. You are encouraged to use the correct terminology with the students, however do not get them confused with too much at a time.

* Many of the activities are to be done in small groups. You may find it useful to do these activities as a whole group with you directing the class. This is particularly true if your group does not have many good readers.

* Try to get at least one other classroom in the school involved in the curriculum. The more opinions you can generate, the more the students get from it.

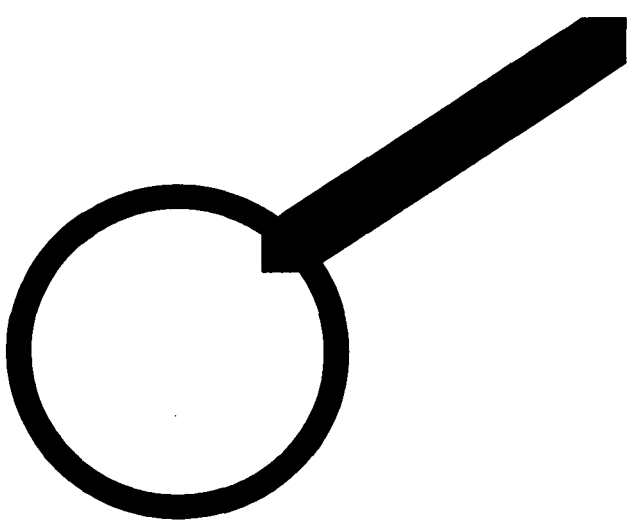
* Do not be afraid to call on some local experts to come to your classroom. The Mosquito Commission and Harbor Branch have several people willing to come and do presentations. These people are a great resource to you and your students.

* Most of all, have fun with it. The more you enjoy teaching the material, the more your students will enjoy learning it.

MANGROVES, MOSQUITOES, AND MAN

UNIT 1

Investigation Techniques



UNIT 1

Investigation Techniques

Unit 1 introduces the student to the process of arriving at an informed environmental decision. This unit sets the stage for students to become detectives looking for some possible answers in an environmental investigation. The lessons in this introductory unit are the foundation of the techniques used throughout the curriculum. Students will begin to see scientists as individuals who are constantly asking questions and seeking ways to find answers to these questions. The investigative activities will take them out of the classroom and into the field. They will begin to observe their environment and ask questions such as I wonder why or what would happen if?

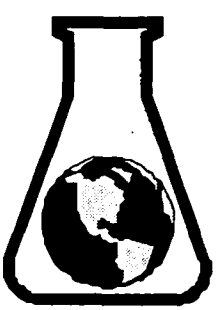
Students will begin to look at things in relation to their world as well as the entire world around them. They will begin to see that they must investigate as many considerations as possible before making a decision that will impact the environment. Students will be introduced to the Indian River Lagoon. They will take this knowlege into the field on their first field trip.

At the conclusion of Unit 1, students will be ready to begin their investigation into the Indian River Lagoon, mosquitoes and the future of the Mosquito Impoundments in St. Lucie County.

1.1 Introduction to the Curriculum

Background Information

The Indian River Lagoon extends 140 miles and through 5 counties along the east coast of Florida. It is a unique and delicate **ecosystem** which supports more **species** and a wider range of species than any other **estuary** in North America. It is an important resource to ever increasing numbers of people: from the water skier, **recreational** and **commercial fisher** and **field biologist** to the **land developer**, motel owner, and curious child. Along the length of the Lagoon, much of the shoreline has been **altered** by man's **intervention**. One of these changes has occurred in much of the wetland areas which support huge breeding populations of salt-water mosquitoes. These mosquitoes need mud shorelines to lay their eggs. When these shorelines are flooded, the eggs hatch and the mosquito lives out its **life cycle**. As an alternative to **pesticides** and chemicals many of these areas have been altered from natural wetlands to **mosquito impoundments**. These wetland areas have been enclosed with **earthen dikes** so they can be flooded and remain so during the mosquito breeding season. This technique is quite effective in interrupting the life cycle sufficiently to control the numbers of pests. However, the altering of the ecosystem has come to be questioned as an **environmentally sound practice**. This curriculum will give the students the tools to make an informed decision about mosquito impoundments and how they should be managed in an environmentally friendly way.



Vocabulary

ecosystem - n. *the relationships between a community of plants and animals and their environment.*

species - n. *a distinct kind of plant or animal*

estuary - n. *a coastal body of water where seawater and fresh water mix.*

recreational fisher - n. *one who fishes as a hobby or just for fun.*

commercial fisher - n. *one who fishes as a profession or job.*

field biologist - n. *one who studies the origin, history, characteristics, habits etc. of plants and animals in their natural environment instead of in a laboratory.*

land developer - n. *one who alters the land such as for houses, parks, etc.*

alter - v. *change*

intervention - n. *the act of coming between to modify, settle, or change some action or event.*

Vocabulary

life cycle - n. *the continuous sequence of physical changes that an organism passes through, from a fertilized egg to an adult that can reproduce.*

pesticide - n. *a chemical used to kill pests, usually insects and rodents.*

mosquito impoundment - n. *a wetland area that has been physically confined by earthen dikes and in which water is not allowed to freely flow between the main body of water and the wetland. These areas are used for mosquito control*

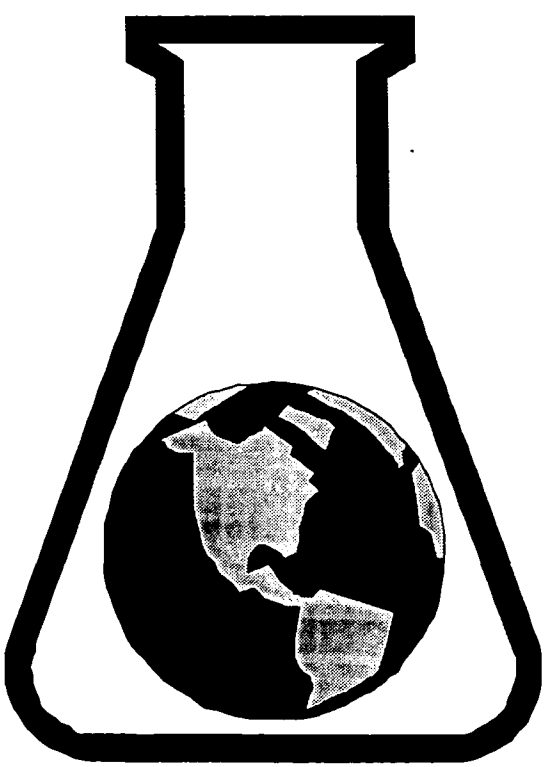
earthen dike - n. *a wall or dam that is built to keep a sea or river from flooding over land (For mosquito impoundments the dikes are used to hold water into the wetlands so the mud banks remain covered with water.)*

environmentally sound practice - n. *a practice or policy which is good for the environment*

Rationale

Section 1.1 is designed to spark the interest of the students in this program pertaining to the **environment** close to their home . Students will be introduced to the concept of being a **detective** in conducting an environmental **investigation**. Their **mission =** to decide what should happen to **mosquito impoundments** along the Indian River Lagoon. The **Indian River Lagoon** and a basic definition and description of mosquito impoundments will be introduced. The students will begin to think about where they can go to find information for their investigation.

Students will also be given a pretest so that a base-line of knowledge of the subject matter can be established. This test will be repeated at the end of the program to see how much their knowledge has increased.



Objectives

Students will:

Begin their Investigative Notebook
Identify sources for gathering information
Identify areas they may want to investigate
Become familiar with the goals of the program
Take the Pretest

Materials

Student notebooks (can be added to as needed)
Pencils, pens, markers or crayons, scissors, glue
Newspaper issues from a few days prior to the teaching of the lesson, including that day's.
Pretest for each child (Master 1.1a)
Master 1.1b - Vocabulary

Vocabulary

Environment *- n. all the things and conditions that surround a person, animal, or plant and affect the health, growth, development, and character of such living things*

detective - n. *a person, often a police officer, whose work is to solve crimes or get secret information*

Investigation - n. *the act of looking into so as to learn the facts*

mystery - n. *something that is not known or explained, or that is kept secret*

mission - n. *a special duty or piece of work that a person or a group is sent out to do*

Lagoon - n. *a special type of shallow estuary with a small opening to the sea and small water shed or in fresh water a shallow lake.*

Indian River Lagoon - n. *extends 140 miles and through 5 counties along the east coast of Florida*

Teacher Preparation

Prior to the start of the curriculum, teachers will request students to bring in notebooks to be used exclusively as their investigative journals.

Make copies of Masters 1.1a (optional), and 1.1b,curriculum glossary for each student

✍ Teacher Note ✍

Note books should be of the type that students can add to as the program progresses

Lesson Development

1. Explain to students that they are going to be part of an investigation of an important Environmental issue or problem. Tell them their mission is to decide how people should manage mosquito impoundments along the Indian River Lagoon in St. Lucie County.
2. Administer the pretest explaining to the students that they must first see what they already know before they decide what and where they should begin investigating.
3. Give the students copies of the curriculum glossary to place in their notebooks (copies are made directly from Appendix A). Give them copies of the vocabulary list for lesson 1.1 (Master 1.1b). Have the students look up the words in the glossary and fill in the definitions.
4. Begin discussing the vocabulary words, Mosquito Impoundments and the Indian River Lagoon. Ask students what they already know about the Indian River Lagoon and what they would like to know. Make a list on large poster paper which can be posted on a bulletin board.
5. Ask students who they feel have an interest in the Indian River Lagoon and what that interest may be. As the discussion continues you may want to throw in a few of your own that students would not ordinarily think of such as a motel owner, travel agent, home builder. You may want to list these also on large poster paper to be posted for future reference.

✍ Teacher Note ✍

You may want to be sure any worksheets you give the students are already 3 hole punched to go into their journals.

✍ Teacher Note ✍

You may need to suggest sources to get the discussion going. Be sure they hit on sources which they are able to begin looking and collecting from immediately.

6. Lead a discussion with the class about where they can go to begin collecting information about the subject of their investigation. As sources are stated by the students, list them on the board.
7. From the list, highlight those sources from which they could already begin looking and collecting information. Demonstrate how much pertinent information can be obtained from their daily newspaper by going over the past few days papers. Discuss why certain articles would be good to keep for future reference in their investigation.
8. Encourage them to begin collecting newspaper articles, talking to family and friends, and looking in their library for information which may be important to their investigation.
9. Have them get out their notebooks and label them as their Indian River Lagoon Journal. Explain that these journals will be used to take notes and collect data as they investigate the Indian River Lagoon and mosquito impoundments. Encourage them to begin putting newspaper articles or any other information they may collect into their journals. As they do their investigations in the classroom they will collect all their investigative report sheets and "player" lists (those individuals who have an interest in the issue) for each area of investigation.

Teacher Note

You may want to give students a chance every day to look through newspapers. Encourage them to look for articles pertaining to all aspects of the Indian River Lagoon (major weather events, development, tourism, recreational and commercial fishing, historical notes, etc.)

Conclusion

Tell students that this mission will continue throughout the year. Preview what the students have to look forward to (field trips, hands on activities, art activities, etc.) Impress upon them that there is no right or wrong answer to their mission. Each of them may come up with different opinions. This is why we need to look at as much information as possible before making our decision.

MASTER 1.1a Pretest

*Teacher*_____*School* _____

Detective _____

MANGROVES, MOSQUITOES, AND MAN

WHAT DO WE KNOW?????????

Instructions:

After reading the question, select as many answers as you think are correct.

1. Who will grow up to be a scientist???
   - ❒ Someone who likes school
   - ❒ Someone who likes to work outside
   - ❒ Someone who gets good grades
   - ❒ Someone who likes to ask questions
   - ❒ Someone who likes laboratories
   - ❒ Me
2. Whose opinion is important in making environmental decisions???
   - ❒ Environmentalists
   - ❒ Business Owners
   - ❒ Visitors
   - ❒ Scientists
   - ❒ Voting Citizens
   - ❒ Government Leaders
   - ❒ School Children
   - ❒ Mine
3. Who makes good decisions???
   - ❒ Someone who decides only what is best for them
   - ❒ Someone who makes a decision quickly
   - ❒ Someone who knows a whole lot about the subject
   - ❒ Someone who investigates the subject
   - ❒ Me

4. Where is the Indian River Lagoon???
   - ❒ The United States
   - ❒ Florida
   - ❒ North America
   - ❒ The tropics
   - ❒ The Western Hemisphere
   - ❒ St. Lucie County
5. What is the Indian River Lagoon???
   - ❒ A River
   - ❒ A Lagoon
   - ❒ A Bay
   - ❒ An Estuary
   - ❒ A Lake
   - ❒ Part of the Ocean
6. Who is the Indian River Lagoon important to, now or in the past???
   - ❒ Indians
   - ❒ Early Settlers
   - ❒ Fisherman
   - ❒ Wildlife
   - ❒ Builders
   - ❒ People not living in St. Lucie County
   - ❒ Business Owners
   - ❒ Scientists
   - ❒ Me
7. What are mosquitoes???
   - ❒ Insects
   - ❒ Mammals
   - ❒ Reptiles
   - ❒ Birds
   - ❒ Plants
   - ❒ Good for nothing
   - ❒ Important to the ecology of the Indian River Lagoon
8. What are mangroves???
   - ❒ Plants that live along the water's edge
   - ❒ Areas where men pick fruit
   - ❒ Swamps that are not good for anything
   - ❒ Important to fish
   - ❒ Important to all people in St. Lucie County
   - ❒ Worth saving
   - ❒ Beautiful
9. What should we study to learn about the ecology of the Indian River Lagoon
   - ❒ Mangroves
   - ❒ Mosquitoes
   - ❒ Plants and animals
   - ❒ Economics
   - ❒ History
   - ❒ Water
   - ❒ Geography
   - ❒ Weather
   - ❒ Fossils
   - ❒ Habitats
10 What do I think about studying Science???
   - ❒ It's fun
   - ❒ It's boring
   - ❒ Boys like it
   - ❒ Girls like it

Detective _____

Master 1.1b Vocabulary

Vocabulary

1. ecosystem _____

_____

2. species _____

_____

3. estuary _____

_____

4. recreational fisher _____

_____

5. commercial fisher _____

_____

6. field biologist _____

_____

7. land developer _____

_____

8. alter _____

_____

9. intervention _____

_____

10. life cycle _____

_____

11. pesticides _____

_____

12. mosquito impoundments _____

_____

13. earthen dikes _____

_____

14. environmentally sound practice _____

_____

15. Environment _____

_____

16. detective _____

_____

17. Investigation _____

_____

18. mission _____

_____

19. Lagoon _____

_____

20. Indian River Lagoon _____

_____

1.2 INVESTIGATIVE TECHNIQUES

Rationale

Section 1.2 is designed to help students use their **observational** skills to become good investigators. In section 1.1 students identified resources they could use to gather information. This section will help them to see that just by observing the world around them they are able to gather information. Students need to recognize that the first step in being a good detective (scientist) is being a good observer.

They will begin with observing something they are quite familiar with. A list of what they already know will be developed. As their list develops, they should begin to raise questions about what they do not know but that would be interesting to find out. The **rationale** for an investigation will be developed to answer those questions. They will determine how they can make observations or measurements and what **variables** could affect these measurements. The **independent variables** as well as the **dependent variables** will be identified. The elements of the investigation, a **hypothesis**, a list of materials needed to complete their observations, a **procedure**, and a **data** table, will be developed. Worksheets for designing the elements will be used to guide the students through the process. They will conduct their investigation and draw **conclusions** from the observations they have made. The standard worksheets which will be used throughout the curriculum will be introduced. These worksheets will be included in their investigative notebooks as they complete their activities.

Students will develop two investigations The first one will investigate something that is concrete (the height of 4th graders). In the classroom, there are not any variables affecting the results of their

Vocabulary

Observation - n. *the act or power of seeing or noticing*

Rationale - n. *the reasons or rational basis for something*

Variable - - n. *[something that is] likely to change or vary (be different)*

Independent Variable - n. *(a variable) not ruled or controlled by another*

Dependent Variable - n. *(a variable) controlled or decided by something else*

Hypothesis- n. *an unproven theory, etc. tentatively accepted to explain certain facts*

Procedure - n. *a way or method of doing something*

data - n. *facts and figures from which something can be learned*

Conclusion - n. *an opinion formed after careful thinking*

Vocabulary

Standard - n. *something set up as a rule or model with which other things like it are to be compared*

Qualitative - adj. *[having to do with] one of the features that makes a thing what it is*

Quantitative - adj. *[having to do with] an amount or portion*

Trial - n. *the act of testing or trying*

Consistent - adj. *acting or thinking always in the same way*

measurements if they are done with a **standard** procedure. The second investigation, will have students observing the flight of paper airplanes. Their observations and measurements will be either **qualitative** (how well does it fly) or **quantitative** (how far does it fly). They will also see that each time they fly the plane their results will vary (unlike the repeated **trials** of measuring height) because there are many variables affecting the flight of the plane. Many of these variables can be identified; however there are many that cannot. They will begin to see the importance of their procedure being **consistent** every time they repeat the investigation. Parallels and contrasts will be drawn between the two investigations and what they will be doing in their detective work on the Indian River Lagoon and Mosquito Impoundments.

Objectives

Students will:

- Learn the importance of observation
- Develop an investigation technique that is consistent
- Learn the essential elements of a scientific investigation
- Observe and investigate the height of 4th graders
- Observe and investigate the flight of paper airplanes
- Learn how these techniques will be used in their Mission

Investigation 1.2a

Developing a Procedure

Materials

Box of crackers with inner bags unopened
Table knife
Jar of jelly with the lid
Jar of peanut butter with the lid
Paper and pencil for each student
Master 1.2 a - Vocabulary list

Procedure

Teacher Preparation

Copy and distribute vocabulary lists for each student (Master 1.2a)
Cover a demonstration table with a large piece of paper. Give each student a paper plate.

Lesson Development

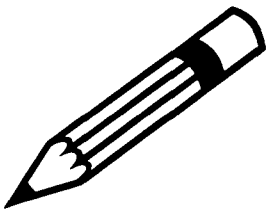
1. Give each student a copy of the vocabulary list (Master 1.2a). Go over the definitions.
2. Have each student get out a piece of paper and put their name at the top of the page.
3. Tell them to write out instructions for making a peanut butter and jelly cracker sandwich. Allow them about 5 minutes.
4. Collect the papers.
5. Select several students to make a sandwich by precisely following their instructions as you read them aloud.
6. If the directions do not tell them to open the box, or jars first, they should go back to their seats empty handed. **Do not let the students do anything that is not written as a direction** (shift things in their hands, put things down, open their mouths, etc.). Have several students try. Most of the students will not get a sandwich made.

Teacher Note

This activity has the most impact when it is done totally out of context. If you are planning to use it, do it as a special treat, not as part of their science program.

Teacher Note

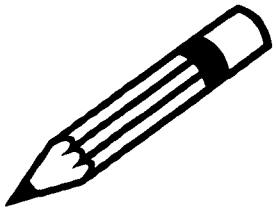
You will probably need to provide enough supplies to have everyone make a sandwich.



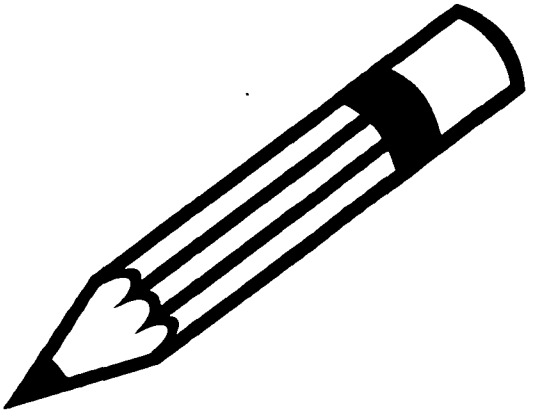
7. Divide the class into small groups. Have them repeat the writing exercise. This time allow at least 10 minutes. There will be a great deal of discussion along the way.
8. Collect the papers and repeat the sandwich making exercise.

Conclusion

Point out to students how important it is to be very detailed in writing a procedure. Relate this to their designing an investigation. Anyone conducting the investigation should follow the exact same procedure as you are using. There should be absolutely no guessing as to how to do any of the steps in the investigation. This insures that there are not any variables changed that may make a difference in the results.



***Adapted from Students and Research, 1993.*



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Investigation 1.2b (Day 1)
How tall is a 4th Grader

Materials

Measuring device (yard / meter stick, tape measure)
Pencil for each child
Copies of Master 1.2b for each child
Copies of Master 1.2d for each child

Procedure

Teacher Preparation

Make copies of Master 1.2b for each child.
Make copies of Master 1.2d for each child

Lesson Development

1. Review with the students some of the information sources they had identified in Section 1.1. Ask them to share with the class some information they have already gathered as Environmental Detectives. Ask them how a detective gains information about a case if there are not any of those sources available to him/her or if the subject of the case has never been investigated before. Introduce the concept of observation and begin the activity.
2. Ask the students how tall is a 4th grader. Begin listing on the board what they already know. The list may include such things as: We are all different heights; Johnny is taller than Susie; Billy is the smallest in the class; etc. As the list gets larger, start raising questions about what they say they already know such as: I wonder if all the boys are smaller than the girls; I wonder if the older students will always be taller; etc.
3. Have them select a question they would like to investigate about the height of 4th graders.
4. Give them copies of the "How Tall is a 4th Grader" worksheet (Master 1.2b).

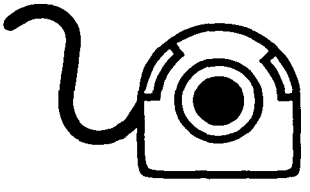
Teacher Note
You may want to break the students up into small groups to do the measurements and then share their measurements with the entire class or you may want to keep it as a whole group activity calling students to the front of the class to be measured.

Teacher Note
When developing the procedure you may want to review Investigation 1.2a

Teacher Note
At some point have one of the students measure your height. During the second set of trials, have the student measure you again but this time have your shoes off (works best if you wear heals that day) so there is a difference in your height. Get them to determine what is the variable affecting your height.

Teacher Note

You may want to point out to students that this is a great way to develop a Science Fair Project. The terms being introduced are the same that they should begin to use as scientists. The report form could also be used as an outline. Have the students turn the report into an expository writing exercise.



5. Help them design their investigation by going through the steps on the worksheet. Be sure they indicate how they will measure the height of the students (ie. against a wall or holding the measuring device up to their backs). (See example worksheet.)
6. Have them follow the procedure exactly as they have stated it. Enter their data into the table.
7. Have them draw conclusions from their observations.
8. Ask them to measure all the students' heights again. Check to see if there is any difference. Discuss what variables affect those results (slouching, tip toes, etc.)
9. Give each student a copy of the Detective Report Master (1.2d). Go over each section and relate it to the worksheet they have just completed. Introduce all the new terms which are listed on the Report. Explain to them that in order for an investigation to be consistent, the steps must always be repeated in the same way. By designing their investigations following the steps listed on the Detective's Report they will always have reliable information.

Conclusion

Tell students that being good observers is very important to all detectives (scientists). When we began making our observations, we may have felt that we knew everything there is to know about the height of 4th graders. After we began to observe closer, we found that there were still many questions we would like answered. We found that we could develop an investigation to find the answers. Usually, in an investigation one question answered leads to another question asked. Point out to students that this is exactly how we will conduct our mission. We will observe and investigate the Indian River Lagoon and Mosquito Impoundments and answer as many questions as we can so we will be good environmental decision makers.

Detective _____ **Date** _____

Group Members SAMPLE

How Tall is a 4th Grader??????
(What do we want to Investigate)

1. What do we already know?????? Rationale
All 4th graders are different heights
Johnny is taller than Susie
Billy is the smallest in the class

2. What do we want to find out????? Purpose
Are the boys bigger than the girls?

3. What do we think we will find????? Hypothesis
Boys are bigger than girls

4. What can we do to find out if we are right?????? Procedure
Stand a boy against the blackboard.
Use a pencil laid across the top of their head to mark their height on the board
measure from the floor to the mark
Repeat for all students

5. What supplies and tools do we need to find out????? Materials
Yard stick
pencil and paper

6. What will be different with each observation or measurement??? independent variable
Whether the person we are measuring is a boy or a girl

7. How will we measure that difference????? Dependent Variable
Height in inches

8. How can we keep a record of what we observe???? *Data Table*

Use this table to record your observations. Be sure to label what each column and row represents. If you need a larger table, make your own on an extra sheet of paper.

Independent Variable (What is different) *Boy or Girl (name)*	Dependent Variable (What we measure or observe) *Height in inches*	
	First time	Second Time
boy (Johnny)	*55 inches*	*55 inches*
girl (Dee Dee)	*46 inches*	*46 inches*
Teacher Note Ask the students if the results of this one trial are accurate. Have them measure a second set of students (try to select a set which will give different results). Suggest that maybe they need to repeat the investigation several time to get better results. You may want them to line up from largest to smallest and see if there are more tall boys than girls. Ask if they think the results would be the same for all classes.		

9. What did our investigation teach us???????Conclusion

We need to measure many boys and many girls in order to get good results. In our class there were more tall boys than girls.

10. What else might we investigate about the height of 4th graders??????

Do all short 4th graders have short parents????

Investigation 1.2c (Day 3)
Flight of Paper Airplanes

Materials

Copies of Master 1.2c for each child
Copies of Master 1.2d for each child
8.5" X 11"paper (one sheet per child)
Assorted paper clips,
Scissors
Safety goggles

Procedure

Teacher Preparation

Make copies of Masters 1.2b,1.2c

Lesson Development

1. Review the Detective Worksheet with the students. Emphasize the concept of variables. Explain to the students that they will be investigating the flight of paper airplanes. Have them begin to fill in the Worksheet.
2. Ask the students what they already know about the flight of paper airplanes. Ask them what they think makes one plane fly better than another. As they come up with different ideas, write them on the board so they can refer back to them in developing the rationale for the investigation.
3. Have the students make a paper airplane using only the paper. They may not cut or tear the paper in any way. The teacher should make an airplane as well.
4. One at a time, fly the airplanes. Do not attempt to measure the flight the first time through. Have the students observe as each plane is flown.
5. After the last plane, ask the students for one quality of the airplanes that could be observed for all the flight trials. As these qualities are mentioned, make a list on the board. Discuss with the students

Teacher Note
You will be using the same list of materials for the next investigation. You may want to make double copies of the masters for the students at this time.

Teacher Note
Students can do this activity in small groups or individually.

Teacher Note
Students need to recognize that the first step in any investigation is making observations. From these observations they will be able to develop the rationale for the investigation.

Teacher Note

You can define the types of observations before making the list so you can categorize their suggestions as they make them.

Teacher Note

The students may have some ideas for modification which require other materials. Limit them to what is available to them in the classroom.

Teacher Note

You may want all the students to modify their planes in the same way so the results can be compared or you may want them each to use their own idea.

Teacher Note

Use your unmodified plane as an example of a control trial or one that does not have the independent variable changed to see if that is what is in fact making the change in the dependent variable

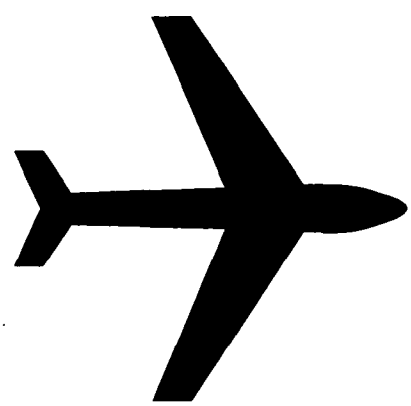
which observations are quantitative (measured in a standard scale such as distance or time) and which are qualitative (descriptive with non-standard measurement scale). Have them decide what observation they will use to investigate their airplane.

6. Have the students fly their airplanes again, this time using their chosen observation to measure its flight. Have them record this in the "first time" column on the data table. Repeat the trial again. Record in the "second time" column.
7. From idea list for what makes planes fly better, have the students decide on one change they can make in their airplane to make it fly better. The purpose of their investigation will be to see if that change will make their plane fly better. Have them state this as a hypothesis for their Worksheet.
8. Have them write the procedure for the investigation. They have already started with their first observation. They need to include all the steps they have followed so far.
9. Have them list all the materials they will be using.
10. Point out to the students that the change in the design of their plane is the independent variable while the measurement of their observation will be the dependent variable.
11. Have the students modify their plane in the manner they have decided to be their independent variable.
12. The students should each fly their modified plane again and measure the results. Have them do at least 2 trials.
13. Discuss what their results show. Was their hypothesis correct?
14. Have the students compare the results of the two trials for each plane. Have them do several more trials with their modified planes. Discuss if they always get the same results. Ask them what else may have an effect on the flight of the plane other than the independent variable. Ask them if they could identify all the other variables. Once the variables are identified ask the students how they can be controlled. Explain that in designing an investigation, one of the most important aspects is identifying all the

variables. Those that can be controlled should be identified as either a step in the procedure or as a standard material used in all the trials.
15. If the students are familiar with graphing, have the students graph the results of their trials.
16. Have the students complete the Detective Report.

Conclusion

Compare this investigation with the Height of 4th Graders Investigation. The variables associated with flying a paper airplane are numerous and difficult to define. When measuring someone's height, there are very few variables and those that may exist are easily controlled (wearing shoes, slouching, etc.). There were several measurements which could have been used for the airplane investigation while height could only be done two ways (metric or US measure). Point out to the students that investigating environmental topics is much like the airplane investigation. It is very difficult to identify all the variables affecting the results. As we go through our investigation, we will be looking at many of the variables that affect the Indian River Lagoon and Mosquito Impoundments. In the time that we have, we will not be able to cover all these variables, however our investigation will give us more information than we now have for making a recommendation for an environmental problem.



Teacher Note

Be sure to point out that line graphs are to be used with quantitative measurements while bar graphs are used for qualitative measurements.

Teacher Note

If each student decided on his/her own independent variable, have them do a verbal report to the class using the Detective Report as an outline.

*** Activity adapted from Students and Research, 1993.*

Investigation 1.2c (Day 4)
Flight of Paper Airplanes - Part 2

Materials

Materials
Copies of Master 1.2c for each child
Copies of Master 1.2d for each child
8.5" X 11"paper (one sheet per child)
Assorted paper clips,
Scissors
Safety goggles

Procedure

Teacher Preparation

Make copies of Masters 1.2c,1.2d

Lesson Development

1. Review the completed detective worksheets from Investigation 1.2b with the students. Ask them if they learned anything about the design of paper airplanes and if they would build the airplanes differently if they were given a second opportunity.
2. Using the same materials available to them the first time, have the students repeat the same activity based on their newly acquired knowledge.

Teacher Note
You may want the students to work together in groups so they can share their ideas from the last activity. The entire class should work together to design the investigation.

Conclusion

Compare the results of this investigation with the previous one. The knowledge gained from the first investigation should have lead the students to a much better design of both the airplanes tested as well as the experimental design. Relate this "improved" design to the process investigators go through as they gain more and more knowledge.

Teacher Note
As extra credit, the students could do some research on paper airplane design. There are numerous books available on the subject.

MASTER 1.2a
Vocabulary

Detective _____

Vocabulary

1. Observation _____

_____

2. Rationale _____

_____

3. Variable _____

_____

4. Independent Variable _____

_____

5. Dependent Variable _____

_____

6. Hypothesis _____

_____

7. Procedure _____

_____

8. data _____

_____

9. **Conclusion** _____

_____

10. **Standard** _____

_____

11. **Qualitative** _____

_____

12. **Quantitative** _____

_____

13. **Trial** _____

_____

14. **Consistent** _____

_____

MASTER 1.2b
How Tall
Worksheet

Detective _____

How Tall is a 4th Grader??????
(What do we want to Investigate)

1. What do we already know?????? Rationale

_____

_____

2. What do we want to find out????? Purpose

_____

_____

3. What do we think we will find????? Hypothesis

_____

_____

4. What can we do to find out if we are right?????? Procedure

_____

_____

5. What supplies and tools do we need to find out????? Materials

_____

_____

6. What will be different with each observation or measurement???
   independent variable

_____

7. How will we measure that difference????? Dependent Variable

8. **How can we keep a record of what we observe???? Data Table**

Use this table to record your observations. Be sure to label what each column and row represents. If you need a larger table, make your own on an extra sheet of paper.

Independent Variable (What is different)	Dependent Variable (What we measure or observe)	
	First time	Second Time

9. **What did our investigation teach us???????Conclusion**

_____

_____

10. **What else might we investigate about the height of 4th graders??????**

_____

Master
1.2c
Detective
Worksheet

Detective _____

Group Members _____

Detective Worksheet

1. What do we want to Investigate???? Title or Question

_____

_____

2. What do we already know?????? Rationale

_____

_____

3. What do we want to find out????? Purpose

_____

_____

4. What do we think we will find????? Hypothesis

_____

_____

5. What can we do to find out if we are right?????? Procedure

_____

_____

_____

_____

6. What supplies and tools do we need to find out????? Materials

_____

_____

7. What will be different with each observation or measurement???
Independent variable

8. How will we measure that difference????? Dependent Variable

9. How can we keep a record of what we observe???? Data Table

Use this table to record your observations. Be sure to label what each column and row represents. If you need a larger table, make your own on an extra sheet of paper.

Independent Variable (What is different)	Dependent Variable (What we measure or observe)	
	First time	Second Time

10. What did our investigation teach us???????Conclusion

11. What else might we investigate about this evidence??????

Detective _____

MASTER
1.2d
Detective
Report

DETECTIVE REPORT

(Use this as a guideline to write your report)

1. Title:

2. Introduction: Why you did the investigation (rationale)

What you wanted to learn (purpose)

What you thought would happen (hypothesis)

3. Procedure: How you did the investigation

4. Results: Data Table

Graph (Bar graph for categories or descriptions)
(Line graph for measurements with a standard unit)

5. Conclusion: What was the purpose?

What were the results?

Was the hypothesis correct?

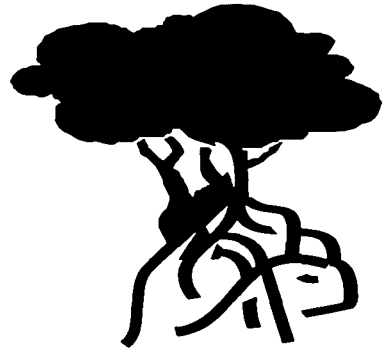
Did any other investigators find different results

Can you explain the results?

How can the experiment be improved?

What other questions would you like to investigate about this topic?

1.3 Introduction to the Indian River Lagoon



Background Information

The Indian River Lagoon stretches 156 miles along the east coast of Florida. It passes through 5 counties and contains over 4,000 different species of plants and animals. In fact, it supports the most **diverse community** of plants and animals of any estuary in North America. (A more detailed discussion of habitats, flora and fauna, history, climate, etc. will be included in later portions of the curriculum.)

The **ecological balance** of the Indian River Lagoon has been greatly influenced by large population increases since the early 1800's. The harsh environmental conditions - disease, mosquitoes, dense swamp lands and unfriendly Indians - made this area difficult to settle even after the first Spaniards appeared in the 1500's. In fact, in 1825 there were only approximately 317 people living in the Indian River Lagoon region. A steady increase in population continued until the year 1950 when 45,000 people had settled in this area. Since then, in just 40 years, the population has exploded to about 750,00 with a projected population of 1,000,000 by the year 2010 (from Indian River Lagoon: A Fragile Balance of Man and Nature, Indian River Lagoon National Estuary Program.)

Part of making this area more **inhabit**able was the development of mosquito impoundments. More than 75% of the **salt marsh** and **mangrove wetlands** along the Indian River Lagoon have been altered or **isolated** from the natural system since 1950. Salt water mosquitoes breed in these wetland areas. They require exposed soil for depositing their eggs. If the soils are not available, the **reproductive cycle** is sufficiently **interrupted** so the population of mosquitoes is considerably reduced. Impoundments allow these areas to be flooded during the breeding season, thus covering the exposed soil.

Vocabulary

diverse - adj. *different*

community - n. *all the people (or things) that live in a particular area*

ecological - adj. *having to do with ecology*

ecology - n. *the science that studies the relations between living things and all of the things and conditions that surround and affect them.*

balance - n. *equality between two things or between the parts of a single thing*

inhabit - v. *to live in or on; occupy*

salt marsh - n. *low lying areas which are often covered by salt water during high tide but are exposed at low tide. they are dominated by non-woody plant species such as grasses or rushes*

Vocabulary

mangrove - n. *a tropical tree which have adapted to living in salt water wetlands*

wetlands - n. *swamps or marshes*

isolate - v. *to set apart from others*

reproductive cycle - n. *the complete set of events which make up the process by which animals and plants produce new individuals like themselves.*

interrupt - v. *to make a break in; put a temporary stop to*

perimeter - n. *the boundary or distance around a figure or area*

artesian wells - n. *a deep well in which water is forced up by pressure of underground water draining from higher ground*

vegetation - n. *things growing from the ground; plant life*

aquatic - adj. *growing or living in water*

Impoundments are constructed by digging a ditch around the wetland area. The earth removed from the ditch is used to build a dike along the **perimeter** of the wetland. The dike holds in the water as the interior of the impoundment is flooded either by **artesian wells** or pumps. This essentially isolates the marsh areas from the Indian River Lagoon and can kill wetland **vegetation** and keep **aquatic** organisms from their natural **nursery** areas.

Approximately 70 percent of the impoundments have now been reconnected to the Lagoon using **culverts** through the dikes. Some of these culverts remain closed during the entire breeding season of the mosquito while other areas choose to open the culverts periodically while pumping in order to exchange the water in the impoundment. This method improves the water **quality** in the impoundment.

Much of the vegetation found within the interior of the impoundments are mangrove forests. In fact 20 percent of the mangrove forests of the eastern seaboard are located in the Indian River Lagoon. These forests serve as important nursery and **spawning** ground for many of the ocean and lagoon fish. This area is the northern limit for the mangrove forests. In the northern areas of the Lagoon, saltmarsh communities become more abundant. These are areas dominated by non-woody plants such as grasses or rushes.

There are three species of mangroves found along the Lagoon. In the deeper areas of the **tidal zone** the red mangrove is most prevalent. These plants are characterized by their **aerial prop** roots which give them the appearance of standing on their toes. These roots trap all sorts of **decaying** plant and animal material or **detritus**. Much of this detritus is a source of **nutrients** to the lower organisms in the food web. These roots also trap **eroding** soils. As more and more of this material becomes trapped in the prop roots, small mangrove islands will begin to appear or existing islands will grow larger. Another characteristic of the red mangrove is its relatively large, dark green, waxy leaves.

Higher up in the tidal zone, in or above the average high tide zone, the black mangrove begins to become the **dominant** specie. Black mangroves are easily identified by the breathing roots called **pneumatophores**. These are finger-like structures coming around the base of the tree. These pneumatophores also catch much of the detritus and soil from the upland areas. The leaves of the black mangrove are distinctive from the other species of mangroves because the backs of the leaves are silvery. Often tiny salt crystals can be seen sparkling in the sunlight on the underside of the leaves. Generally the leaves are smaller than those of the red mangrove.

Moving further up the shoreline the white mangrove becomes more and more prevalent. These trees do not have prop roots or breathing roots although the underground root system acts like an anchor for the soil along the shoreline. The leaves of the white mangrove can be distinguished from the red or black mangrove because of a small notch at the tip of the leaf and two small swellings at the leaf base.

All three species of mangroves are important to the ecology of the Indian River Lagoon. In many areas along the Lagoon, **exotic** plants are beginning to overtake the natural vegetation. One of these plants is the Brazilian Pepper. This plant is found along many of the mosquito impoundment dikes. At first glance these plants may look like mangroves however they can be distinguished by the small red berries they produce and their leaves. Another exotic plant of concern is the Australian Pine. This is the very tall pine with the long needles found along many of our shorelines. Both of these plants can out **compete** the natural vegetation which is so important to the fragile balance along the Lagoon.

Vocabulary

nursery - n. *a place where young animals can find food and hide from predators*

culvert - n. *a drain or pipe under a road or dike.*

quality - n. *degree of excellence*

spawn - n. *the eggs or newly hatched young of fish, lobsters, frogs, or some other water animals. v. to produce eggs in large numbers*

tidal zone - n. *the area of the shoreline where the water rises and falls due to the tides*

tide - n. *the regular rise and fall of the ocean's surface due to the gravitational pull of the sun and moon.*

aerial - adj. *of, in, or by air*

prop - v. *to lean against for support*

decay - v. *to become rotten by the action of bacteria*

Vocabulary

detritus *- n. a mixture of decaying plant and animal remains covered with microorganisms.*

nutrients *- n. elements necessary for life and growth*

erode *- v. to wear away*

dominant *- adj. most important*

pneumatophores *- n. roots of the black mangrove which project up out of the soil*

exotic *- adj. strange different of foreign*

compete *- v. to be a rival for something*

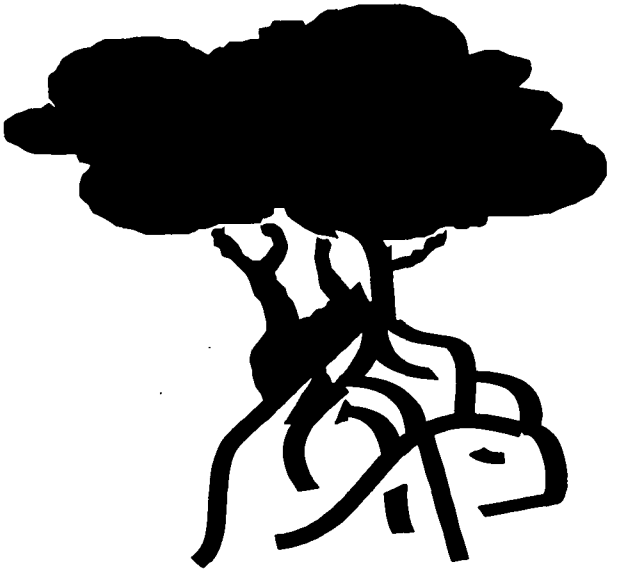
Rationale

Section 1.3 is designed to introduce students to the Indian River Lagoon before they go on their field trip to see a mosquito impoundment. They will understand how and why an impoundment works. They will also learn about the three types of mangroves and how to identify each specie and where they will be found along the impoundment dike. They will also be introduced to the idea of exotic plants and how they can begin to harm the ecology of the Indian River Lagoon.

Objectives

Students will:

Build a model of a mosquito impoundment
Learn how they work
Identify where the different species of mangroves could be found along the shoreline
Identify some of the problems associated with exotic plants in Florida



Materials

Master 1.3a - Vocabulary List
Master 1.3b - Impoundment Diagram
Master 1.3c - Impoundment Model Worksheet
One large plastic bin (approximately 12" x 18" x 6") a large sweater storage bin would work well
Fine sand (sand box sand) - enough to fill the bins about 1/3 full
2 - 3 straws per group
1 water container per group

Procedure

Teacher Preparation

Divide the class into small groups (3-5 students)
Gather necessary materials for each group
Make copies of Master 1.3a, 1.3b and 1.3c for each student

Lesson Development

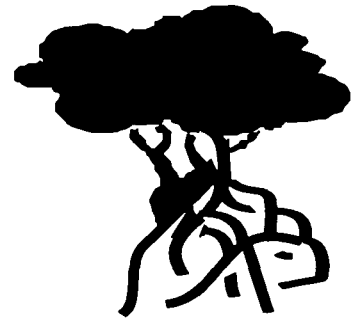
1. Hand out vocabulary list for section 1.3 (Master 1.3a). Have the students look up the words in the glossary and fill in the definitions. Ask students if they have found any newspaper articles they would like to share with the class about the Indian River Lagoon.
2. Ask the students what they know about the Indian River Lagoon. Add to their list of facts any that you feel will help with introducing the Indian River Lagoon.
3. Ask the students what they know about mosquitoes and how they are important to the ecology of the Indian River Lagoon. Ask them if they feel mosquito control is important to their lives.
4. Explain to them the concept of mosquito impoundments. Hand out Master 1.3b - Diagram of Mosquito Impoundments.

✍ ***Teacher Note*** ✍
Any supplemental information which you may have in your classroom on the Indian River Lagoon can be used throughout this curriculum as you see appropriate. This is to be used as a guide for teaching students about the Lagoon while also teaching them to be good decision makers.

✍ ***Teacher Note*** ✍
As the students list the facts they know, you may want to list them on the board or a poster which could be posted in the classroom.

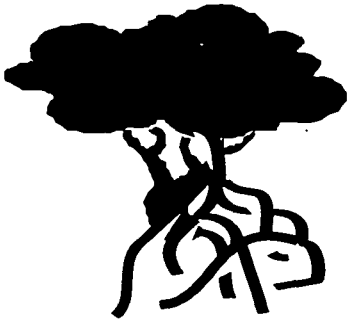
✍ ***Teacher Note*** ✍
You may want to do this activity as a demonstration instead of group activity

✍ ***Teacher Note*** ✍
You will probably want to do the model outside. The students will be working with water.



✍ ***Teacher Note*** ✍
Impress on the students that it is very important to pour the water into the bin slowly. If they do it too quickly their shoreline will erode away.

✍ ***Teacher Note*** ✍
Ask the students what the ebb and flow of the tide is. This is not in their vocabulary list. See if they can now define for you what the tidal zone is on their shoreline.



✍ ***Teacher Note*** ✍
You may need to demonstrate how to build the dike.

5. Divide the class into small groups. Give each group a plastic bin filled with sand, a container of water, and 2-3 straws. Based on diagram 1 of the natural marsh on Master 1.3b, have the students model a shoreline out of the sand in their box. The shoreline should extend from one end of the box to the other. Most of the sand should be piled along one side with a gradual slope to the other side. Have them identify for each other which is the Lagoon side of the shoreline.
6. Have them simulate the tide coming in by **gently** pouring water along the side of the shoreline representing the Indian River Lagoon. They should only pour enough water for the shoreline to begin to be covered with water. Tell them that this is like low tide in the Lagoon. Have them write down their observations on Master 1.3c - Impoundment Model Worksheet.
7. Have them predict what will happen when the tide rises to high tide.
8. Point out the gradual slope of the shoreline and that the mosquitoes will lay their eggs on the muddy banks where the tide ebbs and flows. Ask them how this area could be continually covered with water so the mosquitoes no longer have an area to lay their eggs
9. Have the students look at diagram 2 on Master 1.3b - Impounded marsh. Ask the students to build a dike in their "shoreline" model. This is done by digging a trench in the deeper portion of the sand and piling the dug out sand along length of the shoreline. This models a mosquito impoundment as seen in diagram 2.
10. After the dikes are built, have the students **gently** pour water inside the dike (not on the Lagoon side) until the level is approximately half way up the dike. This is like pumping water into the mosquito impoundment. Ask the students what is happening to the water level on the inside of the dike as compared to the Lagoon side of the dike. The water level will be higher in the impoundment. Have them record their observations on Master 1.3c.

11. Looking at diagram 3 on Master 1.3b, ask the students how they can use the straw to reconnect the impoundment to the Lagoon. At one spot along the dike a trench should be cut through to the Lagoon. The trench should be no deeper then the water level inside the impoundment so no water is allowed to drain out of the impoundment. Take the straw and lay it inside this new trench so one end is in the impoundment and the other is in the Lagoon. Cover the straw with sand so the straw is buried where it is crossing the dike. (Both ends will be sticking out either side of the dike.) This represents a culvert or pipe in the impoundment.

12. Have the students **gently** pour more water into the impoundment. Have them write down their observations. The water will flow through the straw into the Lagoon. This is exactly how an impoundment works

13. Allow the students to build their impoundment with several straws (culverts) and experiment with closing some off, having the water on the Lagoon side get deeper than the impoundment side, etc. Have them record their observations.

14. Tell the students about the different species of mangroves and where they can be found along the shoreline. (See background information.) Have the students draw a similar diagram as found on Master 1.3b of their impoundment. Tell them to include a drawing of each of the different type of mangrove and where it would be found along their shoreline.

15. Have the students predict what will happen to the ecology of the shoreline if the exotic plants are not controlled.

✍ ***Teacher Note*** ✍

Give the students some time to figure out how they can use the straw. If they are having trouble, demonstrate with one of the groups.

✍ ***Teacher Note*** ✍

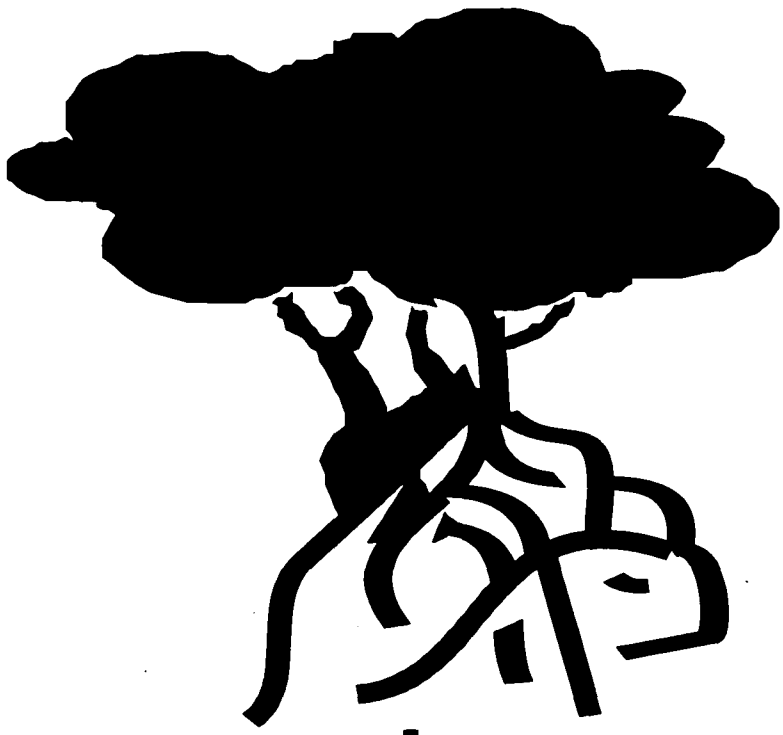
If at all possible, have some examples of mangrove leaves available for students to look at while you are explaining the differences in the species. There are many good references which will show the difference in the leaves if you are unable to collect some true examples.

✍ ***Teacher Note*** ✍

A small hole can be put in the bottom of the bin. By covering it with plastic wrap, it will seal the hole. The wrap can be removed and the water drained to simulate a falling tide.

Conclusion

Tell students that in a few weeks they will be visiting a mosquito impoundment. These impoundment areas are not hard to find since more than 75% of the salt marsh and mangrove wetlands along the Indian River Lagoon have been altered to build mosquito impoundments. Each county in the state of Florida has their own Mosquito Control Commission. These scientists and technicians manage their mosquito problems as they see best for their area. For this reason, many areas have different strategies for controlling their mosquito populations. Throughout the rest of their mission the students will be learning about the Indian River Lagoon and mosquitoes. When they have completed their investigation, they will be expected to make a decision about how the impoundments in their county should be managed.



Remind students to continue looking for newspaper articles about the Indian River Lagoon and how the people around the Lagoon are impacting its ecology.

Master
1.3a
Vocabulary

Detective _____

Vocabulary

1. diverse - _____

_____

2. community _____

_____

3. ecology _____

_____

4. salt marsh _____

_____

5. mangrove _____

_____

6. wetlands _____

_____

7. reproductive cycle _____

_____

8. perimeter _____

_____

9. vegetation _____

10. aquatic _____

_____

11. culvert _____

_____

12. spawn _____

_____

13. Tide _____

_____

14. decay _____

_____

15. detritus _____

_____

16. nutrients _____

_____

17. erode _____

_____

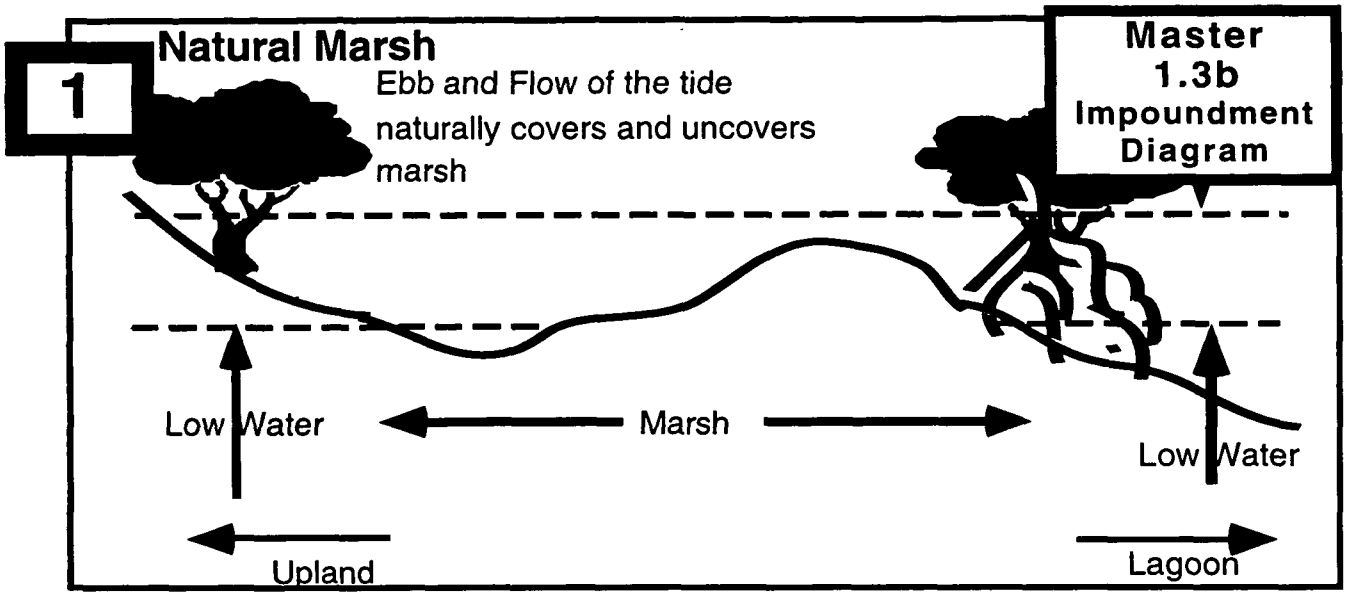
18. dominant _____

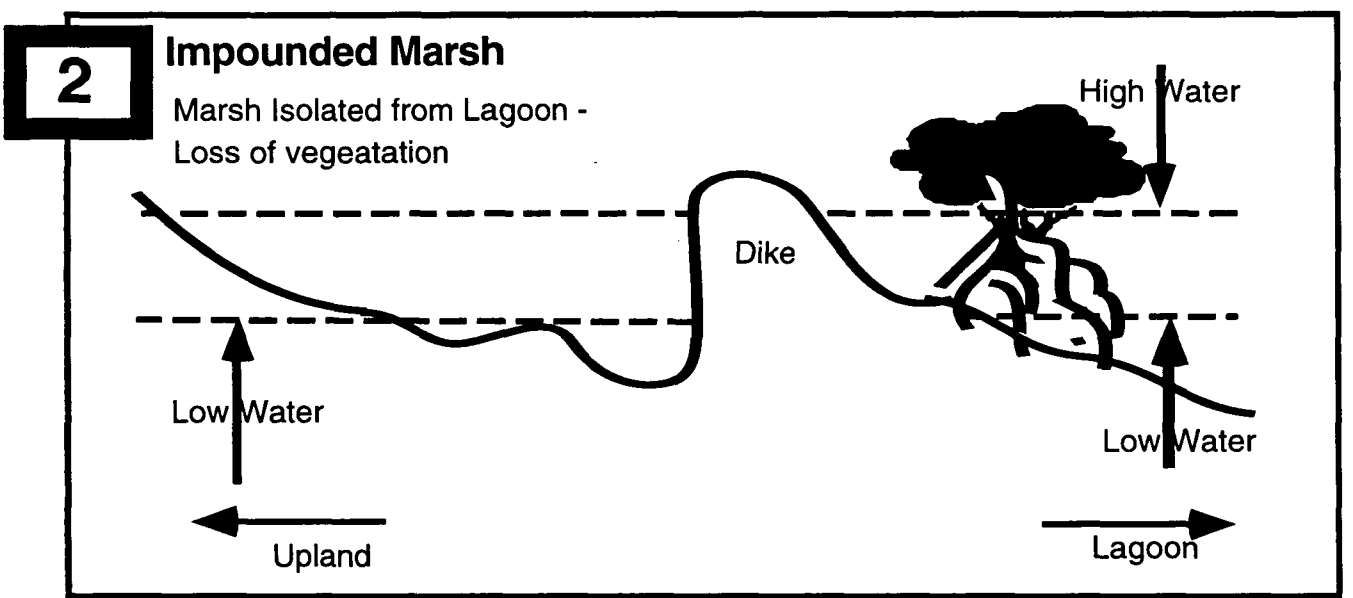
_____

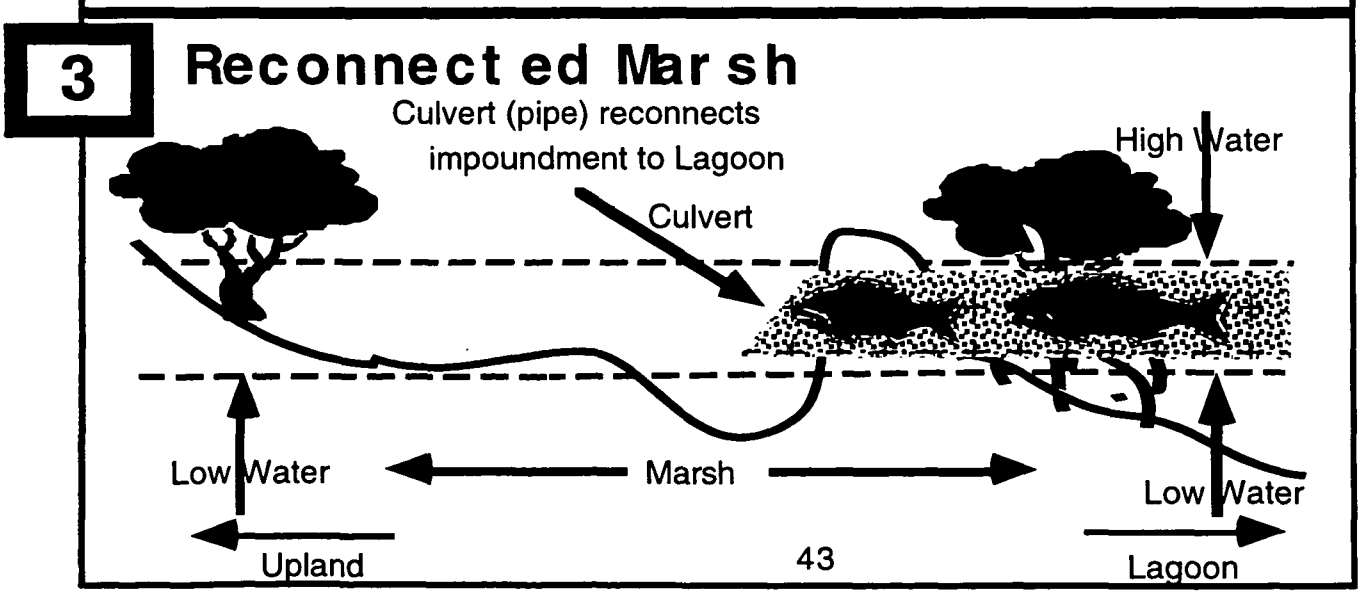
19. phematophores _____

_____

20. exotic _____


1
Natural Marsh
Ebb and Flow of the tide naturally covers and uncovers marsh
Master 1.3b Impoundment Diagram
Low Water
Marsh
Low Water
Upland
Lagoon


2
Impounded Marsh
Marsh Isolated from Lagoon - Loss of vegeatation
High Water
Dike
Low Water
Low Water
Upland
Lagoon


3
Reconnect ed Mar sh
Culvert (pipe) reconnects impoundment to Lagoon
Culvert
High Water
Low Water
Marsh
Low Water
Upland
Lagoon

Master
1.3c
Impoundment
Model
Worksheet

Detective _____

Impoundment Model Worksheet

1. **Natural Shoreline:** The small amount of water in your model represents low tide. Without adding any more water, predict what would be <u>different</u> at high tide.

_____

_____

_____

2. **Impounded Marsh:** Your model now represents the impoundment at low tide with the impoundment pumped full of water to cover the muddy banks so the mosquitoes cannot lay their eggs. Without adding any more water, predict what will happen to the level of the water in the impoundment at high tide.

_____

_____

_____

3. **Reconnected Marsh:** Your model now represents the reconnected impoundment at low tide. Without adding any more water, predict what will happen to the level of the water in the impoundment if the tide rises above the level of the culvert._____

4. **Try using more straws as culverts in your impoundment. How can the straws be used to move the water around in the impoundment? (Hint: block off some straws while leaving others open)**

_____

_____

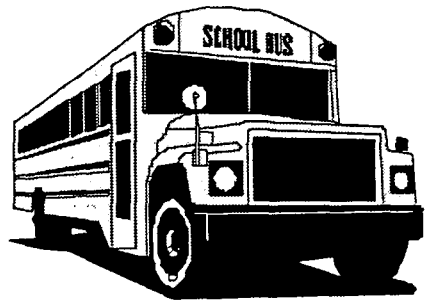
_____

5. **Draw a picture of your impoundment. Add the three types of mangroves where they would be found growing along the shoreline.**

1.4 FIELD TRIP 1

Bear Point Mosquito Impoundment

Rationale



Field Trip 1 is designed to introduce the students to mosquito impoundments and their environment. In section 1.1, students discussed ways they could collect information or clues for their overall investigation of mangroves, mosquitoes and man. One of the sources they identified was the actual study site or mosquito impoundments along the Indian River Lagoon. They talked about some of the things they could **observe** while at the site. During Field Trip 1 students will engage in activities which will require them to observe the area in very specific ways. As they work on the activities they will be making observations which will help reinforce the upcoming classroom investigations of the Indian River Lagoon wetlands and Mosquito Impoundments. In this way, students will be able to visualize the concepts they will be studying.

There will be 4 basic investigations. Each investigation will be introduced to students during the field trip prep and orientation day. This day will prepare the students for what they will be doing during the field trip. The results of their field investigations will be discussed the week following the field trip in class.

The four investigations are as follows:

* **Flora** and **Fauna** Survey - Students will identify and record plants and animals as they see them throughout the field trip. They will use field survey sheets to record their observations. Materials for identification will be provided to each group.

Vocabulary

observe *- v. to see watch or notice*

data *- n. facts and figures from which something can be learned, information*

flora *- n. all the plants of a particular place or time*

fauna *- n. all the animals of a particular place or time*

Vocabulary

marine *- adj. of the sea*

debris *- n. the scattered remains of something that has been broken, destroyed, or thrown away; rubbish*

survey *- v to look over something in a careful way; (n.)a detailed study or inspection, made by gathering information and analyzing it*

scavenger *- n. 1. a person who gathers things that other people have thrown away; 2. an animal that feeds on rotting meat and garbage*

transect *- n. a cut across a specific area*

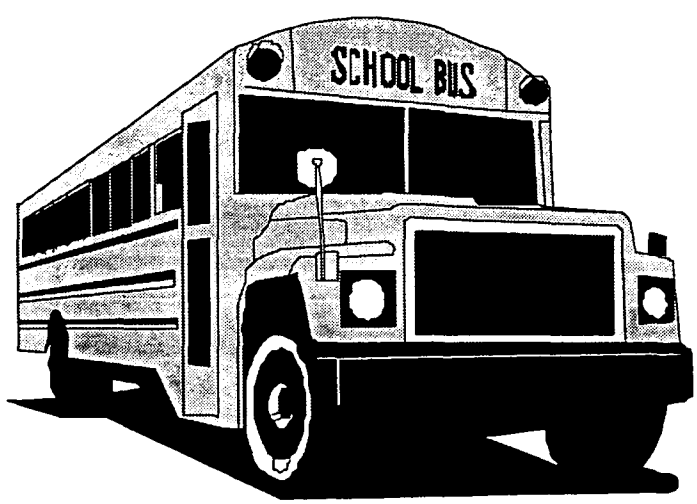
elevation *- height above sea level*

* **Marine Debris Survey** - Each group of students will have a large trash bag for collecting marine debris while they are engaged in the other activities. Before leaving the study site, they will record what they have found on their Marine Debris Survey sheet. This data will be shared with the entire class in the field trip follow-up.

* **Scavenger** Hunt - The students will have a list of items they are to collect while on the field trip. The items collected will be used in the classroom during their classroom investigations.

* **Transect** of the Impoundment Dike - Students will do a band transect (a wide transect) from the water's edge of the Indian River Lagoon, up over the dike, and down to the water's edge inside the impoundment. Students will record the **elevation** changes as well as the flora, fauna, and debris found within the transect band. This will reinforce the student's models of how an impoundment actually works. The transect will also show students how water availability and tide levels effect all the plant and animal communities in the Indian River Lagoon area.

The field experience will help the students visualize the concepts they will be learning in their investigation of the Indian River Lagoon.



Objectives

Students will:

- Become familiar with the wetland environment of a mosquito impoundment on the Indian River Lagoon.
- Learn to identify some of the flora and fauna found along the Indian River Lagoon and the mosquito impoundments
- Become aware of the issue of marine debris as an impact of man on the study site
- Develop good observational skills by looking for and identifying items on a scavenger hunt
- Become familiar with the collection of physical data and why this data is important to their investigation
- Develop an understanding of how impoundments work by doing a band transect from the water's edge of the Indian River Lagoon, over the dike and down to the water's edge inside the impoundment.
- Develop an understanding of land elevation and water availability and how this effects the plant and animal communities

1.4a Field Trip Preparation and Orientation

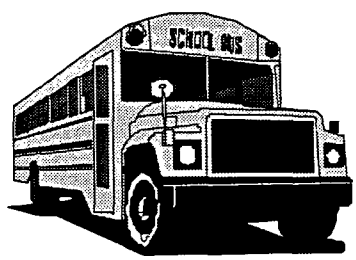
Materials

Road map of St. Lucie County
Pencil and paper to record directions to study site
Overhead of Detective Worksheet
Master 1.4a - Vocabulary
Master 1.4b - Impoundment sheet
Master 1.4c - Classroom Transect
Graph Paper,
Overhead of Graph Paper
Master 1.4d - Transect Data Sheet
Master 1.4 e - Field Transect
Master 1.4f - Flora and Fauna
Master 1.4g - Marine Debris
Master 1.4h - Time Line
Master 1.4i - Scavenger Hunt
Master 1.4j - Information Sheet

Teacher Note

There will be three days associated with the field trip.

Day 1 - Orientation
Day 2 - Field Trip
Day 3 - Wrap up



Teacher Note

If you have a bulletin board you could designate for this investigation, you may want to display the map and have the students mark the best route. As the investigation continues, you may want to add information and clues to the bulletin board

Procedure

Teacher Preparation

Make one copy per child of:
Masters 1.4a, 1.4b, 1.4c, 1.4e, 1.4f, 1.4g, 1.4h, 1.4i
Make two copies per child of Master 1.4d
Make overhead transparencies of all data sheets as well as the classroom transect diagram
Several pieces of graph paper per child
Find Bear Point on the St. Lucie County map and mark for the students. It is located on A1A just north of FPL on the east side of the Indian River Lagoon.
Be sure to review the transect activity. You will probably need to try it once so you are familiar with it before you start the explanation to your students.

Teacher Note
The students will be doing other mapping investigations in Unit 2, section 2.1

Lesson Development

1. Review the vocabulary words for 1.4 (Master 1.4a).
2. Review with students all the activities they have completed up to this point in their investigation. Review with the students some of the sources they identified for gathering information or clues for their investigation. Ask students to share any newspaper articles they have collected about the Indian River Lagoon Introduce the field trip and review why it is important for them to visit their study site as the first real step in their investigation.
3. Using the street map of St. Lucie County, have the students find their school. Bear Point (the study site) has been marked on the maps. Point out where Bear Point is located and have the students find the best way to get to the study site.Have the students write down their best directions. Save these directions to share with the bus driver on the day of the field trip.

Teacher Note
Some students may have local knowledge about the best way to get to the site. Have them share their knowledge with the class. Point out what a great source of information local experts can be.

Florida Writes Activity

Have the students write out the directions to the study site.

Classroom Transect Activity

1. Give each student a copy of Master 1.4c (Detective Worksheet, classroom Transect). Go over the steps on the worksheet to help develop a good investigation for finding out how to do a transect. Define what a transect is and why this is a good technique to use for their investigation. Have them look at Master 1.4b (SWIM Fact Sheet). Explain that the diagrams are actually profile lines developed by doing transects. This is what they will be doing on their field trip. To help them understand this, they will do a transect across their classroom. Go over the procedure outlined on the Detective Worksheet (Master 1.4c) Use the overhead of the classroom transect to help them through the steps.
2. Using an overhead of Master 1.4d, go over each of the sections of the data sheet. Fill in the data as it is collected.
3. Using the graph paper overhead, plot the data points for the classroom transect. Each square on the graph paper will represent 1 square centimeter (or inch). You will need several sheets of the gaph paper in order to graph the entire transect.

Flora and Fauna Survey

1. Give each student a copy of Master 1.4f (Flora and Fauna Survey) Using the overhead, explain how this data sheet is going to be used in the field.
2. Ask them about what they know about the behavior of animals they might see in the field. Go over basic principals of observation, for instance, they will want to be as quiet as possible while in the field.
3. Remind students that they are not to take any live animals from the study site. They may observe them while at the site but there are no facilities back in the classroom for maintaining live organisms. They will not be permitted to take animals home.
4. See if the students have any predictions about animals they may see.

Teacher Note

This activity will be the main focus of the field trip. It is essential that the students get a good understanding of this procedure before going to the field.

Teacher Note

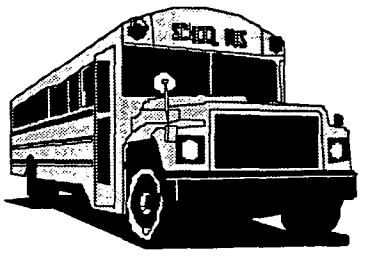
You may want to divide the students up into groups for this activity. It does require good skills at following directions.

Teacher Note

Start a bulletin board for their observations. After the field trip, they can add pictures of what they see on the field trip. They could also draw an enlarged profile of the dike and add their observations to the profile where appropriate.

Teacher Note

The discussion on Marine Debris will be followed up in the Wrap up Day



Marine Debris Survey

1. Give each student a copy of Masters 1.4g (Marine Debris Survey) and 1.4h (Marine Debris Time Line). Define for them what Marine Debris is and discuss whether this is an issue for our investigation. Ask who are the players.
2. Using the overhead, show them what data they will be collecting about Marine Debris on the field trip.
3. Be sure to stress to the students that they are not to collect anything that could cut them such as, fish hooks, rusty metal, or glass.
4. Share with the students the Marine Debris Time Line (Master 1.4h)

Teacher Note

The collections may be put on a bulletin board for display.

Scavenger Hunt

1. Hand out Master 1.4i to each student. Explain that these items are things that we will bring back to the classroom to start a collection.
2. Using the overhead, explain each section of the data sheet.
3. Remind students that they are not to bring back anything that is still alive or was alive when found.

Teacher Note

This sheet should go home with each student to be returned with the parent's signature

Field Trip Information Sheet

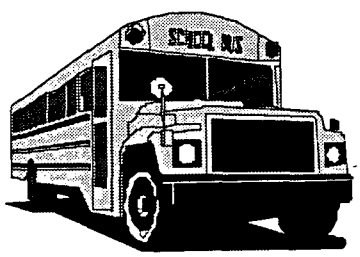
1. Give each student a copy of Master 1.4j (Field Trip Information Sheet).
2. Go over the information. When discussing rules, come up with consequences for breaking the rules. These consequences will be strictly enforced.

1.4b Field Trip
Bear Point

Materials

Mater 1.4d (Students need a second transect data sheet for their field data)
Master 1.4e
Master 1.4f
Master 1.4g
Mater 1.4h
Master 1.4i
At least one set of identification sheets per group (Appendix B)
Field notebooks with masters
extra notebook paper
pencil
One large garbage bag per group (for collecting marine debris)
2 - 3 large ziplock bags for scavenger hunt items
2 transect poles per group
1 length of rope per group marked off in meter increments (approximately 50 meters each)
1 tape measure (centimeters) with a weighted end per group
1 sheet of notebook paper hole reinforcement sheets

Teacher Note
These Masters should already be in their notebooks before going on the field trip.



Procedure

Teacher Preparation

Be sure each student has copies of all the necessary masters in their notebooks.
Be sure the information and rules (Master 1.4j) have been returned and signed by each student and their parents.
Be sure all the data sheets have been introduced to students before going to the field.
Divide the students into 2 groups per classroom.

Teacher Note
If you have enough volunteers to split the class into smaller groups the transect goes much easier. More students will be involved in the activity

Lesson Development

Teacher Note
Once arriving at the site, keep students on board the bus for further instructions.

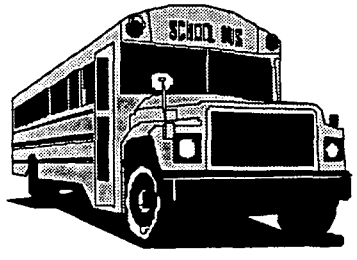
1. Once the students have arrived at the field site, remind them of the activities they will be doing throughout the field trip. Stress that they are here to gather evidence for their investigation into Mangroves, Mosquitoes, and Man and not to play.
2. Quickly go over the identification sheets. Have them pay particular attention to the differences in the types of mangroves. If possible, have examples of the leaves and seeds to show them at this time.

Teacher Note
Have as many adults with each group as possible. Allow them to see the procedure sheets for the transect so they may help with the activity. You may want them to have data sheets of their own to record their observations.

3. Explain that the transect poles have been set for each area. Assign each group their site number.
4. Have each group select students who will do the measuring for the profile line and students who will do the survey along the profile line. Explain that they can share their information when they get back to the classroom.
5. Walk the students out to the transect sites. Stop along the way and show them one of the culverts and allow them to observe the water flow.
6. Point out any birds, animals, or plants of interest to the students. Have them record their observations.
7. Once at the transect sites, allow the students to begin their transect. Remind them that they have a copy of the procedure in their notebooks to which they can refer.
8. Once the transect is complete, students must roll up the ropes and return the ropes, measuring tape and paper clips to their group leader.

Teacher Note
Be sure to keep a close watch on students so they are not going into the water. Any students not handling animals gently will be removed from the activity.

9. Allow the students to look for any scavenger hunt items they may not have found.



1.4c Field Trip Wrap-up

Materials

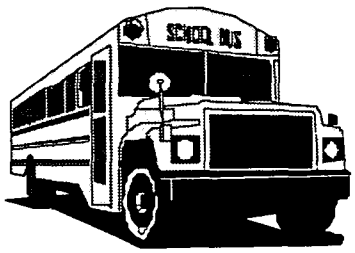
Field Note Books with all field trip data sheets
Graph paper
Overhead of graph paper

Teacher Preparation

1 piece of graph paper per child
Master 1.4h - Time Line

Lesson Development

1. Plot the results of the transects done on the field trip. (See classroom transect diagram for set up of graph paper.) There will be two sets of data to graph.
2. Add into the profile all the items found along the profile line survey. Ask the students to share their observations.
3. Go over all the observations students made on their flora and fauna survey. If any of the observations were made in areas which could be included on their profile, have them added. Discuss any animal behaviors which may have been observed. Talk about the animal's adaptations to the environment.
4. Go over the Marine Debris Survey data sheets. Using Master 1.4h, have the students fill in the "Time needed to decompose" column. Discuss dangers to the environment for each of the items listed.
5. Go over the scavenger hunt data sheet. See how much was collected. Ask students for anything else they may have collected while they were on the field trip.



Teacher Note

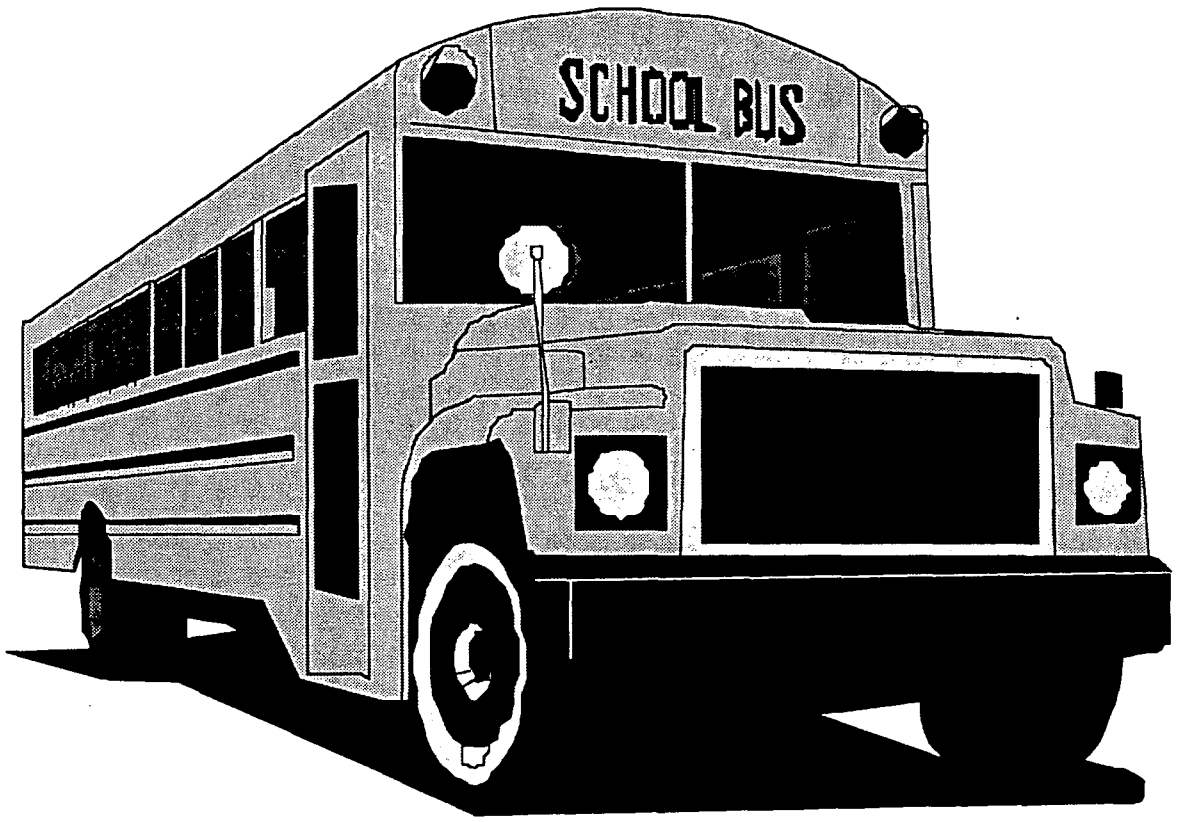
You may want to plot one of the profiles on a large sheet of paper. This profile could be added to a bulletin board and the items found on the profile line survey could be drawn in or, if they were collected on the scavenger hunt, pasted on to the sheet.

Teacher Note

With most of the activities we will be doing a Detective's Case Study. Students may want to keep all of these together in one section of their notebooks for future reference.

Conclusion

The purpose of the field trip is to familiarize the students with the environment they will be studying. As their investigation continues, they will be able to visualize some of the areas, plants, and animals we will be learning about. Observation skills should be emphasized throughout the investigation. Encourage students to share their experiences with their families.



Detective _____

Master 1.4a Vocabulary

Vocabulary

1. observe - _____

_____

2. data - _____

_____

3. flora - _____

_____

4. fauna - _____

_____

5. marine - _____

_____

6. debris - _____

_____

7. survey - _____

_____

8. scavenger - _____

_____

9. transect - _____

_____

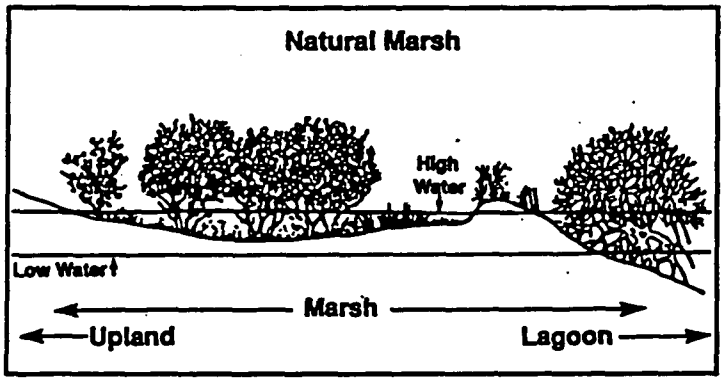
10. elevation - _____

Surface Water Improvement and Management

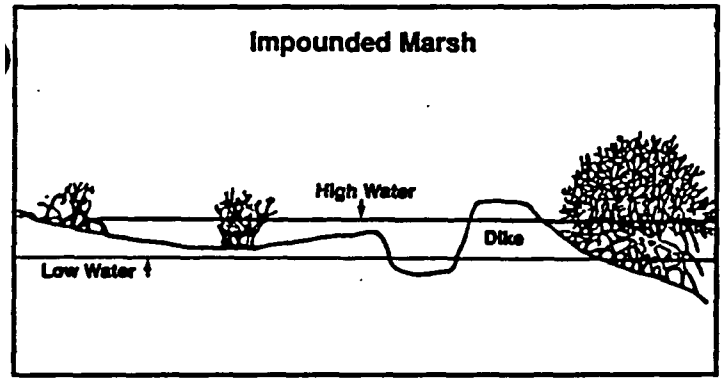
Master 1.4b
Impoundment Information Sheet

Fact Sheet

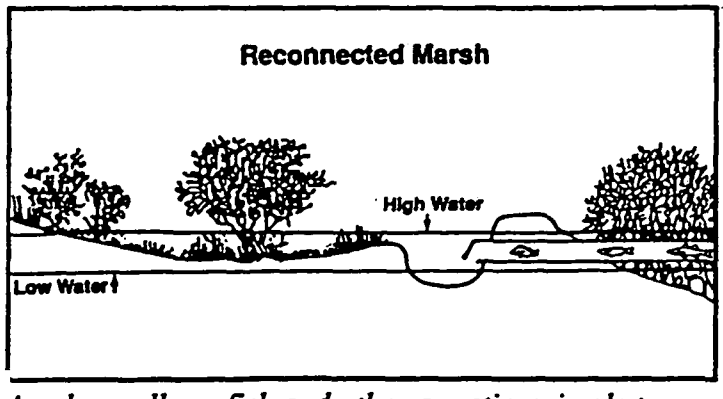
Rehabilitation of impounded salt marshes will benefit Florida's Indian River Lagoon



This is how a natural salt marsh looks. Fish and other aquatic animals find shelter and food in the marsh.



Dikes built to control mosquito breeding isolate the marsh from the lagoon and also kill vegetation.



A culvert allows fish and other aquatic animals to travel between the marshes and the lagoon.

The Indian River Lagoon system, which stretches from New Smyrna Beach south to Jupiter Inlet, acts as a breeding ground and nursery for aquatic animals. It has the highest species diversity of any estuary (where salt and fresh waters mix) in North America, with more than 4,300 species of animals and plants. The lagoon's salt marshes and mangrove swamps provide nursery areas for many species of aquatic animals. Fish, crabs and birds are provided abundant food and protection from predators in the periodically flooded vegetation of the marsh. But because most of the marshes are now impounded, they are shut off from the many fish and other animals in the lagoon.

The problem

Since 1954, more than 40,000 acres of salt marshes and mangrove swamps have been diked off and flooded to prevent salt marsh mosquitoes from laying their eggs in the mud. Unfortunately, isolation of the marshes from the 156-mile lagoon system adversely affected fisheries and wildlife habitat.

Scientists now know that only a few inches of water are needed in the marshes to control mosquito breeding. And those water levels are only necessary during the summer mosquito breeding months.

As a part of the Indian River Lagoon SWIM (Surface Water Improvement and Management) Plan, thousands of acres of impounded marshes in Brevard and Indian River counties are to be reconnected to the lagoon, in an attempt to partially restore the ecological function of the marshes without compromising mosquito control effectiveness.

continued

The St. Johns River Water Management District, Florida Department of Health and Rehabilitative Services, Florida Medical Entomology Laboratory, U.S. Fish & Wildlife Service and mosquito control districts in Brevard and Indian River counties are now working together on this ambitious project.

Their coordinated, long-range management plan will mean significant improvements in fish and wildlife resources as well as water quality while maintaining mosquito control. Reconnecting impounded marshes has never been attempted on this scale.

How reconnection solves the problem

Culverts with flap gates (and in some cases, pumps) will be installed in approximately 43 impoundments in Brevard and Indian River Counties. Culverts will allow water, nutrients, fish and other aquatic animals to travel between the impounded marshes and the lagoon. The culverts will remain open except during the summer months when they will probably need to be closed for mosquito control.

Costs dependent on land values

Total cost of the five-year project is estimated at $9.4 million. Purchase and installation of culverts, flapgates, pumps and other water control structures, together with planning and permitting, is estimated to cost $2.4 million.

Land acquisition potentially accounts for the largest single expense for this project, estimated at $7 million. Many of the impounded marshes are privately owned and may have to be purchased if the owners don't consent to having culverts installed.

Benefit-Cost ratio more than 5-to-1

The Indian River Lagoon serves as a nursery ground for estuarine and ocean fish, accounting for half of the $300 million east Florida fish catch each year. This project will enhance the lagoon's fisheries because juvenile fishes will now have access to these marshes.

According to a 1989 University of Florida study, reconnecting only 4,600 of the 40,000 acres of isolated salt marshes to the lagoon would benefit commercial and sport fisheries by up to **$50 million**. This figure is conservatively estimated and does not include shellfish or total economic benefits (fish processing, purchase or rental of boats, gear, tackle and lodging).

Even after factoring in land acquisitions, **the benefits to fisheries alone are more than five times the cost for the entire project.**

Additionally, reconnecting these impounded salt marshes to the lagoon will enhance water quality. Several studies indicate enhanced water quality and environmental improvements could increase the potential value of these marshes by as much as **$44 million per year.** This project also will provide alternatives to the management of stormwater runoff, improve aesthetics and recreation, and increase habitat for non-fisheries species.

For more information about the Indian River Lagoon SWIM program, call Marty Smithson at (407) 984-4940 or the District's Division of Public Information at (904) 329-4540.

What is SWIM?

SWIM stands for the Surface Water Improvement and Management Act passed by the Florida Legislature and signed into law in 1987. SWIM provides for the clean-up, restoration and protection of Florida's vital water resources.

In passing the SWIM bill, the Legislature noted that pollution and destruction of natural systems have jeopardized some functions of many of Florida's important water bodies, such as the Indian River Lagoon.

The lagoon was one of six water bodies the state targeted for immediate attention by the SWIM program. Reconnecting impounded salt marshes to the Lagoon is just one of the many SWIM projects which will benefit the Indian River Lagoon.

MASTER
1.4c
Detective Worksheet
Classroom Transect

Detective _____ Date _____

Group Members _____

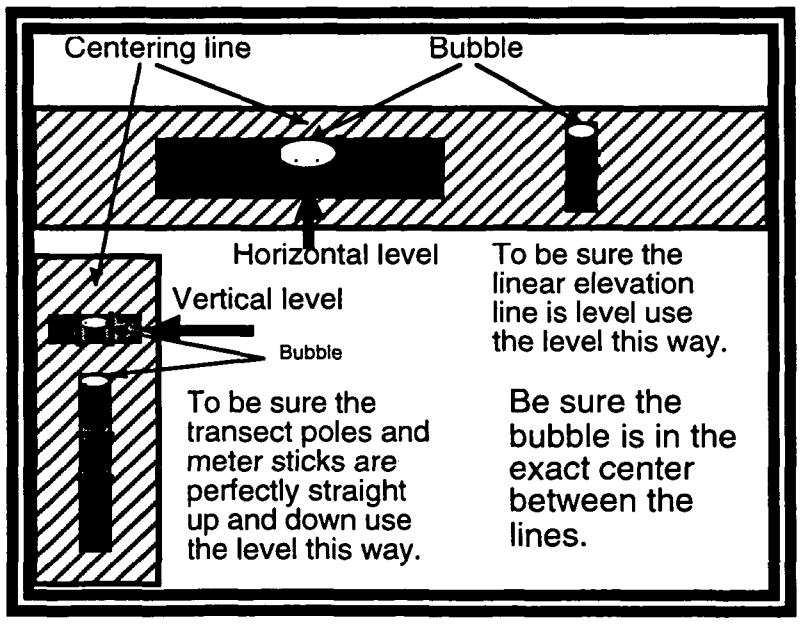
Detective Worksheet
Classroom Transect

Materials

2 Transect poles
1 string marked off in meters (elevation line)
3 levels
Tape measure with one end weighted
clothes pins
data sheets
pencil
graph paper

Procedure

1. Set up the transect poles ([1] on the Classroom Transect Measurement Diagram) across the classroom



2. Tie the elevation line to one transect pole. This line has been marked off in meters. Stretch the line across the classroom to the other transect pole making sure the rope is not blocked by or touching any object in the room. (See [2] on the Classroom Transect Measurement Diagram.) With a student at each transect pole, pull the elevation line tight between the poles so there is no bend in the line as it goes across the classroom. Using

the level as shown, adjust the level of the string so that it is parallel or level with the floor. You may need to wrap the line around the poles in order to get the poles standing up straight. (You may check this by using the level vertically along the poles.) Be sure the first meter mark is at the transect pole where you will start your measurements so all other meter marks are still exactly whole meters away from the first pole. Hold the poles as straight as possible. Take turns with other students so everyone gets a chance to do each job.

3. Using the tape measure, allow the weighted end to touch the floor. Measure the distance from the floor to the line each time there is a large change in elevation. Any large objects such as desks and chairs should be treated as though they are part of the floor. Smaller objects such as pens, books, and paper will be recorded in the survey of the transect line. Your transect will be more accurate the more measurements you take. (See [3] on the Classroom Transect Measurement Diagram.) Record the measurements on the data sheet. (See sample on data sheet, column B) Keep checking that the transpect poles are as straight as possible and the line is pulled tight when making the measurements.

4. At the place where the measurement is taken, fold and stick a notebook paper hole reinforcement circle over the elevation line ([4] on Classroom Transect Measurement Diagram.) This will mark the distance from the transect pole where you took the elevation measurement.

5. After taking all the elevation measurements, go back and measure how far the reinforcement stickers are along the elevation line from the transect pole. (Remember each meter is marked off on the line so you do not have to measure from the transect pole each time. Count the number of meter marks from the transect pole and add the portion of a meter or centimeters from the last meter mark.) Record the distance from the transect pole on the data sheet next to the correct elevation measurement. (See sample on data sheet, column D).

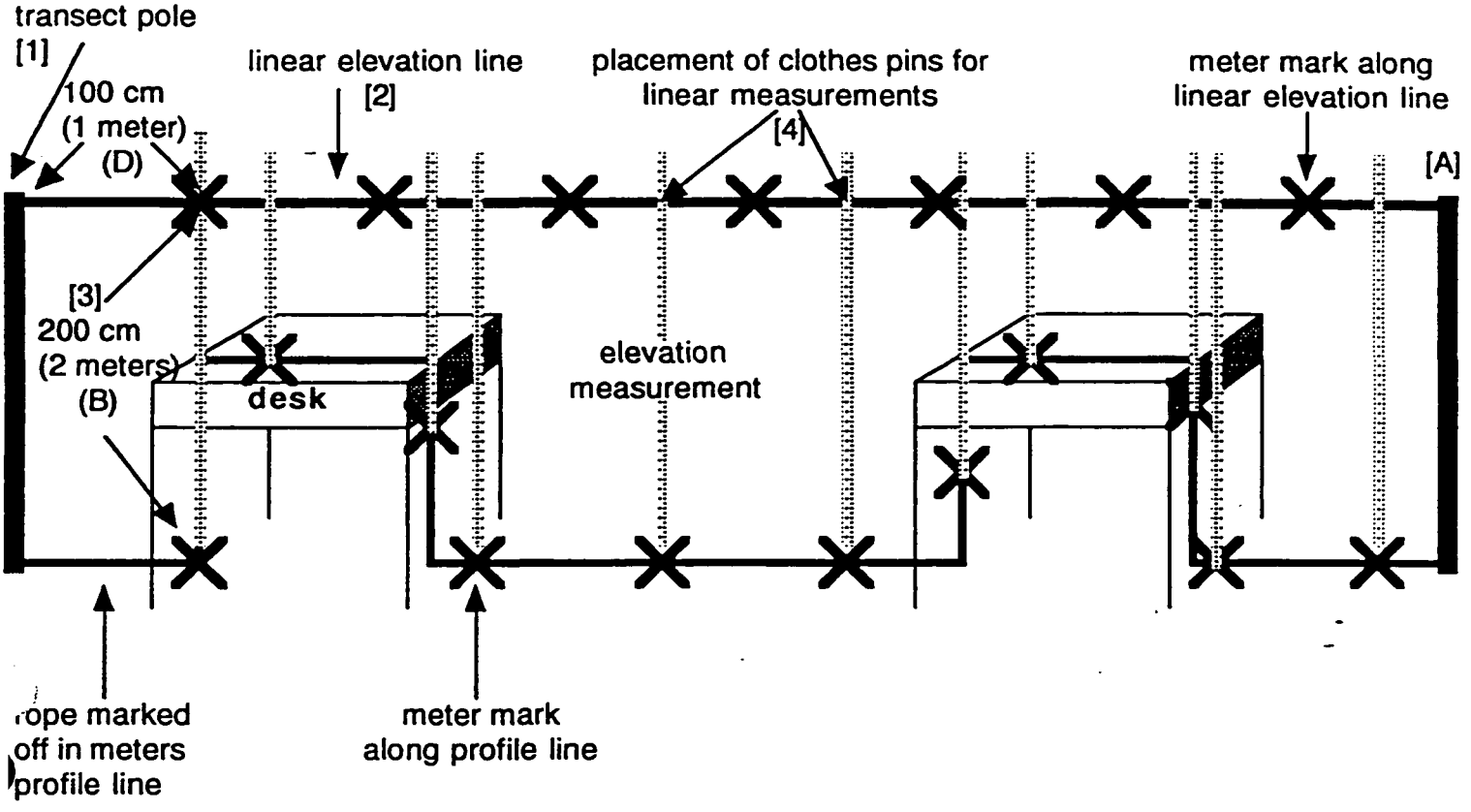
6. Go back to the beginning of your transect line and record all the smaller objects which are along the line. Be sure you record them at the correct measurement from the transect pole. If the object is 2 meters from the pole, record it as being that distance away from the pole.

7. Determine which elevation measurement was the **greatest** and record in **column A.** **Subtract** each measurement (**column B**) from this number (**column A**) and record on data sheet as actual elevation from point 0. (See sample on data sheet, column D.) In the classroom transect, this will be the distance from the actual floor to the elevation line.

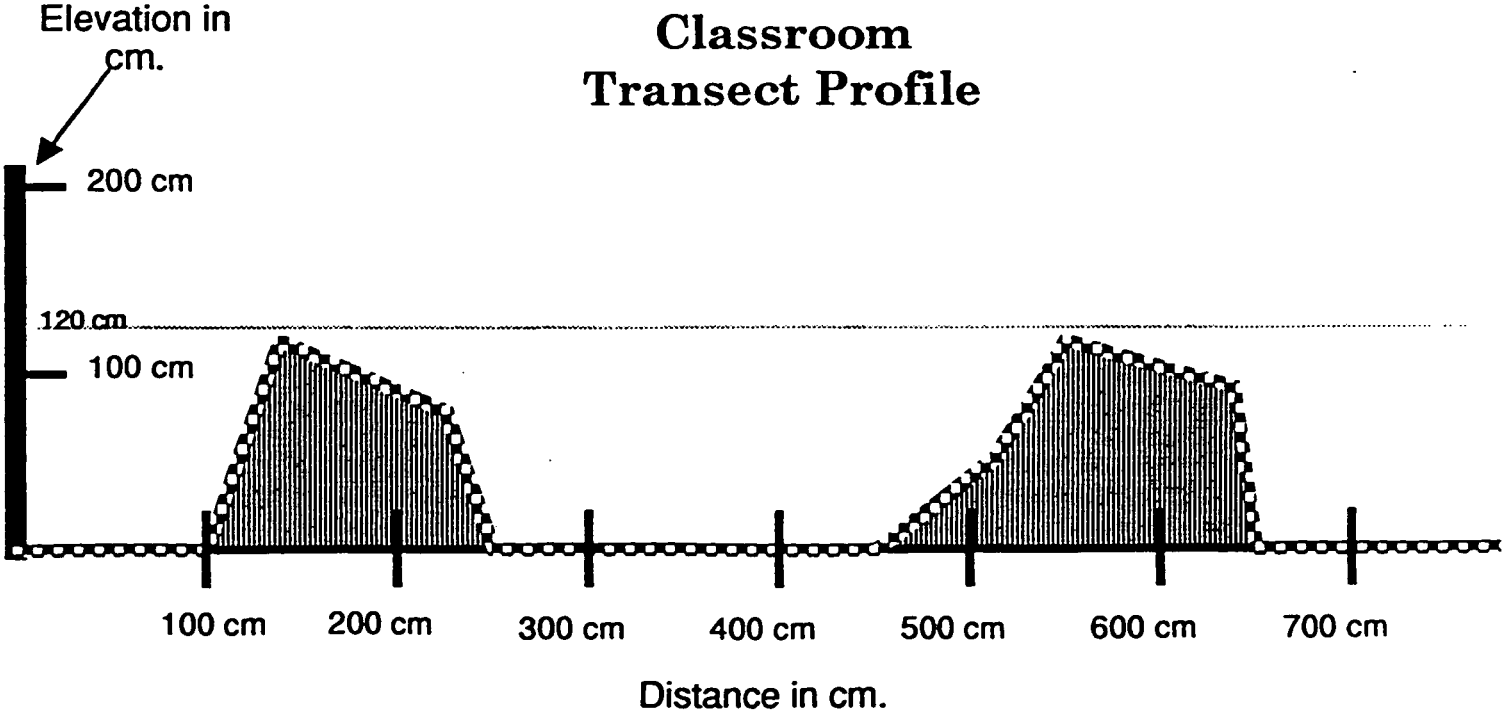
10. Using a sheet of graph paper, plot your elevation data. See Classroom Transect Profile. Connect all data points.

11. Along the elevation line on your graph, either draw or write in the objects as they occurred in your survey.

Classroom Transect Measurement Diagram



Classroom Transect Profile



MASTER
1.4d
Transect data

Detective _____ **Date** _____

Group Members _____

Transect Data Sheet

Time _____ **Weather** _____

A Largest measurement	B Distance from elevation line to ground	C A - B = C Actual Elevation	D Distance from Transect pole to measurement mark	E Profile line survey
sample 200 cm	200 cm (2 meters)	0	100 cm (1 meter)	paper, pencil,
200	80 cm	120 cm	130 cm	

A Largest measurement	B Distance from elevation line to ground	C A - B = C Actual Elevation	D Distance from Transect pole to measurement mark	E Profile line survey

Detective _____ Date _____

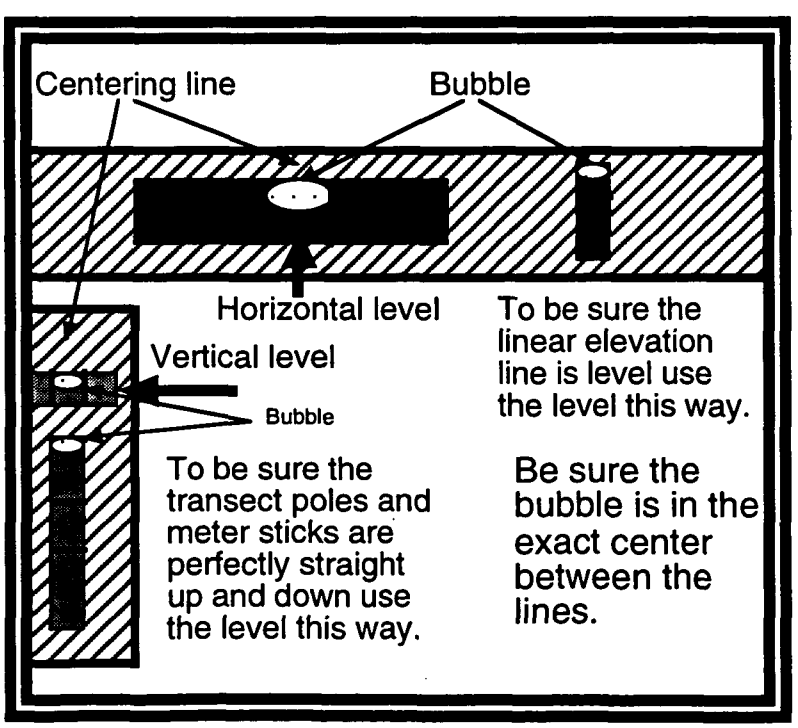
Group Members _____

Detective Worksheet
Field Transect

Materials

2 Transect poles
1 string marked off in meters (elevation line)
3 levels
meter sticks
clothes pins
data sheets
pencil
graph paper

Procedure



1. Set up the transect poles on either side of the dike at the edge of the water on both sides.
2. Tie the elevation line to one transect pole. This line has been marked off in meters. Stretch the line across the dike to the other transect pole making sure the rope is not blocked by or touching anything across the dike. With a student at each transect pole, pull the elevation line tight between the poles so there is no bend in the line as it goes across the dike. Using the level as shown, adjust the level of

the string so that it is parallel or level with the horizon. You may need to wrap the line around the poles in order to get the poles standing up straight. (You may check this by using the level vertically along the poles.) Be sure the first meter mark is at the transect pole where you will start your measurements so all other meter marks are still exactly whole meters away from the first pole. Hold the poles as straight as possible. Take turns with other students so everyone gets a chance to do each job.

3. Measure the distance from the ground to the line each time there is a large change in elevation. Your transect will be more accurate the more measurements you take. (See [3] on the Classroom Transect Measurement Diagram.) Record the measurements on the data sheet. (See sample on data sheet, column B) Keep checking that the meter sticks are as straight as possible and the line is pulled tight when making the measurements.

4. At the place where the measurement is taken, fold and stick a notebook paper hole reinforcement circle over the elevation line ([4] on Classroom Transect Measurement Diagram.) This will mark the distance from the transect pole where you took the elevation measurement.

5. After taking all the elevation measurements, go back and measure how far the reinforcement stickers are along the elevation line from the transect pole. (Remember each meter is marked off on the line so you do not have to measure from the transect pole each time. Count the number of meter marks from the transect pole and add the portion of a meter or centimeters from the last meter mark.) Record the distance from the transect pole on the data sheet next to the correct elevation measurement. (See sample on data sheet, column D).

6. Go back to the beginning of your transect line and record all the smaller objects which are along the line. Be sure you record them at the correct measurement from the transect pole. If the object is 2 meters from the pole, record it as being that distance away from the pole.

7. Determine which elevation measurement was the **greatest** and record in **column A.** **Subtract** each measurement **(column B)** from this number **(column A)** and record on data sheet as actual elevation from point 0. (See sample on data sheet, column D.) This will be the distance from the lowest water level to the elevation line. The water levels can be different if the impoundments are flooded at the time of the field trip.

10. Using a sheet of graph paper, plot your elevation data. See Classroom Transect Profile. Connect all data points.

11. Along the elevation line on your graph, either draw or write in the objects as they occurred in your survey.

Master
1.4f
Detective Worksheet
Flora and Fauna Survey

Detective _____ **Date** _____

Group Members _____

Detective Worksheet
Flora and Fauna Survey

Materials

Field identification Sheets
Data sheets
Field note book
pencil

Procedure

Using identification sheets given to each group, identify and record as much flora (plants) and fauna (animals) as possible while on the field trip. If you cannot identify something take detailed notes on its description.

Remember to stay as quiet as possible when making observations

Use this table to record your observations. Be sure to label what each column and row represents. If you need a larger table, make your own on an extra sheet of paper.

Observation	Location	Behavior	Notes
Great Blue Heron	Water's edge	looking for food	use its beak to catch fish, very fast, strange call when it flew away

Draw pictures of anything you are unable to identify

MASTER 1.4g
Detective Worksheet
Marine Debris Survey

Detective _____

Group Members _____

Detective Worksheet
Marine Debris Survey

Materials

Large Garbage bag for each group
Data sheets
Field note book
pencil

Procedure

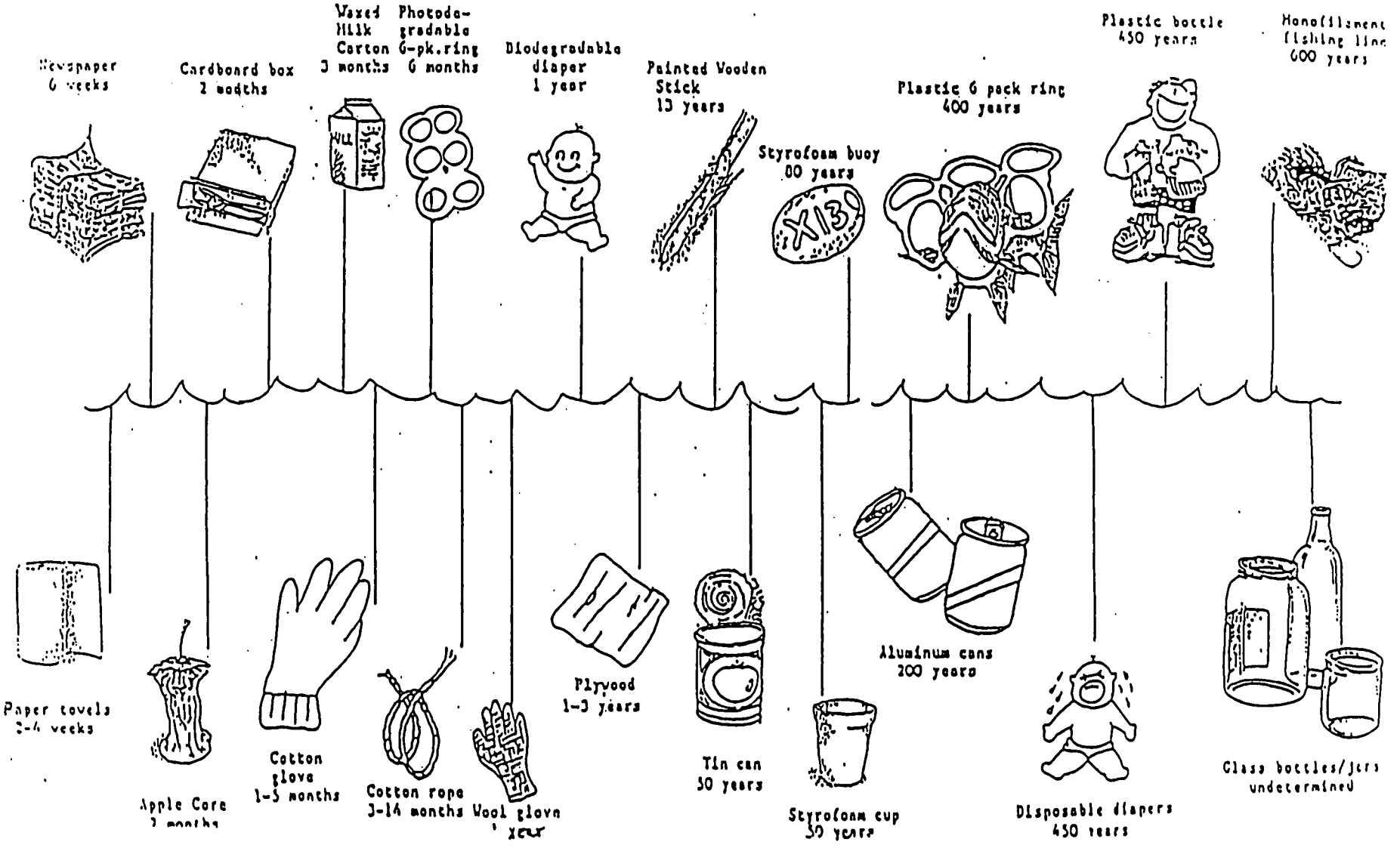
In a large trash bag, collect any marine debris found during the field trip. Do not pick up any fish hooks, rusty metal, or glass. This is for your safety. Be sure to record these items along with all you have collected.

Use this table to record your observations. Be sure to label what each column and row represents. If you need a larger table, make your own on an extra sheet of paper.

Marine Debris Item	Location Collected	Time Needed to Decompose	Danger to the Ecosystem
Six Pack rings	Water's edge	400 years	animals can get caught in the rings

MASTER 1.4h
Marine Debris
Time line

MARINE DEBRIS TIMELINE



Detective _____

MASTER 1.4i
Detective Worksheet
Scavenger Hunt

Detective Worksheet
Scavenger Hunt

These items are to be collected by the group. They can all be brought back to the classroom for further study. Use your identification materials to help in finding these items. Put the items in the zip lock bag to carry back to the school. Each group only needs to collect one of each item.

Item	Location Collected	Notes
Red Mangrove leaf and seed		
White Mangrove leaf and seed		
Black Mangrove leaf and seed		
Oyster shell		
Clam Shell		
Crab Claw shell		
Barnacle shell		
Sea Grape leaf and fruit		
Australian Pine Branch and cone		
Bird Feather		
Drawing of an animal track		
Anything of interest		
Anything of interest		
Anything of interest		

MASTER 1.4j
Field Trip
Information

Field Trip Information Sheet

Bear Point

Detective _____ Teacher_____

Date of Field Trip _____

We will be taking a field trip to Bear Point (just north of FPL on A1A) as part of our Mangrove, Mosquitoes and Man investigation. We will be making field observations of this mosquito impoundment.

What To Wear.

Long Pants and a Long Sleeve shirt (light in color if possible)
Shoes which can get wet and muddy
Hat (if protection from the sun is needed)
Sun Screen (apply at home)

What to Bring

Investigation Notebook with Detective Worksheets
Pencil
Lunch (there will be no place to purchase a lunch)

Rules

1. Students are not to go into the water.

2. Students will not run, push, shove, or yell at anytime during the field trip.

3. Do not abuse or destroy any plants or animals. The only things to be removed from the site are those on your scavenger hunt list or those approved by your teacher.

4. If these rules are not followed, these are the consequences:

_____ _____

student's signature parent's signature

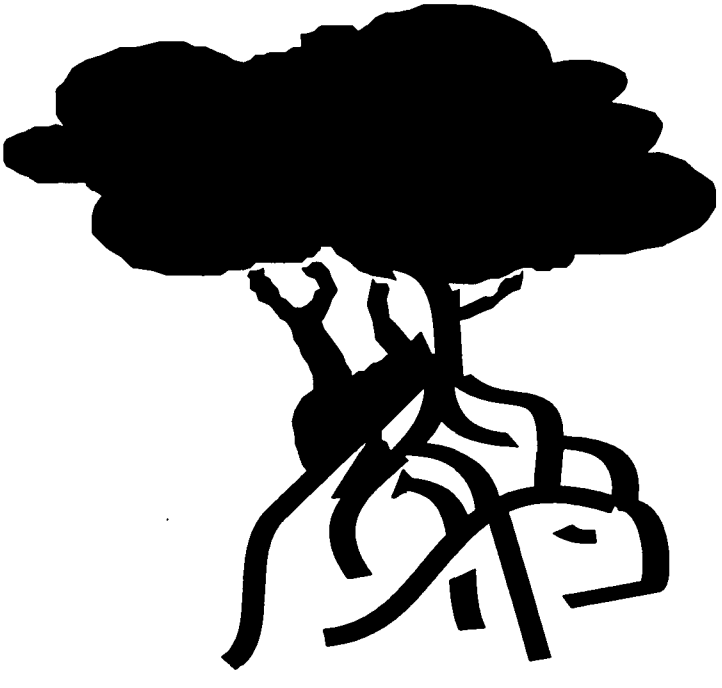
Parents are welcome to join us. Please let us know.

_____ I will attend

MANGROVES, MOSQUITOES, AND MAN

UNIT 2

THE INDIAN RIVER LAGOON: AN OVERVIEW



UNIT 2

THE INDIAN RIVER LAGOON: AN OVERVIEW

Unit 2 is an investigation into the Indian River Lagoon. Using the techniques learned in Unit 1, students will study physical, biological, ecological, historical, and economic aspects of the Lagoon. They will begin to learn to look at the system as interdependent on each element. After visiting an impoundment and becoming aware of how impoundments work, students will see how all aspects of the system fit together and how man's presence has had major impacts on the Lagoon. As the study develops, students will identify players (groups of people) who have an interest or stake in the future of the Indian River Lagoon.

2.1 Geography / Climate

Background Information

Geography

The word geography can be broken into two parts. The "geo" part of the word means "Earth" and the "graph" part means "to describe". Thus, geography is the study of describing the Earth. In simple terms, **geography** asks (and hopefully answers!) questions that people throughout the world need and want to know:

Where am I?
How can I get from here to there?
What will be there when I get there?

Explorers wanting to know the answers to all these questions were responsible for discovering places that no one had ever been before. It was their investigative skills that solved the mysteries of unknown places in faraway lands.

Maps can help find where we are now, where we want to go, and how to get there. People use maps not only to find their way around, but also to learn more about that location. Maps come in different **scales.** The scale you will choose will depend upon the information you will need. A large scale map shows more detail than a small scale map. For instance, a street map is an example of a large scale map where a world map is an example of a small scale map. If you were interested in finding the best way to get from your house to the school, you would want to use a large scale map of St. Lucie County showing all the streets and roads (and their names), the parks, schools, shopping areas, railroads, airports, and important buildings. In fact this map could help you find anything in St. Lucie County. But if you were interested in finding the best way to get to California, you would want a smaller scale map of the United States showing all the major highways.

Vocabulary

Geography - n. *1. the study of the surface of the earth {or any place in the universe} and how it is divided into continents, countries, seas, and other parts. Geography also deals with the climates, plants, animals, and resources of the earth. 2 the natural features of a certain part of the earth [the varied geography of China]*

Maps - n. *a drawing or chart of all or part of the earth's surface [or any place in the universe], showing where countries, oceans, rivers, cities, and other features are located.*

Scale - n. *the way that the size of a map, drawing, or model compares with the size of the thing that it stands for [Example: 1 meter = 200 meters means one meter measured on the map equals 200 meters as measured on the ground]*

Vocabulary

Topographic map - n. *map showing the surface areas of a certain region*

latitude - n. *distance north or south from the equator. Latitude is measured in degrees*

longitude - n. *distance that is measured in degrees east or west of an imaginary line running north and south through the town of Greenwich, England*

Navigate - v. *To steer, or control the course of [a ship, vessel, or any mode of transport]*

peninsula - n. *a long piece of land almost completely surrounded by water.*

coastlines - n. *the outline or shape of the land along the sea [or other body of water]*

If we wanted to know about the place we are in, there are different types of maps that would tell us different information. We've already talked about street maps showing roads, parks, schools, shopping areas, etc. **Topographic** maps, made by the United States Geologic Survey are used by people who want to find information about a larger area. They show major streets and roads, rivers, streams, canals, railroads, parks, types of vegetation and elevations of the land. They also include **latitude** and **longitude** designations.

Aerial maps give a "bird's eye" view of what's on the ground. They differ from street maps and topographic maps in that they are photographs taken from airplanes or helicopters. They can be used to see exactly what is on the ground at that moment in time.

Navigational charts are used by boaters who want to know where they are going, where the marinas and docks are, and what underwater hazards are in the water, such as rocks, reefs, and shipwrecks. They also show the water depth.

All maps have an arrow designating which way is North, as well as a key which includes the scale of the map and an explanation of the symbols and colors used on the map.

Florida is an easy place to find on the map. It is a **peninsula** that juts out into the water between the Atlantic Ocean and the Gulf of Mexico. Since peninsulas are surrounded on three sides by water, they often have long **coastlines**. Florida has two coasts: the East Coast, bordering on the Atlantic Ocean, and the West Coast, bordering the Gulf of Mexico.

The Indian River Lagoon is 156 miles long, and located along the mid portion of the Atlantic Coast of Florida. The Lagoon spans about one-third of the Atlantic Coast. It extends from Ponce de Leon Inlet in New Smyrna Beach on the north to Jupiter Inlet on the south. Portions of the Lagoon are found in Volusia, Brevard, Indian River, St. Lucie, and Martin Counties. It encompasses three major water bodies: Mosquito Lagoon, Indian River and Banana River.

The Lagoon covers 40% of the east coast of Florida. The **watershed** includes all pinelands, scrub lands, hammocks, fields, pastures and our homes and cities. The water drains through natural rivers, streams and **canals.** The Lagoon's watershed comprises about 1.5 million acres.

Climate

Weather and **climate** affect us everyday -- in what we wear, what kinds of plants will grow in our gardens, even where we choose to live. Weather consists of the day-to-day, ever changing events of **precipitation,** wind, temperature, clouds, **humidity**, and **air pressure**.

Weather patterns that stray from the norm can wreak havoc in the lives of residents. Snow storms are prevalent and expected in northern states, but severe snowfalls occurring close together in time can affect air travel, cause traffic jams, close schools and businesses, and damage power lines, effectively shutting down a town or city. In the Deep South, freezing weather can adversely affect crops, creating an increase in prices for fruits and vegetables in the grocery stores. On the other hand, a warmer-than-usual winter in the North can save residents money in heating bills, and a cooler than usual summer in the South can save in air conditioning bills. Weather can also have some deadly effects. In 1993, extreme rains in the Midwest caused flooding, with billions of dollars in damage, and left many people without safe drinking water. Over 400 deaths in the Chicago area were contributed to the oppressive heat in 1995, with temperatures over 100° **Fahrenheit** (37° **Celsius**). Many residents there, unaccustomed to long periods of high temperatures, do not have air conditioners and the fear of crime kept many from opening their windows.

Vocabulary

watershed - n. *the area of land drained from a river system.*

canal - n. *a channel dug and filled with water so that ships [and water] may cross a stretch of land. In Florida, canals are dug for land drainage to drain wetlands for farms, development and mosquito control*

Climate - n. *the usual weather conditions of a place over a long period of time*

weather - n. *the conditions outside at any particular time and place. Temperature, sunshine, and rainfall are important weather conditions that are measured*

precipitation *- n. rain, snow, or any other moisture that falls from the sky.*

humidity - n. *the amount of moisture, or water in the air*

air pressure - n. *the pressure of the atmosphere or compressed air*

Vocabulary

Fahrenheit - adj. *having to do with a thermometer that measures the freezing point of water as 32 degrees above zero and the boiling point of water as 212 degrees above zero*

Celsius - adj. *of or describing a thermometer on which the freezing point of pure water is zero degrees and the boiling point is 100 degrees*

centigrade - adj. *another word for Celsius*

temperate - adj *neither very hot nor very cold. The temperate zone is there fore not very hot or very cold when compared to all other areas of the Earth.*

tropic - adj. *either of the two imaginary circles around the earth that are parallel to the equator and about 23.5 degrees latitude from it. The one to the north is called the* ***Tropic of Cancer.*** *The one to the south is called the* ***Tropic of Capricorn.*** *This region has a very hot climate.*

Subtropic zone - n. the zone between the tropic and the temperate zones.

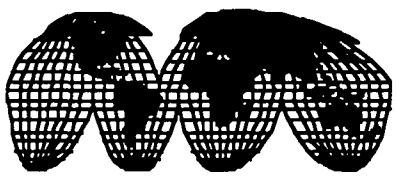
Observations of weather elements over a period of time lead to the discovery of generalized patterns, called climate. Florida falls into two distinct climatic zones. The northern portion of the state is the **temperate** region, while the southern portion is subtropical. The dividing line is approximately the middle of the state, around the Cape Canaveral Area. Globally, the temperate zone lies between the polar and tropic climatic zones. Temperate zone areas usually experience a greater range of temperatures than do polar (mostly cold) and tropic (mostly hot) areas. The **subtropic zone** occurs just north of the tropic zone and just south of the temperate zone. Even though there are two zones, Florida in general experiences a cold dry season and a warm rainy season. The dry season occurs from October or November to May and the wet season from June through September or October. In addition, the climate of the Keys area is distinctive because the differences of the wet and dry seasons largely disappear.

The two climatic zones can be delineated by the north to south decrease of the annual temperature range. Variations in precipitation can be seen as well. South Florida experiences more extremes -- the dry season is drier and the wet season rainier than North Florida. Temperature ranges are wider in the Northern portion of the state. According to the government records (National Climatic Data Center, Asheville, NC), the all time high and low temperature records for Florida cities were both set in the Panhandle. The highest temperature was recorded in Monticello at 109° F., set on July 29, 1931. The lowest was in Tallahassee on February 13, 1899, with a temperature of minus 2° F. (Source: Florida Today from the National Climatic Data Center in Asheville, NC.) Frosts and freezes are more frequent and of longer lasting duration in Northern Florida than in the Southern portion of the state. However, between 1930 and 1979, with the exception of the Keys, none of Florida escaped below freezing temperatures.

Ft. Pierce is located at 27° 26.8' N latitude and 80° 19.6 W longitude. This is in the northern end of the subtropics and the southern extreme of the temperate zone. Because of this location, the plants and animals and the ecology of the Indian River Lagoon can be greatly impacted by the extremes in conditions. Mangroves and coconut palms are species found in the subtropics. In years with severe freezes, these plants will die back. The animals which depend on subtropic species of plants killed by deep freezes will then suffer as well. In 1989 St. Lucie County suffered such a freeze. Mangroves were greatly impacted by the freeze. Many of the subtropic species of fish were found floating in the Lagoon due to the severe change in water temperature. Temperature is affected also by its relation to water bodies. On cold, still days in the winter, the air temperatures will be warmer for areas closer to the water. Conversely, on hot, summer days, the cooler water temperature will keep the temperatures cooler near the water.

Precipitation is caused by **convective clouds**, sea breezes, and tropical storms and hurricanes. Snow and rain provide fresh water input to streams and lakes, as well as to ground water via **percolation** into the ground. **Droughts** occur when atmospheric and climatic conditions do not favor the formation of rain clouds, and can have devastating effects on crops and water supplies. Droughts also occur when ground water supplies are depleted or more water is used than available from rain or snowfall. Wetlands such as the mangroves found along the Indian River Lagoon help store flood waters. Much water is evaporated off these wetland areas to help in the formation of clouds and rain.

Florida's location makes it a prime candidate for hurricanes and other tropical storms. The word "hurricane" has Spanish and West Indian roots. A **hurricane** is a tropical cyclone, most often found in the Caribbean Sea, Gulf of Mexico, and adjacent portions of the Atlantic Ocean. Hurricanes obtain their energy from the recycling of sea water (through evaporation and precipitation), and usually begin to



Vocabulary

convective clouds - n. *clouds that form by moist air being heated, rising, and then cooling*

percolation - n. *[the act of] oozing through a porous substance*

Drought - n. *a long period of dry weather, with little or no rain*

****hurricane - n.*** *an intense tropical weather system with a well defined circulation and maximum sustained winds of 74 mph or higher. In the western Pacific, hurricanes are called "typhoons," and similar storms in the Indian Ocean are called "cyclones."*

Vocabulary

***tropical depression - n.** an organized system of clouds and thunderstorms with a defined circulation and maximum sustained wind speeds of 38 miles per hour or less.*

***surge - n.** a sudden, strong rush [A **storm surge** is a rise in tide caused by a hurricane as it moves over or near the coastline. It can be much higher than the normal tide rise, with breaking waves on top.)*

*** Tropical storm - n.** an organized system of strong thunderstorms with a defined circulation and maximum sustained winds of 39 to 73 miles per hour*

*** watches - n.** alert given when a storm (either tropical storm or hurricane) poses a threat to a certain area within 36 hours*

*** warnings - n.** alert given when a storm (either tropical storm or hurricane) is expected to strike a certain area within 24 hours.*

weaken as they move from the sea to over a large land mass. Hence, the prime time frame for tropical storms and hurricanes is when the ocean water is warmest and the humidity the highest: This occurs from June through November, with the peak time during September and October.

While Florida experiences rain and other effects from **tropical depressions,** hurricanes with their winds of 74 or more miles per hour can have deadly consequences. At full strength, winds can gust more than 200 miles per hour. These destructive winds cause injuries and damage from flying debris, disrupt electrical power, telephone service, fresh water supplies, and transportation. **Storm surges** may cause water levels to rise 10 feet or more above normal high tide levels, and high energy, destructive waves may overcome coastal lowlands or flood towns and fields. High water levels accompanied by extensive rainfall can result in widespread flooding. Wetlands help store floodwaters and protect the shoreline from erosion, wind and flooding. Since mosquito impoundments are diked areas which can hold in flood waters, they are good storm buffers.

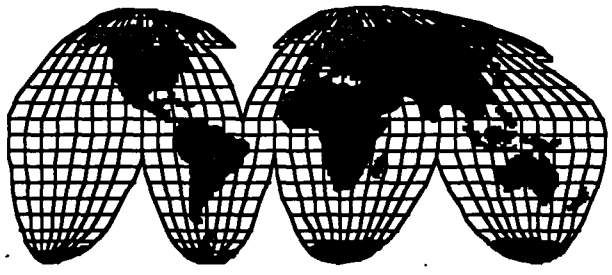
During the hurricane season, the National Hurricane Center in Miami maintains a constant watch for tropical disturbances that could develop into destructive storms. By using the longitude and latitude measurements on the globe, storms can be tracked or followed on a map. Weather forecasters are able to make predictions on where storms will have the greatest affect based on years of collected weather data and how certain weather conditions will dictate where a storm will move to in the future. **Tropical storm** and **hurricane watches** and **warnings** are issued to alert residents to the possibility of upcoming severe weather.

* definitions from **Hurricanes The Greatest Storms on Earth: A Preparedness Guide,** US Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, March 1994

Rationale

Section 2.1 is designed to familiarize students with some basic concepts of geography and climate. From these concepts students will learn more about the geography and climate of this area. A brief background on maps and the information maps can provide will be discussed. Using several different types of maps, students will locate their school and Bear Point and see what information they can derive from these maps.

Students will also be given a background on climate. The climate of Florida and the Indian River Lagoon will be discussed. Major climatic and weather conditions will be introduced, such as hurricanes.



Issues and players related to geography and climate will be introduced. Students begin to list those people who are most affected or have an interest in the climate and geography of the Indian River Lagoon. This list will be expanded as the students move through the curriculum.

Objectives

Students will:

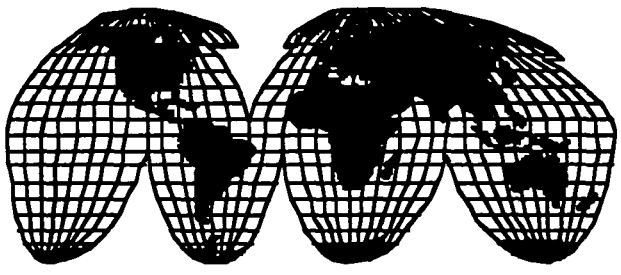
- Become familiar with some basic geography concepts
- Learn about different parts of a map
- Become familiar with several different types of maps and what information can be found on each
- Become familiar with the climate and weather of Florida and the Indian River Lagoon in particular.
- Identify players and issues involved in the geography and climate of the Indian River Lagoon Area.

Materials

World Globe
World Map - Flat
Florida Map
Topography Map
Tax assessor's aerial map of school (large scale)
Tax assessor's aerial map of school (small scale)
Navigation Chart - Ft. Pierce Inlet
Navigation Chart - Florida Straights
Navigation Chart - Sebastian Inlet to Jupiter Inlet
Geological Survey Map
Nautical Chart Symbols and Abbreviation Guide
Master 2.1a (Vocabulary)
Master 2.1b (Map Scavenger Hunt) & Transparency
Master 2.1c (Indian River Water Shed)
Master 2.1d (Hurricane Map)
Master 2.1e (Hurricane Tracking) & Transparency
Master 2.1f (Ft. Pierce Weather Data)
Graph Paper (transparency)
Master 2.1g (Players and Issues) & transparency
Overhead Projector
Hurricane Tracking maps (available from local T.V. stations, newspapers, and American Red Cross)
Optional -
2.1f for each student

Teacher Note

The list of maps is a suggested list. You will have to do some investigating of your own to find maps which will work with your students. (See Appendix G - Resource list) Be sure you are familiar with any maps you select so you can give the students some help in doing the exercises.



Procedure

Teacher Preparation

Read and become familiar with all background material
Make copies of Masters 2.1a, 2.1b, 2.1c, 2.1d, and 2.1e for each student
Optional - Master 2.1f for each student

Lesson Development

Geography

1. Go over the vocabulary words on Master 2.1a. Ask the students if they have any newspaper articles to share with the group.
2.. Introduce the students to the study of Geography. Discuss the concept of explorers going out to find new worlds and how difficult and exciting it must have been. Ask if there are any new frontiers man is exploring today.
2. Introduce the concept of maps and mapping. Discuss the idea of scale and how using maps of different scale will give the investigator different types of information.
3. Break the students into groups (one group for each map you have collected). Give each group one map. As you are passing out the maps, show the maps to the class and explain what information is found on the map. It should be left up to the students to find the key or legend for the map so they can figure out how the information can be read from the map. Hand out one map scavenger hunt (Master 2.1b) to each student. Allow the students about 10 minutes to see how many of the items on the map list they are able to find.
4. Go down the list on the scavenger hunt. Have each group say if they found the item. The students should record which maps had which items on Master 2.1b. Go over the questions on the Master.

Teacher Note

Relate the idea of scale to the drawing produced from the transect data. To change the scale of that map, use a large piece of butcher block (old news print roll) to enlarge the picture. The students would then be able to draw more details into the transect.

Teacher Note

Terrific bulletin boards can be generated from maps using string to locate items of interest to your students.

Florida Writes Activity

Have the students imagine they were exploring an area which had never been explored before. They have no maps. Describe what the adventure is like not knowing where you are going and what you might encounter.

✍ *Teacher Note* ✍

Have the students use an atlas to find a climate map for the world.

✍ *Teacher Note* ✍

Many classroom maps have climate maps included with the Florida map. If your classroom is equipped with such a map, be sure to use it in your discussion of climatic differences in the state.

✍ *Teacher Note* ✍

If at all possible, get hurricane tracking maps for all the students.

✍ *Teacher Note* ✍

Have the students research the track of some of the famous Hurricanes which have hit Florida. After tracking the storm, they can report to the class what damage was done by that particular storm.

✍ *Teacher Note* ✍

There are many books available that discuss the formation of a hurricane. This may make some interesting research projects for students

Climate

1. Introduce the students to the study of weather and climate. Be sure students understand the difference between weather and climate.
2. Site several instances where the weather has strayed from the norm and what were the consequences (See background information).
3. Using a globe, show students where the temperate zones are located (North - between the Arctic Circle and the Tropic of Cancer; South - between the Tropic of Capricorn and the Antarctic Circle). Explain that where the tropic and temperate zones meet, there is a zone called the sub-tropic zone. This is an area of transition between the zones. Using a map of Florida, show the students where the dividing line occurs between the temperate and sub-tropic zones in Florida (band from Cape Canaveral to Vero Beach and Northern St. Lucie County). Have the students discuss where they see coconut trees or mangrove trees. Point out that these are tropical plants and are greatly impacted by freezes.
4. Discuss some of the seasonal climate patterns in Florida. Show the students that as one moves through the state from north to south there are variations. Using a map of the United States, point out to the students how the peninsula of Florida is surrounded by water having an effect on the climate throughout the state.
5. Begin a discussion of hurricanes in Florida. Have the students look at the map of Hurricanes from 1885-1980 (Master 2.1d). The students should be able to locate the Indian River Lagoon on this map. Have them make some general observations about the occurrences of hurricanes along the Indian River Lagoon as compared to the rest of the state.
6. Using the hurricane tracking map(s), show the students how to track a hurricane. Ask them to determine the latitude and longitude of Ft. Pierce. Using Master 2.1e, have the students plot the track of the storm.

7. Hand out Master 2.1f. Using a piece of graph paper, have the students graph the monthly average rainfall and temperatures for Ft. Pierce. Have them also plot the temperature for 24 December 1989 along with the December average. Have them answer the questions on the Master.

Conclusion

Students should be able to discuss players and issues relating to the geography and climate of the Indian River Lagoon. Using Master 2.1g, have the students identify some of the players and issues relating to the geography and climate of the Indian River Lagoon. These should include:

Residents - strong desire to live along the shores of the Indian River Lagoon for water views, beach access, boating access, fishing access, and privacy

Developers - want to build houses and condominiums to sell.

Real Estate Brokers - want to sell more land

Boaters, Fisherman, and water sport enthusiast - want access to lagoon and beach

Tax Collectors and government administrators - developed land increase the tax base for the county and cities.

Mosquito Control District - control mosquitoes by keeping marshes impounded

Environmentalists - development along the lagoon can have negative effects on the ecology of the Indian River Lagoon because of habitat destruction, poor water quality, etc. Severe weather can damage plants at their most northern range allowing fast growing nuisance plants (Brazilian Pepper) to become quickly established. High levels of precipitation can cause the salinity of the Indian River Lagoon to lower affecting the flora and fauna.

Teacher Note

Some units will conclude with a discussion of issues and players. Students should be developing their lists to refer to at the end of the curriculum. They may want to designate a particular section of their notebooks for their player lists.

Teacher Note

Use an overhead to help the students make their lists.

Farmers - the subtropic climate allows St. Lucie County to be one of the largest citrus producing areas of the State. The port allows their crops to be shipped all over the world. Severe weather can damage crops

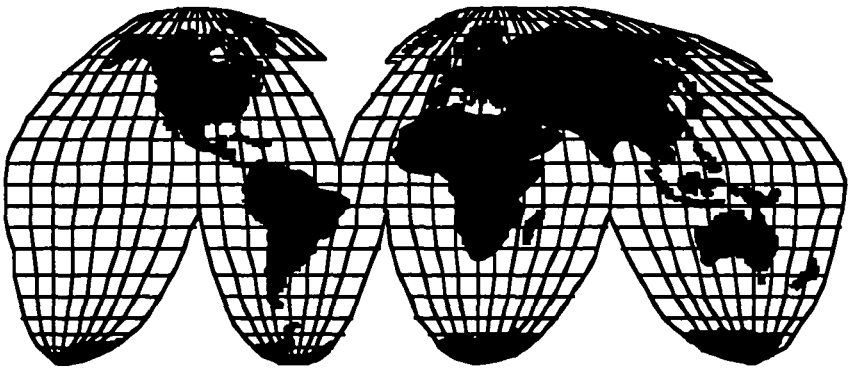
Port Workers - Inlet allows for shipping out of Ft. Pierce

Tourists - the warm winter climate attracts thousands of tourists each year who are looking for "fun in the sun" and enjoyment of everything this environment has to offer. Increases in tourists mean more development.

Construction workers - there is plenty of building to accommodate all those wishing to live in the subtropical climate along the Indian River Lagoon. The amount of concrete and blacktop increases as buildings are constructed and parking lots installed. Every time a square foot of lawn is covered with blacktop, we increase the temperature of that square foot by more than 40 degrees on a sunny day. The moisture transpired by the lawn, shrubs, and trees produce cooling of the air during the growing season. An average deciduous tree with all of its leaves has a cooling effect equal to twenty one-ton air conditioners. In addition, every time we remove a tree, we are increasing the air temperature in the area by many degrees*

Teacher Note

Always be sure to ask students if their families represent any of the players listed



* From an article "Man, the Great Modifier" by E. Ario Richardson, as appeared in The State Climatologist, July 1982.

Optional Activities

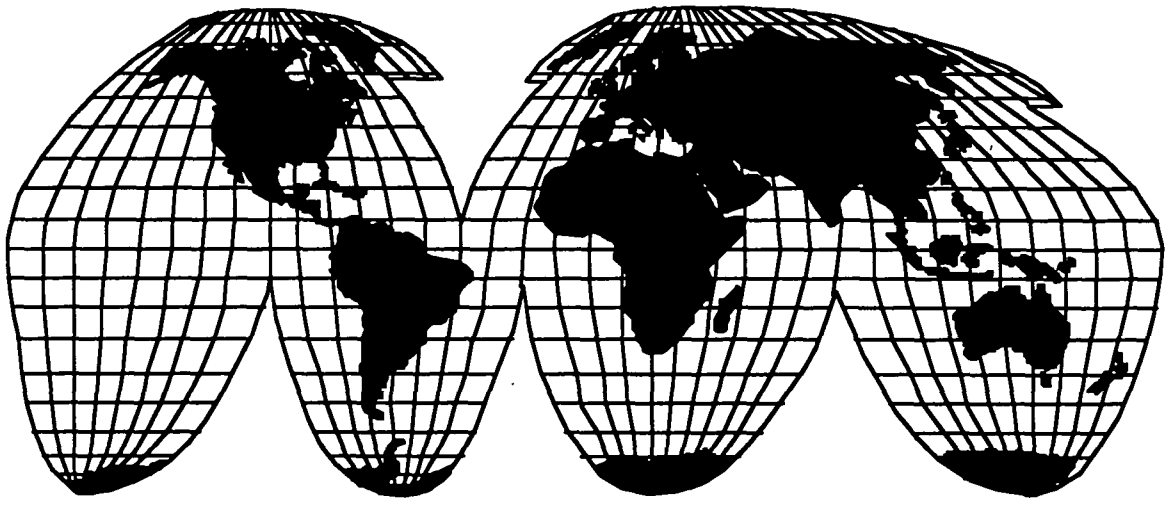
1. Using the weather data reported in the newspaper everyday, begin plotting temperature, rainfall, humidity and other measurements on graphs. See if you can obtain recent data from the local weather office. Compare local data for some other area of the country. Maximum/minimum temperature are reported for areas throughout the country.

2. Use a rain gauge to determine amounts of rainfall levels in school locations as compared to "official" readings at airports and weather center.

3. Review poem (Master 2.1g) and discuss which circumstances are probably myth or "old wives tales", and which could have been used in the past to forecast weather.

Florida Writes Activity

You are watching an approaching hurricane on the weather channel. You must evacuate and can only take with you what you can carry. Describe what you would take and why.



Detective _____

Master 2.1a Vocabulary

Vocabulary

1. *Geography* - _____

_____

2. *Scale* - _____

_____

3. *Topographic map* - _____

_____

4. *latitude* - _____

_____

5. *longitude* - _____

_____

6. *Navigate* - _____

_____

7. *peninsula* - _____

_____

8. *watershed* - _____

_____

9. Climate - _____

_____

10. weather - _____

_____

11. precipitation - _____

_____

12. humidity - _____

_____

11. air pressure - _____

_____

12. Fahrenheit - _____

_____

13. Celsius - _____

_____

14. temperate - _____

_____

15. tropic - _____

_____

16. Subtropic zone - _____

_____

17. convective clouds - _____

_____

18. Drought - _____

_____

19. hurricane _____

_____

20. tropical depression - _____

_____

21. storm surge _____

_____

22. Tropical storm - _____

_____

23. watches - _____

_____

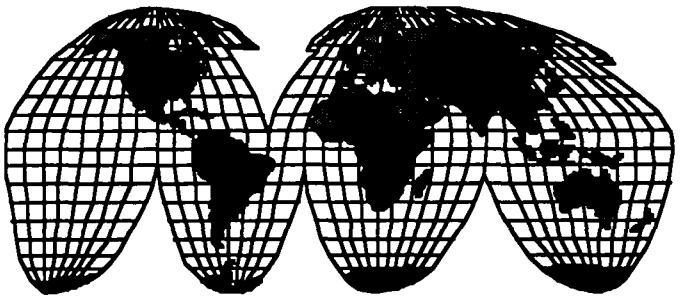
24. warnings - _____

_____

Detective _____

Group Members_____

Master 2.1b
Map Scavenger Hunt



MAP SCAVENGER HUNT

VOCABULARY:

Topographic Map - map showing the surface features of areas
Latitude - distance north or south from the equator
Longitude - distance that is measured east or west of an imaginary line running north and south through the town of Greenwich, England

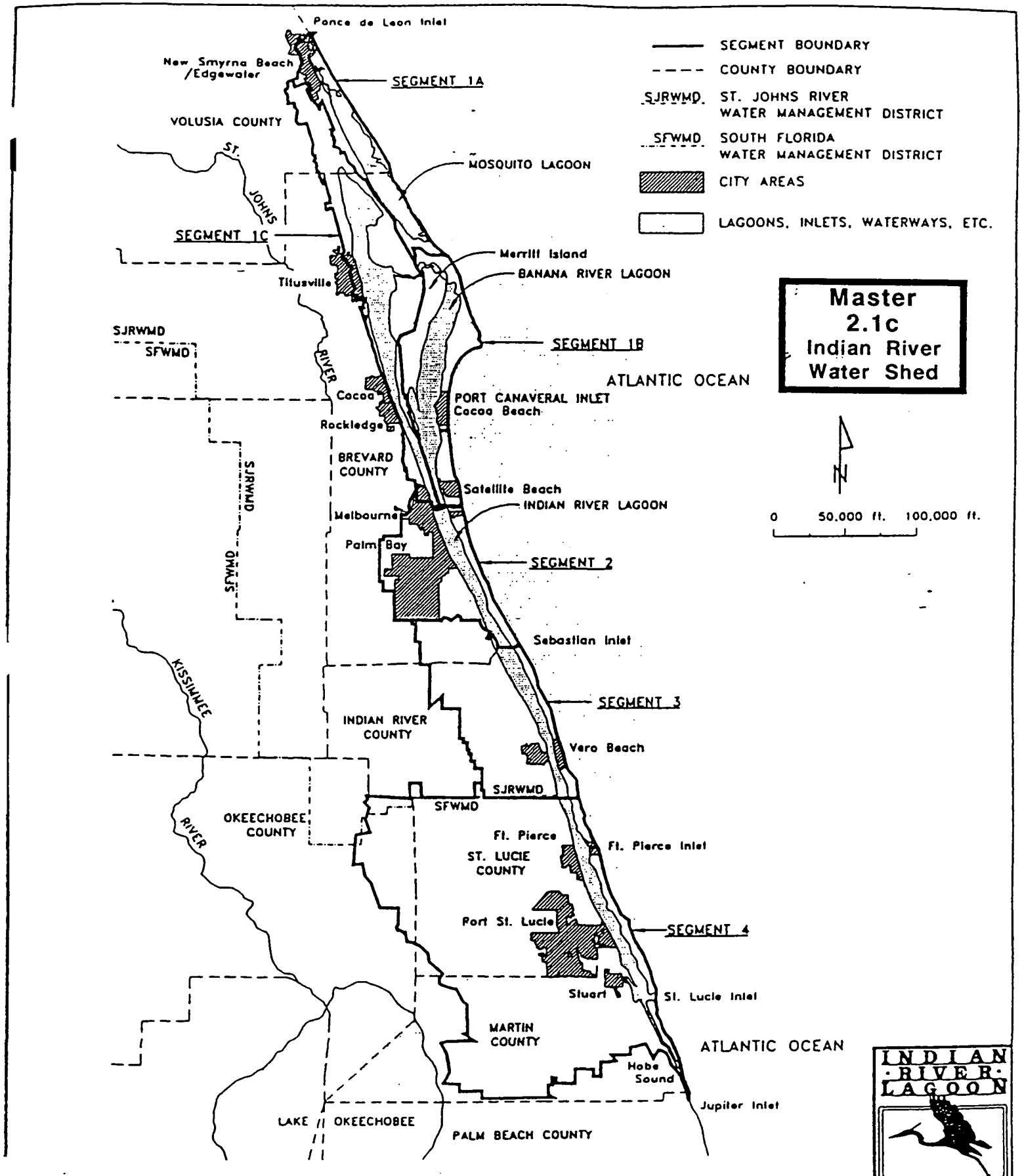
INSTRUCTIONS

Look on your group's map for the items listed below. If you find the items, mark them on the list by writing in the second column the type of map you are using. When the class has completed the list, you will report which items you found. As everyone makes their reports, list the type of maps used to find the items you were unable to find. There may be more than one map for each item. When you have completed the scavenger Hunt, answer the following questions.

What type of map would you use if you wanted to find:

A street in Ft. Pierce???_____
A place to dock your boat???_____
An area to study mangroves???_____
The shortest distance from New York to China???_____
The best soil for planting Citrus???_____
An exact picture of the school grounds???_____

	Check here if found on your map	Maps where found (write in the names of maps from entire class)
Key		
Scale		
Arrow Pointing North		
Longitude		
Latitude		
Elevation Above Sea Level		
Railroad		
Airport		
Creek/Rivers		
Intercoastal Waterway		
Tidal Flats		
Wetlands		
Bear Point		
Impoundment Dike		
County Boundaries		
Picture of Houses		
Water Depth		
Marina		
Mangroves		
Tide Information		
Ft. Pierce Harbor		
Ship Wrecks		
Indian Ocean		



Woodward-Clyde Consultants
Marshall McCully & Associates
Natural Systems Analysts

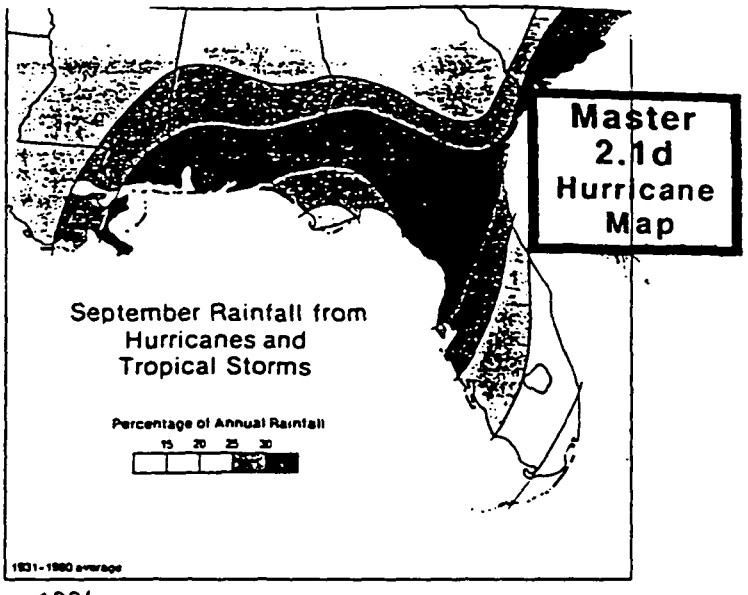
DRAWING NO.: INDIAN10.DWG

DATE: 7-5-94

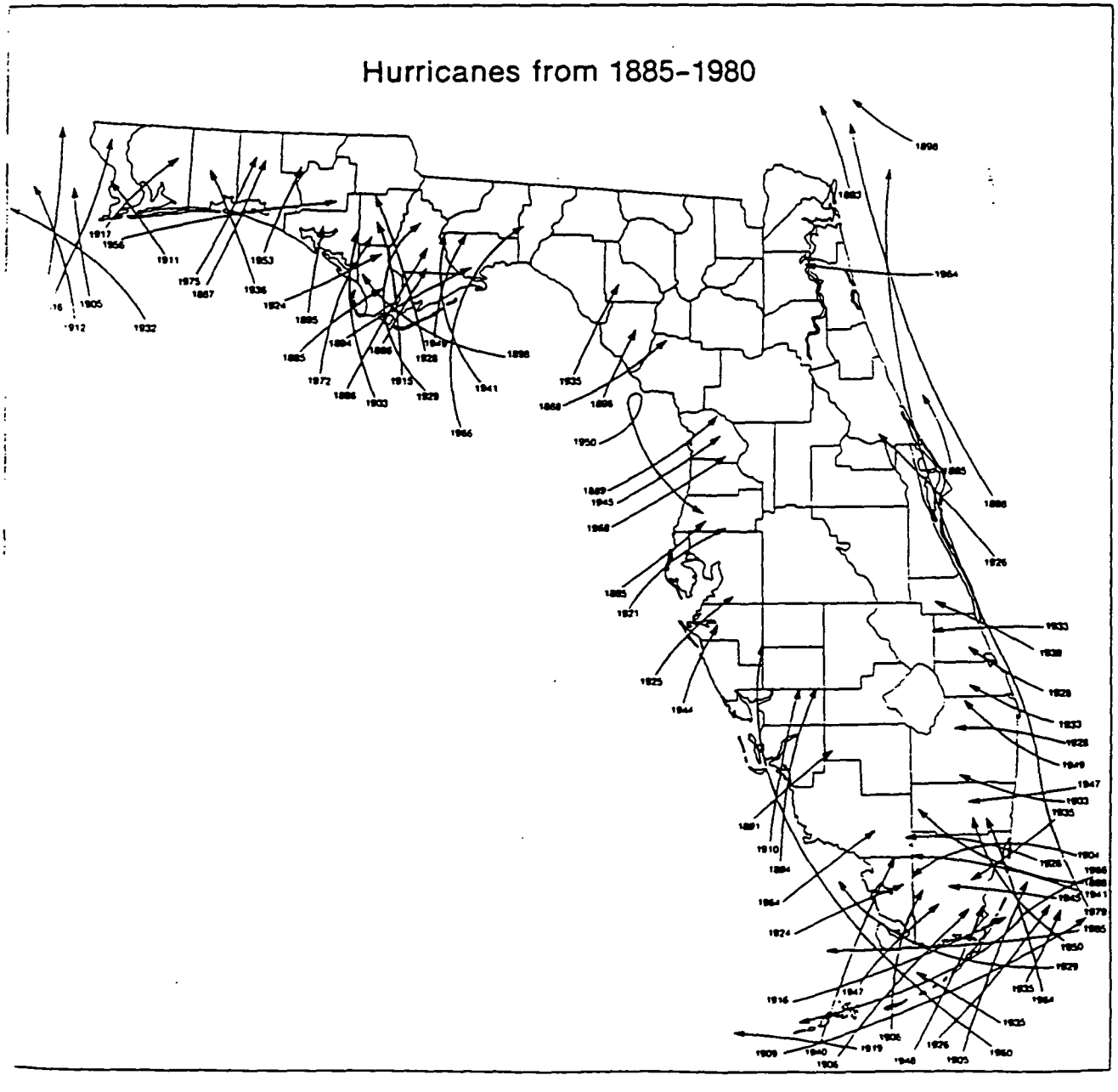
FIGURE 1-1 MAP OF INDIAN RIVER LAGOON SYSTEM AND WATERSHED SHOWING SEGMENTS

Hurricanes

A significant fraction of the total rainfall occurring in Florida is associated with hurricanes and tropical storms, especially during late summer and early fall. Hurricanes have maximum wind speeds of 74 miles per hour or greater and tropical storms have maximum wind speeds of 39 to 73 miles per hour. These storms often have rain areas as large as 300 miles across and are relatively slow-moving so that a station could remain under the influence of an individual storm for three days or longer. The amount of rainfall is not closely related to the strength of the storm (measured by the minimum surface pressure or strongest wind speeds). One of the highest rainfall totals in the state (35 inches in 48 hours) occurred at Trenton in October 1941 as a weak tropical disturbance moved inland near Cedar Key (Bradley 1972). On the other hand, some hurricanes are relatively dry as illustrated by the famous Miami case, also in October 1941, when winds of 123 miles per hour were recorded and the total rainfall during the storm passage was only 0.35 inches.

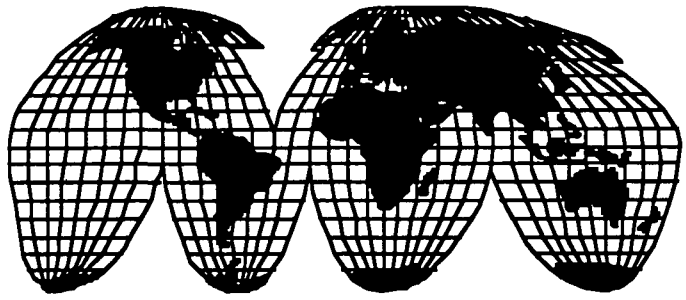


From: Water Resources Atlas of Florida, 1984.



Detective _____

Master 2.1e Tracking Hurricanes



Tracking a Hurricane

1. Look on the Hurricane Tracking Map. What is the approximate Latitude and Longitude of Ft. Pierce.

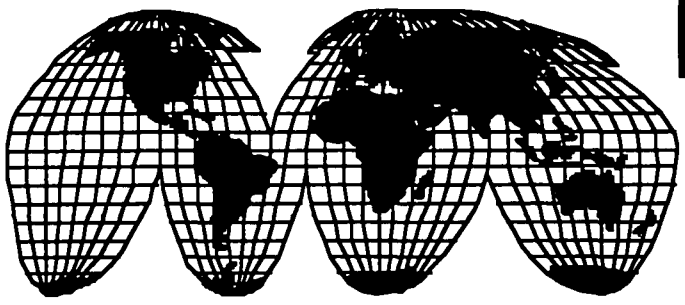
Latitude _____ **Longitude** _____

2. Track the following storm on the Hurricane Tracking Map

Date	Latitude	Longitude
1 September	14°	55°
2 September	14°	57°
3 September	15°	60°
4 September	19°	62°
5 September	20°	64°
6 September	22°	65°
7 September	22°	71°
8 September	24°	72°
9 September	26°	75°
10 September	26°	79°
11 September	27°	80°
12 September	28°	80°
13 September	29°	78°
14 September	31°	77°

Detective _____

Master 2.1f Ft. Pierce Weather Data



Ft. Pierce Weather Data

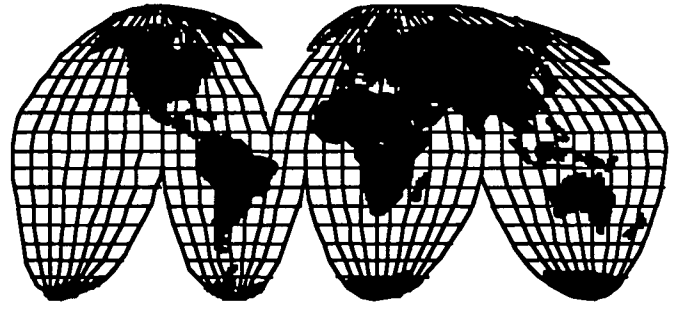
1. Using a piece of graph paper, graph the monthly average rainfall and temperature data. Put the months across the bottom of the graph and put temperature or rainfall on the side. You will make two graphs, one for temperature and one for rainfall.

Month	Average Temperature**	Average Rainfall in inches**
January	64	4
February	60	6
March	64	4
April	70	7
May	75	6
June	74	6
July	75	13
August	76	3
September	75	6
October	70	5
November	62	1
December	61	2

2. Do these numbers surprise you. Remember, they are averages of both night time and day time temperatures.

**** Data provided by the St. Lucie Chamber of Commerce.**

Detective _____ Date _____



Geography / Climate
Players and Issues

Player	Benefit	Burden

Master
2.1g
Issues and players

Player	Benefit	Burden

Detective _____

Master 2.1h Fact or Fiction

Fact or Fiction

Many proverbs relate to weather forecasting. A few of these were put together in rhyme, supposedly by Dr. Jenner, discoverer of the vaccination for smallpox. See if you can figure out which are fact and which are fiction. Underline the ones you think are fact.

"Last night the Sun went pale to bed,
The moon in halos hid her head,
The boding Shepherd heaves a sigh,
For see! a rainbow spans the sky;
Hark how the chairs and tables crack!
Old Betty's joints are on the rack;
Her corns with shooting pains torment her,
And to her bed untimely send her;
Loud quack the ducks, the peacocks cry,
The distant hills are looking nigh;
How restless are the snorting swine!
The busy flies disturb the kine,*
Low o'er the grass the swallow wings;
The cricket, too, how sharp he sings!
In fiery red the sun doth rise,
Then wades through clouds to mount the skies.
'Twill surely rain, - I see with sorrow,
Our jaunt must be put off tomorrow"

* "kine" is an archaic word for cows or cattle

Borrowed from an article by E. Ario Richardson, entitled "The Long Range Forecaster". It was printed in the publication The State Climatologist, January 1982.

Other Popular Proverbs

The American Indians had a very gruesome proverb: "When the locks turn damp in the scalp house, surely it will rain". This was a valid application of scientific knowledge since the high humidity that caused the scalp locks to become damp also favored rain. This may have been a forerunner of our hair hygrometer that has been used for generations.

"Red sky in the morning, sailors take warning; red sky in the night, sailors delight" is another proverb used by sailors in their attempt to predict fair skies and favorable winds for sailing.

What proverbs do you know?????????

2.2 Hydrology / Water Quality

Background Information

In order to understand the **hydrology** of the Indian River Lagoon, there must be a clear understanding of the **water cycle**. A cycle is a continuous set of events that keep repeating over and over again. The water cycle is, therefore, the continuous and repetitive movement of water from the earth into the atmosphere and back to the earth again. Approximately 80% of the earth is covered by water. Since the beginning of time, water has been cycled from the land to the air and back to the land again. The water we use has been used by generations before us and will continue to be used long into the future. No one is making new water. We just keep recycling it over and over again.

When the water on the earth's surface is heated by the sun, some of the water becomes warm enough to change into a gas or vapor as the process of **evaporation** occurs. The vapor rises into the air until it begins to mix with the cooler air in the atmosphere. The vapor begins to create moisture or **condensation**. Initially this condensation can be seen in the atmosphere as clouds. When the moisture becomes too heavy it falls to the earth as **precipitation** in the form of rain, hail, sleet or snow. Precipitation can either evaporate, flow off the land into a body of water, or it can seep through the soil into the **aquifer** below ground. The area of land which the water flows over into a particular body of water is called the **watershed**. In other words, it is the area of land that sheds the water to that body of water. Many factors determine the movement of the water.

The slope of the land is one factor which will determine how quickly the water will flow off the land. If there is very little or no slope to the land, the water will move very slowly or not at all over the land. This will allow the water to evaporate or soak into the ground. As the slope becomes greater, the water will begin to flow faster. In areas with steep **drainage basins** or water sheds, there tends to be more flooding

Vocabulary

hydrology *- n. the study of the earth's waters, their distribution, and the cycle involving evaporation, precipitation, etc.*
water cycle *- the process of water moving from the earth into the atmosphere and back to earth again*
evaporate *- to change into a vapor or gas*
condensation *- droplets of water that have condensed [to make or become thicker or more closely packed together as water going from gas to liquid] from the air onto a window or other surface*
precipitation *- rain, snow, or any other moisture that falls from the sky*
aquifer *- an underground layer of porous rock, etc. containing water*

watershed *- a ridge dividing the areas drained by different river systems; the area drained by a river system*
drainage *- the act or process of draining off water or other liquid*

Vocabulary

basin *- a wide, shallow bowl for holding a liquid. 2 all the land that is drained by a river and by all the streams flowing into the river*

runoff *- something that runs off, as rain that is not absorbed into the ground*

transpire *- v. process by which plants pump water from the ground through their roots, trunk and leaves*

evapo-transpire *- v. process by which plants pump water from the ground through their roots, trunk, and into the air through their leaves. Usually more important in the water cycle than evaporation. This is the reason you feel cooler under the shade of a tree than the shade of an umbrella*

wetland *- swamps or marshes [land where the soil is very wet or soaked with water most of the time]*

filter *- a device that makes air, water, or other fluid clean or pure. The fluid is passed through sand, charcoal, or some other material that keeps back dirt or other unwanted substances.*

decompose *- to rot or decay*

because the water flows so quickly it fills up the drainage basin faster than it is able to drain.

Water that is able to seep through the ground is actually filtered by the soil and sediments. Since the flow of the water is very slow as it is filtered, any chemical pollutants it may contain will have a chance to break down or absorb onto the soil particles before reaching its final destination, either the aquifer below ground or another body of water such as the Indian River Lagoon.

The rate of flow is also affected by objects in the path of the **runoff**. Plants such as trees and grass help to slow the water. Water flows much more quickly over bare or paved surfaces. There is nothing to slow the progress of the water. The fast moving water is able to carry with it debris and pollutants (chemicals, oil, gasoline, pesticides and fertilizers) present on the ground. If the water begins to slow down, the objects will settle out of the water if they are too heavy for the water to continue carrying them. As the water begins to slow down, it is able to evaporate, be **evapo-transpired** by vegetation, or seep into the soil. The obstructions and the soil then, act as filters, both by slowing the progress of the water and by obstructing the movement of the debris.

The best example of this is **wetland** areas. These areas are flat, low lying areas. The soil is very wet or soaked with water most of the time. Wetlands are abundant with plants and wildlife because of the amount of water and rich food supply. Along the Indian River, wetlands are a major ecological feature. They act as **filters** for the surface water runoff into the Lagoon. The vegetation slows the water allowing wastes and sediments to settle into the soil. The soil contains natural substances that will begin to **decompose** the debris and pollutants. The water then flows into the Lagoon leaving behind the debris and pollutants. Wetlands are, therefore, very important to the health of the Indian River Lagoon.

Florida receives an average of 54" of rainfall a year. Of that 15% (approximately 1/7) flows over the land, 19% (approximately 1/5) seeps into the ground and 66% (approximately 2/3) evaporates or evapo-transpires. When the rainfall occurs as many smaller storms, the runoff moves more slowly and has more time to seep into the ground or evaporate. When there are severe storms, such as hurricanes and tropical storms, which produce large amounts of rain, the water rushes to the Indian River Lagoon quickly, carrying with it larger amounts of debris and pollutants.

In 1780 ,there were nearly 20 million acres of wetlands (fresh and salt water) in Florida. By 1980 only 11 million acres remained. Much of these wetlands were the salt marshes, fresh water marshes and mangrove wetlands of South Florida. The loss of these areas has had major consequences on the ecosystems of all of South Florida, including the Indian River Lagoon. The filtering effect of the wetlands and habitats for fish and birds is lost, causing much of the upland pollutants to flow into the Lagoon. It is very important to realize what happens when land use is changed and the change impacts the water systems.

The Indian River Lagoon has another source of water besides the runoff from the surrounding land. The Indian River Lagoon is not a river at all. It is actually an **estuary.** An estuary is a body of water in which salt water and fresh water mix forming **brackish** water. The source of the salt water is from the flow of salt water from the Atlantic Ocean, through the inlets and into the Lagoon. The flow is caused by the **tides** and circulation of the water moved by the wind. The Lagoon is a wind driven system. The tides have a major influence only near the inlet, elsewhere wind moves the water and mixes the fresh water and the salt water. Estuaries support a large **diversity** of plants and animals. The salt water wetlands and all the plants and animals living in and around the Lagoon, depend on the flow of salt water as well as the flow of fresh water from the lakes, streams, and rivers. A delicate balance of this mixing is necessary for survival.

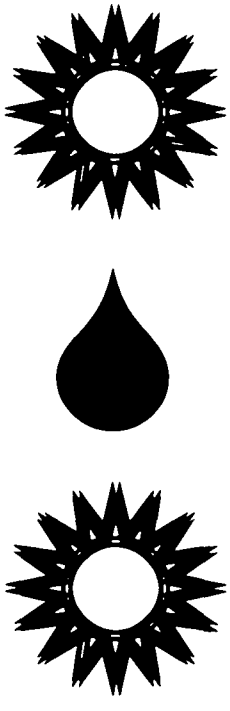
Vocabulary

estuary *- the wide mouth of a river where the tide flows in [a body of water in which salt water and fresh water mix]*

brackish *- salty [water which is a mix of salt and fresh water]*

tides *- the regular rise and fall of the ocean's surface about every 12 hours*

diversity *- the condition of being different or varied; difference or variety*

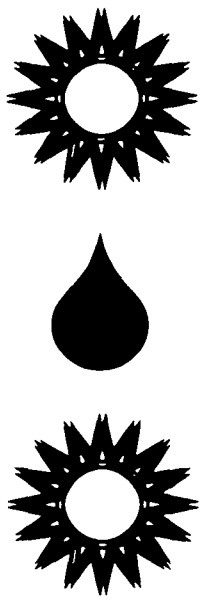


Vocabulary

flushing *- to empty out with a sudden flow of water*

exchange *- to give in return for something else [as with tidal exchange - to change salt water for fresh as the tide rises or fresh for salt as the tide falls]*

salinity *- the amount of salt*



Teacher Note

The Waterways curriculum cited at the end of this section is highly recommended. It offers many additional activities and information which would support this section.

Along the 156 miles of the Indian River Lagoon the five inlets provide **flushing** and **tidal exchange** only to a small area near the inlets themselves. The **salinity** along the river changes as the distance from the inlets change. A change in the species of plants and animals also occurs with the change in salinity. The balance of the salt and fresh water flows are therefore very important to the ecology of the River.

The water quality of the Indian River Lagoon is dependent on the ability of the system to handle the runoff and the sediments and pollutants it carries. Along the Indian River Lagoon water quality ranges from poor to very good. The areas with the poorest water quality are near cities, towns, big drainage canals or places with many septic tanks. Development, and high runoff potential seem to be major factors impacting water quality. It is in these areas where much of the adjacent wetlands have been either destroyed or disturbed allowing freshwater runoff to flow directly into the Lagoon. Development decision makers must keep these concepts in mind when looking at how communities should use the areas surrounding the Indian River.

For more information refer to Indian River Lagoon: A Fragile Balance of Man and Nature, Indian River Lagoon National Estuary Program publication

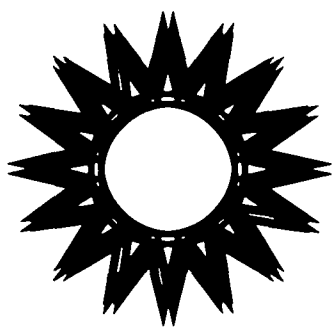
Rationale

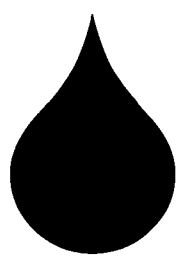
Section 2.3 is designed to get students to begin thinking of the Indian River Lagoon as a system of interdependent parts: uplands, forests, marshes, farms and cities. Students will see that decisions made for one area along the Indian River will impact the entire system. Students are now familiar with the geography and climate of the Indian River and how the system was formed. They will now look at the water which supports the system and how man is impacting the ability of the water to keep the system healthy. Students will begin to develop opinions for where priorities in decision making should be placed.

Objectives

Students will:

Become familiar with the concept of the water cycle and how important it is to the ecosystems of the Indian River Lagoon
Look at different types of drainage basins and how changes in runoff can impact the ecosystems of the Indian River Lagoon
Learn how a wetland acts as a filter to freshwater runoff before it enters the Indian River Lagoon
Become familiar with how wind and tides work to move water in the Lagoon.
Learn that the Indian River Lagoon is an estuary because of its shape and the degree of mixing of fresh water and salt water.
Begin to look at how man's impact on the area surrounding the Indian River Lagoon relates to water quality and the ecology of the area.



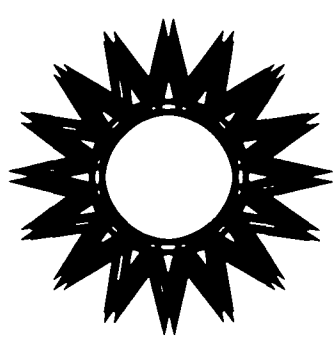


Materials

Master 2.2a - Vocabulary

Tide Demonstration

Hula Hoop
Chalk
black board
string



Activity 1 - The Water Cycle

One copy of Master 2.2b for the first group
1 wide mouth glass jar
1 large rubber band
gravel
topsoil
one or 2 small plants or seeds to plant
spray bottle with water
plastic wrap

Teacher Note

Each of these activities could be done by all the groups instead of having each group do a different investigation.

Activity 2 - Water Shed

One copy of Master 2.2c for the second group
a plastic box approximately 1 foot by 2 feet in size
two one gallon bags of sand
two paper cups
chocolate syrup
grass plugs or pieces of astroturf
water

Activity 3 - Wetlands

One copy of Master 2.2d for the third group
two coffee filters, soaked and allowed to dry over night
one colander
clear plastic wrap
tape
small piece of moss
pencil
container with a lid
water
sand, leaves and vegetation debris

Activity 4 - Estuary

One copy of Master 2.2e for the fourth group
graduated cylinder
2 paper cups
food coloring
salt
dropper

Activity 5 - Whole group

Master 2.2f
Master 2.2f transparency
Overhead

Procedure

Teacher Preparation

Read and become familiar with all background material
Make one copy of Masters 2.2b, 2.2c, 2.2d, and 2.2e (each group gets only one of the activities)
Make one copy per student of Master 2.2a and 2.2f

Teacher Note
When the activities are completed, copies of the masters could be made for each student to include in their notebooks for future reference.

Lesson Development

1. Go over vocabulary on Master 2.2a. Ask if there are any students who would like to share newspaper articles with the class.
2. Introduce the concept of the water cycle to the students. Explain what a watershed is and how it can impact the Indian River Lagoon. Describe a wetland and give some local examples of wetland areas the students would be familiar with (field trip location). Define an estuary and point out why the Indian River Lagoon is an estuary and not a river.
3. Demonstrate the concept of tides using the hula hoop. The hula hoop represents the layer of water (all the oceans) covering the earth. Have four students come forward and stand around the hoop at the 12:00, 3:00, 6:00 and 9:00 positions. Have two more students come forward to represent the sun and moon. The student representing the sun will remain behind the student stationed at 12:00. The student representing the moon will move around the circle. As the moon comes to each of the quarters of the moon, have the students at those locations pull gently on the hoop. When the sun and moon are directly behind one another, the tides are at the new moon. When they are opposite, the tides are at the full moon. At the other locations, the moon is at quarter phase. Using the string and chalk, draw a circle on the board. At each phase of the moon, draw what the circle (water) is shaped like as the gravity from the moon and sun pulls on the circle. Ask the students when the tides will be the highest (full and new moon phases).

Teacher Note
Be sure to use any supporting materials already available in your classroom

Teacher Note
Tides are a difficult concept. You may want to get tide charts from the local fishing supply stores to show the difference from one day to the next

Teacher Note
From local tide data students can graph the tide heights against the phases of the moon.

Teacher Note

Try to be sure you have at least one good reader and writer in each group.

Teacher Note

Only the materials manager is allowed to leave the group

References:

WaterWays: a Water Resource Curriculum. 1991
Division of Public Information, St. Johns River Water Management District.
(All activities have been adapted from this curriculum) This can be obtained from South Florida Water Management District. To obtain copies, teachers must attend a training session.

4. Divide the students into 4 groups. Assign students within each group certain responsibilities:
   - materials manager - only student to be able to leave the group to get supplies
   - principal investigator - will read instructions to the group and be sure the correct procedure is followed
   - recorder - will take notes on investigation and observations
   - reporter - will report to the class what the group has observed
5. Give each materials manager the investigation for the group (Masters 2.2b, 2.2c, 2.2d 2.2e). The group should read through the investigation. If there are any questions, they should be addressed before the materials manager begins getting the supplies.
6. Allow approximately 30 minutes for the group to do their investigation.
7. The groups will report to the class their investigation by explaining the following:
   - materials
   - procedure
   - observations
   - conclusions (answers to questions listed on investigation sheet)
8. After all investigations are reported, give each student a copy of Master 2.2f. Go through each of the problems and help the students to identify the players impacted by each.

Conclusion

The concept of the Indian River Lagoon as a system should be clear to students. After going through the list of problems and players on Master 2.2f, students should begin to see that solutions for one problem may create problems for other parts of the system. As it specifically relates to this section, students should begin to realize the water they use today is the water that will be in the Indian River tomorrow.

Detective _____

Master 2.2a Vocabulary

Vocabulary

1. *hydrology* - _____

_____

2. *water cycle* - _____

_____

3. *evaporate* - _____

_____

4. *condensation* - _____

_____

5. *precipitation* - _____

_____

6. *aquifer* - _____

_____

7. *watershed* - _____

_____

8. *basin* - _____

_____

9. runoff - _____

_____

10. transpire - _____

_____

11. evapo-transpire - _____

_____

12. wetland - _____

_____

13. filter - _____

_____

14. decompose - _____

_____

Master 2.2b
The Water Cycle

Group Members :
Material Manager:
Principal Investigator:
Recorder:
Reporter:
Detectives:

THE WATER CYCLE

Vocabulary

water cycle - the process of water moving from the earth into the atmosphere and back to earth again
evaporate - to change into a vapor or gas
condensation - droplets of water that have condensed [to make or become thicker or more closely packed together as water going from gas to liquid] from the air onto a window or other surface
precipitation - rain, snow, or any other moisture that falls from the sky
terrarium - a glass container holding a garden of small plants, or one used for raising small land animals
evapo-transpiration - process by which plants pump water from the ground through their roots, trunk, and into the air through their leaves. Usually more important in the water cycle than evaporation

Materials

1 wide mouth glass jar
1 large rubber band
gravel
top soil
one or 2 small plants or seed to plant
spray bottle with water
plastic wrap

Procedure

1. Put 1/2 inch gravel in the bottom of the jar.
2. Cover this with 2 inches of topsoil.
3. Plant one or two small plants in soil.
4. Using a spray bottle, water soil lightly. Be careful not to water too much. (The soil should be damp but there should not be any puddling of water.)
5. Cover top of jar with plastic wrap and secure with a rubber band.
6. Place terrarium on a table or shelf away from direct sunlight. After about an hour, observe for signs of the water cycle at work. Check terrariums periodically over several days. Note any changes you see.

Hypothesis - What do you think will happen???????

_____

_____

What do these clues mean??????

1. What changes do you see in the bottle?

_____

_____

2. Did condensation form???? If so, explain where, why and how it formed.

_____

_____

3. Unlike plants in a pot, you don't need to water a terrarium. Why????

_____

_____

4. What would happen to a terrarium without water????

_____

_____

5. Draw the water cycle in your terrarium. How does it compare to the water cycle of the Indian River Lagoon?????

Group Members :
Material Manager:
Principal Investigator:
Recorder:
Reporter:
Detectives:

Master
2.2c
Water Shed

Water Shed

Vocabulary

aquifer - an underground layer of porous rock or sand containing water
watershed - a ridge dividing the areas drained by different river systems; the area drained by a stream system
drainage - the act or process of removing water from land surfaces usually through canals, channels or pipes
basin - (1) a wide, shallow bowl for holding a liquid. (2) all the land that is drained by a river and by all the streams flowing into the river
runoff - something that runs off, as rain that is not absorbed into the ground

Materials

a plastic box approximately 1 foot by 2 feet in size
two, one gallon bags of sand
two paper cups
chocolate syrup
grass plugs or pieces of astroturf (can use small pieces of a welcome mat)
water

Procedure

1. Pour sand into plastic box. Make a river channel through the sand from one corner to the opposite corner (diagonally). Scoop sand from the middle of the box up on the sides to form river banks. Make a steep slope on one side of the river and a gentle slope on the other side.
2. Place several grass plugs on the side with the gentle slope. This represents vegetation.
3. Position one detective on each side of the "river" holding a cup of water.Very slowly pour water on the river banks. Observe which runoff flows faster and drains into the river first.

4. Repeat Step 3 using about 1/4 cup of chocolate syrup. The syrup represents storm water pollution. Observe what happens.
5. Repeat step 3 again using about 1/2 cup of water. Observe what happens.

Hypothesis - What do you think will happen???

_____

_____

What do these clues mean?????

1. What part of this investigation represents storm water runoff????

_____

_____

2. Which side of the river had the fastest runoff??? Why???

_____

_____

3. What effect did the grass have on storm water runoff??? On pollution???

_____

_____

4. Did the chocolate syrup "pollution" stay in one place??? How does water pollution affect fish and wildlife???

_____

_____

5. List several things that determine the speed of runoff in a drainage basin.

_____

_____

6. What are some of the things we can do to help clean up the water in the Indian River Lagoon???

_____

_____

Group Members :
Material Manager:
Principal Investigator:
Recorder:
Reporter:
Detectives:

Master 2.2d Wetlands

WETLANDS

Vocabulary

wetland - swamps or marshes [land where the soil is very wet or soaked with water most of the time: mangrove forest, fresh or salt marsh, some hammocks, cypress swamps
filter - a device that makes air, water, or other fluid clean or pure. The fluid is passed through sand, charcoal, or some other material that keeps back dirt or other unwanted substances.
decompose - to rot or decay
aquifer - an underground layer of porous rock or sand containing water

Materials

two coffee filters, wet these the night before and allow to dry out
one clear glass bowl
one colander
clear plastic wrap
tape
small piece of moss
pencil
container with lid
water
sand, leaves and vegetation debris

Procedure

1. Cut two pieces of plastic wrap about 1 1/2 feet long. Put one piece of plastic on top of the other in the shape of a cross. Use this to line the inside of the colander, making sure all the holes are covered. Fold edges over the outside of the colander and tape securely. The colander represents the soil of in a wetland.

2. Use a pencil to punch six or eight holes through the plastic wrap and colander holes at the bottom of the colander.
3. Put two coffee filters together and place them in the colander. Put a small piece of moss on top of the filters, representing wetland plants.
4. Set the colander and filters in the glass bowl. The bowl represents the aquifer.
5. Put sand, leaves and vegetation debris in a container of water. Put the lid on the container and shake the contents. Slowly pour it into the coffee filter. The dirty water represents rain and storm water runoff.
6. Observe what happens to the dirty water.

Hypothesis - What do you think will happen?????

_____

_____

What do these clues mean???

1. How do the wetland plants help filter pollutants and debris from the water???

_____

_____

2. Why are the wetlands important to the Indian River Lagoon???

_____

_____

3. How do wetlands improve the quality of water in rivers, lakes, and streams???

_____

_____

4. How would you expect the water quality in the Indian River Lagoon near a city to compare to the water quality in an undeveloped area of the River.

_____

_____

5. Is it important to preserve wetlands???? Why????

_____

_____

Group Members :
Material Manager:
Principal Investigator:
Recorder:
Reporter:
Detectives:

Master 2.2e Estuary

ESTUARY

Vocabulary

estuary - a coastal body of water where salt and freshwater mix
brackish - slightly salty [water which is a mix of salt and fresh water]
tides - the regular rise and fall of the ocean's surface about every 12 hours
diversity - the condition of being different or varied; more kinds of different things
flushing - to empty out with a sudden flow of water
exchange - to give in return for something else [as with tidal exchange - to change salt water for fresh as the tide rises or fresh for salt as the tide falls]
salinity - the amount of salt
density - the condition of being dense, thick or crowded; the number of things found in a specific size space

Materials

graduated cylinder
2 paper cups
food coloring
salt
dropper

Procedure

1. Fill the graduated cylinder half full of water. Pour the water into the paper cup.
2. Add approximately 1/4 teaspoon of salt and 3 drops of food coloring to the water in the cup. Mix well. This represents salt water flowing into an estuary.
3. Pour the mixture into the graduated cylinder.

4. Put fresh water into the other cup. This represents the fresh water flowing into an estuary. Fill the dropper with some fresh water from the cup.
5. Hold the dropper at an angle so the open end touches the inside of the test tube. Squeeze the dropper **very slowly and carefully**. Let the water trickle down the side of the test tube. **Do not shake or move the test tube when you are adding fresh water.**
6. Continue adding fresh water until you have about an inch layer on top of the salt water. Allow water in the test tube to sit for a few minutes. Are there more than two layers of water????
7. Cover the test tube opening and shake. Observe what happens.

Hypothesis - What do you think will happen?????

_____

_____

What do these clues mean???

1. Which is more dense, salt water or fresh water??? How do you know???

_____

_____

2. In an estuary, does fresh water float on top of salt water??? Why or why not???

_____

_____

3. What part of this investigation represented the tide going **out**???

_____

_____

4. Compare this investigation to what happens in an estuary. What do we call a mixture of salt water and fresh water???

_____

_____

5. Where do fresh water and salt water in an estuary come from??? Is the Indian River Lagoon a river or an estuary???

_____

Detective _____
Group Members

Master 2.2f Water Quality Issues

Detective Worksheet
Hydrology / Water Quality Issues

Did you know????

*** Florida receives an average of 54" of rainfall a year. Of that 15% (approximately 1/7th) flows over the land, 19% (1/5th) seeps into the ground and 66% 2/3rd) evaporates or evapo-transpires.

*** In 1780, these were nearly 20 million acres of wetlands (fresh and salt water) in Florida. By 1980 only 11 million acres remained. Many of these areas were South Florida mangroves, fresh and salt marshes and cypress swamps or hammocks.

*** Along the Indian River Lagoon, water quality ranges from poor to very good. Areas of high development where man has had the biggest impact are the areas with the poorest water quality.

What are some of the problems and issues which effect the water quality of the Indian River Lagoon.

_____

_____

_____

_____

_____

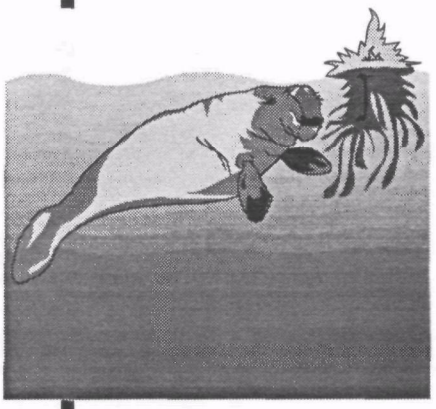
Who are some of the players effected by these issues?

(Continue on the back of the paper if needed)

Player	Benefit	Burden

2.3 Habitats, Flora and Fauna

Background Information



The Indian River Lagoon system supports an amazing **diversity** of **flora** and **fauna.** Nearly 2,100 species of plants inhabit the watershed along with more than 2,200 species of animals. The number of animals is the most in any North American estuary. There are nearly 700 species of fish, 68 reptile and amphibian species, 370 bird species and 29 mammal species. More than 125 species of birds breed in the Lagoon while another 170 species winter here. It is also a stopping ground for millions of birds migrating between North America, the Caribbean, and South America. It is the only place in the world where the Atlantic salt marsh snake lives as well as the submerged seagrass, Johnson's seagrass. It is also home for approximately one-third of all the manatees living in the United States.

This amazing diversity is due to the Lagoon's location on the east coast of the United States as well as its long, narrow configuration. The temperate and tropical climate zones meet in this area. This allows tropical and sub-tropical species which cannot tolerate much cold weather, and temperate species which can survive colder climates to exist in one area. Thus the climate is able to support a wide range of species.

The **habitats** supporting the plant and animal communities in the Lagoon watershed are varied as well. The habitats range from inlets which are similar to those in the near shore ocean areas to very dry habitats on the upland scrub ridges. These habitats are each specialized, and are extremely sensitive to change on site and also to all changes in the watershed. A drop of rain falling into the upland scrub area may travel all the way to the Lagoon via aquifers, runoff, and streams. Each community of plants and animals is dependent on surrounding systems for water and nutrients. They are interdependent. These unique habitats are of critical importance to the 36

Vocabulary

diversity *- the condition of being different or varied; difference or variety*

flora *- all the plants of a particular place or time*

fauna *- all the animals of a particular place or time*

habitats *- the place where an animal or plant is normally found*

threatened or endangered species of animals living in and along the shores of the Indian River Lagoon.

The major ecosystems found within the Indian River Lagoon and its surrounding areas are the seagrasses, open water, the mangrove forests, and salt marsh communities, spoil islands, hammock, scrub lands, and pine flat woods.

Seagrasses

Seagrasses, unlike **algae** or seaweed, are underwater plants with roots and flowers just like **terrestrial** plants. The seagrass "meadows" or beds depend on the balance of environmental factors of light, salinity (salt content of the water) and temperature. This balance can be impacted by water coming into the Lagoon.

There are three **dominant** species of seagrass found in the Indian River Lagoon, turtle grass, manatee grass and shoal grass and one specie which is only found in the Indian River Lagoon, Johnson's seagrass. Seagrasses produce the major food supply for all animals in the Lagoon. These areas serve as hatchery and nursery grounds for fish from the ocean.

Open Water

About 65% of the Indian River Lagoon can be classified as open water. The open water habitats include the water column (water above the surface of the bottom or flowing over the bottom) as well as the bottom of the Lagoon not covered by seagrasses. The bottom may either be rocky, sandy, or muddy. Most of the animals living on or in the bottom (benthic organisms) are invertebrates (those having no backbone). The **phytoplankton** living in the water column provide the basis for the food chain. Zooplankton feed on the microscopic algae as do the **larval** forms of many species of fish. The small fish provide food for larger fish and some birds.

The delicate balance of the Lagoon can however be upset by human activities. During summer rains **nutrients** from fertilizers, poorly functioning septic

Vocabulary

algae *- a group of simple plants that have no leaves, stems, or roots. They grow in water or on wet surfaces. Most seaweeds are algae.*

terrestrial *- living on land, not in water*

dominant *- most important or most powerful [most abundant]*

phytoplankton *- the mass of tiny plants found floating in a body of water.*

larva *- the young form of an insect or some animals without a backbone.*

nutrients *- any substance or matter that is needed for the life and growth of plants, animals, or people. Proteins, minerals, and vitamins are nutrients.*

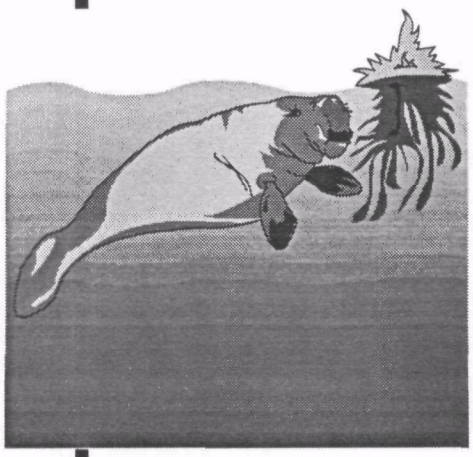
systems, businesses and farms are washed into the Lagoon. The nutrients promote so much phytoplankton growth, called a **bloom**, that the water becomes cloudy. Light is shaded from the seagrasses which need light to grow and survive in order to produce food and oxygen to sustain the food web of the Lagoon.

Soon the phytoplankton begin to use more oxygen than the seagrass can produce. As the phytoplankton begins to die bacteria breaks down the decaying plant matter and more and more of the oxygen is used. Eventually there is not enough oxygen for the other animals in the Lagoon and they begin to die. It is at times such as these that fish kills can occur.

Vocabulary

bloom - n. *a period of high health and vigor. A phytoplankton bloom occurs when conditions are favorable to promote rapid, uncontrollable growth of the phytoplankton.*

Mangrove Forests and Salt Marshes



Mangrove forests and salt marshes are found along the edges of the Indian River Lagoon. They are covered by salt water at high tide and exposed at low tide. The mangrove forests have three species of mangroves, the red mangrove (deeper water edges with the high prop roots), black mangrove (higher upland with air roots coming out of the sediments) and white mangrove (higher upland with silvery leaves). These forests are found in the southern areas of the Lagoon because mangroves are sensitive to cold weather. Salt marshes are most abundant north of Merritt Island where winter freezes occur more frequently. These flat areas are covered by non-**woody** plants such as salt marsh grasses, rushes, sedges and have very few, if any, trees.

As the tides rise and fall from the mangrove forests and salt marshes, the water transports much dead vegetation into the Lagoon. This vegetation provides a food source to support a large number of plants and animals. Approximately 80% of the recreational and sport fish spend some portion of their lives in these areas. Some animals, such as the dusky seaside sparrow, have had much of their habitat destroyed in the Merritt Island area because of

woody *- made up of wood, the hard material beneath the bard of trees and shrubs.*

Vocabulary

forage *- to go about looking for food*

roosting *- to rest or sleep on a roost [a pole or shelf where a bird can rest or sleep]*

spoil *- excess soil or sand removed from one place and disposed of as unused*

turbid *- muddy or cloudy from having the sediment stirred up*

intertidal *- the area covered and uncovered by the tides*

canopy -n. *the portion of the treetops that are the highest, often forming a "roof" as you walk under them.*

mosquito impoundments. This species is now extinct. Many species of wading birds **forage** in these areas for small fish and insects. The trees also provide areas for nesting and **roosting**.

Mangroves and salt marshes also serve as a filter for water coming into the Lagoon by trapping sediments and pollutants. They also provide a buffer from waves along the shoreline, preventing erosion.

Spoil Island Habitats

These habitats are man-made. They result from the dredging of the Intracoastal Waterway in the 1950's and 1960's. As the bottom was dredged to increase the depth of the channel, the soil, sand, muck and clay dredge **spoil** was piled in the river to form over 200 islands in the Lagoon. Initially the environmental impact was detrimental. Areas of seagrasses were covered and the water became very **turbid** and cloudy. Now the islands have stabilized and have become habitats in themselves. Areas around the islands have become colonized by seagrasses once more and mangroves have become established in the **intertidal** areas. The higher areas have become covered with various trees, shrubs and grasses. The submerged vegetation and intertidal areas provide habitats as mentioned above. Some of the islands have bare, sandy areas which provide nesting sites for terns and other shore birds as well as recreation areas for humans. Over the years some islands have provided valuable habitat for the Lagoon ecosystem. Other islands have eroded away or are being eroded by storms.

These habitats provide all the necessary elements to support the diversity seen along the Indian River Lagoon. The ecosystem depends on the stability of these areas.

Hammocks

Hammock areas consist of hardwood trees - live oak, cabbage palms and other trees such as southern magnolia - which combine to form a dense **canopy**

with **understory** shrubs and ground cover. Other plants typically found in hammocks include American holly, fern, beauty berry, coral bean, snowberry and poison ivy. Animals that use hammock areas are frogs, squirrels, several kinds of snakes as well as many species of birds. Hammocks are used by migrating birds as stopping places to rest and feed. Hammocks can be found throughout Florida, usually along streams and rivers. Those along the coast are known as **maritime hammocks** (synonyms: coastal hammock, maritime forest, tropical hammock). Maritime hammocks are generally **mesic** (dry to moist, with soils of clay, silt, and organic material). They may be located in areas that are **hydric** (soils that are very wet and poorly drained) such as mangrove marshes. Kings Island, a mosquito impoundment in St. Lucie County, has several places where the land is higher than the marsh areas. These higher areas are hammocks. In this situation, animals can move freely between the two areas, utilizing both habitats for shelter, roosting and feeding. This provides for a great diversity of species in these shared areas.

Scrub

Scrub, a **xeric** (very dry and well drained) community, is characterized by the white or light colored sandy soils, often called "sugar sand." Well drained and practically devoid of silt, clay, and **organic material**, these soils are infertile and very low in nutrients. The vegetation that grows on scrub is well adapted to the harsh growing conditions. Some species of plants grow in no other place. The diverse scrub contains sand pines, scrub oaks (live, Chapman's and myrtle), Florida rosemary, saw palmettos, gopher apple, British soldier moss (actually a lichen) and cacti. Thirteen are federally listed as endangered or threatened and twenty-two are listed by the State of Florida.

Vocabulary

understory - n. *shrubs, bushes and other small plants that grow under the canopy*

maritime hammocks - n. *hammocks growing along the coast*

mesic - adj. *refers to plant communities and systems that are dry to moist, in soils with clay, silt, and organic material. Moisture in these plant communities is neither xeric or hydric, but in between.*

hydric - adj. *refers to plant communities and systems where soils are organic, very wet (saturated) and poorly drained. These systems remain wet most of the year and often contain standing water during and after heavy rains.*

sterile - adj. *free from living microorganisms*

xeric - adj. *plant communities which are very dry and in well drained soils with little or no organic material. Xeroscaping is the practice of planting plants that do not need much water to survive.*

Vocabulary

organic material - n. *material of, like, or made from living organisms*

cache - n. *to hide something secretively*

fecal - adj. *containing excrement*

pyrogenic - adj. *relating to fire - fire controlled and adapted.*

The animals that inhabit the scrub are also very diverse and well adapted to the habitat. Scrub is home to many different species of animals, including the threatened Florida scrub jay and gopher tortoise. Other animals that make their home in the scrub include the Florida mouse, Florida scrub lizard, and sand skink. A number of larger animals utilize the scrub, including raccoons, black bear, squirrels, white-tailed deer, bobcats, and skunks. In addition, a scrub site is capable (and often does) of supporting several thousand species of arthropods. However, only some of those species are restricted to scrub as the only habitat they utilize.

The condition and development of the scrub vegetation is critical to wildlife habitat. Scrub jays require an open or low shrub plants with no or very little pine canopy. The birds gather acorns from the oaks and bury them in the open sands for later excavation and consumption. If the understory layer becomes too dense, the open sand areas are severely reduced, leaving no area in which to store food. When the canopy reaches a certain level, or there is no open space in which to **cache** acorns, the jays will abandon the site.

Gopher tortoise burrows are constructed in the sand areas, and are home to many insects. The dung beetle, for example, lives on **fecal** material from the tortoises, and these beetles in turn serve as food for others higher in the food web. Burrows also serve other scrub animals as protection from predators, inclement weather and fire.

Fire is important for scrub vegetation. Scrub is considered a **pyrogenic** ecosystem. Its survival depends on regular burning. Historically, lightning was the means by which scrub fires started. Nearby ecosystems with great amounts of dry underbrush (saw palmettos, etc.) would catch fire, and if the fire was hot enough and the wind was right, would spread to the scrub. During such a fire, overstories and pines, if present, are killed outright, while understory plants are burned and killed back to ground level. The heat of the fire causes the seed-containing pine cones to open. New trees will then be regenerated from the seeds now

liberated by the fires. Many shrubs resprout, and some, such as rosemary, grow from seeds stored in the sand. Today, with scrub surrounded by urban development, fires need to be purposely set and managed to maximize vegetation levels. This creates complications, as urban areas **encroach** on scrub. Air quality and safety concerns are foremost issues when it comes to burning scrub in urban areas.

One of the most important functions that scrub serves is its ability to filter water. The well drained sandy soils allow water to **percolate** into the ground with little or no runoff. This water is then available to enter the shallow aquifers that provide water to drinking wells for many residents in scrub or near to scrub areas. As scrub areas are developed, these **recharge** areas become lost. Water that enters the scrub areas may find its way into wells, canals, and eventually down to the lagoon and ocean area.

Pine Flatwoods

Pine flatwoods were once the most prevalent ecosystem in Florida and the south eastern US. Much of the watershed of the Lagoon was covered by these slash or long leaf pine and palmetto flatlands. The areas are characterized by their very flat topography. The highly developable lands have been converted into pastures, sub-divisions and commercial centers.

Pine flatwoods are on sandy soils prone to some flooding and the soils do not generally drain rapidly due to the flatness of the land. During the rainy seasons, the soil remains wet and poorly aerated. Pine flatwoods are often interspersed with open grassy sloughs and marshes. These areas form the headwaters of coastal streams and creeks.

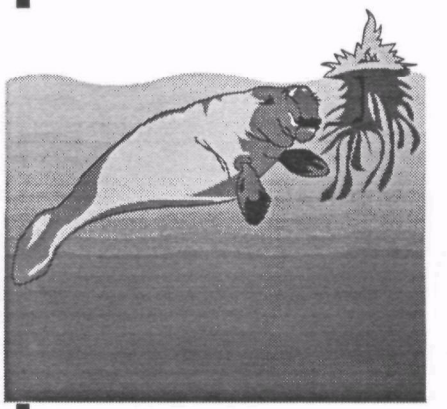
Plants of the flatwoods include pines and an understory of palmettos and shrubs, fetterbush, gallberry, wire grasses and herbaceous plants. Animals found in these areas include reptiles, amphibians, birds and mammals. Three large mammals which are native to Florida, that can be found in these areas (but not exclusively) are the white-tailed deer, black bear, and the endangered Florida panther.

Vocabulary

percolate *- v. to pass through a porous substance: filter*

recharge *- v. to put back what has been used up. Water flows into the scrub sand, and goes back into the aquifer where it can be used again.*

encroach *- v. to lessen the boundaries or space between objects*



Rationale

Section 2.4 is designed to introduce the students to the diverse ecosystem of the Indian River Lagoon region. By looking at the habitats and the plant and animal communities, students will begin to see the interrelationships of the various systems which make up the entire ecosystem.

Students will build a "food web" based on the animals living in the Lagoon. They will then begin to remove portions of that "web" to see how an upset in the ecosystem's balance can have impacts on the entire system.

Several worksheet activities will be offered as reinforcement of the concepts talked about in this section.

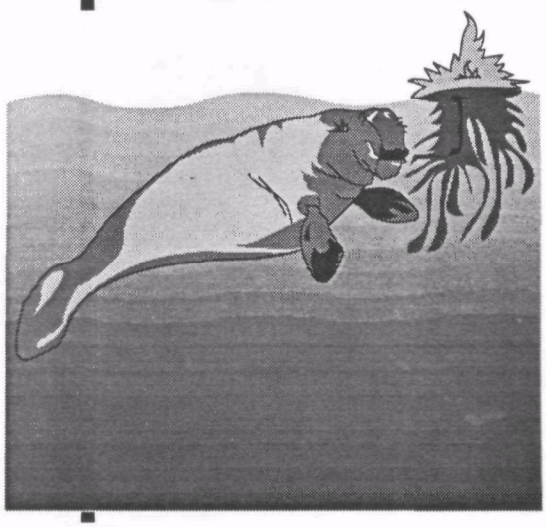
✍ ***Teacher Note*** ✍

The Indian River - An Exceptional Lagoon, has been included with these materials. (Appendix C) It has some great ideas for activities and worksheets. The food web activity in this curriculum was adapted from one in this publication.

Objectives

Students will:

- Become familiar with the various habitats and ecosystems of the Indian River Lagoon.
- Learn how the concepts learned about water quality and hydrology apply to the ecosystem as a whole.
- Look at the "food web" of the Indian River Lagoon.
- Continue to look at the players and issues facing the Indian River Lagoon and how decisions impact the ecosystem as a whole.



Materials

Master 2.3a - Vocabulary
Master 2.3b - Habitats
Master 2.3c - Food Webs
paper strips (approximately 8 1/2" X 1 1/2")
glue sticks (one for every 4 or 5 students)
List of plants and animals of the Indian River Lagoon from The Indian River - An Exceptional Lagoon, page 14
Master 2.3d - Habitats, Flora and Fauna
Optional : Worksheets from The Indian River - An Exceptional Lagoon
Student notebooks

Procedure

Teacher Preparation

Read and become familiar with all background material.
Make one copy for each student of Masters 2.3a, 2.3b, 2.3c, and 2.3d
Cut strips of paper, 8 1/2" X 1 1/2", enough for about 10 per student

Lesson Development

1. Go over the vocabulary on Master 2.3a. Ask the students if they have any newspaper articles they would like to share with the class.
2. Have students read aloud to the class Master 2.3b - Habitats. After the reading is completed, discuss where the students may have seen these habitats.
3. Have the students look in their notebooks at the list of plants and animals they saw on the field trip. Have them discuss where they saw them and anything they remember learning about them on the field trip.
4. Give each student approximately 10 strips of paper.
5. Divide the class into groups of 4 or 5. Have the groups follow the procedure on Master 2.3c- Building a Food Web.
6. Lead a group discussion of the questions on Master 2.3c.

Teacher Note

Students could cut their own strips of paper if time is permitted. They may want to use different colors representing different levels on a food chain.

Teacher Note

Students may have heard the term food chain instead of food web. Have them explain the difference between a web and a chain.

Teacher Note

Instead of using glue stick, you may want to use staplers or tape. The glue stick sometimes takes too long to dry.

✍ *Teacher Note* ✍

In lesson 1 of The Indian River - An Exceptional Lagoon, students can make a picture of their own estuary. You may want to use this concept to make their own dike using pictures of animals they saw along their transect.

Florida Writes Activity

Have the students become an animal in a particular habitat. Describe what happens when man threatens to encroach on its home. Remind them that the story could have a happy or sad ending. Could the animal influence the actions of man????

7. Have the students read the facts on Master 2.3d. Discuss the questions on this master.
8. **Optional:** Do some of the worksheets and activities from The Indian River - An Exceptional Lagoon.

Conclusion

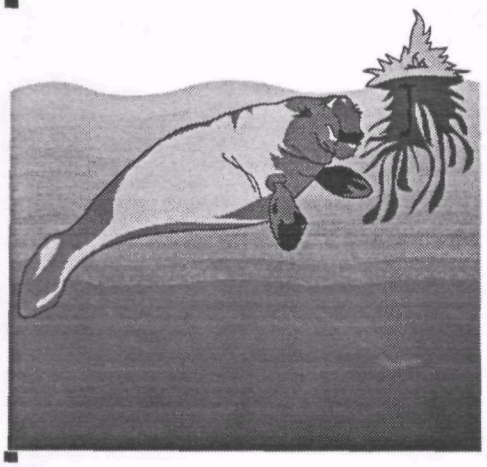
Students should now be equipped to draw some conclusions about the ecological significance of the Indian River Lagoon. Up to this point they have learned where the Indian River Lagoon is, how it was formed, how the watershed works and how this impacts water quality, the various ecosystems, and plant and animal communities. Every step of the way the students have seen how these building blocks are interdependent on one another.

References

Indian River Lagoon: A Fragile Balance of Man and Nature. Indian River Lagoon National Estuary Program.

Benthrup, Diane. The Indian River - An Exceptional Lagoon Activity Book, Department of Environmental Protection, The State of Florida.

WaterWays: A Water Resource Curriculum, 1991 Division of Public Information, St. Johns River Water Management District.



Detective _____

Master 2.3a Vocabulary

Vocabulary

1. detritus _____

_____

2. plankton - _____

_____

3. scavengers - _____

_____

4. primary producers - _____

_____

5. consumer - _____

_____

6. primary consumers - _____

_____

7. secondary consumers - _____

_____

8. tertiary consumers - _____

_____

9. top predators - _____

_____

10. diversity - _____

_____

11. flora - _____

_____

11. fauna - _____

_____

12. habitats - _____

_____

13. terrestrial - _____

_____

14. dominant - _____

_____

15. spoil - _____

_____

16. intertidal - _____

_____

Detective _____

Master 2.3b Habitats

Habitats of The Indian River Lagoon

Habitats of the Indian River Lagoon Ecosystem

Mangrove Forests and Salt Marshes -

These wetlands found along the shoreline of the Indian River Lagoon act as a filter for the water running off the land, hatchery and nursery grounds for sport and recreational fish, as well as many other animals. Many birds, both residential and migratory, also use these wetlands for food and to build their nests. Healthy wetlands are vital to birds migrating from North to South America.

Seagrass Habitats -

Seagrasses are underwater plants with roots and flowers just like land plants. They grow in "meadows" on the bottom of the Lagoon, providing protection for small fish and animals without backbones. . They are the basis of the food web by converting sunlight to food for the rest of the system, from microscopic animals to manatees. They are the basis of the food web for most of the animals living in the Lagoon. They are highly sensitive to losses of sunlight, changes in the amount of salt in the water, and temperature. Because of their importance to the ecosystem, they are highly protected by governmental agencies.

Open Water Habitats-

These habitats cover about 65 percent of the Indian River Lagoon. All water covered sandy, rock, or muddy bottom without seagrasses are open water habitats. The bottom could be rocky, sandy or muddy. There are many animals living in the bottom of the open water habitats. Some animals feed on the microscopic plants (phytoplankton) and animals (zooplankton) drifting in the water (together the two are called plankton). If a high amount of nutrients (fertilizers) flow into the Lagoon, the tiny plants will grow or bloom out of control killing the seagrasses because they get dense they do not allow enough sunlight

to get to the plants. As the plankton begin to die, the decaying organisms use so much oxygen there is too little for the rest of the plants and animals in the Lagoon.

Spoil Island -

These habitats are man-made. They were made when the Intracoastal Waterway (deep channel for boat traffic) was dredged or dug to increase the depth of the channel. The portion of the bottom that was dug out was piled into the river making over 200 islands in the River. At first this caused bad problems for the Lagoon because the water was very cloudy and many seagrass beds were destroyed. Now the islands have become part of the ecosystem. Along the edges of many of the islands there are now salt marshes and mangrove forests. The higher areas of the islands with trees and shrubs provide nesting areas for birds. The sandy beaches are used by birds for nesting as well as by man for recreation.

Hammocks -

Hammocks are dominated by hardwood trees, forming a dense canopy, with shrubs and ground lower to the ground. They are primarily found along streams and rivers. Those found along the coast are called maritime hammocks. The soils of the hammocks are damp but not always saturated as they are in wetlands. They can be found as higher areas surrounded by wetlands.

Scrub

Scrub is a very dry habitat. The soils are very sandy (sometimes called sugar sand) which allow water to drain down to the aquifer very quickly. The plants and animals living in this habitat are well adapted to the harsh conditions. Thirteen plants are listed by the Federal government as threatened or endangered and twenty two are listed by the State of Florida. Fire is very important for scrub vegetation. Some of the seeds (pine cones) will only open in the heat of a fire. Once the fire goes through, new plants begin growing immediately. Up until the 1940 no real conservation efforts were needed for the scrub. It was thought to be too harsh for agriculture. With increased development, much of the scrub is disappearing from Florida.

Pine Flatwoods

Pine flatwoods were once the most prevalent ecosystem in Florida. These very flat areas are covered with pines and palmetto. Because of the flatness of these areas, they do not drain quickly and during the rainy season stay very wet.

Detective _____

Group Members _____

Master 2.3c Food Webs

Building a Food Web

Vocabulary

detritus - a mixture of decaying plant and animal remains covered with microorganisms.

plankton - microscopic plants and animals that float in the water.

scavengers - organisms that feed on whatever food they can find; live or dead animals and plants

primary producers - green plants that use sunlight, water, and nutrients to manufacture food.

consumer - an organism that obtains its food from eating plants or other animals

primary consumers - animals that eat the primary producers, they are the second level in the food web

secondary consumers - animals that eat the primary consumers. They are the third level in the food web.

tertiary consumers - animals that eat the secondary consumers. They are sometimes called the top predators.

top predators - consumers that are at the top of the food chain that are not hunted by other animals. Most top predators have only one enemy - People. We may not eat all top predators, but we can kill or harm them by polluting or destroying their habitat.

Definitions from: The Indian River - An Exceptional Lagoon, Written by Diane Benthrup of the Department of Environmental Protection, State of Florida.

Materials

Paper Strips
glue sticks
pencil or markers
Master 2.4a
List of plants and animals of the Indian River Lagoon (from The Indian River - An Exceptional Lagoon)

Procedure

1. **Each group member will make a food chain.** Using the list of Plants and Animals of the Indian River Lagoon, make a food chain by taking one strip of paper and writing a producer on it. Make a link by gluing the ends of the strip together. On a second strip, write the name of a consumer that would eat that producer. Add this to the first link by gluing the ends together so that this link is hooked to the first link. Add two more consumers to your chain making sure they are consumers of the links they are attached to.

2. **The group will make a food web.** Using more links, connect all the chains to one another by hooking the consumers of one chain to what they eat on the other chains. (You may need to use more than one link to reach all the consumers from all the chains.)

3. **Make habitat links.** The group should make four links, each representing the four habitats listed on Master 2.4a. Connect these links to the food web where the primary producers growing in each habitat are located.

4. **Destroy one link in the web and watch what happens.** Select one type of link in the web an cut it. For example, if you select clams, cut all the links which are clams. Continue to cut all the links connected to the clams, then all the links connected to that consumer, and on until you reach no more links.

5. **Answer the following questions with your group members. Take notes on another piece of paper for your notebook.**

What happened??????

What would happen if the entire habitat disappeared???????

What does this mean for making decisions about what should be done with the Indian River Lagoon and its habitats, plants and animals?????

Detective _____

Master
2.3d
Habitats
Flora and Fauna

Detective Worksheet
Habitats, Flora and Fauna

Did You Know?????

*** There are nearly 700 species of fish, 68 reptile and amphibian, 370 bird and 29 mammal species living in or around the area of the Indian River Lagoon and a total of about 2,200 species of animals (including all other groups).

*** There are about 2100 species of plants.

*** More than 125 species of birds breed in the Lagoon area and 170 species winter here. Millions of birds stop along the Lagoon as they migrate from North America to the Caribbean and South America.

*** 36 Species of animals have been classified as threatened or endangered.

*** It is the only place in the world where the Atlantic Salt Marsh snake lives

*** The seagrass, Johnson's Seagrass, is only found in the waters of the Indian River Lagoon.

*** The Dusky Seaside Sparrow is now extinct because of human impacts including the construction of mosquito impoundments.

*** The Indian River Lagoon is home to approximately 1/3 of all manatees living in the United States.

What are some of the problems and issues which effect the plants and animals of the Indian River Lagoon???

_____

_____

Who are some of the players effected by these issues?????

Player	Benefit	Burden

2.4 History / Economics

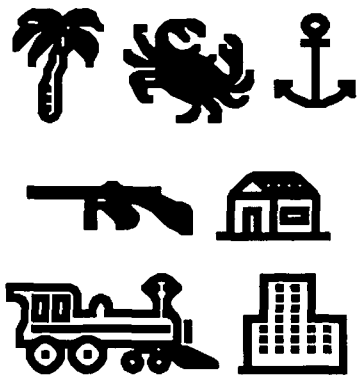
Background Information

About 6000 years ago, sea level rose flooding the shallow basin we know today as the Indian River Lagoon. Before that time this area had been dry and cool with little water and food to sustain people. The rich waters of the sea, confined in the Lagoon, formed a protected nursery for fish, clams, oysters and turtles.

With abundant food supply, more rain and pleasant temperatures, a tribe of native Americans, the **Ais Indians**, established itself along the Lagoon about 2000 years ago. They lived in large villages, traveling seasonally between towns making their homes on the beach or mainland, depending on the mosquito breeding cycle. Mosquito control consisted of rubbing their bodies with bear grease or **rancid** fish oil. (They may have warded off people as well as mosquitoes with that cure.)

The population of about 10,000 was concentrated in villages of up to 2,000 people. Evidence of the Indians can still be found today in old **shell mounds**. Huge piles of discarded shells, bones, and broken pots accumulated. Some shell mounds were as high as 70 feet and several blocks wide. Homes were built on top of the mounds where sea breezes tended to blow away mosquitoes. When too much waste accumulated or the shellfish was eliminated due to overfishing, the whole town moved to a more pristine site.

In 1513 Ponce de Leon, sailing along the coast, could see the Lagoon from the top of his ship's mast. The unfriendly Ais drove him off to the north. Pedro Menendez de Aviles marched his troops through the Lagoon area and tried unsuccessfully to establish the colony of Santa Lucia in 1565. While no permanent settlement of Spanish occurred, the population of Ais decreased from 10,000 in 1513 to 80 by 1720 due to Spanish **enslavement**, disease and torture. In 1763



Vocabulary

Ais Indians - n. *first settlers of the east coast of Florida, first appearing about 2,000 year ago.*

rancid - adj. *having a bad smell or taste of stale fats or oils; spoiled*

shell mound - n. *piles of discarded shells, bones, and broken pots from Indian settlements*

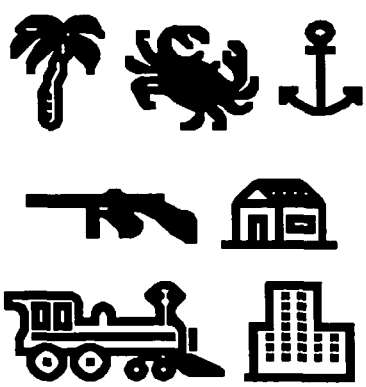
enslavement - n. *the act of making a slave out of an individual*

Vocabulary

Seminoles *- **n.** native Americans moving to Florida from Georgia and Alabama*

land grant *- **n.** land given or transferred to by the government.*

Intracoastal Waterway *- **n.** Navigable waterway extending the length of the Eastern United States mostly in inshore waters.*



many of the remaining Indians were taken to Havana, Cuba by Spanish officials when Florida became a British colony.

After the Revolution, American colonists and Indians from Georgia and Alabama pushed south. The **Seminoles** or "runaways" were forced into the back country west of the Lagoon. Florida remained a British colony until 1783 when it was returned to Spain. During the late 1700's and early 1800's the population of the state grew and many **land grants** were made including one to James Hutchinson. Agriculture began as new technologies in drainage were employed to begin rice production.

During the Seminole Wars from 1835 - 1842, American navel forces and land troops stalked the Indians using the Lagoon waterways because it was an easy transportation route. The land areas were so dense with vegetation, much of it palmetto, that land travel was very difficult. In 1835 the first land route was established along the present site of U. S. Highway 1. Mapping of the Lagoon and the interior was started at about this time. Steamboat travel was introduced and the Lagoon became the 1880's equivalent of our Interstate 95. In 1882 the construction of the **Intracoastal waterway** was started. This brought the first push of settlers to the shores of the Lagoon.

The sandridge paralleling the Indian River Lagoon was heavily cultivated for pineapples from 1880 until 1916. Pines, as they were called, were shipped across the US by Flagler's railroad which first reached Ft. Pierce in 1894. The railroad connected cities and farms making it easy to get fish, fresh fruit and vegetables to northern markets. A devastating fungus and high rail rates made Florida fruit unable to compete with Hawaii and pineapple plantations were abandoned after 1916.

While pineapple plantations occupied the high and dry scrub areas, other farms were often flooded. In 1916 new state laws encouraged land drainage, moving rainfall and runoff quickly through channels to

the Lagoon. This made more land available to pastures, farms and homes but often dumped fresh water carrying sediments and nutrients into the Lagoon upsetting the delicate balance.

Mosquitoes and the Florida heat plagued troops and settlers alike. In 1901, Ft. Pierce was **incorporated** as a town. One visitor suggested that the name be changed to Port Fierce to describe the attacking mosquitoes. It was because of heat, mosquitoes and flooding that the population of coastal Florida remained slow. In 1821 when the United States took possession of Florida, there were 317 settlers along the Lagoon. By 1830 the population had grown to 733. During the Seminole wars almost all settlers abandoned their homes and no one lived on the Lagoon. After the American Civil War, the Homestead Acts made free land available to anyone who would clear and farm it for several years. Displaced settlers and black Americans found home sites along the shoreline of the Lagoon and creeks. By 1916 there were 12,603 settlers along the Lagoon, about 2000 more than that of the Indian Villages of 1513.

In 1925 the St. Lucie County Mosquito **Eradication** Association was formed. New mosquito control practices were tested in this area. In 1927 local leaders had tried to reduce mosquito populations by draining wetlands with small ditches which emptied into the Lagoon. Beginning in the 1940's, **DDT** was tested for effectiveness against mosquitoes. It was quite good at killing mosquitoes along with crabs, shrimp larvae and other organisms vital to the Lagoon. The 1950's introduced the use of mosquito impoundments to the Lagoon. More than 40,000 acres of emergent salt marsh and mangrove wetlands bordering the Lagoon have been converted to mosquito impoundments.

During World War II thousands of soldiers were trained along the Indian River Lagoon. After they left for the War and eventually returned home, the Lagoon, its beauty, the kindness of the people, and the great fishing were etched in the memory of those who visited.

Vocabulary

incorporate *- v. to bring together into a single whole*

Eradication *- n. the act of uprooting, destroying, or stamping out*

DDT *- n. a powerful insecticide*

Florida became the place to live. Land was drained and inexpensive, great for large housing developments for returning soldiers needing homes for new families. Mosquito populations were controlled and air conditioning made summer heat bearable. Progress, growth, and new jobs associated with the space program, the citrus industry and **tourism**, have supported population growth to 750,000 by 1990.

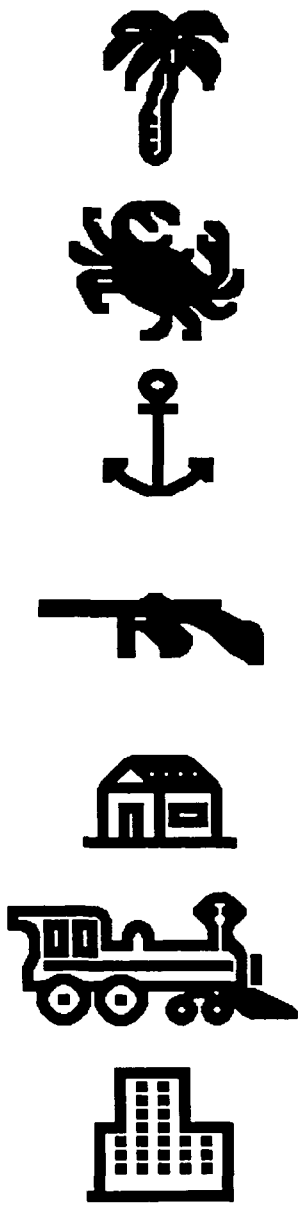
Since 1970 there has been increased awareness of how important the environment is to our lives and economy. Plans and laws have been written to protect water, land, plants and animals. Problems in the Lagoon have shifted from the impact of nature on the quality of life for the human (heat, flooding, and mosquitoes) to the impact of mankind on the quality of life for the plants and animals (pollution, habitat destruction). All these problems are interrelated just as the food web is all interrelated and dependent upon all the parts.

Jobs and economic stability of the Lagoon region depend on a healthy environment. Citrus, ranching, farming, fisheries and tourism depend on clean air, water and productive land. People visit our shorelines from all over the world bringing dollars to residents' paychecks and savings. Before the net ban, $300 million in fisheries were landed in the Lagoon. The shallow, warm waters of the Lagoon are productive shellfish beds for both natural and farmed or aquaculture clams. In July of 1995, the State of Florida enacted a ban on the use of nets larger than 500 sq. feet in any waters within 3 miles of the shoreline. This included the Indian River. This was done as a conservation effort to save diminishing populations of fish from being over fished.

Solutions to the ever increasing population (projected to be 1,000,000 along the Lagoon by 2010) and the associated environmental pressures are always being researched and investigated. As with the experiments with DDT, we will make mistakes, but from these mistakes we will learn. By being good environmental decision makers we can learn to live in this wonderful area along with a thriving and healthy ecosystem.

Vocabulary

***tourism** - n. the industry of attracting these who travel, especially for pleasure.*



Rationale

Section 2.4 is designed to help students see how the Indian River Lagoon has changed throughout history. The students will be broken up into groups to look at a particular time period in history and draw conclusions as to what events may have impacted the Indian River Lagoon. They will make a time line of the events and compare it to population growth along the Lagoon. They will then look at some of the industries found in the Indian River Lagoon region and build webs, similar to those built previously, to indicate how all the economic aspects of the Lagoon are also interrelated. In this way, students will begin to see how economic decisions will also impact the ecology of the Lagoon.

Objectives

Students will:

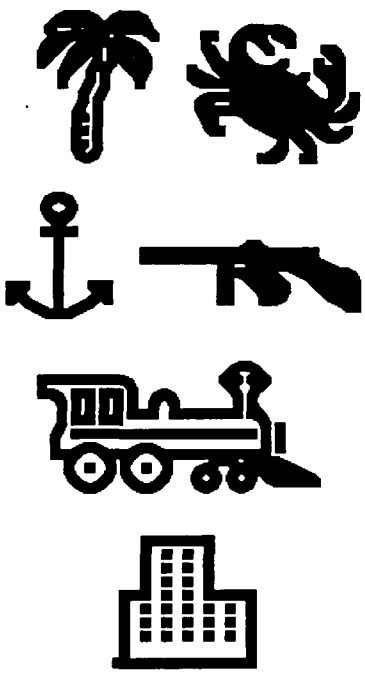
- Become familiar with the history of development along the Indian River Lagoon.
- Draw conclusions about what events in history have had major effects on the ecology of the Lagoon
- Build an "economic web" representing many of the industries found along the Indian River Lagoon.

Materials

Master 2.4a - Vocabulary
Master 2.4b - Events
Master 2.4c - Population
Master 2.4d - Detective Worksheet
Master 2.4e - Economic Web
Highlighters
Paper Strips - approximately 8 1/2" X 1"
Glue sticks (optional: staplers, tape)
Approximately 100 clothes pins
Clothes line to be stretched across classroom

Teacher Note

This section is to be only a supplement to the Florida History curriculum taught in Fourth Grade. It is designed to give history a different perspective for the students.



Teacher Note

Many of your students may have living relatives who could share stories about how life in St. Lucie County was when they were growing up. This is a great opportunity to bring history to life for your students

✍ *Teacher Note* ✍

As you go through the time events listed on Master 2.4b, you may want to delete some of the events depending on the level of your class.

✍ *Teacher Note* ✍

The events with both dates and years are events taken from a time line provided by St. Lucie County Historical Society. Students could make a St. Lucie County Historical calendar by putting these notable dates on the days they occur throughout the year.

✍ *Teacher Note* ✍

You may want to allow the students time to do some role playing for how their life may be different in the different times throughout history.

Procedure

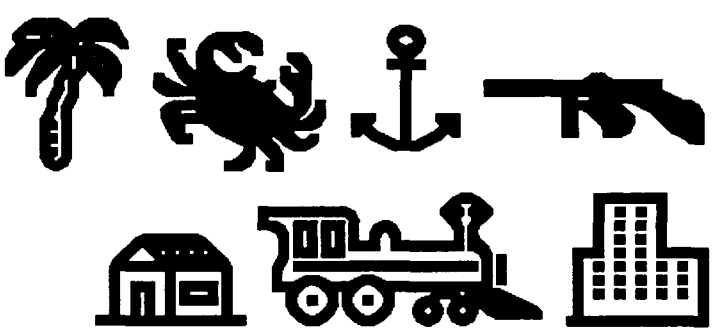
Teacher Preparation

Read and become familiar with background material
Make a copy of Master 2.4b (total of 11 pages) The copies can only be one sided
Make one copy for each student of Masters 2.4a, 2.4c, 2.4e
Make on copy of Master 2.4d for each event you will be using in the activity
Be sure you have highlighters for each student
Cut plain white paper into strips approximately 1" X 8-1/2" in size
Cut copies of Master 2.4b into strips along lines
Stretch clothes line across classroom for time line
Cut strips of colored paper and mark with year divisions for use on time line (ie. 100 year marks, 50 year marks, etc.)
Cut strips of paper out of a third color to use for population numbers on time line.

Lesson Development

1. Go over the vocabulary on Master 2.4a. Ask if the students have any newspaper articles they would like to share with the class.
2. Discuss with the students how life around the Indian River Lagoon has changed for the inhabitants of the Indian River Lagoon. Point out how early in the history of the development life focused on the Lagoon as the major supplier of transportation, food and necessities. As development continued, the Lagoon became less important for necessities. Changes occurred to make life easier but these changes have had some severe impacts on the Indian River Lagoon.
3. Give the students the strips of paper with the events printed on them. Have them answer the questions on Master 2.4d for each event. Each student will get more than one event (there are approximately 85 events in total.

4. Explain the clothes line which is going to become their time line. Using the year divisions, divide the clothes line up into time period increments. Have each student bring their events to the time line and discuss whether the event had an impact on the Indian River Lagoon.
5. Add the population data to the time line at the appropriate place along the time line. See if the students can relate any events on the time line that may have contributed to increases in population.
6. Divide the class into 8 groups. Give each group their copies of Master 2.4e - Economic Web. Have the students get their materials for the activity. Allow them approximately 10 - 15 minutes to complete their economic web. You will probably need to get them started by suggesting they use the jobs of members of their own families.
7. Allow the students to hook all their webs together.



✍ ***Teacher Note*** ✍

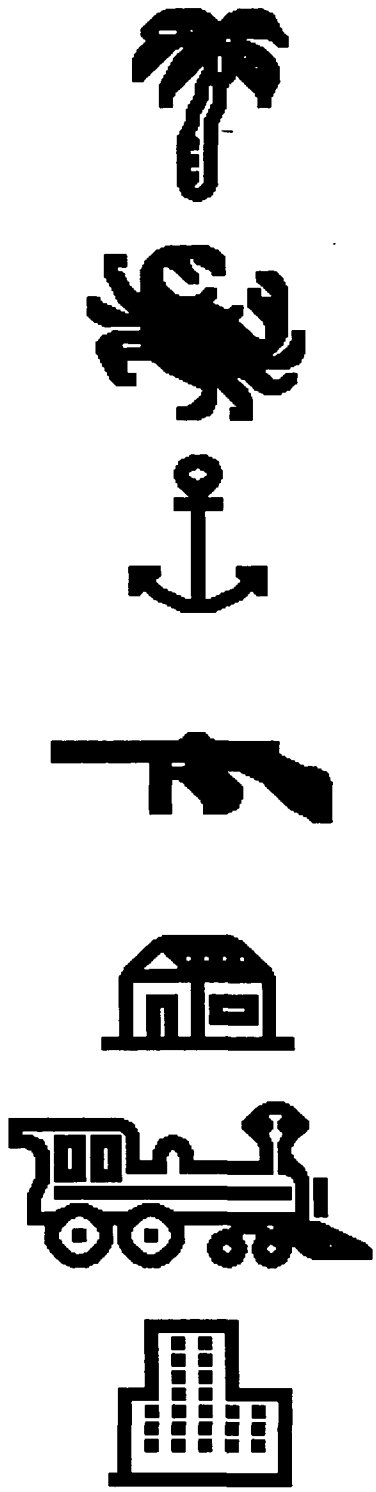
Each student may arrive at different conclusions about the impacts of man throughout history. These questions are designed to help generate discussion between the students.

✍ ***Teacher Note*** ✍

You may want each group to work with different colored paper links to identify at a glance how the economic webs all fit together.

✍ ***Teacher Note*** ✍

If you still have your food web, you can hook the economic web to the food web where the needs and occupations depend on the Indian River Lagoon



Conclusion

Students should have a better understanding of how man has impacted the ecology of the Indian River Lagoon. They should see that these impacts have occurred in more recent history as the population of the Lagoon area continues to increase.

The relationships of the economics of the area should become more relevant to the students in their lives. They should see that the economic web is as fragile as the food web they built in the previous section.

References

Personal communication with Dee Dee Roberts, St. Lucie County Historical Museum Supervisor I.

Indian River Lagoon: A Fragile Balance of Man and Nature, Indian River Lagoon National Estuary Program.

Where the Coast is Clear. A Publication of St. Lucie County Chamber of Commerce.

The Way It Was In St. Lucie County. Second Historical Calendar, A project of the St. Lucie Historical Society.

George, Dr. Paul S., Florida USA. 1995, Silver Burdett Ginn, Morristown, NJ. pp. 198 - 199.

Detective _____

Master 2.4a Vocabulary

Vocabulary

1. Ais Indians - _____

_____

2. rancid - _____

_____

3. shell mound - _____

_____

4. enslavement - _____

_____

5. Seminoles - _____

_____

6. land grant - _____

_____

7. Intracoastal Waterway - _____

_____

8. corporate - _____

_____

9. Eradication -_____

_____

10. DDT -_____

_____

11. tourism -_____

_____

✍ *Teacher Note* ✍

Copy next 11 pages single sided

Master 2.4b Events

Indian River Lagoon Important Events

6000 years Before Present (BP) - Lagoon Floods as Sea level rises as polar ice caps melt.

2000 Years BP - Ais Indians inhabit Lagoon and establish towns

---

1513 - Ponce de Leon sails along coast

1565 - December 13 - Fort Santa Lucia Constructed

1565 - Pedro Menendez de Aviles establishes colony called Santa Lucia somewhere between Vero Beach and Stuart (thought to be the site of Fort Pierce)

Late 1500's - Spanish leave citrus, cattle and hogs behind. These become the start of citrus and cattle industries.

1696 - September 23 - Jonathan Dickinson Shipwrecked

1715 July 31 - Wreck of Spanish "Plata" Fleet: Loss so great it causes devastation to entire European economic structure. Does this make us the Treasure Coast???? Coins are still found on our beaches today

---

1720 - most of the original Indian tribes of Florida are gone because of Spanish enslavement, disease and torture.

1750 - Creek Indians (later called "Seminoles") begin moving into Florida at invitation of Spanish

---

1763 - Florida becomes a British Colony

1778 - Only Revolutionary War battle fought in Florida occurs near Jacksonville

---

1784 - Britain returns Florida to Spain.

Late 1700's - First drainage control activities for rice production

---

1803 - James Hutchinson is awarded Spanish land grant on Mainland of Florida between Indian River Inlet and Jupiter Inlet

---

1807 - Hutchinson requests transfer of grant to offshore island because Indians are molesting his slaves, destroying his crops and stealing his cattle. He dies a short time later during a violent storm.

1818 - First Seminole War begins

1821 - Florida becomes a United States territory and Andrew Jackson is first governor.

1821 - Beginning of permanent settlement along Indian River Lagoon

---

1828 - First commercial orange production Merritt Island

1830 - January 2 - Construction of Fort Pierce Commenced

1835 - Second Seminole War begins.

1835 - First Inland route established (Capron Hernandez Trail) which later becomes U.S. Highway 1

1835 - Great Citrus Freeze

1837 - December 25 - Battle of Okeechobee

1838 - Fort Pierce, a military supply depot, is established by, and named for, Benjamin Kendrick Pierce, brother of Franklin Pierce, 14th president of the United States (1853 - 1857)

1841 - May 21 - Seminole War Chief "Wildcat" captured at Fort Pierce

1842 - Second Seminole War Ends

1842 - August 25 - Fort Pierce Abandoned

1842 - August 4 - Armed Occupation Act Established

1843 - December 11 - Fort Pierce destroyed by fire

1845 - Florida becomes the twenty-seventh state

1855 - Third Seminole War begins

1857 - April 30 - Fort Capron Payroll Lost in Indian River Inlet

1859 - June 14 - Fort Capron Deactivated

1861 - Civil War begins

1865 - Civil War Ends

1868 - December 4 - Post Office established at St. Lucie

1879 - August 28 - Benjamin Hogg Trading Post Established

1882 - Steamboat era, Intracoastal Waterway construction begins

---

1886 - Sebastian Inlet first constructed

1888 - November 14 - John L. Jensen acquired land grant

1892 - St. Lucie Inlet constructed

1894 - January 29 - Florida East Coast Railway (Flagler Railroad) reached Fort Pierce - pineapple plantations and fisheries flourish

---

1901 - February 2 -Ft. Pierce Incorporated

1903 - July 1 - Formation of St. Lucie County

1905 - July 21 - First Edition of St. Lucie County Tribune

1906 - Fort Pierce Board of Trade Established

1908 - February 19 - St. Lucie County Bank Opened

1909 - June 6 - Ground Breaking for St. Lucie County Courthouse

1912 - November 28 - Fort Pierce received electricity

1916 - Pineapple crops begin to fail

1916 - Drainage Districts formed to drain inland marshes to the Indian River

1916 - C-44 St. Lucie Canal Construction started; completed in 1924

1917 - 1918 United States in World War I

1917 - April 1 - William Jennings Bryan spoke in Ft. Pierce

1917 - August 7 - Okeechobee County Created

1920 - First causeway constructed across Lagoon (New Smyrna Beach North Causeway

1921 - Fort Pierce Inlet constructed

1921 - May 15 - St. Lucie County's First Political Election

1922 - Great Florida land Boom begins - towns expand, land cleared and drained

1924 - November 1 - John Ashley killed in shootout

1925 - June 29 - Indian River County Created

1925 - September 19 - St. Lucie County Mosquito Eradication Association Formed

1927 - August 20 - Bank of Ft. Pierce Collapsed

1928 - Major Hurricane hits Lake Okeechobee

1930 - February 22 - Port of Ft. Pierce opened

1940's - DDT use for mosquito control begun

1940 - Frozen concentrate revolutionizes the citrus industry

1941 - World War II begins- extensive dredging of Lagoon, Widening of inlets, and military training along Lagoon

1945 - World War II ends

1947 - Major Flooding throughout Southern Florida

1948 - Sebastian Inlet permanently opened

1950 - First missiles are launched from Cape Canaveral

1950 - Flood Control District established

1954 - October 29 - U. S. Customs Port of Entry Established at Fort Pierce

1957 - January 25 - Florida's Turnpike opened

1958 - NASA begins operations at Cape Canaveral

1961 - April 27 - Port St. Lucie Incorporated

1962 - April 6 - Indian River Junior College Ground breaking Ceremonies

1963 - November 3 - Formal Dedication of Indian River Junior College

1965 - Environmental protection laws passes to help protect air and water quality, endangered species and habitats from being developed unsensibly; legislation continues today

1971 Walt Disney World opens

1987 - Florida becomes the fourth most populated state in the United States.

1989 - December 24 - Freezing temperatures kill many tropical species along the Lagoon

1992 - Hurricane Andrew slams into southern Florida

1995 - July 1 - Net Ban enacted - Use of nets, 500 sq. feet or larger, outlawed within 3 miles of the shoreline and all inshore waters in Florida

Master
2.4c
Population

Population Along the Indian River Lagoon

6,000 Before Present	0
2,000 Before Present	10,000 Ais Indians
1513	10,000 Ais Indians
1720	80 Ais Indians
1825	317
1830	733
1870	1,216
1910	8,792
1916	12,603
1920	15,391
1950	45,000
1960	200,000
1970	303,900
1980	439,000
1990	750,000
2010	1,000,000 (projected)

St. Lucie County Past and Projected Population

Jurisdiction	1970	1980	1990	1994	2010
Ft. Pierce	29,721	33,802	36,830	36,945	
Port St. Lucie	330	14,690	55,866	68,223	
St. Lucie Village		593	584	627	
Un-incorporated	20,785	38,097	56,891	60,951	
Total	50,836	87,182	150,171	163,192	250,900

Source: 1994 Florida Statistical Abstract and U.S. Census Bureau

Master
2.4d
Detective
Worksheet

Detective _____

Detective Worksheet
History along the Indian River Lagoon

Materials:

Highlighter
Event and Population strips (provided by teacher)

Procedure

1. You will be given strips of paper with a year and event printed on it. Decide if the event had an impact on the ecology of the Indian River Lagoon. If it did, highlight it.
2. For each of the events, answer the following questions. Be sure to have one Worksheet for each event.
3. After you have answered the questions, take your strip and add it to the time line.

1. What is your event????

Year _____ **Event** _____

2. What, if any, impact did your event have on the Indian River Lagoon????

_____

_____

3. How does this event impact our life today???

_____

_____

_____

4. As environmental decision makers, what would we have done differently if we had lived during this time????

_____

_____

5. How would your decision make our lives different than they are today???

_____

_____

Detectives _____

Master 2.4e Economic Web

Building an Economic Web

Vocabulary

Economics - the study of the way that goods and wealth are produced, distributed, and used.

Materials

Paper strips
glue stick
pencil
one colored marker or crayon

Procedure

1. You will be divided into 8 groups. Think about the jobs members of your family or friends have who live in St. Lucie County. Pick two or three and write each one on a separate paper strip (link for the web). Each group will give one link to the teacher making sure that there is only one link for each job. (You will have links that you do not use. You needed to pick more than one job to be sure there would not be any duplicates.)

2. The links will be mixed up and your group will pick one of the jobs. Take a marker or pencil and color both sides of the link.

3. Discuss with your group members what that job is and how it is important to people living in St. Lucie County. As you are discussing the job, make a list of all the people who work with or need the service of the job. For instance, if your job is a grocery store worker, **goods and services are provided to the worker** by all the people producing food such as farmers and fishermen, and the worker **provides goods and services for** people buying food in the store such as residents and visitors. .
4. For each person make a link for your chain. Attach all the links to the first colored link so it will have many links attached to it. From each of those links, add links to represent people (or things) who work with these new links. You economic web will begin to look like a pyramid

5. When time runs out, your group will report to the class who is included on your web.

6. As each group completes their report, they will attach their web to the other group's where they mention the same people.

7. Write a brief paragraph about how an economic web is similar to a food web.

_____

_____

_____

_____

_____

_____

_____

2.5 Past and Present Issues

Rationale

Section 2.6 is designed to show the students how **issues** influence management decisions throughout history. They will see that these issues are actually what caused many of the events they talked about in the previous lesson. The activity is designed to help them visualize how these issues have had an effect on not only the quality of life for the people living and visiting the area around the Indian River Lagoon, but also the plants, animals, and ecosystem of the Indian River Lagoon. The students will begin with a list of issues suggested by the teacher and then be asked to add any issues they see as important. They will talk about any present day issues they see as needing solutions.

Vocabulary

Issues *- something that needs to be talked over or decided [in this case, a problem that needs to be resolved]*

Objectives

Students will:

- Become familiar with the issues which have shaped life around the Indian River Lagoon for its residents.
- Identify what events took place to help resolve these issues
- Identify what effect these events and issues have had on the ecosystem of the Indian River Lagoon
- Identify some current issues that are of importance to the quality of life around the Indian River Lagoon
- Propose some solutions to these issues and try to predict their consequences, both beneficial and detrimental

✍ *Teacher Note* ✍

You may want to use different colored index cards for habitats, plants, animals, people.

✍ *Teacher Note* ✍

If its a nice day, this is a great outdoor activity.

✍ *Teacher Note* ✍

The students could each have a copy of the time line used in the previous lesson to come up with the events which addressed each of the issues.

Materials

Master 2.5a - Players
2 packs of index cards, each card cut into 6 pieces
plastic zip lock bags - one for each player card
Master 2.5b - Detective Worksheet
Tape

Procedure

Teacher Preparation

Make a copy of Master 2.5a one single sided paper
Cut apart each of the Player sections
Place one player card along with the number of index card pieces indicated on the card in a plastic bag
Make one copy for each student of Master 2.5b
Optional: Make a copy of page 22 from *The Indian River - An Exceptional Lagoon* (Appendix C) for each student.

Lesson Development

1. Ask the students if there are any newspaper articles they would like to share with the class. There is no vocabulary sheet for this section. Be sure the students understand the term issue.
2. Have the students stand in a large circle. Give each student one bag of cards and players. Tape the name of an animal, plant or habitat to each student. Tell the students that each piece of card represents hundreds of animals, plants, or acres (if a habitat). Ask each student if he or she represents a plant, animal, or habitat. Be sure the students know what they represent in the game.

3. Give the students the following instructions:

I am going to read some events that have been important throughout history beginning with 1513 when Spain began colonizing Florida. With each event, I want you to tell me some consequences, good or bad, which may have followed the event. For each event and its consequences, decide whether your population (if you are a plant or animal) or size (if you are a habitat) increases or decreases.

Each time the events surrounding the issue have either increased or decreased your population or size, either add or subtract pieces of card. If your size or population increased, take your additional cards from those whose population or size decreased.

At different times during our activity I will ask who has increased the number of cards they have and who has decreased the number of cards.

If you run out of cards you must sit down and say "I'm in trouble".

4. You will use the issues sheet provided at the end of this lesson as your guide. If the students are having a hard time deciding what happened to their population or size on their own, after stating each event, go around to each student and have them say what are their consequences.
5. Continue until you reach the present time.
6. Have each of the students summarize what happened to the number of cards they had during the game.
7. Have the students return to their seats.
8. Give each student a copy of Master 2.5b. Go over each of the questions and allow the students to discuss their answers.

Teacher Note

You may want to continue into the future to see if the students can come up with some solutions to today's issues which would not only benefit those living and visiting the Indian River Lagoon but also the ecosystem.

Teacher Note

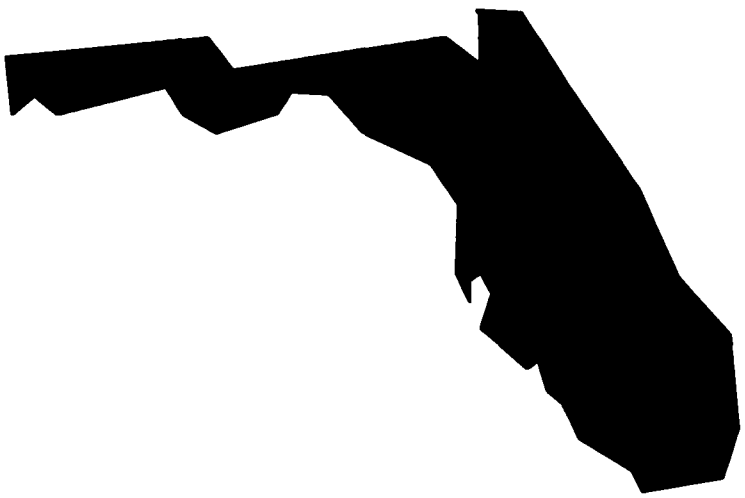
You may want to use an overhead of Master 2.5b to help the students fill in the answers to the questions.

Teacher Note

If the students are good at working in groups, have them split up into groups to discuss the answers to the questions and have each group report back to the class. The groups could either be random or the groups could be according to what player they were in the activity.

Conclusion

This activity is designed to help students see that the ecosystem of the Indian River Lagoon have changed throughout history because of different management strategies man has implemented to help solve problems. As each issue was addressed and life along the Indian River Lagoon got easier, more and more people began to move into the area. As the population of people increased, habitat was destroyed and the populations of plants and animals decreased. In recent history, decisions have been made which have helped to protect the environment while also addressing issues. Students will begin to see that we are becoming better environmental decision makers and that the damage done to the environment has now become an issue as important as all others.



This lesson will set the stage for making their future decisions for mosquito impoundments along the Indian River Lagoon.

REFERENCES

Activity adapted from: *An Activity Guide for Teachers: Everglades National Park,* Florida National Parks and Monuments Association, Inc.

Issues Causing Events and their Consequences

Year	Issue	Event	Consequence
1513	10,000 Ais Indians living along the Lagoon	Spanish begin to explore the area	Disease, enslavement, and torture to Indians
1565	Spanish settle	Santa Lucia settled	Only a few people settle on the Lagoon
Late 1500	food	introduce citrus trees, hogs and cattle	Indians decrease, small Spanish increase
Late 1700	food begin rice production	first drainage control	increase people habitat destruction
1821	settlers decide to stay	first permanent settlements	increase people decrease food animals
1835	transportation routes	establishment of first inland route - now US 1	Increase people
1882	transportation routes shipping	Intracoastal Waterway construction started	habitat destruction increase people increase development, Economy exotic plants (Australian Pine and Brazilian Pepper), decrease in native plants
1894	transportation shipping, tourists, pineapple plantations	Henry Flagler's Railroad extended into the Indian River Lagoon area	
1916	agricultural land building land	Drainage Control Districts established	
	ornamental plants	exotics introduced	
1920	settle on barrier islands	First causeway constructed (turtle nesting grounds)	
1927	mosquito population	Mosquito Control Districts	
1941-1945	World War II	military training, dredging, widening inlets	
1950	Flooding	Flood Control Districts	
1965	water quality poor	Water Quality Act	less pollution in Lagoon
1969	environmental awareness	Aquatic Preserves established	Environmental Protection **Development impacted with associated economic impacts**
1972	water pollution continues	Clean Water Act	
1972	species decreasing	Endangered Species Act	
1987	water for South Florida	Surface Water Improvement and Management Bill Control of runoff	

Year	Issue	Event	Consequence
1990	Protection of the Indian River Lagoon	Water Monitoring IRL National Estuary Program Indian River Protection Bill Upland Acquisition Program	Environmental Protection
1992	Environmental Protection	First survey of plants and sediments	

Always ask what is happening to the plants and animals with each issue, event and consequence. It is important for the students to realize that all along the way the population of people is increasing.

✍ *Teacher Note* ✍

Copy next two pages single sided

Master 2.5a Players

Players

Seagrass Meadow (25)	**Open Water** (25)
Mangrove Forest (25)	**Spoil Island** (0)
People (0)	**Fiddler Crab** (25)
Scrub Habitat (25)	**Manatees**
Mullet (25)	**Snook** (25)
Oysters (25)	**Crabs** (25)
Phytoplankton (Plant plankton) (25)	**Sea Turtles** (15)
Florida Panther (15)	**Alligator** (25)

Pelican (15)	**Osprey** (15)
Butterfly (15)	**Mosquito** (25)
Seagrasses (25)	**Hammock Community** (25)
Red Mangroves (25)	**White Mangroves** (25)
Australian Pine (0)	**Saw Grass** (25)
Flounder (25)	**Shrimp** (25)
Pine Flatwoods (25)	**Stingray** (25)
People (0)	**People** (0)

Master
2.5b
Detective
Worksheet

Detective _____

Detective Worksheet
Players and Issues

1. What happened to the population of people along the Indian River Lagoon? Is this still happening today???_____

2. What happened to the population of plants and animals along the Indian River Lagoon?????_____

3. How have present day issues changed from issues in early history?????_____

_____

_____

4. What have we learned????_____

_____

_____

5. Are there any issues today which need solutions?? Who are the players????_____

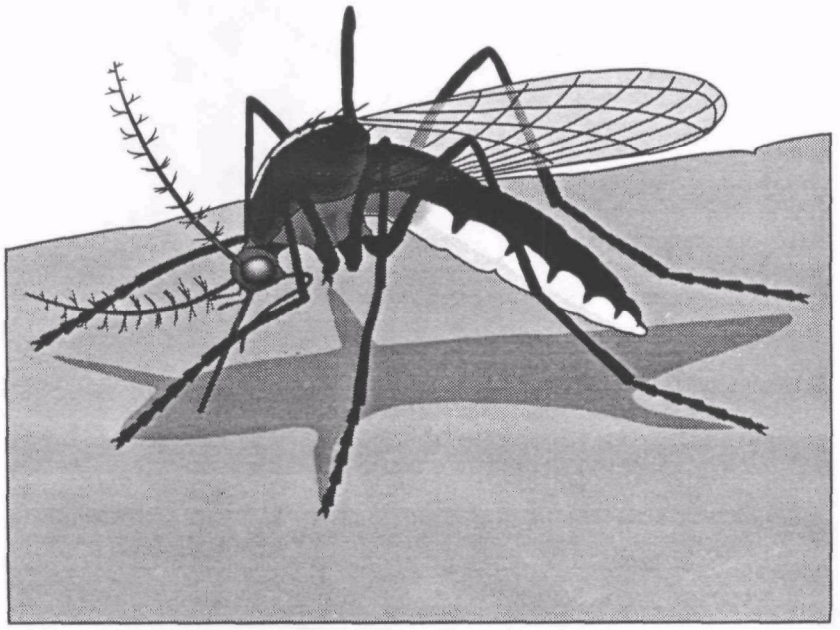
_____

Player	Benefit	Burden

MANGROVES, MOSQUITOES, AND MAN

UNIT 3

MOSQUITOES



UNIT 3

MOSQUITOES

Unit 3 introduces the biology and the control of mosquitoes and their disease transmission potentials. Students will first learn the general anatomy and life cycles of mosquitoes and then concentrate on the salt water species which are targeted for control in the mosquito impoundments. The rationale for using different types of control and how the strategies have changed throughout history will be emphasized.

Students will relate this information to their knowledge of the Indian River Lagoon and be encouraged to develop their own opinions on how the impoundments in St. Lucie County should be managed. From this exercise, students will learn what problems environmental decision makers must confront to solve the many problems in ecosystem management. There is no right or wrong answer.

At the conclusion of Unit 3, students will be prepared to develop a questionnaire to be sent to community leaders about mosquito impoundments.

3.1 Mosquito Biology: Diversity and Life Cycle

Background

Mosquitoes probably originated in the tropics at least 200 million years ago during the age of reptiles. These smallest most primitive mosquitoes obtained blood from reptiles, amphibians, and lungfish. Modern mosquitoes appeared 25 to 50 million years ago after the demise of the dinosaurs when land mammals became abundant. With the rise of mammals and birds, many modern mosquitoes evolved to obtain their blood meals from these warm blooded animals.

Mosquitoes belong to the **order** of insects called *Diptera,* or the two-winged insects. Other families of insects included in the order *Diptera* are flies, sandflies, lovebugs, craneflies, and blind mosquitoes. Scientists have identified many **genera** of mosquitoes containing over 3450 species worldwide. Three-fourths of all species live in the subtropics and tropics. The number of species declines dramatically toward the higher latitudes, however the number of individuals in each species may be much greater. In the Arctic there are less than a dozen species, but the thousands of square miles of tundra pools produce hordes of mosquitoes that blacken the sky. As many as 9000 bites per minute have been reported by Canadian researchers. At this rate, death in humans could result in two hours after about half of their blood supply is lost. Seventy-three species of mosquitoes can be found in Florida and in St. Lucie County, 43 species are represented. (See Appendix D.)

At all stages of their life cycle, mosquitoes are a food source to many animals. In order to maintain their population, the insects produce a very large number of offspring. However only a small percentage of these young actually make it to the reproducing adult stage. Once the female mosquito lays her eggs, she plays no further roll in the survival of her offspring.

Vocabulary

Order - n. *a group of related animals or plants that is larger than a family For example, reptiles and mammals are related because they both have backbones but they are placed in a different order. [taxonomically or in the classification system of plants and animals]*

Genera - n. *(plural of genus) a group of plants or animals that are closely related. A genus is divided into individual kinds, called species. Dogs and wolves are different species that belong to the same genus.*

Class
↓
Order
↓
Family
↓
Genus
↓
Species

Vocabulary

Metamorphosis - n. *the change in form that some animals go through in developing. The change from caterpillar to butterfly or from tadpole to frog are examples of metamorphosis*
plural metamorphoses

Egg - n. *(1)the oval or round object that is laid by a female bird, fish, reptile, insect, or other animal. A young animal of the same kind hatches from it at a later time. The egg has a brittle shell or a tough outer skin. 2. the cell formed by a female, which will make a new plant or animal of the same kind if it is fertilized.*
Larva - n. *the young form of an insect or some other animals A caterpillar is the larva of a butterfly.*

Pupa - n. *a insect in the stage of development between a larva and an adult, generally not feeding. The chrysalis is the pupae of a butterfly*

adult - n. *a plant or animal that is fully developed and in the reproductive stage.*

As with many insects, mosquitoes grow through four stages. This process is called **metamorphosis.** The four stages are **egg, larva, pupa** and **adult**.

Mosquitoes begin life as an egg. The eggs are deposited in various environments, depending on the species. The eggs of all mosquitoes, no matter what species, require water to hatch. After they develop however, eggs may hatch within a few minutes or lay **dormant** for long periods of time depending on the availability of water, time of year, or environmental factors. The genera *Culex* and *Anpopheles* lay their eggs on water. *Culex* eggs stick together in 1" long egg rafts of about 100 which float on the water. Some *Culex* species prefer their eggs to be deposited in polluted sites and stagnant water however other *Culex* species may utilize cleaner water found in groves and swamps. The genera *Anopheles* prefer cleaner water. The eggs of these two genera hatch in about one to two days after being laid. *Aedes* and *Psorophora* utilize moist areas for laying their eggs. These areas are not actually in water but are typically areas just above the water line or in areas subject to flooding. These eggs require 5 - 8 days to hatch. However, anytime after this initial **incubation** period they will hatch when flooded. This may occur months or ever years after they have been laid. This is why after a heavy rain or very high tides there is often a great increase in the population of mosquitoes. One square foot of salt marsh may contain over 10,000 salt marsh mosquito eggs waiting for a high tide or heavy rain. The genera *Mansonia* lay their eggs on the undersides of leaves of water plants and hatch after a few days. Females of some species may blood feed and lay eggs several times during her life span.

The second stage of the mosquito metamorphosis is the larval stage which resemble small worm-like animals with no legs. Mosquito larva live in salt or fresh water, depending on their species. If the water dries up before they become adults they will die. Mosquito larva resemble small worm-like animals with no legs. They are sometimes called "wigglers" because they move around by jerking their bodies back and forth. Larval mouth parts are covered

by tiny hairs and are constantly moving as they search for small particles of food from the water. At the base of the "tail" the larva have a small air tube or **siphon** which they stick out of the water in order to breathe. The outside skin or **exoskeleton**, of the larvae must be shedded or **molted** as the animal becomes larger. Under the old exoskeleton there is a newer one that is soft and able to stretch to fit the subsequent larger larvae. All species of mosquitoes molt 4 times. Each of these molt periods is called an **instar**. At the forth molt the larvae turn into pupae. The larval stage of many species last about 5 days in the summer and longer in cooler weather. In some species, development may take considerably longer.

After the fourth molt, the wriggler emerges as a pupae or "tumbler". In this third stage of development, the pupa looks like a fat comma and has no eyes. During this stage the pupae do not eat. They spend most of their time connected to the water's surface by their two breathing tubes or trumpets and "tumble " when disturbed. These are located just behind the head. This stage lasts about 2 days in the summer.

When the pupa is ready to become an adult it rests at the water's surface, straightens out its body and splits the back of the exoskeleton. The new adult emerges out of the exoskeleton and rests on the water surface briefly before it flies off to some surrounding vegetation to rest and allow its new wings to dry.

The main difference in the appearance of the male and female mosquito is in the antennae. The males have feathery or hairy antennae while the females have inconspicuous hairs. The antennae of the mosquito are used to help detect sound. The males feathery antennae help them to detect the high-pitched sound produced by the female's wing so they are able to find a female with which to mate. The life span of the males is shorter than the females, only a few weeks compared to the females which, in some species can be as much as two months.

Vocabulary

Incubate *- v. development of the larvae mosquito inside the egg before hatching*

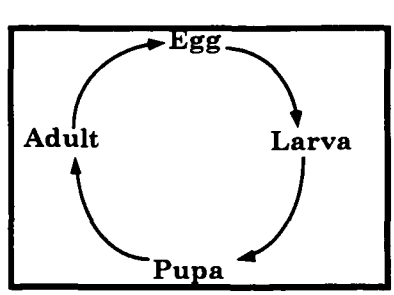
Dormant adj. *- not active; quiet*

Siphon *- n. tube on the posterior end of mosquito possibly used for breathing or attaching to plants*

Exoskeleton *- n. any hard, external supporting structure, as the shell of an oyster.*

Molt *- v. to shed skin, feathers, hair, or a shell before getting a new covering. Snakes, birds, and insects molt.*

Instar *- n. each molt period of a larva.*



Many of the mosquitoes living in our area spend most of their adult life resting in leaf litter or in dense vegetation. They are most active just after sunset for about 1 to 2 hours, however some are active before sunrise as well. Many times when you are bitten during the day you may have come close to the resting place of female mosquitoes. There are also some mosquitoes which are active during the day. These tend to be some of the more annoying mosquitoes and tend to live close to humans. These are the species which lay their eggs in containers such as rain barrels, pans, dishes, and old tires holding standing water. There are some species of mosquitoes which live in the water contained in the leaf **axis** of some air plants. One species of mosquito lives its entire life cycle in land crab holes.

Some mosquitoes stay in the general area where they grew as larvae. Other species, such as the salt marsh mosquitoes, make long flights during the first night of their life. They may fly as far as 20 miles from where they were hatched. Most of the males of our local salt marsh species can be found in swarms as they fly back and forth over a small tree, bush or light patch on the ground.

All mosquitoes require **nectar** for food. However the female requires a blood meal for egg development. Blood contains a necessary protein for the development of the eggs. Many species of mammals, birds, reptiles and amphibians can provide the blood meal for the females. Usually only a few species of mosquitoes in a particular area actually create a problem for humans. Many species are specific to other groups of animals for their blood meals.

In order for the mosquito to be successful in obtaining her blood meal, she must land on her "victim" very gently to avoid detection. On the tip of her **proboscis** (mouth parts) she has knife-like stylets which she uses to pierce the surface of the skin. She pushes her proboscis further into the skin until it punctures a **capillary**. Saliva containing an anti-**coagulant** is injected into the blood which makes it possible for her to suck the blood through her tiny

Vocabulary

Axis *- n. a real or imaginary straight line about which something turns. [In the case of plants, it refers to the spot where all the leaves emerge from.]*

Nectar *- n. the sweet liquid in many flowers, made into honey by bees.*

proboscis *- n. an elephant's trunk, or any other similar long, flexible snout. On a mosquito this is the mouth parts.*

Capillary *- n. one of the tiny blood vessels that join the arteries and the veins.*

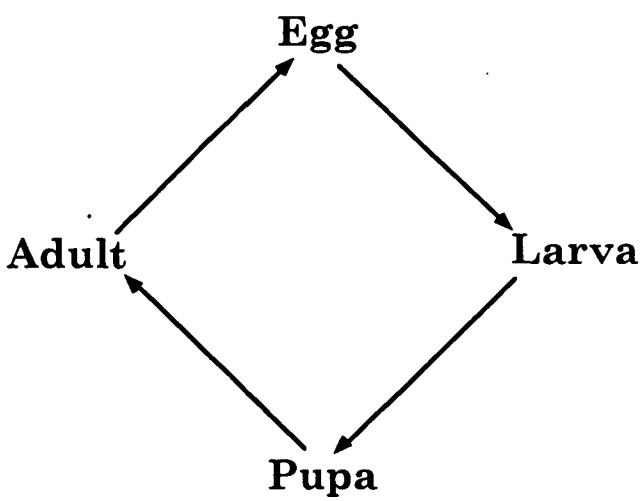
Coagulant *- n. a substance which causes a liquid to become semisolid such as a blood clot*

proboscis. The saliva which is left in the host's body may cause an irritation which we commonly call a mosquito bite.

Knowledge of the life cycle of the mosquito is useful for determining what kind of population control man has used for limiting the number of mosquitoes. It was with the first understanding of this life cycle that these strategies where devised.

Rationale

Section 3.1 is designed to introduce mosquito biology. This will enable students to develop an understanding of mosquito control and why the various strategies work. Students will learn where mosquitoes can be found world wide. The species differences of mosquitoes will be focused on and how these differences may impact mosquito control strategies. Students will learn the life cycle of the mosquito and some of the anatomical differences in male and female mosquitoes.



Objectives

Students will:

- Become familiar with the basic principals of mosquito biology.
- Identify where mosquitoes are found throughout the world and how their densities and diversities change from region to region.
- Identify the different stages in the mosquito's life cycle
- Relate what is learned to how mosquito control strategies can be developed.

✍ *Teacher Note* ✍

You may want to make the copies on sheets of otag or some type of paper which is thicker than regular paper.

✍ *Teacher Note* ✍

It would be very helpful to have an overhead of the masters so you can point out the areas they need to cut out.

✍ *Teacher Note* ✍

Show the students how to puncture a hole in the middle of the area to be cut out so the scissors can cut along the lines.

Materials

Master 3.1a - Vocabulary
Master 3.1b - Mosquito Life Cycle
scissors
brass brads (one for each student)
tape, glue, or glue stick
pencil
crayons or markers (optional)
hole punch (optional)

Procedure

Teacher Preparation

Read and become familiar with the background material on mosquito biology
Make one copy for each student of Master 3.1a - Vocabulary
Make one copy for each student of Master 3.1b (be sure each side is on a separate sheet of paper.)
Be sure each student will have their own pair of scissors for the activity.

Lesson Development

1. Go over vocabulary on Master 3.1a. Ask students if they have any newspaper articles they would like to share with the class.
2. Begin the lesson with telling the students about the density and diversity of mosquitoes. (See background material.) Relate this information to what is found in St. Lucie County.
3. Hand out to the students copies of Master 3.1b - Mosquito Life Cycle. Instruct them to cut out each of the large circles. These will be the two circles of the life cycle wheel the students will be making.
4. After they cut out the large circles, they will cut out the wedge on the circle on the first master sheet. The 2 squares and rectangle which are outlined with dashed lines are also to be cut out.

5. Using the brass brads (or hole punch), punch holes in the center of each of the large circles where indicated by the large black dot. Push the brad through both holes so the circle with the wedge cut out is on top. The smaller circles with the life cycle stages on the second sheet should show through the wedge as the papers spin around the brad.
6. Begin telling the students about the life cycle of a mosquito. Tell them to listen carefully to what you are saying so they can complete their wheels. For each stage, the students will fill in the name of the stage, how long the stage lasts, and where that stage can be found. This information fits into the printed statements on the top circle. The following is what should be filled in:

1. **Egg picture**
   This is the **Egg** stage of a mosquito's life cycle. Depending on the species and the temperature, it will be in this stage for **1 to 8 days. Still Water or Moist soil** are the best places to find this stage.
2. **Larva picture**
   This is the **Larva** stage of a mosquito's life cycle. Depending on the species and the temperature, it will be in this stage for **5 days or longer. Salt or fresh water** are the best places to find this stage.

3. **Pupa picture**
   This is the **Pupa** stage of a mosquito's life cycle. Depending on the species and the temperature, it will be in this stage for **2 days or longer. Salt or Fresh water** are the best places to find this stage.

4. **Adult picture**
   This is the **Adult** stage of a mosquito's life cycle. Depending on the species and the temperature, it will be in this stage for **up to 21 days (males) or two months (females). Leaf litter and dense vegetation** are the best places to find this stage.

Teacher Note

The students should be able to pull the information from your presentation. You may want to make a master of all the choices they can make for the answers.

Teacher Note

The places where mosquitoes can be found can also be filled in with pictures instead of words.

✍ *Teacher Note* ✍

The students may want to make a hole in a sheet in their notebooks to push the brad through. The Life Cycle wheel will then become part of their notebook for future reference.

✍ *Teacher Note* ✍

The July 1991 issue of Natural History is completely dedicated to mosquitoes. This issue can be obtained from the magazine for $3.50 by calling (212) 769-5537 or writing to Natural History, Back Issue Dept., Central Park West at 79th St., New York, NY 10024.

7. End the discussion of the life cycle with the necessity of the blood meal for some species of mosquitoes. Tell them that the proteins in the blood are required for the eggs to develop. Mosquitoes can get their blood meal from not just humans, but also birds, reptiles, and amphibians. Usually there are only a few species in a given area which create a problem for people.
8. Have the students put their wheels in their notebooks. They will be referring to them in a later discussion about mosquito control.

Conclusion

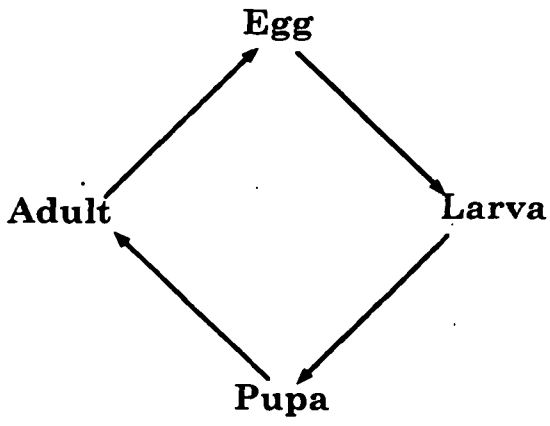
The life cycle of the mosquito is what has determined the strategies used for mosquito control. Man has discovered several methods of interrupting this cycle to help with the problems created by the mosquito. In the next lesson, we will begin discussing the various diseases which mosquitoes are able to transmit.

REFERENCES

Wilkinson, Neil, Ponds, Puddles, and People: An Aquatic Systems/Mosquito Education Unit. Environmental Education, The School District of Lee County and the Lee County Mosquito Control District.

Evans, Hedvig Tetens, *Mosquitoes in Saint Lucie County.* St. Lucie County Mosquito District.

Evans, Hedvig Tetens, *Easily Recognized Mosquitoes of Florida.* St. Lucie County Mosquito Control District.



Detective _____

Master 3.1a Vocabulary

Vocabulary

1. *Order* - _____

_____

2. *Genera* - _____

_____

3. *Metamorphosis* - _____

_____

4. *Egg* - _____

_____

5. *Larva* - _____

_____

6. *Pupa* - _____

_____

7. *adult* - _____

_____

8. *Incubate* - _____

_____

9. Dormant _____

_____

10. Siphon - _____

_____

11. Exoskeleton - _____

_____

12. Molt - _____

_____

13. Instar - _____

_____

14. Axis - _____

_____

15. Nectar - _____

_____

16. proboscis - _____

_____

17. Capillary - _____

_____

18. Coagulant - _____

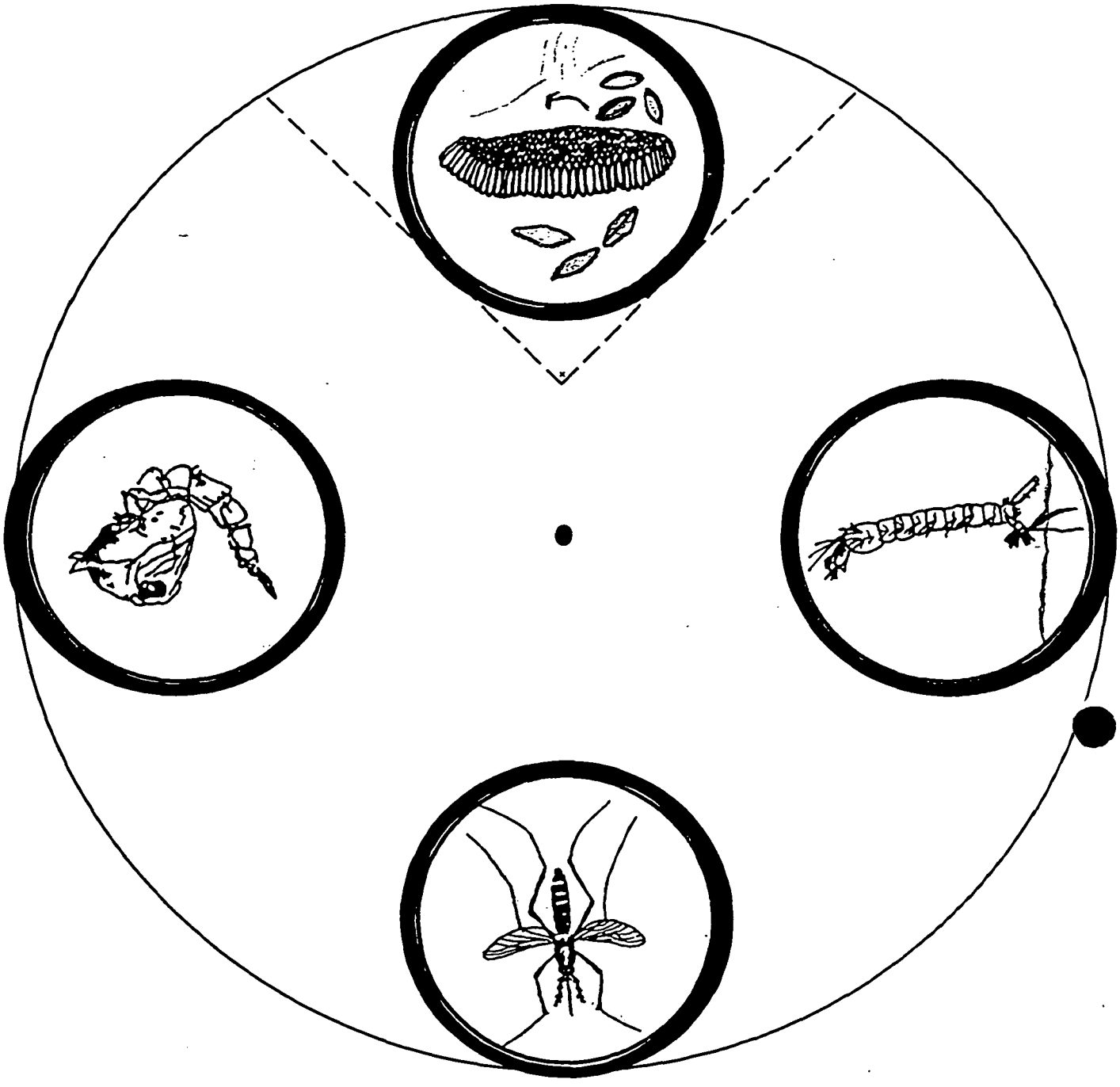
_____

Master 3.1b Mosquito Life Cycle

This is the _____ Stage of a mosquito's life cycle. Depending on the species and the temperature, it will be in this _____ stage for _____ are the best places to find this stage.

✍ ***Teacher Note*** ✍

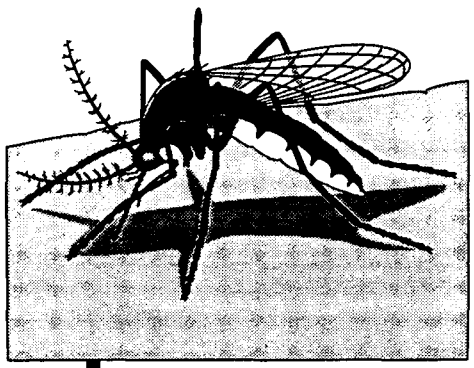
Be sure to copy this page and the next on two separate sheets for students.



Pictures from Ponds, Puddles, and People, Lee County Mosquito District.

3.2 Anatomy of an Adult Mosquito

Background



Mosquitoes, along with gnats, flies and midges, belong to the order of insects called Diptera. The characteristic which distinguishes this order from most insect orders is the presence of two wings instead of 4.

Like all insects, the mosquito has three body parts, the head, the **thorax,** and the **abdomen.** The head of the mosquito is highly specialized for finding and obtaining food. The large compound eyes help avoid predators and work together with the **antennae** to search for food. A notable distinguishing characteristic between males and females is in the structure of the antenna. The antenna of the male is feather-like and is able to detect the presence of female mosquitoes by picking up the high-pitched sound produced by the female's wings. This is important to enable him to mate. The female's antenna is much simpler in structure, lacking the feather-like appearance. The mouth parts or **proboscis** are specialized for sucking the plant juices and nectar all mosquitoes feed on. In females of some species, it is further specialized for taking the blood meal necessary for optimal egg development before they are laid.

The thorax of the mosquito is quite muscular and has the legs and wings attached to it. The abdomen contains most of the vital organs including the area where the blood is stored and digested by the female.

Rationale

Section 3.2 is designed to familiarize the student with the anatomy of the adult mosquito. The anatomy, particularly the structure and function of the proboscis is basic for an understanding of the ability of the mosquito to feed.

Vocabulary

Anatomy - n. *the science that studies the different parts that make up an animal or plant. Anatomy deals with the tissues, organs, and systems of a body or plant. 2 the way a body is put together*

Thorax - n. *the part of the body between the head and the abdomen, the middle part of an insect's body*

Abdomen - n. *the rear part of an insects body (in some other animals, including humans, it is the part of the body between the chest and hips; belly. It contains the stomach, intestines, and liver.)*

Antennae - n. (plural of antenna) *- long, thin, movable body parts on the head of an insect, crab, lobster, or other similar animal. Antennae are used for touching and smelling.*

Proboscis - n. *an elephant's trunk or any similar long, flexible snout; On a mosquito this is the mouth parts*

Teacher Note

Most of these materials are readily available but some time must be spent in preparation of this activity.

Teacher Note

Be sure the glue is a liquid glue. A glue stick will ***probably not work***

Teacher Note

It may be very helpful to have a sample mosquito made for the students to refer to while they are making their model.

Objectives

Students will:

- Build a model of an adult mosquito
- Identify the basic parts of a mosquito and relate how it is different from other orders of insects.
- Identify distinguishing characteristics of male and female mosquitoes
- Identify other insects in the order Diptera

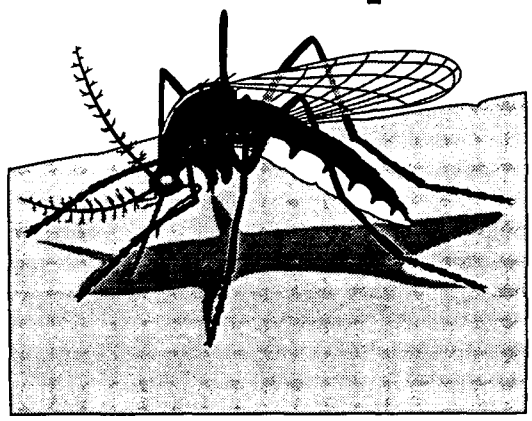
Materials

- Master 3.2a - Vocabulary
- Master 3.2b- Anatomy of an Adult Mosquito
- Master 3.2c - Mosquito Outline
- Master 3.2d - Make Your Own Mosquito
- Tag board (heavy paper) 1/2 sheet of an 8 1/2" X 11" sheet
- Black markers or crayons
- Small thin cocktail drink straws
- black pipe cleaners - 3 1/2 per student
- glue - one **tube** for every 4 students to share
- 5/16" round adhesive labels - 2 per student
- pencil
- scissors
- stapler

Procedure

Teacher Preparation

- Read and understand all background information.
- Make an overhead of Master 3.2b - Anatomy of an Adult Mosquito
- Make copies of Master 3.2a, Master 3.2c and Master 3.2d for each student
- Gather all other materials for making mosquito model



Lesson Development

1. Go over the vocabulary on Master 3.2a. Ask if there are any newspaper articles the students would like to share with the class.
2. Begin the lesson with a review of the life cycle of a mosquito. Have the students use the wheels they made last week to discuss the various stages and anything they remember about each of the stages.
3. Pass out to each student a copy of Master 3.2c - Mosquito Outline. Using the overhead of Master 3.2b (Anatomy of an Adult Mosquito) describe the different parts of the mosquito. Explain how most of the parts are the same for almost all insects. Distinguish how the order of Diptera are different from most other insects. Ask the students if they can think of any other insects which might belong to the same order because they only have two wings.
4. As you are explaining the parts of the mosquito, have the students label the parts on their copy of Master 3.2c - Mosquito Outline.
5. Pass out Master 3.2d - Make Your Own Mosquito, to each student. While you are passing out the instructions, have the students get out a pencil, a pair of scissors and a black marker or crayon. Go over the instructions with them before handing out any of the other materials. Once the students understand the instructions, have them begin. Begin handing out the remaining materials in the order that they will need them.

Teacher Note

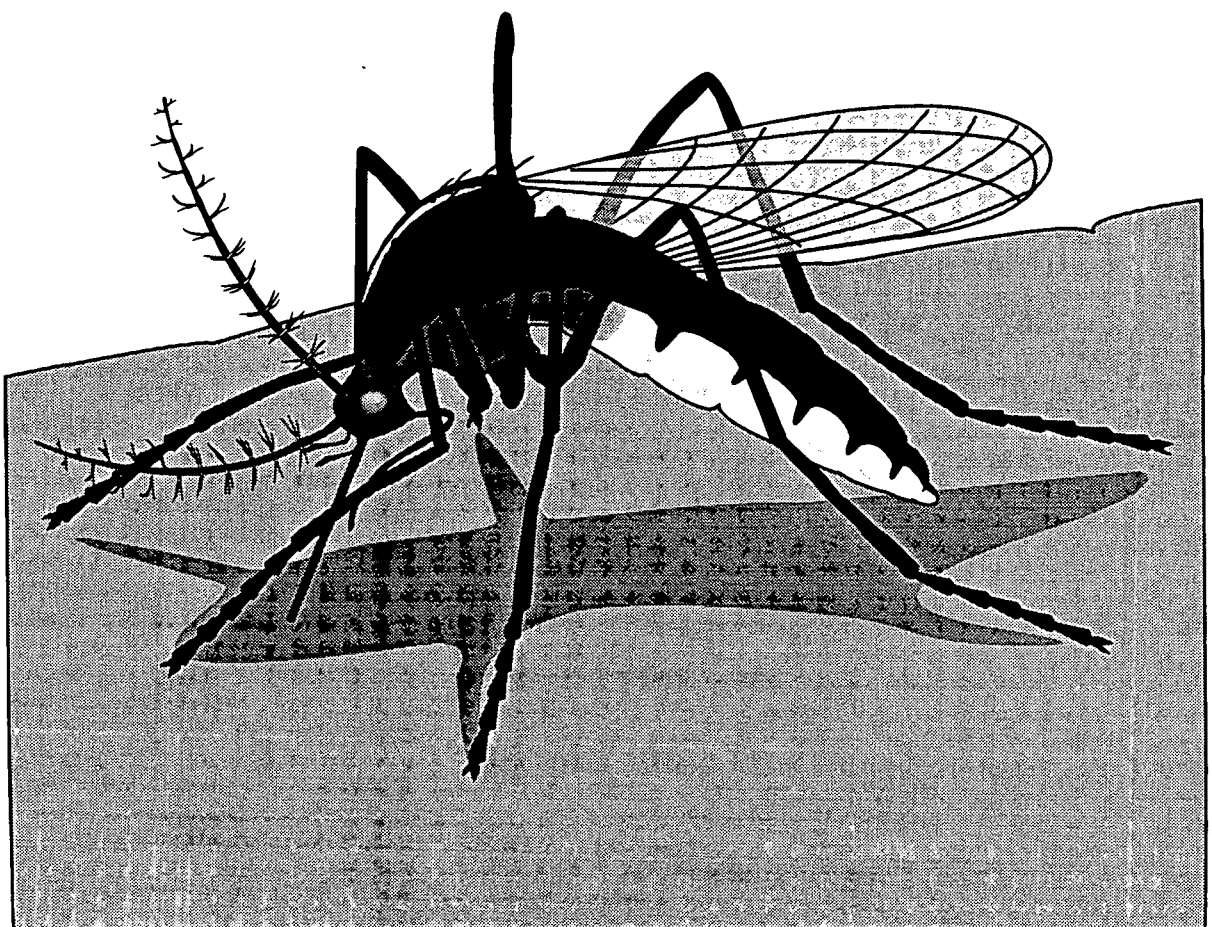
You may want to have an overhead of a generic insect available for comparison to show the similarities and the differences.

Teacher Note

The class could be split up into groups of about 4 students to work together on their models. Each student in the group should still build their own model.

Conclusion

At the completion of this section the students should have a good understanding of the basic biology of the mosquito. They should understand where mosquitoes can be found world-wide, what the life cycle of the mosquito is, and the anatomy of the adult mosquito. This understanding will be the basis for future lessons on disease and mosquito control.



Detective _____

Master 3.2a Vocabulary

Vocabulary

1. *Anatomy* - _____

_____

2. *Thorax* - _____

_____

3. *Abdomen* - _____

_____

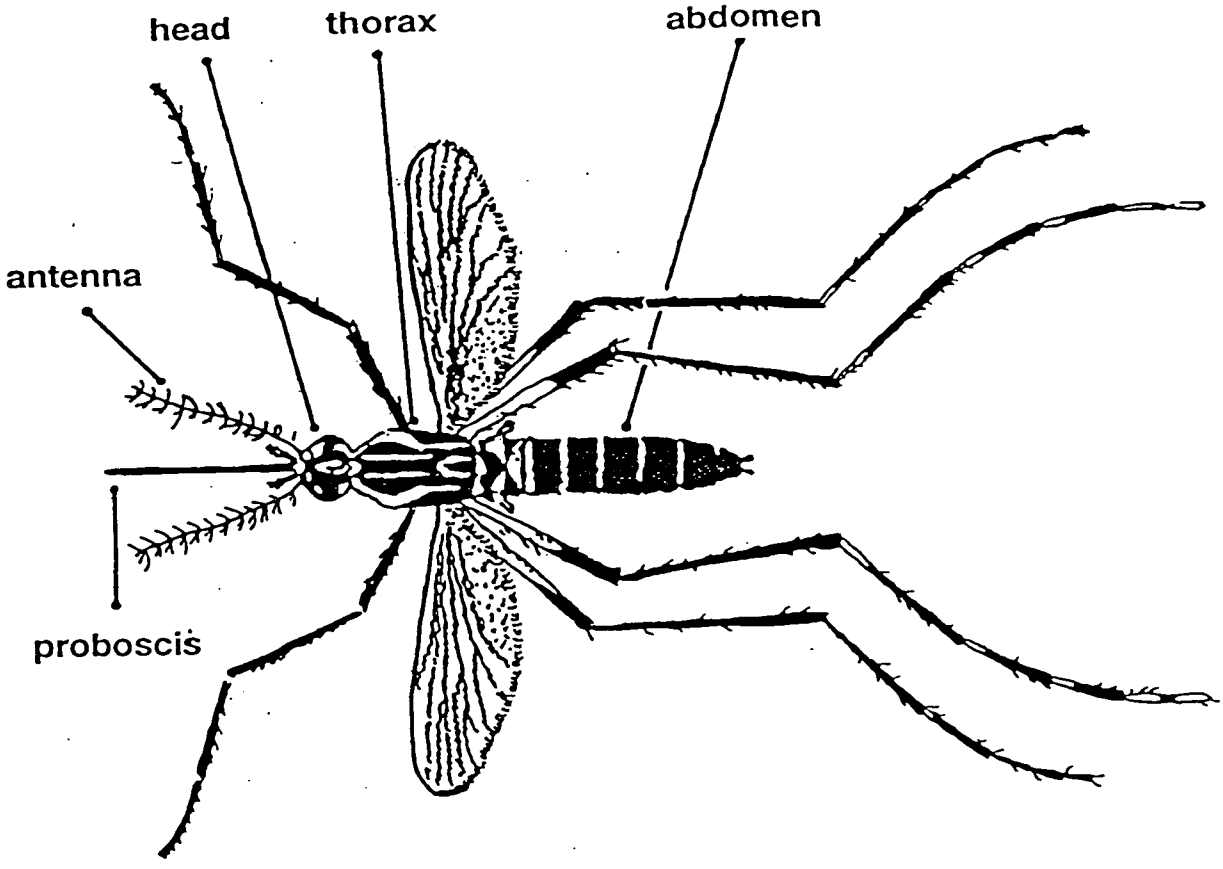
4. *Antennae* - _____

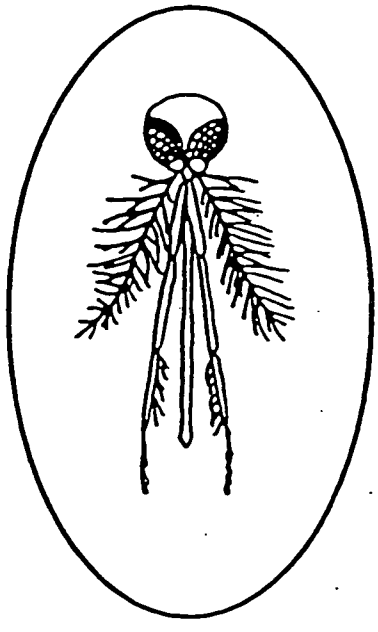
_____

5. *Proboscis* - _____

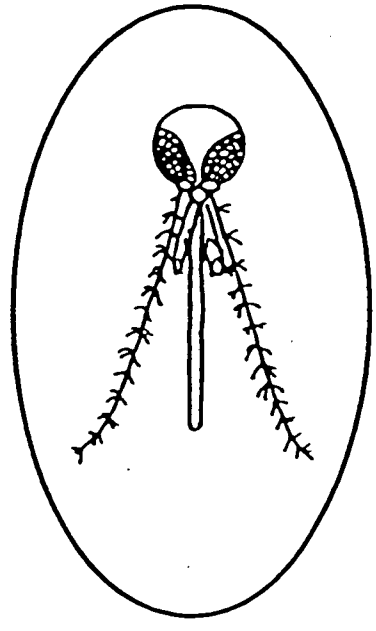
_____

Master 3.2b
Anatomy of an Adult Mosquito



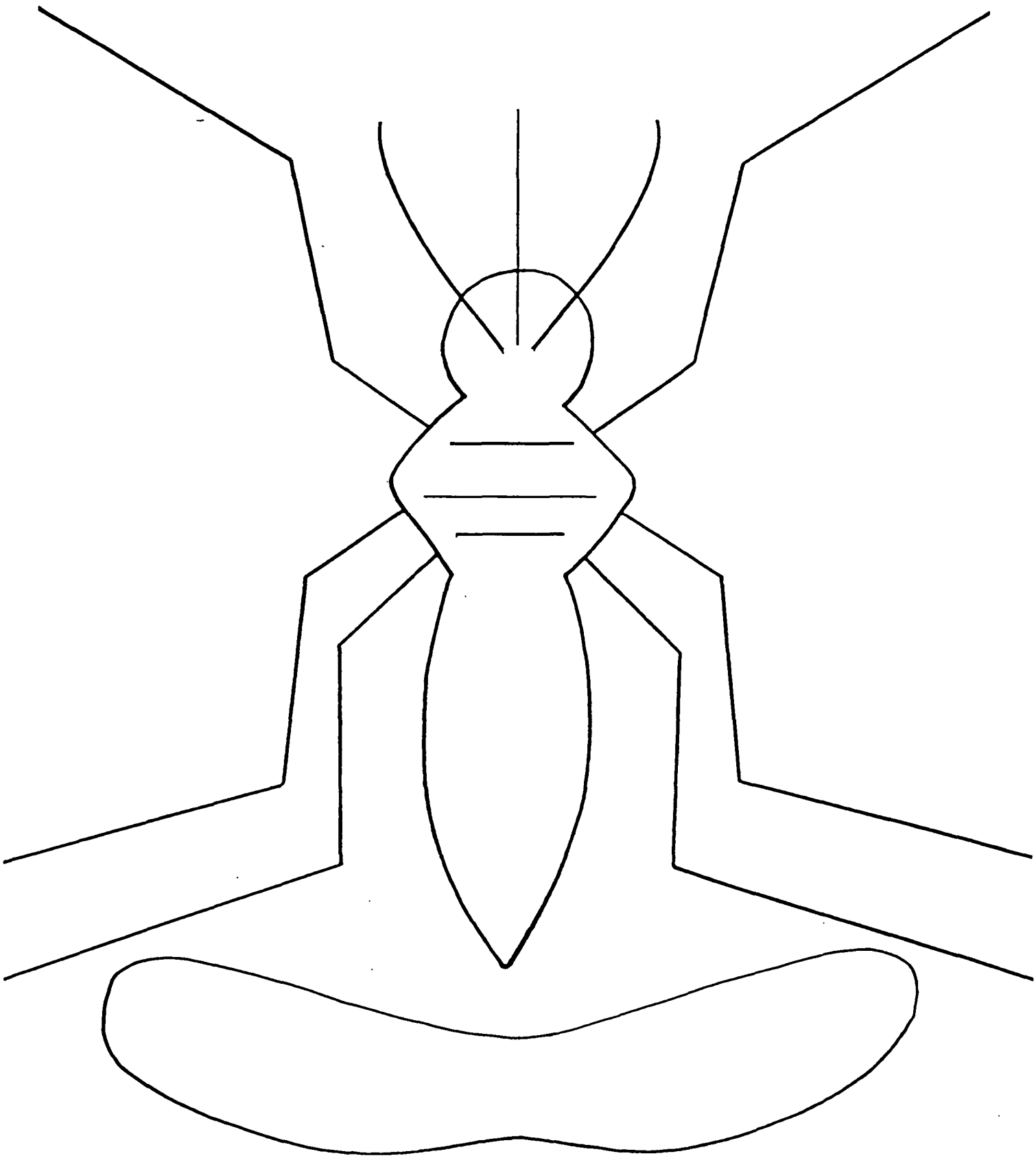


Male *Culex* Head



Female *Culex* Head

Master 3.2c
Mosquito Outline



Master
3.2d
Make Your Own Mosquito

Materials (for each student):

Master 3.2 b - Mosquito Line Drawing

1 piece of heavy paper	2 - round sticker labels
black marker or crayon	pencil
proboscis tube (small straw)	scissors
3 1/2 black pipe cleaners	glue

Procedure:

1. Cut out the mosquito outline of the head, thorax and abdomen. (Do not throw-out or wad up the rest of the outline sheet. You will need it later.)
2. Trace the outline of the head, thorax, and abdomen on the heavy paper.
3. Cut out the outline from the heavy paper. (You may throw out the rest of the paper.)
4. Write your name on the one side of the mosquito body.
5. Color the other side to look like the overhead of the Anatomy of the Adult Mosquito.
6. Bend the body along the center. (See figure a on back)
7. Carefully use your pencil to make three holes on either side of the thorax (see figure b on back). This is most easily done by putting your paper on the floor or some other soft surface and pushing the point of a ball point pen through at either end of the lines on the thorax.
8. Push 3 long pipe cleaners through the holes so the matching holes on either side of the thorax have one pipe cleaner going through both holes (see figure c on back).
9. Glue the pipe cleaners in place by putting a <u>**small**</u> drop of glue next to each hole.

10. Fold the short pipe cleaner in half. Make hole in the head on either side of the fold. Push the pipe cleaner through the holes from the bottom for the antenna.
11. Slide the small straw under the antenna pipe cleaner on the underside of the head. Staple in place.
12. Draw a criss cross pattern on the eyes to make them look compound. Stick the eyes to the head.
13. Place the mosquito over the spot on the outline page where you cut out the body. Using the leg lines for a pattern, bend the pipe cleaner legs with two bends per leg. The first pair of legs bend upwards and the last 2 pairs of legs bend downwards.

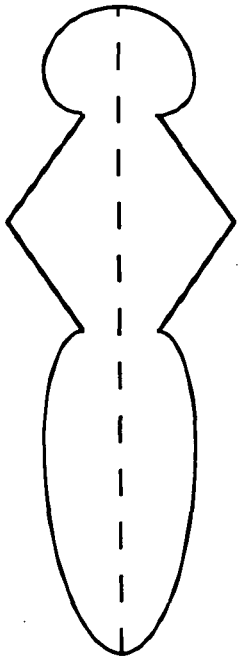


Figure a
Fold in half along dotted line

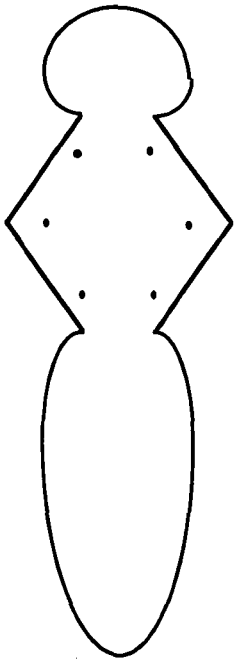


Figure b
Make holes in thorax on place marked with dots

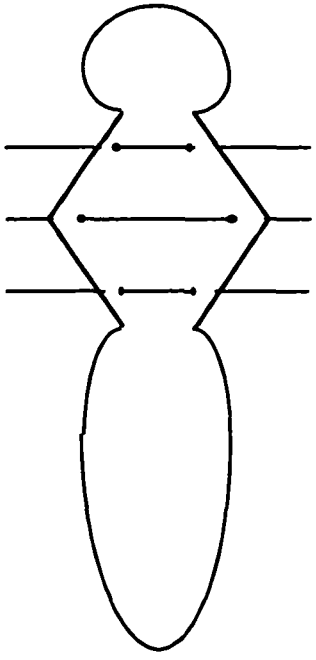
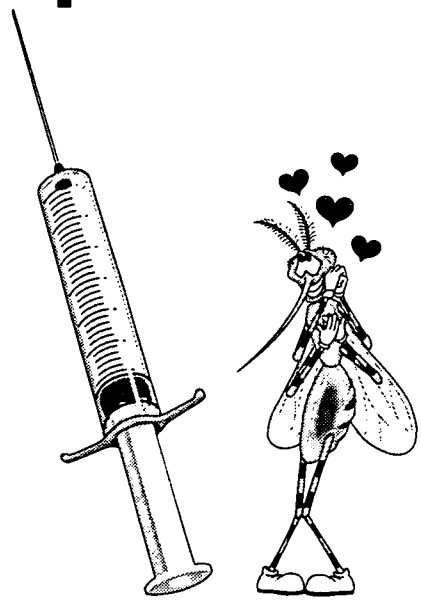


Figure c
Fit pipe cleaners through holes

14. Cut the wings out of the outline paper.
15. Draw wing vein pattern (see overhead)
16. Glue the wings to the body. They may also be stapled.

3.3 Mosquitoes and Man - Disease

Background



As **vectors** of disease, mosquitoes have been responsible for more human deaths than any other animal (Nielsen, Natural History 7/91:6). Malaria has killed hundreds of millions of people and it is believed that there were about 200 million people infected with the disease in 1991. Approximately 100 million new cases are found each year with the same number of deaths, primarily children, each year. Other major health threats in humans are dengue or "break-bone fever", various types of encephalitis, Yellow fever and Filariasis (Elephantiasis).

Because mosquitoes take in blood borne pathogens when blood feeding on a **host**, they can serve as vectors for many diseases. In order for a mosquito to **transmit** a disease, the disease agent must (1) be picked up by the mosquito (usually by taking blood), (2) be able to survive and reproduce within the mosquito and, (3) be given to another host (usually via the salivary gland in the mosquito) by injecting saliva into its body. There are relatively few disease agents which meet all these requirements. For example, if a mosquito bites someone with a cold, the cold virus will be picked up by the mosquito but since the virus cannot reproduce within the mosquito, the disease agent is not transmitted. The current research on the AIDS virus indicates that the same is true if a mosquito bites a person who is HIV positive. The virus cannot live within the mosquito body.

Malaria has not been of a significant concern in Florida since the mid-1950's. Most cases occurring in the state are acquired outside the US. The 1988 CDC Annual Summary of Malaria showed 1,023 malaria cases in the US. Of these, only 32 were acquired in this country and none of these were in Florida. In 1990 the first case in 42 years of malaria acquired in Florida was reported. The infected mosquito bit a woman while she was camping in Gulf County in the

Vocabulary

Vector - n. *an animal that transmits a disease-producing organism*

Pathogen - n. *microorganism, etc. capable of causing disease*

Host - n. *any organism on or in which a parasitic organism lives*

Transmit - v. *to cause to pass through air or some other substance [mosquito]*

CDC *- Center for Disease Control*

Vocabulary

Protozoan *- **n.** any of various, mostly microscopic, single celled-animals*

Symptom *- **n.** any circumstance or condition that indicates the existence, as of a particular disease*

Epidemic *- **n.** the rapid spreading of a disease to many people at the same time*

Virus *- **n.** a form of matter smaller than any of the bacteria. It grows in the cells of other living things and causes disease in animals and plants. Smallpox, measles, and the flu are caused by viruses.*

Strain *- **n.** a group of animals or plants [or viruses] that have developed from a common ancestor*

Replicate *- **v.** to repeat or duplicate*

Immune *- **adj.** protected from a disease*

Panhandle. In 1996 there were two reported cases in Palm Beach County. Malaria is caused by microscopic **protozoa** which can be found throughout the world. They are transmitted from person to person by the bite of *Anopheles* mosquitoes. The protozoan is able to reproduce in the salivary glands of the mosquito thus giving it the ability to be transmitted. The **symptoms** start with a headache, aching in the bones, anorexia, and sometimes vomiting. The initial symptoms mimic the flu. This would be followed by chills, chattering teeth and high fever and sweating. (For more information see *Human Malaria,* A Florida Mosquito Control Fact sheet, Appendix E.)

Saint Louis Encephalitis is a problem in Florida. As of 1990, cases of the disease had been reported in all but 6 states, Maine, Vermont, Massachusetts, Rhode Island, Connecticut, and South Carolina. It was first identified in St. Louis, Missouri in 1933 with **epidemics** breaking out periodically since then. In Florida, major epidemics have occurred in 1959, 1961, 1962 and 1977. It is important to note that the **virus** is present in some South Florida counties nearly every year even when there is not an epidemic. The virus, although transmitted in non-epidemic years, may not cause an outbreak of the disease. This suggests that an epidemic may be caused by a particular "hot" **strain** of the virus. Even in epidemic years, only a small portion of individuals infected with the virus become ill. The transmission cycle of the virus is believed to be linked with the infection of some bird species. A bird which has been infected by the bite of a carrying mosquito is able to support the virus so that it can reproduce enough so that when another mosquito bites the bird it too can become infected. After the bird is infected, it takes 1-2 days to for the virus to **replicate**. The virus rapidly disappears from the bird 1-3 days later. Once the bird recovers from the infection, it stays forever **immune**. The mosquito however will always remain infected. An infected mosquito can then transmit the disease to a human. Humans, however are considered a "dead-end" host since the virus does not replicate in enough

in human blood for the transmission back from human to mosquito. As more and more birds become immune to the virus and the infected mosquitoes begin to die off, the epidemic will rapidly end. Encephalitis causes inflammation of the brain which can cause retardation or death. The symptoms of the disease are high fever, disorientation, severe headache and stiff neck. The disease has a higher incidence in older people. Since the disease appears in bird populations, blood samples are taken from "sentinel chicken flocks and tested for the presence of **antibodies** to the virus. (For more information see *Saint Louis Encephalitis - A Florida Problem*, Florida Mosquito Control Fact sheet, Appendix E.)

Eastern Encephalitis is also of concern for Florida. It is a fatal disease in both human and horses. Typically there are 50-75 cases each year in horses and only one or two in humans. The transmission cycle of the virus is similar to St. Louis Encephalitis and humans are again a dead-end host for the virus. There is no specific treatment for the disease in humans and in horses, however there is a **vaccine** against the disease in horses. The disease can be found throughout the eastern United States and Canada from Mid-July until the first frost (in the North) or during most of the year in Florida. (For more information see *Eastern Encephalitis - A Fatal Mistake,* Florida Mosquito Control Fact sheet, Appendix E.)

Mosquito-borne Dog Heartworm disease is of great concern to pet owners in Florida. Until recently the disease was confined to tropical and subtropical regions throughout the world. Recently cases have been reported in almost every state within the United States and in several provinces of Canada. Heartworm disease is caused by a thread-like round worm or **nematode**. The adult worms live in the **pulmonary arteries** and the right **ventricle** of the heart. The parasite can only be transmitted from one dog to another by a vector mosquito species. After biting an infected dog, the early stages of larva begin developing in the mosquito. After 2-3 weeks in the mosquito, the larva migrate to the mouth parts of the

Vocabulary

Antibody - n. *a substance made in the body that can act against a virus or other foreign substance. In this way the body becomes protected against certain diseases.*

Vaccine - n. *a substance put into the body to help fight off a disease. It is made up of dead or weakened germs that cause the body to produce antibodies.*

Nematode - n. *a long, cylindrical, unsegmented worm; roundworm*

Pulmonary - adj. *of the lungs*

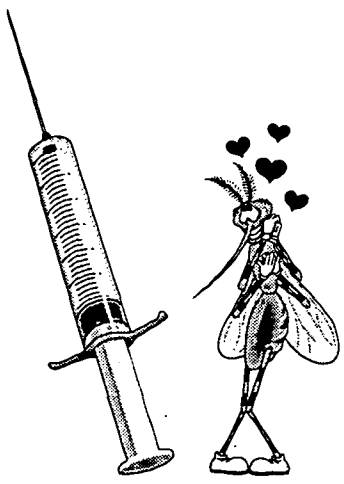
Artery - n. *one of the blood vessels that carry blood away from the heart to all parts of the body*

Ventricle - n. *either of the two lower chambers of the heart*

mosquito. When the mosquito takes a blood meal from a dog, the larva come out of the proboscis and lay on the skin of the animal until the mosquito is done with its blood meal. The larva then enters the host through the puncture left by the mosquito. After 70-90 days and further development from larva to adult, the young adults reach the heart via the blood stream. The symptoms from the disease are fatigue, coughing, and general unthriving. These signs may not appear until a full year after the initial infection has occurred. Some breeds of dogs seem to inhibit the maturity of a smaller percentage of the larva than others. Heartworm disease is sometimes found in humans but primarily in the lung instead of the heart. It is detected as a "coin **lesion**" with the use of X-rays. Its clinical significance has not been fully determined. There have been approximately 80 cases found in humans in Florida in the past 20 years. (For more information see *Mosquito-Borne Dog Heartworm Disease,* Florida Mosquito Control Fact sheet, Appendix E.)

Vocabulary

Lesion - n. an injury of an organ or tissue resulting in impairment of function



Each mosquito-borne disease is carried by only certain species of mosquitoes. For instance malaria is only carried by 50 night-biting *Anopheles* species while *Culex nigripalpus* is a common carrier of St. Louis encephalitis in Florida. *Aedes aegypti* is the primary vector of Dengue or Breakbone fever. The Asian Tiger mosquito is also believed to be a vector of Dengue. Up until 1985 tiger mosquitoes were only found in Asia and many islands in the Pacific Ocean. In recent years, this species has greatly increased its range into every continent except Antarctica. The larva of this species inhabit containers with standing water. It is thought that their spread is due to the shipment of used tires from Japan or Taiwan into the United States. This is an example of how important mosquito control efforts are in controlling the spread of mosquito-borne diseases. (For more information see *The Asian Tiger Mosquito in Florida,* Florida Mosquito Control Fact sheet, Appendix E.)

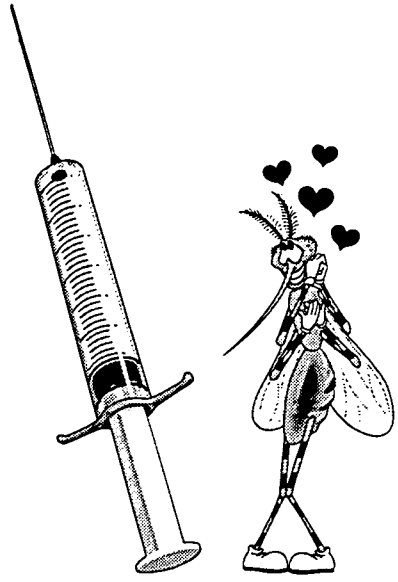
The prevalence of mosquito-borne diseases and their consequences have been a major factor in

developing mosquito control techniques. Throughout history the prevalence of these diseases have made a dramatic impact. It wasn't until the yellow-fever bearing mosquitoes were brought under control that the Panama Canal could be completed.

Varying control techniques are used to target different stages of the life cycle of mosquitoes. At the egg stage, impoundments are used to eliminate areas for laying eggs. This technique has been found to be very cost effective when compared to the use of chemical controls. The consequences of building impoundments are still being investigated. Initially, these impoundments isolated much of the wetland immediately adjacent to the Lagoon. The environmental effects of this practice have always been questioned. In an attempt to return these areas to the natural balance of the Lagoon, St. Lucie County is reconnecting the impoundments. The tides are allowed to flow in and out of the dikes on off breeding periods (winter, spring, fall). During the mosquito breeding season, water is periodically drained from the impoundments. This is often done by draining the lower layers of the water by opening the culverts at one end while pumping Lagoon water into the other end.

At the larva stage spraying is used. The artificial chemical sprays will kill the larval mosquitoes as they feed. Some of these chemicals, called larvicides, not only kill the larva of mosquitoes, but also the larvae of other organisms. The risks to the environment by using insecticides can be high. Other forms of larvicide which can be used are natural bacteria or biochemical compounds which may largely affect only the larva of mosquitoes. The bacteria interfere with their digestion and cause their death. This type of control, while being largely non-detrimental to the environment, is however very costly and not completely effective and may cause resistance.

At the pupa stage there are limited numbers of available techniques specifically designed to target the larva. (The chemical **larvicides** however may be effective to this stage.) For both the larva and pupa stages, small fish have been introduced to help control larva and pupa populations. Although



Vocabulary

larvicide - n. *control method, either chemical or natural, used to kill the larva stage of an organism*

Vocabulary

adulticide - n. *control method, either chemical or natural, used to control adult populations of organisms.*

pesticide - n. *any chemical used to kill insects or weeds.*

Teacher Note

This section is presented in a discussion format. You may want students to research the various diseases and control techniques and do oral presentations to the class

mosquito fish or Gambuzia do control these populations, on a large scale they are not effective enough because they cannot reach the isolated egg deposits and larval development sites.

Because larva and pupa require water in order to develop, individuals can help with mosquito control by making sure there is no standing water around house and businesses for mosquito development. The increased range of the Asian Tiger mosquito since 1985 is a perfect example of how man has impacted (and could have prevented the spread of) mosquito populations through used tire importation. It is now found in every continent in the world except Antarctica.

Adult populations are controlled by the use of **adulticides** or chemical **pesticides**. While these techniques produce immediate results, they are artificial chemicals introduced into the environment and are necessary when other alternatives are not available..

The need for mosquito control has never been disputed since the connection has been made to mosquitoes as the vector for disease and because of quality of life issues. Control methods are always being refined to make them more and more environmentally sound. Because of the cost of using larvicides and adulticides and their potential impacts to the environment, mosquito impoundments are an experimentally researched alternative. In St. Lucie County, as well as throughout Florida, new impoundment management practices are constantly being researched and implemented.

Rationale

Section 3.3 is designed to make students familiar with the health problems associated with mosquitoes. The background information is provided so teachers can present the information in a discussion format. Many students will have questions regarding the transmission of AIDS through mosquito bites. This information is important for students. Students may be familiar with Encephalitis since it seems most to be a problem during October. Students may remember

years when they were unable to Trick-or Treat on Halloween. Teachers must be careful not to scare students but to give them a clear understanding on the health factors. The curriculum provides more in depth information on Fact Sheets printed by the University of Florida.

Objectives

Students will:

- Become familiar with the basic health risks associated with mosquito borne diseases.
- Identify diseases world wide as well as those which can be found in Florida.
- Learn why AIDS cannot be transmitted by a mosquito.
- Make an information brochure about mosquitoes and mosquito control.

Materials

- Master 3.3a - Vocabulary
- Master 3.3b - Brochure
- Pencils, crayons, etc.

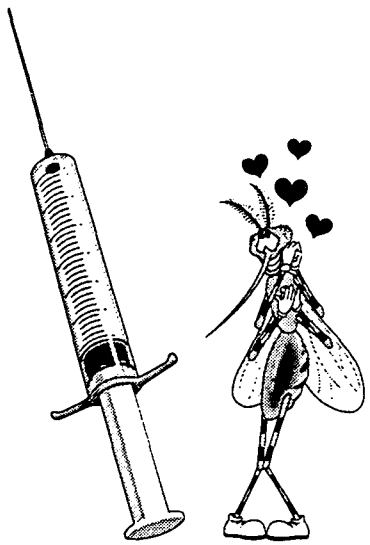
Procedure

Teacher Preparation

- Read and become familiar with the background material on Mosquito Diseases
- Make one copy for each student of Masters 3.3a and 3.3b.

Lesson Development

1. Go over the vocabulary on Master 3.3a. Ask students if they have any newspaper articles they would like to share with the class.
2. Begin the lesson telling students about how mosquitoes actually transmit disease. Go over the three factors which must be present for a disease to be



Teacher Note

You may want to contact the St. Lucie County Mosquito Control Commission for a speaker for your class. They may also provide some mosquito fish and larva to the class. Students love to watch them develop through the stages. Be sure to cover the container if you choose to do this activity.

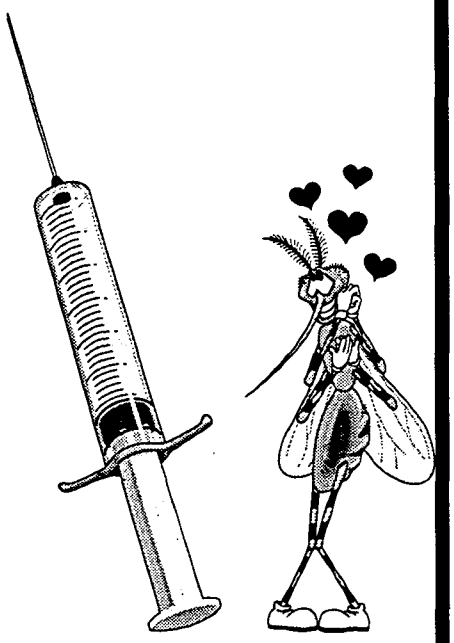
✍ *Teacher Note* ✍

You may want the students to work together making their brochures.

✍ *Teacher Note* ✍

It might help students if you have a sample brochure to show them.

Reference:
Natural History Magazine: July 1991.



successfully carried and passed on by mosquitoes. Be sure to explain that this is the reason why AIDS cannot be transmitted by mosquitoes.
3. Discuss the various types of diseases which are transmitted by mosquitoes. Be very careful not to scare students with this information. 4. Ask students if they have found any articles on mosquitoes in the newspaper. Chances are there may have been some stories, particularly if the curriculum was started in the fall. If there are any articles, have the class share them.
5. Hand out Master 3.3b. Have the students get out their Life cycle wheel (Section 3.1) and fill in the circles with pictures of the stages of mosquito development.
6. In the second column, fill in the types of control which are used at each stage of development. You will need to give the students the information and have them fill it in.
7. Give the students time to decide for themselves whether the control technique is good or bad. They should write their reason in the space provided.
8. From what the students have learned about mosquitoes, have them fill in the Interesting Facts and the What You can do .... sections.
9. Post the brochures in the classroom.

Conclusion

It is important for students to see how a tiny animal such as the mosquito has had major affects on human history. Man is still battling diseases in some areas while in others, through advanced technology, many disease problems have been eliminated.

Mosquito control techniques have also changed throughout history. In St. Lucie County, one of the major control techniques is through the use of impoundments. Students should now be ready to make some judgments about whether the alteration of the natural shoreline is the correct alternative to mosquito control.

Reference

Disease and Control information provided by David Mook - St. Lucie County Mosquito Commission

Detective _____

Master 3.3a Vocabulary

Vocabulary

1. *Vector* - _____

_____

2. *Pathogen* - _____

_____

3. *Host* - _____

_____

4. *Transmit* - _____

_____

5. *Protozoan* - _____

_____

6. *Symptom* -

_____

_____

7. *Epidemic* - _____

_____

8. *Virus* - _____

_____

9. Strain - _____

_____

10. Replicate - _____

_____

11. Immune - _____

_____

12. Antibody - _____

_____

13. Vaccine - _____

_____

14. Nematode - _____

_____

15. Artery - _____

_____

16. Lesion - _____

_____

17. larvicide - _____

_____

18. adulticide - _____

_____

19. pesticide - _____

_____

Master
3.3b
Brochure

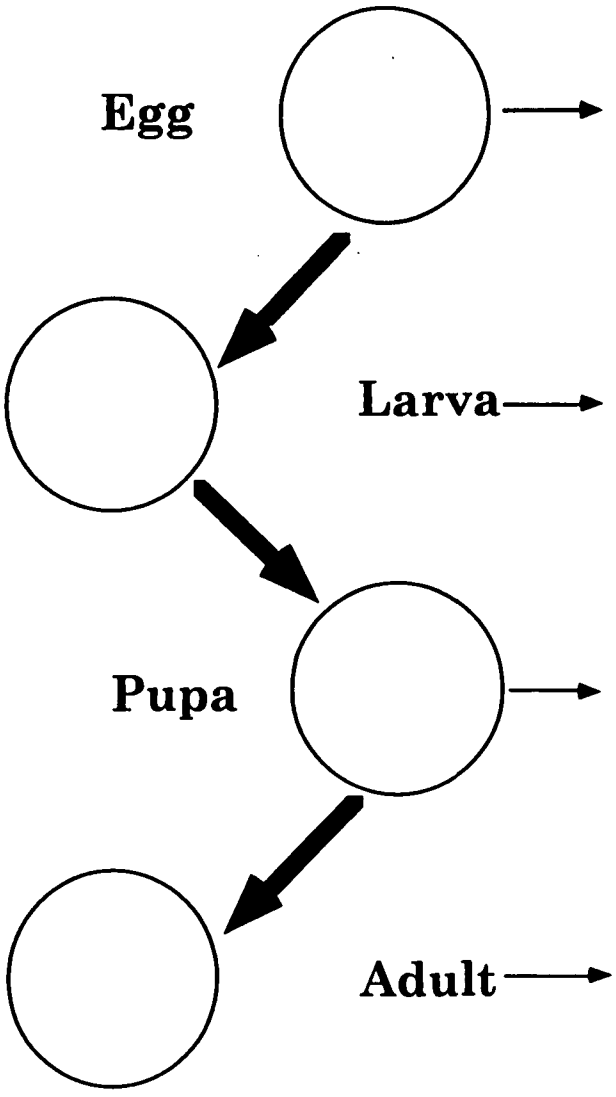
Next two pages

Copy two sided

Life Cycle

Mosquito Control Method used for Each Stage

Good *OR* Bad???



? _____

? _____

? _____

? _____

Interesting Mosquito Facts

1. _____

2. _____

3. _____

4. _____

5. _____

What You Can Do.....

1. _____

2. _____

3. _____

4. _____

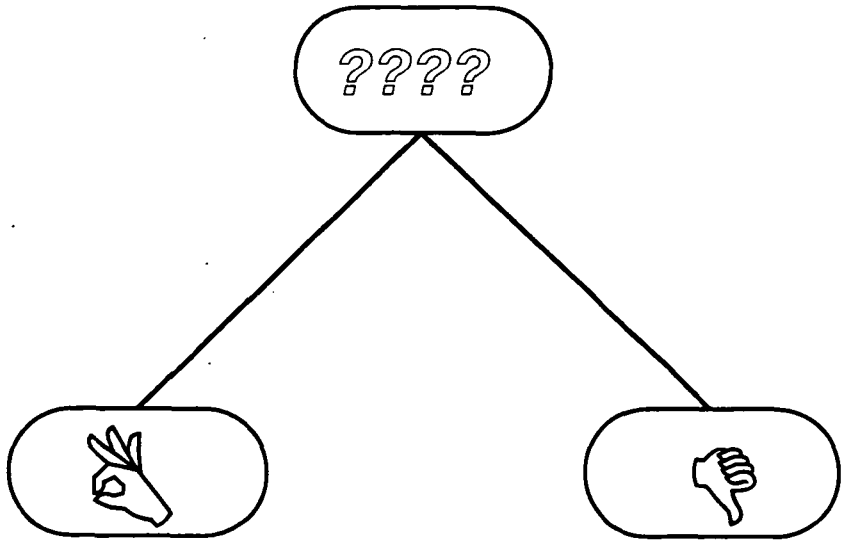
5. _____

Mosquitoes and YOU

MANGROVES, MOSQUITOES, AND MAN

UNIT 4

Issues for the Indian River Lagoon and Mosquito Control



UNIT 4

Issues for the Indian River Lagoon and Mosquito Control

Unit 4 gives students the opportunity to put all their knowledge about the Indian River Lagoon and Mosquitoes to work in recommending solutions to an environmental problem. Students now have an understanding of the Indian River Lagoon Ecosystem. They have also studied mosquito biology and learned about mosquito control techniques. These techniques include the use of chemicals, impounding areas of wet land, and natural pesticides. The students should be prepared to look at these forms of control along with issues impacting the Indian River Lagoon and make recommendations for a course of action. This Unit is designed to put all their knowledge together and help in the environmental decision process.

4.1 Environmental Decision Making

Background / Rationale

Section 4.1 is designed to allow students to conduct an investigation as environmental decision makers. Throughout this curriculum, students have investigated the Indian River Lagoon, mosquito biology, and impoundments. The knowledge they have gained in these areas will help them develop recommendations for the management of wetland ecosystems along the Indian River Lagoon in St. Lucie County. How these areas should be managed is currently being debated by environmentalists, scientists, community leaders, fishermen, and many who have an interest in the future of the Lagoon. Students have identified specific **events** and **issues**, past and/or present which may have or had an effect on the Lagoon. For each issue, they have decided what key **players** are/were involved in recommending **responses** to these issues. A **risk assessment** of these responses has been discussed. Students have been encouraged to design other investigations within the subject area which would make them better decision makers in determining responses to the issue. They have identified the **consequences** of specific responses and how they **benefit** and/or **burden** the players and the environment. From their view point as a player, they should see what is the best response. This whole process is called an issues analysis.

This process will be demonstrated for students with an issue that the students have seen while watching the newspapers. Using newspaper articles that have been collected throughout the study, students will identify the players and their responses to the event. They will discuss the consequences for all the players involved. Finally, they will look at all the burdens and benefits and develop their recommendations for the issue.

For the purposes of developing a lesson, we will demonstrate this activity using the net ban. This event has received a great deal of attention since the

Vocabulary

event - n. *something that happens, especially something that is important*

issue - n. *something that needs to be talked over or decided.*

player - n. *a person who plays a game (in our context the game is the process of making an environmental decision)*

response - n. *something that is said or done in answer (to an event)*

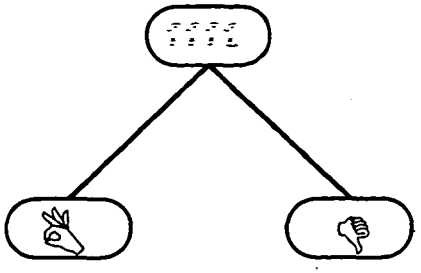
risk - n. *the chance of losing, failing, or getting hurt*

assessment - n. *[the act of] deciding or trying to find out the importance or value of something*

consequence - n. *a result or outcome*

benefit - n. *something that is good or helpful*

burden - n. *anything that is very hard to bear*



nets were banned in July of 1995. Using the articles and their current knowledge of the issue, students will be asked to follow the steps outlined in the Detective's Case Study report (Master 4.1b). After reading and discussing the newspaper articles, students will recommend responses to the issue. They will present their recommendations to the class and the class will vote on which response, if there should be any at all, will be the best for the players and the environment.

Objectives

Students will:

- Be introduced to the process of environmental decision making
- Use the Detective's Case Study report to identify the event and issue in question
- Recommend responses to the issue
- Identify the benefits and consequences to the players involved in the issue
- Vote on which response is the best

Materials

Master 4.1a - Vocabulary
Master 4.1b - Detective's Case Study
Set of newspaper articles
Highlighter for each group

Procedure

Teacher Preparation

- Make copies of Masters 4.1a and 4.1b for each student
- Assign student partners
- Read through the articles so you will be prepared to help with any difficult words or ideas contained in the articles.
- Make a transparency of Master 4.1b

Teacher Note

Master 4.1b contains sections similar to those used throughout the curriculum. Students may want to refer to some of these sheets to get ideas for this case study.

Lesson Development

1. Go over the vocabulary on Master 4.1a. Ask students if they have any newspaper articles they would like to share with the class.
2. Briefly review with students what they have learned while investigating the Indian River Lagoon and mosquito impoundments. Ask them why these two areas of investigation are important to their lives.
3. Ask them if they know if there have been any recent decisions which may have an effect of the Indian River Lagoon. Have them look at their newspaper articles for some issues. Ask them how they feel about decisions that have been made.
4. (For purposes of demonstration, this lesson will be developed as though the students have identified the net ban. Ask them what they know about the net ban (or their identified issue) and list any ideas they may have on the board.
5. Give each student a copy of the Detective's Case Study report form. Have them fill in the Event space with their issue.
6. Have each group find all the articles relating to the identified issue.
7. Have each group identify what players are represented by the article. They should highlight any portions of the article which are important. They should discuss what the benefits or consequences the player group has experienced since the event. These should be listed on their Case Study report under Event. (See Sample Detective Case Study)
8. Each group should select one member to report to the class about what the group has identified as the players, benefits and consequences of the event.
9. As the students identify their players, the rest of the students need to record the players, benefits and burdens on their Case Study.
10. Introduce the burden the event has placed on one of the player groups as an issue.

Teacher Note

Some Suggestions:

Port Dredging
New developments
Beach Clean-ups
Net Ban

Teacher Note

Be sure each group has at least one good reader. If this is not possible, you may want to do this activity as a whole group. You would lead the discussion about each article

Teacher Note

You may want to be completing the form on the board or overhead projector so the students can see how they are to complete their form.

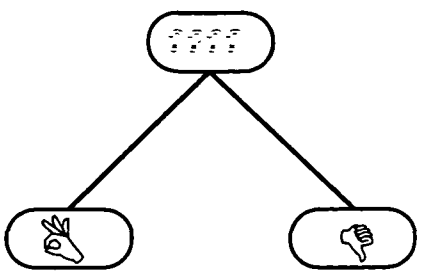
Florida Writes Activity

Have the students think about what it would be like to be a particular player. Have them write about that player's experience through the identified event.

11. Tell the students they must come up with a response to the issue which they feel would have the greatest benefit for their player group. Have them list the possible consequences of that response to the other player groups.
12. Have the groups report back to the class.
13. Have the class vote on which response they feel would be the best. Be sure to impress upon the students the idea that there is no right or wrong answer.

Teacher Note

Ask if any of the students know any players. Have them share their knowledge with the class.



Conclusion

Review the whole process with the class. Remind them that when making environmental decisions, there are often many groups of people (players) and the environment which will reap benefits or suffer consequences. Ask them how important investigations are in the process of environmental decision making. See if they think voters making decisions such as the net ban always have enough information.

Explain that they have been selected to be detectives investigating the issue of mosquito impoundments along the Indian River Lagoon. Years ago, scientists were asked to find a way to manage the enormous populations of mosquitoes. Environmental decision makers decided to impound or build dikes around areas which would hold enough water to destroy the breeding habitats of the salt water mosquitoes along the Lagoon. Although this method has worked well for controlling mosquitoes, there is now some controversy about whether this is a wise choice for the health of the Lagoon. Environmental decision makers have now come to you to make recommendations for managing the mosquito impoundments.

At the completion of this section students will be ready to begin their issue analysis. The students have the background to see how environmental decisions impact not only the ecology of an area, but the lives of all those with an interest in the area.

REFERENCES:

Koenig, Dr. Herbert G. Environment: Events Assessment, Response. Middletown, New York, N & N Publishing Co., Inc., 1993.

Detective _____ **Date** _____

Group Members _____sample_____

Detective's Case Study

EVENT:
WHAT HAPPENED???
July 1995 - net ban

CONSEQUENCES

PLAYERS	BENEFITS	BURDENS
commercial fisher.		*no way to make money*
recreational fish.	*more fish to catch*	
fish eater		*less fish in market*
ecologist	*less pressure on river*	
me	*more fish to catch*	*less fish in market*

ISSUE:
WHAT IS THE PROBLEM????

net ban has been too much of a burden to commercial fishermen because they are losing the only way they know to make money.

POSSIBLE RESPONSES (WHAT CAN BE DONE?????)

RESPONSE: *Limit the catch of the commercial fishermen*		
PLAYERS	BENEFITS	BURDENS
commercial fishers	*some income*	*not enough*
commercial fishers	*some income*	*not enough*
ecologists	*lessen pressures*	*too much pressure*
RESPONSE: *retrain fishermen*		
PLAYERS	BENEFITS	BURDENS
commercial fishers	*future income*	*no present income*
fish eaters	*future increase supply*	
RESPONSE: *retrain fishermen*		
recreational fishers	increase in fish	
ecologists	less pressure	lack of research

BEST RESPONSE

retrain commercial fishermen to be water farmers (aquaculturists)

Master
4.1a
Vocabulary

Detective _____

Vocabulary

1. *event* - _____

_____

2. *issue* - _____

_____

3. *player* - _____

_____

4. *response* - _____

_____

5. *risk* - _____

_____

6. *assessment* - _____

_____

7. *consequence* - _____

_____

8. *benefit* - _____

_____

9. *burden* - _____

_____

Detective _____

Group Members _____

Master 4.1b Detective Case Study

Detective's Case Study

CONSEQUENCES

EVENT:
WHAT HAPPENED???

PLAYERS	BENEFITS	BURDENS

ISSUE:
WHAT IS THE PROBLEM????

POSSIBLE RESPONSES
(WHAT CAN BE DONE?????)

RESPONSE:		
PLAYERS	BENEFITS	BURDENS
RESPONSE:		
PLAYERS	BENEFITS	BURDENS
RESPONSE:		

BEST RESPONSE

4.2 Issues and Players - Mosquito Control

Rationale

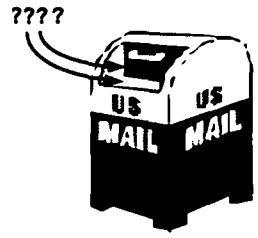
Section 4.2 is designed to get the students to begin the process of environmental decision making. They will first identify what they see as the important **issues** for the Indian River Lagoon as an ecosystem. They will narrow the issues down to mosquito control **policies** for the area. Finally, they will identify who are the **players** that they feel would have important input for them formulating their final **recommendation** on mosquito control and specifically mosquito impoundments.

From this information, the students will develop a **questionnaire** they would like to send to 10 key players. The responses from these questionnaires will help in determining their final recommendations. These recommendations will be presented at a **mock** County Commission Meeting in which a board of Commissioners will listen to the recommendations and take a vote on which course of action would be the best.

Objectives

Students will:

- Identify the major issues (problems) impacting the Indian River Lagoon today.
- Identify the major issues surrounding mosquito control
- Identify the key players who should have input into the solutions of mosquito control
- Develop a questionnaire to be sent to the key players



Vocabulary

Issue - n. *something that needs to be talked over or decided.*

Policy - n. *a plan, rule, or way of acting [It is a good policy to be honest. A country's foreign policy is its way of dealing with other countries]*

Player - n. *a person who plays a game (in our context the game is the process of making an environmental decision)*

Recommendation - n. *advice; suggestion*

Questionnaire - n. *a printed list of questions used in gathering information from people.*

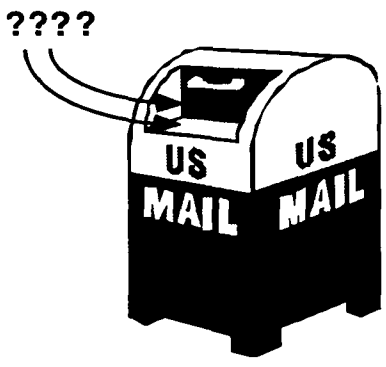
Mock - adj. *not real, pretend.*

Teacher Note

You may want to give each child a copy of the outline so it can be included in their notebooks.

Teacher Note

Make these groups up ahead of time. It is important that they work well together because they will remain a group for the next several classroom lessons.



Materials

Master 4.2a - Vocabulary
Student notebooks as resource information
Outline form (one per group) for questionnaire development
2 Overheads of Master 4.2b
Pencil or pen
Telephone Book and other resources for addresses of players
Envelopes
Cover Letter

Procedure

Teacher Preparation

Briefly review all the information covered in the curriculum
Make copies of Master 4.2b, Questionnaire Outline Form, one per group.
Divide the class into groups, 3 to 5 students per group

Lesson Development

1. Go over the vocabulary on Master 4.2a. Ask students if they have any newspaper articles they would like to share with the class.
2. Explain to the students they will be involved in a Public meeting to make recommendations to a mock County Commission Board about mosquito control in St. Lucie County. They will specifically be looking at Mosquito Impoundments.
3. Review with the students the various types of mosquito control used and how they work. Emphasis should be placed on mosquito impoundments since they have been heavily relied upon in Florida. Begin a discussion of how they feel about mosquito control and the impacts on the ecosystem of the Indian River Lagoon.
4. Divide the class into working groups. Give each group a copy of Master 4.2b. Explain that the outline

is designed to help them develop a questionnaire they will send to people throughout the community.

5. Using the sample questionnaires provided in the curriculum (Appendix F), select some of the questions asked to give the students some ideas to get them started. Allow the groups a specified period of time to complete the outline.

6. One member from each group will be selected by the group to report to the class how they filled out the questionnaire. Using the overhead, fill in each group's responses to the outline. Ask them to justify why they made each of the responses.

7. Using a second blank overhead, have the students develop the questionnaire using all the group information.

8. Be sure students include the last three questions listed on the sample questionnaires.

9. Give the students envelopes to address to each of the players they identified on the outline form. Ask them what resources they can use to find addresses for these people.

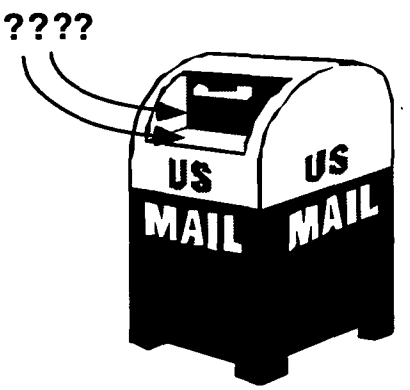
10. A master questionnaire will be developed from the class' work. This will need to be typed and copied so it can be sent to the identified players along with a cover letter (Master 4.2c - sample cover letter). Be sure there is a quick turn around date for the questionnaire so the students will have plenty of time to work with them for their final presentation.

11. When sending out the questionnaire, the students should include information about mosquito control and impoundments. One of the results of the survey will be to show students that they really know more about the subject than most of the people they survey. The information can either be designed by the students or from the information they have in their student notebooks.

12. Students should also be encouraged to pass the surveys around to friends and family.

Teacher Note

You may need to do this activity as a whole group lesson instead of in smaller groups. If so, use the overheads to help get responses from the students.

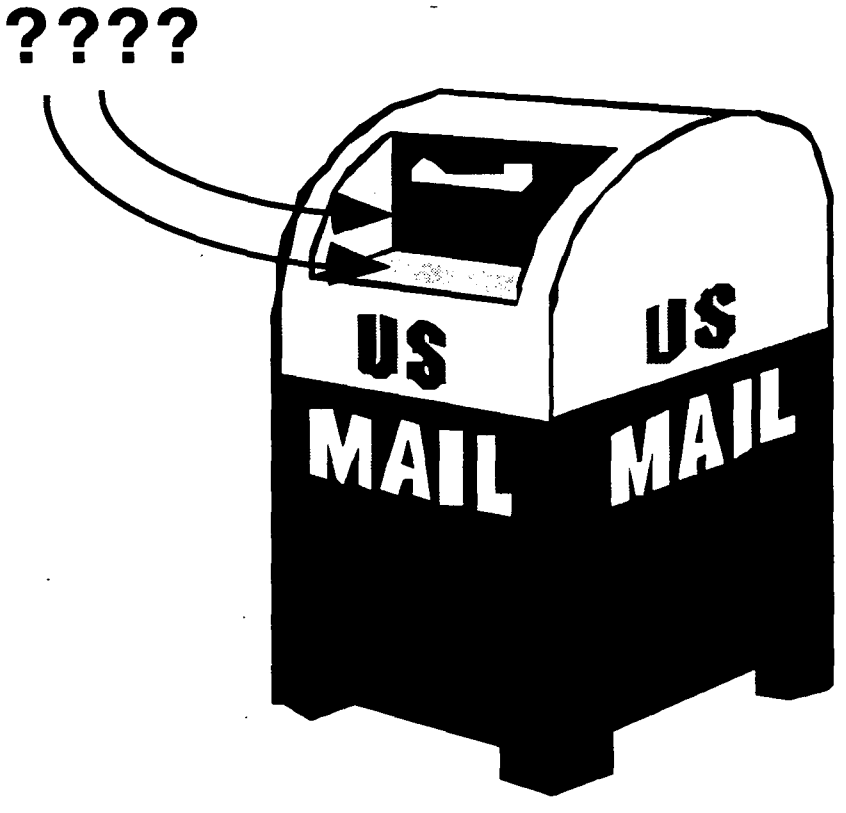


Teacher Note

Use some of the Mosquito Brochures from section 3.3 to send out with questionnaires.

Conclusion

All of the information they have learned in this curriculum has been designed to help the students investigate the problem of mosquito control. The questionnaire they have developed is based on what the students feel is of greatest importance in making an environmental decision. By polling community members about how they feel about the issues impacting the ecosystem as a whole and specifically mosquito impoundments, students will be able to see the problem from other points of view. This will help them to see that environmental decision making impacts more than just themselves, but all members of the community.



Detective _____

Master 4.2a Vocabulary

Vocabulary

1. *Issue* - _____

_____

2. *Policy* - _____

_____

3. *Player* - _____

_____

4. *Recommendation* - _____

_____

5. *Questionnaire* - _____

_____

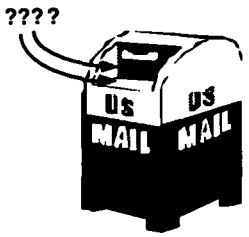
6. *Mock* - _____

_____

Detectives _____

Making a Questionnaire

Master 4.2b Outline



1. What do we want to know about the person????

* _____

* _____

* _____

2. What is most important to you about the Indian River Lagoon?? (decide on some choices to be selected)

* _____

* _____

* _____

3. What are the most important issues (problems) impacting the Indian River Lagoon?? (decide on some choices)

* _____

* _____

* _____

4. What do you know about mosquito control in St. Lucie County? (decide on some choices)

*_____

*_____

*_____

5. How should St. Lucie County manage mosquito impoundments??? (decide on some choices)

*_____

*_____

*_____

6. Is there anything else you would like to ask?

*_____

*_____

*_____

7. List who you think are important players in this environmental decision.

*_____

*_____

*_____

Master 4.2c Sample Cover Letter

School Letterhead

Date

Name (Player being polled)
Address

Dear *Player,*

The 4th grade classes at ***name of school*** have been studying the Indian River Lagoon ecosystem and mosquito control in St. Lucie County. The curriculum, "Mangroves, Mosquitoes and Man", funded by the Environmental Protection Agency in cooperation with Harbor Branch Oceanographic Institution, The St. Lucie County Mosquito Control District, the Marine Resources Council, and the St. Lucie County School Board is designed to help the students understand the process of environmental decision making. The students have been gathering information so they can make some environmental recommendations concerning the future management of mosquito impoundments. The students are learning that when making recommendations, there are many factors to consider. In the case of mosquito impoundments, which is more important, mosquito control by the use of impounded salt water wetlands causing changes in the delicate balance of the ecosystem, or the benefits of decreased numbers of mosquitoes.

The students have also learned that when making recommendations they must look at an issue from many points of view. They must consider the impacts of their decisions on not only people other than themselves, but also the entire ecosystem. In class they have studied the ecosystem enough to consider the impacts of the impoundments on the Indian River Lagoon. In forming their recommendations, they need to see how others in the community feel about the issue. This is where they can use your help.

The enclosed survey has been designed by *name of teacher's* class. The class worked in small groups and then came to a consensus that they needed certain information to help them get a bigger view of the impacts of mosquito impoundments on other people. Please help them with forming their recommendations by filling out the enclosed questionnaire as soon as possible. (We have included some information about impoundments that may help you). They need to have the responses back to the school by *fill in date.* On *date, at time* the

County Commission Meeting room, the students will be presenting their recommendations to an elected "mock" County Commission Board comprised of fellow classmates. As participants in the survey, the students would like to invite you to the meeting. It will be a great opportunity for our students to participate in the democratic process while learning how important it is to be good decision makers.

Thank you for all your help in this project. We hope to see you at the meeting on *date*. If you have any questions, please call *contact name for the project.*

Sincerely

4.3 Wrap-up: County Commission Meeting

Background

St. Lucie County, which is managed by a **professional administrator**, is governed by a five-member Board of Commissioners. Commissioners each represent a different district within the County, however elections are county-wide. This means that all citizens, no matter what district they live in, can vote for all district commissioners. Each Commissioner serves a four-year term, and the elections are **partisan** in nature. Their terms are **staggered**. The Board of County Commissioners are the governing body which give the final approval for the actions of the Mosquito Commission. This includes the management of control programs as well as the management of the impoundments. They base their decisions on the recommendations from the scientists employed by the Mosquito Control Commission and input from the public at large.

The City of Fort Pierce serves as the **county seat** of St. Lucie County. It is run by a five-member City Commission which employs a professional city manager. A mayor / commissioner is the **presiding** elected official. Commissioners serve staggered four year terms, and elections are non-partisan.

The City of Port St. Lucie is rapidly growing. Incorporated in 1961, it is governed by a five-member City Council presided over by a mayor / councilman. There is also a city manager who acts as the chief administrative officer and is responsible to the council. The mayor and the Commissioners serve two-year terms. Council members are elected city-wide.

The Fort Pierce Utilities Authority is a totally independent body responsible for administering the City's electric, water, gas, and sewage services. It is a five-member policy board consisting of four city Commission appointees and the Mayor. Each appointee serves a four-year term.

Vocabulary

professional - adj. *engaged in a specified occupation for pay*

administrator - n. *one who manages or directs*

partisan - n. *a strong supporter of a faction, party, etc. such as a political party. A partisan election is one which has candidates running as representing specific political parties.*

stagger - v. *to arrange so as to come at different times.*

county seat - n. *town designated within the county for all the county offices and administration*

preside - v. *to have control or authority*

Vocabulary

jurisdiction - n. *legal authority*

public comment - n. *comment made for the use or benefit of all. Usually at a general meeting.*

expenditure - n. *a spending of money, time, etc.*

St. Lucie Village consists of an elected five-member Board of **Aldermen** and a mayor. These individuals are responsible for governing the small residential community.

Before any of the governing boards adopt or change policy for their **jurisdiction**, they will invite **public comment**. At this time, members of the community as well as experts in the policy area are given the opportunity to present their support or objection to the new policies. These individuals would represent players. They would all have an interest in the outcome of the decisions made by the Board. Decisions may create either a benefit or burden to these players.

This same process is followed when the Mosquito Commission wants to make a change in population control procedures. In recent years the Board of County Commissioners have been trying to obtain the right to manage mosquito impoundments which are privately owned. In many instances this means the **expenditure** of a great deal of money. During the summer of 1996, some of the privately owned lands were not managed by the Commission. This caused an increase in the mosquito populations in some portions of the County. Gaining public control of these lands will ultimately depend on the County Commission.

Rationale

Students should now have the background to have an opinion about how mosquito impoundments should be managed. They should also have the results of the surveys they have distributed throughout the community. Students should be able to identify with specific player groups within the community. After learning about how the government of St. Lucie County operates and decides on the management policies for mosquito control, they will conduct a mock county commission meeting and vote on future management practices of mosquito impoundments.

Objectives

Students will:

- Become familiar with the government of St. Lucie County
- Identify the process of the Mosquito Commission for making decisions for mosquito control and impoundment management.
- Identify opinions of player groups represented by their survey results
- Elect a "Mock" County Commission
- Prepare presentations for public comment to the Board of Commissioners regarding the management of impoundments.
- Vote on the best practice for impoundment management

Materials

Master 4.3a - Vocabulary
Surveys returned from player groups

Procedure

Teacher Preparation

- Make copies of Master 4.3a for each student.
- Become familiar with background information
- Assemble returned surveys for students to review

Lesson Development

1. Go over vocabulary on Master 4.3a. Ask students if they have any newspaper articles they would like to share with the class.
2. Discuss how the government of St. Lucie County is organized. Be sure to emphasize that the County Commission has authority over the Mosquito Commission.

Teacher Note

If there are other classes doing this curriculum, you may want to combine the Commission meetings. The more students participating, the better the meeting. When the curriculum was tested, we used 9 classrooms from 2 different schools. Each classroom made their own presentation and each had one Commissioner on the Board.

Teacher Note

It is important for students to realize that they should always continue to read the paper so they will always know the issues important to them in making decisions

Teacher Note

Be sure to ask students if any of them have an elected official in their family. If they do, you may want to ask them to come to class and make a presentation about what they do and how they were elected.

Teacher Note

If you contact the Office of Elections for St. Lucie County, you can get information regarding how elections are held.

Teacher Note

You may want to divide the surveys into player groups before you hand them out to the students.

Teacher Note

A school is able to reserve the County Commission Chambers for special programs. You may want to think about doing your meeting in the evening and invite some Commissioners to the meeting.

3. Have the students elect a Board of County Commissioner. Be sure that the students understand this is not a popularity contest. They need to elect someone who will represent their opinion when making final decisions.
4. Hand out the returned surveys. Have the students divide them according to player groups (ie. recreational fishermen, tourist trade, scientist, etc.). They will need to read through the surveys to see what is the greatest interest by the respondent.
5. Decide on about 5 main player groups.
6. Divide the class among the interest groups. This does not necessarily have to be evenly divided. One group may be greater than another. Just be sure there are at least 4-5 groups.
7. Allow the students in each group to look at the survey results.
8. Explain to the students that each of the player groups will be making a presentation in front of their elected County Commissioners. They are to work together on developing the presentation. They may use any format for the presentation (ie. skit, song, statement, etc.) as long as it gets across their feeling on how mosquito impoundments and/or mosquito control should be managed in St. Lucie County.
10. Set the designated date for the meeting. Ask students to invite parents to the meeting.
11. On the day of the meeting, set the room up so there is a podium for the speakers and 5 chairs for the Commissioners. Allow the students to make their presentations to the Board.
12. After the Board has a brief discussion, have them vote on the best choice for mosquito control and the management of mosquito impoundments.

Conclusion

This is the final activity for the curriculum. Students have gone from knowing very little about the environmental issue of mosquito control. They have conducted an intense investigation and become experts in the field. They have learned that they must look at all aspects of an issue in order for them to be good decision makers.

As expert decision makers, the students should be rewarded with a special field trip. Using the list of suggested trips in Section 4.4, select one that will enforce a special area of interest for the students.

Detective _____

Master 4.3a Vocabulary

Vocabulary

1. *professional* - _____

_____

2. *administrator* - _____

_____

3. *partisan* - _____

_____

4. *stagger* - _____

_____

5. *county seat* - _____

_____

6. *preside* - _____

_____

7. *jurisdiction* - _____

_____

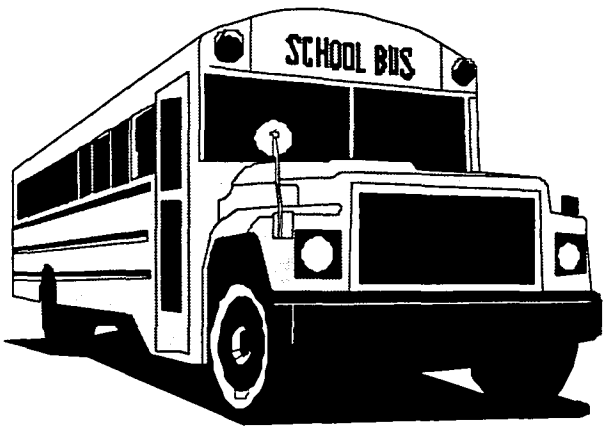
8. *public comment* - _____

_____

9. *expenditure* - _____

4.4 Final Field Trip

Rationale



The final field trip for students should be used as a reinforcement of the entire curriculum. The following list is of suggested trips.

Elliot Museum: 825 N.E. Ocean Blvd., Hutchinson Island (225-1961) - Features a collection of Americana dating back to 1865. Also included here are shops, local history exhibits, Indian artifacts, shell collection, contemporary art exhibit, antique and classic automobiles and motorcycles, bicycles and horse drawn vehicles.

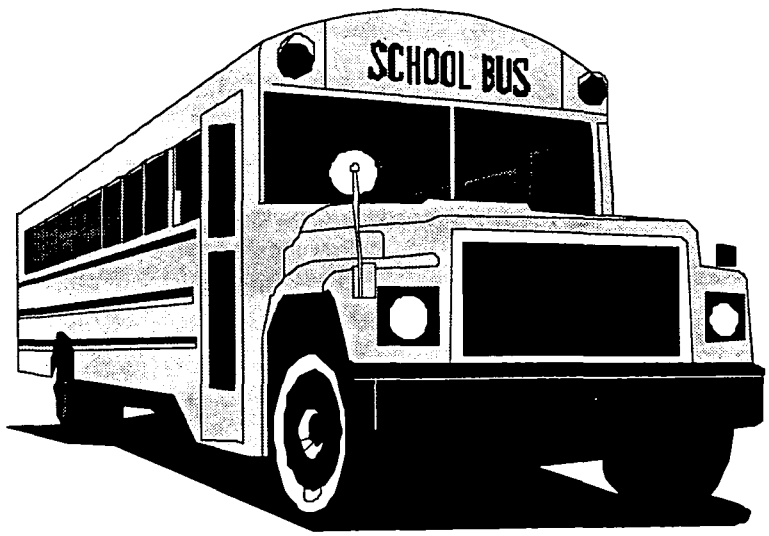
Environmental Studies Center: 2900 Indian River Dr., Jensen Beach (334-1262) - Operated by the Martin County School system, the center is one of Jensen Beach's richest treasures. The center provides environmental education for students from kindergarten through eighth grade and special studies for high school students and adults. Visitors are welcome to see the saltwater aquariums, marine life museum, wet lab, fruit tree grove and native plants.

Florida Power and Light Energy Encounter: A1A, Hutchinson Island (468-4111) - Enjoy more than 25 interactive displays and exhibits, intriguing games and demonstrations as well as secrets of the atom and a look at nuclear power at Florida Power and Light's St. Lucie nuclear power plant.

Florida Ranch Tours: West of Ft. Pierce via State Road 68 (467-2001) - Visit a working Florida cattle ranch and enjoy the natural beauty of wildlife.

Ft. Pierce Inlet State Recreation Area / North Jetty Park: State Road A1A - 340 acres on North side of ft. Pierce inlet. An abundant variety of birds on 2,200 feet of oceanfront land, plus 1`,500 feet on the north side of the inlet. Picnic facilities, showers, restrooms and fishing jetty

Harbor Branch Oceanographic Institution: 5600 U. S. 1 North, Ft. Pierce (465-2400) - A non-profit research and education organization dedicated to integrating the technology of the sea with the needs of humankind for sustainable management of the earth's marine resources. This is also the home port of the Johnson-Sea Link and Clelia manned submersibles. Conducted tours of the 500-acre campus via open air tram are available Monday - Saturday at 10 as, noon and 2 pm, departing from the Visitor's Center. Special tours for school groups can be arranged.



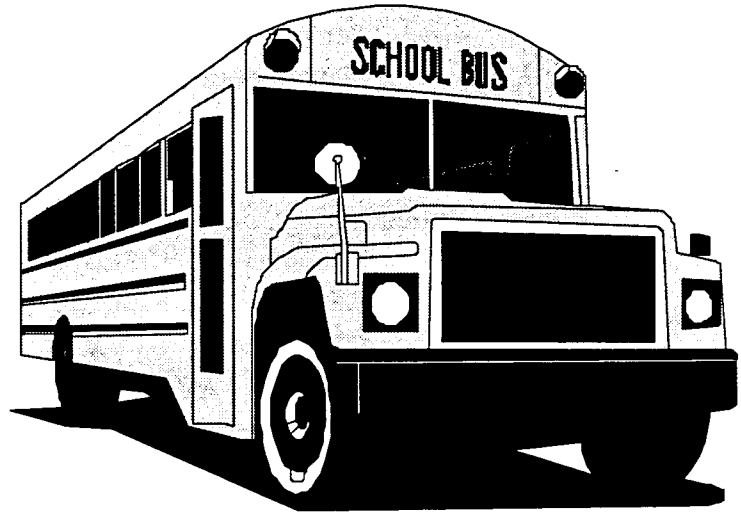
Heathcote Botanical Gardens: 210 Savannah Rd. Ft. Pierce (464-4672) - A living museum of tropical flowers and foliage, both native and exotic, including an enchanting Japanese garden. Educational programs are offered.

Historic Downtown Ft. Pierce: (466-3880) - Take a walking tour of historic downtown Ft. Pierce where you'll see such attractions as the river view marina and the A. E. Backus Art Gallery as well as visit specialty and novelty shops and dine in quaint restaurants.

Hobe Sound Nature Center at the Hobe Sound National Wildlife Refuge: 13640 SE Federal Highway (546-2067) - A cooperative effort between a nonprofit organization and the U. S. Fish and Wildlife Service, this center offers environmental learning programs, exhibits, seminars, sea turtle walks, nature walks and educational camps for all ages.

House of Refuge: 301 SE MacArthur Blvd., Stuart (225-1875) - The oldest standing structure in Martin County, the home was originally built to serve as a rescue and refuge center for shipwrecked sailors. Now a museum, the home contains a collection of marine artifacts and life-saving equipment.

Jack Island State Park: North Bridge Causeway to A1A. Go north 2 1/2 miles to Jack Island Access Road. a 631-acre mangrove island and mosquito impoundment; bird sanctuary. Walk along mosquito impoundment dikes and view abundant wildlife. Trail leads to a look-out tower overlooking the Indian River Lagoon.



Manatee Observation and Education Center: 480 North Indian River Drive (between the City Marina to the South and A.E. Backus Gallery to the North) on Moore's Creek (466-16-- ext. 3333) Museum and viewing center where manatees congregate during the cooler months. The building is equipped with an open air classroom, viewing deck, displays and exhibits. Call for prearranged school tours and programs.

St. Lucie County Historical Museum: 414 Seaway Dr., Ft. Pierce (462-1795) - Includes a reconstructed portion of a Spanish galleon salvaged from a 1715 wreck as well as a Seminole Indian encampment, restored 1907 Gardner House, a 1919 fire engine pumper and a replica of a Florida East Coast railway station. Open Tuesday through Saturday, 10 am - 4 pm, Sunday noon - 4 pm.

St. Lucie River Tours: 510 Prima Vista Blvd., Port St. Lucie (871-2817 or 460-2332) Explore the wild and scenic St. Lucie River.

The Savannas: 1400 SE Midway Rd., Ft. Pierce (464-7855) - Made up of 550 acres of five distinct biological communities, the Savannas include pine flatwoods, marshes and lakes. Represents the last fresh water lagoon system existing in the state of Florida. Activities include fishing, camping, canoeing, hiking, wildlife exhibit, playground and picnic areas.

Treasure Coast Wildlife Hospital: 2800 SE Bridge Rd., Hobe Sound (546-8281) - View and learn about Florida wildlife at this museum. Call for hours.

Walton Rocks Beach: South Beach just north of Power Plant. Great place for shell collecting. Could be a stop in conjunction with a trip to the Power Plant.

Listings from St. Lucie County Chamber of Commerce and the Community Pages of the Phone Book.

Appendix A

Glossary

Glossary

***Abdomen* - n.** *the rear part of an insects body (in some other animals, including humans, it is the part of the body between the chest and hips; belly. It contains the stomach, intestines, and liver.)*

***administrator* - n.** *one who manages or directs*

***adult* - n.** *a plant or animal that is fully developed and in the reproductive stage*

***adulticide* - n.** *control method, either chemical or natural, used to control adult populations of organisms.*

***aerial* - adj.** *of, in, or by air*

***air pressure* - n.** *the pressure of the atmosphere or compressed air*

***algae* - n.** *a group of simple plants that have no leaves, stems, or roots. They grow in water or on wet surfaces. Most seaweeds are algae.*

***alter* - v.** *change*

***Anatomy* - n.** *the science that studies the different parts that make up an animal or plant. Anatomy deals with the tissues, organs, and systems of a body or plant. 2 the way a body is put together*

***Antennae* - n. (plural of antenna) -** *long, thin, movable body parts on the head of an insect, crab, lobster, or other similar animal. Antennae are used for touching and smelling.*

***Antibody* - n.** *a substance made in the body that can act against a virus or other foreign substance. In this way the body becomes protected against certain diseases.*

***aquatic* - adj.** *growing or living in water*

***aquifer* - n.** *an underground layer of porous rock, etc. containing water*

***Artery* - n.** *one of the blood vessels that carry blood away from the heart to all parts of the body*

***artesian wells* - n.** *a deep well in which water is forced up by pressure of underground water draining from higher ground*

***assessment* - n.** *[the act of] deciding or trying to find out the importance or value of something*

***Axis* - n.** *a real or imaginary straight line about which something turns. [In the case of plants, it refers to the spot where all the leaves emerge from.]*

***balance* - n.** *equality between two things or between the parts of a single thing*

basin - ***n.*** *a wide, shallow bowl for holding a liquid. 2 all the land that is drained by a river and by all the streams flowing into the river*

benefit - ***n.*** *something that is good or helpful*

bloom - ***n.*** *a period of high health and vigor. A phytoplankton bloom occurs when conditions are favorable to promote rapid, uncontrollable growth of the phytoplankton.*

burden - ***n.*** *anything that is very hard to bear*

cache - ***n.*** *to hide something secretively*

canal - ***n.*** *a channel dug and filled with water so that ships [and water] may cross a stretch of land. In Florida, canals are dug for land drainage to drain wetlands for farms, development and mosquito control*

canopy - ***n.*** *the portion of the treetops that are the highest, often forming a "roof" as you walk under them*

Capillary - ***n.*** *one of the tiny blood vessels that join the arteries and the veins.*

CDC - *Center for Disease Control*

Celsius - ***adj.*** *of or describing a thermometer on which the freezing point of pure water is zero degrees and the boiling point is 100 degrees. is centigrade - adj. another word for Celsius*

Climate - ***n.*** *the usual weather conditions of a place over a long period of time*

Coagulant - ***n.*** *a substance which causes a liquid to become semisolid such as a blood clot*

coastlines - *n. the outline or shape of the land along the sea [or other body of water]*

commercial fisher - *one who fishes as a profession or job.*

community - ***n.*** *all the people (or things) that live in a particular area*

compete - *v. to be a rival for something*

Conclusion - *an opinion formed after careful thinking*

condensation - ***n.***- *droplets of water that have condensed [to make or become thicker or more closely packed together as water going from gas to liquid] from the air onto a window or other surface*

consequence - ***n.*** *a result or outcome*

Consistent - *acting or thinking always in the same way*

consumer - ***n.*** *an organism that obtains its food from eating plants or other animals*

convective clouds - ***n.*** *clouds that form by moist air being heated, rising, and then cooling*

corporate *- v. to bring together into a single whole*

county seat *- n. town designated within the county for all the county offices and administration*

culvert *- n. a drain or pipe under a road or dike*

data *- facts and figures from which something can be learned*

DDT *- n. a powerful insecticide*

debris *- n. the scattered remains of something that has been broken, destroyed, or thrown away; rubbish*

decay *- v. to become rotten by the action of bacteria*

decompose *- v. to rot or decay*

Dependent Variable *- (a variable) controlled or decided by something else*

Detective *- a person, often a police officer, whose work is to solve crimes or get secret information*

detritus *- n. a mixture of decaying plant and animal remains covered with microorganisms.*

detritus *- n. a mixture of decaying plant and animal remains covered with microorganisms.*

diverse *- adj. different*

diversity *- n. the condition of being different or varied; difference or variety*

dominant *- adj. most important*

dominant *- adj. most important or most powerful [most abundant]*

Dormant adj. *- not active; quiet*

drainage *- n. the act or process of draining off water or other liquid*

Drought *- n. a long period of dry weather, with little or no rain*

earthen dike *- n. a wall or dam that is built to keep a sea or river from flooding over land (For mosquito impoundments the dikes are used to hold water into the wetlands so the mud banks remain covered with water.)*

ecological *- adj. having to do with ecology*

ecology *- n. the science that studies the relations between living things and all of the things and conditions that surround and affect them.*

ecosystem *- n. the relationships between a community of plants and animals and their environment.*

Egg *- n. (1)the oval or round object that is laid by a female bird, fish, reptile, insect, or other animal. A young animal of the same kind hatches from it at a later time. The egg has a brittle shell or a tough outer skin. (2.) the cell formed by a female, which will make a new plant or animal of the same kind if it is fertilized.*

elevation *-n. height above sea level*

encroach *- v. to lessen the boundaries or space between objects*

enslavement *- n. the act of making a slave out of an individual*

Environment *- n. all the things and conditions that surround a person, animal, or plant and affect the health, growth, development, and character of such living thing*

environmentally sound practice *- n. a practice or policy which is good for the environment*

Epidemic *- n. the rapid spreading of a disease to many people at the same time*

Eradication *- n. the act of uprooting, destroying, or stamping out*

erode *- v. to wear away*

estuary *- n. a coastal body of water where seawater and fresh water mix.*

evapo-transpire *- v. process by which plants pump water from the ground through their roots, trunk, and into the air through their leaves. Usually more important in the water cycle than evaporation This is the reason you feel cooler under the shade of a tree than the shade of an umbrella*

evaporate *- v.- to change into a vapor or gas*

event *- n. something that happens, especially something that is important*

Exoskeleton *- n. any hard, external supporting structure, as the shell of an oyster.*

exotic *- adj. strange different of foreign*

expenditure *- n. a spending of money, time, etc.*

Fahrenheit *- adj.having to do with a thermometer that measures the freezing point of water as 32 degrees above zero and the boiling point of water as 21 degrees above zero*

fauna *- n. all the animals of a particular place or time*

fauna *- n. all the animals of a particular place or time*

fecal *- adj. containing excrement*

***field biologist* - n.** *one who studies the origin, history, characteristics, habits etc. of plants and animals in their natural environment instead of in a laboratory.*

***filter* - n.** *a device that makes air, water, or other fluid clean or pure. The fluid is passed through sand, charcoal, or some other material that keeps back dirt or other unwanted substances.*

***flora* - n.** *all the plants of a particular place or time*

***flora* - n.** *all the plants of a particular place or time*

***forage* - v.** *to go about looking for food*

***Genera* - n.** *(plural of genus) a group of plants or animals that are closely related. A genus is divided into individual kinds, called species. Dogs and wolves are different species that belong to the same genus*

***Geography* - n.** *1. the study of the surface of the earth {or any place in the universe} and how it is divided into continents, countries, seas, and other parts. Geography also deals with the climates, plants, animals, and resources of the earth. 2 the natural features of a certain part of the earth [the varied geography of China]*

***habitat* - n.** *the place where an animal or plant is normally found*

***Host* - n.** *any organism on or in which a parasitic organism lives*

***humidity* - n.** *the amount of moisture, or water in the air*

***hurricane* - n.** *an intense tropical weather system with a well defined circulation and maximum sustained winds of 74 mph or higher. In the western Pacific, hurricanes are called "typhoons," and similar storms in the Indian Ocean are called "cyclones."*

***hydric* - adj.** *refers to plant communities and systems where soils are organic, very wet (saturated) and poorly drained. These systems remain wet most of the year and often contain standing water during and after heavy rains.*

***hydrology* - n.** *the study of the earth's waters, their distribution, and the cycle involving evaporation, precipitation, etc.*

***hypothesis* - n.** *an unproven theory, etc. tentatively accepted to explain certain facts*

***Immune* - adj.** *protected from a disease*

***Incubate* - v.** *development of the larvae mosquito inside the egg before hatching*

***Independent Variable* - n.** *(a variable) not ruled or controlled by another*

Indian River Lagoon - n. *extends 140 miles and through 5 counties along the east coast of Florida*

inhabit - v. *to live in or on; occupy*

Instar - n. *each molt period of a larva.*

interrupt - v. *to make a break in; put a temporary stop to*

intertidal - adj. *the area covered and uncovered by the tides*

intervention - n. *the act of coming between to modify, settle, or change some action or event.*

Intracoastal Waterway - n. *Navigable waterway extending the length of the Eastern United States mostly in inshore waters.*

Investigation - n. *the act of looking into so as to learn the facts*

is Indians - n. *first settlers of the east coast of Florida, first appearing about 2,000 year ago.*

isolate - v. *to set apart from others*

Issue - n. *something that needs to be talked over or decided.*

issue - n. *something that needs to be talked over or decided.*

jurisdiction - n. *legal authority*

Lagoon - n. *a special type of shallow estuary with a small opening to the sea and small water shed or in fresh water a shallow lake.*

land developer - n. *one who alters the land such as for houses, parks, etc*

land grant - n. *land given or transferred to by the government.*

larva - n. *the young form of an insect or some animals without a backbone.*

Larva - n. *the young form of an insect or some other animals A caterpillar is the larva of a butterfly.*

larvicide - n. *control method, either chemical or natural, used to kill the larva stage of an organism*

latitude - n. *distance north or south from the equator. Latitude is measured in degrees*

Lesion - n. *an injury of an organ or tissue resulting in impairment of function*

life cycle - n. *the continuous sequence of physical changes that an organism passes through, from a fertilized egg to an adult that can reproduce*

longitude - n. *distance that is measured in degrees east or west of an imaginary line running north and south through the town of Greenwich, England*

mangrove - n. *a tropical tree which have adapted to living in salt water wetlands*

Maps - n. *a drawing or chart of all or part of the earth's surface [or any place in the universe], showing where countries, oceans, rivers, cities, and other features are located.*

marine - adj. *of the sea*

maritime hammocks - n. *hammocks growing along the coast*

mesic - adj. *refers to plant communities and systems that are dry to moist, in soils with clay, silt, and organic material. Moisture in these plant communities is neither xeric or hydric, but in between.*

Metamorphosis - n. *the change in form that some animals go through in developing. The change from caterpillar to butterfly or from tadpole to frog are examples of metamorphosis (plural metamorphoses)*

Mission - n. *a special duty or piece of work that a person or a group is sent out to do*

Mock - adj. *not real, pretend.*

Molt - v. *to shed skin, feathers, hair, or a shell before getting a new covering. Snakes, birds, and insects molt.*

mosquito impoundment - n. *a wetland area that has been physically confined by earthen dikes and in which water is not allowed to freely flow between the main body of water and the wetland. These areas are used for mosquito control*

Mystery - n. *something that is not known or explained, or that is kept secret*

Navigate - v. *To steer, or control the course of [a ship, vessel, or any mode of transport]*

Nectar - n. *the sweet liquid in many flowers, made into honey by bees.*

Nematode - n. *a long, cylindrical, unsegmented worm; roundworm*

nursery - n. *a place where young animals can find food and hide from predators*

nutrient - n. *any substance or matter that is needed for the life and growth of plants, animals, or people. Proteins, minerals, and vitamins are nutrients.*

nutrients - n. *elements necessary for life and growth*

Observation - n. *the act or power of seeing or noticing*

observe - v. *to see watch or notice*

Order **- n.** *a group of related animals or plants that is larger than a family For example, reptiles and mammals are related because they both have backbones but they are placed in a different order. [taxonomically or in the classification system of plants and animals]*

organic material **- n.** *material of, like, or made from living organisms*

partisan **- n.** *a strong supporter of a faction, party, etc. such as a political party. A partisan election is one which has candidates running as representing specific political parties.*

Pathogen **- n.** *microorganism, etc. capable of causing disease*

peninsula **- n.** *a long piece of land almost completely surrounded by water.*

percolate **- v.** *to pass through a porous substance: filter*

percolation **- n.** *[the act of] oozing through a porous substance*

perimeter **- n.** *the boundary or distance around a figure or area*

pesticide **- n.** *any chemical used to kill insects or weeds.*

pesticides **- n.** *a chemical used to kill pests, usually insects and rodents*

phneumatophores **- n.** *roots of the black mangrove which project up out of the soil*

phytoplankton **- n.** *the mass of tiny plants found floating in a body of water.*

plankton **- n.** *microscopic plants and animals that float in the water.*

Player **- n.** *a person who plays a game (in our context the game is the process of making an environmental decision)*

player **- n.** *a person who plays a game (in our context the game is the process of making an environmental decision)*

Policy **- n.** *a plan, rule, or way of acting [It is a good policy to be honest. A country's foreign policy is its way of dealing with other countries]*

precipitation **- n.** *rain, snow, or any other moisture that falls from the sky.*

precipitation **- n.**- *rain, snow, or any other moisture that falls from the sky*

preside **- v.** *to have control or authority*

primary consumer **- n.** *animals that eat the primary producers, they are the second level in the food web*

primary producer **- n.** *green plants that use sunlight, water, and nutrients to manufacture food.*

proboscis - ***n.*** *an elephant's trunk, or any other similar long, flexible snout. On a mosquito this is the mouth parts.*

Procedure - ***n.*** *a way or method of doing something*

professional - ***adj.*** *engaged in a specified occupation for pay*

prop - ***v.*** *to lean against for support*

Protozoan - ***n.*** *any of various, mostly microscopic, single celled-animals*

public comment - ***n.*** *comment made for the use or benefit of all. Usually at a general meeting.*

Pulmonary - ***adj.*** *of the lungs*

Pupa - ***n.*** *an insect in the stage of development between a larva and an adult, generally not feeding. The chrysalis is the pupae of a butterfly*

pyrogenic - ***adj.*** *relating to fire - fire controlled and adapted.*

Qualitative - ***adj.*** *[having to do with] one of the features that makes a thing what it is*

quality - ***n.*** *degree of excellence*

Quantitative - ***adj.*** *[having to do with] an amount or portion*

Questionnaire - ***n.*** *a printed list of questions used in gathering information from people.*

rancid - ***adj.*** *having a bad smell or taste of stale fats or oils; spoiled*

Rationale - ***n.*** *the reasons or rational basis for something*

recharge - ***v.*** *to put back what has been used up. Water flows into the scrub sand, and goes back into the aquifer where it can be used again.*

Recommendation - ***n.*** *advice; suggestion*

recreational fisher - ***n.*** *one who fishes as a hobby or just for fun*

Replicate - ***v.*** *to repeat or duplicate*

reproductive cycle - ***n.*** *the complete set of events which make up the process by which animals and plants produce new individuals like themselves.*

response - ***n.*** *something that is said or done in answer (to an event)*

risk - ***n.*** *the chance of losing, failing, or getting hurt*

roost - ***v.*** *to rest or sleep on a roost [a pole or shelf where a bird can rest or sleep]*

runoff - ***n.*** *something that runs off, as rain that is not absorbed into the ground*

***salt marsh* - n.** *low lying areas which are often covered by salt water during high tide but are exposed at low tide. They are dominated by non-woody plant species such as grasses or rushes*

***Scale* - n.** *the way that the size of a map, drawing, or model compares with the size of the thing that it stands for [Example: 1 meter = 200 meters means one meter measured on the map equals 200 meters as measured on the ground]*

***scavenger* - n.** *1. a person who gathers things that other people have thrown away; 2. an animal that feeds on rotting meat and garbage*

***scavenger* - n.** *organisms that feed on whatever food they can find; live or dead animals and plants*

***secondary consumer* - n.** *animals that eat the primary consumers. They are the third level in the food web.*

***Seminoles* - n.** *native Americans moving to Florida from Georgia and Alabama*

***shell mound* - n.** *piles of discarded shells, bones, and broken pots from Indian settlements*

***Siphon* - n.** *tube on the posterior end of mosquito possibly used for breathing or attaching to plants*

***spawn* - n.** *the eggs or newly hatched young of fish, lobsters, frogs, or some other water animals. v. to produce eggs in large numbers*

***species* - n.** *a distinct kind of plant or animal*

***spoil* - n.** *excess soil or sand removed from one place and disposed of as unused*

***stagger* - v.** *to arrange so as to come at different times.*

***Standard* - n.** *something set up as a rule or model with which other things like it are to be compared*

***sterile* - adj.** *free from living microorganisms*

***storm surge* - n.** *a rise in tide caused by a hurricane as it moves over or near the coastline. It can be much higher than the normal tide rise, with breaking waves on top.*

***Strain* - n.** *a group of animals or plants [or viruses] that have developed from a common ancestor*

***Subtropic zone* - n.** *the zone between the tropic and the temperate zones.*

***surge* - n.** *a sudden, strong rush*

***survey* - v** *to look over something in a careful way; (n.)a detailed study or inspection, made by gathering information and analyzing it*

***Symptom* - n.** *any circumstance or condition that indicates the existence, as of a particular disease*

***temperate* - adj** *neither very hot nor very cold. The temperate zone is there fore not very hot or very cold when compared to all other areas of the Earth.*

***terrestrial* - adj.** *living on land, not in water*

***tertiary consumer* - n.** *animals that eat the secondary consumers. They are sometimes called the top predators.*

***Thorax* - n.** *the part of the body between the head and the abdomen, the middle part of an insect's body*

***tidal zone* - n.** *the area of the shoreline where the water rises and falls due to the tides*

***tide* - n.** *the regular rise and fall of the ocean's surface due to the gravitational pull of the sun and moon.*

***top predator* - n.** *consumers that are at the top of the food chain that are not hunted by other animals. Most top predators have only one enemy - People. We may not eat all top predators, but we can kill or harm them by polluting or destroying their habitat.*

***Topographic map* - n.** *map showing the surface areas of a certain region*

***tourism* - n.** *the industry of attracting those who travel, especially for pleasure*

***transect* - n.** *a cut across a specific area*

***Transmit* - v.** *to cause to pass through air or some other substance [mosquito]*

***transpire* - v.** *process by which plants pump water from the ground through their roots, trunk and leaves*

***Trial* - n.** *the act of testing or trying*

***tropic* - adj.** *either of the two imaginary circles around the earth that are parallel to the equator and about 23.5 degrees latitude from it. The one to the north is called the Tropic of Cancer. The one to the south is called the Tropic of Capricorn. This region has a very hot climate.*

***tropical depression* - n.** *an organized system of clouds and thunderstorms with a defined circulation and maximum sustained wind speeds of 38 miles per hour or less.*

***Tropical storm* - n.** *an organized system of strong thunderstorms with a defined circulation and maximum sustained winds of 39 to 73 miles per hour*

***turbid* - adj.** *muddy or cloudy from having the sediment stirred up*

understory **- n.** *shrubs, bushes and other small plants that grow under the canopy*

Vaccine **- n.** *a substance put into the body to help fight off a disease. It is made up of dead or weakened germs that cause the body to produce antibodies.*

Variable **- n.** *[something that is] likely to change or vary (be different)*

Vector **- n.** *an animal that transmits a disease-producing organism*

vegetation **- n.** *things growing from the ground; plant life*

Ventricle **- n.** *either of the two lower chambers of the heart*

Virus **- n.** *a form of matter smaller than any of the bacteria. It grows in the cells of other living things and causes disease in animals and plants. Smallpox, measles, and the flu are caused by viruses.*

warnings **- n.** *alert given when a storm (either tropical storm or hurricane) is expected to strike a certain area within 24 hours.*

watches **- n.** *alert given when a storm (either tropical storm or hurricane) poses a threat to a certain area within 36 hours*

water cycle **- n.** *the process of water moving from the earth into the atmosphere and back to earth again*

watershed **- n.** *a ridge dividing the areas drained by different river systems; the area drained by a river system*

watershed **- n.** *the area of land drained from a river system.*

weather **- n.** *the conditions outside at any particular time and place. Temperature, sunshine, and rainfall are important weather conditions that are measured*

wetland **- n.** *swamps or marshes [land where the soil is very wet or soaked with water most of the time]*

wetlands **- n.** *swamps or marshes*

woody **- adj.** *made up of wood, the hard material beneath the bard of trees and shrubs.*

xeric **- adj.** *plant communities which are very dry and in well drained soils with little or no organic material. Xeroscaping is the practice of planting plants that do not need much water to survive.*

Appendix B

Field Identification Sheets

Borrowed From:
3rd and 4th Grade Activity Books
Environmental Studies Center
Jensen Beach, FL

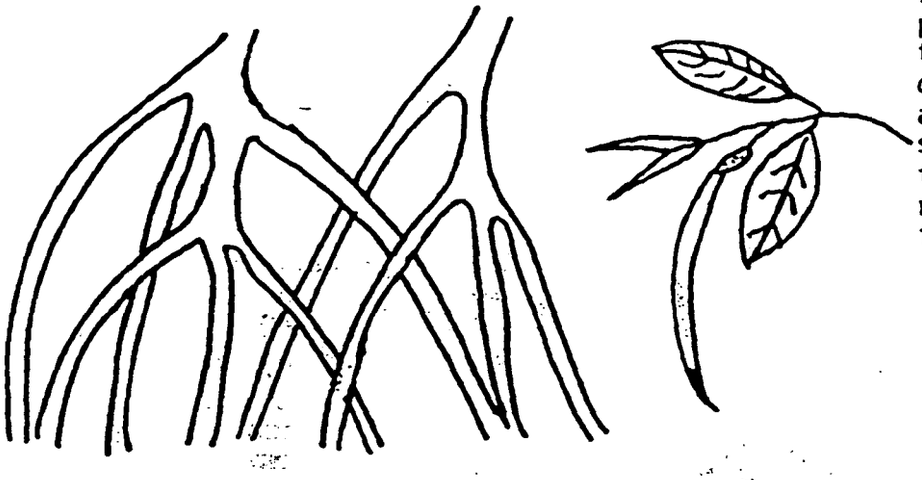
MANGROVE COMMUNITIES

Mangrove communities are a part of the total ecosystem which makes up our Indian River. The mangroves, like all other living things, have an important relationship with all other life around them. They serve as a shelter for many small fish found in the river. They also serve as a place for the attachment of many animals such as barnacles, sea squirts and oysters.

When you visit the Environmental Studies Center you will be investigating a mangrove community. This booklet will give you a brief introduction to some of the plants and animals found in the mangrove community.

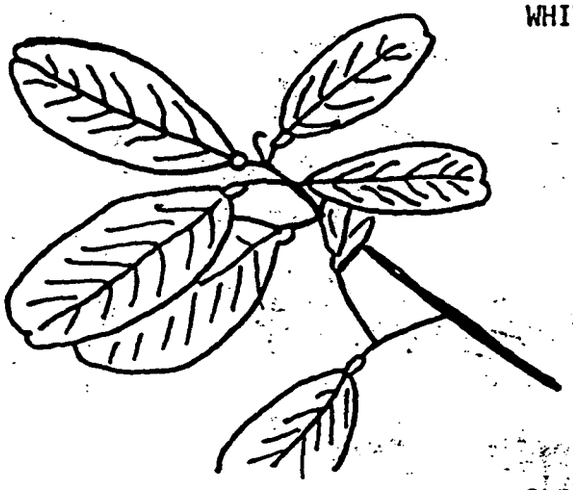
PLANTS

RED MANGROVES



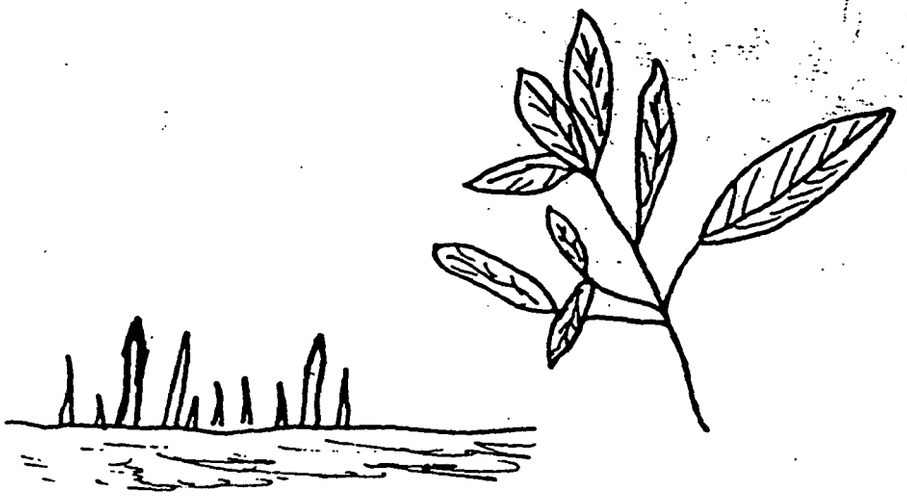
Red mangroves are easily recognized by their long prop roots which grow from the branches of the tree down into the water. They also have long pencil like seeds which are often found floating in the river. The red mangrove usually grows in the intertidal zone

WHITE MANGROVE



The white mangrove is recognized by its oval leaves. Each leaf has a notch in the tip of the leaf blade. On the leaf stem at the base of the leaf blade, there are also two little swellings. The white mangrove usually grows in an area just behind the intertidal zone.

BLACK MANGROVE



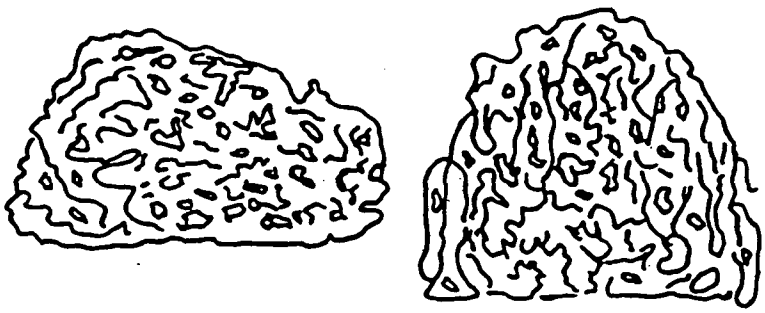
The black mangrove has three characteristics which help to identify it. It has darker bark than the other mangroves. It has breathing roots which stick up out of the soil around the base of the tree. Its leaves are green on the front and silvery on the back. Many times, except right after a rain, one side of the leaf will be covered with salt crystals. The black mangrove usually grows in an area that is only covered with water at very high tides.

ALGAE

The algae are plants that are found growing in waters all over the world. Some are so tiny they can only be seen with a microscope. Some are so large they may be 100 feet long or more. Algae are usually put into groups according to their colors.
For example: green algae, red algae and brown algae. Algae may be found attached to the roots of the red mangroves or floating in the water around the red mangrove.

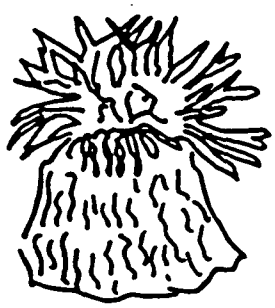
ANIMALS

SPONGE



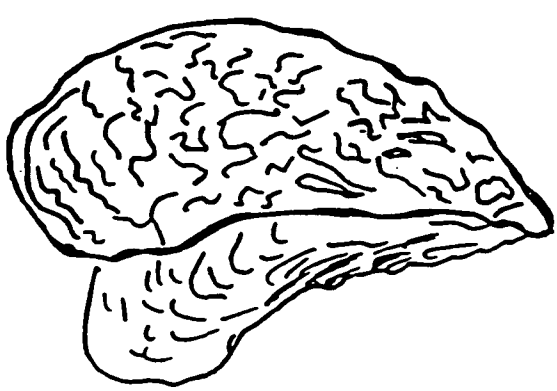
Sponges are very simple animals. Their body is full of thousands of very tiny holes and canals. In these canals they have small hairs which whip back and forth causing water to move through their body. As the water moves through them they trap tiny plankton in the water and use the plankton for food. Sponges are always found attached to something solid, and once they attach they can never move. Many sponges attach to the roots of the red mangrove.

SEA ANEMONE

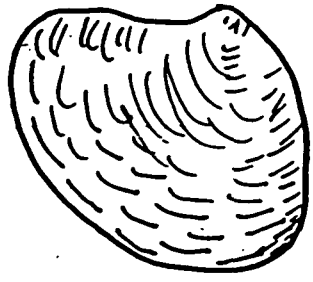


The sea anemones are animals that look like plants. Around their mouth they may have hundreds of arm-like tentacles which they use to catch their food. Some anemones catch fish in their tentacles and sting them to death. Other anemones spread out their tentacles and catch small particles floating in the water. Anemones are almost always found attached to something solid; although they may slowly move from place to place. You will find many different kinds of anemones attached to the roots of the red mangroves.

OYSTERS

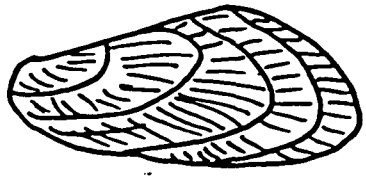


Oysters are related to clams and mussels. They have two shells which cover their soft bodies inside the shells. One of the shells of the oyster is always attached to something solid. Since they cannot move, oysters use tiny hairs to make water flow in between their shells. They have sticky material on part of their body which traps tiny plankton and detritus in the water for food. Oysters may be found growing on rocks, sea walls and red mangrove roots.



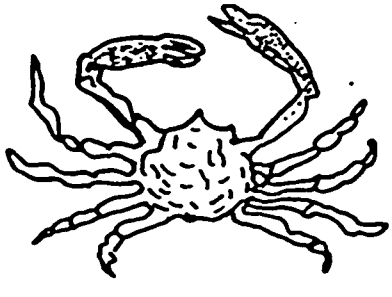
CLAM

Clams are related to oysters and mussels. They have two shells which cover their soft bodies inside the shells. Clams have a hard foot which helps them dig into the mud and sand on the bottom of the river. They have two long tubes which they stick up through the sand and suck water down through their shells. They trap plankton and detritus in the water for food. Clams are often found buried in the mud around the red mangrove roots.



MUSSELS

Mussels are related to oysters and clams. They also have two shells. Mussels attach by using hundreds of tiny threads. Large clumps of mussels may be found attached to red mangrove roots. They eat plankton much like the oyster does.



SPIDER CRAB

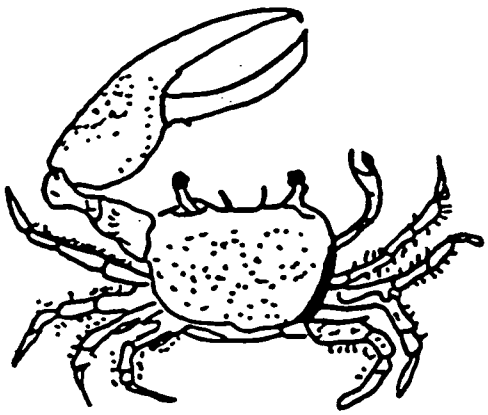
The spider crab has long spider-like legs. He is very slow moving and cannot swim. You can often find him crawling around the red mangrove roots. Spider crabs are scavengers. They eat just about anything they can find on the bottom. Sometimes you will find a spider crab with a sponge growing on its back.

MANGROVE CRAB

The mangrove crab has a flat square body with curved legs for holding onto rocks and tree roots. These little crabs are good climbers and can be found running all over the red mangrove trees.

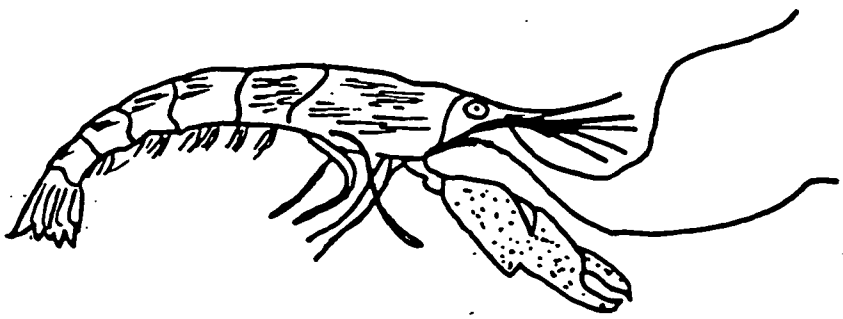
FIDDLER CRAB

Fiddler crabs are easily recognized by the one large claw which the males have. They live in holes which they dig in the sand along the water's edge. Sometimes you can see large "herds" of fiddler crabs moving among the roots of the black mangroves. They feed on detritus found in the mud.

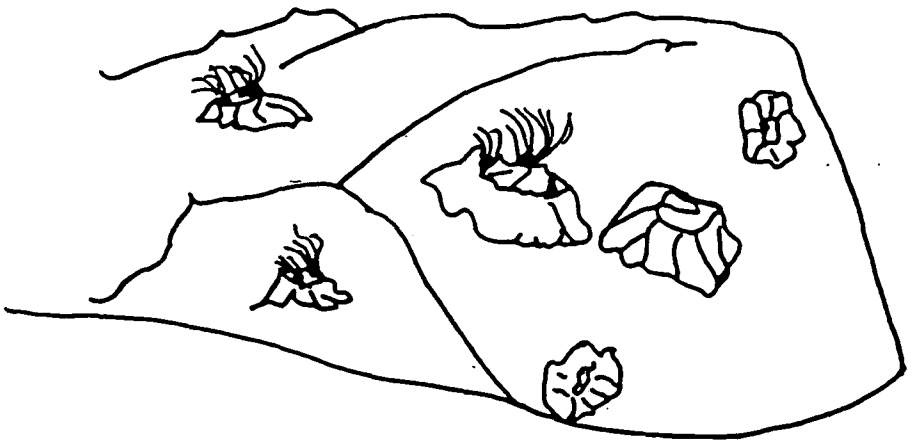


PISTOL SHRIMP

The pistol shrimp also has one large claw and one small claw. They use the large claw to snap shut and stun their prey. Pistol shrimp live in holes in rocks and around mangrove roots. They like to find spaces in sponges and hide inside. They eat small fish and other shrimp. If you are very quiet while visiting a mangrove community you may hear the popping sound of a pistol shrimp.

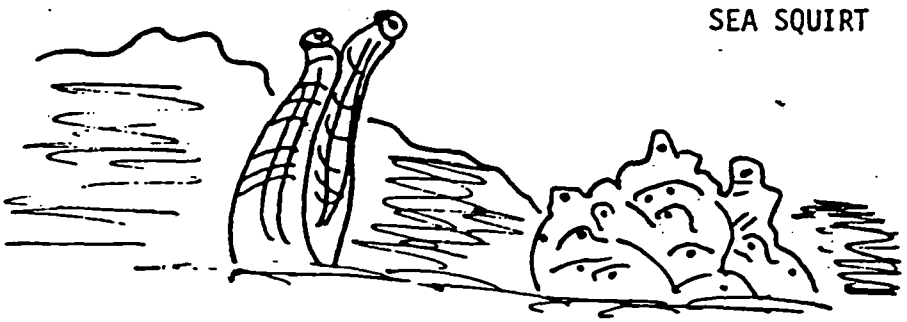


BARNACLE



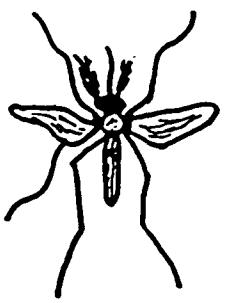
Barnacles are relatives of the crabs and shrimp. When a barnacle is very young it swims around looking for a place to attach. Once it attaches it never can move to another place. Barnacles build around them a series of shells which form a house for them. Barnacles feed by kicking their feet into the water and catching plankton. You will find barnacles attached to the roots of red mangroves.

SEA SQUIRT



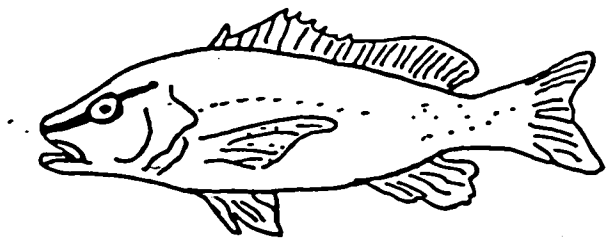
Sea squirts look very much like sponges except they only have two openings into their body while sponges have many. They pull water in one opening and strain plankton and detritus out of the water. If you squeeze them gently they will squirt water at you. Sea squirts can be found attached to the roots of red mangroves.

MOSQUITOES



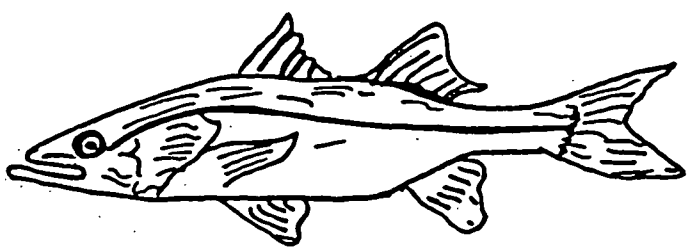
Mosquitoes are small insects which are often found in or around mangrove swamps. They lay their eggs in water trapped around the roots of black mangroves. Mosquitoes serve as food for many small birds and fish found in the mangrove community.

MANGROVE SNAPPER



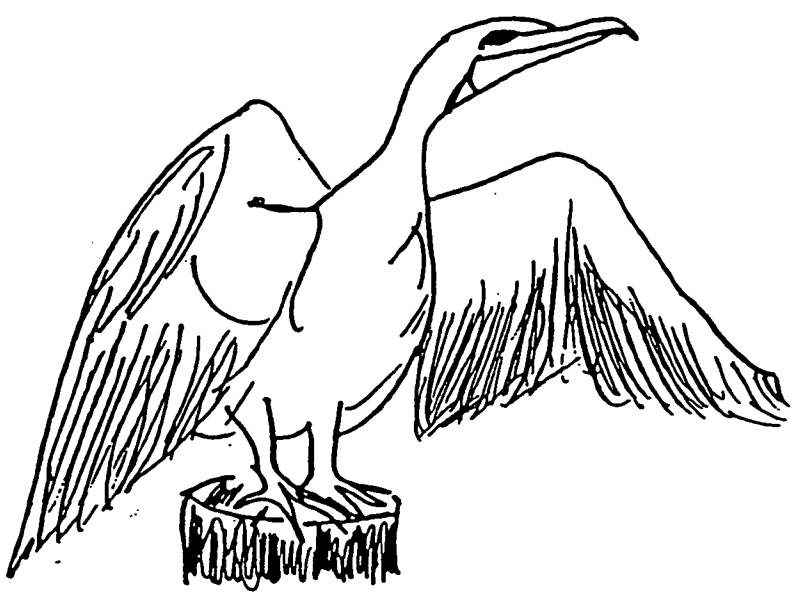
The mangrove snapper is recognized by a dark stripe which runs from his nose across his eye. Young snappers hide among the mangrove roots for protection from larger fish. Older mangrove snappers feed on barnacles, mangrove crabs and other small fish living among the red mangrove roots.

SNOOK

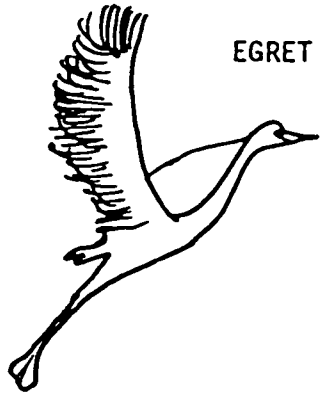


The snook is recognized by a dark stripe which runs along the side of its body from the gills to the tail. Snook are good fighting fish and can often be found feeding on smaller fish around the red mangroves.

CORMORANT

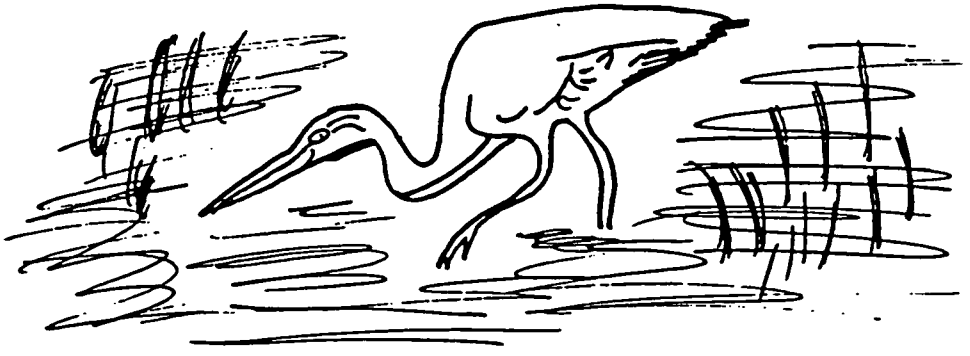


Cormorants are dark colored, swimming water birds. They are most often seen diving underwater for fish or sitting on markers or in trees drying their wings. Cormorants are good swimmers and can swim underwater to catch fish. Cormorants often nest in mangroves.



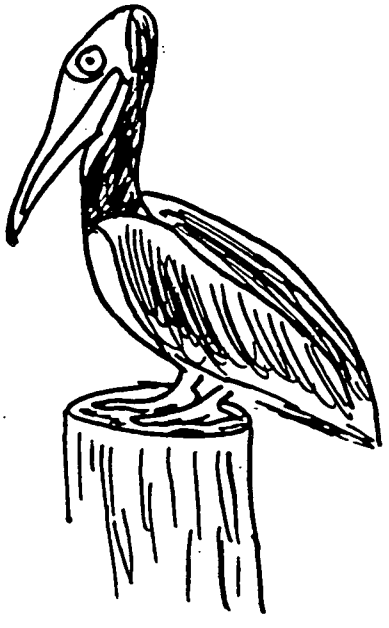
EGRET

Egrets are usually recognized as having white feathers and black legs. The common egret has a large white body, yellow bill, and black legs and black feet. The snowy egret is smaller and has a black bill with black legs and yellow feet. Egrets can be seen nesting in mangrove areas or looking for small fish, crabs and animals of the mangrove community.



BROWN PELICAN

The brown pelican can often be seen flying over the Indian River in search of food. Sometimes they fly so close to the water that their wing tips almost touch the surface of the water. Brown Pelicans do not swim after their food. They spot fish from the air, and then dive straight down into the water and scoop up the fish in their pouch-like beak. Pelicans often nest in mangroves



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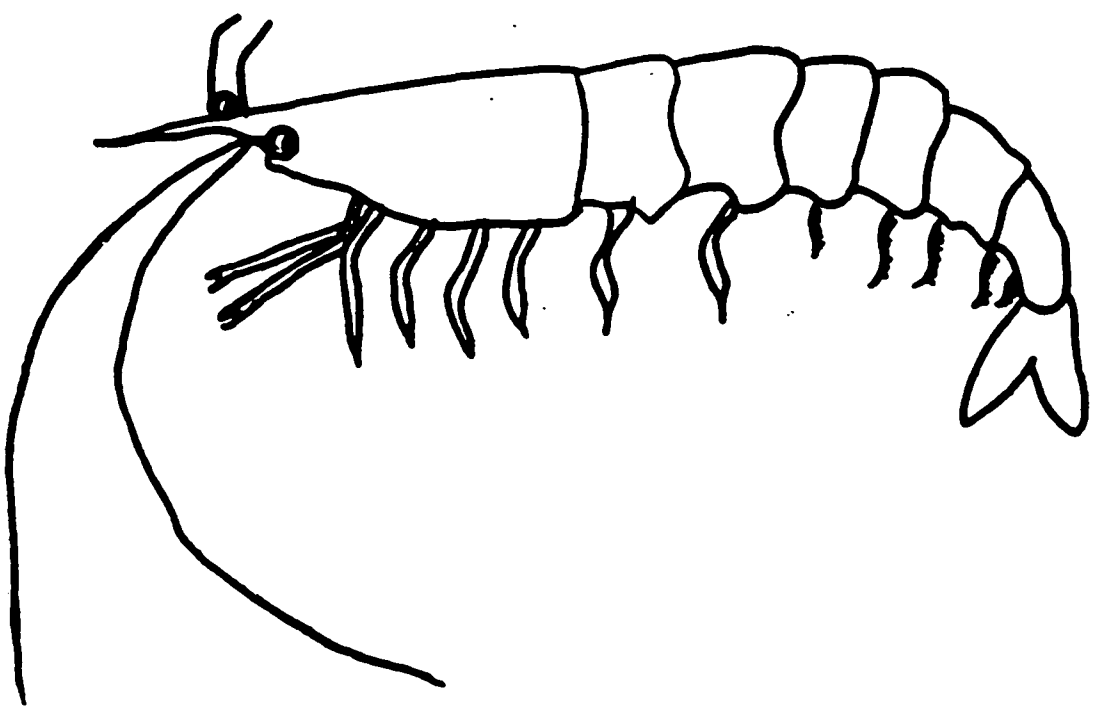
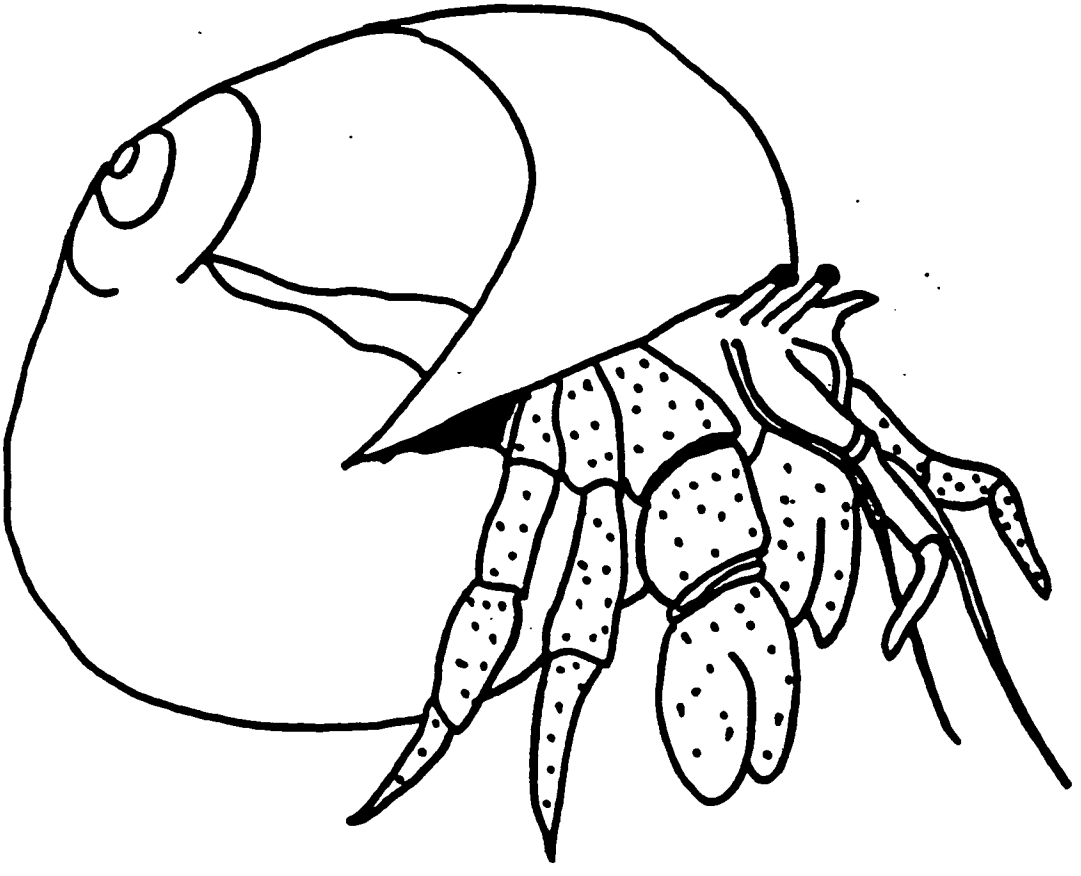
Jensen Beach, Fla. 33457

Grass Shrimp



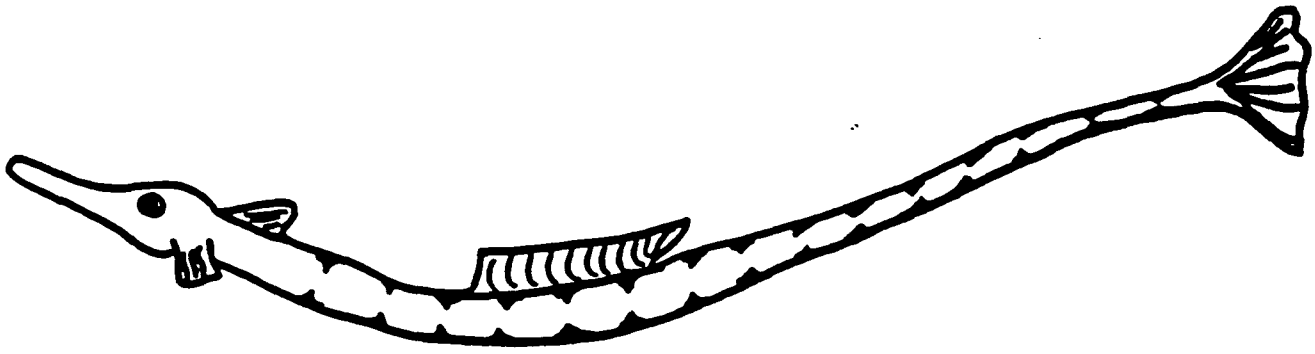
SHRIMP are little animals who live in the grassflat. They are good cleaners. They eat algae and dead plants found in the grassflat.

Hermit Crab



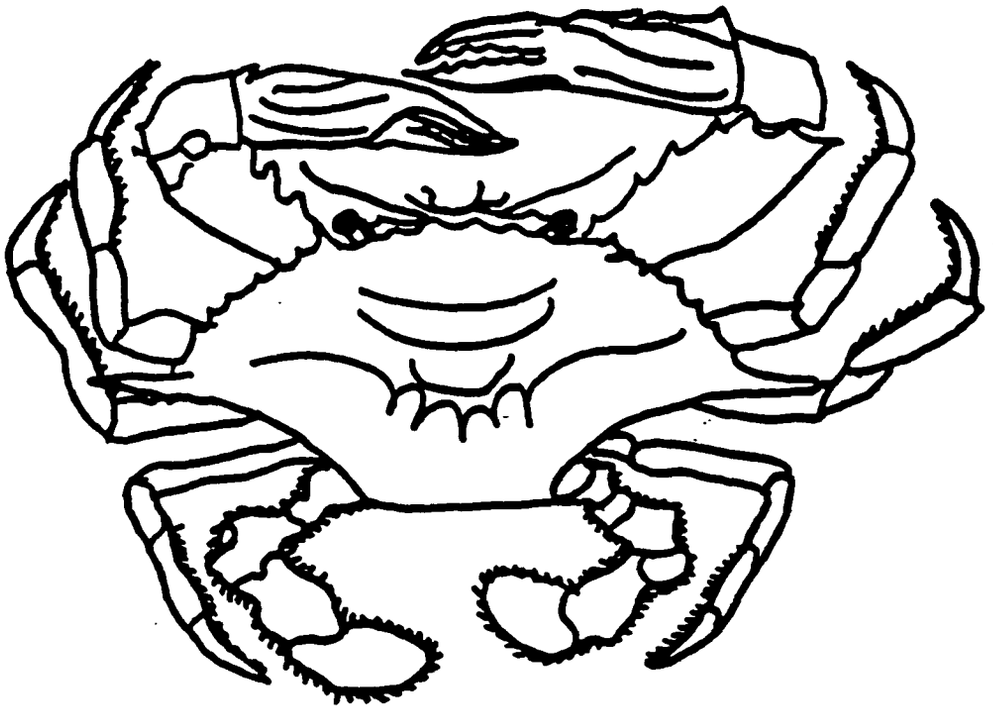
The HERMIT CRAB is a strange little fellow, who lives in the shells of dead animals. As he grows, he moves to a larger shell. He eats dead plants and shrimp.

Pipefish



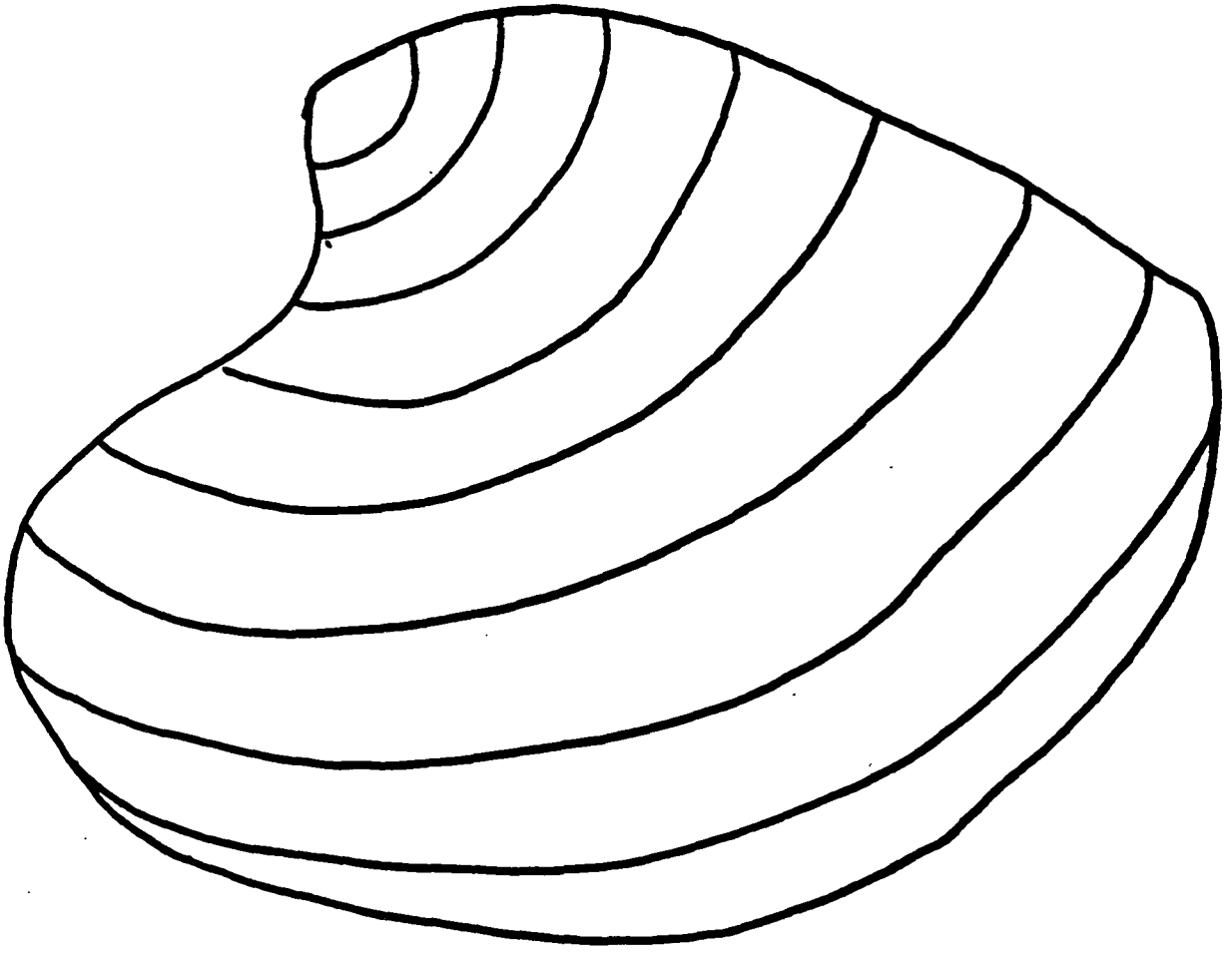
The PIPEFISH is a cousin of the seahorse. He can swim straight up, which is something no other fish can do. He usually eats small shrimp.

Blue Crab



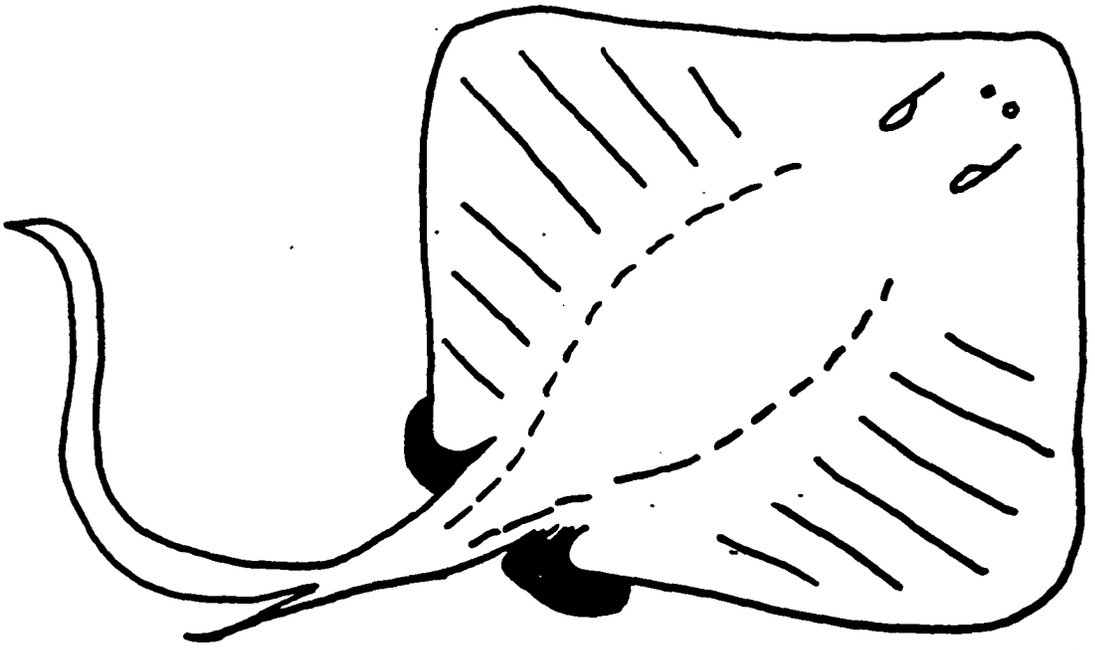
The BLUE CRAB is a mean animal found in the grassflats. It can swim in the water or bury in the bottom. It uses strong pinchers to catch its food. The BLUE CRAB eats fish, algae, grass and dead plant and animal parts.

Clam



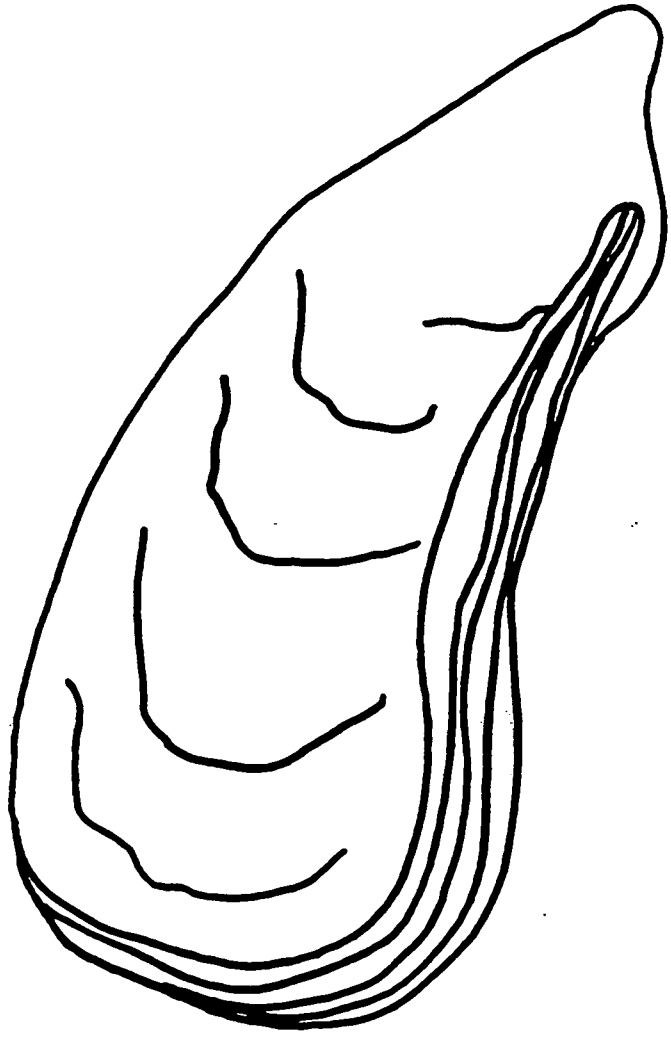
The CLAM is a shelled animal that can be found buried in the bottom of the grassflat. It eats the free floating plants and animals called PLANKTON, that are found in the water around the grassflat.

Stingray



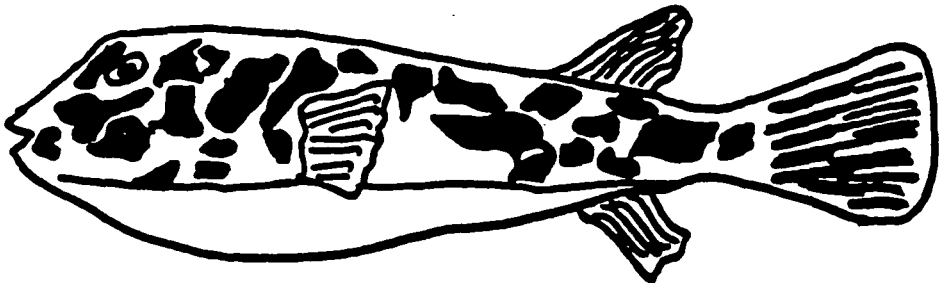
The STINGRAY is a very shy creature of the grassflats. He is not at all like his mean cousin, the shark. He is easily scared away, but if you should happen to step on him, his barb can be very painful. He likes to eat clams, who like himself, burrow into the ground.

Oyster



The OYSTER lives in the shallow waters of the river. This shelled animal must live attached to something, like a rock, or shell, or some roots. The OYSTER eats dead plant parts and plankton.

Puffer

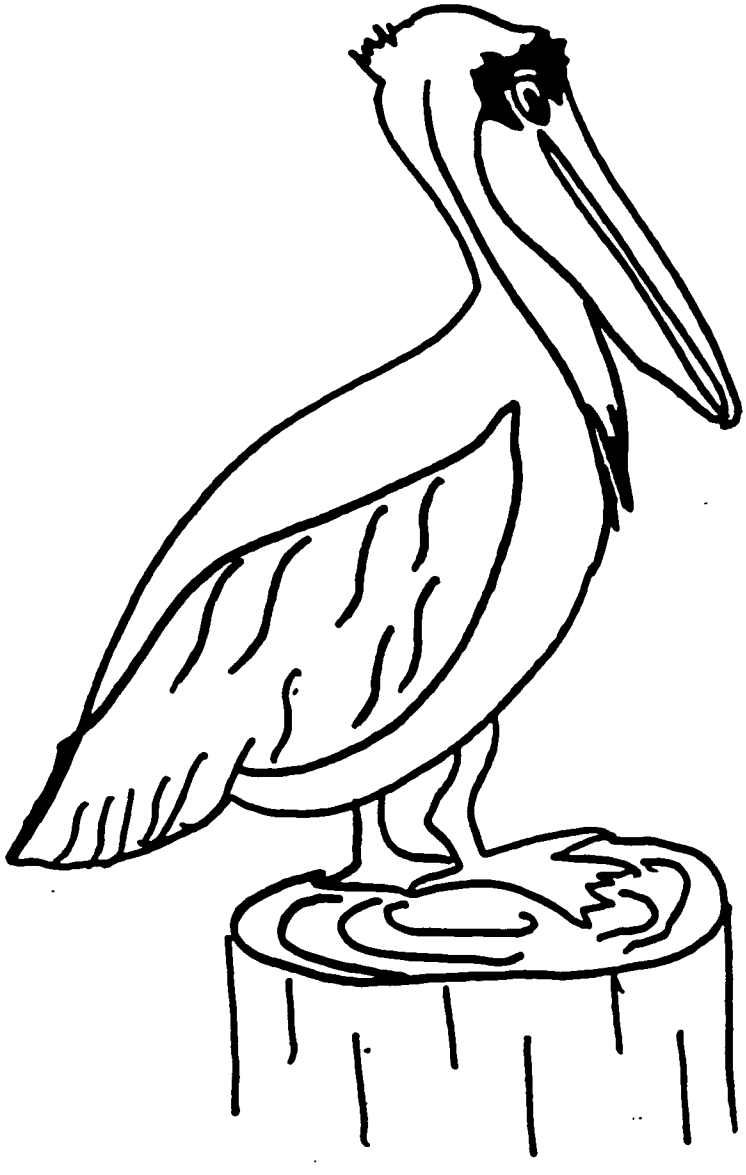


The PUFFER is one of many fish that you will see out in the grassflats. When he is faced with an enemy, he inflates himself like a balloon, so that he looks much bigger than he really is. The PUFFER is a meat-eater. He will eat almost anything.

Blue Heron

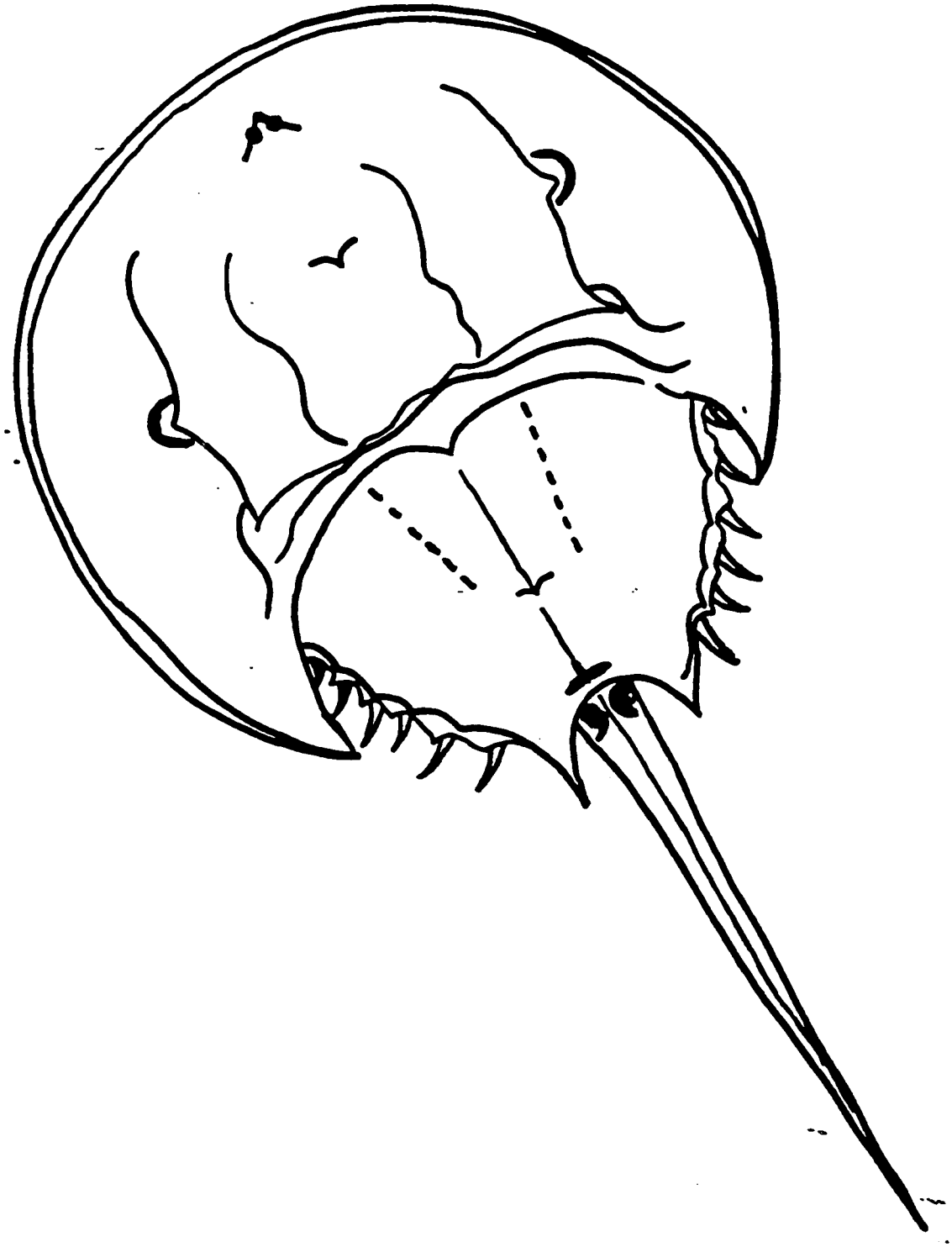
This long legged fellow does not live in the grassflat, but he does spend a lot of time there. The HERON eats the fish that live there.

Pelican



This is a bird that many of us see quite often. He nests on the islands in the Indian River and dives into the water using his large throat pouch to scoop up fish.

Horseshoe Crab



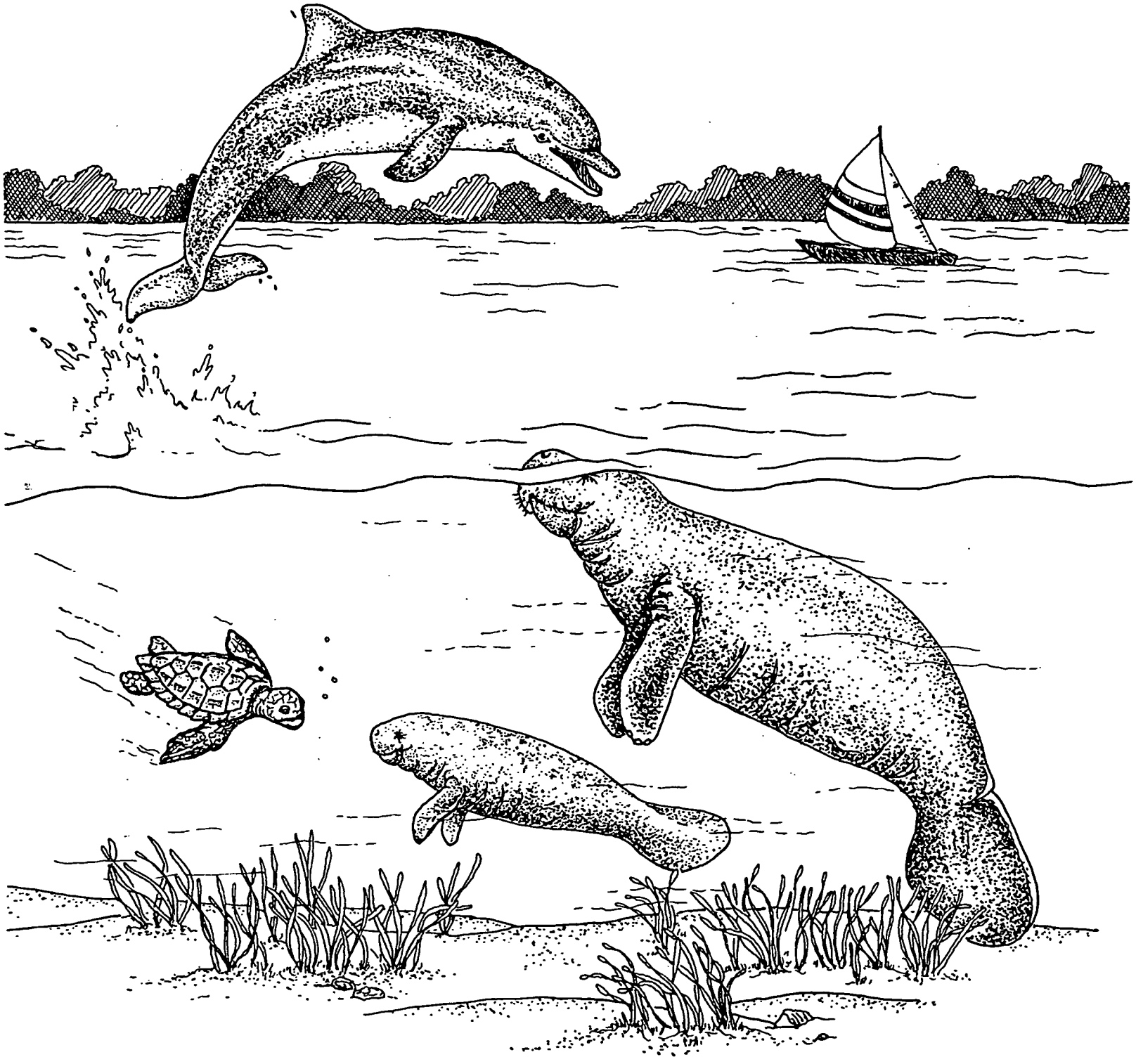
The HORSESHOE CRAB is not a true crab but is more closely related to the scorpion. The crab breathes through gills, and in deep water swims on its back. The HORSESHOE CRAB eats tiny fish, shrimp, and just about anything it finds on the bottom of the river.

Martin County School's
Environmental Studies Center

Appendix C

The Indian River: An Exceptional Lagoon

The Indian River-
An Exceptional Lagoon



Dear Parents and Educators,

What is 140 miles long, crosses five counties, has trees on stilts, underwater meadows, and contains over 4,000 kinds of plants and animals?
Answer: The Indian River Lagoon.

What does the lagoon mean - to you? A place to escape to on the weekends, a cool breeze, something thats needs to be crossed to go to the beach, a livelihood?
When asked what the Indian River Lagoon meant to them, excited students raised their hands, saying; "jet, skiing, boating, seeing manatees, and fishing trips with Mom and Dad."

The lagoon is an important part of many peoples' lives. However the delicate balance of life that exists along the shoreline and under the water goes unnoticed by the majority of people using the lagoon. This delicate balance of life that makes the lagoon so productive is being threatened by Florida's increasing population pressures. The purpose of this activity book is to help young people gain a better understanding of the Indian River Lagoon and the interdependence of its plants and animals. This knowledge is vital, for our young people will soon be the ones managing this valuable resource.

Please take time to explore this activity book with your child. Let your child share with you the new knowledge he or she has gained. Their excitement is contagious!

"If a child is to keep alive his inborn sense of wonder... he needs the companionship of at least one adult who can share it, rediscovering with him the joy, excitement and mystery of the world we live in."
-Rachel Carson

Sincerely,

St. Johns River Water Management District
South Florida Water Management District
Florida Department of Environmental Protection

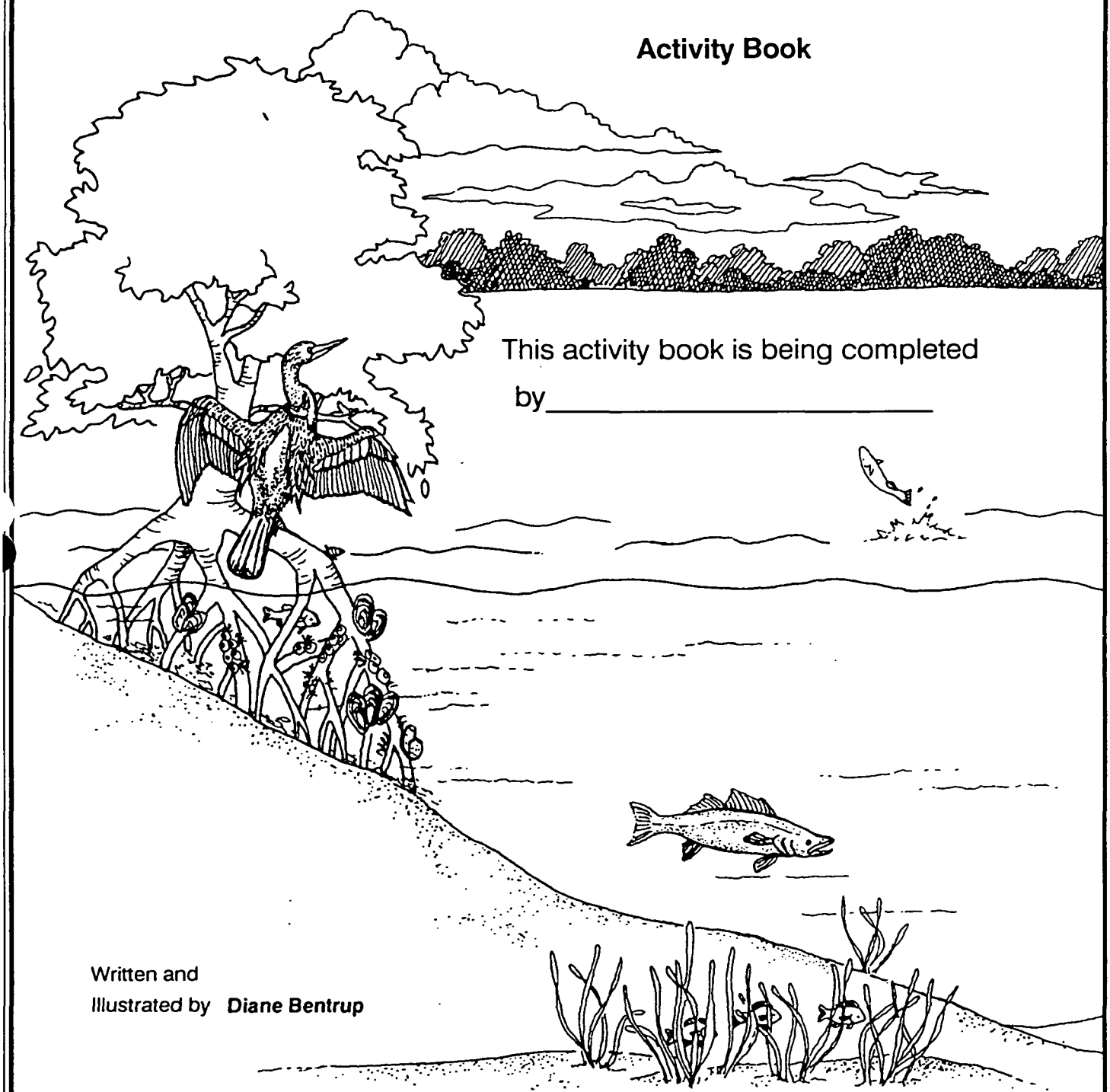
This environmental education program is part of the Indian River Lagoon Surface Water Improvement and Management program (SWIM). SWIM is a state act passed by the legislature in 1987. The act provides state funds for programs that restore and preserve Florida's important water bodies. The governor has declared the Indian River Lagoon as a priority water body needing special attention. Environmental education and awareness is a major goal of the SWIM plan. These materials were developed by the Florida Department of Environmental Protection in cooperation with St. Johns River Water Management District and South Florida Water Management District.

SWIM
Surface Water Improvement and Management

Rev. 8/96

The Indian River -
An Exceptional Lagoon

Activity Book



This activity book is being completed

by_____

Written and
Illustrated by **Diane Bentrup**

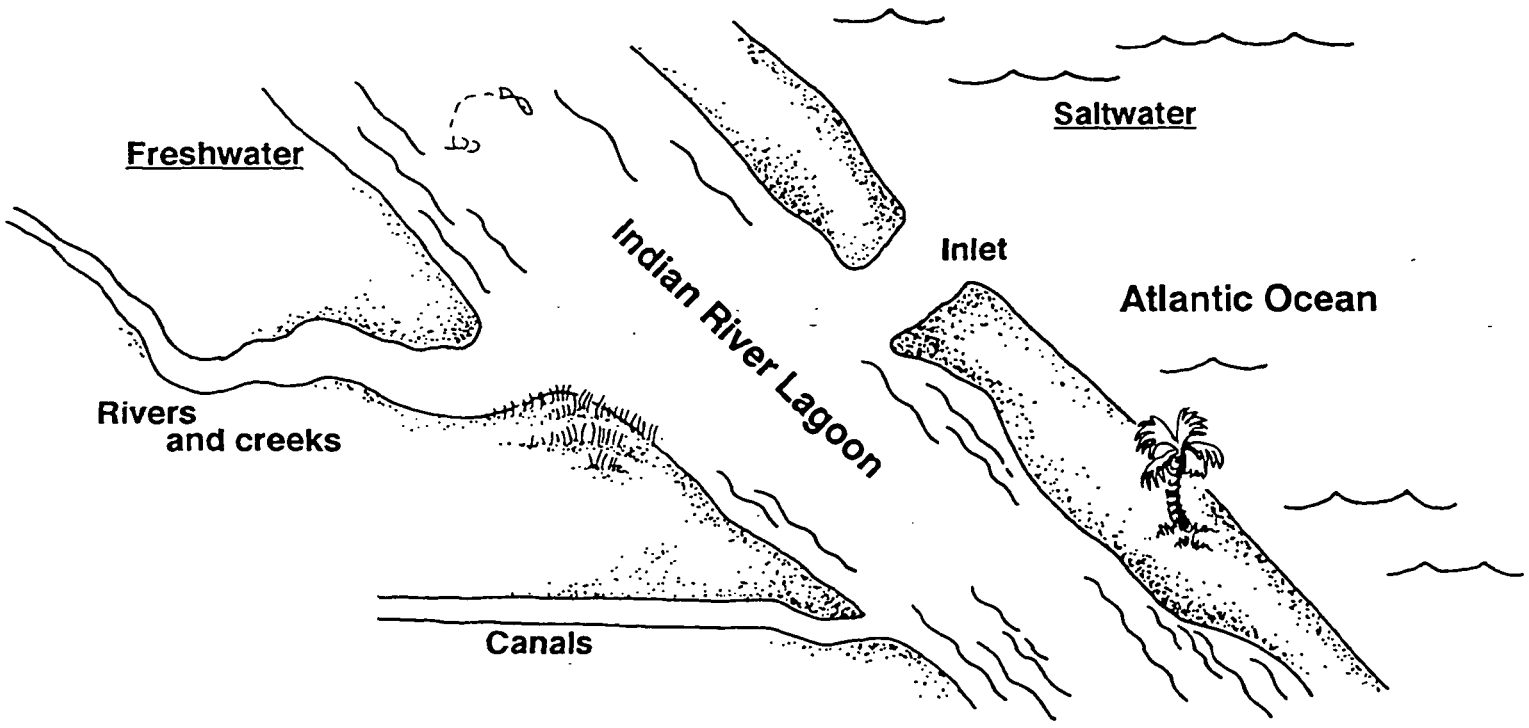
Acknowledgement:
I would like to thank Paul S. Mikkelson for his assistance with all computer related aspects of the project. His patience and dedication is greatly appreciated.

Lesson 1

The Indian River - An Exceptional Lagoon

That is quite a title, but then the Indian River is quite a place. By studying this unit you will learn why the Indian River is exceptional and how you can preserve and protect this fragile coastal resource.

Is the Indian River really a river? The Indian River is actually a lagoon, a shallow body of water protected from the ocean by barrier islands.

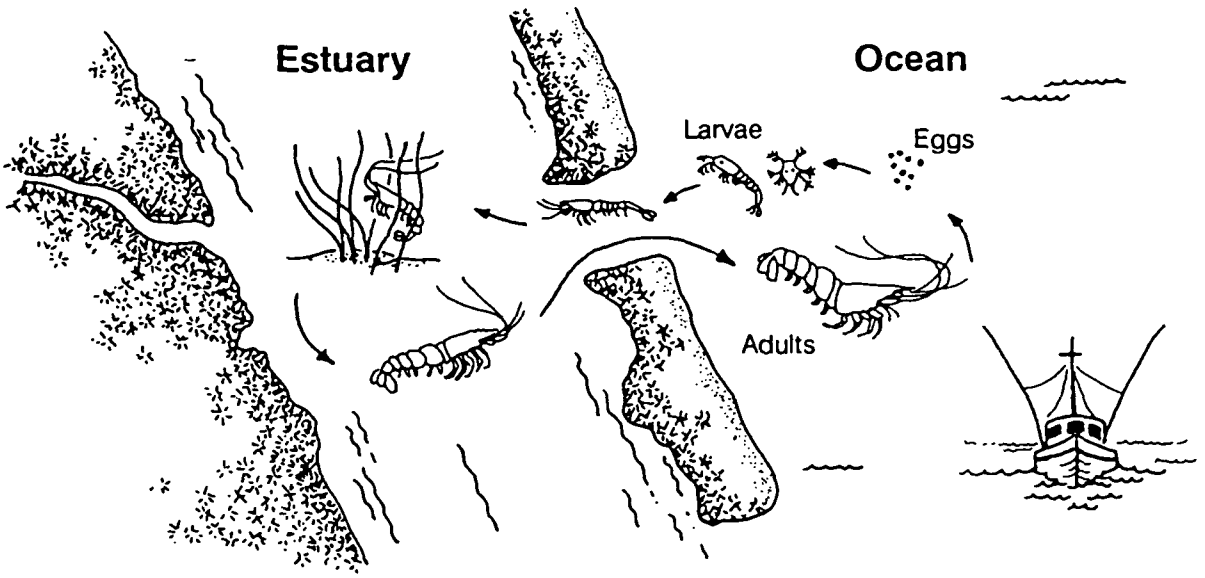


The Indian River Lagoon is an estuary. An **estuary** is a body of water where fresh and saltwater meet and mix. Freshwater enters the estuary through rivers, creeks and canals. Saltwater enters from the ocean through inlets.

Estuaries are full of life, and the Indian River Lagoon is no exception. The lagoon's mangroves, marsh grasses, and seagrasses provide food and shelter for a large variety of organisms. Over 4,315 species of plants and animals live in the Indian River Lagoon.

Many of the fish, shrimp, and shellfish (clams, oysters) that are important to Florida's economy must spend part or all of their lives in an estuary.

Shrimp, for example, spawn (produce eggs) offshore as adults. The eggs hatch in the ocean and the larvae move toward shore. The young shrimp that survive this hazardous journey from the sea enter the estuary and hide among the seagrasses and algae. As the shrimp become adults they leave the estuary and return to the sea, where the cycle begins again.

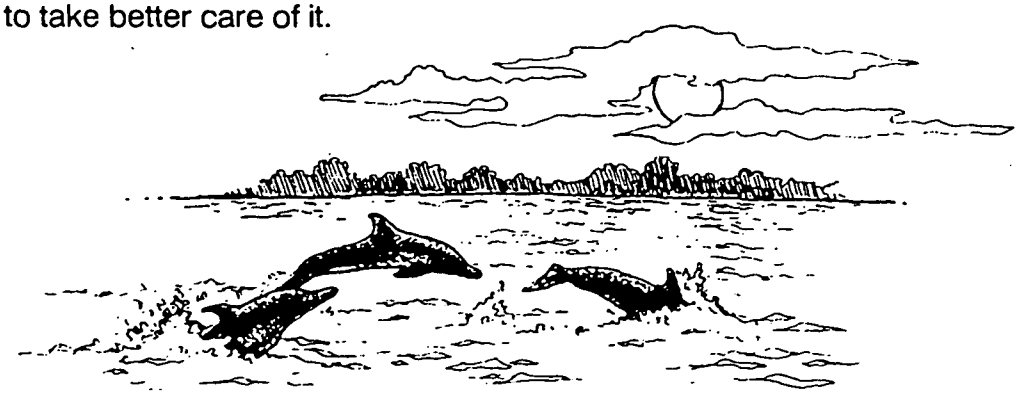


The striped mullet have a similar life cycle. The adults spawn offshore and the juveniles (young fish) move into the estuary. In the winter they gather in groups called schools and return to the ocean to spawn. During this journey they become food for birds and many ocean fish. Thus the benefits of estuaries are felt a long way from shore.

In fact, their value has been felt all the way to Washington,D.C. Congress has declared it is in our nation's best interest to protect and preserve this important but endangered resource: our estuaries.

We are fortunate indeed to live so close to a beautiful estuary like the Indian River Lagoon. There are many different ways we can enjoy the lagoon such as boating, fishing, bird watching, and viewing a quiet sunset.

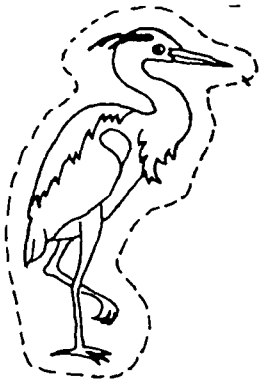
Let's take this opportunity to learn more about the Indian River Lagoon and its inhabitants, so we will be able to take better care of it.

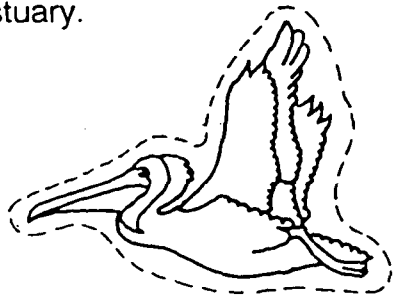


Make Your Own Estuary

Materials needed: A pair of scissors, glue, and crayons.

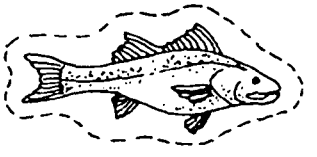
Directions: Cut this page out of the book. Cut out each plant, animal, or habitat. Glue each picture on the next page. Color your estuary.


great blue heron

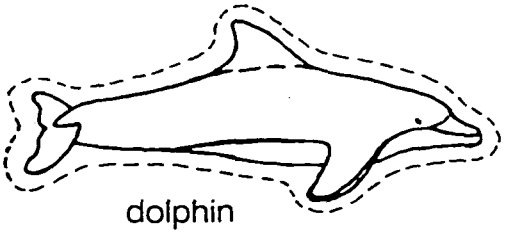

pelican

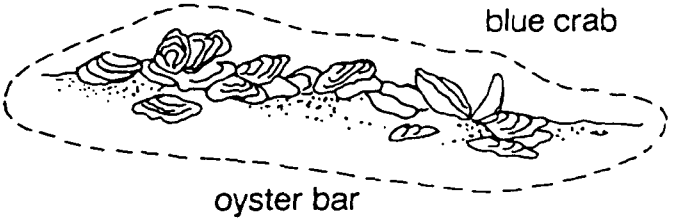
algae

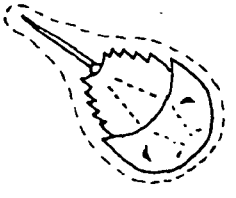
seagrass

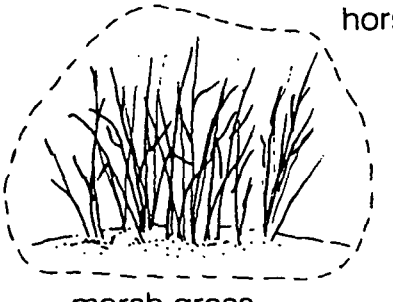

snook

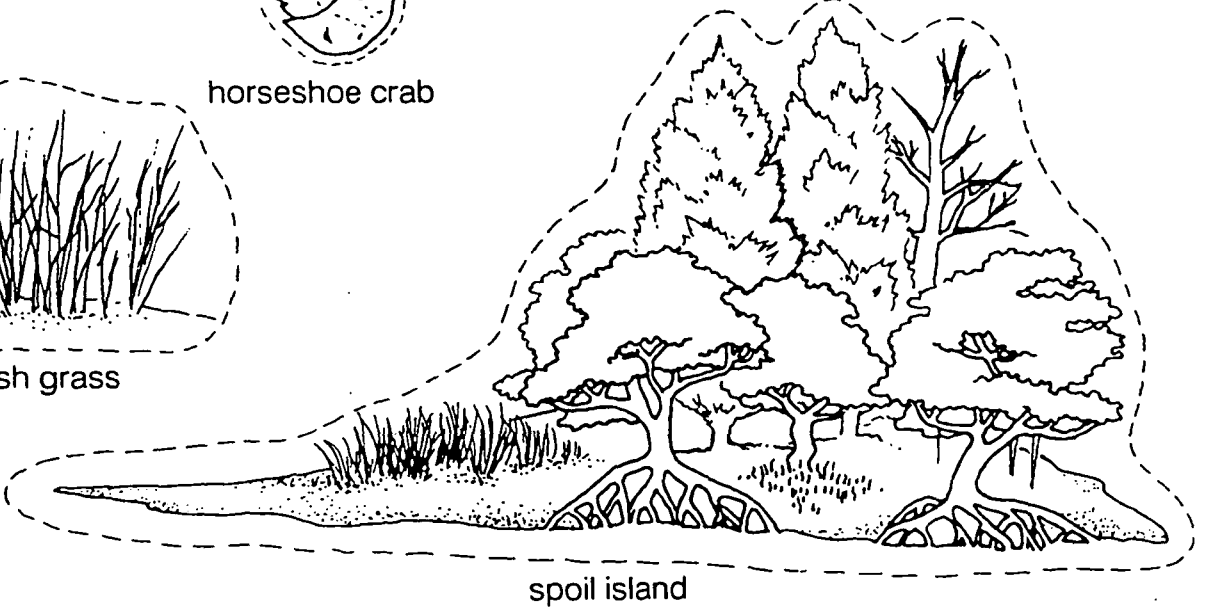
blue crab

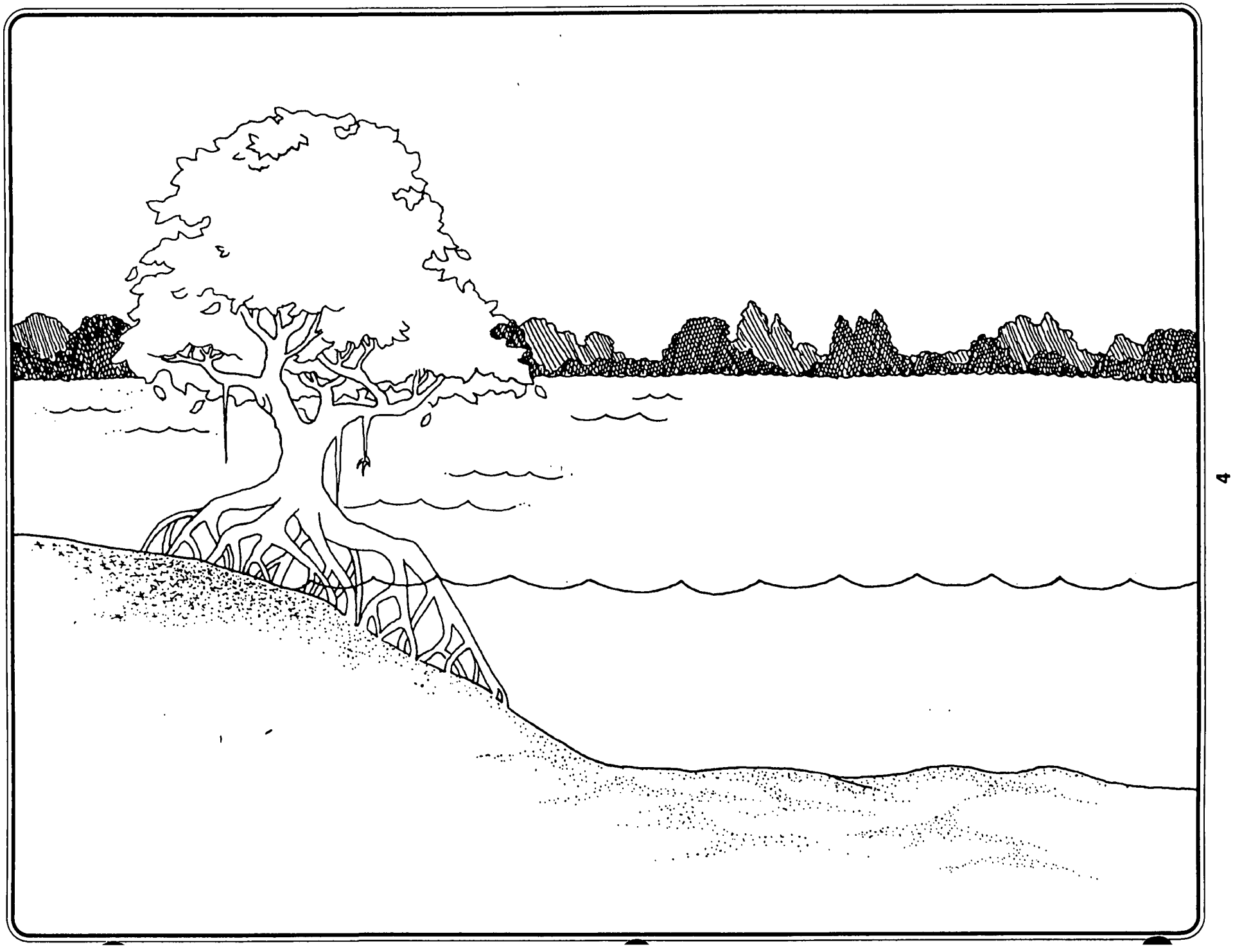

dolphin


oyster bar


horseshoe crab


marsh grass


spoil island



Lesson 2

Habitat Sweet Habitat

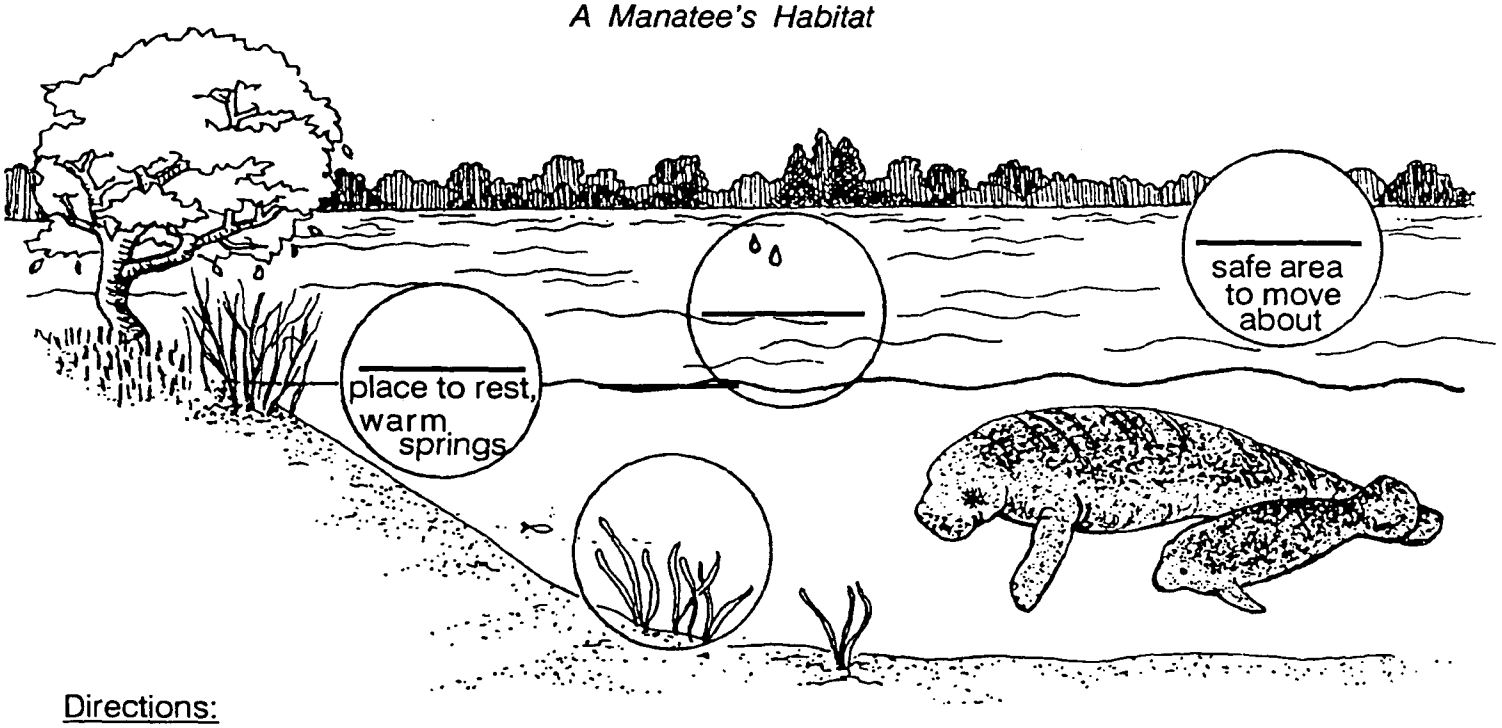
We all require certain basic things in order to live. Write down what you think these are.

NEED	WHERE YOU FIND IT
Example: Water	Well, lake, river

Other organisms have many of the same requirements. Plants and animals find what they need in their habitat. A **habitat** is the area where an organism is supplied with food, water, shelter, and space.

The picture below shows what a manatee needs in its habitat. If one of the parts in missing the manatee can not survive. To help animals and plants we need to first protect their home - their habitat.

A Manatee's Habitat



Directions:

Fill in the blank in each circle by matching each drawing or definition with the following words: **food, water, shelter, space.**

What If?

Directions: What would happen to manatees if different parts of their habitat were affected? Write down your ideas and then discuss them as a class.

1) What if .....people were always trying to approach manatees? (shelter)

_____

2) What if.....the seagrass died because the water was cloudy? (food)

_____

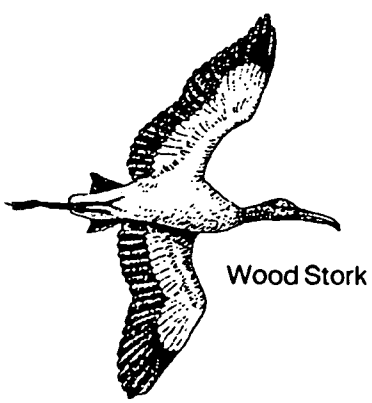
3) What if.....the water became polluted with pesticides, herbicides, or other chemicals? (water)

_____

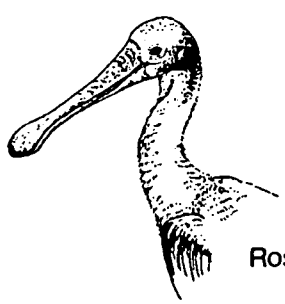
4) What if.....there was no place for manatees to avoid fast power boats? (space)

_____

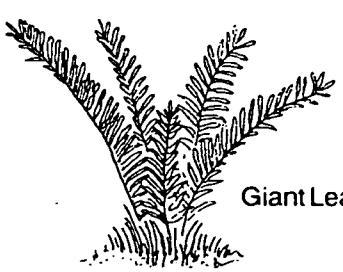
These are a few of the plants and animals in Florida that are listed as endangered or threatened. This means there are not many of them left. They are threatened by extinction.



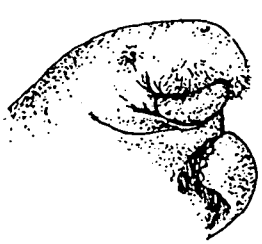
Wood Stork



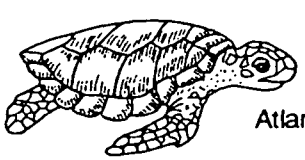
Roseate Spoonbill



Giant Leather Fern



West Indian Manatee



Atlantic Loggerhead

Florida has more endangered and threatened animals and plants than any other state. The main reason is loss of habitat.

Lesson 2

Habitat is rapidly disappearing in Florida. Much of the loss happens when land is cleared for industry and houses.

Two important habitats in the Indian River Lagoon are declining. The Department of Natural Resources has estimated that the lagoon has lost approximatley 80% of its mangroves--

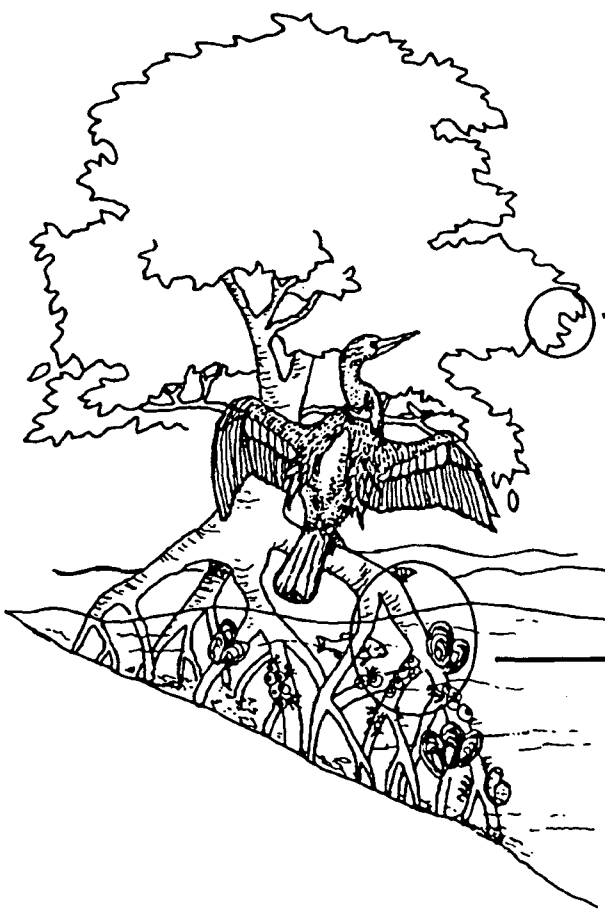
and 30% of its seagrass beds--

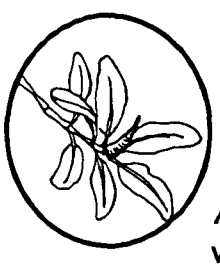
By learning more about the lagoon's habitats, how they are important and what affects them, we will be better equipped to protect them.

The Marvelous Mangrove

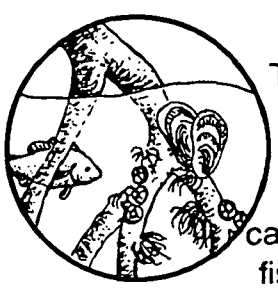
Mangroves grow along the shore of the lagoon and provide valuable habitat for many animals.

Birds nest in the branches or use the trees as a roost to rest.





Mangrove leaves are tough. Not many animals will eat them while the leaves are still on the tree. After the leaves fall into the water they start to decay. Decaying mangrove leaves are an important food source for the small critters in the lagoon.



The prop roots of the red mangrove provide a nursery area to young fish, a place where they can find shelter from larger fish and find food as well. The prop roots also provide a place for oysters and barnacles to attach. A mangrove tree is a very busy place!

Find out more about seagrass by doing the 'Seagrass Search' on the next page.

Seagrass Search

Lesson 2

Follow these directions until you reach the manatee munching on seagrass.

1. Are seagrasses the same as seaweeds? ___Yes. Go to #12 ___No. Go to #9

2. **False.** Seagrasses are important for animals and people. Now go to #11

3. **True.** The beds of seagrass slow the waves and allow the sediments to sink to the lagoon's bottom. Are these thick seagrass beds avoided by juvenile fish and other young aquatic animals? ___Yes. Go to #6 ___No. Go to #8

4. **False.** In shallow water boats can be a problem. Now go to #5

5. **True.** In shallow water the propeller from a boat's motor can dig the seagrasses up and shred them. It is important to avoid shallow seagrass beds. If you cannot avoid them, then drive very slowly and lift the motor. Are seagrass beds important to people? ___Yes. Go to #11 ___No. Go to #2

6. **False.** The seagrass beds provide a nursery for the young animals. Now go to #8

7. **False.** Seagrasses can help keep the water clear. Now go to #3

8. **True.** The seagrass beds provide hiding places for the juveniles from larger animals. The seagrasses also provide food. Many people use the lagoon along with the animals. Can boats be a problem for seagrasses? ___Yes. Go to #5 ___No. Go to #4

9. **True.** Seagrasses are flowering plants unlike seaweeds which are algae. Seagrasses grow in the brackish (salty) waters of the Indian River Lagoon. Rainwater that runs too quickly off of farms, roads, and towns carries a lot of sediments (soil and other particles) into the Indian River Lagoon. These sediments make the water turbid, or cloudy. When the water is turbid, is this good for the seagrass? ___Yes. Go to #10 ___No. Go to #13

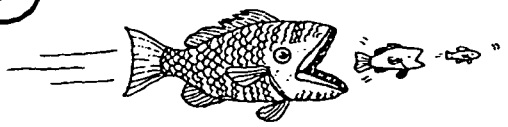
10. **False.** If the water is very turbid it can kill the seagrass. Now go to #13

11. **True.** Most of the fish. clams, oysters, and crustaceans that people catch for food need the seagrasses at some time in their lives. Seagrasses also help to keep the Indian River Lagoon clear and healthy.

12. **False.** Seaweeds are algae. Now go to #9

13. **True.** The turbidity prevents sunlight from shining through the water to the seagrasses. Seagrasses need the sun's energy to produce food. Do seagrasses help to keep the water clear? ___Yes. Go to #3 ___No. Go to #7

Lesson 3

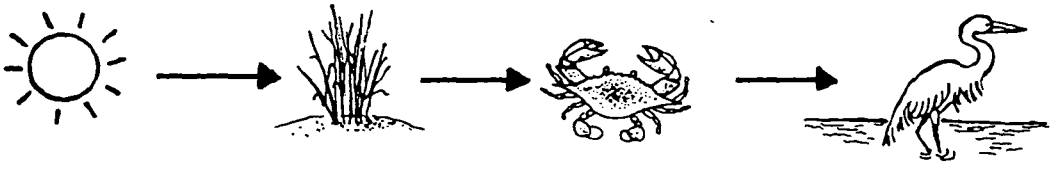


What's For Supper?

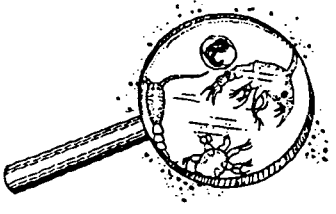
All organisms need food in some form or another, but only plants can use the energy of the sun to make food. They use sunlight and nutrients to manufacture food and oxygen. Plants are called **primary producers** because they provide food for all animals.

Animals are called **consumers** because they cannot make their own food like primary producers. Consumers must get their energy in the form of food from either plants or other animals.

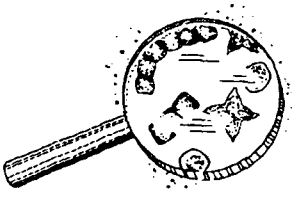
This flow of energy from: the sun to plants ⟶ plant eaters ⟶ meat eaters is called a **food chain.**



Primary producers in the Indian River Lagoon are mangroves, marsh grasses, seagrasses, and algae. There are even primary producers floating in the water that are too small for you to see without a microscope. These microscopic plants, called phytoplankton, provide food for microscopic animals called zooplankton as well as for larger animals like clams and oysters.



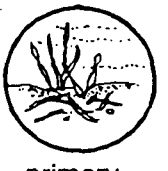
zooplankton



phytoplankton

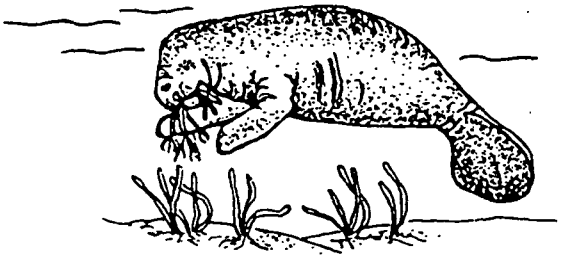
Let's take a closer look at an example of a food chain. Plants are the first link in the food chain because they get their energy from the sun. In the previous lesson we studied about seagrass. It is an important primary producer in the Indian River Lagoon.

1



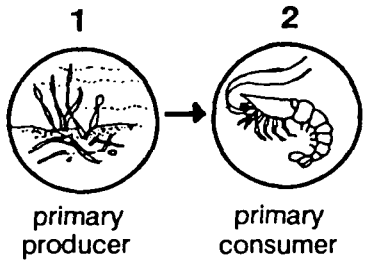
primary producer

There are three ways that seagrass provides food for animals in the lagoon. Some animals,such as manatees, eat the seagrass.



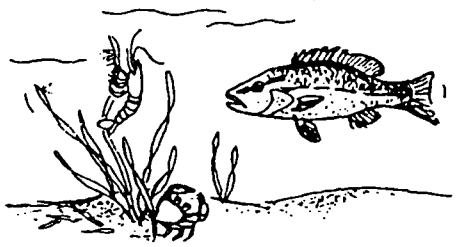
Other animals, such as shrimp and snails, eat algae that grows on the blades of seagrass.

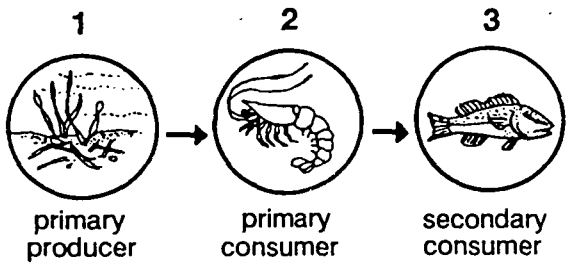
As seagrass grows, old leaves die and settle to the bottom of the lagoon. There they become covered with microorganisms (tiny plants and animals). These microorganisms are called **decomposers** because they cause dead plants and animals to decay. This mixture of decaying dead leaves covered with microorganisms is called detritus. This is the third way that seagrass provides food. Crabs, clams, and shrimp are a few of the animals which feed on detritus in the Indian River Lagoon.



Animals that eat plants are called **primary consumers**. They are the second link in the food chain.

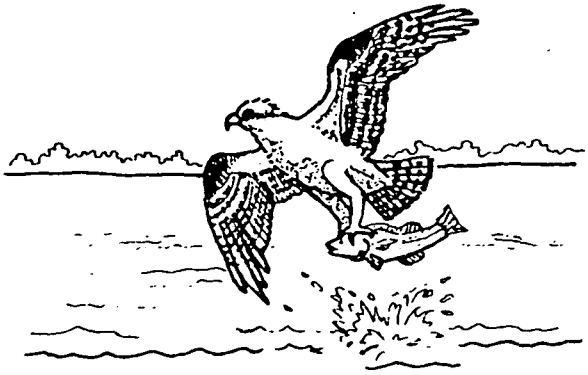
Animals that eat the primary consumers are called **secondary consumers**. In the lagoon, a snapper would feed on shrimp and crabs.

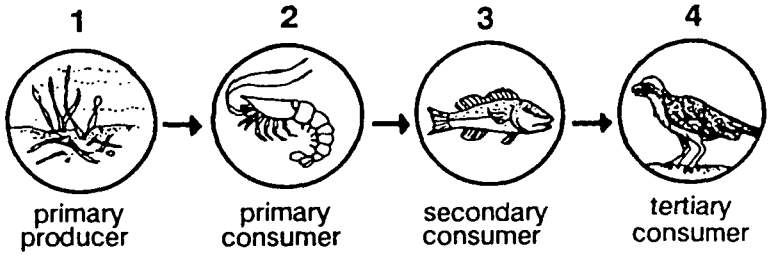




This is the third link in the food chain.

Animals that eat secondary consumers are called **tertiary consumers**.

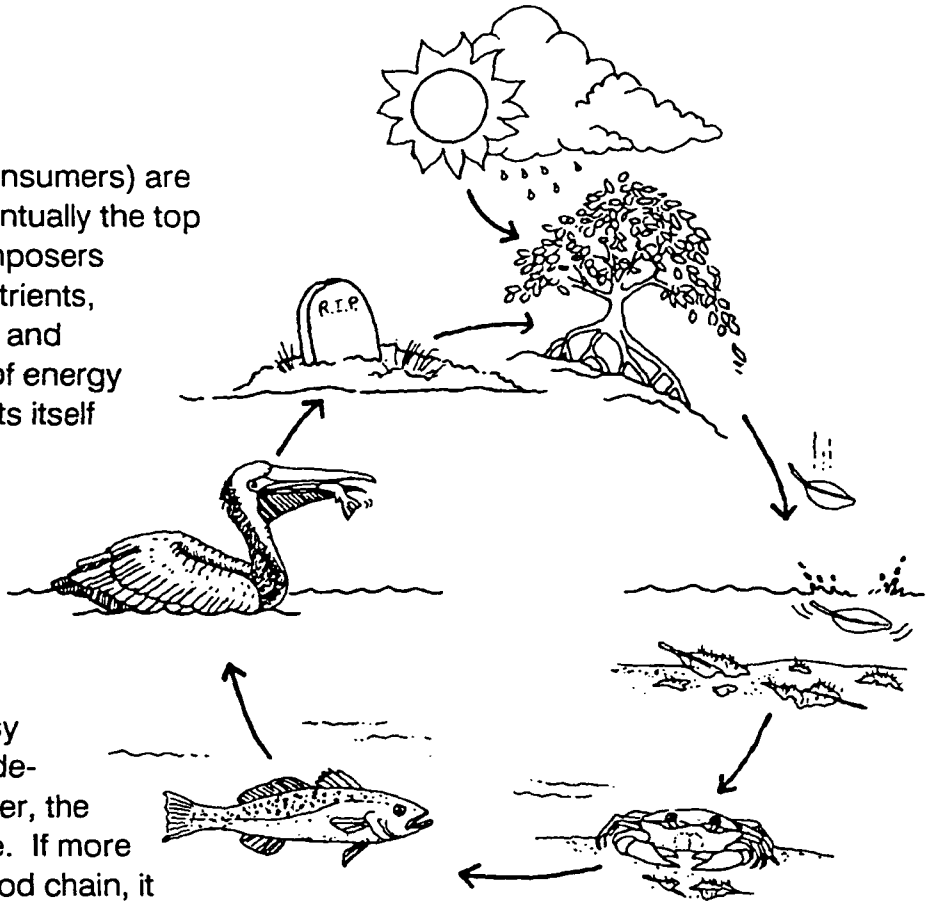




An osprey becomes the fourth link in the food chain as it snatches the grey snapper out of the water.

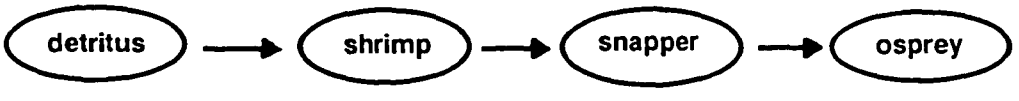
Lesson 3

Only **top predators** (tertiary consumers) are safe from being eaten. But eventually the top predators die. Then the decomposers break the dead material into nutrients, which plants use again to grow and produce more food. The flow of energy completes a circle which repeats itself over and over.

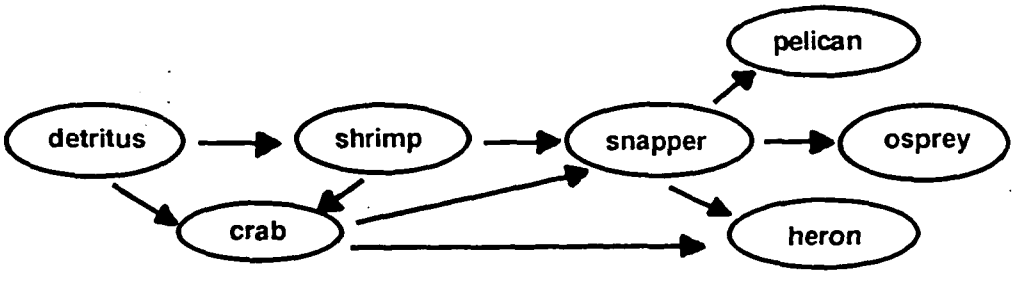


Studying a food chain is an easy way of seeing how organisms depend upon each other. However, the process isn't always this simple. If more consumers are added to the food chain, it becomes more complex.

We can start out with a simple food chain like this:



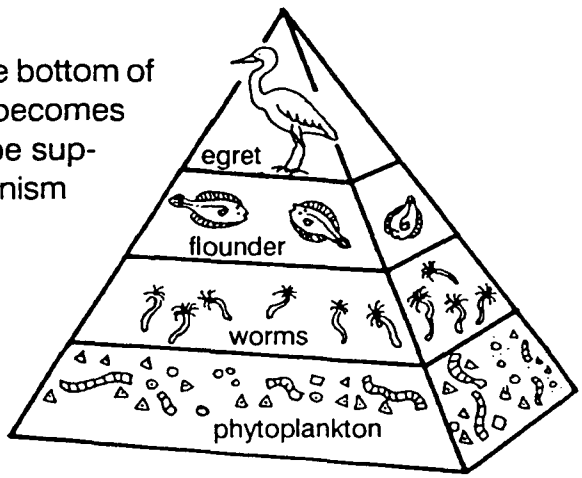
but when we add a crab, pelican, and heron, it begins to look more like a web than a chain.



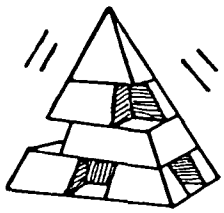
A **food web** is a more realistic way to view the flow of energy among organisms. In addition to understanding how energy flows through food chains and webs, it's important to realize what happens to the energy.

Plants and animals need to use some of the energy they obtain. Animals need energy to grow, move about, and reproduce. When one animal eats another, it stores part of the original energy and uses the rest. Only a small part of the original energy gets to the top of the chain. This idea is best illustrated by a **pyramid of energy.**

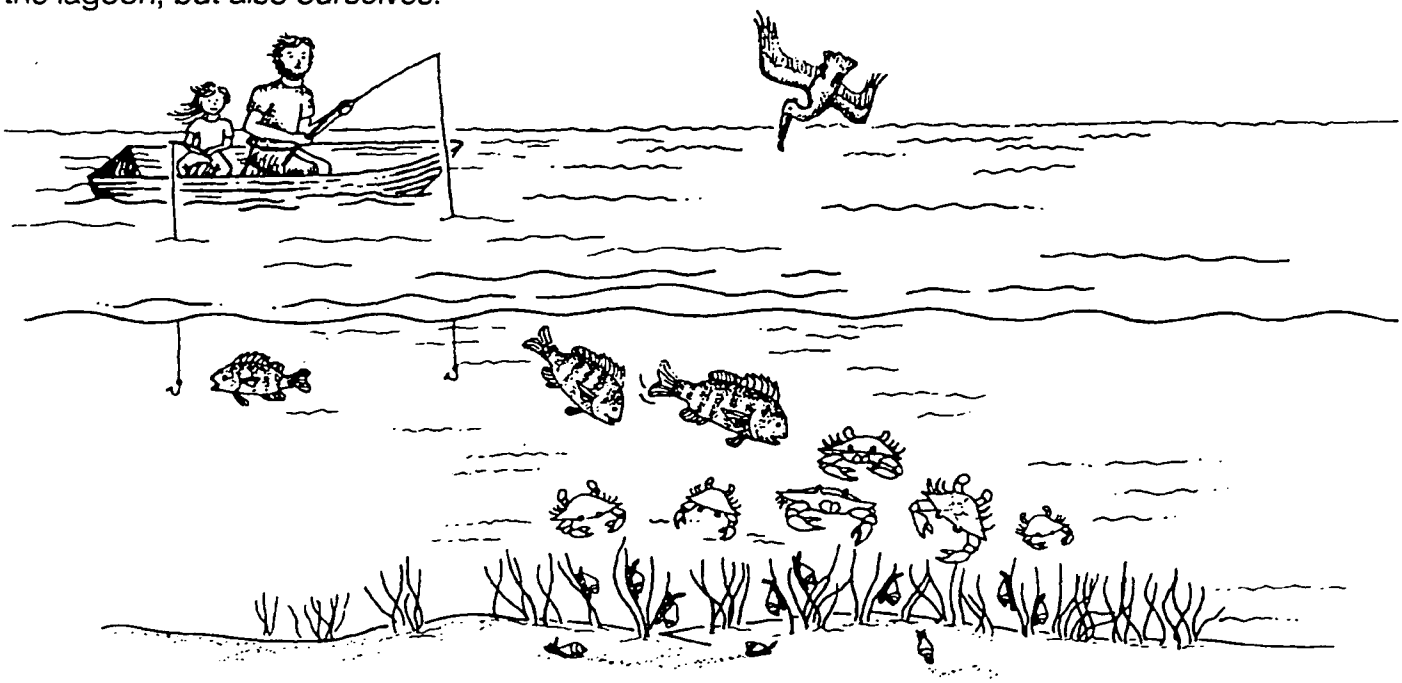
There are many organisms (primary producers) at the bottom of the pyramid. The amount of energy passed upward becomes smaller and smaller until only a few organisms can be supported at the top. In order to sustain life, every organism depends on each other.



If we remove too much of the pyramid by destroying habitat, pollution or over-fishing, what will happen?



Humans are also a part of the food chain. Fish, clams, oysters, and shrimp are some of the benefits we receive from the Indian River Lagoon. When we disrupt the delicate balance, we affect not only the lagoon, but also ourselves.



Lesson 3

Fast Food Chains

This does not refer to hamburgers or hot dogs. This refers to an activity where you will see how many food chains you can make using a list of plants and animals of the Indian River Lagoon.

Materials needed: Several sheets of blank paper, a pair of scissors, tape or glue, and a pencil.

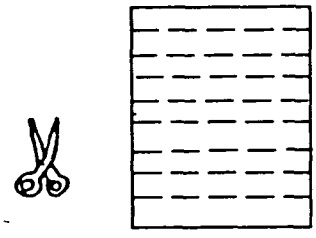
Directions:

1. Work together in groups of four or five. On a sheet of paper, write down a food chain using the list of plants and animals on the next page.

   Example: **phytoplankton** ⟶ **barnacle** ⟶ **snapper** ⟶ **pelican**

   (Hint: It may be easiest to start with a top predator (such as a pelican or raccoon), and work backwards.)

2. Cut a blank sheet of paper into strips about an inch wide.



3. Taking one strip of paper write the producer on it.

phytoplankton

Make a link by taping or glueing the ends of the strip together.

4. On another strip, write the consumer that will eat that producer.

barnacle

Add this link to your chain.

5. On the next strip write the consumer that will eat the first consumer.

snapper

Add this link to your chain.

6. Keep adding links until you reach a top predator.

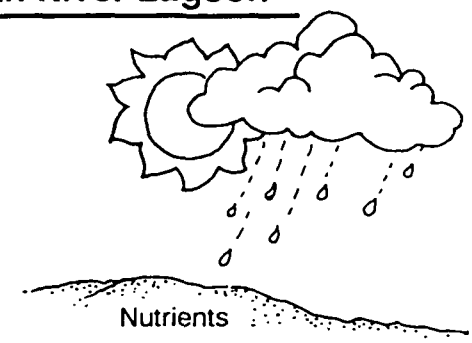
pelican

Add this link to your chain.

7. Write down more food chains using the list of plants and animals. Make as many different food chains out of paper as you can in the time limit set by your teacher.

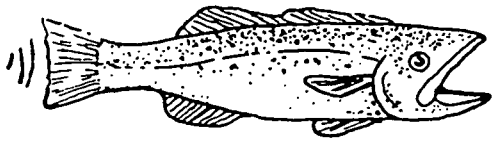
Plants and Animals of the Indian River Lagoon

Primary Producers (Plants)



seagrass
marsh grass - dead grass becomes detritus
mangroves - fallen leaves become detritus
algae
phytoplankton (plant plankton)

Consumers (Animals)



Consumers (Animals)	What They Eat
zooplankton (animal plankton)	phytoplankton
clam	detritus, zooplankton, phytoplankton
worm	detritus, zooplankton, phytoplankton
barnacle	detritus, zooplankton, phytoplankton
snail	algae, clams
shrimp	detritus, fish, algae
blue crab **fiddler crab** **hermit crab**	Crabs are scanvengers and eat about anything they can find, such as marsh grass, fish, detritus, worms and shrimp.
flounder	worms, fish, crabs, snails
mullet	plants, detritus
pipefish	zooplankton, tiny shrimp
sheepshead	clams, crabs
snapper	barnacles,crabs,fish, shrimp
stingray	worms,clams,crabs, fish
seagull	any plant and animal small enough for it to eat - dead or alive
heron & egret	fish, crabs
pelican	fish
osprey	fish
manatee	seagrass
raccoon	clams, crabs, fish
human	fish, crabs, shrimp. clams

Lesson 4

People and the Lagoon

To better understand how people affect the lagoon, start by studying the map on the next page.

Materials needed: A pencil, and a blue, green, orange, and yellow crayon.

1. What is the name of your state? _____
   Using a regular pencil, write it on the map.

2. What county do you live in? _____
   Using a regular pencil, write it on the map.

3. What is the name of the town you live in? _____
   Locate it on the map and draw an orange circle around it.

4. The Indian River Lagoon is an _____, that is a body of water where fresh and saltwater meet and mix.

5. The freshwater enters through _____, _____ and _____.

   How many can you find on the map? _____ Color them blue.

6. The saltwater from the ocean enters the lagoon through _____.

   How many are there in your county? _____
   Color the ocean and the inlet yellow.

7. Color blue in this square.

   Now color yellow over the blue. What color do you get when the two colors are combined?

8. On your map you colored freshwater blue and saltwater yellow. These combine in the Indian River Lagoon, so color the lagoon green.

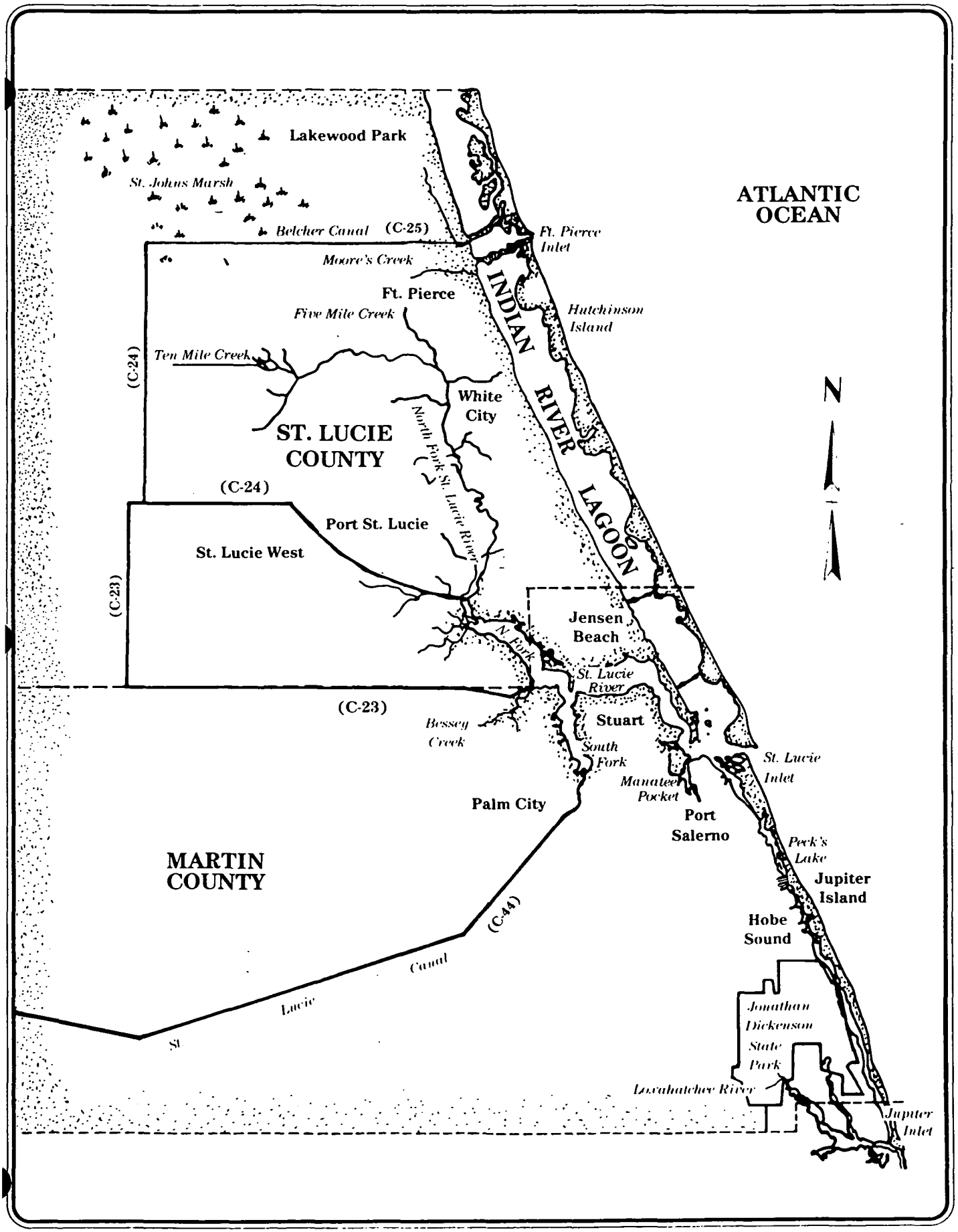
9. The St. Lucie River is an estuary too. Color it green.

All over the world people like to live near estuaries. Why do you think this is so?

_____

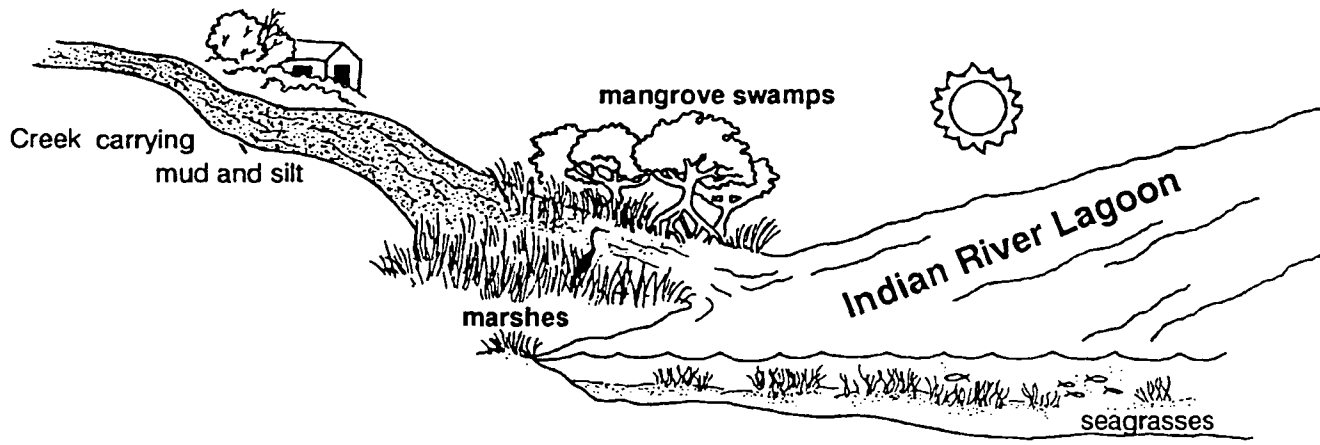
Notice how many towns in your county are built along the Indian River Lagoon.

Many people are moving into this area every year. The increasing number of people is causing some problems for the lagoon.


Lakewood Park
St. Johns Marsh
Belcher Canal
(C-25)
Moore's Creek
Ft. Pierce
Five Mile Creek
Ten Mile Creek
(C-24)
ST. LUCIE COUNTY
White City
North Fork St. Lucie River
(C-24)
Port St. Lucie
St. Lucie West
(C-23)
(C-23)
Ft. Pierce Inlet
INDIAN RIVER LAGOON
Hutchinson Island
ATLANTIC OCEAN
N
Jensen Beach
N. Fork
St. Lucie River
Bessey Creek
Stuart
South Fork
Manatee Pocket
St. Lucie Inlet
Palm City
Port Salerno
Peck's Lake
Jupiter Island
MARTIN COUNTY
(C-44)
Hobe Sound
St. Lucie Canal
Jonathan Dickenson State Park
Loxahatchee River
Jupiter Inlet

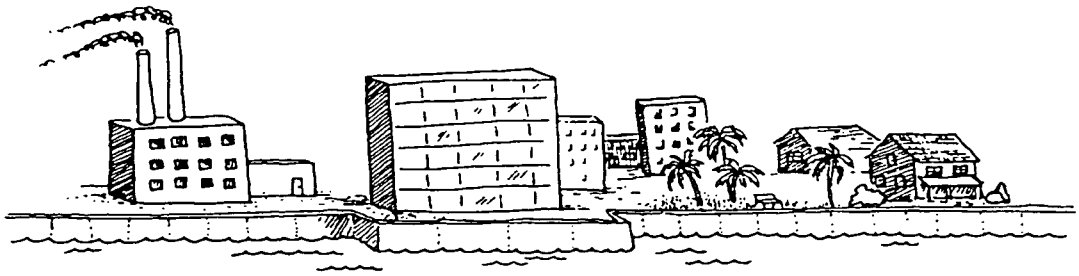
Lesson 4

The plants growing along the lagoon's shore are very important to its health. Mangrove swamps and salt marshes cleanse the water flowing through them before it reaches the Indian River Lagoon.

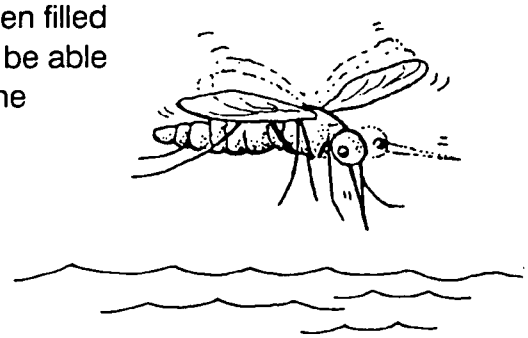


As water slowly passes through the swamps and marshes, mud and silt can settle out. The fast-growing marsh plants absorb excess nutrients that could cause problems for the Indian River Lagoon. Mangroves and salt marshes also provide a nursery area for young organisms and a food source for many of the animals that live in the lagoon.

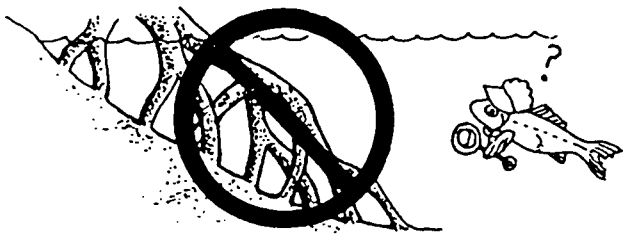
These important habitats are disappearing.



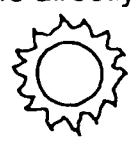
Marshes and swamps are shallow and many have been filled with soil to make new land for houses and industry. Thousands of acres of black mangroves were lost by the construction of mosquito impoundments. This was a method used to control mosquito populations. Dikes were built around high mangrove marshes and then filled with water so that the female mosquito would not be able to find any moist soil on which to lay her eggs. The roots of the black mangroves were covered with water and the trees suffocated.



The loss of mangroves and marsh grass removes some important producers from the lagoon's food chains and reduces the estuary's ability to function as a nursery. How would this affect the fish that live in the lagoon?..... the clams?..... Would it affect all of the animals?.....

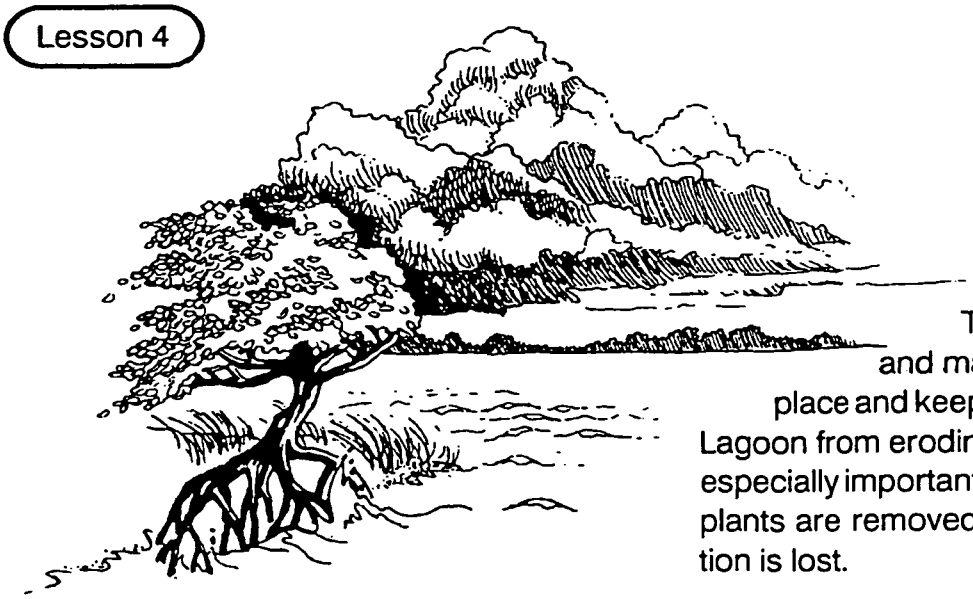


When these marshes and swamps are gone, turbid (cloudy) water flows directly into the lagoon. What does this do to the seagrass?.....



If the seagrass dies, who will be affected?.....

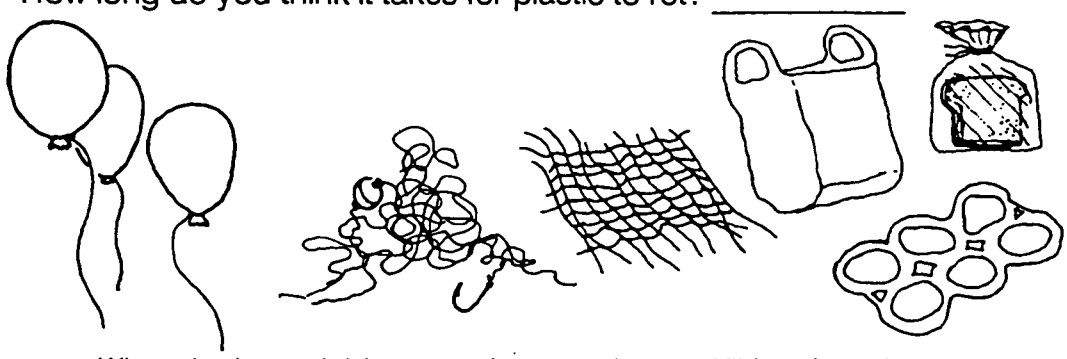
Lesson 4



The roots of the mangroves and marsh grasses hold the soil in place and keep the shore of the Indian River Lagoon from eroding, or washing away. This is especially important during storms. When these plants are removed, valuable shoreline protection is lost.

Litter is a problem on the spoil islands and throughout the lagoon. To many animals, litter looks like food. A floating plastic bag looks like a jellyfish to a hungry sea turtle. If large pieces of plastic are eaten, the animal's stomach becomes lined with it. This prevents digestion, and the animal will starve. Another type of litter which can be deadly to animals is discarded fishing line and nets. Animals can become trapped which may result in death from drowning, starvation, or strangulation.

How long do you think it takes for plastic to rot? _____



When plastics are left in or near the water, they can kill for a **long** time.

With the increasing numbers of people using the Indian River Lagoon and its resources there is a need for conservation. **Conservation** is the protection and sensible use of our natural resources, such as forests, animals, and estuaries. In order to protect the Indian River Lagoon we need to understand how it works, how the lagoon's plants and animals are dependent on each other. We also need to know how people affect the lagoon through their activities. This information is collected through scientific research. After the information is collected it needs to be shared with people through education.

How can information about the Indian River Lagoon be shared? List at least three ways.

1._____ 3._____

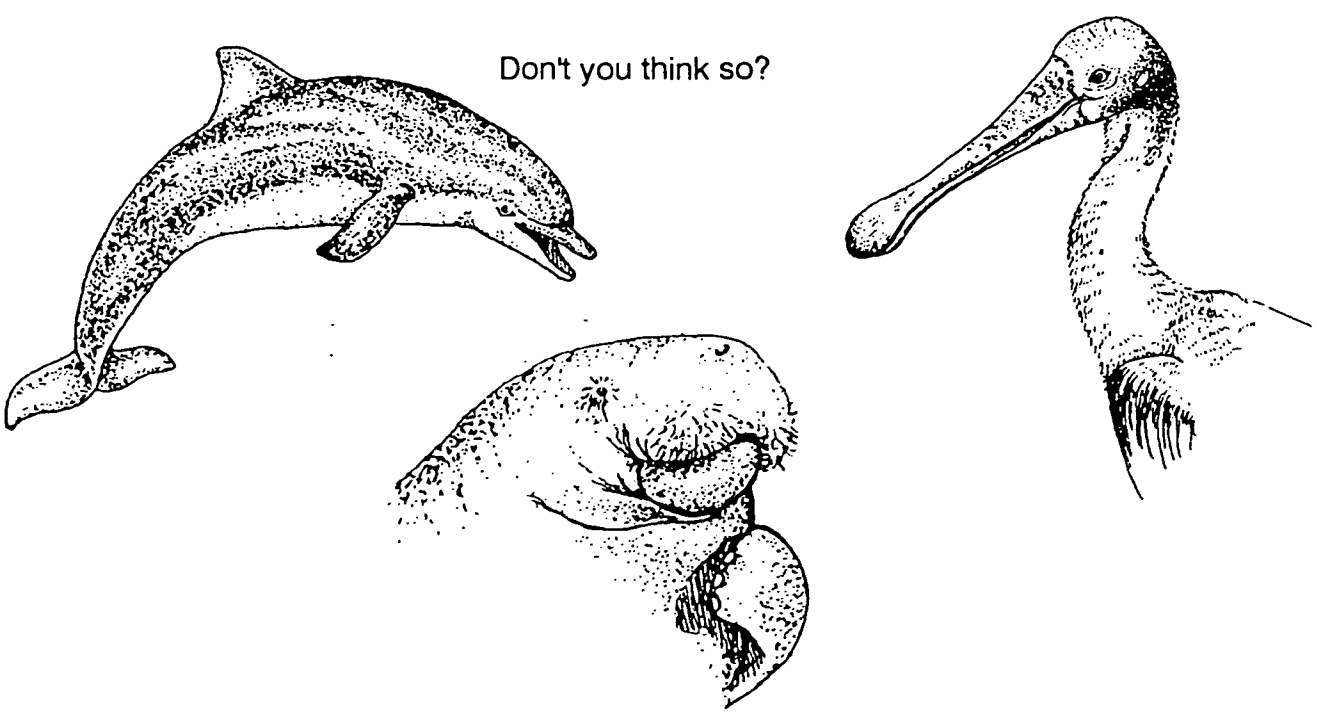
2._____ 4._____

Will you help spread the news?

Gaining more knowledge about our natural resources can help us to conserve them better. An example of this is the establishment of the Florida Aquatic Preserve Program. As people realized the importance of estuaries they felt these special areas deserved better protection. As a result of this concern much of the Indian River Lagoon, Banana River and Mosquito Lagoon have been designated as aquatic preserves.

Aquatic preserves are exceptional (special) areas of submerged (underwater) lands and associated waters to be maintained in their natural condition. The aquatic preserves are managed by the Florida Department of Natural Resources for the people of Florida. The Florida DNR has special rules to protect the mangroves, seagrasses, and other plants and animals that live in the aquatic preserves.

In order for us to assure the Indian River Lagoon and its inhabitants a place in Florida's future, we may have to refrain from doing certain things. There may be many areas where we have to reduce our boat speed to save the manatee, or places where we can't build a dock or dredge in order to protect seagrasses. When we take care of the lagoon and its plants and animals by giving a little, we receive much in return.



Lesson 4

What's Wrong?

Study the picture on the next page. Name at least 5 things wrong with this picture.

1. _____ 5. _____

2. _____ 6. _____

3. _____ 7. _____

4. _____ 8. _____

What Can We Do?

Along with the privilege of enjoying the Indian River Lagoon comes the responsibility of taking care of it Write down ways people can make the Indian River Lagoon a better place for plants and animals to live and for people to enjoy.

1. _____

2. _____

3. _____

What are some things your family could do?

1. _____

2. _____

3. _____

(Take these home and share them with your family.)

What can **you** do?

1. _____

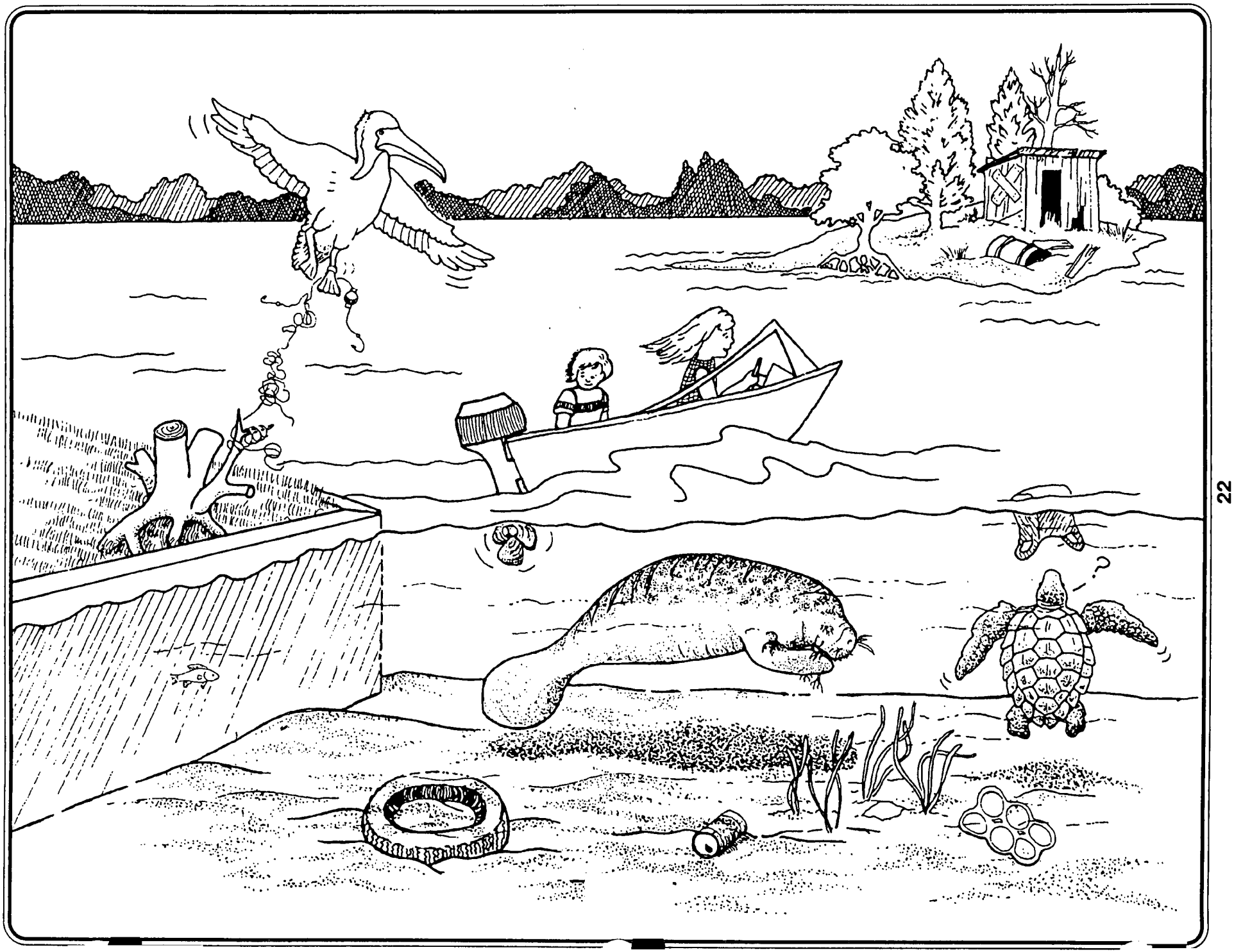
2. _____

3. _____

4. _____

"What can I do???
I am only one,
But I am one.
I cannot do everything,
But I can do something."

- Anonymous



Glossary

aquatic: growing or living in water.

brackish: a mixture of freshwater and saltwater.

coastal: near the ocean.

conservation: the protection and sensible use of our natural resources, such as forests, animals, and estuaries.

consumer: an organism that obtains its food from eating plants or other animals.

crustaceans: a large class of animals, usually living in or near the water, that have a hard crustlike shell (exoskeleton). This group includes lobsters, crabs, and shrimp.

decomposers: organisms that break down dead plant and animal material.

detritus: a mixture of decaying plant and animal remains covered with microorganisms.

endangered: an organism that's in immediate danger of becoming extinct.

estuary: a body of water where fresh and saltwater meet and mix.

extinction: when a species of animal or plant no longer exists. It has been lost forever.

food chain: the flow of energy from: the sun to plants→plant eaters→meat eaters.

food web: an interlocking group of food chains.

habitat: the area where an organism is supplied with food, water, shelter, and space.

herbicide: a substance used to kill plants.

invertebrate: an animal without a backbone.

juvenile: an immature (young) organism.

lagoon: a shallow body of water protected from the ocean by barrier islands.

larvae: the early stages of any animal that differs in form and appearance from the adult.

life cycle: the continuous sequence of physical changes that an organism passes through, from a fertilized egg to an adult that can reproduce.

nursery: a place where young animals can find food and hide from predators.

nutrients: elements necessary for life and growth.

organism: a living person, animal, or plant.

plankton: microscopic plants and animals that float in the water.

pesticides: a chemical used to kill pests, usually insects and rodents.

predator: an animal that captures and eats other animals.

prey: an animal hunted and killed by another animal for food.

primary producers: green plants that use sunlight, water, and nutrients to manufacture food.

scavengers: organisms that feed on whatever food they can find; live or dead animals and plants.

secondary consumers: animals that eat the primary consumers. They are the third level of the food chain.

sediments: fine particles such as sand, silt and clay.

shellfish: an aquatic animal such as a clam or oyster, having a shell or shell-like covering (exoskeleton).

spawn: to produce or deposit eggs.

species: a category given to a population of individuals that are more or less alike, and that are able to breed and produce fertile offspring.

spoil islands: islands that were formed when the intracoastal waterway was dug; soil was removed from the bottom of the lagoon and placed next to the channel.

top predators: consumers that are at the top of the food chain that are not hunted by other animals. Most top predators have only one enemy - People. We may not eat all top predators, but we can kill or harm them by polluting or destroying their habitat.

tertiary consumers: animals that eat the secondary consumers. They are sometimes called the top predators.

turbidity: a clouding of water caused by sediments.

Organism Checklist

Directions: Put a ✓ by each organism you find.

jellyfish _____

sea squirt _____

Mollusks:

clam _____

sea hare _____

oyster _____

snail _____

Crustaceans:

arrow shrimp _____

barnacle _____

beach hopper _____

blue crab _____

broken-back shrimp _____

fiddler crab _____

grass shrimp _____

hermit crab _____

horseshoe crab _____

mangrove crab _____

pink shrimp _____

spider crab _____

Fish:

anchovies _____

filefish _____

flounder _____

goby _____

mojarra _____

mullet _____

pigfish _____

pinfish _____

pipefish _____

puffer _____

seahorse _____

seatrout _____

sheepshead _____

snapper _____

stingray _____

others _____

Birds:

cormorant _____

egret _____

great blue heron _____

gull _____

osprey _____

pelican _____

wood stork _____

others _____

Plants:

algae _____

manatee grass _____

shoal grass _____

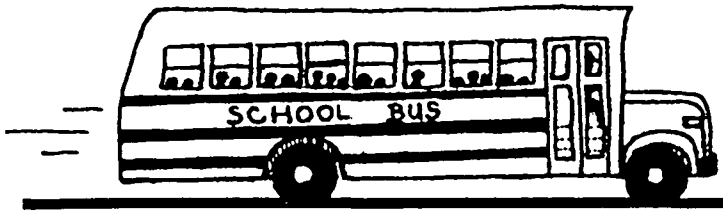
turtle grass _____

black mangrove _____

red mangrove _____

white mangrove _____

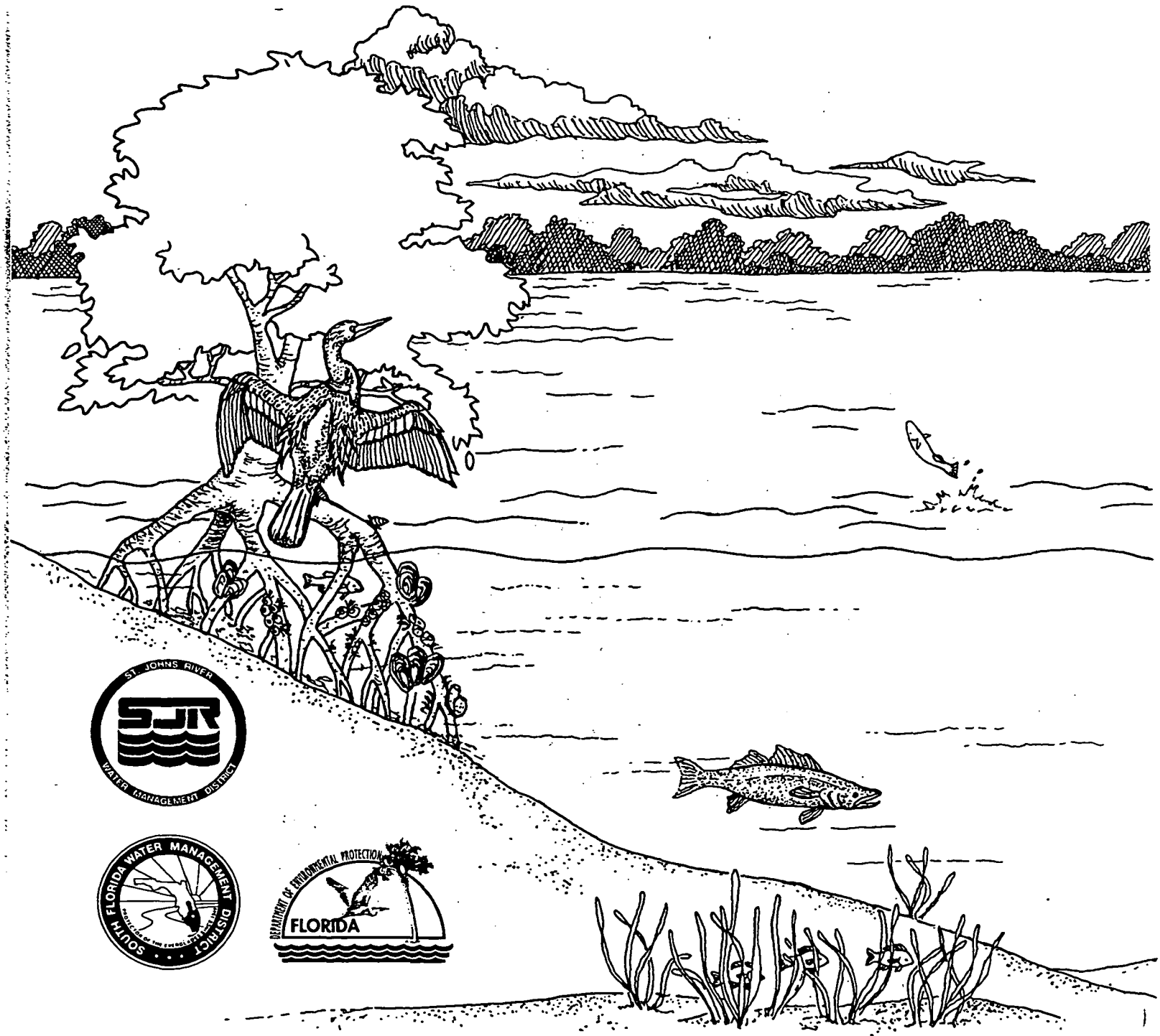
others _____



BINGO

Pine Tree	Litter	A Person Fishing	Source Of Water Pollution	Bridge or Causeway
A Building Over Two Stories High	Creek or River	Vulture	Palmetto	Trashcan
Motorboat	Flower	**Free Space**	Estuary	Source Of Air Pollution
Camper	Telephone Pole	Mammal	Bird Sitting On Wire	Fruit Tree
Heron or Egret	House	Cabbage Palm	Ocean	Sailboat

Directions: When studing nature it is very important to use your power of observation. To get 'warmed up', play this Bingo game as you ride to the field trip site. When you see these objects mark an **X** in the right square.



For more information contact:

FL Department of Environmental Protection
Bureau of Submerged Lands and Preserves
1801 S. Hillmoor Dr., Suite C-204
Port St. Lucie, FL 34952 (561) 871-7662

South Florida Water Management District
P.O. Box 24680
West Palm Beach, FL
(561) 686-8800

St. Johns River Water Management District
1900 S. Harbor City Blvd., Suite 107
Melbourne, FL 32901
(407) 722-5363

Appendix D

Easily Recognized Mosquitoes of St. Lucie County

EASILY RECOGNIZED

MOSQUITOES

OF FLORIDA

Hedvig Tetens Evans

ST. LUCIE COUNTY
MOSQUITO CONTROL DISTRICT
3150 Will Fee Rd., Ft. Pierce, FL 34982
407-468-1691

Mosquitoes belong to the ORDER of insects called DIPTERA (the two-winged insects).

They are divided into GENERA, and the genera are divided into SPECIES.

When you see a Latin name of a mosquito the genera is the first name and always written with a capital = Culex, the second name is the species name = nigripalpus.

We are mainly dealing with 5 genera of mosquitoes:

ANOPHELES: slender, with spotted wings. Rests at an angle to the surface.

AEDES: small to medium size. Some bite in the day-time, but most species are active during dusk and dawn.

PSOROPHORA: large to very large mosquitoes.

MANSONIA: medium to large. They are 'fat"-looking and coarse, wing scales are so large that they can be seen with very slight magnification.

CULEX: small to medium size mosquitoes. They are mostly light-colored, brownish-yellowish without special markings.

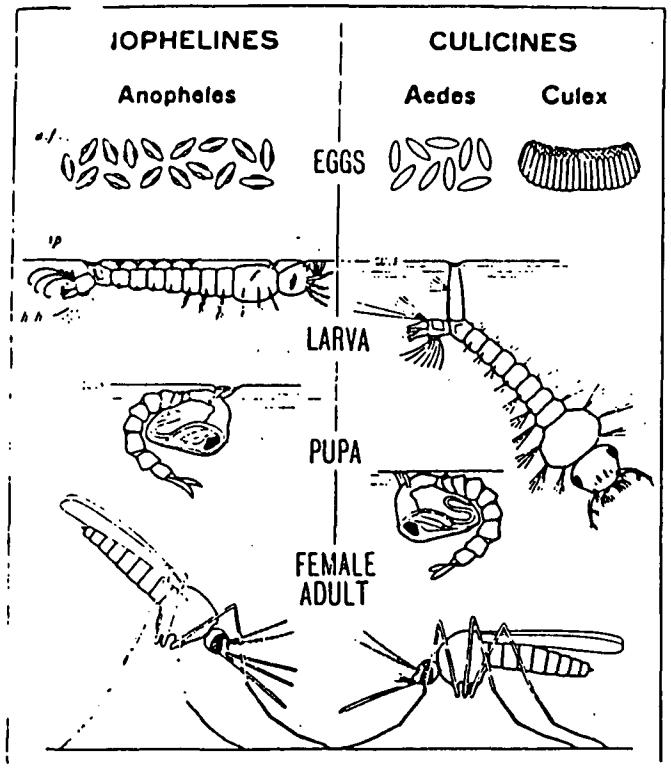
Other Genera

Wyeomyia: Tiny mosquitoes. They are found in heavily vegetated areas especially around airplants.

Toxorhynchites: Huge mosquito with brilliant iridescent colors.

Deinocerites: medium size, lives in and near crabholes.

Uranotaenia: Tiny mosquitoes, with a magnifier, iridescent blue scales may be seen in a line on the wings and on the body.



EGGS

Only few kinds of mosquito eggs are easily found:

Culex lay masses of eggs that stick together in small boat-shaped groups that floats on top of the water. The individual egg is banana-shaped, white when just laid, but soons turns dark.

In treeholes, tires, airplants and artificial containers, Toxorhynchites eggs are found as small white 'ping-pong' balls, floating in the water-surface.

The eggs of the following genera are difficult to find:

Anopheles lay eggs singly on the surface of fairly clean water.
Aedes and Psorophora lay single eggs in crevasses in moist soil or leaf litter or humus in depressions which will hold water after rains or tides.
Mansonia lay masses of eggs stuck to the underside of leaves of water plants (water lettuce).
Wyeomyia drop single eggs on the inner surfaces of air plants.

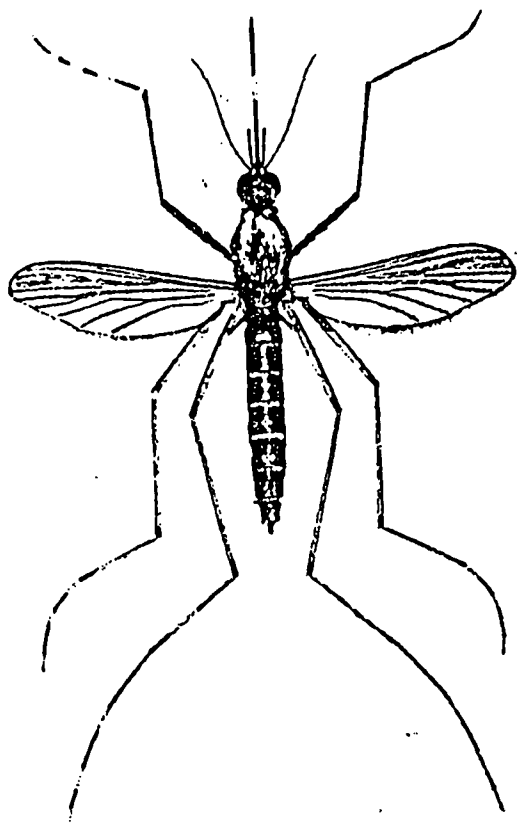
LARVAE

1. Culex often with long airtubes.. Usually light brown in color. Head often looks large.
2. Aedes and some Psorophora very short airtube. Dark colored, with fairly small heads. Often found in dense masses (Aedes taeniorhynchus)
3. Robust larvae with short airtubes. Head distinct and square. Psorophora species which eat other mosquito larvae.
4. Anopheles are very slender larvae with no visible airtube. They lie in the surface and do not readily dive, but scoot along the surface.

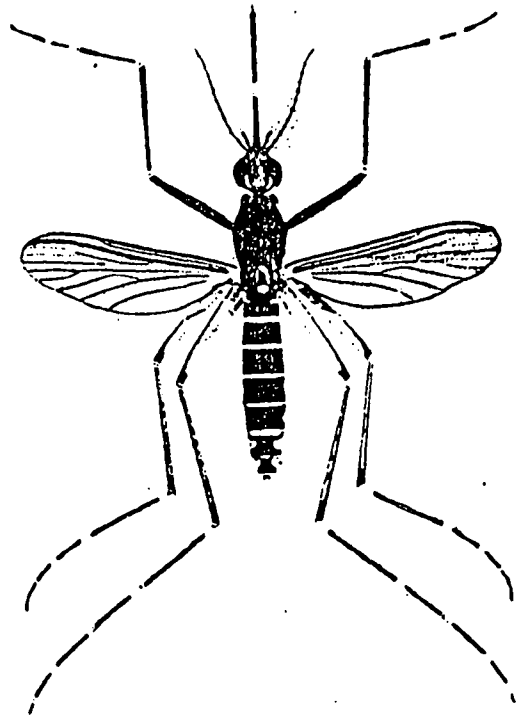
5. Mansonia larvae attach to stems and roots of water lettuce. Their airtube has been formed as a thorn by which they attach.

ADULTS FOUND ON THE BEACHES AND SOMETIMES JUST WEST OF THE INDIAN RIVER

1. Aedes sollicitans -- the golden saltmarsh mosquito. A fairly large mosquito, often flying up from grass along road sides or other open, sunny areas. Its general coloration is golden. It has a band on the proboscis, wide bands on the tarsi and a light colored stripe down the back of the abdomen.

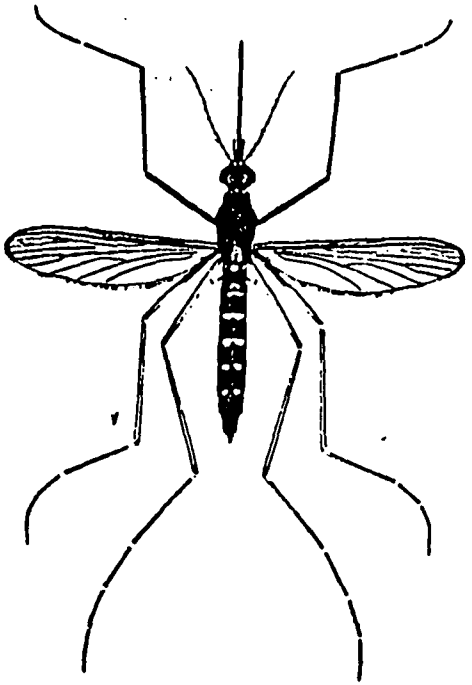


2. Aedes taeniorhynchus -- the black saltmarsh mosquito. Small to medium, dark species, especially found in shady places. It has a distinct white band on proboscis and small white bands on the tarsi. The abdomen has white bands, but no stripe down the center.

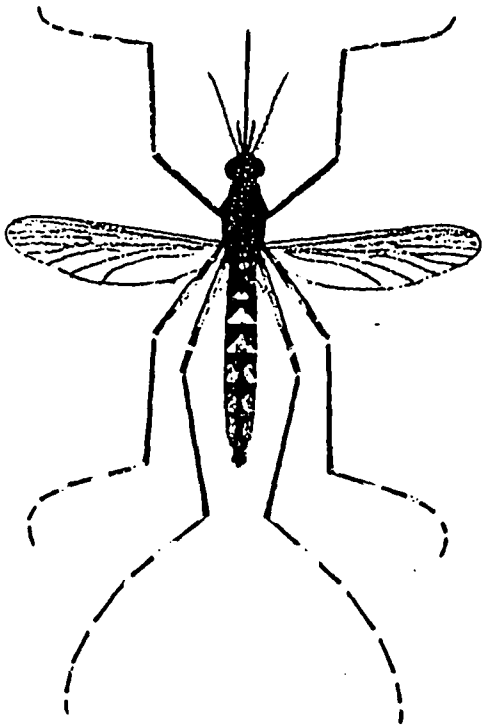


INLAND MOSQUITOES
FOUND IN GROVES AND PASTURES

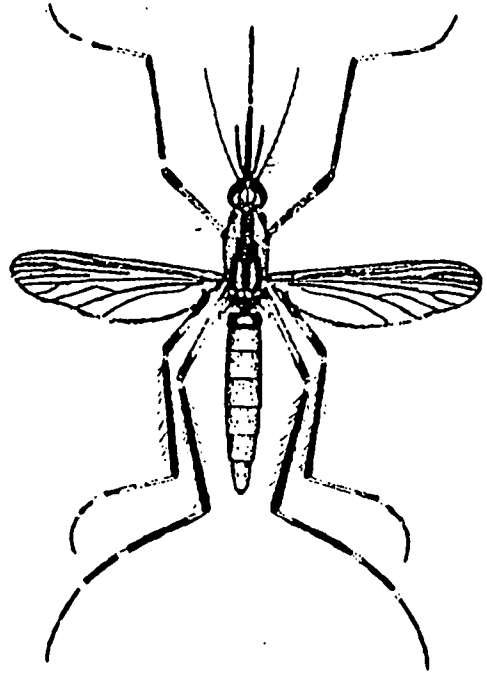
1. Aedes vexans -- the grove mosquito. It is similar to Ae. taeniorhynchus, but has no band on the proboscis, the bands on the tarsi are very narrow, and the bands on the abdomen are indented in the middle, not straight as in Ae. taeniorhynchus.



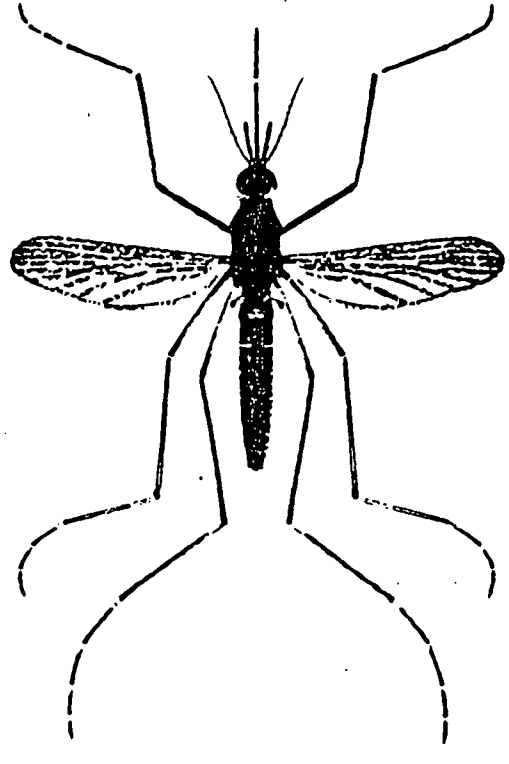
2. Psorophora columbiae -- the Glades mosquito. Fairly large, black mosquito with clearly marked bands on legs, with a small band near "elbow" on femur, and speckled front legs (can be seen with magnification). It has an indistinct wide band on proboscis.



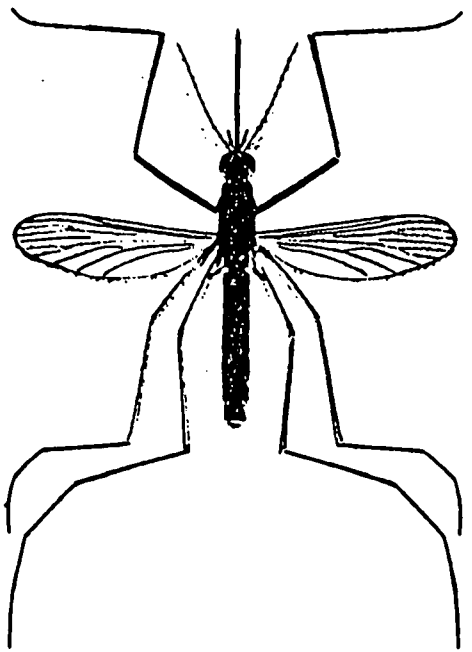
3. Psorophora ciliata -- the Gallinipper. Very large mosquito, straw-colored with a golden stripe down the back of thorax. The legs have bands, but more noticeable is that they are decorated with large erect dark scales, giving them a 'fuzzy' appearance.



Mansonia species -- medium to large mosquito. It looks robust, has a stubby squared-off tip of abdomen. It looks coarse with a handlens, the wing scales are like plates insteas of hair-like scales on other mosquitoes. The legs are banded.

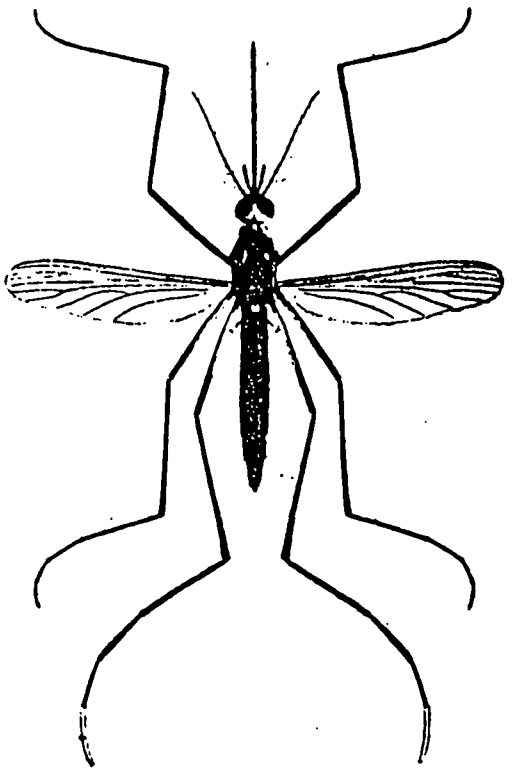


4. ex species -- small to medium size. They have no special markings, are often light-brown or greenish in color. They usually do not bite man, but prefer birds. They breed in polluted water, ditches, artificial containers, groves. They are common throughout the county/

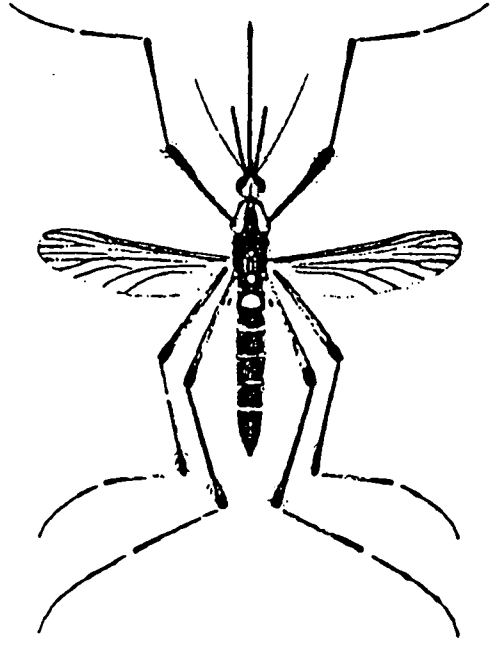


HAMMOCKS AND OTHER HEAVILY WOODED AREAS

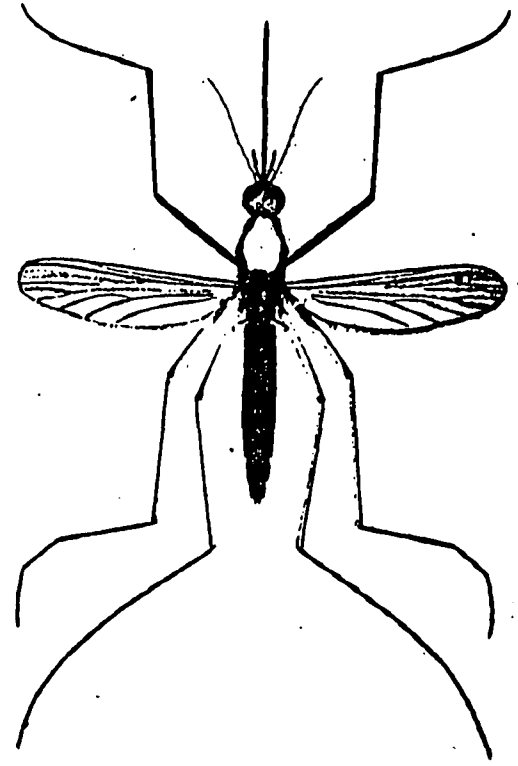
1. Psorophora ferox -- the white-footed mosquito. It is medium to large, black with bluish reflecting scales. It has no bands on proboscis or legs, but white hind feet, which are easily seen when it bites.



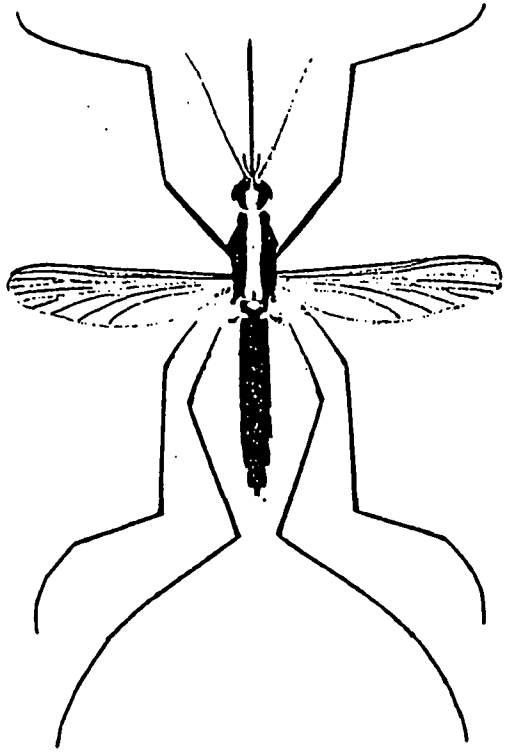
2. rophora howardii -- very large mosquito with bluish reflecting scales and white markings on thorax. There is no band on proboscis, but legs have indistinct bands, and they look 'fuzzy', but not as fuzzy as the legs of the gallinipper.



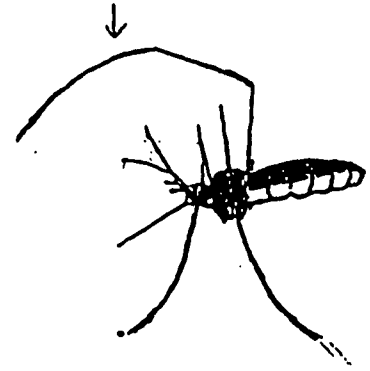
3. Aedes infirmatus -- medium size black mosquito with no bands on proboscis or legs, the abdomen is black. Thorax has a wide, snow-white patch which is very easily seen with the naked eye.



4. Aedes atlanticus -- very similar to Ae. infirmatus but the thorax is decorated with a narrow light-colored mid-line.

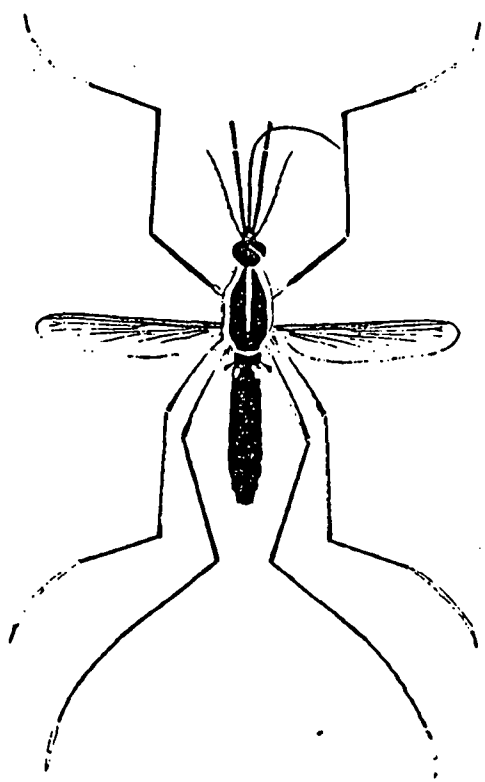


. Wyeomyia species -- the airplant mosquito. A very small mosquito with long legs, which it flings above its head when it bites you. Its coloration is mostly black, with white underside, there are no bands, but the middle pair of legs may have white tarsi, but it is difficult to see.



5. Toxorhynchites rutilus -- the good mosquito. It is huge, with bluish-reflecting and snow white scales. It has a long, strongly curved proboscis, adapted to feed on nectar in flowers. It does not take blood.

Its larvae feed on other mosquito larvae, and live in tires, tree holes and airplants. It is an effective mosquito control agent, and another species (Tox. amboinensis) is raised in the laboratory and distributed throughout the older part of town and areas with much water-holding debris.



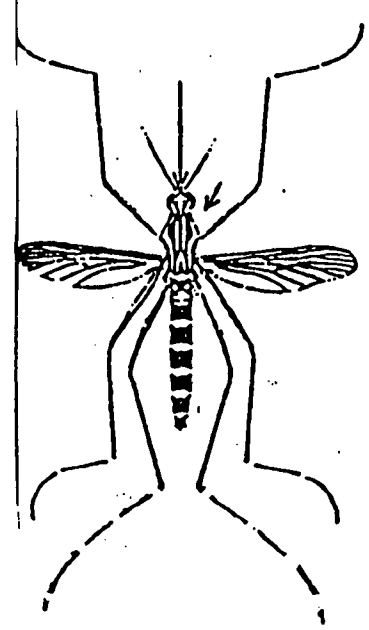
NEAR HABITATIONS

1. Aedes aegypti -- the yellow-fever mosquito. Small to medium size, black, but with silvery white lyre-shaped marking on thorax. At first glance it looks like the black saltmarsh mosquito, but it has no band on proboscis, and the last two segments on the hind feet are nearly completely white.

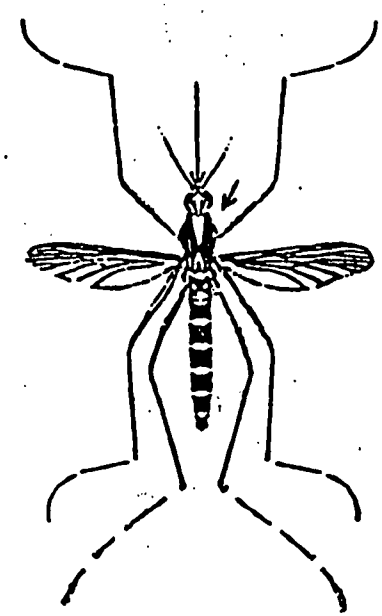
It often flies back and forth under a table or bench or other well-shaded places. It likes to rest inside buildings. It breeds in any small collection of water (flower pots, tires, etc.) It often bites the ankles.

2. Aedes albopictus -- the Asian Tiger mosquito. It is very similar to Ae.aegypti except that instead of the lyre-shaped figure on thorax, it has a V-shaped silvery line. It lives in the same places as Ae. asegyti. It has recently been introduced into the U.S. and has been found at several locations in St. Lucie County.

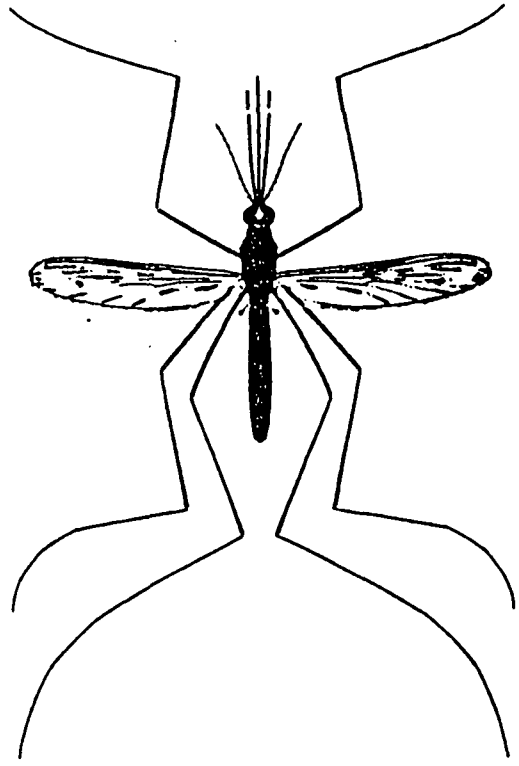
AEDES AEGYPTI

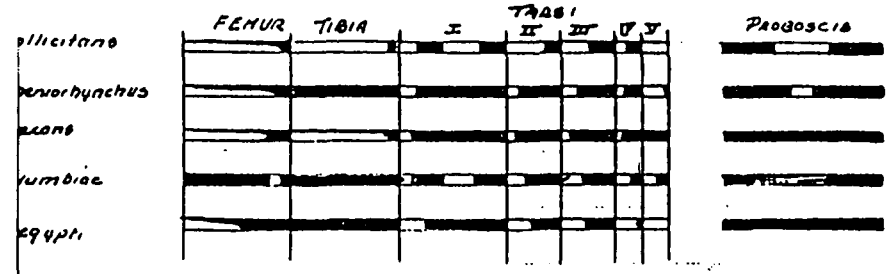


AEDES ALBOPICTUS



3. Anopheles species -- malaria mosquitoes. These are medium to large mosquitoes, slender looking and with markings on the wings. They rest (or blood-feed) with the abdomen raised at an angle to the surface (other mosquitoes keep the body parallel to the surface). See picture Page 3. They often rest in dark corners in sheds.





The table above may be a help when trying to separate the species with banded legs and banded proboscis.

Please note: Aedes sollicitans and Psorophora columbiae have two white bands on the first tarsal segment, but Ps. columbiae in addition has a distinct small band on the femur just before it joins the tibia.

Aedes taeniorhynchus and Aedes aegypti and Aedes albopictus have distinct bands on hind tarsi, but Ae. taeniorhynchus has a distinct band on proboscis, the two other species do not have bands on the proboscis.

Appendix E

Mosquito Disease Fact Sheets

A Florida Mosquito Control Factsheet

Human Malaria

C. D. Morris, Ph.D., R. H. Baker, Ph.D. & J. K. Nayar, Ph.D.

In June 1990, a human case of *Plasmodium vivax* malaria acquired in Florida occurred in a woman camping in the panhandle's Gulf County. This is the first, and only, acquired infection from a mosquito in Florida in 42 years. This factsheet was prepared in response to this case.

Although malaria disappeared as a significant problem in the US by the mid-1950's, it is still one of the most important communicable diseases on a worldwide basis (Figure 1). There were an estimated 489 million cases worldwide in 1986, of which 2.3 million were fatal (Sturchler, Parasitology Today 5:39)

Malaria in humans is a disease caused by any one of four species of microscopic protozoan parasites in the genus *Plasmodium* (*P. vivax, P. falciparum, P. malariae* and *P. ovale*) distributed throughout the world.

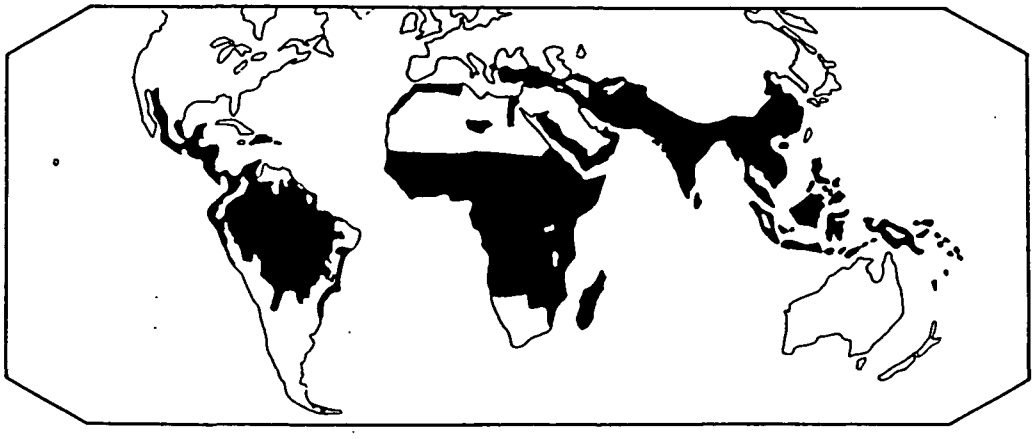


Figure 1. Worldwide distribution of malaria.

Overall symptoms may start with headache, aching in the bones, anorexia, and sometimes vomiting. One may feel like the flu is coming on. This is followed by chills, teeth chattering and then sensations of great heat with high fever and sweating, usually in a repeating cycle. If you experience these symptoms and have been in an area were malaria was reported, see your doctor immediately. Malaria can be treated effectively, particularly in the early stages.

Clinically, the malaria infection varies from a moderately severe to a highly fatal illness, depending on the species of parasite, the human's condition, and how soon the patient receives treatment. Malaria caused by *P. falciparum* is particularly severe and often fatal in infants and young children. *P. vivax* generally causes a less severe illness and a lesser rate of mortality. Persons may be infected over and over again, usually developing a tolerance for the parasite which prevents severe illness from reoccurring.

If insufficiently treated, a malaria infection may persist in a person for many months or years and have a continuing or periodically renewed ability to infect mosquitoes, often in the absence of symptoms or with a less severe illness. For *P. vivax* and *P. ovale*, parasites may persist in the liver cells for years and give rise to relap-

ses of the disease by reinvading the red cells during times of stress.

HOW MALARIA IS TRANSMITTED BY MOSQUITOES

The parasite is transmitted from person to person by the bite of *Anopheles* mosquitoes, and ONLY *Anopheles* mosquitoes (Figure 2). The malaria parasite inhabits the human red blood cells, where it multiplies asexually. After reaching maturity in 48-72 hours, the red blood cells burst and release large numbers of new parasites most of which enter new red blood cells; thus, reinitiating the cycle. Others enter liver cells. Before the asexual cycle in the human red cells is established, the parasite must complete at least a 5-10 day period of multiplication in liver cells. The typical malaria symptoms, chills and fever, are associated with this rupturing of infected red cells.

In addition to these asexual forms in humans, some of the parasites develop into sexual forms: the male and female gametocytes. Infection of the mosquito takes place when an *Anopheles* female feeds on an infected person who is carrying gametocytes. The parasite then undergoes a sexual cycle in the mosquito for the next 7-20 days. Numerous microscopic, spindle-shaped forms, known as sporozoites, then invade the mosquito salivary glands. The human infection is initiated when sporozoites are injected during the bite of the infected mosquito.

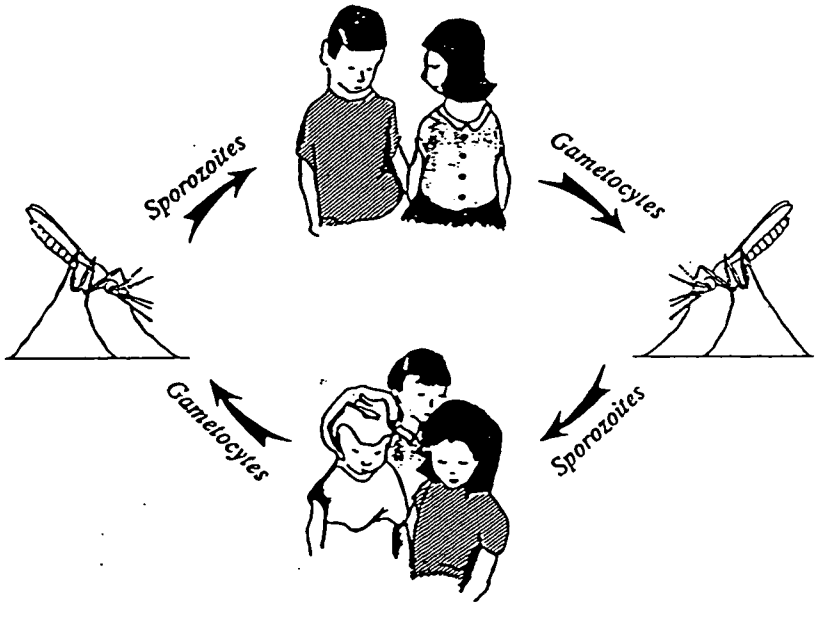


Figure 2. How malaria is transmitted (From CDC, 1989).

INTRODUCED MALARIA

Up to now, the only hazard of malaria transmission in Florida stems from people who have relapses, or cases recently acquired in foreign countries where malaria is common. This is referred to as introduced malaria. Despite the widespread presence of *Anopheles* mosquitoes in the US, a highly susceptible human population, and the importation of thousands of cases of malaria acquired overseas, there are relatively few cases reported in the US each year, and very few of those reported were actually infected in the US.

The CDC Annual Summary of Malaria for 1988 (issued in November 1989) reports a total of 1,023 malaria cases in the US. Only 32 of these acquired the infection in this country, none in Florida. Six were fatal. This compares to 932 cases reported in the US in 1987. The geographic distribution of malaria cases in the US during 1988 is shown in Figure 3. In that year, 49 cases of malaria were reported in Florida. However, unlike the case reported in 1990, all the infections were acquired outside the US. They didn't become ill until returing to Florida.

The largest outbreak of introduced malaria since 1952 recently occurred in San Diego County, California. Of the 30 cases between July 24 and September 18, 1988, 28 were in migrant workers and 2 were in local residents who had no apparent malaria risk factors.

FLORIDA'S ANOPHELES MOSQUITOES

Of the 70 species of mosquitoes occurring in Florida, 13 are in the genus *Anopheles*. It is easy to recognize adult *Anopheles* mosquitoes by the way they rest on a flat surface, like the skin. Unlike mosquitoes of other genera, *Anopheles* rest with their heads pointed downward and their bodies slanted at a steep angle upward (Figure 4). Other mosquitoes hold their bodies parallel to the resting surface.

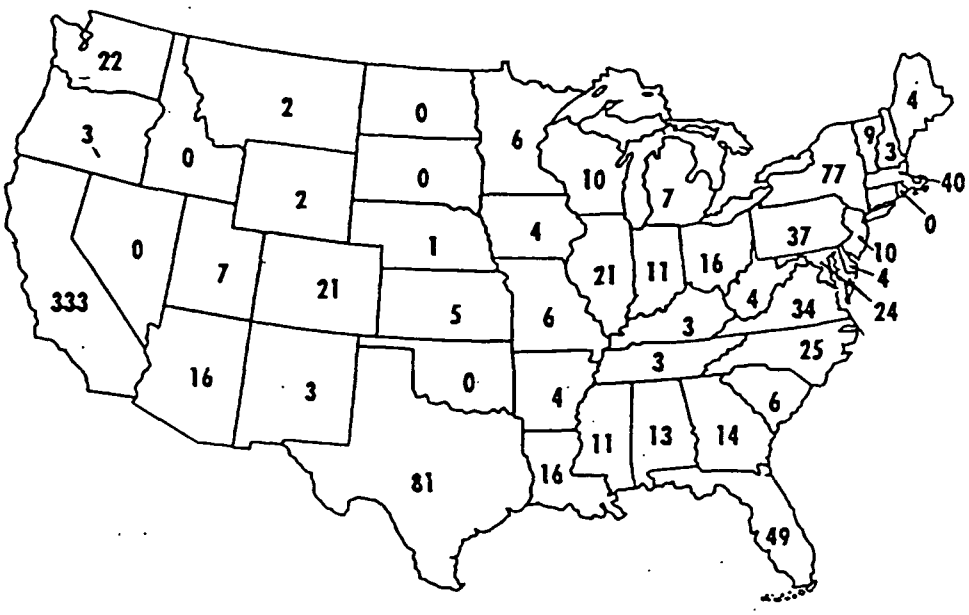


Figure 3. Distribution of introduced malaria cases in the US during 1988.

Anopheles adults also have 3 long mouth parts protruding from the head. Other mosquitoes have 1 long and 2 short mouth parts (Figure 4). The immature stages of *Anopheles* are not easily recognized in the water, as the larvae lie near the surface and are easily confused with floating debris.

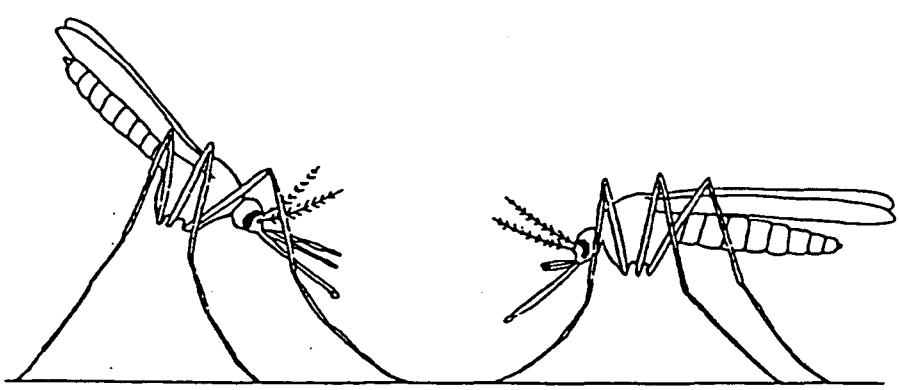


Figure 4. *Anopheles* female on the left, a non-*Anopheles* female on the right.

While all *Anopheles* may be able to transmit malaria, historically, those belonging to the *Anopheles quadrimaculatus* complex of 4 species are considered the important carriers of the disease in the eastern US.

Anopheles quadrimaculatus adults are dark with 4 spots on each wing. They typically breed in permanent bodies of fresh water, e.g. lakes, containing emergent or floating vegetation. The eggs are laid singly on the surface and breeding is continuous if the temperature permits. During cold periods adult females hibernate in protected sites. They feed primarily on large mammals, including humans, mostly at dusk and during the night. They typically do not fly more than 4 miles from their breeding sites. Although species of this complex are most abundant in the northern and panhandle sections of the state, one or more species probably occur in all Florida counties.

AVOIDING MALARIA MOSQUITOES

To avoid the risk of malaria, avoid mosquito bites - it is that simple. Humans cannot get malaria from wild animals, domestic animals or pets. Transmission of malaria from human to human is accomplished by *Anopheles* mosquitoes or by reuse of needles contaminated with the blood of an infected person.

Avoid mosquito bites by staying out of mosquito infested areas, securing window screens, and by applying a repellent containing DEET. Most repellents on today's market contain DEET. DO NOT OVER-APPLY DEET-containing repellent, as this may cause side effects. Some adults have skin reactions to overexposure to DEET, and, in rare cases, children dosed heavily have experienced serious neurological problems, including slurred speech, confusion, seizures and comas. Misapplication of DEET can lead to symptoms similar to malaria and the result could be worse than malaria. **PLEASE USE DEET WITH CAUTION.**

NEED MORE INFORMATION . . .

. . . on malaria in Florida? Contact the Florida Department of Health and Rehabilitative Services.

. . . on mosquito control in the state? Contact the mosquito control program in your county,or **Dr. Charlie Morris, Extension Medical Entomologist, Florida Medical Entomology Laboratory, IFAS - University of Florida, 200 9th Street, SE, Vero Beach, FL 32962, 407/778-7200, or William Opp, Entomology Services, Mosquito Control Section, Department of Health and Rehabilitative Services, P.O. Box 210, Jacksonville, FL 32231, 904/798-4597.**

About the authors:

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Sponsored by the Florida Medical Entomology Laboratory, IFAS-University of Florida and Entomology Services, Mosquito Control Section, Florida Department of Health and Rehabilitative Services.

July, 1990

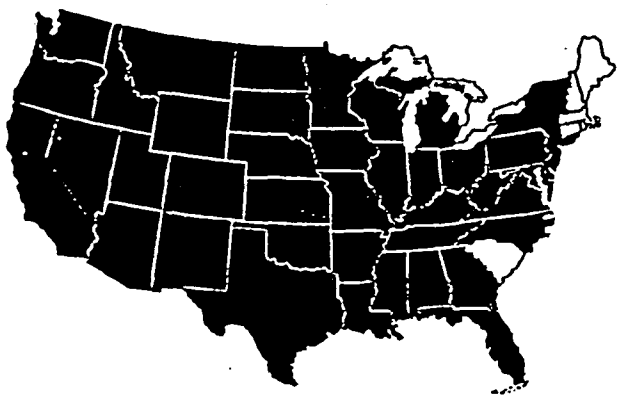
A Florida Mosquito Control Factsheet

SAINT LOUIS ENCEPHALITIS - A FLORIDA PROBLEM

Donald A. Shroyer, Ph.D., Florida Medical Entomology Laboratory

St. Louis encephalitis, abbreviated SLE, is the mosquito-transmitted virus disease that is generally considered to be of greatest medical importance in North America. SLE was first recognized in 1933 (in St. Louis, Missouri), and epidemics have occurred sporadically and unpredictably in the subsequent decades. During epidemics large numbers of people become seriously ill, sometimes fatally. Major SLE epidemics occurred in Florida in 1959, 1961, 1962 and 1977. SLE virus also occurs in Central and South America, but rarely causes human disease in those regions.

It is important to distinguish between the human disease that we call SLE, and the mosquito-transmitted virus that may cause such disease. Even during epidemics, only a small proportion of individuals actually infected with SLE virus become ill. SLE VIRUS is more common and widely distributed than SLE DISEASE. The virus is a permanent resident of Florida and can be found in some south Florida counties nearly every year.



Historic distribution of SLE in the U.S.

However, the causes of epidemics of SLE disease are not known with certainty. Different strains of SLE virus vary substantially in their ability to cause disease. This suggests that epidemics might be caused by the local appearance of a "hot" strain of virus. Risk of epidemics increases when there are exceptionally large numbers of mosquitoes that are capable of transmitting SLE virus.

DISEASE IN MAN

The occurrence and severity of SLE in man is strongly dependent on age. During epidemics, incidence of disease in people older than 60 is generally 5-40 times greater than in those less than 10 years old. Frequency of encephalitis (the most severe symptom associated with SLE) is also age-dependent, increasing from 56% for those age 20 or younger, to 87% for those over 60. Risk of death shows the same trend. Mortality is 7-24% among those with SLE and over 50, and less than 5% for those under 50. It is not uncommon for those surviving severe cases of SLE to suffer long-term residual neurological damage (known as "sequelae"), which may include paralysis, memory loss, or deterioration of fine motor skills.

It bears repeating that substantial numbers of people are infected with SLE virus, but do not

develop recognizable disease. However, those who do become ill face a very serious threat to life. The incubation period from the infective mosquito bite to the first symptoms of SLE is 4-21 days.

TRANSMISSION CYCLE OF SLE VIRUS

The TRANSMISSION CYCLE leading to SLE epidemics is thought to accompany infection of various species of wild birds. A bird infected by the bite of a mosquito can later produce enough virus in its blood to infect other susceptible mosquitoes that might feed upon it. It takes 1-2 days after infection for the bird to produce significant quantities of virus in its blood, and this virus rapidly disappears 1-3 days later as the bird recovers from the infection. Thus, there is a narrow "window of opportunity" for the mosquitoes to pick up the virus and then further spread ("amplify") it. After experiencing one SLE infection, an individual bird is forever immune from another SLE infection. SLE virus is not known to cause disease in birds, and birds cannot infect one another.

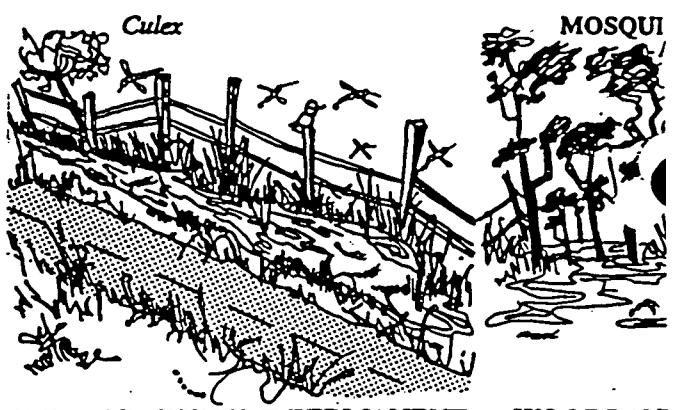
Under suitable conditions, SLE virus is sufficiently amplified in local bird populations that virus is by chance also transmitted to man and other incidental hosts of the virus. Although SLE virus can produce severe disease in man, humans are poor hosts of the virus; they produce little SLE virus in the blood and are "dead ends" for further virus transmission. As ever greater numbers of susceptible birds recover from SLE infections and become immune, new infections in mosquitoes dwindle. Since mosquitoes are short-lived, mosquitoes with "old" SLE infections rapidly disappear as well, and the epidemic rapidly ends.

The TRANSMISSION CYCLE described above is just one part of the largely unknown, annual LIFE CYCLE of SLE virus in Florida. We know that the virus is maintained in parts of Florida even in years when we do not detect the virus in birds and mosquitoes.

There are mosquito species in Florida that are not suspected of playing a part in the TRANSMISSION CYCLE leading to epidemics, yet may nonetheless be important in maintaining the SLE virus LIFE CYCLE. The role small mammals, such as rodents, play in maintaining virus is also unknown.

VIRUS INFECTION OF MOSQUITOES

Unlike birds and man, mosquitoes infected with SLE virus remain infected for life. Fortunately, that life rarely exceeds a week or two. It is surprisingly difficult for an individual mosquito to become infected with SLE virus <u>and</u> transmit that virus by biting another bird or man. Much



has to happen before a mosquito can be converted from an uninfected mosquito to a dangerous transmitter of SLE virus.

Not all of the 70 mosquito species that occur in Florida are equally susceptible to infection with SLE virus. Some are incapable of ever transmitting this virus. When a susceptible mosquito takes a blood meal from an infected bird, its stomach cells become infected. After a few days, the virus goes on to infect other organs, including the salivary glands. When salivary glands begin to produce SLE-enriched saliva, the mosquito has been transformed into a dangerous insect that can transmit virus to each host that it bites.

SUSPECTED MOSQUITO TRANSMITTERS

The mosquito *Culex nigripalpus* is a common Florida mosquito that has been linked to past SLE epidemics in the state. It is a highly efficient transmitter and its preference to take blood meals from birds favors its involvement in the SLE TRANSMISSION CYCLE in Florida. *Cx. nigripalpus* is a tropical species and does not occur in most of North America; other *Culex* mosquitoes serve as the principal SLE transmitters in northern states. Three of these, *Cx. quinquefasciatus, Cx. salinarius* and *Cx. restuans,* are common in Florida but have not, as yet, been implicated in SLE transmission in Florida.

During past Florida SLE epidemics, several additional mosquitoes were found infected in nature, but it is unknown whether these species are important transmitters. While it is currently believed that *Culex nigripalpus* is the most important SLE-transmitting mosquito in Florida, it is unwise to ignore the likelihood that other species also contribute to the SLE problem.

SEASONAL OCCURRENCE

SLE virus transmission to birds - and to man during epidemics - is most likely from August through November. Populations of *Cx. nigripalpus* also tend to reach their annual peak during this period. While it is impossible to reliably predict epidemic activity, transmission to birds in Florida seems to increase when long periods of drought are broken by subsequent heavy rains. Efforts to monitor SLE virus, and to control *Cx. nigripalpus* in Florida have traditionally focussed on August-November.

MONITORING THE PROBLEM

Many mosquito control districts or county health departments participate in a state-wide encephalitis surveillance program organized by the Florida Department of Health & Rehabilitative Services. This surveillance system was begun in 1978, with the hope that it would indicate when the threat of an SLE epidemic is especially severe. The same surveillance system also monitors another mosquito-transmitted encephalitis virus, Eastern Encephalitis, which is discussed in another IFAS/HRS Factsheet.

SLE virus activity is monitored by establishing "sentinel chicken flocks." Blood samples are taken from chickens in each flock on a regular basis and tested for the presence of antibodies to SLE virus. The presence of these antibodies indicates that the chicken recovered from a recent SLE infection acquired by a mosquito bite.

For a variety of reasons, a sentinel-based surveillance system cannot be expected to reliably predict the occurrence of an SLE epidemic. Unfortunately, the absence of infections in a small sentinel flock can provide a false sense of security. Although there is a need for more effective means of monitoring risk of SLE epidemics, the present sentinel chicken system can provide important evidence of seasonal and annual patterns of virus activity.

An often over-looked potential benefit of sentinel flocks is their value, not in predicting epidemics, but in confirming that a developing epidemic of encephalitis is due to SLE virus infection, and not to one of many other microorganisms that can cause encephalitis in man.

PREVENTION AND CONTROL OF DISEASE

There is no vaccine that can protect against SLE virus infection, and like all virus infections, SLE cannot be cured. Prevention must, therefore, concentrate on minimizing contact between man and potentially transmitting mosquitoes. This is usually done by suppressing populations of suspected transmitters of SLE virus. Unfortunately, *Cx. nigripalpus* uses a wide variety of semi-permanent or temporary water sources as larval habitats which are often difficult to find or eliminate.

Spraying to control adult populations is appropriate in certain circumstances, especially during an epidemic. Unfortunately, the explosive nature of epidemics often means that knowledge that an epidemic is underway may come only after peak transmission to man has already passed. This makes it nearly impossible to assess the effectiveness of emergency insecticide applications.

Need more information . . .

. . . on SLE and its control in Florida? Contact the mosquito control district in that county, or **Dr. Charlie Morris, Extension Entomologist, Florida Medical Entomology Laboratory, IFAS-University of Florida, 200 9th Street Southeast, Vero Beach, FL 32962, 407/778-7200.**

About the author:

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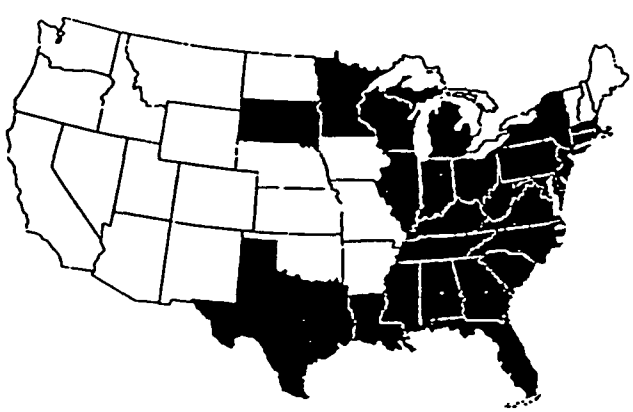
Sponsored by the Florida Medical Entomology Laboratory, IFAS-University of Florida and the State of Florida Department of Health and Rehabilitative Services, Office of Entomology Services.

August, 1990

Eastern Encephalitis - A Fatal Mistake

Charlie D. Morris, Ph.D., Florida Medical Entomology Laboratory

Eastern encephalitis, also called eastern equine encephalitis and abbreviated EE, is a fatal disease of humans and horses caused by a virus carried by mosquitoes. The disease occurs throughout the eastern United States and Canada from mid-July until first frost in the north, and during most of the year in Florida. Disease outbreaks are usually limited to 1-3 counties and typically occur every 5-10 years. In some locations, however, there may be horse cases every year. The virus that causes the disease is not normally found in either of these animals, thus the disease is truly an accident of nature.



Distribution of eastern encephalitis in the U.S.

Any Florida horse from Pensacola to Lake Okeechobee that is located near a freshwater swamp or marsh is at greater risk to EE. On the average there are 50-75 horse cases each year in the State. Over 90% of these animals would die if left alone. Mercifully, once a diagnosis is confirmed, most animals are destroyed.There are typically only one or two human cases each year in Florida. Unfortunately, many are fatal; and of those that do survive, nearly all have some residual effects, particularly mental impairment. There is no specific treatment or cure for EE in man or horses but there is a vaccine against the disease in horses.

THE CAUSE

The cause of eastern encephalitis is a virus called eastern equine encephalomyelitis. The virus is normally found only in wild song birds and mosquitoes that live in and around wooded swamps; not just any swamp, but a swamp where there is a certain species of mosquito. The EE mosquito or "black-swamp-mosquito" has the scientific name *Culiseta melanura* (cue-la-see-ta mel-ah-nur-ah).

The virus does not usually cause disease in wild birds, although it may cause a temperature, and perhaps a minor illness similar to a cold or flu in a human. It does not affect the mosquitoes in any way.

MOSQUITO CULPRITS

Culiseta melanura, which translates to "curly black hairs," is indeed a dark mosquito that has a very long proboscis or probe that it uses to draw blood from its hosts. *C. melanura* has very specific breeding requirements. It occurs in most states east and a few states west of the Mississippi River. The larvae are found only in the underwater root systems of deciduous trees that grow in swamps. Fortunately for us, they get their blood from song birds; rarely do they bite humans or other mammals. And, since *C. melanura* flies no further than 5 miles from its breeding sites, most cases of EE occur within 5 miles of these swamps.

HOW DOES IT HAPPEN?

Well, if *C. melanura* doesn't bite mammals, how do horses and humans get the disease? The entire story is unknown but enough facts have been gathered to construct the following life history:

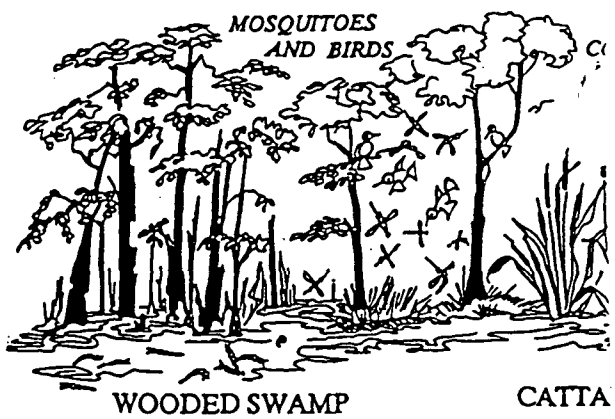
During warm months when *C. melanura* breeds, there are usually plenty of small birds around for adult mosquitoes to feed on. When female mosquitoes [males do not bite] feed on an infected bird, they pick up the virus. Later, when the mosquito blood feeds on another bird, the virus is transmitted to the new bird. The mosquito remains infected for life and can transmit virus to all birds it feeds on.

After the mosquito blood feeds, the bird becomes infected and the virus begins reproducing in the bird. In a few days, and for only 1 or 2 days, the blood of the bird contains enough virus to infect other mosquitoes that bite it. The bird quickly recovers from the infection and develops immunity. As far as we know, the immunity keeps the birds from becoming infected again. Only newly infected birds can serve as a source of virus for mosquitoes. Therefore, the mosquito seems the most important host as far as virus survival is concerned.

Since *C. melanura* does not bite people, the key to human and horse infection is tied to the short period when birds have high concentrations of virus in their blood. When other mosquitoes feed on infected birds they can become infected as well. It is these "secondary" mosquito species that carry the virus to other vertebrate hosts, including horses and humans. For these secondary mosquitoes to transmit the virus from birds to humans, an individual mosquito must successfully blood feed on both groups of animals. Not all mosquito species do that, *C. melanura* for example.

There is another species of mosquito that is most often associated with outbreaks of EE in horses and humans. This mosquito, the "salt-and- pepper mosquito," has the scientific name *Coquillettidia perturbans* (Coke-qua-la-tid-e-ah purr-tur-bans) or "cokes" for short. This is a large black and white mosquito that looks for blood around dusk. Cokes have a geographic distribution similar to *C. melanura*, but rather than breed in wooded swamps, they breed in cattail or grassy marshes that have a mucky bottom. These types of marshes are often next to the swamps that produce *C. melanura*.

There may be other mosquitoes, particularly those in the genus *Aedes* (a-e-dees), that also feed both on birds and mammals and thus could possibly transmit EE. The species of *Aedes* involved differ from area to area. Cokes are the

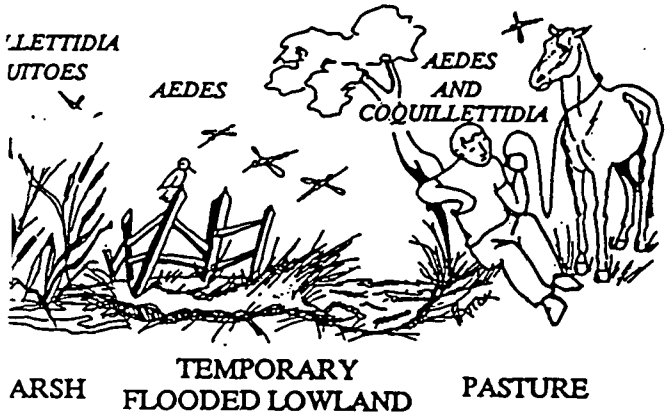


only other mosquitoes found throughout the range of EE in the United States. While cokes and *Aedes* can fly more than 5 miles, EE generally does not occur in areas where there are no *C. melanura*.

Cokes and *Aedes* can, and do, take bloodmeals from a variety of other domestic and wild animals; such as cattle, dogs, cats, squirrels, raccoons, and deer. Fortunately, these animals are resistant to the virus and do not develop EE. Of course, mosquitoes also can blood feed on birds other than wild song birds. Birds that are not native to the U.S., such as ring-necked pheasants and starlings, and some native birds,

such as whooping cranes and sandhill cranes can become ill, and many die. Die-off's of exotic birds, particularly pheasants, often precede outbreaks of EE in humans and horses.

Unlike wild birds, infected horses and humans normally do not develop high enough concentrations of virus in their blood to infect mosquitoes. This means that they are not good hosts for the survival of the virus. Once the animal recovers from the infection, or dies, the virus in that animal also dies. Animals like this are called "dead-end hosts," not because they die, but because the virus can not be perpetuated. Thus, EE in non-bird hosts is not part of the virus' normal life cycle. It's a fatal mistake for humans, horses and virus alike.



KEEPING A LOOKOUT

Many mosquito control programs in Florida use "sentinel chickens" to alert them when the threat of EE is greatest. Chickens are penned in areas where there are mosquitoes. Every two weeks, a blood sample is taken from some of the birds and tested for antibodies to the virus. Chickens seldom become ill when infected with EE virus. Sentinels were first established throughout Florida in 1978 following a 1977 epidemic of another mosquito-borne viral disease, St. Louis encephalitis (SLE). [There is an IFAS Factsheet on SLE available.] Though chicken flocks were established to monitor SLE, they also have been used to some extent for EE.

While sentinels do not forecast SLE or EE outbreaks, they do provide some limited information on virus activity. Still, the absence of virus activity in chickens does not necessarily mean there is no virus activity. Consequently, sentinel chickens can give a false sense of security regarding EE or SLE activity.

Use of sentinel flocks has been on the decline among mosquito control programs since 1983. Even the Florida Department of Health and Rehabilitative Services, which set up the system, has reduced its support in recent years.

The best system to monitor for EE is to 1) monitor the population levels of the important mosquitoes, *C. melanura*, cokes, and man-biting *Aedes*, 2) test these same species for virus, 3) test native song birds for antibodies to EE virus, and 4) establish a system to rapidly detect horse cases near the swamps. Since EE activity in a county during any given year can be limited to a single swamp among many, it is necessary to monitor these factors in all *C. melanura* breeding swamps.

Florida mosquito control programs typically have a mosquito monitoring system in residential areas. Where there is a potential for EE, the system should extend to the swamps and marshes. Testing mosquitoes and wild birds for virus activity is more expensive than sentinel chickens, but the test results are more reliable for determining the potential for an EE outbreak. Unfortunately, today's testing methods are not readily available or cost effective for mosquito control programs. Frequently, horse cases occur before human cases and are used to indicate the spill-over of virus transmission from the bird-mosquito-bird cycle to the bird-mosquito-mammal pathway.

PREVENTION AND CONTROL

There is a vaccine against EE for horses; and every horse in the state should be vaccinated

and have twice yearly boosters. On the other hand, there is no vaccine or cure for EE in humans. The only way to prevent EE in humans is by controlling the mosquitoes that carry the virus. This means controlling cokes, some *Aedes*, and particularly, *C. melanura*. Without *C. melanura*, there can be no EE in horses or humans. It is as simple as that.

It is usually not practical to spray swamps frequently for *C. melanura*, as is normally done to control other mosquitoes in residential areas. Concerted efforts to reduce mosquito populations in non-residential areas are only made after the State Department of Health and Rehabilitative Services declares an EE alert.

Aborting the threat of an EE outbreak, or an outbreak itself, is most easily done by an aerial application of insecticide to kill adult *C. melanura*, cokes, and man-biting *Aedes*. If done properly, only one or two well-timed aerial applications are needed to control the problem for a year. Where aerial application is not possible, adulticides must be applied with the normal ground based equipment used for mosquito control in residential areas.

Aedes can sometimes be controlled in the immature or larval stages, but there is currently no effective way to control larval *C. melanura* and cokes. Larval control is indicated only for prevention, not as a response to an outbreak.

NEED MORE INFORMATION . . .

. . . on EE and its control in Florida? Contact the mosquito control district in that county, or Dr. Charlie Morris, Extension Entomologist, Florida Medical Entomology Laboratory, IFAS- University of Florida, 200 9th Street Southeast, Vero Beach, FL 32962, 407/778-7200.

. . . regarding EE prevention in horses,? Contact your local veterinarian or Dr. Paul Gibbs, Department of Infectious Diseases, University of Florida, College of Veterinary Science, J137 JHMCH, Gainesville, FL 32611, 904/392-9257.

Sponsored by the Florida Medical Entomology Laboratory, IFAS-University of Florida and Entomology Services, Mosquito Control Section, Florida Department of Health and Rehabilitative Services.

August 1991

A Florida Mosquito Control Factsheet

Mosquito-Borne Dog Heartworm Disease

Jai K. Nayar, Ph.D., Florida Medical Entomology Laboratory

Each year thousands of dogs become disabled or die from lung, heart or circulatory problems caused by the heartworm disease. Heartworm disease in dogs and related canines is caused by a filarial nematode (thread-like round worm), *Dirofilaria immitis*. It is a major problem that promises to become more serious with time. The adult inhabits the right ventricle and pulmonary arteries, and because of its location in the heart, it is commonly called "the dog heartworm". The parasite can only be transmitted from one dog to the other by some vector mosquito species.

DISTRIBUTION OF HEARTWORM DISEASE

Heartworm is distributed worldwide in most tropical and subtropical regions, with increasing frequency in temperate climates. Until the late sixties, the diasease was restricted to southern

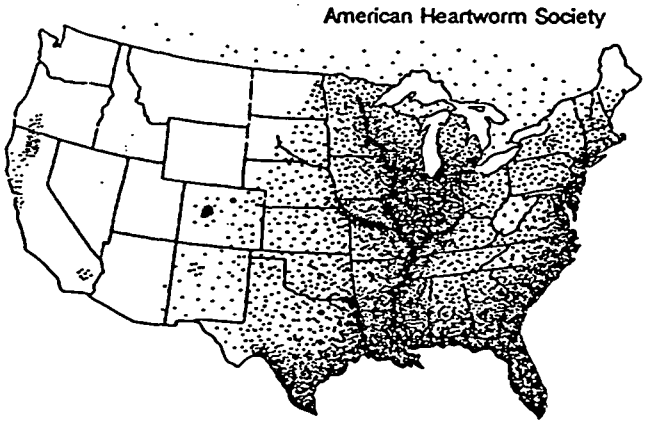


Fig. 1. Heartworm infection, 1986

and eastern coastal regions of the United States. Now, however, cases have been reported in almost every state and in several provinces of Canada (Fig. 1). For most of North America, the danger of infection is greatest during the summer when temperatures then are favorable for mosquitoes. In the southern U. S., especially the Gulf Coast and Florida, where mosquitoes are present year-round, the threat of heartworm disease is constant.

THE HEARTWORM PARASITE

The complete development of the nematode parasite requires two hosts; the dog and the mosquito. The problem starts when a mosquito draws blood from an infected dog. In the dog, sexually mature adult nematodes are 8-14" long and live in the heart. Once a dog is infected it is infected for life. The sexually mature nematodes deposit tiny immature worms called **microfilariae**, which circulate in the blood stream. Microfilariae are less than 1/800" long. They do not develop further in the dog, but they can survive in circulation for upto seven years. They must be ingested by a mosquito before they can progress in their development. Numbers of microfilariae in blood are generally higher during the day than at night. Optimum numbers of microfilariae in the peripheral circulation coincide with times of peak feeding activity by the mosquito vector. Numbers of microfilariae may be higher in the summer when mosquitoes are abundant.

LIFE CYCLE IN THE MOSQUITO

Development of heartworm in the vector starts when microfilariae are ingested by the female mosquito during blood feeding on an infected dog. Microfilariae leave the midgut of the mosquito soon after ingestion and migrate into the Malpighian tubules cells (the mosquito kidney). During the next four days the parasite becomes immobile, shortens and thickens, and

gives rise to the so-called **"sausage form"** larva. This larval form is followed by the first stage larva and the first molt occurs in the Malpighian tubule cells at 8 days. During the second larval stage formation of internal organs takes place. The second molt occurs at 12 days.

Third-stage larvae resemble miniature adults. During the next 2-3 days, they increase in length, break out of the Malpighian tubules, migrate through the body to the head, and accumulate in the mouthparts. These third stage larvae are now called **infective larvae** (Fig. 2). Thus, in 2-3 weeks, a microfilaria transforms into an infective larva. This infective larva cannot develop further in the mosquito. Futher development can only take place in a dog.

Infective larvae are found primarily in the proboscis, or mouth parts. As the infective mosquito feeds on a dog, the infective larvae emerge from the tip of the proboscis and on to the skin of the animal. A drop of mosquito blood protects the larvae from drying prior to their entry into the host. The infective larvae penetrate the skin through the puncture wound that remains after the mosquito withdraws her mouthparts.

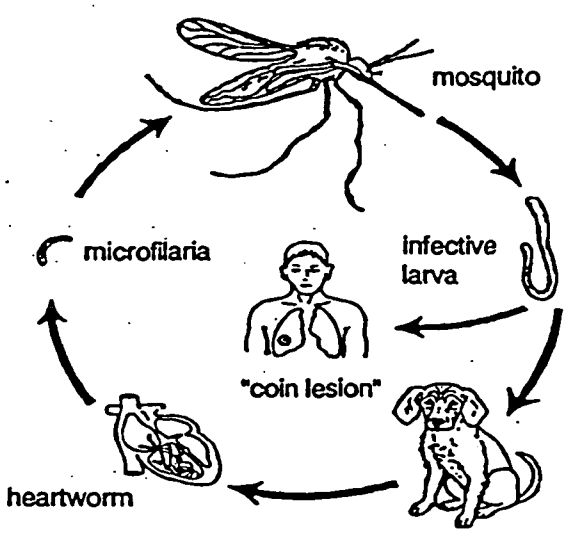


Fig. 2. Life cycle of the dog heartworm

LIFE CYCLE IN THE DOG

After penetrating the skin, the larvae stay close to the site and grow very little during the next few days. The molt from third- to fourth-stage larvae occurs 6-10 days after infection. Fourth-stage larvae migrate through subcutaneous tissue and muscle toward the upper abdomen and thoracic cavity. Fourth-stage larvae grow to about 1/10" in length during the next 40 to 60 days and then molt to the fifth and final larval stage, or **young adults**. The young adults penetrate veins to get into the blood stream and eventually, after 70 to 90 days in the dog, reach the heart (Fig. 2). For unknown reasons, the percentage of infective third-stage larvae that reach maturity vary in different breeds of dogs

Upon reaching the heart, the young adults continue to grow. Up to now there has been no evidence of disease in the dog. It is only after adult worms mate and start to deposit tiny motile microfilariae that circulate in the blood that disease becomes apparent. Microfilariae appear in the blood about 200 days after infection.

THE SYMPTOMS

Visible signs of heartworm disease may not appear until a full year after infection. In fact, the disease may be well advanced before the dog shows any symptoms. Dogs with typical heartworm disease fatigue easily, cough, and appear rough and unthriving. Blood and worms from ruptured vessels may be coughed up. Blockage of major blood vessels can causes the animal to collapse suddenly and die within a few days.

Dogs with 50-100 mature worms exhibit moderate to severe heartworm disease. Dogs with 10-25 worms that receive little exercise may never show signs of heartworm disease, and one may not be able to find microfilaria in the blood. Heartworm infection without detectable microfilaremia is called **occult dirofilariasis.**

DIAGNOSIS

Diagnosis of dog heartworm disease is done by drawing a blood sample and looking for microfilaria using a microscope. These tests are reliable only 80% of the time. A more reliable method is to take X-rays. When heartworm dis-

ease is confirmed, a treatment program is set up to remove both adult worms and microfilariae.

HEARTWORM DISEASE IN CATS

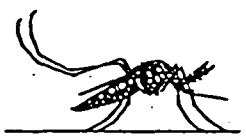
Heartworm disease in cats is less frequent than in dogs. Cats are susceptible but appear to be poorer hosts than the dog. The most prominant clinical signs include coughing, **dyspnea,** vomiting, lethargy, and anorexia. Acute collapse and death can occur. Because less than 20% of infected cats have microfilaria in the blood, diagnosis is best confirmed by X-rays.

HEARTWORM DISEASE IN HUMANS

Heartworm is also an occasional parasite of humans. The parasite is usually found in the lung (**pulmonary dirofilariasis**), less often in the heart. Although the worm forms a "coin lesion" in the lung which may be confused with other diseases on x-rays, such as carcinoma, its clinical signficance in man has not been fully determined. During the last 20 years about 80 cases of human pulmonary dirofilariasis have been reported from Florida.

MOSQUITO VECTORS

More than 70 of the nearly 3,000 known species of mosquitoes world-wide have been identified as capable of sustaining the development of dog heartworm microfilariae to the infective stage. In Florida, about 20 species are potential vectors. The main vectors near the coasts are two mosquitoes that breed in salt marshes; *Aedes taeniorhynchus* and *Ae. sollicitans*, and 1 freshwater species, *Culex nigripalpus*. The inland vectors that breed in fresh water are *Culex quinquefasciatus*, *Culex salinarius*, *Aedes aegypti*, *Anopheles quadrimaculatus* and *Mansonia titillans*. These mosquitoes breed in a wide variety of habitats, including marshes, swamps, ponds, ditches, old tires and trash piles.



TREATMENT, PREVENTION, AND CONTROL

Heartworm disease in dogs and cats cannot be eliminated, but it can be controlled or prevented. The first step in ridding a dog of the parasites is to administer an agent to kill the adult worms.

a) Kill the adult worms: **Capasolate®** (Arsenamide, Thiacetarsamide), is an arsenical compound used to kill adult heartworms in both dogs and cats. It is given as an intravenous injection and two doses are given each day for two days followed by restriction of physical activity for one to two months. As the worms die they are carried by the bloodstream to the lungs. One dog in twenty may be expected to die as a result of complications from this therapy. There are fewer complications with cats. Adult female worms and immature forms are somewhat resistant to Capasolate and , consequently, this drug may be less than 100 percent effective.

b) Kill the microfilariae: After the adult worms have been eliminated, the next step is to kill the microfilariae. **Dithiazanine Iodide** is the recommended microfilaricide. The compound is given orally; the dosage varies with the weight of the dog. After 7 days on this program, the dog's blood should be re-examined. If microfilariae are still present, and there has been no drug reaction, the dosage may be continued until the blood is microfilariae free.

c) Prevent larval development: Only after the adult heartworms and the microfilaria have been eliminated may an infected dog be put on a program to prevent reinfection.

Filaribits® (Diethylcarbamazine–DEC, **Caricide®**, **Hetrazan®**) kills the infective larval stage, but is less effective against the adult heartworm. It should be administered daily throughout the mosquito season when dogs are exposed to infective larvae. It is a safe and efficacious drug in noninfected dogs, but may cause a fatal shock reaction if given to dogs with microfilariae. Sudden destruction of large num-

bers of microfilariae occasionally causes severe shock-like symptoms that may kill the dog. **Cypip®** can be mixed with dog meal for continuous administration of DEC in feed.

Heartgard-30® (ivermectin), a recently developed drug when given once-a-month can prevent heartworm disease. It eliminates infective larvae before they reach the heart. It also kills microfilariae. In certain dogs, particularly of the Collie breed, Heartgard has been reported to cause serious adverse reaction. The major advantage is that it need be given only once every 30 days. The disadvantages are that the dog owner may forget to give the medication and that there are risks of a mild reaction and transient diarrhea if given to a heartworm infected dog.

d) Control mosquitoes: In addition to drug therapy for dogs and cats, Mosquito control in residential areas where dogs and cats live can break the transmission cycle of heartworm. Dog owners should keep their animals out of mosquito infested areas. Dog's living quarters should be mosquito-free. Indoor dogs usually show much lower incidence of infection. Insect repllents are safe and effective when applied properly.

For more information . . .

. . . about dog heartworm, contact your **local veterinarian** or **Dr. Charlie Morris, Extension Medical Entomologist at the Florida Medical Entomology Laboratory, IFAS-University of Florida, 200 9th Street Southeast, Vero Beach, FL 32962, (407) 778-7200.**

About the author:

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Sponsored by the Florida Medical Entomology Laboratory, IFAS-University of Florida and Entomology Services, Mosquito Control Section, Florida Department of Health and Rehabilitative Services.

July, 1990

A Florida Mosquito Control Factsheet

The Asian Tiger Mosquito in Florida

G. F. O'Meara, Ph.D. & A. D. Gettman, Ph.D.

Prior to 1985, the distribution of *Aedes albopictus*, the Asian tiger mosquito, was confined to Asia and many islands in the Pacific Ocean, including some of the Hawaiian Islands. Yet, in recent years the range of this mosquito has greatly expanded. It is now known to occur on every continent except Antarctica.

Aedes albopictus was most likely introduced into North America through the importation of used tires from Japan or Taiwan. During the 1980s there was a large increase in the number of used tires imported into the United States from countries where *Ae. albopictus* is indigenous. Most imported used tires arrive in containerized shipments that are not adequately inspected for mosquitoes at the ports of entry. Imported tires are sent to numerous locations where they may be stored outdoors. Those that are not suitable for recapping may end up at illegal dump sites. These conditions have enabled *Ae. albopictus* to become well-established in the United States. To date, *Ae. albopictus* has been detected in 22 states including Hawaii.

In 1986, the Asian tiger mosquito was initially discovered in Florida at a tire dump site in Jacksonville (Duval County). By December 1991, this exotic mosquito had been found at one or more sites in 61 of the 67 Florida counties (Fig. 1). Currently, *Ae. albopictus* populations are very common throughout north Florida, widely but sparsely distributed in the central part of the state and rare in south Florida. *Aedes albopictus* will probably continue to expand its range down the Florida peninsula, becoming a common container-inhabiting mosquito statewide.

FACTORS CONTRIBUTING TO THE SPREAD OF *AEDES ALBOPICTUS*

- The widespread availability of suitable aquatic habitats
- The movement of containers
- The decline of *Aedes aegypti* populations
- The rapid adaptation of *Ae. albopictus* to shorter photoperiods

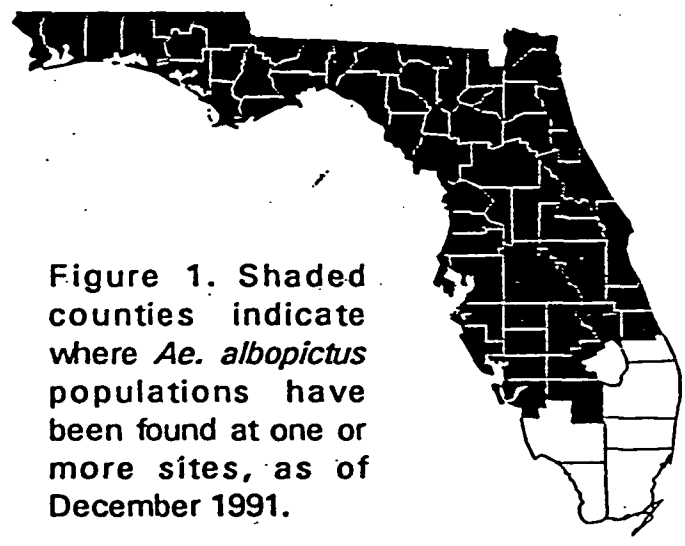

Figure 1. Shaded counties indicate where *Ae. albopictus* populations have been found at one or more sites, as of December 1991.

AQUATIC HABITATS

Although immature *Ae. albopictus* inhabit many different types of containers, scrap tires harbor this mosquito more frequently and in greater numbers than any other type of habitat. Major pest problems caused by *Ae. albopictus* are often associated with accumulations of

scrap tires. Approximately 12 million waste tires are generated yearly in Florida. To deal with this solid waste problem, the Florida Department of Environmental Regulation established new regulations concerning the storage, movement and disposal of waste tires. Authority to issue the Waste Tire Rule was provided by new state laws that became part of the Florida Statutes (§403.717, F. S.) in 1988 with amendments added in 1990. If vigorously enforced, the new waste-tire regulations will eventually diminish the availability of used tires as habitats for *Ae. albopictus* and related mosquitoes.

Other common man-made habitats for immature *Ae. albopictus* include bird baths, water bowls for pets, buckets, plates under potted plants, clogged rain gutters and flower vases. Natural containers, such as treeholes and tank bromeliads, also provide suitable habitats for immature *Ae. albopictus*. Indeed, this mosquito shows a much greater propensity for using natural containers than does *Ae. aegypti*.

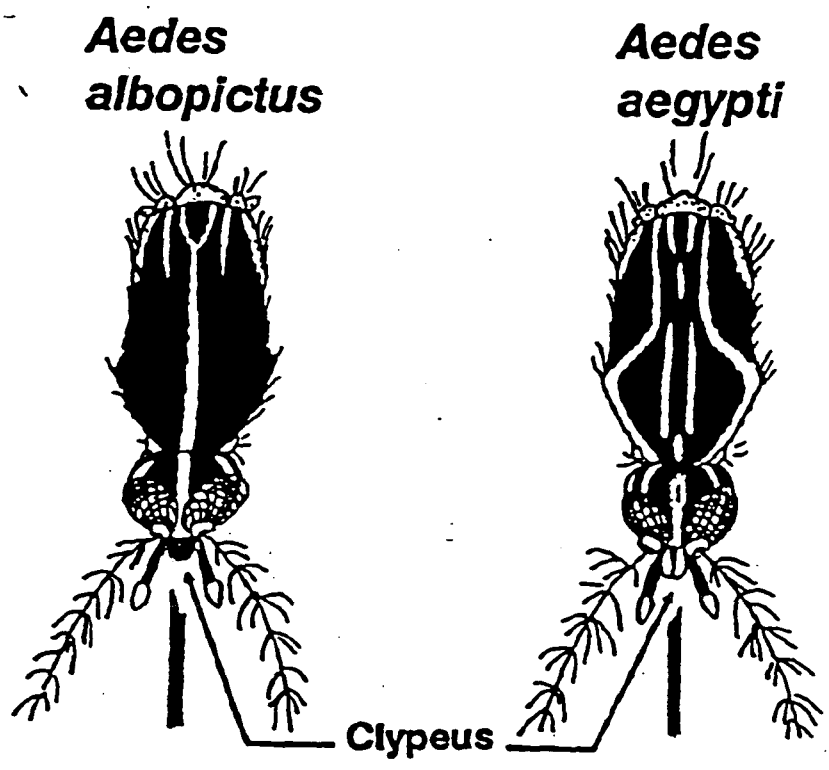

Figure 2.

MOVEMENT OF CONTAINERS

The movement of waste tires to disposal and recycling sites has enhanced the spread of *Ae. albopictus*. Along the east coast of Florida, the southern-most population of *Ae. albopictus* occurs at a site where waste tires are brought from all parts of the state for recycling. Unfortunately, waste tires have been accumulating at this site faster than they are being shredded. Similar problems have occurred at some county landfills, thereby allowing these sites to serve as focal points for the spread of *Ae. albopictus*.

In more than a dozen Florida counties, the initial discovery of *Ae. albopictus* was made at cemeteries. Plastic floral baskets with fresh-cut flowers are often placed at a grave site at the time of burial. After a few days, the wilted flowers are discarded, but the baskets are usually recycled. They may return to the same or a different cemetery holding either fresh or silk flowers. *Aedes* eggs laid while the basket is in one cemetery may hatch in another. This invasion route may explain why *Ae. albopictus* has become well-established in some cemeteries before appearing in nearby accumulations of waste tires.

DECLINE IN *AEDES AEGYPTI* POPULATIONS

The spread of *Ae. albopictus*, especially in north Florida, seems to be occurring at the expense of resident *Ae. aegypti* populations. The abundance of *Ae. aegypti* in several Florida cities has declined drastically and rapidly with the introduction of the Asian tiger mosquito. Several theories have been proposed to account for the apparent displacement of *Ae. aegypti* by *Ae. albopictus*. However, additional field studies are needed to assess the role *Ae. albopictus* populations may play in bringing about these changes.

ADAPTATIONS TO SHORTER PHOTOPERIODS

Populations of *Ae. albopictus* in North America exhibit photoperiod-induced egg diapause, and this is one of several factors which suggests this mosquito has invaded the continental United States from the temperate region of Asia. Probably due to its temperate origin, *Ae. albopictus* quickly spread in the temperate zone of central and eastern United States.

By contrast, this mosquito was relatively slow in spreading to lower latitudes. Short daylength (<13.5 hours) triggers egg diapause. For *Ae. albopictus* populations to remain active in south and central Florida during a significant portion of the year requires a lowering of the daylength threshold or the total elimination of the photoperiod response, because in this region daylengths for much of the year are less than 13.5 hours. Rapid selection for both of these features has been detected in *Ae. albopictus* populations along the southern border of its Florida distribution.

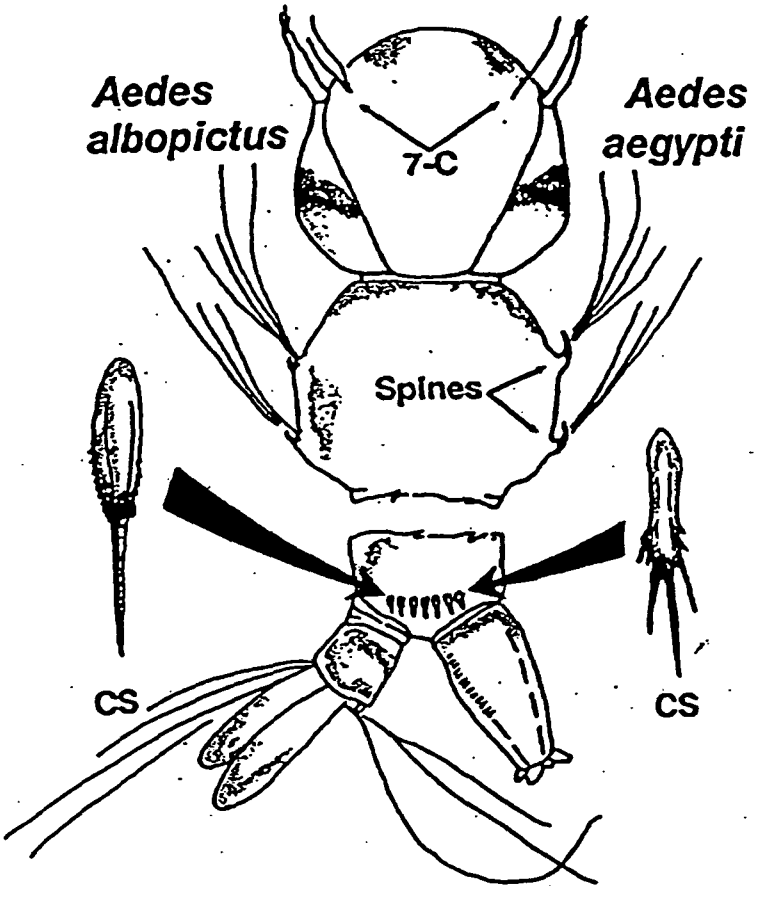

Figure 3.

DISTINGUISHING *AEDES ALBOPICTUS* FROM *AEDES AEGYPTI*

Adult *Ae. albopictus* and *Ae. aegypti* are day-active mosquitoes which usually can be distinguished with ease in the field by the distinctive scaling patterns on the top of the thorax (its back) (Fig. 2). These scales may be rubbed off, especially in specimens taken in light or suction traps. In addition, fortunately, the clypeus, a structure located on the head between the palpi (Fig. 2), is covered with white scales in female *Ae. aegypti* and with only black scales in female *Ae. albopictus*. The scales on the clypeus are seldom absent.

Larvae of the two species can be separated by differences in the shape of the comb scales (CS), the size of the thoracic spines and the number of branches in seta 7-C on the head (Fig.3). These structures are easily seen with a stereomicroscope at 40 to 50X using a good illuminator.

STATUS OF *AEDES ALBOPICTUS* AS A PEST AND DISEASE VECTOR

Aedes albopictus has quickly become a serious pest species in many north Florida communities where the annoyance level generated by populations of this mosquito is considerably greater than that caused previously by *Ae. aegypti* populations. The wider range of habitats occupied by *Ae. albopictus* tend to make it more common than *Ae. aegypti*. Moreover, Florida populations of *Ae. albopictus* were most likely derived from temperate zone stock, thus they may be better adapted to survive and thrive in north Florida than *Ae. aegypti*, which is primarily a tropical and subtropical mosquito.

In Florida, the Asian tiger mosquito has not been implicated in the transmission of any

human pathogens. However, it is a major vector of dengue and yellow fever elsewhere. Results of laboratory tests indicate that *Ae. albopictus* is capable of serving as a vector for several other viruses that are pathogenic to man or animals.

CONTROL

The best approach for controlling *Ae. albopictus* (and *Ae. aegypti*) is by eliminating larval habitats. Educational programs, which inform citizens about the important role they can play to prevent mosquito production from containers around their homes, need to be expanded and offered on a continuing basis. By eliminating unneeded containers and by frequently emptying the water in other containers (e.g., bird baths and pet-watering dishes) around their homes, residents can complement the control efforts of the local mosquito control program. Current requirements for the storage of waste tires are grossly inadequate for mosquito abatement. The Waste Tire Rule should be revised to require that all tires be stored under cover. With improved legislation and better informed citizens, it should be possible to greatly reduce the abundance of container-inhabiting mosquitoes throughout Florida.

Achieving permanent mosquito control in natural containers, such as tank bromeliads, may be more difficult. Therefore, homeowners should consider limiting the number of these plants that they place in their yards. Chemical and microbial larvicides may provide temporary control, but generally they are not cost effective. Mosquitoes and plant debris can be flushed out of tank bromeliads with a garden hose equipped with an appropriate nozzle. It is unlikely that plants flushed twice a week would produce many adult mosquitoes. Growing bromeliads in plastic pots makes it easier to flush out the mosquitoes.

NEED MORE INFORMATION . . .

. . . on the distribution of the Asian tiger mosquito in your county, contact the mosquito control program in that county, or Dr. Charlie Morris, Extension Medical Entomologist, Florida Medical Entomology Laboratory, IFAS-University of Florida, 200 9th Street Southeast, Vero Beach, FL 32962, 407/778-7200.

ABOUT THE AUTHORS. . .

. . . Dr. O'Meara is a Professor of Entomology and Dr. Gettman a Post-Doctoral Research Assistant at the Florida Medical Entomology Laboratory, IFAS-University of Florida, 200 9th Street Southeast, Vero Beach, FL 32962, 407/778-7200.

Sponsored by the Florida Medical Entomology Laboratory, IFAS-University of Florida and the State of Florida Department of Health and Rehabilitative Services, Office of Entomology Services.

December, 1991

Appendix F

Sample Questionnaires

Mrs. Priest's Class - Fairlawn Elementary

Mosquito Control Survey

1. What do you do for a living????? _____

2. How long have you lived in St. Lucie County??? _____

3. What is your education level (last grade or graduate degree completed)???

4. Do you know much about mosquitoes??? ❒ YES ❒ NO

5. Do you think mosquitoes are good or bad??? _____

6. Should we control the population of mosquitoes in St. Lucie County???

   ❒ YES ❒ NO

7. What is most important to you about the Indian River Lagoon?? Select as many as you wish)

❒ Fishing	❒ Water Skiing	❒ Swimming
❒ Boating	❒ Wind Surfing	❒ Clamming
❒ Recreation	❒ Animals and Plants	❒ Other _____
❒ Canoeing	❒ Hydro-sliding	❒ Other _____
❒ Jet Skiing	❒ Scuba Diving	❒ Other _____

8. Do mosquitoes effect your job??? _____ How?

9. What are the most important issues (problems) facing the Indian River Lagoon???

☐ Chemical Pollution	☐ Water Pollution	☐ Pesticides
☐ Mosquitoes	☐ Marine Debris	☐ Habitat Destruction
☐ Other _____	☐ Other _____	☐ Other _____
☐ Other _____	☐ Other _____	☐ Other _____

10. How much do you know about mosquito control in St. Lucie County???

Impoundments	☐ a lot	☐ a little	☐ Nothing
Chemical Pesticides	☐ a lot	☐ a little	☐ Nothing
Natural Pesticides	☐ a lot	☐ a little	☐ Nothing
Dumping stagnant water from containers	☐ a lot	☐ a little	☐ Nothing
Mosquito Fish	☐ a lot	☐ a little	☐ Nothing
Smacking / Swatting	☐ a lot	☐ a little	☐ Nothing
Other _____	☐ a lot	☐ a little	☐ Nothing

11. From the above list, which method of control(s) do you think is(are) the best for St. Lucie County??? _____

12. How should St. Lucie County manage their mosquito impoundments??? (See enclosed information)

☐ Flood impoundments only during breeding season (summer months)

☐ Open culverts (pipes connecting impoundments to the Indian River) all year long (no longer manage impounded areas)

☐ Destroy dikes around the impoundments allowing them to return to their natural condition.

☐ Other - Please explain

Ms. Buckley's Class - Fairlawn Elementary

Mosquito Control Survey

1. What do you do for a living????? _____

2. Do you live on the Indian River Lagoon??? ☐ YES ☐ NO

3. Where were you born???

4. What are your hobbies???

5. Do you know much about mosquitoes??? ☐ YES ☐ NO

6. Do you think mosquitoes are good or bad??? _____

7. Do you have much standing water around your house??? ☐ YES ☐ NO

8. What is most important to you about the Indian River Lagoon?? Select as many as you wish)

☐ Commercial Fishing	☐ Interesting Habitats	☐ Jet Skiing
☐ Recreational Fishing	☐ Scenic Views and Breezes	☐ Power Boating
☐ Other _____	☐ Other _____	☐ Other _____
☐ Other _____	☐ Other _____	☐ Other _____
☐ Other _____	☐ Other _____	☐ Other _____

9. What are the most important issues (problems) facing the Indian River Lagoon???

☐ Water Quality	☐ Water Pollution	☐ Pesticides
☐ Mosquitoes	☐ Marine Debris	☐ Habitat Destruction
☐ Other _____	☐ Other _____	☐ Other _____
☐ Other _____	☐ Other _____	☐ Other _____

10. How much do you know about mosquito control in St. Lucie County???

Impoundments	☐ a lot	☐ a little	☐ Nothing
Chemical Pesticides	☐ a lot	☐ a little	☐ Nothing
Natural Pesticides	☐ a lot	☐ a little	☐ Nothing
Dumping stagnant water from containers	☐ a lot	☐ a little	☐ Nothing
Mosquito Fish	☐ a lot	☐ a little	☐ Nothing
Smacking / Swatting	☐ a lot	☐ a little	☐ Nothing
Other _____	☐ a lot	☐ a little	☐ Nothing

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☐ Open culverts (pipes connecting impoundments to the Indian River) all year long (no longer manage impounded areas)

☐ Destroy dikes around the impoundments allowing them to return to their natural condition.

☐ Other - Please explain

Ms. Clark's Class - Fairlawn Elementary

Mosquito Control Survey

1. What do you do for a living????? _____

2. Do you live near the Indian River Lagoon??? ❒ YES ❒ NO

3. Have you been to the Indian River Lagoon??? ❒ YES ❒ NO

4. What are your hobbies??? _____

5. What kind of animals do you have??? _____

6. Do you like wildlife along the Indian River Lagoon??? ❒ YES ❒ NO

7. Are mosquitoes important to the ecology of the Indian River Lagoon??

❒ YES ❒ NO

8. Are mosquito populations a problem in St. Lucie County?? ❒ YES ❒ NO

9. Do you have an interest in mangroves??? ❒ YES ❒ NO

10 Do you have an interest in science??? ❒ YES ❒ NO

11. What is most important to you about the Indian River Lagoon?? Select as many as you wish)

❒ Commercial Fishing	❒ Habitats	❒ Swimming
❒ Boating	❒ Scuba / Snorkeling	❒ Clamming
❒ Recreational Fishing	❒ Number of Species of Plants and animals	❒ Catch and Release Fishing
❒ Other _____	❒ Other _____	❒ Other _____
❒ Other _____	❒ Other _____	❒ Other _____

12. What are the most important problems facing the Indian River Lagoon???

☐ Littering	☐ Resource Management	☐ Agricultural Run-off
☐ Speeding through Manatee Zones	☐ Air Pollution	☐ Killing animals for Sport
☐ Habitat Destruction	☐ Other _____	☐ Other _____
☐ Other _____	☐ Other _____	☐ Other _____

13. How much do you know about mosquito control in St. Lucie County???

Impoundments	☐ a lot	☐ a little	☐ Nothing
Chemical Pesticides	☐ a lot	☐ a little	☐ Nothing
Natural Pesticides	☐ a lot	☐ a little	☐ Nothing
Dumping stagnant water from containers	☐ a lot	☐ a little	☐ Nothing
Mosquito Fish	☐ a lot	☐ a little	☐ Nothing
Smacking / Swatting	☐ a lot	☐ a little	☐ Nothing
Other _____	☐ a lot	☐ a little	☐ Nothing

14. From the above list, which method of control(s) do you think is(are) the best for St. Lucie County??? _____

15. How should St. Lucie County manage their mosquito impoundments??? (See enclosed information)

☐ Flood impoundments only during breeding season (summer months)

☐ Open culverts (pipes connecting impoundments to the Indian River) all year long (no longer manage impounded areas)

☐ Destroy dikes around the impoundments allowing them to return to their natural condition.

☐ Other - Please explain

Ms. Bell's Class - Fairlawn Elementary

Mosquito Control Survey

1. What do you do for a living????? _____

2. Do you live near the Indian River Lagoon??? ☐ YES ☐ NO

3. Are mosquitoes a problem to you??? ☐ YES ☐ NO

4. Are you allergic to mosquito bites??? ☐ YES ☐ NO

5. Is the population of mosquitoes less now than in the past???

   ☐ YES ☐ NO

6. Do you think mosquitoes are a health problem for St. Lucie County???

   ☐ YES ☐ NO Why? _____

7. What is most important to you about the Indian River Lagoon?? Select as many as you wish)

☐ Mangroves	☐ Fishing	☐ Wildlife
☐ Mosquito Control	☐ Swimming	☐ Collecting interesting things
☐ Hydro-sliding	☐ Hunting	☐ Jet Skiing
☐ Boating	☐ Site-seeing	☐ Exploring
☐ Other _____	☐ Other _____	☐ Other _____

8. What are the most important issues (problems) facing the Indian River Lagoon???

☐ Pollution	☐ Over Fishing	☐ Impoundments
☐ Mosquito Control	☐ Draining Wetlands	☐ Development
☐ Other _____	☐ Other _____	☐ Other _____
☐ Other _____	☐ Other _____	☐ Other _____

9. How much do you know about mosquito control in St. Lucie County???

Impoundments	☐ a lot	☐ a little	☐ Nothing
Chemical Pesticides	☐ a lot	☐ a little	☐ Nothing
Natural Pesticides	☐ a lot	☐ a little	☐ Nothing
Dumping stagnant water from containers	☐ a lot	☐ a little	☐ Nothing
Mosquito Fish	☐ a lot	☐ a little	☐ Nothing
Smacking / Swatting	☐ a lot	☐ a little	☐ Nothing
Other _____	☐ a lot	☐ a little	☐ Nothing

10. From the above list, which method of control(s) do you think is(are) the best for St. Lucie County??? _____

11. How should St. Lucie County manage their mosquito impoundments??? (See enclosed information)

☐ Flood impoundments only during breeding season (summer months)

☐ Open culverts (pipes connecting impoundments to the Indian River) all year long (no longer manage impounded areas)

☐ Destroy dikes around the impoundments allowing them to return to their natural condition.

☐ Other - Please explain

Ms. Baker's Class - Fairlawn Elementary

Mosquito Control Survey

1. What do you do for a living????? _____

2. Do you live on the Indian River Lagoon??? ☐ YES ☐ NO

3. Are you a ☐ MALE or ☐ FEMALE???

4. What are your hobbies???

5. Do you eat seafood??? ☐ YES ☐ NO

6. How many years have you lived in St. Lucie County??? _____

7. What is most important to you about the Indian River Lagoon?? Select as many as you wish)

☐ Recreational Fishing	☐ Commercial Fishing	☐ Habitats for Animals
☐ Swimming	☐ Scenic Views	☐ Surfing
☐ Hydro-sliding	☐ Water Skiing	☐ Jet Skiing
☐ Boating	☐ Seafood Source	☐ Commercial Cargo
☐ Scuba and Snorkeling	☐ Other _____	☐ Other _____

8. What are the most important issues (problems) facing the Indian River Lagoon???

☐ Pollution	☐ Oil Spills	☐ Oil Spills
☐ Motor Boats Speeding through Manatee Zones	☐ Crab Traps and Lobster Traps	☐ Cast Nets
☐ Mangrove Removal	☐ Draw Bridges	☐ Dredging_
☐ Mosquitoes	☐ Marine Debris	☐ Development
☐ Commercial Shipping	☐ Commercial Fishing	☐ Other _____

9. How much do you know about mosquito control in St. Lucie County???

Impoundments	☐ a lot	☐ a little	☐ Nothing
Chemical Pesticides	☐ a lot	☐ a little	☐ Nothing
Natural Pesticides	☐ a lot	☐ a little	☐ Nothing
Dumping stagnant water from containers	☐ a lot	☐ a little	☐ Nothing
Mosquito Fish	☐ a lot	☐ a little	☐ Nothing
Smacking / Swatting	☐ a lot	☐ a little	☐ Nothing
Other _____	☐ a lot	☐ a little	☐ Nothing

10. From the above list, which method of control(s) do you think is(are) the best for St. Lucie County??? _____

11. How should St. Lucie County manage their mosquito impoundments??? (See enclosed information)

- ☐ **Flood impoundments only during breeding season (summer months)**
- ☐ **Open culverts (pipes connecting impoundments to the Indian River) all year long (no longer manage impounded areas)**
- ☐ **Destroy dikes around the impoundments allowing them to return to their natural condition.**
- ☐ **Other - Please explain**

Ms. Jacobson's Class - C. A. Moore Elementary

Mosquito Control Survey

1. What do you do for a living????? _____

2. Are there a lot of mosquitoes where you live??? ❒ YES ❒ NO

3. Is it hard to control mosquitoes??? ❒ YES ❒ NO

4. Are there more mosquitoes now than in the past??? ❒ YES ❒ NO

5. What is most important to you about the Indian River Lagoon?? Select as many as you wish)

❒ Fishing	❒ Crabbing	❒ Animals
❒ Swimming	❒ Lobstering	❒ Exploring
❒ Wade Fishing	❒ Shrimping	❒ Sharks
❒ Boating	❒ Camping	❒ Clamming
❒ Canoeing	❒ Development	❒ Oystering
❒ Other _____	❒ Paddle Boating	❒ Other _____

6. What are the most important issues (problems) facing the Indian River Lagoon???

☐ Littering	☐ Habitat Destruction	☐ Speeding Boats
☐ Killing Manatees	☐ Water Pollution	☐ Over Fishing
☐ Other _____	☐ Other _____	☐ Other _____
☐ Other _____	☐ Other _____	☐ Other _____

7. How much do you know about mosquito control in St. Lucie County???

Impoundments	☐ a lot	☐ a little	☐ Nothing
Chemical Pesticides	☐ a lot	☐ a little	☐ Nothing
Natural Pesticides	☐ a lot	☐ a little	☐ Nothing
Dumping stagnant water from containers	☐ a lot	☐ a little	☐ Nothing
Mosquito Fish	☐ a lot	☐ a little	☐ Nothing
Smacking / Swatting	☐ a lot	☐ a little	☐ Nothing
Other _____	☐ a lot	☐ a little	☐ Nothing

8. From the above list, which method of control(s) do you think is(are) the best for St. Lucie County??? _____

9. How should St. Lucie County manage their mosquito impoundments??? (See enclosed information)

☐ Flood impoundments only during breeding season (summer months)

☐ Open culverts (pipes connecting impoundments to the Indian River) all year long (no longer manage impounded areas)

☐ Destroy dikes around the impoundments allowing them to return to their natural condition.

☐ Other - Please explain

Ms. Wetherington's Class - C. A. Moore Elementary

Mosquito Control Survey

1. What do you do for a living????? _____

2. What are your hobbies??? _____

3. Do you know much about mosquitoes??? ☐ YES ☐ NO

4. Are there a lot of mosquitoes where you live??? ☐ YES ☐ NO

5. Are mosquitoes a problem in St. Lucie County??? ☐ YES ☐ NO

6. What is most important to you about the Indian River Lagoon?? Select as many as you wish)

☐ Fishing	☐ Crabbing	☐ Good place to find recyclable materials
☐ Swimming	☐ Sea Do Riding	☐ Exploring
☐ Relaxing	☐ Boating	☐ Jet Skiing
☐ Other _____	☐ Other _____	☐ Other _____
☐ Other _____	☐ Other _____	☐ Other _____

7. What are the most important issues (problems) facing the Indian River Lagoon???

☐ Killing Fish for No Reason	☐ Water Pollution from Boats and Ships	☐ Speeding Boats Hitting Manatees
☐ Water Quality	☐ Littering	☐ Development
☐ Impounding Wetlands	☐ The Smell of the River	☐ Other _____

8. How much do you know about mosquito control in St. Lucie County???

Impoundments	☐ a lot	☐ a little	☐ Nothing
Chemical Pesticides	☐ a lot	☐ a little	☐ Nothing
Natural Pesticides	☐ a lot	☐ a little	☐ Nothing
Dumping stagnant water from containers	☐ a lot	☐ a little	☐ Nothing
Mosquito Fish	☐ a lot	☐ a little	☐ Nothing
Smacking / Swatting	☐ a lot	☐ a little	☐ Nothing
Other _____	☐ a lot	☐ a little	☐ Nothing

9. From the above list, which method of control(s) do you think is(are) the best for St. Lucie County??? _____

10. How should St. Lucie County manage their mosquito impoundments??? (See enclosed information)

☐ Flood impoundments only during breeding season (summer months)

☐ Open culverts (pipes connecting impoundments to the Indian River) all year long (no longer manage impounded areas)

☐ Destroy dikes around the impoundments allowing them to return to their natural condition.

☐ Other - Please explain

Ms. Contois' Class - C. A. Moore Elementary

Mosquito Control Survey

1. What do you do for a living????? _____

2. Do you work on the Indian River Lagoon??? ☐ YES ☐ NO

3. Do you think the Indian River Lagoon is important to your job?????? ☐ YES ☐ NO

4. Have you ever cut down trees along the Indian River Lagoon???
   ☐ YES ☐ NO If so why??? _____

5. Have you ever killed an animal living in the Indian River Lagoon???
   ☐ YES ☐ NO If yes, why???

6. What is most important to you about the Indian River Lagoon?? Select as many as you wish)

☐ The Fish	☐ Important Animals	☐ Important Plants
☐ See many birds	☐ Fishing	☐ Nursery for Ocean Fish
☐ Islands are Fun	☐ Canoeing	☐ Sailing
☐ Manatees	☐ Shrimping	☐ Other _____
☐ Other _____	☐ Other _____	☐ Other _____

7. What are the most important issues (problems) facing the Indian River Lagoon???

☐ Animals are dying	☐ Pollution	☐ Plants are being killed
☐ Trash in the Water	☐ Kill Fish for No Reason	☐ Boats hurting Manatees
☐ Speeding Boats	☐ Erosion	☐ Boats Spill Oil and Fuel in the Water
☐ Fish Get Tangled in Fishing Line and Garbage	☐ Nets Kill Dolphins and Other Fish	☐ Hurricanes
☐ Other _____	☐ Other _____	☐ Other _____

8. How much do you know about mosquito control in St. Lucie County???

Impoundments	☐ a lot	☐ a little	☐ Nothing
Chemical Pesticides	☐ a lot	☐ a little	☐ Nothing
Natural Pesticides	☐ a lot	☐ a little	☐ Nothing
Dumping stagnant water from containers	☐ a lot	☐ a little	☐ Nothing
Mosquito Fish	☐ a lot	☐ a little	☐ Nothing
Smacking / Swatting	☐ a lot	☐ a little	☐ Nothing
Other _____	☐ a lot	☐ a little	☐ Nothing

9. From the above list, which method of control(s) do you think is(are) the best for St. Lucie County??? _____

10. **How should St. Lucie County manage their mosquito impoundments??? (See enclosed information)**

- ☐ **Flood impoundments only during breeding season (summer months)**
- ☐ **Open culverts (pipes connecting impoundments to the Indian River) all year long (no longer manage impounded areas)**
- ☐ **Destroy dikes around the impoundments allowing them to return to their natural condition.**
- ☐ **Other - Please explain**

Ms. Armstrong's Class - C. A. Moore Elementary

Mosquito Control Survey

1. What do you do for a living????? _____

2. Do you live on the Indian River Lagoon??? ❒ YES ❒ NO

3. Do you care about the environment??? ❒ YES ❒ NO

4. Do you litter??? ❒ YES ❒ NO If so why??? _____

5. Do you eat fish??? ❒ YES ❒ NO

6. Are mosquitoes a problem in St. Lucie County??? ❒ YES ❒ NO

7. What is most important to you about the Indian River Lagoon?? Select as many as you wish)

❒ The Environment	❒ Fishing	❒ Jet Skis
❒ Swimming	❒ Sun Bathing	❒ Recreation
❒ Cook Outs	❒ Boating	❒ Scuba Diving
❒ Research	❒ Water Skiing	❒ Family Reunions
❒ Other _____	❒ Other _____	❒ Other _____

8. What are the most important issues (problems) facing the Indian River Lagoon???

☐ Littering	☐ Killing Fish We Do Not Eat	☐ Development of Shoreline
☐ Water Quality	☐ Oil Spills	☐ Over Fishing
☐ Water Pollution	☐ Mangrove Cutting	☐ Habitat Destruction
☐ Erosion	☐ Air Pollution	☐ Hurricanes
☐ Other _____	☐ Other _____	☐ Other _____

9. How much do you know about mosquito control in St. Lucie County???

Impoundments	☐ a lot	☐ a little	☐ Nothing
Chemical Pesticides	☐ a lot	☐ a little	☐ Nothing
Natural Pesticides	☐ a lot	☐ a little	☐ Nothing
Dumping stagnant water from containers	☐ a lot	☐ a little	☐ Nothing
Mosquito Fish	☐ a lot	☐ a little	☐ Nothing
Smacking / Swatting	☐ a lot	☐ a little	☐ Nothing
Other _____	☐ a lot	☐ a little	☐ Nothing

10. From the above list, which method of control(s) do you think is(are) the best for St. Lucie County??? _____

11. How should St. Lucie County manage their mosquito impoundments??? (See enclosed information)

☐ Flood impoundments only during breeding season (summer months)

☐ Open culverts (pipes connecting impoundments to the Indian River) all year long (no longer manage impounded areas)

☐ Destroy dikes around the impoundments allowing them to return to their natural condition.

☐ Other - Please explain

Survey Participants Suggested by Students

Ambulance Driver	❒ Sent	❒ Received
Biologist	❒ Sent	❒ Received
Boat Seller	❒ Sent	❒ Received
Builder	❒ Sent	❒ Received
Chamber of Commerce	❒ Sent	❒ Received
College Student	❒ Sent	❒ Received
Commercial Fisher	❒ Sent	❒ Received
Construction Worker	❒ Sent	❒ Received
County Commissioner	❒ Sent	❒ Received
Developer	❒ Sent	❒ Received
Doctor	❒ Sent	❒ Received
Environmental Educator	❒ Sent	❒ Received
Environmental Scientist	❒ Sent	❒ Received
Farmer	❒ Sent	❒ Received
Fire Fighter	❒ Sent	❒ Received
Fishing Guide	❒ Sent	❒ Received
Garbage Collector	❒ Sent	❒ Received
Garbage Man (Litter)	❒ Sent	❒ Received
Gardener / Yard Worker	❒ Sent	❒ Received
Grove Boss	❒ Sent	❒ Received
Grove Picker	❒ Sent	❒ Received
Hotel Owner	❒ Sent	❒ Received
Indian River Lagoon Scientist - Harbor Branch	❒ Sent	❒ Received
Judge	❒ Sent	❒ Received
Kid	❒ Sent	❒ Received
Landscaper	❒ Sent	❒ Received
Lawyer	❒ Sent	❒ Received
Life Guard	❒ Sent	❒ Received
Litter Bug	❒ Sent	❒ Received

Marine Biologist	❒ Sent	❒ Received
Marine Patrol	❒ Sent	❒ Received
Mayor	❒ Sent	❒ Received
Mosquito Control Worker	❒ Sent	❒ Received
Mosquito Researcher	❒ Sent	❒ Received
Naturalist	❒ Sent	❒ Received
Nurse	❒ Sent	❒ Received
Orange Grove Picker	❒ Sent	❒ Received
Park Ranger	❒ Sent	❒ Received
Photographer	❒ Sent	❒ Received
Police Officer	❒ Sent	❒ Received
Power Plant Worker	❒ Sent	❒ Received
Principal	❒ Sent	❒ Received
Real Estate Salesperson	❒ Sent	❒ Received
Recreational Fisher	❒ Sent	❒ Received
Resort Owner	❒ Sent	❒ Received
Road Worker	❒ Sent	❒ Received
Scuba Diver	❒ Sent	❒ Received
Superintendent of Schools	❒ Sent	❒ Received
Teacher	❒ Sent	❒ Received
Tourist	❒ Sent	❒ Received
Vetererinarian	❒ Sent	❒ Received
Waste Water Treatment Operator	❒ Sent	❒ Received
Water Front Home Owner	❒ Sent	❒ Received
Water Tester	❒ Sent	❒ Received
Water Treatment Person	❒ Sent	❒ Received

Appendix G

Resource List

Resource List

General Information

Indian River Lagoon: A Fragile Balance of Nature. Characterization Report, Indian River Lagoon National Estuary Program (IRLNEP), Melbourne, Florida.

Boater's Guide to the Indian River Lagoon. IRLNEP Program, Melbourne, Florida. 1965.

Both published by and obtained from:

Indian River Lagoon National Estuary Program Office,
1900 Harbor City Boulevard,
Melbourne, FL 32901
(561) 984-4950 or (800) 226-3747 (FL). FAX (561) 984-4937

Florida's Estuaries: A Citizen's Guide to Coastal Living and Conservation. Florida Sea Grant Publication SGEB-23. Obtainable from:

Florida Sea Grant College Program
University of Florida
P.O. Box 110409 - Building 803
Gainesville, FL 32611-0409
(904) 392-2801

Cost $2.00

Geography Section

References:

Exploring Your World - The Adventure of Geography. National Geographic Society, Washington, DC. 1989.

Davis, Kenneth C. 1992. Don't Know Much about Geography - Everything You Need to Know about the World but Never Learned. Morrow and Company, NY.

Tarbuck, E. J. and F. K. Lutgens.
The Earth - An Introduction to Physical Geology. Merrill Publishing, Columbus, OH.

Other Sources:

Atlantic and Gulf Coastal Barriers - Restless Ribbons of Sand.
Written by: John T. Wells, and Charles H Peterson.
Institute of Marine Sciences,
University of North Carolina at Chapel Hill
Morehead City, NC 28557

In Cooperation with:
U. S. Department of the Interior
Fish and Wildlife Service
National Wetlands Research Center
Slidell, LA 70458

U.S.G.S. Topographic 7.5 minute Quadrangle, Ft. Pierce, FL
U.S.G.S. Topographic Maps can be obtained from several sources:

Order From: Map Distribution
U.S. Geological Survey
Box 25286, Federal Center
Denver Colorado 80255

Maps of the local area can be purchased at local map stores and some stationers. Check the Yellow Pages and call first to make sure they have them - not all map stores carry what you may want and many supplies are limited.

The Rand McNally store in Tampa ("A World of Maps") carries Florida maps, including U.S.G.S. topographic quads, and street maps. They will ship upon payment with a credit card or UPS C.O.D. They also have a toll-free number (800) 226-2771.

Note: Prices of U.S.G.S. Topographic Maps vary with vendor.

Soil Survey Maps may be ordered by telephone from:

USDA Soil Conservation Service (local St. Lucie County, FL Office)
8400 Picos Road, Suite 202
Ft. Pierce, FL 34945-3041
Phone: (561)461-4546
FAX: (561) 461-6923
As of this writing, there is no charge for these maps.

Navigation Charts

Charts Used: Ft. Pierce Inlet, Small Scale
Florida - Cuba, Large Scale
Chart Number 1: Key to symbols Used on Navigation and Topographic Maps

Navigation Charts can be purchased in various scales at most local marina and ship stores. Charts are updated periodically and old issues are destroyed. West Marine and St. Lucie Outboard local marine dealers supplied some of the maps used in this project. If using outdated maps, be sure to mark them "Warning - For Educational Use only - Not to be used for navigational purposes." With this disclaimer, the vendor was able to donate the maps.

Aerial Maps may be requested by phone from:

St. Lucie County Property Appraiser
2300 Virginia Ave. Rm. 107
Ft. Pierce, FL 34982
(561) 462-1000
Cost is $2.50 each however they may donate them for an school project.

Note: When requesting maps over the phone, it is necessary to have section, range, and township designations to assure that right map will be received.

Environmental geology map can be requested by telephone and obtained from:

Florida Geological Survey
903 W. Tennessee Street
Tallahassee, FL 32304-7700
(904) 487-2219 (librarian/publications)

There was no charge for these maps, however the supply is limited.

Aerial photos of the Inlet can be obtained from Marine Resources Council of East Florida's collection of aerial photos for barrier island communities in St. Lucie County. Contact:

Marine Resources Council
P.O. Box 228982
Melbourne, FL 32902
Phone: (561)952-0102
FAX: (561) 952-0103

Other sources of aerial photos include:

Maser Aerial Photo Service (They provide stock and custom photos.)
P.O. Box 100048
Ft. Lauderdale, FL 33310
Phone: (305) 493-5220

Flood Prone Areas Maps

U.S.G.S. Publication. 1972. Flood prone areas maps were available prior to the Flood Insurance Rate Map (FIRM) published by the Federal Emergency Management Agency (FEMA). A copy is available from the Marine Resources Council of East Florida's map collection. Additional copies of the map were made at a Melbourne, Florida blueprint shop at a cost of $2.00 per sheet.

National Wetlands Inventory Maps

Florida State University
(A State Earth Science Information Center)
Florida Resources and Environmental Analysis Center
361 Bellamy Building
Tallahassee, FL 32306-4015
(904) 644-2883 or
1-800-USA-MAPS

Climate

Reference Materials

Ahrens, C. Donald. 1994. Meteorology Today. West Publishing Company, St. Paul, MN.

Critchfield, Howard J. 1983. Grapefruit and Toyotas. The State Climatologist, Vol. 7, Number 2, April 1983.

Fernald, E. A. ed. 1981. Atlas of Florida. The Florida State University Foundation, Inc.

Fernald, E. A. ed. 1984. Water Resources Atlas of Florida. The Florida State University Foundation.

Hurricane Manual for Marine Interests in St. Lucie County. Published by Florida Inland Navigation District and St. Lucie County Division of Emergency Management.

Hurricanes... The Greatest Storms on Earth - A Preparedness Guide. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, March 1994.

Lehr, Paul E. and R. W. Burnett. 1987. Weather. Golden Press, New York, New York.

Myers, Ronald L. and J.J. Ewel. 1990. Ecosystems of Florida. University of Central Florida Press, Orlando, Florida.

Richardson, E. Arlo. 1982. Man, The Great Modifier. The State Climatologist, Vol. 6, Number 3, July 1982.

Richardson, E. Arlo. 1982. The Long Range Forecast. The State Climatologist, Vol. 6, Number 1, January 1982.

Ecosystem Communities (Flora and Fauna)

Myers, R. L. and J. J. Ewel, Eds. 1990. Ecosystems of Florida. University of Central Florida Press, Orlando, FL.

Raven, P. H. and G. B. Johnson. 1986. Biology. Times Mirror/Mosby College Publishing, St. Louis, MO.

Maps and Brochures

Atlantic Coast Ecological Inventory 1:250,000 scale, produced by U.S. Fish and Wildlife Service. Available from:

Map Distribution, U.S. Geological Survey
Box 25286, Federal Center
Denver, CO 80255

Poster: Florida's Indian River lagoon: A Rare Place for Wildlife and People.

Published by:

East Central Florida Environmental Education Service Project
300 SR 401
Cape Canaveral, FL 32920-2099

Manatees - A Coloring And Activity Book. Produced by Northeast Florida Regional Planning Council and Florida Department of Environmental Protection.

Indian River Lagoon - A Fragile Balance. Can be obtained through the Indian River Lagoon National Estuary Program.

Homeowner's Guide to the Indian River lagoon. Prepared by the Marine Resources Council for the St. Johns River Water Management District. Can be obtained through the Indian River Lagoon National Estuary Program.

No Room for Monsters in the Indian River lagoon. Published by:

St. Johns River Water Management District (SJRWMD)
P. O. Box 1429
Palatka, FL 32178-1429
Phone: 1-800-232-0904.

Man Meet Coast (Coastal Issues Game)

Copies available from:
Marine Advisory Program
Florida Cooperative Extension Service
GO22 McCarty Hall
University of Florida
Gainesville, FL 32611

Information on Man Meets Coast game available from:

Marine Resources Council
P.O. Box 228982
Melbourne, FL 32902-2892
(561)952-0102

Brochures:

The Following brochures are produced by Florida Power and Light:

Sea Turtles and Lights
The Florida Panther
The Bald Eagle in Florida
Florida's Wood Storks
Florida's Alligators and Crocodiles
The West Indian Manatee in Florida

Copies may be obtained by calling FPL at 1-800-342-5375.

The following brochures are produced by Florida Game and Freshwater Fish Commission:

The Snail Kite
The Florida Scrub Jay

Copies may be obtained from:

Florida Game and Freshwater Fish Commission
Office of Informational Services
1239 Southwest Tenth St.
Ocala, FL 34474
(352) 732-1225