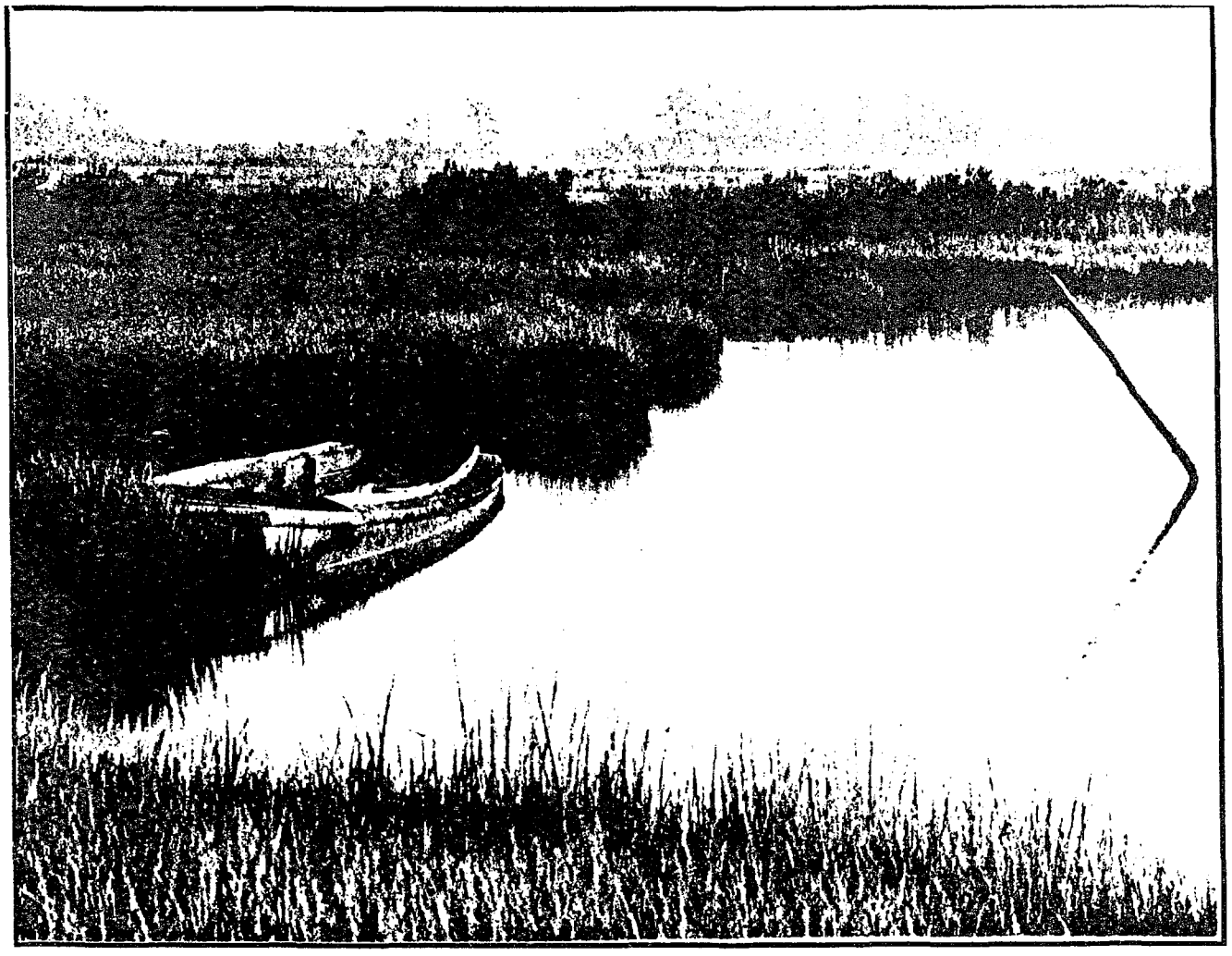
THE ESTUARY

A BALANCE OF FORCES



MIDDLE GRADES STUDY UNIT

Teacher Information Packet

THE ESTUARY

An Interdisciplinary Study Unit for the Middle Grades

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Hillsborough County Public Schools

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REVISED EDITION
FALL 1986

The preparation of this document was made possible through a grant from the Florida Department of Natural Resources, Bureau of Marine Research, 100 Eighth Avenue S.E., St. Petersburg, Florida 33701

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FOREWORD

This unit is one in a series on Coastal Ecology produced by the Office of Environmental Education, Hillsborough County Public Schools. It is intended for use at the Environmental Studies Centers at Cockroach Bay and Upper Tampa Bay Park.

The Estuary is designed for use with average ability sixth grade students. The lessons in this unit have been adapted from a number of sources. They have been field tested at the Environmental Studies Centers in Hillsborough County and at fifteen of our elementary schools.

It is hoped that the use of this material in a structured education program will play an important role in the development of a citizenry which thinks and acts on a basis of factual knowledge of key concepts about Florida's important coastal environment.

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ACKNOWLEDGMENTS

A great deal of work goes into the production of a curriculum packet of this size. A large number of individuals were involved in its production.

The staff of the Florida Department of Natural Resources, Bureau of Marine Research was instrumental in the creation of the project. They feel strongly that Florida's citizens need to acquire a knowledge of our unique coastal systems. A special thanks goes to those individuals listed below for their ongoing support:

Dr. Karen A. Steidinger
Mr. George Henderson
Mrs. Violet Stewart
Ms. Barbara Harris
Ms. Jean Smith

The Florida Office of Coastal Management, Department of Environmental Regulation provided the funds necessary for the project and a wealth of resource materials.

The Florida Chamber of Commerce and Mr. Kenneth Prest with REGfiles, Inc. were especially helpful in guiding our writing team through a vast quantity of information which greatly resembled one of our famed mangrove swamps.

The pilot teachers were most helpful with comments, criticisms and the lessons they contributed to the project:

Georgie Burnett, Patricia Cadrecha, Domenick Chillura, Nilla Conte, Cheryl Dafeldecker, Carol Dorman, Diane King, Linette King, Beatrice Green, Stanley Koester, Joan Lund, Verlie Nelson, Ronald Ortner, Diana Rudolph, Kathy Stokes, Margaret Williams, Lori Weiss, and Carol York.

Without this group, the product you hold in your hands would not have been nearly as effective.

Our advisory committee helped us by providing feedback on the accuracy of the content and the appropriateness of the methodology.

ESTUARINE EDUCATION PROJECT ADVISORY COMMITTEE

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Patricia Kirkland and Charlotte Lloyd from the Duval County Schools' Marine Science Center were most helpful in allowing us to duplicate their excellent slide show, Man and the Coast to use with our units on the human forces in the estuary.

A very special thanks goes out to those students in the pilot group who provided us with an evaluation of the effectiveness of our efforts.

TABLE OF CONTENTS

This teacher information packet on the estuary contains teacher instructions, objectives, scripts for the slide shows and a copy of all student materials.

The materials are arranged in a sequence which culminates in a synthesis activity. The Shell Island simulation is designed to draw on all the learning from the rest of the units. In order for the students to get the full benefit of this activity, we suggest that all of the units and their associated laboratory activities be worked through by the students before they tackle the simulation.

CONTENTS

THE ESTUARY - PROGRAM SUMMARY

UNIT GOAL: To acquaint the student with all of the ecological forces that affect Florida's estuaries and to provide him with evidence that man is one of these forces.

SPECIFIC OBJECTIVES: Upon completion of this unit a student should be able to:

1. Construct a food web for each of the estuarine communities covered in the unit.

2. Define the term estuary and describe the characteristics of the major ecological communities found in Florida estuaries.

3. Describe how the forces described in the unit affect estuaries and their inhabitants.

4. Demonstrate knowledge of estuarine systems by actively participating in a simulation on a typical Florida estuary.

5. Demonstrate safe and effective laboratory skills while conducting experiments which illustrate estuarine concepts.

6. Be able to state the role that Florida's citizens can play in the protection of our estuaries.

7. Demonstrate a knowledge of Florida's government by indentifying agencies which help manage Florida's estuaries.

TEACHERS INSTRUCTIONS - THE ESTUARY

INTRODUCTION:

The sixth grade program ties together the many communities found in an estuary. Although it is not necessary for students to have gone through the Environmental Studies Centers 3-5 grade programs, the sixth grade program lends itself well to an extension of these programs.

There are nine units presented in the Student Readings booklet. The units should be duplicated for student use.

It is suggested that the units be presented in the order in which they appear. The sequence was designed to help build the concept of the estuary as a product of many forces.

Each of the units are supported by laboratory and other activities. These are found in the Student Activities booklet.

If we can be of assistance to you in the successful presentation of this material, do not hesitate to call the Office of Environmental Education at (813) 272-4821 or the Environmental Studies Center at (813) 879-7222.

Copies of the three slide shows featured in this curriculum can be borrowed from:

Violet Stewart
Administrative Assistant
Florida Department of Natural Resources
Bureau of Marine Research
100 Eighth Avenue, S.E.
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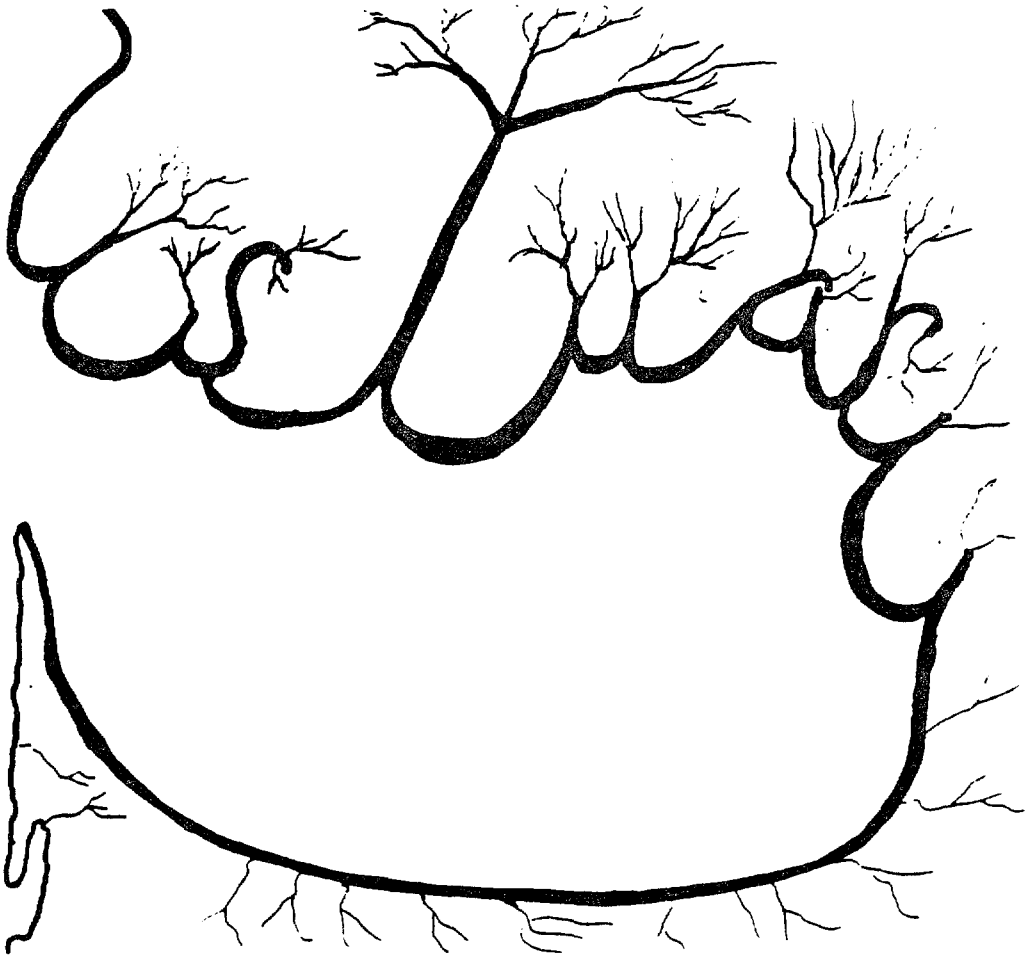
WHAT IS AN



?

WHAT IS AN ESTUARY?

Vocabulary:

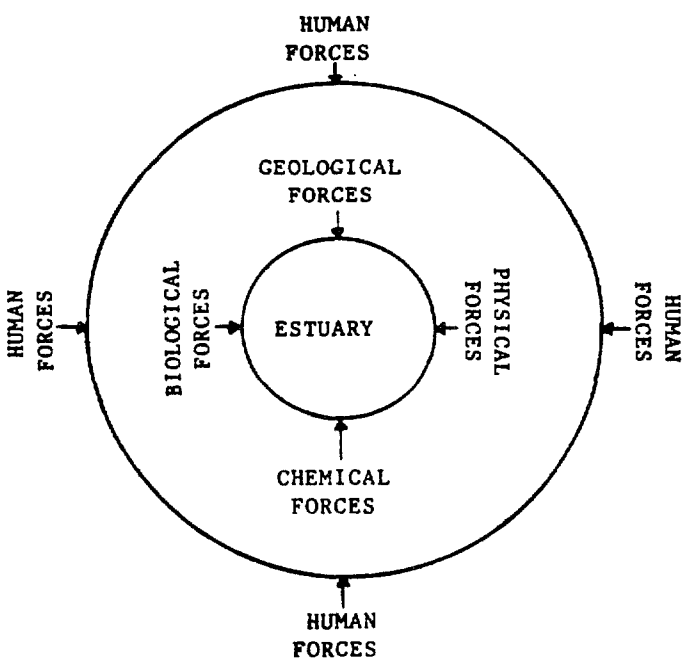
biological	chemical	competition
currents	ecosystem	estuary
geological	habitat	interdependence
lagoon	nutrients	physical
pollution	predation	salinity
turbidity	nitrate	phosphate
temperate	salt marsh	community
tropical	mangrove forest	brackish
metabolic	sediment	

An Estuary is a semi-enclosed body of water where fresh and sea water mix. A healthy estuary can support a tremendous number of plants and animals. For this reason, estuaries are among the most productive ecosystems on the planet. This high level of productivity is created by the interaction of unique geological, physical, chemical, biological and human forces. Estuaries provide food and shelter for a great number of marine animals. In addition to supporting all this living material (biomass), estuaries and their associated wetland areas also provide a natural water cleaning system. The plants remove pollutants from water that enters the system and convert the pollutants into more plant material. Humans have viewed estuaries from several different directions. Some have thought of estuaries only as dumping grounds for wastes. Others have seen the shoreline plants as ugly "weeds" that they must cut down and remove. Still others have considered estuaries in terms of their tremendous economic potential because they support so much sea life (fishes, oysters, shrimp, etc.).

Finally, many have come to view estuaries as beautiful natural systems that should be appreciated for themselves. Certainly, as we learn more about estuaries, we can all come to believe that estuaries are so important that we should do all that we can to preserve them.

WHAT FORCES CREATE AN ESTUARY?

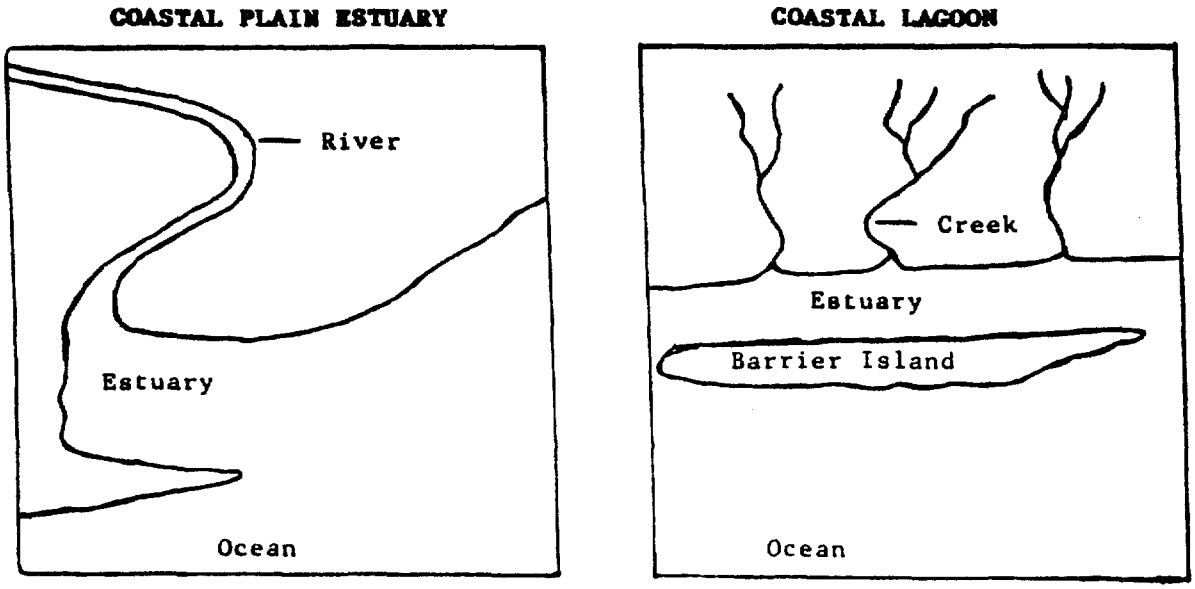
An estuary is a special ecosystem shaped by many forces. These forces include tides, rainfall, wind, currents, biological agents and man. Estuaries are capable of withstanding a wide range of environmental conditions. This variation would destroy other ecosystems. However, these extremes are the driving forces of the system. Without them there would be no estuaries. Only when the forces get out of balance is the system threatened.



Geological Forces

Geological forces play an important part in the origin of estuaries. In Florida, there are two major types of estuaries. One type was formed by the melting of the glaciers at the end of the last ice age. As the sea level rose, the valleys of rivers which flowed to the sea were filled with the

rising sea water. These types of estuaries are called coastal plain estuaries. Tampa Bay and Charlotte Harbor are examples of coastal plain estuaries. Another type of estuary is the coastal lagoon. This type of estuary is formed when sand flowing along a coastline forms barrier islands. These islands create a body of water which is separated from the Gulf or the Atlantic. Sarasota Bay and the Indian River are examples of coastal lagoons.



Physical Forces

The waters of the estuary are constantly in motion. Waves, tides and currents move sediment, nutrients, gasses, chemicals and organisms throughout the estuary. However, unlike the Gulf or the Atlantic, the movement of waters in estuaries is restricted by the shallowness of their depth, their abundant vegetation and the surrounding land.

Temperature is another physical force which affects estuarine organisms. Many organisms in Florida can be subjected to freezing temperatures during the winter and almost boiling temperatures during the summer. These temperature differences affect the metabolic rate of many organisms. It also affects

the amount of dissolved gasses that the water can hold. Temperature also plays an important role in what happens to this marine environment. Many young organisms react to temperature changes. Temperature affects the entire ecosystem.

Light is another physical force in the estuary. Light is necessary for the existence of plants. They use the light as an energy source to manufacture food. The presence of mud and silt in the waters of the estuary reduces the amount of light available to plants. This cloudiness of the water is call turbidity.

Chemical Forces

A number of chemical forces affect estuaries. At times, there is a high salinity (salt) level. This may occur when there has been little rainfall in the watershed of the estuary. At other times rainfall is abundant. This causes a tremendous increase of fresh water in the estuary. This means that both plants and animals have to adapt to an environment that may have high salinity levels at one time or very low levels on other occasions. Much of the time however, the water of the estuary is brackish. This means that it is neither fresh nor salt, but a mixture of the two.

Nutrients are chemicals which plants and animals use to build their bodies. As rivers and streams travel to the estuary they bring nutrients from the land. Plants in the estuary use these nutrients. The major nutrients needed by plants are nitrate and phosphate. Other nutrients of some biological importance are sulfate and carbonate. Sodium and chlorine are the major elements in sea water, but other elements are import to organisms. Calcium, magnesium, iron, manganese and potassium are all major elements used by estuarine organisms.

Biological Forces

The biological forces that operate in an estuary are the interactions among the organisms. They include competition, predation, and interdependence. In some estuaries in Florida, there is a fierce competition for habitat between the temperate salt marsh community and the tropical mangrove forest. Interdependence is a powerful biological force that binds many estuarine organisms together. When some of the organisms in the system are harmed, many other organisms can be affected.

Human Forces

Human activity in Florida's estuaries is a powerful force. Since the 1950's, Florida's population has climbed dramatically. Many of these people have settled around estuaries. Many of their activities have destroyed or altered these systems. There has been a loss of productive habitats and a pollution of the waters. Many of Florida's most productive estuaries have been badly stressed by this most powerful of forces.

Estuary Glossary

biological - the nature of living matter; connected with the study of plants and animals.

brackish - a mixture of fresh water and salt water.

chemical - the changes that result from reactions between atoms & molecules.

competition - the struggle among organisms for food, space and water when the supply is limited.

community - all the living things in a given area.

currents - streamlike movement of the water in estuaries and oceans.

ecosystem - the non-living environment in a given area plus the organism living in that area.

estuary - a semi-enclosed body of water where salt water from the sea mixes with fresh water from rivers or streams.

geological - the study of the features of an estuary, including structure and development.

habitat - a place where plants or animals live.

interdependence - animals and plants interact and depend on each other.

lagoon - a shallow body of water which separates a barrier island from the mainland along a coastline.

mangrove forest - an intertidal community dominated by one or more species of tropical trees.

metabolic - the sum total of an organism's body processes.

nitrate - a nutrient composed of nitrogen and oxygen which is used by organisms to build proteins.

nutrients - elements or molecules necessary for energy transfer and growth in organisms.

phosphate - a nutrient composed of phosphorous and oxygen which organisms use to store energy.

physical - having to do with the motion of water, temperature or light in an environment.

pollution - to make unclean; contaminate; dirty.

predation - living or preying upon others.

salinity - the amount of salt present in water.

salt marsh - an intertidal community dominated by grasses and herbs.

sediment - particles such as sand, silt & clay.

temperate - a climatic zone in which the winter temperatures are often below freezing.

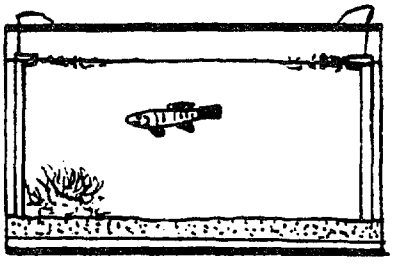
tropical - a climatic zone in which the winter temperatures do not usually fall below freezing.

turbidity - cloudy water conditions caused by mud or sand in the water.

ESTUARINE ENVIRONMENT

Lab #1 — Setting Up an Aquarium

Materials: Two 10 gallon aquariums, gravel, filter, instant ocean, bucket, newspapers, air stones, hydrometer, nylon scrubber, small plastic bowl, baking soda.



Student Directions:

Activity I:

- Clean all aquarium parts thoroughly with nylon scrubber and baking soda (Do not use soap or cleaners).
- Place underground filter on the bottom of aquarium.
- Spread rinsed gravel over filter. Slope gravel back to front.
- Place small plastic bowl on gravel and add approximately 2 cups of instant ocean for 10 gallons of fresh water. Use a hydrometer to help you bring the salinity up to the level needed by your organization.
- Fill bucket with water and pour slowly into bowl.
- Hook up plastic tubing to valves, filter and pump.
- Plus in pump.
- Run 24 hours before putting if fish.

Activity II:

- Set up second aquarium in the same manner.
- Omit instant ocean.

Activity III:

- Begin a log for water readings.
- Use a hydrometer to test readings from both aquariums

Note: Refill with treated tap water as needed. (Salt does not evaporate.)

SALINITY CHART

hydrometer reading	temperature (degrees Celsius)								hydrometer reading
	13	16	18	21	24	27	29	32	
1.000	0.8	1.1	1.6	2.4	3.2	4.1	5.1	5.9	1.000
1.001	2.1	2.4	2.9	3.7	4.5	5.4	6.6	7.2	1.001
1.002	3.4	3.7	4.3	5.0	5.9	6.8	7.9	8.6	1.002
1.003	4.7	5.0	5.6	6.3	7.2	8.1	9.2	9.9	1.003
1.004	6.0	6.3	7.0	7.7	8.5	9.4	10.6	11.2	1.004
1.005	7.2	7.6	8.2	9.0	9.8	10.7	11.9	12.7	1.005
1.006	8.5	8.9	9.6	10.3	11.1	12.2	13.2	14.0	1.006
1.007	9.8	10.2	10.8	11.6	12.6	13.5	14.5	15.3	1.007
1.008	11.1	11.5	12.2	12.9	13.9	14.8	16.0	16.7	1.008
1.009	12.4	12.8	13.5	14.2	15.2	16.2	17.3	18.0	1.009
1.010	13.7	14.1	14.8	15.6	16.5	17.5	18.6	19.4	1.010
1.011	15.0	15.4	16.1	17.0	18.0	18.8	20.0	20.8	1.011
1.012	16.3	16.7	17.4	18.3	19.2	20.1	21.3	22.1	1.012
1.013	17.6	18.0	18.7	19.6	20.5	21.6	22.6	23.5	1.013
1.014	19.0	19.4	20.0	20.9	21.8	22.9	24.0	24.8	1.014
1.015	20.3	20.6	21.3	22.2	23.1	24.2	25.4	26.1	1.015
1.016	21.6	22.0	22.7	23.5	24.4	25.5	26.7	27.6	1.016
1.017	22.9	23.3	24.0	24.8	25.9	26.9	28.1	28.9	1.017
1.018	24.2	24.6	25.4	26.1	27.2	28.2	29.4	30.2	1.018
1.019	25.5	25.9	26.7	27.6	28.5	29.5	30.7	31.6	1.119
1.020	26.8	27.2	28.0	28.9	29.8	30.8	32.1	32.9	1.020
1.021	28.1	28.5	29.3	30.2	31.1	32.3	33.4	34.2	1.021
1.022	29.4	29.8	30.6	31.5	32.5	33.6	34.7	35.6	1.022
1.023	30.7	31.1	31.9	32.8	33.8	34.9	36.0	37.0	1.023
1.024	32.0	32.4	33.2	34.1	35.1	36.2	37.5	38.2	1.024
1.025	33.2	33.7	34.5	35.4	36.4	37.6	38.8	39.7	1.025
1.026	34.5	35.0	35.8	36.7	37.7	38.9	40.1	41.0	1.026
1.027	35.8	36.3	37.1	38.1	39.2	40.2	41.5	42.3	1.027
1.028	37.1	37.6	38.0	39.4	40.4	41.5	42.8		1.028
1.029	38.4	38.9	39.7	40.7	41.8	42.9			1.029
1.030	39.7	40.2	41.0	42.0					1.030
Density	55.0	60.8	64.4	70.0	75.2	80.0	84.0	89.6	
	temperature (degrees Fahrenheit)								

ESTUARINE ENVIRONMENT

Lab #2 — Salinity and Density

Materials:

Graduated cylinder, instant ocean, container (glass jar or large bowl), metric scales (grams), spoon, and boiled egg.

Discussion:

Establish a hypothesis about whether an egg will float or sink in salt water.

Student Directions: (Small Group Activity)

- Fill container with 250 ml of water.
- Place boiled egg in the water. Observe what happens to the egg.
- Weigh 5 grams of instant ocean. Add this to the water and stir to dissolve.
- Continue adding 5 grams of instant ocean to water until the egg floats.
- Use this formula to determine the salinity level in the container.

$$\frac{\text{Amount of instant ocean}}{\text{Amount of water}} \times 1{,}000 = \_\_\_\_\_\%.$$

1 ml of water weighs 1 gram
(Instant Math: divide and move decimal three places to the right.)

Follow-up Discussion:

1. When the salinity level increases enough to float an egg, the mixture is called "brine." (Cucumbers are pickled in a similar solution.)
2. Compare "brine" to the salt water tank in your classroom.
3. What happened when salt was added?
4. Do other objects float with the same amount of salt?

ESTUARINE ENVIRONMENT

Lab #3 — Temperature and Density

Materials:

Gallon jar, medicine vial (that has a square bottom), food coloring and hot water, coffee pot.

Student Directions: (small group activity)

- Fill large jar with cold water.
- Fill the small medicine vial with hot water. Add a few drops of food coloring. Cover top of vial.
- Slowly set the vial on the bottom of the jar. Remove top of vial.
- Observe what happens.

Follow-up Discussion:

1. Density can be defined as the number of particles or molecules in a given space. The more molecules in a space, the denser and heavier that space.
2. Would cold or hot water have the most molecules in the space?
3. Which would be denser?
4. What happens to the warm water?

Note: May want to reverse procedure to see what happens.

THE ESTUARINE ENVIRONMENT

Lab #4 Turbidity

Materials:

Jar, water, flashlight, clay, sand, paper, markers or crayons.

(May wish to use microscopes as follow up activity).

Student Directions: (Use in darkened area.)

Experiment A:

- Fill jar with water.
- Hold flashlight up to side of jar.
- Turn on flashlight and make sure the beam shines through the jar.
- Place paper behind the jar.
- Outline the pattern of light on the paper.

Experiment B:

- Use jar from previous experiment.
- Add sand and clay to the water.
- Turn on flashlight.
- Place paper behind jar.
- Shake jar.
- Outline the pattern of light on the paper.

Discussion Questions:

1. What effect did the sand and clay have on the light.
2. What is the role of light in the estuary?
3. The sand and clay produced a turbid mixture. How might this turbidity affect estuarine organisms?

ESTUARINE ENVIRONMENT

Lab #5

Respiration Study

"Swim For It"

Materials:

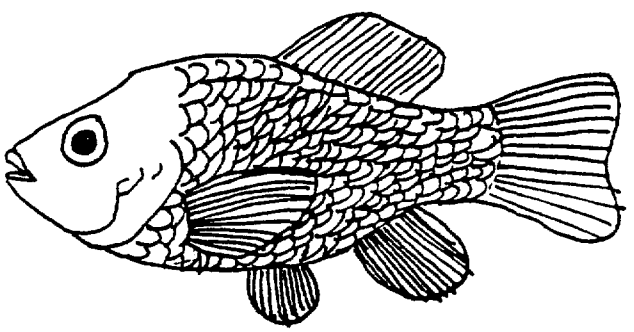
(Two aquariums - may have one tank salt water, the other fresh)

Fish, thermometer, aquarium heating unit, watch

Student Directions:

Activity 1:

- Take temperature of tanks at room temperature (C°).
- Log results _____C°
- Select a fish and observe his gills.



- Time the fish for one minute and count the rate (how many times the gill moves back and forth).
- Record your data on a group chart (each person adds the respiration rate of their fish).
- Average group results.

Lab #5

Respiration Study
"Swim For It"

Preparation For Activity II

- Add aquarium heater to tanks.
- Turn thermostat up 10^{o} from recorded temperature.
- Let aquarium sit overnight.

Activity II:

- Take temperature of tanks with raised temperatures.
- Log results _____C^{o}
- Select fish and observe the respiration rate for one minute.
- Record data on group chart.
- Average group results.
- Compare results.

Follow-up Questions:

1. What appears to be the relationship between respiration rate and raised temperature?
2. How do estuarine organisms adjust to raised temperature?
3. Why do you think there is a change in the respiration rate?

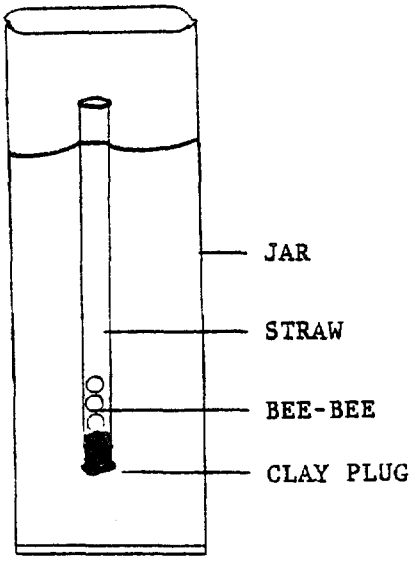
ESTUARINE ENVIRONMENT

Lab #6 Making Your Own Hydrometer

Materials: Plastic straw (10 cm in length), small amount of waterproof clay, waterproof marker, bee-bees, tall thin jar or graduated cylinder at least 200 ml of 35 0/00 salt water.

Student Directions:

- Add water to the jar or graduated cylinder to a depth of 150 cm.
- Place the clay in one end of the straw and slowly lower it into the water.
- Add the bee-bees one at a time until the straw floats upright with about 1 cm of its length out of the water.
- Mark the water level on the straw with the waterproof marker.
- Add 5 ml of fresh water.
- Mark the level on the straw.
- Repeat adding the water several times.
- Mark the straw after each repetition.



Follow-up Direction

1. How does adding the fresh water change the salinity?
2. What happens to the straw as the salinity decreases?
3. How might a decrease in salinity affect estuarine organisms?

The Estuarine Sign

Materials: Paper and Pencil

(may be used to produce signs)

Characters: cord grass, mangrove pencil, roots, leaves, sun, wind, Mr. Freeze

Role Play/Pantomine:

. Cord grass is growing in the salt marsh.

. A mangrove pencil comes along and plants itself in the cord grass, it grows, branches out and takes over area.

. Cord grass dies out because of lack of sun.

. Cold weather/Mr. Freeze comes along and kills mangroves.

. Cord grass starts goowing again in the sun.

The Estuarine Trivia

Materials: Pictures of plants and animals that live in estuarine communities, glue, construction paper

*Use Bay Life Guide

Student Directions: (Small group activity)

. Each group will make a set of cards by cutting out plants and animals. Glue pictures to construction paper.

Game:

. Each group will have a set of estuarine cards.

. Teacher will present a definition of a plant or animal that lives in the estuary.

. Students will race to select the correct picture from the estuarine cards.

. One point will be given for each correct answer.

Create An Estuary

Materials: Large sheet of cardboard, pizza box or table, beach sand, clay, soil, saran wrap (for water), blue, green, brown construction paper (2-3 sheets, 1 each color)

Student Directions:

. Create an estuarine community

. Create a salt marsh community

. Create a mangrove community

. Create a mud flat community

. Create a grass flat community

(May include one or all of the above)

. Place blue paper on table or cardboard (to represent water).

. Create an estuarine design out of brown paper and place on top of blue paper.

. Use materials to create plants and animals that live in the estuarine community of your choice.

WHAT IS AN ESTUARY? - VOCABULARY

O Z P K D Y N M H S Q G B P V E A Q S G

V C L Q J P H Y S I C A L R L V V L H Z

T A A G Q H I K Y O E B A E V I U Q G V

P S G B W L A C I M E H C D B N H O J I

E C O S Y S T E M E T K I A D T F Y P I

X M O S C L T I E U S I G T B E K Q X Y

O G N I U V D L R Q M E O I K R Z Z L G

F I N T A T I B A H O S L O Z D P S K Q

N S A L I N I T Y L W I O N D E O M C G

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Y W L I I U A G G X U R B I M E L H R P

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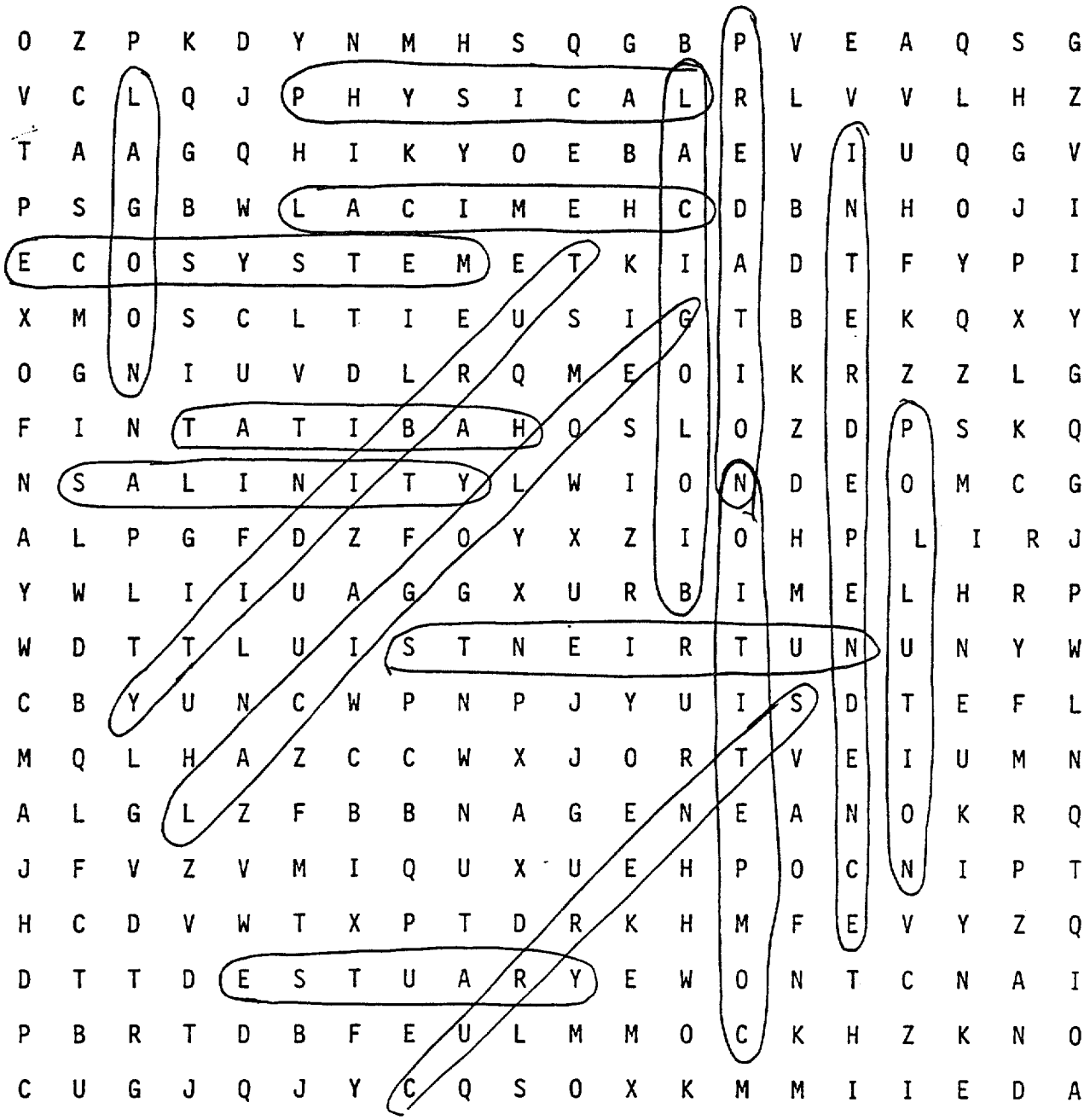
P B R T D B F E U L M M O C K H Z K N O

C U G J Q J Y C Q S O X K M M I I E D A

WORD LIST

BIOLOGICAL
CHEMICAL
COMPETITION
CURRENTS
ECOSYSTEM
ESTUARY
GEOLOGICAL
HABITAT
INTERDEPENDENCE
LAGOON
NUTRIENTS
PHYSICAL
POLLUTION
PREDATION
SALINITY
TURBIDITY

WHAT IS AN ESTUARY? - VOCABULARY



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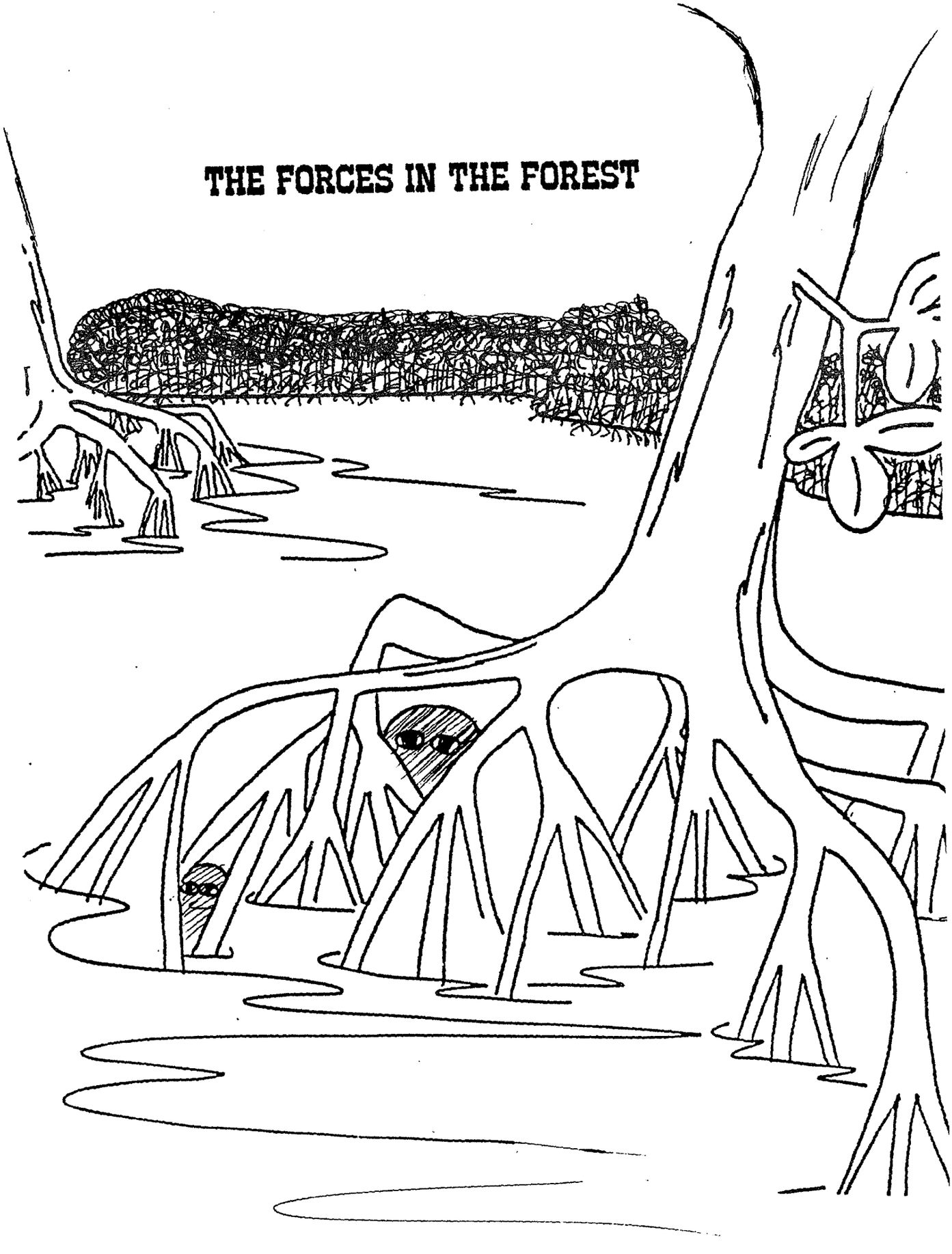
THE FORCES IN THE FOREST



THE FORCES IN THE FOREST

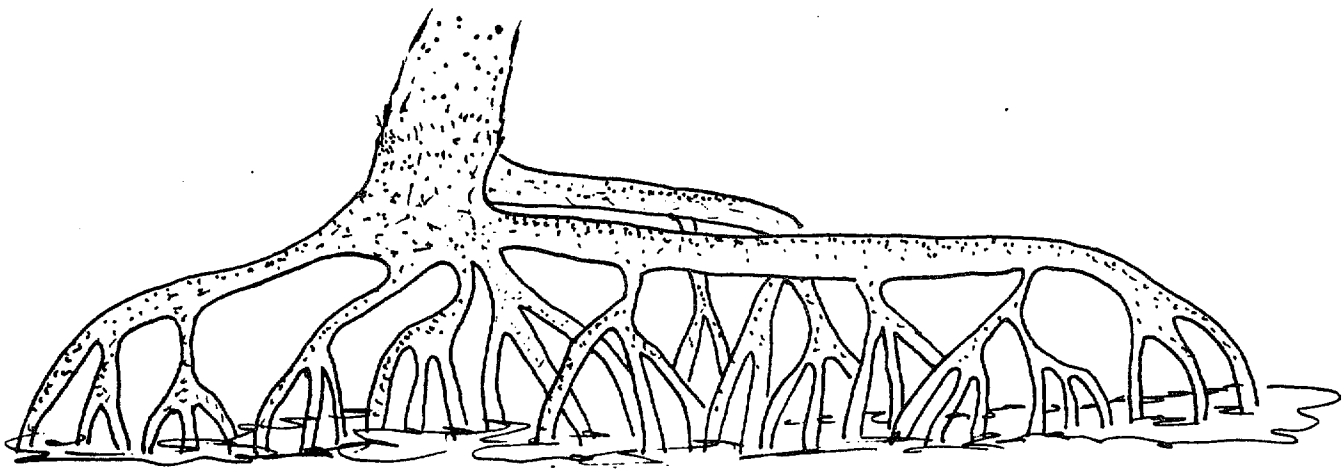
Vocabulary:

red mangroves	white mangroves	black mangroves
algae	barnacles	cormorants
crabs	detritus	egrets
fish	food chain	litter
mangrove forest	oysters	pelicans
pencil	plankton	prop-root
shrimp	photosynthesis	interdependence
mangroves	phytoplankton	zooplankton
carnivores	food web	

Have you ever seen a forest growing in the water? Well, mangrove forests do. Mangroves are tropical trees that grow in Florida's estuaries. Mangrove trees can extend their roots over large areas and provide a unique environment for plants and animals that live in this community. Mangrove seeds take root in the shallow quiet areas of the estuaries where the forces of waves, tides, and currents are at a minimum. Here they become a biological force to be reckoned with.

The tangled root structures of the mangrove forest provide traps which catch moving dirt particles and other materials. Over a period of time, this buildup of trapped material creates land. Some species of mangroves have roots that grow down from their outstretched limbs. As the roots of the mangroves reach out, they continue to form new growth. Thus the size of the forest is increased by this creeping biological force.

Red Mangrove: Prop Roots



The 469,000 acres of mangroves in Florida provide a diversified forest system that protects the coastal regions. Young fish, crustaceans, and shellfish are examples of some of the marine life protected by mangroves. Other animals are protected by the roots and branches of the mangroves. Birds use their branches for nesting and smaller organisms find a wall of protection within the spreading forest.

Artwork courtesy of U.S. Fish & Wildlife Service

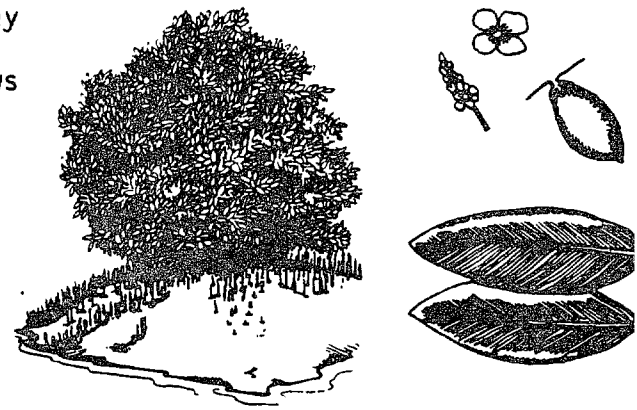
The Plants of the Forest

There are three species of mangroves common to Florida, although there are some 50 species found in the world. The red mangrove is the most well-known because of its unique prop-roots which make the trees appear to be walking. In fact, these trees have been called "the walking trees." Also unique to the red mangroves are their elongated

Red Mangrove, Rhizophora mangle

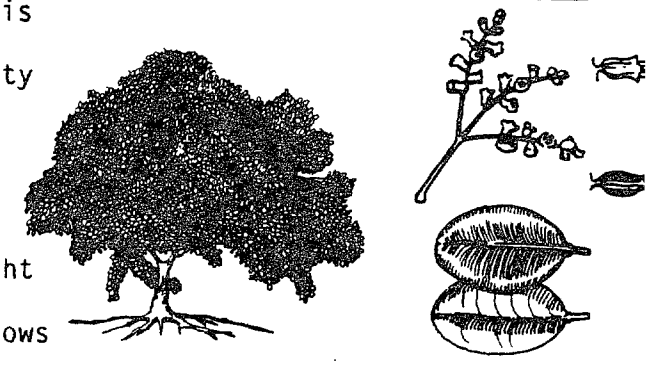
seedlings called pencils. They are eventually dropped into the mud below the parent where they can grow into new trees. The red mangrove grows in the water below the high tide line.

The black mangrove tree is found at higher elevations in the forest. It is distinguished by its finger-like breathing roots that stick up from the soil around the base of tree. The leaves of the black mangrove excrete salt. This allows these trees to live in an extremely salty environment.



Black Mangrove, Avicennia germinans

The white mangrove is usually found at the highest points in the forest. Its leaf is light green and has two glands at its base which allows salt to be excreted.



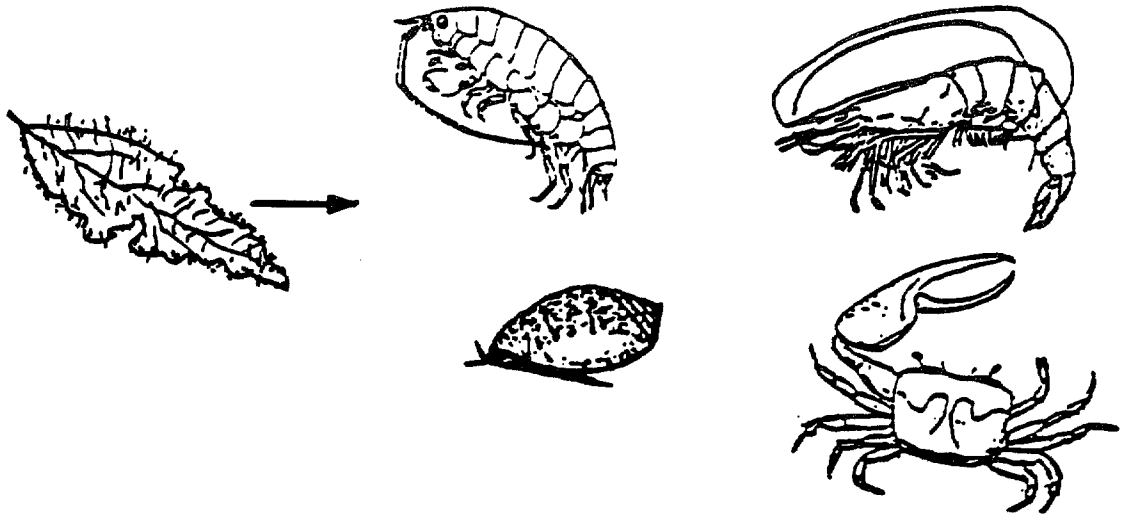
White Mangrove, Laguncularia racemosa

Since mangroves are tropical plants, temperature effeuts their growth. Black mangroves may be found in some scattered patches in northern areas of Florida, but the red and white mangroves are generally found south of Cedar Key on the Gulf Coast and Cape Canaveral on the Atlantic Coast.

Mangroves and Food Chains

Mangroves are important links in the food chains of many Florida estuaries. Their thick canopy of green leaves captures sunlight and changes it into plant material through the process of photosynthesis. This plant material provides a food source for many animals which live in the estuary. Mangroves are "messy." They continually litter the water with dead leaves, twigs, pieces of bark, and seeds. You may find this littering objectionable, but the organisms of the estuary depend upon it.

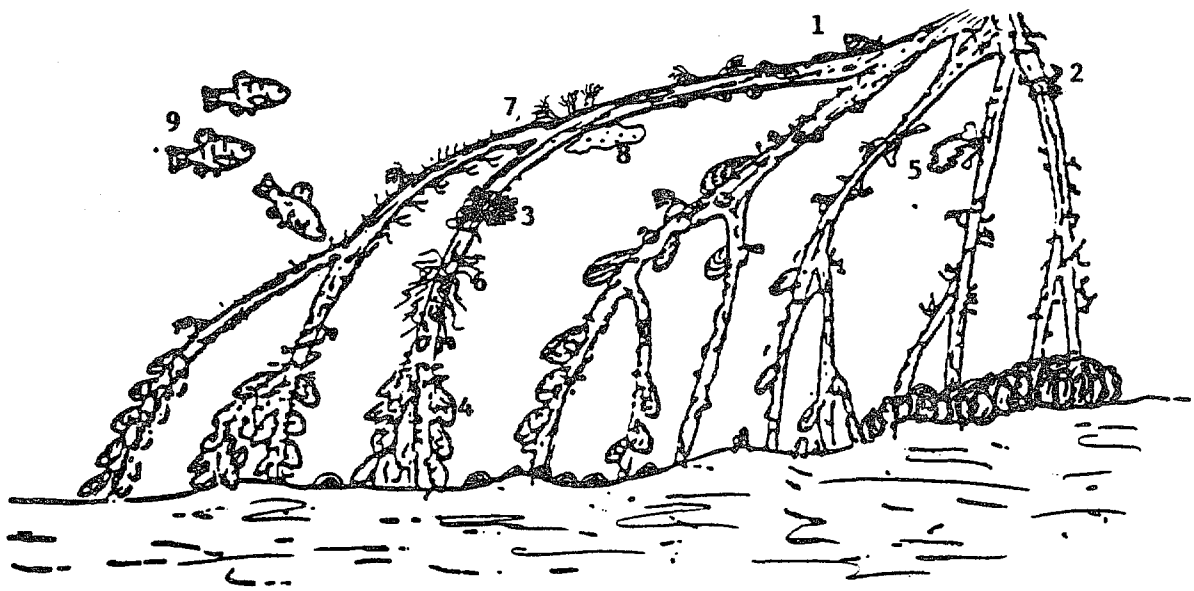
After the mangrove litter falls into the water, microorganisms begin to cover its surfaces. This begins the process of decay. This decaying litter, with its coating of microorganisms, is called detritus. Detritus provides a supply of food for many organisms in the estuary. As the tide moves in and out, mangrove detritus is carried throughout the estuary and provides a food source for shrimp, small fish, crabs, and other marine organisms.



Organisms develop an interdependence in the mangrove community. In addition to mangroves, plant plankton and attached algae provide energy sources which fuel food chains found in this habitat. Plankton, which is made up of small plants and animals that float in the water, provides a rich food source in the estuary. Phytoplankton, microscopic plants, makes food by photosynthesis just as other plants do. This phytoplankton is eaten by microscopic animals, zooplankton. Barnacles, sea squirts, oysters, and other attached animals consume great quantities of both types of plankton.

On the roots of the red mangrove trees, several types of algae may be found. These alga serve as food for small fish, snails, crabs, and other marine organisms.

Life on a Red Mangrove Prop Root

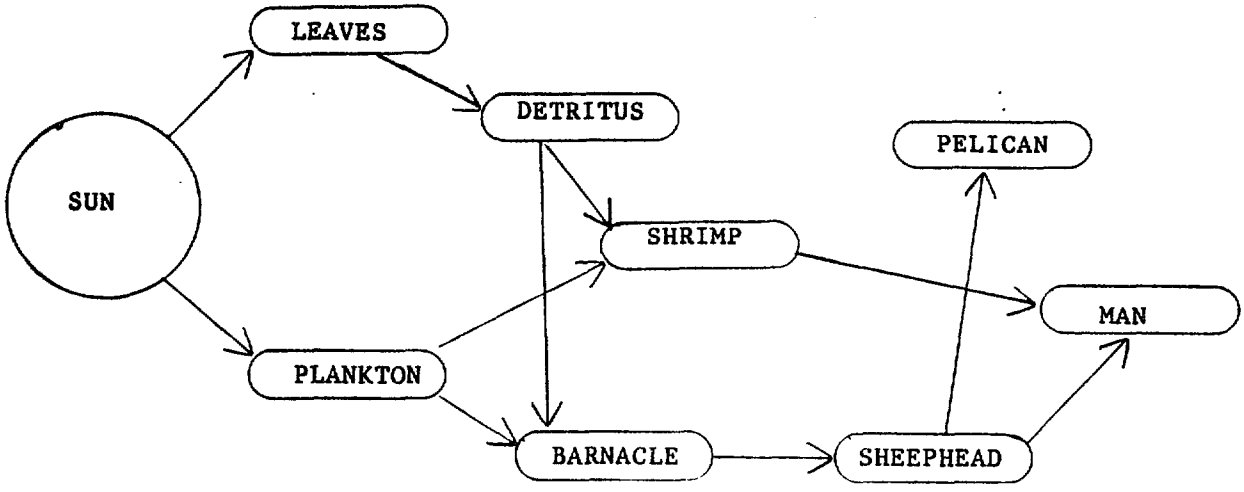


1. Snails	4. Oysters	7. Anemone
2. Crab	5. Algae	8. Sponge
3. Tunicate	6. Worms	9. Fish

Many fish in the mangrove community are meat eaters or carnivores. They feed on organisms swimming around the mangrove roots. They may also feed on barnacles, crabs, oysters, and shrimp.

Birds appear next in the food chain. Pelicans, egrets, and cormorants are hunters of fish. Humans also eat fish along with shrimp and oysters. Thus, they too benefit from the food chain found in the mangrove forest community. As we can see, this interaction of food chains is very complex. Because many of the food chains are linked together the actual flow of energy in the mangrove forest community is more like a web than a chain. Scientist therefore refer to this as a food web.

Mangrove Food Web



Mangrove Forest Glossary

algae - a group of marine water plants without roots, stems or leaves.

barnacle - a small crustacean which fastens on rocks or things under water.

black mangrove - a tree that grows in tropical intertidal zones and has finger-like roots that protrude from the soil.

carnivores - meat eaters.

cormorants - a large diving bird with webbed toes and a hooked beak.

crabs - crustaceans with four pairs of legs, one pair of pincers, and a flat shell; crabs, such as fiddler crabs prefer sandy soil near the water's edge.

detritus - a decaying mixture of plant and animal remains covered with micro-organisms. Food substance for small organisms in the estuary.

egret - a wading bird with long legs and a sharp spear-like bill.

fish - an aquatic vertebrate with fins and scales. Many fish begin life in the protected areas of an estuary where they are protected by the environment.

food chain - groups of plants and animals that depend on each other for energy.

interdependence - where organisms have a mutual dependence on each other.

litter - dead leaves, twigs, pieces of bark. These combine with dirt particles to create new land.

mangroves - tropical trees that grow in Florida's estuaries.

oysters - a marine mollusk with two irregularly shaped hinged shells.

pelicans - a large water bird with a pouch shaped bill for catching fish.

pencil - the seedling of the red mangrove tree. They grow among the leaves and drop in the water and grow into new trees.

photosynthesis - the process of using light energy to manufacture food from carbon dioxide and water.

phytoplankton - plant plankton.

plankton - microscopic plants and animals that move with the ocean's currents; a source of food for many organisms.

prop-roots - roots which grow from trunk & limbs of the red mangrove tree; prop-roots provide protection for young fish and other organisms.

red mangrove - a tree with prop-roots that grows in tropical intertidal zones. The tree's prop-roots appear to be walking. The red mangrove reproduces by dropping pencil-shaped seeds in water.

shrimp - a small edible crustacean related to the lobster.

white mangrove - a tree found growing highest in the tropical intertidal zone. The light green, oval leaf is notched and secrets salts.

zooplankton - animals plankton.

MANGROVE LAB

Lab #1 — Plant Mangrove Pencils

Materials: Styrofoam cups, potting soil, mangrove pencils, holding tray and pen (or sharp object).

Student Directions: Fill cup with potting soil and plant mangrove pencil. Use pen to make a couple of drain holes in the bottom side of cup.

- Add a little water to plant and place in holding tray. The soil should be kept moist.

- Label cup with type of plant.
- Measure the length of the seedling on a regular basis and graph your results.
- Record date when the first leaf appears.

Follow-up Discussion:

1. Do all of the seedlings in the class grow at the same rate?

2. What advantage does the shape of the mangrove pencil give it in its attempt to become rooted in the mangrove forest soil?

MANGROVE LAB

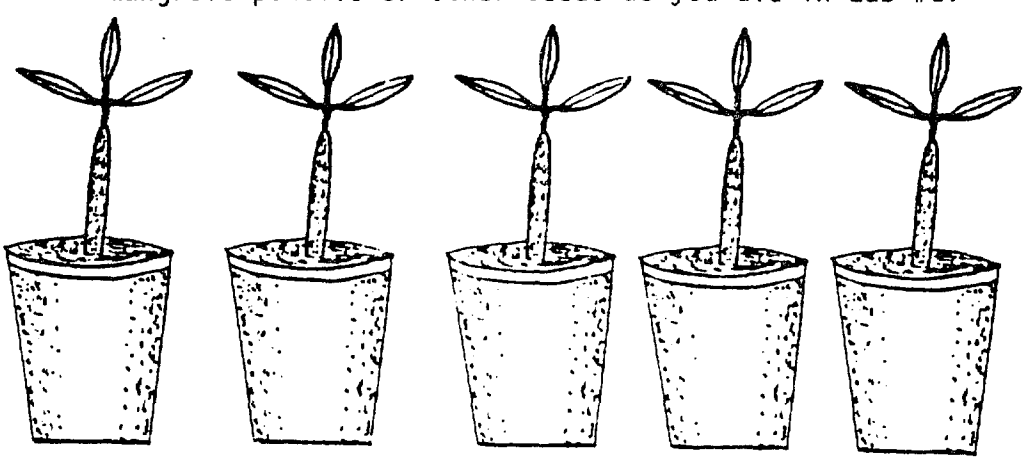
Lab #2

Effects of Salinity on Mangrove Plants

Materials: A variety of mangrove pencils (other seeds may be substituted for comparison), instant ocean, water, four plastic containers (to be used for pouring), hydrometer.

Student Directions:

- Prepare five different mixtures of instant ocean and water in marked containers.* Use 0 0/00 as a base number for the salinity level. Vary the other salinity levels up to 50 0/00. (Refer to salinity charts).
- Plant mangrove pencils or other seeds as you did in Lab #1.



- Label each cup with the salinity of the water you are using. (Label each cup with the salinity of the water you are using. Keep holding tray moist and add the same amount to each cup holding mangrove seeds every other day.
- Record growth and log observations daily.
- Prepare a hypothesis to project what will happen.
- Prepare a chart which would contain possible variables - lengths of stem, size of leaves, number of leaves, etc.

Follow-up Discussion:

1. Does the salinity of the water appear to affect the growth rate of the mangrove pencils?

2. Which plant in this study could be considered the control?

*Be sure to check salinity readings with the hydrometer. Add fresh water to replace evaporated water.

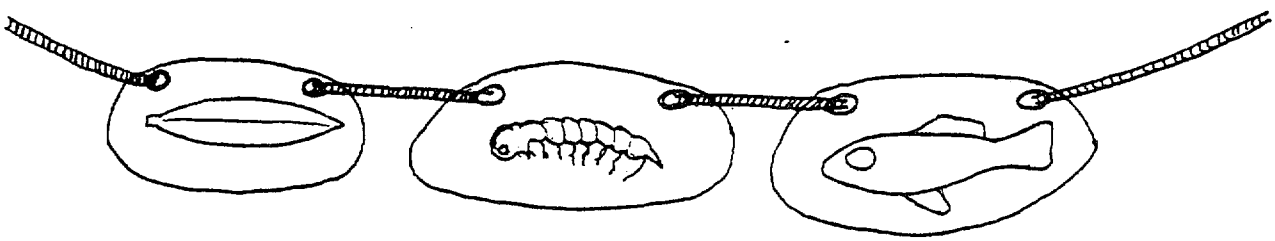
MANGROVE LAB

Lab #3 Mangrove Food Chain

Materials: Clay, pencil or sharp object, string, yarn, or leather. (May want to collect mangrove leaves to be pressed into clay.)

Student Directions:

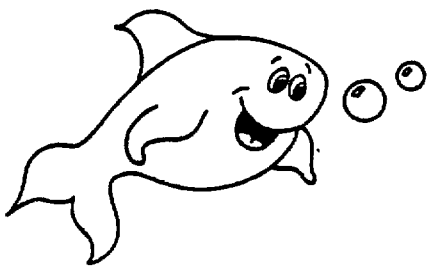
- Roll the clay into ball about 2 cm in diameter.
- Flatten the balls to form disks.
- Press, organisms or parts of organisms found in the mangrove forest into the clay to form impressions.
- Draw organisms seen but not collected on the dish with a sharp object.
- Punch 2 holes in the top of the dish.
- Allow clay to air dry or fire in a kiln if available.



Follow-up Discussion:

1. How are the units in an actual food chain linked?

2. Why is a chain not a very accurate representation of what actually happens in an estuary?



Let your trees do the walking...

Student Directions: Use coordinate pairs* to plot the letters and form words on the grid.

Example: (2,9) = I ; (1,9) = H ; (3,9) = !

*(→ , ↑)

I.

1. (0,3) = L
2. (0,2) = A
3. (0,0) = K
4. (0,4) = B
5. (0,1) = C

II.

1. (6,5) = O
2. (2,5) = R
3. (8,5) = T
4. (3,5) = O
5. (1,5) = P
6. (9,5) = S
7. (4,5) = P
8. (5,5) = R
9. (7,5) = O

III.

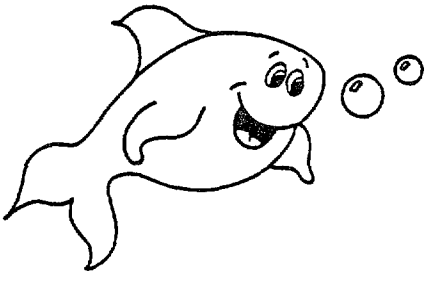
1. (5,5) = R
2. (5,2) = E
3. (5,7) = N
4. (5,9) = M
5. (5,1) = S
6. (5,4) = O
7. (5,6) = G
8. (5,8) = A
9. (5,3) = U

IV.

1. (5,2) = E
2. (6,2) = D
3. (4,2) = R

V.

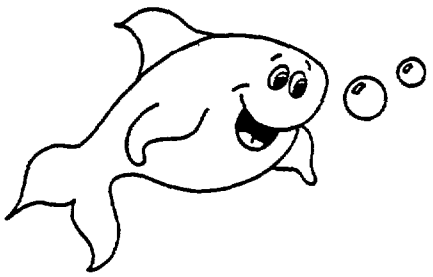
1. (8,5) = T
2. (8,7) = H
3. (8,8) = W
4. (8,4) = E
5. (8,6) = I



Let your trees do the walking...

ANSWER SHEET

9		H	I	!						
8										
7										
6										
5										
4										
3										
2										
1										
0										
	0	1	2	3	4	5	6	7	8	9



Let your trees do the walking...

ANSWER SHEET

9		H	I	!		M				
8						A			W	
7						N			H	
6						G			I	
5		P	R	O	P	R	O	O	T	S
4	B					O			E	
3	L					V				
2	A				R	E	D			
1	C					S				
0	K									
	0	1	2	3	4	5	6	7	8	9

THE MANGROVE FOREST-VOCABULARY

P Z B X Y Q E I L D R O J T M D E R Q M

J L K S O W B X D S E P L X A Y U R M U

U Q N S A X R V A F B O O F E Z Z H R X

Z N K J H A G W J D C O M O R A N T S U

J L D H E Z B H F J L K L O X T C N D Y

D B T B P I U E S Q Z W D D X O M I M J

T J S H B U I A I E S B V C W F Z P H J

O I N N P B S B C L L D L H Q N X E Q L

C Q Q W E C F H Q C R C W A C O U L R C

G P A O Y L M L R J X E A I C T R I W F

Y B E K Y E I A R V S L T N D K I C E C

F C H O R S B C N S N I A T R N Y A C U

S Q L S M S T R N G T S T Y I A G N Z K

L M S V U J I E U E R E A H Q L B S H B

K Q K Z N T O O R M P O R P A P T X R I

H T K P I S I V D S J M V G G D B P V E

M V A Z L V I R J I H Y I E E D D S W P

I X E M Q W H I T E L N Z R P W Y C U F

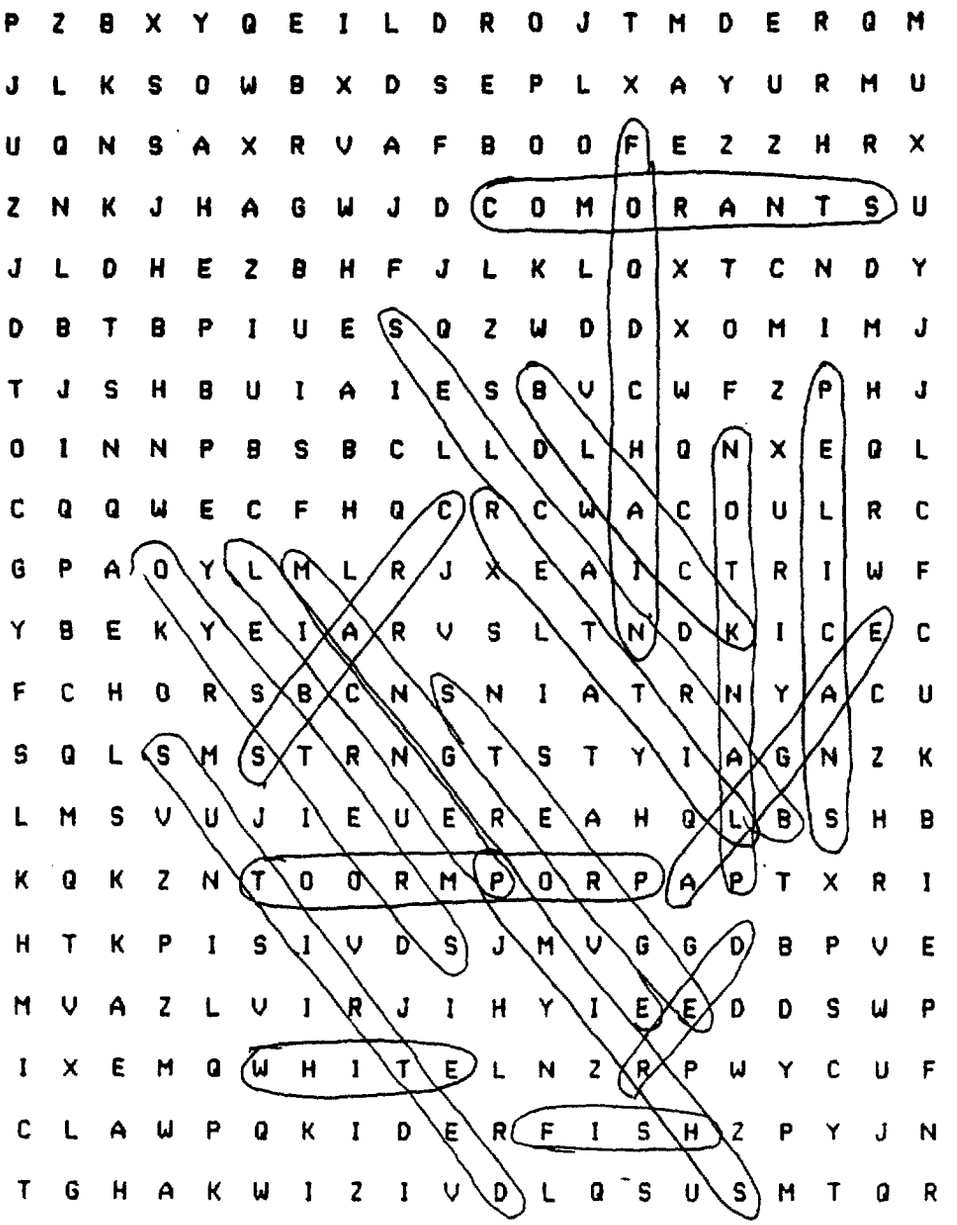
C L A W P Q K I D E R F I S H Z P Y J N

T G H A K W I Z I V D L Q S U S M T Q R

WORD LIST

ALGAE
BARNACLES
BLACK
COMORANTS
CRABS
DETRITUS
EGRETS
FISH
FOOD CHAIN
LITTER
MANGROVE
OYSTERS
PELICANS
PENCIL
PLANKTON
PROP-ROOT
RED
SHRIMP
WHITE

THE MANGROVE FOREST-VOCABULARY



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PENCIL
PLANKTON
PROP-ROOT
RED
SHRIMP
WHITE

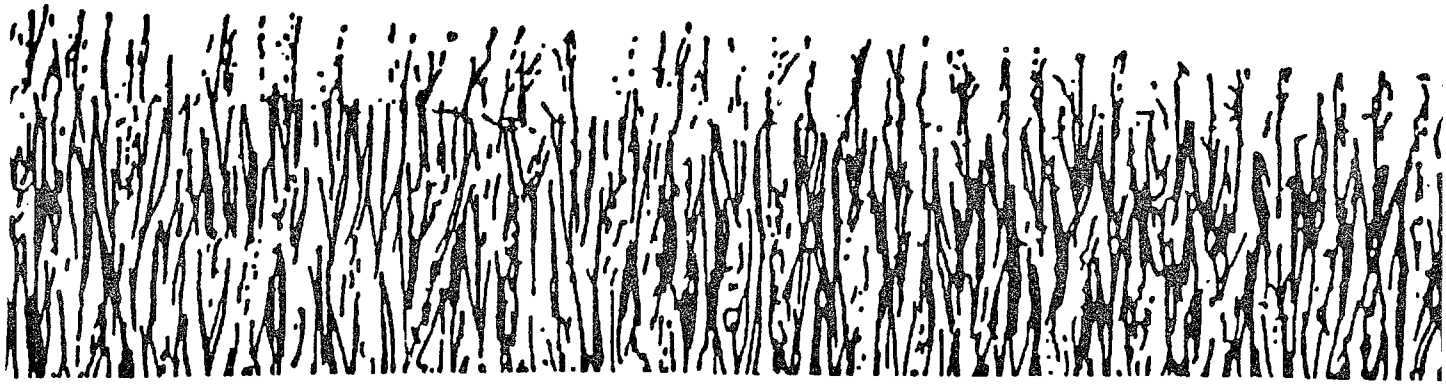
THE MANGROVE FOREST COMMUNITY

Contributors: David Kraemer, Bill Haynes and Mike Mullins

1	Aerial view of a mangrove coastline	Bordering the estuaries of South Florida is a magical, tropical forest.
2	Mangrove shoreline	This forest is produced by the prolific growth of three species of salt tolerant trees called mangroves.
3	Mangrove forest	These mangrove trees create a unique environment which provides food and shelter for a large number of plants and animals.
4	Red mangrove	The red mangrove is the most well known of the three species.
5	Prop roots	Strange prop roots reach out from the trunk and hang down from the limbs creating a tree which appears to be walking.
6	Red mangrove	Another special feature of the red mangrove is its method of reproducing.
7	Red mangrove flower	After the flower is pollinated,
8	Mangrove fruit	The seed which results sprouts while it is still attached to the parent plant.
9	Mangrove pencil	The seedling is known as a mangrove pencil because of its shape.
10	Pencil in mud	After it falls from the tree, the seedling can grow into a new plant.
11	Black mangrove	Another tree found in the mangrove forest community is the black mangrove.
12	Close up of roots	Surrounding the trunk of this tree are hundreds of finger-like projections called breathing roots.
13	Salt on leaf	Black mangroves have special glands in their leaves which get rid of excess salt.
14	White mangrove	A third tree frequently found in the mangrove forest is the white mangrove.
15	Leaf	This tree is distinguished by its spoon-shaped leaves which have two salt glands on their petioles.

16	Red mangrove	Using the process of photosynthesis to capture energy from the Florida sun, the leaves of the mangrove trees become producers at the beginning of a giant food web.
17	Red leaf	After these leaves fall into the water, they take a great deal of stored energy with them.
18	Leaf with slime	This energy is food for decomposers such as bacteria and fungus.
19	Close-up of slime on leaf	This creates a rich food source called detritus.
20	Crustacean	Small crustaceans and snails feed on the detritus,
21	Killifish	And then fall victim to small fish.
22	Large fish	The small fish are eaten by larger fish,
23	Wading bird	Birds, and the ultimate mangrove community predator
24	Fisherman	Man!
25	Mangrove shore	Mangroves are an important biological force in many of Florida's estuaries.
26	Mangrove roots	Their twisted network of roots, act as pollution filters and reduce wave action.
27	Mangrove roots	They also trap sand and detritus. This reduces the depth of the estuarine water.
28	Dredge and fill	In spite of laws to protect them, the human forces in the estuaries continue to threaten these valuable mangrove forests.
30	Mangrove island	Perhaps in time, with enough education, most Floridians will come to appreciate this important biological force.

THE FORCES IN THE MARSHES

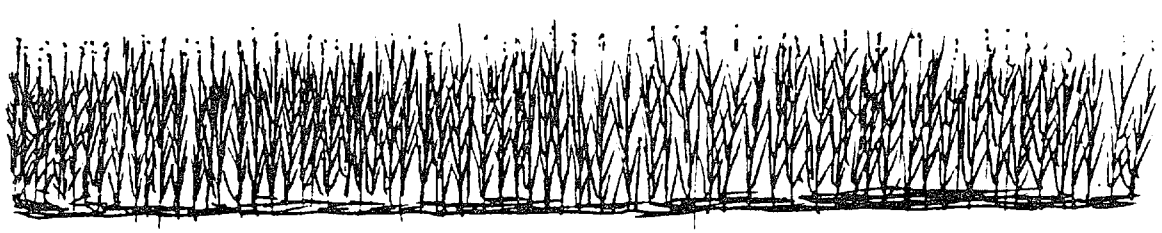


THE FORCES IN THE MARSHES

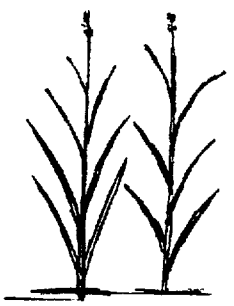
Vocabulary:

cord grass	needle rush	detritus
erosion	estuarine	food chain
habitat	intertidal	silt
tides	nutrients	light
aerate	burrows	zooplankton
phytoplankton		

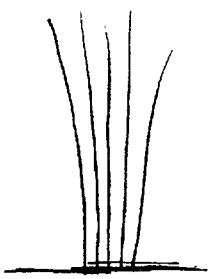
Salt marshes are estuarine wetlands. They provide habitats which are rich in marine life. The forces that shape salt marshes are tides, temperature, nutrients and light. Salt marsh plants cannot survive the force of high energy waves. They thrive in quiet coastal areas. Cold winter temperatures are the allies of salt marsh plants. Their extensive underground root systems can easily survive winter freezes. As a result they are abundant in the estuaries of North Florida where the more cold sensitive mangrove trees cannot survive. Salt marsh plants can also grow in the warmer parts of the state but do not compete well with mangroves for light. In South Florida they are usually found in the zone between the mangrove forest and freshwater marshes. Because of their great adaptability, salt marsh plants can grow in a wide variety of habitats. For this reason salt marshes are the most abundant intertidal communities in Florida.



Several types of plants are found in Florida salt marshes. Cord grass and needle rush are the most common species. Cord grass is especially common in the east coast estuaries. Needle rush is more common in South Florida and along the upper west coast from Tarpon Springs to Apalachicola Bay.

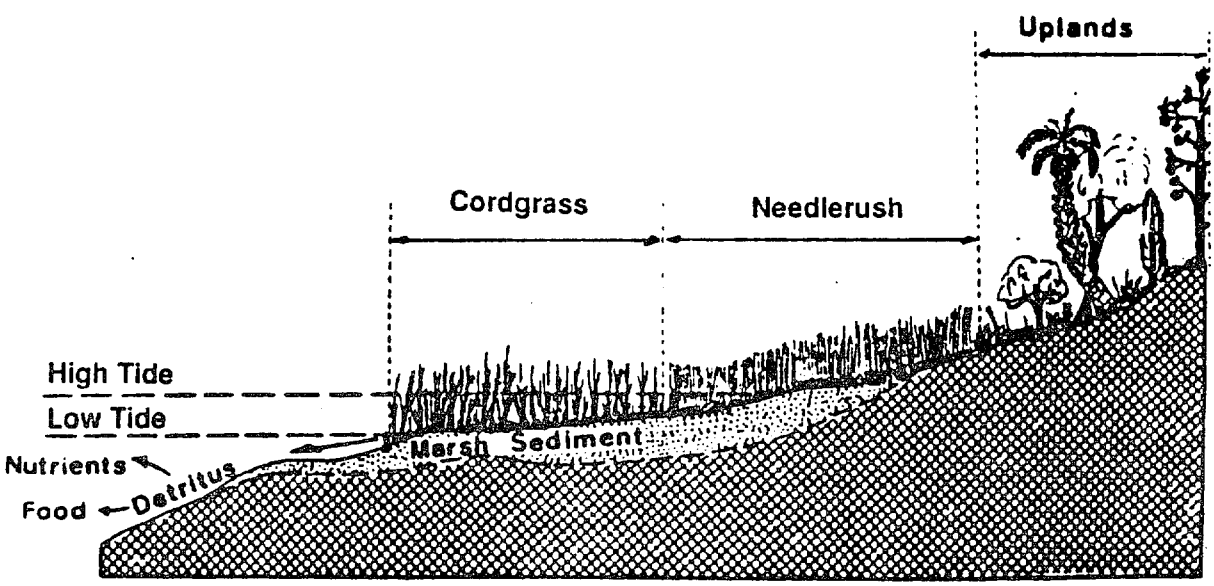


CORD GRASS



NEEDLE RUSH

When they occur together cord grass generally grows in deeper water than needle rush.



Modified from Bureau of Marine Research Publication

Needle rush grows year round but cord grass leaves usually die back in the winter like their cousins that live on the land. Cord grass gives off excess salt through its leaves while needle rush blocks salt from entering its roots.

The dense mass of stems and leaves of the salt marsh plants slows currents and wave action. This prevents erosion of the soil. Over a period of time silt and detritus collect around the base of the salt marsh plants. This can help create new land.

Salt Marsh Food Chains

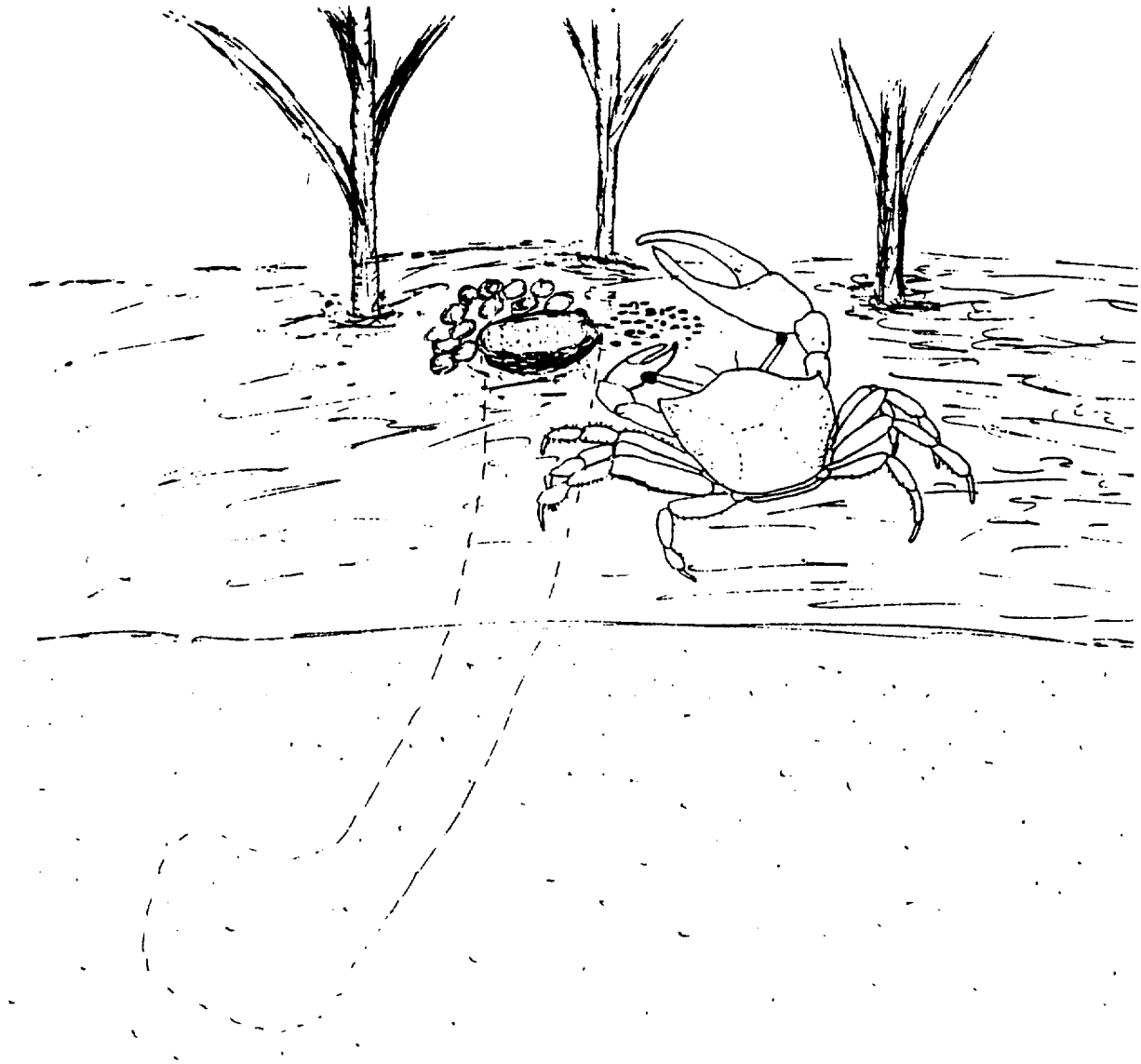
Salt marshes provide an abundant crop of food for estuarine organisms. But like the mangrove forest community, about 90% of the plant material has to be broken down to detritus before it is used by animals. Many of the animals that eat detritus in the salt marshes are the same or similar to the ones found in the mangrove forest. The food chains that begin in the marshes often extend into the open ocean. Nutrients from the break down of marsh plants support a rich phytoplankton community both in the estuary and offshore. Phytoplankton provides food for zooplankton. Both types of plankton end up being eaten by filter feeders in the estuary.

Biological Forces in the Marsh

The interaction of plants and animals influence the salt marsh habitat. One common inhabitant of the salt marsh is the fiddler crab. This tough little fellow feeds on the rich detritus and benthic microalgae found in the marsh. The fiddler crab tunnels deep into the marsh soil. The incoming tide fills his burrow with mud.

When the tide goes out, the sturdy fiddler clears the accumulated mess from his home. These permanent burrows aerate the marsh soil. They allow waste gasses to escape to the air and they allow oxygen to penetrate below the surface of the soil.

FIDDLER CRAB



Salt Marsh Glossary

aerate - to mix with air or to charge with gasses.

burrows - tunnels in the sediments produced by organisms.

cord grass - marine grasses that grow in intertidal areas where wave action is not strong.

detritus - a decaying mixture of plant and animal remains covered with a microorganisms food substance for small organisms in the estuary.

erosion - a loss of sediment.

estuarine - an adjective form of the word estuary. Used to describe both living and non-living things associated with estuaries.

filter feeders - organisms that strain their food out of the water.

food chain - the transfer of energy from one organism to another in an ecosystem.

habitat - a place where plants and animals live.

intertidal - between low and high tide.

light - energy source for green plants.

needle rush - grayish plants that grow in the higher areas of the salt marsh community.

nutrients - elements or molecules necessary for energy transfer and growth in organisms.

phytoplankton - plant plankton.

silt - small sized particles, such as, mud deposited by a stream.

tides - the rhythmic rising and falling of large bodies of water caused by the gravitational pull of the sun and the moon.

zooplankton - animal plankton.

SALT MARSH LAB

Lab #1 — Something's Rotten in the Marsh!

Materials: Microscopes, petri dishes, detritus samples*

Student Directions:

- Place small amounts of detritus in a petri dish.
- Add a little water to petri dish.
- Place petri dish under microscope.
- Observe the detritus sample and try to identify the remains you see.
- Prepare a list of the types of decomposing materials that you found.
- Draw some of the examples you see.

Follow-up Discussion:

1. Why is rotting important in estuarine food chains?

2. How is the plant material changed in this process?

* Can use sample from marsh, river or ditch.

SALT MARSH LAB

Lab #2 — Fiddler's on the Roots

Materials: Aquariums, fiddler crabs, salt marsh soil, fish food

Student Directions:

- Observe the artificial colony of fiddler crabs established by your teacher.
- In the space below list four behaviors exhibited by the crab. (Be as complete in your description as possible. (e.g., locomotion - The crab moves by walking sideways on four pair of legs.)

1.

2.

3.

4.

. From your observations, predict what behaviors the crabs will exhibit when a shadow falls over them.

I predict that..._____

_____

_____

_____

. Test your hypothesis

Follow-up Discussion:

1. How might this reflex behavior help the crabs in their environment?

2. What differences did you note in the behaviors of male and female fiddler crabs?

3. How is the large claw of the male fiddler useful? How is it a disadvantage?

SALT MARSH LAB

Lab # 3 Living in a marsh can be swell!

Materials:

Potato, small objects to add to potato such as: yarn, buttons, plastic, and toothpicks or straight pins. Also needed are four plastic pans, instant ocean and water.

Student Directions:

Take one potato. Decorate potato as a fish. Add eyes, fins, and other fish features.

Prepare four pans of water. Each pan will have a different level of salinity, 00/00, 10/00, 30/00, 40/00, 100/00.

Observe your potato fish and compare this observation to other potato fish swimming in water with different salinity levels.

Record Data on Chart Below:

Fish Weight Before	Salinity	Fish Weight After
	00/00	
	10/00	
	30/00	
	40/00	
	100/00	

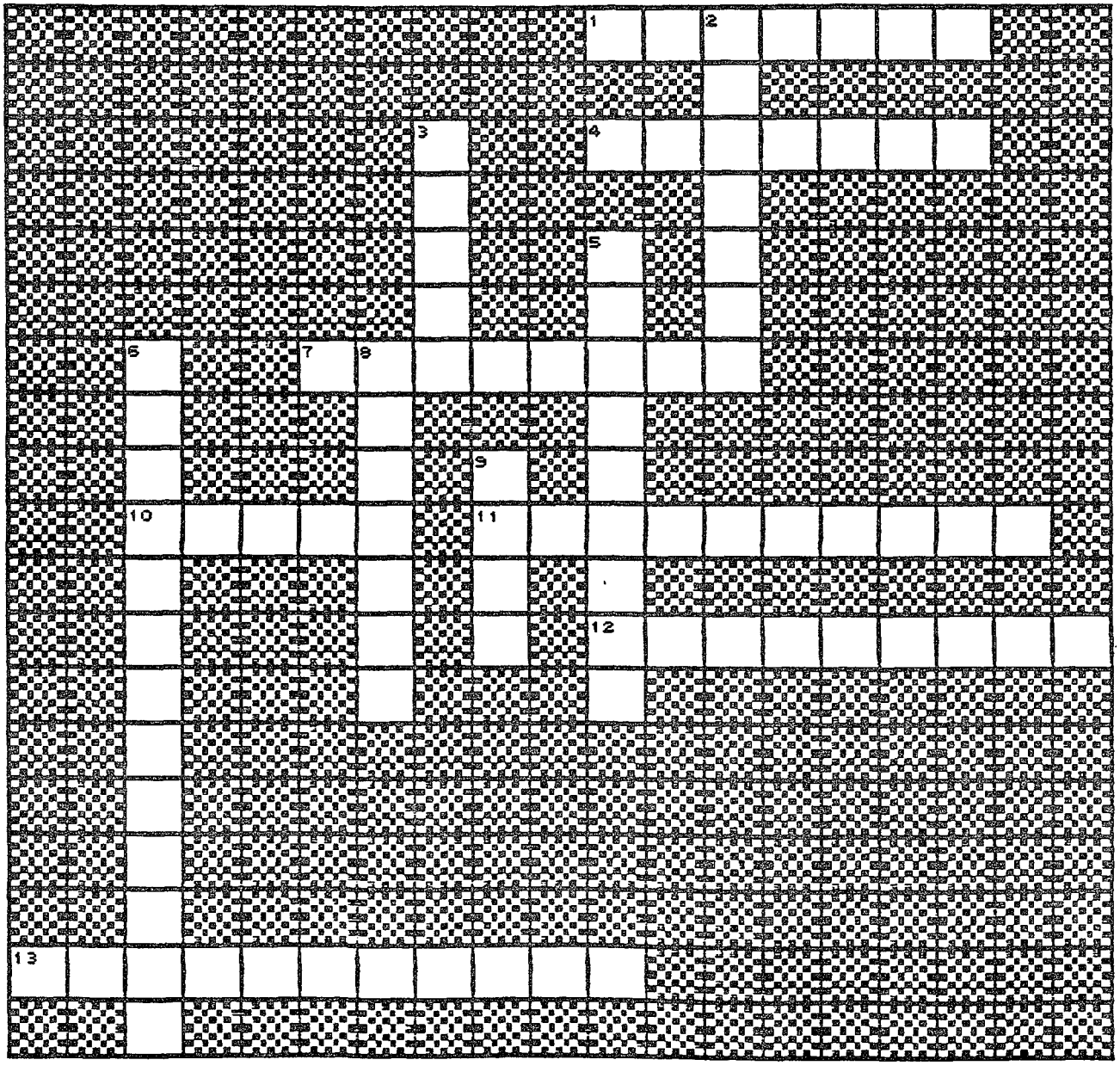
Follow-up Discussion:

1. What change occurred in the fish?

2. What change might changes in salanity cause in living organisms?

3. How could you protect your fish from these changes?

THE SALT MARSH



ACROSS CLUES

1. A PLACE WHERE PLANTS AND ANIMALS LIVE
4. TO MIX WITH AIR OR CHARGE WITH GASES
7. A DECAYING MIXTURE OF PLANT AND ANIMAL REMAINS
10. THE RHYTHMIC RISING AND FALLING OF LARGE BODIES OF WATER.
11. BETWEEN HIGH AND LOW TIDES
12. SUBSTANCES NECESSARY FOR ENERGY TRANSFER AND GROWTH
13. ANIMAL PLANKTON

DOWN CLUES

2. TUNNELS IN THE SEDIMENT PRODUCE BY ANIMALS
3. THE ENERGY SOURCE FOR GREEN PLANTS
5. THE ADJECTIVE FORM OF THE WORD ESTUARY
6. PLANT PLANKTON
8. A LOSS OF SEDIMENT
9. A VERY SMALL TYPE OF SEDIMENT

Script for: THE SALT MARSH COMMUNITY

Produced by: Mike Mullins and David Spencer

		NARRATION
1	creek	Lining the estuaries of northern Florida is a highly productive community known as the salt marsh.
2	salt marsh meadow	Traces of the salt marsh community are found in Southern Florida....
3	cord grass and mangrove	But it is eventually replaced by the fast growing mangrove swamp community.
4	title slide	
5	credit slide	
6	cord grass meadow	What type of forces control this estuarine community?
7	salt meadow cord grass	Elevation, tidal range, temperature and salinity all are forces which play a part.
8	mud flat with algae	Salt marshes often begin where sediment is being deposited on a mud flat or marine grass flat.
9	cord grass in deep water	When the water becomes shallow enough, seeds of a salt-tolerated called cord grass can take root.
10	cord grass in shallow water	The cord grass plants reduce water flow and gradually trap more sediment. This decreases the depth off the water.
11	cord grass and oysters	At other times, cord grass may take root on an oyster bar. In time it may gradually out compete and cover this community.
12	needle rush	When the cord grass is well established other plant such as needle rush often join it.

THE SALT MARSH COMMUNITY (cont)

13	salt meadow cord grass	In addition to tides, other forces affect salt marsh communities.
14	flooded marsh	The soil in which it grows is low in oxygen and high in salt.
15	cord grass leaf-closeup	The plants have special structures on their roots and leaves to help them live with these forces.
16	cord grass and snails	Within the salt marsh are a number of animals which depend on the plants for food.
17	deer and cord grass	Some animals such as deer and insects feed directly on the leaves of the plants.
18	dead needle rush	However, most of the energy captured from the sun by these green plants enters the salt marsh only upon the death of the leaves and roots.
19	amphipod on	Salt marsh consumers such as amphipod and mollusks feed on this dead plant material shredding it into small particles.
20	dead grass	The shredded plant material is rapidly covered by fungi and bacteria forming a rich food source called detritus.
21	fiddler crab	Detritus is eaten by a large number of marsh consumers. The eventual break down of this material releases nutrients which....
22	copepod and diatoms	Support the growth of a large plankton community within the estuary.
23	Oyster bars	The animals of the salt marsh community are well adapted to the cycle of the tides.
24	ribbed mussels	On the rising tide, barnacles, oysters and mussels open to feed on plankton and detritus.

THE SALT MARSH COMMUNITY (cont)

25	periwinkle	At the same time, periwinkles climb the stalks of the plants staying ahead of the rising water.
26	longnose killifish	The animals which live in the tidal creeks at low tide, such as the longnose killifish....
27	diamond killifish	And this diamond killifish follow the rising tide into the marsh to hunt for food.
28	blue crab	Crustaceans, such as crabs and shrimp also move high into the marsh looking for a tasty meal.
29	gulf killifish	Some of the fish feed with gusto on the larva of the salt marsh mosquito which are washed from among the cord grass stalks by the swift tidal currents.
30	black drum	As the tide turns and begins to fall, all of the swimming creatures begin a hasty retreat back to deeper water.
31	heron	Many will fall prey to the wading birds which move into the salt marsh as the waters retreat.
32	Aerial of boat in the marsh	Sharing in this rich catch are many human fisherman.
33	close up of fisherman	Many of the commercially important shellfish and finfish caught in Florida waters are dependent on estuarine salt marshes during some stage of their life cycle.
34	duck	Salt marshes are also extremely valuable because they provide a resting area for water fowl.
35	tidal creek	The cleanse the water on its way to the estuary by removing silt and excess nutrients.
36	creek	Marshes protect the coastal plain surrounding the estuary from severe waves.
37	lighthouse	Finally, they have a value to man which cannot be measured but only appreciated.

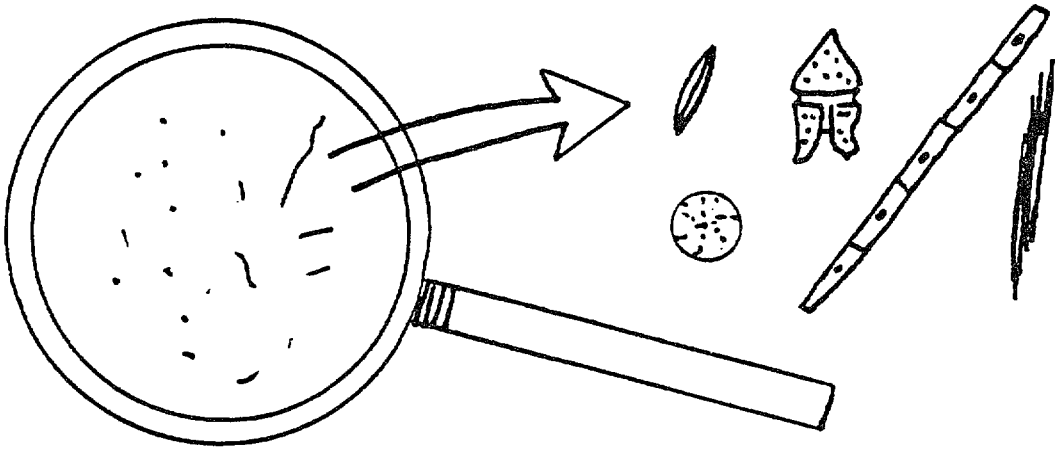
THE FORCES ON THE MUD FLATS

UNSEEN FORCES AT WORK - THE MUD FLATS

Vocabulary:

mud flats	intertidal zone	algae
microscopic	diatoms	producers
dinoflagellates	food chain	tide
currents	scavengers	detritus
consumers	filamentous	benthic
infauna		

When we think of life in the estuary we might be tempted to ignore those large areas of bare sand and mud which are found in the intertidal zone of most estuaries. But the mud flats are not what they seem. I don't see any plants, you say and plants are necessary for life. Fear not, the plants are here. Not towering mangrove trees or thick stands of cord grass, but a fine thin carpet of microscopic algae.

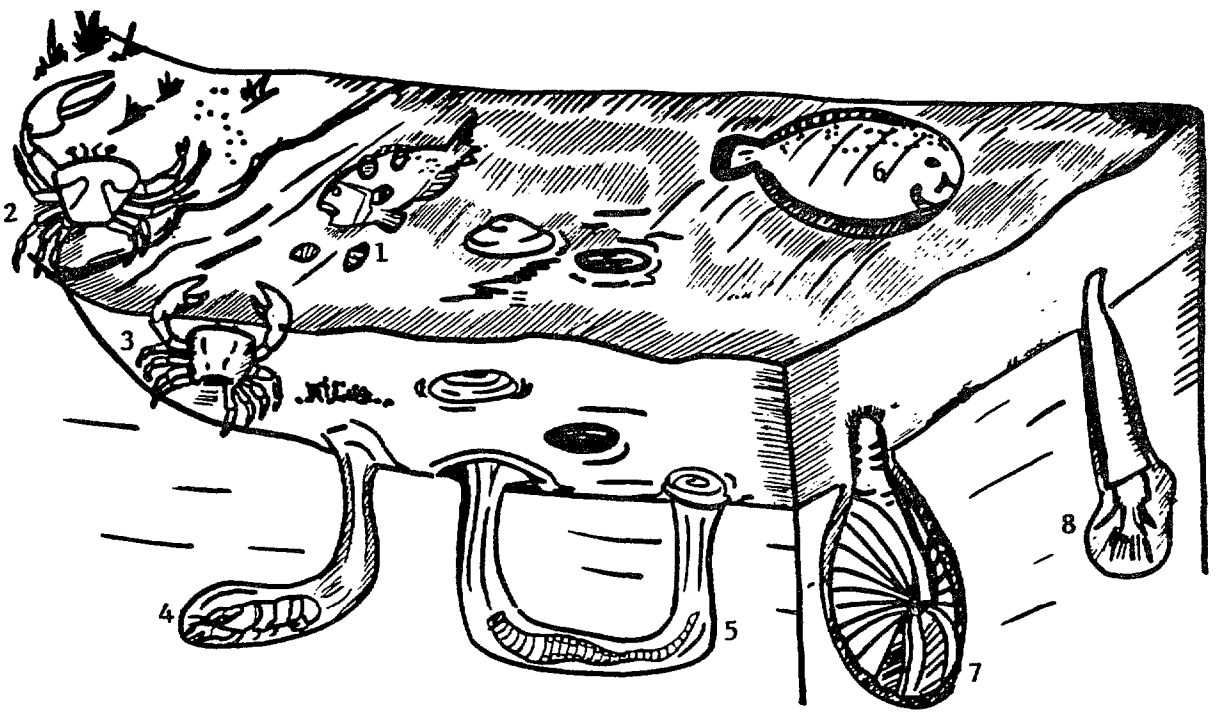


Diatoms, dinoflagellates, filamentous, green algae and blue-green algae are the producers of the mud flats. You can see them if you look closely at

the surface of the mud. They add a variety of color to the drab gray. yellows, greens and even purple colors can be found.

So where are the animals? Well, where do you think a marine animal would live when the tide is out? That's right, how did you guess? Some of them do go out with the tide, but others stick around. Benthic infauna, a fancy name for critters that live below the surface of the sand, are the most common inhabitants of the mud flats when the tide is out.

The diagram below shows you some of the critters that are common in estuarine mud flats.



1. mud snails
2. fiddler crab
3. mud crab
4. ghost shrimp
5. lug worm
6. flounder
7. clam
8. trumpet worm

Feeding on these critters during low tide are a number of different birds. They use their beaks to probe the mud for nice fat worms and juicy clams. When the tide comes back in, back come the fish, crabs and shrimp to pick

off the stragglers. These critters are especially active at night when they are relatively safe from attack by wading birds on the next link in the food chain.

In addition to their value as food producers, the mud flats serve another function. Currents and tides carry detritus from other communities where it is stranded during low tide. Fiddler crabs, sand fleas and other scavengers break this detritus down into small pieces which make their way to other consumers in the estuary.

Mud Flats Glossary

algae - simple plants without roots, stems or leaves.

benthic - at the bottom.

consumers - organisms that depend on others for their food supply.

currents - streamlike movement of the water in estuaries and oceans.

detritus - a decaying mixture of plant and animal remains covered with microorganisms; food substance for small organisms in the estuary.

diatoms - one-celled plants with shells made of glass.

dinoflagellates - one-celled microorganisms with the characteristics of both plants and animals.

filamentous - a series of cells hooked together to form a chain.

food chain - transfer of energy from one organism to another in an ecosystem.

infauna - animals that live below the surface of the sediment.

intertidal zone - an area between low and high tide.

microscopic - things not visible to the naked eye.

mud flats - unvegetated intertidal flats.

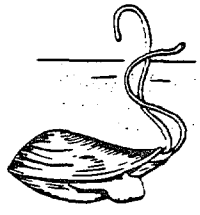
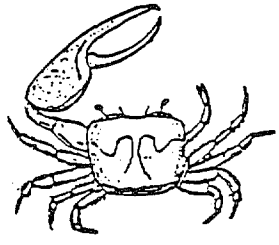
producers - organisms which make their own food.

scavengers - organisms which feed in dead things.

tide - the rhythmic rising and falling of large bodies of water caused by the gravities of the sun and the moon.

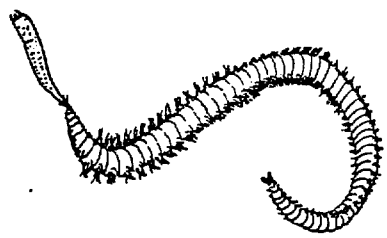
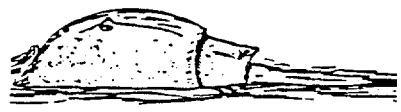
WHAT'S THAT ON THE MUD FLAT?

Directions: Match each organism by listing the number (#) that gives the description and the letter (A, B or C) used to illustrate "mud flat critters".

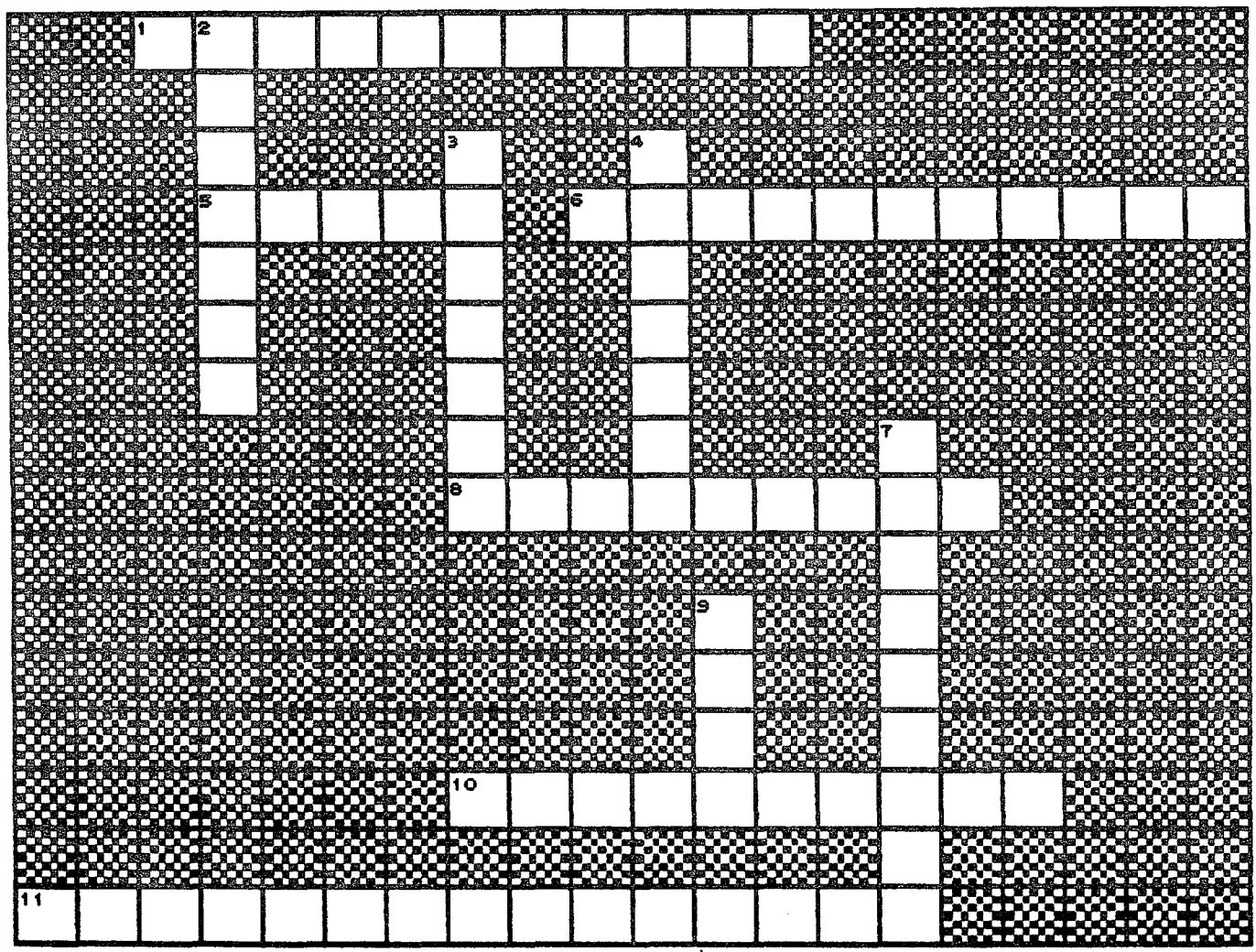
Description	Picture	Organism	#	Letter
1. This small "critter" is called a fiddler because the male has an enlarged claw which it waves in the air like a fiddle. It feed on algae and detritus at low tide.	A. 	horseshoe crab	___	___
2. This "critter" gets its name from the fact that the tip of its shell is curved to the left when viewed from above. It stays buried in the mud and uses its long siphon to suck algae and detritus from the surface of the mud.	B. 	bent nose macoma	___	___
3. This plow shaped "critter" pushes through mud to feed on a variety of small organisms. It has a long spinelike tail and crawls on five pairs of spider-like legs.	C. 	blue crab	___	___
4. This "critter" is a predator that throws out a long proboscis equipted with hooks to capture prey. It is a highly developed red annelid that enjoys "mud slinging".	D. 	mud snail	___	___

WHAT'S THAT ON THE MUD FLAT?

Page 2

Description	Picture	Organism	#	Letter
5. This "critter" gets its name from the fact that long segments make it appear like a stalk of bamboo. It builds a soft mucus-lined tube which sticks up above the surface of the mud. It feeds on plankton which is sucked into the tube.	E. 	blood worm	___	_____
6. This "critter" has a curved beak to probe burrows for worms and mollusks. Long legs help elevate the critter's body. Its beady eyes scan the mud flat for action.	F. 	white ibis	___	_____
7. This small "critter" is a mollusk that lives on the mud flat. It is a scavenger and can often be found feeding on a dead fish left behind by the falling tide.	G. 	fiddler crab	___	_____
8. This "critter" is a predator with large claws which it uses to capture food. It prefers brackish water and is usually found in the estuary. It molts and sheds the old shell. This leaves the critter without a shell for protection until a new one forms on the body.	H. 	bamboo worm	___	_____

THE MUD FLATS



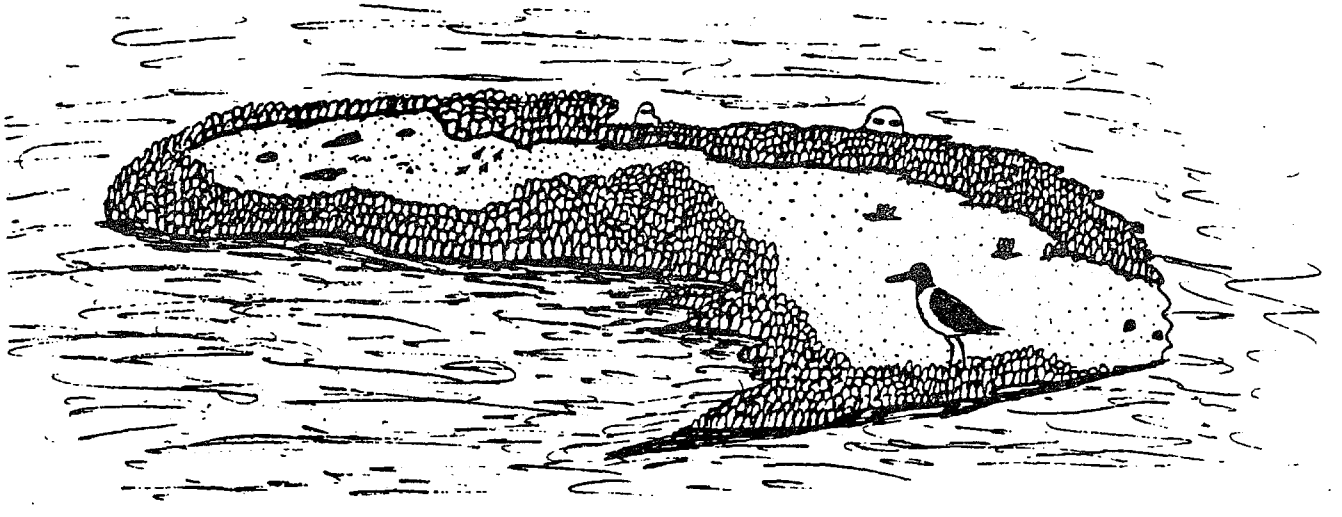
ACROSS CLUES

1. NOT VISIBLE TO THE UNAIDED EYE
5. SIMPLE PLANTS WITHOUT ROOTS, STEMS OR LEAVES
6. A SERIES OF CELLS HOOKED TOGETHER
8. ORGANISMS THAT DEPEND ON OTHERS FOR THEIR FOOD
10. ORGANISMS THAT FEED ON DEAD ANIMALS
11. MICROORGANISMS WITH BOTH PLANT AND ANIMAL CHARACTERISTICS

DOWN CLUES

2. ANIMALS THAT LIVE BELOW THE SURFACE OF THE SEDIMENT
3. AT OR ON THE BOTTOM
4. ONE-CELLED PLANTS WITH SHELLS OF GLASS
7. ORGANISMS WHICH MAKE THEIR OWN FOOD
9. THE RYTHMIC RISING FALLING OF LARGE BODIES OF WATER

THE FORCES ON THE BAR



WHAT ARE OYSTER BARS?

Vocabulary:

oyster	bivalve	gastropod
mollusk	intertidal zone	omnivores
sediment	current	turbidity
predators	silt	predation
competition	submerged	pollution
dredging	filling	habitats

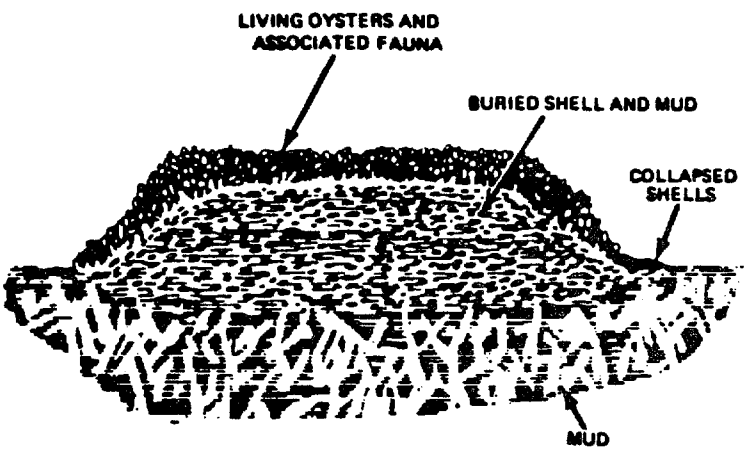
Many of the estuarine communities you have studied are formed by the biological forces of plants. Not this one. The oyster bar community is created by an animal. This animal is the Virginia Oyster. It is a bivalve mollusk which is common in many southern estuaries.

Oysters can form huge colonies which grow in the intertidal zone of an estuary when conditions are favorable. These colonies are commonly called oyster bars, oyster beds or oyster reefs. The hard surfaces provided by the shells of the oysters in this community provide suitable habitats for many types of organisms. The many nooks and crannies created by the irregular shape of the oyster shells attract even more organisms to this community.

In Florida, oyster bars range in size from small scattered clumps to large mounds of living oysters and dead shells. The oysters grow the largest

in the middle part of the intertidal zone. However, those that live in the upper part of the intertidal zone are usually small. This is because they can only feed when they are covered by water. Likewise, oysters which live deep enough that they are covered by water most of the time do not do very well. They are often covered with silt or eaten by marine predators.

A typical oyster bar has a flat top with steeply sloping sides. Living oysters are only found on the top and sides of the bar. Those below are smothered by sediment that settles out when turbid water slows down while passing over the bar.



Artwork courtesy of U.S. Fish & Wildlife Service

The Forces That Shape The Bar

Oyster bars are shaped by many forces in the estuary. The tide is one of the physical forces. Oysters can not pump water through their systems if they are not submerged. Without this water flow, they cannot filter feed. It also becomes very difficult for them to take in oxygen and give off waste gasses. For this reason, oysters grow best in areas where they are covered by the tide at least fifty percent of the time. The amount of time they are covered by water also affects the temperature of the oysters. When they are exposed to the air, they experience greater extremes of temperature than when they are under water.

Another physical force that affects the life on the oyster bar is current flow. The more water flowing over the bar, the greater food supply available to the oysters. Because of this force, the oysters on the outside edges of the bar grow faster than those near the center. This increases the size of the bar.

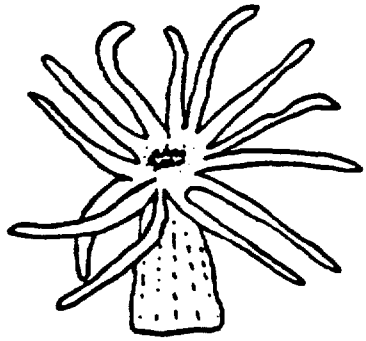
A third physical force is turbidity. Suspended silt in the water clogs the gills which oysters use to strain food from the water. The silt also affects the bar in another way. It settles out on the bar as the water flow is slowed by the oyster shells. This silt build up eventually covers and kills some of the oysters.

Biological forces also affect the oyster bar community. The inhabitants of the community are affected by both predation and competition. When the tide is out the community is attacked by predators from the land. Raccoons and birds feed until the tidal waters return. When the tide is in, marine predators began feeding on the bar. Fish, crabs, starfish and gastropod mollusks all enjoy dining on oyster bar inhabitants.

In some Florida estuaries, the oysters have another predator, man. Oysters are harvested from a number of estuaries in Florida. However, pollution and dredging and filling have greatly reduced the number of estuaries which support a commercial oyster industry. Only Apalachicola Bay remains as a major oyster producing estuary. As oyster bars become covered with silt, they can be invaded by pioneer species from other communities. These may be the seeds of cord grass or the seedlings of mangroves. If the invasion is successful, the oyster bar community may be replaced by a mangrove forest or salt marsh community.

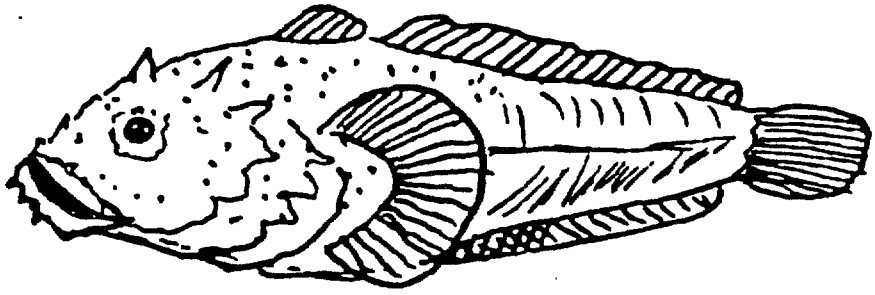
The Creatures At The Bar

If you saw the movie Star Wars, you know that some pretty weird creatures hang out at bars. The oyster bar is no exception. Animals that look like plants (sea anemones).



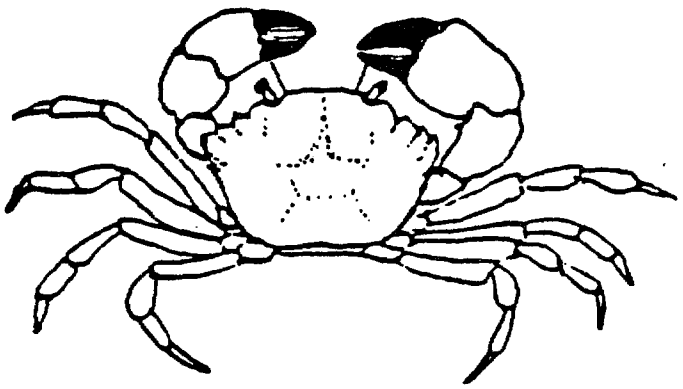
Animals that look like rocks (barnacles).

And fish that look like Jaba the Hut (toadfish), all are found on oyster bars.



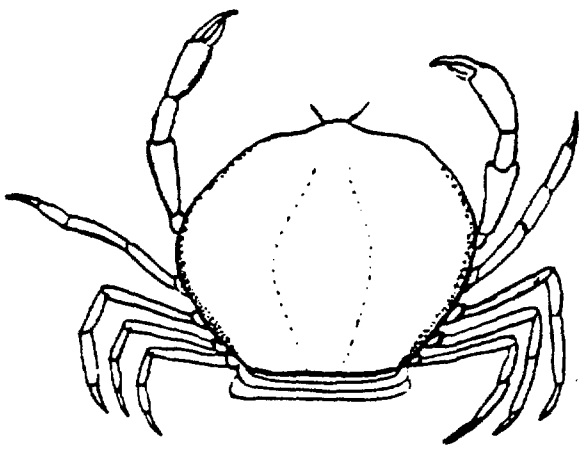
Over fifty different types of critters have been identified living in oyster bar communities. Sea squirts, mussels, sponges and a wide variety of worms

are common on most oyster bars. Two species of mud crabs are very common in this community. They stay hidden at low tide but come out of the numerous crevices to feed when the tide is high.

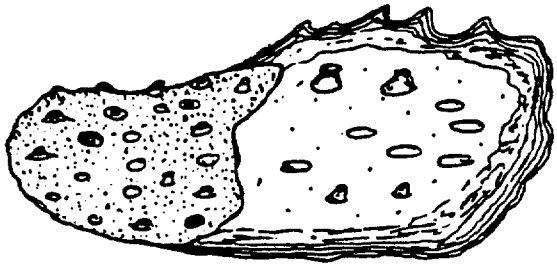


These crabs are omnivores. They harvest the film of detritus and algae that accumulates on the shells of the oysters. They also are important predators of young oysters and crustaceans. The delicious stone crab is a close relative of the mud crabs. It preys on adult oysters which it opens with its powerful claws.

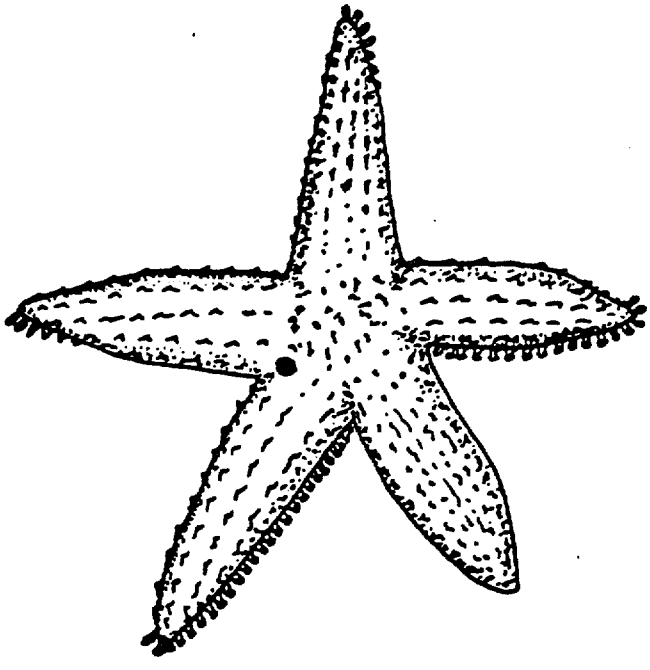
A small crab called the oyster pea crab, actually lives inside the shells of the living oysters. The crab shares some of the food that the oysters strain from the water. It also is protected from predators.



The boring sponge makes holes into the shells of the oysters. This activity weakens the shell and makes the oyster more vulnerable to predators.



In some Florida estuaries, starfish eat large numbers of oysters. They use the tube feet on their five arms to open the oyster's shell. They then stick their stomach inside the shell and digest the oyster.



The Oyster Bar Glossary

bivalve - a mollusk with two valves or two shells hinged together.

competition - the struggle among organisms for food, space and water when the supply is limited.

current - the stream movement of water in estuaries and oceans.

dredging - the removal of soil from ocean or river bottoms to create a channel.

filling - the depositing of dredged material in a low lying area in order to increase its elevation.

gastropod - a mollusk with one shell which crawls on its stomach.

habitat - a place where an organism lives.

intertidal zone - an area between low and high tide.

mollusk - a type of marine animal that usually has a shell or pair of shells.

omnivores - organisms which eat both plants and animals.

pollution - to make unclean; contaminate; dirty.

oyster - a bivalve mollusk that attaches itself to a hard surface.

predation - living or preying upon others.

predators - animals which hunt and kill other animals.

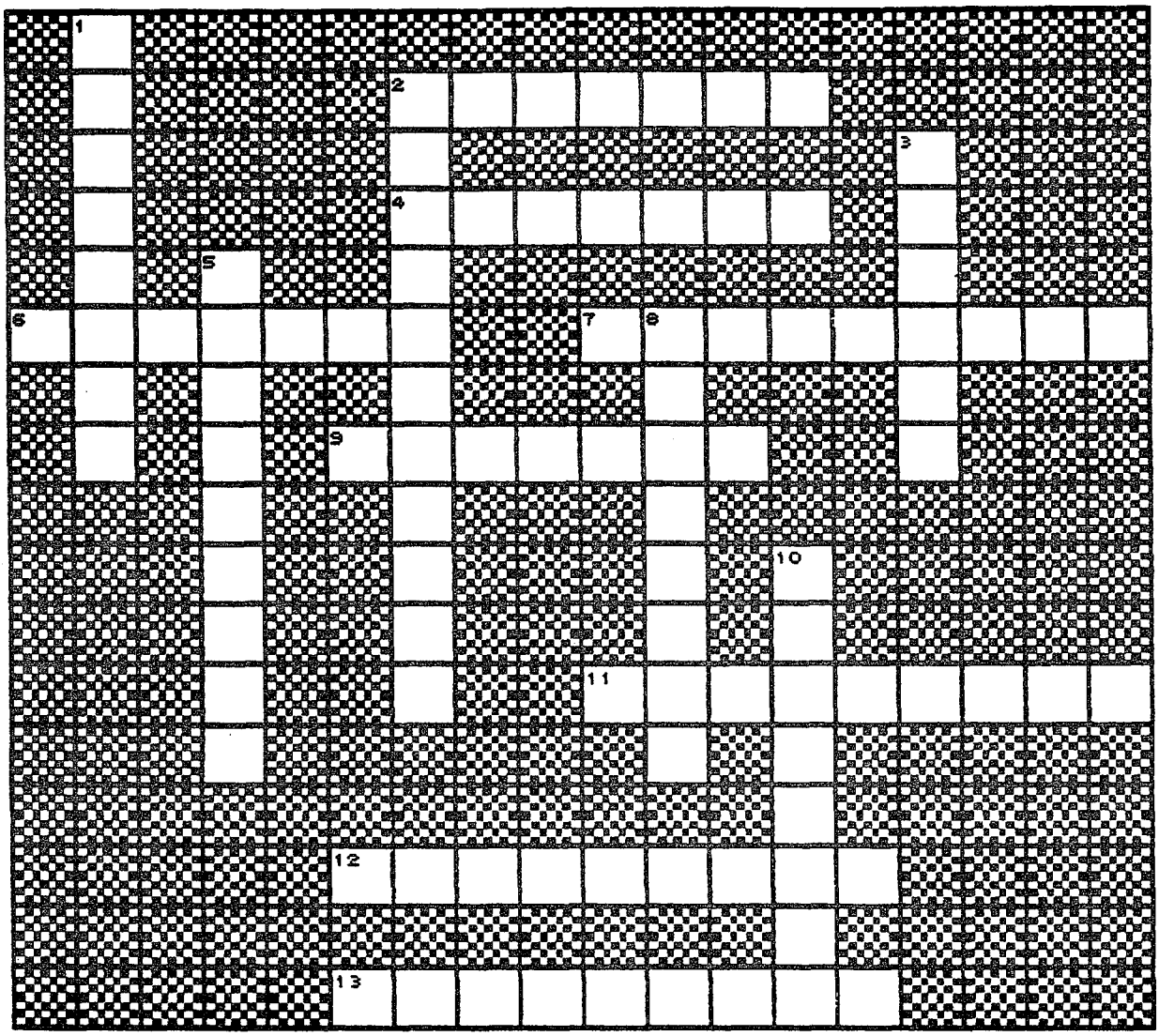
sediment - particles such as sand silt and clay on the bottom of estuaries.

silt - small size particles such as mud deposited by a stream.

submerged - to be covered by water.

turbidity - cloudy, muddy water caused by silt or clay.

THE OYSTER BAR



ACROSS CLUES

2. THE STREAM-LIKE MOVEMENT OF WATER IN AN ESTUARY
4. A MARINE ANIMAL WITH SHELLS MADE OF LIME
6. A MOLLUSK WITH TWO SHELLS
7. UNCLEAN, DIRTY, CONTAMINATED
9. THE DEPOSITING OF DREDGED MATERIAL
11. THE ACT OF KILLING ANOTHER ANIMAL FOR FOOD
12. TO BE COVERED BY WATER
13. A CLOUDINESS OF THE WATER

DOWN CLUES

1. THE REMOVIAL OF SEDIMENT
2. THE STRUGGLE AMONG A GROUP OF ORGANISMS FOR THE SAME RESOUECES
3. A BIVALVE MOLLUSK WITH AN IRREGULAR SHAPED SHELL
5. A ONE SHELLED MOLLUSK WHICH CRAWLS ON ITS STOMACH
8. AN ORGANISMS WHICH EATS BOTH PLANTS AND ANIMALS
10. PARTICLES OF ROCKS, SAND OR SILT FOUND ON THE BOTTOM OF ESTUARIES

OYSTER BAR LAB

Lab #1 Living With Oysters

Materials:

Clumps of oysters, large pans, jars, tweezers, Bay Life Guide or other identification books, gloves, water, hand lens, Popsicle stick.

Student Directions: (be sure to wear gloves when handling the oysters.)

. Place a small clump of oysters in your pan of water.

. Carefully examine each individual oysters and remove any attached organisms. Place these organisms in a jar.

. Pry open any dead oysters with your Popsicle stick and remove any organisms to another jar.

. Use the booklets to help you identify the organisms collected.

. Reexamine several oysters with the land lens to see if you can find any additional organisms.

. Divide the organisms into major groups: mollusks, crustaceans, worms, etc., and count the total numbers in each group.

. Graph the results.

Follow-up Discussion

1. What features of oysters make them ideal habitats for other organisms?

2. How did the organisms found in the dead oysters differ from those living on live oysters?

3. What group of organisms was the most common inhabitant of the oyster clumps?

OYSTER BAR LAB

Lab #2 Get Off My Back, You Scum!

Materials:

Microscopes or Microprojector, slides or petri dishes, blunt knife (or object for scraping), water (that houses oysters from Lab #1)

Student Directions:

- Use blunt object to scrape microorganisms off two or more oyster shells.
- Place scrapings in petri dishes or slides.
- Add a small amount of water from Oyster Lab #1.
- Place petri dish under microscope or microprojector for viewing.
- Predict what you will see when scrapings and marine water are magnified.
- Write prediction:

_____

I predict that..._____

_____

_____

_____

Follow-up Discussion:

1. How did your prediction compare with your observation?

2. What things were common to most oyster shells?

THE FORCES ON THE GRASS FLAT

THE FORCES ON THE GRASS FLATS

Vocabulary:

commercially	seagrasses	suspended sediments
photosynthesis	widgeon grass	shoal grass
turtle grass	manatee grass	recreationally
juvenile	detritus	foodchain
clam	shrimp	tunicates
predator	prey	habitat
land development	offshore	turbidity
salinity		

The grass flat community is produced by several species of flowering plants called seagrasses. This community is located offshore of the mangrove, salt marsh and mudflat communities in most Florida estuaries. Seagrasses are similar to their relatives which grow on the land. They have an underground stem. Their roots bind and stabilize the sediment. Their leaves grow up from the stems through the sand. The leaves of seagrasses serve an important function. They reduce the amount of energy in the water as it flows through the community. As the amount of energy is reduced, the amount of sediment that the water can carry is also reduced. This sediment is dropped among the leaves of the seagrasses. Thus, this community helps to reduce turbidity in the estuary.

The distribution of grass flat communities is controlled by a number of forces. Temperature is one of these. Seagrasses may be killed by winter freezes. This occurs during extreme low tides when the grasses may be exposed to freezing temperatures for several hours. Salinity is another force which helps determine the distribution of seagrasses. Some of the grasses such

as widgeon grass and shoal grass are restricted to the parts of the estuary with fairly low salinity. Others, such as turtle grass and manatee grass thrive in the areas with salinities similar to normal sea water. In fact, both of these grasses do well in the Gulf of Mexico and the Atlantic Ocean.

The clarity of the water is another force which affects seagrasses. Because they are dependent upon sunlight to carry on photosynthesis, seagrasses require fairly clear water. Turbid water conditions are often found in estuaries. These conditions result from suspended sediments, dissolved chemicals or excess plant growth. Light is both absorbed and reflected by water. These processes are increased in turbid water. If conditions are too turbid, seagrasses can not receive enough sunlight to produce the food they need to survive.

Human forces in Florida's estuaries frequently impact the grass flat community. They have physically removed or covered grass flats and they have increased greatly in turbidity. These multiple effects have greatly reduced the number of acres of seagrasses found in our estuaries.

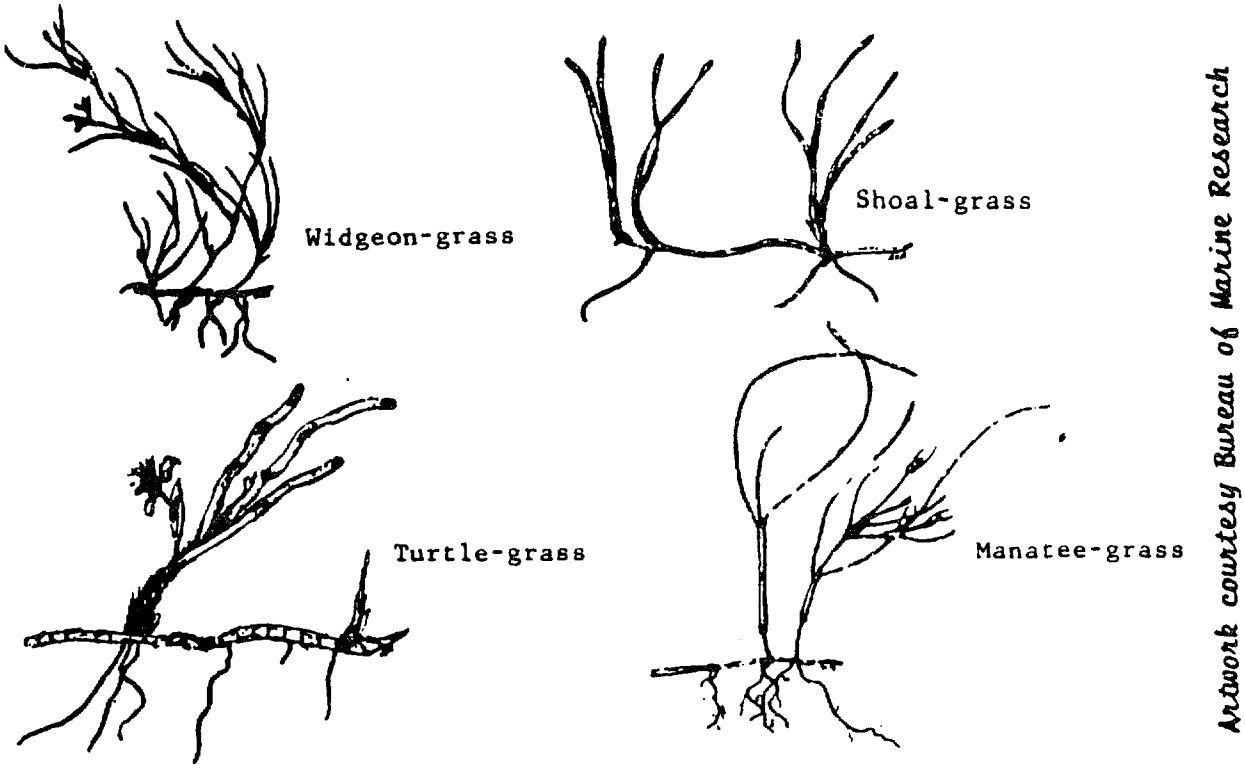
Grass flat communities are an important force in Florida's estuaries. First, they clean the water by trapping fine sediments and detritus with their leaves. Second, they stabilize the bottom with their stems and roots in much the same way that grasses on land reduce soil erosion. Third, they provide habitats for many fishes, crustaceans, mollusks and worms. Fourth, seagrasses and the organisms that grow on them are food sources for many marine animals. Lastly, they act as nurseries for many commercially and recreationally important marine organisms.

The Plants of the Grass Flats

Of the 52 species of marine seagrasses in the world, 6 or 7 are found in Florida waters. These seagrasses are located in coastal regions throughout the state. Four of the seagrasses are common to most areas:

1. Widgeon grass is found in estuaries and grows in fresh or salt water.
2. Shoal grass grows in shallow water and is usually one of the first seagrasses found in a disturbed area.
3. Turtle grass has long roots and wide leaves and is the most common seagrass.
4. Manatee grass has cylindrical leaves.

Both turtle grass and manatee grass grow in the saltier parts of the estuary.



Artwork courtesy Bureau of Marine Research

The leaves of seagrasses provide protection for marine organisms. This is especially important for the juvenile stages of fish, crustaceans, and shellfish. In this community, plants and animals interact. A blade of grass provides food for one organism and protection for another.

Since detritus is formed by plants and plant particles that break down, seagrass is an important part of the food chain. In fact, detritus supplies a food substance for many organisms in the intertidal community.

Animals of the Grass Flat Community

There are many organisms found in the grass flat community and they would not be able to survive without this habitat. One group of organisms lives on the stems or leaves of the seagrasses. Hydroids, barnacles and sea squirts all grow on the leaves of the grasses. They compete for space with colonial tunicates and bryazoans.

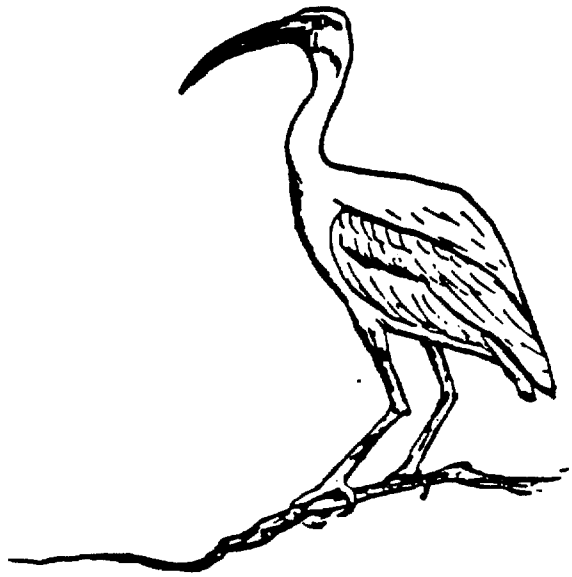
Broken back shrimp

The broken back shrimp is another example of an organism that lives on the leaves. They rest on the blades of the seagrasses. They can change color from brown to green. This acts a protective device. They feed on detritus and smaller plants and animals which are also found on seagrass leaves.

Pipefish

A pipefish is yet another example of an organism that lives in the grass flats. This fish is a predator and moves through the blades of grass looking for prey. The pipefish is long and resembles a blade of grass as it swims in the grass flats. The male pipefish carries the young in his pouch, just like his cousin the seahorse.

A predator of the grass flat community is the white ibis. This bird has a downcurved bill, wing feathers with black tips, and red legs. The white ibis appears on the grass flats during low tide. The ibis looks for crabs and other crustaceans by probing the mud with its bill.



White Ibis

Why Are Grass Flat Communities Important To Man?

Grass flat communities are disappearing. Their value to man is becoming more obvious as we begin to examine "what used to be found in these communities" and compare those finds with "those things now found in grass flat communities." Fishermen used to find silver and speckled trout in these areas. This has changed now due to the decrease of grass beds. Scallops and shrimp also used to be common in the grass flats. Land development has changed many grass flat areas and considerable dredging and filling took over those communities. The destruction of grass flats has created considerable awareness of their importance and value to man.

The Grass Flat Glossary

bryazoans - small colonial animals which filter feed with modified legs.

clam - a free living bivalve mollusk which burrows into the soft sediment of grass flats with its muscular foot.

commercially - marine organism which are caught and sold as food.

detritus - a decaying mixture of plant and animal remains covered with micro-organisms. Food substance for small organisms in the estuary.

food chain - a group of plants and animals that depend on each other for energy.

habitat - a place where an organism lives.

hunter - an organism which stalks and kills its prey.

juvenile - an immature organism.

land development - changing land to make it more useful for human needs.

manatee grass - a seagrass with thin round leaves.

offshore - beyond the edges of the intertidal zone. Underwater.

photosynthesis - the process of using light energy to manufacture food from carbon dioxide and water.

predator - an organism that captures and kills the food.

prey - organisms that are eaten by predators.

recreationally - marine organisms that are caught by fishermen for sport.

salinity - the amount of salt present in water.

sea squirts - animals with sack like bodies which filter feed by drawing water in through one opening, trapping food in the gills and expelling the water through a second opening.

seagrasses - flowering plants which live underwater in marine evironments.

shoal grass - a seagrass with thin flat leaves.

shrimp - a crustacean with a long thin body and five pair of walking legs.

suspended sediments - particles of silt and sand which are carried by the water.

tunicates - colonial animals very similar to sea squirts.

turbidity - cloudy water conditions caused by mud or sand in the water.

GRASS FLAT LAB

Lab #1 Calming of the Waves

Materials:

*Plastic tray, 1 strip of bahia sod, wave generator, battery or power supply, water.

Student Directions:

- Place strip of grass in center of plastic tray.
- Add water to cover the grass by about 1 cm.
- Position wave generator outside tray/pan with only blade in water.
- Turn on wave generator.
- Observe what happens to the waves as they pass through the grass.

Note: May use wave machine without grass first to observe the difference when grass is added.

Discussion Questions:

1. What effect did the grass have on the waves?

2. How does this demonstration help illustrate the role of grasses in estuarine systems?

*May use plastic student's tray or broiler pan.

GRASS FLAT LAB

Lab #2 Sea Grass Hide and Seek

Materials:

Pipe cleaners, clay, food coloring, string, yarn, toothpicks, buttons, spools, scissors, glue, sponges, magic markers, balloons, Q-tips, rubber bands, Popsicle sticks, paint, brushes.

Procedure:

Each team is to design:

1. polychaete worm which feeds with tentacles.
2. shrimp.
3. fish.
4. snail.
5. crab.
6. or, develop your own original organisms. The animal should be disguised so that it can hide in a grass flat.

Take the animals outside and hide in a selected area of the school lawn.

Take three minutes. Try to find the critters from another team in your class.

Follow-up Discussion:

1. Why is it better to look like a plant than an animal when you are a baby animal in an estuarine grass flat?

2. What senses might predators use to help find food in an estuarine grass flat?

Note: Critters will move to foreign space to escape predators.

Grass Flat Scramble

Student Directions:

Unscramble the following words that are found in the reading section on the grass flat community.

1. degoiwn-sagrs
2. rutelt-rasgs
3. hosla-agsrs
4. tanemae-srags
5. ritteuds
6. sargesas
7. sflagsrats
8. ydsna
9. dyumd
10. ysnotthoehspis
11. brutdi
12. dofo
13. cteotriopn
14. glaea
15. epfisiph
16. nkeobr kcab rhsimp
17. dreporta
18. tehiw bsii
19. tsaucrcaesn
20. kcepsdel tuort

Key

(Grass-Flat Vocabulary)

1. widgeon-grass
2. turtle-grass
3. shoal-grass
4. manatee-grass
5. detritus
6. seagrass
7. grass flat
8. sandy
9. muddy
10. photosynthesis
11. turbid
12. food
13. protection
14. algae
15. pipe fish
16. broken back shrimp
17. predator
18. white ibis
19. crustaceans
20. speckled trout

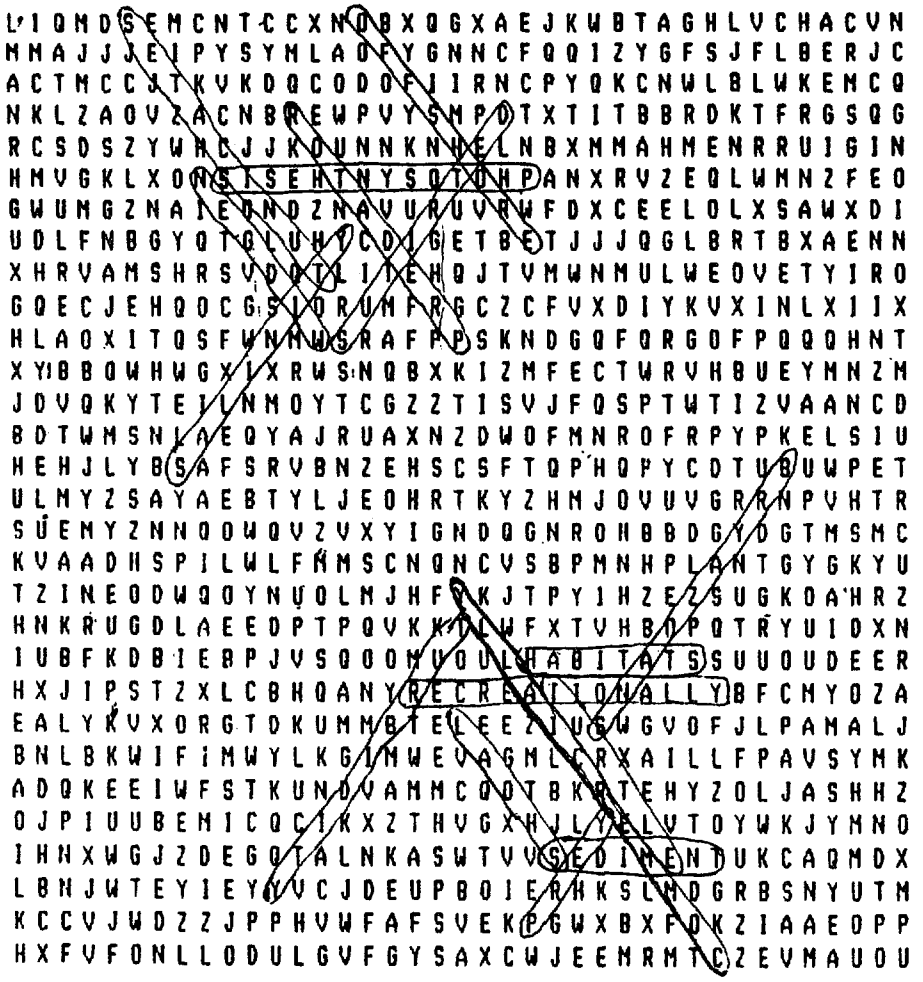
GRASS FLAT VOCABULARY

L I Q M D S E M C N T C C X N O B X Q G X A E J K W B T A G H L V C H A C V N
M M A J J J E I P Y S Y M L A O F Y G N N C F Q Q I Z Y G F S J F L B E R J C
A C T M C C J T K V K D Q C O D O F I I R N C P Y Q K C N W L B L W K E M C Q
N K L Z A O V Z A C N B R E W P V Y S M P D T X T I T B B R D K T F R G S Q G
R C S D S Z Y W H C J J K O U N N K N H E L N B X M M A H M E N R R U I G I N
H M V G K L X O N S I S E H T N Y S O T O H P A N X R V Z E Q L W M N Z F E O
G W U M G Z N A I E O N D Z N A V U R U V R W F D X C E E L O L X S A W X D I
U D L F N B G Y Q T G L U H Y C D I G E T B E T J J J Q G L B R T B X A E N N
X H R V A M S H R S V D Q T L I T E H Q J T V M W N M U L W E O V E T Y I R O
G Q E C J E H Q O C G S I O R U M F R G C Z C F V X D I Y K V X I N L X I I X
H L A O X I T Q S F W N M W S R A F P P S K N D G Q F Q R G O F P Q Q Q H N T
X Y B B Q W H W G X I X R W S N Q B X K I Z M F E C T W R V H B U E Y M N Z M
J D V Q K Y T E I L N M O Y T C G Z Z T I S V J F Q S P T W T I Z V A A N C D
B D T W M S N L A E Q Y A J R U A X N Z D W O F M N R O F R P Y P K E L S I U
H E H J L Y B S A F S R V B N Z E H S C S F T Q P H Q P Y C O T U B U W P E T
U L M Y Z S A Y A E B T Y L J E O H R T K Y Z H M J O V U V G R R N P V H T R
S U E M Y Z N N Q O W Q V Z V X Y I G N D Q G N R O H B B D G Y D G T M S M C
K V A A D H S P I L W L F M M S C N Q N C V S B P M N H P L A N T G Y G K Y U
T Z I N E Q D W Q O Y N U Q L M J H F Y K J T P Y I H Z E Z S U G K O A H R Z
H N K R U G D L A E E D P T P Q V K K T L W F X T V H B O P Q T R Y U I D X N
I U B F K D B I E B P J V S Q O O M U O U L H A B I T A T S S U U O U D E E R
H X J I P S T Z X L C B H Q A N Y R E C R E A T I O N A L L Y B F C M Y O Z A
E A L Y K V X O R G T D K U M M B T E L E E Z I U S W G V O F J L P A M A L J
B N L B K W I F I M W Y L K G I M W E V A G M L C R X A I L L F P A V S Y M K
A D Q K E E I W F S T K U N D V A M M C Q O T B K R T E H Y Z O L J A S H H Z
O J P I U U B E M I C Q C I K X Z T H V G X H J L Y E L V T O Y W K J Y M N Q
I H N X W G J Z D E G Q T A L N K A S W T V V S E D I M E N T U K C A Q M D X
L B N J W T E Y I E Y Y V C J D E U P B O I E R H K S L M D G R B S N Y U T M
K C C V J W D Z Z J P P H V W F A F S V E K P G W X B X F O K Z I A A E O P P
H X F V F O N L L O D U L G V F G Y S A X C W J E E M R M T C Z E V M A U O U

WORD LIST

Bryazoans
Commercially
Detritus
Habitats
Offshore
Photosynthesis
Predator
Prey
Recreationally
Salinity
Sediment
Shoal
Tunicates
Turbidity
Turtle
Widgen

GRASS FLAT VOCABULARY



WORD LIST

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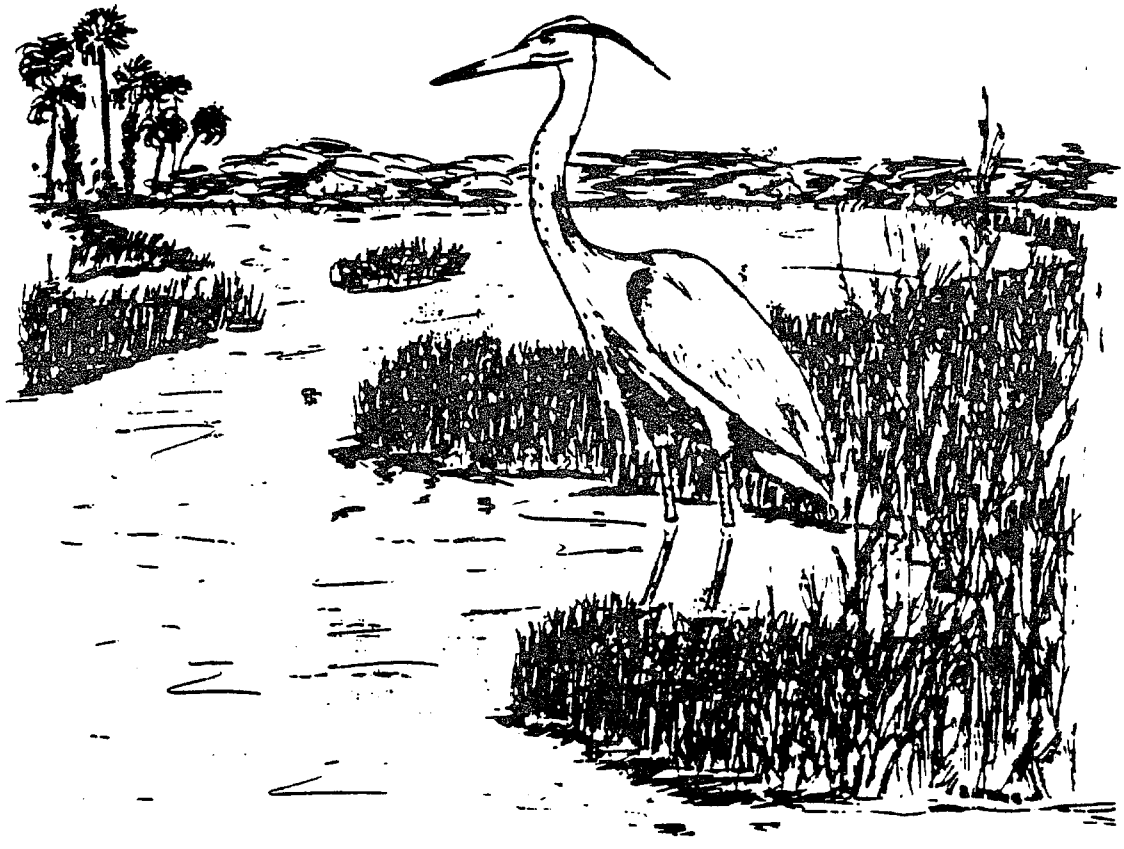
INVESTIGATING IN AN ESTUARY



BIRDS AND MAMMALS

Introduction

Many birds and mammals use the estuary. Some live here others just visit.

Directions

As you enter the edge of the estuarine ecosystem, record the birds and mammals you see on the check list. The code is as follows:

CF = Coastal Forest
SB = Salt Barrens
MG = Mangroves
SM = Salt Marsh
MF = Mud Flat
GF = Grass Flat
OR = Oyster Reef

COMMUNITY

MAMMALS	CF	SB	MG	SM	MF	GF	OR
Raccoon							
Cotton Rat							
Beach Mouse							
Opossum							
Deer							
Marsh Rabbit							
Skunk							
Manatee							
Bobcat							

BIRDS AND MAMMALS

COMMUNITY

BIRDS	CF	SB	MG	SM	MF	GF	OR
Great Blue Heron							
Little Blue Heron							
Green Heron							
Louisiana Heron							
American Egret							
Snowy Egret							
Spoonbill							
Wood Stork							
White Ibis							
Cormorant							
Pelican							
Anhinga							
Tern							
Sea Gull							
Black Skimmer							
Willet							
Plover							
Sandpiper							
Osprey							
Bald Eagle							
Red-winged Blackbird							

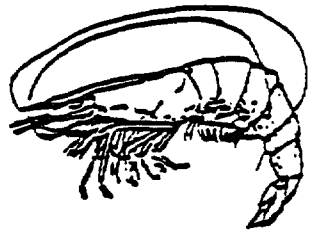
TEAM #_____ SCHOOL _____

WATER CHEMISTRY DATA SHEET

THE ESTUARY IS INHABITED BY MANY PLANTS AND ANIMALS. THESE ORGANISMS ARE AFFECTED BY THE WEATHER. LETS RECORD WHAT THE WEATHER IS LIKE TODAY.

1. TODAY'S DATE:

2. THE WEATHER TODAY IS:



3. WHAT IS THE TEMPERATURE OF THE AIR?

_____ °F _____ °C

NOW USING THE HYDROMETER KIT, TAKE A SAMPLE OF THE WATER FROM THE ESTUARY.

4. WHAT IS THE HYDROMETER READING?_____

5. WHAT IS THE TEMPERATURE OF THE WATER? _____

NOW USING THE SALINITY CHART - FIND THE SALINITY OF THE WATER.

6. _____‰ SALINITY

pH IS ANOTHER FORCE WHICH SHAPES THE ESTUARINE ENVIRONMNE. USE THE TEST KIT TO FIND OUT THE pH OF THE WATER.

7. _____ pH IS THIS: ACIDIC BASIC NEUTRAL

NITRATE AND PHOSPHATE ARE NUTRIENTS WHICH AFFECT THE GROWTH OF ORGANISMS IN THE ESTUARY. USE THE TEST KITS TO FIND OUT HOW MUCH FREE NUTRIENTS ARE FOUND IN THE WATER.

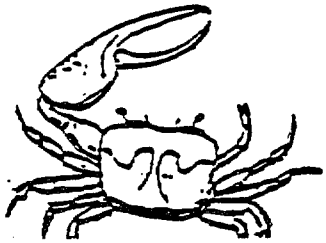
8. _____ NITRATES _____ PHOSPHATE

9. WHAT IS THE CLARITY OF THE WATER?

VERY CLEAR SLIGHTLY TURBID VERY TURBID

10. WHAT IS THE COLOR OF THE WATER?

COLORLESS BLUE GREEN YELLOW BROWN



PRODUCERS OF THE ESTUARY

Introduction

Plants are necessary to begin the estuarine food chains.

Directions

Check off the estuarine plants you see on your trip.

CF = Coastal Forest
SB = Salt Barrens
MG = Mangroves
SM = Salt Marsh
MF = Mud Flat
GF = Grass Flat
OR = Oyster Reef

COMMUNITY

TREES	CF	SB	MG	SM	MF	GF	OR
Red Mangrove							
Black Mangrove							
White Mangrove							
Button Wood							
Marsh Elder							
Salt Bush							
Sable Palm							

SEA GRASSES							
Shoal Grass							
Manatee Grass							
Turtle Grass							
Widgen Grass							
Star Grass							

PRODUCERS OF THE ESTUARY

COMMUNITY

SUCCULENTS	CF	SB	MG	SM	MF	GF	OR
Grass Wort							
Sea Purslane							
Salt Worb							
HERBS							
Sea Ox-eye Daisy							
Seaside Lavender							
Marsh Aster							
ALGAE							
Green Algae							
Red Algae							
Brown Algae							

BOUNTY FROM THE WATERS

Introduction

A large number of marine organisms live in the waters of the estuary.

Directions

Check off the organisms you captured on the list below. Key them as to the communities in which they were found.

CF = Coastal Forest
SB = Salt Barrens
MG = Mangroves
SM = Salt Marsh
MF = Mud Flat
GF = Grass Flat
OR = Oyster Reef

COMMUNITY

FISH	CF	SB	MG	SM	MF	GF	OR
Anchovy							
Filefish							
Flounder							
Hog Choaker							
Goby							
Longnose Killifish							
Diamond Killifish							
Rainwater Killifish							
Goldspot Killifish							
Gulf Killifish							
Atlantic Mummichog							
Sheepshead Minnow							
Sheepshead							
Mangrove Snapper							
Pinfish							
Mojarra							
Needlefish							
Tidewater Silverside							
Mullet							

BOUNTY FROM THE WATERS

COMMUNITY

FISH	CF	SB	MG	SM	MF	GF	OR
Menhaden							
Spot							
Silver Perch							
Leather Jacket							
Pigfish							
Sea Robin							
Smooth Puffer							
Spiny Boxfish							
Halfbeak							
Pipefish							
Sea Horse							
Speckled Trout							
Toad Fish							
Blenny							

BOUNTY FROM THE WATERS

COMMUNITY

ARTHROPODS	CF	SB	MG	SM	MF	GF	OR
Blue Crab							
Fiddler Crab							
Hermit Crab							
Horseshoe Crab							
Mangrove Crab							
Marsh Crab							
Mud Crab							
Stone Crab							
Spider Crab							
Broken-back Shrimp							
Grass Shrimp							
Pink Shrimp							
Brown Shrimp							
White Shrimp							
Pistol Shrimp							

BOUNTY FROM THE WATERS

COMMUNITY

MOLLUSKS	CF	SB	MG	SM	MF	GF	OR
Handshelled Clam							
Scallop							
Macoma Clam							
Ribbed Mussel							
Oyster							
Razor Clam							
Auger Snail							
Coffeebean Snail							
Tulip Snail							
Moon Snail							
Periwinkle							
Crown Conch							
Whelk							

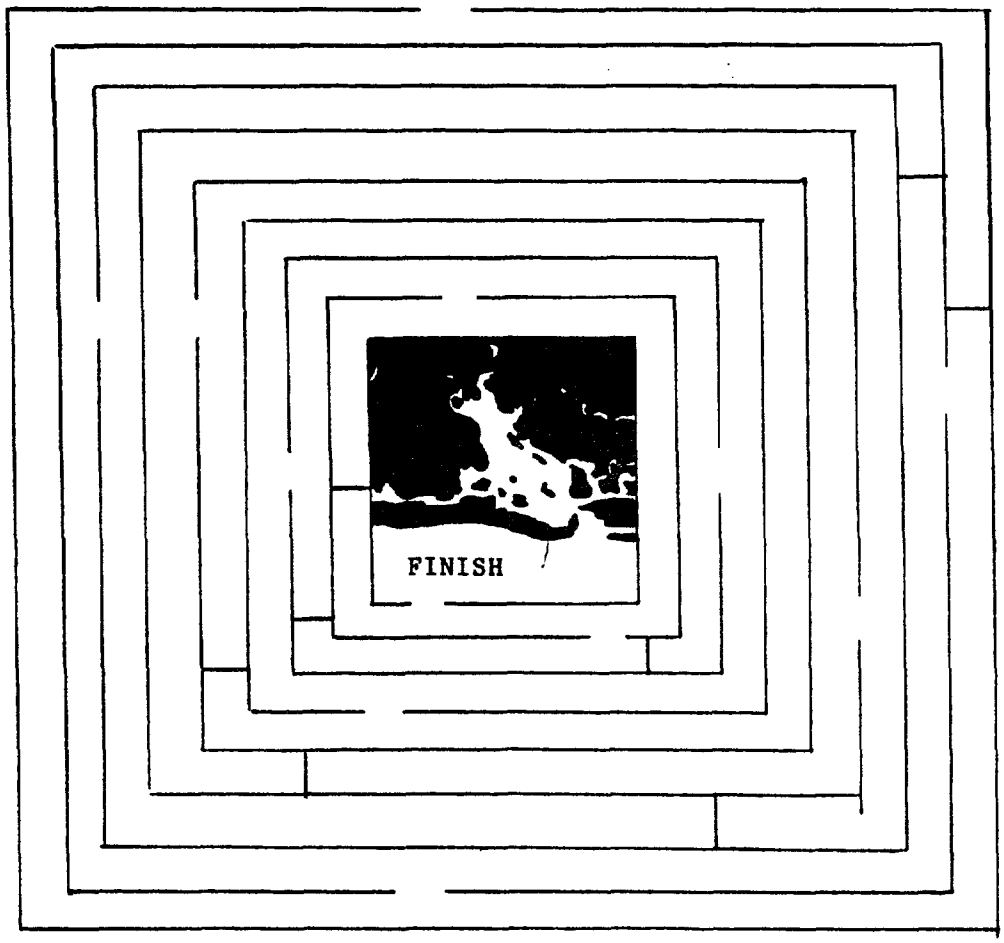
BOUNTY FROM THE WATERS

COMMUNITY

OTHER ANIMALS	CF	SB	MG	SM	MF	GF	OR
Sea Urchin							
Brittle Star							
Star Fish							
Decorator Worm							
Lug Worm							
Comb Jelly							
Sea Squirt							
Medusa Worm							
Trumpet Worm							
Clam Worm							
Sand Worm							
Ribbon Worm							
Bamboo Worm							

THE ESTUARY GAME

START



WHAT IS IT?
WHY PLAY IT?

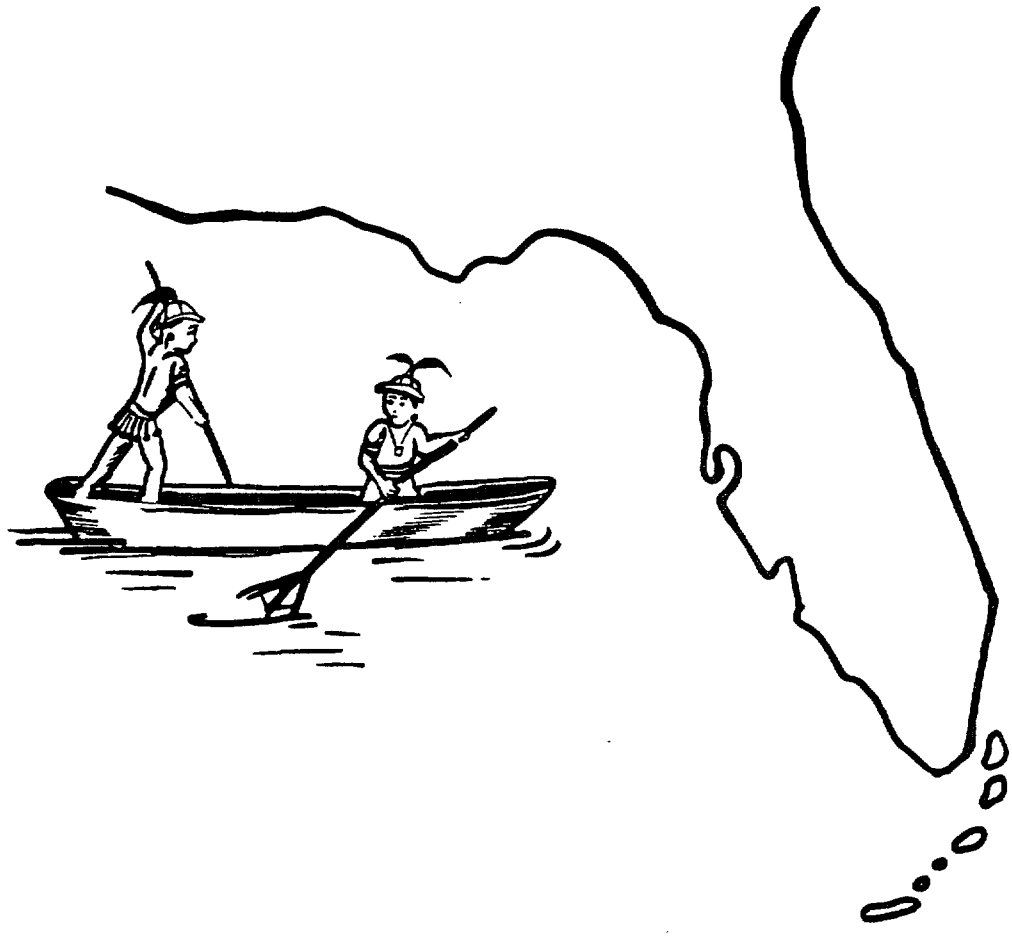
WHAT IS THE GAME AND WHY PLAY IT?

THE HUMAN FORCES IN THE ESTUARY

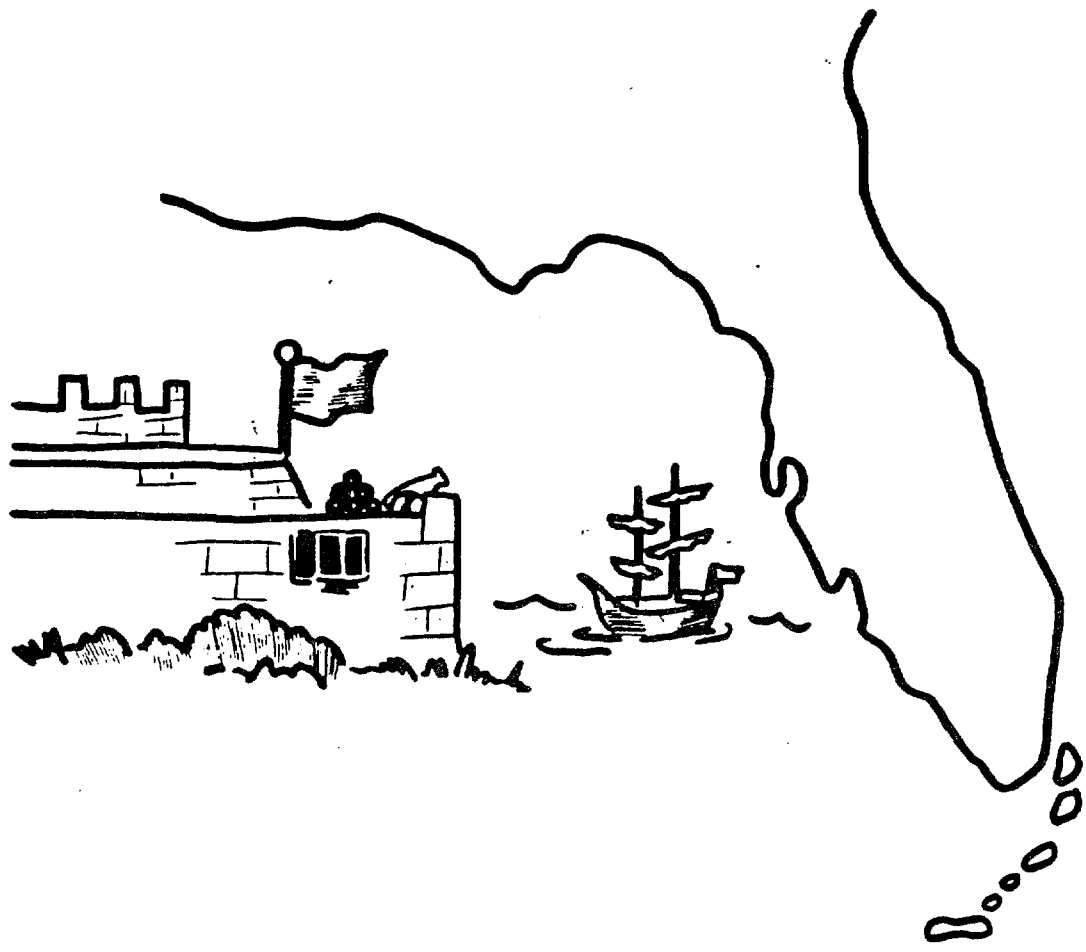
Vocabulary:

estuary	pollution	deteriorate
impact	stress	channelization
human forces	organic	fragile
management	abundant	predatory
runoff	contaminate	migration
population	erosional	

Indians had been living in Florida for thousands of years before the arrival of the European explorers. Many of these early Indians lived along the coast using the abundant resources found in the estuaries.



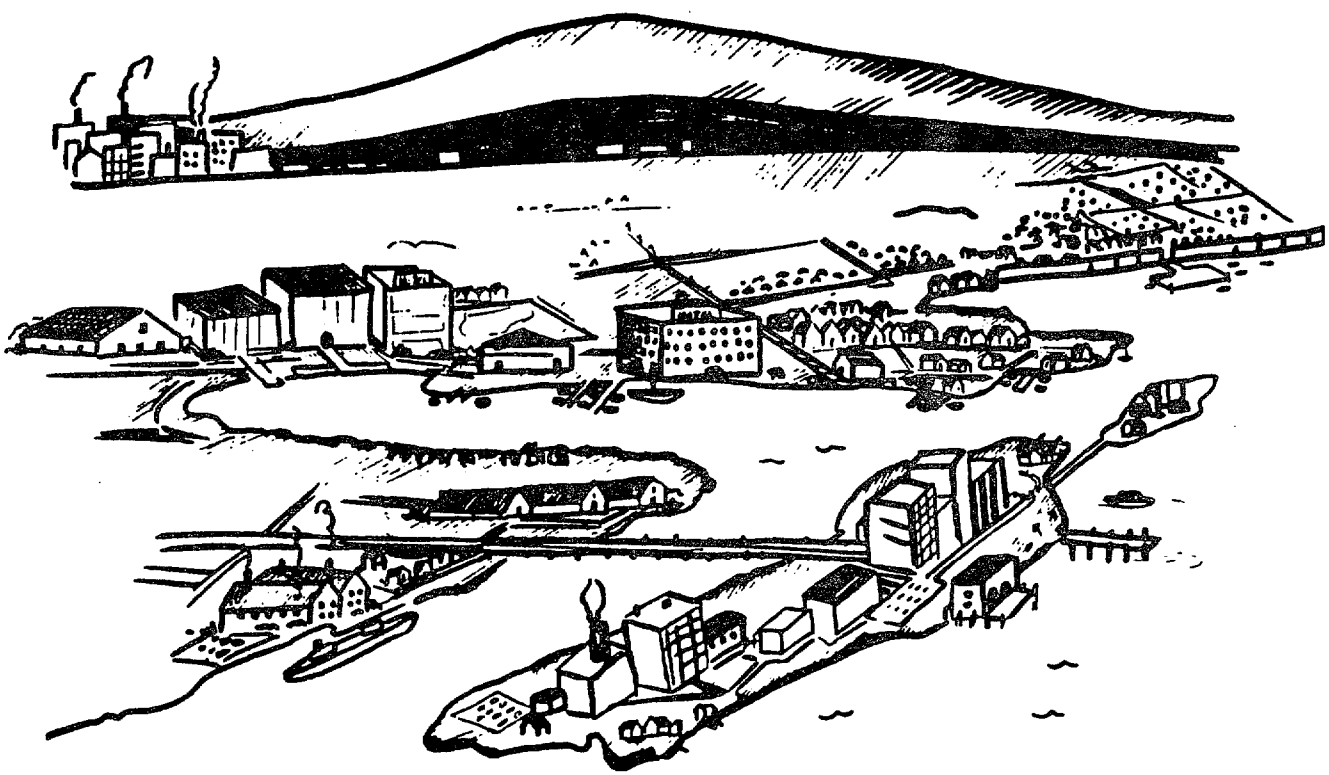
The Spanish Explorer, Ponce de Leon, arrived in Florida around 1513. The first permanent settlement was at St. Augustine, Florida, in 1565. For the next 200 years, the Spanish controlled Florida. Most of the Europeans settled along the coast. The estuaries at St. Augustine and Pensacola became important ports.



The activities or human forces of the native Americans and early European settlers placed little stress on the environment. These human forces had little impact because the population was low and their economics did not require many changes in the coastal environment.

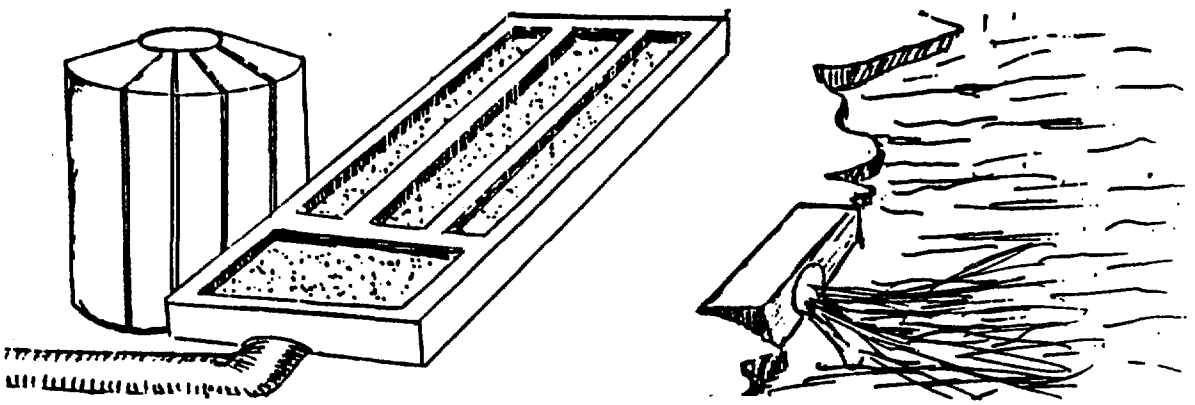
In the 20th Century, human forces on the environment increased. Florida's population and economy changed and began to grow rapidly. People came to our state because of the warm climate and sunny beaches. Concentration of the population shifted to the central and southern part of the State, mainly along the coast. The rapidly growing population and the associated development have placed great stress on the environment. Many of the environmental stresses are concentrated in the estuaries where the environment is very fragile, but very attractive to the population.

The estuarine environment has been altered by people who have tried to make it more suitable for settlement. These human forces have thus caused major changes in the ecology of Florida's estuaries.

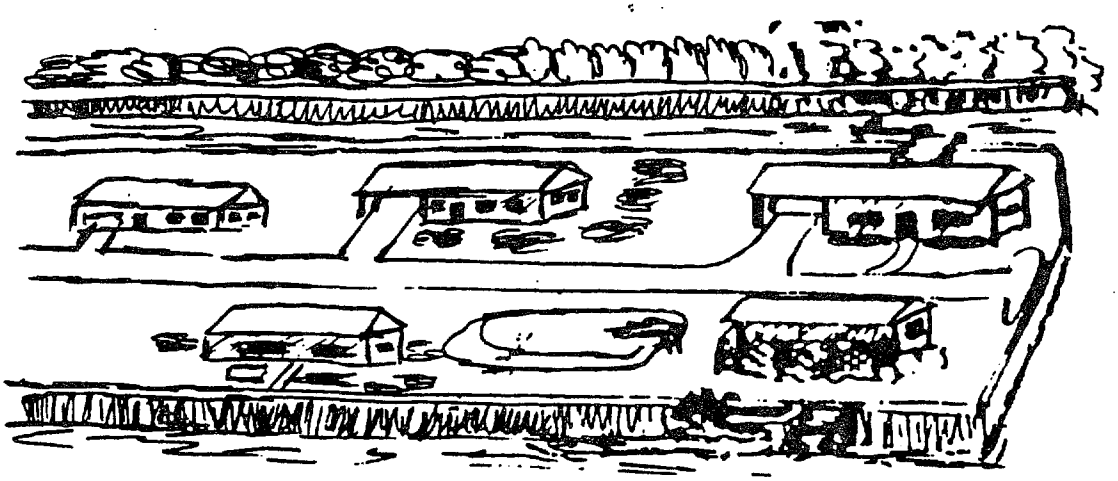


Urban growth and development creates problems for the estuary. A number of human activities reduce water quality. These include runoff from streets, industrial and agricultural waste, harmful chemicals and sewage. Organic waste reduces the oxygen supply in the estuary. It also contaminates shellfish making

them hazardous to eat. Agricultural and industrial waste can be concentrated by food chains making them dangerous to predatory organism and even man.

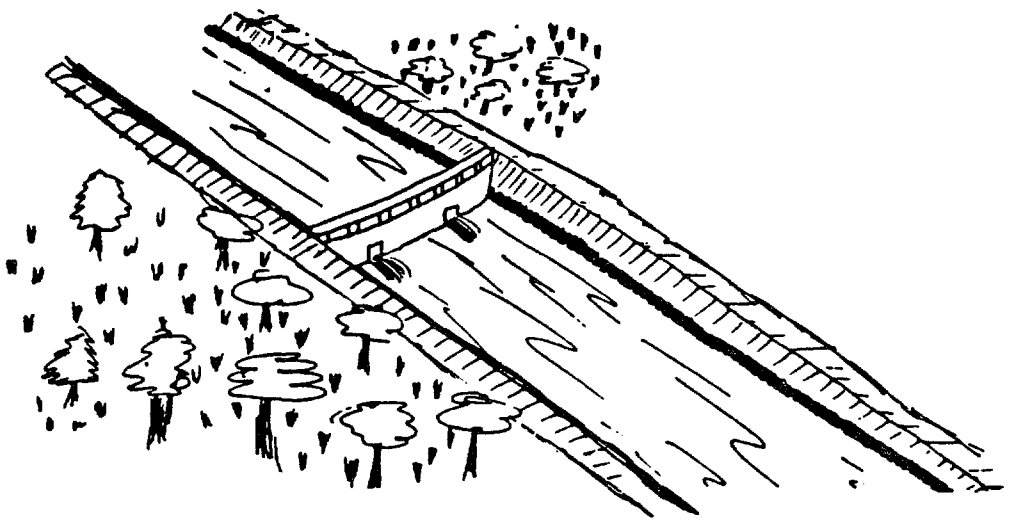


Dredging and filling of ecologically valuable mangrove swamps, salt marshes and marine grass flats have reduced the ability of the estuary to function as a nursery area, thus contributing to the decline of marine fisheries. This activity physically destroys the communities and creates turbidity problems for areas of the estuaries which are not physically altered.



Improper development of the barrier islands has altered the natural geological forces. This has led to erosional problems. Channelization of streams and

drainage of freshwater wetlands surrounding the estuaries have created salt water intrusion. This migration of salt water into formally freshwater areas has caused shortages of fresh water for agriculture, industry and human uses.



Given all of the bad effects of the human forces on the estuary, it would be easy to condemn all human uses of the estuary. However, the issue is not that simple. Trying to balance the human economic and social needs of the estuary with the environmental needs requires a coastal management plan. Even though people benefit from estuaries, their uses generally cause changes. A management program becomes necessary in order to balance the need to protect the environment with the desire to develop. This overall management program is what we call the "Estuarine Management Game." Understanding and playing this game is important to the future of Florida's estuaries.

SLIDE	NARRATION
1	(Slides 1 - 3 are title slides. Allow 5 seconds between each.)
2	
3	
4	Coastlines are Florida's most valuable resource. The coastal zone's assets include seashores, harbors, and waterways. Already 50% of the nation's populace resides near the coasts.
5	90% of the population growth is occurring in coastal states, and Florida's growth is second only to California's.
6	Residents and tourists alike are lured here by Florida's sunny shores. But is man using the coast wisely? Is he preserving it or destroying it?
7	The major economic uses of our coast are shipping, real-estate, tourism, and defense. Jacksonville is a major seaport - even though it is located 25 miles inland. The river has been dredged to accommodate ocean tankers and other cargo vessels which enter the port to load or unload.
8	Area shipyards can provide haul-out and repair services.
9	Near the mouth of the river where a bridge cannot be built because of limited landspace and usage the ferry carries local traffic from Mayport to Ft. George.
10	With almost 1,200 miles of coastline, coastal property becomes more valuable every year. Because of increased knowledge about the value of sand dunes for protecting beachfront property from erosion,

SLIDE	NARRATION
10 cont.	much new construction is being built behind the secondary dunes.
11	Amelia Island is an example of how one should build on the coast behind the sand dunes.
12	Walkovers through out the secondary dunes
13	and Maritime forest protect the vegetation. The vegetation stabilizes the sand and helps keep it in place.
14	Where there is less space,
15	condos are lining the coast to meet the great demand by people who want to live on the oceanfront.
16	To preserve some coastal areas for its citizenry now and in the future, the state of Florida is acquiring coastal areas.
17	Some cities also have coastal parks, such as Hanna Park in Jacksonville.
18	The National Park Service also maintains some areas for coastal wild life preserves.
19	Recreational useage is the most enticing aspect of the sea coast.
20	Fishing is a favorite hobby or past time for many - some go to piers;
21	some use small boats;
22	some go seining;
23	some use cast nets.

SLIDE	NARRATION
24	But, some would rather catch a wave.
25	Others, such as SCUBA divers, go where the fish live.
26	Besides recreation, the coastal area is a prime location for a naval facility because of deep offshore waters.
27	The Navy at its Mayport Base houses ships of the 6th Atlantic Fleet.
28	The Coast Guard polices our coastline out to the 200 mile limit. They enforce drug laws and also provide rescue.
29	They maintain navigational aids such as these river buoys, which mark the channel
30	so that boats or ships do not run aground.
31	Lighthouses - like this one in St. Augustine - are now automated with lights to prevent ships at sea from running into land, or submerged objects.
32	NOAA, the National Oceanographic and Atmospheric Administration, has ships which collect oceanographi and weather data. This information is used to update maps and chart weather changes.
33	Small marine businessmen, like this marina owner, need to know weather conditions. This marina has wet and dry storage.
34	Triple deck storage like this maximizes the use of valuable coastal space.

SLIDE	NARRATION
35	Seafood markets provide a place for people to buy local seafood.
36	Here the catch is fresh - right off the boat.
37	This fish camp located adjacent to Big Talbot Island is an example of a small marine business which caters to the recreational fisherman.
38	Commercial fishermen need big boats to go offshore. This one is being custom built.
39	After commercial boats have been used awhile, the boat bottom needs to be scraped and re-painted with anti-fouling paint, a copper based paint which is poisonous to many marine invertebrates. This proces has to be repeated once or twice a year. This small boat is being worked on at low tide by the owner.
40	Larger boats like these shrimp boats are having the same process done at small shipyards along the river.
41	Commercial hook and line fishermen like to load their boat with red snapper.
42	Every commercial fisherman would like to catch a big red snapper like this. This fish is worth over $70.00
43	Fish caught by commercial fisherman are unloaded, weighed, packed in ice - then shipped to other marke But catches now are smaller than they were. Proper management of our coastal fishery will help slow the tide of decreasing catches.
44	Big lobsters found offshore bring big dollars to commercial fishermen.

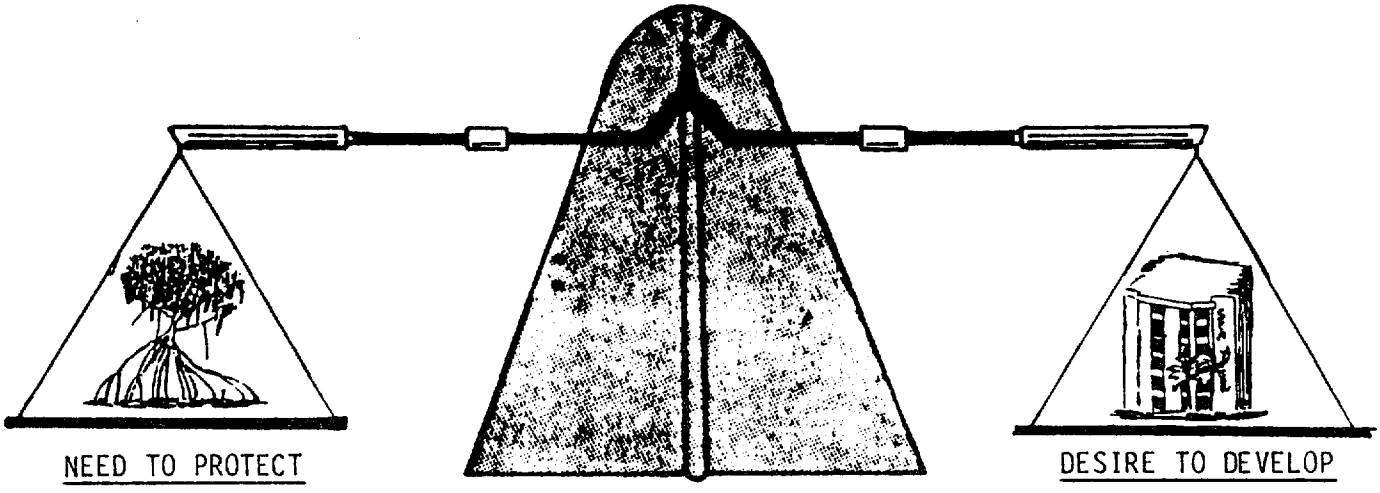
SLIDE	NARRATION
45	The shrimp fishery has also declined drastically in recent years.
46	Cold winters and declining numbers of shrimp have forced many shrimpers out of business.
47	Between shrimp seasons or when catches are poor, some shrimp boats such as the Sassy Lady convert to whelk or conch fishing.
48	The meat of these shells is cooked and used for an Italian dish in restaurants.
49	Unlike snapper and shrimp, the whelk fishery is new here and hasn't been overfished yet.
50	Other shrimpers are scallop fishing.
51	---
52	Net fishermen have to keep their nets repaired.
53	Dredging is a process which is used to maintain the depth of channels for shipping.
54	The dredged material - or spoil as it is called - is piped to some permitted site to be used as fill.
55	This is a dike being built on the Navy Base from river and carrier basin spoil. Sometimes spoil from ship basins and boat yards contains heavy metals such as lead, and copper, and other toxic materials.
56	Much of this marsh has been disturbed by spoil material. It has lost much of its productivity.

SLIDE	NARRATION
57	This healthier marsh is evidenced by the abundance of marsh grass and oyster beds.
58	The site of the now defunct Offshore Power Systems was once shallow bay and pristine marsh like the previous slide.
59	Twelve hundred acres of marsh and bay bottom were destroyed to facilitate the building of nuclear power plants which would float offshore. By the destruction of this marshland 1200 acres of nursery for marine animals was lost.
60	Finger canals such as these are the result of dredge and fill to establish waterfront property out of what was previously marshland. Besides marsh destruction, water stagnation and the potential for fish kills are other problems.
61	Coastal waters are used for many things. Around Jacksonville treatment plants pump treated liquid wastes back into the river.
62	Shrimp and fish larvae are harmed when they drift into the chlorinated effluent.
63	Because generating plants require large amounts of water for cooling, they are built near water. Jacksonville's coal-fired northside generating plant is built on coastal marsh. The smoke stack is built tall to get the suldur dioxide emissions up high enough to by-pass the city of Jacksonville. Sulfur dioxide combines with moisture in the air to form acid rain.
64	Emissions from paper mills also have the potential for contributing to air pollution.

SLIDE	NARRATION
65	Even the fishermen's old cables can become bank pollution or shoreline litter.
66	Jacksonville's commercial waterfront property shouldn't look like this. However, the most harmful part of this eyesore is the presence of heavy metals such as iron.
67	Do you notice the rainbow effects of oil on water? This is a common problem at marinas and at oil depots where tankers unload. The main problem with oil is tainting of intertidal organisms, such as oysters and clams. Oil also gets on shorebirds' feathers. Because birds clean their feathers by preening, the oil sickens or kills them.
68	As more and more people are lured to our beaches, litter pollution has become an escalating problem.
69	Styrofoam and plastics do not decompose - they are not biodegradeable. They merely break down into smaller and smaller particles to be eaten by fish, turtles, and whales. If these animals consume large pieces of plastic, their stomachs become lined with it, digestion is prevented, and death results. Disposable plastics are one of the greatest threats to coastal marine organisms.
70	Not only is broken glass dangerous to beach-goers, but glass is non-biodegradeable. Cigarette filters also remain in the environment.
71	Pets using the beach are not compatible with beach-goers. Dog feces often contain parasites.

SLIDE	NARRATION
72	A problem with high-rise condominimums is that they cast afternoon shadows over our beaches. Yet it is the citizens of Florida who own the land between the tide lines. People who go to the beach to sunbathe are being deprived of sunlight.
73	So is man using the coast wisely? Is he preserving it or is he destroying it? Man has only recently become aware of the real need to preserve the coast for the future. There is no definite answer to the question, but what is presently being done is not enough. There has to be a compromise between environmental and industrial issues. Future voters, like you, need to be aware of what is happening to our coasts. You need to become knowledgeable so that you can vote for politicans who will make wise decisions concerning the environment.
74	In this way we can be assured that our beaches and waterways will continue to serve future needs and will continue to provide a natural habitat for coastal organisms. YOU WILL CONTROL THE FUTURE.
75	Credits
76	Credits
77	Credits

BALANCING THE FORCES



NEED TO PROTECT

DESIRE TO DEVELOP

Directions:

From your readings, list the features of Florida's estuaries which need to be protected in column A. List types of human activities which might threaten these features in column B.

A	B
Estuarine Features	Human Activities

WHO ARE THE PLAYERS?

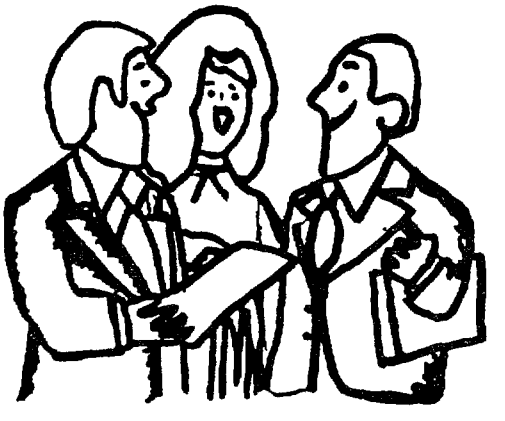
THE ESTUARY GAME

PLAYERS IN THE GAME

Vocabulary:

developing	status	competing
agency	influence	aesthetic
public interest	scenic	

The Estuarine Management Game has many players. By players we mean anyone who has impact on the estuaries and the land around them. Individuals, groups and agencies play the game.

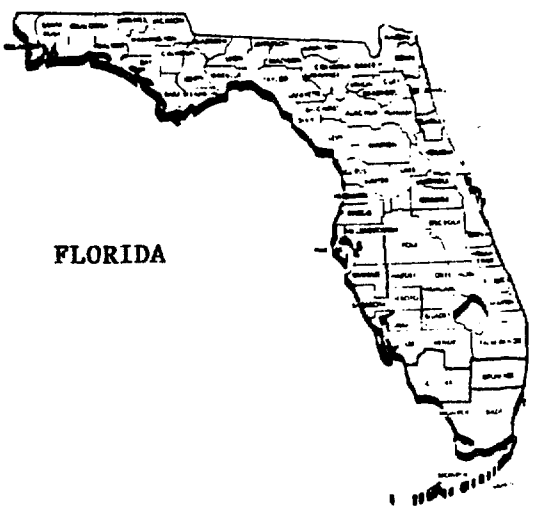


There are two reasons why people have an important role in playing the Estuarine Management Game: private ownership and public interest. Many people own land and have interest in developing in the estuarine areas. The public also has a claim to these areas for subjects such as air and water quality, archaeological and historical sites, and the scenic qualities of our coast. Public interest must be considered.

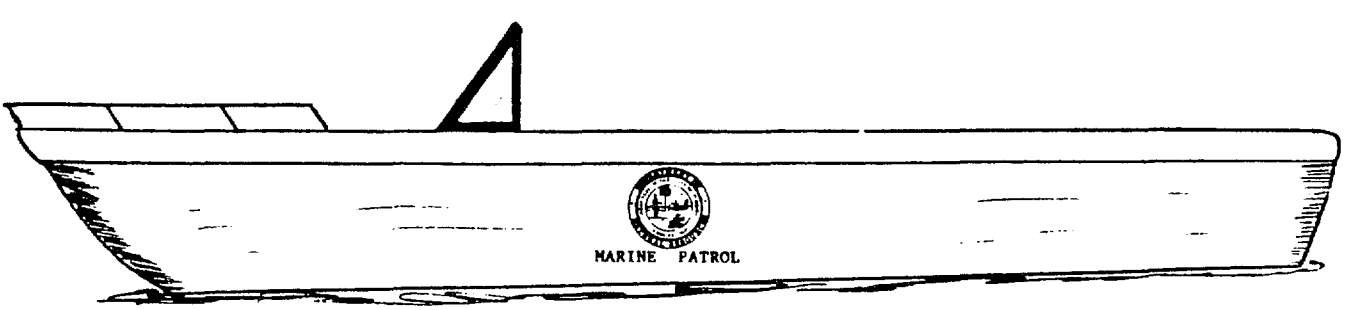
Coastal areas including Florida's estuaries have a special status. Water in Florida, by law, is owned by the public. The state holds these waters in trust for the people. Waters of the state include such features as bays, sounds, estuaries, rivers and streams and portions of the ocean and gulf.

In addition to the individuals playing the game, government agencies can also be considered players because of the influence they have over estuarine areas. The Estuarine Management Game takes place at three levels - state, regional, and local. Each of these play an important part in managing Florida's coastal resources.

STATE: To manage the competing forces in the coastal zone, the Florida Legislature in 1978 passed the Coastal Zone Management Act stating: "the coastal zone is rich in a variety of natural, commercial, recreational, ecological, industrial, and aesthetic resources of immediate and potential value to the present and future well-being of the residents of this state which will be irretrievably lost or damaged if not properly managed."

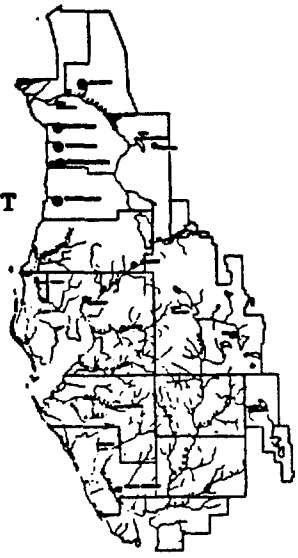


The important players in the Estuarine Management Game at the state level are: the Department of Environmental Regulation, the Department of Natural Resources, and the Department of Community Affairs. Most of the programs for resource protection and coastal development are carried out by these three agencies.



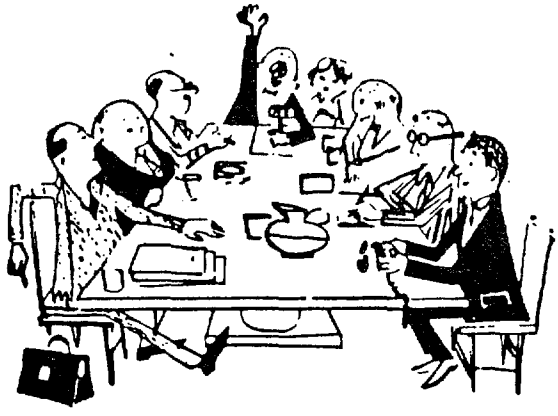
REGIONAL & LOCAL: In addition to the state agencies, the Estuarine Management Game includes regional and local players. There are four regional water management districts. Eleven regional planning councils play a part in the Game.

SOUTH WEST FLORIDA
WATER MANAGEMENT DISTRICT



Local players include county and municipal governments and many other agencies, such as the shore preservation districts and the mosquito control districts.

BAY VIEW
CITY COUNCIL



GOVERNMENT AGENCIES

PLAYERS	ROLES IN GAME	ACTIVITIES REGULATED
DEPARTMENT OF ENVIRONMENTAL REGULATION (DER)	The DER tries to protect the quality of life in the coastal zone by ensuring good land use and conserving resources.	-discharge substances into air or water -operate a water or waste treatment facility -dispose of solid or hazardous waste -dredge or fill in Florida's waters -siting electric power plant, transmission lines, industries and roads -construct and operate percolation ponds underground storge tanks -sanitary land fill -livestock waste lagoons
DEPARTMENT OF NATURAL RESOURCES (DNR)	The DNR is responsible for land management of state owned lands. The DNR is also involved in the acquisition and management of state parks and recreation areas. The DNR conducts research on the status of marine resources. The DNR makes recommendations to the DER on permits involving marine resources.	-residential development -shopping centers -office parks -colleges and universities -airports -hospitals -ports -industrial parks
WATER MANAGEMENT DISTRICTS	The State's 5 regional water management districts have the authority to manage the ground and surface waters of the state.	-construction of storm water discharge facility -consumptive use of water -construction of wells -management of surface water -artificial recharge
LOCAL POLLUTION-CONTROL PROGRAMS	Local pollution control programs supplement State regulations and County land use ordinances.	-local pollution control -environmental permitting -local environmental studies -monitoring pollution control

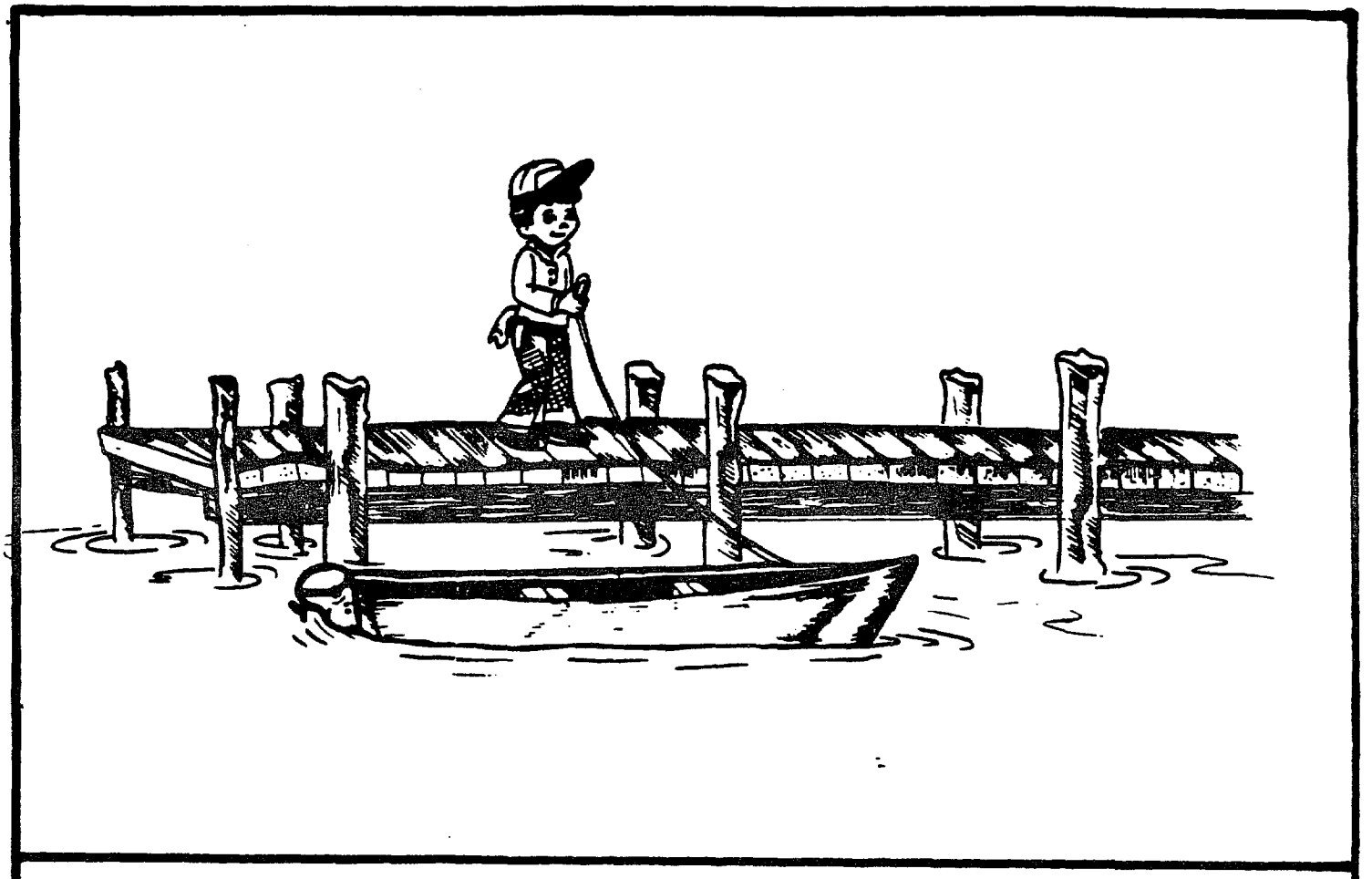
TEACHER DIRECTIONS FOR ACTIVITY CARDS*

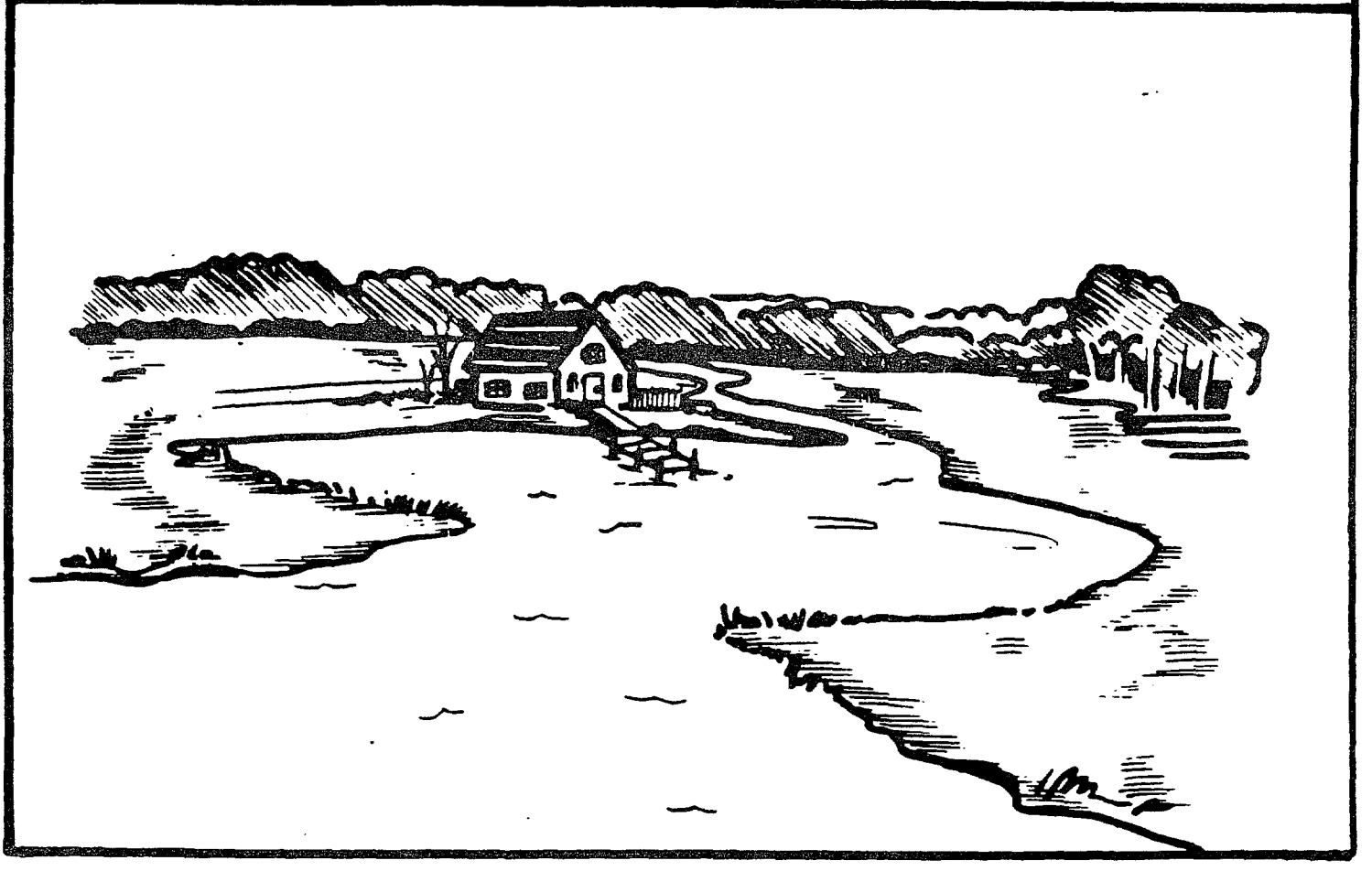
Each of the activity cards describe a proposed activity that will have an impact on the estuarine system. For each card:

1. Have the students write a definition for each of the vocabulary terms. (This may be done in class discussion, in small groups, or individually using a dictionary or context clues.
2. Have the students study the picture and read the short description to help them answer the questions.
3. Finally, have the students use the Government Agencies chart to help them complete the Identifying the Players section.

*These cards will also be used later in the unit to help the students practice the use of a decision-making model.

THE BOAT DOCK





Activity Card 1: The Boat Dock

John Boatman recently bought a house on the beautiful Sweetwater River. His house is about 1/2 mile from the mouth of the river. At low tide, the water near John's home is too shallow for his boat. John would like to build a boat dock and boat house on the river. Building the dock and boathouse will mean driving pilings into the river bottom. His dock will have to extend out 35 feet from the river bank. This will allow him to use his boat at both low and high tide.

Vocabulary: (Write a definition for each of the following terms)

river mouth

river bank

low tide

high tide

pilings

Questions: (Answer the questions using the reading and the picture on the front of the card.)

1. Does Mr. Boatman want to build his dock in an estuary? _____
2. Why does the dock have to project out into the river? _____

_____

3. What problems will be caused for the estuary by Mr. Boatman's dock?

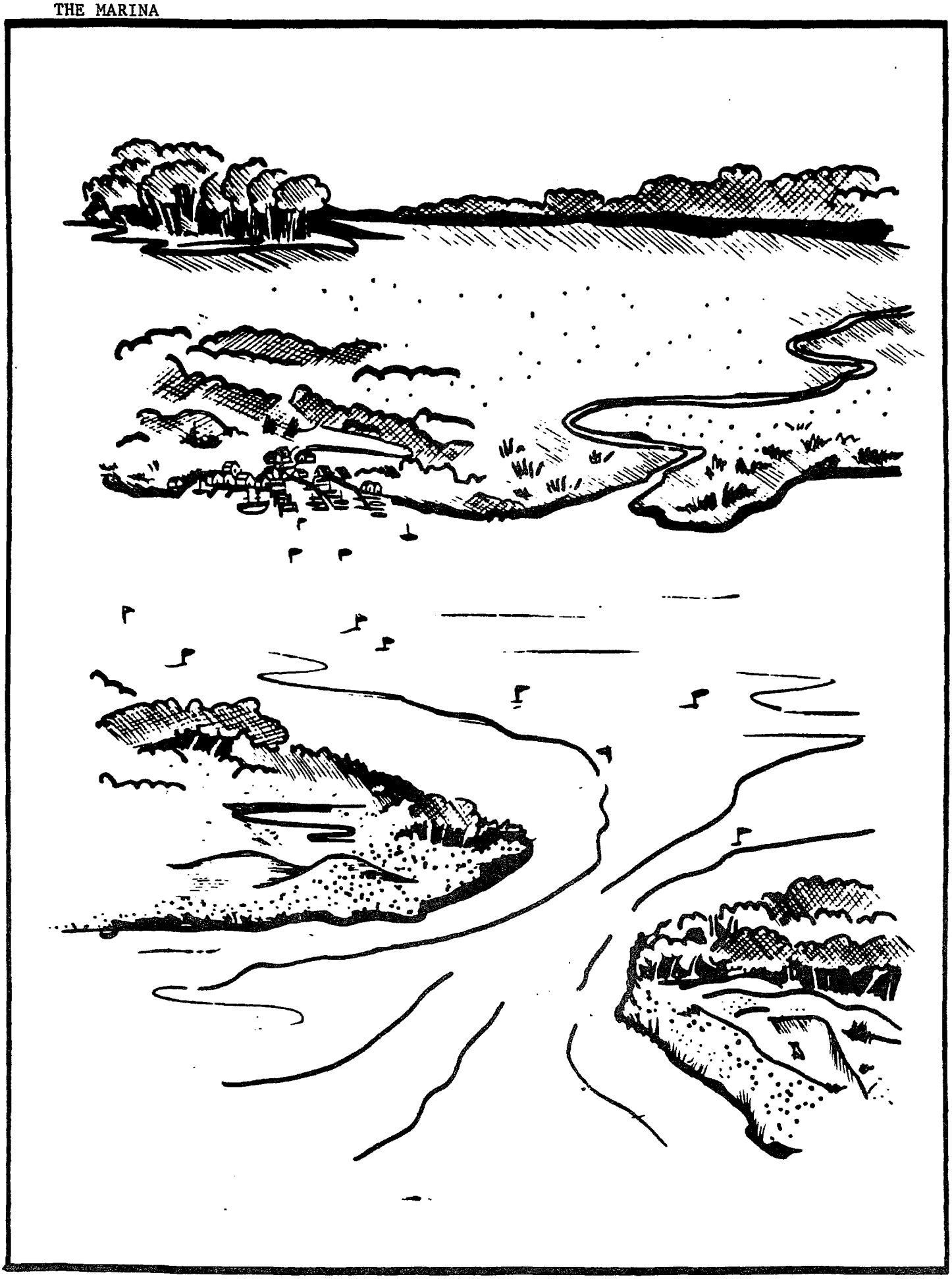
_____

Identifying the players (Use the chart on the agencies to answer the following)

What agencies will Mr. Boatman have to contact before he can build his deck?

_____

_____



Activity Card 2: The Marina

Bob Yachtman owns a private marina on Blue Bay. Only small boats can use his marina because of the depth of the channel. He would like to improve his marina to attract more business. Bob wants to deepen the channel leading into his marina from 3 to 5 feet. To do this, he will need to dredge the existing channel. A deeper channel will allow larger and commercial boats to use his marina.

Vocabulary:

marina

channel

dredge

commercial

Questions:

1. Why is the estuary a good location for a marina? _____

_____

2. Why does Mr. Yachtman want to dredge the channel? _____

_____

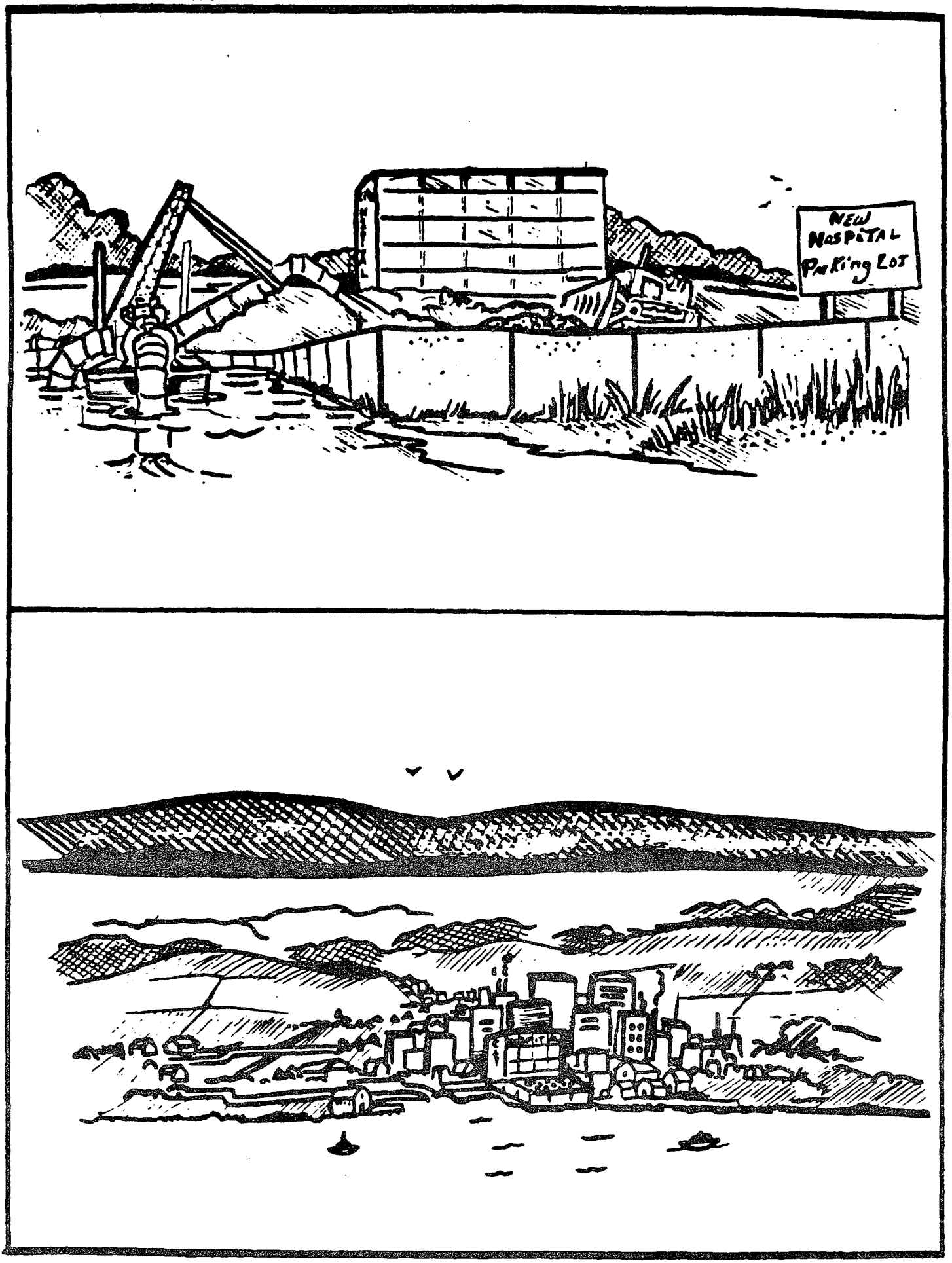
3. What problems might the deepening of the channel cause for the estuary?

_____

What agencies will Mr. Yachtman have to contact for permission to dredge the channel? _____

_____

THE PARKING LOT



Activity Card 3: The Parking Lot

The City of Breakwater does not have enough parking for its hospital! The City wants to expand the waterfront parking lot for their city hospital. To do this they will need to dredge and fill the land along the shoreline. To keep the fill from eroding, they want to build a sea wall. This project will change the existing shoreline. However, it will provide much needed parking space for the growing hospital.

Vocabulary

dredge and fill

eroding

sea wall

Questions?

1. Why does the parking lot have to be expanded on the waterfront side?

_____

2. Why does the City want to expand the parking lot? _____

_____

3. What problems might this project cause for estuary? _____

_____

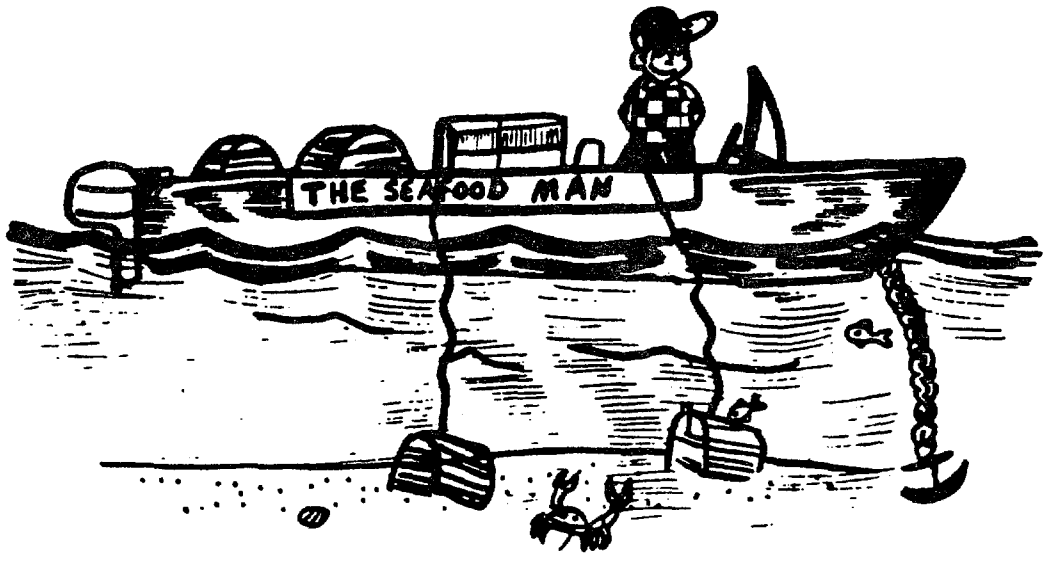
_____

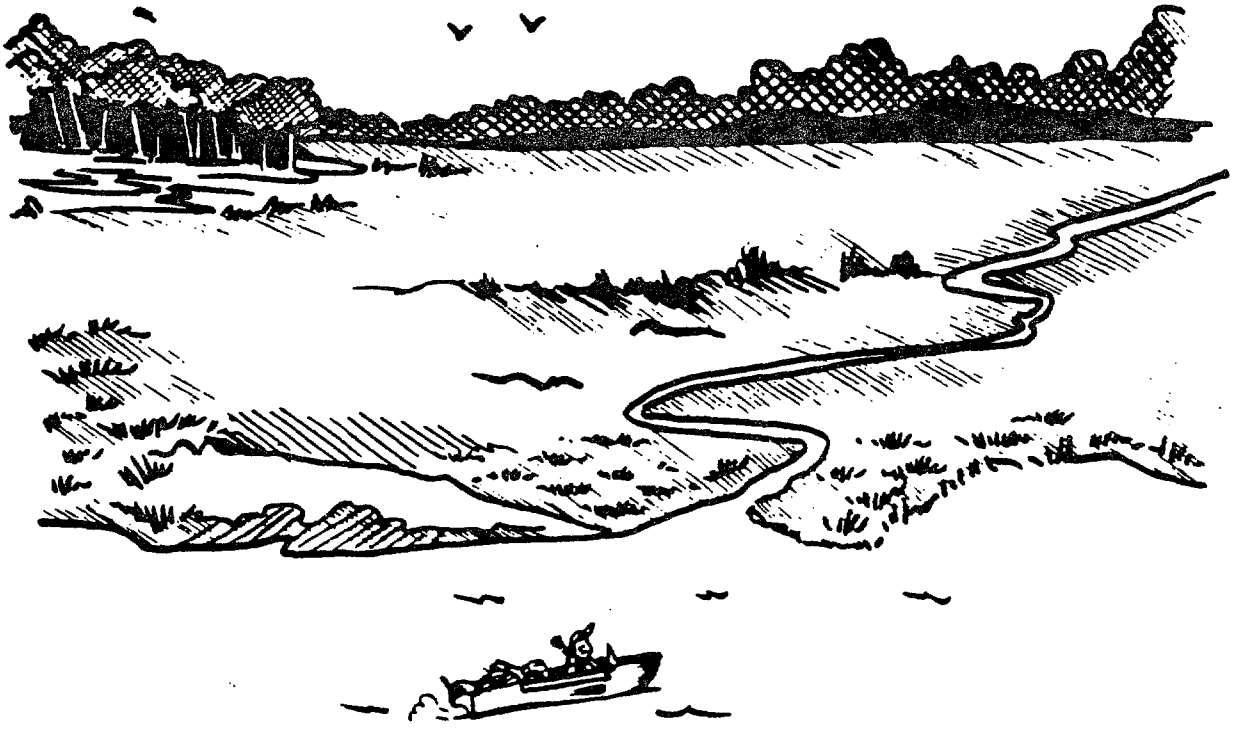
What agencies will the City have to contact to get permits for the project?

_____

_____

HARVESTING BLUE CRABS





Activity Card 4: Harvesting Stone Crabs

Oyster Jack is a commercial fisherman. Jack wants to expand his business by selling crabs to nearby restaurants. Jack will need to lay crab traps throughout the estuary and up into Blackwater Creek. He will use his power boat to set out the traps and to collect the crabs from the traps. This project will help Jack meet the demand for a variety of seafood. He wants to start harvesting stonecrabs in Blackwater Creek Estuary.

Vocabulary:

demand

harvesting

variety

Questions:

1. Why would the Blackwater Creek Estuary be a good place for commercial fishing? _____

2. Why does Oyster Jack what to harvest stone crabs in Blackwater Creek Estuary? _____

_____

3. What problems will Jack's business cause for the estuary? _____

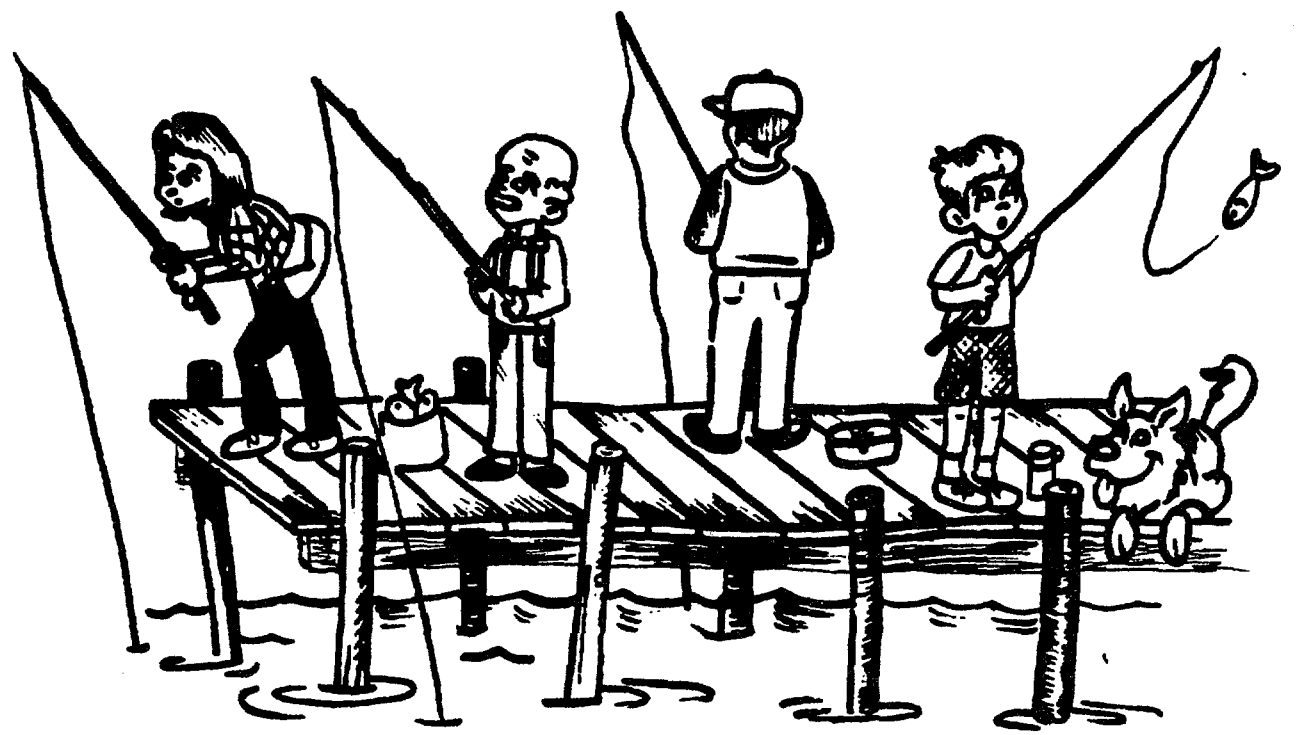
_____

_____

What agencies will Jack have to contact to get permission to harvest the crabs? _____

_____

THE FISHING PIER



Activity Card 5: The Fishing Pier

The City of Oceanside wants to attract more people to their city to improve the economy. The City wants to construct a fishing pier on Sweetwater Bay. The pier will be built out of concrete and extend 150 feet out into the Bay. It would take 6 months to build the pier and will require large equipment and machinery. The pier will attract many recreational fishermen. In addition, many other tourists and sunbathers will gather near the pier providing other commercial opportunities.

The activities centered around the pier will boost Oceanside's economy.

Vocabulary:

recreational

opportunities

boost

Questions:

1. Why is this a good place to place a pier? _____

_____

2. Why does Oceanside want to build the pier? _____

3. What problems might the pier cause for the estuary? _____

_____

What agencies will the City of Oceanside have to contact to get permission to build their pier. _____

_____

WHAT IS THE GAME AND WHY PLAY IT?
Comprehension Check

Name _____

Put a dozen fish in the estuary and win!

Using your text, answer the questions correctly and put a baby fish in the estuary.

1. Who were the first people to live in Florida? _____

2. When did Ponce de Leon arrive in Florida? _____

3. Where was the first settlement? _____

4. Why did the human forces have little affect on the coastal environment during early settlers time? _____
_____

5. Why did people come to Florida? _____
_____

6. The population moved to _____ and _____.

7. Where were the environmental stresses at that time? _____
_____

8. What reduced the water quality? List two reasons why. _____
_____
_____

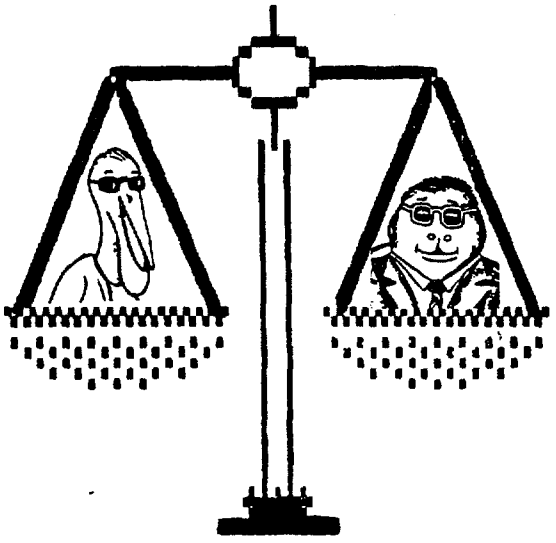
9. What causes the decline of marine fisheries? List two. _____
_____
_____

10. What causes a shortage of fresh water? _____
_____

****

Draw a baby fish if you are correct.

MAKING DECISIONS



THE ESTUARY GAME

Decision Making Model

Later in this unit you will be playing a game. You will be asked to make some decisions about using land in an estuarine area. In making decisions it is important to have a clear idea of all the things involved in making the decision. Using a decision making model will help you to make better decisions (& play the game better). There are a lot of different decision making or problem solving models. You are going to use a five step model.

STEP 1: Identify the problem (Write a sentence explaining what the problem is.)

STEP 2: List the alternatives (Make a list of all the possible solutions to the problem.)

STEP 3: Set up Criteria for judging the alternatives (Make a list of standards that you will use to judge which is the best solution.)

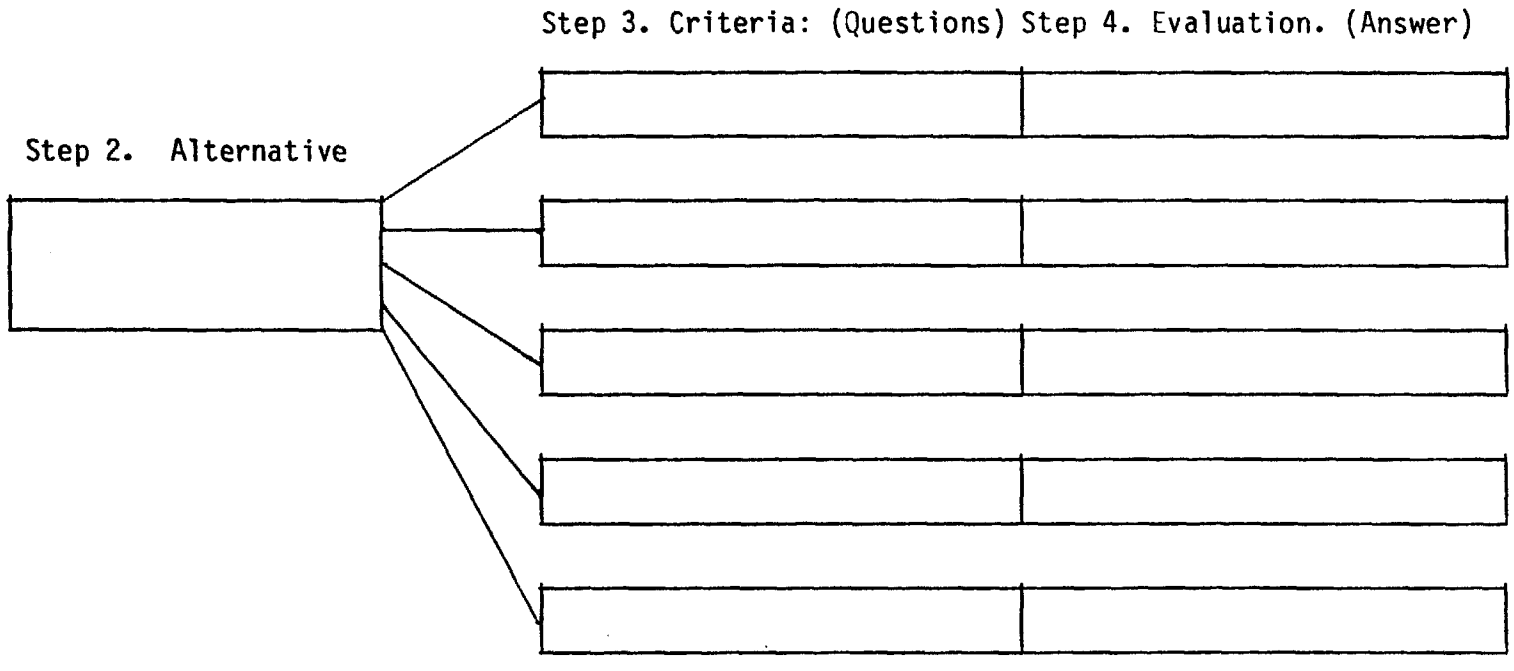
STEP 4: Evaluate each alternative (Judge how good each possible solution is by how well it meets the standards you set up in Step 3.)

STEP 5: Make the decision (Choose the best possible solution.)

To help you become familiar with this problem-solving model you are going to practice. You will apply the model to the situations on the activity cards you used earlier. A sample has been done for you. After studying the example use the same steps on at least two of the other cards.

DECISION-MAKING MODEL

Step 1 Problem: _____



Step 5. Decision: _____

_____

_____

SAMPLE

Step 1: Identifying the problem. What is the problem on Activity Card #1? (Water too shallow at low tide to use boat.)

Step 2: List alternatives. What are some things John could do to solve the problem? (Build a boat ramp, sell his boat, buy a smaller boat, build a boat dock out to deeper water, dredge to make water deeper near house.

Step 3: Develop criteria for judging alternatives. What are some of the things John should consider in making his decision? Write these in the form of questions. (How much will it cost cost? Will it make it easier to use his boat? Is it allowed by local zoning regulations? How much time will it take? Will it allow him to use boat more often? What permits will be required.

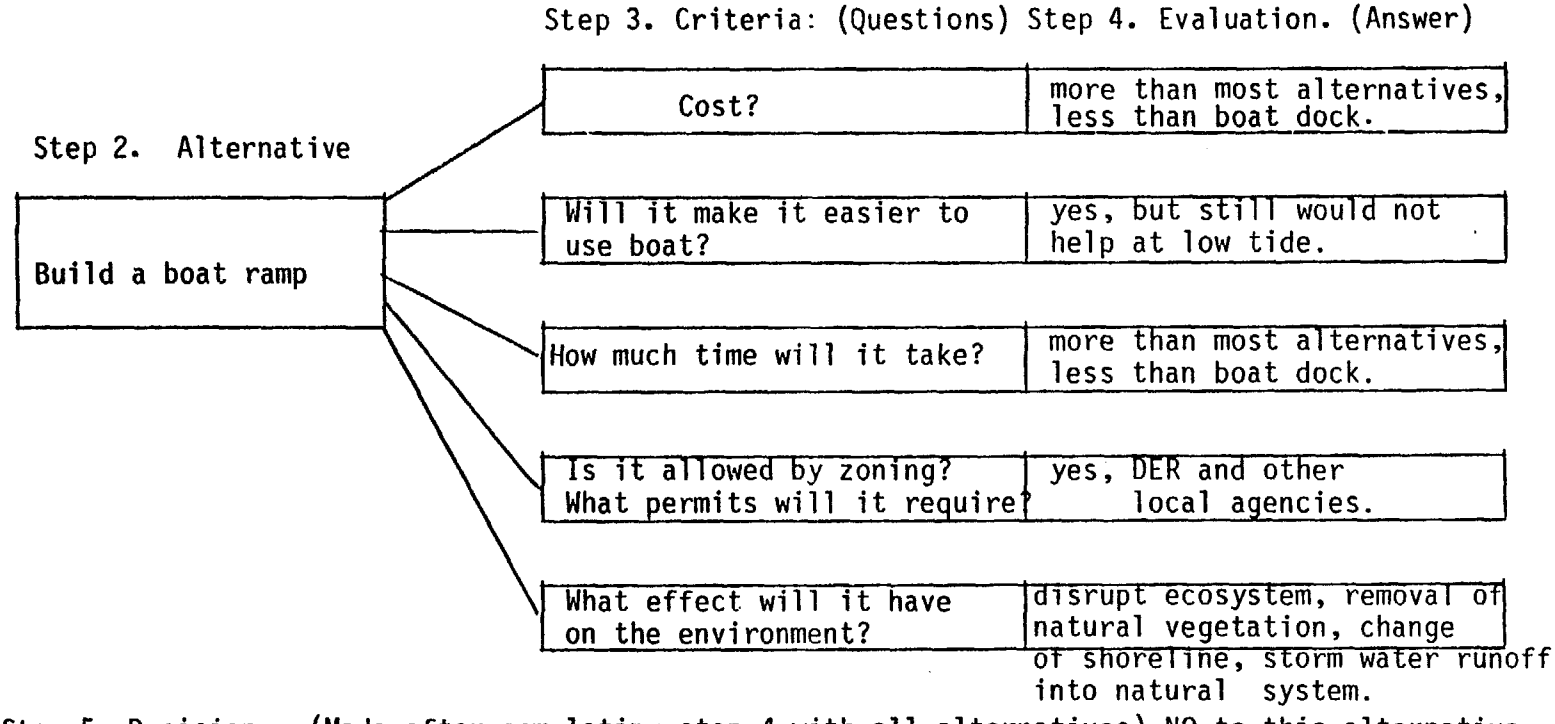
Step 4: Evaluate the alternatives. Ask each question developed in Step 3 for each of the alternatives listed in Step 6. Use the decision making worksheets. One sample is done for you.

Step 5: Make the decision.

SAMPLE

DECISION-MAKING MODEL

Step 1 Problem: Water is too shallow at low tide to use John's boat.



Step 5. Decision: (Made after completing step 4 with all alternatives) NO to this alternative because of harm to environment and will not solve low tide problem. (John chooses boat dock because of less harm to environment and ease of using boat.)

TEACHER DIRECTIONS

SHELL ISLAND

A Lesson Plan for a Land Simulation Game

Some information about simulation games: the techniques used in simulation names combine elements of simulations, names, and role-playing. Students assume the roles of decision-makers in a simulated environment and compete for certain objectives according to specified procedures and rules. (Note to coordinator: This activity is similar to the Coca-Cola Ecology Game, but on a more complex level suitable for middle school, high school, and adult groups as an evening program in a large group situation. The "game" can be quite serious and involving for everyone, and should always be followed by some sort of "unwinding" activity like a dance, campfire, night hike, etc., to release some of the emotional energy which builds up during the game.)

Simulations are operating models of real life situations. They may be about physical or social situations.

Most simulations for classroom use involve gaming. A game is defined as something enjoyable; however serious it might be involving competition for specified objectives and observing rules.

Some simulation games are based on environmental issues. What are some benefits of using simulation games as an instructional technique for investigating problems?

- -They are fun
- -They get people involved
- -They are a logistically easy way of helping to prepare people for becoming involved with solving environmental problems
- -People analyze case and effect relationships of environmental issues
- -People are put in role-playing situations where they have to suggest alternative solutions to environmental concern
- -People interact with each other in the decision-making process (two or three school groups can do this activity together providing that the groups are split up for Task 0 making them work with students from the other schools.)

So simulation games not only develop understandings about problems in the environment and develop awareness and concern about those problems, but they help people develop skills they need for citizen action and involvement in environmental management.

Shell Island - procedures for the coordinator

Necessary items which will be available:

-Tables (leave up after last meal)
-Large sheets of white paper (2' x 3')
-Masking tape
-Markers (sets of 5-6 colors, one set for each 10 students)
-Pencils (ask students to bring them but have some available)

I. INFERRING, RECORDING, AND CLASSIFYING POSSIBLE USES OF LAND

A. Distribute Task A, Shell Island - Land Use Problem (10 minutes-students work individually)

B. Questions and Discussion (Note: when most people have started to write down uses on Task A, go ahead with question #1.)

1. What are some possible uses for Shell Island? As people respond, write all comments on board just as they say them. Do not paraphrase for them unless they are too wordy, in which case ask, "How shall I write that on the chart?" If they give major categories right away, like recreation or industry, say, "Can you give me an example of that ?" Number the items as you go along to simplify identification later. When you get 15 or 20 items, stop.

2. "Which of these uses are familiar?" Designate similar uses by letters, A is for all of one type, B, the next, etc. When most are designated with a letter or the group seems to run out of thoughts, stop. It is okay to change the groupings if the students change their minds.

3. "What label could we give to all the items in group A, group

B?", etc., e.g., recreation, industrial, utilities, housing, commercial, etc. It is okay if they suggest more than one label for a group, write both down.

II. DEVELOPING AND GIVING PRESENTATIONS

A. Divide the students into smaller groups (6-10 in each group) corresponding with the number of categories decided on in #3.

B. Assign each group to represent one of the categories.

C. Go on to Task B. Inform the students they have 10 minutes to list and analyze possible land uses in the assigned category. They may consider those listed on the board in their category plus any other possible uses they can think of within the category.

(At the end of 10 minutes, go on.)

III. DEVELOPING AND GIVING PRESENTATIONS

D. Pass out markers and a large sheet of paper to each group. "You have 20 minutes to plan a strategy and develop a 3-minute presentation to be made to the County Commission."

Example:
1. This presentation will be a proposal for Shell Island.
2. You must have a land use map drawing.
3. More than one person in your group must help in making the presentation.
4. Illustrations should be large enough to be seen by everyone in the room.

E. Ten minutes into the group strategy planning session have each group select one of its members to meet together as the County Commission. Take the commissioners into another room and tell them they will be responsible for hearing the presentations and deciding upon the best one. Their job in the next ten minutes is to:

1. Develop criteria they will use in evaluating the proposals.

2. Develop an evaluation system based on the criteria, using the County Commissioner's worksheets.
3. Elect a chairperson to preside during group presentations.

Alternatives for County Commission: It is often difficult for students to play the role of a county commissioner. As game moderator, you may want to:

1. Suggest that the commissioners assume roles corresponding to the "special interest" groups they were elected from (e.g., a school teacher from the education group, a retired Army colonel from the military-industrial complex, etc.) or

2. Allow the students to choose their own roles as commissioners (e.g., housewife, lawyer, scientist, construction worker, real estate salesperson, etc.)

F. Fifteen minutes after groups start planning their presentations, remind them they have 5 minutes left to have their verbal and visual presentation ready. Let them have a few more minutes to finish, if needed.

G. Have the County Commission enter the room and sit up front. Appoint a timekeeper to cut all presentations off at 3 minutes (give 1 minute warning.) Announce, "Because of time, there will be no rebuttals or discussion. The Commissioners may want to ask questions or have rebuttal time after all presentation. However, allow only 5-10 minutes for this part so it won't get out of hand.

H. The commissioners retire for 5-10 minutes to select the better proposal (the "government-in-the sunshine" law prohibits a quorum of elected officials from deliberating in private. If the students bring this up, you should enforce it. If not, allow the commissioners to leave.)

I. While the Commission is meeting, ask the whole group to suggest a list of criteria they think should be used in choosing among the plans submitted. Write these on the board.

J. The County Commissioners individually announce their votes, i.e., which proposal they preferred and why. Also, why didn't they vote for another proposal. The chairman then announces the over-all decision.

K. County Commission reads their criteria aloud.

DISCUSSION

-"What additional date would you have to have had for your groups?" List on board, e.g., topography, vegetation, economics of area, adjacent keys, climate, soil, historical information, wildlife, interest of County Commissioners, available money, educational needs, public utility needs, county and state regulations, existing zoning, political climate, population information (age, needs, race, and jobs).

-"How has your knowledge of Florida's estuaries helped you in this activity?"

Note: This is one of the most important parts of the activity because it emphasizes that we need a variety of information and data before we can intelligently make a land management or environmental decision to best meet the needs of people and their environment. This question list has all the elements that need to be considered in studying a local environmental issue or concern. It also includes elements of all the curriculum subject areas (sociology, economics, science, engineering, language, arts, etc.)

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"Shell Island" is a modification entitled "Paradise Key." "Paradise Key" was adapted by Bill Becker of the Newfound Harbor Marine Institute. Big Pine Key, Florida from "A Lesson Plan for Land Use Simulation Came - Centerplace City," utilized by the U.S. Forest Service, who in turn adapted it with permission from the May 1979 Journal of Geography article. "A land use alternatives model for upper elementary environmental education" by Dennis Asmussen and Richard Cole, University of Washington.

TASK A

SHELL ISLAND - A Simulation

The Mosquito County Commission has been confronted with a decision concerning a small island known as Shell Island in Ponce De Leon Bay. The island is county-owned, uninhabited and presently accessible only by boat. The Florida Department of Transportation (DOT) is scheduled to replace the existing deteriorating Bonita River Bridge with another two-lane bridge.

Shell Island is located a few hundred yards south of the mouth of the Bonita River (see map). DOT is exploring the possibility of routing the new bridge through Shell Island. It has requested a recommendation from the Mosquito County Commission. The commissioners have decided to hold a public hearing to listen to proposals from various groups on a long term management plan for Shell Island and the surrounding estuary of Ponce De Leon Bay.

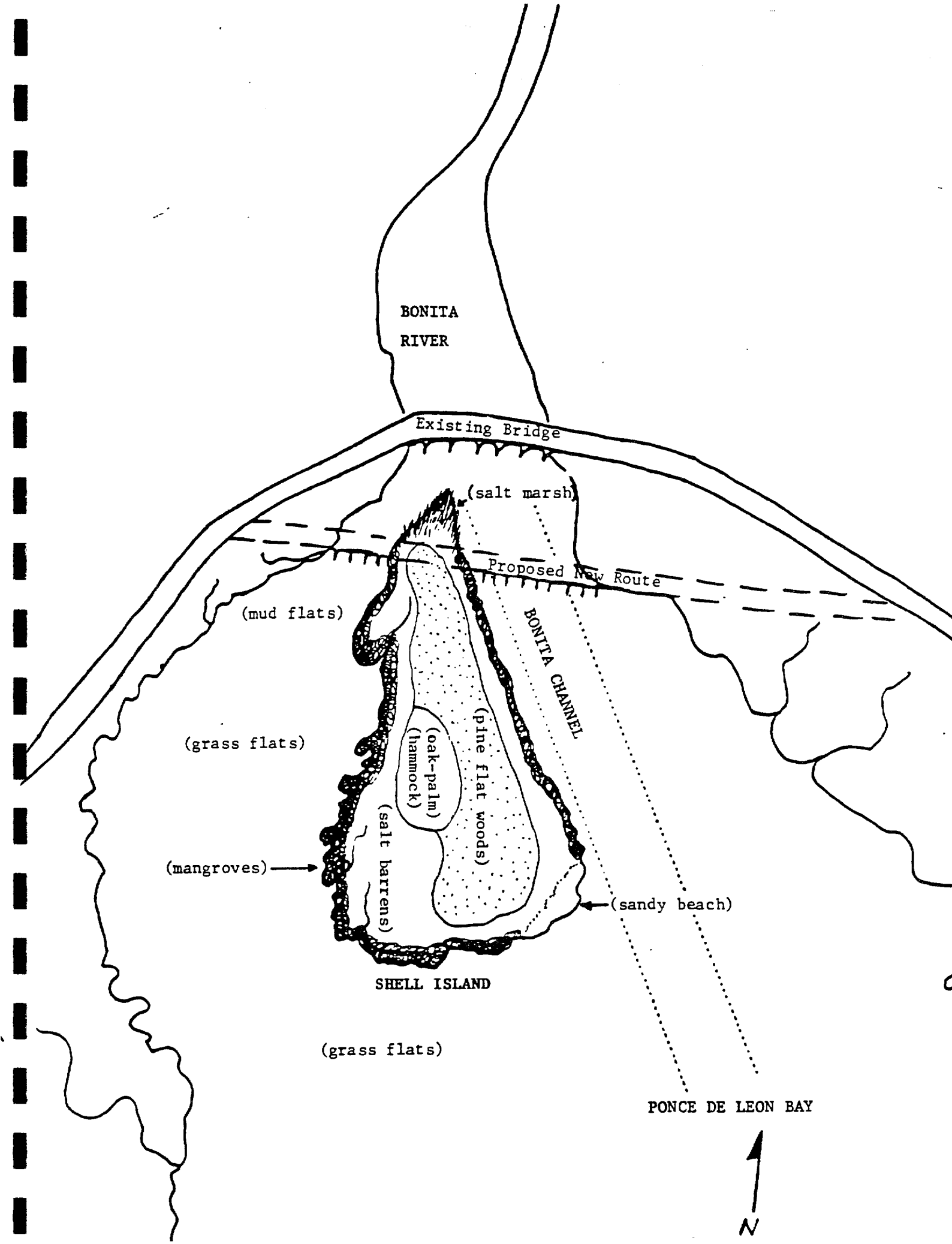
Shell Island is one (1) mile wide by one and one half (1½) miles wide. It is surrounded by shallow mud and grass flats to the north, south and west. To the east is the Bonita Channel, with a minimum depth of 8 feet. The island is composed of several distinct zones: a pine-palmetto flatwood, a hardwood hammock, a salt barren, and a mangrove fringe. On the north end, there is a small area of salt marsh and on the southeast point, there is a narrow sandy beach.

TASK B

CHECKLIST

Before you make your presentation check to be sure you have considered all the questions that might come up about your proposed project. Be sure you are prepared to argue the benefits of your project and defend your project against criticism. Use this checklist to help you think of things you may wish to consider in preparing your presentation.

- What benefits will your project have for the community? (Jobs, services, etc.)
- Will there be any costs to the county government?
    - ____ emergency services (ambulance, fire, etc.)
    - ____ police protection
    - ____ disaster preparations
    - ____ public transporation
    - ____ miscellaneous expenses (list them separately)
- Will there be any environmental damage to land or water?
- What estuarine communities will be affected?
- Will there be any problems from coastal storms?
- Have you made adequate provisions for transportation?
- Have you made plans for other facilities necessitated by your project (sewage, power, drainage, etc.)
- What agencies will be involved in issuing permits for your project?
- What steps have you taken to lessen any negative effects from your project?
- Are there other things you should consider due to the nature of your particular proposal?


BONITA
RIVER
Existing Bridge
(salt marsh)
Proposed New Route
(mud flats)
BONITA CHANNEL
(grass flats)
(oak-palm)
(hammock)
(pine flat woods)
(salt barrens)
(mangroves)
(sandy beach)
SHELL ISLAND
(grass flats)
PONCE DE LEON BAY
N

TASK A

STUDENT WORKSHOP

Directions:

1. (10 min. - work by yourself) List possible uses for Shell Island!

2. Group similar uses in the space below. Give each group or category a name.

TASK C

COUNTY COMMISSION WORKSHEET

PROPOSALS						CRITERIA
1	2	3	4	5	6	
						Example: Will this development benefit the community economically?

NOTE: County Commissioners may want to use the TASK B checklist to help them develop criteria for judging proposals.

TEACHER DIRECTIONS

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DIRECTIONS

Each of these cards describes as proposed activity that will have an impact on the estuarine system. For each card:

1. Write a definition for each of the vocabulary terms (this may be done in class discussion, in small groups or individually using a dictionary or context clues.
2. Study the picture and read the short description to help them answer the questions.
3. Use Government Agencies chart to help them complete the Identifying the Players section.

*These cards will also be used later in the unit to help you practice the use of a decision making model.

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HILLSBOROUGH COUNTY MEDIA CENTER

. "Will The Fishing Have To Stop?"

. "Adaptations For Survival - Mammals"

. "Ecology - A Community Beneath The Sea"

. "Food Chains In The Ocean"

. "Birth Of A Florida Key"

. "Salt Marsh - A Question Of Values"