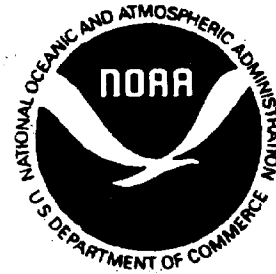
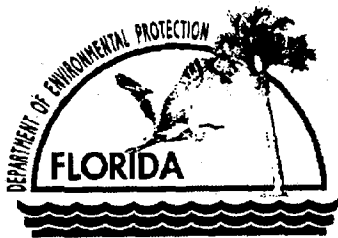


PROJECT ESTUARY

**A Five Lesson Classroom Curriculum That
Features The Wonders Of The Apalachicola River
And Bay System**



Sponsored By:

**The Florida Department of Environmental Protection
The Apalachicola National Estuarine Research Reserve**

and

**The National Oceanic And Atmospheric Administration
Sanctuaries And Reserves Division**

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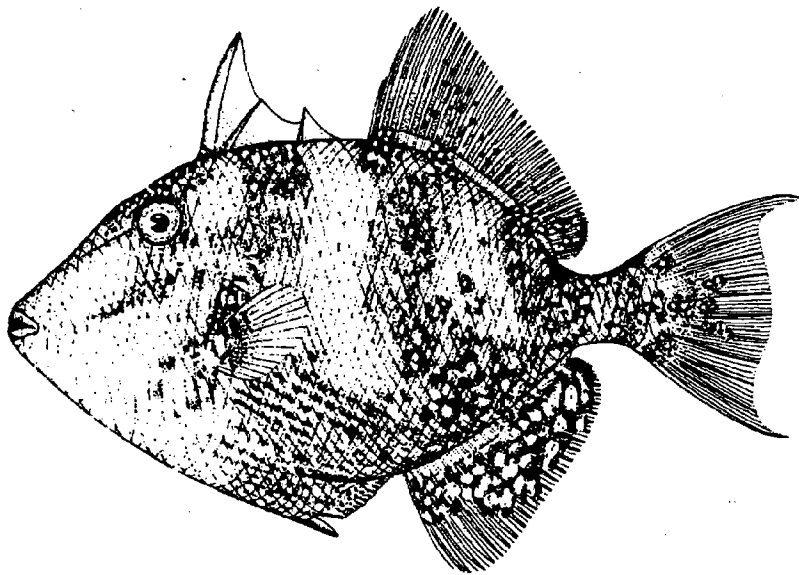
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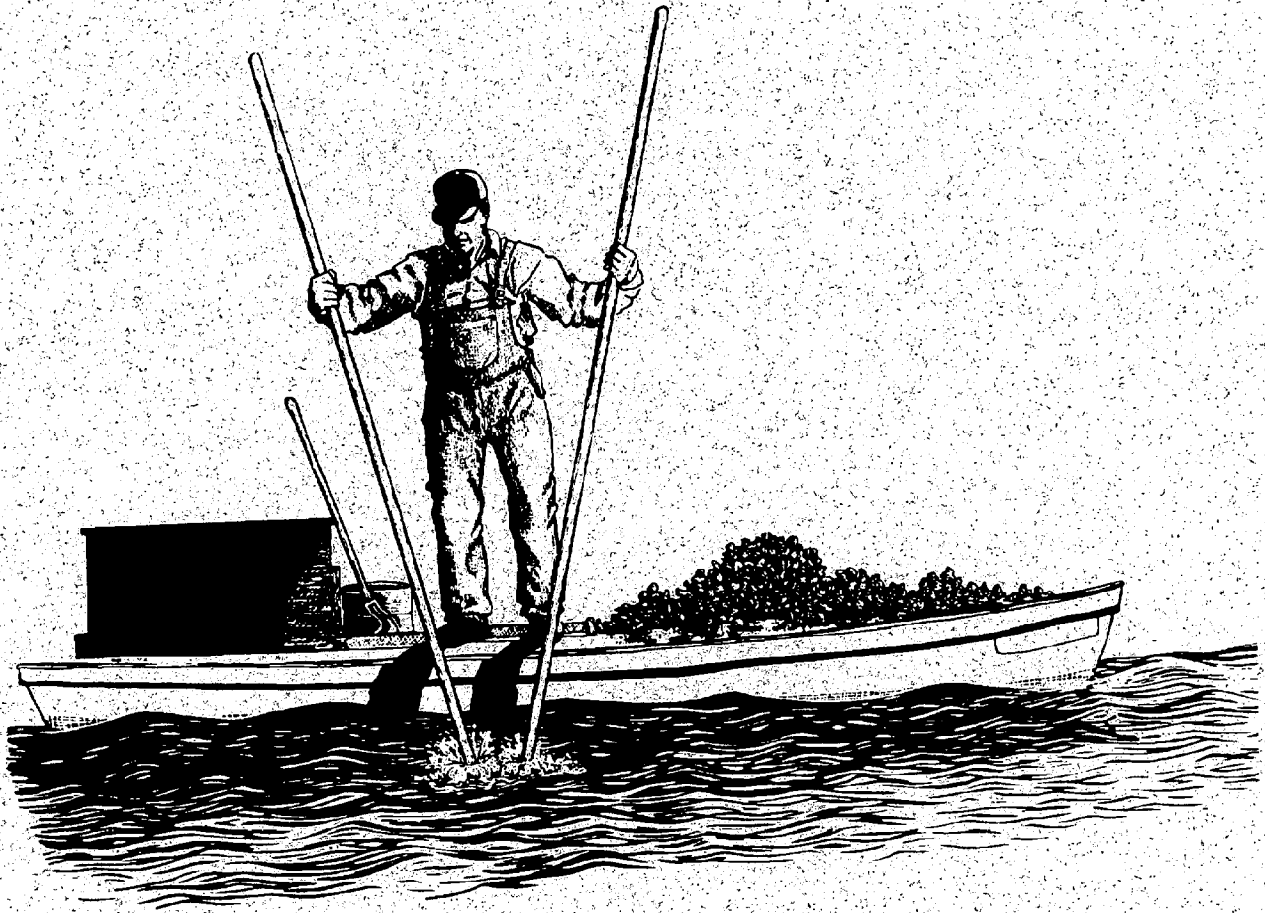
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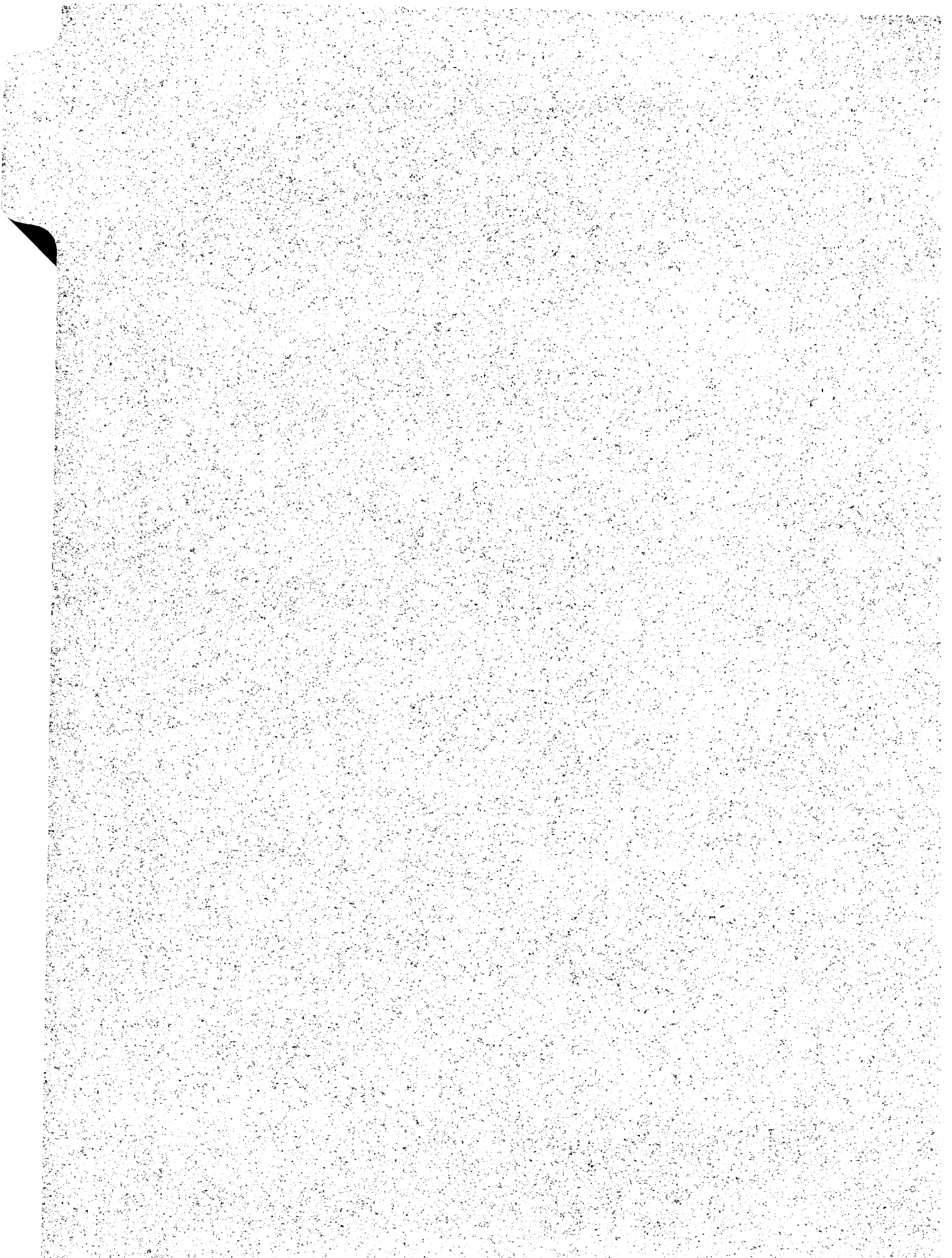


Gray Triggerfish



Oysterman "tonging" oysters in Apalachicola Bay.

Illustration by Diane Sterling,
Northwest Florida Water Management District.



INTRODUCTION

About Project Estuary

What is Project Estuary?

Project Estuary is a five-lesson curriculum featuring the Apalachicola River and Bay Estuarine System. It is designed to be completed in approximately eight 50-minute class periods.

Who is it For?

Materials were developed for middle and high school students in grades 6-9.

What Topics are Covered?

Lesson I features the definition and overview of an estuarine system. It is conducted through the use of a slide/tape or video program.

Lesson II focuses on the significant role an estuary plays in the local environment. It includes relationships to economics, seafood industry, recreation, navigation, migratory waterfowl, and other wildlife. Lesson II involves the use of a few slides as well as several overhead transparencies.

Lesson III concentrates on human impacts to the estuarine system and covers topics such as pollution and multi-use demands.

Lesson IV highlights the organisms of the estuarine system and the habitats they depend on. Topics featured include microorganisms, bottom dwellers and fishes.

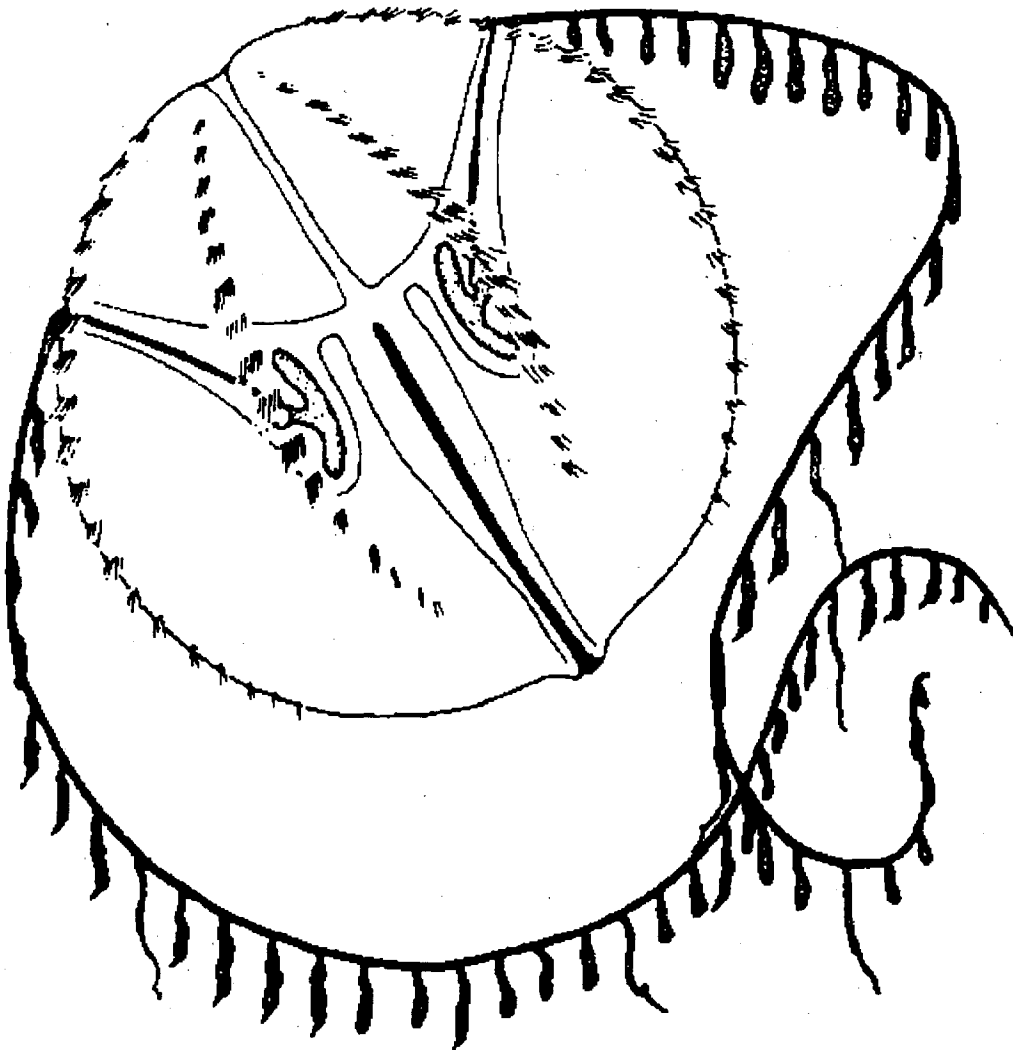
Lesson V involves the students in a coastal management decision-making activity and points out the many perspectives involved in the decision-making process.

Development and Distribution

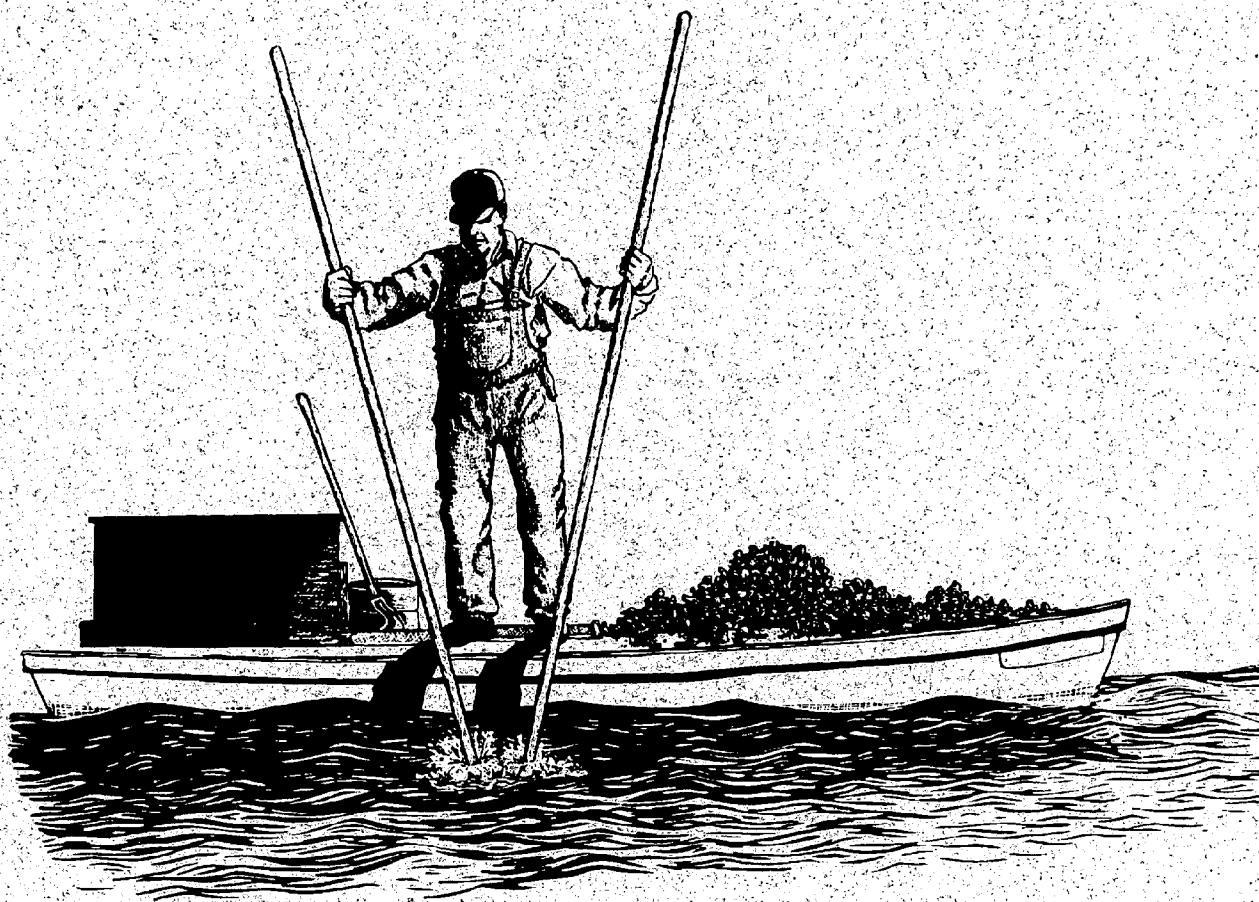
Project Estuary was developed by the Florida Department of Natural Resources (now the Florida Department of Environmental Protection) with cooperative funding from the National Oceanic and Atmospheric Administration and the Board of County Commissioners, Franklin County, Florida. The original printing was done in 1987 and funding was provided by the Northwest Florida Water Management District for a reprinting and distribution in two additional counties.

This edition has been revised to incorporate the teacher's guides and other information into the body of the notebook, as well as add a new lesson focusing on the organisms of the estuarine system and more graphics. Funding was provided by the Florida Department of Environmental Protection and The National Oceanic and Atmospheric Administration.

Thus far, Project Estuary has been introduced in eight counties through teacher training workshops. It has had a much wider use through the A/V Checkout Library at the Apalachicola Reserve. Copies of this edition, along with the accompanying slide/tape program or video, have been sent to media centers in both private and public schools within the following counties: Bay, Calhoun, Franklin, Gadsden, Gulf, Jackson, Leon, Liberty, and Wakulla.



Comb Jelly (Pleurobrachia)



Oysterman "tonging" oysters in Apalachicola Bay.

Illustration by Diane Sterling,
Northwest Florida Water Management District



A TEACHER'S GUIDE TO LESSON I

OBJECTIVES

1. Students will be oriented geographically to the Apalachicola River and Bay System and be able to describe major physical and biological features of the system.
2. Students will be able to define what an estuary is.
3. Students will understand many reasons why estuaries are important.
4. Students will understand the local importance of the Apalachicola Estuary.
5. Students will understand certain management considerations related to human use of the estuary.

TIME: Approximately two 50-minute class periods.

PROCEDURE: It is suggested that steps 1 and 2 below be completed in one period and steps 3 and 4 in another.

1. Begin by reviewing the vocabulary list for this lesson before proceeding with other steps.
2. Next, you may show the slide/tape program (or video) for Lesson I titled "Apalachicola Ramblings." Following this, go over "Important Review Points for Apalachicola Ramblings video," on p. 5.
3. Make copies of the student activity pages and distribute them to your group. You should allow approximately 40 minutes for students to complete these activities.
4. Complete Review Quiz for Lesson I.
5. Discuss answers or post answer keys to student activities and review quiz for Lesson I.

ANSWER KEYS TO LESSON I

Crossword Puzzle

ACROSS

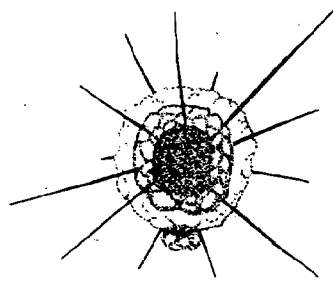
1. primary producer
4. exploit
5. seafood
7. hurricane
10. bay
12. erosion
16. barrier island
18. sea
20. research
22. salinity
23. productive
24. sun
26. ocean
28. impurities
31. true estuarine
34. wildlife
37. photosynthesis
38. phytoplankton
39. nesting

DOWN

2. resources
3. refuge
6. nutrient trap
8. estuary
9. NOAA
11. agriculture
13. environment
14. forestry
15. marsh
17. detritus
19. ecosystem
21. Flint
25. economic
27. management
29. predators
30. brackish
32. river
33. tern
35. habitat
36. plant

Hidden Words

Apalachicola, estuary, marsh, nutrients, detritus, salinity, brackish, resource, zooplankton, manage, photosynthesis, ecosystem, impurities, barrier island, habitats, floodplain, environment, refuge, nurseries, predator, erosion, productive, energy, shellfish, oyster, navigation, bay, river

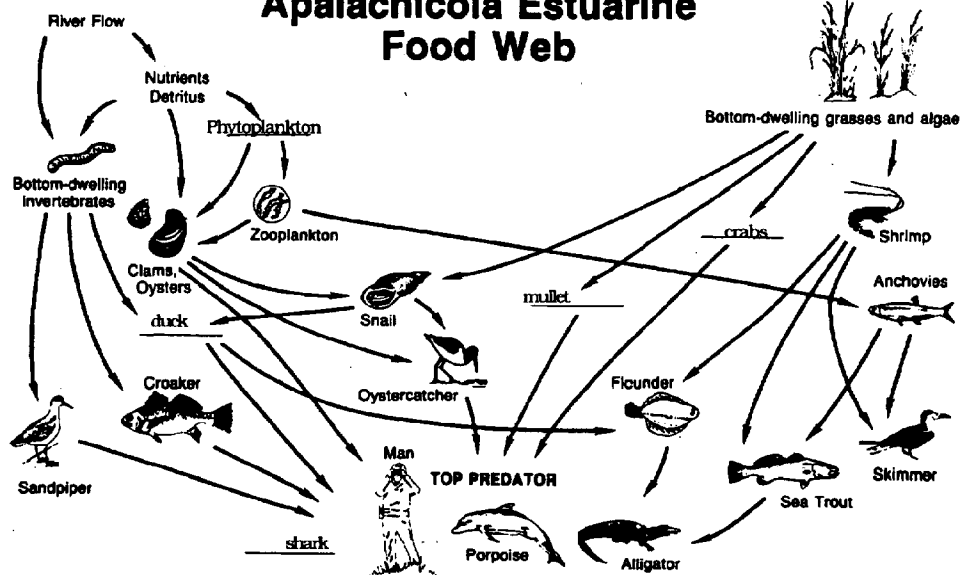


Radiolaria

Use words in the given word list to complete the food web:

Shark
Phytoplankton
Crabs
Mullet
Duck

Apalachicola Estuarine Food Web



Answer Keys Continued...

TRUE/FALSE

1. true; 2. false; 3. true; 4. true;
5. false; 6. true; 7. true; 8. true

FILL IN THE BLANK

1. brackish; 2. nutrient trap;
3. estuary; 4. habitats; 5. Georgia;
6. ecosystem; 7. nutrients and detritus;
8. photosynthesis

MATCHING

1. (C) predator; 2. (A) food source; 3. (D) industry; 4. (B) primary producer; 5. (E) habitat;
6. (D) industry; 7. (A) food source and (B) primary producer; 8. (A) food source

REVIEW QUIZ

- I. 1. estuary; 2. food, shelter, nurseries; 3. salinity; 4. nutrient trap;
5. detritus; 6. misused
- II. 7. T, 8. T, 9. F, 10. T

IMPORTANT REVIEW POINTS FOR "APALACHICOLA RAMBLINGS" VIDEO

1. Apalachicola Bay is an example of an estuary.
 - a. An estuary is where fresh water from the land mixes with salt water from the sea (Gulf of Mexico in our case).
 - b. An estuary is an important nursery area for juvenile animals. It provides food and cover.
2. The Apalachicola River is formed where the Flint and Chattahoochee Rivers come together.
 - a. Most of the drainage area is in Georgia (3/4). Alabama has 1/8 and Florida has 1/8.
 - b. 84% of our fresh water comes from Georgia and Alabama.
3. The mixture of fresh and salt water is called "brackish" water.
4. River flow varies with rainfall.
 - a. The river moves detritus and nutrients into the bay.
 - b. Detritus is dead, decaying plant and animal material that is an important food source in the bay for shrimp, oysters, crabs and many other animals.
5. Major habitats in the Apalachicola River and Bay Ecosystem include: Floodplains, Marshes, Islands, River, and Bay.
6. The Apalachicola System is economically important to residents.
 - a. 85% of residents in Franklin Co. derive their income directly from the seafood industry.
 - b. The system is also important for other industries such as forestry, agriculture, sport fishing, recreation, navigation.

FOLLOW-UP ACTIVITIES

1. The Apalachicola River System includes the river and its tributaries, which involve Florida, Georgia, and Alabama. Have students locate on a map the major rivers that form the Apalachicola River. Discuss the meeting of the rivers in Lake Seminole and the effect of the Jim Woodruff Dam on the Apalachicola River.
2. Fill separate cups one-third full of red clay, sand, soil, pebbles, and leaves. Ask students to come up with a way to demonstrate the runoff of these materials into the Apalachicola River. Have them demonstrate and explain how changes in the flow of the river (flooding and slow-moving water) affect the movement and settlement of the materials.

MORE DISCUSSION QUESTIONS

Use these thought provoking questions to stimulate more discussion regarding the general ecology of the Apalachicola River and Bay System.

1. Why is an estuary important?
2. Why is detritus important to the Apalachicola River and Bay estuary?
3. Name three industries that are economically dependent on the Apalachicola River and Bay System. Research and explain why these industries are so dependent on the system.
4. Why do we need an environmental land management plan?
5. Why must people in different states and with different jobs work together to protect the Apalachicola River and Bay Estuarine System?
6. Research and discuss other physical and biological features of the Apalachicola River and Bay Estuarine System, such as dissolved oxygen, color, tides, and food webs and population distribution.
7. Discuss and research ways humans have used and altered estuaries.
8. Discuss some ways people can participate in management decision-making, concerning how to use our estuarine resources.

STUDENT PERFORMANCE STANDARDS COVERED IN LESSON I OF PROJECT ESTUARY

(For Grades 9-12)

Biology I: 1.11, 11.01, 11.03, 11.04, 12.01, 12.02

Chemistry I: 1.22

Earth/Space Science: 1.11, 10.03, 18.03

Ecology: 1.11, 2.01, 2.03, 2.05, 3.02, 9.02, 12.01

Environmental Science: 1.11, 4.01, 6.01, 7.02, 8.01, 9.03, 9.04

General Science: 1.11, 18.04, 18.05, 20.04, 20.05, 20.06, 21.01

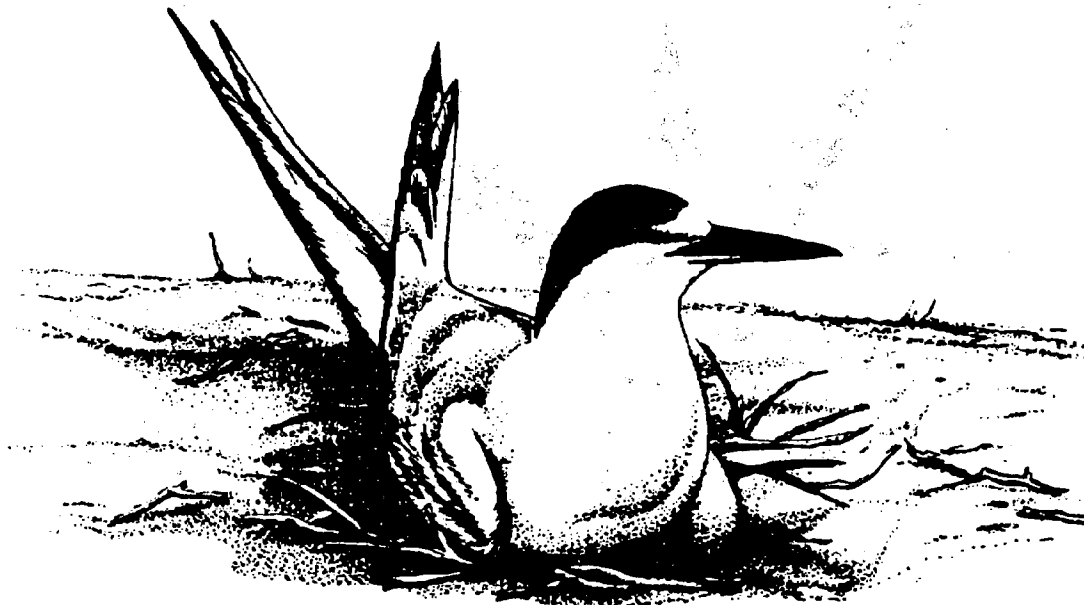
Marine Biology: 1.11, 3.02, 3.03, 3.05, 4.04, 4.05, 4.06, 10.03

Fundamentals Of Oceanography: 1.11, 5.04, 5.05, 6.04, 7.01, 7.02, 7.03, 8.04

Oceanography: 1.11, 4.02, 5.03, 5.04, 5.05, 5.06, 6.01, 6.02

Physics: 1.09

Zoology: 1.11, 9.01, 9.03, 9.04



Least Tern

CURRICULUM FRAMEWORKS COVERED IN LESSON I OF PROJECT ESTUARY

(For Grades 6-8)

M/J Earth/Space Science: 1., 2., 15., 17.

M/J General Science: 1., 2., 4., 7.

M/J Life Science: 1., 2., 7., 11.

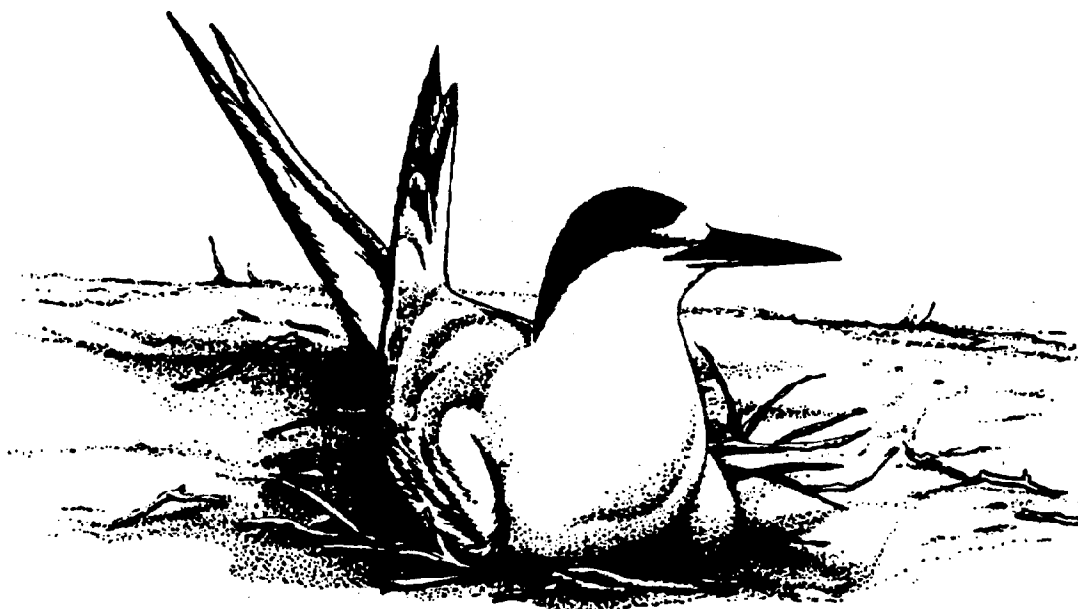
M/J Comprehensive Science I: 1., 2., 16.

M/J Comprehensive Science II, Basic: 1., 2., 3., 6., 9., 17.

M/J Comprehensive Science II: 1., 2., 3., 9., 16.

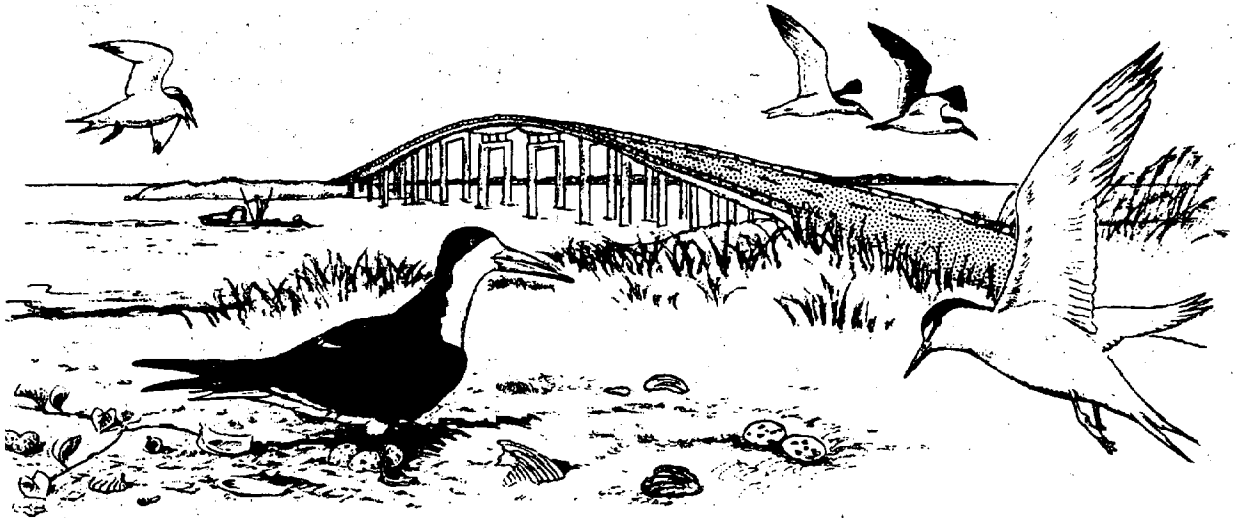
M/J Comprehensive Science III, Basic: 1., 2., 11., 16.

M/J Comprehensive Science III: 1., 2., 11., 16.



Least Tern

LESSON I STUDENT ACTIVITY PAGES



Nesting on the Causeway

It seems as if everyone likes the beach. Thousands of people live on and visit St. George Island every year. However, with more and more people enjoying the beautiful beaches, there is less and less space left for wildlife.

Many species of sea birds, including least terns, black skimmers, and Oystercatchers, nest on St. George and other nearby barrier islands. They lay their eggs in a shallow depression right on the bare ground. The eggs are camouflaged, so they are easy to miss as people walk along the beach.

Because the birds must now compete with beach goers for nesting places, some of these enterprising birds have turned to surprising places, such as the causeway to St. George Island. The causeway provides suitable places to nest, but the birds are in danger from fast-moving cars. Signs placed at either end of the bridge caution drivers when nesting birds are present. Slowing down helps motorists avoid the birds.

While the causeway does provide an alternative to nesting places on the beach, the fact that it must be used means that natural habitat is shrinking. These birds provide an indication of changes occurring in the environment. We need to be aware of these changes, because they affect us as well.

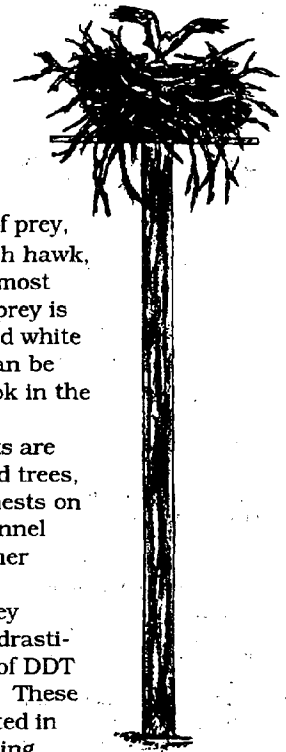
Critter Corner

Osprey

This raptor, or bird of prey, is often called the fish hawk, because its diet is almost entirely fish. The osprey is dark brown above and white below. In flight, it can be identified by the crook in the long slender wings.

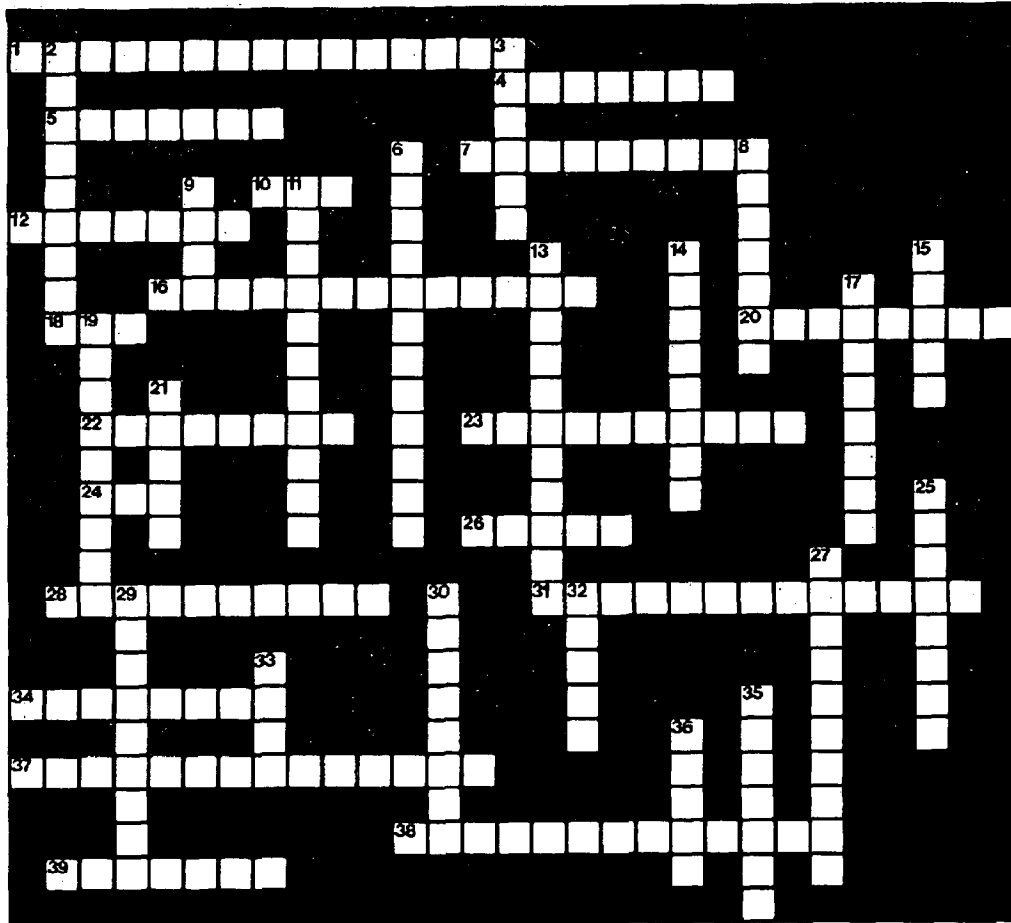
Their large stick nests are usually found in dead trees, but they also build nests on telephone poles, channel markers, and any other available platform.

In the past, the osprey population declined drastically due to the use of DDT and other pesticides. These pesticides accumulated in their bodies after eating contaminated fish. Their eggs had such thin shells that they often cracked during incubation. With legal protection and the ban of DDT, the osprey has made a comeback and is again common in Florida.



Critter
Corner

CROSSWORD PUZZLE



ACROSS

1. Green plant which may provide food for organisms and carries out photosynthesis (2 words).
4. To misuse the resources.
5. Apalachicola Bay is an important _____ harvesting area.
7. Elena.
10. Oystermen get 4-6 million pounds of oyster meat yearly from the Apalachicola _____.
12. Marsh vegetation helps protect an estuary from _____.
16. Acts like wall of sink holding in nutrients (2 words).
18. Many animals spend part of their life cycles in estuaries and part in the _____.
20. The Apalachicola Reserve provides a laboratory for environmental study or _____.
22. Changing water flow into the Bay causes changes in the _____ of the Bay.
23. Estuaries are highly _____ ecosystems.
24. Plants get energy from the _____ and convert it by photosynthesis to sugar.
26. Saltwater in Apalachicola Bay comes from the _____.
28. Marsh vegetation filters _____ from the water.
31. Because most cannot adapt to rapid salinity and temperature changes, there are few _____ organisms (2 words).
34. _____ finds refuge in estuaries.
37. Process by which green plants convert sunlight energy into chemical energy.
38. Microscopic plants.
39. A shortage of _____ places has forced some sea birds to use the causeway.

DOWN

2. Supplies of things which take care of needs are called _____.
3. Place of shelter.
6. An estuary holds nutrients and is therefore a _____ (2 words).
8. The Apalachicola River and Bay is a local example of a(n) _____.
9. One of the agencies operating the Apalachicola National Estuarine Research Reserve.
11. Farming or _____ is an important activity in the Apalachicola Valley.
13. All the surroundings that affect an organism.
14. Navigation, sport fishing, recreation and _____ are important activities in the Apalachicola Valley.
15. A _____ holds excess water like a sponge, helping prevent flooding.
17. Dead or decaying plant and animal matter.
19. An area where organisms live and interact.
21. The _____ and Chattahoochee Rivers form the Apalachicola River.
25. _____ dependence means to rely on something or someplace for goods, services, and jobs.
27. The Apalachicola National Estuarine Research Reserve studies environmental _____ to best use the area.
29. Marsh vegetation provides places to hide from _____.
30. When fresh and salt water mix, this type of water results.
32. _____ flow varies with rainfall.
33. Sea bird.
35. Floodplains and marshes are examples of _____ in the Apalachicola ecosystem.
36. Estuaries are home to many _____ and animal species.

HIDDEN WORDS

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

Can you find 28 words that relate to the Apalachicola estuary? They read sideways, up and down, or diagonally.

Apalachicola, estuary, marsh, nutrients, detritus, salinity, brackish, resource, zooplankton, manage, photosynthesis, ecosystem, impurities, barrier island, habitats, floodplain, environment, refuge, nurseries, predator, erosion, productive, energy, shellfish, oyster, navigation, bay, river.

Did You Know?

A young oyster is called a spat.

The Apalachicola National Estuarine Research Reserve consists of 193,758 acres of land and water.

Barrier islands are constantly changing shape and size because of wind and tides.

Sea turtles spend their whole lives at sea, coming ashore only to lay their eggs.

Sally, jimmy, buckram, and picker are all names for different phases of the blue crab.

The Apalachicola National Estuarine Research Reserve contains over 1100 species of plants, including 36 which are threatened or endangered.

The docile indigo snake can kill and eat the poisonous diamondback rattlesnake.

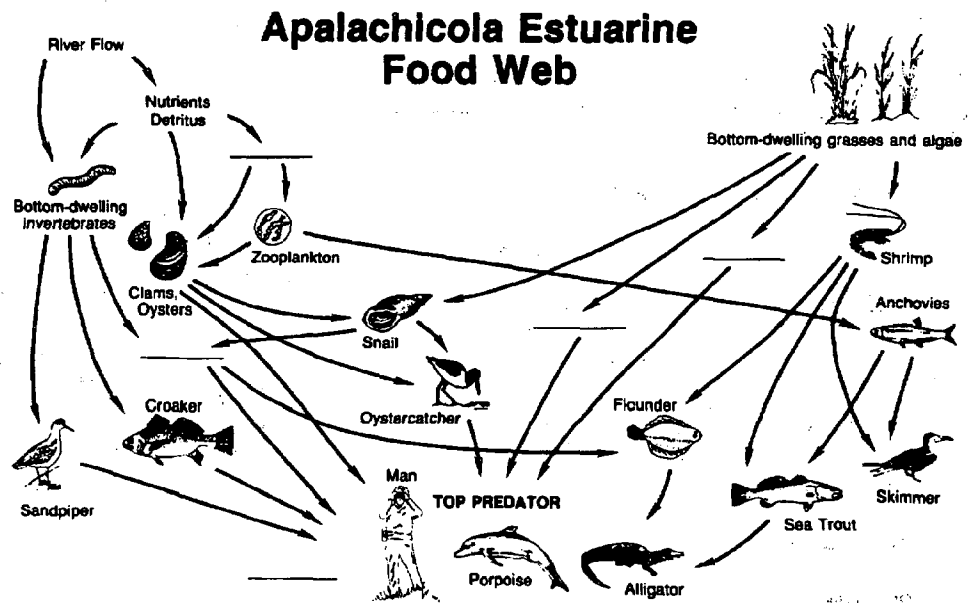
Bats are mammals, and a single bat can eat thousands of insects every night.

The monarch butterfly migrates thousands of miles between breeding areas in Canada and wintering areas in south Florida, California and Mexico.

The Apalachicola National Estuarine Research Reserve supports over 1000 species of land and aquatic animals.

Use words in the given word list to complete the food web:

Shark
 Phytoplankton
 Crabs
 Mullet
 Duck



QUESTIONS? QUESTIONS? QUESTIONS? QUESTIONS?

True or False? (Circle the T for true or F for false)

- T F 1. There are few animals ("true estuarine " types) that have adapted to the wide range of temperatures and salinities of the Apalachicola Bay.
- T F 2. Although wildlife rely heavily on the resources of the Apalachicola River and Bay, People do not rely on them at all.
- T F 3. A management plan cannot work without cooperation among the many users.
- T F 4. Estuaries are important because they provide food, shelter, and nurseries for plants and animals.
- T F 5. The estuaries food web ends with detritus, phytoplankton and green plants.
- T F 6. Changing salinity levels helps keep predators out that might eat estuarine animals.
- T F 7. Marsh vegetation protects against flooding and erosion, cleanses the water and provides food.
- T F 8. Environmental land management is looking at an area and finding out ways it can be used by man without being mis-used.

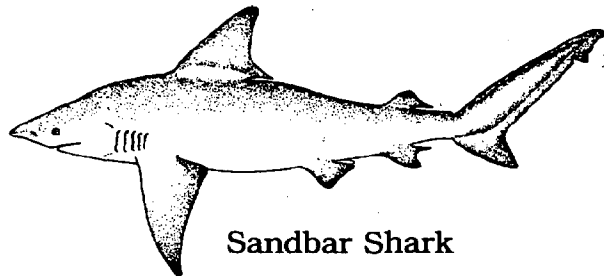
Fill in the _____

1. When fresh water and salt water mix, _____ water results.
2. The Apalachicola River and Bay is a(n) _____ because of barrier islands and the mixing of fresh water and salt water.
3. A(n) _____ is an area where fresh water and salt water meet and mix.
4. Floodplains, marshes, and barrier islands are examples of _____ in the Apalachicola Valley ecosystem.
5. The Apalachicola River System flows through Florida, Alabama and _____.
6. An area where organisms interact with each other and with nonliving things is called a(n) _____.
7. Varying river flow is important because it moves _____ and _____ into the estuarine system.
8. The process of converting energy from sunlight by green plants is called _____.

Matching

Match the items in the right column with the ones most closely related in the left.

- | | |
|------------------------|---------------------|
| 1. _____ shark | A. food source |
| 2. _____ nutrients | B. primary producer |
| 3. _____ agriculture | C. predator |
| 4. _____ green plant | D. industry |
| 5. _____ salt marsh | E. habitat |
| 6. _____ forestry | |
| 7. _____ phytoplankton | |
| 8. _____ detritus | |



Sandbar Shark

VOCABULARY FOR LESSON I

Brackish Water: A mixture of fresh water and salt water.

Detritus: Particles of dead and decaying plants and animals.

Drainage Basin: Total land area from which water drains into a river or river system.

Economic Dependence: To rely on something or someplace for goods, services, and jobs.

Estuary: An area where fresh water from rivers, streams, and other sources meets salt water from the sea.

Exploit: To make use of something. Also to overuse or abuse.

Habitat: A place where a plant or animal lives that provides food, water, shelter and space in a suitable arrangement.

Impurities: Foreign elements, such as chemicals, which cause something to be unclean.

Nutrients: Minerals such as nitrogen and phosphorus which provide food for plants and animals.

Organism: A living thing.

Phytoplankton: microscopic plants

Primary Producer: Green plant which may provide food for organisms and carries out photosynthesis.

Productivity: The amount of carbon produced through photosynthesis in the form of plants in a certain place, over a certain amount of time.

Resource: A supply of something which takes care of a need.

Salinity: The amount of dissolved salts in water.

"True Estuarine" Organisms: Plants or animals which have evolved to adapt to the wide range of temperatures and salinities in an estuary and spend their life there.

Zooplankton: Microscopic aquatic animals.

REVIEW QUIZ FOR LESSON I OF PROJECT ESTUARY

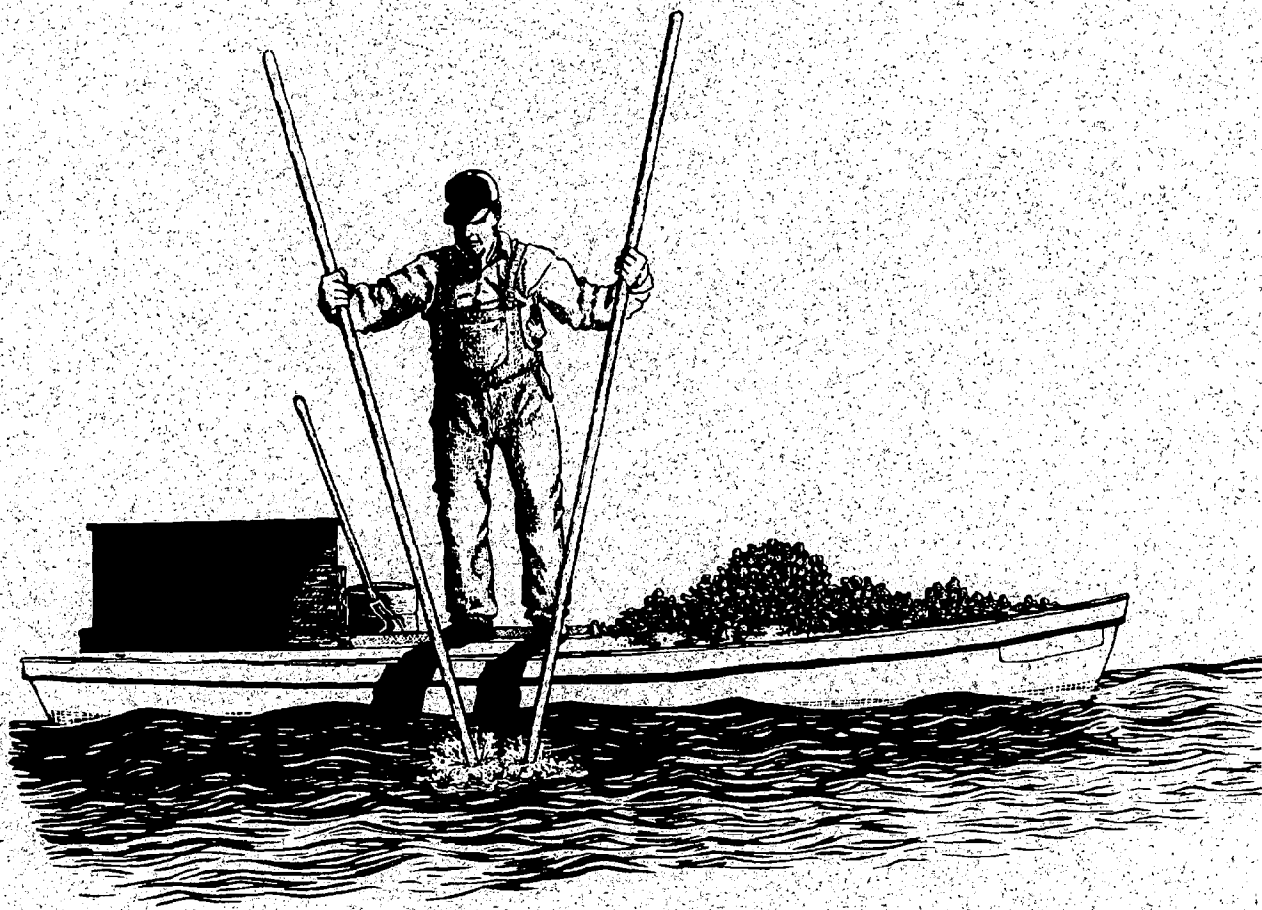
- I. Fill in the blanks with the word or words that best complete each sentence. Choose your answer from the word list below.**

estuary	misused	salinity	detritus
nutrient trap	food	shelter	nurseries

1. The _____ is an area where freshwater from rivers, streams and other sources meets saltwater from the sea.
2. Estuaries are important because they provide _____ and _____, and serve as _____ for young plants and animals.
3. The changing _____ of the Apalachicola Bay helps to keep predators out that might eat the estuarine animals.
4. The Apalachicola River and Bay Estuarine System provides much food for animals and plants due to the barrier islands and the mixing of fresh and salt waters. For this reason it is known as a _____.
5. The estuarine food web begins with phytoplankton, green plants and _____.
6. Environmental management involves looking at an area and determining the ways it can be used by man without being _____.

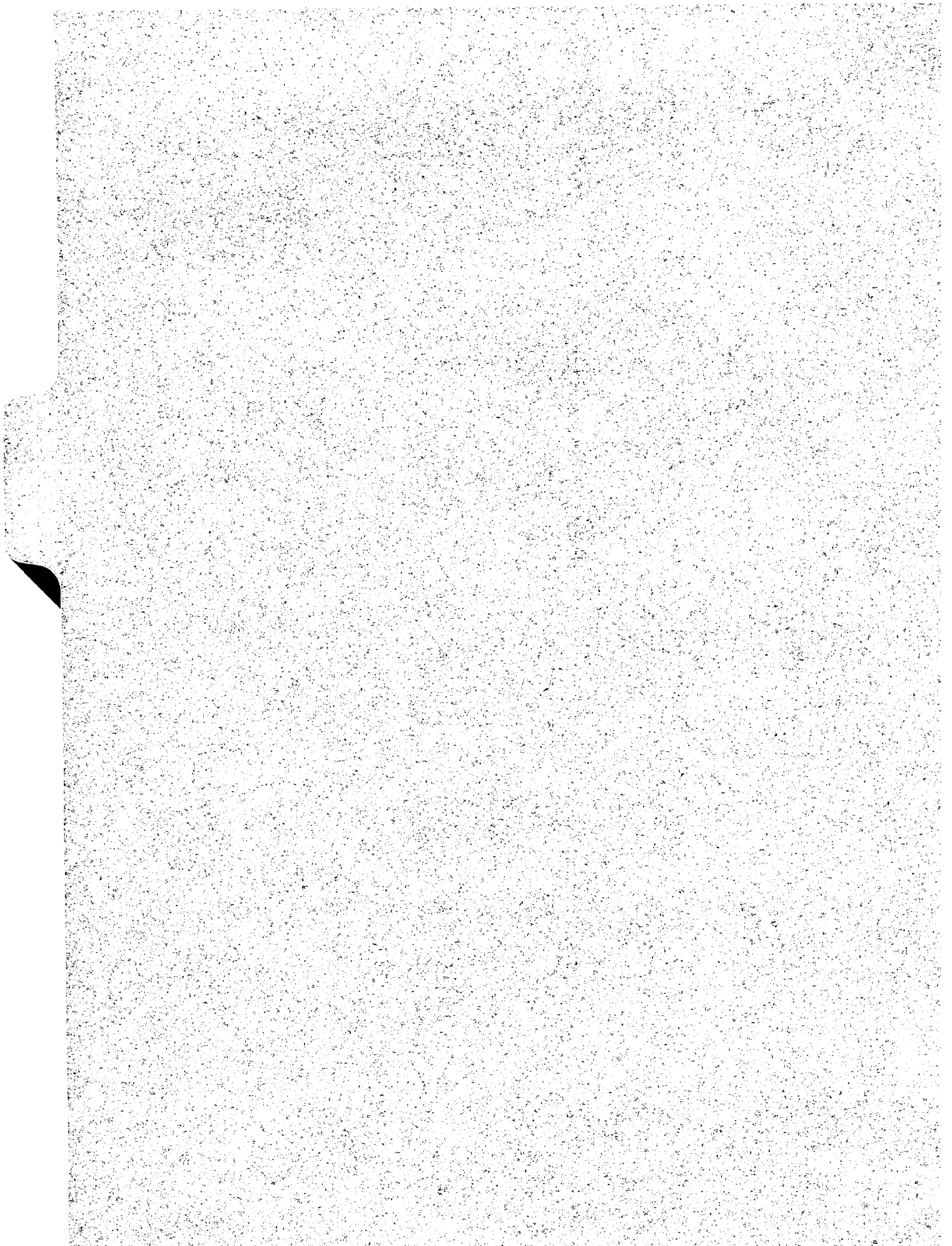
- II. Read the sentences below. Put a T before each true statement and an F before each false statement.**

- ___ 7. The changing flow of river water is important to organisms because it moves detritus into the estuary.
- ___ 8. The plants of the Apalachicola River and Bay System protect against flooding and erosion, cleanse the water and provide food.
- ___ 9. There are many "true estuarine organisms" that have evolved to adapt to a wide range of temperatures and salinities existing in the Apalachicola Estuary.
- ___ 10. Many people in the Apalachicola River and Bay area rely on the resources of the system for goods, services and jobs.



Oysterman "tonging" oysters in Apalachicola Bay.

Illustration by Diane Sterling,
Northwest Florida Water Management District.



A TEACHER'S GUIDE TO LESSON II

OBJECTIVES

1. Students will gain an understanding of the importance of the Apalachicola River and Bay System to the local economy in the areas of forestry, agriculture, recreation, commercial fishing and other industries.
2. Students will understand the importance of the Apalachicola River and Bay System to wildlife populations.
3. Students will learn how the Apalachicola River and Bay System are used for navigation.

TIME: Approximately one 50-minute class period.

PROCEDURE:

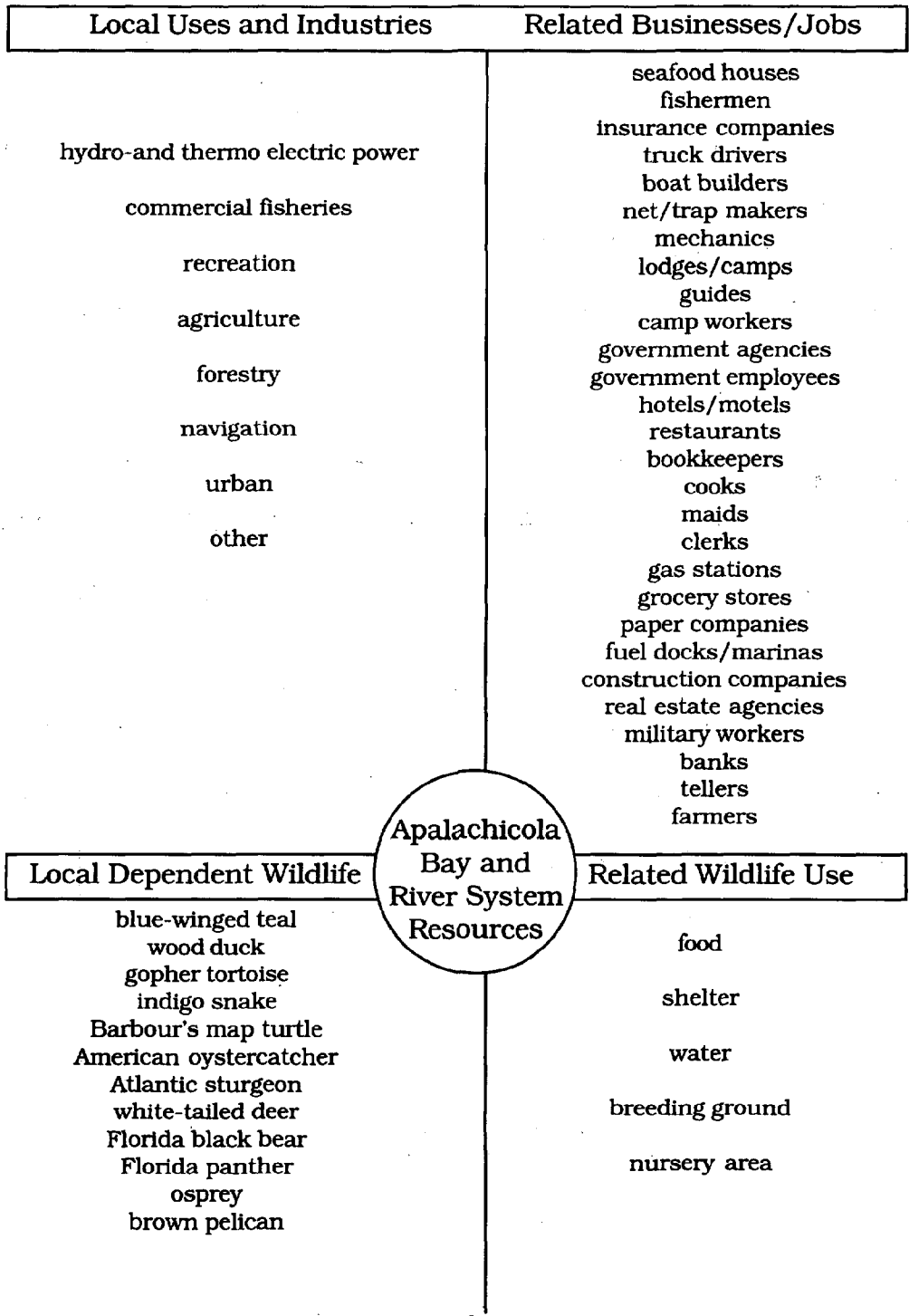
1. Review the vocabulary list for this lesson prior to proceeding with other steps.
2. Use the Lesson II script and go over the transparencies and slides. (Transparencies and slides are located in the back cover of this notebook)
3. Make copies of the Student Activity Pages and distribute to students.
4. Complete the Review Quiz for Lesson II.
5. Discuss answers or post answer keys for Student Activities and Review Quiz.



Blue Crab

ANSWER KEYS TO LESSON II

Apalachicola Bay and River Resources Chart: Below is an example of answers which might be generated as a result of class participation using the Apalachicola Bay and River Resources Chart. Answers will vary from county to county and class to class.



Answer Keys Continued...

FILL IN THE BLANK

- largest; 2. Franklin, Gulf, Wakulla;
- local, national; 4. water; 5. animals, plants

TRUE/FALSE

- true; 2. true; 3. true
- false; 5. false

MATCHING

- (A) land resources
(B) water resources
- (A) land resources
(B) water resources
- (A) land resources
(B) water resources
- (B) water resources
- (B) water resources

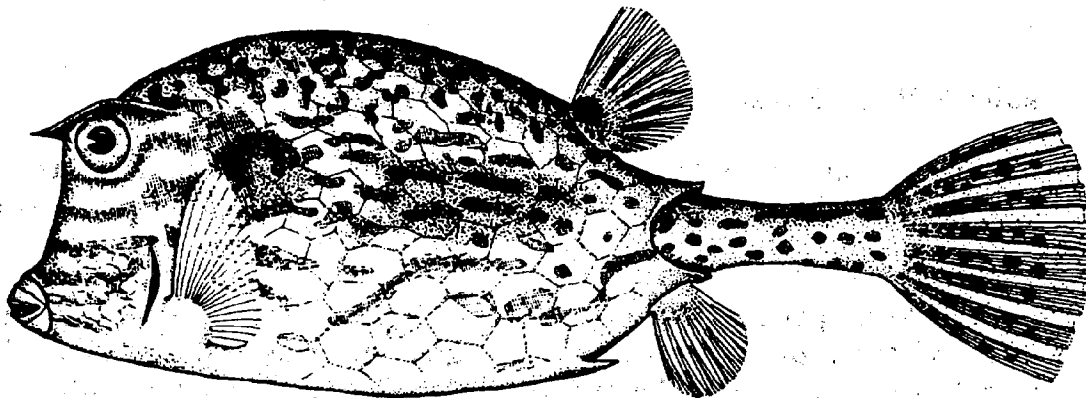
MAGIC SQUARE

MAGIC NUMBER=65

23	5	7	14	16
A	B	C	D	E
4	6	13	20	22
F	G	H	I	J
10	12	19	21	3
K	L	M	N	O
11	18	25	2	9
P	Q	R	S	T
17	24	1	8	15
U	V	W	X	Y

REVIEW QUIZ

- (B), 2. (D), 3. (D), 4. (A), 5. (D)
6. T, 7. T, 8. F, 9. T, 10. T



Scrawled Cowfish

LESSON II SCRIPT

FOR TRANSPARENCIES AND SLIDES

"Gifts from the Apalachicola"

Introduction:

As you may remember, in Lesson I we talked about estuaries, namely Apalachicola Bay. What is an estuary? An estuary is a place where fresh water from rivers, such as the Apalachicola River, streams or other sources, meets and mixes with salt water from the ocean (Gulf of Mexico).

We also discussed some of the ways we use our estuary. Can you name some of the industries that depend on the Apalachicola River and Bay System for their resources? (Answers: forestry, agriculture, commercial fisheries, navigation, and recreation)

As you can see, the Apalachicola System is very important to us. We depend on its land and water resources for many jobs, goods, services and activities. It is a multi-use system. Let's first talk about ways this special estuary is related to us through the use of its land resources.

Transparency Text:

****Asterisks, which indicate notes to teacher, and transparency numbers are found in the left-hand column. Transparencies and slides for Lesson II may be found in the back cover of this notebook.**

T-1 Fifty seven percent of the land in the drainage basin is used for forestry. This floodplain area contains many acres of timber that are harvested and used to produce various wood products such as paper, lumber and furniture.

**** Teacher's Note: Point out that forestry is the largest land use.**

Eleven percent of the land in the drainage basin is used for agriculture (farming). Local farm crops include peanuts, rice, corn, cotton, blueberries, sorghum, crawfish and catfish.

Within the lower portion of the Apalachicola basin, there are several tracts of land and water in public ownership through state or federal agencies. They are available for recreational activities such as hunting, fishing, hiking, camping, etc.

T-2 This land includes management areas, such as the Apalachicola National Estuarine Research Reserve, Apalachicola National Forest, St. Vincent Na-

tional Wildlife Refuge and the Northwest Florida Water Management District. In order to preserve this part of the basin there are designated areas and seasons within public lands for certain recreational activities, such as hunting and fishing.

- T-1 Only one percent of the Apalachicola basin is populated by people. This is called urban land use.

The last 29% of the basin area, is classified as wetlands and provides much habitat for wildlife as well as multiple opportunities for public recreation and industry.

As you probably know, if you are in a county along the system, people in your area use the Apalachicola estuarine system's valuable water resources.

- T-3 The main industries that use the Apalachicola River and Bay water resources are commercial fishing and recreation.

Commercial fisheries in Apalachicola Bay employ approximately 85% of the people in Franklin County and a number of people in Gulf and Wakulla Counties as well.

The ten-year averages for Franklin County's dock-side values for oysters, shrimp, blue crabs and finfish were as follows:

- ** Teachers Note: Read ten-year averages under "Dockside Value" on Transparency 3 and discuss variations among years.**

By the time these seafood products reach dinner tables and restaurants all over the nation they generate up to five times their dock-side value. The national value for Franklin County's seafood over a ten-year period has averaged somewhere in the neighborhood of \$59,000,000 per year.

- T-4 Recreation is the other main industry which uses the water resources. Many local businesses benefit from those who enjoy recreational activities on the Apalachicola River and Bay.

- ** Teachers Note: Point out businesses in the example as you read this section.**

For example, if a group of bass fishermen comes into town for a tournament they will probably stay in a local hotel or motel, eat at a local restaurant, buy groceries from the local store, dock and gas up their boat at a local lodge or marina, buy some supplies from a local retail or department store, buy seafood to take home and gas up their car or truck when leaving town. If they like the area well enough they might even buy land and build a vacation home at a later date.

- T-5 Other uses of the Apalachicola System waters are navigation of barges and other river traffic, industrial plant processing of wood products and cooling of thermoelectric generators, and also the production of hydroelectric power. Navigation is more important for GA and AL than for FL; however, Jackson County, in Florida, does have a port for fueling and unloading barges. Petroleum products, fertilizer, sand and gravel are main commodities unloaded in Jackson County. However, the list of items transported on the River is much broader and includes such things as coal, wood products, gasoline, kerosene, turpentine, jet fuel, paints, fuel oil, pesticides, caustic soda, sodium hydroxide, aluminum sulfate, and acids.

Industries such as the St. Joe Paper Company draw and use 30 million gallons of water per day from the Chipola River (an Apalachicola River tributary) to run their plants. In Jackson County, Gulf Power Company uses 1 million gallons of water per day to cool thermoelectric power generators. The Jim Woodruff Dam at the beginning of the river, uses the moving water's energy to turn turbines for electricity production.

- T-6 Now that you know the many ways we use the Apalachicola Estuarine system, let's see what industries are related to the Apalachicola System resources in surrounding counties (for those counties located on the river).

**** Teacher's Note: Point out one industry at a time and the counties where it can be found. Aquaculture includes the farming of several different species along the system. These include catfish, crawfish, shrimp and alligators.**

- T-7 People are not the only ones that depend on estuaries. Various wildlife and plants rely on the Apalachicola Drainage Basin for food, shelter, water, breeding grounds and growing space, or simply put, for habitats.

Slide Show Text:

- S-1 The Apalachicola Bay area and its surrounding barrier islands - St. George, Cape St. George, St. Vincent and Dog Island serve as feeding and wintering grounds for migratory waterfowl such as the blue-winged teal which arrives in August...
- S-2 and the wood duck which arrives in October and November. There are also wood duck residents in our area year-round that nest from March through May.
- S-3 There are several animals and plants which are endemic to the Apalachicola System. This means they live only in the Apalachicola Estuarine System. One example of an endemic animal species is the Barbour's map turtle which lives in the Apalachicola, Chattahoochee, Flint and Chipola Rivers. It

is a species of special concern. Females get as large as 12 inches (30 cm) long and males are only 5 inches (13 cm) long. Its carapace or shell is olive-green with pale yellow u-shaped markings and ridges in the center. The head is also olive-green with yellow lines and has large blotches of yellow behind the eyes. Males and small females eat caddisfly larvae and other water insects, snails and sometimes plants. Large females eat snails and Asian clams by cracking them with their powerful jaws. It is protected due to its limited range and use by humans at one time for food.

- S-4 An example of a plant endemic to the Apalachicola System is the endangered Harper's beauty, found in flatwoods around the Apalachicola Basin.
- S-5 The Apalachicola Estuarine System is also home to a number of other protected animals that are either endangered, threatened or species of special concern.

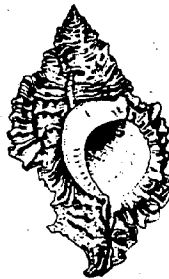
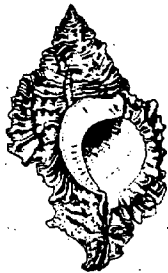
The Atlantic loggerhead sea turtle which is threatened, nests each year on the beaches of St. George, Cape St. George, Dog and St. Vincent islands in June, July and August. The female digs a nest and lays about 120 eggs, which hatch in 50-60 days. The adult's flippers and shell are reddish-brown and often have barnacles on them. They also have large heads. Loggerheads may weigh up to 700 pounds (318 kg). Females return to nest on the beaches where they hatched. Threats to this animal's survival are fishing nets (drowning), human development of beaches (nesting areas destroyed, young confused by lights), plastic litter (mistaken for food and results in death), and egg predation by raccoons, birds and other animals. In the Reserve area, there is a program in place to detect nests and protect them by putting a wire grate, with holes large enough for hatchlings to dig through, over the nest to keep raccoons and other predators from destroying the eggs.

- S-6 The gopher tortoise is another protected reptile and is a species of special concern. Its shell size can reach 12 inches (30 cm) in length. This critter lives in a burrow usually in pine and oak uplands where the soil is dry. It eats grasses, leaves, herbs, and sometimes wild fruits and berries. Gopher tortoises share their burrows with pine snakes, indigo snakes, Florida mice, and gopher frogs. All of the animals are at risk due to land development, predation, and gassing of their burrows by humans. The gassing is done to force the rattlesnakes out of the burrows and is illegal.
- S-7 The indigo snake, an endangered species, which lives in the tortoise burrow with the gopher tortoise, is a gentle, harmless snake despite its large size. It can reach a length of 8 feet (2.4 m). The indigo is glossy black or bluish-black and is thus prized by collectors. Collecting is now illegal without special permission. Indigos feed on mice, rabbits, birds, frogs, lizards and other snakes such as rattlesnakes. Unfortunately, these beautiful creatures are losing their habitats to land development and dying due to the gassing of their burrows by humans. Auburn University in cooperation with the

U.S. Fish and Wildlife Service has released several of the threatened indigos on St. Vincent Island, within the Reserve.

- S-8 Another endangered animal probably living within the Reserve is the Florida panther. Panthers live in forested areas and feed on deer, raccoons, hogs and other small mammals. The panther is 6 feet (1.8 m) or longer and is pale brown with a long tail. The Florida panther is the same species as the mountain lion found in the western U.S.. Panther populations have split and decreased due to land development and being hunted by humans.
- S-9 This is a species of special concern that you should remember from Lesson I; the American oystercatcher. This bird nests on beaches and the causeway to St. George Island in the summer. It can grow to a length of 16 inches (40 cm). Oystercatchers, as you may recall, eat oysters, other shellfish, marine worms and crabs. The threat of their survival is habitat loss to land development.
- S-10 What you see here is the unusual looking Atlantic sturgeon. This fish is a species of special concern which spends most of its time as an adult in the Gulf of Mexico, feeding on bottom-dwelling plants, worms, shellfish, crabs and fish. They use their barbels, or feelers, for finding food. Their scales are bony, diamond-shaped and are called plates. Sturgeon may grow up to 18 feet in length and may weigh anywhere from 200-600 pounds (91-273 kg). They are called anadromous fish because they migrate or move from the Gulf, up the Apalachicola River to spawn (mate and lay eggs) from February through July. Because of this migration, they once supported a thriving caviar (sturgeon eggs) industry in the Apalachicola. Unfortunately their numbers have been drastically reduced because they cannot reach their spawning grounds in the upper Apalachicola River due to barriers such as dams and canal locks. Another factor that seems to limit their population size is the long period of time it takes for them to reach breeding age.

The Apalachicola Estuarine System is very important to us and to wildlife. We are all involved with it in many ways. We need to understand it so we can protect it.



Apple Murex



FOLLOW-UP ACTIVITIES

1. Have students make a seafood collage or poster that includes seafood labels, restaurant menus, seafood ads and pictures of seafood products. Discuss the importance of estuaries and the relationships of these products to the surrounding counties' economics.
2. Have students visit local industries that are dependent on the Apalachicola Estuarine System to find out how they use the resources. Have students interview people working in these industries in order to learn about job opportunities. End the activity with a class discussion of each student's findings.

MORE DISCUSSION QUESTIONS

Use these thought provoking questions to stimulate more discussion regarding the important role an estuary plays in the local environment; including economics, navigation, recreation, etc.

1. Research and list career and job opportunities in your county that relate to the Apalachicola System.
2. Locate and discuss human-made structures on the Apalachicola System. How have they impacted the system?
3. Discuss your local government involvement in the Apalachicola River and Bay Estuarine System.
4. Talk about ways in which the state and federal governments are involved in the Apalachicola System.
5. Find and discuss current research projects concerning the Apalachicola System.
6. Research and share information on local endangered or potentially endangered fish and wildlife. How are they dependent on the Apalachicola System?

**STUDENT PERFORMANCE STANDARDS
COVERED IN LESSON II OF PROJECT ESTUARY**
(For Grades 9-12)

Biology I: 1.11, 11.03, 12.02, 12.06

Chemistry I: 1.11

Earth/Space Science: 1.11, 18.03

Ecology: 1.11, 6.04, 8.01, 8.02, 8.06, 8.06, 12.01

Environmental Science: 1.11, 4.01, 6.01, 7.02

General Science: 1.11, 20.05, 21.01, 21.02

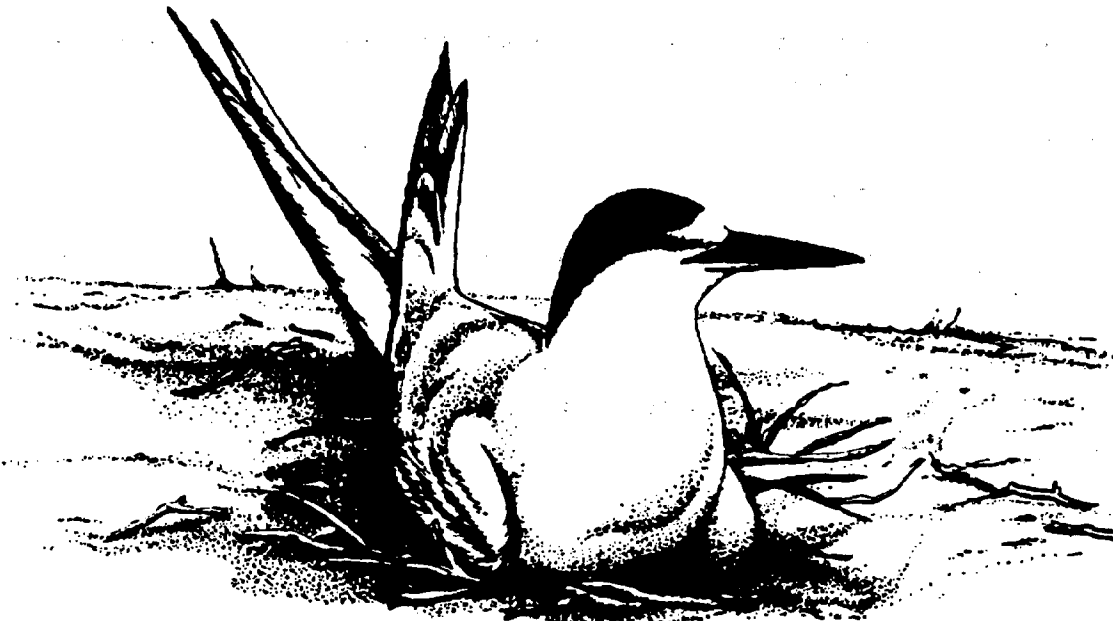
Marine Biology: 1.11, 3.02, 3.03, 3.05, 4.04, 9.07, 10.03, 11.02, 11.05

Fundamentals of Oceanography: 1.11, 6.04, 7.02, 7.03, 8.04, 9.06

Oceanography: 1.11, 4.02, 5.05, 6.01, 6.02

Physics: 1.09

Zoology: 1.11, 9.01, 9.03, 9.04



Least Tern
24

CURRICULUM FRAMEWORKS COVERED IN LESSON II OF PROJECT ESTUARY

(For Grades 6-8)

M/J Earth/Space Science: 1., 2.

M/J General Science: 1., 2., 4., 7.

M/J Life Science: 1., 2., 7., 11., 14.

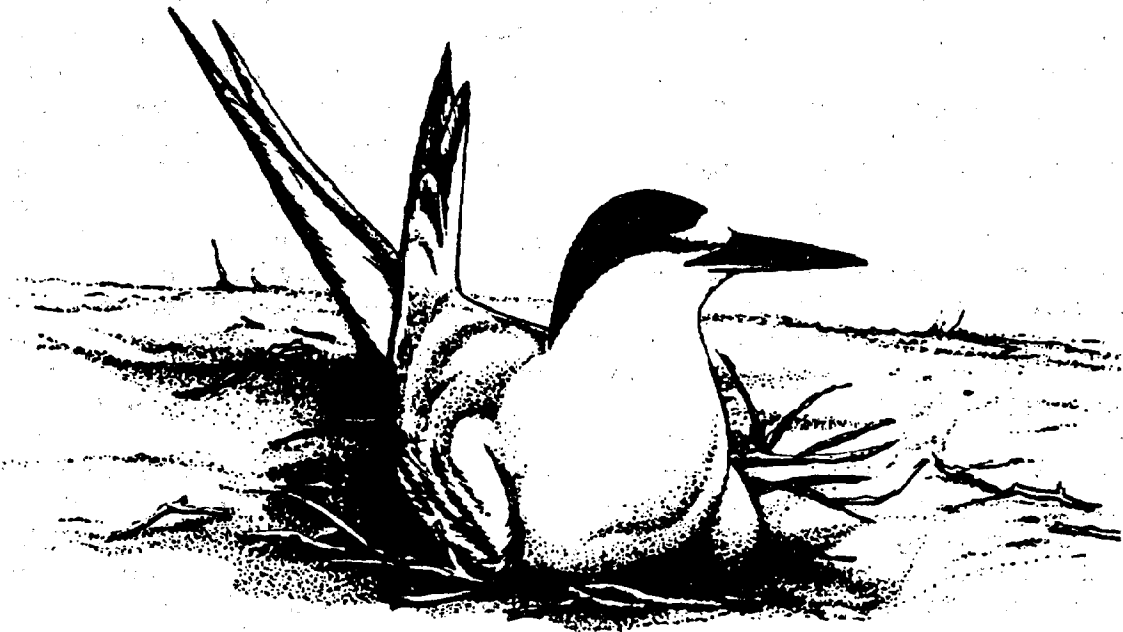
M/J Comprehensive Science I: 1., 2., 5., 16.

M/J Comprehensive Science II, Basic: 1., 2., 6., 7., 9., 16.

M/J Comprehensive Science II: 1., 2., 6., 9.

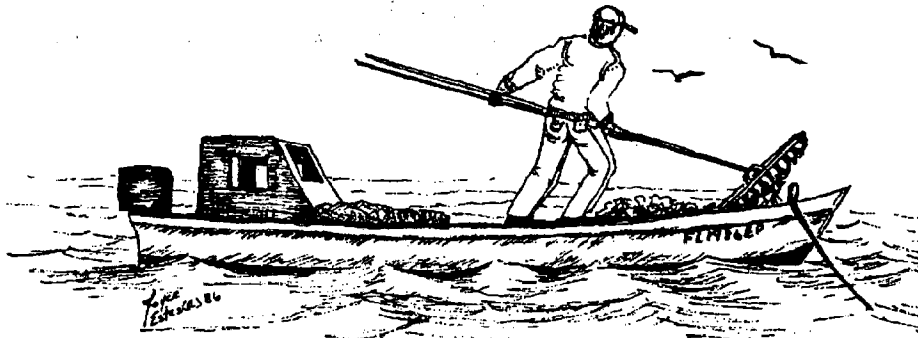
M/J Comprehensive Science III, Basic: 1., 2., 16.

M/J Comprehensive Science III: 1., 2., 16.



Least Tern

LESSON II STUDENT ACTIVITY PAGES



Apalachicola Estuary: Nature's Amazing Provider

Water from 19,800 square miles of land in Florida, Georgia, and Alabama drains into the Apalachicola River System, taking with it nutrients, soil and pollutants. Millions of gallons of water then deposit these particles when they reach the mouth of the river at Apalachicola Bay.

The Apalachicola Bay is one of the most productive estuaries in the northern hemisphere. According to Woody Miley, manager of the Apalachicola National Estuarine Research Reserve, "There are systems that produce more, such as Chesapeake Bay, but it's 10 times bigger. When you compare productivity per unit area (acre for acre), Apalachicola Bay is the most productive as well as the healthiest," Miley said.

The Apalachicola Drainage Basin includes 2,400 square miles of river floodplain forest. The estuary consists of 21,860 acres of marshes, which accounts for 14 percent of the total water area.

Like most wetlands, the marshes in an estuary cleanse the water, protect against flooding and provide food.

However, it is the Apalachicola Bay's ability to act as a major nursery and spawning ground for many animals such as shrimp, crabs, oyster and finfish that is most appreciated by humans. Miley explained that the health of the estuary is what makes the Bay's thriving seafood industry possible.

Apalachicola Bay produces 2 to 6 million pounds of oyster meat per year, using only 4 to 5 percent of the bay bottom. Biologists have predicted that annual production could reach as high as 150 million pounds with the use of more bottom areas. Furthermore, oyster supply could increase if oysters were provided with more vertical surface to grow on as well as the typical horizontal beds.

While shrimp harvests generally have decreased in other areas of Florida, the supply has remained relatively stable in the Apalachicola Bay area.

"This is a more protected system. When 85 percent of the people here depend on seafood for their livelihood, it becomes very important to them to protect their natural resources," Miley said.

Another noted value of Apalachicola Bay is its beauty. Miley said that part of the estuary's appeal has to do with its variety of migratory birds and other wildlife. It's really important for waterfowl. Miley said wetlands should be protected for their own sake and because they increase the quality of human life.

"A lot of things that we curse, like mosquitoes, are needed by the things we like. The aquatic larvae of mosquitoes are a major food source for young fish." It's a mixed blessing. If we understand the function of wetlands and estuaries, we can work to save them for the use and enjoyment of many future generations."

DIRECTIONS: Complete the chart below using local examples.

Local Uses and Industries **Related Businesses/Jobs**

--	--

Local Dependent Wildlife **Related Wildlife Uses**

Apalachicola
Bay and River
System
Resources

CHECK YOUR KNOWLEDGE

Fill in the _____.

1. The forestry industry uses the _____ amount of land in the Apalachicola Drainage Basin.
 2. Commercial fisheries in Apalachicola Bay employ people in _____ County, as well as _____ and _____ Counties.
 3. Both _____ and _____ dollars are generated by commercial fisheries in the Apalachicola Estuary.
 4. Gulf Power Company in Jackson County uses _____ from the Apalachicola System to cool thermoelectric generators.
 5. The Apalachicola Estuarine System has several endemic species of _____ and _____.
-

TRUE/FALSE

1. _____ Migratory waterfowl depend on the Apalachicola Bay area and its surrounding barrier islands as their feeding and wintering grounds.
 2. _____ Wildlife depend on the resources of the Apalachicola system for food, shelter, water, breeding grounds and nursery areas.
 3. _____ The Apalachicola Estuarine System is home for a number of protected animal species whose survival is threatened by over-exploitation by humans, loss of habitat, disease, predation and other human-made or natural conditions.
 4. _____ Salmon once supported a thriving caviar industry in Apalachicola.
 5. _____ Gassing of gopher tortoise burrows does not harm any of the animals living in the burrows.
-

MATCHING

Match the resources in the right column with the Florida industries most closely related in the left column. The resource may be used more than once. There may be more than one resource per industry.

- | | |
|-----------------------------|--------------------|
| 1. _____ Forestry | A. Land Resources |
| 2. _____ Recreation | B. Water Resources |
| 3. _____ Agriculture | |
| 4. _____ Commercial Fishing | |
| 5. _____ Navigation | |

MAGIC SQUARE

Directions: Select from the numbered definitions the best answer for each of the terms below. Put the number in the proper space in the magic square box. The total of the numbers will be the same across each row and down each column.

VOCABULARY WORDS

- A. Barbels
- B. Anadromous
- C. Carapace
- D. Caviar
- E. Commodities
- F. Economic Dependence
- G. Endangered
- H. Endemic
- I. Estuary
- J. Exploit
- K. Habitat
- L. Hatchlings
- M. Marine
- N. Migratory Waterfowl
- O. Multi-Use
- P. Predation
- Q. Private Interests
- R. Resource
- S. Shellfish
- T. Spawn
- U. Species of Special Concern
- V. Thermoelectric Power
- W. Threatened
- X. Tributary
- Y. Uplands

DEFINITIONS

1. Any species that is likely to become endangered in Florida within the near future if current natural or human-made conditions affecting its survival continue.
2. An animal having a protective shell and no backbone.
3. To serve various functions.
4. To rely on something or someplace for goods, services and jobs.
5. Types of fish that return from open saltwater into freshwater to spawn.
6. Any species of fish and wildlife found in Florida and protected by law that is in danger of extinction due to loss of habitat, over-exploitation by humans, disease, predation, or other natural or human-made conditions affecting its survival.
7. A hard protective case or shell covering the back or part of the back of an animal.
8. A stream, creek or river which feeds into a larger river.
9. To produce or deposit eggs or sperm.
10. A place where a plant or animal lives that provides food, water, shelter and space.
11. Process in which one organism (prey) is eaten by another (predator).
12. Recently hatched animals.
13. Restricted or native to a particular area or region.
14. Processed, salted eggs of large fish.
15. Higher grounds along rivers, usually out of the floodplain.
16. Products of activities such as agriculture or mining.
17. Any species in Florida and protected by law that does not fit into the endangered or threatened categories but deserves special attention due to current natural or human-made pressures.
18. Belonging to or concerning individual persons, companies and businesses.
19. Of or relating to the ocean.
20. An area where fresh water from rivers, streams and other sources meets salt water from the sea.
21. Swimming game birds which fly from one region to another over great distances.
22. Make use of something. Also to overuse or abuse.
23. Feelers around the mouth used in locating food by touch and smell.
24. The conversion of heat into electricity.
25. A supply of something which takes care of a need.

MAGIC NUMBER =

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

VOCABULARY FOR LESSON II

Anadromous: Types of fish that return from open salt water into fresh water to spawn.

Barbels: Feelers around the mouth used in locating food by touch and smell.

Carapace: A hard protective case or shell covering the back or part of the back on animals such as shrimp, crabs and turtles.

Caviar: Processed, salted eggs of certain fish such as sturgeon.

Commodities: Products of activities such as agriculture or mining.

Endangered: Any species of animal or plant found in Florida and protected by law that is in danger of extinction due to loss of habitat, over-exploitation by humans, disease, predation or other natural or human-caused conditions affecting its survival.

Endemic: Restricted and native to a particular area or region.

Floodplain: The area adjacent to a river or marsh that periodically is flooded by seasonally high water.

Hatchlings: Recently hatched animals.

Hydroelectric Power: Using water power to turn turbines that generate electricity.

Marine: Of or relating to the ocean or Gulf.

Migratory Waterfowl: Swimming game birds which fly from one region to another over great distances.

Multi-Use: To serve various functions.

Navigation: Use of a waterway for transporting various commodities or people.

Predation: Process in which one organism (prey) is eaten by another (predator).

Private Interests: Belonging to or concerning individual persons, companies and businesses.

Shellfish: An animal having a protective shell and no backbone.

Spawn: To produce or deposit eggs or sperm.

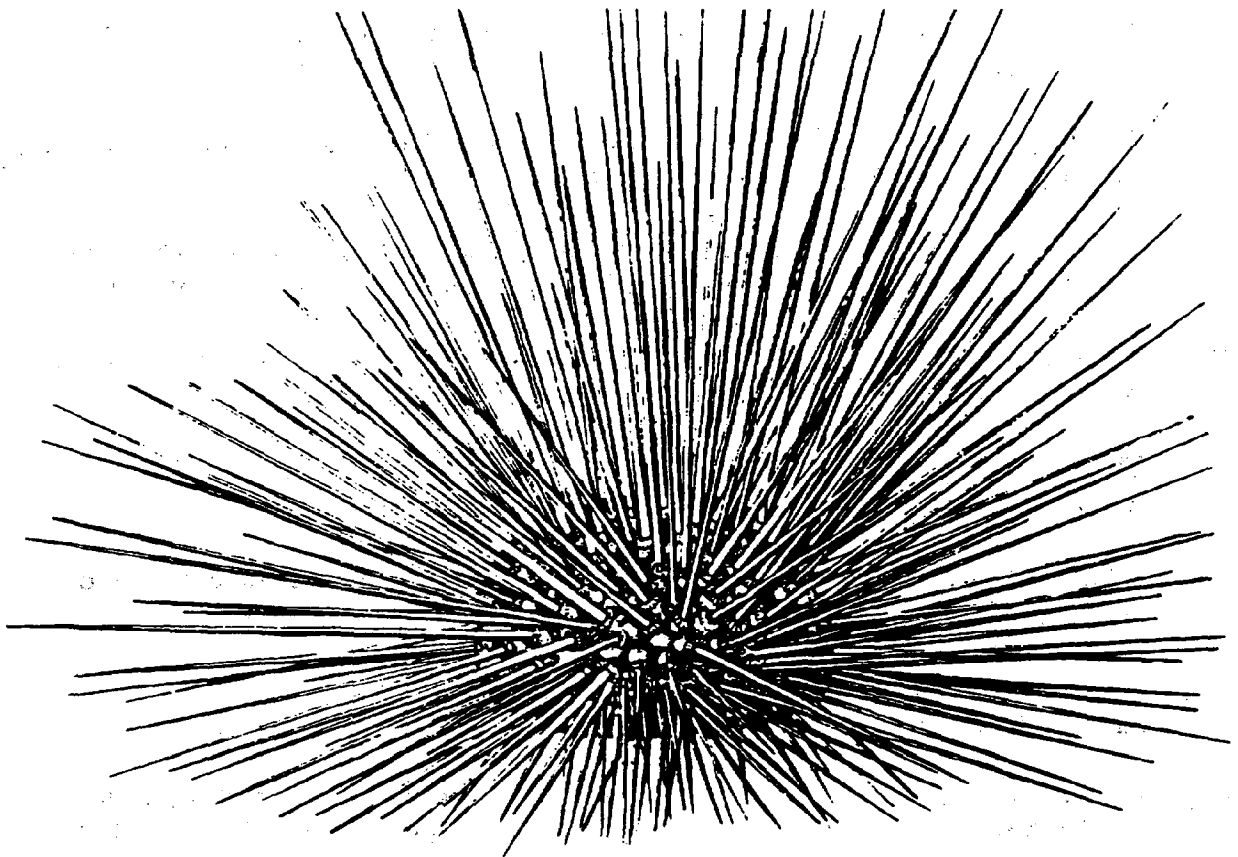
Species of Special Concern: Any species in Florida protected by law that does not fit into the endangered or threatened categories but deserves special attention due to current natural or human-caused pressures.

Thermoelectric Power: The conversion of heat into electricity.

Threatened: Any species that is likely to become endangered in Florida within the near future if current natural or human-caused conditions affecting its survival continue (protected by law).

Tributary: A stream, creek or river which feeds into a large river.

Uplands: Higher grounds along rivers, usually out of the floodplain.



Long-spined Urchin

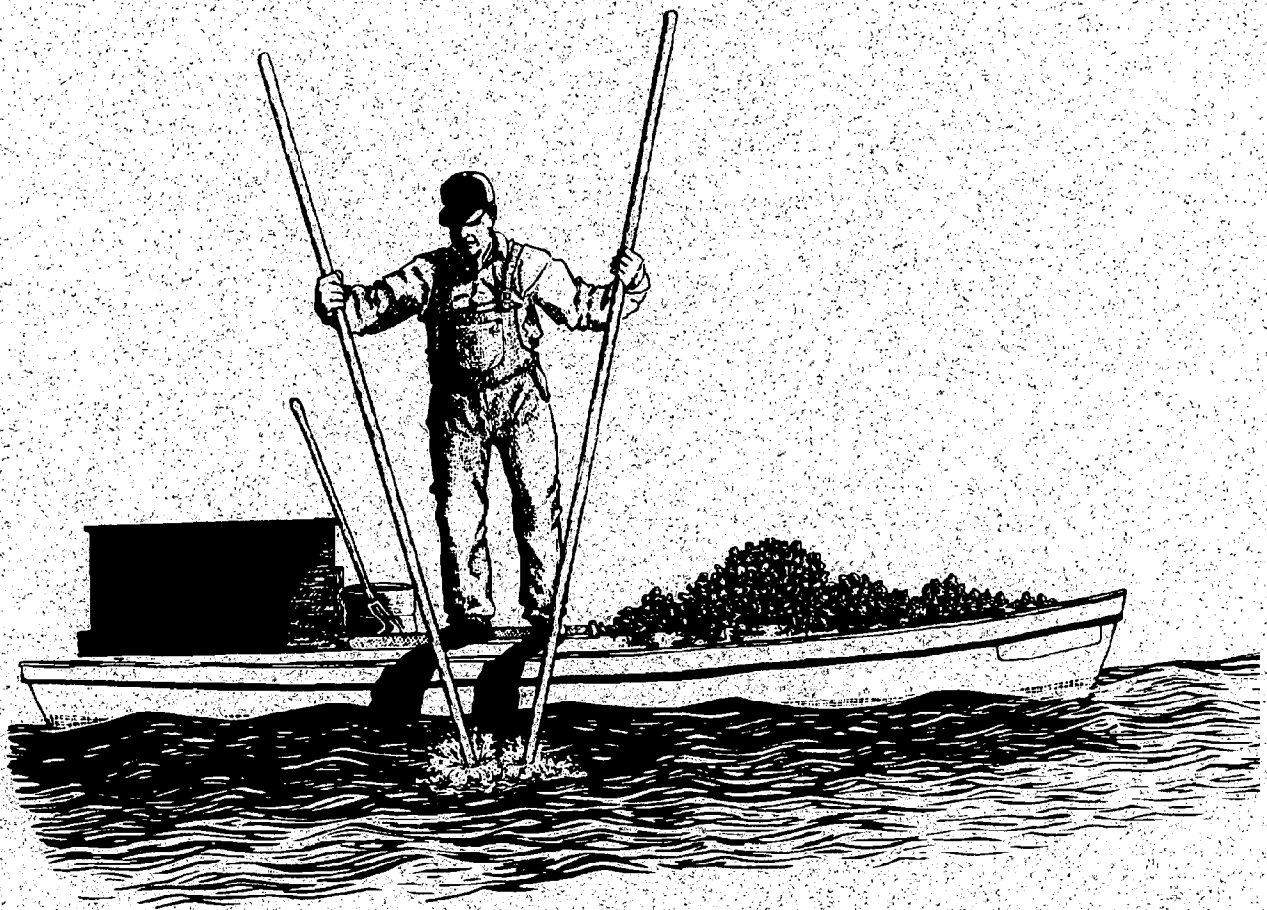
REVIEW QUIZ FOR LESSON II OF PROJECT ESTUARY

I. Choose the word that best completes each sentence. Put the letter of your choice on the line before the statement

1. ___ All of the following are industries in Florida that use the land resources of the Apalachicola River and Bay System EXCEPT: (A) forestry, (B) thermo-electric power, (C) agriculture, (D) recreation.
2. ___ Which of the following are industries in Florida that use the water resources of the Apalachicola River and Bay System? (A) commercial fishing, (B) recreation, (C) navigation, (D) hydroelectric power, (E) all of the above.
3. ___ The Apalachicola Estuary's resources provide people with many recreational opportunities such as hunting, fishing, swimming, and boating. Which of the following local businesses benefit from recreational activities? (A) hotels/motels, (B) restaurants, (C) gas stations, (D) all of the above.
4. ___ The largest amount of land in the Apalachicola drainage basin is used by (A) forestry, (B) agriculture, (C) recreation, (D) military and private ownership.
5. ___ Commercial fisheries in the Apalachicola Estuary employ people in which of these counties? (A) Franklin, (B) Gulf, (C) Wakulla, (D) all of the above.

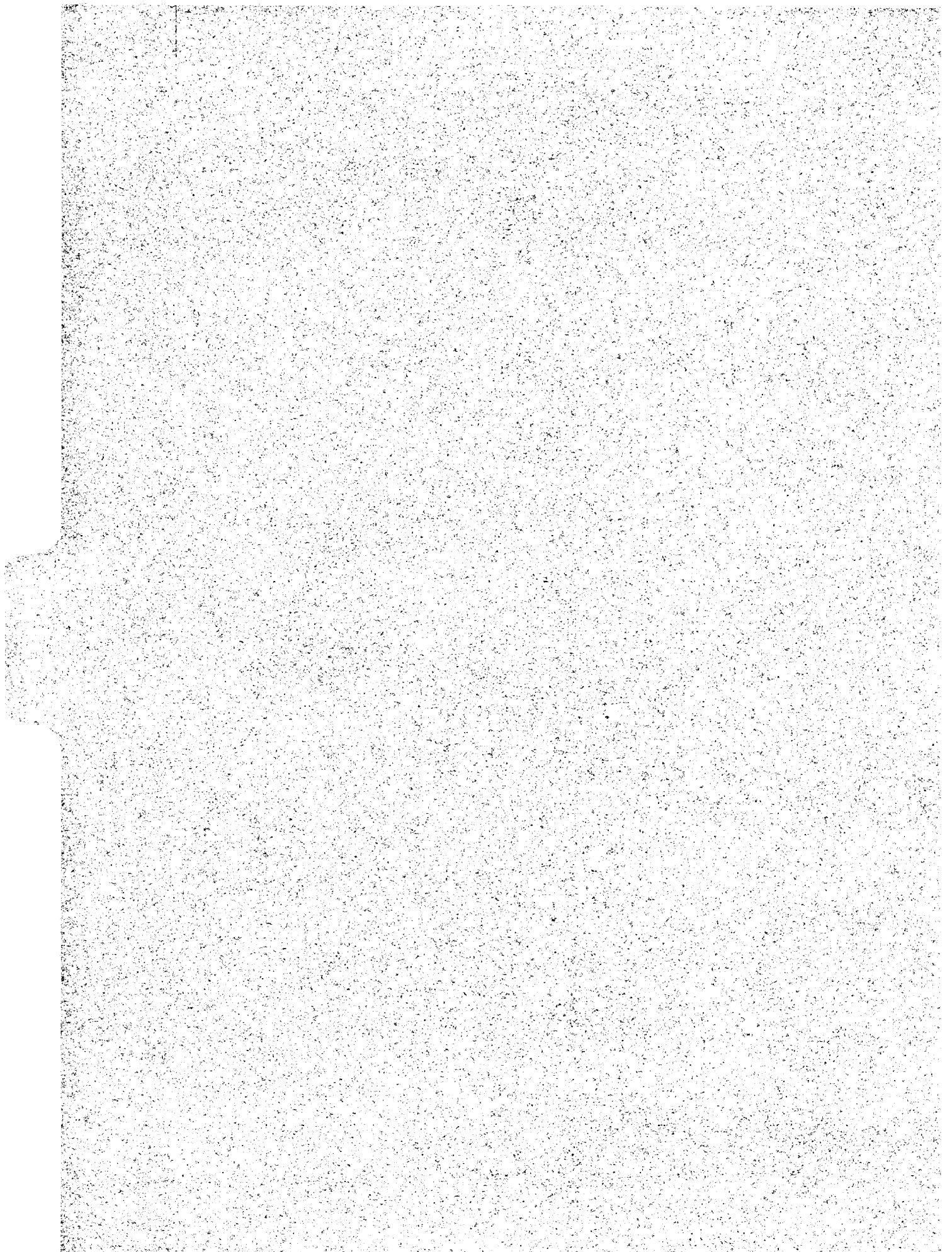
II. Read the sentences below. Print a T before each true statement and an F before each false statement.

6. ___ The commercial fishing industry in the Apalachicola Bay generates both local and national dollars.
7. ___ Wildlife depends on the Apalachicola River and Bay Estuarine System for food, shelter, water, breeding grounds and nursery area.
8. ___ There are no animals or plants that are endemic to (only found in) the Apalachicola system.
9. ___ Migratory waterfowl such as the blue-winged teal and the wood duck depend on the Apalachicola Bay area and its surrounding barrier islands as their feeding and wintering grounds.
10. ___ The Apalachicola System is home to a number of protected animals whose survival is threatened with over-exploitation by humans, predation, disease, loss of habitat, or other natural or human-caused conditions.



Oysterman "tonging" oysters in Apalachicola Bay.

Illustration by Diane Sterling,
Northwest Florida Water Management District.



A TEACHER'S GUIDE TO LESSON III

OBJECTIVES

1. Students learn that humans impact the Apalachicola System in many ways.
2. Students will learn how pollution affects the Apalachicola System.
3. Students will understand many multi-use demands on the Apalachicola System.

TIME: Approximately one 50-minute class period.

PROCEDURE:

1. Review the vocabulary list for this lesson before proceeding with other steps.
2. Use the Lesson III Script to take the students through a brief review of things learned in Lesson II.
3. Then pass out the Lesson III Student Activity Pages and work with the students to create a list of HUMAN USES of the Apalachicola System on the chalk board (note: script includes guidance on the 8 main uses of the system).
4. Next, divide the students into 8 groups and assign each group one of the 8 uses. Have them list, in their small groups, any IMPACTS or problems they can think of that may result from their assigned use (note: script includes guidance on the impacts of the 8 uses).
5. Now have each group share the impacts or problems they have listed and write them on the chalk board (note: use the guide questions provided in the script to draw out as many impacts as possible).
6. As a class, have students list WAYS TO PREVENT OR LESSEN HUMAN IMPACTS on the system (note: use the script for guidance on this). Put the list on the chalk board and have students fill in their worksheets as you write the items down.
7. Complete Review Quiz for Lesson III.

8. Discuss answers or post answer keys to student activities and Review Quiz for Lesson III.



Great Egret

ANSWER KEYS TO LESSON III

Humans and the Apalachicola Estuarine System Chart: Below is an example of answers which might be generated as a result of class participation using this chart. Answers will vary from county to county and class to class.

HUMAN USES	RESULTANT IMPACTS	WAYS TO PREVENT OR LESSEN HUMAN IMPACTS
Farm land Irrigation	Stormwater runoff Lower water quality Pesticides Land clearing Eutrophication	Control stormwater runoff Limit fertilizer and pesticide use Limit land clearance
Timberland Wood processing water	Land clearing/drainage Erosion Chemical spills	Limit land disturbance near water Dispose of chemicals properly
Seafood	Over harvest Waste dumping	Observe fishing laws Dispose of wastes properly
Hunting Fishing	Over harvest Litter Oil/chemical spills	Observe fishing/hunting laws Dispose of wastes properly
Land development Sewage treatment	Dredging and filling Stormwater runoff Eutrophication	Protect and preserve wetlands Proper sewage treatment Direct runoff into natural holding areas
Water to create electricity	Human-made structures (dams, locks) block fish migration	Limit human-made structure use
Water to cool generators	Warmed water kills aquatic life	Cool and treat water before releasing
Water for barge traffic	Dredging Human-made structures	Limit dredging Limit human-made structure use

WORD SCRAMBLE

- | | | |
|------------------------|-----------------|-----------------|
| 1. dredging | 2. heavy metals | 3. sewage |
| 4. erosion | 5. antifreeze | 6. pesticide |
| 7. pollution | 8. battery acid | 9. detergent |
| 10. petroleum products | 11. chemicals | 12. plastic |
| 13. biodegradable | 14. fertilizer | 15. development |

REVIEW QUIZ

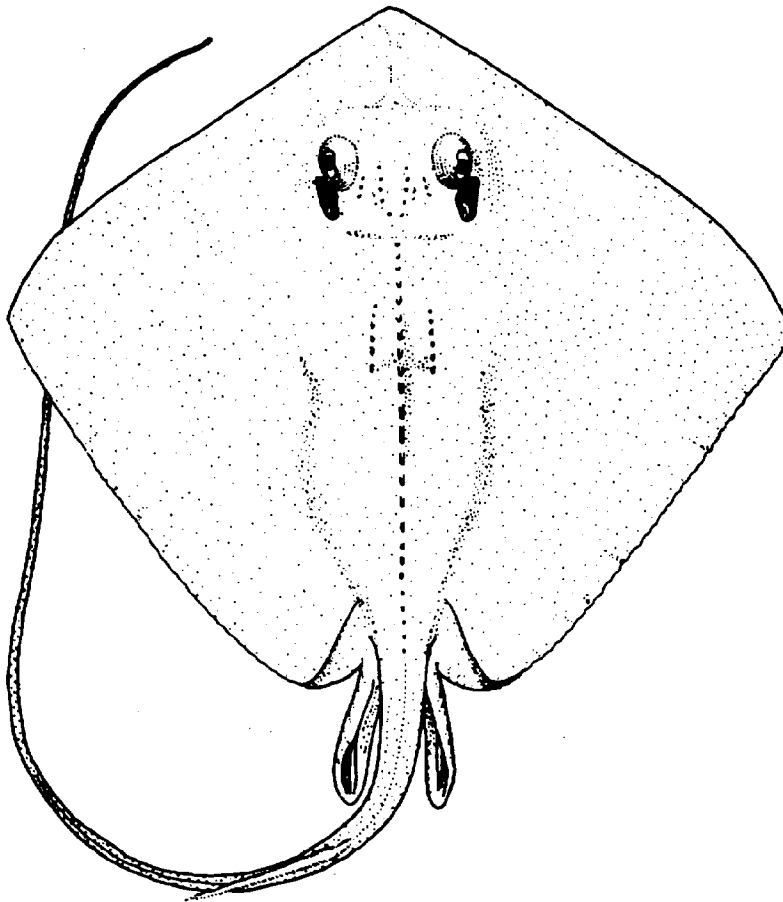
I. Answers will vary. Students may choose any 3 of the following or a use that falls within these categories: forestry, agriculture, recreation, urban use, commercial fishing, hydroelectric power, thermoelectric power, waterborne navigation.

2. Answers will vary. oils, petroleum products, detergents, household cleaners, fertilizers, pesticides, sewage, animal waste, industrial wastes, etc.

3. Answers will vary. dredging, filling, land development, land clearing and draining, dams, locks, other human-made structures, etc.

II. 4. D, 5. B

III. 6. T, 7. T, 8. T, 9. T, 10. F



Southern Stingray

LESSON III SCRIPT

Introduction:

Before we begin Lesson III, let's quickly review some information about estuaries.

Question: What is an estuary?

Answer: An estuary is a place where fresh water and salt water meet and mix.

Question: Why are estuaries important?

Answer: Estuaries provide food and shelter for organisms, protection from flooding and erosion, a filtration system to cleanse the water, nurseries for young animals, beauty, goods, services and jobs for humans.

Question: The source of Apalachicola Bay's fresh water is the Apalachicola River and its tributaries. What are the two largest tributaries of the Apalachicola River?

Answer: The two largest tributaries are the Flint River and The Chattahoochee River.

Question: The Apalachicola River and Bay and its tributaries flow through what three states?

Answer: Alabama, Georgia and Florida.

In Lesson II we talked about some of the ways humans use the Apalachicola River and Bay Estuarine System. We discovered that the Apalachicola System has many uses and is therefore called a multi-use system.

In this lesson, we will review human uses of the Apalachicola Estuarine System in Alabama, Georgia, and Florida and we will discuss the impacts or effects these uses have on our estuary. Let's first talk about ways we use the Apalachicola System.

**** Teacher's Note: Pass out the Lesson III activity pages to students and have them look at the HUMANS AND THE APALACHICOLA ESTUARINE SYSTEM chart.**

Together and in groups we are going to complete this chart. Using a pen or pencil, let's first list human uses of the Apalachicola Estuarine System.

**** Teacher's Note:** Have students raise their hands to call out human uses. List the uses on the chalk board as the students say them. Have students list the uses on their activity page chart. Complete this portion of the lesson in 10 minutes. Guide students so that the list looks as follows (in no specific order):

HUMAN USES OF THE APALACHICOLA ESTUARINE SYSTEM

Agriculture: farm land, irrigation water

Forestry: timberland, wood processing water

Commercial Fishing: seafood

Recreation: hunting, camping, hiking, boating, fishing

Urban Use: land development, sewage treatment, municipal drinking water, industrial plant power

Hydroelectric Power: moving water to create electricity

Thermoelectric Power: water to cool generators

Waterborne Navigation: water for barge traffic

As you can see, Florida, Alabama and Georgia use the Apalachicola system for many reasons. These uses together or separately can cause changes in the estuarine system. These changes or impacts on the environment can be grouped into two categories: physical assault and pollution. Our river and bay area is beautiful and more people are discovering it every day. As people develop the land around our estuary, they are physically changing and altering it. Our rivers and tides carry detritus and other nutrients important for estuarine critters. Unfortunately, these rivers and tides can also carry pollutants that humans have discarded. The results of misused and mismanaged land many miles away from the estuary can find their way to the bay by way of the Apalachicola River and its tributaries. Stormwater running off of the land around the Apalachicola River and Bay System can carry pollutants such as oils from cars, fertilizers, pesticides, sewage, animal wastes and industrial wastes. Presently, human activities in the Apalachicola Estuarine System are causing very few problems but as development of this system occurs, more and more problems will result. If we change even one thing in the Apalachicola Estuary many other things are going to be affected both positively and negatively.

**** Teacher's Note:** The following pages titled **IMPACTS AS A RESULT OF HUMAN USES, GUIDE QUESTIONS** and **WAYS TO PREVENT OR LESSEN HUMAN IMPACTS** are included as



True Tulip

information for the teacher to help stimulate student responses.

Divide students into 8 groups. Assign each group a listed use. Instruct them that they will have 10 minutes to come up with impacts or problems that could result from their assigned use. Emphasize to students to focus on types of physical assault or pollution their use could cause. Hand out a sheet of blank paper to each group and instruct students to jot down the impacts or problems they think of.

When time is up ask a representative from each use group to express the group's findings. Write down the class results on the chalk board. Try to complete this portion of the lesson in 10 minutes. Have students fill in their activity page chart with the impacts as you write them on the chalk board.

IMPACTS AS A RESULT OF HUMAN USES

Agriculture: Stormwater runoff (containing pollutants like fertilizers, pesticides, animal waste, and road oils) can cause eutrophication, and lower water quality, thereby killing plants and animals. Land clearing destroys habitats. Over-use of the water could lower the water table to a point at which too much salt water could enter and contaminate fresh water.

Forestry: Clearing and draining land removes plants which filter pollution, prevent erosion and provide habitats. Chemicals from wood processing plants can pollute water if improperly disposed of.

Commercial Fishing: Over-harvesting could occur. Pollution could occur due to boats and seafood houses dumping seafood by-products, oils, gas and other waste materials.

Recreation: Over-harvesting could occur. Oil and other chemicals from boats, cars, etc, can pollute water. Litter people leave behind can pollute the land and water and harm wildlife.

Urban Use: Dredging and filling in wetland areas to develop marinas, businesses, homes, etc., destroys natural habitats, takes out natural plant filters and clouds water, preventing sunlight from reaching marine life. Improperly treated human and household wastes (sewage) can enter the estuarine system through ground water and stormwater runoff and pollute our drinking water, cause eutrophication, and lower oxygen in the water available for fish and other wildlife. Many products used to care for cars and homes are not biodegradable and can also pollute the water.

Too much use of water for drinking, household purposes, etc., could lower water tables and lead to salt water contamination. Construction and development efforts can lead to dredging and filling which destroys natural habitats and the natural ability of plants to filter pollution and could cause erosion. Industrial wastes, if dumped into the estuary, could pollute the system.

Hydroelectric Power: Construction of dams, locks and other human-made structures to create reservoirs of water for uses above the structure, such as the generation of electricity, change the natural flow of the river. Eventually, these changes can create problems for the estuary below the structure. As fresh water flow is taken away from the estuary, higher salinities, fewer nutrients and smaller sized sediments occur, causing changes in estuarine conditions. The human-made structures also block aquatic life such as the sturgeon, from reaching their breeding habitats.

Thermoelectric Power: Warm water discharge could raise river water temperatures to levels that would kill aquatic life. However, during cold winters, the discharge can be a refuge for aquatic life. If the plant shuts down during the winter, the rapid drop in temperature can kill many aquatic organisms.

Waterborne Navigation: Dredging the river to keep the waterway open to traffic can cloud the water, suffocate aquatic life and destroy natural habitats. Oils and other chemicals from barges and other traffic can cause pollution. Dams and other human-made structures designed to assist river traffic change the natural flow and cause loss of habitats.

GUIDE QUESTIONS

Agriculture:

1. What must farmers do to begin a new crop field?
2. How could clearing the land affect natural habitats?
3. Do farmers use any substances which could have an impact on the estuarine system? If so, how could these substances reach the estuary and what problems could they cause?

Forestry:

1. What changes occur as trees are harvested from the land around the river basin?
2. What natural functions did the plants in the harvested areas have?
3. Do paper mills and pulp mills use any substances or do any activities which could have an impact on the Apalachicola Estuarine System? If so, how could these substances reach the estuary and what problems could they cause?

Commercial Fishing:

1. Do fishing vessels and seafood houses use any substances or do any activities which could have an impact on the estuary?

Recreation:

1. Do recreational users do activities or use substances which could have an impact on the Apalachicola River and Bay System?

Urban Use:

1. How could increased development affect the area around the Apalachicola River and Bay System?
2. What development activities are involved? How do they change the natural surroundings.
3. What, if any, effects could sewage disposal have on the estuary?
4. What other pollutants, if any, from the urban lands could cause problems? How do these pollutants reach the estuary?
5. How could the municipal drinking water supply from the Apalachicola System become polluted?
6. What, if any, substances or activities do industries use or carry out that could have an effect on the estuary?

Hydroelectric Power:

1. What type of human-made structures are necessary to focus this moving water and create electricity?
2. What effect could these structures have on the natural flow of the river system and the aquatic life in the river and estuary area below?

Thermoelectric Power:

1. Water from the Apalachicola River System is used to cool thermoelectric generators which create another power source. Could the warmed water discharged from these power plants cause any changes in the river system? If so, what changes might occur?

Waterborne Navigation:

1. How is the river and bay system maintained to keep it open to water traffic?
2. How could this activity affect the aquatic life and habitats in the system?
3. What substances or activities do barges and other water traffic use or carry out that could affect the Apalachicola River and Bay Estuarine System?

**** Teacher's Note: Once human impacts have been discussed, instruct students to think of ways to prevent or lessen the impacts on the Apalachicola Estuary. As students raise their hands and respond, write down their solutions on the chalk board and instruct them to fill in their activity page chart as you go along. This portion of the lesson should be completed in 5-10 minutes.**

WAYS TO PREVENT OR LESSON HUMAN IMPACTS

Agriculture: Control stormwater runoff by leaving a natural vegetation area between crop fields and bodies of water. Build areas designed to hold and filter runoff. Limit use of fertilizers and pesticides. Keep grazing animals away from water bodies.

Forestry: Keep roads, logging operations and any other disturbances to sediments away from water bodies. Build areas designed to hold and filter runoff.

Commercial Fishing: Recycle and properly dispose of waste materials. Observe fishing regulations. Don't discard litter in water. Do not use gear in sensitive areas.

Recreation: Observe boating, fishing and hunting regulations. Properly dispose of oils, other chemicals and trash. Work with coastal cleanup groups.

Urban Use: Protect and preserve wetlands from damage. Use and maintain proper private and public sewage and waste water treatment systems. Create holding areas in lawns to filter stormwater runoff. Landscape areas around buildings and homes to absorb runoff and prevent erosion. Utilize native vegetation that doesn't require extra watering. Direct rainwater from pavements onto grassy areas or use porous materials to allow rain to slowly filter through the ground. Use less toxic and biodegradable household products. Dispose of household and car chemicals properly. Conserve water use. Limit construction and development. Properly dispose of industrial waste. Properly observe building codes.

Hydroelectric Power: Limit human-made structures along estuarine systems.

Thermoelectric Power: Cool and treat warmed water before returning it to the natural system.

Waterborne Navigation: Limit human-made structures and dredging operations in the estuarine system. Properly dispose of oils and other chemicals.

Conclusion:

Quickly let's review the two major impacts human involvement has on estuaries. These impacts are physical assault and pollution. Name a few types of physical assault (dredging and filling, over harvesting, clearing and draining, human-made structures such as dams and locks, etc.). Name a few sources of pollution (litter, oils, other petroleum products, pesticides, sewage, fertilizers, animal waste, industrial chemicals, household cleaners, heavy metals, etc.).

Humans will always be involved with the Apalachicola Estuarine System. We need to be aware of the impacts or changes our growing uses have on our estuary so that we can conserve and protect the Apalachicola System and its treasured natural resources.

FOLLOW-UP ACTIVITIES

1. Find out if there are any proposals for new developments in your area, such as dams, shopping centers, golf courses, marinas, etc. If so, consider how these developments will affect the wildlife and other natural resources of these developments.
2. Have students search school grounds for evidence of physical assault and pollution. Trace the course of stormwater runoff from the school to the Apalachicola River and Bay. Discuss ways to prevent or lessen these impacts on the school grounds and in the Apalachicola Estuarine System.
3. Divide students into groups. Each group is to select a different pollution source, design and demonstrate an experiment to show how the estuary could become polluted as a result.
4. Have students write and produce a newspaper that contains Apalachicola River and Bay Estuarine information and issues.
5. Have students write Senators and Representatives about environmental issues concerning the Apalachicola Estuary.
6. Have students conduct a stormwater drain stenciling project to discourage improper use of drains for oil dumping, waste disposal, etc.
7. Get involved with a coastal cleanup effort in your area by contacting the Reserve for information.

MORE DISCUSSION QUESTIONS

Use these thought provoking questions to stimulate more discussion regarding human impacts on the Apalachicola Estuarine System.

1. What can you do at home and/or at school to help prevent or reduce pollution of the Apalachicola Estuary?
2. Research established zoning laws or land use regulations in your county. List and discuss uses that would be compatible with these laws and regulations.
3. Are there any laws in your area concerning pollution on the Apalachicola River and its tributaries or Apalachicola Bay.

4. The following are pollutants commonly found in estuarine systems: petroleum products, plastics, pesticides, fertilizers, sewage, chemicals, and heavy metals. Give two examples of ways each pollutant enters an estuarine system. What actions can be taken to prevent these pollutants from entering our estuarine system?

LIST OF HELPFUL RESOURCES FOR STUDENTS

Burke, David, G., Meyers, Erik, Tiner, Jr., Ralph, and Groman, Hazel, Protecting Nontidal Wetlands. Chicago, American Planning Association, 1988.

Cavanaugh, Peggy and Spontak, Margaret, Protecting Paradise: 300 Ways to Protect Florida's Environment, Fairfield, Florida, Phoenix Publishing, 1992.

Center for Science in the Public Interest, 99 Ways to a Simple Lifestyle, New York, Anchor Books, 1977.

East Central Florida Regional Planning Council, The Waterfront Property Owner's Guide, Winter Park, Florida, 1979.

Florida Department of Environmental Regulation, Stormwater Management, the Florida State of the Environment Series.

Hammer, Marie S., Hazardous Household Substances: Alternatives That Are Relatively Free of Toxic Effects, Gainesville, Florida Cooperative Extension Service, University of Florida, Institute of Food and Agricultural Sciences, 1988.

MacEachern, Diane, Save Our Planet: 750 Everyday Ways You Can Help Clean Up the Earth, New York, Dell Publishing, 1990.

Sponenberg, Torsten D., Kahn, Jacob H., and Sevebeck, Kathryn P., A Homeowner's Guide To Septic Systems, Blacksburg, Virginia, Virginia Polytechnic Institute and State University, Virginia Water Resources Research Center, 1985.

Taggart, Judith and Bracht, Betty, Handle With Care: Your Guide To Preventing Water Pollution, Washington, D.C., The Terrene Institute, 1991.

STUDENT PERFORMANCE STANDARDS COVERED IN LESSON III OF PROJECT ESTUARY

(For Grades 9-12)

Biology I: 1.03, 1.04, 1.05, 1.07, 1.11, 1.12, 11.03, 12.01, 12.02, 12.05

Chemistry I: 1.03, 1.04, 1.05, 1.07, 1.11, 15.01, 15.02

Earth/Space Science: 1.03, 1.04, 1.05, 1.07, 1.11, 1.12, 11.01, 11.02, 13.03, 16.03, 16.04, 18.03, 20.04, 20.07, 20.08, 20.10

Ecology: 1.03, 1.04, 1.05, 1.07, 1.11, 1.12, 2.01, 9.01, 9.03, 9.04, 10.01, 10.02, 12.01, 12.03

Environmental Science: 1.03, 1.04, 1.05, 1.07, 1.11, 1.12, 2.01, 2.03, 9.03, 2.04, 2.05, 2.06, 2.07, 2.08, 2.09, 3.01, 4.01, 6.01, 6.02, 6.03, 6.04, 7.02, 8.01, 8.02, 9.04, 10.05, 11.01, 11.02, 11.03

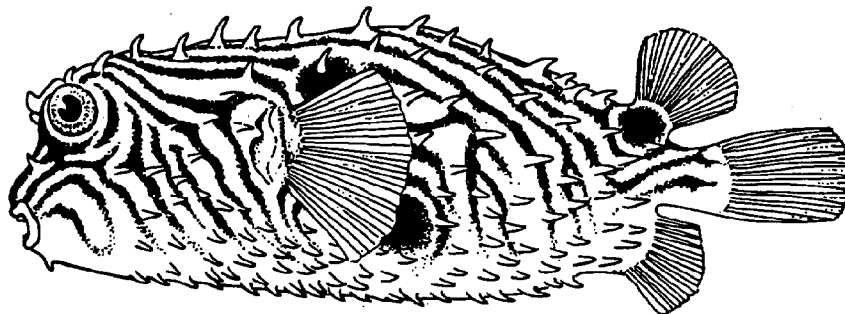
General Science: 1.03, 1.04, 1.05, 1.07, 1.11, 21.01, 21.02, 21.06, 22.02

Marine Biology: 1.03, 1.04, 1.05, 1.07, 1.11, 1.12, 3.02, 4.04, 9.01, 9.03, 9.04, 9.05, 9.06, 9.07, 10.03, 11.02

Fundamentals of Oceanography: 1.03, 1.04, 1.05, 1.07, 1.11, 1.12, 5.04, 5.05, 6.04, 7.01, 7.03, 8.01, 8.02, 8.03, 8.04, 8.05, 8.06, 9.03

Oceanography: 1.03, 1.04, 1.05, 1.07, 1.11, 1.12, 4.02, 5.05, 6.01, 6.02, 6.03, 10.01, 10.04, 11.05

Physics I: 1.06, 1.07, 1.08, 1.09, 21.05



Striped Burrfish

CURRICULUM FRAMEWORKS COVERED IN LESSON III OF PROJECT ESTUARY

(For Grades 6-8)

M/J Earth/Space Science: 1., 2., 18.

M/J General Science: 1., 2., 3., 4., 7.

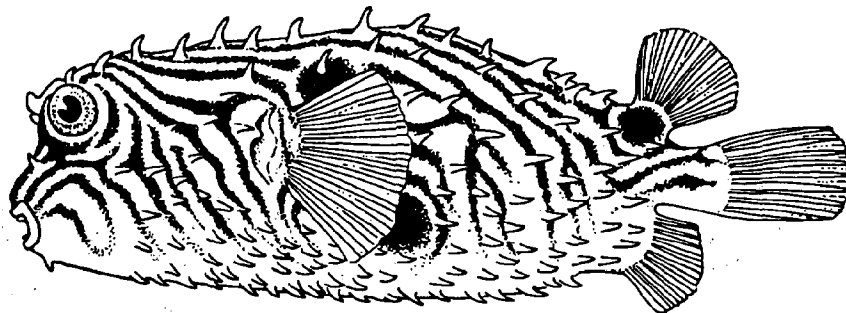
M/J Life Science: 1., 2., 11., 14.

M/J Comprehensive Science I: 1., 2., 8., 12., 16.

M/J Comprehensive Science II, Basic: 1., 2., 6., 9., 17.

M/J Comprehensive Science II: 1., 2., 6., 9.

M/J Comprehensive Science III, Basic: 1., 2., 16.



Striped Burrfish

LESSON III STUDENT ACTIVITY PAGES



Directions: In the box provided below design a warning sign which will express one or more effects of pollution or physical assault on the Apalachicola River and Bay estuarine system and you. Be prepared to explain your sign.

HUMANS AND THE APALACHICOLA ESTUARINE SYSTEM

Directions: Complete the chart below as instructed by your teacher.

HUMAN USES	RESULTANT IMPACTS	WAYS TO PREVENT OR LESSEN HUMAN IMPACTS

WORD SCRAMBLE

Directions: Unscramble the words below. Each word can be found in the list at the bottom of the page.

1. ggnidedr _____
2. ayevh tasmel _____
3. gaewse _____
4. orsonel _____
5. fiezrntea _____
6. tsiedeicp _____
7. olunipol _____
8. ratybet icda _____
9. gteentred _____
10. meltuoper srutpcod _____
11. ahicesclm _____
12. litcaps _____
13. oddabelbiaegr _____
14. reelziftr _____
15. pemtevedlno _____

Antifreeze
Chemicals
Dredging
Heavy metals
Plastic

Battery acid
Detergent
Erosion
Pesticide
Pollution

Biodegradable
Development
Fertilizer
Petroleum products
Sewage

VOCABULARY FOR LESSON III

Aquatic: Growing or living in or around water.

Biodegradable: Capable of being broken down by natural processes such as rotting.

Contaminate: To make impure or unhealthy.

Dredging: The act of digging and removing material from a waterway.

Erosion: The act or process of removing or wearing away of soil by water, wind, ice, or other forces or methods.

Eutrophication: The collection of nutrients in rivers and other water bodies, causing rapid algae growth, which uses up oxygen in the water.

Ground Water: Water below the surface that supplies wells and springs and moves underground toward rivers, lakes and bays.

Hydroelectric Power: The conversion of energy, created by moving water, into electricity.

Impact: A noticeable effect that occurs in an ecosystem, such as an estuary, due to a change in the environment.

Irrigation: The practice of artificially supplying land or crops with water.

Municipal: Of or relating to a city or town.

Pesticides: Chemicals used to kill plants or animals.

Physical Assault: Development or material alterations made in the environment.

Pollution: Anything added to the natural system whether physical, biological, or chemical which changes the conditions of that system. **Pollutants:** Something which can alter the natural system.

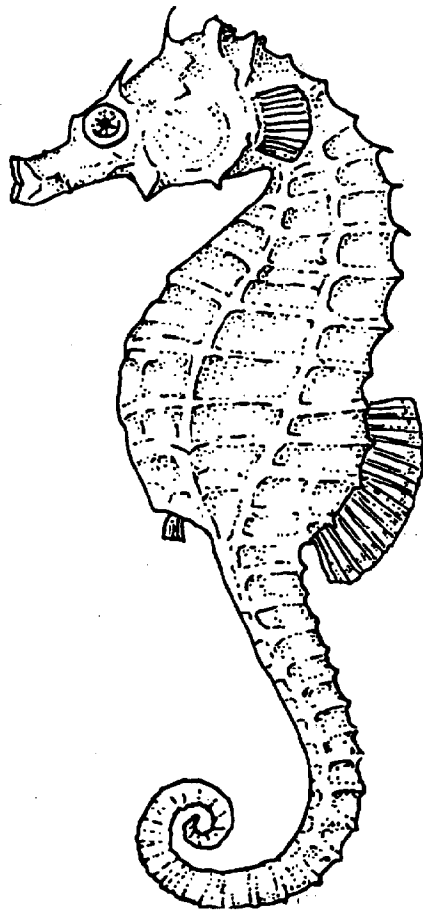
Reservoirs: Human-made lakes where water is collected and stored in large quantities for use.

Toxic: Poisonous or harmful.

Waterborne: Supported or carried by water.

Water Quality: The basic nature or characteristics of water that make it good or bad; used in reference to water purity.

Wetland: A land area which is covered or soaked by water for some portion of the year.



Lined Seahorse

REVIEW QUIZ FOR LESSON III OF PROJECT ESTUARY

I. Write a short answer for each of the following questions.

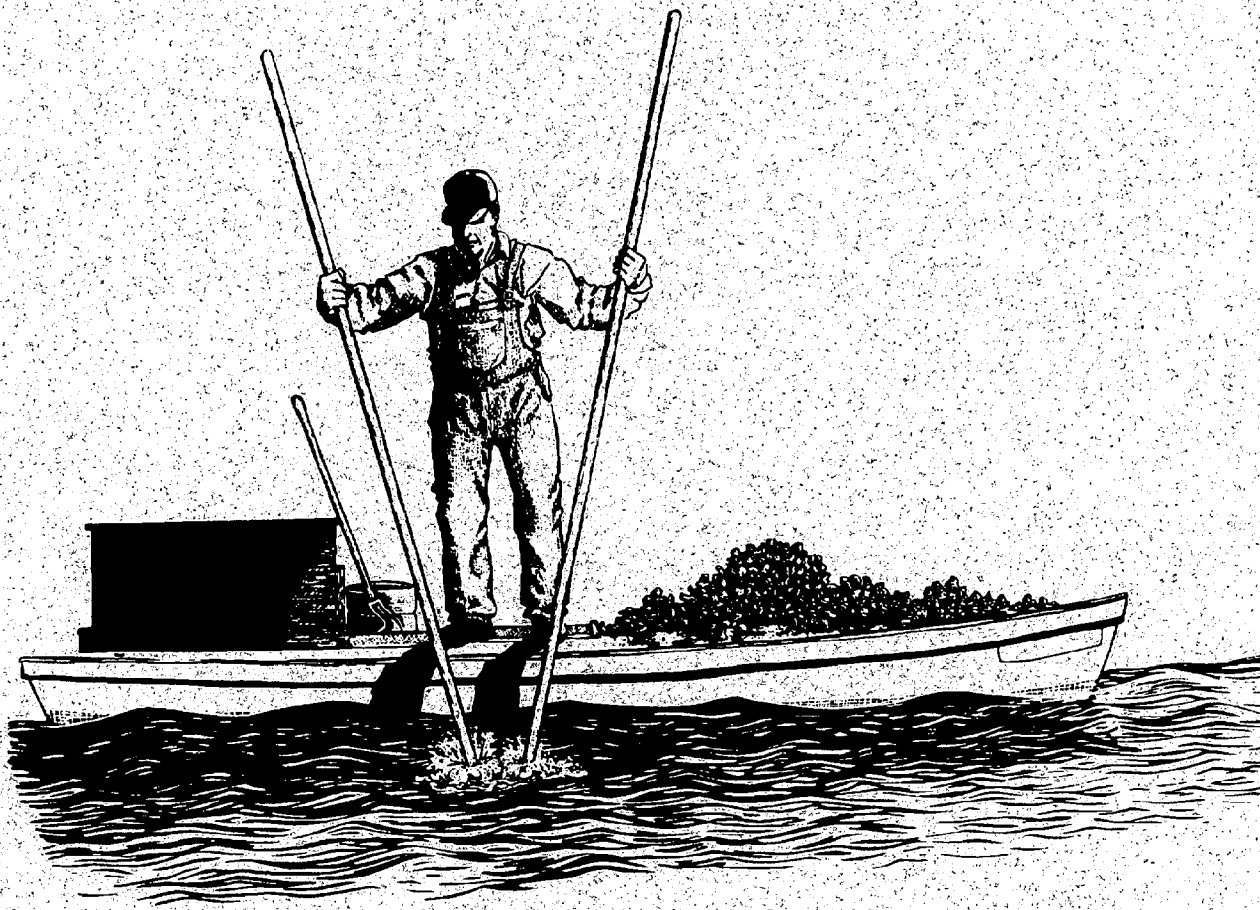
1. List three uses of the Apalachicola Estuarine System's resources.
2. Name one source of pollution which can affect the Apalachicola River and Bay Estuarine System.
3. Name an activity which can physically assault the Apalachicola River and Bay Estuarine System.

II. Choose the word or words that best completes each sentence. Put the letter of your choice on the line before the statement.

4. ___ Stormwater runoff from farms, towns and cities contains pollutants which can (A) harm wildlife, (B) destroy habitats, (C) lower water quality, (D) all of the above.
5. ___ Increased construction and development pressures within the Apalachicola System can lead to all of the following EXCEPT: (A) destruction of habitats, (B) increases in wildlife populations, (C) erosion, (D) changes in estuarine conditions.

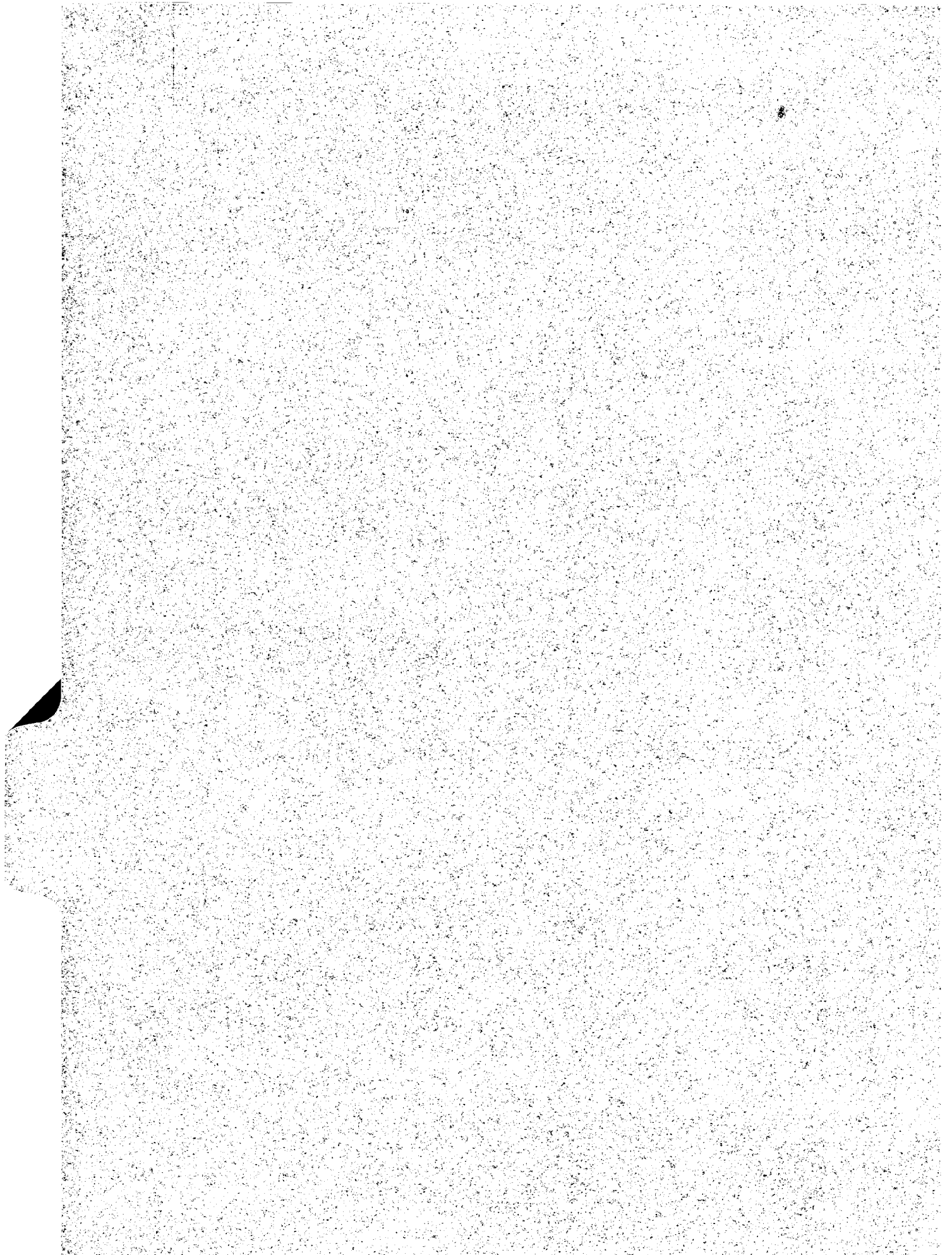
III. Read the sentences below. Print a T before each true statement and an F before each false statement.

6. ___ The two major destructive impacts humans have on estuaries are physical assault and pollution.
7. ___ Dams, locks, and other human-made structures cause changes in salinity, nutrients and sediment size in Apalachicola Bay by altering the natural fresh water flow coming from the Apalachicola River.
8. ___ Presently our activities in the Apalachicola Estuarine System are causing very few problems but as further development of this system occurs, more problems will result.
9. ___ The results of misused and mismanaged land many miles away can make their way to our estuary by way of the Apalachicola River and its tributaries.
10. ___ As resource users, we are not responsible for the future of the Apalachicola Estuary.



Oysterman "tonging" oysters in Apalachicola Bay.

Illustration by Diane Sterling,
Northwest Florida Water Management District.



A TEACHER'S GUIDE TO LESSON IV

OBJECTIVES

1. Students will learn about the role of plankton, benthic organisms and fish in estuarine food webs.
2. Students will develop listening skills while learning about estuarine organisms.
3. Students will learn some basic types of plankton, benthic organisms and fish in an estuarine system.
4. Students will identify basic fish body parts.
5. Students will gain knowledge about commercially and recreationally important fish species, including human uses, habitat requirements, basic descriptions, and average size and weight.

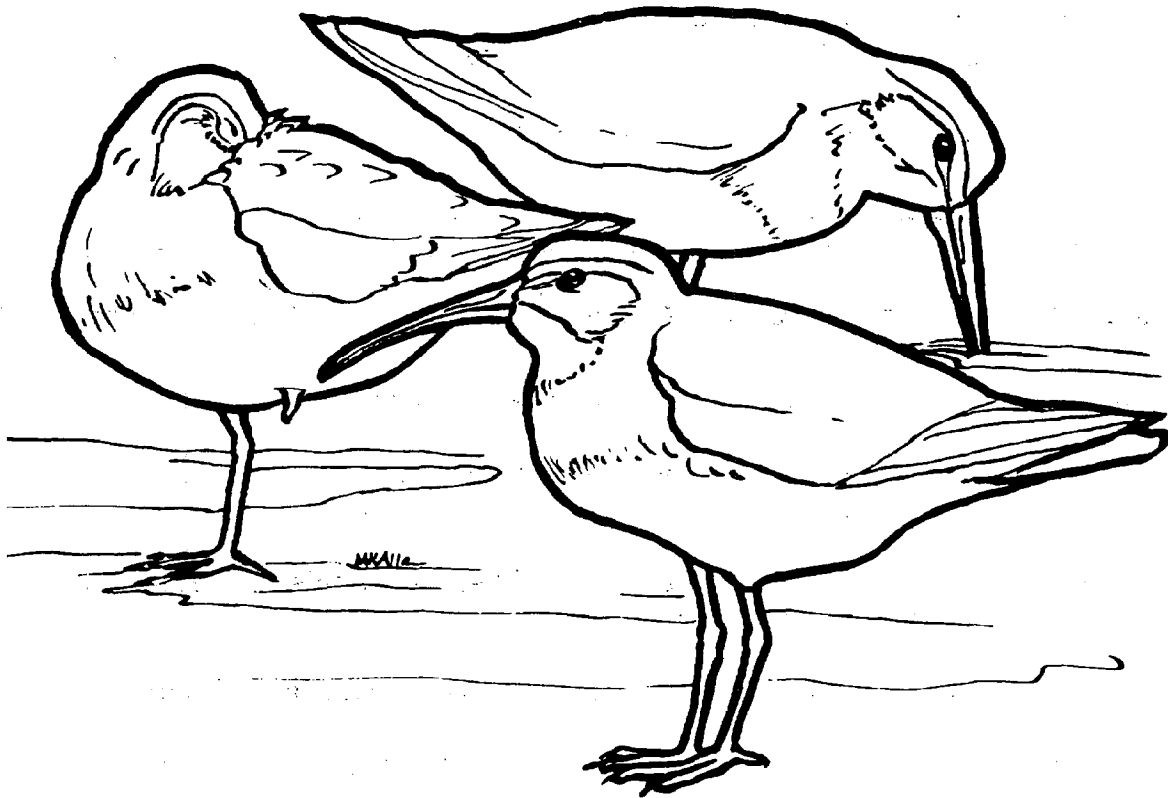
Time: Approximately two 50-minute class periods.

Procedures: It is suggested that the plankton and benthic organisms be covered in one session and fish during another session.

1. Review the vocabulary list for this lesson before proceeding with other steps.
2. Use the Lesson IV Script to introduce the activity and take the students through the plankton and benthic organism narrative.
3. Pass out the student activity page with the listening skills test on it and have the students answer the questions.
4. Go over the answers and have the students grade themselves for fun.
5. Have the students complete the plankton matching activity by following instructions given on the activity sheet.
6. Introduce the fish portion of this lesson with the narrative provided and pass out the "Parts of a Fish" student activity page. Help students fill in the

blanks from the provided list of fish parts.

7. Next, pass out the "Guess What Fish I Am" activity page and have the students guess which kinds of fish you are describing with the clues.
8. Finally, allow the students time to review the information provided on the "Commercially and Recreationally Important Species" pages and have them answer the fill-in-the-blank questions.
9. Complete the Review Quiz for Lesson IV.
10. Discuss answers or post answer keys to student activities and review quiz for Lesson IV.



Shorebirds

ANSWER KEYS TO LESSON IV

Listening Skills Test

- | | | |
|-------------------|-------------|-------------------|
| 1. wander | 6. neuston | 11. diatoms |
| 2. plants | 7. oxygen | 12. zoea |
| 3. zooplankton | 8. benthos | 13. nannoplankton |
| 4. holoplanktonic | 9. epifauna | 14. macroplankton |
| 5. meroplanktonic | 10. infauna | 15. oxygen |

Fish Parts I.D.

- | | |
|---------------------|-----------------|
| 1. eye | 6. anal fin |
| 2. lateral line | 7. scales |
| 3. spiny dorsal fin | 8. pelvic fin |
| 4. soft dorsal fin | 9. pectoral fin |
| 5. caudal fin | |

Guess What Fish I Am

- | | |
|-----------------|-----------------------|
| 1. tarpon | 6. vermillion snapper |
| 2. gag grouper | 7. sheepshead |
| 3. bluefish | 8. spotted sea trout |
| 4. ling (cobia) | 9. black drum |
| 5. pompano | 10. Spanish mackerel |

Commercially and Recreationally Important Species

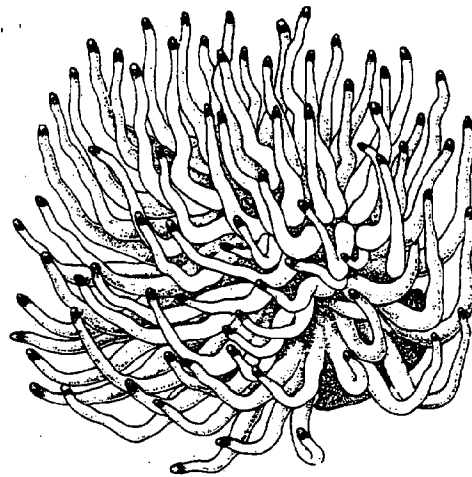
1. 2-3; 2. 7-13; 3. rocks; 4. ling; 5. smallest; 6. 130; 7. molluscs; 8. oyster bars; 9. 20; 10. 2

Review Quiz

- I. 1. zooplankton, phytoplankton; 2. meroplankton; 3. benthic, sea star; 4. lateral line; 5. tarpon, swim bladder
- II. 6. T; 7. T; 8. F; 9. F; 10. T

Plankton Roundup Activity

- | | |
|-----------------|-----------------------|
| 1. crab zoea | 6. blue-green algae |
| 2. copepod | 7. polychaete worm |
| 3. sea star | 8. fish egg |
| 4. oyster larva | 9. by-the-wind sailor |
| 5. diatom | 10. dinoflagellate |



Sea Anemone

LESSON IV SCRIPT

Introduction:

Thus far we have been learning about what an estuary is and how humans depend on estuarine systems. We have also studied human impacts on the estuarine system through pollution and multi-use demands. This lesson of Project Estuary will focus on the organisms that inhabit an estuarine system. In particular the plankton, the bottom dwellers, and the fish. First, we will be concentrating on the plankton and bottom dwellers and then later on the fish.

PLANKTON AND BENTHIC ORGANISMS IN THE ESTUARY

The first part of this activity is a listening and note-taking skills activity to let you test yourself on how well you listen and take notes for a portion of text that I will read to you. After the reading you will have a chance to answer some questions about estuarine organisms.

**** Teacher's Note:** Read the narrative about plankton and benthic organisms then pass out the listening skills portion of the student activity pages. This portion of the activity should take approximately 20 minutes. Following this, run through the answers to the questions and have the students grade themselves on the following scale (90 % or better: you have the ears of a bat! you listen extremely well) (70-90 %: have the ears of a cat, you hear well but don't always respond!) (50-70 %: you may be able to avoid a collision with a 747, if it's still at the gate!) (below 50 %: don't apply for a position as a telephone operator!).

Narrative for Listening Skills Test

Plankton and Benthic Organisms of the Estuary

It is estimated that 98% of the ocean's living material is planktonic. Plankton are mostly microscopic marine organisms. The word "plankton" comes from the Greek root "planktos," meaning "to wander." They are the ocean's free-floating organisms that are either plants or animals.

The planktonic plants, or phytoplankton, live near the water's surface. There are two groups that make up the bulk of the ocean's phytoplankton. They are diatoms and dinoflagellates. Diatoms, also known as the golden-brown algae, are housed in tiny, perforated glass shells of many beautiful and different shapes.

Dinoflagellates are double-flagellated organisms (flagella are small whip-like organelles). Dinoflagellates are very abundant with as many as five million in one litre of sea water. The ocean's phytoplankton produce 80% of the earth's oxygen.

The planktonic animals are called zooplankton. The zooplankton are broken into two different groups. The zooplankton that spend all of their life as part of the plankton are known as holoplankton. Copepods are holoplankton, they are the world's most abundant animals with more individuals than any other order. Plankton that spend only part of their life as plankton (the larval stage) are called meroplankton. Larval stages of shrimp, crab, and fish are an example of meroplankton. Some planktonic organisms never leave the top few inches of water. They are called neuston. The phytoplankton would fall in this group. Phytoplankton transform the sun's energy and dissolved ocean nutrients into useable food, create a large portion of the earth's oxygen, and form the base of the ocean's food webs.

Marine life is divided into three groups based on where they live in the marine environment. Organisms that live in or on the bottom, such as sea grasses or crabs, are called the benthos. Strong-swimming animals that live in the open water, such as squid and many adult fish, are called the nekton. The third group are the plankton, the drifters of the ocean.

Nearly 16% of all living marine animal species are benthic. Benthic animals that live on the ocean bottom on rocks, shells, seaweed, pilings, etc. are called the epifauna. Animals that live buried in the bottom, such as clams, tube worms, some types of shrimp, etc. are known as the infauna.

The larvae of benthic animals are an extremely important component of the meroplankton. It is estimated that 75% of the types of benthic invertebrates have a planktonic larval stage. One of these larval stages for a crab is known as a zoea. Each animal may produce millions of eggs per year, yet only one or two will survive to adulthood. Most will be eaten before settling to the bottom.

Zooplankton can be further classified according to size. Nannoplankton are between 5/1000ths and 60/1000ths of a mm and include protozoans, unicellular animals that feed on phytoplankton and eat other zooplankton. Microplankton are between 60/1000ths and 1 mm in size and are made up primarily of eggs and larvae of invertebrates. Macroplankton include mainly the large jelly fishes and their relatives such as the Portuguese man-o-war and the by-the-wind sailor, which move at the mercy of the currents and winds.

**** Teacher's Note: After the listening skills activity, allow the students to complete the plankton matching activity then go over answers with them.**

FISH IN THE ESTUARINE SYSTEM

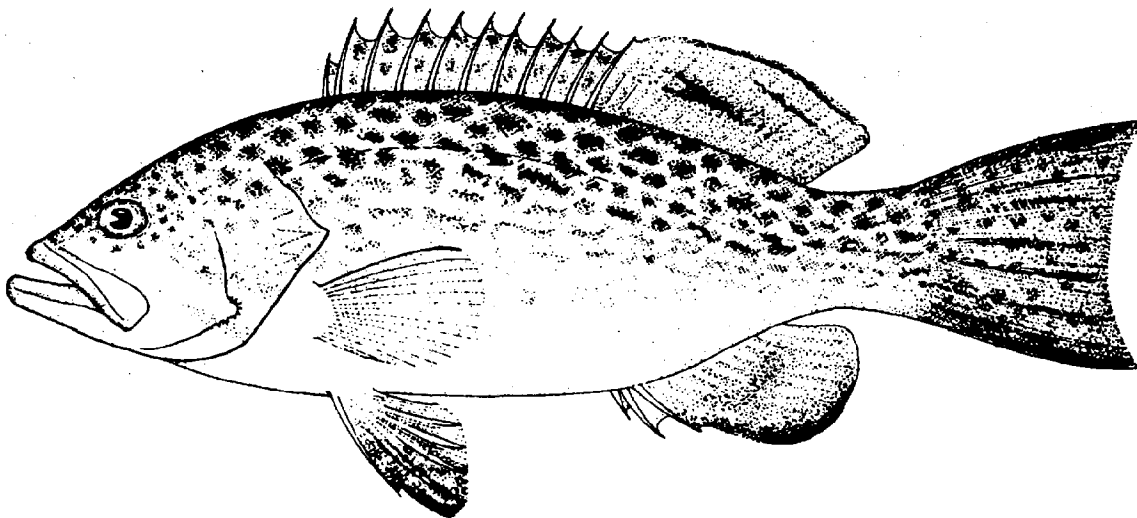
This portion of Lesson IV focuses on the roles that fish play in the estuarine system. The tremendous diversity in form and function of fish species inhabiting the estuary provides much more information than we can cover in this one period, so we will be limiting the discussion to three main topics:

1. Basic Fish Anatomy
2. Types of Fishes in an Estuary
3. Important Commercial and Recreational Species

**** Teacher's Note:** Pass out the student activity page with the "Parts of a Fish" and help the students fill in the blanks from the given list of fish body parts. Do this part of the activity in about 10 minutes.

Next, review the "Guess What Fish I Am" page by going over the worksheet portion with this title. Have the students try to guess the kinds of fish described in the given clues and write their answers on their answer sheet.

Finally, have the students read the information associated with the "Commercially and Recreationally Important Species" and answer the fill-in-the-blank questions at the end of that section.



Scamp Grouper

FOLLOW-UP ACTIVITIES

1. Have students research the life history of particular fish species and create a class library from their reports.
2. Go on a sampling field trip at the Reserve or other facility to discover the rich diversity of marine life first-hand.
3. Have your class study fisheries research techniques such as age determination, creel surveys, population management techniques, etc.

MORE DISCUSSION QUESTIONS

Use these thought provoking questions to stimulate more discussion regarding plankton, benthic organisms and fish of the estuary.

1. If higher vertebrates were removed from the estuary it would affect relatively few total organisms. What if all plankton were removed? Make a list.
2. What causes bottom sediments to be different in different parts of the bay? (clay, sand, etc.)
3. Research the effect of sedimentation on various benthic organisms.
4. Why are dinoflagellates considered to be phytoplankton?
5. How does a shark maintain bouyancy without a swim bladder?
6. What would a fish have to count on if it lost its lateral line?
7. Which has more impact on fisheries resources, commercial or recreational fishing? Be sure to consider many aspects such as pollution, depletion, etc.
8. How do size limits on a fisherman's catch help a fish population?

**STUDENT PERFORMANCE STANDARDS
COVERED IN LESSON IV OF PROJECT ESTUARY
(For Grades 9-12)**

Biology I: 1.02, 1.03, 1.05, 1.08, 2.04, 7.03, 11.01

Fundamentals of Oceanography: 1.11, 1.12, 6.01, 6.04, 6.05, 6.07, 7.02

Oceanography: 1.11, 4.02, 5.06, 10.01

**CURRICULUM FRAMEWORKS COVERED IN
LESSON IV OF PROJECT ESTUARY
(For Grades 6-8)**

M/J Earth/Space Science: 1., 2., 16.

M/J General Science: 1., 2., 4., 6.

M/J Life Science: 1., 2., 6., 7.

M/J Comprehensive Science I: 1., 2., 5.

M/J Comprehensive Science II, Basic: 1., 2., 3., 5., 6., 9.

M/J Comprehensive Science II: 1., 2., 3., 5., 6., 9.

M/J Comprehensive Science III, Basic: 1., 2.

M/J Comprehensive Science III: 1., 2.

LESSON IV STUDENT ACTIVITY PAGES

LISTENING AND NOTE-TAKING SKILLS TEST

Directions: Following the reading, answer as many of these questions as possible about plankton and benthic organisms.

1. The Greek root "planktos" describes how microscopic plankton move. Planktos means to _____.
2. Phytoplankton live near the waters surface, they are tiny _____.
3. The planktonic animals are called _____.
4. The zooplankton that spend all of their life as plankton are called _____.
5. The zooplankton that spend part of their life as plankton are called _____.
6. The planktonic organisms that never leave the top few inches of water are called _____.
7. Phytoplankton performs three basic functions, it produces usable food, forms the base of the oceans food web and creates a large portion of the earth's _____.
8. Marine life can be divided into three basic categories. Nekton, plankton and _____.
9. Animals that live on the ocean's bottom on hard surfaces are called _____.
10. Animals that live buried in the ocean's bottom are known as _____.
11. There are two main types of phytoplankton. They are dinoflagellates and the golden-brown algae called _____.
12. The larval stage for a crab is called a _____.
13. Zooplankton have been classified into sizes. The smallest is called _____.
14. The largest zooplankton class size is called _____.
15. It is estimated that phytoplankton produce 80 percent of the earth's _____.

PLANKTON ROUNDUP ACTIVITY

Directions: Try to match the plankton pictures and brief descriptions with the list of possible answers below.

**oyster
fish egg**

**polychaete worm
dinoflagellate**

**diatom
crab**

**copepod
sea star**

**blue-green algae
by-the-wind sailor**

1.



I shed my shell as I grow and I have two big claws as an adult.

2.



I am found in the holoplankton group and I am the worlds most abundant plankton animal.

3.



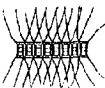
I generally have five radial arms and I am a benthic animal.

4.



I grow into one of the main shellfish harvested from the benthic substrate of the bay.

5.



I am a phytoplankton that is also known as the golden-brown algae.

6.



I help produce 80 percent of the earth's oxygen and am at the beginning of the ocean food web.

7.



I am a zooplankton that is considered part of the infauna.

8.



I develop into a strong swimmer and am a part of the nekton environment.

9.



I become megaplankton in size and am at the mercy of the wind and waves.

10.

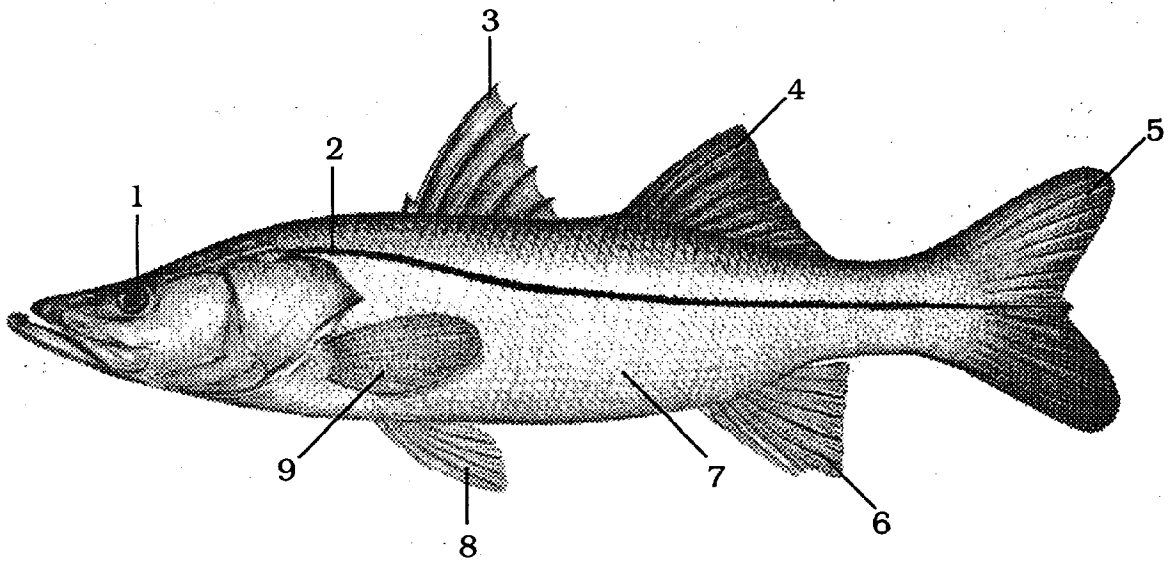


I am a phytoplankton that has a flagella and am nanoplankton in size.

FISH PARTS I.D.

Directions: See if you can identify the numbered parts on this fish. Choose your answers from the given list of parts below.

- | | | | |
|---|--|-----------------------------------|---------------------------------------|
| <input type="checkbox"/> caudal fin | <input type="checkbox"/> lateral line | <input type="checkbox"/> anal fin | <input type="checkbox"/> pectoral fin |
| <input type="checkbox"/> spiny dorsal fin | <input type="checkbox"/> pelvic fin | <input type="checkbox"/> scales | <input type="checkbox"/> eye |
| | <input type="checkbox"/> soft dorsal fin | | |



Common Snook

GUESS WHAT FISH I AM

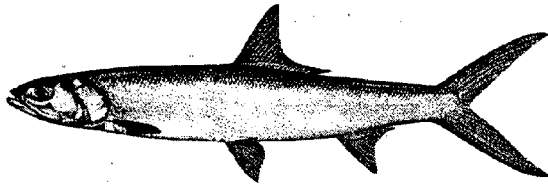
Directions: Try to figure out which fish best matches the given set of clues. There is only one best answer for each clue set. Choose your answers from the list below.

bluefish	sheepshead	gag grouper	spotted sea trout
black drum	tarpon	Spanish mackerel	ling (cobia)
vermillion snapper	pompano		

1. I am sought after by recreational fishermen. The last ray of my dorsal fin is extended into one long filament. I am silver in color.
2. I am caught by long line commercial and recreational fishermen. I am a reef dwelling fish and I'm good to eat.
3. I have very prominent sharp teeth and migrate in large schools. I'm an aggressive feeder.
4. People hold recreational fish catching contests for me in the Spring. My lower jaw sticks out past my upper jaw and I can grow to over 100 pounds.
5. I am commercially and recreationally caught, mostly in the surf. I am greenish-gray on the top and have silver sides. I have a deep flattened body with a small mouth.
6. My entire body is reddish with diagonal blue lines. I am caught near reefs.
7. I am found near seawalls. I am silver with 5 to 6 vertical black bands on my sides. A favorite bait for me is fiddler crabs.
8. I have black spots on my back. I live mainly in the estuary and feed on shrimp and small fish in the grasses and around oyster bars.
9. I am gray or black in color. I have 10 to 14 pairs of chin barbels and have cobblestone-like teeth that can crush oysters.
10. I have golden-yellow spots along my sides. I'm green dorsally, shading to silver. I migrate in schools offshore, during spring and summer. I have oily meat.

COMMERCIAL AND RECREATIONALLY IMPORTANT FISH SPECIES

Directions: Look over the information provided with each fish pictured below and answer the fill-in-the-blank questions at the end of this section.



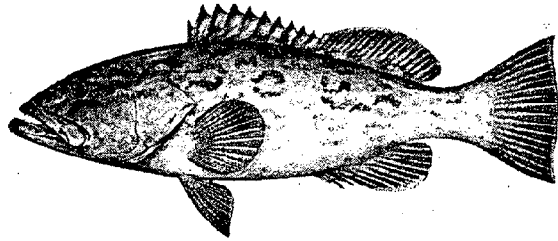
LADYFISH

Description: terminal mouth; slender body; small scales; head small and pointed.

Where found: INSHORE fish, in mays and estuaries; occasionally enter freshwater, often forms large schools and harasses bait at the surface.

Size: 2 to 3 pounds.

Remarks: adults feed predominantly on fish and crustaceans; leaps when hooked.



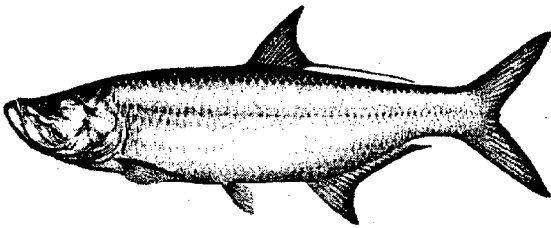
GAG GROUPE

Description: brownish gray in color with dark worm-like markings on sides and often confused with black grouper.

Where found: adults OFFSHORE over rocks and reefs.

Size: common to 25 pounds.

Remarks: forms spawning aggregations in water no shallower than 120 feet; young gags are predominantly female, transforming into males as they grow larger; feeds on fish and squid.



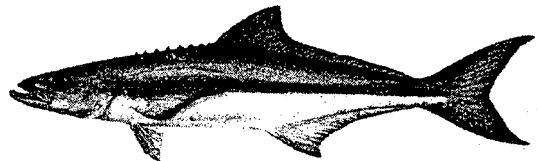
TARPON

Description: last ray of dorsal fin extended into long filament; back blue to green or greenish black, shading into bright silver on the sides; huge scales.

Where found: primarily INSHORE fish, al though adult fish spawn OFFSHORE.

Size: most angler catches 40-50 pounds.

Remarks: can tolerate wide range of salinity; feeds mainly on fish and large crustaceans.



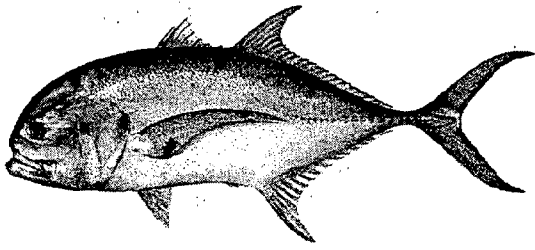
COBIA (LING)

Description: long, slim fish with broad depressed head; dark lateral stripe extends through eye to tail.

Where found: both INSHORE and NEARSHORE inhabiting inlets, bays, and among mangroves.

Size: common to 30 pounds

Remarks: feeds on crabs, squid, and small fish.



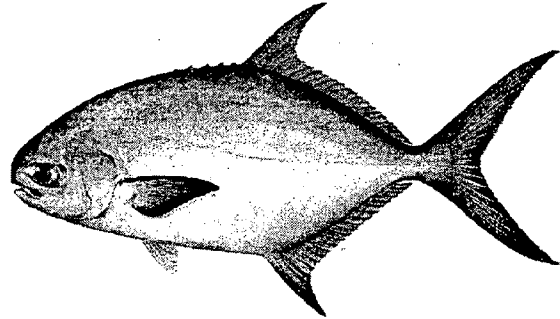
CREVALLE JACK

Description: color bluish-green to greenish-gold back and silvery or yellowish belly; prominent black spot on operculum (gill cover).

Where found: common in both INSHORE waters and the open sea.

Size: usually 3 to 5 pounds.

Remarks: tolerates a wide range of salinities; feeds mainly on small fish.



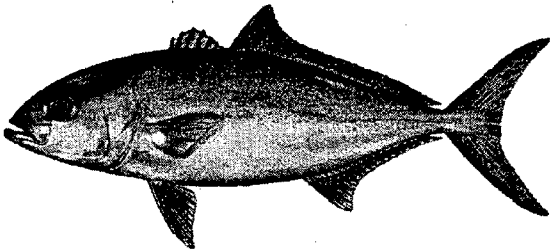
FLORIDA POMPANO

Description: greenish gray on back, shading to silvery sides; deep flattened body with small mouth.

Where found: INSHORE and NEARSHORE waters, especially along sandy beaches, oyster bars, and over grass beds.

Size: usually less than 3 pounds.

Remarks: spawns OFFSHORE between March and September; feeds on mollusks and crustaceans, especially sand fleas.



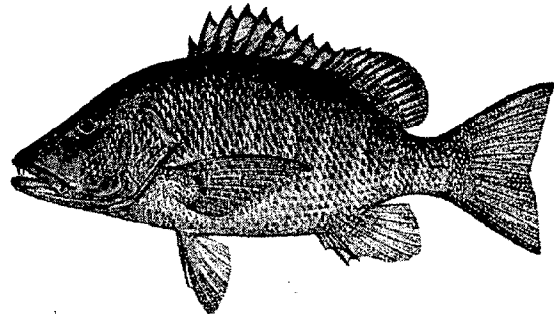
LESSER AMBERJACK

Description: olive green or brownish back and silver sides; dark band (variably present) extends backward and upward from eye.

Where found: NEARSHORE and OFFSHORE (commonly 180-410 feet deep)

Size: usually under 10 pounds.

Remarks: smallest of the amberjacks.



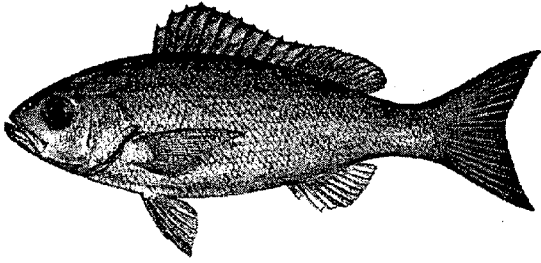
SCHOOLMASTER

Description: color olive gray on upper sides with yellow tinge; long triangular snout.

Where found: juveniles in grass flats; adults NEARSHORE.

Size: usually less than 1 pound.

Remarks: feeds on crustaceans, small fishes, and gastropods.



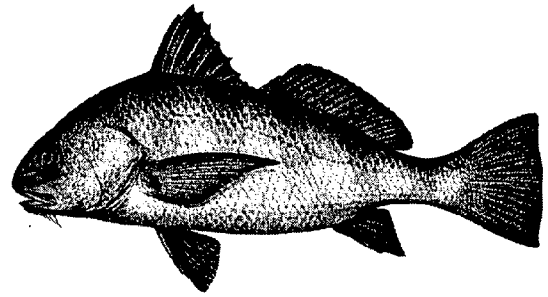
VERMILLION SNAPPER

Description: color of entire body reddish, with a series of short, irregular lines on its sides, diagonal blue lines formed by spots on the scales above the lateral line.

Where found: suspends at mid-depths over rocky reefs OFFSHORE.

Size: usually less than 1 pound.

Remarks: feeds on small, swimming crustaceans and mollusks.



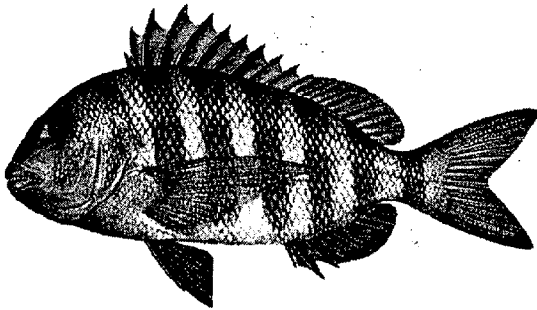
BLACK DRUM

Description: high arched back; 10 to 14 pairs of chin barbels; gray or black colored body in adults.

Where found: INSHORE fish common to bays and lagoons.

Size: common to 30 pounds.

Remarks: largest member of the drum family; feeds on oysters, mussels, crabs, shrimp, and occasionally fish.



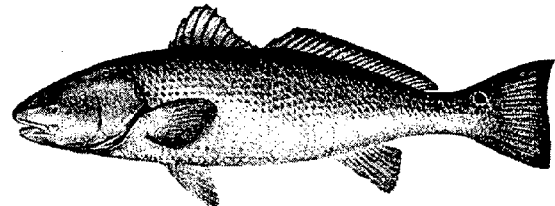
SHEEPSHEAD

Description: basic silvery color, with 5 or 6 distinct vertical black bands on sides, prominent teeth, including incisors, molars, and rounded grinders.

Where found: INSHORE species around oyster bars, seawalls and in tidal creeks.

Size: INSHORE, 1 to 2 pounds; OFFSHORE, common to 8 pounds.

Remarks: feeds on mollusks and crustaceans such as fiddler crabs and barnacles.



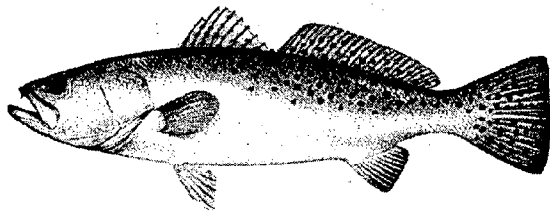
RED DRUM (REDFISH)

Description: chin without barbels; copper-bronze body, one to many spots at base of tail (rarely no spots).

Where found: juveniles are an INSHORE fish, migrating out of the estuaries at about 30 inches (4 years).

Size: one of 27 inches weighs about 8 pounds.

Remarks: feeds on crustaceans, fish, and mollusks.



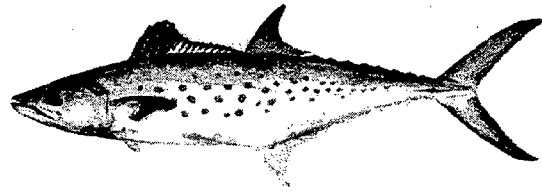
SPOTTED SEATROUT

Description: dark gray or green above, with sky-blue tinges shading to silvery and white below; numerous distinct round black spots on back.

Where found: INSHORE and/or NEARSHORE over grass, sand, and sandy mud bottoms.

Size: common to 4 pounds on west coast, larger on east coast.

Remarks: adults feed mainly on shrimp and small fish.



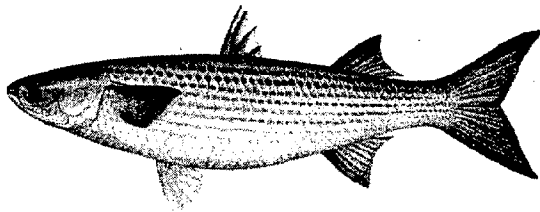
SPANISH MACKEREL

Description: color of back green, shading to silver on sides, golden yellow irregular spots above and below lateral line.

Where found: INSHORE, NEARSHORE, and OFFSHORE, especially over deep grass beds and reefs.

Size: average catch less than 2 pounds (20 inches).

Remarks: schooling fish that migrates northward in spring; feeds on small fish and squid.



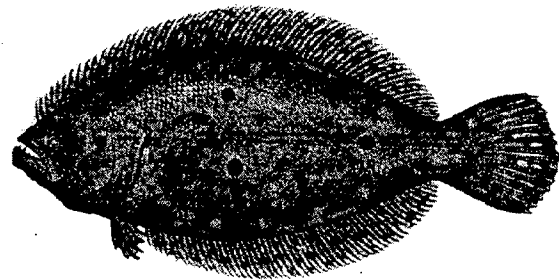
STRIPED MULLET

Description: color bluish-gray or green above, shading to silver on sides, with indistinct horizontal black barrings, white below.

Where found: INSHORE

Size: roe mullet common to 3 pounds, but in aquariums known to reach 12 pounds or more.

Remarks: feeds on algae, detritus, and other tiny marine forms.



GULF FLOUNDER

Description: body color brown, its shade depending on color of bottom, with numerous spots and blotches; 3 prominent eye-like spots forming a triangle.

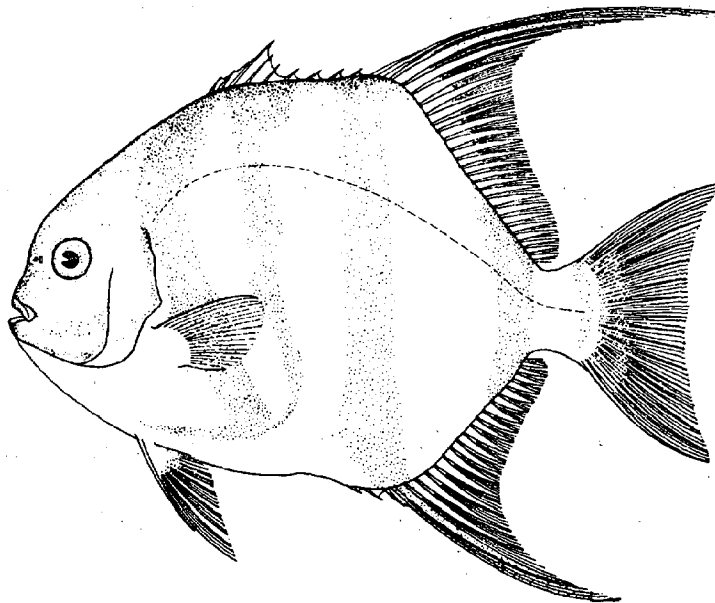
Where found: INSHORE on sandy or mud bottoms.

Size: common to 2 pounds.

Remarks: hatches into usual fish form, but right eye migrates over to left side early in life; feeds on crustaceans and small fishes.

FILL-IN-THE-BLANK

1. The ladyfish normally ranges from _____ to _____ pounds in weight.
2. Tarpon are slow growers and require _____ to _____ years to mature.
3. Gag groupers need habitat of _____ and reefs offshore.
4. Another name for the cobia is the _____.
5. The lesser amberjack is the _____ of the amberjacks.
6. Pompano may be found in water as deep as _____ feet.
7. The vermilion snapper feeds on small crustaceans and _____.
8. Sheepshead live around _____, seawalls and tidal creeks.
9. Red drum may live to be _____ years old or more.
10. The Gulf flounder is usually about _____ pounds in weight.



Atlantic Spadefish

VOCABULARY FOR LESSON IV

Analfin: Pertaining to the lower surface of a fish near the anal region.

Benthic: Referring to the bottom of a water body.

Benthos: The organisms living in or on the ocean bottom.

Caudal: The tail or posterior end of an organism.

Diatom: Any of a class of planktonic one-celled or colonial algae with skeletons of silica.

Dinoflagellates: Any of an order of planktonic plant-like flagellates (possessing a whip-like flagella) of which some cause red tide.

Dorsal: The upper surface of an animal. In chordates (animals possessing a spinal cord), the upper or back surface.

Epifauna: Benthic animals that live on the bottom, either attached to the substrate or crawling on the bottom.

Holoplankton: Planktonic organisms that spend their entire lives drifting in the water.

Infauna: Benthic organisms that live within the sediments on the bottom.

Lateral-line: A system of vibration detectors on most fishes. In most instances, the lateral-line is seen as a prominent mark along the sides of fishes.

Macroplankton: The largest class of plankton including jellyfishes.

Meroplankton: Planktonic organisms that spend only part of their lives as plankton.

Nannoplankton: Plankton between 5/1000ths and 60/1000ths of a mm in size.

Nauplius: The first planktonic larval stage of barnacles and some other crustaceans, which developed from a fertilized egg.

Nekton: Strong swimming animals living in the open water.

Neuston: Small organisms living on or near the water surface.

Pectoral: Pertaining to the upper thoracic region, or breast (see fish diagram p. 64).

Pelvic: Pertaining to the posterior girdle and paired appendages of vertebrates (see fish diagram p. 64).

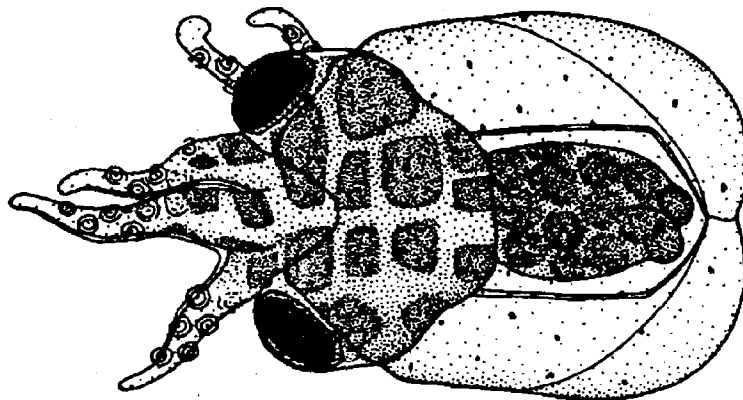
Phytoplankton: Plant plankton.

Plankton: Organisms that drift in the ocean because they either do not swim or are too small to resist ocean currents (also called ocean wanderers). Many commercially important species such as fish, crabs and oysters, spend part of their life as plankton.

Swim Bladder: A gas-filled structure in bony fishes that is used to regulate buoyancy.

Zoea: An early form of some crustacean larvae such as crabs.

Zooplankton: Planktonic animals.



Juvenile Octopus

REVIEW QUIZ FOR LESSON IV OF PROJECT ESTUARY

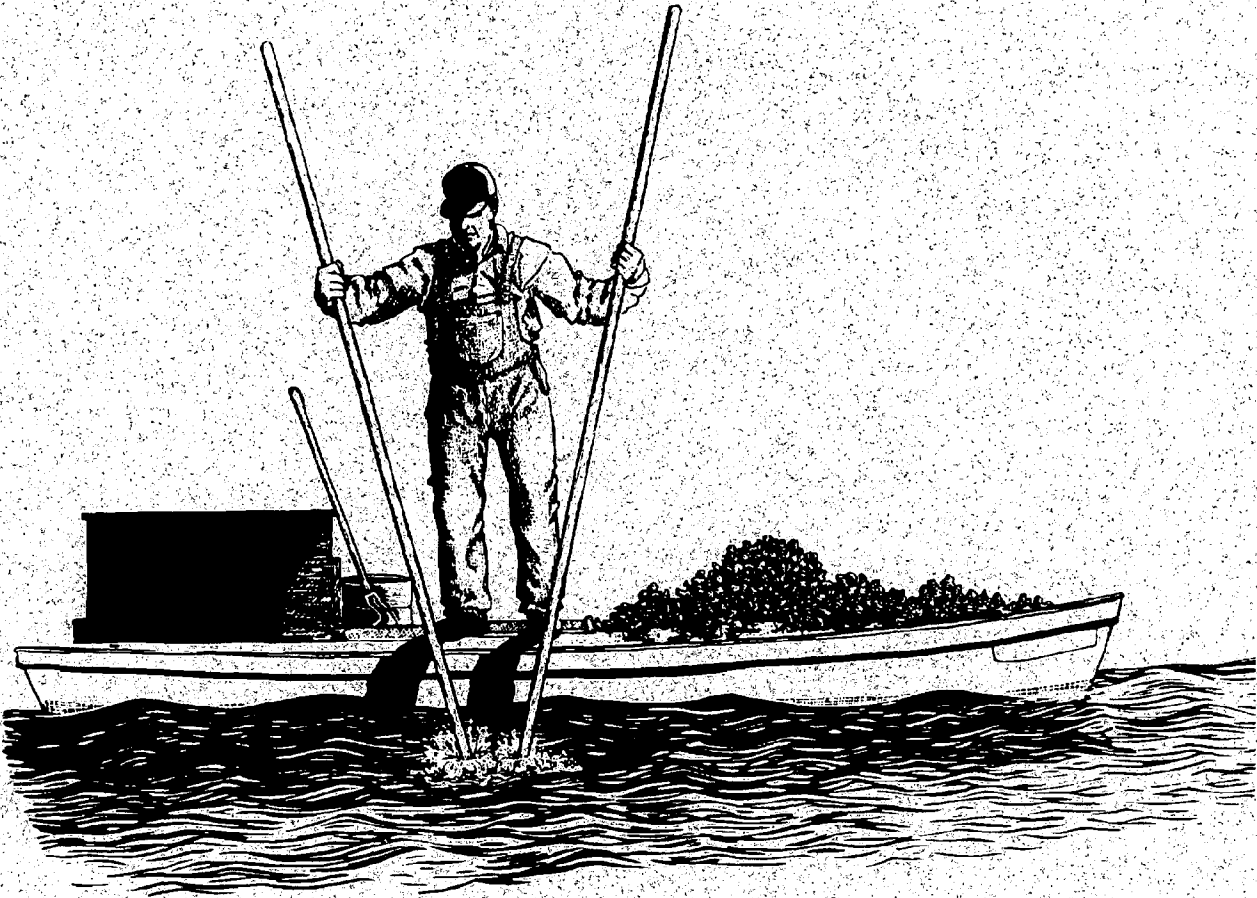
- I. Fill in the blanks with the word or words that best complete each sentence. Choose your answers from the word list below.

meroplankton sea star tarpon phytoplankton
benthic lateral line zooplankton swim bladder

1. Planktonic animals are referred to as _____ and plants as _____.
2. Animals that eventually grow out of the planktonic stage are called _____.
3. Organisms living on the bottom are called _____ organisms and one such animal is the _____.
4. Fish use their _____ to sense movement in their environment.
5. The _____ has an elongated dorsal fin ray and uses its _____ to maintain buoyancy in the water.

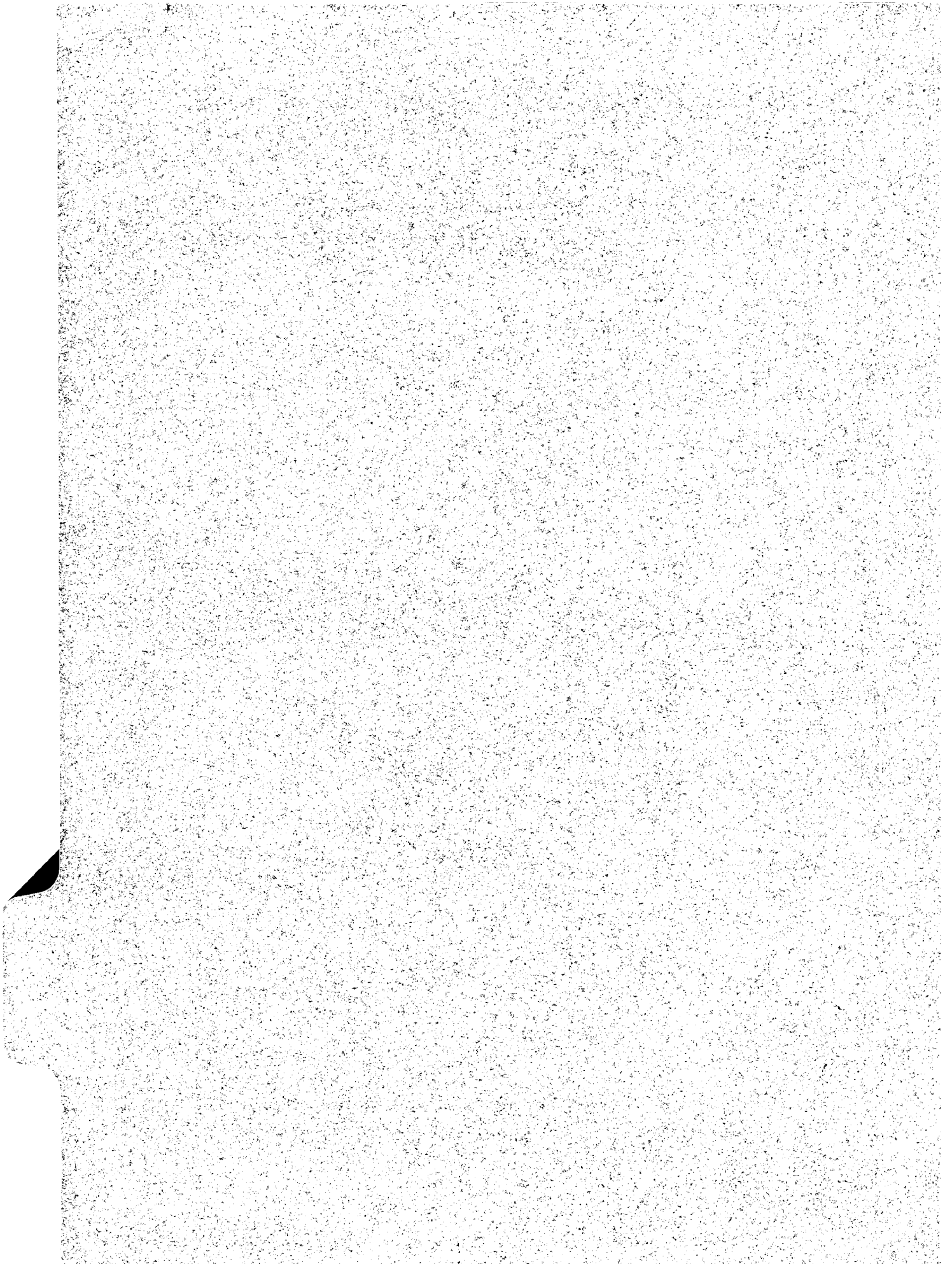
- II. Read the sentences below. Put a T before each true statement and an F before each false statement.

6. ___ Plankton make up the majority of organisms in the ocean.
7. ___ Dinoflagellates are part of the phytoplankton (plant plankton).
8. ___ Diatoms eat large quantities of fish in their diet.
9. ___ The tail on a fish is called the pelvic fin.
10. ___ Copepods are the world's most abundant animal.



Oysterman "tonging" oysters in Apalachicola Bay.

Illustration by Diane Sterling,
Northwest Florida Water Management District.



A TEACHER'S GUIDE TO LESSON V

OBJECTIVES

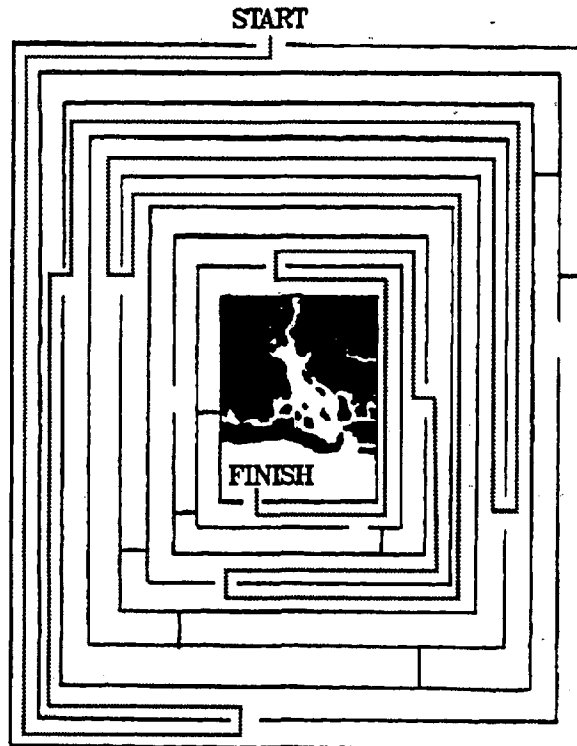
1. Students will learn many issues involved in making wise coastal management decisions.
2. Students will discover different perspectives in how coastal management decisions are made.

TIME: Approximately one 50-minute class period

PROCEDURE:

1. Begin by reviewing the vocabulary list for this lesson before proceeding with other steps.
2. Pass out role description sheets (p. 82). Assign roles to students so there are approximately the same number of students per role.
3. Pass out the BACKGROUND INFORMATION (p. 75) and PALM ISLAND MAP (p. 77) sheets to each student. Read preparatory information (TEACHER'S SCRIPT AND BACKGROUND INFORMATION) to students. Make sure each student understands what they are being asked to do.
4. Pass out the Student Activity Pages (pp. 82-84) and instruct students to begin thinking about their roles and the coastal management decision they must make. Have them use the appropriate worksheet to tally up positive and negative reasons for their group's perspective.
5. Allow 10 minutes for each group to reach a consensus about their decision on whether or not they support the bridge project.
6. Allow 2.5 minutes for each group to present their view, as well as time for each Commissioner to state why they support or do not support the bridge project. Have a vote of the Commission and discuss the results.
7. Complete Review Quiz for Lesson V.
8. Discuss answers or post answer keys to student activities and review quiz for Lesson V.

ANSWER KEYS TO LESSON V



REVIEW QUIZ

(Answers will vary, see samples below)

1. Coastal management is the process by which humans try to achieve a careful balance between the use and preservation of our coastal resources.
2. No, coastal management decisions are difficult to make because there are so many issues and interests involved in this process.
3. See last activity in FOLLOW-UP ACTIVITIES section for example issues.
4. We should all be concerned about our coastal resources because our actions have a direct effect on them.
5. We, as individuals, are all responsible for protecting our coastal resources.

LESSON V SCRIPT AND BACKGROUND INFORMATION

TEACHER'S SCRIPT

In lesson V of Project Estuary you will be playing a coastal decision game. You have been assigned one of the following roles: county commission member, developer, business owner, local environmentalist, Department of Ecology representative, seafood worker or Department of Roads and Bridges representative.

You are all residents of Pelican County. I am going to read to you some very important background information concerning the hypothetical situation in question and then I will explain to you the coastal management decision you are being asked to make. As you listen, try to connect this situation with everything we have talked about so far concerning estuaries (READ BACKGROUND INFORMATION)

You will each be put into a group with others assigned your same role. Special interest groups will then have 10 minutes to decide whether they feel the Pelican County Commission should allow the bridge to go through Palm Island and why or why not. You must balance the needs of your group with the need for resource protection. Can you come up with any possible mitigation activities?

At the end of the 10 minute period, each group will have 2.5 minutes to present their case for or against the bridge going through Palm Island, with the reason for this decision to the commissioners.

After the presentations, the commissioners will render a decision or at least give their individual views on how they will make their decision based on what they have heard.

Finally, you will have a review quiz containing short answer questions at the end of this lesson.

BACKGROUND INFORMATION

The Palm Island Bridge: A Coastal Management Decision Making Game

The Pelican County Commission must make a decision concerning the management land use of an island known as Palm Island located in Gulf Bay. Palm Island is county-owned, unpopulated and can only be reached by boat.

The Department of Roads and Bridges is planning to replace the existing two-lane Gulf River Bridge with a four-lane bridge. It has been determined through research that the present bridge has deteriorated and no longer meets safety standards or increased traffic needs. The Department of Roads and Bridges is considering routing the new bridge through Palm Island. Research has shown that the bridge would cost significantly less if built through Palm Island, the bridge must cross a productive oyster bar and several fragile salt marsh habitats. The Department has requested a recommendation from the Pelican County Commission. The commissioners have decided to hold a public hearing to listen to different views from public interests groups concerning the bridge project and its possible impacts on Palm Island and Gulf Bay (an estuary).

Palm Island is located a few hundred yards south of the mouth of the Gulf River. Palm Island is 5 miles wide by 12 miles long (see map on next page). It is one of two undeveloped islands within Gulf Bay. Surrounding it are salt marshes and submerged seagrass beds. To the west is the Intracoastal Waterway Channel with a minimum depth of 9 feet.

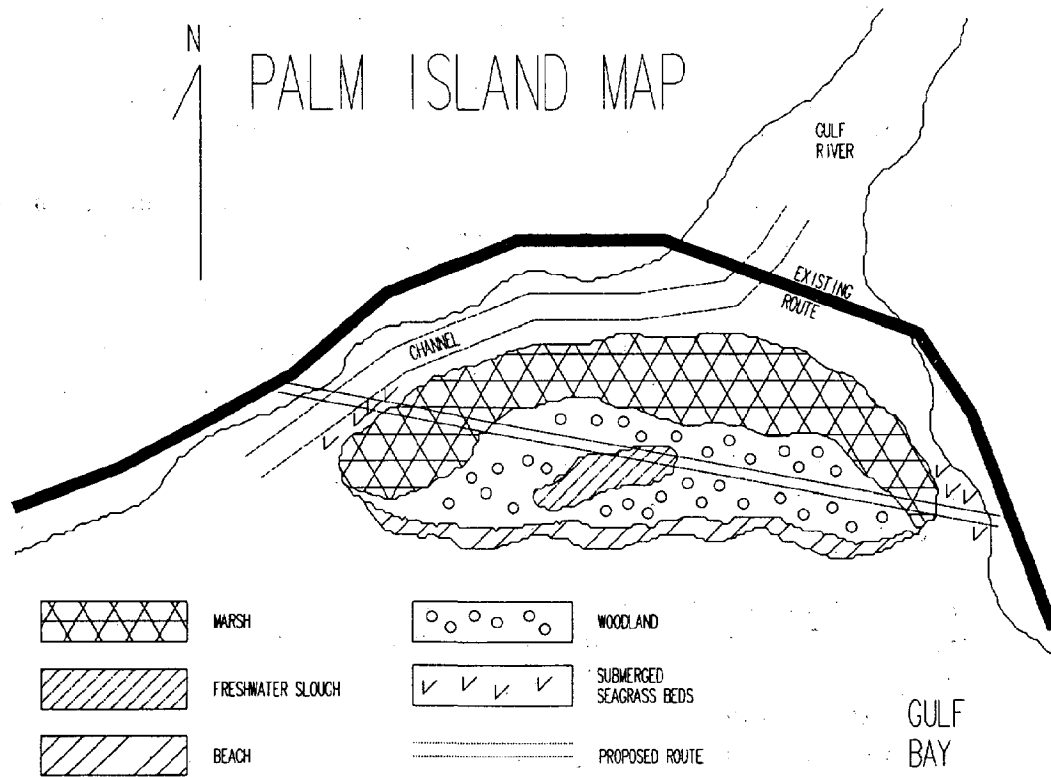
Palm Island contains several distinct habitats: beaches and berms, woodlands, fresh water marshes and sloughs, salt marshes and submerged seagrass beds.

The marshes provide protection for young animals, many of which become commercial seafood products. The marshes also control flooding, serve as a storm buffer, and filter pollution from the water; all of which directly benefit humans. The present multimillion dollar seafood industry, which includes 85% of the people employed in Pelican County, depends on the marshes, oysters bars and other natural resources.

Research has shown that a total of 40% of the original marshes surrounding Gulf Bay have been replaced by development. The marshes in question in the Palm Island plan represent 10% of the remaining marshes of Gulf Bay.

Public interest groups and government agencies in Pelican County are concerned about the benefits and problems the bridge through Palm Island could create. Construction of the bridge will provide new jobs for local people. A bridge would allow for rapid development of the island. Homes, businesses, and recreational facilities would appear in rapid succession. Which, in turn, would bring new jobs to the county, additional tax dollars, and a boost in the local economy. However, population growth requires additional services from the county such as road maintenance, adequate waste disposal and water supplies, increased fire and police protection, medical facilities, and schools. Increased population will also increase pollution going into the estuary. As development increases, a change in the local atmosphere may result as well.

Many people see a need for new development in the county, but are concerned about how and where this development occurs. Is the development of Palm Island going to be better or worse for the local community in the long run? Should the bridge be built to access the island or not?



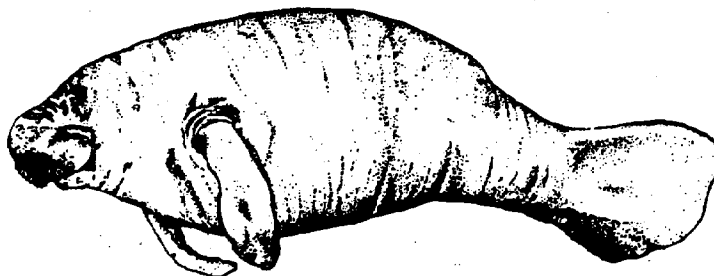
FOLLOW-UP ACTIVITIES

1. Have students change roles and hold another hearing. Compare and discuss any differences in the coastal decision-making process.
2. Below is a list of other possible roles which students may wish to use in holding another simulation game concerning the bridge project scenario:
 - Outdoorsman: Concerned about the possible effects the accessibility of Palm Island will have on the recreational resources.
 - Banker: Promotes long-term economic opportunities which would financially benefit the community.
3. Investigate local proposals for new developments. Discuss the positive and negative impacts due to one or more of these developments.
4. Visit a recent industrial or development site such as a dam, marina or shopping center. Find out what impacts or effects it has on people and the environment.
5. Below is a list of other possible role-playing issues which students may wish to use in creating a new coastal management decision simulation game:
 - :Proposal for dam construction
 - :Proposal for rezoning of property for development
 - :Proposal for marina construction
 - :Proposal for condominium construction
 - :Proposal for shopping center construction
 - :Proposal for expanded waterfront parking area
 - :Proposal for commercial fishing ban
 - :Proposal for sale of beachfront property
 - :Proposal for coastal oil exploration
6. Visit a county commission meeting and have students prepare testimony for an agenda item related to environmental concerns.

MORE DISCUSSION QUESTIONS

Use these thought provoking questions to stimulate more discussion regarding coastal management decision-making.

1. What additional information would have helped you come to a decision in Lesson V?
2. Name two or more possible positive and negative impacts on people and the environment due to the access and possible development of Palm Island.
3. How did the information about estuaries, given to you prior to Lesson V, help you with the role playing game?
4. What main considerations would the players in each different group have concerning the bridge project decision?
5. How should coastal management decisions meet the needs of people and their environment.
6. If the plan to build the bridge through Palm Island was carried out what possible mitigation activities could be implemented to prevent or lessen the damage to the estuarine area?
7. Can you suggest any plans in addition to the ones mentioned in Lesson V?
8. Is there a similar real life situation concerning development in your area? If so, how will this local development affect you and your environment?
9. Are there ways in which individuals can become involved in the coastal management decision-making process (eg., letters, phone calls, attending public meetings, writing articles, supporting organizations, etc.)?



West Indian Manatee

**STUDENT PERFORMANCE STANDARDS
COVERED IN LESSON V OF PROJECT ESTUARY
(For Grades 9-12)**

Biology I: 1.03, 1.05, 1.07, 1.08, 1.11, 1.12, 1.13, 11.01, 11.03, 12.01, 12.02, 12.05

Chemistry I: 1.03, 1.05, 1.07, 1.08, 1.11, 1.12, 1.13, 15.01

Earth/Space Science: 1.03, 1.05, 1.07, 1.08, 1.11, 1.12, 1.13, 11.01, 11.02, 13.03, 13.05, 16.03, 16.04, 18.03, 20.04, 20.07, 20.08

Ecology: 1.03, 1.05, 1.07, 1.08, 1.11, 1.12, 1.13, 2.01, 2.05, 9.01, 9.02, 9.03, 10.01, 10.02, 12.01, 12.02, 12.03, 12.04

Environmental Science: 1.03, 1.05, 1.07, 1.08, 1.11, 1.12, 1.13, 2.01, 2.03, 2.04, 2.05, 2.07, 2.08, 3.01, 3.02, 3.03, 4.01, 5.02, 6.01, 6.02, 6.03, 6.04, 7.01, 7.02, 7.03, 7.04, 8.01, 9.03, 9.04, 10.05

General Science: 1.03, 1.05, 1.07, 1.08, 1.11, 1.12, 1.13, 20.06, 21.01, 21.02, 21.06

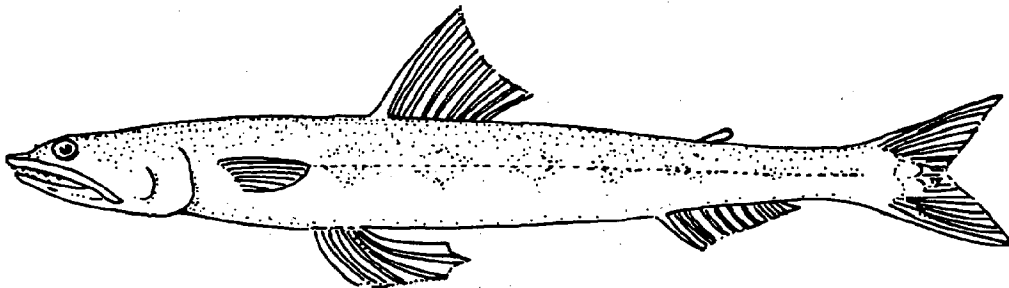
Marine Biology: 1.03, 1.05, 1.07, 1.08, 1.11, 1.12, 1.13, 3.02, 4.04, 9.01, 9.03, 9.06, 9.07, 10.03, 11.02

Fundamentals of Oceanography: 1.03, 1.05, 1.07, 1.08, 1.11, 1.12, 1.13, 6.04, 7.01, 7.02, 7.03, 8.01, 8.02, 8.04

Oceanography: 1.03, 1.05, 1.07, 1.08, 1.11, 1.12, 1.13, 4.02, 5.05, 6.01, 6.02, 10.01, 10.04, 10.05

Physics: 1.02, 1.08, 1.09, 1.10, 21.04

Zoology: 1.03, 1.05, 1.07, 1.08, 1.11, 1.12, 1.12, 9.01, 9.03, 9.04, 10.01, 10.02



Inshore Lizardfish

CURRICULUM FRAMEWORKS COVERED IN LESSON V OF PROJECT ESTUARY

(For Grades 6-8)

M/J Earth/Space Science: 1., 2., 18.

M/J General Science: 1., 2., 3., 4., 7.

M/J Life Science: 1., 2., 11., 14.

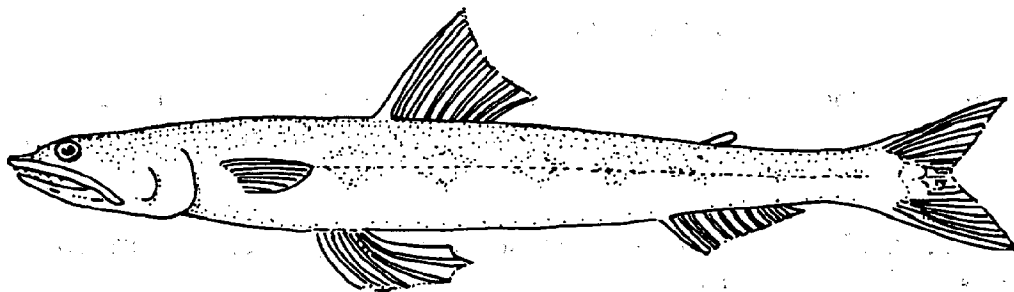
M/J Comprehensive Science I: 1., 2., 8., 12., 16.

M/J Comprehensive Science II, Basic: 1., 2., 6., 9., 17.

M/J Comprehensive Science II: 1., 2., 6., 9.

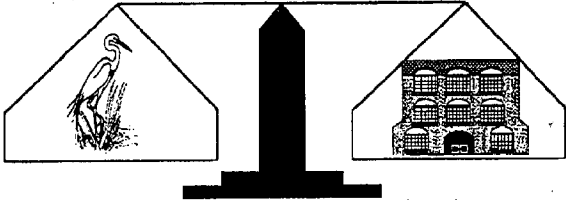
M/J Comprehensive Science III, Basic: 1., 2., 16.

M/J Comprehensive Science III: 1., 2., 16.



Inshore Lizardfish

LESSON V STUDENT ACTIVITY PAGES



COASTAL MANAGEMENT ROLE-PLAYING ACTIVITY

PLAYER	ROLE IN GAME
County Commissioner	Objectively considers all viewpoints and ideas presented and renders a decision which will balance management and protection of the coastal estuarine area with needed development which would fulfill the growth needs of the community.
Business Owner	Promotes long-term business and economic opportunities in the area. Depends on increased population to area.
Land Developer	Promotes the building and sale of facilities such as condominiums, vacation homes, office buildings and shopping centers.
Seafood Worker	Concerned about how the development of Palm Island will affect the seafood industry (habitat destruction). Depends on seafood for income.
Local Environmentalist	Concerned about the possible effects the bridge and development of Palm Island will have on wildlife and habitat. Also concerned about looks, or aesthetic appeal, of area.
Department of Ecology Representative	Promotes management of the public's natural resources. Through education, research, law enforcement, etc.
Department of Roads and Bridges Representative	Promotes development of the public's transportation routes.
Resident Sport Fisherman	Promotes recreational fishing opportunities and businesses.

PUBLIC INTEREST GROUP WORKSHEET

Directions: In order to make a case for or against the bridge going through Palm Island you must first determine the impacts this project could have on your group and its needs. Below are two columns to help your group take a stand. In column I, list the ways the project may help your group's interest. In column II, list the ways the project may hinder your group's interest. Be able to back up the group decision with impacts.

I POSITIVE IMPACTS	II NEGATIVE IMPACTS

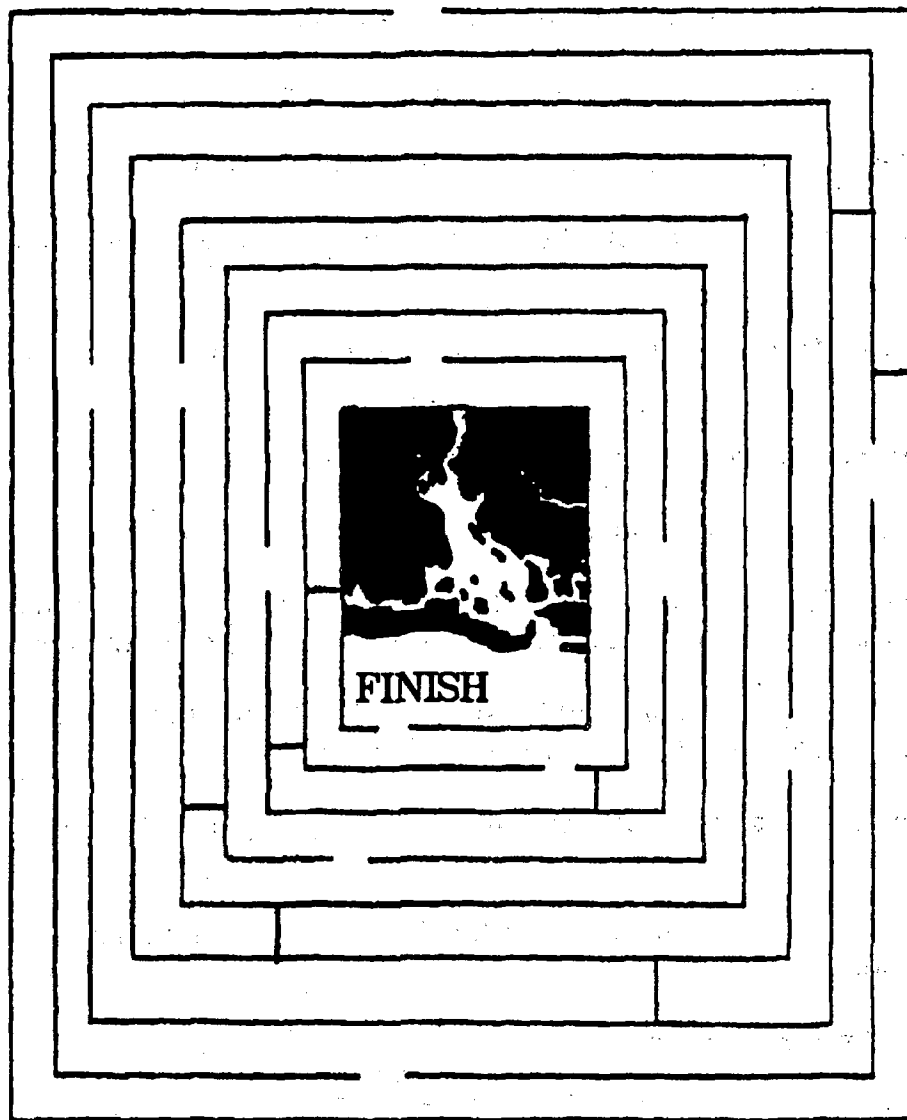
COUNTY COMMISSIONER'S WORKSHEET A BALANCING ACT

Directions: Before hearing interest group concerns you must evaluate the needs of protection and development involved with Palm Island. In your own mind you must take a stand and be able to explain your actions and decisions about the bridge project. Below are three columns to help you perform this balancing act. In column I, from what you know about estuarine systems, list types of human activities associated with the bridge project which could possibly threaten the features of the estuary. In column II list the possible impacts the activities listed in the first column could have on the estuarine area. In column III list the needs of the county which could be met by the human activities mentioned in column I.

I HUMAN ACTIVITIES	II IMPACTS	III BENEFITS TO COUNTY

THE ESTUARY MAZE

START



VOCABULARY FOR LESSON V

Access: To make use of or approach.

Agency: Office of authority, such as a government agency.

Berm: A ledge or shoulder of land along the water's edge.

Development: The action of utilizing an area for human needs.

Economy: Of or relating to the flow of money through an area.

Environment: The sum total of all external conditions which may influence organisms.

Environmentalist: A person concerned about the quality of natural surroundings.

Facilities: Buildings which serve particular purposes.

Hypothetical: An idea based on an assumed situation.

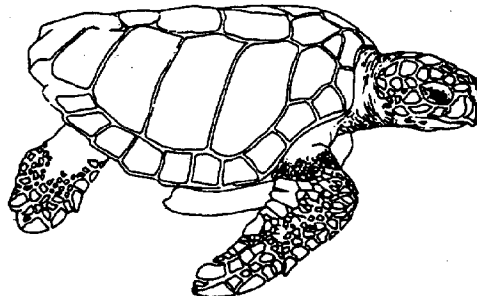
Mitigation Activities: Actions which attempt to make damages or impacts less severe or less harsh, or act as a substitute for such damages or impacts.

Management: The process of handling or controlling something such as the environment by regulating its use for certain benefits.

Public Interest Group: Several individuals who band together to promote a common cause or issue.

Slough: A wet, low area usually containing deep mud that drains across the surface of the land.

Submerged: Covered with water.

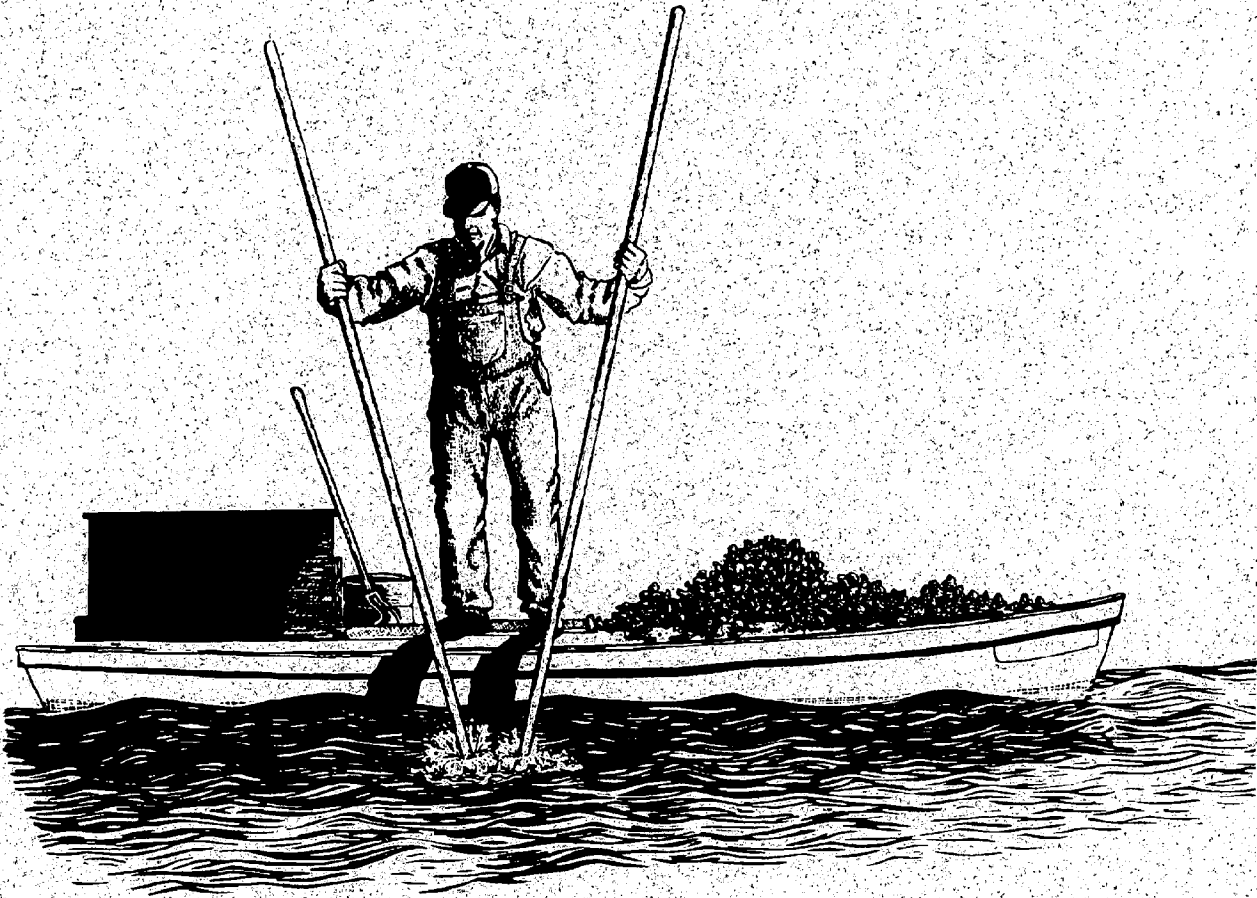


Loggerhead Sea Turtle

REVIEW QUIZ FOR LESSON V OF PROJECT ESTUARY

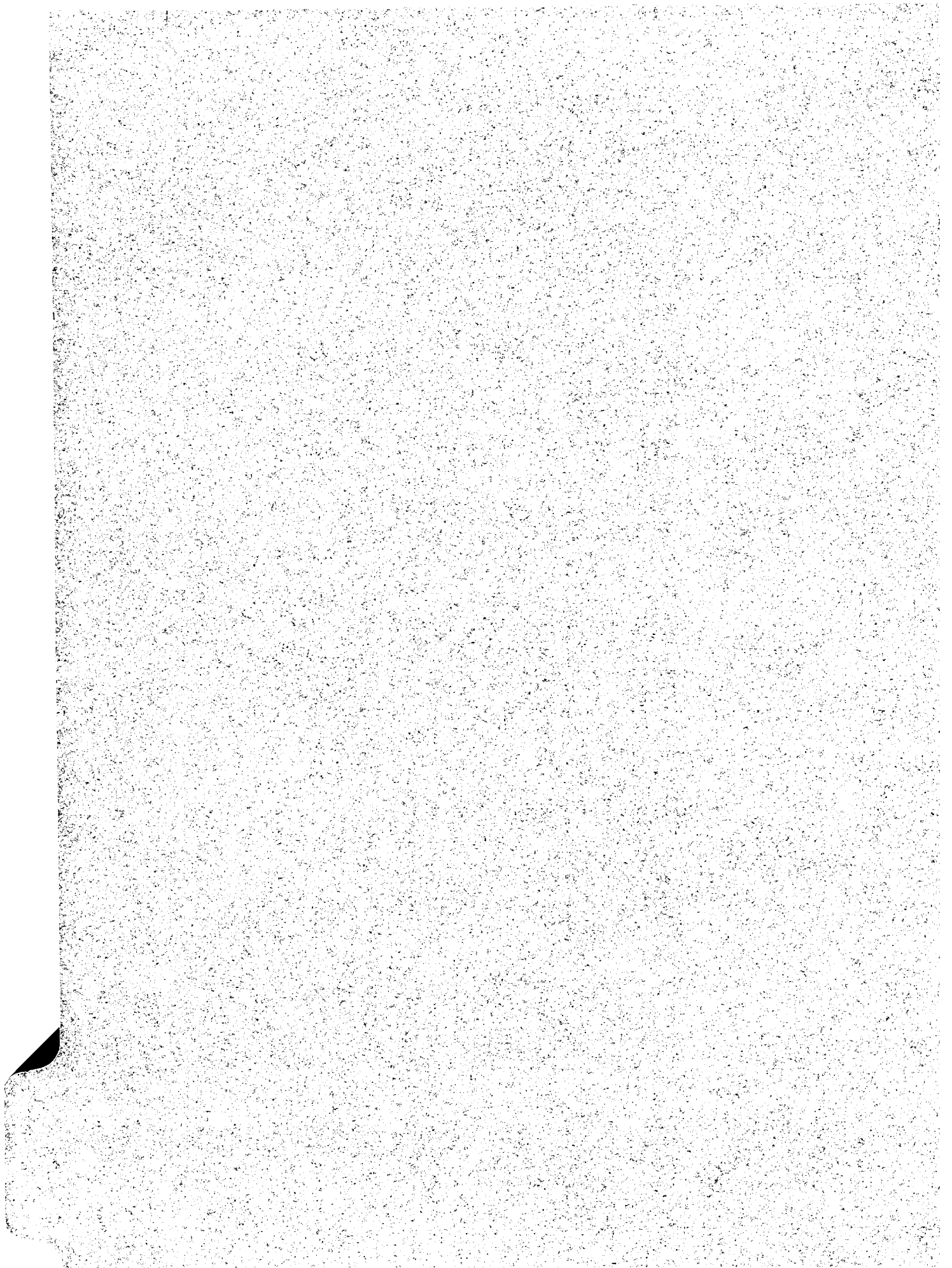
Write a brief answer for each of the following questions.

1. What is meant by coastal management?
2. Are coastal management decisions easy to make? Why or why not?
3. Give an example of a coastal management issue. Identify two or three different points of view concerning the issue.
4. Why should all of us be concerned about our coastal resources?
5. Who is ultimately responsible for protecting our coastal resources?



Oysterman "tonging" oysters in Apalachicola Bay.

Illustration by Diane Sterling,
Northwest Florida Water Management District.



APPENDIX I

ADDITIONAL MATERIALS AVAILABLE

Suggested Reading: (Not Available for Checkout)

Our Nation's Wetlands. Council on Environmental Quality. U.S. Government Printing Office, Washington, D.C., 1978.

Life In And Around the Salt Marshes. Michael J. Ursin, Thomas Y. Crowell Co., New York, 1972.

"Can We Save Our Salt Marshes?" Stephen W. Hitchcock, National Geographic Society, Washington, D.C., June 1971, pages 729-765.

The Estuary Book. Mollie Byrne and Kip Anastasiou, University of British Columbia and Province of British Columbia, Ministry of the Environment, 1981. 39 pages.

The Estuary: Exploring the Fertile Complex Realm Where The River Meets The Sea. William H. Amos, Defenders of Wildlife, Inc. Educational Supplement No. 55-4-a, 1224 19th St., N. W., Washington, D.C. 20036 1980, 50 pages.

Estuary, What A Crazy Place: Wildlife Of Coastal Waters. Lee D. Salber, National Wildlife Federation, 1979, 19 pages.

Estuary: An Ecosystem And A Resource. Oregon State University, 1984.

Resource Atlas Of The Apalachicola Estuary. Robert J. Livingston, Florida Sea Grant College Program, 1983.

Suggested Films, Filmstrips and Videos: (Available for Checkout)

VHS-04 Plankton (video) 12 min.

VHS-13 The Warm Blooded Sea: Mammals of the Deep (video) 60 min.

VHS-21 Salt Marshes - A Special Resource (video) 30 min.

VHS-24 A Swamp Ecosystem (video) 23 min.

TVV-03 The Apalachicola Experiment (video) 25 min.

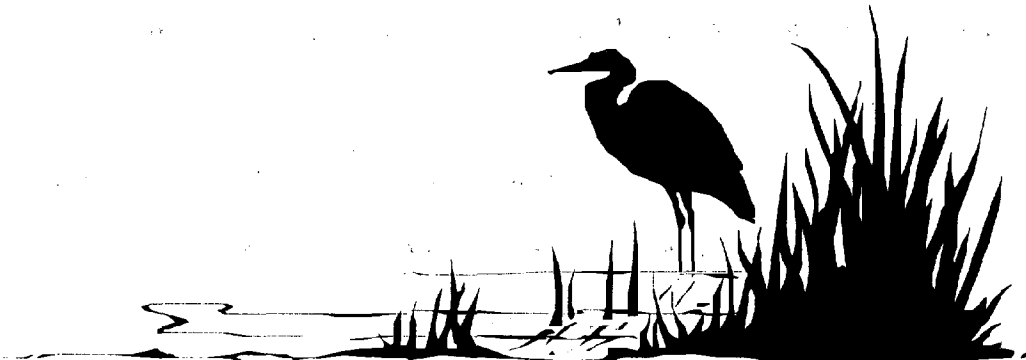
ARV-01 Franklin County Florida, "Oyster Capital of the World" (video) 33 min.

- ARV-03 Chesapeake: The Twilight Estuary (video) 40 min.
- ARV-04 "The Apalachicola System: Paradise in Trouble" (video) 23 min.
- NSA-20 Fabulous Wetlands (video) 7 min.
- FS/C-03 Fishes Of Florida (filmstrip) 10 min.
- FS/C-11 Ocean Life: Life cycles in the Sea (filmstrip) 11 min.
- FS/C-14 The Study of Seawater (filmstrip) 13 min.
- FS/C-15 Ocean Life: The Open Sea (filmstrip) 11 min.
- FS/C-18 Sea Shore Interaction of Two Communities (filmstrip) 10 min.
- FS/C-39 Using A Resource Wisely, Island Earth (filmstrip) 10 min.
- FS/C-51 To Save A Living Sea (filmstrip) 20 min.

Labs:

- LAB-01 Cobbler's Cove: A Coastal Simulation Game
- LAB-17 Breakwater and Bays Outdoor Biology Instructional Strategies, University of California

NOTE: Contact the Reserve for a full listing of available A/V materials.



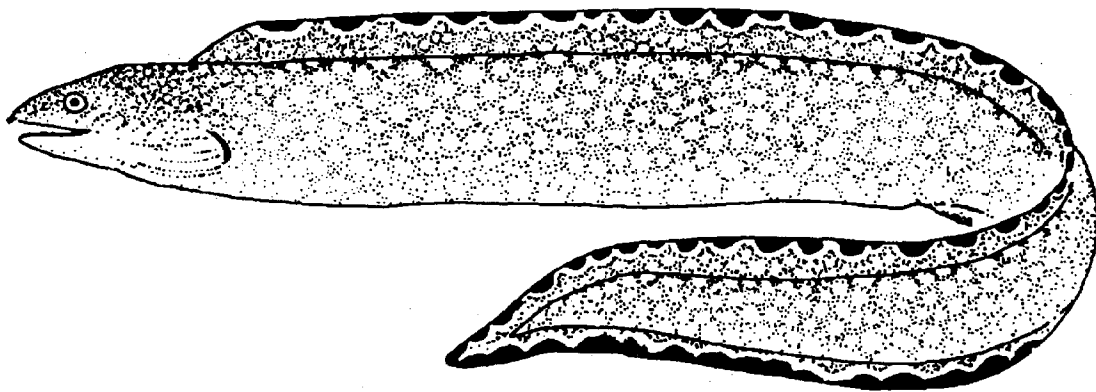
APPENDIX II

PROJECT ESTUARY FINAL EXAM

This series of questions may be used as a summary exam for the entire Project Estuary curriculum.

1. Give the name for an area where fresh water from rivers and streams meets and mixes with salt water from the sea.
2. Green plants, which convert the sun's energy into food for many organisms, are called primary _____.
3. The river supplies a vital food source to the bay which is composed of dead and decaying organic material. What is this material called?
4. Varied amounts of fresh water coming into Apalachicola Bay are dependent on what?
5. Name two industries that make use of the Apalachicola River and Bay System.
6. Name two local businesses that benefit from recreational activities in the River and Bay.
7. What industry utilizes the greatest portion of land in the Apalachicola Drainage Basin?
8. Name two groups of animals that make up a major portion of the commercial fishing industry in coastal counties associated with the Apalachicola System.
9. Name one source of pollution to the Apalachicola System.
10. List two uses of the Apalachicola Estuarine System land or water resources.
11. Stormwater runoff from urban areas or farms can be harmful to the system because it contains what?
12. Two major destructive impacts humans have on the Apalachicola System are physical assault and _____.
13. Planktonic animals are called what?

14. Planktonic plants are called what?
15. Fish sense movement around them with their eyes and their _____.
16. What is the worlds most abundant animal?
17. Organisms living on the bottom are called what?
18. Give one example of a coastal management issue.
19. Why are coastal management decisions difficult to make?
20. What is the name of this curriculum you have been studying?

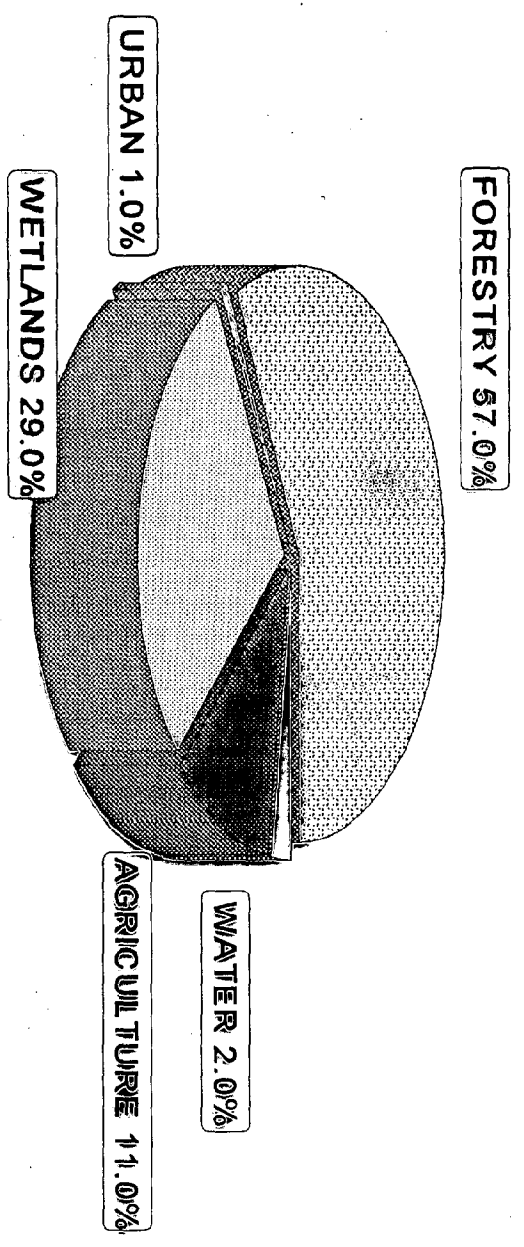


Ocellated Moray

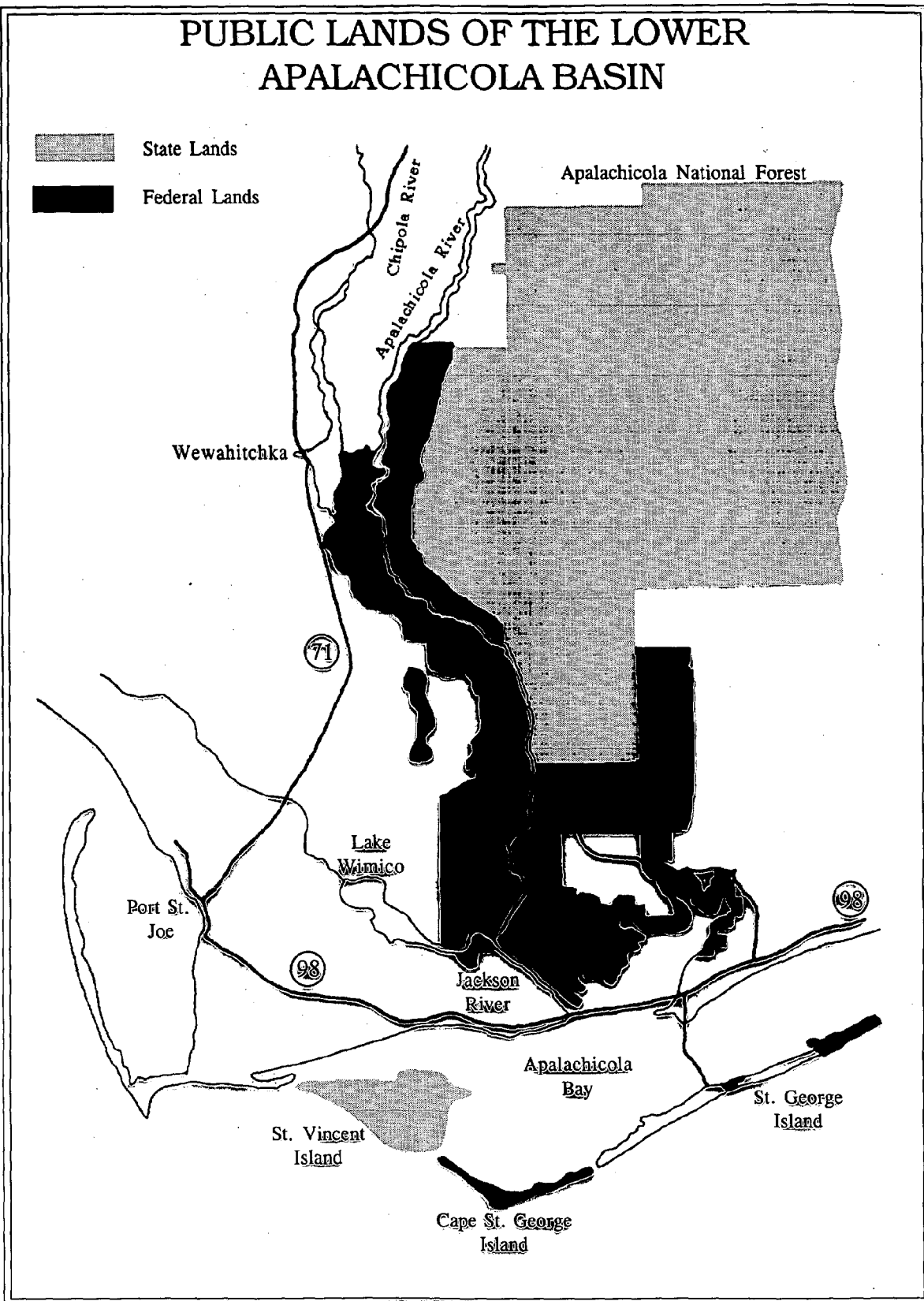
FINAL EXAM ANSWER KEY

1. estuary
2. producers
3. detritus
4. rainfall
5. answers will vary: forestry, power production, agriculture, recreation, aquaculture, commercial fishing.
6. answers will vary: restaurants, motels, gas stations, etc.
7. forestry
8. answers will vary: oysters, shrimp, crabs, finfish
9. answers will vary: oils, detergents, pesticides, fertilizers, sewage, litter, etc.
10. answers will vary: forest products, commercial fishing, recreation, power production, navigation
11. pollution
12. pollution
13. zooplankton
14. phytoplankton
15. lateral line
16. copepods
17. benthic
18. answers will vary: construction, rezoning, fishing rules, etc.
19. because so many varied interests are involved.
20. Project Estuary

HOW WE USE THE LAND OF THE APALACHICOLA RIVER AND BAY DRAINAGE BASIN



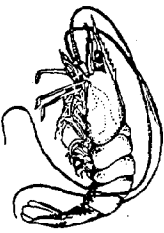
PUBLIC LANDS OF THE LOWER APALACHICOLA BASIN



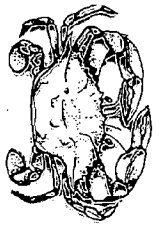
FRANKLIN COUNTY SEAFOOD VALUES



OYSTERS



SHRIMP



BLUE CRABS



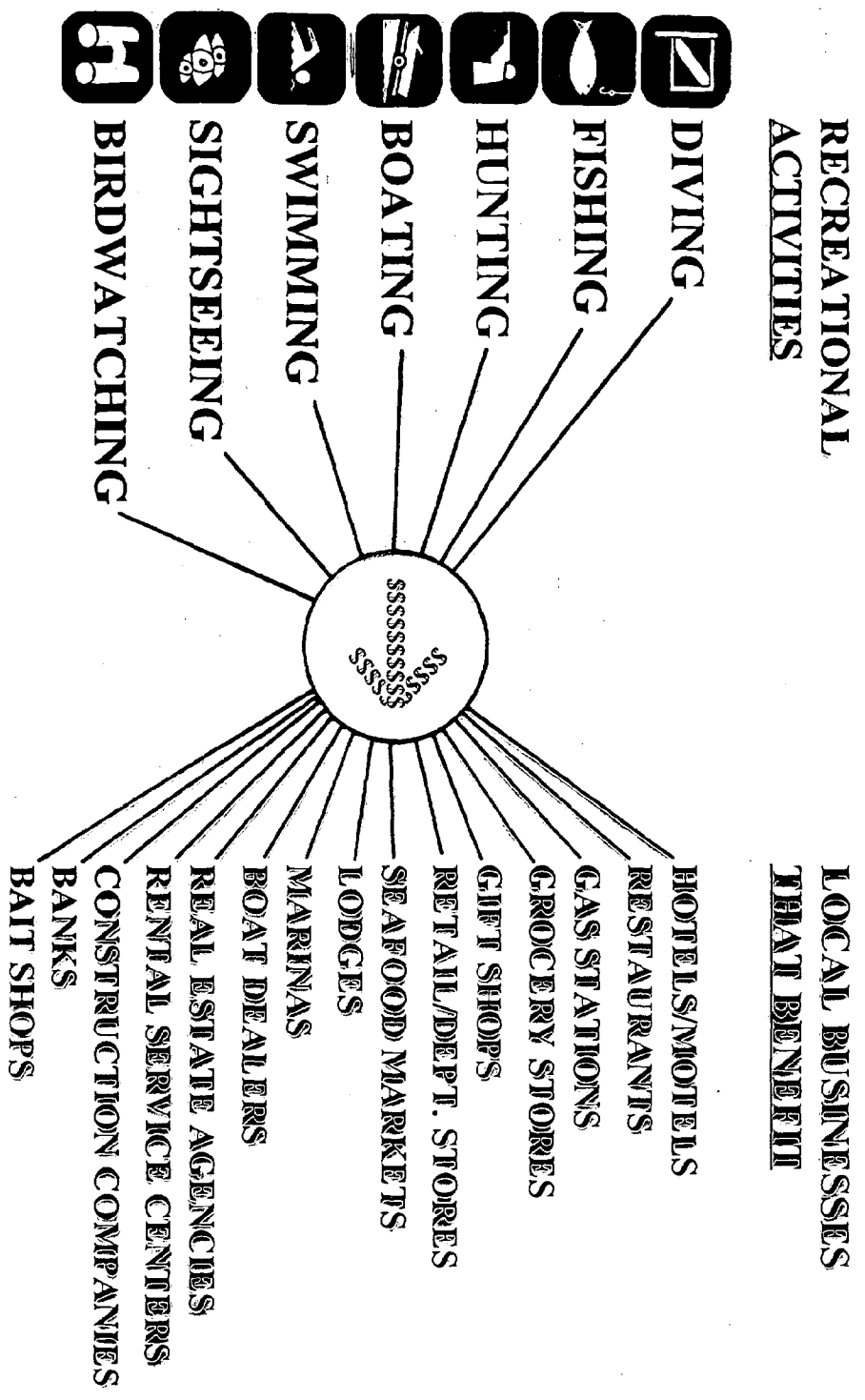
FINFISH

YEAR	SSS	DOCKSIDE VALUE	SSS
1982	\$ 4,150,000	\$ 6,399,000	\$ 275,000
1987	\$ 5,199,000	\$ 3,190,000	\$ 200,000
1982	\$ 2,672,000	\$ 4,278,000	\$ 140,000
10 YEAR AVERAGE	\$ 4,238,000	\$ 6,159,000	\$ 287,000

YEAR	SSS	ESTIMATED NATIONAL VALUE (up to 5 times dockside value)	SSS
1982	\$ 20,750,000	\$ 31,995,000	\$ 1,375,000
1987	\$ 25,995,000	\$ 15,950,000	\$ 1,000,000
1992	\$ 13,360,000	\$ 21,390,000	\$ 700,000
10 YEAR AVERAGE	\$ 21,190,000	\$ 30,795,000	\$ 1,435,000

10 YEAR AVERAGE **\$ 21,190,000** **\$ 30,795,000** **\$ 1,435,000** **\$ 5,745,000**

HOW RECREATIONAL ACTIVITIES BENEFIT LOCAL BUSINESSES



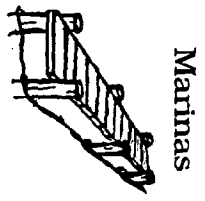
OTHER USES OF THE APALACHICOLA SYSTEM



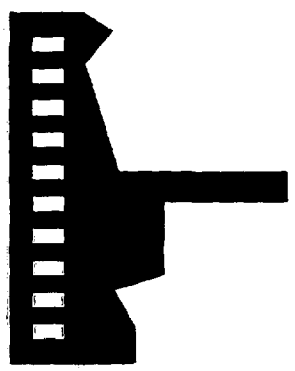
NAVIGATION

Fueling and Loading Docks

Transportation Route for Recreational and Commercial Vessels



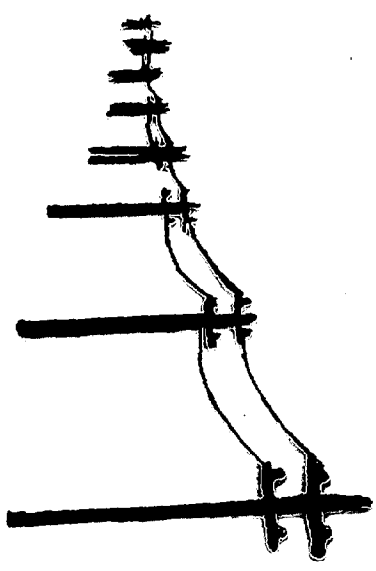
Marinas



INDUSTRY

Paper Processing

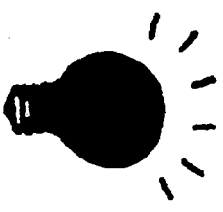
Treated Wastewater Discharge
Chemical Production from paper by products








POWER PRODUCTION

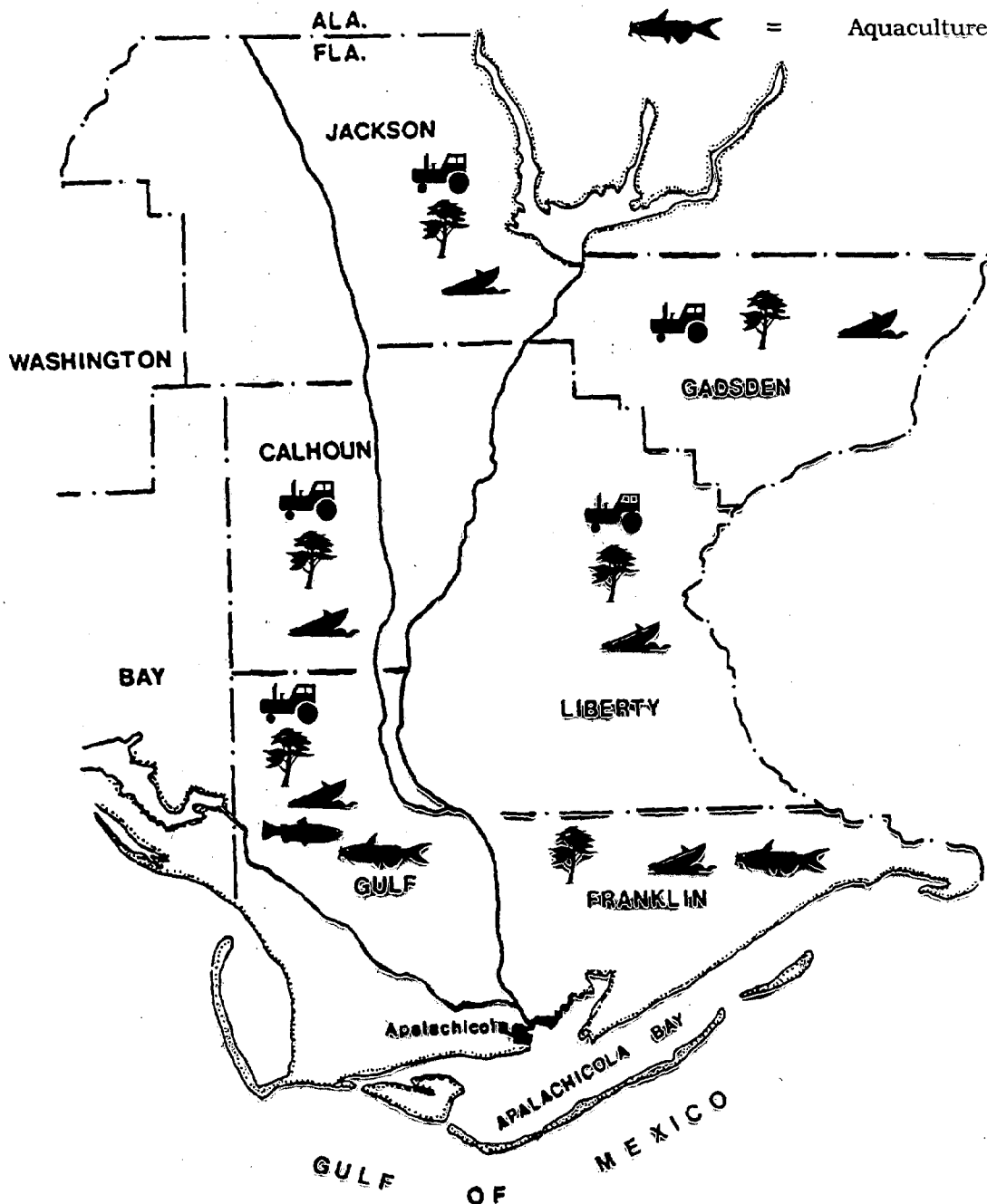
Cooling Thermoelectric Generators

Turning Turbines for Hydroelectric Power

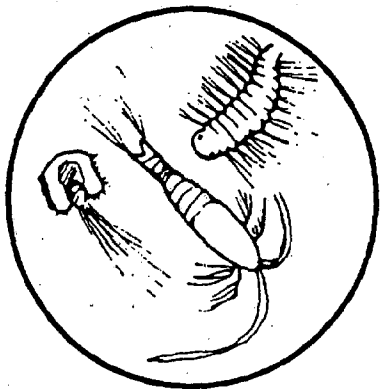


MAJOR LOCAL BUSINESSES RELATED TO THE APALACHICOLA RIVER AND BAY SYSTEM

-  = Agriculture
-  = Forestry
-  = Commercial Fishing
-  = Recreation
-  = Aquaculture



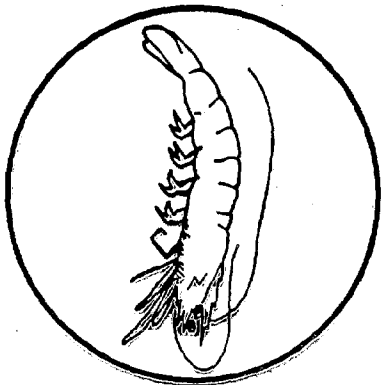
HOW WILDLIFE DEPENDS ON THE APALACHICOLA RIVER AND BAY SYSTEM



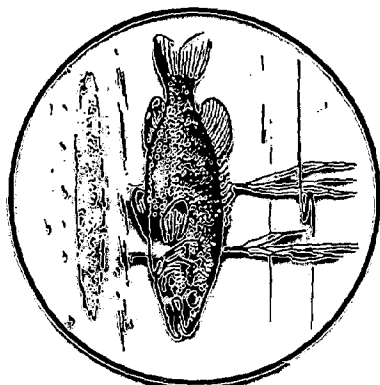
FOOD



SHELTER



NURSERY AREA



WATER



BREEDING GROUND

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