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ABSTRACT

This environmental education guide focuses on man's impact on the estuary. The program contained in the guide is developed around the following nine questions: (1) What is a definition of the ecosystem being investigated?; (2) What are some of the biotic and abiotic features of the ecosystem and how do these features interrelate?; (3) Where are some specific locations of the ecosystem being investigated?; (4) What biotic and abiotic features in the ecosystem have changed and are undergoing change?; (5) What are the natural factors causing change in the ecosystem and how have they been brought about?; (6) What are the man-made factors causing change in the ecosystem and how have they been brought about?; (7) What are the results of changes?; (8) What, if any, new changes are needed in the ecosystem?; and (9) How might these needed changes to the ecosystem be brought about? Following the inquiry questions is a section of learning activities, which also includes resources, evaluation strategies, and teacher suggestions. The final section, teacher comments, is material which will help initiate and implement this program in to the existing curriculum. (TK)

MAN'S IMPACT ON THE ENVIRONMENT

The Estuary as an Ecosystem

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ESEA, TITLE III

FOR PILOT TESTING ONLY

ESTUARY AS AN ECOSYSTEM

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MAN'S IMPACT ON THE ENVIRONMENT

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Change in an Ecosystem

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III. Where are some specific locations of the ecosystem being investigated?

IV. What biotic and abiotic features in the ecosystem have changed and are undergoing change?

V. What are the natural factors causing change in the ecosystem and how have they been brought about?

VI. What are the man-made factors causing change in the ecosystem and how have they been brought about?

VII. What are the results of the changes?

A. Beneficial?
B. Detrimental?

VIII. What, if any, new changes are needed in the ecosystem?

IX. How might these needed changes to the ecosystem be brought about?

Inquiry Question: I. WHAT IS A DEFINITION OF THE ECOSYSTEM BEING INVESTIGATED? (ESTUARY)

Learning Activities	Resources	Evaluation	Teacher Suggestions
Investigation #1: A. INTRODUCE 1. Divide class into small groups. 2. Write the following question on the chalkboard: What is an estuary? 3. Tell students you are going to show them several estuaries and their group is to write an answer to the above question after seeing the examples	A. INTRODUCE	A. INTRODUCE	A. INTRODUCE 1. Read Teacher Comment (TC) #'s 1 and 2, pages 55-58. 2. One standard definition of an estuary: "a semi-enclosed coastal water body which has free access to the sea; the water in which is measurably diluted below the salinity of open ocean water by freshwater associated with land runoff." University of Georgia, Technical Report Series No. 72-5, 1972. 3. For an additional definition of estuary, see Modern Earth Science, Holt, Rinehart, and Winston, 1969, page 307. 4. Read TC #3, page 59 for background.
B. SHOW 1. On a physical map of North America, point out to students the major estuaries depicted in TC #4. 2. On a physical map of Florida, point out to students the following estuaries: - Charlotte Harbor	B. SHOW 1. Physical map of North America and Florida usually can be found in the social studies department of your school.	B. SHOW	B. SHOW

Inquiry Question:

I. WHAT IS A DEFINITION OF THE ECOSYSTEM BEING INVESTIGATED? (ESTUARY)

Learning Activities	Resources	Evaluation	Teacher Suggestions
- Tampa Bay - St. Andrews Bay - St. Lucie Bay	2. TC #4, p. 61		
C. WRITE Give each group time to discuss the question and write out a definition.	C. WRITE	C. WRITE Student Comment (SC) #1, page 20	C. WRITE
D. REPORT/DISCUSS 1. Have each group report their definition to the class by placing it on the chalkboard. 2. Allow class to comment on each definition and arrive at one definition which will satisfy the entire group.	D. REPORT/DISCUSS	D. REPORT/DISCUSS TC #6, p. 65	D. REPORT/DISCUSS TC#5, p. 63
E. READ/DISCUSS 1. Divide class into small groups and have students read SC#'s 2 and 3 2. After reading, ask groups to answer these questions: a. Does your class definition of estuary explain what you have read? b. Are you satisfied that your definition is complete? c. If not satisfied, how would you change your class definition?	E. READ/DISCUSS SC #'s 2 and 3, pp. 22 and 23	E. READ/DISCUSS 1. SC #1, p. 20 2. TC # 6, p. 65	E. READ/DISCUSS Have students make note of the final revised definition of estuary and refer to it throughout this unit.
F. ILLUSTRATE To conclude these activities, have	F. ILLUSTRATE	F. ILLUSTRATE 1. Collect and	F. ILLUSTRATE 1. Selected drawings

Inquiry Question: I. WHAT IS A DEFINITION OF THE ECOSYSTEM BEING INVESTIGATED? (ESTUARY)

Learning Activities	Resources	Evaluation	Teacher Suggestions
students draw and appropriately label an actual or imaginary estuary.		evaluate drawings 2. You may wish to have students exchange drawings and grade each other's work.	may be placed on bulletin board during this unit of work. 2. A committee of students could pick the drawings to be displayed.

Inquiry Question: II. WHAT ARE SOME OF THE BIOTIC AND ABIOTIC FEATURES OF THE ECOSYSTEM AND HOW DO THESE FEATURES INTERRELATE?

Learning Activities	Resources	Evaluation	Teacher Suggestions
Investigation #1: A. DISCUSS 1. In class discussion, have students suggest meanings of the words biotic and abiotic. 2. Discuss meaning of root word -bio and prefix a. 3. Write student suggested meanings of biotic and abiotic on chalkboard.	A. DISCUSS	A. DISCUSS TC #6, p. 65	A. DISCUSS Meanings: Biotic means all things living or recently living. Abiotic means all things non-living. Bio - from the Greek, bios meaning life A - from the Greek, meaning not.
B. RESEARCH/REVISE 1. Have students look for definitions of biotic and abiotic in reference books. 2. In class discussion, revise originally suggested meanings, if necessary.	B. RESEARCH/REVISE Dictionaries, science books, encyclopedias, etc.	B. RESEARCH/REVISE TC #6, p. 65	B. RESEARCH/REVISE
C. VIEW/WRITE 1. Show the film, Estuarian Heritage, with no comment other than announcing the subject. 2. After the film, have student write a brief paragraph, or two, answering these questions: a. What biotic features are in the estuary? b. What abiotic features are in the estuary? c. How do the biotic and abiotic features interrelate?	C. VIEW/WRITE Order the film Estuarian Heritage, from either of these sources: - Shell Film Library, 450 N. Meridian St., Indianapolis, Ind., 46204 - Motion Picture Service, U.S. Dept. of Commerce, NOAA, Rockville, Md. 20852	C. VIEW/WRITE If you wish, collect the written paragraphs and evaluate.	C. VIEW/WRITE If Estuarian Heritage, is unavailable use any film or filmstrip which depicts the estuary.

Inquiry Question: II. WHAT ARE SOME OF THE BIOTIC AND ABIOTIC FEATURES OF THE ECOSYSTEM AND HOW DO THESE FEATURES INTERRELATE?

Learning Activities	Resources	Evaluation	Teacher Suggestions
D. DISCUSS 1. In class discussion, consider the various answers to the previous questions. 2. Make on the chalkboard, a composite list of answers to questions 1 and 2, and record selected responses to question 3. 3. Have class then react to these two questions: a. Why is the estuary important to man? b. Why should the estuary be protected?	D. DISCUSS	D. DISCUSS TC #6, p. 65	D. DISCUSS
E. READ/DIAGRAM 1. Have each student read SC #'s 4 and 5. 2. Each student should then select at least one relationship between biotic and abiotic features in the estuary and diagram that relationship showing how the presence of one affects the other.	E. READ/DIAGRAM SC #'s 4 and 5, pp. 24, 26	E. READ/DIAGRAM Collect diagrams and evaluate.	E. READ/DIAGRAM Display selected diagrams on bulletin board.

Inquiry Question: III. WHERE ARE SOME SPECIFIC LOCATIONS OF THE ECOSYSTEM BEING INVESTIGATED?

Learning Activities	Resources	Evaluation	Teacher Suggestions
Investigation # 1:			
A. VIEW/PREDICT 1. Divide class into small groups 2. Have each group view SC #6 and predict answers to the following questions: a. What areas are considered estuaries? b. At what points do Brevard waters have access to ocean water?	A. VIEW/PREDICT SC #6, p. 27	A. VIEW/PREDICT SC #1, p. 20	A. VIEW/PREDICT 1. For background read SC #7, which lists major estuary systems in the area. 2. Suggest students review the definition for estuary that was developed in Activity E for the Inquiry Question. 3. Local water reaches ocean through Sebastian and Ponce de Leon (Volusia County) Inlets.
B. STUDY/LOCATE 1. Have groups study SC #7 and then, on SC #6, locate the six major Brevard estuary systems listed in the reading. 2. Make any needed revisions to predictions made in Activity A.	B. STUDY/LOCATE SC #7, p. 28 SC #6, p. 27	B. STUDY/LOCATE SC #1, p. 20	B. STUDY/LOCATE 1. TC #7, page 66, briefly describes each local estuary. 2. Following this Activity students should realize that both Indian and Banana Rivers are considered estuaries.

Inquiry Question: IV. WHAT BIOTIC AND ABIOTIC FEATURES IN THE ECOSYSTEM HAVE CHANGED AND ARE UNDERGOING CHANGE?

Learning Activities	Resources	Evaluation	Teacher Suggestions
Investigation #1: A. READ/LIST 1. Divide class into small groups 2. Have each group read SC #'s 11-19 and list all the biotic and abiotic changes mentioned in the articles.	A. READ/LIST SC #'s 11-19, pp. 39-46	A. READ/LIST SC #1, p. 20	A. READ/LIST
B. COMPARE Have groups exchange lists and compare their listed changes.	B. COMPARE	B. COMPARE	B. COMPARE
C. DISCUSS In class discussion arrive at a master list of biotic and abiotic changes taking place in the estuary.	C. DISCUSS	C. DISCUSS TC #6, p. 65	C. DISCUSS

Inquiry Question: V. WHAT ARE THE NATURAL FACTORS CAUSING CHANGE IN THE ECOSYSTEM AND HOW HAVE THEY BEEN BROUGHT ABOUT?

Learning Activities	Resources	Evaluation	Teacher Suggestions
Investigation #1: (Background)			
A. READ Have students read SC #8 and answer this question: What are two natural processes which cause change in the estuary?	A. READ SC #8, page 31	A. READ	A. READ[1] SC #8 points out eutrophication and siltation as two processes changing the estuary.
B. DISCUSS 1. In class discussion, decide answer to the above question. 2. Next, predict a definition for eutrophication and siltation and place on chalkboard.	B. DISCUSS	B. DISCUSS TC #6, p. 65	B. DISCUSS Keep predicted meaning of siltation for further reference. It will be defined in a later Investigation.
C. RESEARCH 1. Divide class into small groups. 2. Have each group locate definitions and descriptions of eutrophication by using various classroom sources. 3. Have students review SC #9 for better understanding of eutrophication.	C. RESEARCH 1. Dictionaries, natural science text books, encyclopedias 2. SC #9, p. 32	C. RESEARCH SC #1, p. 20	C. RESEARCH
D. REVISE/REPORT 1. Have each group revise the predicted definitions of eutrophication which written on the chalkboard.	D. REVISE/REPORT	D. REVISE/REPORT SC #1, p. 20 TC #6, p. 65	D. REVISE/REPORT Final understandings of terms should be noted by students.

Inquiry Question: V. WHAT ARE THE NATURAL FACTORS CAUSING CHANGE IN THE ECOSYSTEM AND HOW HAVE THEY BEEN BROUGHT ABOUT?

Learning Activities	Resources	Evaluation	Teacher Suggestions
2. Each group should report their revised meanings to the entire class. 3. The class should decide on a final understanding of eutrophication.			
E. REVIEW Have students review SC #8 and predicted definition of siltation made in activity on page.	E. REVIEW SC #8, p. 31	E. REVIEW	E. REVIEW
F. RESEARCH/REVISE 1. Have each student locate definitions and descriptions of siltation by using various classroom sources. 2. Revise the predicted definition of siltation which was written on the chalkboard. 3. Through class discussion arrive at a general definition of siltation.	F. RESEARCH/REVISE Dictionaries, science books, encyclopedias	F. RESEARCH/REVISE 1. If definitions are written, collect and evaluate. 2. TC #6, p. 65	F. RESEARCH/REVISE
G. READ/SKETCH Have each student read SC #20 and sketch a diagram showing how siltation affects the biota.	G. READ/SKETCH SC #20, p. 47	G. READ/SKETCH Collect sketches and evaluate.	G. READ/SKETCH A committee of students may by appointed to evaluate sketches.

Inquiry Question:

VI. - VIII.

Learning Activities	Resources	Evaluation	Teacher Suggestions
Investigation #1: A. <u>CREATE</u> 1. Have each student create an original work in which he describes the following: - causes of change in the estuary - results of change in the estuary - improvements needed in the estuary. 2. Have students select one of the following media or suggest one not listed: Write: - a poem - a letter to the editor of a newspaper - a script for a special television show - a short story - a song - a play - a series of public service commercials. Design: - a collage - a poster or chart - a series of political cartoons - a series of drawings - a series of billboard advertisements - a series of bumber stickers.	A. <u>CREATE</u> 1. SC #'s 16-19, pp. 42-46 2. SC #20, p. 47	A. <u>CREATE</u>	A. <u>CREATE</u> TC #9, p. 73 gives background on changes in the estuary.

Inquiry Question:

VI. - VIII.

Learning Activities	Resources	Evaluation	Teacher Suggestions
3. Students should review SC # 11-19 and read for the first time SC #20, for factual material needed to create their original work.			
B. PRESENT Upon completion of works, students should present them to class.	B. PRESENT	B. PRESENT 1. Each work should be collected and evaluated. 2. Students could be allowed to judge each other's work.	B. PRESENT
C. DISCUSS Following all presentations, have class reach conclusions on each of the Inquiry Questions and list on chalkboard.	C. DISCUSS	C. DISCUSS TC #6, p. 65	C. DISCUSS Have students note conclusions reached.

Inquiry Question: IV. - IX.

Learning Activities	Resources	Evaluation	Teacher Suggestions
Investigation #2:			
A. PREPARE 1. Divide class into small groups. 2. Have each group review and use a list of Inquiry Questions IV. - IX (SC #10) as a guideline to preparing a written report. 3. Activities B through F should provide needed data to answer questions.	A. PREPARE SC #10, p. 35	A. PREPARE	A. PREPARE Investigation #2 is an alternate set of activities to answer Inquiry Questions IV-IX.
B. READ Have students read SC #'s 9-20 and select information which will contribute to answering their Inquiry Questions for their report.	B. READ SC #'s 9-20, pp. 34-47	B. READ	B. READ TC #8 gives background on tertiary sewage treatment mentioned in SC #12.
C. COLLECT Have students review daily newspapers and collect aritcles which will contribute to updating readings in SC #'s 9-20.	C. COLLECT	C. COLLECT Collection of articles could be evaluated.	C. COLLECT
D. INVITE SPEAKER 1. Invite a qualified person to speak to the entire class on the questions included in SC #10 2. Provide guest with list of questions (SC #10) prior to his class appearance.	D. INVITE SPEAKER Sources for qualified speakers include the following: - Brevard Health Dept., Environmental Health,	D. INVITE SPEAKER Students could be evaluated on how well they listen and particticipate in question/ answer session.	D. INVITE SPEAKER 1. Allow students to contact speakers and arrange visit. 2. Have students write thank-you letters to speaker.

Inquiry Question:

IV. -IX.

Learning Activities	Resources	Evaluation	Teacher Suggestions
3. Following guest's presentation, allow students to ask him questions.	1149 Lake Dr., Cocoa phone 632-6010. - Central and Southern Florida Flood Control District, Field Services, 2133 Wickham Rd., Melbourne. phone-254-1761. - Game and Freshwater Commission, 7630 Coral Dr., West Melbourne. phone - 724-1575. - Indian River Audubon Society: North Brevard: 269-2368, Mrs. John A. Gulsby, 1620 Tee Circle, Titusville, Fl. 32780. Central Brevard: 632-7445, Mrs. Malcolm L. Conant, 941 Brookview Lane, Rockledge, Fl. 32955 South Brevard: 727-8846, Mr. Hugh C. Nicolay, 2805 S. Babcock, Apt. 105-E, Melbourne, Fl. 32901		

Inquiry Question:

IV. - IX.

Learning Activities	Resources	Evaluation	Teacher Suggestions
E. INTEGRATE Have students integrate notes with previously taken ones as they continue to prepare their reports	E. INTEGRATE	E. INTEGRATE	E. INTEGRATE
F. VISIT 1. Plan a field trip to a local sewage disposal plant. 2. Before trip prepare questions to ask on how sewage from that particular plant affects the estuary. 3. Upon return from trip hold a "debriefing session" in which students share with class information they discovered.	F. VISIT Possible sites: 1. Melbourne, Fl. Sewage Treatment Plants: 2300 South Grant, 943 Sarno Road. 2. Cocoa, Fl. Sewage Disposal Plant, Taft Ave. 3. Cocoa Beach, Fl. Sewer Dept., Minuteman Causeway.	F. VISIT TC #6, p. 65	F. VISIT 1. Allow students to make most of the arrangements for the field trip 2. Students could phone the plants and find the best times for a visitation 3. Students should write thank-you letters to plant personnel.
G. WRITE Have small groups use information from all previous activities and prepare their final written reports.	G. WRITE	G. WRITE 1. SC #1, p. 20 2. Collect final report and evaluate.	G. WRITE
H. DISCUSS After writing reports, have class discuss answers to Inquiry Questions IV. - IX. and reach a conclusion to each.	H. DISCUSS	H. DISCUSS TC #6, p. 65	H. DISCUSS Encourage students to cite evidence (e.g. news articles, speakers, etc.) for their conclusive statements.

Inquiry Question:

IX. HOW MIGHT THESE NEEDED CHANGES TO THE ECOSYSTEM BE BROUGHT ABOUT?

Learning Activities	Resources	Evaluation	Teacher Suggestions
Investigation #1: A. DESIGN 1. Divide class into small groups. 2. Each group will design a program for bringing about needed improvements in policies and practices toward the estuary. - the program should have detailed plans and techniques for influencing members of a target group and how they should change the way they act toward the estuary. 3. Small groups should select one of the following target groups at which to aim their "program for change" - the general public - business interests - government leaders	A. DESIGN	A. DESIGN	A. DESIGN Students may suggest other target groups.
B. REVIEW Have students review Student Comments in this unit for factual material on which they may base their "program for change."	B. REVIEW All appropriate Student Comments in this unit.	B. REVIEW SC #1, p. 20	B. REVIEW Encourage students to be creative in their designs. Allow time for students to design example of any visuals they suggest for their program.
C. PRESENT/DISCUSS 1. Have each group present their "program for change" to the class.	C. PRESENT/DISCUSS	C. PRESENT/DISCUSS 1. Evaluate each presentation or	C. PRESENT/DISCUSS Have students note final conclusions reached.

Inquiry Question:

IX. HOW MIGHT THESE NEEDED CHANGES TO THE ECOSYSTEM BE BROUGHT ABOUT?

Learning Activities	Resources	Evaluation	Teacher Suggestions
2. Allow class to question and discuss each "program for change" after it has been presented. 3. Conclude activity by having class summarize ways of bringing about change in each <u>target group</u> and place on chalkboard.		allow students to judge them. 2. TC #6, p. 65	

Inquiry Question:

IV. - IX. (OPTIONAL)

Learning Activities	Resources	Evaluation	Teacher Suggestions
Investigation #1:			
A. READ Using a copy of the Model Inquiry Questions #'s IV. - IX. (SC #10) as a guide have students read SC #21 and make mental note of possible answers to the Questions.	A. READ 1. SC #21, p. 49 2. SC #10, p. 35	A. READ	A. READ 1. This Investigation is optional and may be given only to the most interested students. 2. Each student should have a copy of SC #10 before them or they should be placed on the chalkboard. 3. Encourage students to investigate words in the reading that they do not understand.
B. DISCUSS/WRITE 1. After reading, have students break into small groups. 2. Have students record their small groups' answers to the Inquiry Questions. - note paragraph and sentence in SC # 21 used to support answers.	B. DISCUSS/WRITE	B. DISCUSS/WRITE 1. SC #1, p. 20 2. Teacher could collect answers from each group and evaluate with a letter grade or points or both.	B. DISCUSS/WRITE 1. Have each group make two copies of their answers, one for the group and one for the teacher. 2. Encourage students to use any resources (printed materials, experts, etc.) necessary to find answers.
C. REPORT/DISCUSS 1. Student groups will now report, in a class discussion, their group's answers to Inquiry Questions #'s IV. - IX. 2. A Moderator will call on	C. REPORT/DISCUSS	C. REPORT/DISCUSS 1. The generalizations or conclusions drawn from the group through dis-	C. REPORT/DISCUSS 1. TC #5, p. 63 2. Moderator, Board Reocrder, Desk Recorder should receive extra points each day of the discussion.

Inquiry Question: IV. -IX. (OPTIONAL)

Learning Activities	Resources	Evaluation	Teacher Suggestions
different students that offer answers to the Inquiry Questions. Each group or student must reinforce his or her answers by specifying paragraph and sentence where found, or what expert. 3. A Board Recorder, during discussion, will record on the chalkboard the answers suggested by the groups. 4. A Desk Recorder will keep a record of all answers placed on the chalkboard and each day will keep a log for the entire large group or class. 5. Have class arrive at conclusions to each of the Inquiry Questions #'s IV. -IX.		cussion and validation by citing from the article and experts could be evaluated by the teacher. 2. These conclusions could be shown to other sections or classes that might do the same investigation and their answers could be compared.	3. The answers to the Inquiry Questions #'s IV. - IX. could and should vary. There would be no absolutely correct answers. 4. Students will draw their own conclusions. 5. Have a student or the teacher make a reproduction of students' answers so each pupil may have a copy.

STUDENT COMMENTS

STUDENT COMMENT NO. 1 : Small Group Evaluation • Example Forms

EXAMPLE #1

Student Evaluation of Small Group Discussion

Name ______________________

Period ______________________

Date ______________________

Scale

5 points - Excellent
4 points - Above Average
3 points - Average
2 points - Below Average
1 point - Poor

Student Names	Contribution of Ideas	Participation	Cooperation	Conduct	Interest	Total	Average Divide by 5

1. All students in the group should arrange names in the same order. The Small Group leader's names should be first, and then he/she can possibly decide the order for the rest of the group.
2. Students should evaluate themselves and the group seriously and confidentially.
3. Using 5-1 scale, students should complete each category, add the total and place it in the total column. Then arrive at the average, by dividing by five (5 columns). If a fraction remains, include it in the average.
4. Teacher collects forms, arranges horizontally according to the order of the students' names, with only the average column showing at the right.
5. At a glance, the teacher can estimate the students' evaluations and place a grade at the top right hand corner of the form.
6. If a teacher wishes, the captain's or leader's evaluation of each member of the group can be recorded also.

EXAMPLE #2

1. Since the election/selection of group leaders is an honor and a privilege, it also brings a responsibility. This should be emphasized to the students.
2. Therefore, the group leader should be given some responsibility. During the Small Group Discussion, he/she should be aware of all members' contributions.
3. At any time, the teacher may ask for the group leader's evaluation of the group.
4. If the teacher awards participation points, the group leader could evaluate them by giving from 50 to 0 points, depending on their contributions.
5. Any number of points could be awarded. This is left up to the discretion of the teacher.
6. The 5, 4, 3, 2, 1 method as used in evaluation Example #1 could also be applied if a grade is desired.

STUDENT COMMENT NO. 2: Definitions of Estuary

An estuary is a partially-enclosed body of water which is connected with the ocean. The salt water in an estuary is measurably diluted by fresh water from the surrounding land. Estuaries are common along the east coast of the United States, where the ocean has moved into glacial river valleys and "drowned" rivers not yet filled in with sediment. The salinity in an estuary varies widely, depending on the rate of freshwater discharge into the estuary from the land and the rate of exchange of water with the open sea. It may be almost as fresh as normal river water, or nearly as salty as the ocean.

--Weyl, Peter K., Oceanography, N.Y., 1970, pp. 465-67.

Definition of estuary is difficult due to many various opinions as to what actually constitutes an estuary. It seems that each area of the country holds a slightly different definition based on local conditions. For a suitable meaning it seems best to combine a little of many of these into one.

An estuary:

--is a semi-enclosed body of water

--has free access to the ocean

--is diluted by run-off from the land

--has a measurable dilution

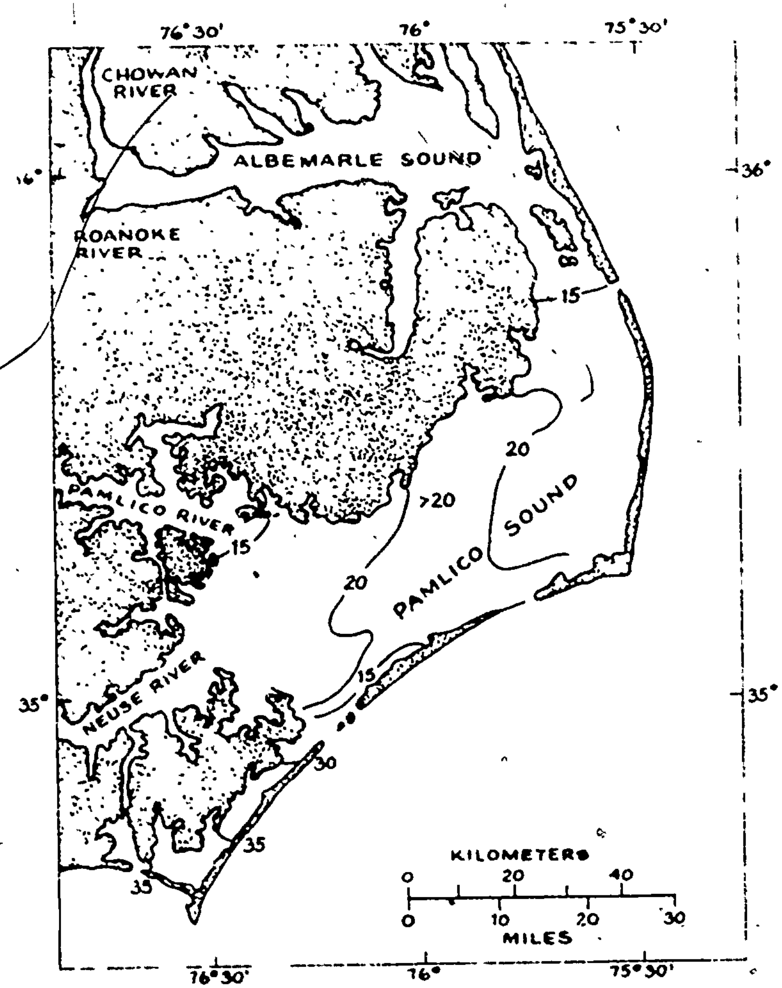
--may be a drowned river valley

--Teachers' Curriculum Guide For Field Ecology Supplement, 1972-1973, page 5-25.

STUDENT COMMENT NO. 3 : A Sample Estuary

Pamlico Sound, shown in the figure at the right, is a large, bar-built embayment on the North Carolina coast, a shallow estuarine system consisting of a complex of drowned river valleys. It is a broad lagoon-like area, cut off from the ocean by barrier beaches through which several small shifting inlets provide access to the ocean.

The estuarine system pictured here depicts how fresh river water flowing from the land mixes with ocean water surging in with the tides, producing graded dilutions of salt water. The approximate salinities for the Pamlico Sound estuary are shown here as parts of salt per thousand parts of water. The result is a salinity gradient that stretches from .35 parts of salt per thousand parts of water (ppt) at the southern tip of the estuary to 15 ppt at the mouths of the Pamlico River and Albemarle Sound.



STUDENT COMMENT NO. 4: The Estuary--Nursery of the Sea

When you go to the edge of the sea along much of the coast of this continent you find stretches of quiet water between flat grass-covered islands. These are the estuaries (ES-chew-air ees) where the rivers run down to the sea. In them the salty ocean water and fresh river water mix: They are sheltered from the waves and storms of the open ocean by sand dunes, points of land or sandy offshore islands.

Without counting all of the bays, sounds and inland waterways, the American mainland coastline is more than 88,000 miles long. There is hardly a mile of it that is not broken by the mouth of a freshwater stream from mighty rivers to tiny creeks. Even on the Pacific Coast where steep shores slope quickly into deep sea, there are vast estuaries such as Puget Sound and Grays Harbor in Washington; San Francisco Bay, Monterey Bay, and others in California.

The greatest estuary in this country is Chesapeake Bay on the East Coast. It is more than 100 miles long and contains over 3000 square miles of water. The ocean tide flows in and out between the Virginia Capes, and many rivers flow into the branches of the Chesapeake Bay.

This bay is one huge sea nursery. It is the home of the famous Virginia oysters. In the past, great numbers have been harvested each year by oyster fishermen. Scallops, crabs and shrimps are also fished. Almost all the seafood we eat can be fished from the Chesapeake Bay. In fact, more than two hundred kinds of fish spend at least part of their life in this estuary.

Some of them enter from the sea in order to feed, but do not really live there. Most, however, use the estuary waters to lay their eggs and raise their young. Others only pass through the bay to reach the rivers where they spawn (lay their eggs).

The shallow, sunlit waters of the estuaries are rich in microscopic plants and animals which are food for other estuary dwellers.

Nearest the sea, we find gulls, terns, cormorants and skimmers. Terns dive into the water for fish or shrimps. The black skimmers fly with their lower beaks actually plowing the water to pick up any small creatures close to the surface. Shore birds, particularly the sandpiper, wade and run along the edges of beaches. Kingfish and cliff swallows make homes in the steep sandy banks.

A bit farther inland are quiet salty rivers, hidden creeks and ponds. Banks and islands are covered with waving grasses. Altogether, an acre of water in an estuary may support seven times as much life as an acre of hayfield. It supports twenty times as much as the open ocean.

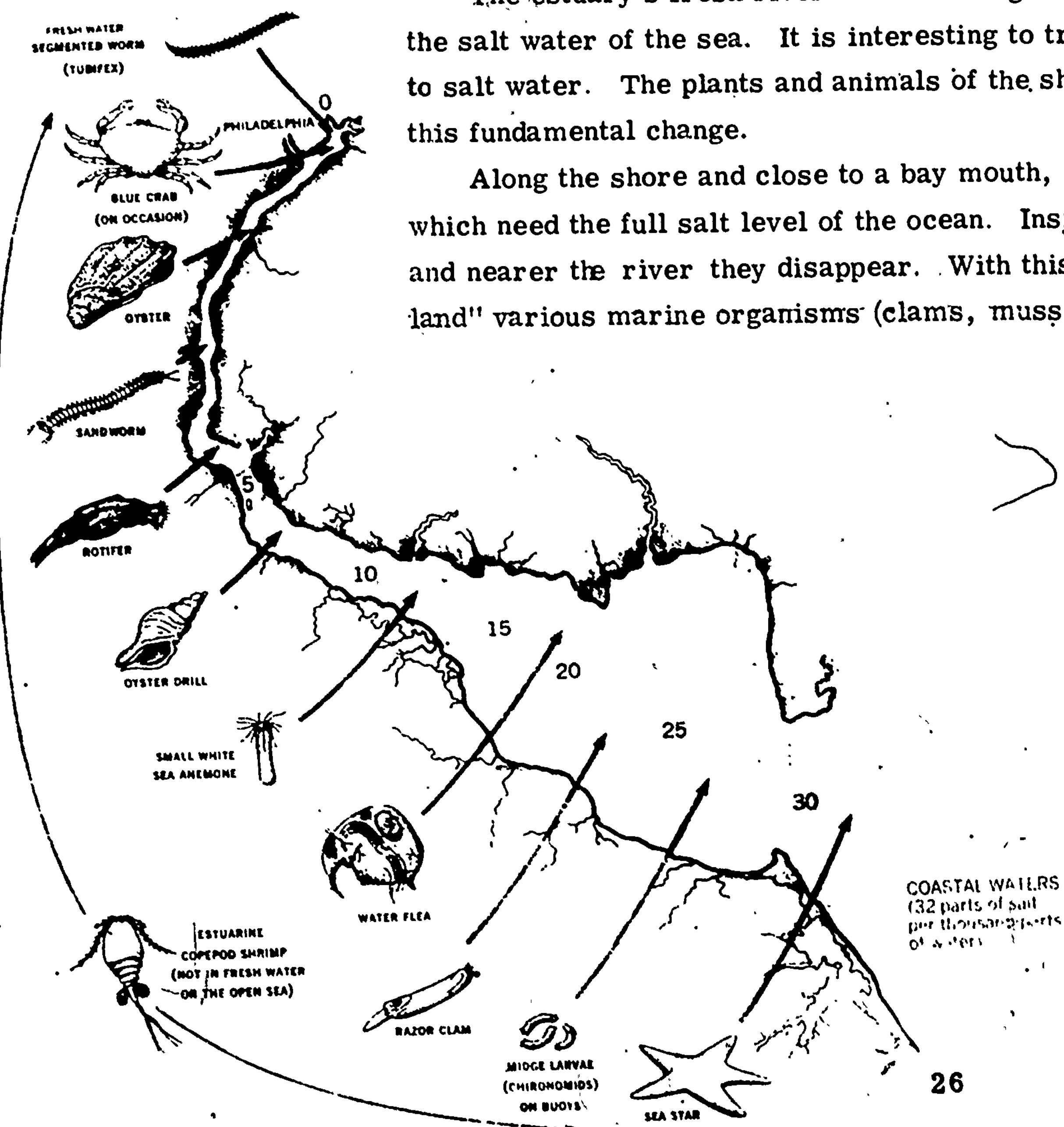
Farther away from the sea, where plants are thicker and waters less salty, are the ducks, loons, grebes and bitterns. Large handsome wading birds, such as the great blue heron and the smaller American egret, stand in the shallows watching for a fish or crab. Redwinged blackbirds and marsh wrens find all the seeds and insects they need in the tall, sheltering grasses.

--*Ranger Rick's Nature Magazine,* November, 1971, pp. 25-30.

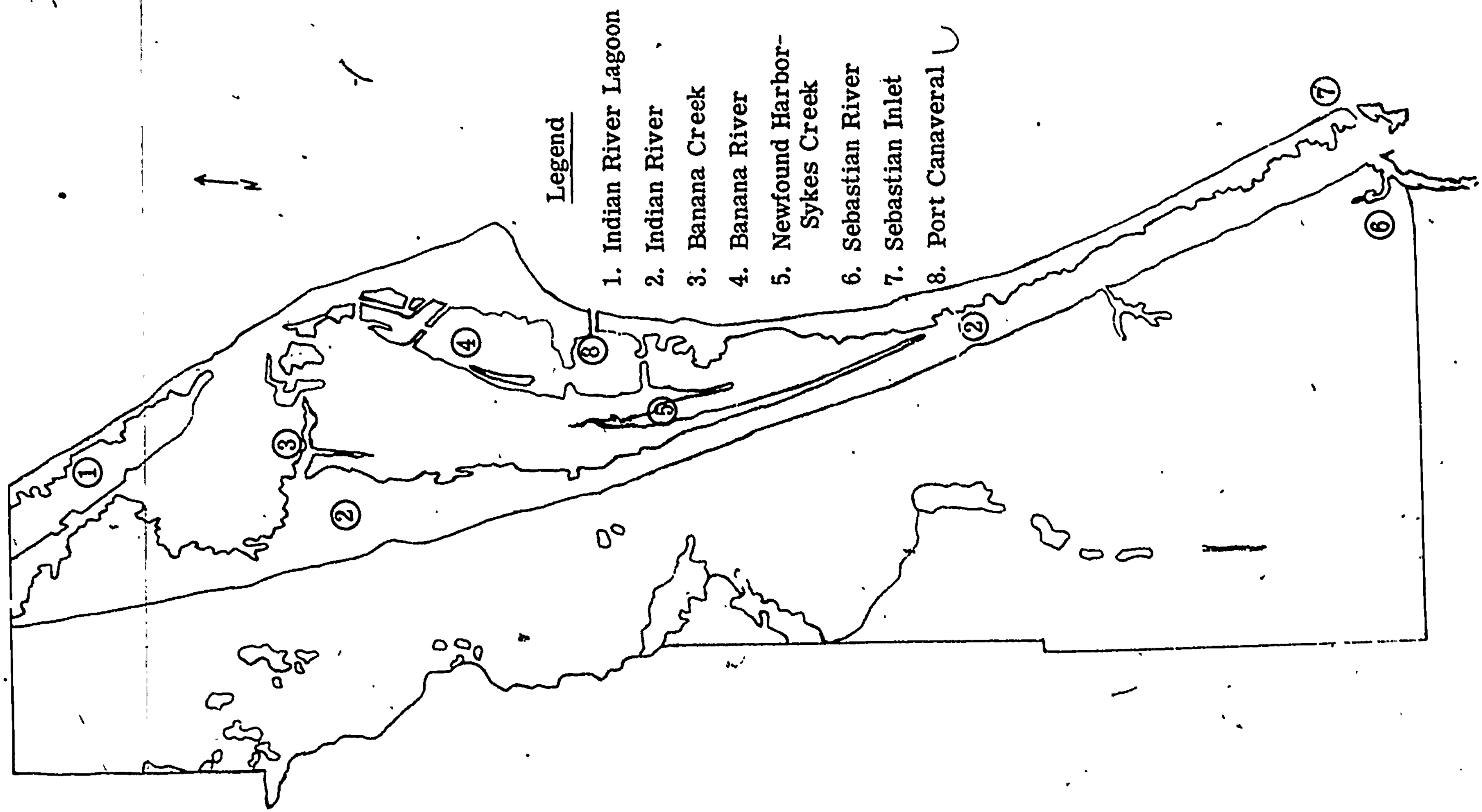
STUDENT COMMENT NO. 5: Salinity and Estuarine Life

The estuary's fresh river water flowing from the land gradually combines with the salt water of the sea. It is interesting to try to trace the slow change from fresh to salt water. The plants and animals of the shore and the bay flats provide clues to this fundamental change.

Along the shore and close to a bay mouth, there should be sea stars and sea urchins, which need the full salt level of the ocean. Inside the bay their numbers drop quickly, and nearer the river they disappear. With this in mind, you can discover how far "inland" various marine organisms (clams, mussels, barnacles, clam worms, seaweeds, and so on) can live. Each differs from the others in the amount of dilution of sea water by fresh that it can stand. The oyster drill, a predatory snail that attacks oysters, cannot go upstream in the winter farther than where there are nine parts of salt to a thousand parts of water (coastal sea water contains more than thirty parts of salt to a thousand parts of water). In the summer, it is restricted to water in which the salt is not less that 15 parts per thousand. The oyster can stand much lower dilutions and so lives upstream of the "drill line," free from this predator.



TUDENT COMMENT NO. 6: Map of Brevard County



TUDENT COMMENT NO. 7: Local Estuary System and Inlets

An Estuary is defined as the zone where fresh and salt water meet. The lagoons and related waters of the Coastal Area meet this qualification perfectly since most of the meeting and mixing of fresh water from the land and salt water from the ocean occurs here. For purposes of this study, the estuary is considered to include the coastal lagoons and connecting inshore waters plus adjoining marsh and swamp as they appear to have existed before any of man's alteration. The total area involved is some 194,113 acres of open water and 66,270 acres of marsh and swamps for a total estuary acreage of nearly 261,090 acres. The following table details the size of acreage, detailed shoreline, and the county in which they are located.

ES: FINE AREA AND SHORELINE IN THE EAST CENTRAL FLORIDA COASTAL AREA

	Open Water (Acres)	Swamp (Acres)	Total Estuary (Acres)	Detailed Shoreline (Miles)
VOLUSIA	31,714	28,203	60,425	359.3
Bulow Creek	35	705	740	4.7
Halifax River	8,765	7,663	16,420	86.2
Tomoka River	360	3,240	3,780	24.3
Rose Bay	240	280	570	5.6
Strickland Bay	580	1,020	1,836	13.7
Spruce Creek	187	547	734	12.3
Indian R. Lagoon	21,227	8,025	29,292	201.9
Indian River	320	6,723	7,053	10.6
BREVARD	145,587	30,945	176,561	600.1
Indian R. Lagoon	15,728	5,367	21,095	53.8
Indian River	74,786	10,097	84,892	237.3
Banana Creek	358	2,920	3,278	43.0
Banana River	47,676	11,285	58,981	232.1
Newfound Harbor / Sykes Creek	6,782	1,148	7,930	21.9
Sebastian River	257	128	385	12.0
INDIAN RIVER	16,812	7,122	24,104	151.7
Sebastian River	232	52	284	14.4
Indian River	16,580	7,070	23,820	137.3
COASTAL AREA	194,113	66,270	261,090	1,111.1

Inlets

Three openings through the barrier beach are found in the Coastal Area; Ponce de Leon in Volusia County, Port Canaveral just south of Cape Kennedy, and Sebastian Inlet at the Brevard-Inlet River County line. It is through the Ponce de Leon and Sebastian Inlets that practically all exchange of fresh and salt water must occur, since Port Canaveral is closed to normal water circulation.

Ponce de Leon Inlet is the only natural inlet of the three and is mentioned in the earliest historical documents of the area. It provides access from the ocean to the Halifax River and Indian River Lagoon, and before the cutting of canals into the Matanzas River on the north and Indian River on the south, it was the Area's only water access. It also provided the only means of tidal circulation and exit for fresh water accumulating in the coastal lagoon during the rainy season.

Due to the configuration of the sand bars and the amount of water passing through it, the inlet has acquired a reputation for being extremely rough and treacherous. Thirty people are reported to have drowned there in the past 25 years, a result of boats being swamped or overturned during passage. Present channel depth and widths vary according to wind, tide, and sand drift.

A joint project of the Ponce de Leon Inlet District and Port Commission and Corps of Engineers is now in the process of correcting this problem. The new minimum channel depth will be 15 feet with a 200 foot width. Protective jetties 1200 feet apart will extend 3600 feet into the ocean on the north and 1200 feet on the south. Sand from the littoral drift will be caught in a deep impoundment basin next to the channel entrance and periodically pumped to the south side to prevent beach erosion there and further down the beach.

Port Canaveral is not a true inlet since free exchange of water to the Banana River is prevented by a dike and a 90 x 600 foot lock on the inner side of the harbor which is opened only to pass vessels into the coastal lagoon waters. It is a man-made facility completed in 1953 and connected with the Intercoastal Waterway by means of a 12 foot deep, 125 foot wide canal across the Banana River and Merritt Island. The port is connected to the sea by a short channel 38 feet deep by 400 feet wide and protected by two jetties each 1,150 feet long. These jetties plus the 38 foot channel combine to constitute a complete barrier to littoral drift with beach material being deposited either in back of the north jetty (182,000 cubic yards annually) or in the channel (167,000 cubic yards annually).

uture plans of the Canaveral Port Commission and Corps of Engineers include a sand transfer plant which will ypass an estimated 90% of the sourtherly littoral drift. Plans also include deepening of the inner harbor.

Sebastian Inlet is an artificial cut through the barrier beach at the Brevard-Indian River County line, about 40 miles south of Canaveral Harbor. It leads into the Indian River through a channel varying in depth and width but normally about 4 feet deep and 300 to 600 feet wide. Parallel coquina rock jetties have existed for a number of years extending into the ocean about 100 feet and at elevations of 3 to 8 feet above sea level. These were quite inefficient for their intended purpose, permitting littoral drift to pass both over and aroung the north jetty end into the channel. The shallowness of the offshore bar permits some 140,000 cubic yards to resume its southward drift but 160,000 yards is either forced out into deeper water or finds its way on to inner shoals which plague this inlet.

Work now being accomplished by the Sebastian Inlet Commission will extend the north jetty 500 feet into the ocean and the south jetty 100 feet. Sand transfer methods are under discussion but not yet definite.

STUDENT COMMENT NO. 8: Changes in Estuaries

Because estuaries are nurseries for so much valuable life, they are extremely precious. It is therefore important that everyone should know this and why it is so--for some of our treasure has already been lost.

Many things we do are destroying the life of the estuaries. Waste from industry and towns along the rivers washes down into the estuaries' water. This destroys the rivers' usefulness as spawning grounds for migrating fish. It also pollutes the broad estuaries. These waste products pollute the estuaries' water by speeding up a natural process called eutrophication.

Towns and industries along the shores of an estuary pour in even more waste. San Francisco Bay has already been so poisoned that hardly anything can now live where oyster beds once used to flourish. Without clean shores and clean rivers the rich estuary life is doomed.

Besides dumping wastes, man is also destroying these natural areas by dredging. Dredging is digging out the mud from the bottom and sides of estuaries in order to build yacht basins and ship channels. This mud is often used as "fill" to form land for all kinds of building areas. Sometimes it is used for airport runways. Dredging causes layers of mud to cover valuable oyster beds. Mud and silt upset the whole balance of the estuary. This mud and silt are built up by nature's process of siltation.

Some say the only hope for feeding a hungry world lies with the sea. Remember, estuaries support twenty times as much life as the open ocean! Can we afford to allow our estuaries to be destroyed?

Ranger Rick's Nature Magazine, November '71, p. 30.

"TUDENT COMMENT NO. 9: Eutrophication

Eutrophication is nutrient enrichment of lakes and streams, which promotes the growth of algae and plants and, indirectly, the growth of aquatic animals. This is a natural process. Man has speeded up this natural process by adding his waste nutrients to water bodies.[1]

In nature, eutrophication occurs primarily as a result of precipitation which causes surface runoff and underground drainage from forest and plain areas. Organic materials such as decaying plants and animal wastes are carried along and deposited in waterways, where they support and enhance the growth of aquatic animals and plants. Man's activities have done much to alter the balance of nature. Discharges of sewage, industrial wastes and run-off from agricultural fertilizers have added many substances to lakes and streams. Some of these substances are nutrients; others are not. Eutrophication applies only to those discharges which are organic nutrients. Pollution is the mere inclusive term.

Since there is no single source of eutrophication, there is no one solution. In some areas, the major sources are natural and agricultural runoff, whereas in other locations sewage and urban drainage are the primary contributors. It is not easy to differentiate between sources of eutrophication. One method is to conduct chemical analyses to determine levels of nitrogen and phosphorus, two basic elements found in most nutrients, and then trace these concentrations to their major sources. "In these kinds of studies, extensive sampling may be required to distinguish between natural runoff, agricultural runoff, sewage and water effluents, urban runoff, groundwater flow patterns and contributions from precipitation."[2] Studies of this nature have revealed great differences in sources of eutrophication. For example, as in-depth investigation in the Lake Mendota, Madison, Wis., drainage basin indicated that of the total rural runoff, approximately 45,000 pounds of soluble nitrogen and 15,000 pounds of soluble phosphorus were derived from manure. On the other hand, at Lake Wauseba in Madison, an urbanized area, at least 75% of the nitrogen and 88% of the phosphrus was traced to domestic waste disposal in the form of sewage.

Eutrophication Can Be Measured Indirectly

Chemical analysis is one means of measuring levels of eutrophication. There are other indicators, both biotic (living) and abiotic (non-living). One abiotic phenomenon which often reflects eutrophication levels in 'akes is the opacity (amount of "opaqueness") of the water. An instrument known as the Secchi disc can be used to measure changes in transparency in lake water. Since increased nutrient levels promote the growth of plankton, the clarity of the water varies directly with the level of eutrophication. Long-term opacity studies spanning several summers can be an effective means of estimating eutrophic activity. A second means of tracing patterns of eutrophication over a period of time is to take a vertical sample (core) of sediment from the lake bottom and subject it to chemical analysis. As mentioned above, present nutrient levels (and fluctuations) can be determined by analyzing water samples for dissolved solids. Another abiotic index to eutrophication is the degree of light penetration into water. Light penetration is extremely variable in different bodies of water. Even distilled water impedes the passage of light to some extent, and cuts it off almost entirely at a depth of 300 feet. Several factors influence the penetration of light in natural settings: suspended microscopic plants and animals, suspended mineral particles such as silt, stains, detergent foams, floating mats of debris, or a combination of these. Since eutrophication causes an increase in aquatic life, it could be expected to cause a decrease in light penetration. Due to the many factors involved, however, reduced light penetration would not necessarily show eutrophication, although it would quite likely be a contributing factor in many cases.

Eutrophication Affects All Types of Marine Life

There are several biotic indicators used to approximate eutrophication. One good indicator is algal growth. Scientists study the intensity and frequency of algal blooms, as well as changes in species composition, chlorophyll content and primary productivity (the rate at which energy is stored in the form of organic substances). Another indicator, one step further removed on the food chain, is fish population. Sharp changes in population often reflect the presence of large amounts of nutrients which stimulate the growtn of plankton, a major food source for other species of aquatic life. Since fish can be relatively difficult to capture, many eutrophication studies have been conducted on the basis of benthic, or bottom-dwelling organisms, such as oysters, clams, snails, and worms. Since benthic organisms have limited mobility, they are good indicators of water quality over their life history. In general, a non-polluted stream will support many different species of organisms, but relatively small populations of each species, due to natural predation and competition for food and living space. The opposite is usually true in a stream polluted with organic wastes. Most predators are eliminated, while certain bottom-dwelling organisms which adapt much more readily to the degraded environment multiply rapidly without counterbalancing natural competitors. In some polluted waterways, sludgeworm populations have been estimated at better than 50,000 pounds per acre of stream bottom. The same pattern holds true for lakes. Organic pollution kills off some benthic forms, resulting in population increases among more resistant species.

It is not always necellary to conduct a scientific inquiry -- chemical, abiotic or biotic -- to perceive the effects of eutrophication. They are often painfully evident -- in the form of thick growths of algae and weeds which diminish the aesthetic and recreational value of lakes and other waterways. There may also be effects such as undesirable tastes and odors if the lake is used for a water supply.

--Source not given on Xerox copy

Notes

1. (p. 1 of Xerox Copy)
2. (p. 1 of Xerox Copy)

TUDENT COMMENT NO. 10: Guidelines for Estuary Report

1. What biotic and abiotic features in the ecosystem have changed and are undergoing change?
2. What are the natural factors causing change in the ecosystem and how have they been brought about?
3. What are the man-made factors causing change in the ecosystem and how have they been brought about?
4. What are the results of the changes?
   A. Beneficial?
   B. Detrimental?
5. What, if any, new changes are needed in the ecosystem?
6. How might these needed changes to the ecosystem be brought about?

TUDENT COMMENT NO. 11: The Interrelationship of Man and Estuaries

Many of the world's largest cities are located on estuaries, which often serve as fine natural harbors. Inevitably, man has an effect upon his immediate environment, and the estuaries are no exception. Many times man has altered the actual geography of the estuary by dredging channels and filling in other areas for urbanization. He uses the waters of the estuary for recreation and transportation. Sewage and industrial wastes are often dumped in these waters, and thermal pollution sometimes results from the heat from steam electric-generating plants.

The effects of man's interrelationship with his environment are not limited to the permanent flora and fauna of the estuaries, because estuaries are important also as breeding grounds for many other marine creature which spend their adult lives in the open sea. Thus, polluting an estuary may not only destroy shellfish beds in the estuary itself, but affect the population of certain offsh...e species of fish as well.

The effects of man's actions upon estuarine life are often complex. For example, the growth of abnormally large amounts of algae in Long Island Sound in the early 1950's was traced to the depositing of wastes from duck farms in these waters. These wastes, unusually high in phosphates, favored the growth of certain algae, to the detriment of the normal plankton population. As a further consequence, there was a serious decrease in the oyster fishing. Ironically, the waste products of one major Long Island industry had served to damage another major livelihood in the area.

There is another danger associated with dumping organic waste materials in estuaries. Although these materials can serve as nutrients for photosynthesis by marine plant life at the surface, the ability of estuarine marine animals to use the organic matter thus synthesized by plants depends entirely on the oxygen level of the water. In the open sea, this is usually no problem, but the delicate balance of temperature and salinity in estuaries sometimes causes oxygen depletion. The lack of oxygen kills off animal life, and bacteria which do not require oxygen take over.

--Weyl, Peter K., Oceanography, N. Y., 1970, pp. 470-71.

STUDENT COMMENT NO. 12: Pollution in the Local Estuary

Damage to the lagoons is the Coastal Area's major pollution threat. While these water bodies cover wide areas, they are extremely shallow and lack any positive circulation. Sources of pollution are many and scattered in an uneven pattern around the area. Pollution is prohibiting the harvesting of oysters, closing water areas for swimming, fostering contraction of disease such as hepatitis from body contact with water considered marginally safe and causing poor fishing, disagreeable odor, excessive corrosion and discoloration of paint on boats and buildings near the water.

Human waste is undoubtedly the major pollutant of the lagoon system in terms of both volume and problems created. Most damaging per unit of volume is untreated or raw sewage released directly into the lagoons from boats, overflowing sewage treatment plants, sewage pumping stations, breaks in sewer lines and a few homes which will have direct outfall connections. Next most damaging per unit of volume is sewage which receives inadequate treatment before being flushed into the lagoon. Chemical boat toilets, primary sewage treatment plants, septic tanks are examples.

Least damaging per unit of volume is sewage now treated at most of the disposal plants in the Coastal Area. However, a fact unknown by most people is that no type of sewage treatment used in the Coastal Area at this time completely eliminates the pollution producing characteristics of its effluent. Solids are reduced, most pathogenic organisms are killed, oxygen demand of the effluent is reduced, and algae producing effect is changed but no polluting characteristic is completely eliminated. The only method presently in use which will completely eliminate the pollution potential of raw sewage in a water body, is to completely prevent the introduction of raw sewage and effluent into that water body. As with many of the Region's other problems, a compromise between what the public would like and what they are willing and able to pay for is the most likely solution.

Pollution from storm sewers and drainage ditches is probably the second greatest pollution problem of the lagoons. Septic tank effluent, oil, street litter, inorganic sediment, fertilizer elements, animal wastes, a variety of poisonous compounds and freshwater are brought into the lagoon by this process. Other minor or localized pollutants include litter from boats; grass clippings, litter, and debris thrown in from adjacent shoreline; silt from dredging operations; water from flowing wells high in sulfur content; petroleum products from outboard motors and hot water from power plant condensers.

The variety of effects and interactions of this mass of pollutants could be the subject for a book and cannot be adequately covered here. It must suffice to say that man, through pollution, has reduced the ability of the coastal lagoon system to serve mankind. Recommended steps toward the reduction and elimination of pollution are:

1. Further examination of biological processes, ability of receiving waters to assimilate pollution, methods to increase lagoon circulation, and methods of pollution reduction.

2. Striving toward tertiary treatment at all sewer plants, elimination of raw sewage overflows, treatment of all human waste and eventual elimination of effluent disposal in lagoons.

3. Reduction of waste loads in storm sewers and drainage canals by proper engineering design, more efficient street cleaning, and enforcement of litter laws.

4 Reduction of fresh water drainage to the lagoon for the dual purpose of saving water supply and preventing pollution.

5. Formulation of fair, but effective legal tools for pollution control.

NO DUMPING ONLY CURE

Sykes Creek Near Death

Sykes Creek on Merritt Island is dying — sluggish, overfed and overheated — but still might be saved if no more treated sewage is dumped into it.

So says an interim water quality management plan for Brevard prepared by the County Planning Department.

Four private sewer plants on Merritt Island now dump more than one million gallons a day of treated waste into the six-mile creek, a nature preserve, and the nutrients from that sewage effluent are killing the creek, the report says.

"Hopefully, if the effluent discharges were stopped, there seems to be a good chance the Sykes Creek area could be saved by natural processes," said Lynn Hansel, Brevard community planner.

County government is about to fill part of the prescription to save the ailing waterway.

Some $2.68 million of a new $11.02 million county utility bond issue is earmarked for acquiring and modifying six private Merritt Island sewer plants.

By Sunday, the county should close the deal on purchasing the plants and will link them up, redirect the flow of sewage and reduce the amount of treated waste dumped into the creek. A total halt to using the creek for disposal is many years off, however.

"The increased nutrients may often result in algae blooms which take up so much oxygen from the water that very little animal life can survive in those waters," Hansel said.

"If you treat sewage to the 90 percent standard (as is proposed), the nutrients still aren't removed in that process.

"And because of the low — almost nil — flow rate of the water, those nutrients are not significantly diluted and thus their impact is felt for a longer period of time.

The plan says the Indian and Banana River lagoons also face problems from discharge of treated sewage, but are healthy enough to remove the harmful nutrients by natural processes. Water quality in the two rivers is listed as good.

More than 1,155,000 gallons of treated sewage a day are dumped directly into Sykes Creek by the four plants: Merritt Island Sanitation, Inc., 500,000 gallons; Hampton Homes, 270,000 gallons; Merritt Ridge, 150,000 gallons; and Vetter Isles, 235,000 gallons.

Countywide, 18 million to 20 million gallons of treated sewage a day are poured into various waters of Brevard by 100 different sewage plants.

The report noted Sykes Creek's main problem is not industrial waste or surface water runoff, but said "increased nutrients from existing waste treatment plant discharges are causing degradation of Sykes Creek water quality."

Sykes Creek, as well as the Indian and Banana Rivers and Newfound Harbour, is used heavily for propagation and management of fish and wildlife, recreation, sport and commercial fishing, boating and waterskiing, the report states. Demand on these water bodies is expected to increase with more population and the trend to more leisure time.

The water quality study says five existing sewage plants in Central Merritt Island now "discharge treated sewage effluent into Sykes Creek and Newfound Harbor at the rate of two million gallons per day, or over 700 million gallons each year.

"Since 1967, no less than 27 reported fish kills have occurred in Sykes Creek, Newfound Harbor and nearby canals. The Sykes Creek area has more fish kill incidents, longer in the season, than any other area of the county.

Studies show fewer different types of marine life than normal, abnormal growth of algae and bottom grasses and decaying vegetation along shorelines, causing odor complaints. The waters are turbid and often get as hot as 95 degrees during the summer.

"In conclusion, the biology of the Sykes Creek area indicates eutrophic conditions demonstrated by heavy propagation of a few species of pollution-tolerant seaweeds and an almost complete lack of a natural balance of healthy water constituents."

Hansel put it more simply: "Eutrophy means dying."

TUDENT COMMENT NO. 14

Indian and Banana Rivers Well Enough to Fight Pollution

The Indian and Banana river lagoons face increasing pollution threats from treated sewage and storm water runoff, but are healthy enough at present to remove the harmful nutrients by natural processes, a Brevard water quality management plan reports.

The plan, prepared by the county planning department, shows how the battle for the rivers' survival is joined:

- Rich nutrients in the treated sewage tend to kill the rivers by causing a too heavy growth of algae, which depletes the oxygen supply and kills the animal life.
- But the rivers' plant life is fighting back to absorb the nutrients, and the rivers remain healthy, despite shallow water, high summer heat and little water exchange through tides and currents.

In the Banana River, the report says, "Continued discharge of nutrients can be expected to substantially increase the process of eutrophication (dying) in some areas where decaying aquatic vegetation is already a problem.

"We cannot expect the adverse effects of storm water runoff from urban and rural areas to be completely eliminated, but will increase with additional developments."

But with all these problems, "The Banana River estuary and aquatic preserve is a clean, healthy body of water capable at present of its own nutrient removal and is also capable of supporting a clean environment to provide for a diverse and rich spawning ground."

In the Indian River, the report says, two package sewer treatment plants on Merritt Island and the Cocoa and Rockledge sewer plants are pouring treated waste into the Indian River.

But "these discharges are not at this time causing a significant degradative influence on Indian River water quality," the report says.

"The Indian River could be classified as a biologically productive estuary capable at present of affording satisfactory conditions for providing spawning grounds for a good variety of fish, shrimp and shellfish."

STUDENT COMMENT NO. 15:

A TODAY Special Report

More than $2.5 million worth of sewage treatment system improvements are "urgently" needed within three years, and millions more will be needed later, to end dangerous pollution threats on Merritt Island and near Cocoa Beach, a new water quality management plan warns.

The plan, prepared by the county planning department recommends short-range spending of:

• $1,720,000 to install two small "package" treatment plants in the unincorporated areas just north and south of Cocoa Beach, now imperiled by pollution from septic tanks and drain fields.

• And $810,000 to combine operations of seven private treatment plants on Merritt Island.

The Cocoa Beach area problems are particularly acute, the report states. "The short-range improvements should be implemented without delay. Any postponement will result in the continuance of a very serious public health hazard and water quality deterioration."

County commissioners intend to purchase six of the seven Merritt Island plants this week, and merge their operations. The seventh, First Florida Utilities, has refused to negotiate sale.

The county has tried vainly for several years to get Cocoa Beach to extend sewer service to the north and south, but city officials have balked on financial details.

The report also proposes long-range spending of $7.3 million on Merritt Island, and an unspecified amount on the beaches for improved water quality between 1975 and 1985.

On Merritt Island, the plan is for a five million gallon a day sewage treatment plant, with pipes and pumping system big enough to handle the area's needs for 20 years to be in operation by 1975 or 1976. By then, it's hoped, all existing small sewage treatment plants and septic tanks will be phased out.

The treated effluent should be disposed of by pumping into deep wells, well below the fresh water supply. The plant would be on a 100-acre site in a presently undeveloped area north of the barge canal and east of SR 3.

The report projects federal funding of 75 percent of the cost of long-range facilities through the Environmental Protection Agency (EPA).

The plan outlines various other short and long-range alternatives to solve the problems, but rejects them as too expensive, impractical, politically unfeasible, requiring too much time or not contributing to eventual establishment of an overall regional utility system.

"The problem on Merritt Island is that some of those plants are not meeting and cannot meet state or federal effluent disposal standards," said Lynn Hansel, Brevard community planner. "Thus, we're talking about an interconnecting program to pipe sewage to the plants which can handle the volume and treat it to the required standards. This interconnection will also reduce the effluent discharge into the Sykes Creek area.

On the beach, Hansel said, "under average conditions sewage from septic tanks seeps eventually into the Banana River. In a high rainfall and raised water table, many of the septic tanks overflow, thus creating another health hazard."

Cocoa Beach may find it difficult to get any EPA funds for future sewer expansion due to its balkiness, Hansel said. "EPA will not touch anything with a severe (water) infiltration problem (in sewer pipes.) The money we planned to give the city for extending its lines would have solved its infiltration problem.

"But the city commission did not feel the agreement (with the county) was satisfactory, so we have no alternative but to propose the two package plants."

The report said the best way to solve part of the problem would be for Cocoa Beach simply to extend its sewer lines into the two "no-man's-land" unincorporated areas. But because of "political feasibility," it recommended the small package plants instead, even though they are a step away from a regional sewer system which EPA prefers.

The unincorporated area between Cape Canaveral and Cocoa Beach includes 140 acres with 770 residents producing 77,000 gallons of waste a day. Potential ultimate population is 3,500 persons and 350,000 gallons of waste daily.

The unincorporated area between Cocoa Beach and Patrick AFB covers 216 acres, including about 1,360 persons producing 135,000 gallons daily. Ultimate population is 3,800 persons and 380,000 gallons.

Financed by a $5,000 grant from the East Central Florida Regional Planning Council, the water plan is a requirement of the U.S. Environmental Protection Agency before it will grant more money to build new sewage plants or improve old ones.

Planning council staff members have reviewed it and suggested minor changes, and the Florida Department of Pollution Control also is studying it. A South Brevard water quality plan is being prepared, and eventually a more detailed countywide plan will be drawn

STUDENT CCMMENT NO. 16:

Estuaries are common target for dredge and fill projects. Shallow water, meandering shoreline, and soft bottom make these areas popular for quick and often poorly planned "waterfront retirement homes." Until recent years most states felt that the developer was doing them a favor by filling the unwanted breeding places for insect pests.

Within the last few years many states have become "dredge and fill" shy. Dredging disasters were common news but many of the side effects have not become known until it was too late. Wild fowl and fish populations were wiped out due to ecological imbalances. Siltation ruined weed beds used for fish breeding frounds. Southern mangrove swamps were destroyed by rapid flooding due to new dykes used for mosquito control. Circulation patterns were changed or in some area eliminated by new construction. Recreational water canals have dried out many shallow, fertile areas.

Physical and chemical pollution added on top of construction changes may well be the factors that cause the death of our estuaries. We as a population have used estuarine areas as a dumping ground since time began for man. Population centers often spring up on the edges of the estuary since it provides access to the sea and often an inland river for transportation. Earlier in our histroy availability of food (fish, fowl, game) was also instrumental in locating population near estuarine areas. It's ironical that the need for food brought man to the estuary and man is destroying the very commodity that he at one time depended on for survival.

Industrial waste, sewerage, storm sewer run-off, agricultural drainage, solid wastes, and garbage fills all contribute their poisons to the Estuary. Stopping these problems and cleaning up the deposits and residuals has one larger barrier -- money: money for new industrial processes, sewage plants, surface recharge areas for run-off and garbage disposal, money lost due to denying development rights, money to buy back previously sold bottom lands (areas submerged that have been sold by the states to individuals).

Ban Bulldozers; Save Rivers and Streams

By TOM McNALLY
(Special to the Melbourne Times)

MTimes-3/21/72

Each year hundreds of miles of America's prime rivers and streams are being destroyed for the sake of what some, mostly politicians, call "progress."

The straightening, channelization, diking and leveeing of waterways is needlessly killing many of this country's most scenic, most important, most irreplaceable rivers and streams.

"Pork barrel projects" — which accomplish little good other than to enrich politicians and certain "businessmen" — usually are to blame for the destruction, if only partial, of valued rivers and streams. But other despoilers are the "highwaymen," or road builders, most of whom couldn't care less that the stream they ravage with their bulldozers was, formerly, a world-renowned trout stream.

In most instances road-builders do not hesitate to launch bulldozers into rivers and streams, where their powerful earthmoving monsters swiftly and efficiently gouge, tear, gut, and destroy the streambed.

The ecological life-blood of any river, stream, or creek is in its bottom. Ravage a streambed, and you ravage the stream!

It is on the floor of a river that life in the river begins. Indiscriminate bulldozing of a streambed kills the nymphal stage of all of the stream's aquatic life in the area bulldozed. It alters the natural flow of the stream and drastically changes its current, and greatly decreases the oxygen content of the water. Bulldozing, or "channelization," causes siltation that consumes a river. Bulldozing devours rapids, bends, eddies, pools, islands, riffles — and the destruction is permanent!

Few American waterways have gone unaffected by "road building" or "channelization." To name just a few of the country's most famous rivers and streams that have been at least partially slaughtered through indiscriminate, unnecessary bulldozing, there is Florida's Kissimmee, Wyoming's Snake, Montana's Yellowstone and Big Hole Rivers and prized Spring Creek (Lewistown), New York's famed Beaverkill, Pennsylvania's Brodhead and Utah's Logan River.

The reckless launching of bulldozers into our rivers and streams continues daily. At times, of course, the channelization, straightening, and bulldozing of a stream's floor is unavoidable, but most of the time such destructive work is totally unnecessary since equally effective alternate projects could be engineered.

In most instances the stated purpose of channelization is to control or prevent floods by speeding the surface runoff of rainwater that falls on a watershed. But what this usually accomplishes is the destruction of the natural features of the land which serve to retard runoff, so the channelization actually increases downstream flooding and erosion, as well as destroying the biological productivity of the original water course, and its adjacent flood plains.

Following channelization of a portion of Utah's Logan River, the Utah Division of Wildlife Resources reported that the Logan River, "once a high quality habitat for wild brown trout, has been torn completely apart and destroyed by ditching, and 1971's brown trout and whitefish reproduction may have been completely eliminated, and the recreational fishing potential of the area has been lost." The Army Corps of Engineers subsequently ordered a halt to "work" on the Logan River — but the damage had been done.

The bulldozing and channelization of rivers and streams is, unfortunatly, common to all areas. Every state has suffered, with many miles of natural streams converted into ditches.

Missions of dollars were spent on the Cross Florida Barge Canal before work was ordered halted after conservation groups mounted a protest heard all the way to Washington, D.C.

Ohio discovered there were plans to "improve," via channelization, 149 of its 309 watersheds. On one Ohio river alone, 190 miles of stream channelization had been planned at an estimated cost of $7,800,000 to federal taxpayers.

Stream channelization is conducted primarily by three agencies: the Bureau of Reclamation (in the west), the Army Corp of Engineers, and the U.S. Soil Conservation Service. The federal Department of Transportation and agencies such as the South-Central Flood Control Disttict also are occasionally involved. Of the three major agencies, however, the one conducting the most extensive channelization projects is the Soil Conservation Service. They are charged with "improving" conditions on small watersheds, and thie is where the bulldozers are most active.

There is much the average fisherman and citizen can do to see that more of our valued streams and rivers are not turned into fishless ditches. They should write their representatives in Congress and in their state legislatures urging them to study carefully "flood control" proposals and to generally oppose reckless bulldozing and channelization of rivers and streams. Letters and petitions also should be filed with state conservation departments, regional offices of the U.S. Soil Conservation Service, and the Commanding General, Army Corps of Engineers, Washington, D.C.

Detailed information on the channelization problem, and what individual and organized sportsmen can do to help solve it, is available in brochure form from the National Audubon Society, R.R. 4, Rolling Hills, Red Wing, Minn., 55066, or from the Society's national office, 950 Third Ave., N.Y.C., N.Y., 10022.

STUDENT COMMENT NO. 18: Filling in the Estuarine Area

Marshes and Swamps Adjoining Lagoons

Filling of swamps and marshes adjoining the coastal lagoon system is widespread in the three-county Coastal Area but has been most common in Central Brevard County. The greatest acreage has been used for homesites, but highway and commercial development are also significant users. Mosquito control authorities have done some filling but this has been limited due to the high cost.

Advantages of salt marsh and mangrove swamp filling are many. Land of little or no direct human utility is made usable, and in fact highly desirable, for building sites. Breeding sites for pests (primarily mosquitos and sand flies) are eliminated and adjoining urban areas are thereby often benefitted. Land values of both swamps and adjoining areas increase and homeowners have the benefit of waterfront locations.

The most widely understood disadvantages involve the direct loss of habitat for fish and wildlife by both the fill itself and siltation of adjoining areas. Less understood are the problems of maintenance created by seawall deterioration, bank erosion, weed growth, dead end canals accumulating trash, dislodged seaweed, floating debris, and polluted storm water runoff and periodic fish kills. The least understood disadvantage is the loss of the marsh's function as a buffer between upland areas and open water, filtering and clarifying water inflows, mixing fresh and salt water and acting as a continuous source of beneficial nutrients and microscopic biological life.

While the complex relationships of this type of filling are not yet fully understood, the following recommendations can assist in solving the problems:

1. Conservation agencies should determine the priority values of various types and locations of estuarine swamps and marshes, map them, publicize their location, and then take formal conservation and preservation action consistent with the value of the area involved.

2. Combine in further studies the efforts of biologists, urban planners, landscape architects, engineers, geographers, and hydrologists to properly relate man's proposed activities to their likely consequences in the natural environment.

3. The filling should be consistent with long-range community (city or county) plan recommendations including those for resource conservation and proposed land use streets and highways, waterways, and public

facilities, including utilities.

4. Public officials in waterfront communities should recognize that major waterfront maintenance problems are involved and prepare adequate building codes and subdivision regulations to alleviate them.

Open Water Areas

Filling open water areas within the coastal lagoon system is without a doubt the most controversial subject regarding dredge and fill operations. Some open water filling has occurred in all three counties but it is least common in Indian River County and most common in Brevard. Filling has usually been accomplished by dredging material from adjoining areas. Small amounts of sand have been trucked in from other locations and occasionally demolition material and waste concrete from mixing trucks are used. These areas are most commonly used for residential homesites, but highways, recreation areas, marinas, sewage treatment plants, port facilities, a rail-road, a hospital, a city hall, and a variety of commerical uses also exist on filled open water areas in the three counties.

Advantages result from a relatively low cost to the developer for high value waterfront property and the high potential aesthetic appeal of such a site. Final property owners benefit from the fill in proportion to the scenic or physical use they make of the adjoining water.

Disadvantages are disruption of the scenic views of other waterfront property owners, destruction of the existing habitat for fish and wildlife, and disruption of adjoining habitat due to siltation or pollution. When intricate patterns of canals are included in the fill complex, the usual maintenance problems mentioned earlier are multiplied. Urban activity is frequently a degrading activity on the natural open water environment. Damage is generally proportionate to the amount of urban activity, and its closeness to the water. Any steps tak n to reduce pollution will assist in mollifying but will never completely eliminate this damage.

Recommendations to assist in solving problems are the equivalent of those suggested above for marshland filling.

STUDENT COMMENT NO. 19: Causeways and Siltation

During 1970, construction of the Pineda Causeway project under the Department of Transportation was begun. In the initial phases of construction the high volume of dredged materials resulted in excessive siltation and turbidity run-off into the Indian River north and south of the project site. During the dredging phases of this project, as a result of water quality monitoring for turbidity by this department at several locations in the immediately affected area, the dredging was halted upon request for turbidity and siltation control on two occasions. As a result of this action, the Department of Transportation experimented with a hanging skirt baffle (diaper) along the toe area of fill construction in an attempt to keep the heavier silt confined and settled in the causeway right-of-way. This method was only partially successful along the west shore of the Indian River especially during periods of heavy wind currents but was more effective on the protected eastern shore of the project. This method of attempting to control siltation and turbidity is in the early stages of development and experimentation in the State. The same method used later in this county on Department of Transportation dredge and fill road construction projects in waters protected from the wind minimized and maintained the siltation in a small selected area. The use of this baffle was successful at the Sykes Creek dredge and fill bridge project and also at S. R. 528-401 widening and cloverleaf project near Port Canaveral. These two projects were accomplished in protected water areas.

TUDENT COMMENT NO. 20: Siltation

Silt consists of finely divided suspended solid particles which exist in varying amounts of bodies of water. Concentrations of silt are measured in parts per million (ppm). The less silt, the clearer the water; as the silt concentration increases, the water grows more and more muddy, or turbid. "Siltation of water bodies does affect the biota (living things) contained in them. The effects are caused by (1) covering bottom materials with a layer of sediment, (2) reducing light transparency and preventing light penetration, and (3) grinding algae by action of abrasive particles."[1] When vegetation is reduced by silt pollution, the population of marine animals which feed on plants also drops, and this in turn limits the number of carniverous animals, including fish. Siltation can also increase the effects of eutrophication (See Student Comment #9, "Eutrophication," p. 32), by transporting organic nutrients produced from bacterial action on sewage considerable distances. These materials can then cause troublesome algal blooms far from the original pollution source.

Studies have established a correlarion between the population of game fish and the levels of silt in ponds. One such study classified ponds into three categories according to turbidity (muddiness). Those with turbidities of less than 25 ppm of silt were considered clear; those with 25-100, intermediate; and those in excess of 100, muddy. At the end of two seasons, the total weight of all fish in the clear ponds was about 1.7 times greater than the aggregate weight of fish in intermediate ponds, and 5.5 times greater than the total for muddy ponds. Largemouth bass were most severely affected. The fish counts reflected the average volumes of plankton in the surface water, which was eight times greater in clear ponds than in intermediate ponds, and 18.8 times greater in clear ponds than in muddy ponds.

Silt Reduces Productivity of Fisheries

As a result of the above and similar investigations, guidelines have been established for fisheries. Silt levels of 25 ppm or less are not considered harmful. Good fisheries can be maintained at levels of 25-80 ppm, but fish yields might be slightly reduced. Waters containing 80-400 ppm of suspended solids are not likely to support good freshwater fisheries, although they might be marginally productive in the lower part of this range. Only poor fisheries could be expected in waters with turbidities of greater than 400 ppm.

Another factor which must be considered, besides the concentration of silt, is the length of exposure. Levels reaching several thousand parts per million might be tolerated for several hours, or even days, by organisms in streams which are ordinarily clean, but continuous applications of such amounts, or even much smaller quantities can be extremely detrimental. Silt is especially destructive to fish eggs and developing fry (young fish), and should therefore be avoided as much as possible in the spawning grounds of freshwater species such as salmon and trout. This can pose a difficult problem, because the quarries, gravel pits and mines which introduce silt into waterways are often located near spawning grounds list, see Student Comment #9, p. 32). Since silt absorbs light, it makes less energy available for the photosynthetic (food-making) processes of green marine plants.[1] The region in the water in which light intensity is adequate to support photosynthesis is referred to as the trophogenic zone. This zone encompasses 99% of the incident light, and may vary in depth from five to greater than 90 feet. Even slight increases in silt levels could cut off the bottom portion of the trophogenic zone, becuase it receives barely enough light to begin with. This, in turn, would probably eliminate some species of plants and eventually disrupt the marine food chain.

One reliable indicator of siltation is the level of bottom-dwelling organisms known as benthic organisms. (For a description of benthic organisms, see Student Comment #9, "Eutrophication," p. 32). Silts affected benthic organisms in much the same way as toxic wastes, but not quite as severely. Unlike organic nutrients, which can be beneficial to certain species even in large concentrations, silt usually reduces both the number of species and the total population of all species, and silt pollution often reduces the algal population instead of promoting it.

--Source not given of Xerox copy

Notes

1. (p. 1 on Xerox Copy)

STUDENT COMMENT NO. 21: "The Spoils System"

Bearded, gray-haired, sun-tanned, 82-year-old Charlie Brick scratches out a meager existence from the Seven Pines Shoal, a $1\frac{1}{2}$ acre man-made island in the Indian River. (See pictures at end of article). Together with his six-year-old mongrel dog "Duke," 25 araucana chickens with barnacles on their legs, and a family of domesticated cardinals, Charlie Brick lives a hermit's existence in a dilapidated little shanty on his secluded island. Charlie Brick hardly ever leaves the island, except to collect his monthly Social Security check of $174.00 which he used to provide the bare necessities for his little "family". Duke has never left Seven Pines Shoal. His main function is to race up and downthe beach, always taking care not to wet his paws, giving vociferous chase to trespassing sea-birds and an occasional unwary powerboat.

•••

Mattie Sapp sits in a multi-colored deck chair on the porch of her island cabin just north of Vero Beach. The evening breeze and the rays of the settin sun are her own company as she fishes for her supper. This is her favorite pastime.

•••

"River rats, scum and trash!" Althea Jaudon, 63, says her family has been called all these names during its 10-year stay on an island in the Indian River north of Fort Pierce. But nothing people said could deter the Jaudon family from systematically building up an island home. Forced to abandon his livelihood as a plasterer and tile layer due to back trouble, Bill Jaudon pitched a Sears-Roebuck tent on the island for his family. Bringing materials over from the mainland in a home-made barge, they gradually built a sturdy bungalow, room by room. Fishing the Indian River and raising fruits and vegetables, the Jaudons carved a little island "paradise" for themselves.

•••

Charlie Brick, Mattie Sapp and the Bill Jaudons are squatters. Their only claim to the islands they inhabit is the fact that they have taken up residence there, in the tradition of the pioneers who homesteaded in the old American West. There is an essential difference, however; these modern-day squatters have set up quarters not on the lonesome prairie, but on tiny islands in the Intra-Coastal Waterway along the east coast of Florida, only minutes away from densely populated area. These islands were created when the Army Corps of Engineers dredged the Indian River (and other waterways) to produce a channel for the Intra-Coastal Waterway. The fill was deposited in certain places in the river, either covering completely small existing islands, or creating new ones. At first the man-made islands were desolate, but after a while some hardy vegetation took hold, and eventually the little islands began to look attractive. For many, they beckoned as recreational areas. For some, like Charlie Brick, they became a home.

But the matter is not as simple as it appears. The sturdy brand of individualism practiced by the spoil island squatters, while harmonious with an American tradition, is not, according to some, entirely compatible with present-day social needs. One critic of the squatter situation is David Harris, a fisheries biologist for the Florida Game and Fresh Water Commission. He reported:

> A significant number of spoil islands have some form of human habitation. P[illegible] have no [illegible]ght to be there. The only right is that they've been there years and nobody does anything about [illegible].
>
> They're a constant and chronic river pollution source. Fecal matter runs overland or leeches into the water, causing significant ecological problems.
>
> The situation is growing worse and wrose. (The squatters) are taking advantage of the public. They get a free ride. And this when most of the public is DESPERATE for recreation areas. When a squatter is on an island, people won't go there -- and especially not when some joker's sitting out there with a .30-.30 or is siccing dogs on them.[1]

Harris' sentiments are shared by many public officials. In fact, there has never been any official recognition of the squatters' property rights. The chief reason they have existed more-or-less unbothered for the past 10 years is not through governmental approval, but rather a conflict in jurisdiction which has kept any one government agency from actually evicting them. The policy of the Army Corps of Engineers has been essentially to "live and let live." Having the authority to police the navigational areas of the Intra-Coastal Waterway, the Corps could clear squatters off the spoil islands simply by dumping some more spoil on their "property." Instead, the Corps has generally termed inhabited islands "unsuitable" for dumping purposes and deposited the fill elsewhere. "The Corps looks very dimly on dumping spoil on somebody's house", one observer commented.[2]

However, an agency called FIND (for Florida Inland Navigation District) is presently trying to regain control of the maintenance of spoil islands. The islands are presently under the jurisdiction of the Trustees of Internal Improvement Fund (TIIF) which, along with the Army Corps of Engineers, has not taken action against the squatters.

If FIND does regain the title to the spoil islands, it intends to remove the squatters, clear the islands, police them to prevent new squatters from moving in, and see that they are used only for public recreation.

If FIND finds Mattie Sapp, Mattie Sapp may soon find herself bumping elbows with the other early-morning fishermen along a well-travelled causeway, instead of her cherished custon of fishing in the "front yard."

•••

And what of 82-year-old Charlie Brick?

Charlie Brick is not one to take matters lying down. "Go to the top to get action", he says. "Don't mess with the middlemen."[3] He proved it by writing to the head man at the Army Corps of Engineers, Washington, D. C. The reply was that it was OK for Charlie to stay, but that the Corps might have to pile spoil on the island. "I don't give a damn how much spoil they pile up", Charlie declared. "Just so's they leave me room to get in and out the door of my place."[4] Charlie Brick still has the letter from the Army Corps of Engineers. He will also show off to his occasional visitor a Christmas card, 1971, from President and Mrs. Nixon.

Charlie Brick expects to stay on Seven Pines Shoal for at least 12, maybe 15 more years. He appears unconcerned by the latest threat to squatters. "They've been trying to get us off the islands since I came out here in 1961", he asserted. "They got a campaign going now -- but they're not going to get anywhere."[5]

-- Bonin, Robert A., "Plight of the Human Barnacles," Tropic, the Miami Herald Magazine, Dec. 24, 1972, pp. 11-14.

Notes

1 - pp. 12 and 14
2 - p. 14
3 - p. 14
4 - p. 14
5 - p. 14

TEACHER COMMENTS

TEACHER COMMENT NO. 1 : Student Evaluation Scheme

Student performance can be evaluated on more than written tests, even though these have their place. Additional areas in which evaluation may take place include visual (poster, charts, graphs), creation, participation in small group and class discussions, oral reports, and general cooperation.

One suggested method of evaluating these and other areas is through a point system in which a higher number of points reflects higher quality. A point scale is established for each area being judged, points are granted either by students or teacher for an individual's performance and each student records his own accumulation of points. This record could take the form of an Individual Point Sheet (I. P. S.) shown on the next page.

Point Sheets are kept for one week at a time by the student who totals his points and then turns them in to the teacher. At the end of a standard grading period, all I. P. S. totals are added and the teacher converts them into a grade.

Categories, other than the ones on the sample I. P. S., may be added at the teacher's discretion. Be creative and award your students for the good they do. Accentuate the positive and eliminate the negative.

The I. P. S. above bears some general explanation. The subject area of Participation includes verbal participation in both small group and class discussion. Points for all written, oral and art assignments are listed under the Oral-Visual-Written section. Voting points are granted to individuals who actually take part in reaching a class decision by voting. Cooperation points are given to those students who listen to others respectfully, follow instuctions, and generally cooperate in all class activities.

Specific ways for granting points in the Participation and Oral-Visual-Written categories are suggested in Student Comment No. 1, pages 20-21, and Teacher Comment No. 2, pages 57-58. Means for measuring other areas should be devised by the teachers.

Individual Point Sheet	
Total Points ____________	Name ____________ Period ____________ Week ____________
Participation Points M. T. W. Th. F. Sub-total ____________	Oral-Visual-Written Points M. T. W. Th. F. Sub-total ____________
Voting Points M. T. W. Th. F. Sub-total ____________	Cooperation Points M. T. W. Th. F. Sub-total ____________

TEACHER COMMENT NO. 2 : Small Group Discussions • Explanation

Small Group Discussion is an effective method used to develop communication, cooperation, self-expression, leadership, creativity, interaction and sharing of ideas and knowledge. These techniques are successful with students in most learning situations.

1. Counting-off
   a. Decide the number of groups needed.
   b. Suggest four to six members in each group.
   c. Start count anywhere in the room with #1 and go to desired number (4-5-6).
   d. Continue counting off until all students are members of a group.
2. Drawing numbers
   a. Same as #1 a. above.
   b. Same as #1 b. above.
   c. Put in a box the desired sets of numbers.
   d. Students will draw from the box a numbered slip of paper which will determine their group.
3. Self-grouping
   a. Arrange fruniture prior to class meeting for desired number of groups.
   b. Choice of location selected by student upon entering the room.
4. Captain-selection
   a. Counts off and selects desired number such as every tenth person from the rollbook. Student has choice of being or not being a captain.
   b. Continue this until the desired number of captains have been obtained.
   c. Position captains at various stations in the room, as selection is being made.
   d. Select team members by captains, each takes his or her turn as the captain had accepted the responsibility
   e. Continue until all members of the class are on a team

The purpose of these tehcniques is to develop a student-centered classroom rather than a teacher-directed classroom. Through these small group discussions, students feel freer to express themselves and some develop leadership skills which are not present in large groups. Other benefits are that students learn to work or cooperate with a variety of their peers and not just the same group all the time. Most students learn to cope with a new situation and, or problem to solve. It is imperative that a teacher strive to allow students to solve their own group problems. Teachers should allow students in small groups to elect their leadership except in #4 (Captain-selection).

Many teachers refuse to incorporate Small Group Discussions in the classroom because they lack a satisfactory evaluation procedure. Of course, teachers can hear and observe all the activity, but comes the old question, "How do I decide if they're doing what I want them to do?". Why bother--allow the students to evaluate themselves and their group. Who knows better what the group has accomplished than the group itself, and not the teacher. A teacher cannot adequately sit-in on all the small groups' discussions and properly evaluate them. Therefore, given one of the evaluation forms in SC # 1, page 20, the students solve the teacher's frustration by evaluating their peers.

TEACHER COMMENT NO. 3: DEFINITION AND DESCRIPTION OF AN ESTUARY

One of the first problems involving estuarine study is that of definition. A precise definition is difficult, if not impossible, in that geologists, zoologists, botanists and other investigators tend to define an estuary in terms exhibiting professional bias.

The term, "estuary", is derived from the Latin, meaning touched or reached by the tides. For our purposes, an estuary will be defined as the mouth of a river open to the sea where the fresh and salt water mix. The amount of mixing is directly affected by the ebb and flow of the tides. This one factor is the primary abiotic variable needed in defining an estuary.

As the distance up the river from the sea increases, the salinity decreases until a zero point is reached. At the interface of the river water and sea water the salinity will be approximately 32^{0}/oo (parts per thousand) while the open sea exhibits a salinity of 33^{0}/oo. The dilution of the salt water is also affected by runoff from the adjacent land areas. This one variable is the primary factor affecting the biota of particular ecosystems along a river as it flows toward the sea, and will be discussed later.

A new estuary generally begins as a deep channel emptying into the sea; however, transported sediments are deposited at the mouth of the river as the current slows. These deposits slowly fill the channel thus causing the river to shallow and spread out thereby forming mud flats; the estuarine shoreline thus becomes crooked and irregular with many shallow dendritic channels.

Sedimentary deposition results in a black, mudlike ooze covering the bottom of the estuary. This ooze is rich in the nutrients so necessary for maintaining the life in the ecosystem. The nutrients are constantly replenished, not only due to sedimentation but also as a result of the continuous decomposition that is responsible for the characteristic odor of the estuarine ecosystem. The tides also perform a function in that they aid in the mixing and overturning of the nutrients and also aid in the exchange of carbon dioxide and oxygen

Many observers consider the estuary the most productive system in the biosphere. In no other area is such a large and diverse biomass found; however it is, again, the salinity which determines the biota of the estuary. Most organisms cannot tolerate wide ranges of salinity, therefore, the varying salinity levels determine the varying floral and faunal populations.

Among the faunal organisms found near the sea are sea stars, sea urchins, rock crabs, sea anemones, and snails of the family Neritidae. The plant population in this area is composed primarily of phytoplankton and a few sessile algae. Obviously, these organisms must be hardy in order to exist in this portion of the estuary and to endure the changes in variables brought about as a result of tidal action.

The flora changes rapidly as the salt flats are approached; the sessile algae are few as a result of being unable to attach to the muck bottom, in their place the coarse-leaved grass of the genus Spartina is observed with broad stands of the genus Juncus also visible. These grasses provide cover and protection for fry and food for other marsh organisms. The edges of the salt marsh are defined by the presence of the family Rhizophoraceae, the mangroves. At the edge of the salt flats are found the salt tolerant Red Mangrove and Black Mangrove. The leaves of the latter are broader than the Red Mangrove and also present are the salt glands at the base of the leaves which act as salinity regulators for the plant. The Black Mangrove also puts out short, spike-like growths, rhizoids, from the roots which are employed in respiration. The White Mangrove appears to be the least salt tolerant of this family in that it is found furthest from the water.

Faunal species in the estuary are quite diverse as most marine species spend some part of the life cycle in the estuary. Arthropods abound -- shrimp and blue crabs are found in abundance as are the hermit crabs. In the grass flats sea horses and pipefish abound. These fish are unique in that the male carries the fertilized eggs and gives birth to the young. Needlefish and puffer fish also are found in large numbers.

As the distance to the sea increases a subtle change is noted as the flora and fauna become more and more of the freshwater species. On occasion, some marine organisms may be found among the aquatic because these organisms are capable of withstanding a broad range of salinity. Seldom however, is the reverse found to be true. For all intents and purposes, aquatic species cannot tolerate salt variation, hence, salinity becomes a limiting factor or barrier to any effort to invade the sea; the two notable exceptions being the freshwater eel and Pacific salmon.

TEACHER COMMENT NO. 4: Major North American Estuaries

Estuaries and lagoons make up 80 to 90 percent of the Atlantic and Gulf coasts, but only about 10-20 percent of the Pacific coast, as can be seen in Fig. 1. Mountain building on the west coast has left little low-lying coastal plain. The coastline is so mountainous that an estuary can form only in the fewplaces where a river or former glacier has cut through the mountains to reach the sea.

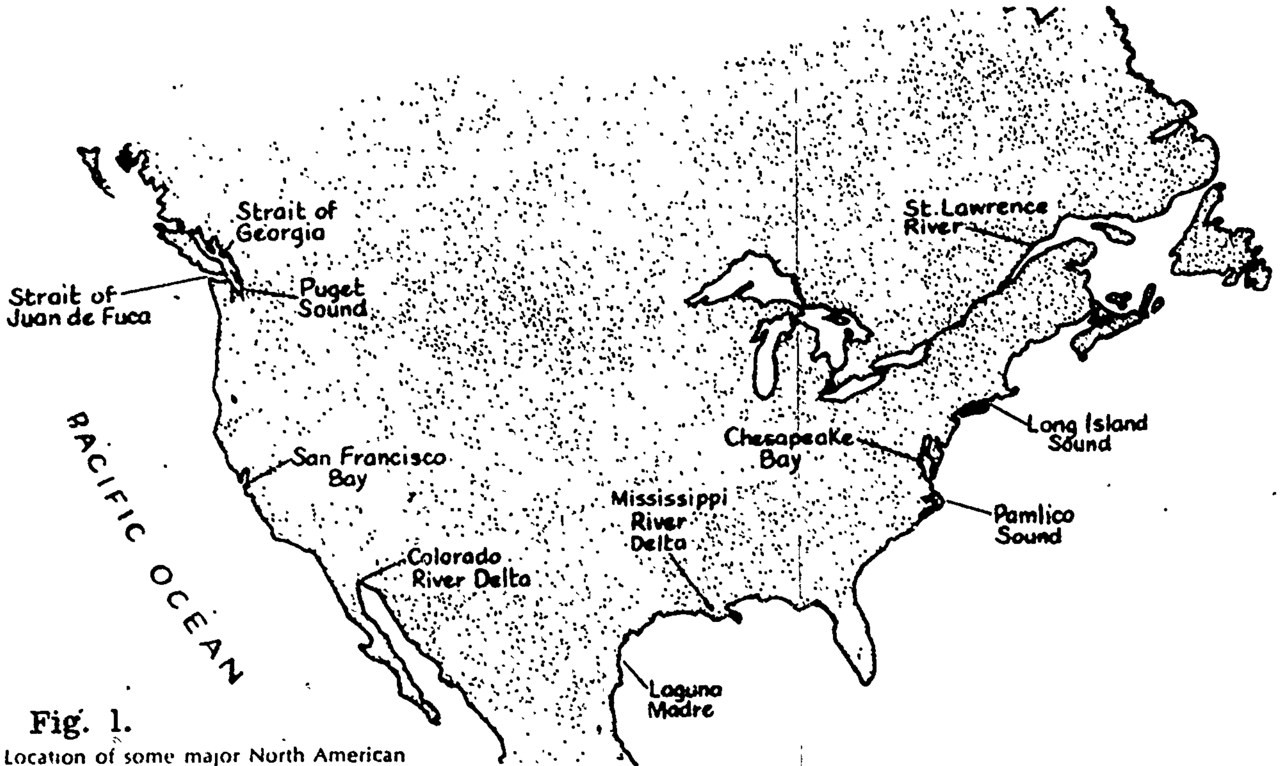


Fig. 1.
Location of some major North American estuarine systems.

On the Pacific coast of the United States, river-drainage basins are generally small. Large desert areas behind the mountains contribute little water to any river system. Much of the rain that falls in the western half of the United States drains into the Gulf of California (via the Colorada River) or the Gulf of Mexico. The largest estuarine systems (Table 1) on the Pacific coast, San Francisco Bay and the Strait of Juan de Fuca system, formed when sections of the continent containing former river valleys sank below sea level because of active mountain building in the region.

CHARACTERISTICS OF SOME NORTH AMERICAN ESTUARINE SYSTEMS

	Estuary area (km²)	Estuary volume (km³)	Mean water depth* (m)	Annual fresh-water discharge (km³/yr)	Land area drained (10³ km²)	Major rivers
Chesapeake Bay System						
(Maryland-Virginia)	11,00	67	6 1	65	110	Susquehanna
Potomac River	1 280	7 3	5 7	12	36	Potomac
James River	650	2 3	3 5	10	26	James
Raritan Bay						
(New York-New Jersey)	230	1 1	4 5	1.8	3 4	Raritan
New York Harbor	159	1 2	7 5	19 4	34 7	Hudson
Long Island Sound						
(New York-Connecticut)	3 180	62	19 4	21	40 7	Connecticut Housatonic
Pamlico-Albemarle Sound						
(North Carolina)	6,630	23.9	3 6	7 8	51	Neuse Pamlico
Strait of Juan de Fuca						
(Washington-British Columbia)	4,370	490	112	nd†	nd†	
Puget Sound						
(Washington)	2,640	185	70	36 5	37 6	Skagit Snohomish
Strait of Georgia						
(British Columbia)	6,900	1,025	156	145	270	Fraser
San Francisco Bay						
(California)	1,190	6 2	5	40	161	Sacramento San Juan
Laguna Madre						
(Texas)	158	1.1	0 9	−0 85‡	nd†	

†nd = no data.
*Mean depth = volume/area
‡Evaporation exceeds river runoff plus rainfall

Gross, Grant M. Oceanography - A View of the Earth. Englewood Cliffs, New Jersey: Prentice-Hall, Inc. pp. 297-298.

Large Group Discussion is probably the most used technique in the classroom. Most of the time this is teacher centered or directed. However, it is possible for Large Group Dicussion to be student centered or directed; therefore, leaving the teacher free to be a listener and evaluator of the discussion.

The room should be arranged so that the students generally face each other and can easily see the chalkbaord. Tables, if available, instead of the traditional desks, enhance the Large Group Dicussion.

Students assume the three following positions: (1) Moderator, (2) Board Recorder, (3) Desk Recorder. These positions are all voluntary and students may choose to be one, two, or all three, not all at once. A sheet of paper for each position may be passed around the room, and students may sign up for any, all, or none of these. When any position is needed, the teacher can just pick one student, starting at the top of the list. Moderator and Board Recorder serve one class period and the Desk Recorder serves throughout the entire Inquiry Question. These positions are excellent for those quiet, shy students who hesitate to express their opinions in a large group. A teacher should award extra participation points to those students who volunteer for these positions.

(1) The Moderator - Responsibilities

A. Calls on students who wish to express themselves.

B. Continues to call on students who wish to speak as long as there is quiet cooperation of the remaining students.

C. Maintains parliamentary procedure. (Simple parliamentary procedure might be explained by the teacher - point of order, call for question, making a motion, etc.)

D. Does not express an opinion.

(2) The Board Recorder - Responsibilities

A. Records pertinent information on chalkboard as directed by students so that the Desk Recorder can make a copy of the information for the class log.

B. May express opinions when recognized by the Moderator.

(3) The Desk Recorder - Responsibilities

A. Records information exactly as it appears on the chalkboard.

B. Acts as secretary when arguments occur over previous material by referring to previous records.

C. Places previous day's work on chalkboard at the beginning of each class meeting. (Keeps class log)

D. Records information on ditto at the conclusion of the Inquiry Question for distribution to members of the class.

This Large Group Discussion technique can be used successfully if the teacher lets it be student directed. Teachers should not interfere or express an opinion, even if called upon by the students. Allow them to work out their own problems, and you act as guide and not the sole authority or intellectual in the room. Offer suggestions sparingly and only if the students get too far off the subject and just can't get back to the business at hand. The teacher should sit with the students at the tables and not at the traditional teacher's desk. Change positions often and refrain from conversing with students because you need to <u>listen</u> to everything that is being said. Remember the teacher is a listener and an evaluator and not the only fountain of information from which the students must drink to quench their thirst.

TEACHER COMMENT NO. 6 : Large Group Discussion • Evaluation

The following checklist is offered as an example of a device which may be used to lend a degree of objectivity to evaluating student participation in class discussions. The teacher may involve students in the evaluative process by devising a rotation system whereby two or three students would evaluate class members during class discussion periods.

When evaluating student comments in class discussion consider the following items:

a. Quantity of student contribution.

b. Content of student's remarks as these indicate knowledge of topic, critical and or innovative thinking by student

c. Relevance of student's remarks to subject under consideration.

d. Clarity of expression and presentation by student.

Based on the four considerations above, points should be awarded on a five point rating scale:

5 points-excellent

4 points-above average

3 points-average

2 points-below average

1 point-poor

Separate points should be given for each comment made by a student and recorded in the appropriate column in the sample Evaluation Sheet for Large Group Discussion below:

Evaluation Sheet for Large Group Discussion

NAME	POINTS	TOTAL
1. Sam Sunshine	4, 3, 4, 2	13
2. Mary Mushroom	1, 5, 2	8
3. Fred Frog	3, 3, 2, 1	9

TEACHER COMMENT NO. 7: Description of Local Estuary Systems

Indian River Lagoon. While known by a variety of names the Indian River Lagoon is here considered to be the lagoon extending 34 miles from Ponce de Leon Inlet to its southern extremity adjoining Merritt Island. Swampy mangrove islands in the northern half restrict open water to deep channels around New Smyrna Beach. Broad shallow channels are obstructed by oyster shell bars further south. The southern half of the lagoon averages seven miles wide and about four feet in depth at mean low water with broad, shallow banks less than one foot deep all around its shoreline. Urban development is common along the shoreline in the northern beaches. Some agricultural development is found, but the southern half adjoins relatively undeveloped land. Pollution exists at the northern end of the lagoon, but is not a problem south of Oak Hill. Much of this is within the Kennedy Space Center and likely to remain undeveloped. Open water accounts for 36 955 acres while swamps cover 13, 392 acres of estuary area.

Indian River. The longest, largest and best known component of the lagoon system is the 122 mile Indian River, 91 miles of which are within the Coastal Area. While generally considered shallow, the largest expanses of water over six feet deep in the Area occur here. The northern end of the river is extremely shallow and extends into a major swamp. Its western bank is quite swamp-free through most of Brevard County, while northern Merritt Island is composed of extensive marshes. Swamp and mangrove islands are common along the river in Indian River County. Depths greater than 12 feet are common from Cocoa to Melbourne. From Melbourne to Valkaria they exceed six feet, but from Valkaria to Sebastian the average depth is about 5 feet at mean low water. From Sebastian to southern Indian River County line, depths average 3 feet with many shallows less than one foot.

Urban development is common along the western shore of Titusville to Sebastian. Pollution varies greatly in the length of the river, being the lightest north of Mims, in the northern Indian River County and in the vicinity of Grant in South Brevard. Septic tanks, sanitary sewer systems, sewage treatment plants, untreated waste from boats, litter, and trash from storm sewers all contribute to the problem. Agriculture lines the shore north of Titusville and in several locations in Indian River County. Major undeveloped shorelines exist on Merritt Island, south of Melbourne Beach and south of Vero Beach. Open water covers 91,686 acres, while swamp and marshes total 23,890 acres.

Banana Creek. Until 1965 this water body connected the Indian and Banana Rivers and thereby provided a means of water circulation and small boat navigation. In that year, a causeway to carry gigantic Saturn Rockets to their launch sites was constructed by the National Aeronautics and Space Administration, blocking the creek. It averages 2,000 feet wide and less than 2 feet deep. It was about 10 miles long originally and had experienced very little development along its shorelines. Except for the NASA installations most of the shoreline remains undeveloped. Pollution is not considered a problem. Open water amounts to 358 acres and marsh 2,920 acres.

Banana River. This large lagoon is 26 miles long and averages between $1\frac{1}{2}$ and $2\frac{1}{2}$ miles wide. Depths as much as 16 feet below mean low water can be found, but average depth is approximately 4 feet. Broad shallow flats exist near the edges of the lagoon except in the constricted southern end. Marginal swamps occur at the northern end. Marginal swamps occur at the northern end on Cape Kennedy, Merritt Island, and on islands separating Banana Lagoon from Banana River. Modification of the land surface for Space Center activities has filled in a considerable amount of swamp and open water for rocket construction sites and causeways to launching platforms. At Cocoa Beach, the Thousand Islands were mainly mangrove but have been filled extensively. A large marshy area lies on the east shore of the river, south to Patrick Air Force Base. The river is considered to be quite heavily polluted. Open lagoon is predominant with 47,676 acres while adjoining swamps and marsh total 11,285 acres.

Newfound Harbor and Sykes Creek. This bay and stream extend from the Banana River northward into the interior of Merritt Island for 9 miles and then a canal extends 6 miles further north. Shorelines are generally swampy with mangrove and marsh to the south and heavily wooded areas furthernorth. Only Horti Point on the southeast lacks this swampy characteristic. Urban development has been quite extensive in recent years from the Barge Canal southward and large acreages of marshland have been filled. Citrus groves are common along the water body but are being partly displaced by subdivisions. Pollution is considered a major problem here, coming primarily from septic tanks, sewage treatment plants, and trash from adjoining urban development. Depths are quite shallow here averaging about three feet. There are 6,782 acres of open water and 1,148 acres of swamp and

and marsh in this hydrographic unit.

Sebastian River. On the Brevard-Indian River County line extending westward is the Sebastian River or Creek. About four miles west of the Indian River it divides into two north and south prongs. The north prong drains southeastern Brevard County and the south prong extends some eight miles into Indian River County. Extensive agricultrual drainage programs have connected major canals to these branches resulting in a greatly increased water and sediment load for the river. Subdivision development has been common in the lower reaches of the stream. Pollution from both urban and agricultural sources has caused major problems here and in nearby portions of the Indian River. Depths are less than six feet at the mouth and become more shallow upstream. Open water covers 489 acres and heavily wooded swamp 180 acres.

TEACHER COMMENT NO. 8: Sewage Treatment

BACKGROUND: After sewage is collected in public sewers and brought to a central point, it may receive only primary treatment or perhaps primary and secondary treatment. In a few instances it may also receive tertiary treatment. These are general terms used to describe the degree to which waste water is cleaned before it is put into a river or lake or used again. Since sewage treatment plants are not all alike, you may see different methods of treatment than those mentioned here if you visit the treatment plant in your community.

If we continue to use water to move sewage and organic wastes and still expect relatively clean streams, rivers, and lakes; we must properly process our huge quantities of sewage and wastes so they will not pollute streams. This is the purpose of sewage-treatment plants. Cities and towns usually construct and operate their own central sewage-treatment plants. In addition to receiving the sewage from homes, hospitals, garages, hotels, and other businesses; they generally serve some industries. However, numerous industrial plants maintain their own facilities for treating sewage before redirecting the water they've used back into the river.

Although new plants and additions to existing plants are being constructed, cities and towns generally are not building sewage-treatment plants fast enough to keep up with the need for them. Many cities and towns use sewage-treatment plants designed and built years ago, and these are overloaded as the cities and towns grow in size and people use more water. In many large cities, storm drains built to handle the runoff from city streets flow directly into the sewer system. When there is much rain, the great amount of runoff cannot be taken care of by the sewage-treatment plant, so some effluent flows directly into a river or lake, carrying raw sewage along with it. Ideally, storm-drainage systems and sewer systems should be completely separate, but this is a very expensive type of operation.

The newer city and urban type of design planning insists on separation of utility drainage and sewage systems but most planning studies have shown that the cost is too prohibitive to attempt redesign of a large city combined facility.

The decision to the specific method of treatment to be used, depends larely on the strength and quantity of the sewage in relation to the nature and volume of the water (river, stream, lake, reservoir) into which the treated waste water is to be discharged.

Primary Treatment. This mainly involves removal of the solids from waste water. This type of treatment is the only kind many towns use, but there are different methods of accomplishing it. The first step in primary treatment is usually some type of screen to trap the sticks, rags, and other large objects. Or all the sewage may pass through a grinder that chops up these large objects. In the next step, the sewage moves slowly through a grit chamber where stones, sand and other heavy inorganic materials sink to the bottom and then are removed from the chamber. Nest, the waste water -- also called effluent -- goes to a settling tank; it stays there long enough for organic matter and fine particles of other material to settle so they can be collected, and to to allow scum and grease to float to the surface where they are skimmed off Certain chemicals can be added to the settling tank to cause the fine particles to cling together and settle out faster.

In primary treatment, the effluent from the settling tank is discharged into a river or stream or allowed to soak into the land. Sometimes, as the effluent flows out of the settling tank, it is treated with chlorine to kill harmful bacteria.

The collected solids -- called sludge -- from the bottom of the settling tank then go to a sludge chamber or digester where decomposing bacteria go to work on them. The digested sludge then goes to a drying bed and after it is dry it may be burned or buried or it can be put on the land as a soil conditioner-fertilizer.

In terms of reduction in Biological Oxygen Demand, Primary treatment results in a 40% reduction (approximate).

Secondary Treatment. Often, the effluent resulting from primary treatment is not clean enough, so secondary treatment is not clean enough, so secondary treatment must be practiced. In secondary treatment, the waste water goes through all the steps in primary treatment and then through one of two processes for further organic decomposition of wastes. Both processes depend upon biological action and both require oxygen, the oxygen is supplied by spraying the effluent into the air or by pumpint air into it (aeration).

In one of the processes, the effluent goes from primary settling tank to a trickling filter in which it passes slowly over stones or other material where biological growth decompose the waste still in the effluent. The purpose of the stones and other material in the trickling filter is not to filter out the solids but to provide as much surface area as possible where there is oxygen so that the biological growths can live and do their work in the other basic secondary process, effluent from the primary settling tank goes into a sludge tank where activated sludge -- material that has various biological growths in it-- completes the process of decomposing organic materials. While the effluent remains in the sludge tank, it is continuously aerated.

The effluent from either the trickling filter or the activated sludge tank then goes to a secondary settling tank to the sludge chamber or digester. As it flows from the secondary settling tank, the effluent is treated with chlorine before being released into a stream, river, or lake, or being allowed to soak into the earth

BOD is reduced an additional 45-55% for a total of 85-95% BOD removal. Costs mount rapidly when 90% BOD removal is approached.

Tertiary Treatment. But even secondary treatment doesn't get waste water clean enough in some situations. So tertiary treatment is used after the waste water goes throguh primary and secondary treatment. After tertiary treatment, the waste water is actually clean enough to be run through a city's water-treatment process for water to be used in homes.

Very little waste water now receives tertiary treatment, and there is no typical tertiary treatment plant. The process used depends upon the specific need for further treatment of the effluent after it has received secondary treatment. Tertiary treatment consists of slow or rapid filtering of the effluent through sand to remove dissolved solids. It could be aeration to foam out detergents. It might be by use of chemical precipitation with alum or silica to settle out solids. Or it could be superchlorination followed by dechlorination to ensure killing of harmful bacteria and disease-bearing organisms.

One important thing to remember is that waste water properly treated is no longer water wasted. It is good water and can be used again. Another important fact is that treatment of waste water helps prevent the great damage that sewage and organic wastes do when they get into streams, rivers, and lakes. As we traced the different methods of treating waste water, you may have observed that all sewage treatment is similar to nature's endless chemical and physical water-purifying processes. But nature's processes take a long time and they simply cannot take care of the huge amounts of waste man wants to get rid of each day. Primary, secondary, and tertiary waste-water treatment does the same thing nature does, only faster and under controlled conditions. Why don't all cities and industries treat their waste water so they can use it again? It is primarily a matter of high costs.

Soil and Water Conservation, Boy Scouts of America, New Jersey, 1968.

TEACHER COMMENT NO. 9: Estuarine Alteration

Table 2 presents in tabular form the total amount of alteration which has occurred in estuaries of the Coastal Area through 1965. This section will explain the simplified form the physical changes which have occcurred in coastal hydrology since the beginning of Eurpoean settlement. The judgement of the public purpose, effectiveness, advantages and disadvantages must of necessity, be left to those competent in the fields of engineering, mosquito control, zoology, marine biology, etc. The extent of alteration should be something of which all are well aware.

The following categories of alteration were used in the study:

1. Fill extending above mean high water.
2. Fill not extending above mean high water.
3. Shoaling caused by works of man.
4. Diked marsh or swamp.
5. Diked and flooded marsh or swamp.
6. Dredged areas evident from aerial photography.
7. Marsh or swamp ditched for mosquito control.
8. In addition to the above alterations, shoreline was considered altered if either urban or agricultural development came to within 500 feet of the edge of the estuary.

The evidence indicates that mosquito control works, which include some fill but mainly ditching, diking, or flooding swamp and marsh areas are by far the most extensive type of alteration. Alterations for navigational purposes are next in the area: causeways and other public works are third in extent, while private alterations are fourth.

Several types of alteration have not been included in these determinations due to lack of basic information. Pollution of varying types and degrees are known to exist in many locations but has not been considered here. Siltation not resulting in major shoals is not evident without detailed studies on location and is therefore not included. Changes in biological composition of the estuary are not known in sufficient detail to be included.

The Coastal Area. East Central Florida Regional Planning Council Staff, Titusville, Florida. October 1969, pp. 11-12.

Table 2

[illegible] ALTERATION IN [illegible] EAST CENTRAL [illegible]

	Total Estuary Area			Total Area Altered			Total Shore Line	Shoreline Affected
	Open Water	Swamp	Total Estuary	Open Water	Swamp	Total		
Coastal Volusia County								
Area	31,714	28,203	60,425	2,670	7,491	10,161	359.3	62.9
Percent Altered				8.4%	26.6%	16.8%		17.5%
Coastal Brevard County								
Area	145,587	30,945	176,561	7,050	9,102	16,152	600.1	251.1
Percent Altered				4.8%	29.4%	9.1%		41.8%
Coastal Indian River County								
Area	16,812	7,122	24,104	1,430	4,791	6,221	151.7	77.4
Percent Altered				8.5%	67.3%	25.8%		51.0%
Total Coastal Area								
Area	194,113	66,270	261,090	11,150	21,384	32,534	1,111.1	391.4
Percent Altered				5.7%	32.3%	12.5%		35.2%

NOTES: Estuary data is given in acres; shoreline data is given in miles.
Total estuary includes island areas not included with open water and swamp data.

STUDENT COMMENT NO. 35: Describing A Community (Quadrat Construction)

MATERIALS: 1 meter stick, 4, 12" wooden stakes, 25 meters of a heavy cord such as chalkline, hammer, 4 thumbtacks.

In making population samples, one of the more effective methods involves employing quadrats. A quadrat may be defined as an area, or site, whose adjacent sides are at right angles to each other (these sides may be of any workable dimension). A convenient size for a quadrat is 1 m^2.

In laying out the quadrat, a random base point, A, is established and a stake is driven into the ground at that point. Points B, C, and D are then located by the obvious method of laying out a square whose sides are each 1 m in length. Having established all four points by means of wooden stakes, a cord is run between adjacent stakes and secured to the stakes by thumbtacks. Strings AB & CD are marked off in 10 cm sections; a cord is tied at the first mark on AB and the other end tied to the corresponding point on CD; this procedure is repeated on each of the marks until ten cords are attached to cords AB & CD. Cords AD & BC are marked in a similar manner and similar cords attached. If this procedure is followed, a quadrat of 100 cm^2 squares will result.

The horizontal rows are labeled alphabetically, while the vertical rows are numbered; thus a given square may be identified by row and number, such as C- 4, designating the square 3 rows up from the bottom and four rows in from the left.

STUDENT COMMENT NO. 36: A Study of Flora and Fauna of a Community

BACKGROUND: The character of any community is primarily determined by the plant life present. Since plants are the dominant features they are more often than not used to determine the name of the community. More subtle is the effect these dominant plants play in determining the types of animals present. Since they serve as a food source, only those animals that feed on them are likely to be present. In this study the students are given methods to describe the plant community. With a knowledge of the plant life present, perhaps a better understanding of the animals will be gained.

PROCEDURE: It is not imperative to know all the plant species but would enhance the value of the study if the major plants are known. Those of seemingly lesser importance can be given common names agreeable by all. For that matter, all the plants can be given common names. However, the students should be familiar with them so that they can all give the same plant the same name.

At the selected site students should make a square meter with the meter sticks (see SC# 4). The plant counters should count all the plants of each species within the square and record the information. The animal recorder's sole responsibility is to observe the plot for all animals present or signs of animals (tracks, feces, holes, etc.) and record the data (numbers aren't necessary for animals unless desired).

RESULTS:

1. Relative density - a calculation of the percentage of the total plant count a certain species is. From the list count the students should:

   a. Count the total number of all species.

   b. Count the total of each species.

With these data use the following formula to calculate the relative density of each species:

$$RD = \frac{\text{total number of species X}}{\text{total number of all species}} \times 100$$

2. Frequency - density of a species in a given site. If the number is low, the species may be one that occurs in patches. If the number is high, the species may be one that is prevalent in the study area. Use the data from all the different sites according to the following formula:

$$\text{Frequency} = \frac{\text{no. of sites in which species X occurs}}{\text{Total no. of sites}} \times 100$$

The students should calculate the frequency of each species, placing the results in a chart beginning with the highest and ending with the lowest frequency.

3. Graph the species area curve, which is an analysis of the sample size. It indicates whether or not the sample size was large enough to adequately describe the general site under study. The following steps should be followed:

a. Using a piece of graph paper, prepare on the horizontal axis the number of sites in the sample. On the vertical axis, prepare a scale that includes the total number of species in the study. At site #1, the total number of different species encountered should be graphed. At site #2, a count should be made of the number of new species encountered, ie. - the number of species that are different from site #1. The procedure is repeated for site #3. All the new species encountered in site #3 that are different from site #1 and site #2 are graphed. Repeat the procedure until all sites have been graphed. Repeat the procedure until all sites have been graphed. Interpretation is based on the type of curve obtained. If the sample size is large enough and therefore valid, the curve should level off. If the sample size is not large enough, new species will still be encountered, therefore causing a continued slope in the line.

4. Analysis of the animal data. The list of animals observed directly or indirectly, should be listed on the board. From this list, the student should attempt to diagram the probable food web for the community. Reference texts should be made available so that the source of food for the animals can be determined by the student.

DISCUSSION:

1. From your relative density calculate which of the plants seem to be the most frequent.
2. What are some of the rarer plants of the community?
3. Based on your data, what do you think this type of community should be named?
4. Which species seems to be found everywhere in the community? What was the frequency?
5. Which species seems to be found in only one spot of a few places? What was the frequency?
6. According to your species area curve, was your sample large enough? How do you know?
7. From your animal data, which animals seem most prevalent?

CONCLUSION: Make a general statement based on your results on each of the following:

A. The name you gave to the community.
B. The frequency of plants in the community.
C. The relative density of plants in the community.
D. The sample size of your study.
E. The animals of the community.

REFERENCES:

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Smith, Robert Leo, Ecology and Field Biology, Harper and Row, New York and London, 1966.