DOCUMENT RESUME

ED 141 145 SE 022 667

TITLE Where Have All the Menhaden Gone? A Learning Experience for Coastal and Oceanic Awareness Studies, No. 209. [Project COAST].
INSTITUTION Delaware Univ., Newark. Coll. of Education.
SPONS AGENCY Office of Education (DHEW), Washington, D.C.
PUB DATE 74
NOTE 27p.; For related documents, see SE 022 662-687; Contains occasional light type

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS Elementary School Science; *Elementary Secondary Education; *Instructional Materials; *Marine Biology; *Oceanology; *Population Trends; Secondary School Science; *Teaching Guides; Units of Study
IDENTIFIERS *Fish; Project COAST

ABSTRACT

This unit focuses on the concept that populations of marine organisms are unevenly distributed. It is designed for upper elementary and secondary school students and will take 6-10 class periods. Students become involved in identifying various causes of the uneven distribution of marine populations, especially that of the menhaden population. Because no conclusive evidence is given that supports any one cause of the decline, the students are faced with the dilemma that there are no actual answers to the problems. Included in the unit are student materials, teaching suggestions, transparency masters, evaluation materials, and selected references. (RH)

WHERE HAVE ALL THE MENHADEN GONE?

A Learning Experience for
Coastal and Oceanic
Awareness Studies

Produced by

MARINE ENVIRONMENT CURRICULUM STUDY
MARINE ADVISORY SERVICE
UNIVERSITY OF DELAWARE

and

POPULATION-ENVIRONMENT CURRICULUM STUDY
COLLEGE OF EDUCATION
UNIVERSITY OF DELAWARE

as part of a

PLAN FOR ENVIRONMENTAL EDUCATION

Fall 1974

Please send evaluations

of learning experiences

to

Dr. Robert W. Stegner, Director

COAST Project

310 Willard Hall Education Building

University of Delaware

Newark, Delaware 19711

Supported in part by

OFFICE OF COASTAL ZONE MANAGEMENT(NOAA)

DELAWARE SEA GRANT COLLEGE PROGRAM(NOAA)

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TITLE: WHERE HAVE ALL THE MENHADEN GONE?

*CONCEPT: I.B.4.b.(2)

I. The earth is a finite natural system.

B. All living things have arisen from and are dependent upon the natural system of the earth.

4. The interaction of organisms with their environment leads to great diversity and wide distribution of organisms.

b. Physical and biotic forces influence the distribution of organisms.

(2) RESPONSIVENESS TO ENVIRONMENTAL CHANGES AFFECTS DISTRIBUTION OF ORGANISMS.

**MARINE CONCEPT: 3.23

3. Marine organisms interact in complex ecosystems.

3.2 Marine organisms are adapted to their environment in different ways.

3.23 POPULATIONS OF MARINE ORGANISMS ARE UNEVENLY DISTRIBUTED.

SUBJECT: Science

GRADE LEVEL: 6-8

PERIODS: 6-10

AUTHOR: Davis

*From A Conceptual Scheme for Population-Environment Studies, 1973. Cost $2.50.
**From Marine Environment Proposed Conceptual Scheme, 1973. No charge.
Both conceptual schemes are available from Robert W. Stegner, Population-Environment Curriculum Study, 310 Willard Hall, University of Delaware, Newark, DE 19711.

R876

INTRODUCTION

As the title "Where Have All the Menhaden Gone?" suggests, the purpose of this unit is to try to determine the cause or causes of the recent decline of the menhaden industry along the Atlantic Coast north of the Chesapeake Bay. This unit is especially concerned with the Delaware menhaden industry. It is important to realize that there is currently not enough information available to determine the actual causes of the decline. As a result, there are no clear-cut answers to the question posed in the title.

This unit focuses on the concept that populations of marine organisms are unevenly distributed. Students will be involved in identifying various causes of the uneven distribution of marine populations, especially that of the menhaden population. Because no conclusive evidence is given that supports any one cause of the decline, the students are faced with the dilemma that there are no actual answers to this problem.

INSTRUCTIONAL OBJECTIVES

At the conclusion of this unit, each student will be able to:

1. Tell where menhaden can be found.
2. Describe the menhaden's physical appearance.
3. Outline the life cycle of the menhaden.
4. List the commercial uses of menhaden.
5. Prepare a graph illustrating the trend in fish landings.
6. Analyze and explain the information given in the graph.
7. Describe how a school of menhaden is located and caught.
8. List at least five natural causes of variations in marine populations.
9. List at least three man-made causes of variations in marine populations.

TEACHER BACKGROUND

The teacher should read each of the student readings and be familiar with the questions and activities which follow each reading.

The first student reading describes the physical appearance, life cycle, and commercial uses of menhaden. The second reading includes statistics for the past thirty to forty years of menhaden landings and an explanation of the method for finding and catching menhaden. The third reading suggests various possible reasons for the decline in menhaden population in the area offshore Cape Cod to the Chesapeake Bay. The reading classifies these reasons into natural and man-made causes.

For more information, the teacher should also read pages 20-39 and 168-200 in Our Changing Fisheries, edited by Sidney Shapiro. Although somewhat technical, the book is interesting reading.

Instructional Procedures

Period	Teacher Directions	Student Activities	Materials Needed
1	Give pre-test to students. Write concept 3.23 on chalkboard. Ask students what they think the concept means and how the concept is related to the title "Where Have All the Menhaden Gone?" In the discussion of the title, you will be able to determine if the students are aware of the recent decline of the local menhaden industry.	Take pre-test. Participate in discussion of concept 3.23 and the title of this unit.	Pre-test.
2	Distribute Student Reading 1 and Activity Sheet 1. Allow students ample time to complete the reading and activity sheet. Have transparencies 1, 2, and 3 and an overhead projector available for student use. Instruct students to use transparencies when they are referred to in the reading.	Read Student Reading 1 and complete Activity Sheet 1.	Student Reading 1 Activity Sheet 1 Transparencies 1, 2, and 3 Overhead projector
3	Distribute Student Reading 2 and Activity Sheet 2. Allow ample time for the students to complete the reading and activity sheet. Let students work in small groups while they complete Activity Sheet 2. Have graph paper available.	Read Student Reading 2 and complete Activity Sheet 2.	Student Reading 2 Activity Sheet 2 Graph paper

Period	Teacher Directions	Student Activities	Materials Needed
4	Use this period to allow slower students to catch up. Find out what the students have learned by discussing the two readings. Discuss question 5 on Activity Sheet 1. List suggestions on chalkboard. Discuss and analyze the graph in question 1 on Activity Sheet 2. Also discuss question 3 and add suggestions to the list above.	Complete activity sheets 1 and 2. Have activity sheet answers available for use in a discussion.	All materials used in periods 2 and 3.
5	Distribute Student Reading 3 and Activity Sheet 3. Allow ample time for students to complete the activity sheet. If time allows, discuss lists which students have prepared.	Read Student Reading 3 and complete Activity Sheet 3.	Student Reading 3 and Activity Sheet 3.
6	Finish discussion started during period 5. Give post-test.	Take post-test.	Post-test.

Student Reading 1

THE ATLANTIC MENHADEN

The Atlantic Menhaden, also called mossbunker, bunker, pogy, and fatback, is a herring-like fish found in the Atlantic Ocean off the coasts from Nova Scotia to Brazil. It is the most abundant fish along the eastern coast of the United States. (See Transparency 1.)

The menhaden is a filter-feeding, plankton-eating fish with a body shaped like a flattened football. Its mouth and head are large. It has no teeth. Yellowish fins, silver sides, and a bluish top give the menhaden a brassy appearance. There is a dark blotch followed by smaller spots on the upper part of the body, directly behind the head. (See Transparency 2.)

The menhaden grows quickly. It weighs about one-half pound when it is a year old and approximately two-thirds to 1 1/2 pounds when it is an adult. It ranges in length from twelve to eighteen inches as an adult.

Relatively little is known about the menhaden's spawning time and habits. Its breeding grounds are in the ocean over the continental shelf. It is believed that most spawning takes place in December, January and February off the coast of North Carolina. Spawning also occurs along the coasts from Delaware to Florida from November to March, and from Massachusetts to New Jersey from May to October.

A single female may release from 40,000 to 70,000 eggs at one time. After they are fertilized, the eggs float near the surface and hatch in about two days. The larvae soon enter the estuaries. Eventually they move to the river tributaries where they feed and grow until they reach the juvenile stage of their life. As adults, the menhaden may return to the ocean where they generally school in nearshore waters. Here they spend the remainder of their lives probably moving up and down the coast--north in the spring and south in the fall. (See Transparency 3.)

The feeding habits of the menhaden change during the course of their lifetime. Zooplankton (small, floating animals) serve as the main food source for the larvae. The adult feeds upon both phytoplankton (small floating plants) and zooplankton.

Even though the menhaden supports the largest commercial fishing industry along the Atlantic and Gulf of Mexico coasts, its primary use is not as food for man because it is very oily. Although menhaden are eaten in the West Indies and in some places along the United States coast, the menhaden is primarily caught to be processed into oil and fish meal.

Fish meal, rich in protein, is used as domestic animal feed. The oil is used in paints, varnishes, soaps, lubricants, inks, cosmetics and pharmaceuticals. The residue remaining after oil and meal production can be used in the manufacture of fertilizers. Another commercial use of the menhaden is as a bait fish in other fishing industries.

The menhaden's value as food for larger fish may be even more important than any of its direct commerical uses.

Activity Sheet 1

THE ATLANTIC MENHADEN

Directions: Answer all questions below. You may refer to the reading for help.

1. If you were a commercial fisherman, where would you look for menhaden?

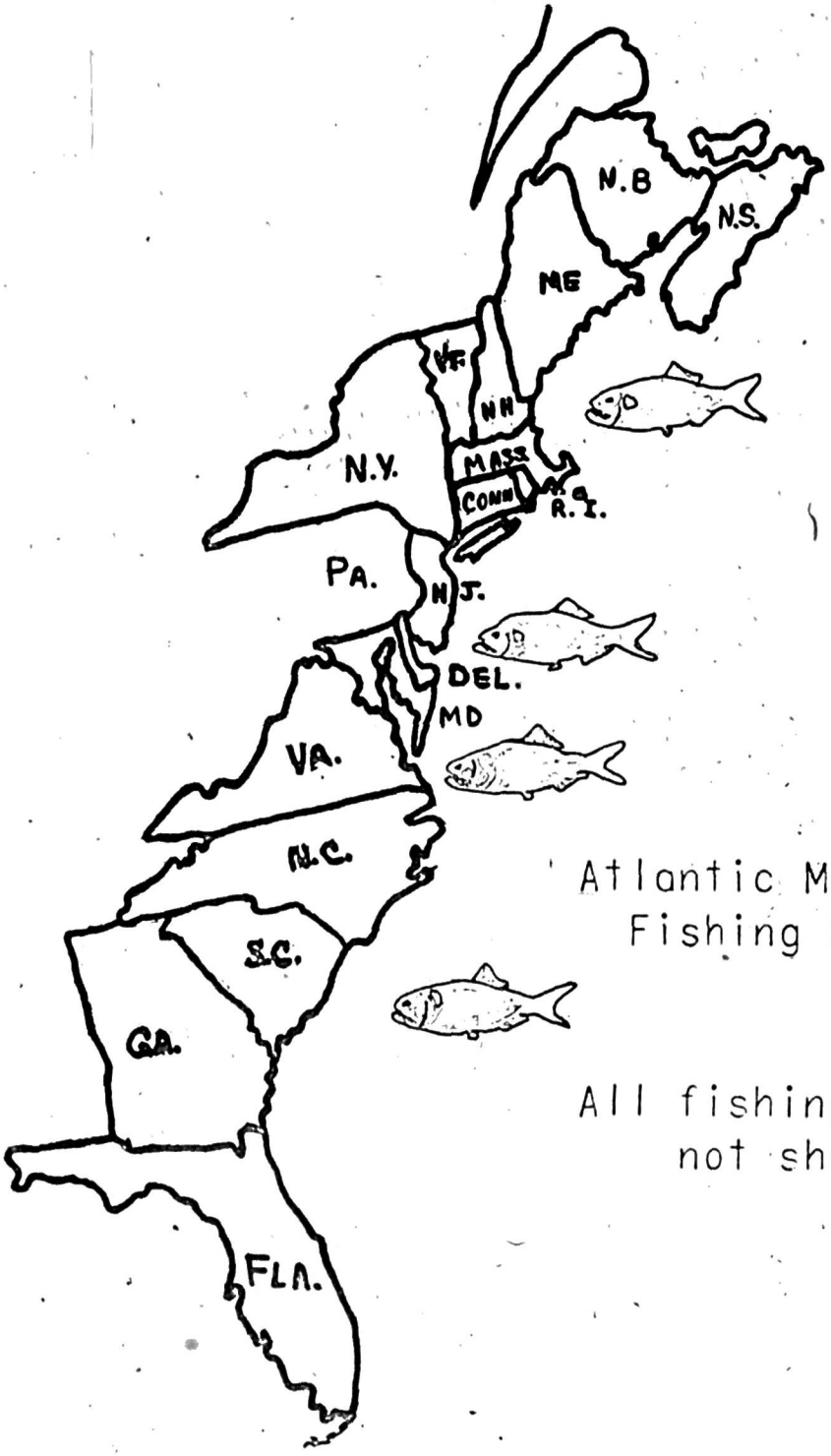
2. Where does the menhaden spawn? When?

3. Outline the major stages in the life cycle of the menhaden. What is the menhaden's main food source at each stage of its life?

4. Explain why the menhaden is an important commercial fish.

5. During the 1950's and early 1960's the menhaden fishing industry was quite large in Delaware. From about 1965 to 1968 the industry declined and soon after all fishing operations in this area had to be discontinued. The fish seemed to disappear. What do you think are some reasons for their disappearance? List them.

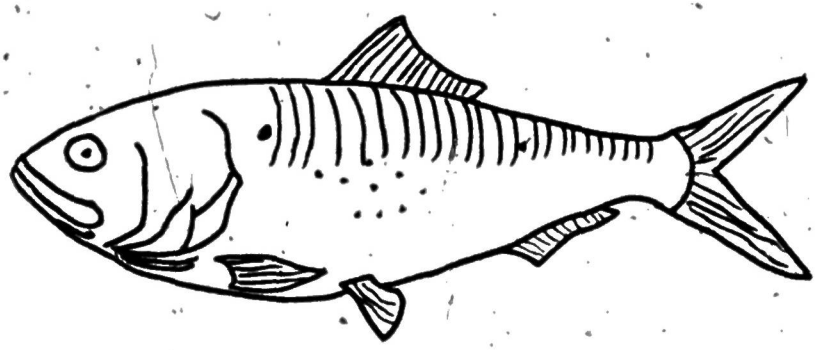
Transparency 1



Atlantic Menhaden
Fishing Grounds

All fishing grounds
not shown.

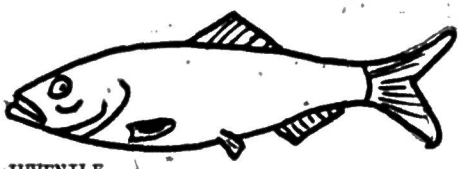
TRANSPARENCY 2: ATLANTIC MENHADEN



ADULT

LARVA

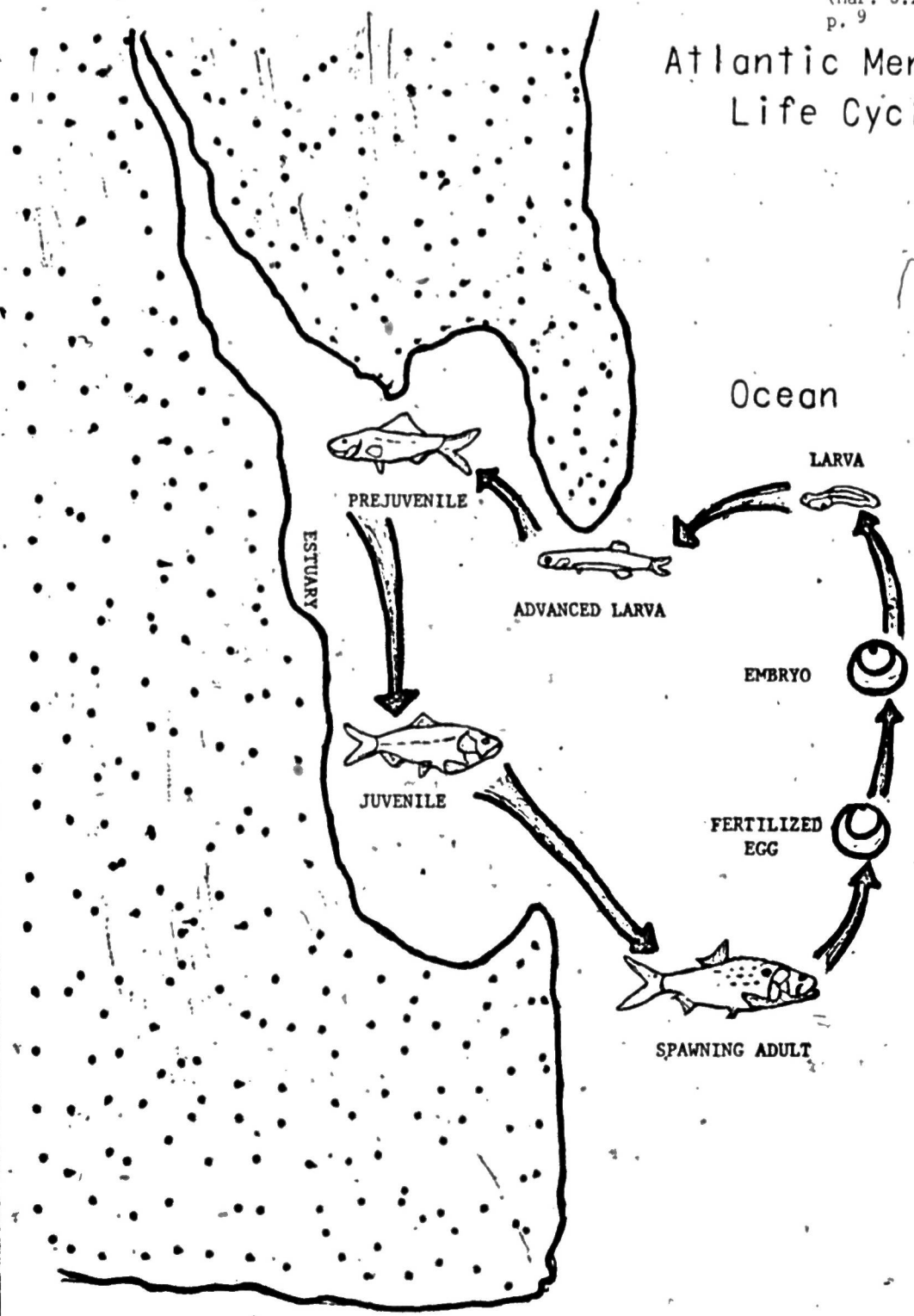
EGG



JUVENILE

Transparency 3

Atlantic Menhaden Life Cycle



Student Reading 2

THE MENHADEN INDUSTRY

The menhaden industry is the largest fishing industry in terms of the quantity of fish caught annually. Economically, however, the menhaden has a lower dollar value than other fish. For example, the total number of pounds of fish and shellfish caught in the area from Cape Cod to the Chesapeake Bay in 1968 was about 700 million pounds, valued at $69 million. Over 50% of this catch consisted of menhaden, but the menhaden were valued at $4.9 million, only 14% of the value of the total catch. In comparison, the 55 million pounds of blue crab caught were valued at $6.7 million.

There have been considerable variations in the annual menhaden catch from Cape Cod to Chesapeake Bay each year. The table below shows the estimated pounds caught in various years.

Year	Estimated Pounds
1930	50,000,000
1935	200,000,000
1940	400,000,000
1945	700,000,000
1947	900,000,000
1950	700,000,000
1953	1,300,000,000
1955	1,400,000,000
1956	1,600,000,000
1958	1,200,000,000
1959	1,500,000,000
1960	1,300,000,000
1962	1,300,000,000
1964	600,000,000
1968	over 350,000,000

(Taken from Important Fisheries of the Atlantic Coast, A Supplement to the Sixteenth Annual Report of the Atlantic States Marine Fisheries Commission, Sept., 1958, pp. 22-23; and Henry, Kenneth A., et al., "Atlantic Menhaden...A Most Abundant Fish," Marine Resources of the Atlantic Coast, Leaflet No. 2, Oct. 1965. Atlantic States Marine Fisheries Commission.)

These statistics show the variations and trends in the menhaden industry. It should be noted that the decline in the number of pounds of menhaden caught has continued to the present. As a result the menhaden processing plants in Delaware have been shut down.

Modern techniques are used to enable to industry to operate efficiently. Since menhaden swim in very large and dense schools near the ocean's surface, "spotter" planes can be used to locate schools and direct the catch by radio-telephone. Ships equipped with radar also help locate the menhaden.

The actual catch is accomplished with two kinds of boats and a crew of twenty to thirty men. (See Transparency 4.) The carrier vessel is from 100 to 200 feet long. Most can carry 125 to 350 tons of fish. Two purse boats are carried to the fishing area by the carrier vessel. Purse boats are thirty to forty feet long and crewed by ten men.

As the carrier vessel cruises the sea, a lookout or the ship's radar scans the water in search of the menhaden. The sighting of a school of menhaden may also be radioed to the carrier vessel by small search planes.

When a school of menhaden is sighted, the boats and their crews quickly move into action. Ten-man crews board the purse boats which are then lowered into the water. The purse seine, a large net, is placed aboard both boats, with half of the seine in each boat. The purse seine is over 1,000 feet long and 60 feet deep. As the purse boats approach the school, they begin to separate, moving in opposite directions and setting the net around the school.

When the school is completely encircled, the bottom of the net is "pursed." This is accomplished by heaving a lead weight called a "tom" overboard. As the 300-pound weight sinks, it pulls a purse line which closes the bottom of the net in much the same way a drawstring closes a bag. Once the net is pursed, the fish cannot dive under and out of the net.

The carrier vessel then pulls alongside the purse boats, forming a triangle. The entire net of fish is trapped within the triangle. A large suction hose is then lowered into the net to suck the fish from the water. The fish are then dumped in a hopper which lets the water drain through. Finally, the fish are dumped into the hold of the carrier vessel. A single catch can net as many as 100,000 menhaden.

The seine is then rearranged on the purse boats which are then hoisted back onto the carrier. Cruising is resumed in search of another school of menhaden.

Activity Sheet 2

THE MENHADEN INDUSTRY

Directions: Answer all the questions below. You may refer to the reading for help.

1. Using the table on p. 10 prepare a graph showing pounds landed (vertical axis) as a function of the year (horizontal axis). After completing the graph, answer the following questions:

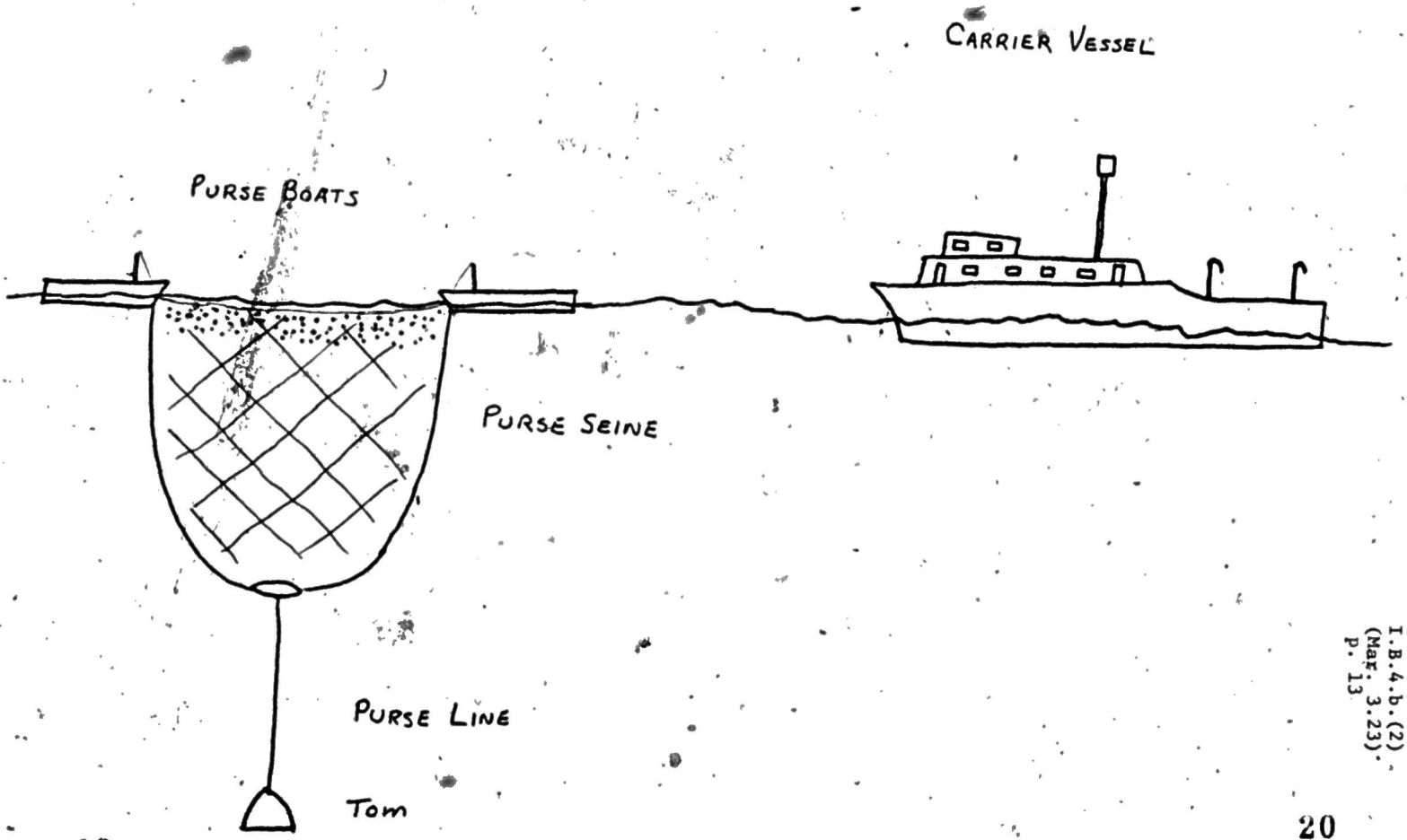
   a. During what time period did the menhaden industry experience great success? What was its greatest year?

   b. What begins to happen after 1956? How does your graph show this latest trend?

2. The description of the menhaden industry indicates it has become highly efficient. How has the industry used modern technology?

3. After reading Student Reading 1, you listed several reasons why you think the menhaden population suffered. Does this reading suggest other reasons why the menhaden seemed to have disappeared? If so, list them.

TRANSPARENCY 4: MENHADEN CATCH OPERATION



I.B.4.b.(2)
(Mar. 3.23)
p. 13

Student Reading 3

POSSIBLE CAUSES OF VARIATIONS IN MARINE POPULATIONS

Although the factors mentioned in this reading may cause variations in all marine populations, it is important to remember that we are most concerned with the decline of the menhaden population. We need to consider the life cycle of the menhaden. Then it is possible to understand how certain stages in the menhaden's life may be affected by these factors. Remember that conditions in the sea are seldom perfect for maintaining stable marine populations. The surface and upper layers of the sea experience greater changes in conditions than the lower layers of the sea do.

Changing weather conditions can have important effects on the sea. Not only can the salinity and temperature of the water be changed, but large amounts of water can be moved from one place to another as a result of heavy wind and rain. New temporary currents can be created. These variations in water movement, temperature, and salinity can affect the presence of newly hatched menhaden and the plankton on which they feed. Having little ability to move around, the planktonic animals are at the mercy of the waters. And if food is not abundant, the menhaden larvae which are born in the ocean may starve.

If the fish survives its larval stage and reaches the juvenile stage, it may face new crises. Since the juvenile menhaden lives and feeds in the estuaries, some activities of man could affect populations of menhaden. Man is changing many estuaries to serve his needs. He has drained or filled in marshes to provide sites for industry, recreational facilities, and residential developments. He has also diverted water from rivers feeding estuaries for various agricultural and industrial uses. Pesticides and herbicides sprayed on farmlands are constantly being washed into the estuaries. Some pesticides are even sprayed directly on the water. In addition, both domestic and industrial wastes are frequently dumped into the estuaries. Many of these substances are deadly to marine life. Dredging channels to handle more shipping alters the bottom of the estuary and can drastically change the estuarine environment. And, as more ships utilize the new channel, water may become polluted from ship wastes and oil spillage.

There are several other possible causes for a decline in the menhaden population. Although it is not known to what extent predation affects the menhaden population, the menhaden does serve as food for many marine mammals, birds, and other fish. It is possible that predation could be heavier in some years than in others.

Disease and infection could also reduce the menhaden population. The menhaden is host to many internal and external parasites.

There is also strong evidence that overfishing may cause changes in marine populations. If a fish population attains a maximum level in relation to its environment, the fishing industry may expand. With this expansion, more fish are caught than can be replaced naturally by reproduction. As a result, the fish population may be decreased to a very low level. It may take many years for the population to increase to its original size.

Activity Sheet 3

POSSIBLE CAUSES OF VARIATIONS IN MARINE POPULATIONS

Directions: Answer all the questions below. You may refer to the reading for help.

1. List all the possible causes of variations in marine populations suggested in the reading. Divide the causes into two categories: 1) Natural Causes, and 2) Man-Made Causes.

2. Taking into account what you have learned about menhaden, select from your list above those causes which you believe affected the decline of the menhaden population. Tell why you chose the ones you did.

3. List any other possible causes for the decline of the menhaden population you can think of.

Pre-test, Post-test

Directions: Complete the following:

1. The menhaden is the most abundant fish along the _____ coast of the United States.

2. When fully grown the menhaden weighs about _____ pounds and is _____ inches in length.

3. Name the four major stages in the menhaden life cycle.

   a.

   b.

   c.

   d.

4. The menhaden is used primarily for _____ and _____.

5. The annual catch of menhaden north of the Chesapeake Bay has (declined, increased) since 1962. (CIRCLE ONE.)

6. The _____ seine is nearly 1000 feet long and 60 feet deep.

7. List at least five possible causes for the decline of the menhaden under each heading below:

   Natural Causes

   a.

   b.

   c.

   d.

   e.

   Man-Made Causes

   a.

   b.

   c.

   d.

   e.

ANSWERS

Activity Sheet 1

1. Along the Atlantic coast of North America and South America from Nova Scotia to Brazil.

2. Spawning grounds are in offshore banks. Menhaden spawn during November to March from Delaware to Florida and during May to October from Massachusetts to New Jersey.

3. a. eggs
   b. larva -- eats zooplankton
   c. juvenile -- eats zooplankton and begins to eat phytoplankton
   d. adult -- feeds on zooplankton and phytoplankton

4. The menhaden is processed into oil and fish meal. The oil is used in paints, varnishes, soaps, lubricants, inks, cosmetics and pharmaceuticals. The residue is used in fertilizer. It is also used as a bait fish.

5. Most any answer is suitable.

Activity Sheet 2

1. a. 1953 to 1962; 1956
   b. Catch begins to decrease--the line moves downward

2. The airplane is used to find schools of menhaden. Radar on the carrier vessel is also used in finding schools of menhaden. Radio is used to direct the operation of the catch.

3. Any answer is acceptable. A possible answer is overfishing.

Activity Sheet 3

1. Natural Causes: Adverse weather conditions can change salinity and water temperature. Heavy winds can move masses of water from one place to another and affect the presence of plankton and menhaden larvae. Ocean currents can be temporarily changed. Lack of food can cause starvation. Predation. Disease and infection.

   Man-Made Causes: Draining and filling marshes and estuaries where young fish develop. Diverting water from rivers. Pesticides and herbicides washed into the estuaries. Pesticides sprayed directly on the water. Dumping of chemicals into the water. Dredging channels. Overfishing.

2. Answers will vary.

3. Answers will vary. Competition with other fish for the same food source might be mentioned.

ANSWERS

Pre-test, Post-test

1. Atlantic
2. 2/3 to 1 1/2 pounds - 12-18 inches
3. egg, larva, juvenile, adult
4. oil, fish meal
5. declined
6. purse
7. See the answer to Activity Sheet 3 on the preceding page. Any five of the answers under each heaing under 1. will do.

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5. "Important Fisheries of the Atlantic Coast," A Supplement to the Sixteenth Annual Report of the Atlantic States Marine Fisheries Commission, Atlantic States Marine Fisheries Commission, September, 1958.

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Language Arts Supplement

#209 WHERE HAVE ALL THE MENHADEN GONE?

SUGGESTED BOOK LIST

Harvesting the Sea. D. X. Fenten. J. B. Lippincott Co. 1970.

Nets Overboard! Jack Coggins. Dodd, Mead & Co. 1965.

The Sea around Us. Rachel Carson. Franklin Watts, Inc. 1961.

The Sunlit Sea. Augusta Goldin. Thomas Y. Crowell Co. 1968.

The Wonderful World of the Sea. James Fisher. Doubleday & Co. 1970.