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ABSTRACT

This booklet contains information on aquaculture and ideas for aquaculture projects. The information provided is for students at upper elementary through high school learning levels. Recommended activities at the end of the text are organized by level of difficulty. The activities can be modified depending on area and availability of resources. A glossary is also included at the end of the text for those students who need assistance with vocabulary. Source books that correspond with the activities are listed for students. A source list for teachers includes selected books, articles, and curricula and supplemental materials. (KR)

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AQUA-TOPICS

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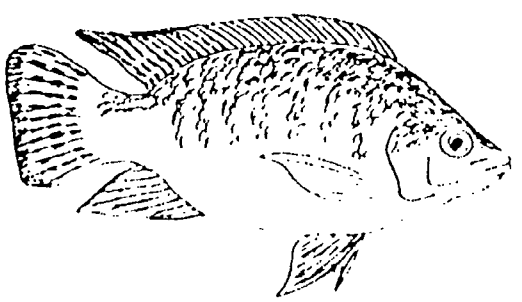
Aquaculture for Youth and Youth Educators

INTRODUCTION

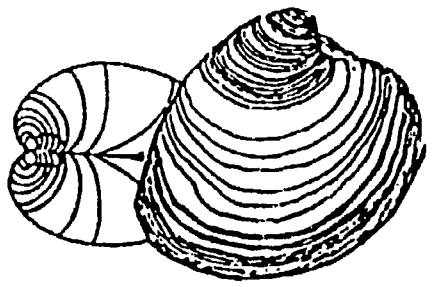
This Aqua-Topic was created in response to requests from teachers, youth leaders, and students who are interested in receiving information on aquaculture and ideas for aquaculture projects. The information provided is for students at upper elementary through high school learning levels. Recommended activities at the end of the text are organized by level of difficulty; **Level I** being the least difficult and **Level III** being the most difficult. The activities can be modified depending on area and availability of resources. A glossary is also included at the end of the text for those students who need assistance with vocabulary. Words that are printed in bold type in the text can be found in the glossary. Bibliographies are also included at the end for both students and teachers.

HISTORY OF AQUACULTURE

No one is absolutely certain when aquaculture or the raising of aquatic animals and plants began. In Egypt there are paintings on some of the tombs which show fish in man-made pools indicating some type of aquaculture. Egyptians were probably raising the fish for decoration rather than food. We do know that some form of aquaculture began thousands of years ago in China. The Chinese developed a unique system raising several species of carp in order to use all the different food supplies in a pond. Today over half the fish that the Chinese eat come from fish farm ponds.



The simplest method of culture was to capture the desired species from the wild and raise it in a protected habitat. Early Romans were known to catch fish and eels and then fatten them in stone-lined ponds. Some **brackish** water fish farming developed in Italy in the mid 1800's. On the island of Comacchio the people farmed an entire **lagoon** using man-made channels and locks. They would allow freshwater from rivers to mix with seawater in the lagoon and raise mullet, eel and sandsmelt. In Northwestern France, the oyster growers placed strings of tiles in the water and waited for the oyster **larvae** to settle on them. When the baby oysters were thumbnail size they put them in a special, protected bed and cultured them until they were large enough to harvest.



In recent years the Japanese have been very successful in **mariculture** farming by copying the successful freshwater methods used in China and applying them to farming of fish, **algae** and shellfish in saltwater. Today they raise many marine species of fish and shellfish. The Japanese are particularly famous for their culture of the pearl oyster for pearls. They also culture **algae** which is used as a wrapper for the sushi which is becoming a popular food in the United States. This edible marine algae is sometimes called **nori**. During 1986, seven million dollars worth of **nori** was imported into the United States according to the Washington State Department of Trade and Economic Development.

Although trout had an established culture program in the United States for restocking streams and lakes, the American farmer really entered the aquaculture field in the 1930's under President Franklin D. Roosevelt's "Farm Pond" program. Farmers were assisted by the United States government in the construction of ponds and stocking of those ponds with fish. The leading aquaculture industry in the United States, channel catfish farming, had its beginnings at this time. There were over 130,200 acres of ponds in catfish production in the United States in 1988. According to Peter R. Limburg in his book titled *Farming the Waters*, a carefully managed catfish farm can produce six thousand pounds of meat per acre. Other widely cultivated species in the United States today are salmon, trout, and crawfish according to the United States Department of Agriculture's Economic Research Service. An article in the May 1989 issue of *Water Farming Journal* states that American fish farmers now produce $700 million worth of fish and shellfish. They cultivate at least twenty different species.

Fish, shellfish and algae are currently cultured all over the world, but we still have a lot to learn about the culture of these water plants and animals. With over 20,000 species of fish identified less than 100 species are farmed or cultured today.

WHAT DOES THE FISH FARMER DO?

The land farmer must know the needs of his plants or animals. Do his plants need special soil? How much water and how much sunshine does each plant need and when will the plants produce the fruits or vegetables that will be harvested? When will the farm animals produce their young?

Reproduction:

The fish farmer also has to know when his fish **spawn** or produce. A few species of fish will produce easily in captivity with no help from the fish farmer. With some fish the farmer can sometimes trick them into **spawning** by changing the water temperature or the hours of light or by using **hormones**. The eggs of saltwater fish tend to float freely while the eggs of freshwater, inland species are non-buoyant. Some fish are like birds and build nests using their tail as a broom to clear a depression on the bottom of the pond and remove larger rocks

or pebbles with their mouth. The farmer must know if they will build nests like the trout; or whether they will carry the eggs in their mouth like the Tilapia sp; or whether the eggs will float freely along the moving water like the eggs of the striped bass. Some eggs such as those of salmon and trout must be protected from direct sunlight.

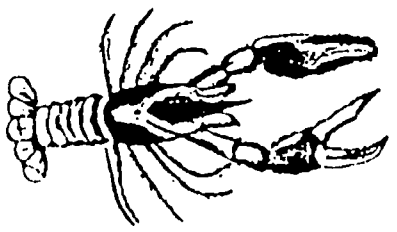
Perhaps some of the strangest and most complicated reproductive patterns occur in the seaweed. Sometimes they are plant-like in form and then they become one-celled swimming forms. In fact, it took a dedicated science detective, Dr. Kathleen Drew, (no relation to that other detective Nancy Drew) to discover the life cycle of the **nori**. She discovered that the seaweed spends part of its time as a small **alga** that bores holes in shells and its adult life as a leafy plant.

Feeding:

Farmers use fertilizer to help their plants grow and aquaculturists use different types of fertilizer to promote **phytoplankton** growth as well as food to help their fish grow. When fish are small or in the **larval** stage they absorb food from their egg sac. When fish grow into the **fry** stage they eat very small plants called **phytoplankton** or very small animals called **zooplankton**. If you visit an aquarium store you can find **Artemia** or **brine shrimp** eggs which are a type of **zooplankton**. They look like very small, brown or reddish-brown eggs and can be hatched at home to feed aquarium fish. Many fish and shrimp hatcheries use these same brine shrimp to feed their **fry**. As the fish grows it becomes a **fingerling** which means it is about the size of a finger or three to five inches in length. The younger fish must be fed more frequently than adult fish.

Water Quality:

The most important ingredient in the culture of fish and shellfish is water. Some fish grow in saltwater, some in freshwater, some in **brackish** water or water which is part salt and part fresh. Some species of fish grow in all three types of water at various stages of their life cycle and some can be adapted to different salinity conditions if the aquaculturist desires.



The water that the cultured animal lives in must be changed or flushed regularly since waste materials from aquatic animals and uneaten feed go directly into the water. The aquaculturist must be careful not to overfeed his animal because uneaten food will cause pollution. Waste materials from the animal may produce toxic chemicals. Growth of specific aquatic **algae** or plants can help purify the water by concentrating toxic chemicals within their structure.

Fish farmers must measure oxygen levels on a regular basis in all three types of water. Fish need oxygen to live. They breathe by drawing water into their mouths and forcing it across their **gills** which take the oxygen into the bloodstream. If the dissolved oxygen in the water is low, the fish will become sick or die. Oxygen is provided by green water plants (**phytoplankton**) that give off oxygen during **photosynthesis**. Oxygen levels are also increased when wind

blows across the surface of the water or when the fish farmer pumps air into the water or stirs the water with a paddle wheel. If you want to see oxygen in water, fill a glass with cold water and leave it in a warm place for a time. Soon you will see bubbles containing oxygen on the inside of the glass, because, as water becomes warmer, it can not hold as much oxygen. This is an important fact for the fish farmer to remember.

The temperature of the water is also important because fish and shellfish are cold blooded animals. Their temperature changes with the temperature of the water. If the water temperature is not correct they will not grow as large or as fast. Trout can survive in water temperature as low as 32° F but will die if the temperature rises to 75° F. Tilapia, a warm water fish, can stand water temperatures as high as 90° F but cannot live if the temperature of the water falls below 50° F. Following is a list of fish and shellfish and the water temperature at which they grow best. Which aquatic animal would grow best in your area?

Fahrenheit Temperatures for Fish and Shellfish

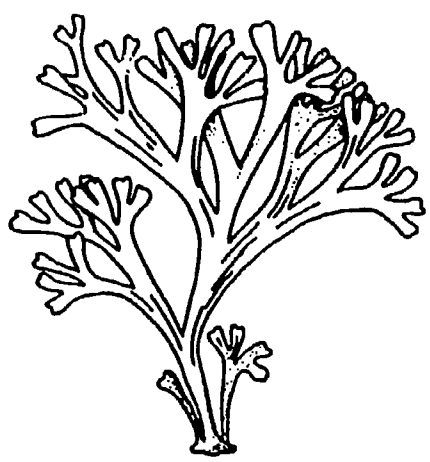
shrimp	78° - 86°
crawfish	72° - 82°
channel catfish	72°
yellow perch	68°
northern pike	63°
coho salmon	54°
rainbow trout	47°

Culture systems:

Aquatic plants and animals can be grown in several different ways depending on the species being cultured. Some are grown in earthen ponds and others in round or square tanks of concrete or fiberglass. Some species grow best in a system of raceways. These are long, narrow, rectangular-shaped containers with water flowing in one end and out the other. Fish such as the catfish may be grown in floating cages that hang in open water. Oysters can be grown on hanging strings or trays in the water; sort of an oyster condominium! If several species are grown together in the same system is is called polyculture while raising only one species is called monoculture.

Some aquaculturists are involved in **sea ranching** which is raising the fish for release to the wild and relying on ... homing instinct for recapture in the future. **Sea ranching** is used in the culture of salmon that return to their home from the sea every year to **spawn**. Some sea turtles are also raised in hatcheries and then released to the wild for conservation purposes with the hope that they will return to the home beach to lay their eggs.

Not all fish are cultured for food. Some aquaculturists raise tropical fish for the aquarium business. Those pretty fish that you see in the tank at the pet store may not be wild caught. Perhaps they were raised by a fish farmer. If you have raised tropical fish at home and helped them reproduce in your aquarium then you are an aquaculturist.



The three major groups of seaweeds (brown, red, and green) can be cultured and are sources of many valuable products for man. Products from seaweed are used in ice cream to keep it creamy; in jello-type desserts, in printing inks, in some fabrics for fireproofing, in surgical gauze to make blood clot quickly, in photographic film, in shoe polish, and in lotions and cosmetics. Algae can be converted to alcohol or dried and burned. About half of the world's toothpaste contains a byproduct from seaweed. Seaweed culture is becoming more important to mankind each year.

As you can see being a "fish farmer" is a pretty complicated business. Remember that the next fish, shrimp, or even oyster that you buy at the supermarket or eat in a restaurant may have been raised by an aquaculturist. And don't forget that seaweed when you brush your teeth!

GLOSSARY

alga or algae: chlorophyll-containing plants that grow in fresh or saltwater

aquaculture: the cultivation of plants or animals in water

artemia: tiny animals related to the shrimp family and used as food by aquaculturists

brackish: water that is partially salty

brine shrimp: artemia (see above)

fingerling: a young fish three to five inches in length

fry: the young of fish, smaller than a fingerling

gill: an arch-shaped breathing organ behind the gill cover on the fish's head

hormones: a product from living cells that affects the activity of cells

lagoon: a shallow lake that opens to the sea

larvae: immature form of young animals

mariculture: the cultivation of plants and animals in saltwater

nori: a water plant or algae that is used as an edible wrapper in Japanese food.

photosynthesis: the process of converting the sun's energy, carbon dioxide, certain minerals and water into carbohydrates, proteins and fats

phytoplankton: tiny plant organisms used as food in fish and shellfish culture

sea ranching: raising animals to release to the ocean

spawn: mass of eggs produced by fish or shellfish or used as a verb meaning production of eggs

zooplankton: tiny animals such as artemia

PROJECTS IN AQUACULTURE

Level I

1. **Objective:** Learn feeding requirements for rearing fish and plants in an enclosed space such as the aquarium.

   Activity: Visit an aquarium store and study the different types of fish that are kept in the aquariums. Ask the owner what types of food he feeds various fish, how much he feeds them, and how often. If there are differences in type of food and amount of food for each species of fish, find out why they are different. Find out why you should not feed fish just before you move them to your house. If there are aquatic plants, ask the owner how he takes care of the plants.

2. **Objective:** Learn the parts of a fish.

   Activity: Using a book from your school or public library draw a fish and label the external parts on the fish. See if you can find information on how different fin shapes affect the way the fish swims.

3. **Objective:** Learn the method for producing one type of live feed for fish and shellfish.

   Activity: Gather information from your library or local aquarium store on raising brine shrimp. Culture a batch of brine shrimp using what you have learned. When they hatch look at them under a microscope and draw what you see. If you have an aquarium feed the brine shrimp to your fish.

4. **Objective:** Learn about an aquatic food chain.

   Activity: Draw an aquatic food chain by starting with the sun and mineral nutrients in the water feeding algae and ending with man eating fish.

Level II

1. **Objective:** Learn about the different types of fish.

   Activity: Using books from your school or public library compile a list of fish. Separate the list into those fish with scales and those without scales. Compile a list of freshwater fish and saltwater fish. Which fish can live in all three types of water? Compile a list of fish that are being cultured and determine what type of water is needed for each.

2. **Objective:** Learn the parts of a fish and what they do.

   Activity: Draw a fish and label the external parts. Draw a fish and label the internal parts. Compare these to the parts of a human. Note the differences and similarities in sensory organs between human and fish and explain why.

3. **Objective:** Learn to identify aquatic plants and their uses.

   Activity: Collect and identify all plants that grow in and on the edge of a pond. Draw a chart of a pond showing the location of the plants that you collected and determine if the plants provide food or shelter for animals in the pond. Find out if any of the plants are considered a pest or weed and must be controlled in a healthy pond and the best methods for controlling those weeds.

Level III

1. **Objective:** Learn the physical characteristics of a fish pond.

   Activity: Visit a local fish farm and study how the pond is designed. Locate the incoming water and drainage. Find out how the fish are harvested. Ask about pond aeration and plant control. Determine the source of the water for the pond. Draw a cross section of the pond showing what you have learned.

2. **Objective:** Learn some of the characteristics of pond water.

   Activity: Test water in a nearby pond for pH, oxygen and turbidity. Test both morning and evening and compare the differences. Test on clear, calm days and after a heavy rain and compare differences. Determine why this information would be important to a fish farmer and determine what the farmer must do to change water chemistry if needed.*

3. **Objective:** Learn the legal requirements for starting a fish farm.

   Activity: Write your state legislature and county offices for information on what permits are necessary to start a fish farm in your area. Be sure to ask about laws or requirements for bringing fish into your state from another state or county to stock your pond or hatchery. Also ask what laws or permits you would need to ship your fish to market in another state or county. Are there any restrictions or regulations on water use in your area? What about pond drainage? Are there restrictions on how and where you can release used pond water?

*This activity will require certain scientific tools such as pH paper, water chemistry test kit and Secchi disk.

SOURCES FOR THE STUDENT

If you would like to read more about aquaculture and related subjects check in your school or public library for these books and articles.

Books - Level I

The Care of Water Pets. Gertrude Pels. Illustrated by Ava Morgan. Thomas Y. Crowell, New York, NY, 1955, 119 pp.

Clams and Other Critters. J. Butzow and M. North Jones. New England Marine Education Project, College of Education, University of Maine, Orono, ME, 1979, 34 pp.

Discovering Freshwater Fish. Bernice Brewster. Franklin Watts, Inc., New York, NY, 1988, 48 pp.

Fish. Fiona Henrie. Junior Petkeeper's Library, Franklin Watts, Inc., New York, NY, 1980, 32 pp.

Goldfish. Herbert S. Zim. Illustrated by Joy Buba. Morrow Junior Books, William Morrow & Co., New York, NY, 1947, [unp.].

The Great Aquarium Book. Jane Sarnoff and Reynold Ruffins. Charles Scribner's Sons, New York, NY, 1977, 47 pp.

How to Raise Goldfish & Guppies: A Child's Book of Pet Care. Sara B. Stein. Random House, New York, NY, November 1976.

Life Cycle of a Stickleback. Philip Parker. Franklin Watts, Inc., New York, NY, 1988, 32 pp.

Science of the Sea. H. Pincus. American Education Publications, Columbus, OH, 1952, 32 pp.

Taking Care of Your Fish. Joyce Pope. Franklin Watts, Inc., New York, NY, 1988, 32 pp.

What Do You Want To Know About Guppies? Seymour Simon. Illustrated by Susan Bonners. Four Winds Press, New York, NY, 1977, 66 pp.

Books - Levels II and III

Aquarium Book for Boys and Girls. Alfred Morgan. Charles Scribner's Sons, New York, NY, 1959, 209 pp.

Aquarium Encyclopedia of Tropical Freshwater Fish. J. D. Van Ramshorst. H.P. Books, Tucson, AZ, 1978, 391 pp. **NAL Call No. DNAL SF457.A6.**

Aquarium Fish Magazine. Available from Subscription Department, P.O. Box 484, Mt. Morris, IL 61054-8042. Annual subscription: $9.99

Aquariums. John Hoke. Franklin Watts, Inc., New York, NY, 1975, 71 pp.

Careers in the Marine Environment. Proceedings of 1979 Career Conference. 19pp. Available from The Wetland Institute, C/O Tidepool Shop, Stone Harbor Blvd., Stone Harbor, NJ 08247. ($1.00 + $1.00 postage)

Fishes and Their Ways. Clarence J. Hylander. Macmillan Publishing Co., Inc., New York, NY, 1964, 240 pp.

Fishing For Fun - Members Guide. Ned E. Fogle. Michigan State Extension Service, 1978, 19 pp. Available from Michigan State University, Youth Programs Publications, 175 South Anthony, East Lansing, MI 48824

4-H Tropical Fish. Richard Hilgers and John L. Skinner. 4-H Youth Development, 1976, 19 pp. Available from 4-H Youth Development, Lowell Hall, 610 Langdon Street, Madison, WI 53706.

4-H Wildlife Project - Fish Culture. J. L. Byford, [et.al]. National 4-H Council, 150 N. Wacker Drive, Chicago, IL, 1979, 8 pp.

Future Food. Harriete S. Abels. Crestwood House, Mankato, MN, 1980, 45 pp.

Howell Beginner's Guide to Aquariums. John Coburn. Howell Books, New York, NY, 1987, 50 pp.

Identification Guide to Marine Tropical Fish. Frederick William Pitcher. Illustrated by Michael Stringer. Arco Publishing Co., Inc., New York, NY, 1977, 59 pp.

Ocean-Going Plants - Seaweeds. C. Parmer. Marine Science 4-H Special Interest Series, Florida Cooperative Extension Service, University of Florida, Gainesville, FL, [n.d.], 4 pp.

Questions About the Oceans. H. Dubach, and R. Taber. U.S. Naval Ocean Office, Washington, DC, 1968, 121 pp.

Strange Breeding Habits of Aquarium Fish. Hilda Simon. Dodd, Mead & Co., New York, NY, 1975, 160 pp.

World of Freshwater Fishes. Thomas D. Fegely. Dodd, Mead & Co., New York, NY, 1978, 128 pp.

Articles - Levels II and III

"Fish Farming: the New Agriculture." B. T. Hunter. In: *Consumers Research Magazine*, August 1988, 72, pp. 36-7.

"Grandpa and the Kids Work at a Fish Hatchery." D. Sisson. In: *Field and Stream*, May 1987, 92, pp. 81+.

"The Living Sea." H. Fice and I. Simkiss. In: *Discovery Project - The Sea*, Macmillan Education Ltd., London, UK, 1972, 33 pp.

"Native Aquarium Fish: a New Aquaculture Crop." B. McLarney. In: *Aquaculture Magazine*, Little Rock, AK, Briggs Associates, Inc., Jan/Feb 1984, v 11(2), p. 26-28.

"School for Salmon (Teaching Hatchery Salmon to Recognize Predators; work of Bori Olla)." V. Quinn. In: *National Wildlife*, April/May 1988, v 26, pp. 44-6.

"Today's Youth in Tomorrow's Sea." Hal Goodwin. In: *Sea World*, 1978, pp 40-8.

"Tropical and Temperate Water Plants for the Home Aquarium." M. Ramirez. In: *Plants-Gard-Brooklyn-Bot-Gard-Rec*, New York, NY, Spring 1985, v 41(1), pp. 56-57.

SOURCES FOR THE TEACHER

Selected Books

Note: For those sources where availability has been given, publications may be in limited supply.

Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms. John E. Bardach, [et al.]. John Wiley & Sons, New York, NY, 1972, 868 pp.

Aquaculture Training Manual. Donald R. Swift. Fishing News Books, Ltd., Farnham, England, UK, 1985, 135 pp. **Call No. NAL SH135.S9**

Aquatic Activities For Youth. H. David Greene, [et al.]. New York Sea Grant Institute, Albany, NY, May 1980. Prepared by the Youth Coastal Education Program, 21 South Grove St., East Aurora, NY 14502. ($2.50)

Crustacean and Mollusk Aquaculture in the United States. Edited by Jay V. Huner and E. Evan Brown. AVI Publishing Company, Inc., Wesport, CO, 1985, 476 pp. **Call No. NAL SH365.A3C78**

Farming the Waters. Peter R. Limburg. Beaufort Books, Inc., New York, NY, 1980, 223 pp. **Call No. NAL SH135.L55 1980**

Fish. T. Smid. University of Arkansas Sea Grant Program, Fairbanks, AK, 1980, 51 pp.

Fish Farming Techniques. Larry Belusz. The Instructional Materials Laboratory. Number 10 Industrial Education Building, 6th and Stewart, Columbia, MO 65211, 1987, 84 pp.

Fish With Small Fry: A Parent's Guide to Teaching Children How to Fish. Jim Freeman. Chronicle Books, San Francisco, CA, 1973, 128 pp.

A History of Marine Fish Culture in Europe and North America. R. Kirk. Fishing News Books, Ltd., Farnham, England, UK, 1987, 192 pp. **Call No. NAL SH163.K5**

Man and the Gulf of Mexico Educational Series. MASGP-82-007. [n.a.]. 1982. Volume 1: *Marine and Estuarine Ecology*, 88 pp. Volume 2: *Marine Habitats*, 88 pp. Volume 3: *Diversity of Marine Plants*, 135 pp. Volume 4: *Marine Animals*, 126 pp. Available from University Press of Mississippi, 3825 Ridgewood Road, Jackson, MS 39211. (Vol. 1 & 2: $5.00, Vol 3 & 4: $6.00)

Organisms: Teacher's Guide. S. Fletcher, [et al.]. D. C. Heath & Company, Boston, ME, 1968, 148 pp.

Articles

"Growing Algae in the Classroom." C. Hampton and C. Hampton. In: *Science and Children*, 1980, v 17(5), Washington, DC, pp. 40-41.

"Survey of Fishery Programs in Colleges and Universities in the United States." UNIHI-Seagrant-JC-87-01. Rose T. Pfund. In: *Fisheries*, 1986, v 11(6), pp. 16-21.

Curricula and Supplemental Materials

Aquatic Science: Marine Fisheries Biology. TAMU-SG-79-405. Grades 4-12, 1979, 18 pp. Single copies available from Marine Information Service, Sea Grant College Program, Texas A & M University, College Station, TX 77843-4115.

Aquatic Resources Education Curriculum. C. Boyd Pfeiffer and Mark Sosin. Kendall Hunt Publishing Co., Dubuque, Iowa, 1987, [random paging]. For information contact AFTMA Sportfishing Educational Foundation, 1250 Grove Avenue Suite 300, Barrington, IL 60010.

Build a Fish to Scale. OHSU-EP-032. M. Canning and M. Dunlevy. 1987, 101 pp. Available from Ohio Sea Grant Program-Publications, Ohio State University, Research Center. 1314 Kinnear Road, Columbus, OH 43212. ($5.00)

Clean Water, Streams and Fish. Elementary Curriculum. Wendy Borton, [et al.]. 1982, 292 pp. Available from Vicki Osis, Oregon State University Hatfield Marine Science Center, Marine Science Drive, Newport, OR 97365. ($10.00 plus postage)

Clean Water, Streams and Fish. Secondary Curriculum. Wendy Borton, [et al.]. 1982, 341 pp. Available from Vicki Osis, Oregon State University Hatfield Marine Science Center, Marine Science DRive, Newport, OR 97365. ($10.00 plus postage)

Coming To Our Senses: An Environmental Approach To Teaching at the Elementary Level. Judith Bock, [et al.]. Second Edition. Centre for Environmental Education, Montreal, Quebec, 1975, 64 pp. Available from STOP, 1361 Greene Avenue, Montreal, Quebec H3Z 2A5. ($2.00)

Common Vascular Plants of the Louisiana Coastal Marsh. LSU-T-79-003. R. Chabreck and R. Condrey. 1979, 120 pp. Available from Louisiana Sea Grant, LSU Center for Wetland Resources, Baton Rouge, LA 70803-7507. ($7.00)

The Community Is Our Classroom. Marjorie Nicol and Gail Jordan. TEAL Occasional Papers, 1977, v 1, 6 pp. Available from Maureen C. Sawkins, British Columbia Association of TEAL, c/o King Edward Campus, V.C.C., 2750 Oak Street, Vancouver, BC, Canada. ($2.50 Canadian plus $.50 postage)

Connections: Guide To Marine Resources, Living Marine Systems and Coastal Field Trips. UNC-SG-84-05. L. Spence, and J. Mendicott. 1984, 93 pp. Available from Marine Education Specialist, University of North Carolina Sea Grant College Program, Box 8605, University of North Carolina, Raleigh, NC 27695-8605. ($2.00)

Determining the Age of Fish. E-1774. Cooperative Extension Service. MSU Bulletin Office, 1984, [unp.]. Available from Michigan Sea Grant Extension, MSU Bulletin Office, P.O. Box 6640, East Lansing, MI 48826-6640. ($0.35)

Fins and Scales. 4H 367. Neil Crenshaw. [n.d.], 11 pp. Available from Publications, Marine Education Program, Sea Grant College Program, Bldg. 803, University of Florida, Gainesville, FL 32611.

Fisheries Biology For Everyone. SGEB-11. Steve Bortone. April 1986, 178 pp. Available from Publications, Marine Education Program, Sea Grant College Program, Bldg. 803, University of Florida, Gainesville, FL 32611. ($3.00)

Fishy Activities For Your Small Fry. Mary E. Sparrow, [et al.]. Educational Series No. 28, October 1985, 36 pp. Grade Level K-6. Available from Sea Grant Communications, Virginia Institute of Marine Science, Gloucester Point, VA 23062. ($2.00)

Fourth Grade Marine Science Career Awareness. D. Borden, [et al.]. Marine Science Center, Poulsbo, WA, [n.d.], 106 pp.

A Guide To Salt Marsh Plants Common To North Carolina. UNC-SG-81-04. Elizabeth Jean Wilson. 1981, 32 pp. Available from Marine Education Specialist, University of North Carolina Sea Grant College Program, Box 8605, University of North Carolina, Raleigh, NC 27695-8605. ($1.50)

A Guide To Salt Water Aquariums. LSU-H-85-001. S. Ruckstuhl. 1985, 13 pp. Available from Louisiana Sea Grant, LSU Center for Wetland Resources, Baton Rouge, LA 70803-7507.

The Hard Clam. MAS-12. William R. Hall. Revised 1986, 6 pp. Available from University of Delaware, Marine Communications Office, Sea Grant College Program, 196 South College Avenue, Newark, DE 19716.

How To Set Up and Maintain a Saltwater Aquarium. TAMU-SG-81-504. Grades 3-12, 1981, 8 pp. Single copies available from Marine Information Service, Sea Grant College Program, Texas A&M University, College Station, TX 77843-4115.

How To Use the Library To Find Marine-related Information. UNIHI-Seagrant-AB-84-02. Peter J. Rappa. March 1984, 4 pp. Available from University of Hawaii, Sea Grant College Program, Publications Office, 1000 Pope Road, MSB 200, Honolulu, HI 96822.

Is Our Food Future In the Sea? E-msg-84-8. John Butzow, et al. Northern New England Marine Education Project, 1984, 31 pp. Available from University of Maine, Sea Grant Marine Advisory Program, 30 Coburn Hall, Orono, ME 04469. ($5.00)

Lake Erie - A Day In the Life Of a Fish. OHSU-EP-033. M. Canning and M. Dunlevy. 1987, 87 pp. Available from Ohio Sea Grant Program-Publications, Ohio State University, Research Center, 1314 Kinnear Road, Columbus, OH 43212. ($5.00)

Let's Go Near the Water. B. Church. Burlington County Girl Scout Council. [n.d.], [n.p.]. Available from New Jersey Marine Science Consortium, Building 22, Fort Hancock, NJ 07732.

Life Cycle of the Salmon. Grades 3-5. Pacific Science Center. 1980, Revised 1988, 126 pp. Available from Pacific Science Center Gift Shop, 200 Second Avenue North, Seattle, WA 98109. ($6.00 plus .75 shipping. Set of 64 slides to accompany unit, $33.00)

Marine Careers: The Oceanographer. William R. Hall. January 1989, 2 pp. Available from University of Delaware, Marine Communications Office, Sea Grant College Program, 196 South College Avenue, Newark, DE 19716

Marine Education: A Bibliography of Educational Materials. Marine Information Service, Sea Grant College Program, TAMU College Station, TX 77843-4115

Marine Life and The Sea - A Resource Unit For Elementary and Junior High Schools. H. Davis. Portsmouth Public Schools, Portsmouth, VA [n.d.], 36 pp.

Marine Science Teaching Aids. (Series). [n.a.]. [n.d.], 4 to 8 pages. Designed for secondary school teachers, this series presents marine-related concepts that can be taught in typical secondary school science classes and includes background information and suggested activities. Available from Louisiana Sea Grant, LSU Center for Wetland Resources, Baton Rouge, LA 70803-7507.

Marine Studies Idea Book: For Teachers, Grades K-6. USCSG-ME-01-82. Gail Ellison. January 1982, 75 pp. Available from University of Southern California Sea Grant, Marine Education Program, University Park, Los Angeles, CA 90089-0341. ($8.00)

National Survey of Fishery Education in Institutions of Higher Education. UNIHI-Seagrant-MR-85-02. Rose T. Pfund. May 1985, 48 pp. Available from University of Hawaii, Sea Grant College Program, Publications Office, 1000 Pope Road, MSB 200, Honolulu, HI 96822. ($1.00)

Sea Sampler: Aquatic Activities For the Field and Classroom (Elementary). SCSG-TR-85-1. Wendy B. Allen and Patty O. McLaughlin. 1985, 118 pp. Available from Publications, South Carolina Sea Grant Consortium, 287 Meeting Street, Charleston, SC 29401. ($4.25)

Sea Sampler: Aquatic Activities For the Field and Classroom (Secondary). SCSG-TR-85-2. Wendy B. Allen and Patty O. McLaughlin. 1985, 114 pp. Available from Publications, South Carolina Sea Grant Consortium, 287 Meeting Street, Charleston, SC 29401. ($4.00)

Sea Turtles In Louisiana's Coastal Waters. LSU-T-87-004. D. Fuller, [et al.]. 1987, 40 pp. Available from Louisiana Sea Grant, LSU Center for Wetland Resources, Baton Rouge, LA 70803-7507. ($4.00)

Seascope: A Marine Activity Book For Elementary Schools. LSU-E-82-0001. J. Schweitzer, [et al.]. 1982, 84 pp. Available from Louisiana Sea Grant, LSU Center for Wetland Resources, Baton Rouge, LA 70803-7507. ($6.50)

Sensing the Sea: A curriculum guide in marine education for grades two and three. Ellen Odell-Fisher and Ronald N. Giese. 1978, 53 pp. Available from Marine Education Center, Virginia Institute of Marine Science, Gloucester Point, VA 23062. ($2.00)

Shrimp In Alabama. MASGP-86-012. [n.a.]. 1986, pamphlet. Available from Mississippi - Alabama Sea Grant Consortium, P. O. Box 7000, Ocean Springs, MS 39564-7000.

Starting and Maintaining a Marine Aquarium. 4H 356. [n.a.]. [n.p.], 12 pp. Available from Publications, Marine Education Program, Sea Grant College Program, Bldg. 803, University of Florida, Gainesville, FL 32611.

Starting and Maintaining a Marine Aquarium. 4H 356. (Project Record). [n.a.]. [n.d.], 7 pp. Available from Publications, Marine Education Program, Sea Grant College Program, Bldg. 803, University of Florida, Gainesville, FL 32611.

Starting and Maintaining a Marine Aquarium. MASGP-81-001. [n.a.]. 1981, 23 pp. Available from Mississippi-Alabama Sea Grant Consortium, P.O. Box 7000, Ocean Springs, MS 39564-7000.

A Survey Of Fishery Programs In Colleges and Universities In the United States. Rose T. Pfund. Reprinted from *Fisheries*, Vol 11(6), December 1986, 6 pp. Available from University of Hawaii, Sea Grant College Program, Publications Office, 1000 Pope Road, MSB 200, Honolulu, HI 96822

Teaching Marine Studies When You Don't Know a Snipe From a Sea Cucumber. USCSG-R-05-77. Gail Ellison. Reprinted from *Sea World*, Fall 1977, pp.33-35. Available from University of Southern California Sea Grant, Marine Education Program, University Park, Los Angeles, CA 90089-0341. ($1.00)

To Harvest a Walleye. OHSU-EP-011/S and OSHU-EP-011/T. S. Leach, [et al.]. Revised 1986, 12 pp. Teacher's Guide 20 pp. Available from Ohio Sea Grant Program-Publications, Ohio State University, Research Center, 1314 Kinnear Road, Columbus, OH 43212. ($3.00)