Acknowledgments

As with any enterprise of such significance, the development of this aquaculture curriculum has absorbed thousands of hours and involved hundreds of dedicated people. Those who believed in this project offered an abundance of support. This is a people-oriented project. And people, in government, the aquaculture industry and agricultural education, were key to this project’s success.

In this regard, we would like to first thank the friends of agricultural education and rural development at the Appalachian Region Commission, U.S. Department of Agriculture’s Soil Conservation Service, Cooperative State Research Service and Extension Service. They provided the seed money, which allowed The Council to survey existing educational materials and validate the need for a national aquaculture curriculum for secondary schools. Their foresight is greatly appreciated. As in the political arena, early support is most important. But so is continuing support. Friends of agriculture in USDA and on Capitol Hill also worked to insure this project received the necessary congressional support for successful completion.

Industry supporters were most helpful in pulling this information together. These included representatives of the aquaculture industry and agricultural education. By working together these individuals combined practical applied knowledge with academic skills to write the material. And, industry reviewers helped refine and validate the material.

Teachers in the six states who tested the draft curriculum with their students helped prove the worth of the document. Instructors in 11 other states also received the material to use in their classrooms. These teachers’ practical experience enabled them to offer many positive suggestions on the material could be better arranged. It was refreshing to also see participation by teachers from other curriculums, principally those involved with math, computers, biology, chemistry, art, language, history and social studies. These instructors proved that the material is suitable for integration with academics and that students are motivated to learn.

Let us not forget the students. While the average student of agricultural education benefitted from the new material and hands-on instruction they received, students at opposite ends of the learning curve also proved the material was relevant and helpful. Educationally challenged students were “turned on,” while “gifted” students were able to engage in independent study.

After only one year of testing at some of the aquaculture learning centers, we are seeing a 400 percent increase in students signing up for the aquaculture class for the 1992-93 school year. Further, there seems to be heightened interest by non-traditional students of agriculture, women and minorities. Programs are being instituted to reach these publics.

Although this document represents the best efforts of The Council to design a basic core curriculum, more remains to be done. Currently under development is species-specific material and a more extensive business management module. Also, the process of providing teachers in-service training will be ongoing.

We want to acknowledge and thank everyone who helped with this project. Special recognition goes to these individuals who were particularly helpful.
Dr. Jasper Lee, Professor of Agricultural Education at Mississippi State University, was the chief curriculum writer for this material. His knowledge of agricultural education and aquaculture enabled him to understand how best to arrange the materials for easier teaching and to facilitate learning by students.

Dr. Wade Miller, Professor of Agricultural Education, Iowa State University, assisted Dr. Lee and served as the author of the companion document on recirculating systems.

Dr. Jane Coulter, Deputy Administrator of the Cooperative Research Service, and Director of the Office of Higher Education, administered the program. Under her leadership, USDA supported this effort to teach math and science to students utilizing aquaculture.

Dr. John Patrick Jordan, Administrator of CSRS, supported the program in times of tight budgets.

Dr. Paul F. O'Connell, also of CSRS, provided early support of the project.

Dr. R. O. Smitherman, Aquaculture Professor at Auburn University, served as acting director of USDA's aquaculture office during the early days of this program's implementation. His encouragement, tenacity, and ability to cut through the bureaucracy were instrumental in moving the project forward.

Jay Budy, State Supervisor of Agricultural Education in Texas, and the Chairman of The Council's Aquaculture Task Force, showed persistence and ability to motivate his peers to support the development of the curriculum.

John Pope, Executive Director of The Council, and Ron Buckhalt, Special Projects Director, shared daily management of the process and ingenious initiatives to achieve success.

Ray Lett, Washington Consultant, was perceptive in suggesting such an undertaking and supporting the project as it evolved.

Woody Cox, Executive Director of the FFA Alumni Association and Robert Graham, Executive Director of the National Vocational Agriculture Teacher's Association, were tireless in their efforts to solidify support for the project on Capitol Hill.

Dr. Tom McLain, Director of the Gulf Coast Research Laboratory, hosted the inservice training for teachers from the six test states, and gave early support to the concept.

Dr. David Powe, President, Mississippi Delta Community College, hosted the second inservice workshop for teachers.

Dr. Bill Urban, Washington Consultant, helped supervise the development and review of the curriculum.

Ted Amick, The Amick Group, gave early leadership to develop the proposal.

Mr. William C. Rowland, Director of the Oceanic Institute, hosted the first meeting of the aquaculture working group.

Dr. Tom Losordo, North Carolina State University, and Dr. Jim Ebeling of The Ohio State University, gave their technical assistance on the recirculating systems manual and on constructing the model high school recirculating system for The Council at N.C. State. Mr. Joe McMullin, Juniata Valley High School, Ms. Martha Sette, Technical College of the Low Country, and Mr. Larry Pfeiffer, Carlinville High School, shared their practical assessment of the parameters of keeping fish alive in recirculating systems. Dr. Wade Miller, served as editor of the recirculating systems manual and Mr. Gary Jensen, USDA Extension Service, gave his support in developing the manual.

Spectrum Communications, particularly Ms. Marsha Maurer, Ms. Jeri Mattics, Ms. Sally Nemeth, Ms. Susan Newburger, Ms. Jane Madsen, Ms. Toni Heineman, Ms. Rae Bollor, Ms. Joan Daniel and Ms. Anita Kelco, edited, designed, illustrated and produced the curriculum.

Carter Printing Company, Diane Shepard, Nancy Farmer and staff.

Mississippi State University, Iowa State University, Gulf Coast Research Laboratory and the Oceanic Institute contributed staff to help write and review much of the material.

Teachers at the Six Aquaculture Learning Centers helped make this project a reality.

Ms. Martha Sette South Carolina
Mr. Jack Kolb
Mr. George Ulmer

Mr. Curt Stutzman Iowa
Mr. Dennis Schiss Mr. Steve Streff

Mr. Joe McMullin Pennsylvania
Mr. Wayne Sollenberger
Mr. Rodney Angle

Mr. Erwin Jansen Texas
Ms. Mary Kathryn Erchut

Mr. Ray Sutter Washington
Mr. Scott Phipps Mr. Steve Lazelle

Mr. Larry Botoroff Indiana
Mr. Jack Kroft
Mr. Bob Wasson

Teachers at Second Tier of Learning Centers

Mr. Frank Triome Alabama
Ms. Sharron Havens Arkansas

Mr. John Morgan Arizona
Mr. Rick Truax
Mr. Greg Vanuk

Mr. Jeff Green Colorado
Ms. Barbara Patterson

Mr. Patrick Hourihan Connecticut
Mr. Paul Rohacik
Ms. Shelley Roy

Mr. David Chai Hawaii
Mr. Maverick Kawamoto Mr. Ted Kawamura

Dr. Rick Parker Idaho
Mr. Terry Patterson

Mr. Jeff Bryant Illinois
Mr. Larry Pfeiffer

Mr. Barry Corley Mississippi
Mr. John "Park" Taylor

Mr. Mike Buchanan Ohio
Mr. Steve Johnson

Mr. Lloyd Earnest West Virginia
Mr. Brad Hartley
<table>
<thead>
<tr>
<th>Aquaculture Task Force</th>
<th>Teacher Educators/Curriculum Specialists Reviewers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Jay Eudy</td>
<td>Dr. Brian Bowen</td>
</tr>
<tr>
<td>Dr. Connie Baggett</td>
<td>The Pennsylvania State University</td>
</tr>
<tr>
<td>Dr. Samuel D. Curtis</td>
<td>Dr. Janet Henderson</td>
</tr>
<tr>
<td>Mr. Noel Blackmon</td>
<td>Kansas State University</td>
</tr>
<tr>
<td>Ms. Susan Forte</td>
<td>Dr. Steve Harbriet</td>
</tr>
<tr>
<td>Dr. Tom Handwerker</td>
<td></td>
</tr>
<tr>
<td>Dr. Meryl Broussard</td>
<td></td>
</tr>
<tr>
<td>Ms. Debbie Hanafinan</td>
<td></td>
</tr>
<tr>
<td>Mr. Tom Cory</td>
<td></td>
</tr>
<tr>
<td>Mr. Bruce Kinnett</td>
<td></td>
</tr>
<tr>
<td>Dr. Jasper Lee</td>
<td></td>
</tr>
<tr>
<td>Mr. Jack Russell</td>
<td></td>
</tr>
<tr>
<td>Dr. Tony Mazzuccaro</td>
<td></td>
</tr>
<tr>
<td>Mr. Robert Shopeid</td>
<td></td>
</tr>
<tr>
<td>Dr. Scott Newton</td>
<td></td>
</tr>
<tr>
<td>Dr. Hank Stoddard</td>
<td></td>
</tr>
<tr>
<td>Dr. John Nickum</td>
<td></td>
</tr>
<tr>
<td>Mr. Charles R. Terrell</td>
<td></td>
</tr>
<tr>
<td>Mr. John Pope</td>
<td></td>
</tr>
<tr>
<td>Mr. Ron Buckhalt</td>
<td></td>
</tr>
<tr>
<td>Dr. Sharon Walker</td>
<td></td>
</tr>
<tr>
<td>Mr. Bill Rowland</td>
<td></td>
</tr>
<tr>
<td>Dr. Tom Zeigler</td>
<td></td>
</tr>
<tr>
<td>Dr. Jerry Shepherd</td>
<td></td>
</tr>
<tr>
<td>Dr. Hank Parker</td>
<td></td>
</tr>
<tr>
<td>Dr. Kevan L. Main</td>
<td></td>
</tr>
<tr>
<td>Dr. Kenneth Chew</td>
<td></td>
</tr>
<tr>
<td>Dr. Clarence D. McNabb</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Writers/Reviewers/Advisors</td>
<td></td>
</tr>
<tr>
<td>Mr. Brian Bristow</td>
<td>Mr. Joe McMullin</td>
</tr>
<tr>
<td>Mr. Michael Campbell</td>
<td>Mr. Bill Witt</td>
</tr>
<tr>
<td>Mr. David Chai</td>
<td></td>
</tr>
<tr>
<td>Mr. Billie Hougart</td>
<td></td>
</tr>
<tr>
<td>Mr. Garry Karr</td>
<td></td>
</tr>
<tr>
<td>Mr. Graydon “Buddy” Keaka</td>
<td></td>
</tr>
<tr>
<td>Mr. William C. Rowland</td>
<td></td>
</tr>
<tr>
<td>Dr. Karen M. Yarbrough</td>
<td></td>
</tr>
<tr>
<td>Dr. Jeff Lotz</td>
<td></td>
</tr>
<tr>
<td>Mr. John Ogle</td>
<td></td>
</tr>
<tr>
<td>Mr. Billy Richards</td>
<td></td>
</tr>
<tr>
<td>Dr. David Williams</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Business and Industry Reviewers</td>
<td></td>
</tr>
<tr>
<td>Mr. Ken Beer</td>
<td></td>
</tr>
<tr>
<td>Mr. Mike Stroope</td>
<td></td>
</tr>
<tr>
<td>Mr. Don Haynie</td>
<td></td>
</tr>
<tr>
<td>Mr. Dan Swecker</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Reviewers</td>
<td></td>
</tr>
<tr>
<td>Mr. Bill Barrow</td>
<td>Shasta College</td>
</tr>
<tr>
<td>Mr. Steve Smith</td>
<td>Clarkston High School</td>
</tr>
<tr>
<td>Ms. Marlies Harris</td>
<td>Tracy High School</td>
</tr>
<tr>
<td>Mr. Douglas Spike</td>
<td>Charles Bowers School Farm</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Business Module Reviewer</td>
<td></td>
</tr>
<tr>
<td>Dr. Carole Engle</td>
<td></td>
</tr>
<tr>
<td>Mr. Mark Keenum</td>
<td></td>
</tr>
<tr>
<td>Dr. Robert Pomeroy</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Catfish Reviewers</td>
<td></td>
</tr>
<tr>
<td>Mr. Julian Allen III</td>
<td></td>
</tr>
<tr>
<td>Dr. James Carr</td>
<td></td>
</tr>
<tr>
<td>Dr. John Jensen</td>
<td></td>
</tr>
<tr>
<td>Mr. Bill Kyser</td>
<td></td>
</tr>
<tr>
<td>Mr. Benford “Bud” Pitman</td>
<td></td>
</tr>
<tr>
<td>Mr. Park Taylor</td>
<td></td>
</tr>
<tr>
<td>Mr. Jerry Williamson</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Crawfish Reviewers</td>
<td></td>
</tr>
<tr>
<td>Dr. William Davin</td>
<td></td>
</tr>
<tr>
<td>Dr. Gary Jensen</td>
<td></td>
</tr>
<tr>
<td>Dr. Harold Klassen</td>
<td></td>
</tr>
<tr>
<td>Dr. Wendell Lori</td>
<td></td>
</tr>
<tr>
<td>Dr. David Morehouse</td>
<td></td>
</tr>
<tr>
<td>Mr. Leroy Richard</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Salmon Reviewers</td>
<td></td>
</tr>
<tr>
<td>Dr. John Forester</td>
<td></td>
</tr>
<tr>
<td>Dr. Jon Lindbergh</td>
<td></td>
</tr>
<tr>
<td>Dr. Evelyn Sawyer</td>
<td></td>
</tr>
<tr>
<td>Dr. Robert Stickney</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Trout Reviewers</td>
<td></td>
</tr>
<tr>
<td>Dr. Ernie Brannon</td>
<td></td>
</tr>
<tr>
<td>Mr. Richard Colintina</td>
<td></td>
</tr>
<tr>
<td>Mr. Don Garling</td>
<td></td>
</tr>
<tr>
<td>Dr. Jeff Hinshaw</td>
<td></td>
</tr>
<tr>
<td>Mr. Terry Huddleston</td>
<td></td>
</tr>
<tr>
<td>Mr. Joe McCraken</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Baitfish Reviewers</td>
<td></td>
</tr>
<tr>
<td>Mr. Neal Anderson</td>
<td>Anderson Minnow Farm</td>
</tr>
<tr>
<td>Mr. Larry Dorman</td>
<td>University of Arkansas</td>
</tr>
<tr>
<td>Dr. Robert Goetz</td>
<td>Keo Fish Farms</td>
</tr>
<tr>
<td>Mr. Sam Herring</td>
<td>Herring Enterprises</td>
</tr>
<tr>
<td>Dr. Nathan Stone</td>
<td>University of Arkansas</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Shellfish Reviewers</td>
<td></td>
</tr>
<tr>
<td>Dr. Fred Conte</td>
<td></td>
</tr>
<tr>
<td>Dr. John Ewart</td>
<td></td>
</tr>
<tr>
<td>Dr. John Faudskar</td>
<td></td>
</tr>
<tr>
<td>Mr. Greg Flinlin</td>
<td></td>
</tr>
<tr>
<td>Dr. John Manzi</td>
<td></td>
</tr>
<tr>
<td>Mr. Don Meritt</td>
<td></td>
</tr>
<tr>
<td>Mr. David Nisbet</td>
<td></td>
</tr>
<tr>
<td>Dr. David Vaughan</td>
<td></td>
</tr>
<tr>
<td>Mr. Lee Wiegardi</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Tilapia Reviewers
Dr. Les Behrends
Mr. Ron Gula
Mr. Jack Robinson
Mr. Steve Van Gorder
Mr. Steven Waite
Mr. Erwin Young

Tennessee Valley Authority
University of Arizona
Tuner Aquaculture
Mississippi Aquaculture Bio-Tech
Kaona, Iowa
Fish Culture Systems
Prairie Springs, Inc.
Rocky Mountain White Tilapia

Striped Bass Reviewers
Dr. James Carlberg
Mr. Mike Freeze
Dr. Reggie Harrell
Dr. Ronald Hodson
Dr. Joe Morris
Dr. Mike Murphy
Mr. Tony Schuur
Mr. Mike Stroup

Aquatic Systems, Inc.
Keo Fish Farms
University of Maryland
North Carolina State University
Iowa State University
Coastal Aquaculture Unit
Bakersfield, California
Scotland Fisheries

Goldfish Reviewers
Mr. Jeff Raceu
Mr. Dick Rice
Mr. Emie Tressalt

Ozark Fisheries
Mount Parnell Fisheries
Hunting Creek Fisheries

Carp Reviewers
Dr. Jim Carrs
Mr. Harry Dupree
Dr. Jerry Shireman
Mr. Leslie Torrans

Osage Carp Fisheries
Stuttgart, Arkansas
University of Florida
Southeast Fish Culture Lab

Walleye Reviewers
Mr. Richard Colesante
Mr. Cal Cornyean
Mr. Steve Flickinger
Mr. Mike Mulford
Mr. Jeff Michael
Mr. Tim Nagel
Dr. Robert Summerfelt

N.Y. State Fish Hatchery
Pure Water Aquaculture, Inc.
Colorado State University
Miltona Fisheries
Golden Pond Fisheries
London Fish Hatcheries
Iowa State University

Yellow Perch Reviewers
Mr. Fred Binkowski
Dr. Don Garling
Dr. Terrence Kayes
Dr. David Smith
Mr. Chris Starr

Center for Great Lake Studies
Michigan State University
University of Nebraska, Lincoln
Fresh Water Farms
Bay Port Aquaculture

Sturgeon Reviewers
Mr. Ken Beer
Dr. Frank Chapman
Dr. Fred Conte
Dr. Serge Doroshov
Mr. Tony Schuur
Mr. Peter Struffenegger

The Fishery
University of Florida
University of California, Davis
University of California, Davis
Bakersville, California
Sea Farms California

Mullet Reviewer
Dr. Jerry Shireman

University of Florida

Redfish Reviewers
Dr. David Moss
Dr. Danny Robert

Redfish Unlimited
Florida Department of Natural Resources
Module I

Discovering the Origins and Opportunities in Aquaculture

To The Teacher—Module I is intended to introduce students to the meaning, history, and opportunities of aquaculture. It is comprised of three problem areas:

I-A Determining the Nature of Aquaculture
I-B Determining the Origins of Aquaculture
I-C Determining the Career Opportunities in Aquaculture

Each problem area can be used independently and sequenced in the teaching calendar as best fits the local instructional program. The suggested sequence is to follow I-A with I-B and I-C. The format of each problem area provides a suggested systematic instructional strategy with considerable emphasis on student activity. The content and techniques focus on achieving the objectives for the problem area. Traditional lecture-presentation and discussion teaching strategies can be enriched with the review and application activities.
Module I — Sources of Reference Materials

The sources of the reference materials cited in the problem areas are as follows: (Note: Materials are listed in alphabetical order by the last name of the senior author.)


Introduction to Aquaculture by Matthew Landau (1992) is available from: John Wiley and Sons, Inc., 605 Third Avenue, New York, NY 10158.

Commercial Catfish Farming by Jasper S. Lee (1991) is available from: Interstate Publishers Inc., P.O. Box 50, Danville, IL 61834-0050.


The videotape entitled “Aquaculture: Farming the Waters” is available from: American Association for Vocational Instructional Materials (AAVIM), 745 Gaines School Road, Athens, GA 30602.
# AQUACULTURE

## Table of Contents

Module I-A: Discovering the Origins and Opportunities in Aquaculture:
  Determining the Nature of Aquaculture ............................................. 1

Content and Procedures ........................................................................ 2

Presentation (Key Questions/Summary of Content, Teaching Techniques) ........ 3

Review/Application/Evaluation ................................................................. 9

Test ........................................................................................................ 10

Test Answer Key ................................................................................... 12

Transparency Masters

  T I-A-1  Discovering the Origins and Opportunities in Aquaculture:
  Determining the Nature of Aquaculture
  T I-A-2  Contrasting Aquaculture and Agriculture
  T I-A-3  Contrasting Aquaculture and Fisheries
  T I-A-4  Definition of Aquaculture (Number One)
  T I-A-5  Definition of Aquaculture (Number Two)
  T I-A-6  Functions in Aquaculture
  T I-A-7  Role of Hatcheries
  T I-A-8  Growout Facilities
  T I-A-10 Factors in a Growout Facility
  T I-A-11 Harvesting
  T I-A-12 Marketing Functions
  T I-A-13 Available Markets
  T I-A-14 Types of Processing
Module I-A — Discovering the Origins and Opportunities in Aquaculture

**Problem Area:** Determining the Nature of Aquaculture

**Estimated Time:** 3-6 hours

**Purpose/Goal:** The goal of this problem area is to help students understand the meaning and practice of aquaculture.

**Learning Objectives:** Upon completing this problem area, students will be able to:
- explain how definitions are derived;
- compare and contrast aquaculture with agriculture;
- compare and contrast aquaculture with fisheries;
- list two definitions of aquaculture and explain the differences in the two;
- list examples of aquatic crops;
- list and describe the functions in aquaculture.

**Instructional Resources:**

The following instructional resources are needed to complete this module:

**Essential:**
- The videotape:
  “Aquaculture: Farming the Waters”
- Overhead transparencies made from the masters attached to this module.

**Additional:** Any general references on aquaculture subjects, such as:

Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms, by Bardach, Ryther and McLarney.

Principles of Fishery Science, by Everhard and Youngh.

Introduction to Aquaculture, by Landau.


CONTENT AND PROCEDURES

Preparation
(Interest Approach):

This interest approach leads students into thinking about the meaning of aquaculture.

Suggested Procedure:

1. Display several objects representing the life sciences in the classroom. Objects might include leaves, skeleton or part of a fish, blossom from a native plant, and a small piece of lumber. Ask students to tell what they are. As they tell what the objects are, ask them why they used the particular names/terms that they did. List the key words that are given on the chalkboard.

2. Explain that defining terms can be thought of as building fences with words. A good definition should include everything which we think should be included and exclude everything that we think should not be included. (Analogy: A good fence confines animals to certain locations; it keeps them where you want them and out of places you don’t want them.)

3. Indicate that the study of aquaculture must begin with establishing the meaning for certain words, particularly “aquaculture.” Explain how defining terms can be thought of as building fences with words. Fences include and exclude certain “things;” definitions include and exclude.

4. Lead discussion into the objectives for the module and problem area.
## Presentation

<table>
<thead>
<tr>
<th>Key Questions/Summary of Content</th>
<th>Teaching Techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>The focus of this teaching plan is to help the learners understand the meaning and general practices in aquaculture.</td>
<td>Present the objectives by using T 1-A-1 or by writing them on the chalkboard.</td>
</tr>
</tbody>
</table>

### I. How are definitions derived?

A. A definition is a statement of the meaning of a word.

B. Two approaches are used to define words.

1. By convention—This involves agreeing on a definition or by using the definition of an authority, such as a teacher. Definitions derived by convention will facilitate debate and discussion but do not necessarily lead to understanding. We decide on the definitions we want, to ensure we are all talking about the same things. If we choose this method to arrive at a definition before we start studying a topic, the content will be determined by the definition.

2. By discovery—This involves agreeing that such a thing as aquaculture exists and that it has certain characteristics which are practiced by people who are “aquaculturists.”

   “Discovery” involves investigating the tools and practices common to aquaculture activities and which are unique to it. This method of defining aquaculture requires studying the nature of aquaculture and developing a definition.

1. Help students understand definition by convention by having them briefly state the pros and cons of nuclear power for the production of electricity. Explain that we need a definition of nuclear power so that everyone is talking about the same thing. Without a definition, some might think of nuclear power in an experimental lab while others envision a huge facility, such as Three Mile Island. These are two vastly different approaches. Therefore, we say that by nuclear power we mean the power plant at Three Mile Island.

2. Have students point to several examples of objects people consider to be chairs. Ask them the properties of these such as, “Do all chairs have backs?” “Are all chairs made of wood?” “Are all chairs for sitting?”

- Explain that the class will study aquaculture as practiced by aquaculturists and not as we think aquaculturists should practice it. (This addresses changing the perceptions people have of the meaning of aquaculture.)
II. How is aquaculture compared and contrasted with agriculture?

A. Aquaculture has distinguishing characteristics.
   1. Occurs in water
   2. Limited by dissolved oxygen in water
   3. Many animal and plant crops
   4. Uses wild and/or domestic organisms
   5. Limited by water supply
   (Note: This distinction is diminishing as aquacrops are domesticated, i.e. trout.)

B. Agriculture has distinguishing characteristics.
   1. Occurs on land
   2. Limited by water supply
   3. Many plant and animal crops
   4. Domesticated organisms

C. Agriculture can be defined as all of the activities involved in producing domestic plants
   and animals, the supplies and services needed to produce them, and the processing, marketing
   and other steps that deliver products to consumers in the desired forms.

II. Use T I-A-2 or the chalkboard to develop a list of distinguishing characteristics. Discuss
each of the characteristics. Ask students to tell what each means.

C. Ask students to offer their definitions of agriculture. Help them understand it is a
broad industry that includes much more than farming.

III. How is aquaculture compared and contrasted with fisheries?

A. Aquaculture has distinguishing characteristics.
   1. Aquaculture involves controlled culture.
   2. Aquaculture involves an individual owning the crops.

B. Fisheries has distinguishing characteristics.
   1. Fisheries involves hunting.
   2. In fisheries, the general public has open access to the crops (fish, etc.) being hunted.

C. Stock enhancement is an important function of aquaculture.
   1. Streams and lakes may be re-stocked.
   2. Sport fishing is more enjoyable and stable.
   3. Commercial fisheries are more assured of economic success.

III. Use T I-A-3 or the chalkboard to present a list of distinguishing characteristics. Discuss
each of the characteristics. Ask students to explain what they mean.

Note: Explain that fisheries involves capturing wild fish and other seafood, followed by
processing and selling the finished product to consumers.
IV. What are two definitions of aquaculture? How are they different?

(Note: Two definitions are offered to distinguish between aquaculture and hydroponics.)

A. Definition One: Aquaculture is the science, art and business of cultivating aquatic plants and animals.

(Note: This is the definition of aquaculture this class will use.)

1. Science implies objectivity or fixed characteristics.
2. Art implies subjectivity as identified by an individual’s perceptions.

3. Business implies making money, or aquaculture as a commercial venture.

4. Cultivating implies caring for the plants and animals so that they grow better; their growth is fostered.
5. Aquatic describes the type of organism being grown; they grow, live in or frequent water.
6. Aquaculture is limited by water. The type and level of production is dependent on the quantity and quality of water.

B. Definition Two: Aquaculture is the science, art and business of cultivating plants and animals in water.

1. This definition includes terrestrial organisms — organisms that live on land.
2. It includes hydroponics, rice production and the culture of other crops that grow in water.

(Note: Hydroponics is growing terrestrial plants in nutrient solutions rather than in soil.)

IV. Tell students two definitions will be used for awhile; however, the definitions may change as aquaculture is studied.

A. Use T I-A-4 or the chalkboard to present the definition.

1. Discuss the difference between objectivity and subjectivity. Relate the difference to kinds of written tests students take in school. (Note: objective test questions have precise answers; subjective test questions have answers that may involve interpretation or opinion.)
2. Have students contrast a hobby with a business from the standpoint of making a profit.
3. Use an agricultural example to explain cultivation, such as cultivation in a garden or caring for cattle.

B. Use T I-A-5 or the chalkboard to present the definition.

1. Have students name examples of crops that grow on land.
2. Have students name examples of hydroponic crops and indicate if they can be grown in water and on land. Examples: lettuce and tomatoes.
C. The distinction in the two definitions lies not so much in the growing medium in which the crops are produced, but in the characteristics of the crops, i.e., aquatic versus terrestrial.

V. What are some examples of aquaculture?
   A. Catfish farming
   B. Shrimp farming
   C. Crawfish farming
   D. Salmon ranching
   E. Tropical fish rearing
   F. Tilapia culture

VI. What are the functions in aquaculture?
   A. The term “function” refers to the activities that must be performed in the production of aquatic crops. These occur in hatcheries, growout facilities and in marketing.
   
   B. Hatcheries produce the seed.
      1. Seed are the young fish used to stock growing facilities.
      2. Seed are obtained in two ways: capturing wild seed and raising offspring from parental stock.
      3. Parental stock are obtained by capturing wild adult animals or by culturing broodstock (the adult animals kept for reproduction).
      4. Reproduction is important for the successful use of broodstock in producing seed.
         • The broodstock must grow to sexual maturity, mate and spawn.
      5. When raising young, careful consideration must be given to feeds and growth needs.
      6. Young may be fed live or artificial feeds.

   C. Explain that fish are aquatic and grow in water; rice is not an aquatic crop though it grows in land that is flooded.

   V. Show the video, “Farming the Waters.”
   Have students give oral reports on what they observed. Ask them to name examples of locally-grown aquatic crops. Indicate the crops will be studied in more detail later.

   A. Use T I-A-6 or the chalkboard to explain “function.”

   B. Use T I-A-7 or the chalkboard to explain the role of hatcheries.
      • Explain aquaculture hatcheries are similar to hatcheries in poultry farming.
      • Arrange a hatchery tour to observe how seed are produced.
C. Growout facilities produce aquacrops from the seed.
   1. Facilities may involve intensive or extensive production systems.
      a. Intensive systems have very high populations of aquacrops in relatively small spaces. They require very careful management. Examples: production in tanks, raceways and ponds.
      b. Extensive systems involve lower populations of aquacrops and require less stringent management. Examples: low density ponds and natural streams and lakes.
   2. Production systems may be land-based, such as ponds, tanks and raceways.
   3. Production systems may be water-based, such as pens, cages and ranching.
   4. Growout facilities must provide a good environment for the aquacrop. This includes attention to:
      • species selection (selecting the “right” crop for the system—some species won’t grow well in some systems);
      • water quality (having water that is appropriate for the aquacrop);
      • water oxygenation (minimum levels of oxygen are required by most aquacrops);
      • disease prevention and control (aquacrops are subject to a number of diseases; good cultural practices can reduce the chance of disease occurring);
      • feeding (aquacrops require certain nutrients to grow).

D. Harvesting involves gathering or capturing the desired crop for marketing. Two types of harvesting are typically used in aquaculture: topping or partial, and total harvest.
   1. Topping is collecting only part of the crop in a production facility.
      • Topping methods include traps, seines and nets, and hook-and-line.

C. Use T I-A-8 or the chalkboard to list the definition of growout.
   1. Use T I-A-9 or the chalkboard to describe production systems.
   2. In case students aren’t familiar with ponds, tanks and raceways, offer a brief explanation of these growout facilities. (Facilities will be treated in detail in future modules.)
   4. Use T I-A-10 or the chalkboard to list the environmental conditions a growout facility must provide.
      • Have students describe what they feel would be a good environment for aquacrops. This will help prepare them for the study of additional problem areas.

D. Use T I-A-11 or the chalkboard to help define harvesting.
2. Total harvest involves collecting all of the crop in a production facility. Total harvest methods include traps, seines and nets, hook-and-line, and drain harvesting.

E. Marketing aquacrops includes functions that connect producers with consumers.

1. The purpose of marketing is providing consumers with desired products.

2. Marketing includes assembling, grading, hauling, processing, packaging, storing, wholesaling, retailing, advertising and changing ownership. (These are similar to marketing other agricultural commodities such as corn, wheat, milk, tomatoes and hogs.)

3. Available markets include:
   - Personal use, including recreation and food;
   - Selling to processors, consumers, live haulers, fee fishing privileges, specialty restaurants and aquarist trade (pet and ornamental dealers).

4. Processing changes the form of the product into one that is more desirable to consumers.

Types of processing are:

- Minimal—little change in product form (such as whole eviscerated); refrigeration and freezing are used.

- Medium—considerable change in product form; dressing, filleting, etc.

- Value added—making consumption convenient; includes easy-to-cook forms (breaded and/or seasoned) and attractive packaging.

E. Use T I-A-12 or the chalkboard to list marketing functions. Briefly explain the functions and ask students to offer agricultural crop examples.

3. Use T I-A-13 or the chalkboard to list available markets.

4. Use T I-A-14 or the chalkboard to define processing and list the different types.
Review

Have students demonstrate their understanding of the objectives by asking key questions, such as:

- What are the major differences between agriculture and aquaculture? Between aquaculture and fisheries?
- What are two definitions of aquaculture? Describe how they are different.
- What are some examples of aquatic crops? Which of these are grown in local area?
- What are the functions in aquaculture? Explain the role of each.

Application

Application can be achieved by involving the students in ways of studying their local community as related to aquaculture. Areas to be investigated include the following:

- What aquaculture production takes place locally? (Identify the aquacrops produced, the facilities used, how the product is marketed, and other factors in production.)
- What is the nature of aquaculture? (Arrange a field trip to a local aquaculture facility or use a resource person in the classroom. Students should observe the nature of the work, the facilities used, the species of aquacrop produced, how the water is managed, and other details of production. They should provide oral and/or written reports of their observations.)
- How important are fish and other aquatic foods in the human diet? (Have students visit a nearby supermarket to observe the kinds of aquaculture foods for sale and how they are packaged. Students may make a list of the species and the various ways they have been processed. For example, salmon may be fresh dressed, canned, frozen, smoked or dried. Read product labels to get an idea of the nutritional value of these products.)

Evaluation

Evaluate how well the students have achieved the specific learning objectives by:

- Giving a written test (example included).
- Observing how students interpret the meaning of aquaculture throughout the duration of the class. Help reinforce the definition.
Determining the Nature of Aquaculture

Problem Area: Discovering the Origins and Opportunities in Aquaculture

Instructions: Provide the information to answer the following questions.

Name

1. Contrast aquaculture with agriculture.
   Put an A in the space by the characteristics of aquaculture and a G in the space by the characteristics of agriculture.
   a. ______ occurs in water
   b. ______ domesticated organisms
   c. ______ limited by water
   d. ______ uses wild and/or domestic organisms
   e. ______ limited by oxygen
   f. ______ occurs on land

2. Define aquaculture.

3. List three examples of aquaculture.
   1. ____________________________
   2. ____________________________
   3. ____________________________

4. What are three general functions in aquaculture?
   1. ____________________________
   2. ____________________________
   3. ____________________________

5. Place an X by each of the items below that occur at hatcheries.
   a. ______ fish are dressed
   b. ______ fish are reproduced
   c. ______ broodstock are maintained
   d. ______ fish are frozen

6. Place an X by each of the items below that are important in growout operations.
   a. ______ proper species selection
   b. ______ disease prevention
   c. ______ feeding
   d. ______ harvesting

7. Place an “X” by each of the items below that are a part of marketing.
   a. ______ reproducing fish
   b. ______ hauling
   c. ______ getting products to consumers
   d. ______ changing ownership
   e. ______ grading
   f. ______ processing
8. Briefly explain the following forms of processing:
   a. minimal —

   b. medium —

   c. value added —

Optional Item

Write a paragraph describing the importance of aquaculture in meeting future human consumption needs.
Determining the Nature of Aquaculture

1. a. ___ A ___ occurs in water  d. ___ A ___ uses wild and/or domestic organisms
   b. ___ G ___ domesticated organisms  e. ___ A ___ limited by oxygen
   c. ___ A & G ___ limited by water  f. ___ G ___ occurs on land

2. Aquaculture is the science, art and business of cultivating aquatic plants and animals.

3. 1. Catfish farming
    2. Shrimp farming
    3. Crawfish farming

4. 1. Hatcheries
    2. Growout facilities
    3. Marketing aquacrops

5. a. _______ fish are dressed  c. ___ X ___ broodstock are maintained
    b. ___ X ___ fish are reproduced  d. _______ fish are frozen

6. a. ___ X ___ proper species selection  c. ___ X ___ feeding
    b. ___ X ___ disease prevention  d. ___ X ___ harvesting

7. a. _______ reproducing fish  c. ___ X ___ getting products to consumers  e. ___ X ___ grading
    b. ___ X ___ hauling  d. ___ X ___ changing ownership  f. ___ X ___ processing

8. a. minimal — Little change in product form
    b. medium — Considerable change in product form
    c. value added — Making consumption convenient

Optional Item

Could include: • increased consumer demand
                • decreasing wild supply
                • healthy/low cholesterol
Discovering the Origins and Opportunities in Aquaculture:
Determining the Nature of Aquaculture

OBJECTIVES

- Explain how definitions are derived
- Compare and contrast aquaculture with agriculture
- Compare and contrast aquaculture with fisheries
- List two definitions of aquaculture and explain the differences
- List examples of aquatic crops
- List and describe the functions in aquaculture
Contrasting Aquaculture and Agriculture

AQUACULTURE
- Occurs in water
- Limited by oxygen
- Limited by water
- Many animal crops
- Uses wild organisms

AGRICULTURE
- Occurs on land
- Limited by water
- Many plant crops
- Domesticated organisms
Contrasting Aquaculture and Fisheries

AQUACULTURE
- Controlled culture
- Individuals own crops

FISHERIES
- Hunting
- Open access of people to crop
Definition of Aquaculture
(number one)

Aquaculture is the science, art and business of cultivating aquatic plants and animals

- Science implies objectivity
- Art implies subjectivity
- Business implies making money
- Cultivating implies caring for the crop
- Aquatic describes where organisms grow
Definition of Aquaculture
(number two)

Aquaculture is the science, art and business of cultivating plants in water

- Involves organisms that live on land (terrestrial)
- Includes hydroponics
- Includes crops such as rice
Functions in Aquaculture

- Hatchery – reproduce young
- Growout – grow young to market size
- Marketing – deliver aquacrops to consumers
Role of Hatcheries

- Produce seed (reproduce)
- Maintain parental stock (broodfish)
- Consider feed and growth needs to produce quality seed
Growout Facilities

- Produce aquacrops from seed
- Used for human food, animal food, pets and recreation
- May use:
  - ponds - large water structure made of earth
  - tanks - small structures of metal or fiberglass
  - raceways - concrete or earthen structures using flowing water
  - cages - containers made of mesh material that float in the water
  - vats - small concrete structures for temporarily holding fish
  - pens - containers made of mesh material anchored to the bottom of a water structure
Growout Facilities

INTENSIVE SYSTEMS:
- High population density of aquacrops
- Require careful management
- Examples include tanks, raceways and ponds

EXTENSIVE SYSTEMS:
- Lower population density
- Different approaches to management used
- Examples include ponds with low stocking rates and natural streams and lakes
Factors in a Growout Facility

- Species selection
- Water quality
- Water oxygenation
- Disease prevention
- Feeding
- Regulations
- Use of therapeutents
- Discharge of effluent/environmental concerns
Harvesting

- Involves capturing aquacrop
- Types of Harvesting:
  - Topping (partial)
  - Total
Marketing Functions

- Assembling
- Grading
- Hauling
- Processing
- Packaging
- Storing
- Wholesaling
- Retailing
- Advertising
- Change of Ownership
Available Markets

- Personal use
- Recreation
- Food
- Sell
- Processors
- Live haulers
- Fee fishing
- Direct to restaurants
- Aquarist trade
Types of Processing

MINIMAL
• little change in product form

MEDIUM
• considerable change in product form

VALUE ADDED
• easy-to-prepare forms
• attractive packaging