

Aquaculture (1990)

Winner of the 1990 American Vocational Association - "VIM Outstanding Curriculum and Instructional Materials Award" (935 pages, 45 transparency masters)

Aquaints students with all aspects of fish farming - site planning, water quality management, fish health management, harvesting, hauling, and marketing. Specialty units address production of catfish, trout, baitfish, crayfish, and other species. Lots of practical hands-on activities for potential fish farmers.

The materials can be purchased through MAVCC
1-800-654-3988.

Multistate Academic and Vocational Curriculum Consortium
1500 West Seventh Avenue
Stillwater, Oklahoma 74074-4364

AQUACULTURE

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Printed in the United States of American by the
Oklahoma State Department of Vocational-Technical Education
Stillwater, OK 74074

Mid-America Vocational Curriculum Consortium, Inc.
1500 West Seventh
Stillwater, Oklahoma 74074-4364

AQUACULTURE

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FOREWORD

Because American agriculture is increasingly subject to unstable markets and inroads from foreign competition, alternatives to agriculture are emerging to help the American farmer find new products and markets. Aquaculture is one of the exciting alternatives that promises economic rewards to those who take the time to plan and develop a fish farm or any other aquaculture project properly. That's what MAVCC'S *Aquaculture* has as an ultimate objective: to help interested students plan, build, stock and run aquaculture facilities of varied sizes. Aquaculture projects require planning and management comparable to any other commercial endeavor. Much of the material in our text addresses the down-to-earth activities of selecting a site, evaluating soil types, selecting equipment, planning a facility, and managing water quality to promote good health and growth. Aquaculture is a good-sized text, almost bigger than a bread basket, but with the bigness comes a comprehensive text from which instructors and students may select materials that can be put to work locally.

As is typical with MAVCC's competency-based format, *Aquaculture is* chock full of hands-on assignment and job sheets that explain to students how to get things done. We think you'll enjoy the text—we feel that everyone will profit from it.

Ann Masters, Chairman
Board of Directors
Mid-America Vocational
Curriculum Consortium

Jim Steward
Executive Director
Mid-America Vocational
Curriculum Consortium

AQUACULTURE

INSTRUCTIONAL / TASK ANALYSIS

JOB TRAINING: What the
Worker Should Be Able to Do
(Psychomotor)

RELATED INFORMATION:
What the Worker Should Know
(Cognitive)

UNIT 1: INTRODUCTION TO AQUACULTURE

1. Terms and definitions
2. Facts about aquiculture
3. The historical background of aquiculture
4. Types of aquiculture environments
5. Types of aquiculture enterprises
6. Species of economic importance
7. Factors to consider before starting an aquiculture enterprise
8. Limiting factors in joint agriculture/aquiculture enterprises
9. Physical and fiscal risks associated with aquiculture
10. Advantages of aquiculture
11. Sources of information about aquiculture
12. Survey local aquiculture production. (Assignment Sheet #1)
13. Visit a support facility and interview the operator(s). (Assignment Sheet #2)
14. Survey local market outlets for types of fish sold. (Assignment Sheet #3)
15. Interview a local producer. (Assignment Sheet #4)

JOB TRAINING: What the
Worker Should be Able to Do
(Psychomotor)

RELATED INFORMATION:
What the Worker Should Know
(Cognitive)

UNIT II: THE AQUATIC ENVIRONMENT

1. Terms and definitions
2. Important variables affecting the ecological balance of a pond
3. Links in the aquatic food chain
4. The oxygen cycle in pond ecology
5. Factors affecting oxygen production in pond water
6. The effects of seasonal temperature changes on pond water
7. The positive roles of plankton and benthic organisms in pond ecology
8. The negative roles of plankton and benthic organisms in pond ecology
9. Problems concerning carbon dioxide in the aquatic environment
10. Problems concerning water acidity (pH) in pond ecology
11. Water alkalinity and hardness
12. Ammonia and ammonia byproducts in pond ecology
13. Hydrogen sulfide in the aquatic environment
14. Aquatic plants
15. Sources of water pollution
16. Collect pond plankton and examine under a microscope. (Assignment Sheet #1)
17. Observe the effects of sunlight on collected samples of pond water. (Assignment Sheet #2)
18. Seine a pond; examine findings and discuss the fish food chain. (Assignment Sheet #3)

JOB TRAINING: What the
Worker Should be Able to Do
(Psychomotor)

19. Collect a pond bottom sample; examine and discuss findings. (Assignment Sheet #4)
20. Prepare a list of food sources a sample pond offers its fish populations; identify benthic organisms and other elements in the food chain. (Assignment Sheet #5)
21. Survey the aquatic plants and marginal ecology of a sample pond; discuss the ecological impact on fish populations environment. (Assignment Sheet #6)

RELATED INFORMATION:
What the Worker Should Know
(Cognitive)

UNIT III: FUNDAMENTAL FISH BIOLOGY

1. Terms and definitions
 2. External parts of a typical fish
 3. Basic external body features that permit fish to live in water
 4. Internal organs of a typical fish
 5. The functions of internal organs and systems of fishes
 6. Life cycles of fish
 7. Fish species
8. Dissect a fish, examine under a microscope, and identify internal organs. (Job Sheet #1)
 9. Kill, weigh, measure, and dress a catfish, and compare dressed and undressed measurements. (Job Sheet #2)

UNIT IV: MARKETING

1. Terms and definitions
2. Processing plant markets
3. Live haul markets
4. Local markets: stores and restaurants
5. Local retail markets
6. The fee-fish market

**JOB TRAINING: What the
Worker Should be Able to Do
(Psychomotor)**

**RELATED INFORMATION:
What the Worker Should Know
(Cognitive)**

7. Economy of scale
 8. Factors to consider when exploring marketing alternatives
 9. Product forms
 10. Food processing cuts and forms
 11. Dressout percentages of processing cuts and forms
 12. On-site versus plant processing
 13. Disposal of processing waste
 14. Permits and regulations
-
15. Survey local markets. (Assignment Sheet #1)
 16. Skin and filet a catfish. (Job Sheet #1)
 17. Dress and package a trout. (Job Sheet #2)

UNIT V: SITE SELECTION

1. Terms and definitions
2. Three basic site requirements
3. Facts to consider when evaluating a site's potential water sources
4. Steps in determining a site's water quality
5. Pond type and site evaluation
6. Steps in determining whether soil is suitable for pond construction
7. Basic soil types
8. Soil considerations in site selection
9. Topographical considerations in site selection
10. General facts to consider in site selection
11. Site-specific factors that determine cost

JOB TRAINING: What the Worker Should be Able to Do (Psychomotor)

RELATED INFORMATION: What the Worker Should Know (Cognitive)

12. Laws, regulations, and permits required to develop a site for fish farming
13. Survey a site's potential as a fish farm. (Assignment Sheet #1)
14. Evaluate a potential site's soil quality. (Assignment Sheet #2)
15. Evaluate a potential site's water sources and quality. (Assignment Sheet #3)
16. Complete a checklist to determine site's feasibility. (Assignment Sheet #4)

UNIT VI: FACILITY DESIGN AND LAYOUT

1. Terms and definitions
2. Types of farm water enclosures
3. Facility requirements for food-fish production
4. Facility requirements for channel catfish fingerling production
5. Requirements for rainbow trout fingerling production
6. Facility requirements for fee-fish operation
7. Initial steps in planning an on-site processing facility
8. Facility and equipment requirements for an on-site processing facility
9. Factors to consider when planning pond size
10. Layout and design considerations
11. Advantages of small versus large pond
12. Estimate water requirements. (Assignment Sheet #1)
13. Calculate common earth pond construction requirements. (Assignment Sheet #2)

JOB TRAINING: What the Worker Should be Able to Do (Psychomotor)

14. Design and layout a pond. (Assignment Sheet #3)
15. Determine costs local well drilling, earthmoving, construction services. (Assignment Sheet #4)
16. Complete a feasibility study of a selected site by estimating construction. (Assignment Sheet #5)
17. Construct a cage for fish culture, (Job Sheet #1)

RELATED INFORMATION: What the Worker Should Know (Cognitive)

UNIT VII: WATER QUALITY MANAGEMENT

1. Terms and definitions
2. Compounds and elements and their chemical formulas and symbols
3. The importance of oxygen in water quality management
4. The role of temperature in oxygen management
5. Natural sources of water temperature variation and their effects
6. Types of thermometers for measuring water temperature
7. Facts about temperature management techniques
8. Causes of DO (dissolved oxygen) loss
9. Signs of DO deficiency
10. Facts about the prevention of DO depletion
11. Guidelines for measuring DO
12. DO measuring equipment and its description
13. Methods of correcting DO deficiency
14. Types of mechanical aerators
15. Facts about turbidity remedies

JOB TRAINING: What the Worker Should be Able to Do (Psychomotor)

RELATED INFORMATION: What the Worker Should Know (Cognitive)

16. The importance of nitrogen compounds in water quality management
17. pH and water quality
18. Methods of managing the pH cycle
19. The purposes of liming
20. General guidelines for water chemistry management
21. Aquatic plant control methods
22. Calculate dosages for chemical treatments. (Assignment Sheet #1)
23. Analyze facility aerator needs. (Assignment Sheet #2)
24. Use a Secchi disc to measure turbidity. (Job Sheet #1)
25. Use an O₂ meter to measure DO (Job Sheet #2)
26. Use a water analysis kit to test water quality parameters. (Job Sheet #3)
27. Predict low DO levels, using Secchi disc, rejection, and chart methods. (Job Sheet #4)

UNIT VIII: FISH HEALTH MANAGEMENT

1. Terms and definitions
2. Skin and tissue conditions
3. Severity of disease or condition
4. Behavior or appearance of sick fish
5. The role of stress in fish diseases
6. Common stressors of fish
7. Signs of stress and disease
8. Common pathogenic viruses
9. Common pathogenic bacteria

JOB TRAINING: What the Worker Should be Able to Do (Psychomotor)

RELATED INFORMATION: What the Worker Should Know (Cognitive)

10. Common pathogenic fungi
 11. Common pathogenic protozoan parasites
 12. Common pathogenic crustacean parasites
 13. Common pathogenic worm parasites
 14. General management measures for preventing disease outbreaks
 15. Basic hygiene for disease prevention and corrective management
 16. Treatment methods and their administration specifics
 17. General guidelines for treatment of fish diseases
 18. Regulations for chemical application in fish production
-
19. Solve problems related to common diseases and conditions of fish. (Assignment Sheet #1)
 20. Calculate treatment rates. (Assignment Sheet #2)
 21. Prepare a list of local, area or state specialists to contact in the event of a disease emergency. (Assignment Sheet #3)
 22. Report on the activities and procedures observed at a disease diagnostic laboratory. (Assignment Sheet #4)
 23. Complete record-keeping forms on fish health management practices. (Assignment Sheet #5)
 24. Prepare and package a specimen for shipment to a diagnostic laboratory. (Job Sheet #1)

Unit IX: COMMERCIAL CATFISH PRODUCTION

1. Terms and definitions
2. The advantages of raising catfish

JOB TRAINING: What the
Worker Should be Able to Do
(Psychomotor)

RELATED INFORMATION:
What the Worker Should Know
(Cognitive)

3. The limitations of raising catfish
 4. The phases of fingerling production
 5. Guidelines for stocking broodfish
 6. Managing broodfish in pens
 7. Managing broodfish in open ponds
 8. Egg, fry, and fingerling management
 9. Stocking rates for fingerling grow-Out
 10. Guidelines for obtaining fingerlings for food-fish production
 11. Size options for stocking fingerlings for food-fish production
 12. Food-fish stocking rates
 13. Types of commercial catfish feeds
 14. Size and quality of catfish feed
 15. Guidelines for feeding food fish
 16. Producing catfish in cages
 17. Advantages of cage culture
 18. Limitations of cage culture
 19. Tank and raceway culture of channel catfish
-
20. Keep daily, weekly, and monthly production records. (Assignment Sheet #1)
 21. Calculate stocking rates. (Assignment Sheet #2)
 22. Calculate FCR and estimate fish weights from feed records. (Assignment Sheet #3)
 23. Calculate feed requirements and costs. (Assignment Sheet #4)
 24. Make an anticipated loss projection. (Assignment Sheet#5)

JOB TRAINING: What the Worker Should be Able to Do (Psychomotor)

RELATED INFORMATION: What the Worker **Should Know** (Cognitive)

25. Perform pond sampling to estimate average fish weights and standing crop weight. (Job Sheet #1)

UNIT X: COMMERCIAL TROUT PRODUCTION

1. Terms and definitions
 2. Trout culture
 3. The external anatomy of a rainbow trout
 4. Basic water quality requirements
 5. Types of trout farming enterprises
 6. Phases of trout production
 7. Broodfish management
 8. Egg management
 9. Fry and fingerling management
 10. General guidelines for feeding different sized fish
 11. General management guidelines
 12. Types of impoundment and rearing units
 13. Raceway design
 14. Water use systems
 15. Typical stocking/loading rates
 16. Flow Index and Density Index
17. Keep trout production records. (Assignment Sheet #1)
18. Calculate raceway carrying capacity based on flow and density indexes. (Assignment Sheet #2)
19. Predict ammonia loads based on food consumption, fish load, and water flow rate. (Assignment Sheet #3)
20. Artificially spawn trout broodfish. (Job Sheet #1)

JOB TRAINING: What the
Worker Should be Able to Do
(Psychomotor)

RELATED INFORMATION:
What the Worker Should Know
(Cognitive)

21. Inventory a raceway load. (Job
Sheet #2)

XI: COMMERCIAL BAITFISH PRODUCTION

1. Terms and definitions
2. The baitfish industry
3. Marketing options
4. Factors affecting marketing success
5. Popular baitfish species
6. General characteristics of baitfish species
7. Guidelines for selection of broodstock
8. Reproductive and spawning characteristics of golden shiner, fathead minnow, and goldfish
9. Propagation methods
10. Methods of pond preparation for the propagation and rearing of baitfish
11. Predators and their control techniques
12. Propagation techniques and stocking rates for golden shiners and goldfish
13. Free-spawning and fry transfer methods of propagating fathead minnows
14. Fertilization techniques for plankton production
15. Feeding practices
16. Basic harvesting equipment needs
17. General guidelines for harvesting baitfish to holding troughs
18. Harvesting methods
19. Guidelines for maintaining baitfish in holding troughs

JOB TRAINING: What the Worker Should be Able to Do (Psychomotor)

RELATED INFORMATION: What the Worker Should Know (Cognitive)

20. Grading procedures and grading equipment
21. Guidelines for transporting fish to long-distance markets
22. Guidelines for transporting fish to short-distance markets
23. Survey baitfish dealers to evaluate local (Assignment Sheet #1)
24. Visit a baitfish farm and report on the operation. (Assignment Sheet #2)
25. Trap, count or weigh, and grade a sample of baitfish. (Job Sheet #1)
26. Make a spawning mat. (Job Sheet #2)
27. Bring baitfish eggs into hatching area and watch them hatch. (Job Sheet #3)

X11: COMMERCIAL CRAYFISH PRODUCTION

1. Terms and definitions
2. Crayfish aquiculture
3. Crayfish body parts and their functions
4. Species selection
5. Red Swamp and White River crayfishes
6. The reproduction and life cycle of crayfish
7. Crayfish pond types
8. Open pond design
9. Open pond management cycle
10. Recirculating ponds
11. Water quality requirements for crayfish
12. Start-up stocking rates

JOB TRAINING: What the Worker Should be Able to Do (Psychomotor)

RELATED INFORMATION: What the Worker Should Know (Cognitive)

- | | |
|--|------------------------------------|
| 16. Identify crayfish species and sexes. (Assignment Sheet #1) | 13. Feeds and feeding practices |
| 17. Identify the external and internal parts of a crayfish. (Assignment Sheet #2) | 14. Harvesting crayfish |
| 18. Research techniques for soft-shell crayfish production, and report to the class. (Assignment Sheet #3) | 15. Handling and shipping crayfish |
| 19. Construct a crayfish trap. (Job Sheet #1) | |

XIII: OTHER COMMERCIAL SPECIES

1. Terms and definitions
2. The commercial culture of tilapia
3. Methods of managing tilapia to control overpopulation
4. The culture of largemouth bass
5. The culture of bluegill and hybrid sunfish
6. The culture of crappies
7. Description and uses of common and Chinese carps
8. The commercial production of striped and hybrid striped bass
9. Marine species that can be cultured in freshwater
10. The commercial production of alligators
11. The commercial production of bullfrogs
12. The commercial culture of hobby and ornamental fish

JOB TRAINING: What the
Worker Should be Able to Do
(Psychomotor)

13. Interview local hobby and ornamental fish retailers to determine area supply and demand. (Assignment Sheet #1)
14. Visit a facility that cultures a species discussed in this unit, and report on the operation. (Assignment Sheet #2)

RELATED INFORMATION:
What the Worker Should Know
(Cognitive)

XIV: HARVESTING AND HAULING

1. Terms and definitions
 2. Advantages of total and partial
 3. Limitations of total and partial harvest
 4. Guidelines for quality control
 5. Correct uses of harvesting equipment
 6. Correct uses of grading equipment
 7. Pre-harvest guidelines
 8. Harvesting techniques and procedures
 9. Pond-to-shed transport procedures
 10. Holding practices
 11. Grading practices
 12. Hauling equipment
 13. Loading procedures and rates
 14. Hauling and water quality
 15. Chemicals, their correct descriptions and rates
 16. Unloading procedures
 17. Guidelines for the care of nets
18. Calculate loading rates. (Assignment Sheet #1)
 19. Observe and report on a commercial harvest. (Assignment Sheet #2)

**JOB TRAINING: What the
Worker Should be Able to Do
(Psychomotor)**

20. Survey your area and state for laws and regulations concerning interstate and intrastate shipping. (Assignment Sheet #3)
21. Check water temperature and other shipping parameters. (Job Sheet #1)
22. Grade fish. (Job Sheet #2)
23. Package fish in a plastic bag, (Job Sheet #3)
24. Disinfect fish transport tanks and equipment. (Job Sheet #4)

**RELATED INFORMATION:
What the Worker Should Know
(Cognitive)**

XV: BUSINESS MANAGEMENT

1. Terms and definitions
2. Reasons for keeping records
3. Basic kinds of records
4. Production credit and consumption credit
5. Guidelines for building and maintaining a good credit standing
6. The three C's of good credit
7. Factors that a lender looks for in a borrower
8. Factors that a borrower looks for in a lender
9. Indicators of good loan repayment ability
10. Indicators of poor loan repayment ability
11. Major types of credit extended by businesses
12. Types of loans issued by banks and other lending institutions
13. Sources of credit for aquacultural enterprises
14. Methods of computing interest
15. True annual interest rates

JOB TRAINING: What the
Worker Should be Able to Do
(Psychomotor)

18. Prepare an equipment cost comparison report. (Assignment Sheet #1)
19. Estimate fixed costs. (Assignment Sheet #2)
20. Develop an enterprise budget to determine actual costs and expected returns. (Assignment Sheet #3)
21. Develop a cash flow projection. (Assignment Sheet #4)
22. Use a computer to evaluate an aquacultural operation. (Assignment Sheet #5)
23. Interview a local lender and report attitudes about aquiculture capital. (Assignment Sheet #6)
24. Complete a checklist to determine individual potential in the aquiculture industry. (Assignment Sheet #7)

RELATED INFORMATION:
What the Worker Should Know
(Cognitive)

16. Essential components of all budgets
17. Budgeting principles

USE OF THIS PUBLICATION

Instructional Units

Aquaculture contains fifteen units of instruction. Each instructional unit includes some or all of the basic components of a unit of instruction; performance objectives, suggested activities for teachers and students, information sheets, assignment sheets, job sheets, visual aids, tests, and answers to the tests. Units are planned for more than one lesson or class period of instruction.

Careful study of each instructional unit by the teacher will help to determine:

- A. The amount of material that can be covered in each class period
- B. The skills which must be demonstrated
 - 1. Supplies needed
 - 2. Equipment needed
 - 3. Amount of practice needed
 - 4. Amount of class time needed for demonstrations
- C. Supplementary materials such as pamphlets or filmstrips that must be ordered
- D. Resource people who must be contacted

Objectives

Each unit of instruction is based on performance objectives. These objectives state the goals of the course, thus providing a sense of direction and accomplishment for the student.

Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction; and specific objectives, stating the student performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Reading of the objectives by the student should be followed by a class discussion to answer any questions concerning performance requirements for each instructional unit.

Teachers should feel free to add objectives which will fit the material to the needs of the students and community. When teachers add objectives, they should remember to supply the needed information, assignment and/or job sheets, and criterion tests.

Suggested Activities for the Instructor

Each unit of instruction has a suggested activities section outlining steps to follow in accomplishing specific objectives. Duties of instructors will vary according to the particular unit; however, for best use of the material they should include the following: provide students with objective sheet, information sheet, assignment sheets, and job sheets; preview filmstrips, make transparencies, and arrange for resource materials and people; discuss unit and specific objectives and information sheet; give test. Teachers are encouraged to use any additional instructional activities and teaching methods to aid students in accomplishing the objectives.

Information Sheets

Information sheets provide content essential for meeting the cognitive (knowledge) objectives in the unit. The teacher will find that the information sheets serve as an excellent guide for presenting the background knowledge necessary to develop the skill specified in the unit objective.

Students should read the information sheets before the information is discussed in class. Students may take additional notes on the information sheets.

Transparency Masters

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheets. They are particularly effective when identification is necessary.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion.

Assignment Sheets

Assignment sheets provide paper and pencil activities to aid the student in practicing and developing the knowledge necessary for skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

Job Sheets

Job sheets are an important segment of each unit. The instructor should be able to demonstrate the skills outlined in the job sheets. Procedures outlined in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress toward the accomplishment of the skill. Job sheets provide a ready outline for students to follow if they have missed a demonstration. Job sheets also furnish potential employers with a picture of the skills being taught and the performances which might reasonably be expected from a person who has had this training.

Practical Tests

Practical tests provide the instructor with an evaluation instrument for each of the job sheets.

Test and Evaluation

Written and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties encountered by students in their efforts to accomplish the unit objective. Test items for objectives added by the teacher should be constructed and added to the test.

Test Answers

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

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