Producing Catfish

AQUACULTURE CURRICULUM GUIDE

YEAR TWO
SPECIES MODULE

Developed by Jasper S. Lee

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Producing Catfish

Description: The module consists of the following seven problem areas:

Module: Producing Catfish

Problem Areas: Exploring Possibilities in Catfish Farming
Selecting Production Systems
Feeding Catfish
Controlling Diseases and Pests of Catfish
Reproducing Catfish
Rearing Food Fish
Preparing Catfish for Marketing

Objectives: The objectives for each problem area are given below:

A. Exploring Possibilities in Catfish Farming
   • Describe how the catfish industry has developed
   • Explain possible returns from catfish farming
   • Identify risk in catfish farming
   • Describe investment required in catfish farming
   • Explain legal regulations

B. Selecting Production Systems
   • Describe the stages of growth of catfish
   • Identify species and their classification
   • Explain the types of catfish farming
   • Select a water facility
   • Describe how to plan and construct water facilities
   • Explain practices in water management

C. Feeding Catfish
   • Describe the types of rations
   • Identify the nutrition requirements of catfish
   • Describe the forms of feed
   • Explain the ratio of feed to gain
   • Explain when and how much to feed
   • Select methods of feeding

D. Controlling Diseases and Pests of Catfish
   • Describe the kinds of diseases
   • Explain characteristics of diseased catfish
   • Describe prevention and treatment procedures
   • Identify and treat diseases
   • Calculate treatments
   • Describe the control of pests

E. Reproducing Catfish
   • Describe the spawning process
   • Distinguish between male and female catfish
   • Identify sources of broodfish
   • Describe how to care for broodfish
   • Determine the number of broodfish needed
   • Select a method of spawning
   • Describe how to hatch eggs
   • Explain how to rear fry
   • Explain how to rear fingerlings
   • Estimate the number of fry and fingerlings
F. Rearing Food Fish
   • Describe how to select fingerlings
   • Explain pond production
   • Explain cage production
   • Explain raceway and tank production
   • Describe routine management in food catfish production

G. Preparing Catfish for Marketing
   • Describe harvesting
   • Select a method of harvesting
   • List precautions in harvesting
   • Describe how to hold (store) catfish
   • Explain how to grade catfish
   • Describe how to haul catfish
   • Explain the problem of off-flavor
   • Describe the role of the producer in marketing
Sources of Reference Materials:

The Catfish Book, by Crawford, Linda, University Press, 3825 Ridgewood Road, Jackson, MS 39211, 1991.


Ancestry and Breeding of Catfish in the United States, by Durham, Rex A. & R. Oneal Smitherman, Alabama Agricultural Experiment Station, Auburn University, AL 36849, 1984.

Effect of Pond Size on Cost of Producing Farm-Raised Catfish in the Delta Area of Mississippi, by Garrard, Anthony B, Jerry M. Burney, Mark E. Keenum & John E. Waldrop, Mississippi Agricultural and Forestry Experiment Station, P.O. Box 5446, Mississippi State, MS 39762, 1990.


Economic Analysis of Farm-Raised Catfish Production in Mississippi, by Keenum, Mark E., & John E. Waldrop, Mississippi Agricultural and Forestry Experiment Station, P.O. Box 5446, Mississippi State, MS 39762, 1988.


Principal Diseases of Farm-Raised Catfish, by Plumb, John A., Alabama Agricultural Experiment Station, Auburn University, AL 36849, 1985.

Water in Catfish Production: Sources, Uses, and Conservation, by Jonathan W., Charles L. Wax & Craig S. Tucker, Mississippi Agricultural and Forestry Experiment Station, P.O. Box 5446, Mississippi State, MS 39762, 1988.


Feeding Intensively Cultured Catfish in Levee-Type Ponds, 1989, Site Selection of Levee-Type Fish Production Ponds, 1988, Channel Catfish Life History and Biology, 1988, and Construction of Levee-
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Type Ponds for Fish Production, 1988, by Wellborn, Thomas L., IFAS, University of Florida. Gainesville, FL 32601.

Commercial Production of Farm-Raised Catfish (no author), Louisiana State University Agricultural Center, Baton Rouge, LA 70803, 1988.

Periodicals:
The teacher should establish a small reference library of materials on catfish production. Several periodicals should be used in the classroom to keep students aware of the latest trends and developments in the catfish industry. Examples include:

Aquaculture Magazine (P.O. Box 2329, Asheville, NC 28802).

Catfish Production (P.O. Box 1608, Rockville, MD 20849-1608).

The Catfish Journal (P.O. Box 55648, Jackson, MS 39296).

Water Farming Journal (3400 Neyrey Drive, Metairie, LA 70002).

Regional Aquaculture Centers:

Five regional aquaculture centers have been established by the U.S. Department of Agriculture. Each state has a contact person who serves as a liaison between the center and the research or Cooperative Extension Service specialists in the state. The contact is usually an individual at the land-grant university. The regional aquaculture centers have produced a number of excellent materials in published and video formats. Contact the center nearest you or the aquaculture specialist with the Cooperative Extension Service in your state for more information. (The videotape, "Catfish Farming in the South," is available through the centers.)

Northeastern Regional Aquaculture Center
Research, 201-B
Southeastern Massachusetts University
North Dartmouth, MA 02747

Western Regional Aquaculture Center
Division of Aquaculture
College of Fisheries
University of Washington
Seattle, WA 98195

Center for Tropical and Subtropical Aquaculture
The Oceanic Institute
Makapuu Point
Waimanalo, HI 96795

North Central Regional Aquaculture Center
Fisheries and Wildlife Department
Michigan State University
East Lansing, MI 48824

Southern Regional Aquaculture Center
P.O. Box 197
Stoneville, MS 38776
Teaching Plan:

Module: Producing Catfish - Section A

Problem Area: Exploring Possibilities in Catfish Farming

Estimated Time: 5-10 hours

Goal: The goal of this problem area is to develop basic skills in assessing the possibilities of catfish farming. Some background on the industry as well as risks in catfish farming, possible returns, and legal regulations will be included. (It is assumed that students have studied the first five modules in Exploring Aquaculture.)

Learning Objectives: Upon completion of this problem area, students will be able to:

- describe how the catfish industry has developed
- explain possible returns from catfish farming
- identify risk in catfish farming
- describe investment required in catfish farming
- describe expected returns from catfish farming
- explain legal regulations

Resources: The following instructional resources are needed to complete this problem area:

Essential: See pages 3-4 for full citations.

Transparencies. The following videotape, "Catfish Farming in the South" (available through the Regional Aquaculture Centers).

Commercial Catfish Farming, by Lee.

Channel Catfish Production in Ponds, by Masser, Jensen & Crews.

Additional: See pages 3-4 for full citations.


Third Report to the Fish Farmers, by Dupree & Huner.

Commercial Production of Farm-Raised Catfish, by Jensen.

Economic Analysis of Farm-Raised Catfish Production in Mississippi, by Keenum & Waldrop.
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Content and Procedures

Preparation (Interest Approach):

To develop student interest in this module, show the videotape entitled "Catfish Farming in the South." Before showing the tape, indicate to the students that the tape is about catfish farming. It will provide an overview of catfish farming.

Ask them to take notes as they view the tape. They should note particular cultural requirements, problems in culturing catfish, amount of time required to grow food-size fish, and other considerations in catfish production. Indicate that they will be asked to report on their observations after viewing the tape.

Show the tape (requires about 38 minutes). Call on students to provide reports on their observations during the tape. They should respond in terms of catfish cultural requirements, problems in culturing, time required to grow catfish, and other areas that were pertinent.

Presentation:

A. How did the catfish industry develop?

Show TM A1 to present the objectives of this section. Show TM A2 to outline the 3 major areas of the catfish industry. Ask students to name local providers of supplies and services for catfish farming. (Use telephone directory or interview farmer to identify sources, if necessary.) Ask students to identify local catfish producers, list them on board, and describe each. Ask students to name examples of aquabusinesses involved in marketing catfish.

1. Catfish farming is part of a highly technical industry comprised of 3 major areas:
   a. Supplies and services: These are the inputs that farmers use to grow catfish. Aquabusinesses have been set up to manufacture, distribute, and provide the supplies and services needed by catfish farmers. Examples include feed, equipment, electricity, chemicals, motor vehicle operators, and consultant services. People are employed in all of these areas.
   b. Production (farming): This involves growing catfish for a variety of markets. Production includes spawning, hatching, growing fry and fingerlings, and growing fish.
   c. Marketing: This involves all of the activities in getting catfish to the consumers in the desired form, such as processing, packaging, transporting, storing, and other functions.

2. All of the aquabusinesses involved in the catfish industry comprise an infrastructure, or underlying framework, that makes it possible for the industry to function.

   Ask students to name elements of catfish infrastructure (feed mills, equipment manufacturers, processors).

   a. The infrastructure has developed since the late 1960s.
   b. In 1960, fewer than 600 acres were in catfish culture in the United States. Most of these were along the Mississippi River system of the midwestern and southern United States. Very few supplies and services were available to help the farmer. There were no marketing channels other than local fish markets.
   c. In 1991, this had reached 175,000 acres with a total production of nearly 400 million lbs.
   d. The farm value in 1991 was estimated at $275 million.
   e. Employment in the catfish industry in supplies and services, farming, and marketing was estimated at 50,000 people in 1991.
   f. Without an infrastructure, farmers couldn't get the supplies they need and market the catfish they grow at the current levels of production.
3. The rapid growth of the catfish industry has been attributed to several factors:

Show TM A3 to list reasons why catfish industry expanded rapidly. Ask students how they like the flavor of catfish. (Serve it in a variety of ways; refer to several recipes. Students could organize a fund-raising activity to sponsor a catfish dinner.) Ask students to explain feed conversion. Have students calculate how much catfish is required to raise the per capita consumption by 1 lb in the U.S. (If the population is 250 million, 250 lbs of processed fish is needed. At most, the dressing percentage is 60% of a live fish, yielding 416 million lbs of live catfish required. At a production of 4,000 lbs per acre, 104,000 acres of catfish is needed.)

a. Increased attention by diet-conscious people to healthful food. Catfish is known as a source of high-quality protein.
b. Appealing flavor of catfish. The catfish can be prepared in many attractive, tasty ways that are healthful foods.
c. Feed conversion: Catfish are efficient in converting feed to meat.
d. Intensive culture: Catfish are suited to intensive culture, and this allows for high per-acre yields.
e. Grown on land unsuited for other crops. Catfish can be grown in ponds and other water structures on land that cannot be used for culture of other crops.
f. Decline in wild fish: The quantity of fish available from oceans, streams, and lakes has declined considerably, due to overfishing as well as killing fish by pollution dumped into the rivers and creeks.
g. Increased consumer demand: The consumption of fish and seafood has been increasing in the United States. (Per capita consumption of fish and seafood is about 18 lbs per person. It is projected that consumption will reach 20 lbs by the year 2000. In addition, population resulted in more people who wanted catfish.)

4. Research, development, and education have played major roles in the rapid growth of the catfish industry.

Ask students to explain why research, development, and education are important; give examples of each. Ask students to name a nearby university that is involved in aquaculture research. Emphasize emergence of aquaculture education in high schools and community colleges.

a. Universities have made major commitments in research in the cultural requirements of catfish.
b. Educational programs have been established by universities, colleges, junior colleges, and high school vocational centers to provide education in catfish farming.
c. Private individuals and businesses have provided money to support the development of new machinery, feeds, and other technology.
d. Associations of catfish growers, suppliers, and marketers have been formed to promote the overall welfare of the catfish industry. The Catfish Farmers of America, headquartered in Indianola, MS, is a good example.

5. Overall, the successful development of the catfish industry has occurred because of the leadership provided by key farmers, business and industry officials, financial agencies, and government programs to support expansion of the catfish infrastructure.

B. What are the types of catfish farming programs?

Ask students to define human food (food produced for consumption by human beings).

1. Catfish are primarily produced for human food.

2. Food fish production involves several stages of growth and some farms specialize in these stages.
3. Some catfish are used for recreational purposes, primarily in fish-for-a-fee ponds. (These are often known as fee-lakes.)

4. The 5 types of catfish farming programs are based on the size and use to be made of the fish.

Show TM A4 to outline the 5 types of programs. Take a field trip to a food fish farm or ask a catfish farmer to serve as a resource person. Observe other types of catfish farming programs.

5. Food fish production: Grown for human consumption. Weight is usually 1-3 lbs, with fish larger or smaller being penalized by the processing plant.

Ask students to explain what happens each season. (Eggs are hatched and grown to fingerlings; second season fingerlings are grown into food fish.)

- a. Two growing seasons may be required to reach this weight.
- b. Many food fish producers stock ponds with fingerlings that have been grown by the producer or obtained from a fingerling farmer. Ponds stocked with fingerlings in the spring will have food-size fish by fall if properly managed.
- c. Food fish may be sold to processing plants, live haulers (individuals who haul to fee-lakes), directly by the producer to the consumer, and in other ways.
- d. By far the largest buyers of food catfish are the processing plants.

6. Fingerling production: The small fish that are used to stock food fish ponds and referred to as seed.

Have students study and classify fingerlings. Explain that fingerlings are classified numerically from 1 to 10. Students should measure length of several fingerlings with ruler and use a length-weight chart to determine number of fingerlings/weight of catfish. For example, 10 lbs of fingerlings averaging 5 inches long would contain 311 fingerlings. (Refer to Appendix A in Commercial Catfish Farming.)

- a. Range from 1-10 inches long, with the preferred size at 5 inches. A 5-inch fingerling can be grown from an egg in a few months.
- b. Most fingerling producers maintain broodfish for the production of eggs and operate hatcheries to ensure that eggs are hatched for the highest possible survival rate.
- c. The newly hatched eggs, fry, are reared in troughs or tanks until large enough to be placed in ponds, usually a few days after hatching.

7. Broodfish production: The production of mature male and female fish to be kept for reproduction.

Tour catfish farm with broodfish. Have students determine size, age, and other characteristics by observation and discussion with owner. Demonstrate use of secondary and primary sexual characteristics to distinguish male and female catfish. Have students calculate pounds of female broodfish needed to stock 100 acres of a catfish pond at the rate of 6,000 fingerlings/acre (no mortality). (100 acres X 6,000 = 600,000 fingerlings; dividing number of fingerlings by 2,000 gives female broodfish weight of 300 lbs.)

- a. Sexual maturity occurs at various ages and weights. Broodfish are typically about 36 months old and weigh 3 lbs when first used for reproduction. (Catfish spawn naturally in the spring and early summer.)
- b. Broodfish producers may sell the fish to hatchery operators or reproduce the fish themselves; a few use improved stocks of fish to produce broodfish. (This refers to selecting and breeding fish to achieve certain characteristics.)
c. A female brood catfish in good condition will produce at least 2,000 eggs/lb of weight at the time of spawning. This is an important number to remember in determining the weight of female broodfish needed to produce a given number of fingerlings.

8. Stocker production: A catfish that is larger than a fingerling but smaller than a food fish, typically 10-14 inches long, though some fish scientists classify stockers as 8-12 inches long.

Have students refer to length-weight chart to determine estimated weight of stockers of various lengths.

a. Stockers weigh less than 3/4 lb. A few food fish growers and some recreational facility operators like to use stocker-size fish because they may reach a marketable weight quickly after stocking.
b. Is the least common type of catfish farming program.

9. Recreational fish: Are grown in lakes or other water facilities and moved to recreational facilities as they reach sufficient size, usually 1 lb or larger.

Visit a recreational lake and observe its operation. Interview the manager to determine management concerns in operating the facility. Tour a recreational facility that uses catfish. Observe layout and discuss operational details with manager. Ask students to identify site locally that might be good for a fee-lake. Discuss its advantages and disadvantages.

a. The operators of recreational facilities charge a fee to the people who come there to fish. The fee structure may vary but is typically a flat charge for admission and a per-pound charge for the fish that are caught.
b. Recreational facilities may be known as catch-out-ponds, fee-lakes, fee-fish ponds, or pay-lakes.
c. A few people have set up large tanks near shopping centers and used them much as fee-lakes.
d. Some food fish producers sell a portion of their crop to recreational facilities. Recreational facilities need to be located conveniently for the public.

C. What are the risks in catfish farming?

Show TM A5 to list risks of catfish farming. Indicate that these risks will be studied in more detail later in the class.

1. As with any farming or business venture, catfish farming involves risks. Careful management can minimize many of them. The risks involve losses that wipe out a fish crop or make a farm unprofitable. Typically, risks can be listed as occurring in 7 areas:

2. Fish loss: Disease, oxygen depletion, predators, poaching, and other problems may result in the loss of catfish.

3. Quality of fingerlings: Poor quality fingerlings may die or fail to grow. (A fish crop can be no better than the quality of the seed!)

4. Failure of water supply: Fish may die off quickly when the water supply fails.

5. Contamination of water: Water should be free of pesticides and other contaminants that impair its quality.

6. Losses during harvesting: Care should be used to insure that catfish are in good condition when harvested and that the seining procedure captures most of the crop.

7. Instability of market: Prices may fall or markets may be lost resulting in losses of returns to the grower.

8. Off-flavors: Catfish sometimes acquire off-flavors and cannot be marketed until the problem is cleared up and the fish have the desired flavor.
D. What investment is required to go into catfish farming?

With student input, list requirements for going into catfish farming. Assign cost estimates per item so that the cost for going into catfish farming can be determined. (These costs may be listed as part 2 below is discussed.)

1. A considerable amount of money (capital) is needed to go into catfish farming:
   a. Land is often a major investment.
   b. Equipment, facilities, seed, labor, and other inputs are needed to produce catfish.
   c. The amount and kind of needs depends on the type of catfish farming program, such as food fish, fingerlings, or fee-lake.

2. Investment may be described as 3 costs:

   Use TM A6 to outline 3 areas of cost.

3. Startup costs: Also known as initial costs, these include those costs associated with starting a catfish farm.
   a. The land and water facility must be obtained or constructed before starting any production. The total cost depends on the size, method of construction, lay of the land, soil characteristics, and kind of farm established.
   b. Examples of items in startup costs: obtaining land, constructing levees, digging water wells, constructing service buildings, installing pumps and pipe systems for water, installing aerators and electrical lines, digging drainage ditches, constructing access roads, feeding equipment, and hauling trucks and tanks.
   c. Examples of startup costs: ponds $600-2,500 or more/acre; water wells $4,000-30,000/well; and hauling trucks and tanks $15,000 or more each depending on the size.

4. Annual fixed costs: Often overlooked but must be considered in assessing the financial situation of a catfish farm. These costs are associated with the long-term operation of a catfish farm. Examples: taxes (on property), insurance, depreciation, interest, amortization payments (for repayment of borrowed money)

   Have students name examples of annual fixed costs.

5. Variable production costs: These are the costs that vary with the size of the catfish farm. Larger farms have much greater total variable production costs than smaller farms. Examples: feed (may cost $1,000 or more/acre for 1 growing season), seed (fingerlings) (may cost $300 or more/acre when stocked at the rate of 5,000 fingerlings costing 6 cents each), fuel and/or power, chemicals, harvesting costs, and labor.

   Ask students to give example of variable production costs.

E. What are the expected returns from catfish farming?

   Ask a student to explain the meaning of profit. Use TM A7 to explain "returns." Ask students to explain why net return is important.

1. Returns include the money that the catfish farmer receives from the sale of catfish. Larger farmers should receive more money.

2. Profit is the most important return and is determined by subtracting the costs of production from the amount received when the catfish are sold. (Note: Startup costs, annual fixed costs, and variable production costs must all be used in calculating production costs.)
3. Returns from catfish farming may be reported as "gross" or "net" returns - the distinction between the two is very important!
   a. Gross return refers to the total amount of money received for the catfish that are sold.
   b. No consideration is given to how much it costs to produce the crop.
   c. Gross return is calculated by multiplying the total number of pounds sold by the price received per pound for the fish.

4. Net return refers to the total amount of money remaining after all costs of production have been subtracted from the gross returns.
   a. Net return is also known as profit.
   b. Net return is a more important measure of a catfish farm than gross return.

5. Management is very important in achieving both gross and net returns.

Have a catfish manager describe the important areas of management.

   a. Gross return is a function of the volume of catfish produced.
   b. Large farms should have larger gross returns.
   c. Net return reflects on the efficiency of the catfish farm.

6. A few areas of management related to profit are:
   a. Using efficient feeding practices.
   b. Preventing water problems.
   c. Controlling diseases.
   d. Stocking at the best level.
   e. Harvesting efficiently.

7. Relationships exist between fixed costs and profit.

On the chalkboard, calculate the fixed cost/pound as presented in the example.

   a. As pounds of catfish produced per acre increase, fixed cost per pound produced decreases.
   b. Example: When considering land cost per acre and levels of yield, fixed cost per pound of fish would be less as the number of pounds produced per acre increased. If land costs $1,000/acre for two ponds and one pond produced 5,000 lbs of catfish and the other produced 3,000 lbs, the fixed cost of land per pound of fish is much less at the higher level of production.
   c. Production should be maximized per acre to reduce fixed costs per pound of fish.

8. Relationships exist between variable costs and profit.

Ask students to explain why trying to produce at a higher level may be less profitable than producing at a lower a lower level.

   a. As pounds of production per acre are increased, total variable costs per acre increase.
   b. Example: When more pounds of catfish are produced per acre of pond, more feed and other costly inputs are used. Trying to produce at too high a level may result in inefficiency and lower net returns.
   c. Production should be at the level per acre where the greatest net return is obtained.

9. Returns from catfish farming reflect a delicate balance of fixed and variable costs.

Call on a student to quickly list the costs of production. Ask students to explain why larger farms are harder to manage. (Hired workers are not dependable, larger ponds more difficult to monitor ands control, and ponds on larger farms may get less attention from the manager.)
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a. All costs of production must be considered.
b. Research has shown that profit tends to increase as the per acre level of production increases.
c. Larger catfish farms that harvest greater pounds of fish per acre tend to be more profitable. (In some cases, the reverse is true because smaller farms may be more profitable per acre due to better management.)
d. The cost of producing a pound of catfish is 15% less at the harvest weight of 5,000 lbs/acre than at the harvest weight of 3,750 lbs/acre, according to some authorities.
e. Good management is essential to insure efficient operation of the farm. (Larger farms are often harder to manage.)

F. What legal regulations must be considered in catfish farming?

Invite a catfish farmer or other resource person to discuss legal regulations of catfish farming. Have students name examples of restrictions that exist at various levels.

1. Legal restrictions for catfish farming are increasing. The catfish farmer must be aware of applicable regulations.

2. Ignorance is not an acceptable excuse when the law is violated. Catfish farmers must become familiar with the regulations that apply where their farms are located or where they propose to locate farms.

3. Restrictions are established at the local, state, and federal levels.
   a. The farmer can identify the agencies involved by talking to individuals all ready farming, officials of the Soil Conservation Service, aquaculture consultants, Extension Service Specialists, and others.
   b. Local and state laws must not be in violation of federal laws.

4. Most regulations fit into one of eight categories:

Show TM A8 to outline areas of regulation.

5. Worker health and safety. The Occupational Safety and Health Administration (OSHA) has established regulations designed to promote safe and healthful working conditions. (This is a federal law, but about half of states have established programs that are administered by the state government.)
   a. These regulations have most application in the supplies and services and processing areas of the catfish industry.
   b. Individuals must have protection from noise, eye injury, respiratory injury, and other possible sources of human danger. Protective garments and safety features must be present in the work environment.

6. Environmental concerns. Environmental laws are intended to protect the air, water, and soil from pollution.
   a. The Environmental Protection Agency (EPA) of the federal government is the lead agency.
   b. A major area of concern is the use and discharge of water. Catfish farmers may be required to register their use of water.
7. License requirements. Catfish farmers are required to have a license in some states.

Determine the kinds of permits that are needed locally to become in various areas of the catfish industry.

a. States where aquaculture has been defined as agriculture do not require a license.
b. Farmers who operate retail markets may need to have a license for that enterprise.

8. Transportation requirements. States often have regulations about the hauling of certain species into or through the state.

Ask students to talk with a local driver of a fish haul truck about the work and regulations that must be met. The piranha is an example of an illegal fish.

a. Certain ornamental fish are illegal, even if used as pets. The release of some species into streams and lakes is prohibited.
b. All motor vehicles should be properly licensed and operated by trained individuals.

9. Theft of fish. These laws are intended to protect the fish farmer by making the theft of fish illegal and punishable by a fine, imprisonment, or both.

Determine local laws related to theft of catfish. This information is available from local law enforcement officer or area game warden.

10. Uniform weights. As fish farming has expanded as an industry, regulations have been established to insure uniform weights and measures.

Determine if uniform weight laws exist in your state or local area. (This information is available from a processor, truck driver, or other person involved with the sale of catfish.)

a. Such regulations protect both the farmer and processor.
b. Standard regulations on weights insure that the weights are as accurate as possible.

11. Ways of doing business. These laws relate to how farmers and aquabusinesses go about doing business.

a. Catfish farming and associated businesses are expected to comply with all tax laws and other regulations.
b. Cooperatives are often used in the catfish industry. (These are associations that are formed to provide services, supplies, or market services for farmers.)

12. Wholesome food products. Many laws and regulations apply to the processors of catfish to insure that a uniform, wholesome product is produced in a sanitary environment.

Tour a catfish processing plant and observe sanitation practices. Learn about the practices taken to insure that a wholesome product is produced.
Review:

Review by having the students report in class on the content of each of the objectives. Ask individual students to orally review the content as related to each objective. The teacher can use this approach as a way of clarifying content that may not be clear or sufficiently thorough.

Application:

Application can involve several approaches. A few examples are listed here: Arrange to take a tour of a catfish farm. Prepare students for the tour by having them identify things to observe before they go on the tour. Repeat the showing of the videotape that is used in the Interest Approach. Invite a qualified resource person to visit class and discuss catfish farming from the perspective of what it takes to establish a farm and make a profit. Survey the occupational opportunities in the local community in the catfish industry. This can be done by having students make contacts with catfish farmers, managers of aquabusinesses, and other places in the community. Careful preparation for this activity is needed, in terms of what questions to ask and how to ask them. Provide an opportunity for students to report their findings to the class. Students can apply the content of this problem area in their supervised experience program.

Evaluation:

Evaluation should focus on the achievement of the objectives specified for this problem area. One or more of the following might be used: Orally question students about the objectives. Observe how students approach their supervised experience programs as related to the content of this problem area. Example exam questions are attached.
Objectives

- Describe development of the catfish industry
- Describe types of farming programs
- Identify risks
- Describe investment required
- Describe returns expected
- Explain legal regulations
Areas of the Catfish Industry

- Supplies and Services:
  Inputs used by the farmer
  Feed, equipment, electricity, consultants

- Production:
  Growing catfish (or farming)

- Marketing:
  Getting catfish to consumers in dressed form
  Processing, packaging, hauling, storing, pricing, etc.
Reasons for Rapid Expansion of Catfish Industry

- Diet-conscious consumers
- Appealing flavor
- Efficient feed conversion
- Suited to intensive culture
- Grown on land not fit for other uses
- Decline in wild fish
- Increased consumer demand
Types of Catfish Farming Programs

- Food fish production
- Fingerling production
- Broodfish production
- Stocker production
- Recreational fish production
Risks in Catfish Farming

- Fish loss
- Fingerling quality
- Water supply failure
- Water contamination
- Harvesting losses
- Market instability
- Off-flavors
Types of Catfish Farming Investments

• Startup:
  Costs associated with starting a farm
  Land, ponds, aerators, etc.

• Annual Fixed:
  Costs for operating a farm
  Do not vary with level of production
  Taxes, insurance, depreciation, etc.

• Variable Production:
  Costs that vary with production
  Feed, fuel, labor, etc.
Returns From Catfish Farming

- Gross:
  Returns from sale of catfish
  Cost to produce not considered

- Multiply total pounds sold times price per pound

- Net (Profit):
  Amount of money remaining after costs
  have been subtracted from gross
Legal Regulations

- Worker health and safety
- Environment protection
- License (permit) regulations
- Transportation
- Theft
- Uniform weights
- Ways of doing business
- Wholesome food products
Producing Catfish

Quiz for Section A

Name:

Date:

Quiz on Exploring Possibilities in Catfish Farming

Directions: Answer the following questions in the space provided.

1. Briefly describe the development of the catfish industry.

2. What are the 3 major components of the catfish industry? Briefly describe the role of each.
   a.
   b.
   c.

3. What are the 5 types of catfish farming programs? Briefly describe each.
   a.
   b.
   c.
   d.
1. Because of the rapid growth of the catfish industry, an infrastructure of aquabusinesses dealing with supplies and services, production, and marketing emerged. This rapid growth is attributed to many things: increased diet consciousness, a decline in wild fish, appealing flavor. Thus, research, development, and education in the catfish industry have followed.

2. a. Supplies and services. Aquabusinesses set up to manufacture, distribute, and provide these supplies and services.
   b. Production. Growing catfish for a variety of markets: includes spawning, hatching, growing fry, fingerlings, and food fish.
   c. Marketing. All phases in getting catfish to consumers in desired form: processing, packaging, transporting, and storing.

3. a. Food fish production. Catfish that are grown for human consumption.
   b. Fingerling production. The small fish used to stock food fish ponds and may be referred to as seed.
   c. Broodfish production. Production of mature male and female fish to be kept for reproduction.
   d. Stocker production. A stocker is a catfish that is larger than a fingerling but smaller than a food fish.
   e. Recreational fish. Fish grown in lakes or other facilities and moved to recreational facilities as they reach proper size.

4. a. Fish loss: Disease, oxygen depletion, predators, poaching, others.
   b. Quality of fingerlings: Poor quality fingerlings may die or fail to grow.
   c. Failure of water supply: When water supply fails, fish may die off quickly.
   d. Water contamination: Water must be free of pesticides and other contaminants.
   e. Harvesting losses: Fish should be in good condition and seineing should capture most of the fish.
   f. Market instability: Prices may fall, or markets lost: returns can be lost.
   g. Off-flavor: Off-flavor fish cannot be marketed until they have the desired flavor.

5. a. Start-up costs associated with starting a catfish farm, e.g., land, water facility, construction, equipment.
   b. Annual fixed costs refers to long-term operation of catfish farm. e.g., taxes, insurance, depreciation, interest, and payments.
   c. Variable production costs vary with size of catfish farm. e.g., feed, seed, fuel/power, chemicals, harvesting costs, and labor.

6. a. Gross: Refers to the total amount of money received for the catfish that are sold, without consideration of production costs.
   b. Net: Refers to the total amount of money remaining after all costs of production have been subtracted from the gross returns.

7. Restrictions are established at the local, state, and federal levels and include regulations regarding worker health and safety, environmental concerns, license requirements, transportation requirements, theft of fish, uniform weights, ways of doing business, and wholesome food products.
Teaching Plan:

Module: Producing Catfish - Section B

Problem Area: Selecting Production Systems

Estimated Time: 9-18 hours

Goal: The goal of this problem area is to develop competencies in the production systems that may be used to produce catfish. This will be based on a foundation of catfish biology and biological requirements for growth.

Learning Objectives: Upon completion of this problem area, students will be able to:

- describe the stages of growth of catfish
- identify species and their classification
- explain the types of catfish farming
- select a water facility
- describe how to plan and construct water facilities
- explain practices in water management

Resources: The following instructional resources are needed to complete this problem area:

Essential: See pages 3-4 for full citations.

Commercial Catfish Farming, by Lee.

Watershed Fish Production Ponds, by Jensen.

Site Selection of Levee-Type Fish Production Ponds, by Wellborn.

Construction of Levee-Type Ponds for Fish Production, by Wellborn.

Additional: See pages 3-4 for full citations.


Channel Catfish Life History and Biology, by Wellborn.

Effect of Pond Size on Cost of Producing Farm-Raised Catfish in the Delta Area of Mississippi, by Garrard, Burney, Keenum & Waldrop.

Commercial Production of Farm-Raised Catfish, by Jensen.

Water in Catfish Production: Sources, Uses, and Conservation, by Pote, Wax & Tucker.
Preparation (Interest Approach):

To develop student interest in this module, explain that farmers in the United States produce a wide range of plant and animal crops. Indicate that each crop has unique cultural requirements. These characteristics must be considered if a quality crop is to be efficiently produced.

Ask students to name one plant or animal crop that is grown in the local area. (This should be a nonaquaculture crop.) Possible examples include corn, tomatoes, soybeans, wheat, and beef cattle. List on the chalkboard the example that is prominent locally.

Ask students to name cultural requirements for the crop. List those that are named on the chalkboard. (For example: Corn is planted in a prepared seedbed in the spring after the danger of frost. Seed from adapted improved varieties should be planted; fertilizer is needed for the corn to grow. Weeds and insects must be controlled. Irrigation may be needed to supplement the water that is available, and the harvesting occurs in the fall after the corn is mature and the moisture content has declined.)

After the list has been completed, begin a discussion of what a farmer must know and the skills they must have in order to produce the crop and implement the cultural requirements for the crop. Explain that just as the crop or livestock farmer needs knowledge and skill unique to the crop being grown, catfish farmers must also have knowledge and skill related to the production of catchfish.

Presentation:

A. What are the 6 stages of growth of catfish?

   Show TM B1 and present the objectives for this module. Show TM B2 to list stages of catfish growth. Have students refer to page 54 in Commercial Catfish Farming, for a diagram that shows the development stage. Compare the parts of a catfish egg to those of a chicken. Arrange to have a fertilized egg mass in the school lab. Set up the proper conditions for hatching. Have students observe the mass several times a day and record the developments they observe as the embryos develop in the eggs.

   1. Stage 1: egg.
      a. The egg is the mature female sex cell (gamete).
      b. It consists of an ovum, albumen, membranes, and a shell.
      c. Upon sexual maturity during the spring and early summer, female catfish spawn (produce eggs). (For natural spawning, the water temperature should be 70-85°F.)
      d. When fertilized by sperm (the sex cell of the male catfish), the egg begins developing an embryo.
      e. Matting is the courting behavior between male and female fish at the time of spawning. A mature female fish will produce 2,000 or more eggs/lb of body weight in a spawn.
      f. The eggs adhere together in a jelly-like mass. The male catfish swims above the eggs and releases sperm cells.
      g. The embryo in the fertilized egg will hatch in 7-8 days at a water temperature of 70-85°F.
      h. Catfish farmers typically hatch eggs in hatching troughs.

      (Note: More detail on reproduction is presented in Section E.)

   2. Stage 2: fry.

      Continue with the egg mass described above and have the students observe newly hatched fry and record their observations on development several times each day for the first week. Also observe a
producing catfish

sac fry under magnification. Have students feed sac fry in the school lab. Use a commercial feed formulated for fry. Particle size should be appropriate.

a. Newly hatched catfish less than 1 inch long are known as fry.

b. Upon hatching, the fry have a yolk sac attached, referred to as sac fry. The sac contains nourishment for the fry until they are able to feed for themselves.

c. In 2-3 days or more the yolk sac is used up and the fry must begin to eat. (At this time, they are known as advanced fry.)

d. The fry stage is a fragile, very sensitive stage of development. Careful attention is needed to avoid loss.

e. Fry are typically grown in troughs until they reach fingerling size. Some farmers transfer advanced fry to fingerling growing ponds.


After the fry stage have students frequently monitor and record their observations as fingerlings in lab or farm grow. Note changes. Have students classify fingerlings into numbers of 1-10. Have students use length-weight chart to estimate weight of fingerlings in tank, trough, or pond. (Refer to Appendix A in Commercial Catfish Farming.)

a. When fry are 1 inch long they are known as fingerlings. The maximum length for fingerlings is 10 inches.

b. Fingerlings are designated by numbers on the basis of their length. For example, a number 4 fingerling is 4 inches long.

c. Fingerlings are typically grown at high population densities in ponds.

d. A fingerling should grow large enough in one growing season to be ready to stock in a food fish pond the following spring.

e. Fingerlings often grow very little after the water cools in the fall. (Fingerlings grow best in water that is 70-85°F.)

f. They are harvested when they are 4-7 inches long and moved to food fish ponds in the spring.


Have students continue their observations and recordings begun above with the eggs. Record observations less frequently as fish age because changes due to maturity occur less frequently.

a. Stockers are fish larger than 8 inches long but weighing less 3/4 lb.

b. Some farmers like to use stockers in growout ponds because they reach food size quicker than fingerlings.

c. Some recreational lake operators use stockers in their fee facilities.

d. The stocker stage is not widely used in commercial catfish production.

5. Stage 5: food-size fish.

Have students observe and record the growth of fish in growing ponds. Collect samples and weigh or measure them to estimate the weight in a pond or tank.

a. Food-size fish are 3/4 lb or larger. The preferred size is 1-3 lbs.

b. Fish larger than 3 lbs create problems in automated processing plants. Considerable hand labor may be needed to prepare the fish into filets and other cuts.

c. A fingerling stocked in the spring should grow to food size by the fall.
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Arrange for students to tour a farm with broodfish. Interview manager about maintenance procedures followed.

a. Broodfish are sexually mature fish that are kept for reproduction.
b. Broodfish are typically 3 lbs or larger.
c. They are typically used for spawning at 3 years old.
d. Broodfish are carefully selected on the basis of desirable characteristics for food fish.
e. Farmers keep both male and female broodfish. The ratio is typically 1 male fish for each 2 female fish.
f. Broodfish are kept in broodfish ponds. Pens may be used at the time of spawning to isolate pairs. Spawning nests may be placed in the pens.

7. Each stage of catfish growth presents unique problems for the catfish farmer.

Ask students to explain why water quality, nutrition, and management are important at each stage of growth.

a. Maintaining quality water is always a major consideration.
b. Providing proper nutrition requires knowledge of the needs of fish at the different stages of growth.
c. Management requires knowledge and skill in catfish biology.

B. What species are used in catfish farming?

1. Approximately 1,250 species of catfish are known to exist.

2. One species predominates in farming: the channel catfish.

3. Blue and white catfish are sometimes grown for food.

4. Some species of catfish are ornamentals and kept in aquaria. These include the glass catfish and the upside down catfish.

5. Scientists use a classification system to distinguish among the various species. Scientific names are universally acceptable.

Ask students to explain scientific classification and give examples of scientific names of local plants or animals. (Most students have studied scientific classification and names in general science, biology, or aquaculture.)

a. Common names are used in local communities and may not be understood in other locations.
b. Scientific classification is based on structure, function, and development of catfish.
c. Scientific names show a relationship of one species of catfish to another species and to other fish and animals.
d. No two species have the same scientific names.

6. The scientific names for the cultured species of catfish are as follows:

Use TM B3 to list common and scientific names of commonly cultured catfish.

a. Channel catfish: Ictalurus punctatus.
b. Blue catfish: Ictalurus furcatus.
c. White catfish: Ictalurus catulus.
7. All catfish have similarities, such as barbels and an outer covering of skin (no scales), and identifying characteristics.

8. Channel catfish characteristics are as follows:

Show TM B4 to summarize major distinguishing characteristics of channel catfish. Display specimens of channel catfish and have students locate and examine distinguishing characteristics. Refer to drawings illustrating characteristics of channel catfish. (Refer to page 58 in Commercial Catfish Farming.)

a. Mature size varies considerably. A channel catfish weighing 5 lbs is considered large but weights approaching 75 lbs have been observed.
   b. Color is bluish or olive on the upper part of the body to silver on the sides and white on the belly.
   c. The anal fin is rounded and has 25-35 rays.
   d. The tail fin is deeply forked.
   e. Young channel catfish have spots, but these disappear as the fish mature.

9. The major distinguishing characteristics of the blue catfish are as follows:

Show TM B5 to summarize distinguishing characteristics of blue catfish. Refer to drawing that delineates major distinctions of blue catfish (See page 58 in Commercial Catfish Farming.) Display a specimen of blue catfish and ask student to count the rays on the anal fin.

a. Mature size averages 3-20 lbs but weights of 150 lbs may be reached.
   b. Color is dull-blue or bluish olive on the upper side of the body fading to silver on the sides and white on the belly.
   c. The anal fin is straight and has 30-35 rays.
   d. The tail fin is deeply forked.
   e. Blue catfish typically do not have spots.
   f. The channel catfish and blue catfish are very similar. The major distinction is the anal fin shape and, to a lesser extent, the color.

10. The major distinguishing characteristics of the white catfish are as follows:

Show TM B6 to present distinguishing characteristic of white catfish. Display specimen and have students study it. Refer them to a drawing of a white catfish (page 59 in Commercial Catfish Farming).

a. Mature size varies but is somewhat larger than the channel catfish.
   b. Color is light bluish to silver and white under the belly.
   c. The anal fin is rounded.
   d. The tail fin is not deeply forked.
   e. White catfish do not have spots.
   f. The major distinction between the white catfish and the channel and blue catfish is that the tail fin of the white species is not deeply forked.

11. Species have certain advantages in catfish culture:

Show TM B7 to list advantages of the 3 most popular species of farm-raised catfish.

a. The channel catfish is more tolerant of handling than the blue catfish and dresses out better than the white catfish. It also has better name recognition and is more widely cultured than the other species.
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b. The white catfish is more tolerant of crowding and low oxygen levels than the blue or channel catfish but has a lower dressing percentage than either of the other two species.

c. The blue catfish is more difficult to transport than the channel or white catfish. The blue catfish grow more uniformly and dress out better than the other two species.

C. What kinds of water facilities are used in catfish farming?

Ask students to explain why they feel that the kind of water facility determines the nature of a catfish farm.

1. The kind of water facility that is used shapes the nature of the entire catfish farm operation. Water is the environment in which catfish are grown.
   a. Careful attention must be given to selecting a water facility that can use available water to grow a quality crop.
   b. Some facilities require more water than others; therefore, consideration must be given to the volume of water that is available.

2. Catfish appear to be better suited to efficient growth in some types of water facilities.
   a. The grower is concerned with producing a crop that will result in a profit when it is sold.
   b. The aspiring grower should study catfish production as it currently exists in the local area, visit farms in other locations, attend field days at research stations, talk with experts, review written materials, and seek information in other ways.

3. Three kinds of water facilities are used to grow catfish:

Show TM B8 to outline use of ponds in catfish farming. Tour a farm that uses cages or pens in ponds. Observe how they are used in production process.

   a. Ponds are the most common water facility for catfish. A pond is a water impoundment (container) that is constructed with earthen levees or dams. Catfish may be placed in the pond and allowed free access to the water or put in pens or cages to restrict their access. Most ponds are filled with water pumped from deep wells or watershed runoff from rainfall. Ponds vary considerably in size, though research is showing advantages for certain sizes.
   b. A pen is a rectangular-shaped structure typically made of a wooden frame and meshed wire that rests on the bottom of the pond.
   c. A cage is similar to a pen but floats in the water. Cages have frames of plastic that are covered with a plastic-coated meshed wire. Cages have mesh bottoms; pens do not.

4. Several kinds of ponds are used:

Show TM B9 to explain the kinds of ponds that may be used. Tour a farm that has various kinds of farms. Note how they are constructed and the size of each. Interview the manager to determine how each is used in catfish farming.

   a. Spawning pond: Is where broodfish are placed for spawning. The ponds are usually 1-5 acres in size and 3-4 feet deep. Pens may be placed in the pond to isolate pairs of fish ready for mating.
   b. Rearing pond: Is a pond in which fry are placed to grow into fingerlings suitable for seed. Rearing ponds are often 5 or so acres in size. One acre of rearing pond will grow sufficient 7-inch fingerlings to stock 15 acres of growing pond. Water in rearing ponds is 3 to 4 feet deep.
   c. Growing pond: Is a pond in which catfish are grown for food. The recommended size is about 10-20 surface acres with water 3-4 feet deep.
   d. Holding pond: Is a small pond in which broodfish are kept between spawning seasons. Water in holding ponds is 3 to 5 feet deep or more. Farms may have several holding ponds of 1/4 acre in size. (Keeping broodfish divided among several ponds is a good practice in case of a disease
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outbreak or water quality problem. An outbreak can result in the loss of all of the broodfish in a pond.) About 50 4-lb broodfish can be kept in a 1/4-acre holding pond.

e. Recreational pond: Is a pond used for recreational fishing and sometimes known as a fee-lake or catch pond. Size and shape may vary considerably; however, small ponds of less than an acre are usually best. Easy access by the fishing public is very important. Safety and convenience must be considered in establishing recreational ponds.

Tour a recreational facility and if time permits, go fishing! Interview the manager about the operation.

5. Raceways are water facilities that use flowing water.

Show TM B10 to summarize use of raceways in catfish farming. Make a field trip to observe the use of a raceway, either in a tank or an earthen facility. Interview a raceway manager to determine management concerns, including volume of water used and how it is disposed of after use.

a. Raceways are not widely used in catfish farming.

b. Raceways may be long, narrow, earthen, or concrete structures that may be constructed in series so that water flows from one to another.

c. Raceways may be in round or rectangular tanks.

d. Systems in raceways may be open or closed.

e. Open system: This involves putting water into the system at one end and removing it at the other. These are also known as flow-through systems. Larger volumes of water will be needed to grow a pound of catfish in a raceway compared to a pond. Pumping water may require considerable energy. Once water has gone through the system, it must be disposed of properly.

f. Closed system: This involves reusing water once it has moved through the raceway. Water filtration and aeration are required. Systems to recondition water are expensive to set up and operate and are not always dependable. Most closed systems require the addition of about 10% new water each day.

Ask a student to explain "closed system."

g. Raceways that involve a slower rate of water flow are known as semi-raceways.

h. Costs of operating raceways are higher than ponds even though catfish can be grown at higher stocking rates. Raceways are not widely used in catfish farming.

6. Tanks and vats.

Show TM B11 to summarize tanks and vats in catfish industry. Make a field trip to observe a tank or vat in operation. If not available, construct a tank system as part of the school aquaculture lab.

a. These are rectangular structures used to hold water. High density stocking requires considerable attention to aeration and the removal of wastes from the water. (Aquaria are sometimes used for specialized purposes and are little more than small tanks.)

b. Tanks and vats may use open or closed systems.

c. They may be constructed of fiberglass, nontoxic metal, concrete, concrete blocks, or other material.

d. Some growers have used round tanks of 20 or so feet in diameter and 30 inches deep. The water flows into the tank at the outer circumference and goes in a circular direction toward the middle of the tank where it is removed.

e. Rectangular tanks, for example, may be 25 feet long, 3 feet wide, and 30 inches deep. The bottom may slightly slope toward one end. Water enters at the high end and is removed at the low end.
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f. Tanks and vats require aeration to insure sufficient dissolved oxygen in the water. Some farmers inject pure oxygen into the water.

7. Several considerations are important in selecting a water facility:

Show TM B12 to outline consideration in selecting a water facility. Have students interview a farmer/constructor who builds water facilities to determine costs of establishing and operating the various kinds of facilities. Written or oral reports can be prepared to summarize their findings.

a. Cost: The amount of investment required to establish a catfish farm must be reasonable in terms of the expected returns. Money to construct ponds, buy tanks, drill wells, install pumps, establish waste water disposal systems, and other areas must be available.

b. Operating costs must also be considered: Systems that require considerable electricity or other investments to operate must be carefully studied before attempting to begin catfish farming.

c. Location: The amount of space available and proximity to the market are important.

d. Climate: Since catfish grow in warmer water, locations with colder climates may require the use of facilities where the water can be warmed or where natural supplies of water are warm. Tanks may work best in colder climates but are not economically feasible. (Note: Most authorities do not recommend catfish production in colder climates.)

Have students discuss climate factors in the community that may influence the kind of water system that could be used.

e. Water supply: The volume and quality of water is a definite consideration. If water is limited, catfish farming may not be an appropriate endeavor. Ponds and flow-through systems require more water.

f. Technical and management skill: The people who operate a farm must understand the system and know how to make it an efficient, productive unit.

g. Legal regulations: All legal regulations must be determined in assessing the feasibility of a system.

8. Profitability: Profit is the absolutely essential part of a catfish farm if it is to stay in operation. Careful analysis must be made to determine expected returns from the investment.

Ask students to explain why profitability is important.

9. Personal preferences: Some individuals are interested in the challenge of certain kinds of systems. Since their interest is higher, they are more likely to be motivated to carefully manage the system.

Ask students why personal preference is important. Have them select a water facility they would like to use and defend their choice.

10. Other facilities: Observe the catfish farming facilities that are used in the local area. Assess the experiences that the farmers have had with them. A prospective farmer can learn a lot from observing the experiences of others.

D. How are water facilities planned and constructed?

Show TM B13 to outline considerations in site selection. Tour a catfish farm to observe characteristics of sites where ponds are located. Select site in community that has not been developed for catfish farming and have students assess potential of site using the following criteria: draining, flooding, previous site use, proximity to possible sources of pollution, soil texture, and construction costs.
1. The predominant water facility used in catfish farming is the pond. Three areas should be considered in establishing water facilities:

2. Site selection: This is an important first step and involves giving consideration to several features:
   a. Drainage: Sites that allow ponds to be drained easily should be selected. For example, locating a pond where it can be drained by gravity saves the cost of pumping it dry.
   b. Flooding: Sites where ponds are constructed should not be subject to flooding by rivers and creeks. If streams flood over the levees of ponds, the fish crop may be lost and trash fish enter the pond. Sometimes levees can be constructed to a greater height to keep out flood water but this adds to the cost of construction. (Levees should not be constructed on both sides of a creek up to the creek. This constricts the channel and increases the risk of flooding.)
   c. Previous site use: Always investigate how the land was used in the past. Land that was in row crops or other uses may be unsuited to catfish because of contamination of the soil.
   d. Proximity to possible sources of pollution: Land near row crops or other uses where hazardous chemicals may be used may not be a good site for a catfish farm. Drift from these uses can make a catfish crop unfit for consumption or could kill the fish.

Ask a student to explain how ponds near row crops could be contaminated. (For example, chemicals applied to the crops may drift to the fish pond and a chemical might be improperly applied, such as an airplane failling to precisely target the field.)

   e. Soil texture: The water-holding capacity of the soil should be thoroughly investigated. Sandy soil will allow water to escape. (Officials of the local office of the Soil Conservation Service can help with this.)
   f. Construction costs: Sites that minimize the costs associated with construction are preferred. A site that may require considerable excavation to get ready for a pond may be too expensive to use. A site with considerable growth of timber will require clearing, which adds to the cost of building a pond.

Name different locations in local community, perhaps school grounds, and have students assess the site preparation needed to build a catfish pond.

3. Pond design: Research and past experience have shown that some designs are better than others.

Show TM B14 to outline the 3 types of ponds.

   a. Pond type: This refers to how the pond is structured into the land. Three types of ponds are used: levee, excavated, and ravine. (The ravine pond is often known as a watershed or hill pond; some watershed ponds contain 30 or more acres with only a 10-foot dam, which means that a ravine may not be in a construction site.)
   b. The levee pond is best suited to flat land and involves building a levee around the area to be in the pond. This is the preferred type of pond for catfish farming.
   c. The excavated pond is built by removing the soil from the pond area and using it to construct the levee. Since this type of pond is usually lower than the surrounding area, draining involves pumping the water out and this is an expensive process. Excavated ponds are usually much too expensive to build and are more difficult to manage.
   d. The ravine or hill pond involves placing a dam across a hollow or gully between hills. If built properly, these ponds can be suitable for seining and other production practices.

4. Pond size: This refers to the volume of water the pond will hold. The most frequent size dimension is the number of surface acres of water in a pond. Depth of the pond is also a part of size and the amount of water required to fill a pond.

Show TM B15 to outline considerations in pond size.
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a. The size is important in cost of construction and catfish production. Smaller ponds cost more per acre to build. Levee erosion is more likely to be a problem with large ponds. Also, disease outbreaks are more difficult to control in large ponds. Small ponds can be more quickly filled and drained than larger ponds.

b. The recommended size for growing ponds is often 10 to 20 acres. Ponds over 20 acres may be so large that the volume of fish at harvest time is too great to easily handle. (Note: The nature of the intended market should influence pond size. If the market is for a small quantity of catfish on a monthly basis, it may be more suitable to build ponds much smaller, especially if the market pays more per pound than processors.)

5. Pond arrangement: This refers to how ponds are situated on the land and in relationship to each other. The lay of the land, including streams, roads, and topography, has a lot to do with arrangement.

Show TM B16 to outline considerations in pond arrangement. Refer to reference materials on pond arrangement. (See pages 71-73 in Commercial Catfish Farming.) Make a field trip to farm to observe layout. Note location of levees, drainage ditches, water wells, roads, equipment storage areas, hatcheries, and other facilities. Have students sketch a sample layout for a catfish farm. Put sketches on bulletin board. Have each student explain features of his/her design.

a. Ponds should be positioned to efficiently use electricity, require the minimum of water movement, capitalize on any prevailing winds, and provide easy transportation.

b. Pond shape is a part of planning arrangement. Rectangular shapes are often preferred because of ease in harvesting, but square ponds are more economical to construct. For example, dimensions on a rectangular 20-acre pond might be 660 feet wide by 1320 feet long. Water depth is typically 3-4 feet.

c. Ponds used for different purposes need to be located to maximize efficiency. For example, holding, rearing, and spawning ponds may located adjacent to each other and should not interfere with growing ponds.

7. Pond construction: This involves forming the earth into a water structure. Heavy earth-moving machinery is used. Several areas should be considered.

Show TM B17 to outline steps in building ponds for catfish farming.

a. Surveying and laying out the pond: Individuals trained in the use of survey equipment and how ponds are laid out should be employed for this purpose.

b. This involves determining elevations; making measurements; and marking the locations of various site and construction specifications, including the levee, pond bottom, drainage ditches, and other features.

c. Site preparation: Trees, stumps, roots, and other obstacles should be removed from the site before the levee is built.

8. Levee specifications: Levees must be designed and constructed for efficient and effective use.

Use TM B18 to describe levee specifications.

a. Dimensions to remember in planning levees are as follows: Levee slope - slopes are often 3:1 or 4:1. (With a 3:1 slope, this means that for every 1 foot of levee height, the base of the levee extends 3 feet horizontally.)

b. Levee top: Tops of main levees should be 22 feet wide to allow for the use of motor vehicles. Narrower tops of 12 feet or so may be used on levees that will have little traffic.
c. Levee height: Water is usually 3-4 feet deep in a growing pond. A freeboard of 2 feet is recommended. (This is the distance from the top of the water to the top of the levee.) Overall, most levees are 5-7 feet high.
d. The levee foundation is made by removing soil down to the parent material. This is often no more than 3 feet deep, but can be much deeper.
e. Soil containing a high clay content should be used in building levees. When clay content varies, the soil with the highest clay content should be used on the front of the levee. Sandy soils are unfit for use in levee construction. Soil with roots, limbs, and other objects should not be used in levee construction.

Ask students to explain why they think clay soil is preferred over other soils in building levees. Bring a sample of clay to class and demonstrate how it can be formed into a small cup that will hold water. Demonstrate how sand responds to the same effort.

f. Construction should involve applying 6-inch layers of soil that are packed before the next layer is added. Packing often involves driving heavy earth-moving equipment over the levee.

9. Bottom construction: Bottoms should be constructed to facilitate water management and harvesting. Most ponds have a slight slope of 0.2 feet for each 100 feet toward the lowest end of the pond.

Show TM B19 to outline bottom construction.

a. Some older ponds have harvest basins, which are somewhat like smaller ponds within a pond that are 18-24 inches deeper than the pond and have a surface area of about 10% of the size of the pond. Harvest basins are often circular at one end of a pond. Harvest basins are not now recommended by authorities.
b. Bottoms should be smooth and not have holes that will hold water and allow fish to escape the seine.
c. All ponds should drain evenly to the drain pipe. Watershed ponds should have an area covering about 20% of the pond used for harvest when the depth is 5 feet at the drain.

10. Control erosion: Soil around newly constructed ponds needs to be stabilized to prevent erosion. Cover the area with hay or other material and plant a low-growing, adapted variety of grass.

Ask students to explain erosion. Have them name examples in the local community where erosion prevention has been practiced and locations where erosion is a problem.

E. What practices should be observed in water management?

Ask students to name sources of water for catfish farming. (Note: The content on sources of water was presented previously.)

1. As the environment in which catfish live and grow, water is important to the success of the farm. Water must be obtained from a good source.
   a. The water must be of proper quality.
   b. The water must be economical.
   c. The water supply must be dependable.

2. Once a good water source has been located, proper management of the water in the growing facility is very important.

3. Good water management involves understanding some of the fundamentals of water dynamics in the system being used. Water in most growing facilities, particularly ponds, is continually undergoing
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interactions between the fish and the physical, chemical, and biological qualities of water environment.

4. Water problems are related to several areas that can be controlled through management practices.

Show TM B20 to outline water problems that are managed by catfish farmers. Ask students to describe the relationship of erosion control and sedimentation in a pond. Ask students to explain the meaning and importance of plankton in a pond and why oxygen is important to the life of fish and other animals. Have them name sources of oxygen in water: photosynthesis of phytoplankton, action of wind, mechanical aeration, and chemical processes.

a. Nutrient cycling: This involves the decay of excess feed, feces, and other solid material in the water. Certain bacteria have a large role in nutrient cycling.

b. Sedimentation: This problem is more likely to occur in ponds where the water runoff enters a pond and carries soil particles that are suspended in the water and settle to the bottom. Materials in the sediment that are high in fertility may result in excessive algae growth. Covering the areas around ponds where there is no vegetation with hay will reduce erosion and sedimentation. Planted cover crops can help reduce sedimentation needs.

c. Plankton growth: Plankton are tiny plants and animals that live in water and make large contributions to its quality. Plankton compete for nutrients as well as produce by-products through respiration and photosynthesis. Phytoplankton (tiny plants) are important in helping keep oxygen in the water of ponds.

d. Dissolved oxygen: Catfish require an oxygen level of above 3.0 ppm for best growth. Water management practices can be used to maintain and increase oxygen. Regular monitoring of the water is essential because oxygen concentration can change quickly. The rate of stocking catfish in a water structure has a large influence on the amount of oxygen needed; the greater the stocking density, the more oxygen needed. As fish density increases, plankton concentration may also increase.

e. Temperature: Water temperature is an important factor in catfish growth. The best growth is obtained when water temperature is 85°F. At this temperature, catfish readily feed and grow. Below 60°F and above 95°F, feeding and growth are markedly reduced.

5. Maintaining adequate dissolved oxygen is essential.

Use TM B21 to outline oxygen management. Information on water quality was presented previously. Use a meter to determine level of oxygen in a sampler of water.

a. Oxygen depletion may cause the death of all catfish in a pond in a few hours. Large fish die first.

b. Time of day is related to the amount of oxygen in the water. Fish are more likely to die from oxygen depletion at sunrise than any other time of the day.

c. Water should be monitored 24 hours a day, using oxygen meters to determine oxygen concentration and observing the behavior of fish.

d. When water is low in oxygen, the fish come to surface and gasp for air.

6. Water aeration is used to expose more water surface to the air and allow it to take up oxygen.

Have students use a meter to check the oxygen level in a jar of water (with plankton) that has been sitting still for several hours. Shake the jar and take another reading. Compare the 2 readings. What conclusions did they reach? Also test oxygen concentration in a jar of pond water and put it in the dark and test again after 24 hours. What changes occurred and why?

a. Water is aerated by splashing it into the air, agitating the surface, and injecting oxygen or air directly into the water.

b. Paddle wheel aerators are commonly used with ponds to splash the water into the air.
b. Paddle wheel aerators are commonly used with ponds to splash the water into the air.

7. Nitrogen forms (ammonia, nitrite, and nitrate) may cause severe problems in catfish ponds. Show TM B22 to outline management of nitrogen problems. Have students use a test kit to assess the amount of ammonia in the water in a catfish pond.

   a. Excess feed, feces, and other organic materials in the pond undergo a bacterial process that results in the production of ammonia.
   b. Ammonia is toxic to fish and may cause damage to the gills and kidneys, impair metabolism, and result in other fish abnormalities.
   c. Bacteria convert ammonia to nitrite and later to nitrate.
   d. Nitrite forms are more likely to be a problem in cool water.
   e. Bacteria convert nitrite to nitrate, which seldom causes problems with catfish.

8. Ammonia problems can be minimized in several ways:
   a. Feed only the amount that is eaten.
   b. Add fresh water that is low in ammonia to the pond.
   c. When problems develop, the pond can be flushed with water that is low in ammonia. Some authorities recommend flushing the pond with water high in phytoplankton from a nearby pond.
   d. When the problem is severe, it may be best to move the fish to another pond that is free of ammonia problems.
   e. When the problem is nitrite, sodium chloride (salt) can be added to the pond so that nitrite is not taken up by the fish.

9. Weeds are problems in some catfish ponds and can be controlled in 4 ways:

Use TM B23 to list and define the ways weeds may be controlled in catfish ponds. Also ask students to name weeds that are problems. Have students control weeds in the school lab pond and also visit local farm supply store and determine which chemicals are approved for use in controlling weeds in catfish ponds. If possible, have a sample label in class and review how the chemicals can be used.

   a. Mechanical: Cutting, pulling up, and removing weeds from the pond or area adjacent to the pond.
   b. Manipulation: This involves creating conditions that are unfavorable to the growth of weeds, such as having a minimum of water area that is less than 18 inches deep.
   c. Biological: This method is sometimes used in catfish farming, but involves the use of plant-eating fish.
   d. Chemical: The use of chemicals involves some hazard to the fish crop, but is the often considered to be the most practical. Only herbicides approved by the Environmental Protection Agency and Food and Drug Administration should be used around catfish ponds.

10. The best control of weeds is to prevent them by designing ponds with a minimum of shallow water, tilling empty pond bottoms to destroy weeds, and avoid water from other ponds or streams that might transport weeds into a pond.

11. Water temperature is a major environmental factor in the growth rate of catfish. Catfish farmers find that changing water temperature is impractical because of expense. Some temperature manipulation can be achieved by various methods:

Ask students to describe ideal water temperature for growth of catfish and ask them to review what happens when the water is too warm or cold.
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a. Adding cool well water to a warm pond, particularly in the night hours to reduce the rate of respiration and demand for oxygen.
b. Allowing well water to be pumped into a pond several days before fish are added so that the sun will warm the water.
c. Heating or cooling water using mechanical means may be possible in small tanks and aquarium systems.

12. Plankton growth is an important area in water management.

Ask students to explain plankton and describe benefits of plankton in water. Have students observe water in catfish ponds for plankton growth. Water samples can be examined in the lab using a microscope.

a. Plankton contributes to the suitability of water as well as creates problems.
b. Phytoplankton produces oxygen that is important to the catfish crop.
c. Excessive plankton can use more oxygen than it produces. If it suddenly dies, bacteria that decay the plankton can tie up the oxygen the fish need.

13. Plankton growth can be manipulated in several ways:
   a. Adding a commercial fertilizer to the water will promote its growth.
   b. Flushing with fresh water can remove plankton when the level is too high. (Note: Research has shown that flushing is practical in small ponds.)
   c. Feeding at the appropriate rate controls excessive nitrogen in the water that promotes plankton growth.

14. Water monitoring involves using various testing procedures:
   a. Commercially available kits may be obtained to test for ammonia, nitrite, oxygen, and other water quality factors.
   b. Oxygen meters are often used to quickly and reliably test for oxygen.
   c. Secchi disks are used to assess the transparency of water. (The presence of soil particles, plankton, and other solid material blocks the passage of light through water. A secchi disk is used to assess plankton turbidity. If the turbidity is caused by mud, the reading is useless.)
Review:

Review by having students demonstrate their knowledge and understanding of the objectives for this problem area. Lead a discussion with students by asking questions that cause them to explain the content that goes with each objective.

Application:

Application can involve several approaches. A few examples are listed here. Arrange for students to tour various catfish production systems. They should keep careful notes of their observations and interviews with the managers of the farms. Involve the class in orally assessing their observations, with emphasis on selecting a system that is most feasible locally. Students can apply the content of this problem area in their supervised occupational experience programs. Using the school lab, have students apply what they have studied in production systems to the design, operation, and improvement of the school aquaculture laboratory. Tour the local office of the Soil Conservation Service to study the services that are available. Collect materials on the design and construction of catfish ponds. Using a level and transit, have students stake out a possible catfish pond on the school grounds or other location. They should study the contour of the land, conduct a soil analysis to determine the suitability of the site, design the layout to take advantage of the natural contour, stake out the levee, prepare a site preparation plan, and prepare estimates of cost. (Note: The teacher may wish to use a resource person to assist with this activity.) Using commercially available kits and meters, have the students to measure the oxygen and nitrogen content of water. Also, have them to check plankton bloom and turbidity using a secchi disk.

Evaluation:

Evaluation should focus on the extent to which the students have achieved the objectives for the problem area. Observe how students go about their supervised experience programs in aquaculture. Observe the performance of students in laboratory activities. Have students prepare a written report that summarizes considerations in selecting a production system. Another option is to have students provide oral reports on different aspects of selecting a production system. Provide specimens of various stages of growth of catfish and have students describe the characteristics of the stages and how they relate to each other. Provide specimens of channel, blue, and white catfish. Have students identify each according to species and explain why the specimens are the species indicated. Example exam questions are attached.
Objectives

- Describe stages of growth
- Identify and classify species
- Select a water facility
- Describe water facility specifications
- Explain water management
Catfish Stages of Growth

1. Egg:
   Female sex cell
   2,000 produced/lb of female
   Fertilized by male sperm
   Hatches in 7-8 days in 70-85°F water

2. Fry:
   Newly hatched have yolk sac
   Sac gone in 2-3 days
   Become fingerlings when 1 inch long

3. Fingerlings:
   1-10 inches long
   Grow best in water 70-85°F

4. Stocker:
   Over 8 inches long but weigh less than 3/4 lb
   Not widely used by industry

5. Food Fish:
   Preferred size is 1-3 lbs
   Grow from 5-inch fingerling in 1 growing season

6. Broodfish:
   Sexually mature fish
   Kept for reproduction
   Used for spawning starting at 3 years of age
   Weigh 3 lbs or more
## Names of Cultured Species

<table>
<thead>
<tr>
<th>Common</th>
<th>Scientific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel catfish</td>
<td><em>Ictalurus punctatus</em></td>
</tr>
<tr>
<td>Blue catfish</td>
<td><em>Ictalurus furcatus</em></td>
</tr>
<tr>
<td>White catfish</td>
<td><em>Ictalurus catus</em></td>
</tr>
</tbody>
</table>
Distinguishing Characteristics of Channel Catfish

- Size:
  Up to 5 lbs is common
  75 lbs maximum

- Color:
  Bluish or olive on upper part of body
  Silver and white on belly

- Tail Fin:
  Deeply forked

- Anal Fin:
  Rounded
  25-35 rays

- Spots:
  Young have spots that disappear as fish mature
Distinguishing Characteristics of Blue Catfish

- Size:
  3-20 lbs
  150 lbs maximum

- Color:
  Dull blue or bluish olive on upper side
  Silver on the sides and white on the belly

- Tail Fin:
  Deeply forked

- Anal Fin:
  Straight
  30-35 rays

- Spots:
  Typically do not have spots
Distinguishing Characteristics of White Catfish

- Size:
  Somewhat larger than channel catfish
  8-10 lbs and larger

- Color:
  Light bluish on upper side
  Silver and white under the belly

- Tail Fin:
  Not deeply forked

- Anal Fin:
  Rounded

- Spots:
  No spots
Catfish Species: Advantages and Disadvantages

- Channel Catfish:
  More tolerant of handling than blue catfish
  Dresses out better than the white catfish
  Better name recognition

- White Catfish:
  More tolerant of crowding
  More tolerant of low oxygen levels
  Lower dressing percentage than channel or blue catfish

- Blue Catfish:
  Grows more uniformly than white or channel catfish
  Dresses out better than white or channel catfish
  More difficult to transport than white or channel catfish
Ponds

- Most common facility with catfish farming
- Fish may have open access or placed in cages or pens
- Often filled with water pumped from wells
- Size varies to suit use and need
Kinds of Ponds

- Spawning:
  Use - Spawn broodfish
  Size - 1 to 5 acres
  Depth - 3 to 4 feet

- Rearing:
  Use - Grow fry or fingerlings
  Size - 5 acres common
  Depth - 3 to 4 feet

- Growing:
  Use - Grow fingerlings into food-size fish
  Size - Varies (20 acres is recommended)
  Depth - 3 to 4 feet

- Holding:
  Use - Keep broodfish between seasons
  Size - 1/4 acre common
  Depth - 3 to 5 feet

- Recreational:
  Use - Fee-lake
  Size - Varies
  Depth - 3 to 5 feet or more
Raceways

- Use flowing water
- Made from round, rectangular, or earthen tanks
- Open System:
  New water enters at one end
  Discharged at the other end
- Closed System:
  Filters and reuses water
- Not widely used with catfish
Tanks and Vats

- Round or rectangular structures
- Considerable aeration needed
- May use closed or open systems
- Constructed of fiberglass, concrete, or metal
- Used to rear fry and temporarily hold larger catfish
- Not commonly used to grow food catfish
Considerations in Selecting a Water Facility for Catfish

- Cost
- Location
- Climate
- Water supply
- Skill
- Legal regulations
- Personal preference
- Other facilities in community
Considerations for Site Selection for Catfish Ponds

- Drainage
- Flooding
- Previous site use
- Possible pollution
- Soil texture
- Construction costs
Types of Ponds Used With Catfish

- Levee:
  Around area to be in pond
  Preferred type by catfish growers

- Excavated:
  Earth moved from pond site & forms levee
  Bottom often lower than surrounding area
  Draining is expensive

- Ravine (Hill):
  Dam across a hollow or gully on hilly land
  Can be seined if properly constructed
  Not preferred for food fish
  Can be used successfully
Catfish Pond Size

- Size is measured as surface acres
- Small ponds cost more per acre to build
- May be harder to control disease outbreaks in large ponds
- Large ponds are more difficult to harvest
- Levee erosion is greater problem in large ponds
- Preferred size is often 10-20 acres
Catfish Pond Arrangement

- Lay of land, streams, and other features of site are important

- Efficient Use of:
  - Electricity
  - Prevailing wind
  - Transportation

- Rectangular shapes are preferred

- Convenient to storage areas and rearing ponds
Steps in Building Catfish Ponds

- Survey
- Prepare site
- Construct levee to specifications
- Construct bottom
- Control erosion
Levee Specifications for Catfish Ponds

- Slope should be either 3:1 or 4:1

- Top should be 22 feet wide on main levees
  12 feet on levees with little traffic

- Height is 5-7 feet:
  Water is 3-4 feet deep
  Freeboard is 2 feet

- Foundation:
  Remove existing soil to parent material (no more than 3 feet)
  Use soil high in clay
  Apply 6-inch layers and pack
Bottom Construction in Catfish Ponds

- Should facilitate harvesting and managing crop
- Slope of 0.2 feet/100 feet toward lowest end of pond
- Smooth and no holes
Areas of Water Management Catfish Ponds

- Nutrient cycling
- Sedimentation
- Plankton growth
- Dissolved oxygen
- Temperature
Oxygen Management in Catfish Ponds

- Catfish may die in a few hours from low oxygen
- Larger fish die first
- Time of Day: Oxygen depletion more likely at sunrise
- Monitor 24 hours a day
- Aeration Used to Add Oxygen by: Splashing the water Agitating the surface
Nitrogen Management in Catfish Ponds

- Excess feces, feed, etc., undergo bacterial action

- Ammonia is toxic to catfish; damages gills, kidneys, etc.

- Bacteria convert ammonia to nitrite

- Nitrite more likely a problem in cool weather

- Bacteria convert nitrite to nitrate

- Nitrate formed rarely causes problems

- Control Nitrogen by:
  Feeding right amount
  Flushing pond
  Adding fresh water low in nitrogen
  Moving fish when problems develop
  (practical only in small ponds)
Methods of Weed Control in Catfish Ponds

- Mechanical:
  Cut, dig up, and remove

- Manipulation:
  Don't allow weeds to grow well
  Keep water area less than 18 inches deep

- Biological:
  Use plant-eating fish
  Grass crops most practical and economical

- Chemical:
  Use a herbicide
  Often considered practical
  Use only approved materials
Quiz for Section B

Name:

Date:

Quiz on Selecting Production Systems

Directions: Answer the following questions in the space provided.

1. What are the stages of growth of catfish? List and briefly describe each stage.

2. Three species of catfish are listed below. Briefly distinguish between the species. (Be sure to include color, fin shape, and other characteristics that you would consider in identifying the species.)
   a. Channel
   b. White
   c. Blue

3. What water facilities are used in catfish farming? Briefly describe each of the following:
   a. Growing pond
   b. Rearing pond
   c. Holding pond
   d. Spawning pond
   e. Recreational pond
   f. Raceway
   g. Cage
   h. Pen
   i. Tank

4. What are the major considerations in selecting a water facility? List and briefly explain the four that you feel are most important.
   a.
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5. Briefly describe the following in establishing ponds:
   a. Site selection
   b. Design
   c. Construction

6. Describe how the following water management problems could be handled:
   a. Oxygen depletion
   b. High nitrogen content
   c. Weeds
   d. Plankton growth
   e. Water temperature
Key for Quiz - Section B

1. a. Egg. The mature female sex cell consisting of an ovum, albumen, and a shell.
   b. Fry. Newly hatched catfish less than 1 inch long; they have a yolk sac for 2-3 days, then they begin to eat.
   c. Fingerling. Fry that have reached 1 inch in length with a maximum length of 10 inches.
   d. Stocker. Fish larger than 8 inches long, but weigh less than 3/4 lb.
   e. Food-size fish. 3/4 lb or larger with a preferred size of 1-3 lbs.
   f. Broodfish. Sexually mature fish kept for reproduction with a typical weight of 3 lbs or larger.

2. a. Channel. Mature size varies; young have spots: deeply forked tail fin, rounded anal fin.
   b. White. Light bluish to silver and white underbelly; tail fin not deeply forked, no spots.
   c. Blue. Straight anal fin; typically no spots, dull-blue or bluish olive on upper back.

3. a. Growing pond fish are grown for food, 10-20 surface acres, water 3-4 feet deep.
   b. Rearing pond. Fry grow into fingerlings, 5 acres in size: water 3-4 feet deep.
   c. Holding pond. Broodfish are kept between spawning seasons, water 3-5 feet deep.
   d. Spawning pond. Broodfish are placed for spawning; 1-5 acres, water 3-4 feet deep.
   e. Recreational pond. For recreational fishing; known as fee lake or catch pond.
   f. Raceway. Long, narrow earthen or concrete structures that use flowing water.
   g. Cage. Plastic frame structure with mesh sides, top and bottom; floats in water.
   h. Pen. Rectangular, wood frame structure; mesh sides and top, rests on pond bottom.
   i. Tank. Round or rectangular structure; requires aeration for sufficient DO.

4. a. Cost. Investment must be reasonable in terms of return.
   b. Location. Amount of space and proximity to the market are important.
   c. Climate. In colder climates a facility may require warming.
   d. Water supply. The volume and quality of water must not be limited.

5. a. Site selection. Drainage, flooding, previous site use, proximity to possible pollution sources, and construction costs are considerations.
   b. Design. Pond type, size and arrangement are considerations. Research and experience have shown some designs are better than others.
   c. Construction. Surveying/layout, levee specifications, bottom construction, site preparation, and erosion control are all included.

6. a. Oxygen depletion. Monitor water 24 hours a day with oxygen meters; use aerators.
   b. High nitrogen content. Flush with fresh water; move fish; feed needed amount only.
   c. Weeds. Remove; create unfavorable growth conditions; plant-eating fish, chemicals.
   d. Plankton growth. Add fertilizer or flush with fresh water, if too high or low.
   e. Water temperature. Adding cool well water to a warm pond, waiting to add fish until the sun has warmed the water, or mechanical means.
Teaching Plan:

Module: Producing Catfish - Section C

Problem Area: Feeding Catfish

Estimated Time: 5-10 hours

Goal: The goal of this problem area is to develop competencies in the feeding of catfish. This will include feeding at various stages of growth to meet unique nutritional requirements.

Learning Objective: Upon completion of this problem area, students will be able to:

- distinguish between ration and diet
- describe types of diets
- identify the nutrition requirements of catfish
- describe the forms of feed
- explain ratio of feed to gain
- explain when and how much to feed
- select methods of feeding

Resources: The following instructional resources are needed to complete this problem area:

Essential: See pages 3-4 for full citations.

Third Report to the Fish Farmers, by Dupree & Huner.

Producing Channel Catfish Fingerlings, by Jensen, Dunham & Flynn.

Commercial Catfish Farming, by Lee.

Channel Catfish Production in Ponds, by Masser, Jensen & Crews.

Feeding Intensively Cultured Catfish in Levee-Type Ponds, by Wellborn.

Additional: See pages 3-4 for full citations.

Commercial Production of Farm-Raised Catfish, by Jensen.

Channel Catfish Fingerling Production, by Wellborn.

Nutrient Requirements of Warmwater Fishes and Shellfishes, by Subcommittee on Warmwater Fish Nutrition.

Channel Catfish Farming, by Tucker & Robinson.
Content and Procedures

Preparation (Interest Approach):

To develop student interest in this module, ask the students to describe the kinds of foods that humans should eat to have a balanced diet. List the foods as they are named on the chalkboard. Ask them to explain why they named these foods. (Possible responses might be: "good for you," "contain vitamins," "contain nutrients," and "provide fiber.")

Have the students identify the major nutrients in the foods listed in above. For example: if milk was named, write "calcium" by it because it is a good source of calcium, or if potatoes were named, write "carbohydrates" by the word on the chalkboard.

Ask the students if they are careful to eat foods that are healthful and provide the needed nutrients. (Do not evaluate their responses; let them offer their thoughts.) Explain that just as humans must have certain nutrients, catfish must also have certain foods that are high in the essential nutrients. And the nutritional requirements of catfish are different from humans! (Of course, all animals require the same major nutrients!)

Presentation:

A. What is the distinction between ration and diet?

Show TM C1 to present the objectives of this module. Ask students to relate the terms ration and diet to their own food. Does what is eaten meet nutritional needs? (For example, if a person only ate pizza, would his/her diet needs be met?) Use TM C2 to define ration and diet.

1. The terms ration and diet are often used synonymously but they aren't the same.
   a. A ration is the amount of feed provided for fish in a diet. It is usually measured in pounds fed per day. The composition may or may not meet the nutritional needs of the fish.
   b. A diet is the nutrient composition of the feed. The qualities, composition, and effects on growth and health are considered. Diets should meet the complete nutritional needs of catfish.

2. The catfish farmer must provide the ration containing the diet for efficient production of the crop.

B. What are the types of diets?

Show TM C3 to outline types of diets. Have students collect tags from feed bags that contain complete and supplemental catfish feed. Ask them to study the ingredients and nutrient content of the 2 and discuss their observations.

1. The 2 types of diets are complete and supplemental:
   a. A complete diet provides all of the nutrients needed by the catfish. Fish grown at high stocking density in tanks, ponds, and raceways get little or no nutrition from the water. Complete diets must provide for the unique needs of the different stages of catfish growth: fry, fingerling, food fish, and broodfish. When stocked at 5,000-6,000 fingerlings/acre, a complete diet is essential if the fish are to survive and grow.
   b. A supplemental diet provides a portion of the nutrients needed by catfish. Fish grown at low stocking rates in ponds can gain some nutrition from the natural foods that grow in the water. The natural food available in ponds varies, but can support no more than 50 to 400 lbs of catfish per acre. Careful observation allows the manager of the pond to feed according to the needs of the catfish and availability of natural food. Supplemental diet may be designed to provide only a portion of the nutrients needed by the catfish.
C. What are the nutrient requirements of catfish?

Ask students to explain why the nutrient requirements of catfish are similar to farm animals. (All are animals!) Ask them to explain why nutrient needs of fish vary with their function or growth stage. Have students name an example of a pond where research has been done on catfish, particularly in nutrition.

1. Nutrient requirements of catfish are similar to those of other fish and animals, and the amounts of nutrients vary according to the stage of growth of the catfish.
   a. Fry and other young catfish need higher levels of certain nutrients than older catfish.
   b. The amount that must be provided by the grower depends upon the intensity of the production system and the availability of natural foods.
   c. Diet needs vary with the function of the fish, such as broodfish that are about to spawn should receive more protein. Some farmers even feed raw meat to broodfish before spawning.

2. Research has revealed much about the nutrition of catfish; however, many questions remain to be answered. The 5 basic nutrient requirements of catfish are protein, energy (carbohydrates and fats), minerals, vitamins, and water.

Show TM C4 to outline nutrient requirements of catfish. Arrange a tour of a feed mill to study manufacture of catfish feed, including the ingredients used and nutrient analysis of feed. Refer to a list of the 10 amino acids, such as in Commercial Catfish Farming. Have students use reference materials and investigate composition of the amino acids. Oral reports can be given in class.

3. Protein is the material that builds the body. It is used for growth and to replace tissues that are destroyed by the natural wear of the body.
   a. Proteins are made of amino acids. Research has found that there are at least 10 essential amino acids for catfish.
   b. Young catfish need higher levels of protein than older catfish.
   c. In the wild, catfish naturally eat diets high in protein, such as insects, zooplankton, fish eggs, and fish.
   d. Research is continually providing information that changes and improves the diets of catfish, particularly in the amount of protein required.
   e. The protein in commercial feed is stated as a percentage of the weight of the feed.
   f. The protein needs in catfish feed are as follows:
      - Fry: 35-40% (Some scientists recommend 40-50%.)
      - Fingerlings: 25-36% (Some scientists recommend 32-36%.)
      - Food fish: 25-30% (Some scientists recommend 26-32%.)
      - Broodfish: 28-32%.

Ask students to explain why protein needs of catfish vary with stages of growth.

   g. The major ingredients in feed that provide protein are soybean meal, fishmeal, corn meal, blood meal, rice bran, wheat middlings, and poultry by-product meal.

On the field trip or using labels from feed containers, develop a list of the ingredients used that provide energy.

4. Energy is required for activity and growth. Protein will provide energy but is not recommended for this purpose.
   a. Carbohydrates and fats are the major sources of energy.
   b. The major ingredients in feed that provide energy are soybean meal, fish meal, corn, and grain by-products.
5. Minerals are needed for the development of the skeleton and maintenance of health by the fish.

On the field trip or using labels from feed containers, develop a list of ingredients used that provide minerals. From the labels, determine the mineral content of the feed. Ask the feed mill manager to name how the minerals are added in feed manufacture.

- Calcium and phosphorus are needed for bone development and should be provided in feed at the rates of 1.4-1.5% calcium and 0.8% phosphorus.
- Magnesium, potassium, copper, iodine, and other minerals are needed in very small amounts.
- Most commercial feeds have salt (NaCl) added at the rate of 0.5 to 1.0%.
- Traces of mineral mix may be added to feed during the manufacturing process. (Feeds made with 15% or more protein from animal sources usually do not need to have minerals added.)
- Water tends to be low in the essential minerals; therefore, it is not considered a source of minerals except for calcium when it is present in the water.
- Research is continuing to investigate the exact mineral requirements of catfish.

6. Vitamins are needed by catfish for health and growth but not necessarily to build body tissue.

On the field trip or from labels, determine the vitamins that have been added to catfish feed. Refer to a chart describing the symptoms of vitamin deficiencies, such as in Chapter 7 of Commercial Catfish Farming. Have students name sources of the vitamins in feed ingredients.

- 13 vitamins have been found to be related to the efficient growth of catfish.
- Vitamin C has been found to be particularly beneficial in improving the growth and health of catfish.
- Catfish with deficiencies may exhibit certain symptoms, such as erratic swimming, protrusion of the eyes, reduced weight gain, curvature of the spine, fluid accumulation in the body, and lethargy.
- Commercial feeds usually have a vitamin premix added. (These mixes add considerably to the cost of manufacturing the feed. Research is underway to more precisely determine the kinds and amounts of vitamins that are needed.)

7. Water is needed by catfish but the exact amount and quality are unknown.

- The performance of internal body functions requires water.
- Water should be free of harmful impurities. (Water that is a good environment for growth is also a good source of water for nutrition.)

D. What are the forms of feed for catfish?

Ask students to describe what happens when small fish are fed feed sizes that are too large for them to eat. Show TM C5 to outline the forms of feed that are used. Display samples of each form and have students use a scale (ruler) to measure the particles.

1. Form relates to particle size and how the particles are bound together. Catfish must be able to efficiently eat the feed they are given.
   - Particles that are too large can't be readily eaten by the small fish.
   - Large fish may make poor use of very small particles, as they can't find and consume all of the feed.
   - Five forms of feed are used in catfish farming:

2. Meal: This is a feed made of very fine particle size for feeding to fry and small fingerlings.

3. Crumbles: This feed has larger particle size than meal, but is smaller than pellets and is used with small fingerlings.
4. Floating pellets: This form of feed may vary in size; is used with larger fingerlings, food fish, and broodfish; and floats on the surface of the water.

Using a clear glass jug a water, drop a few pieces of the various forms of feed on top of the water to observe what happens. Note the time required for the various forms to sink or dissolve. (Note: Several days may be required to observe the final dissolving of the feed.) As the feed dissolves, compare this to what happens when fish are fed too much and the feed dissolves in water.

   a. An advantage of floating feed is that fish must come to the surface to eat it, and this allows the farmer to observe the feeding behavior of catfish. (If catfish don't eat, there is a problem that needs to be addressed such as low dissolved oxygen in the water.)
   b. Floating feed is often preferred when the water temperature is above 65°F.
   c. Floating pellets are also known as expanded or extruded pellets.
   d. Floating feed usually costs a little more than sinking feed.

5. Sinking pellets: This form gradually sinks through the water and will settle on the bottom if uneaten.

Visit farms that use different forms of feed and compare the action of catfish when. An alternative is to observe the feeding activity in the school aquaculture lab.

   a. The sinking pellet is also known as a hard pellet.
   b. Sinking pellets are more economical to manufacture than the floating pellet.
   c. Ingredients in the pellet are pressed together, thereby making it impossible for the catfish to selectively eat the ingredients they want.
   d. Sinking pellets are adapted to mechanical feeding and can be handled considerably without deterioration.
   e. Sinking pellets are often used to feed catfish during winter when catfish do not come to water surface readily.

6. Neutral-buoyancy pellets: This form of pellet neither floats nor sinks. They are manufactured so that their density is the same as water.

Ask students to describe why neutral-buoyancy feed might be practical to use with catfish.

   a. This form of pellet has had limited use in feeding catfish.
   b. The neutral-buoyancy pellet can be manufactured with the same nutritional value as floating or sinking pellets.
   c. An advantage of the neutral buoyancy pellet is that it sinks very slowly giving the fish time to eat it before it reaches the bottom of the water structure.

7. The size of feed particle to use is determined by the size of the catfish and is indicated by a number.

Using the measuring activity from above, have students classify pellets as 2, 3, 4, or 5.

   a. No. 2 pellets: 1/8 inch (in.) diameter by 1/8 in. long.
   b. No. 3 pellets: 1/8 in. diameter by 1/2-3/4 in. long.
   c. No. 4 pellets: 3/16 in. diameter by 1/4-1/2 in. long. This pellet is most commonly fed.
   d. No. 5 pellets: 1/4 in. diameter by 1/4-1/2 in. long

8. The best size to use is the largest that the fish can readily eat, because this reduces feed waste.

9. With certain fish, particularly broodfish that will soon spawn, small chunks of raw meat (beef internal organs, beef scraps, fish scraps, dead fish, and poultry scraps) might be fed.
Visit a local broodfish farm and determine if raw meat is fed and if so what kind and how. Ask the manager about the benefits of feeding raw meat to broodfish.

a. The manager carefully monitors feeding and provides no more than would be eaten in a few minutes.
b. The raw meat is usually in addition to the manufactured feed that is given to the broodfish.

E. What is "ratio of feed to gain"?

Show TM C6 to outline the meaning of ratio of feed to gain. Ask students to name ways feed is lost (e.g., spills, overfeeding, torn bags, improper storage so that feed is damaged).

1. Farmers are interested in getting as much growth as possible from feed. This is known as "ratio of feed to gain" or "food conversion ratio."
   a. Profitability is tied to getting as much growth as possible from each pound of food that is fed.
   b. Feeding practices should be used to minimize waste by overfeeding or careless handling or storing of feed.
   c. Most catfish farmers expect to get 1 lb of gain for 2 lbs of feed.
   d. The range is often 1.5 to 2.5 lbs of feed to 1.0 lb of growth.
   e. The lower the amount of feed required for a pound of gain, the better the feed conversion and the more profitable the farm.
   f. Large catfish (3 lbs or so) have poorer feed conversion than smaller catfish (under 3 lbs).

Ask student to explain why larger fish have poorer feed conversion.

2. Feed conversion is calculated by dividing the amount of feed fed to the fish in a pond by the weight of the fish that is harvested and subtracting the stocking weight.

Give students several different examples to calculate the food conversion ratio. The following may be used: (a) 1,000 lbs of feed grew 685 lbs of catfish. (500 six-inch fingerlings had been stocked in the pond.) (b) A 30-acre pond yielded 60 tons of catfish; the farmer put 228,000 lbs of feed into the pond and stocked 100,000 6-inch fingerlings.

   a. For example, if 20,000 lbs of fish was harvested from a pond that had received 40,000 lbs of feed and had been stocked with 11,000 5-inch fingerlings, the feed conversion would be 20,000 minus 353.1 (the weight of the fingerlings, which was found by using a length-weight chart, and multiplying .0321 \times 11,000) or a ratio of 2.035 to 1 (2.035 lbs of feed to 1 lb of gain, which is found by dividing 40,000 by 19,646.9).
   b. Feed conversion is influenced by harvesting procedures. (Fish that escape under the seine are not harvested; therefore, they are not in the weight of fish used in making the feed conversion calculations.) The loss of fish makes it very difficult to accurately calculate a food conversion ratio.

A farmer calculated a food conversion ratio of 1.8 lbs of feed to 1 lb of gain. The pond produced 80,000 lbs of fish after the weight of fingerlings was subtracted. At $250.00 per ton, what was the cost to the feed used in the pond? (1.8 \times 80,000 = 144,000 lbs of feed; 144,000 divided by 2,000 = 72 tons; $250 \times 72 = $18,000 for feed.)

c. Feed conversion is influenced by feeding the right amount. (Overfeeding results in waste and a poor feed conversion ratio.) It is also influenced by health of fish, death losses, and other factors, such as water temperature, feed quality, and management.

3. Fish grown in less intensive ponds with only a few hundred pounds per acre may gain some nutrition from the natural foods present in the water, such as zooplankton.
F. When and how much should catfish be fed?

In the school lab have students monitor the development of fry to determine when the yolk sac is gone and feed should be provided.

1. Feeding practices are influenced by a number of factors:
   a. The stage of growth of the fish, culture system used, number of catfish in a water facility, temperature of the water, skill of the feed person, and general weather conditions are important.
   b. Fry are fed when they lose the yolk sac and begin to seek food. (This is usually within 2 to 3 days after hatching.) Fry are typically fed every hour or so for the first few days. (Fry should be fed no fewer than 8 times per day.)
   c. Fingerlings and food fish are fed at times of the day to minimize the possibilities of water quality problems. (Oxygen is produced during daylight on sunny days by the phytoplankton; therefore, growers often feed in the midmorning and early afternoon.)
   d. Fish should be fed when they will eat. (Never put feed into a water facility if the fish don’t show signs of eating, such as coming to the surface when feed is thrown on the water.)
   e. Water temperature influences the feeding habits of fish. Catfish feed most actively when the water temperature is 70-85°F. Catfish typically stop eating if the water temperature goes over 90°F.

On a tour of a catfish farm, interview the manager about the effects of water temperature on the feeding behavior of the fish. Ask students why fish stop feeding when the water temperature is under 55°F (metabolism rate slows).

   f. Catfish will eat some feed when the water temperature is 55-70°F. (Feeding times are reduced to once a day or a few times a week.) Catfish may almost completely stop feeding when the water temperature is under 55°F. (Feeding times may be only one time a week and then only if the fish will eat.)

2. The catfish farmer must be a good observer of a number of factors and make appropriate decisions about feeding.

3. The amount to feed catfish is influenced by some of the same factors that influence when they should be fed.

Ask students to explain why catfish are fed less in proportion to weight as they grow. Have them calculate amounts to feed in various situations: How much feed should be used in a pond with 15,000 fingerlings that are 5 inches at 75°F? Ask them to seine a sample of fingerlings, measure their length, and establish an average length. Assume there are 20,000 in a pond. How much should be fed if water temperature is 55°F?

1. Catfish are fed less in proportion to their weight as they gain weight. (Of course, water temperature is an important factor.)
   a. Fry are fed all they will eat and no more!
   b. Fingerlings are fed at the rate of 3% of body weight each day when the water temperature is 75°F.
   c. For example, a pond with 10,000 fingerlings that are 5 inches long would typically be fed 9.6 lbs of feed a day. (Refer to a length-weight chart to determine the weight of a 5-inch fingerling.)
   d. Fingerlings are fed at the rate of 1 to 1.5% of weight at a water temperature of 55°F.
   e. For example, a pond with 10,000 fingerlings that are 5 inches long would be fed 3.2 lbs of feed a day. Food fish are fed at the rate of 3% of weight each day if the water temperature is 70-85°F. (Caution: Never feed more than the fish will eat!)
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f. For example, a 20-acre pond stocked at the rate of 5,000 fish per acre with fish that are 12 inches long would receive 1,527 lbs of feed. (Note: 12-inch catfish weigh 509 lbs per 1,000 fish; 3% of 509 equals 15.27 lbs of feed; multiplied by 100 equals 1,527 lbs.)

g. Careful monitoring of ponds is essential at this level of feeding. (Ponds receiving over 30 lbs of feed a day should always be carefully observed for overfeeding and oxygen problems.)

G. What methods of feeding are used?

Show TM C7 to outline feeding methods that may be used. Visit an aquaculture equipment show and have students collect brochures of mechanical blowers. Develop a bulletin board that depicts different brands of mechanical feeders. Have students review aquaculture magazines and catalogs to locate sources and manufacturers of demand feeders. Tour a farm that uses automated feeders with fish and observe the system in operation. Interview the manager to determine the advantages and problems of the system.

1. Catfish farmers select a method of feeding that is most efficient and effective for their particular farm. Several methods are available:

2. Hand: This involves throwing feed into the water by hand.
   a. With fry and small fingerlings or on small food fish farms, hand feeding might be very appropriate.
   b. With large food fish farms, hand feeding is impractical.
   c. Operators of fee-lakes may find hand feeding to be adequate.

3. Mechanical blower: This involves using a powered blower that propels the feed into a pond.

4. Truck-mounted or tractor-powered blowers are often used on commercial catfish farms.

5. Demand feeder: This involves placing a feed hopper over the water with a release trigger suspended into the water. Feed is released when the fish bump the trigger. (These are sometimes known as self-feeders.) Demand feeders are not widely used with pond culture of catfish.

6. Automated feeder: This involves using a system of conveyors and feeders that release the amount to be fed on a scheduled basis. They are not widely used in catfish culture, though their use might be appropriate in tank systems.

7. Air feeding: This involves distributing feed over catfish ponds by airplanes.
   a. Air feeding is not commonly used because of expense and inability to observe feeding behavior.
   b. Air feeding is sometimes used in bad weather or in flooding conditions when trucks and tractors cannot get access to the ponds.

8. The method used must be suited to the size of the farm and stage of the fish.

9. Catfish farmers should use feeding methods that are economical and effective.

Ask students to explain why one method of feeding might be best in a small farm and not on a large farm. Ask them why feed should be given as soon after manufacture as possible.

   a. Large farms must have efficient ways of feeding large quantities of catfish.
   b. Investment in equipment may make it impractical for small farmers to use methods that require expensive equipment.
   c. The methods used should provide the catfish with the most nutritious feed.
   d. Research has shown that catfish feed should be fed as soon as possible after manufacture to avoid loss of nutrients from the feed. (Researchers agree that feed should be stored no longer than 6 weeks before it is used.)
   e. If feed is stored, it should be protected from rodents, water damage, contamination, and loss.
Review:

Review by having the students provide oral reports in class on the objectives for the problem area. Not only is this an effective way to review, it also provides for reinforcement of the learning associated with the objectives. Deficiencies can be noted and corrected as the objectives are reviewed.

Application:

Application can involve several approaches. A few examples are listed here. Tour a feed mill that produces catfish feed. If none is available in the local area, tour a mill that manufactures other animal feeds. Many feed mills follow similar procedures in the manufacture of feed for all livestock as well as aquacrops. Have students observe the processes in receiving, storing, assembling, and mixing the ingredients; moving the manufactured feed; and other processes of the mill. Pay particular attention to the kinds of ingredients and the nutrients provided by each. Tour a catfish farm to observe feeding practices. Note the kind and form of the feed that is used, how it is fed, and the amount fed. Interview the farmer to determine how the amount fed is calculated. Inquire about the effects of weather and time of day on feeding. Students can apply the feeding of catfish in their supervised experience programs. All students should be involved in feeding the fish grown in the school laboratory. Have small groups of students prepare posters on the feeding of catfish. They can focus on a particular area of feeding, such as the nutrient value of feed, methods of feeding, and forms of feed. Each poster should be displayed and explained by those who develop it. Follow up on students who complete the class to determine how the content on feeding catfish is used in their work on aquafarms.

Evaluation:

Evaluation should focus on the extent to which the students have achieved the objectives for the problem area. Observe the performance of students on the application and review activities. Observe how students use the content in their supervised experience programs. Observe the performance of students in laboratory activities. Have students prepare written reports that summarize the feeding practices followed on a farm and recommended changes that would improve the efficiency of the catfish. Provide specimens of forms of feed. Have students classify the forms into the categories of meal, crumbles, floating pellets, sinking pellets, and neutral-buoyancy feed. Example exam questions are attached.
Objectives

- Distinguish between ration and diet
- Describe types of diets
- Identify nutrition requirements
- Describe forms of feed
- Explain ratio to feed to gain
- Explain when and amount to feed
- Select methods of feeding
Distinctions Between Ration and Diet

- Ration:
  Amount of feed provided
  Daily basis
  Measured in pounds

- Diet:
  Nutrient composition of feed
  Should meet nutritional needs of catfish
Types of Diets

- Complete Diet:
  Provides all nutrients
  Used with catfish at high stocking density
  Vary for different growth stages

- Supplemental Diet:
  Provides a portion of nutrients
  Used with catfish in low stocking density
  Some natural food available in the water
Nutritive Requirements of Catfish

- Protein:
  Builds body
  Used for growth and to replace tissue
  Amount needed varies with stage of growth
  Provided by animal and plant sources

- Energy:
  Used for activity and growth
  Carbohydrates and fats are major sources
  Provided by grains and fish meal

- Minerals:
  Used for skeleton growth and health maintenance
  Must include calcium, phosphorus, magnesium, potassium, copper, and salt
  Mineral mix added to feed

- Vitamins:
  Needed for growth and health
  13 are essential
  Vitamin premix added to feed

- Water:
  Needed for internal body functions
  Quality of water is same as for good environment
Forms of Catfish Feed

- **Meal:**
  Fine particle size for feeding fry and small fingerlings

- **Crumbles:**
  Particle size larger than meal
  Smaller than pellets

- **Floating Pellets:**
  Larger than crumbles
  Used with larger fingerlings, food fish, and broodfish
  Floats on water
  Good management tool

- **Sinking Pellets:**
  Also known as hard pellet
  Does not float
  Used with larger fingerlings, food fish, and broodfish
  Sizes vary according to number classification

- **Neutral-Buoyancy Pellet:**
  Same density as water
  Does not float
  Sinks slowly
  Not widely used
Ratio of Feed to Gain

- The amount of feed required to produce 1 lb of growth
- Tied closely to profitability of catfish farm
- Range is 1.5-2.5 lbs of feed per 1 lb of growth
- The smaller amount of feed required, the better the ratio
- Large catfish have poorer feed conversion
Methods of Feeding Catfish

- Hand Throwing:
  Used on small farms
  Used with fry, fingerlings, and broodfish in small ponds or tanks

- Mechanical Blower:
  Feed propelled into the water with air
  Used by large farms
  Used to feed food fish and others
  Popular

- Demand:
  Fish bump releases trigger attached to a hopper
  Also known as self-feeding
  Not widely used with catfish

- Automated:
  System of conveyors and hoppers
  More often with tank systems
  Sophisticated design and layout
  May be computer controlled
  Feeding is on a programmed schedule
  Not widely used with catfish

- Air-Feeding With Airplanes:
  Used on large farms in emergencies
Quiz for Section C

Name:

Date:

Quiz on Feeding Catfish

Directions: Answer the following questions in the space provided.

1. What is the difference between ration and diet?

2. What are the 2 types of diets and how do they differ?

3. Catfish have basic nutrient requirements. Name the 5 nutrient requirements and provide the function of each in the growth of catfish.
   a.
   
b.
   
c.
   
d.
   
e.

4. What forms of feed are used with catfish? Indicate if the forms are used to feed fry, fingerlings, food fish, or broodfish. Also, list one distinguishing characteristic of each form.

5. In feed particle size, why is the "best size to use the largest that the catfish can readily eat?"
6. What is "ratio of feed to gain?" Why is it important?

7. Calculate the feed conversion ratio for the following catfish: The catfish were grown in a 10-acre pond. Total harvest was 4,500 lbs of fish per acre. The total feed provided the pond was 40.5 tons during the growing season. The pond was stocked with 3,000 fingerlings that weigh .0926 lb each.

   The feed conversion ratio was: ___ lbs of feed per pound of gain

8. What is the relationship between water temperature and feed consumption by catfish?

9. What is the general principle on the amount of feed to provide food fish in a growing pond if the water temperature is 80°F?

10. Using the principle cited in question 8, if the catfish are on-feed, how much feed might you use in 1 day with the following pond? The pond has 15 surface acres of water and was stocked with 5,000 fingerlings. The catfish now weigh .5 lb each.

   Pounds of feed for the pond for 1 day: ___

11. Describe the methods of feeding listed below.
    a. Hand
    b. Mechanical blower
    c. Airplane

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Produce Catfish

Key for Quiz - Section C


2. a. Complete: Provides all of the nutrients needed by the catfish and must provide for the unique needs of the different stages of growth.
   b. Supplemental: Provides a portion of nutrients needed as natural food availability varies, but can support no more than 50-400 lbs of fish per acre.

3. a. Protein: Builds the body; used for growth and tissue replacement.
   d. Vitamins: Needed for health and growth.
   e. Water: Needed for the performance of internal body functions.

   d. Sinking pellets: Fed to larger fingerlings, food fish, and broodfish. Features: Gradually sinks, will settle on bottom.
   e. Neutral buoyancy: Fed to larger fingerlings, food fish, and broodfish. Features: food neither floats nor sinks; density is the same as water.

5. It reduces feed waste.

6. Getting as much growth possible from feed. The lower the amount of feed required for a pound of gain, the better the feed conversion and the more profitable the farm.

7. The feed conversion ratio was 1.811 lbs of feed per pound of gain.

8. They feed most actively when water is 70-85°F; typically stop eating if water goes over 90°F; may almost completely stop if under 55°F.

9. Feed at the rate of 3% of weight each day if water temperature is 70-85°F.

10. 1,125 lbs of feed for the pond for 1 day.

11. a. Hand: Throwing feed into water by hand.
    b. Mechanical blower: A powered blower propels the feed into a pond.
    c. Airplane: Distributing feed over ponds from airplane.
Teaching Plan:

Module: Producing Catfish - Section D

Problem Area: Controlling Diseases and Pests of Catfish

Estimated Time: 8-16 hours

Goal: The goal of this problem area is to develop the competencies in controlling the diseases and pests of catfish. Emphasis will be on developing skills in determining when catfish have disease problems and ways of preventing and controlling diseases. Some attention will be given to controlling predators.

Learning Objectives: Upon completion of this problem area, students will be able to:

- name problems in the health and well-being of catfish
- describe the kinds of diseases
- explain characteristics of diseased catfish
- describe prevention and treatment practices
- identify and treat diseases
- calculate treatments
- describe the control of pests

Resources: The following instructional resources are needed to complete this problem area:

Essential: See pages 3-4 for full citations.

Third Report to the Fish Farmers, by Dupree & Huner.

Commercial Catfish Farming, by Lee.

Channel Catfish Production in Ponds, by Masser, Jensen & Crews.

Catfish Farmer's Handibook, by Wellborn.

Calculation of Treatment Levels for Control of fish Diseases and Aquatic Weeds, by Wellborn.

Additional: See pages 3-4 for full citations.


Principal Diseases of Farm-Raised Catfish, by Plumb.

Aquatic Weed Identification and Control Series, by Wellborn.
Content and Procedures

Preparation (Interest Approach):

To develop student interest in this module, ask students to name health problems that humans face. Develop a list on the chalkboard. In some cases, it might be appropriate to ask students to name any they have personally had (e.g., common cold, influenza, cancer, diabetes, and pneumonia). Ask students to name the causes of these problems and how the problems could have possibly been prevented. The emphasis should be on positive health care and lifestyle. Write the causes on the chalkboard by the disease. Also, list key words in the prevention of the health care problem. (In some cases, the causes and preventions may not be known, just as is the case with catfish).

From the discussion, develop a list of positive health care practices with humans (e.g., proper diet, adequate rest, adequate exercise, immunizations, protection from the environment [as with skin cancer], and avoiding contact with people who have contagious diseases).

Ask students to describe relationships between positive health care and health problems with the diseases of catfish (e.g., isolate sick fish, avoid stressing fish, provide proper nutrition, and provide a good environment [water] in which to live). Explain that catfish have health problems just as humans. The origin and nature are somewhat different, but they exist.

Presentation:

A. What are the problems in the health and well-being of catfish?

Show TM D1 to present the objectives of this module. Ask students to name some of the problems that catfish may have. Since they haven't studied diseases, a variety of responses that may appear inaccurate may be given. This, however, allows the students to be active in the classroom setting. Ask students to explain why the farmer should follow approved and legal practices with the health of catfish.

1. Catfish are subject to many kinds of problems that influence their health and well-being. Many of the problems can be controlled or greatly reduced by following sound management practices.

2. Catfish farmers must follow approved and legal practices with health problems of catfish.

3. Catfish live and grow in environments that are conducive to several kinds of health care problems.

4. Outbreaks can result in the loss of entire crops of fish in a matter of a short time.

5. It has been estimated that up to 10% of all cultured catfish are lost each year to disease, with some farmers losing entire ponds and crops.

6. The problems can be categorized into 4 areas:

Show TM D2 to outline the 4 problem areas.

a. Health: Conditions may develop that cause the fish to be diseased resulting in inefficient growth or death.

Ask students to name examples of diseases. (This may go back to the above listing of problems in catfish.)
b. Predators: Other animals that prey on catfish can result in huge losses of quality, market-ready food fish or fingerlings.

Ask students to name examples of farms or ponds that have had predator problems. Have them tell about the predator.

c. Pests: This refers to plant and animal life that competes with the catfish for a quality environment.

Ask students if they know plants and animals that compete with catfish.

d. Destruction of facilities: Some pests attack the water facilities and cause damage that could result in the collapse of the facility and loss of the catfish.

B. What are the kinds of disease problems with catfish?

Show TM D3 to present the definition of disease. Ask students to explain how diseases cost the farmer money.

1. Diseases impair the normal body functions of catfish.
   a. Some diseases cause the death of catfish.
   b. Some diseases cause inefficient growth and cost the farmer money.
   c. Some diseases leave the fish scarred or unfit for sale as a food fish.
   d. The more intensively the catfish are cultured, the greater the potential for disease outbreaks.

2. Diseases can be placed in 2 categories:

Show TM D4 to outline the 2 categories of disease.

3. Infectious diseases: These are caused by living organisms. There are 4 groups of infectious diseases:
   a. Bacteria: There are many kinds of bacteria that can cause large fish losses. Most bacteria cause internal disease problems, though some attack the skin and gills. Specialized laboratory analysis is needed to accurately identify bacterial disease in catfish.
   b. Fungi: These diseases are secondary to some other problems. Catfish that have been injured in some way may be attacked by fungi, which grow on the dead flesh resulting from other injuries.
   c. Viruses: Viruses are very small particles that require elaborate laboratory procedures for identification. They typically live within the cells of living organisms. Treatment of virus diseases is difficult.
   d. Parasites: These are organisms that live in or on other animals, known as hosts. Two broad categories of parasites may be found with catfish: internal, which live in the digestive tract, internal organs, and flesh, and external, which live attached to the external parts of a catfish.

Ask students if they have seen a fish with external parasites. Have them describe what they saw.

4. Noninfectious diseases: These are not caused by living organisms, but by factors in the environment and culture of the catfish. There are 4 groups of noninfectious diseases:
   a. Nutritional diseases: These are caused by improper diet. Feeds deficient in certain nutrients can lead to nutritional disease.

Ask students to recall their study of catfish nutrition. What are the nutrient requirements of catfish?

b. Environmental diseases: These result from catfish being raised in an environment to which they aren't adapted. Oxygen depletion, toxic substances, and toxic plants can cause environmental disease.
c. Physiological diseases: These occur when organs fail to function properly or the blood chemistry gets out of balance. The physiological diseases may be tied to other problems, such as environmental hazards.

d. Toxic chemicals: These occur when the water is polluted by industrial or agricultural chemicals. In many farm areas, insecticides, herbicides, and growth regulators can get into catfish ponds and cause problems.

Ask students if they know of a farm that had a problem with toxic chemicals. Have them describe the situation. Ask them how toxic chemicals relate to environmental diseases.

C. What are the characteristics of diseased catfish?

Arrange for students to tour a catfish disease diagnostic lab and observe the examination of a diseased fish. Ask the lab attendant to explain the signs noted in making exams. Show TM D5 to outline the common symptoms of diseases.

1. Diseased catfish show certain symptoms or clinical signs. The symptoms vary with the kind of disease and stage of development of the disease.
   a. Some diseased catfish may go unnoticed because they do not exhibit symptoms.
   b. Microscopic and laboratory procedures may be needed to identify disease problems.

2. Catfish should be observed each day for any changes in behavior or appearance.

3. The common symptoms indicating that a disease problem may exist can be divided into 4 categories:

4. Change in behavior: The manager of a catfish farm observes certain routine behavior of catfish. If the behavior changes, the fish may have contracted a disease.

Determine if students have observed catfish with any of the common signs. If so, have them describe the problem. Ask students why failing to eat is an important observation to make of catfish. Have them describe the appetite of people when they are ill.

a. Catfish readily seen: Catfish that are in good health are not normally seen except at feeding time. If they gather near the surface of the water, near incoming water, or in vegetation, the farmer should suspect a problem. For example, fish scratching on rocks or vegetation may be trying to remove external parasites.

b. Reduced vigor: Catfish normally swim away very rapidly when a human approaches. Lifeless fish, dropping fins, loss of balance, and sluggishness are several signs of catfish with reduced vigor.

c. Failure to eat: Catfish that don't eat when feed is offered are showing a behavior that should be investigated to determine the reason for not feeding. Water problems may cause the fish to stop eating. Emaciated fish indicate a problem of some type, such as parasites or digestive tract disease.

5. Discoloration and skin lesions: Bloody areas, sores, cysts, blisters, and open ulcers are symptoms of disease. Careful examination may be required to determine the exact problem.

Have students examine a diseased catfish and note the signs, such as color and lesions.

6. Death: This is the most drastic symptom of a disease. Dead fish floating on the water indicate that there is a problem. In some cases, it may be oxygen depletion; in others, it may be any one of many diseases.
7. Body abnormalities: Protruded eyes, swollen bellies, growths protruding from the body, sores, and other abnormalities are signs of disease. Sores around the mouth and on the gills or fins should receive immediate attention.

8. A good catfish farm manager will spend considerable time observing the behavior of normal catfish so that abnormal behavior will be obvious.

Have students spend some time observing catfish so they will know about their behavior. Take time in class to discuss the behavior they observed and how this compares to the expected behavior of catfish.

D. What prevention and treatment practices may be used?

Ask students to describe why it is much more important to prevent a disease than it is to treat the disease after it occurs. Assign students to bring labels from containers to class. Prepare a display of these labels. (They will be useful in later classroom activities.)

1. Several prevention and treatment practices are available for most catfish diseases.
   a. Only legal, approved practices should be followed.
   b. Using unapproved chemicals may result in the fish being condemned.
   c. Regulations often change; the catfish farmer must stay up to date.

2. Labels on chemical containers prescribe the purposes for which a chemical can be used and provide directions for its use.

3. Management is a key in disease prevention.
   a. Prevention involves a combination of quarantine, isolation, and sanitation practices.
   b. Proper nutrition can also help keep down disease problems.
   c. Handling fish to minimize stress is also important in preventing disease.

4. Several management practices can help prevent disease can be used.

Show TM D6 to list common management principles in preventing diseases among catfish. Call on students to explain each.

   a. Use quality water.
   b. Control aquatic weeds.
   c. Stock only healthy catfish.
   d. Use prophylactic treatments when handling catfish.
   e. Quarantine new fish.
   f. Segregate fish by size, species, and use.
   g. Isolate diseased fish.
   h. Allow plenty of room.
   i. Feed properly.
   j. Disinfect equipment, such as haul tanks.
   k. Treat pond bottoms to destroy parasites.
   l. With any disease, accurate diagnosis is essential.

5. Disease treatment is often difficult; however, several methods are available with catfish.

Show TM D7 to outline treatment methods.

6. Dipping: This involves immersing the fish in a concentrated solution of an approved chemical. It is appropriate with external diseases.
Demonstrate the process of dipping catfish. Use fingerlings and dip them into a tub of solution in the lab. CAUTION: Students should be taught all safety precautions in handling chemicals used with catfish.

a. Catfish are usually placed in a net and dipped into the solution for 15 to 45 seconds, depending on the kind and concentration of the chemical.

b. The solution may be in a small tank, vat, or tub. Dipping is practical with small volumes of fish, such as broodfish or fingerlings.

7. Flushing: This method involves adding a chemical at one end of a tank or vat and removing it at another. Water is used to move the chemical through the tank. Flushing is often not practical with ponds, but can be used with raceways. It is practical with external diseases.

Demonstrate how flushing can be performed with a small trough in the school lab.

8. Bathing: Two kinds of baths are used: definite and indefinite. The distinction is the length of time of the treatment, the concentration of the chemical, and how the treatment water is handled after the treatment.

Demonstrate baths in the school lab or have students observe its use on a catfish farm.

9. Definite bathing: This method of treatment involves adding a chemical to a water facility and maintaining the level of concentration for a while.

a. Careful observation of the catfish is essential during the bath to insure that the fish aren't killed.

b. Follow the recommendations for the use of the chemical.

c. Most baths last an hour or so and are then flushed out with fresh water. (Disposing of the bath water is another problem the catfish farmer must solve.)

d. Bathing is practical with vats, troughs, and tanks. It is frequently used for administering prophylactic treatments when catfish fingerlings or broodfish are hauled. Care must be used to insure that the chemical is diffused throughout all of the water. Aeration is often needed to prevent oxygen depletion. Aerators also help to diffuse the chemical.

10. Indefinite bathing: This is a modification of the concentrated bath previously described. It involves using low concentrations of chemicals without flushing away the chemical after the treatment.

a. Most chemicals dissipate after a time in the water.

b. This method is commonly used in ponds and haul tanks. It is essential that the chemical be thoroughly mixed throughout the water.

11. Feeding medications: This method involves mixing the medication with the feed.

Examine the label of a feed that contains medication. Determine the kind of medication and the level of concentration.

a. The medication must be evenly mixed in the feed at the time of manufacture.

b. The practice of feeding medicated feed for long periods of time is not good. Some researchers are finding that the catfish diseases develop resistance to the medication.

12. Capsules: With small numbers of catfish, such as broodfish or those used for research, the medication can be put in a capsule and inserted into the belly of the fish with a balling gun. The capsule must be securely in the belly; otherwise, the fish will expel it from the mouth.

Demonstrate how capsules can be prepared and how a balling gun can be used. Ask students to explain why this can be used only with a small number of catfish.
13. Injecting catfish:

Demonstrate injection of a catfish. (This can be simulated with a cardboard cutout of a crawfish.)

a. This involves using a hypodermic needle and syringe to get the medication into the body of the catfish. Injections get the drugs where they can more quickly take effect. Two kinds of injections may be used: intraperitoneal (IP) and intramuscular (IM).
b. The IP involves making the injection into the body cavity.
c. The IM involves making the injection into the muscle tissue of the catfish.
d. With injections, care must be taken not to damage the internal organs of the catfish.
e. Damage is minimized when the needles are properly inserted. This method of medication is not practical with large numbers of catfish. Injections may also be used to encourage spawning.

14. The treatment method used must be appropriate to the disease of the catfish.

Show TM D8 to contrast the use of the 2 broad categories of treatments.

15. External diseases: Dipping, flushing, and bathing are used in treating diseases on the outside of the body.
   a. These methods are used with external parasite infestations and bacterial infections.
   b. The chemicals (known as therapeutants) most commonly used are potassium permanganate, copper sulfate, formalin, and salt (sodium chloride).
   c. The chemicals must be used according to the labels on the containers. Some may not be allowed on food fish; most (except salt) are toxic to catfish even at low concentrations.

16. Internal diseases.

Ask students to explain why dipping isn't used with internal diseases.

a. Feeding medications, using capsules, and giving injections are used primarily to treat diseases within the body.
b. All of the currently available therapeutants for internal use are antibiotics.
c. The therapeutants used include oxytetracycline (commonly known by its trade name of Terramycin and marketed by Pfizer, Inc.) and sulfadimethoxine plus ormetophim (commonly known as Romet and marketed by Hoffman-LaRoche, Inc.). Currently these are the only antibiotics approved by the Food and Drug Administration for use on catfish used for food.

17. Diseases must be accurately diagnosed and the appropriate treatment selected.

E. What are the 3 common diseases of catfish and how are they treated?

Show TM D9 to outline the bacterial diseases of catfish. Arrange for students to observe a catfish with ESC. If fish aren't available, use photographs that illustrate some of the signs. Have a farmer or other resource person discuss his/her experiences with catfish and ESC.

1. Enteric septicemia of catfish (ESC): This is the most serious disease from the perspective of the losses caused.
a. It affects all stages, but is primarily a problem with fry and fingerlings.
b. ESC tends to occur in the spring and fall when the water temperature is 72-82°F.
c. It is caused by the bacterium *Edwardsiella ictaluri*, which may survive for no more than 2 weeks in pond water but 3 months or more in pond mud at a temperature of 70-85°F.
d. Clinical signs (symptoms) may involve one or more of the following: not eating, listlessness, swimming at the surface with drooping tails, swimming in spiral fashion, hemorrhages around the mouth and on the belly, ulcer-like white spots on the sides, pale gills, and the presence of a
lesion between the eyes on the top of the head. (The lesion on the head is most characteristic of the disease and has resulted in the common name of "hole-in-the-head disease.*)

e. The bacteria causing ESC are easily spread among catfish. Contaminated water or mud may carry the bacteria.

f. Water temperatures above 85°F and below 65°F are rarely conducive to ESC problems. (Some catfish farm managers lower water temperature when an ESC outbreak occurs to decrease the loss of catfish.)

g. Treatment involves using feed containing antibiotics. (Feed manufacturers often blend feed with the precise amount and uniform distribution. The rate is 33 lbs of Romet per ton of feed.)

h. Providing feed with high amounts of vitamin C may lower catfish mortality from ESC.

i. Catfish should be checked daily for ESC and treatments begun immediately when it is confirmed.

j. Catfish with ESC may also have external parasites or external infectious diseases. (Always treat the ESC first.)

k. Stressing catfish often results in higher mortality.

l. Catfish that survive ESC tend to have some resistance to it.

Ask students to explain the meaning of "resistance."

2. Columnaris: Following ESC, columnaris is the most prevalent bacterial disease in catfish.

Have students observe catfish with columnaris or photographs of infected catfish. Have a lab technician describe how columnaris is confirmed by using a sample of fish.

   a. Outbreaks of columnaris are usually associated with stress.

   b. Outbreaks most often occur in the warmer months of late spring through early fall.

   c. The bacterium cause is Flexibacter columnaris. The bacterium is present in most natural water and lives on decomposing organic matter.

   d. Signs include the following: lesions on the gills; lesions on the body, fins, and inside the mouth; ragged and frayed fins; advanced stages may cause internal infections; not feeding; and death.

   e. The disease affects all stages of catfish and can result in the death of many fish in a short time.

   f. Columnaris is rarely a problem unless catfish are stressed.

   g. Transmission of the disease is enhanced by crowding the fish.

   h. As with most diseases, laboratory diagnosis is needed to confirm columnaris.

   i. Columnaris can be prevented by maintaining a good environment for the catfish.

   j. As an external disease, columnaris can be treated with potassium permanganate as a bath treatment at the rate of 10 ppm for 20-30 minutes. Catfish in ponds can be treated with potassium permanganate at the rate of 2-4 ppm if the water is clear and free of phytoplankton. (Organic matter in pond water reduces the toxicity of potassium permanganate but increases the amount needed to be effective.)

   k. If columnaris becomes an internal disease, antibiotics will be needed. (Farmers often use medicated feed to provide antibiotics.)

3. Aeromonas infections: These are caused by a group of bacteria commonly found in aquaculture facilities.

Have students observe aeromonas infections in live catfish or in photographs of infected fish. Have a catfish farmer or other resource person describe the signs of MAS.

   a. The motile aeromonad septicemia (MAS) is the most common aeromonas infection.

   b. The bacteria that cause MAS are Aeromonas sobria and Aeromonas hydrophila.

   c. Signs of MAS include external lesions, frayed fins, open ulcers on the skin, not feeding, eyes change to a blue color, distended abdomen, the body cavity filled with bloody fluid. (Catfish with mild cases of MAS may show no signs.)
 Producing Catfish

d. MAS is more likely to occur when the catfish have been stressed, such as with low oxygen, sudden changes in water temperature, and handling.
e. Outbreaks are more likely to occur in the spring and fall when water temperatures are 65-85°F.
f. Laboratory diagnosis is often needed.
g. Control by minimizing stress and preventing overcrowding.
h. Antibiotics in feed are used to treat MAS.

4. Catfish are subject to attack by fungal diseases, with the egg stage most frequently affected.

Show TM D10 to outline fungal diseases. Observe a catfish with fungal disease or study photographs that show catfish with the disease.

a. Fungal diseases are sometimes referred to as water molds.
b. Water molds are present at all times in water.
c. *Saprolegnia* and *Achlya* are the fungi that most commonly affect catfish.
d. External fungal infections are sometimes referred to as saprolegniasis.

5. The spore stage of fungi is the infective stage.
a. Spores are free-swimming molds that attach themselves to decaying flesh.
b. Infections in catfish result from injury or lack of proper nutrition.
c. Patches of fungi may be seen growing on infected catfish. (These patches are white to brownish in color.)
d. Laboratory diagnosis involves examining scrapings from the lesion with a microscope.

6. Prevention is best achieved by handling fish carefully so as to prevent injury and stress and maintaining a good environment.

Ask a student to review the meaning of "prophylactic treatment."

a. Using prophylactic treatments in hauling tanks reduces the likelihood of a fungal disease from handling.
b. The occurrence of fungal disease increases as the density of stocking increases.
c. Fungal diseases are more likely to occur in cool or cold water (55-70°F).

7. Treatment may involve several chemicals.

Have students review the labels for the chemicals to determine approved use.

a. Catfish in small batches can be dipped in water with a 3-5% concentration of salt for about 2 minutes.
b. Catfish in ponds are more difficult to treat, but potassium permanganate or formalin can be used. (These chemicals may be expensive in large ponds and difficult to apply.)
c. Potassium permanganate is used at the rate of 2-4 ppm in ponds with clear water.
d. Formalin may be used at the rate of 15-25 ppm in ponds.
e. Any use of chemicals in ponds should be done only after careful study of the water and close observation of the fish after the treatment is underway.

8. Viral diseases sometimes attack catfish.

Show TM D11 to outline viral diseases. Arrange for students to observe a fingerling with CCVDD or photographs of fish with the disease.

a. Viral diseases are caused by virions, which are small infectious virus particles.
b. Virus diseases are difficult to treat because the virions get inside the cells of catfish.
Two kinds of virions infect catfish: channel catfish virus (CCVD) and channel reovirus (CRV).
CCVD is the major viral disease of catfish, with CRV only discovered in the last few years.

9. CCVD is primarily a disease that affects fingerlings less than 6 inches long.
   a. Outbreaks are most common in the summer months of June through September.
   b. Outbreaks of CCVD can cause large losses when they occur, up to 90% in small fingerlings in a week.
   c. CCVD outbreaks do not occur as often as some of the bacterial and fungal diseases.
   d. Affected catfish go off feed, swim erratically, have a distended abdomen, and may float head-up in the water. The body cavity may be filled with a clear, yellowish liquid.

Have a catfish farmer or other resource person describe any experiences he/she has had with CCVD in their fingerlings.

   e. Development of CCVD and death of catfish is more likely in warmer water.
   f. The exact transmission of CCVD is not well understood, but a connection has been established between parent broodfish and latent forms of the virus in fish.
   g. No cure for CCVD is available.

10. Management practices can reduce the chance of an outbreak.
   a. Minimizing stress, cleaning facilities (particularly sanitizing troughs after a batch of fry), keeping fish-eating birds away, and controlling water temperature may help prevent CCVD.
   b. Mortality from CCVD is reduced when water temperature is lowered below 70°F.

11. Environmental diseases are problems on some catfish farms.

Show TM D12 to outline environmental diseases. Call on a student to explain saturation as related to oxygen in water.

   a. Pollution, high levels of nitrogen forms, supersaturation of oxygen in the water, and other environmental conditions may result in problems.
   b. Gas bubble disease may result when the water is 150% or more saturated with oxygen. (Aeration can be used to lower the oxygen in water the same as it is used to add oxygen.)
   c. Brown blood disease may result when there is an excess of nitrites in the water. (Water management, including the control of nitrites, was discussed earlier.)
   d. Winter kill may occur in water below 55°F, even when not frozen over. (Though the cause is unknown, it is apparently caused by some predisposition that decreases the ability of the catfish to adapt to cold or rapid changes in water temperature.)
   e. Proliferative gill disease is not well understood and occurs in water temperatures of 60-70°F. (The gills become swollen and fragile, taking on the appearance of hamburger, and fail to function in respiration.)
   f. "No blood disease" describes conditions often associated with anemia, some of which are caused by exposure to nitrites and other substances in the water. A folic acid deficiency is found in the catfish.
   g. Using quality water and following good management practices tends to reduce the probability of environmental diseases.

12. Nutritional diseases may occur in catfish, but the full extent of the problems are unknown.

Ask students to review the nutritional needs of catfish. Have them explain how deficiencies may impair growth and health.

   a. Providing an adequate ration will likely prevent most nutritional problems except for those associated with the environment.
b. The nutritional needs of catfish have been fairly well documented. (These were presented in Section C.)

13. Parasitic diseases may be internal (inside the catfish) or external (on the skin or other parts of the catfish).

Show TM D13 to outline parasitic diseases.

a. Parasites may be further classified as metazoan or protozoan.
b. Metazoan parasites are multicelled animals that develop from embryos, such as the flukes, tapeworms, roundworms, leeches, and certain crustaceans.
c. Protozoan parasites are single-celled, microscopic animals, such as "Ich" (Ichthyophthirius multifilis), trichodina (Trichodina species), scyphidia (Ambiphyra species), trichophrya (Trichophrya species), costia (Ichthyobodo necator), and others.
d. Most parasites cause minor problems in catfish farming, though they may be present on or in the fish.
e. Most external parasites can be controlled by dipping into one of the approved chemicals, such as salt or copper sulfate.
f. Internal parasites, particularly those in the flesh or under the skin, are more difficult to control, with breaking the life cycle of the organism often considered the most practical.

Ask students to explain why internal parasites may be more difficult to remove from a fish than external parasites.

g. Catfish captured in the wild may be more likely to have parasite problems and can certainly introduce parasites into healthy fish populations.
h. Catfish with infestations of parasites may show poor growth, use feed inefficiently, and become weakened so that other diseases can be a problem.

F. How are treatments calculated?

Ask students to explain why diffusion (mixing) of therapeutants is important in the water with catfish.

1. Once a disease has been diagnosed and a treatment selected, proper dosage of the therapeutant is essential. Therapeutants must be provided so that all fish in a body of water receive the treatment.
   a. The dosage must be at a concentration to achieve the intended results.
   b. Recommendations of authorities must be followed and only chemicals approved by the Food and Drug Administration for a particular use should be used.

2. Several steps in calculating treatments apply to catfish in most all situations.

Refer to Section C for detail on making calculations of water volumes. Show TM D14 to list the general steps in calculating treatments. Students can be referred to sources of formulas, such as Chapter 8 in Commercial Catfish Farming.

a. Determine the dosage level. This involves referring to recommendations and an analysis of the water situation in which the therapeutant is to be used. (Therapeutants react differently in different water.)
b. Determine volume of water. The amount of water in a water container must be accurately determined. (This usually involves making careful measurements of the dimensions of the container and calculating the volume of water involved using various formulas.)
c. Calculate amount of therapeutant. Chemicals are added to water to gain a concentration of so many parts per million (ppm) or parts per thousand (ppt).
Aquaculture Curriculum Guide

Using formulas, have students calculate the volume of water and amounts of therapeutants to use for various disease situations.

d. Parts per million means that 1.0 part is added to every 999,999.0 parts of water. Most catfish farmers refer to charts that provide for easy conversion.

Students can refer to pages 177-183 in Commercial Catfish Farming.

e. Carefully measure the therapeutant by understanding the measuring devices and conversions to the metric system. Accuracy is essential.

3. Once proper dosage level is known, procedures must be taken to insure that the therapeutant is thoroughly mixed into the water and that the fish are carefully monitored for any adverse effects.

G. What pests cause problems in catfish farming?

Show TM D15 to outline predators. Ask students to name local examples of predators and determine if they are protected.

1. Predators are animals that eat catfish.
   a. Water birds are often the most prevalent predators, with the cormorant being a costly problem on some catfish farms.
   b. As a protected bird, controlling the cormorant is difficult.
   c. Loud noises, netting, human effigies, and decoys have been used to scare away predatory birds.
   d. Some predatory birds stand in the water; therefore, building ponds with a minimum of shallow water reduces problems.
   e. Other predators include snakes, alligators, otters, and some species of turtles. These are often trapped or killed to remove from the pond.
   f. Farmers are reminded that some species of predators are protected by law and control measures must be taken accordingly.

2. Competitors are those animals that compete with catfish for food, oxygen, and space in the water.

Show TM D16 to outline competitors.

a. Trash fish are species of fish other than catfish that may be present and unwanted in a pond.
   b. Trash fish compete for food, contribute to oxygen problems, carry disease, and must be graded out of the harvested catfish.
   c. Farmers can control trash fish by using fingerlings that are of the desired species, not using water from lakes or streams (or filtering if it is used), and draining ponds that have been contaminated with trash fish before stocking with catfish.
   d. Any animals that live in the water and derive nutrition from it are competitors, including frogs, crawfish, snakes, alligators, and rodents.

3. Rodents, crawfish, and other animals that burrow into levees may cause damage to ponds and other facilities.

Show D17 to list pests that damage water structure.

a. Keeping pond levees mowed closely will destroy hiding places and these animals will move to other locations.
   b. Destroy weeds in the water and sources of food for the pests.

4. Pests may also include livestock, if allowed near catfish ponds.
Ask students how cattle affect water that they can access. What does this do to the water?

a. Catfish ponds should fenced to keep livestock away.
b. Livestock may cut deep paths in levees resulting in weak areas that could break or that make harvesting difficult.

Review:

Review by having the students demonstrate their understanding of the objectives for the problem area. Call on them to orally provide explanations of the content of each objective. Not only is this an effective review, it also provides for reinforcement of the learning and allows the teacher to note and correct deficiencies.

Application:

Application can involve several approaches. A few examples are listed here. Arrange for students to practice the different methods of treating diseases in the school laboratory. Students can simulate the activity without stressing fish that otherwise may be healthy.

Have students make calculations in the use of recommended therapeutants in various shapes and sizes of water structures. Arrange to make a tour of a catfish disease diagnostic laboratory. Have students observe catfish that are diseased for signs and attempt to make a diagnosis. Students can apply the content of the problem area in their supervised experience programs.

Have students prepare bulletin boards or posters that describe the major diseases of catfish. Interview a farm manager about the management practices that are followed in preventing disease.

Evaluation:

Evaluation should focus on the extent to which students have achieved the objectives of the problem area. Examples include oral questioning and written reports. Example exam questions are attached.
Objectives

- Name threats to catfish
- Describe kinds of catfish diseases
- Explain signs of disease
- Describe prevention and treatment practices
- Identify and treat catfish diseases
- Calculate treatments
- Describe control of pests
Threats to the Well-Being of Catfish

- Health:
  Agents of disease
  Causes of inefficient growth and/or death

- Predators:
  Other animals that prey on catfish

- Pests:
  Plants and animals that compete with catfish

- Destructive Animals:
  Attack and damage water facilities
Disease

• Definition:
  Condition impairing normal body functions of catfish

• Results of Disease in Catfish:
  Inefficient growth
  Fish unfit for sale
  Farmers lose money
  Death of fish

• Caution:
  Greater intensity increases potential of disease
Catfish Diseases - Causes

- Infectious - Living Organisms:
  Bacteria
  Fungi
  Viruses
  Parasites

- Noninfectious - Culture Environment:
  Nutritional diseases
  Environmental diseases
  Physiological diseases
  Toxic chemicals
Common Symptoms of Disease in Catfish

- Change in Behavior:
  Catfish readily seen
  Reduced vigor
  Failure to eat

- Discoloration and skin lesions

- Death

- Body abnormalities
Management Practices With Catfish to Prevent Disease

- Use quality water
- Control aquatic weeds
- Stock only healthy catfish
- Use prophylactic treatments
- Quarantine new fish
- Maintain fish in uniform lots by size, species, and use
- Isolate diseased fish
- Allow plenty of room
- Feed properly
- Disinfect equipment
- Treat pond bottoms
Methods of Treating Diseased Catfish

- Dipping
- Flushing
- Bathing:
  - Definite
  - Indefinite
- Feeding medications
-Injecting
Treatment Methods by Location of Disease in Catfish

- External Diseases - Outside the Body:
  Dipping
  Flushing
  Bathing

- Internal Diseases - Inside the Body:
  Feeding medications
  Using capsules
  Injecting
Bacterial Diseases in Catfish

- Enteric septicemia (ESC):
  Cause: *Edwardsiella ictaluri*
  Affects: All stages. Primarily problem with fry & fingerlings
  Signs: Listlessness, swimming at top of water, ulcer-like spots on sides, pale gills, lesions between the eyes on top of head
  Treatment: Antibiotics in feed
  Occurrence: Water temperature 72-82°F, stress, in spring

- Columnaris:
  Cause: *Flexibacter columnaris* (in all natural water)
  Affects: All stages of catfish
  Signs: Lesions on gills, fins, body and inside mouth; ragged and frayed fins; not feeding; can become internal; death
  Treatment: Bath treatment in potassium permanganate at 10 ppm for 20 minutes or in ponds at 2-4 ppm
  Occurrence: Warmer months

- Aeromonas:
  Cause: *Aeromonas sobria* (most common)
  Affects: All stages
  Signs: External lesions, frayed fins, skin ulcers, not feeding, change of eye color to blue, distended abdomen, body cavity filled with bloody fluid
  Treatment: Antibiotics in feed
  Occurrence: Water temperature of 65-85°F, stress
Fungal Diseases in Catfish (*Saprolegniasis*)

- **Cause:**
  *Saprolegnia* and * Achlya*
  Free-swimming spores that attach themselves to decaying flesh

- **Affects:**
  All stages of catfish

- **Treatment:**
  Dipping into 3-5% salt solution for 2 minutes
  Dipping potassium permanganate or formalin in ponds
  Control by using prophylactic treatments in haul tanks

- **Occurrence:**
  More likely in cool water (55-70°F) following handling where fish are injured
Viral Diseases in Catfish (CCVD and CRV)

- **Cause:** Virions
- **Affects:**
  Primarily fingerlings (less than 6 inches long)
- **Signs:**
  Not feeding
  Erratic swimming
  Distended abdomen
  Float head-up in water
  Body cavity filled with clear yellowish liquid
  Death
- **Treatment:**
  None - minimize stress
  Mortality is reduced in water below 70°F
- **Occurrence:**
  Most common June-September
Environmental Diseases in Catfish

- Gas Bubble Disease:
  Signs: Bubbles on catfish skin
  Cause: Water 150% or more saturated with oxygen
  Treatment/Prevention: Lower oxygen level by aeration

- Brown Blood Disease:
  Signs: Blood has brown color
  Cause: Excess nitrates in water
  Treatment/Prevention: Avoid overfeeding; flush pond to control nitrite level

- Winter Kill:
  Signs: Sunken eyes, mucus loss, whitened skin patches, death
  Cause: Uncertain, related to water temperature (below 55°F) and immune system
  Treatment/Prevention: Use good water; avoid overstocking

- Proliferative Gill Disease:
  Signs: Swollen, fragile gills
  Cause: Uncertain; may be related to water toxins, ammonia, and parasites
  Treatment/Prevention: None; helps to keep high level of oxygen in water

- No Blood Disease:
  Signs: Gills and internal organs pale white, blood is straw-colored
  Cause: Nitrites, poor quality feed, low oxygen
  Treatment/Prevention: Use good feed, properly manage water
Parasitic Diseases of Catfish

- Parasites: Animals that live in or on other animals
- Internal Parasites - Inside Catfish
  Tapeworms
  Round worms
  Flukes
- External Parasites - On Skin/External Parts
  Ich (a protozoan)
  Leeches
  Copepods (fish lice)
General Steps in Calculating Treatments

1. Determine dosage and other characteristics of therapeutant
2. Determine volume of water
3. Calculate amount of therapeutant
4. Carefully measure therapeutant
5. Apply/mix therapeutant with water
Catfish Predators

- Predators
  Animals that eat catfish
- Birds (cormorant, egret, heron, etc.)
- Snakes
- Alligators
- Turtles
- Otters
Catfish Competitors

- Animals that compete for food, oxygen, and space
- Trash Fish: Undesirable species mixed with catfish crop
- Crawfish
- Frogs
- Turtles
Water Facility Pests

- Rodents
- Crawfish
- Beaver
- Livestock
- Muskrats
Quiz for Section D

Name:

Date:

Quiz on Controlling Diseases and Pests of Catfish

Part I: Directions: Circle a T if the statement is True or an F if the statement is false.

1. T F Many catfish disease problems can be prevented by following good management practices.

2. T F Catfish live and grow in environments that are conducive to health care problems.

3. T F Up to 10% of all cultured catfish are lost each year to disease.

4. T F Some disease outbreaks can result in the loss of an entire crop in a short time.

5. T F Catfish farmers must follow approved and legal practices in treating catfish diseases.

6. T F Diseases impair the normal body functions of catfish.

7. T F Intensively cultured catfish are no more subject to disease than wild catfish or those in less intensive systems.

8. T F The three common bacterial diseases of catfish are ESC, columnaris, and aeromonas infections.

9. T F Fungal diseases are sometimes referred to as "earth molds."

10. T F The CCVD is an internal parasite of catfish.

11. T F Gas bubble disease is an example of an environmental disease.

12. T F Winter kill occurs when the water temperature is above 85°F.

13. T F Parasitic diseases may be internal or external.

14. T F Predators are animals that eat catfish.

Part II - Instructions: Provide the information to answer the following questions. Be sure to spell correctly and provide the most complete information you can.

1. The problems associated with the health and well being of catfish are categorized into 4 areas, as listed below. Briefly explain each area.

   a. Health

   b. Predators

   c. Pests
d. Destruction of facilities

2. Diseases are often placed in 2 major groups. Describe the 2 groups and briefly explain each.
   a. 
   b. 

3. Catfish exhibit a range of signs (symptoms) of disease. List 4 common symptoms and briefly explain each.
   a. 
   b. 
   c. 
   d. 

4. What management practices can be used to help prevent disease in catfish? (List 4.)
   a. 
   b. 
   c. 
   d. 

5. What methods can be used to treat catfish that have disease? Briefly explain each. (Name any 4 that you feel are most practical. Be sure to include at least one each for internal and external diseases.)
   a. 
   b. 
   c. 
   d.
Key for Section D

1. T
2. T
3. T
4. T
5. T
6. T
7. F
8. T
9. F
10. F
11. T
12. T
13. T
14. T

Part II:

1. a. Health. Conditions causing diseased fish, result in poor growth or death.
   b. Predators. Animals that prey on catfish can result in huge losses.
   c. Pests. Plant and animal life competing with the fish for a quality environment.
   d. Destruction of facilities. Pests that attack facility causing damage and loss.

2. a. Infectious diseases caused by living organisms such as bacteria, fungi, viruses, and parasites.
   b. Noninfectious caused by environmental and cultural factors: nutritional, environmental, physiological, toxic chemicals.

3. a. Change in behavior. The farm manager observes certain routine behavior of the fish. If this changes, the fish may have contracted a disease.
   b. Readily seen. Catfish in good health are usually only seen at feeding time; gathering at water surface or incoming water could mean a problem.
   c. Reduced vigor. Fish normally swim away rapidly from humans; listlessness, drooping fins, loss of balance, and sluggishness are problem signs.
   d. Failure to eat. Fish that don't feed when food is offered could be affected by water problems, parasites, or digestive tract disease.

4. a. Using quality water.
   b. Stock only healthy catfish.
   c. Control aquatic weeds.
   d. Quarantine new fish.

5. a. Dipping. Dipping fish in an approved chemical for external diseases.
   b. Flushing. Adding chemicals at one end of tank, removing at other end.
   c. Feed medication. Mixing medication with feed for internal diseases.
   d. Capsules. For small numbers of fish, medicated capsules are inserted into the belly of the fish with a balling gun.