Carp

AQUACULTURE CURRICULUM GUIDE

YEAR TWO
SPECIES MODULE

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

Module: Carp

Problem Areas:
Identifying Carp Species Important in Aquaculture
Learning Natural History and Ecological Distribution of Carp
Explaining Principles of Reproduction of Carp
Explaining 3 Methods of Propagation
Describing Larvae Hatchery Operations
Producing Juvenile Carp in Earthen Ponds
Producing Carp Fingerlings
Identifying and Treating Health Problems of Carp

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

A. Identifying Carp species Important in Aquaculture
- •Name 7 kinds of Carp important to aquaculture
- •Identify natural habitat, physiology, diet, size, and breeding patterns for each species

B Learning Natural History and Ecological Distribution of Carp
- •Explain distribution of common Carp
- •Discuss introduction of Carp to North America
- •Explain sensory adaptations Carp have evolved
- •Define preferred habitat of Carp
- •Discuss age and growth limits of Carp

C. Explaining Principles of Reproduction for Carp
- •Explain what environmental factors affect eggs and sperm
- •Explain how environmental factors affect gonadotropic hormones
- •Discuss Carp's spawning cycle
- •Explain development of larval stage

D. Explaining 3 Methods of Propagation
- •Explain natural spawning habits of Carp
- •Explain procedures used in semi-artificial propagation
- •Explain procedures used in artificial propagation
- •Describe broodstock management
- •Describe injection and stripping of spawners
- •Explain artificial fertilization and hardening of eggs
- •Describe incubation and fertilization techniques used in Carp aquaculture

E. Describing Larvae Hatchery Operations
- •Describe phases of rearing larvae
- •Describe how to remove larvae from incubation jar
- •Describe how to complete hatching process
- •Explain how to perform exogenous feeding
- •Explain how to transport larvae and early fry

F. Producing Juvenile Carp in Earthen Ponds
- •Identify environmental factors affecting juvenile development

- •Describe biological production cycle of juveniles
- •Explain techniques for production of advanced fry
- •Explain methods used in harvesting advanced fry
- •Describe various means of transporting advanced fry

G. Producing Carp Fingerlings

- •Describe optimum environmental factors for producing fingerlings
- •Describe ponds for raising fingerlings
- •Explain management factors in running a fingerling pond
- •Explain feeding characteristics in raising fingerlings
- •Explain procedures for sorting fingerlings

H. Identifying and Treating Health Problems of Carp

- •Describe health problems that occur in fingerling ponds
- •Explain diseases that affect Carp

Teaching Plan:

Module: Carp - Section A

Goal: The goal of this problem area is to identify and explain why certain species of Carp are important in the aquaculture.

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

name 7 kinds of Carp important in aquaculture
identify natural habitat, physiology, diet, size, and breeding patterns for each species

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

Essential:

A Hatchery Manual for the Common Chinese and Indian Major Carp, by Jhingram, V.G. & Pullin, Asian Development Bank, Manila, 1985.

Introduction to Aquaculture, by Landeu, M., John Wiley & Sons, Inc., NY, 1992.

World map, overhead projector, and transparencies.

Additional:

The Fishes of Missouri, by Plieger, W.L., Missouri Department of Conservation, 1975.

Content and Procedures

Preparation (Interest Approach):

To develop student interest in this module, use the world map and point out the different areas in the world that Carp are native to. Ask the students to talk about the different environmental conditions in those areas. Discuss how those differences might affect fish farming conditions.

Presentation:

A What are the 7 species of fish that are referred to as Carp?

They are often referred to by their geographic origins.

1. Chinese Carps:
   a. Grass Carp.
   b. Silver Carp.
   c. Bighead Carp.
   d. Black Carp.

2. Indian Carps:
   a. Catla.
   b. Rohu.
   c. Mrigala.

3. Common Carp.

B. What are the habitat, feeding and breeding habits of the Grass Carp (Ctenopharyngodon idella)?

Show TM A1 and identify habitat, feeding, and breeding habits of the Grass Carp.

1. Natural habitat.
   a. Flat rivers of China and middle and lower reaches of the Amur River in Russia.
   b. Introduced to many other areas. Widely cultured in the United States.
   c. Used for biological weed control.
   d. Developing food market. Now a higher priced food fish than the channel catfish.
   e. Problems: can't produce at high enough density; are voracious eaters and soon run out of weeds; convert commercial feeds poorly.
   f. Poor growth in water below 14°C.

2. Physiology.
   a. Mouth has specialized pharyngeal teeth for rasping aquatic vegetation. Located on the pharyngeal bone. Larger fish have thicker teeth that have double, flattened serrated cutting surfaces, so they can masticate the leaves of plants and grasses.
   b. Digestion is incomplete. Only half of the food is digested. Undigested food is excreted as feces, which is important in supporting a large biomass of other species of fish.

3. Diet.
   a. Natural: at 7-9 mm long protozoa, rotifers, and nauplii; at 12 mm add cladocera and codepods; at 13-17 mm add benthic algae; at 23 mm add detritus; at 30 mm mostly tender aquatic weeds.

b. Farmed. Carp do well with cereal brans, oil cakes, silkworm pupae, kitchen refuse, pelleted foods, and grasses.

4 Size.
   a. First year: 15-30 cm length; weight between 225 and 650 g.
   b. At maturity: After 4 years, 9-13 3 kg is common; fish up to 20 kg have been caught.
   c. Growth rate dependent upon age and climate, particularly temperature. In China, 15,000 degree days are needed for full maturity.

5. Breeding.
   a. Natural breeding season during monsoon months when rivers are moving rapidly.
   b. Females approximately 7 kg lay between 100,00 and 485,000 eggs in the wild. Raised fish can produce 1 million eggs.

C. What are the habitat, physiology, feeding and breeding practices of the Silver Carp (Hypophthalmichthys molitrix)?

Show TM A2 and identify habitat, physiology, feeding and breeding practices of the Silver Carp. Try to obtain some pharyngeal teeth from a scientific supply company and share with the class.

1. Natural occurrence.
   a. Chinese Rivers: Yangtze, West Kwangsi, and Kwangtung.
   b. Russian River: Amur Basin.

2 Diet.
   a. Small fry (7-9 mm) feed on zooplankton, rotifer, codepod, and nauplii.
   b. As they grow, they add phytoplankton to their diet. Have gill rakers with very long filaments suitable for filtering out the phytoplankton celli.

3 Growth rate.
   a. Little known about growth rate in natural habitat.
   b. Cultured: During first 10 days, weight doubles every second day. Fastest growth rate during 2nd year. Maximum growth rate during 3rd year. Tapers off quickly after that. Maximum weight between 6 and 8 kg.

4. Sexual maturity: Differs according to location: China 2-6 years. Southern United States 2-3 years. Rumania 6-9 years.

5 Breeding.
   a. Natural breeding occurs between April and July. The further north, the later the breeding.
   b. Spawning must be induced in ponds and lakes, i.e., it only occurs naturally in moving water.
   c Mature, injected, pond-raised females normally produce about 1 million eggs.

D. What are the habitat, physiology, feeding and breeding practices of the Bighead Carp (Aristichthys nobilis)?

Show TM A3 and identify the habitat, physiology, feeding and breeding practices of the Bighead Carp.

1. Natural habitat - Chinese rivers: Yangtze, West Kwangsi, Kwangtung.

2. Physiology. Has large alimentary canal in order to digest zooplankton.

3. Diet:
   a. Larvae feed on planktonic organisms, nauplii, and rotifers.
   b. Fry and adults feed on various kinds of planktonic life: zooplankton.
   c. Have well-developed gill rakers. They are smaller and shorter than the Silver Carp, since zooplankton is larger than phytoplankton.

4. Size:
   a. Growth rate dependent on stocking rate, feed, water temperature, and quality.
   b. With available food, maximum growth rate is in 2nd year.
   c. Age of maturity is 4-7 years.
   d. Maximum weight can exceed 10 kg.

5. Breeding:
   a. Natural breeding during monsoon season.
   b. Breeding must be induced in static water.
   c. Five hybrids have been produced. All progeny of original crosses have color.

Show TM A4 and discuss feeding and breeding habits of catla carp.

6. Physiology - Often confused with *Catlocarpia siamensis* because both have enormous heads.

7. Diet:
   a. Are bottom feeders.
   b. Primarily feed on zooplankton and detritus.
   c. 30% of adult diet is algae.

8. Growth rate:
   a. Fastest growing of the Indian major Carps.
   b. Can reach approximately 700 mm in 1st year, weight about 4 kg.
   c. Maximum size reached after 5 years, which can be reduced to 3 years with proper diet. Length: 950 mm. Weight: 18.5 kg.

9. Breeding:
   a. Spawning season twice a year from May to July and from October to November.
   b. Egg production for mature fish between 2.5 and 3 million.

E. What are the habitat, physiology, feeding and breeding practices of the Rohu Carp (Labeo rohita)?

Show TM A5 and identify the habitat, physiology, feeding and breeding practices of Rohu Carp.

1. Natural habitat:
   a. The freshwater sections of rivers in northern and central India, Pakistan Bangladesh, Burma, and Nepal.
   b. It has been introduced into southern India, Sri Lanka, Mauritius, Russia, Japan, Philippines, Malaysia, and some countries in Africa.

2. Hybridization - Much work has been done in interspecific and intergeneric hybridization.

3. Diet: Is a bottom and column feeder. Major part of diet is decaying vegetation.

4. Size:
   a. Fastest growing during 1st year.
   b. Fairly fast growing for next 3 years.
   c. Maximum weight at 10 years is 6.75 kg.

5. Breeding:
   a. Reach first maturity at end of 2nd year.
   b. Males reach full maturity at 4 years.
   c. Females reach full maturity at 5 years.
   d. Fecundity is between 0.23 and 2.8 million.
   e. Spawning season between July and September, depending on monsoon season.

F. What are the habitat, physiology, feeding and breeding practices of Mrigal Carp (Cyprinus carpio)?

Show TM A6 and identify the habitat, physiology, feeding and breeding practices of Mrigal Carp.

1. Natural habitat - Rivers in northern India, Bangladesh, Burma, and Pakistan.

2. Hybridization program
   a. Performed by the Pond Culture Division of the Central Inland Fisheries Research Institute, India.
   b. Consists of crossing Mrigala with other Carp species of India.

3. Diet: Are bottom feeders. Diet consists mainly of semi-decayed organic matter.

4. Size:
   a. Has rapid growth rate during first 4 years.
   b. Maximum size after 2 years is 12.7 kg. and 992 mm long.

5. Breeding:
   a. First maturity at 1 to 2 years.
   b. Fecundity ranges from 0.12 million to 1.1 million.
   c. Spawning depends on monsoon season.

G. What are the habitat, physiology, feeding and breeding characteristics of the Common Carp (Cyprinus carpio)?

Show TM A7 and identify the habitat, physiology, feeding and breeding practices of the Common Carp.

1. Origins - Native to the rivers of central Asia, particularly those draining the Caspian and Black Seas.

2. Species now nearly global and culture is very widespread.

3. Subspecies:

a. European-Transcaucasian.
b. Mid-Asian.
c. Far Eastern.
d. Northern Vietnam.
e. Cultured varieties: Big Bellied, Long Bodied, Orange-Colored, Punte, Majalayan, Mirror, Aischgrunder, Scale, Leather, Asagi, Kursk, Dinnys', and Nasice Carp.

4 Physiological characteristics - The fish dig into sides and bottoms of ponds in search of food. They gulp in mud, eat digestible matter, and reject the rest. This can lead to turbid pond water and damage to levees.

5. Diet - Fingerlings and larger fish eat decaying organic matter that contains bottom dwelling organisms.

6. Size - Common Carp differ in size, depending on their location.

7. Breeding.
   a. Breed naturally in natural habitat, i.e., static water.
   b. Males have highly developed testes that may make up 20-30% of body weight.

Review:

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

Evaluation:

Evaluation should focus on the extent to which achieved the objectives of the problem area, Examples include class participation, quizzes, and final examination. Example exam questions are attached/

TM A1

Grass Carp (Ctenopharyngodon idella)

A. Natural Habitat: China and Russia

B. Characteristics

1. Now a higher priced food fish than channel catfish
2. Used for biological weed control
3. Specialized pharyngeal teeth for rasping vegetation
4. Larger fish have teeth with flattened, serrated surfaces for masticating leaves
5. Digestion is incomplete
6. Undigested food excreted as feces that serve as food source for other species of fish

C. Problems

1. Can't produce at high enough density
2. Growth in water below 14°C

D. Diet When Farmed

1. Cereal
2. Oil cakes
3. Silkworm pupae
4. Kitchen refuse
5. Pellets
6. Grasses

E. Maximum Size (4 years): 9 to 13 kg. typical. Can get to 20 kg

F. Breeding - Natural breeding season during monsoon months

G. Most Important Food Fish in China

TM A2

Silver Carp (Hypophthalmichthys molitrix)

A. Natural Habitat: China and Russia

B. Sexual Maturity: Differs according to location:
   1. South China 2-3 years
   2. North China 5-6 years
   3. Rumania 6-9 years

C. Breeding
   1. Natural breeding occurs later further north
   2. Natural spawning only occurs in moving water

TM A3

Bighead Carp (Aristichthys nobilis)

- Natural Habitat: China
- Physiology: Has large alimentary canal to digest zooplankton
- Size: Maximum size (4-7 years) 5-10 kg
- Breeding: Natural breeding during monsoon season; must be induced in static water
- Second most important food fish in China

TM A4

Catla (Catla catla)

- Natural Habitat: Northern India, Pakistan, Bangladesh, and Burma. Five hybrids have been produced
- Diet: Are Bottom Feeders
- Maximum Size (5 years): length: 950 mm, weight: 18.5 kg
- Breeding: Spawn twice a year, spring and fall

TM A5

Rohu (Labeo rohita)

A. Habitat
   1. Natural: northern India, Pakistan, Burma, and Nepal
   2. Cultured areas: Sri Lanka, Mauritius, Russia, Japan, Philippines, Malaysia, and Africa
   3. Work is being done on interspecific and intergeneric hybridization

B. Diet
   1. Bottom and column feeders
   2. Detritus: Major part of diet is decaying vegetables

C. Size: Maximum weight (10 years) 6.75 kg

D. Breeding
   1. Males reach sexual maturity at 4 years
   2. Females reach full maturity at 5 years
   3. Spawning depends on monsoon season

TM A6

Mrigal (Cyprinus carpio)

- Natural Habitat: India, Bangladesh, Burma, and Pakistan
- Hybridization program in India
- Diet: Detritus and bottom feeders
- Size: Maximum size (12 years) 12.7 kg and 992 mm long
- Breeding: Spawning depends on monsoon season

TM A7

Common Carp (Cyprinus carpio)

A. Natural Habitat: Rivers drain into Caspian and Black seas

B. Species

1. Nearly global; culture is very widespread
2. Subspecies: European-transcaucasian, mid-Asian, Far Eastern, northern Vietnam
3. Cultured varieties: Big Bellied, Long Bodied, Orange-Colored, Punten, Majalayan, Mirror, Aischgrunder, Scale, Leather, Asagi, Kursk, and Dinnyes' Carp

C. Physiological Characteristics

1. Fish dig into sides and bottoms of ponds in search of food, gulp in mud, eat digestible matter, and reject the rest, leading to turbid pond water
2. Size: Differ in size, depending on their location
3 Diet: Grown fish eat decaying organic matter that contains bottom dwelling organisms

D. Breeding

1. Occurs in natural habitat
2. Males have highly developed testes that may constitute 20- 30% of body weight

Quiz for Section A

Name:

Date:

Quiz on Identifying Carp Species Important in Aquaculture

Matching. Match the terms on the left with the short definition on the right by writing the appropriate letter in the space provided.

1.___	Catla	a.	Only digest half their food. Undigested food is used by other fish as food source.
2.___	Pharyngeal	b.	Those raised in Rumania live from 6-9 years.
3.___	*Cyprinus carpio*	c.	River in Russia where several Carp species originated
4.___	Amur	d.	Five hybrids have been produced, all of which have color .
5.___	Grass Carp	e.	Food for small fry
6.___	Monsoon	f.	Used for fish food in Grass Carp operations
7.___	Silkworm pupae	g.	Teeth used for rasping aquatic vegetation
8. ___	Rotifers and zooplankton	h.	Rainy season when most Carp breed
		i.	Species that is now global in distribution

Key for Quiz - Section A

1.	d	Catla	a.	Only digest half their fish as food source. Undigested food is used by other fish as food source.
2.	g	Pharyngeal	b.	Those raised in Rumania live from 6-9 years
3.	i	Cyprinus carpio		
4.	c	Amur	c.	River in Russia where several Carp species originated
5.	a	Grass Carp	d.	Five hybrids have been produced, all of which have color.
6.	h	Monsoon	e.	Food for small fry
7.	f	Silkworm pupae	f.	Used as fish food in Grass Carp operations
8.	e	Rotifers and zooplankton	g.	Teeth used for rasping aquatic vegetation
			h.	Rainy season when most Carp breed
			i.	Species that is now almost global in distribution.

Teaching Plan:

Module: Carp - Section B

Problem Area: Learning Natural History and Ecological Distribution of Carp

Goal: The goal of this problem area is to learn about the natural history and ecological distribution of Carp.

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

explain distribution of the common Carp
discuss introduction of Carp to North America
explain sensory adaptations Carp have evolved
define preferred habitat of Carp
discuss general age and growth limits of Carp

Resources: The following instructional resources are needed for this problem area.

Essential:

Aquaculture of Cyprinids, by Billard, R. & Marcel, J., Editors, Institut National de la Recherche Agronomique, Paris, 1986.

Carp in North America, by Cooper, E.L., Editor, American Fisheries Society, Bethesda, MD, 1987.

Transparencies, overhead projector, and world map

Additional:

Aquaculture, by Bardach, J.E., Ryther, J.E. & McLarney, W.O., Wiley-Interscience, NY, 1972.

Content and Procedures

Preparation (Interest Approach):

To develop student interest in this module, ask the students if they have ever had dandelion greens in a salad, thistle soup, or mustard greens. Lead a discussion about the difference between weeds and domesticated plants. Ask the students if they ever eat fish. Ask them what kind. Discuss how Carp are considered by many people in the world to be like weeds, while others think they are excellent eating fish.

Presentation:

A How are Carp distributed?

Show TM B1 and lead a discussion about the evolution of the common Carp.

Use the world map and have students show the migration of Carp from their original habitat.

1. The common Carp (family Cyprinidae) or minnows.
2. Largest family of freshwater fish in the world, with over 1,500 species.
3. Distribution related to movement of continents millions of years ago.
4. Probably originated in eastern Europe and western Asia and the watersheds of the Black, Caspian, and Aral seas. May have been in Volga River and as far east as Burma.

B. How were Carp introduced to other areas?

Show TM B2 and lead a discussion about the cultural history of Carp.

1. Introduced to the Danube River by Romans. Introduced to England around 1500.

2. Introduced to North America in 1800s.
   a. First imported to and raised in California in 1872.
   b. U.S. Fish Commission founded in 1871 to deal with problems of overfishing native fish.
   c. Professor S.F. Baird suggested introduction of Carp.
   d. Commission imported 345 Carp in 1877.

C. What are the sensory adaptations of Carp?

Show TM B3 and lead a discussion about the Weberian apparatus.

1. Hearing.
   a. Carp have better hearing than many other fish, due to the Weberian apparatus.
   b. Bones and ligaments connect swim bladder to inner ear, which amplifies vibrations that are then sent to the brain.

2. Smell.

Show TM B4 and lead a discussion about the Carp's sense of smell.

a. Some believe that Carp can smell better than most fish.
b. Water enters an olfactory bulb through a pair of openings called nares. This carries odorous materials to receptors that are embedded in the epithelium of the nasal cavity.
c. It is believed that Carp can also release sensory chemicals (allomones) when alarmed. The allomones warn minnows, which then scatter out of the school.

3. Taste.

Show TM B5 and lead a discussion about the Carp's sense of taste.

Carp have an acute sense of taste and can distinguish between salty, bitter, and sweet substances.

D. What is the preferred habitat of Carp?

Show TM B6 and lead a discussion about the preferred habitat of Carp.

1. Can live in wide range of environments, from clear, cold mountain streams to polluted lakes.

2. Prefer shallow, weedy habitat that provides protection and cover like shallow, muddy bottoms.

3. Tolerate wide range of temperatures.
   a. Can survive ice-covered lakes and up to 106°F for a short while.
   b. Optimal temperature is 66°F.
   c. Temperature affects the amount of ADO and therefore the health of fish. Carp have low oxygen consumption and can stand fairly low levels of oxygen, as low as 2 ppm for larger fish in warm water and 0.5 ppm for fry and fingerling. Prefer ADO of above 4.5 ppm.

4. Carp can function in an environment with a high level of turbidity because of highly developed hearing and smelling senses.

5. Carp have a low tolerance for salt, although some researchers do not believe that their tolerance to chlorides is less than other temperate farmed fish.

E. What are the age and growth of Carp?

Show TM B7 and lead a discussion about the age and growth of Carp.

1. Age - There are photographic records of Carp in England that have been caught and recaught over a period of 50 years.
2. Size - The world record Carp weighed 82 pounds and was caught in Pretoria, South Africa.
3. Growth rate - Affected by genetic factors, food supply, and density. High population densities lead to excessive excretion of certain metabolites that have a negative effect on growth, probably NH_3.

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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.

Evaluation:

Evaluation should focus on the extent to which students achieved the objectives of the problem area. Examples include class participation, quizzes, and a final exam. Example exam questions are attached.

TM B1

Evolution of Carp

- Common Carp (*Cyprinus Carpio*) or minnows
- Belongs to largest family of freshwater fish in world
- Distribution related to ancient movement of continents
- Originated in eastern area of Europe and western Asia

TM B2

Cultural History

- Introduced to the Danube River by Romans
- Introduced to England around 1500
- Introduced to North America in 1800s.

TM B3

Physiology - Hearing

Carp have good sense of hearing due to Weberian apparatus.

TM B4

Physiology - Smell

- Carp have good sense of smell
- Related to nares in the olfactory bulb
- Believed that Carp release allomones that cause minnows to scatter

TM B5

Physiology - Taste

Carp have an acute sense of taste.

TM B6

Preferred Habitat

- Can live in a wide range of environments. Prefer shallow, weedy habitats with muddy bottoms.
- Optimal temperature: 66°F. Can tolerate a wide range of temperatures.
- Optimal ADO: 4.5 ppm. Can tolerate as low as 2 ppm in warm water.
- Carp have low tolerance for salt.

TM B7

Age and Growth

- Photographic record of Carp in England is over 50 years old.
- Record Carp weight is 82 lbs.
- Growth rate is affected by genetic factors, food supply, and density.

Quiz for Section B

Name:

Date:

Quiz on Learning Natural History and Ecological Distribution of Carp.

Circle a T for True statements or an F for False statements.

1. T F Carp are members of the Cyprinidae family.

2. T F The Carp family originated in the northern rivers of Europe.

3. T F Carp were introduced to New England in the 1500s.

4. T F The Weberian device helps Carp have an acute sense of hearing.

5. T F Nares in the Carp's olfactory bulb impair the fish's ability to smell.

In a brief paragraph, describe the preferred habitat of the Carp.

Key for Quiz - Section B

1.	T	Carp are members of the Cyprinidae family.
2.	F	The Carp family originated in east central Europe in the Aral Sea and the Amur River.
3.	F	Carp were introduced into England in the 1500s**.** They were introduced into America, in California, in 1872**.**
4.	T	The Weberian device helps Carp have an acute sense of hearing.
5.	F	Nares in the Carp's olfactory bulb improve fish's ability to smell.

In a brief paragraph, describe the preferred habitat of the Carp.

Carp prefer shallow, weedy habitats that provide protection and cover. These can vary in temperature and water conditions and range from cold mountain streams to polluted lakes. The optimum temperature for Carp is 66°F. The optimum DO is 4.5 ppm. Because of their highly developed senses of sight, sound, and smell, Carp easily adapt to many conditions. What Carp cannot tolerate is salt water.

Teaching Plan:

Module: Carp - Section C

Problem Area: Explaining Principles of Reproduction of Carp

Goal: The goal of this problem area is to explain the basic principles of reproduction of the common Carp.

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

explain what environmental factors affect eggs and sperm
explain how environmental factors affect gonadotropic hormones
discuss the Carp's spawning cycle
explain the development of the larval stage.

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

Essential:

Common Carp 1: Mass Production of Eggs & Early Fry, Food and Agriculture Organization of the United Nations, FAO Training Series, Rome, 1985.

Accompanying film strip, projector, and screen.

Additional:

Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms, by Bardach, J.E., Ryther, J.H. & McLarney, W.O. Wiley-Interscience, NY, 1972.

Content and Procedures

Preparation (Interest Approach):

To develop student interest in this module, ask the students what experience they have had with breeding farm animals and pets. Ask them to speculate on how breeding activity in natural surroundings differs from that of domesticated animals. Have them compare and contrast natural and cultured fish breeding as it relates to the breeding of other animals. Ask the students if they think that human behavior might affect natural fish breeding. Ask them to suggest ways to insure that some natural breeding areas will be preserved, both in the United States and throughout the world.

Presentation:

A. How does the reproduction cycle start in gonads?

Show TM C1 and lead a discussion about the environmental factors that affect eggs and sperms.

1. Females have ovaries, which produce eggs.
2. Males have testes, which produce sperm (milt).
3. Development of eggs and sperm directly affected by:
   a. Water temperature.
   b. Availability of food.
   c. Amount of dissolved oxygen (DO).
   d. Photoperiod or increasing length of day.

B. How do development and environmental conditions affect hormonal action?

Show TM C2 and discuss how development and environmental conditions affect the hormone gonadotropin.

1. Final ripening of eggs dependent on release of gonadotropin hormones. These are activated by the pituitary gland and stimulate the gonads.
2. Dependent on following environmental conditions: light, temperature, presence of male Carp, and vegetation

C. When do Carp spawn?

Show TM C3 and discuss the spawning of Carp.

1. In temperate zones, spawning normally happens in the spring.
2. If food is scarce, fish will progressively spawn, i.e., a few eggs at a time.
3. In tropical regions, Carp may spawn more than once. The individual spawns usually one time, but the population may spawn over the entire season.

D. When are Carp mature for spawning?

Show TM C4 and discuss the larval stage of Carp.

In temperate zones, maturity usually takes place within 2 years.

E. How do Carp spawn?

1. Male and female Carp spawn by swimming side by side.

2. When eggs are extruded into water, they are surrounded by milt.
   a. Milt is usually released onto vegetation in shallow water.
   b. High motility of sperm only lasts for 30-60 seconds.
   c. Usually, one sperm enters the micropyle, fertilizing the egg.
   d. The micropyle closes, the egg absorbs water and enlarges, then the egg becomes sticky.

F. How does the Carp larval stage develop?

1. Larvae are nourished from yolk sac.

2. At optimum water temperature of 20-24°C, at about 4 days.
   a. Mouth forms.
   b. Swim bladder is inflated.
   c. Exogenic feeding starts.
   d. Fish enters fry stage.

Review:

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

Evaluation:

Evaluation should focus on the extent to which students achieved the objectives of the problem area. Examples include class participation, quizzes, and a final exam. Example exam questions are attached.

TM C1

Reproduction Cycle

- Starts in gonads
- Females have ovaries, produce eggs
- Males have testes, produce sperm
- Development of eggs and sperm affected by:
  Water temperature
  Quality and quantity of food
  Amount of DO
  Length of daylight

TM C2

Hormonal Action

- Ripening of eggs dependent on release of gonadotropic hormones

- Release of hormones dependent on:
  Light
  Temperature
  Atmospheric pressure
  Presence of male Carp
  Vegetation

TM C3

Time of Spawning

- Temperate climates - happens in spring
- Tropical regions
- Carp may spawn more than once a year

TM C4

Larval Development

- Newly hatched larvae nourished by yolk sac
- Take 4 days with water temperature of 20-24°C
- Fish now enter fry stage

Quiz for Section C

Name:

Date:

Quiz on Explaining Principles of Reproduction of Carp

Circle T for True statements or F for False statements.

1.	T	F	The development of eggs and sperm are affected by the increasing amount of daylight they receive.
2.	T	F	Gonadotropic hormones are activated by the adrenal gland.
3.	T	F	The spawning cycle in temperate regions is different than in tropical regions.
4.	T	F	Male and female Carp spawn by swimming side by side.
5.	T	F	The micropyle on the Carp egg stays open when the egg becomes sticky.
6.	T	F	The larvae is nourished from the yolk sac.

Key for Quiz - Section C

1.	T	The development of eggs and sperm are directly affected by the amount of light they receive.
2.	F	Gonadotropic hormones are activated by the pituitary gland.
3.	T	The spawning cycle in temperate regions is different that in tropical regions.
4.	T	Male and female Carp spawn by swimming side by side.
5.	F	The micropyle on the Carp egg closes when the egg becomes sticky.
6.	T	The larvae are nourished from the yolk sac.

Teaching Plan:

Module: Carp - Section D

Problem Area: Explaining 3 Methods of Propagation

Goal: The goal of this problem area is to explain the 3 methods of propagation used in aquaculture of Carp.

Learning Objectives: Upon completing the problem area, students will be able to:

explain the natural spawning habits of the Carp
explain the procedures used in semi-artificial propagation
explain the procedures used in artificial propagation
describe broodstock management
describe the injection and stripping of spawners
explain artificial fertilization and hardening of the eggs
describe incubation and fertilization techniques used in Carp aquaculture.

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

Essential:

Common Carp 1: Mass Production of Eggs & Early Fry, Food and Agriculture Organization of the United Nations, FAO Training Series, Rome, 1985.

Accompanying film strip, projector, and screen.

Additional:

Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms, by Bardach, J.E., Ryther, J.H. & McLarney, W.O. Wiley Interscience, NY, 1972.

Content and Procedures

Preparation (Interest Approach):

To develop student interest in this module, bring some flowers to class, along with some corn cobs and some other types of seed cases. Talk about the male and female parts of the plant. Also bring some sprouted alfalfa seeds or something similar. Ask the students if they can help explain the cycle in which plants go from sprout to seed. This is propagation. Compare and contrast the similarities and differences between the propagation of plants and the propagation of fish. Within this context, compare and contrast plant farming and fish farming.

Presentation:

A. What are the 3 ways Carp can spawn?

Show TM D1 and introduce the 3 ways that Carp spawn.

1. Natural propagation: No hormones are used, but the environment can be manipulated.
2. Semi-artificial propagation: One injection of gonadotropin is used to induce spawning.
3. Artificial propagation: Two injections of gonadotropin, stripping of eggs and sperm, artificial fertilization, incubation of eggs, and larval rearing.

B. How do Carp spawn naturally?

Show TM D2 and compare and contrast the spawning habits of Carp in the wild with the procedures used in aquaculture spawning techniques.

1. Done in large grassy ponds, which are kept dry in the winter.

2. Stocked with adult fish at the rate of 3-4 fish per hectare and 2-3 males per female.

3. Success is dependent primarily on weather, but other factors such as predation, competition, and fertility contribute.

4. Methods of natural spawning.
   a. The Dubisch method. This induces spawning by maintaining proper water temperature (18-22°C), DO saturation, slowly raising water level, a grass-covered central platform, and the presence of both sexes. It is dependent on good luck with weather.
   b. Catching wild Carp. Catch fish when they are ready to spawn. Strip eggs and milt immediately and fertilize eggs artificially. Transport them to a incubation area for hatching .

C. How are Carp propagated semi-artificially?

Show TM D3 and examine similarities and differences between natural and semi-artificial spawning.

1. The females are injected with human chronic gonadotropin at 500-800 i.u./lb or Carp pituitary at 1-2 mg/lb. No need to inject males.

2. Spawners are stocked in newly filled grassy ponds.

3. Spawning takes place within 2 days.

4. Breeding hapas are used.
   a. Hapas are l x l x 2 m cloth enclosures that are supported at the 4 corners by poles.
   b. The injected breeders are placed in the hapas where breeding takes place, usually within a few hours. The breeders are then removed.
   c. The larvae hatch in the hapas.
   d. This method is good for Grass Carp, whose eggs are buoyant, not sticky.

5. Same procedure can be done using small spawning ponds, wire mesh boxes (kakabans) which are spawning substrates made with long plant fibers.

D. How are Carp propagated artificially?

Show TM D4 and compare and contrast semi-artificial spawning with artificial spawning.

1. Two injections of gonadotropic hormones.

2. Hand stripping of sexual products.

3. Close supervision of artificial fertilization, removal of stickiness, incubation, and hatching.

4. Rearing of newly hatched larvae.

5. Removal of young fry from hatchery building to rearing ponds.

6. Advantages:
   a. Better protection of eggs from parasites, diseases, climatic conditions, and predators.
   b. Better protection of newly hatched larvae.
   c. Good control at first feeding.
   d. Better preparation of stocking ponds.
   e. Number of male spawners reduced.

E. How is the broodstock managed?

Show TM D5 and divide class into management groups and develop plans for breeding, pond management, fish management, and food management. Have students combine their information with an overall management plan.

1. Selecting breeders:
   a. Shape of body.
   b. Health.
   c. Development of sexual organs.
   d. No body wounds.
   e . No parasites.
   f. No deformations.
   g. Proper amount of fat.

2. Determining sex:
   a. Females: Bodies are plump. Genital openings are above the genital papilla.
   b. Males: Bodies are slender. Genital openings are behind the genital papilla.

3. Signs of breeder's maturity:
   a. Females: Well-rounded and soft belly. Genital papilla is erect and reddish. Anal openings enlarged and protruding.
   b. Male: Bellies are slim. Will release milt with slight pressure on the abdomen. Roughness on pectoral fins (tubercles).

4. Broodstock ponds:
   a. Size about .5 to 1 hectare by 1-2 m deep.
   b. Should have vegetation protecting dikes.
   c. Need protected inlet and outlet.

5. Management techniques: Temperate regions
   a. Spent spawners are taken from hatchery and bathed in a salt bath against ectoparasites.
   b. They are stocked in the broodstock ponds, where they are well fed.
   c. They overwinter in the same pond.
   d. In the spring they are salt bathed and graded for potential breeders. Unqualified fish are marketed
   e. They are separated by sex and stored in storage ponds.
   f. They are seined out as needed, salt bathed, and transported to the hatchery.

6. Management techniques: In the tropics
   a. Fish are separated by sexes.
   b. Fish are separated according to whether or not they are spent.

7. Feed
   a. Varies according to the season.
   b. When new eggs are forming, should be 50% natural food high in protein and 50% artificial feed high in carbohydrates
   c. Egg development occurs over the entire year. The fish need a good diet all year long to be good spawners.

8. Selection of breeders - Done the day before propagation is to take place.

F. What is involved in the injection and stripping of spawners?

Show TM D6 and lead a discussion about the use of hypophysis hormones.

1. Use of dried hypophysis:
   a. Females: First injection 0.3 mg/kg. Second injection 3.5 mg/kg.
   b. Males: One injection 2.0 mg/kg. Mix with a 0.65% salt solution to create 1 ml solution per fish.

2. Types of anesthetics

Show TM D7 and lead a discussion about the use of anesthetics.

WARNING: The use of anesthetics is strictly regulated for food fish. Check with state officials to find which anesthetics are appropriate in your area.

   a. MS 222 (tricaine methane-sulphonate).
   b. Quinaldine (2-4 methylquinoline).
   c. Phenoxyethanol.
   d. Dosage is dependent on live weight.

3. Preparation of gonadotropic hormone.

Show TM D8 and lead a discussion about gonadotropic hormones.

   a. Extracted from dried hypophyses, which comes from the pituitary gland.
   b. Needed amount is calculated according to number and weight of breeders.
   c. Dried glands are ground into powder.
   d. Powder is mixed with 0.65% salt solution.
   e. Solution is injected into breeders.

SAFETY NOTE: Breeders should be watched to see if their opercules keep moving. If these stop, fish are in danger. It is essential to keep the fish in well-oxygenated water throughout the process.

4. Preparation for stripping:

Show TM D9 and lead a discussion about preparing for stripping the eggs for milt.

   a. First injection of hypophysis given to anaesthetized females in early morning.
   b. Females are kept in large tank with well-aerated water and left undisturbed for 10-12 hours.
   c. After this time, females are anaesthetized again.
   d. The second injection of hypophysis is then given .
   e. Females are returned to tank when ovulation is completed. Length of ovulation is related to water temperature.
   f. When a female begins looking for a place to spawn, or is being followed by an indicator male, she is ripe.

5. Stripping.

Show TM D10 and lead a discussion about the stripping process used with Carp.

a. First the sutures are cut.
b. Then the genital opening closed with the thumb of the left hand.
c. The ventral part of the body is dried with a towel.
d. Stripping of females under 4 kg is done by one person who uses his right arm to hold the fish. The fish is held by its tail, while the aquaculturist's right hand massages the fish's lower flanks from front to back, releasing eggs into bowl. No water should be added.
e. Stripping of larger females is done by one person holding fish on table and massaging lower flanks and second person holding bowl under fish to catch eggs in. NOTE: Each kilogram of eggs should be put into a separate bowl.
f. After stripping, female should be returned to the tank to recover.

G. How do artificial fertilization and hardening of eggs occur in Carp?

Show TM D11 and lead a discussion about artificially fertilizing Carp eggs.

1. Weigh eggs.
   a. Weigh plastic container.
   b. Add dry eggs.
   c. Weigh container and eggs.
   d. Subtract weight of container.

2. Calculate needed amount of milt.
   a. Proportion is 1:100, or 10 ml for each kilogram of eggs.
   b. For each batch of eggs, obtain milt from two different males.

3. Add milt.
   a. Either strip directly from male to bowl.
   b. Collect milt from a collecting glass.
   c. Best to collect milt first and store in refrigerator.

4. Use of fertilizing solution.
   a. Use Ringer's solution as a milt extender to keep the milt nonmotile until a sufficient fresh water is added to change the osmatic pressure and activate the milt.
   b. The technique is to add fresh water over a 2-3 minute period so that all the milt is spent at 3 minutes.
   c. It is essential to add tannin, clay, or other material to retard the sticking problem, which is sure to start within 3-4 minutes after the first water is added.

H. How are fertilized eggs incubated?

Show TM D12 and TM D13 and lead a discussion about egg swelling and the incubating process of eggs.

1. Water quality: must be clean and aerated.

2. Zug (McDonald) jars.
   a. A thick-walled glass cylinder with a funnel-shaped bottom.
   b. Water enter through hole in bottom, exits drain at top.
   c. Funnel shape create a circular movement of water that keeps the eggs from settling to the bottom, suffocating, and dying.
   d. Jar drainage can be connected.

3. Incubation process:
   a. Fill 7- l Zug jars half way.
   b. Add 1.5-2.0 l of swollen Carp eggs.
   c. Open water supply to roll the eggs on the bottom, but insufficient flush the eggs out of the jar. NOTE: Each 7-l jar can incubate 250-300 g of dry eggs. Use this formula for figuring total quantities of either jars or eggs.
   d. Water flow depends on the geometry of the system and the egg quality (percent of fat in the yolk, etc.). The flow rate has to be increased as the eggs develop.
   e. Duration of incubation period depends on water temperature. Optimum water temperature is 22-24°C.
   f. Need for protection from fungal infection. Check with local authorities to find which fungicides are allowed for use on food fish.
   g. Dead, white eggs rise to surface. Are subject to *Saprolegia* fungus. Do not turn off the water. It is too easy to forget to turn it back on. Instead, net the dead eggs when they float to the surface. Do this when the first dead eggs are seen and continually thereafter.
   h. Inspect continuously for fungal diseases, as well as water flow and temperature.

Review:

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

Evaluation:

Evaluation should focus on the extent to which students achieved the objectives of the problem area. Examples include class participation, quizzes, and a final exam. Example exam questions are attached.

TM D1

Spawning Methods

- Natural propagation: Manipulation of environment only

- Semi-artificial propagation: Use of gonadotropin to induce spawning

- Artificial propagation:
  Two injections of gonadotropin
  Stripping of eggs and sperm
  Artificial fertilization
  Incubation of eggs
  Larval rearing

TM D2

Natural Spawning

- Done in large grassy ponds
- Stock 2-3 males per female per 3-4 hectares
- Success is weather dependent
- Method: Dubisch method
- Maintain proper water temperature (18-22°C),
- Maintain correct DO
- Pond has a grass-covered center for spawning
- Need fish of both sexes
- Catching wild Carp when they are ready to spawn
- Strip eggs and sperm immediately
- Fertilize eggs artificially
- Transport eggs to incubation area

TM D3

Semi-Artificial Propagation

- Spawners are injected with a single dose of gonadotropic hormones
- Stock in newly filled ponds
- Spawning takes place within 2 days
- Use of hapas: 1 x 1 x 2 m cloth enclosures
- Breeding takes placed in hapas
- Breeders are then removed
- Larvae hatch in hapas

TM D4

Artificial Propagation

- Requires 2 injections of gonadotropic hormones
- Hand-strip eggs and sperm
- Perform artificial propagation
- Remove stickiness
- Supervise incubation
- Supervise hatching
- Transport young fry to rearing ponds
- Advantages
- Need for males reduced
- Better protection of eggs
- Better protection of newly hatched larvae
- Good control of first feeding
- Better preparation of stocking ponds

Broodstock Management

A. Selecting Breeders
   1. Shape of body. Larger, faster growing fish important.
   2. Scale distribution.
   3. Healthy, with desirable hereditary characteristics.
   4. Developed sexual organs.
   5. No body wounds, parasites, or deformations.
   6. Proper amount of fat.
   7. Select day before propagation is to take place

B. Determining Sex
   1. Female: Plump body. Genital opening is above the genital papilla.
   2. Male: Slender. Genital opening is behind the genital papilla.

C. Signs of Breeder's Maturity
   1. Female: Well-rounded soft belly. Genital papilla erect, reddish. Anal opening enlarged and protruding.
   2. Male: Slim belly. Will release milt with slight pressure on the abdomen.

D. Broodstock Ponds
   1. Size about .5 to 1 hectare by 1-2 m deep.
   2. Should have vegetation protecting dikes.
   3. Need protected inlet and outlet.

E. In Temperate Regions
   1. In spring, spent spawners are taken from hatchery.
   2. Bathed in a salt bath against ectoparasites.
   3. Stocked and well fed in the broodstock ponds they are
   4. Overwinter in the same pond.
   5. Salt bathed & graded for breeders in spring. Market unqualified fish.
   6. Separated by sex and stored in storage ponds.
   7. Seined out salt bathed, transported to hatchery.

F. In the Tropics: Separated by sexes and if spent

G. Feed
   1. Varies according to the season.
   2. New eggs need 50% natural food high in protein & 50% artificial feeds high in carbohydrates.
   3. When eggs are dormant, 30-40% of diet is artificial.

TM D6

Use of Dried Hypophysis

Females: First injection 0.3 mg/kg. Second injection 3.5 mg/kg

Males. One injection 2.0 mg/kg.

TM D7

Anesthetics

Note: Check with state officials to find the legal status of drugs and chemicals used on food fish.

Types of anesthetics:

- MS 222 (tricaine m ethane-sulphonate)
- Quinaldine (2-4 methylquinoline)
- Phenoxyethenol

TM D8

Gonadotropin Hormones

- Induces final ripening of eggs
- Preparation: Extracted from dried hypophyses, which comes from the pituitary gland
- Mixed in salt solution, which is injected into breeders
- Safety note: Breeders should be watched to see if their opercules keep moving. If these stop, fish are in danger and should then be moved immediately to well-aerated water.

TM D9

Preparation for Stripping

- Injection of gonadotropin is given to anesthetize female
- After anesthetizing, female should be kept in tank with well-aerated water and left undisturbed for 10-12 hours.
- Female is anesthetized a second time and her genital opening is sutured closed to prevent wild spawning.
- A second injection of gonadotropin is given
- Female is returned to tank when ovulation is completed. Note: Maintenance of proper water temperature is important.
- Female is ripe when male begins to look for place to spawn and she is being followed by an indicator male

TM D10

Stripping of Eggs

- Cut the sutures.
- Close the genital opening with the left thumb.
- Dry the fish with a towel.
- Using right arm to hold fish by her tail, massage her lower flanks with the right hand from front to back. This releases the eggs into the bowl.
- Return female to tank for recovery.

TM D11

Artificial Fertilization

- Weigh eggs.
- Calculate needed amount of milt. Proportion is 1:100.
- Obtain milt from two males for each batch of eggs.
- Add milt directly from male from mixing bowl.
- Prepare fertilizing solution:
  40 g NaCl to 30 g urea to 10 l of water.
- Add fertilizing solution.

TM D12

Egg Swelling

- Process lasts 1-5 hours.
- Each liter of dry eggs produces 6-9 l of swollen eggs.
- Change fertilization solution 3-4 times during process.
- Add tannin solution because it removes stickiness and completes hardening of eggs.

TM D13

Incubation Process

1. Fill 7-l Zug jars half way.
2. Add 1.5-2.0 l of swollen carp eggs.
3. Open water supply allows 0.6-0.8 l /min. overflow.
4. Note: Each 7-l jar can incubate 250-300 g of dry eggs. Use this formula for figuring total quantities of either jars or eggs.
5. Water flow in stages.
    a. First 10 hours (morula) 0.6-0.8 l/min.
    b. Next period (blastula stage) 1.0-1.2 l/min.
    c. Final tail, eyes, and color of embryos become visible, 1.5-2.0 l/min.
6. Duration depends on water temperature: 22-24°C.
7. Protect from fungus. Check with local authorities to find acceptable fungicide to use on food fish.
8. Dead, white eggs turn white and rise to surface.
    a. Are subject to *Saprolegia* fungus.
    b. At the eyed, embryonic stage, water flow should bestopped.
    c. Siphon off dead eggs.
    d. Turn water back on.Repeat every 10 hours, if necessary.
9. Inspect regularly.
    a. Water flow.
    b. Temperature.
    c. Development of eggs/addition of malachite green.
    d. Usually requires 60-70 degree days.

Quiz for Section D

Name:

Date:

Quiz on Explaining 3 Methods of Propagation

To complete the following, fill in the blanks.

1. Name the two ways to do natural spawning with carp: _____ and _____.

2. To perform semi-artificial propagation, give the female one dose of_____.

3. This substance is obtain from the following gland: _____.

4. The cloth enclosure used for semi-artificial propagation is called a _____.

5. There were five advantages to using the artificial propagation method listed in class. Name three of them:_____, _____, _____.

6. What are the three general considerations in broodstock management? _____, _____, and _____.

7. What is the major purpose of using gonadotropic hormones? _____.

8. In the artificial fertilization process, for each batch of eggs, milt from how many males should be used?_____.

9. A 4-year-old silver carp can produce approximately 1 kg of eggs. If you can incubate 275 g of eggs in one 7-l Zug jar, how many 7-l Zug jars will you need to incubate the eggs from one female?_____.

10. Write a paragraph that briefly describes the process of stripping eggs from the female carp.

Key for Quiz - Section D

1. Name the two ways to do natural spawning with carp: Dubisch method and catching wild fish.

2. To perform semi-artificial propagation, give the female one dose of gonadotropic hormone.

3. This substance is obtain from the following gland: pituitary.

4. The cloth enclosure used for semi-artificial propagation is called a hapas.

5. There were five advantages to using the artificial propagation method listed in class. Name three of them. Need fewer male fish, better protection against environmental problems, good protection f or newly hatched larvae, good control of feeding, and better preparation of broodstock ponds.

6. What are the three general considerations in broodstock management? select for desirable hereditary characteristics, select for well-developed reproductive organs, and management practices for ponds and brood fish.

7. What is the major purpose of using gonadotropic hormones? It induces the final ripening of the eggs

8. In the artificial fertilization process, for each batch of eggs, milt from how many males should be used? Two

9. A four year old silver carp can produce a little over 1 kg of eggs. If you can incubate 275 g of eggs in one 7-l Zug jar, how many 7-l jars will you need to incubate the eggs from one female? Four

10. Write a paragraph that briefly describes the preparation and stripping of eggs from the female carp.

    The female is given one shot of gonadotropin and is left to rest for 10-12 hours, after which she is anesthetized, and her genital opening is sewn closed. She is then given a second hormone shot. When she begins to look for a place to spawn, or is followed by an indicator male, she is ripe. She is then removed from the water. The sutures are cut. By massaging her flanks from front to back, her eggs are released.

Teaching Plan:

Module: Carp - Section E

Problem Area: Describing Larvae Hatchery Operations

Goal: The goal of this problem area is to demonstrate knowledge of the larvae hatchery operations.

Learning Objectives: Upon completing the problem area, students will be able to:

describe the phases of rearing larvae
describe how to remove larvae from the incubation jar
describe how to complete the hatching process
explain how to do exogenous feeding
explain how to transport larvae and early fry

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

Essential:

Common Carp 1: Mass Production of Eggs & Early Fry, Food and Agriculture Organization of the United Nations, FAO Training Series, Rome, 1985.

Accompanying film strip, projector, and screen.

Content and Procedures

Preparation (Interest Approach):

To develop student interest in this module, ask the students if they have ever hatched out any chicken or duck eggs. Discuss the process and the care of baby chicks. Compare the raising of fish larvae at a hatchery to that of bird raising.

Presentation:

A. What is the traditional method (labor intensive) for raising larvae?

Show TM E1 and lead a discussion about the removal of larvae from hatching jars.

1. Removal of larvae from incubation jars.
   a. As soon as the eggs begin to hatch and some become free-swimming larvae.
   b. Eggs are siphoned in a plastic bowl and gently transferred to the bottom of the bowl.

2. Complete hatching process.

Show TM E2 and discuss how to complete the hatching process.

   a. Leave larvae in bowls for maximum of 10 minutes.
   b. Reduction in dissolved oxygen causes larvae to leave eggs.
   c. Leaving too long endangers larvae.

3. Larval rearing jars.

Show TM E3 and describe a hatching jar.

   a. Similar to Zug jars.
   b. Larger 200-l jars.
   c. Water flow vertical, rather than spiral.
   d. Cover with a filtering ring of 0.2 mm mesh. Need to clean regularly.
   e. Density: approximately 500,000 per 200 l of water. Produces about 5 each of 7-l jars.

B. What is the modern method (management intensive) of raising larvae?

1. Water management.
   a. Keep level low enough so that eggs will not be flushed over the edge of top.
   b. Need sufficient water to carry away the egg shells and egg contents.

c. Newly hatched fry will sink (or swim) to the bottom at this stage. Do not cover the container at this point because the egg shells will be retained and cause difficulties later.

2. Eggs should all hatch in approximately 10 hours. After this, and when all egg shells are gone, water flow can be reduced.

3. Position a box covered with Saran Wrap. Cloth can be positioned in front of the side drain to keep the fry from escaping when they start to "swim up." The box should be sufficiently large so that the surface area is adequate to dissipate the flow.

C. What are the phases of larval rearing?

Show TM E4 and discuss the phases of larval rearing.

1. Cycle lasts 4 days.
2. First 1.5 days larvae attach themselves to wall surface.
3. Next 1.5 days they assume horizontal positioning, but move to surface to fill their air bladders.
4. Final stage: Once they are swimming horizontally, larvae are able to eat exogenous food. These are called early fry.

D. What is exogenous feeding?

Show TM E5 and discuss exogenous feeding.

1. First feeding is of hard-boiled eggs.
   a. Mix three eggs with 0.5 l of water.
   b. Feed 5-6 tablespoons of mixture every 2-3 hours.

2. Can also keep yolk intact and the rub it to break off the small particles directly into the water.

3. Switch to plankton-rich ponds after 1.5 days. Be careful zooplankton are not so large that they eat the larvae.

4. Fish meal formulated for striped bass or red fish can also be used.

E. How are larvae transported?

Show TM E6 and discuss transportation of larvae.

1. For long-distance journeys, use plastics bags of 4-6 mil.
   a. Inject water with O_2, possibly with bacteriostatic.
   b. Stock very early in the morning or late in the evening.
2. For short distance, use fiberglass tanks.

Review:

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

Evaluation:

Evaluation should focus on the extent to which students achieved the objectives of the problem area. Examples include class participation, quizzes, and an exam. Example exam questions are attached.

TM E1

Removing Larvae From Jar

When eggs begin to hatch, gently siphon eggs into a plastic bowl.

TM E2

Hatching Process

- Leave larvae in bowl for 10 minutes.
- The reduction in dissolved oxygen causes larvae to leave eggs.
- Leaving in water too long endangers larvae.

TM E3

Hatching Jars

- Similar to Zug jars, but larger, 200 l
- Water flow is vertical, rather than spiral
- Need to clean regularly
- Density about 500,000 per 200 l of water

TM E4

Phases of Larval Rearing

- Cycle lasts for 4 days.
- First 1.5 days larvae attach themselves to the wall surface.
- Next 1.5 days larvae assume horizontal positioning in jar but move to the surface to fill their air bladders.
- Final day as soon as larvae can swim horizontally, they are able to eat exogenous food.
- They are now called early fry.

TM E5

Exogenous Feeding

First feeding is of hard-boiled eggs.

Switch to plankton-rich ponds after 1.5 days.

TM E6

Transportation of Larvae

For short distances, use fiberglass tanks.

For long distances, use plastic bags.

Quiz for Section E

Name:

Date:

Circle a True for True statements or an F for False statements.

1	T	F	Transfer eggs from the incubation jar to a plastic bowl as soon as they begin to hatch.
2.	T	F	Raising the available oxygen causes the larvae to leave the egg.
3.	T	F	Exogenous feeding begins during the first 1.5 days of the rearing cycle.
4.	T	F	When the larvae are swimming horizontally, they are said to have entered t he early fry stage.
5.	T	F	Ground grain meals are good examples of food for first feeding.
6.	T	F	In transporting larvae, use fiberglass tanks for short distances and plastic bags for long distances.

Key for Quiz - Section E

1. T

2. F Reducing the available oxygen causes the larvae to leave the egg.

3. F Exogeneous feeding begins during the final stage of the rearing cycle.

4. T

5. F Hard-boiled eggs are good examples of food for first feeding.

6. T

Teaching Plan:

Module: Carp - Section F

Problem Area: Producing Juvenile Carp in Earthen Ponds

Goal: The goal of this problem area is produce juvenile carp in earthen ponds.

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

identify the environmental factors affecting juvenile production
describe the biological production cycle of juveniles
explain the techniques for the production of advanced fry
explain the methods used in harvesting advanced fry
describe the various means of transporting advanced fry

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

Essential:

Common Carp 2**,** Food and Agriculture Organization of the United Nations, FAO Training Series, Rome, 1985.

Aquarium, filters, light, etc.

Additional:

Aquatic Project Wild, Western Regional Environmental Education Council, Project Wild, Boulder, CO.

Content and Procedures

Preparation (Interest Approach):

To develop student interest in this module, set up an aquarium. Contact your local pet store, and get some newly hatched fish. Experiment with different temperatures and amounts of light. Observe how the fish react to different environmental conditions. Apply this information to the hatchery business.

Presentation:

A. What are the environmental factors needed to produce juvenile carp?

Show TM F1 and discuss environmental factors affecting growth of juveniles.

1. Water temperature for good growth of at least 18°C.
2. Quality and availability of natural food such as rotifers.
3. DO of 5-8 mg/l.
4. Predators/competition.
5. Weather conditions.

B. What is the biological production cycle of juveniles?

Show TM F2 and explain biological production cycle of juvenile carp.

1. Elements that contribute to the productivity of a pond.
   a. Nutrients from soil.
   b. Bacterial activity.
   c. Organic matter at the bottom.
   d. Oxygen from photosynthesis.
   e . CO_2 from animal respiration and the decay of plant products.

2. Beneficial organisms in the pond environment.
   a.. Phytoplankton: green algae.
   b. Zooplankton: Rotifers, small and large cladoceres become important as fry grow. Juvenile codepods, mosquito and chironomid larvae become important as fry grow larger.

3. Organisms that are often detrimental to growth of juveniles.
   a. Phytoplankton: blue green algae and flagellates.
   b. Zooplankton: adult codepods.
   c. Insect larvae.
   d. Small crustaceans.
   e. Vertebrate predators: frogs, snakes, fish, and birds.

C. What are the techniques for the production of advanced fry?

Show TM F3 and discuss the production of advanced fry.

1. Time frame about 21-30 days to grow to 3 cm.

2. Environmental factors.
   a. Water temperature at least 18°C.
   b. Quality and availability of natural food.
   c. DO at 5-8 mg/l.
   d. Control of predators/competitors.
   e. Weather conditions.

3 Fry rearing ponds.

Show TM F4 and discuss fry rearing ponds.

   a. Physical factors: size 0.01 to 1 ha x 1 m deep. Good water supply. Well-constructed outlet.
   b. Seasonal preparation. The practical method is to drain the pond and dry as much as possible considering the weather. Vegetation will usually die if pond is drained and if left will supply nutrients. Poison out-holes and treat damp areas with about 500 kg hydrated lime.
   c. Avoid quick lime (CaO) because it is very corrosive. NOTE: It is essential to add a pre-emergent herbicide to control the rooted vegetation.
   d. Apply organic manure at 2 tonnes/ha. (NOTE: 1 tonne = 1,000 kg).
   e. Other organics are also appropriate, such as rice bran, oil seed, protein meal, hay, and vegetation.
   f. Fill pond half way with water.
   g. Add inorganic fertilizer to stimulate growth of microorganisms at 20 kg N/ha.and 30 kg/ha as P_2O_5 in a soluble form.
   h. Check zooplankton regularly. There should be no cladocere for 5 days.
   i. When rotifer population is high, approximately 4-5 days after filling pond, add early fry.

4. Stocking fry.
   a. Fill pond with water which is screened through mesh or sand, etc.
   b. Check temperature. It is essential to stock fry in early morning or late evening.
   c. Stocking rate is 200-600 ind./m^2.

5. Feeding phases.
   a. For the first 10 days, fry feed on rotifers.
   b. During second 10 days they feed on small cladoceres and codepods begin to grow and furnish food. Zooplankton are added at about 12 days after chemical treatment.
   c. Third period fry feed on cladoceres and codepods. Must add artificial foods: soy meal, wheat meal, fish meal, and blood meal.
   d. It is important to add formulated diets and other ingredients to the daily food regime from the beginning because they provide food for the organisms and to acquaint the growing fish to the feeding sites and procedures.

6. Healthy fry:
   a. Deep, plump body.
   b. Yellow belly.
   c. Greyish green back.
   d. Bright, shiny tail.
   e. Rapid tail movement.
   f. Size: length about 3 cm. Live weight about 300 mg after 4 weeks.
   g. At the end of month, fish are called advanced fry.

C. How are advanced fry harvested?

Show TM F5 and discuss harvesting advanced fry.

1. With the pond still filled, add feed at the pond corners to "bait in" the advanced fry so that they can be seined. This can be continued until the number caught is insufficient for the work required.
2. Lower water level to half full and net out rest of fish.

D. How are advanced fry transported and how is the fish population estimated?

Show TM F6 and discuss estimating numbers of advanced fry. Using beans, for example, have the class practice estimating populations.

1. Based on volume:
   a. Count the number of fish that will displace a volume of water, i.e., 100 cc.
   b. Add fish in a volumetric cylinder or partly water filled bucket marked in liters.
   c. From the 100-cc subsample, calculate number of fish per liter, etc.

2. Based on weight:
   a. Count the number of fish per 100 g or other subweight.
   b. Put fish into partly water filled tared bucket.

3. Treat fry with salt bath to control ectoparasites using a 2-3% salt solution. Return to well-aerated water.

4. Stock in bags for transportation.
   a. It is up to the users to work out a system suitable for their program.
   b. Things to consider include aeration, gaseous O_2 added, agitators, and ice.

TM F1

Environmental Factors

- Water temperature of at least 18° C for good growth
- Availability of natural food
- DO of 5-8 mg/l

TM F2

Biological Production Cycle

A. Elements Contributing to the Productivity of a Pond
   1. Nutrients from soil.
   2. Bacterial activity.
   3. Organic matter at the bottom.
   4. Oxygen from absorption at the surface and from photosynthesis.
   5. CO_2 from animal respiration.

B. Beneficial Organisms in the Pond Environment
   1. Phytoplankton: green algae.
   2. Zooplankton: Rotifers, small and large cladoceres become important as fry grow. Juvenile codepods, mosquito and chironomid larvae are important as fry grow larger.

C. Organisms That Are Detrimental to Growth of Juveniles
   1. Phytoplankton: blue-green algae and flagellates.
   2. Zooplankton: adult codepods
   3. Insect larvae
   4. Small crustaceans
   5. Vertebrate predators: frogs and snakes

TM F3

Production of Advanced Fry

A. Takes 21-30 Days to Grow 3 cm

B. Environmental Factors:
   1. Water temperature at least 18°C
   2. Availability of natural food
   3. Available dissolved oxygen at 5-8 mg/l
   4. Control of predators/competitors
   5. Weather conditions

TM F4

Fry Rearing Ponds

- Size about 1 ha x 1 m deep
- Need good water inlet and outlet
- Seasonal Preparation
- Drain pond and dry out
- Poison out holes and treat damp areas with about 500 kg hydrated lime. NOTE: May need to add a pre-emergent herbicide.
- Apply organic manure at 2 tonnes/ha
- Fill pond half way with water
- Add inorganic fertilizer to stimulate growth of microorganisms
- Check zooplankton regularly
- When rotifer population is high, add early fry

TM F5

Harvesting Advanced Fry

- Lower water level to half full.
- Net out most of the fish.
- Continue to drain with mesh over drain.

TM F6

Estimating Fish Population

- Estimate based on volume
- Fill a small, calibrated measuring device and count fish one at a time
- Figure out how many of the small measures fit into a larger one
- Count the number of large strainers of fish in the unit of harvest

Quiz for Section F

Name:

Date:

Quiz on Producing Juvenile Carp in Earthen Ponds

Write a paragraph describing the biological reproduction cycle of juvenile Carp.

Key for Quiz - Section F

The biological production cycle of ponds can be broken into 3 parts: First, there are elements that contribute to the productivity of a pond, which include nutrients from soil erosion, bacterial activity, organic matter at the bottom, and oxygen from absorption at the surface and from photosynthesis. Second, there are organisms that are beneficial to the pond's environment, such as the phytoplankton green algae and the following zooplankton: rotifers, small caldoceres, codepods, and mosquito larvae. Third, there are organisms that are detrimental to the pond's environment: the phytoplanktons blue-green algae and flagellates and the following zooplankton: adult codepods, insect larvae, small crustaceans, and vertebrate predators such as frogs, snakes, other fish, and birds.

Teaching Plan:

Module: Carp - Section G

Problem Area: Producing Carp Fingerlings

Goal: The goal of this problem area is to produce Carp fingerlings.

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

describe optimum environmental factors for producing fingerlings
describe ponds for raising fingerlings
explain management factors in running a fingerling pond
explain feeding characteristics in raising fingerlings
describe harvesting procedures for fingerlings
explain procedures for sorting fingerlings.

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

Essential:

Common Carp 2**,** Food and Agriculture Organization of the United Nations, FAO Training Series, Rome, 1985.

Aquarium, filter, lights, heater, etc.

Content and Procedures

Preparation (Interest Approach):

To develop student interest in this module, continue to experiment with the aquarium. Try different environmental factors and feedings. Ask the students if they have raised pets or livestock at home. Ask them to compare the kinds of food the animals eat when they are young to what they eat when they get older. Examine how this relates to the different stages of Carp growth.

Presentation:

A. What is the objective of second growing?

1. To grow advanced fry to fingerling size of 10-40 g.
2. In temperate climates, lasts 3-4 months.

B. What environmental factors affect fingerling production?

Show TM G1 and lead a discussion about the effect of environmental factors on fingerling production.

1. Temperature range best at 20-30° C.
2. DO of 5-8 mg/l.
3. Control of predators/competition.
4. Need for artificial food.
5. Weather conditions.

C. How should fingerling ponds be operated?

Show TM G2. Divide class into 4 groups dealing with various phases of management: pond, feeding, overall operations, and harvesting and sorting and ask them to develop a management plan pertinent to each topic.

1. Size.
   a. Area of 1 to 5 ha.
   b. Depth of 1 to 1.5 m.

2. Management.
   a. Keep filled with water in winter to retard levee erosion and loss of nutrients from precipitation.
   b. Drain in late winter, repair, clean, and cut vegetation on banks.

3. Spring preparation for filling.
   a. Parts of bottom are treated with hydrated lime 150-250 kg/ha.
   b. Spread manure over entire bottom at rate of 200-300 kg/ha.

c. Shallow till bottom.
d. Protect pond sides.
e. Seal pond outlet.

4. Fill pond with filtered water.

5. Add inorganic fertilizer.
   a. Superphosphate at 50 kg/ha. initially and 50 kg at 1 month.
   b. Ammonium nitrate at 40 kg/ha. initially with subsequent applications 2 and 4 weeks later.

D. How are fish added?

Stock at 50,000 to 100,000 individuals per ha. Small productive ponds stocked at higher rate.

E. What are the feeding characteristics of Carp?

Show TM G3 and use this information to develop a management plan for raising fingerlings.

1. Feeding changes as fish grow older.

2. Use of artificial feeding stops when temperature goes below 12°C, as Carp stop feeding at 7°C.
   a. Large zooplankton, especially chiropoids, and bottom fauna are important for first month.
   b. After first month, artificial food becomes most important.
   c. In third month, artificial food should be reduced. Fish should now be consuming food in low density ponds about half natural food and half artificial food; and in high-density ponds about one-third natural food, one-third ground grains, and one-third balanced protein.

3. Distribution.
   a. Delivered from boat.
   b. Use between 5 and 7 feeding stations per ha.

4. Checking on consumption. Checks are made 2-3 hours after feeding. If a lot of food is still present in the water, rations should be reduced.

F. How should water be managed?

Show TM G4 and discuss water management for large fry.

Pond is fertilized every 2 weeks. 20-40 kg/ha each of superphosphate and ammonium nitrate are added to surface of pond.

G. How can you determine what the fish are eating?

1. Press a sample fish between you thumb and forefinger to obtain some intestinal content. Digested natural food will be dark. Digested artificial food will be light.
2. When the majority of the digested food is light colored, it indicates that the fish have changed to a diet of artificial food.
3. When this happens, some high protein pellets should be added to the ration.

H. How can healthy fish be distinguished?

Show TM G5 and discuss how to distinguish healthy fish.

1. Healthy fish have plump bodies, deep yellow bellies, grayish green backs, and bright, shiny tails.
2. Poor quality fish have slender, bigheaded bodies; yellow bellies; dark backs; and dull tails.

I. How are fingerlings harvested?

1. Use large seine net 20-30 m long x 2.5 m high.
2. Do work early in the morning.

J. How are fingerlings sorted?

Show TM G6 and use information for developing a sorting plan.

1. After the fish have been harvested, they are sorted.
2. First, the fish are put on the tables.
3. The tables have several opening on the sides. Under each opening is a container.
4. The sorters sort the live fish into the different containers according to size. NOTE: It is important to work as fast as possible, so as to get the fish back into clean water before they die.
5. The sorted fish are transported to 1 of 2 ponds:
   a. Storage ponds, where they will be sold-off farm or kept for overwintering.
   b. Grow out ponds, where they will be raised to a marketable size.
6. During transportation the fish are chemically treated for ectoparasites.

K. What does the advanced fingerling stage look like?

Show TM G7 and discuss appearance of the advanced fingerling.

1. Size:
   a. Length 8-12 cm.
   b. Weight 10-40 g.
2. Survival rate should be about 80%.
3. Good yield is 2 tonnes/ha.

Review:

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

Evaluation:

Evaluation should focus on the extent to which students achieved the objectives of the problem area. Examples include class participation, quizzes, and an exam. Example exam questions are attached.

TM G1

Environmental Factors Affecting Fingerlings

- Water temperature
- Available dissolved oxygen
- Control of predators/competition
- Need for artificial food
- Weather conditions

TM G2

Fingerling Ponds

A. Size:
   1. 1- to 5 ha
   2. Depth 1 to 1.5 m

B. Management
   1. Keep filled with water in winter to retard levee erosion and loss of nutrients from precipitation
   2. Drain in late winter
      a. repair
      b. clean
      c. cut vegetation on banks
   3. Spring preparation for filling
      a. Wet parts of bottom are treated with hydrated lime
      b. Spread manure over entire bottom at rate of 200-300 kg/ha
      c. Shallow till bottom
      d. Protect pond sides
      e. Seal pond outlet
   4. Fill pond with filtered water

TM G3

Feeding

Feeding changes as fish grow older. First month, large zooplankton are important. Second month, artificial food becomes important.
Third month, artificial food should be reduced.

Deliver from a boat or banks. Check on consumption 2-3 hours after feeding.

Feed Schedule:

Water Temperature (°)	Feed Offered (%)	Frequency
25-20	2	daily
20-15	1	daily
15-10	1	alternate days
10-5	0.5	alternate days

TM G4

Water Management

Pond is fertilized every 2 weeks with liquid pig manure, superphosphate and ammonium nitrate.

Determining what fish are eating:

Press fish between thumb and forefinger.

Digested natural food will be dark.

Digested artificial food will be light.

TM G5

Distinguishing Healthy Fish

Healthy Fish Have:

Plump bodies
Deep yellow bellies
Grayish green backs
Bright shiney tails

Poor Quality Fish Have:

Slender bodies
Yellow bodies
Dark backs
Dull tail

TM G6

Sorting the Fingerlings

- Sort fish into different containers according to size.

- Sorted fish are transported to storage ponds for sale off farm or to be overwintered or to grow out ponds raised to a marketable size

TM G7

Advancement to Fingerling Stage

- Size: Length 8-12 cm. Weight 10-40 g.
- Survival rate should be about 80%.
- Good yield is 1-2 tonnes/ha.

Quiz for Section G

Name:

Date:

Quiz on Producing Carp Fingerlings

Complete the following statements by filling in the blanks.

1. Name 4 of the 5 environmental factors that affect the well-being of fingerlings.
   _____, _____, _____, and _____.

2. Artificial food should be added to the diet after the _____month.

3. Artificial food should be reduced after _____months.

4. Every 2 weeks, fertilizer should be added in the form of _____.

Key for Quiz - Section G

1. We discussed five environmental factors that affect the well-being of fingerlings. Name four of them.

   Warm water best. DO of 5-8 mg/l. Control of predators. Weather conditions. Need artificial food.

2. Artificial food should be added to the diet after the 1st month.

3. Artificial food should be reduced after 3 months.

4. Every 2 weeks, fertilizer should be added in 2 forms: superphosphate and ammonium nitrate

Teaching Plan:

Module: Carp - Section H

Problem Area: Identifying and Treating Health Problems of Carp

Goal: The goal of this problem area is to identify and treat the common health problems of Carp.

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

describe health problems that arise in fingerling ponds
explain diseases that affect Carp.

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

Essential:

Common Carp, Food and Agricultural Organization of the United Nations, FAO Publications, Rome, 1985.

Content and Procedures

Preparation (Interest Approach):

To develop student interest in this module, ask the students what animals they have in their homes or on their farms. List some of the various animals on the board. At one end of the board, add Carp to the list. Then ask students to identify the kinds of health problems that arise with these animals. Next, list some treatments that are used for the animals. Within the context of caring for animals, introduce the need to take care of the health needs of Carp in an aquacultural setting.

Presentation:

A. What are the problems in fingerling ponds?

Show TM H1 and describe the symptoms and treatments of Ich. Show TM H2 and describe other monocellular ectoparasites and their treatment.

1. Monocellular ectoparasites.
   a. Ich: *Ichthyophthirius multifilis* called white spot disease. Treat with formalin at 25 ppm in ponds. DO (dissolved oxygen) problems may arise.
   b. *Trichodina:* Found on the fins.
   c. *Costia*: Found on the gills.
   d. *Chilodonella*: Found on both the fins and the gills. Treat these three with copper sulfate at 1 ppm for each 100 ppm alkalinity.

2. Other ectoparasites

Show TM H3 and describe the non-monocellular ectoparasites.

1. *Argulus foliaceus*
2. *Lernaea cyprinacea*
3. *Ergasilus sieboldi*
4. *Dactylogyrus vastator*
5. *Piscicola geometra*
6. Treatment for these is use of an agricultural insecticide that is legal for use on food fish. NOTE: As mentioned earlier, the use of chemicals is banned from use on food fish. Contact state authorities to determine what is usable in your locale.

B. What diseases do Carp get?

Show TM H4 and describe the fish diseases that trouble Carp and the treatments for these problems.

1. Gill rot and gill necrosis.
   a. Caused by fungus and bacteria.
   b. Use potassium permanganate at 2-3 ppm.
   c. Use medicated feeds (containing antibiotics).

2. Gill infection and fin rot. These are bacterial diseases; therefore treat with potassium permanganate or antibiotics.

Review:

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

Evaluation:

Evaluation should focus on the extent to which students achieved the objectives of the problem area. Examples include class participation, quizzes, and an exam. Example exam questions are attached.

Ich - *Ichthyophthirius multifilis*

Called white spot disease

Treat with formalin

TM H2

Other Monocellular Ectoparasites

- *Trichodina* - found on the fins
- *Costia* - found on the gills
- *Chilodonella* - found on both the fins and the gills
- Treat these three with copper sulfate.

Non-Monocellular Ectoparasites

- *Argulus foliaceus*
- *Lernaea cyprinacea*
- *Ergasilus sieboldi*
- *Dactylogyrus vastator*
- *Piscicola geometra*

TM H4

Fish Diseases

- Gill rot and gill necrosis caused by fungus and bacteria.
- Gill infection and fin rot caused by bacteria.
- Treat with potassium permanganate and/or antibiotics.
- Increase water supply.

Quiz for Section H

Name

Date:

Quiz for Identifying and Treating Health Problems of Carp

Fill in the blank to complete the following statements.

1. Another name for the monocellular ectoparastic disease, Ich, is _____ disease.

2. A good treatment for Ich is _____.

3. *Trichodina* is another monocellular ecotoparasite which affects the Carp's_____.

4. *Costia* affects the Carp's _____.

5. Diseases of the gills are caused by _____and _____.

Key for Quiz - Section H

1. Another name for the monocellular ectoparasitic disease, Ich, is **white spot d**isease.
2. A good treatment for Ich is **formalin**.
3. *Trichodina* is another monocellular ecotoparasite which affects the Carp's **fins**.
4. *Costia* affects the Carp's **gills**.
5. Diseases of the gills are caused by **fungus** and **bacteria**.