

# Walleye

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## AQUACULTURE CURRICULUM GUIDE

### YEAR TWO SPECIES MODULE

This is a project of the National Council for Agricultural Education, Alexandria, Virginia  
with a grant from  
United States Department of Agriculture

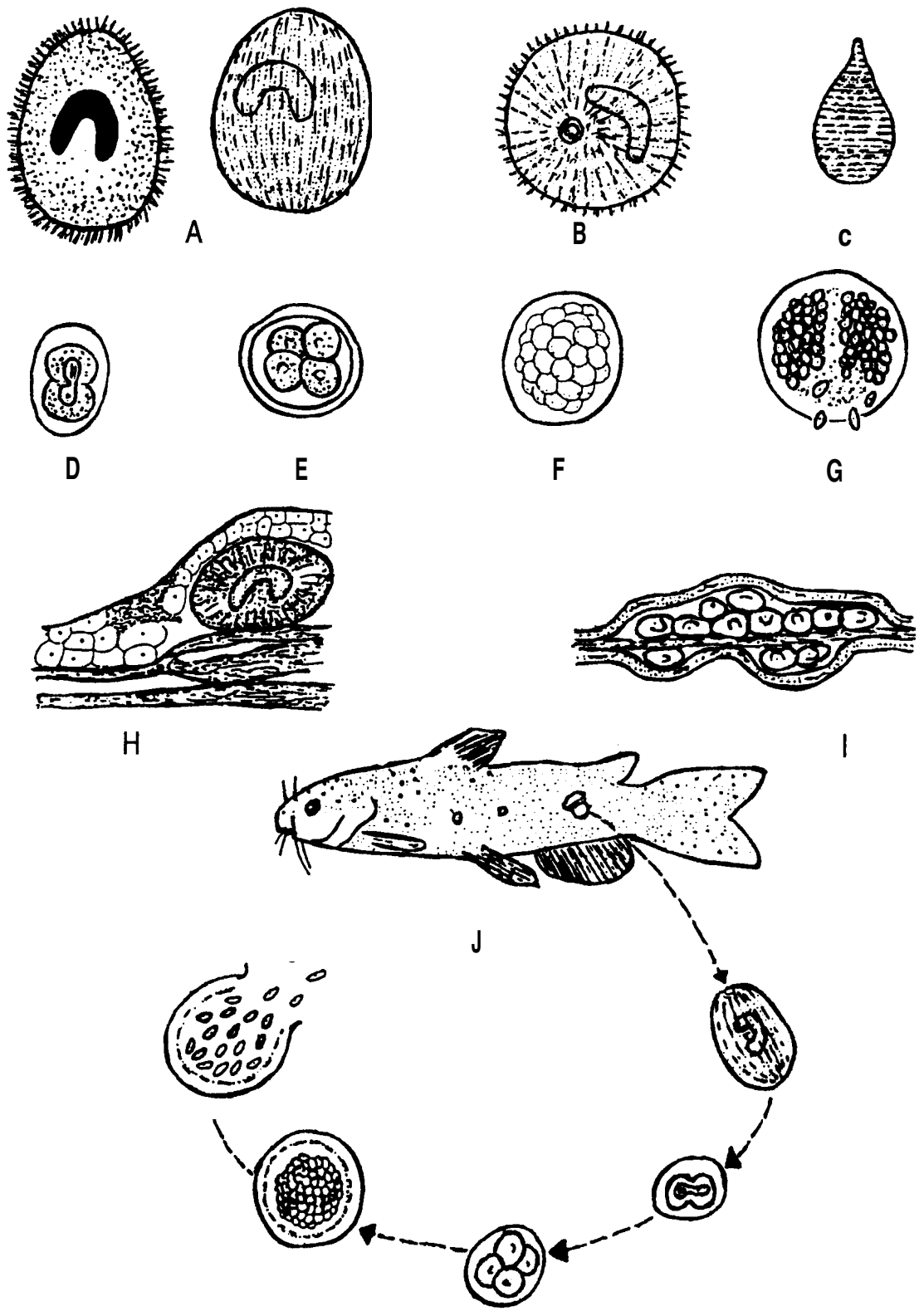
1995 Preliminary Edition

Send all comments to:  
W. Wade Miller  
201 Curtiss Hall  
Department of Agricultural Education and Studies  
Iowa State University  
Ames, Iowa 50011-1050

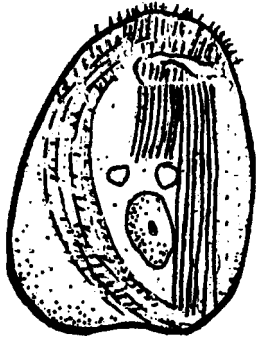
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# Life Cycle of Ich



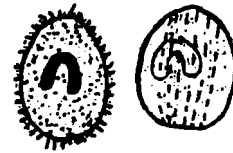
# Parasites



Chilodonella



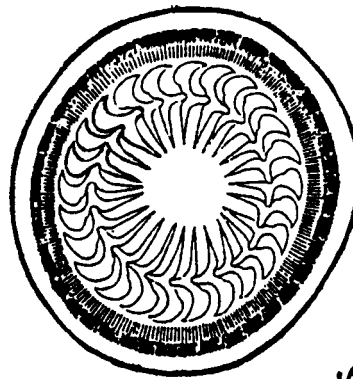
Trichophyra



Ichthyophthirius



Epistylis



Trichodina



Ambiphyra



# Walleye

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

Module: Walleye

Problem areas: Exploring Opportunities in Walleye Culture  
Producing Walleye  
Hatching and Rearing Walleye  
Raising Walleye to Food Size  
Feeding Walleye  
Controlling Pests and Diseases  
Marketing Walleye

Objectives:

A Exploring Opportunities in Walleye Culture

- Explain why walleye culture developed
- Determine how profitable walleye culture is
- Determine the risks in walleye culture
- Determine legal restrictions of walleye culture

B. Producing Walleye

- Explain the walleye life cycle
- Identify the walleye culture techniques
- Identify the biological requirements of walleye

C. Hatching and Rearing Walleye

- Describe the spawning techniques for walleye
- Explain the incubation techniques of walleye eggs
- Describe the fry culture techniques of walleye
- Identify the methods of fingerling harvest and grading
- Describe the techniques involved in training walleye fingerlings to eat artificial feeds
- Calculate the number of fry or fingerlings on hand
- Discuss the specific hauling requirements of walleye fingerlings

D. Raising Walleye to Food Size

- Identify the aspects of raising or obtaining fingerlings
- Predict the quantity of fingerlings needed
- Identify the culture facilities used for walleye production
- Describe the culture techniques of food size walleye
- Identify the routine management techniques involved in walleye culture
- Identify the parts of the walleye industry which must be improved

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### E. Feeding Walleye

- Describe the types of walleye feed available
- Identify the nutritional requirements of walleye
- Identify the feeding schedule required by walleye
- Identify the different feeding methods
- Explain what is meant by “food conversion rates”

### E Controlling Pests and Diseases

- Discuss the types of walleye diseases
- Identify a disease problem
- Discuss the prevention and treatment of walleye diseases
- Identify the different methods of pest control

### G. Marketing Walleye

- Identify the harvesting techniques
- Identify the hauling equipment and technique
- Discuss the techniques of walleye processing

Teaching Plan:

Module: Walleye - Section A

Problem Area: Opportunities in Walleye Culture

Goal: The goal of this problem area is to introduce the walleye's life cycle and to identify the water requirements for walleye culture.

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

- explain why walleye culture developed
- determine how profitable walleye culture is
- determine the risks in walleye culture
- determine legal restrictions of walleye culture

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

Essential

Transparencies,

Additional:

Walleye Culture Manual, by Richard, P.D. & J. Hynes, Ontario Ministry of Natural Resources, 1986.

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## Content and Procedures

Preparation (Interest Approach):

To develop student interest in this module, ask them to guess why a particular fish may become popular. Then ask what problems are involved in raising such a fish.

Presentation:

A. What are the 5 reasons that walleye culture has developed?

Use TMA1 or the chalk board to discuss the reasons for producing walleye

1. People are eating more fish.
2. Walleye is already established as one of the "select" fish products.
3. Fresh walleye is an attractive alternative to the normal available fresh fish.
4. Walleyes grow in the water that is too warm for trout but is not warm enough for catfish or tilapia to grow well
5. Fingerling production was begun to enhance sport fishing, but interest has slowly developed for producing food size fish.

B. How profitable is Walleye Culture?

Use the TM A2 and demand and discuss how the price of walleye may fluctuate both seasonally and year to year.

1. Currently the technology of walleye fingerling culture makes the economics of culturing food size walleye look a little bleak. Not only are feed-trained fingerlings nearly impossible to purchase, but when you do find them, the price is likely to nearly exceed the value of a food size fish.
2. Current retail selling price for walleye fillets ranges from \$4.50 to \$7.00 per lb.
3. If you are producing fish at the highest estimated cost and receiving the lower price, you will be losing money, but if you can produce the fish for the lower cost and demand the higher price, then walleye production can be a fruitful venture.

C. What risks are involved in walleye culture?

Lead a discussion on the risks of any agricultural industry, and especially mention the need for caution with fish due to their fragile environment

1. Financial loss due to catastrophe.
2. Some economic forecasters believe that Canadian wild caught walleye currently comprise almost all of the walleye market, and with increased commercial fishing in Canada the price of walleye could be reduced. Others claim that this is not likely to be allowed. Also, it is not likely to be sustained for any length of time.
3. If poor management decisions are made, the cost of raising the fish may exceed their marketable value.
4. The impact of possible nearby agricultural runoffs,
5. Environmental impacts.

D. Is walleye culture legal in your area?

Call or write to your state fisheries biologist/department of agriculture, and inquire about the legality of walleye culture in your area.

Many states may require a special permit for farmers to possess or sell farm raised walleye.

### 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 the students to explain the content that goes with each objective.

### Evaluation:

Evaluation will be based on class participation, quizzes and a final examination. Example exam questions are attached.

## **Reasons for Raising Walleye**

- People are eating more fish.
- Walleye is already established as one of the “select’ fish products.
- Fresh walleye is an attractive alternative to the normal available fresh fish.
- Walleyes grow best in water that is too warm for trout but not warm enough for catfish or tilapia to grow well.
- Fingerling production was begun to enhance sport fishing, but interest has slowly developed for producing food size fish.

## Example of the Economics of Raising Walleye

- Assumption: No mortality
- Purchase 1,000 trained fry =\$1 ,000
- Weight of shipment= 300/lbs  
Weight/fish = .33 lb
- With a growth rate of 5-7 mm/wk, at constant temperature of about 65°F, you can expect the fish to be 1 lb, or 13“, in 12 months or so; therefore, you need a recirculation system or heated effluent to maintain temperature.
- After growing, you have 1,000 lbs of fish. Assume walleye conversion of 2.2. Therefore, you will need about 2,200 lbs of food.
- Cost of food is \$0.35/lb =\$770.00 in food.  
Therefore, food and seedstock are \$1800.
- Then you sell your 1,000 fish as fillets or in the round. If fillets, expect about 2/3-1/2 waste; therefore, 1/3-1/2 of weight is saleable or 333-500 lbs @ \$5.00/lb= \$1,600-2,500.  
Therefore, at lower price, you lose money. At higher price, you make \$700.00, or 39%.
- From there you go on with amortization, labor, etc.

Quiz for Section A

Name:

Date:

Quiz on Opportunities in Walleye Culture

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

1.     T     F     Canadian wild caught walleye make up the majority of all walleye fillets sold today.
2.     T     F     Most walleye fillets sell for \$2.00 to \$3.00 per lb.
3.     T     F     The market value of walleye should drop in the winter.
4.     T     F     Walleye wild catch has declined rapidly since 1979,
5.     List the main reasons for the development of food size walleye production.

6.     Describe a situation where a walleye producer would lose money on a production venture.

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### Key for Quiz - Section A

1. F
2. F
3. F
4. F
  
5. People eat more fish, it's a 'select" product, nice alternative to regular fish, grown readily
  
6. Poor management decisions, trauma to environment, cost exceeding market value.

Teaching Plan:

Module: Walleye - Section B

Problem Area: Producing Walleye

Goal: The goal of this problem area is to introduce the walleye's life cycle and to identify the water requirements for walleye culture.

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

- explain the walleye life cycle
- identify the walleye culture techniques
- identify the biological requirements of walleye

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

Essential:

Transparencies. Water quality test kit.

Additional:

Walleye Culture Manual, by Richard, P.D. & J. Hynes, Ontario Ministry of Natural Resources, 1986.

# Aquaculture Curriculum Guide

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## Content and Procedures

### Preparation (Interest Approach)

Ask the students to recall the various fish production systems from the first part of the course. Discuss those systems, and speculate on which might be appropriate for walleye.

### Presentation:

#### A Describe the walleye.

1. The walleye (*Stizostedion vitreum vitreum*) are native to much of the United States.
2. Record growth over 25 be in nature.
3. Have been introduced into many reservoirs, rivers, and lakes in North America as a sportfish.
4. Have been propagated by man for over 100 years.
5. Tasty, the Walleye are widely recognized as one of the best eating fresh water fish.

#### B. What are the stages of the walleye?

Lead a discussion of the life stages of the walleye. Could use a slide show with pictures of each life stage.

1. Egg.
  - a. Walleye eggs are 1.8 to 2.5 diameter, and readily stick to each other and to any object when they are freshly spawned.
  - b. A large female can produce over 50,000 eggs each season.
  - c. The time it takes the eggs to hatch is temperature dependent. They may takeover three weeks at 7°C as little a 10 days at 15°C.
2. Larvae.
  - a. The larvae of waleye are 5.5-7.5 mm long when they hatch. They begin feeding between the 5th and 10th day post-hatch and will starve by 14 days post-hatch if food is not available, unless the temperature is below 50°F
  - b. The larvae eat copepods and cladocerans, types of zooplankton (and brine shrimp and some formulated feeds when cultured intensively in the nursery) during the first few weeks following stocking. They also have a tendency to eat each other when less than 20 days old.
  - c. Larval walleye are phototactic meaning they swim towards light. This may facilitate inflation of the gas bladder as larvae must gulp air from the surface to inflate their gas bladder during their first week post-hatch.
3. Juvenile (fingering).
  - a. The juvenile stage is defined as the stage of life after the fish resembles the adult but prior to sexual maturity.
  - b. For walleye fingerlings to be stocked at high densities and cultured to food size, they must be trained to eat artificial feed. Research is being done on this very important aspect of walleye culture. The success of this research has been increasing rapidly.

4. Adult.
  - a. The walleye is a predator of other fish in the wild. This characteristic can cause problems to the producer when some of the fish are bigger than others in the population.
  - b. This size problem can be controlled if the fish are regularly graded to remove the excessively large ones which could become cannibals. Once a walleye is trained to eat artificial feed, it will continue to eat other fish if they are available and small enough.
  - c. Therefore, one of the keys to successful walleye culture is to keep similar sized fish together.

C. What are the specific requirements of the walleye?

Use TM B1 to identify the optimum water quality ranges of the walleye.

1. Temperature.
  - a. Spawning occurs when spring water temperatures rise to near 10°C and the day length increases.
  - b. Optimum temperature for growth is 22-25°C.
  - c. Growth slows to near zero below 12°C and above 29°C.
  - d. Walleye can survive temperatures between 1 and 33°C.
2. DO.
  - a. Optimum growth will occur if DO is kept above 5 ppm at all times.
  - b. Supplemental aeration is required when DO falls below 4 ppm, but the fish can survive short exposure to DO of 2 mg/l.
3. Ammonia,
  - a. Total Ammonia should be kept below 0.6 ppm for optimal health.
  - b. 0.5 ppm un-ionized ammonia will cause severe stress and may cause death.
4. pH. pH should be between 7 and 8.
5. Nitrite.
  - a. A nitrite concentration greater than 2 ppm may cause methemoglobin to form in the blood and reduce the fish's ability to respire, thereby causing stress and lost production.
  - b. A chloride to nitrite ratio of 6:1 should be maintained if possible.
6. Salinity. Adding 1-5 ppt salt (0.1 to 0.5%) to the water when handling and transporting the fish will help to reduce stress. In extremely soft water, >20 ppm CaCO<sub>3</sub>, the addition of salt may be harmful.
7. Alkalinity. Alkalinities of below 25 ppm are not desirable, because the buffering capacity (ability to prevent wide pH swings) is too low, and alkalinities of 150 ppm or more are best.
8. Hardness. Water hardness is best when above 25 ppm.
9. Nitrogen gas N<sub>2</sub>. Nitrogen gas supersaturation can cause gas bubble disease and should be kept below 102% of saturation.
10. CO<sub>2</sub>. Carbon dioxide concentrations should be held below saturation to prevent stress and gas bubble disease.

## ***Aquaculture Curriculum Guide***

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### Review:

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

### Evaluation:

Evaluation will be based on class participation, quizzes and a final examination. Example exam questions are attached.

## Water Quality Requirements of the Walleye

- Temperature:  
Optimum for growth 25°C  
Can survive 1 to 33°C  
Growth slows to near zero below 12 and above 29°C  
DO 5 ppm or higher
- Ammonia:  
Below 0.6 ppm TAN is optimal  
0.5 ppm un-ionized may cause severe stress or death
- pH between 7 and 8
- Nitrite:  
Keep below 2 ppm  
Maintain a 6:1 Cl to NO<sub>2</sub> ratio
- Alkalinity:  
Keep above 25 ppm  
Above 100 ppm best to prevent fluctuations in pi-l
- Hardness:  
Best above 25 ppm
- CO<sub>2</sub>:  
Must be kept below 110% of saturation

Quiz for Section B

Name

Date

Quiz on Producing Walleye

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

1.     T     F     Walleye can grow to over 25 lbs,
2.     T     F     Walleye spawn when the water temperature reaches 19%.
3.     T     F     The additiion of salt to transport water will help to reduce stress.
4.     T     F     Walleye are cannibalistic when only a few weeks old.
5.     T     F     Adult walleyes eat primarily invertebrates.
- 6-9.   List and describe the life stages of the walleye.

## ***Aquaculture Curriculum Guide***

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### **Key for Quiz- Section B**

1. T
2. F
3. T
4. T
5. F
  
6. Egg. 1.8-2.5 mm wide tick together; 50,000 produced. Hatch 3 weeks or 10 days, 7°C or 15%, respectively.
7. Larvae. Hatch are 5.7-7.5 mm long. Feed between 5th and 10th. Eat corepods cladocerans phototactic.
8. Juvenile (fingerling). Before sexual maturity Trained to eat artificial food.
9. Adult. Predator of other fish. Fish should be graded regularly.

Teaching Plan:

Module: Walleye - Section C

Problem Area: Hatching and Rearing Walleye

Goal: The goal of this problem area is to explain the techniques involved in hatching and rearing walleye.

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

- describe the spawning techniques for walleye
- explain the incubation techniques of walleye eggs
- describe the fry culture techniques of walleye
- identify the methods of fingerling harvest and grading
- describe the techniques involved in training walleye fingerlings to eat artificial feeds
- calculate the number of fry or fingerlings on hand
- discuss the specific hauling requirements of walleye fingerlings

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

Essential:

Transparencies.

Additional:

Walleye Culture Manual, by Richard P.D. & J. Hynes, Ontario Ministry of Natural Resources, 1986.

# ***Aquaculture Curriculum Guide***

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## Content and Procedures

Preparation (Interest Approach):

Compare the production of walleye fingerlings with the production of feeder pigs or calves.

Presentation:

A. What spawning techniques are used with walleye?

A slide show showing the spawning technique would be very informative.

1. Manual spawning.
  - a. Spawning usually begins within three weeks of iceout on northern lakes. Fish are captured and placed into a holding tank until personnel are ready to manage the spawn.
  - b. Female walleyes usually do not appear on spawning grounds until ovulation has begun.
  - c. As ovulation occurs, the eggs are stripped into a dry pan and sperm is added from the male. After the sperm is added, the gametes are stirred with a feather or with a finger to allow for complete mixing. Some producers add a 1% saline solution after mixing; others prefer to allow fertilization to occur without adding the saline. In this case a small amount of water should be added to activate the sperm.
  - d. Fertilization will be complete within five minutes.
  - e. After fertilization, walleye eggs must be specially treated with Fuller's earth, silt, clay, starch, sodium sulfite, or tannic acid to remove the adhesive quality of the egg shell. Stir with feather to "tease" clumps apart. Stir continually for 30 min.

B. How are the eggs incubated?

1. Water temperature is kept between 9-15%(11% is optimum) and the temperature is not allowed to fluctuate more than 2°C per day.
2. McDonald jars.
  - a. 2000-3000 ml (2.5-3 qt) of eggs are placed into each hatching jar.
  - b. Enough water is allowed to flow into the jar to keep the eggs rolling slowly but not so much that the eggs are pushed more than 25mm (1") up into the water column or agitated severely. Dead eggs (opaque) will work to top and can be siphoned off.
3. Hatching will occur in 10 days or less when the eggs are incubated at 15%, and may take up to 25 days at 9°C.
4. Fry screens are important, a 710.
5. Estimate numbers of eggs.
6. Collecting fry from holding tank,
7. Positive phototaxis.

c. How are fry transported?

Show TM C1 and have the class bag some small fish for transport. Guppies will work. If possible, leave the fish overnight to demonstrate the efficiency of this method.

1. Ship fry prior to feeding.
- 2, Fry are transported in 5 to 10 gallon clear plastic bags with 2-3 gallons of water.
3. Fry will live for up to 48 hours when bagged properly and insulated.
- 4, 25,000 fry per gallon is the maximum density when the fry will remain bagged for more than 12 hours,
5. Bagging technique,
  - a. Fry and water are placed in the bags and all air is replaced with pure oxygen.
  - b. The bag top is twisted and tightly sealed with strong rubber bands, plastic ties or elastrators.
  - c. The bags are placed into plastic foam boxes to keep the temperature from fluctuating.
  - d. If the pond water is warmer than the hatchery water, and the fry are to be transported for short distances, the bags can be placed into empty feed sacks to prevent puncture. This will also allow the water to warm slightly and reduce the tempering time of stocking.

D. What are the important aspects of pond culture?

Use TM C2 as a guide as you discuss the techniques involved in pond culture of walleye fry.

1. Pond preparation.
  - a. Drain pond.
  - b. Fill with clean water,
  - c. Inoculate the new pond water with plankton collected at other sites. The pond should be filled two to three weeks prior to stocking to allow the larger zooplankton populations to become established.
  - d. Just prior to introduction of fry, inoculate a second time to be sure that there are zooplankton less than 0.5 mm for the small fry to eat.
  - e. Fertilizing. Fertilization is needed to achieve the desired density of phytoplankton and zooplankton which is necessary for fry survival and growth. A combination of organic and chemical fertilizers will generally give the best results.
  - f. Organic fertilizers such as alfalfa pellets and cottonseed meal should be spread over the pond at rates of 150 to 300 lb/acre while the pond is being filled, and 50-100 lb/acre should be added a few days prior to stocking, and again each week after stocking until the fish are harvested.
  - g. Manure can be used as an organic fertilizer, but ammonia problems may arise,
  - h. Chemical fertilizers such as ammonium nitrate or phosphoric acid can be acquired from most farm suppliers in either liquid or granular form. The granular 0-46-0 mix can be dissolved during the pond filling process by placing 10-15 lb/acre in a mesh bag and tying it onto the inflow pipe. Two to three gallons per acre of liquid fertilizers such as 11-37-0 should be added two or three times per week prior to stocking and at least once each week following stocking until the fish are harvested.
  - i. Granular fertilizers may be substituted for the liquid, but they must be completely dissolved prior to application.

## Aquaculture Curriculum Guide

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Demonstrate this method of eliminating insects with a few drops of a diesel/oil mixture in a tank containing some air breathing aquatic insects such as waterboatmen or backswimmers.

- j. Inorganic fertilizer should not be applied to the pond any time within two days of stocking.
- k. Predacious insects must be controlled, applying 2-5 gallons of diesel mixed with 1 qt vegetable oil per acre will kill all air breathing insects in the pond. It is best to apply the diesel when a light breeze is blowing to help spread it over the entire surface of the pond. This procedure should be done 2-3 days prior to stocking and repeated for a couple of weeks following stocking.

### 2. Stocking.

- a. Stocking rates and food supply will determine growth and prediction of desired fingerling size for consumer demand and need.
- b. Stocking rates of 75,000 to 200,000 fry per acre are currently used by most producers.
- c. Fry should be stocked at 1 day post-hatch.
- d. The fry must be tempered to both temperature and pH before releasing into the pond. This is accomplished by first placing the bags containing the fry into the pond unopened and allowing them to sit for a short period. Check the temperature and pH in both the pond and the bags. If the temperature difference is less than 1% and the pH difference is less than 0.2 units, it is safe to release the fish. If the differences are greater, add 2 liters of pond water to the bags every 15 minutes until the differences are less than those stated above.

### 3. Sampling.

- a. Between 14 to 21 days after stocking a 1/16th inch mesh seine should be used to check for survival and fingerling size.
- b. Only a small portion of the pond need be seined and care should be taken as sometimes fish this young are difficult to see in the seine.
- c. Using a light at night is a good way to attract fish for first two weeks.

4. Harvest. The harvesting of walleye fingerlings is generally done 25 to 40 days after stocking. The fingerlings must then be graded and feed trained prior to continued culture.

### E. How are walleye fingerlings trained to artificial diets?

- 1. Current **technology** requires that the fingerlings be removed from the pond and trained in tanks.
- 2. The success rate has been slow, but progress is being made and trained fingerlings are now available on a limited basis. London, Ohio, fish hatchery has 90-95% survival on many replications.
- 3. Following a prolonged training period the fish can be put back into ponds or raceways.
- 4. Training facilities are costly and prohibit the small farmer from training large quantities of fingerlings.

### F. How are fingerlings harvested and sorted to size?

#### 1. Seining.

The entire pond is often seined, although some producers prefer to attract the fish to a current of water and harvest only a portion of the total population at one time. This also reduces the number of fish which may be stressed when the pond is drained to catch all of the fish.

2. Use of light attraction at night, with glass V traps, etc.

3. Draining,
  - a. Drainable ponds are often constructed with a concrete catch basin where all fish from the pond will be concentrated when the pond is drained. These basins make the harvesting process more efficient as large seines and some equipment are not necessary.
  - b. The catch basins must be carefully observed during drawdown because concentrating large quantities of fish in a small area can lead to major water quality problems and fish stress,
  - c. Now there is a catch basin design that utilizes fresh water, making this problem disappear.
4. Grading.
  - a. Grading is the process of separating the larger fish from the smaller ones, along with other species of fish, tadpoles, crayfish, etc.
  - b. Grading is done to help prevent cannibalism,
  - c. A wide variety of commercial fish graders is available. Some are small volume, labor-intensive manual graders, while others are automated to grade large numbers of fingerlings,
  - d. Most fish graders involve a set of aluminum bars which allow small fish to pass between them, but hold back the larger fish.

G. What are the techniques for counting fry and fingerlings?

Use the chalkboard to work a few sample problems and have the students complete TM D3 for more practice.

1. Wet sample weight.
  - a. A container holding water is weighed, fish are added to this and it is weighed again. The weight of the fish equals the final weight minus the initial weight.
  - b. This method is often used to weigh fingerling walleye; it is not as stressful on the fish because they spend almost no time out of the water.
2. Dry sample weight.
  - a. The fish are placed into a mesh or net basket, all of the water is allowed to drain off, and then they are weighed.
  - b. The weight of the basket must be subtracted from the total. Most scales can be adjusted to tare the basket.
  - c. This method can cause severe stress on small fingerlings, but is the most accurate when trying to weigh a few fish to find the average size.
3. Volumetric sample (preferred method).
  - a. In this method a graduated cylinder, beaker, or a marked bucket is filled to a certain level with water. The fish are added to the container and the rise in the water level is noted.
  - b. The volume of the fish equals the change in the water level. Since fish have very near the same density as water, their weight equals the weight of the water they displaced.

H. What are the methods for hauling walleye fingerings?

Use TM C3 as you discuss the techniques for hauling walleye fingerings.

1. Hauling densities. With proper aeration and temperature control, a guideline for a haul shorter than 4 hours is 0.4 lb of fish per gallon of water. On a haul longer than 4 hours, it is recommended that this be reduced to 0.2 lb/gal.

## *Aquaculture Curriculum Guide*

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2. Oxygen addition.
  - a. The DO in the hauling tank must be maintained at 5 ppm for the duration of the haul.
  - b. Oxygen can be added to the water as pure oxygen with either a compressed oxygen or liquid oxygen system, with a forced air blower system, or with agitators. Watch mesh size on basket, relative to size of fingering. Be careful with agitators they maybe harmful to small fry

3. Temperature regulation.

Have the students try to adjust the temperature of a tank of water by adding warmer or colder water Slowly.

- a. It is important that the temperature of the hauling water be close to the temperature that the fingerlings are being held at when loading.
  - b. When loading is complete the temperature of the hauling water maybe lowered by adding block ice to the tank. The fish will transport best when the water temperature is below 60°F.
4. Anesthetic. Be sure to check with local and state authorities before using any chemicals on food fish.
  - a. A light dose (5 to 15 ppm) of MS222 (Finquel) will reduce handling and hauling stress on fingerlings.
  - b. Caution must be used, as an overdose can kill the fish. Also, if the fish are stressed prior to the application of an anesthetic, they may experience oxygen debt and die.
  - c. The addition of 0.5% salt to the hauling water will reduce stress to the fish.
5. Tempering for release.
  - a. This process insures that the fish experience as little temperature shock as possible upon release.
  - b. The temperature of the hauling water must be slowly changed to equal the temperature of the water the fish are to be released into.
  - c. This is done by slowly adding water from the reception tank or pond into the hauling tanks.
  - d. Ideally, the temperature of the hauling water should not be altered more than 5°F per hour. In practice, however, 30-60 minutes is normal.
  - e. Release can be initiated when the temperature difference is less than 3°F.

### 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 the students to explain the content that goes with each objective.

### Evaluation:

Evaluation will be based on class participation, quizzes and a final examination. Example exam questions are attached.

## **Transporting Fry**

- Ship prior to feeding
- Transport in clear plastic bags

25,000 fry/bag maximum density

## **Techniques for Pond Culture of Walleye Fry**

- Pond Preparation:
  - Draining
  - Filling
  - Inoculating
  - Fertilizing
  - Insect control
- Stocking:
  - Tempering to temperature and pH
- Sampling
- Harvest and grading
- Feed training

## **Hauling Walleye Fingerlings**

ž Densities of 0.2 to 0.4 lb per gallon of water

- Oxygen addition
- Temperature regulation
- Anesthetic and salt
- Tempering for release

## **Hauling Walleye Fingerlings**

ž Densities of 0.2 to 0.4 lb per gallon of water

- Oxygen addition
- Temperature regulation
- Anesthetic and salt
- Tempering for release

## ***Aquacluture Curriculum Guide***

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### Key for Quiz - Section C

1. F
2. T
3. F
4. F
5. T
  
6. Place eggs with fry into pond unopened.
7. Let then sit for a short period.
8. Check temperature and pH in pond and bags.
9. If  $<1^{\circ}\text{C}$  and pH  $<2$  units, release fish.
10. If differences are greater, add 2 liters pond water to bags every 15 minutes until differences are as stated above.

Teaching Plan:

Module: Walleye - Section D

Problem Area: Raising Walleye to Food Size

Goal: The purpose of this problem area is to understand techniques involved in growing walleye to market size.

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

- identify the aspects of raising or obtaining fingerlings
- predict the quantity of fingerlings needed
- identify the culture facilities used for walleye production
- describe the culture techniques of food size walleye
- identify the routine management techniques involved in walleye culture
- identify the parts of the walleye industry which must be improved

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

Essential

Transparencies.

Additional:

Walleye Culture Manual, by Richard, P.D. & J. Hynes, Ontario Ministry of Natural Resources, 1986.

## Content and Procedures

### Preparation (Interest Approach):

Have the students discuss an animal finishing operation. Compare and contrast growing fish to food size with swine, cattle or poultry production.

### Presentation:

#### A. What are the 5 factors important to obtaining walleye fingerlings?

Show TM D1 and lead a discussion outlining the different aspects to be considered when purchasing fingerlings.

1. Finding availability.
2. Feed trained.
  - a. The majority of available walleye fingerlings are not trained to eat artificial feeds. This is fine if the buyer simply wants to stock a few into a lake for future fishing, but it is imperative to the aquaculturist that they be feed-trained.
  - b. Purchasing untrained fingerlings maybe cheaper, but unless the producer is set up to train them in large quantities, it is cheaper to purchase trained fingerlings.
  - c. When purchasing feed trained fingerlings try to visit the fingerling producer and see the fish eat prior to purchasing them. Some producers may sell "feed-trained fingerlings that will not eat artificial feed.
  - d. Farmers can train their own fish.
3. Size. Untrained fingerlings will usually be less than 3 inches long, although fish have been trained as small as 1". A fish greater than 4' inches is probably trained to eat artificial feed.
4. Graded. It is important that fingerlings be graded for size to remove the cannibals. If the fingerlings are not graded when purchased, the producer must grade them prior to stocking to prevent future losses to cannibalism.
5. Seasonal availability. Production of walleye fingerlings is usually completed by late summer, and the few fingerlings produced each season are generally sold by early fall.
6. Price. The current production of feed-trained walleye fingerlings is so sporadic that a going market price has not been established, but if production increases, the price should stabilize at between \$.75 and \$1.25 each.

B. How can the producer predict the number of fingerlings needed?

Show TM D2 and discuss the procedures for determining the number of fingerlings needed. Using TM D3 have students calculate the number of fingerlings needed for a given size area or volume of water.

1. Estimate the total number of fish that can be marketed economically.
2. Estimate the available space for production, i.e., how intensive will the system be.
3. Decide on how intensive the production will be, based on facility size.
4. Figure out how large will the fish be at market time.
5. Calculating the flow and density indices. Temperature is important in both calculations. Also, flow and density assumed to be about 1/2 that of trout.
  - a. Flow index.  
 $F = W/L+I$   
F = Flow index (in lbs, kg, etc.)  
W = Max, weight of fish which can be held in the area  
L = Length of fish in inches  
I = Inflowing water g/rein
  - b. Density index.  
 $W = D * V * L$   
W = Max. weight of fish which can be held in the area (or volume).  
D = Density index, 0.5 for trout  
V = Volume of holding area  
L = Length of fish in inches

C. What are the different facility types for growing walleye to food size?

1. Ponds.
2. Tanks.
3. Raceways.
4. Cages,
5. Natural ponds.
6. Heated effluent.

D. What is even-age production?

1. Unlike catfish, walleye must be produced using an even-age system, meaning that all fish in a certain vat or pond must be the same age and size to prevent cannibalism.
2. The alternative to even-age production is odd-age production. This technique is widely used in the catfish industry where fingerlings are stocked with fish nearing harvest weight to maximize the total number of pounds in a pond at any time.

## ***Aquaculture Curriculum Guide***

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- E. What are the specific techniques required for producing food-size walleye?

Discuss how each system has advantages and disadvantages depending upon the farmer's situation. Review work done on water quality during first semester.

1. Water quality management.
2. Stocking.
3. Regular feeding.
4. Monitoring for parasites and diseases.
5. Predator and weed control.
6. Harvesting.

- F. What is a typical work schedule for a walleye production facility?

Use the chalkboard to develop a typical weekly schedule, keeping in mind that some tasks are seasonal, variable because of demand, or a necessary daily task.

1. Regular water quality checks.
  - a. For ponds, monitor oxygen daily, more often if DO fluctuates greatly. Most important check is at sunrise, as this is when the DO will be at its lowest. Checking every morning at sunrise will give the producer a chance to predict any future DO problems.
  - b. In tanks and raceways, check ammonia and pH several times per week, everyday if problems arise.
  - c. Check nitrite, chloride, and CO<sub>2</sub> weekly.
  - d. Check for gas saturation and gas bubble disease.
2. Regular feeding schedule.
  - a. Feeding the fish two or three times per day with demand or automatic feeders will increase growth of the fish: intensive-10 times a day. Extensive-at dusk.
3. Watch for sick or dead fish.
  - a. Anytime that sick or dead fish are found, it is important for the producer to discover the cause of the problem.
  - b. Even if only one or two fish are affected, this knowledge may give the producer a chance to head off any major problem.
4. Predator control. Predators, especially piscivorous birds such as grebes, herons, egrets and cormorants can cause large losses in fingerling production. As the fish reach 1 lb, the problem decreases because the fish are too large for most predators and can out-manuever many others. Fish-eating birds are also an important link in the life cycle of some fish parasites.
5. Stocking, grading and harvesting when needed.
6. Equipment maintenance and repair.
7. Regular chores such as tank cleaning, filling feeders, etc.

G. What must be done to improve the walleye industry?

UseTM D4 to discuss each of these changes and how they would effect the walleye industry.

1. Work must continue on the domestication of broodstock and the development of a more reliable fingerling supply,
2. Research must also continue on the development of a good method for producing feed trained fingerlings at an affordable price,
3. Development of cheaper, more efficient feeds.
- 4, Improve disease diagnostic procedures and license more treatments for fish diseases,
5. Continue to develop more cost effective production procedures.

### 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 the students to explain the content that goes with each objective.

### Evaluation:

Evaluation will be based on class participation, quizzes and a final examination. Example exam questions are attached.

## Factors to Consider When Purchasing Fingerlings

- Feed-trained
- Size
- Graded
- Seasonal availability
- Price
- Inspected for parasites and diseases

## **Determining the Number of Fingerling Needed**

- Estimate the available space
- Determine the desired density

## Problem

### Question:

A producer needs to stock a 40,000-gal raceway with walleye fingerlings, The average inflow to this raceway is 500 gpm with a DO of 13 ppm at 69°F. If the producer feeds at 5% body weight per day, and 1 lb of feed eaten requires 0.2 lb of oxygen to be broken down, How many pounds of fish can this raceway maintain assuming all other variables remain within the safety limit?  
(Hint, the outflowing water must contain at least 4 ppm oxygen.)

### Answer:

$500 \text{ gpm} \times 60 \text{ min/hr} \times 24 \text{ hr/day} = 720,000 \text{ gal water per day}$   
 $720,000 \text{ gpd} \times 8.34 \text{ lb/gal} = 6,004,800 \text{ lb water per day}$ . The water contains 13 ppm oxygen, 4 must remain in the water, so there are 9 ppm available oxygen. Therefore, there would be 0.000009 lb of oxygen available for every pound of water.  $0.000009 \times 6,004,800 = 54.05 \text{ lbs available oxygen}$ .  $54.05 \text{ lbs oxygen per day} / 0.2 \text{ lb oxygen per lb feed} = 270 \text{ lbs feed}$ .  $270 \text{ lbs of feed per day} / .05 \text{ lb feed per lb fish} = 5400 \text{ lbs of fish}$ .

## **Needed Improvements**

- Continue work on domestication of brood stock and year-round supply of fingerlings
- Cheaper, more efficient feeds
- Improved disease treatments and diagnostic techniques
- Development of more efficient production procedures

Quiz for Section D

Name

Date:

Quiz on Raising Walleye to Food Size

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

1.     T     F     A two-inch walleye is probably feed trained.
2.     T     F     Most walleye fingerlings sold today are feed trained.
3.     T     F     Grading of walleye fingerlings is not necessary.
4.     T     F     Walleye can be cultured in an all age system.
5.     T     F     If the nitrite level falls below 5 ppm there may be problems.
- 6-10.   Describe the factors that control the density at which fish can be cultured.

## ***Aquaculture Curriculum Guide***

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### Key for Quiz - Section D

1. F
2. F
3. F
4. F
5. F
  
6.  $W = D \cdot V \cdot L$  (Weight equals density X volume X length.)
  
7. Max. weight fish can be held in area.
  
8. Density index = 0.5 for trout.
  
9. Volume = holding area.
  
10. Length = length of fish in inches

Teaching Plan:

Module: Walleye - Section E

Problem Area: Feeding Walleye

Goal: The goal of this problem area is to identify the types of rations and feed requirements of walleye and to develop an understanding of the term "conversion."

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

describe the types of walleye feed available  
identify the nutritional requirements of walleye  
identify the feeding schedule required by walleye  
identify the different feeding methods  
explain what is meant by "food conversion rates"

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

Essential:

Transparencies.

Additional:

Walleye Culture Manual, by Richard, P.D. & J. Hynes, Ontario Ministry of Natural Resources. 1986

# Aquaculture Curriculum Guide

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## Content and Procedures

### Preparation (Interest Approach):

Discuss the importance of feeding in any livestock production system. Highlight feeding rates, efficiency and quality. Also, discuss how feed can be the largest expense to the producer.

### Presentation:

#### A. What types of feed are available to the walleye producer?

Call or write to several of the local feed mills and receive a list of the feeds produced. Discuss the list with the class and determine if any of the feeds would be suitable for walleye culture. See if you can get the owner or manager of a mill to visit. Discuss with him/her the possibilities of getting the proper feeds from a local mill.

1. Feed availability depends upon geographic location. It is an economical strain to have to transport large quantities of feed great distances, so the local walleye producer should try to locate a feed source within a few hundred miles.
2. Small quantities of fry or fingerling feeds maybe ordered from across country.
3. The walleye industry is so new that feeds for adult walleyes have not been specifically developed, but many companies are producing diets which are satisfactory.

#### B. What are the nutritional requirements of the walleye?

Use TM EI or the chalkboard to feed a disussion on the nutritional requirements of the walleye.

1. The natural foods of the walleye include a variety of zooplankton, insects, crustaceans, and fish.
2. Fry. Walleye fry feeds should contain at least 45-50% protein.
3. Fingerlings. Walleye fingerling diets should contain at least 35% protein.
4. Adult. Adult walleye need 40-50% of their diet to be protein
5. Protein sources. Good sources of protein are krill, shrimp, pellets, insects, minnows, etc.

#### C. How much and how often should the walleye be fed?

UesTM E2 or the chalkboard to lead a discussion on the feeding of walleye. Review the material on the methods of distribution feeds from the first semester material.

Larvae in intensive culture must have feed available 24 hours per day. An automatic clock type feeder, set to feed every five minutes will work.

D. What are the 4 methods for feeding walleye?

1. Hand feeding is good for fingerlings and adults in pond culture, at dusk,
2. Manual/mechanical.
3. Automatic/timer,
  - a. Care must be taken when calibrating an automatic feeder to insure that no more feed than the fish will eat is being fed, while on the other hand there must be enough feed provided to insure optimum growth.
  - b. Walleye fingerlings, advanced fingerlings and adults will acclimate to a solenoid feeder.
4. Demand, Walleye are feed ad libitum — as they desire.

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 the students to explain the content that goes with each objective.

Evaluation:

Evaluation will be based on class participation, quizzes and a final examination. Example exam questions are attached.

## Nutritional Requirements of Walleye

- Larvae:
  - 45+% protein
  - 8+% fat
- Fingerlings:
  - 35-45% protein
  - 6+% fat
- Adults:
  - 32+% protein
  - 4-10% fat

## Feeding Rates for Walleye/Manual Feeding

- 1-3-inch Fingerlings:  
5-10% of body weight per day
- 3-6 Inch:  
5% of body weight per day
- 6-inch Plus:  
3-5% of body weight per day
- Adults:  
2-3% of body weight per day

Quiz for Section E

Name:

Date:

Quiz on Feeding Walleye

1.     T     F     A demand feeder allows the fish to get feed when they want to eat.
2.     T     F     A walleye fry diet should contain roughly 25% protein.
3.     T     F     Feeds designed for adult walleye are available from many sources.
4.     T     F     Walleye fry in intensive culture require feed to be available nearly constantly.
5.     T     F     Using demand feeders can improve feed efficiency.
- 6-10.   List the natural foods of walleye.

# ***Aquaculture Curriculum Guide***

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## Key for Quiz - Section E

1. T
2. F
3. T
4. T
5. F
  
6. Zooplankton
  
7. Insects
  
8. Crustaceans
  
9. Fish
  
10. Krill

Teaching Plan:

Module: Walleye - Section F

Problem Area: Controlling Pests and Diseases

Goal: The goal of this problem area is to identify the types of disease and predator problems faced by walleye producers and learn methods of controlling these problems.

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

- discuss the types of walleye diseases
- identify a disease problem
- discuss the prevention and treatment of walleye diseases
- identify the different methods of pest control

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

Essential:

Transparencies.

Water Quality in Ponds for Aquaculture. by Boyde, C. E., 1990.

Additional:

Slides of infected fish. Microscope, dissecting kit, several .5 to 1.5 lb fish.

Textbook of Fish Health, by Post, G., TFH Publication, Neptune City, N.J., 1987.

# Aquaculture Curriculum Guide

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## Content and Procedures

### Preparation (Interest Approach):

Have the students dissect a fish, Identify the parts. Discuss how various pests and diseases can attack certain internal parts as you are identifying them. Tell the students that it is critically important to identify diseases as early as possible, as progress is of disease is quick in warm water. Tell them they should keep daily mortality records and watch for behavioral changes.

### Presentation:

#### A. What diseases are walleye susceptible to?

Use TM F1 as a guide as you lead a discussion on the diseases of walleye. Slides showing infected fish would help.

1. Bacterial diseases- *Flexibacter columnaris*.
  - a. Can occur as an internal, systemic infection, an external infection, or both simultaneously. Internal infections may cause the fish to stop eating, swim listlessly in shallow water and die.
  - b. External infections generally will appear as gray or dark yellow lesions or ulcerations on the skin. Infections often occur on the gills and in the mouth, these are usually dark yellow to brown.
  - c. Diagnosis of the disease is made by identifying the bacteria either microscopically or through isolation and biochemical testing.
  - d. An external infection of Columnaris can be treated with potassium permanganate. The amount of potassium required will vary with the amount of organic material in the water.
  - e. For tank treatments, the most common method of treatment is to add 2 ppm to the water every hour, using a constant flow siphon or a chemical meter, until the red color persists for several hours. An internal infection should be treated with Terramycin medicated feed.
  - f. Columnaris generally appears as a stress related disease, usually from handling and crowding heavily, whether it be trapping, grading or tank capacity conditions. It is a common harvest problem. Keep handling of fish to a minimum,
2. Bacterial disease- *Aeromonas and pseudomonas*.
  - a. Are common bacteria of fresh water which may cause subacute or chronic infections following a period of stress.
  - b. Behavioral changes caused by an infection may include: reduced feeding activity, lethargy, and swimming listlessly in shallow water.
  - c. Clinical signs of these infections are highly variable but may include: small hemorrhages which look like pin pricks on the body and fins, irregular red or gray lesions on the skin, eroded fins, raised scales, protruding eyes (exophthalmia) swollen abdomen, and a discharge of fluid from the anus.
  - d. Internal signs may include pale liver and kidney, hemorrhaging of the internal organs and body cavity, fluid in the stomach and intestine. *Aeromonas* can be treated with medicated feeds.

### 3. Protozoan parasites - *Ichthyophthirius multillis* (Ich),

UseTM F2 to describe the life cycle of Ich.

- a. Ich can decimate a producer's stock once it becomes infected. Ich is the only protozoan parasite of fish that can be seen with the unaided eye.
- b. The disease signs include small white spots on the skin, fins and gills which, when examined under a microscope, are shown to be large ciliated protozoans with a crescent-shaped nucleus.
- c. The complex life cycle of Ich makes it difficult to treat. The mature parasite is found just under the skin of the fish and can't be treated when encysted because the skin protects the parasite from any chemical treatment. After spending one to three weeks (varies with temperature) in the fish, the adult leaves the fish and attaches to the bottom or side of the tank or pond,
- d. There it will develop into a mature trophont within 24 hours and will then rupture and release up to 2,000 free swimming tomites, which must find a fish to infect within 2 days or die.
- e. Treatment of Ich requires multiple applications of chemicals, because only the free swimming stage can be killed.

### 4. Protozoan parasites - other protists.

UseTM F3 to demonstrate what some of the parasites of walleye look like.

- a. There area wide variety of protozoan parasites of walleye. Most of these occur as external parasites of the skin and gills.
- b. A healthy fish will almost always harbor a small population of these parasites, but when the fish's natural ability to control this population is disrupted by stress, e.g., when fingerlings are going through a starvation period associated with conversion to dry diets, the population of protozoans can multiply rapidly.
- c. A severe infection can interfere with the fish's ability to respire or may open a pathway for a bacterial pathogen to infect the fish.

### 5. Trematodes.

- a. Monogenetic (meaning one host). External parasitic flatworms are common, but generally are not a problem unless the fish are stressed and the population of flatworms increases dramatically.
- b. Digenetic (meaning at least two hosts). Yellow grubs, white grubs and black spot are all names for various trematodes which infect walleye. Each has a specific area within the body in which it lives.
- c. There are not any known cures for these grubs and the only prevention is to break the life cycle of the parasite.
- d. Their life cycle involves living as an adult in piscivorous (fish-eating) birds and shedding eggs into the water, The eggs hatch and infect snails, where the parasite reproduces and, after an incubation period, releases large numbers of young which search for and infect fish. If the fish is eaten by a bird, the parasite will finally reach the adult stage in the bird.

## ***Aquaculture Curriculum Guide***

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6. Viral diseases.
  - a. Lymphocystis is a viral disease that is most common in walleyes.
  - b. The disease can be identified by the gray or white warty growths that form on the fins and skin of infected fish.
  - c. The disease is rarely fatal, but will reduce the market value of the fish.
  - d. There is no known therapy for lymphocystis the best treatment would be to isolate the infected stock, and sterilize the facility.
  
7. Fungi.
  - a. Fungal infections can occur either internally or externally in fish, but the majority of infections will be external.
  - b. Saprolegnia is the fungus that causes an external fungal infection on fish.
  - c. Fungal infections can be identified by the white or gray mossy patches which form on the fish's skin, gills, or fins.
  - d. Infections usually begin on the margins of the fins or gills and work toward the center of the fish.
  - e. Fungal infections not severe enough to kill the host may open a port of entry for another infectious agent, or weaken the fish's defenses enough to allow a parasite problem to develop.
  - f. Fungal infections themselves are usually a secondary invader, following injury or bacterial infection in the fish.

**B. How can the producer diagnose the causative agent?**

The best way for a producer to be sure of the causative agent of a problem is to take some of the sick fish to a diagnostic lab to take a short course on disease identification in fish.

**C. What are the disease prevention and treatment techniques?**

Check with local authorities on the safety of all chemicals by using the one on food fish

ShowTM F4.

1. For columnaris
  - a. Minimum handling, no more than absolutely necessary
  - b. Proper maintenance of O<sub>2</sub> concentration.
  - c. Proper water quality.
  - d. Slow tempering of fish from pond temperature to tank temperature.
  - e. Keep fish as stress free as possible.
  
2. Bacterial diseases.
  - a. Water quality maintenance tank cleaning and maintain DO.
  - b. Removal of advanced disease infected fish and prompt removal of dead fish.
  - c. Proper sanitary practices, e.g., quarantine of materials, use of clean tools, decontamination, etc.
  - d. Medicated feeds.
  - e. Chemical baths.
  - f. Chemical injection.

3. Ich.
    - a. Examine all fish prior to stocking and never release infected fish.
    - b. Disinfect all equipment with chlorine or formalin after handling infected fish.
    - c. Isolate the discharge water from infected fish to prevent spreading.
    - d. Formalin. A prolonged treatment of 25 ppm every other day for 10 days should cure the problem, A treatment of 1 ppm copper sulfate for every 100 ppm of hardness every 2 or 3 days for at least 3 treatments.
  
  4. External protists.
    - a.  $\text{CuSO}_4$
    - b. Formalin -be aware of possible toxicity to walleye.
    - c.  $\text{KMnO}_4$ .
    - d. Salt.
  
  5. Trematodes.
    - a. Monogenous. Formalin at 25 ppm for a prolonged treatment or at 250 ppm for a 1 hour bath should remove the parasites.
    - b. Digeneous. There is not a cure for these parasites. The only prevention is to break the life cycle, by either removing the snails or by keeping the birds away.
  
  6. Fungi.
    - a. Fungi can be treated with formalin at 25 ppm for a prolonged period, or at 250 ppm for 1 hour.
    - b. A 500 to 1000 ppm or 1 -3% solution salt bath will also help to combat a fungal infection.
    - c. Egg treatment -1:600 for 15 minutes flow-through.
- D. What are the major pest problems in pond culture, and how are they controlled?
1. Fry predation by aquatic insects, mud minnows, etc.
  
  2. Snakes.
    - a. Eradication.
    - b. Removal of cover,
    - c. Barriers,
  
  3. Birds.
    - a. Scare. Many techniques involving firecrackers, scare crows, and propane cannons have been developed to keep birds away from valuable fish stocks. None of them are completely effective alone, but with perseverance and some imagination the birds will stay away.
    - b. Depredation permits. Some producers maybe eligible for a federal depredation permit which will allow limited killing of some piscivorous birds. These permits are granted by the U.S. Fish and Wildlife service, Department of Animal Control.
    - c. Prevent access, Many ingenious arrays of mesh netting and wires have been used to prevent birds from getting to the fish; most work with limited success and should not be relied upon totally for protection.

## Aquaculture Curriculum Guide

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4. Mammals.
  - a. Removal by trapping or hunting if legal.
  - b. Prevent access.

E. How can aquatic weeds become a problem?

1. Impede harvest.
2. Cause low DO at night and prevent fish from getting to aerator.
3. Hamper feeding.
4. Ecological and environmental impact of depredation today and tomorrow.

### 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 the students to explain the content that goes with each objective.

### Evaluation:

Evaluation will be based on class participation, quizzes and a final examination. Example exam questions are attached.

## **Diseases of walleye**

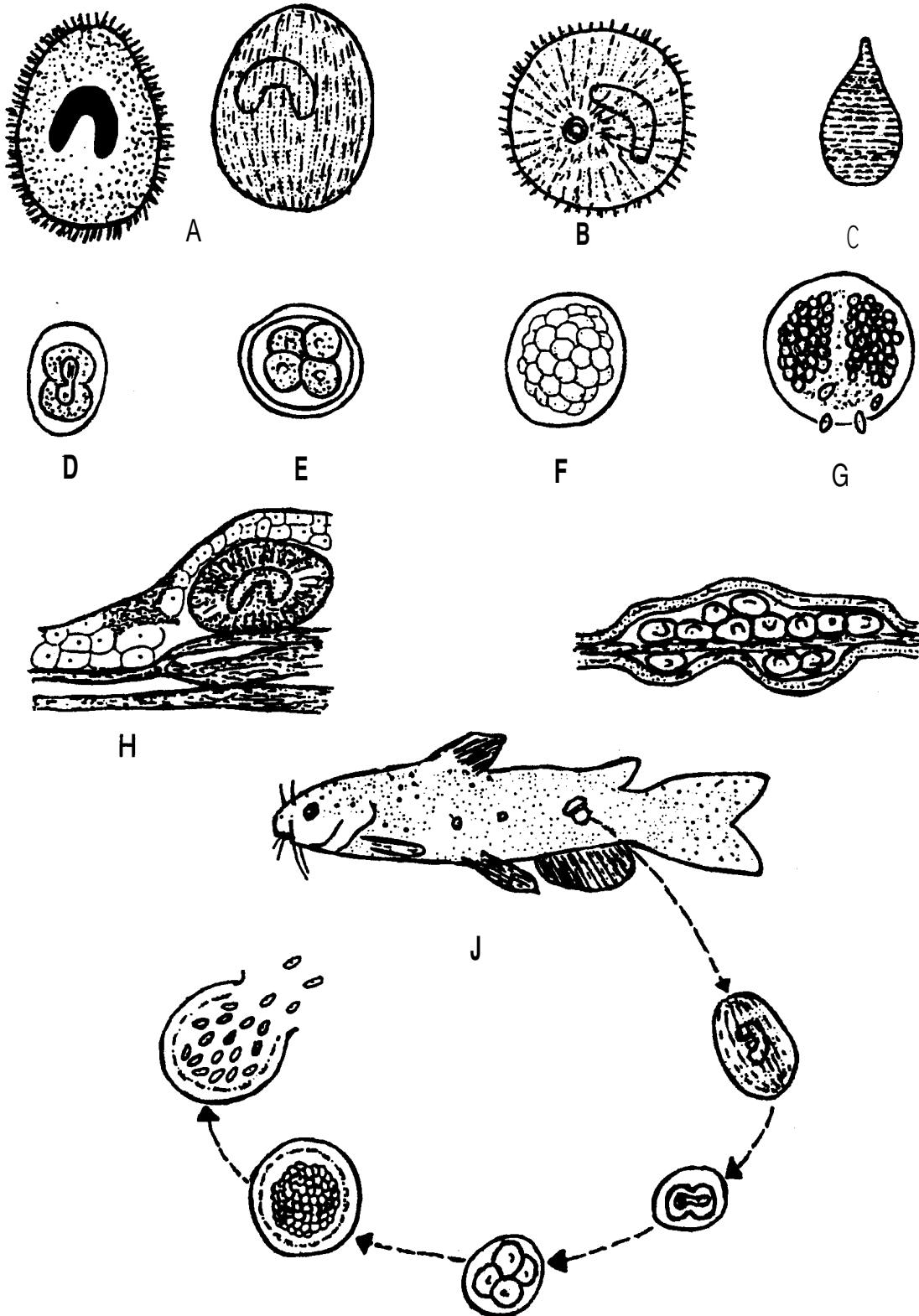
### Bacterial diseases:

Columnaris

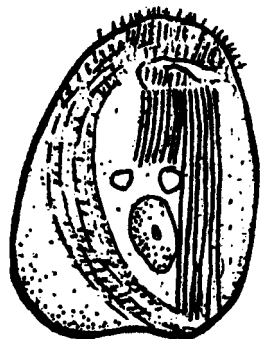
Aeromonas and pseudomonas

- Parasites:
  - Ich
  - Other protists
  - Trematodes
- Viral
- Fungi (saprolegnia)

# Life Cycle of Ich



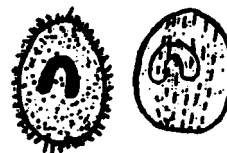
# Parasites



Chilodonella



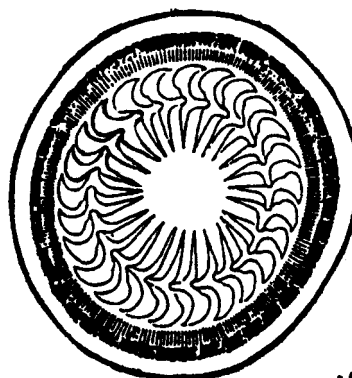
Trichophyra



Ichthyophthirius



Epistylis



Trichodina



Ambiphyra

## **The Most Important Aspects of Fish Health**

- Prevention of stress

Quiz for Section F

Name:

Date:

Quiz on Controlling Pests and Disease

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

1.     T     F     There is no treatment for Ich.
2.     T     F     Saprolegnia can be treated with formalin.
3.     T     F     A monogenous trematode lives in fish-eating birds as an adult.
4.     T     F     Bacterial infections are generally treated with medicated feeds.
5.     T     F     Lymphocystis can cause massive fish kills.
- 6-10.   List some behavioral changes that a sick fish may exhibit.

## ***Aquaculture Curriculum Guide***

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### Key for Quiz - Section F

1. F
2. T
3. F
4. T
5. F
  
6. Stop eating.
  
7. Swim listless if in shallow water.
  
8. Lethargy.
  
9. Small hemorrhages.
  
10. Protruding eyes.  
Swollen abdomen.  
Discharge of fluid from anus.  
Lesions on skin.  
Eroded fins.  
Raised scales.

Teaching Plan:

Module: Walleye - Section G

Problem Area: Marketing Walleye

Estimated Time

Goal: The goal of this problem area is to explain the techniques involved in marketing walleye.

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

- identify the harvesting techniques
- identify the hauling equipment and technique
- discuss the techniques of walleye processing

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

Essential:

Transparencies.

Additional:

Walleye Culture Manuel, by Richard, P.D. & J. Hynes, Ontario Ministry of Natural Resources, 1986.

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## Content and Procedures

### Preparation (Interest Approach):

Make a list of all retail markets in your area which sell walleye, Try to contact each of these and develop a series of questions to ask each one. (e.g. How much sold per week? Sold as?) Also, visit a local fish market and discuss the potential volume of walleye that could be marketed and at what price. Have students contact hatcheries and fisheries to determine area markets across the states, in accordance with walleye fingerling demands and sales to fisheries across state lines. Also, inquire into the intrastate and interstate regulations for transporting food.

### Presentation:

#### A. What are the 3 main harvest techniques for walleye?

Review harvesting techniques from the first semester material. A elide show or video showing examples of transport equipment would work well here.

1. Crowding with seine and dipping.
2. Crowding by draining.
3. Trapping.

#### B. How are walleye transported?

##### 1. Live.

- a. This is difficult in the summer because high temperatures make it necessary for haulers to add large quantities of ice to the hauling tanks, which stresses the fish by going from high to low temperatures.
- b. High summer water temperatures make pond harvest much more difficult and make it almost impossible to get large quantities of food size walleye loaded onto a truck and delivered alive.

##### 2. Whole on ice.

- a. This is probably the best method for hauling pond-seined fish in the summer, although it does create a large expense for the ice.
- b. At present, there are no walleye proceseors in the U.S. and thus the farmer likely will have to process his/her own foodsize walleye. Thus, no transportation.

##### 3. Gilled and gutted on ice.

- a. This requires an onsite processing facility.
- b. Hauling costs are reduced because the weight of the internal organs is not being hauled.
- c. Could also fillet The skin and bones could be disposed of too.

C. How are walleye processed for sale?

Use TM G1 as a guide while you discuss processing walleye. If possible, visit a fish processing facility.

1. All processing of fish intended for sale must be done in a health department inspected facility.
2. Scaled, gilled, and gutted (whole).
3. Fileted.

D. What are the main markets for walleye?

Use TM G2 or the chalkboard to discuss the different market channels for walleye. Have a local seafood retailer give a talk about the potential of walleye sales in the area. Make a list of all retail markets in your area which sell walleye. Try to contact each of these and develop a series of questions to ask each one, i.e., how much sold per week, sold as?

1. Retailers.
  - a. Examples of retail outlets are restaurants, grocery stores and fish markets.
  - b. A producer could maintain a small-scale market with several retail outlets, but most would require that the fish be processed prior to delivery.
2. Seafood wholesaler/fish brokers.
  - a. Distribute products to many retail outlets.
  - b. Often have their own processing facilities,

### 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 the students to explain the content that goes with each objective.

### Evaluation:

Evaluation will be based on class participation, quizzes and a final examination. Example exam questions are attached.

## **Types of Processed Walleye**

- Whole/gilled and gutted
- Fileted

## **Markets for Walleye**

- Seafood wholesalers
- Seafood retailers
- Contracts

Quiz for Section G

Name:

Date:

Quiz on Marketing Walleye

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

1.     T     F     An efficient method for harvesting walleye is with a rod and reel.
2.     T     F     It is important to guard against stress when transporting fish.
3.     T     F     A good, marketable form of walleye is as a filet.
4.     T     F     It is presumptuous to think that a fish farmer could market his/her own products.

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Key for Quiz -Section G

1. F
2. T
3. T
4. F