

## Lesson C3–2

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# Understanding the Environmental Requirements for Fish

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**Unit C.** Animal Wildlife Management

**Problem Area 3.** Fish Management

**Lesson 2.** Understanding the Environmental Requirements for Fish

### **New Mexico Content Standard:**

**Pathway Strand:** Natural Resources and Environmental Systems

**Standard:** III: Apply scientific principles to natural resource management activities.

**Benchmark:** III-C: Examine natural cycles and related phenomena to describe ecological concepts and principles.

**Performance Standard:** 1. Describe the hydrologic cycle. 2. Describe the nitrogen cycle. 6. Identify potential pollution sources.

**Student Learning Objectives.** Instruction in this lesson should result in students achieving the following objectives:

1. Describe factors affecting water quality
2. Understand water oxygenation
3. Understand the effects of nitrogen
4. Describe the effects of other common compounds in water

**List of Resources.** The following resources may be useful in teaching this lesson:

**Recommended Resources.** One of the following resources should be selected to accompany the lesson:

Lee, J.S. & Newman, M.E. *Aquaculture—An Introduction* 2<sup>nd</sup>. Danville, Illinois: Interstate Publishers, Inc., 2000. (Chapter 5)

**Other Resources.** The following resources will be useful to students and teachers:

Selness, D. *Exploration Activities in Aquaculture*. Danville, Illinois: Interstate Publishers, Inc., 1997.

## List of Equipment, Tools, Supplies, and Facilities

Writing surface  
Overhead projector  
Transparencies from attached masters  
Bottle of water

**Terms.** The following terms are presented in this lesson (shown in bold italics):

Aeration  
Ammonia toxicity  
Biomass  
Eutrophication  
Nitrogen cycle  
Oxygenation  
pH  
Phytoplankton  
Plankton  
Salinity  
Water biology  
Water chemistry  
Zooplankton

**Interest Approach.** Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

*Have a bottle of drinking water. Take a big drink of the water and comment on how good it tastes and how refreshing it is. Start a class discussion on the importance of water for human health. Now ask the class about the importance of water to fish. Allow this discussion to lead into the content of this lesson.*

# Summary of Content and Teaching Strategies

**Objective 1:** Describe factors affecting water quality

**Anticipated Problem:** What factors affect water quality?

- I. Water is a simple compound consisting of two parts hydrogen and one part oxygen. However, when dealing with fish, water and water quality are paramount for a healthy environment for fish. When evaluating water quality, three characteristics need to be considered. They are: chemical characteristics, physical characteristics, and biological characteristics.
  - A. In addition to two parts hydrogen and one part oxygen, water contains many dissolved molecules. All of this combines to form the **water chemistry**. Some common substances in water include dissolved oxygen, nitrogen, hydrogen sulfide, carbon dioxide, and iron. The pH and salinity of water also affect its quality. The **pH** of water is a measure of its acidity or alkalinity. **Salinity** is the amount of dissolved salt in water.
  - B. Temperature determines the physical characteristics of water. As the temperature changes, water can be a solid, liquid, or gas. Most species of fish have a specific range of water temperatures that they can survive in. If fish are raised in an environment controlled by man, temperature control is critical for success.
  - C. The final characteristic of water that affects quality is water biology. **Water biology** is all the living and non-living organisms in the water. This includes large aquatic plants and small microscopic organisms. Some of these microscopic organisms include **plankton**, which are tiny plants and animals that float in the water. Plankton can be further divided into **phytoplankton** (algae plankton which produce oxygen through photosynthesis) and **zooplankton** (microscopic animal life that is often used as food by many fish). All living organisms in a given location compose its **biomass**.

*There are many techniques that can be used to assist students in mastering this material. Students need text material to aid in describing factors affecting water quality. Chapter 5 in Aquaculture—An Introduction 2<sup>nd</sup> Edition text is recommended. Use TM: C3–2A to aid in discussion on this topic.*

**Objective 2:** Understand water oxygenation

**Anticipated Problem:** What is water oxygenation?

- II. Fish rely on dissolved oxygen (DO) in water to sustain their life functions. The amount of available oxygen is a limiting environmental factor for fish. When oxygen is limited in an aquatic environment, oxygen is often added to the water. This process is called **oxygenation**. One source of oxygen is from the air that is above the water. The process of water obtaining oxygen from the air is called **aeration**. Some common methods of adding dissolved oxygen to water are:

- A. Splashing the water. Splashing occurs as water is added to a system. The water is splashed against concrete or something similar. This splashing allows the more of the water molecules to come in contact with air molecules.
- B. Pumping air or oxygen into the water. This allows oxygen molecules to come in contact with water molecules, thus allowing oxygen to become dissolved in the water. This method is commonly seen fish tanks.
- C. Spraying the water into the air. This is often achieved by using a fountain or a paddle wheel. As the water is sprayed into the air, it comes into contact with oxygen and catches some of it as the water falls back into the pond or other body of water.
- D. Using chemicals. Potassium permanganate is sometimes added to ponds to cause a chemical reaction that releases oxygen. Another common method of using chemicals is fertilizing the pond. This allows aquatic plants to grow, which increases oxygen from photosynthesis.

*There are many techniques that can be used to assist students in mastering this material. Students need text material to aid in understanding water oxygenation. Chapter 5 in Aquaculture—An Introduction 2<sup>nd</sup> Edition text is recommended. Use TM: C3–2B to aid in discussion on this topic.*

### **Objective 3:** Understand the effects of nitrogen

**Anticipated Problem:** What are the effects of nitrogen in water?

- III. Nitrogen is an abundant element in the environment. Nitrogen circulates through the atmosphere, soil, water, animals, and plants. This circulation is known as the **nitrogen cycle**. Excessive nitrogen in water can be toxic to fish. In highly intensive fish production systems, nitrogen can be a problem.
  - A. Organic wastes in the water can cause excessive nitrogen in fish production systems. This organic matter can be manure from the fish or uneaten feed. As this organic matter decomposes, ammonia is released. Ammonia is then converted into nitrites. Ammonia and nitrites can both be harmful to fish. **Ammonia toxicity** is the level of ammonia that can cause harm. High levels of nitrite in the water will prohibit the blood of fish from effectively carrying oxygen. Several factors affect ammonia toxicity.
    - 1. As temperature increases, ammonia becomes more toxic.
    - 2. As the pH becomes more alkaline, ammonia becomes more toxic.
    - 3. As the dissolved oxygen (DO) decreases, ammonia becomes more toxic.
    - 4. As the carbon dioxide increases, ammonia becomes more toxic.
    - 5. As the salinity decreases, ammonia becomes more toxic.
  - B. In highly intensive fish production systems, nitrogen levels can change quickly. To prevent problems, nitrogen levels should be tested regularly. In addition to testing, care should be taken to prevent over feeding of the fish. Additionally, the systems should be designed to allow for proper water flow to remove waste from the system.

*There are many techniques that can be used to assist students in mastering this material. Students need text material to aid in understanding the effects of nitrogen. Chapter 5 in Aquaculture—An Introduction 2<sup>nd</sup> Edition text is recommended. Use TM: C3–2C and C3–2D to aid in discussion on this topic.*

**Objective 4:** Describe the effects of other common compounds in water

**Anticipated Problem:** What are the effects of other common compounds found in water?

- IV. As noted above, nitrogen can cause problems. Additionally, phosphorus, chlorine, and heavy metals may cause problems in water quality.
- A. Excess phosphorus is usually attributed to wastes entering the water. Excess phosphorus in combination with nitrogen can cause excessive nutrients in the water, which is called **eutrophication**. This may lead to algae blooms, which can cause a decrease of oxygen in the water.
  - B. Excess chlorine is usually attributed to municipal chlorinated water entering the aquatic system. This chlorinated water can cause problems for some species of fish. To eliminate the chlorine, the water needs to be de-chlorinated by aging or chemical treatment.
  - C. Heavy metals, such as lead and mercury, are usually attributed to water pollution from manufacturing or illegal dumping of pollutants into the water. Although some heavy metals may not kill the fish, they can be absorbed into the fish and cause problems for humans that consume the fish. Care should be taken to test water for heavy metals.

*There are many techniques that can be used to assist students in mastering this material. Students need text material to aid in describing the effects of other common compounds in water. Chapter 5 in Aquaculture—An Introduction 2<sup>nd</sup> Edition text is recommended. Use TM: C3–2E to aid in discussion on this topic.*

**Review/Summary.** Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at end of chapters in the textbook may also be used in the review/summary.

**Application.** Several opportunities for application are listed in the “Exploring” section at the end of Chapter 5 in the *Aquaculture—An Introduction 2<sup>nd</sup> Edition* text. Laboratory Activities 2, 7, 8, 9, 10, 11, 12, 13, 14, 15, and 17 in *Exploration Activities in Aquaculture* are appropriate for this lesson.

**Evaluation.**

## **Answers to Sample Test:**

### **Part One: Matching**

1 = f, 2 = e, 3 = b, 4 = g, 5 = a, 6 = h, 7 = c, 8 = d

### **Part Two: Completion**

1. toxicity
2. increases
3. phosphorus
4. heavy metals
5. temperature

### **Part Three: Short Answer**

1. Splashing water, pumping air into the water, spraying water into the air, and using chemicals
2. phosphorus, chlorine, and heavy metals

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# Test

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## Lesson C3–2: Understanding the Environmental Requirements for Fish

### Part One: Matching

*Instructions.* Match the term with the correct response. Write the letter of the term by the definition.

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|-------------------|------------------|
| a. Aeration       | e. Phytoplankton |
| b. Biomass        | f. Salinity      |
| c. Eutrophication | g. Water biology |
| d. Oxygenation    | h. Zooplankton   |

- \_\_\_\_\_ 1. The amount of dissolved salt in water.
- \_\_\_\_\_ 2. Algae plankton, which produce oxygen through photosynthesis.
- \_\_\_\_\_ 3. All living organisms in a given location.
- \_\_\_\_\_ 4. All the living and non-living organisms in the water.
- \_\_\_\_\_ 5. The process of water obtaining oxygen from the air.
- \_\_\_\_\_ 6. Microscopic animal life that is often used as food by many fish.
- \_\_\_\_\_ 7. Excessive nutrients in the water.
- \_\_\_\_\_ 8. Adding oxygen to water.

### Part Two: Completion

*Instructions.* Provide the word or words to complete the following statements.

1. Ammonia \_\_\_\_\_ is the level of ammonia that is harmful to fish.
2. As temperature \_\_\_\_\_, ammonia becomes more toxic.
3. Excess \_\_\_\_\_ is usually attributed to wastes entering the water.
4. \_\_\_\_\_, such as lead and mercury, are usually attributed to water pollution from manufacturing or illegal dumping of pollutants into the water.
5. \_\_\_\_\_ determines the physical characteristics of water.



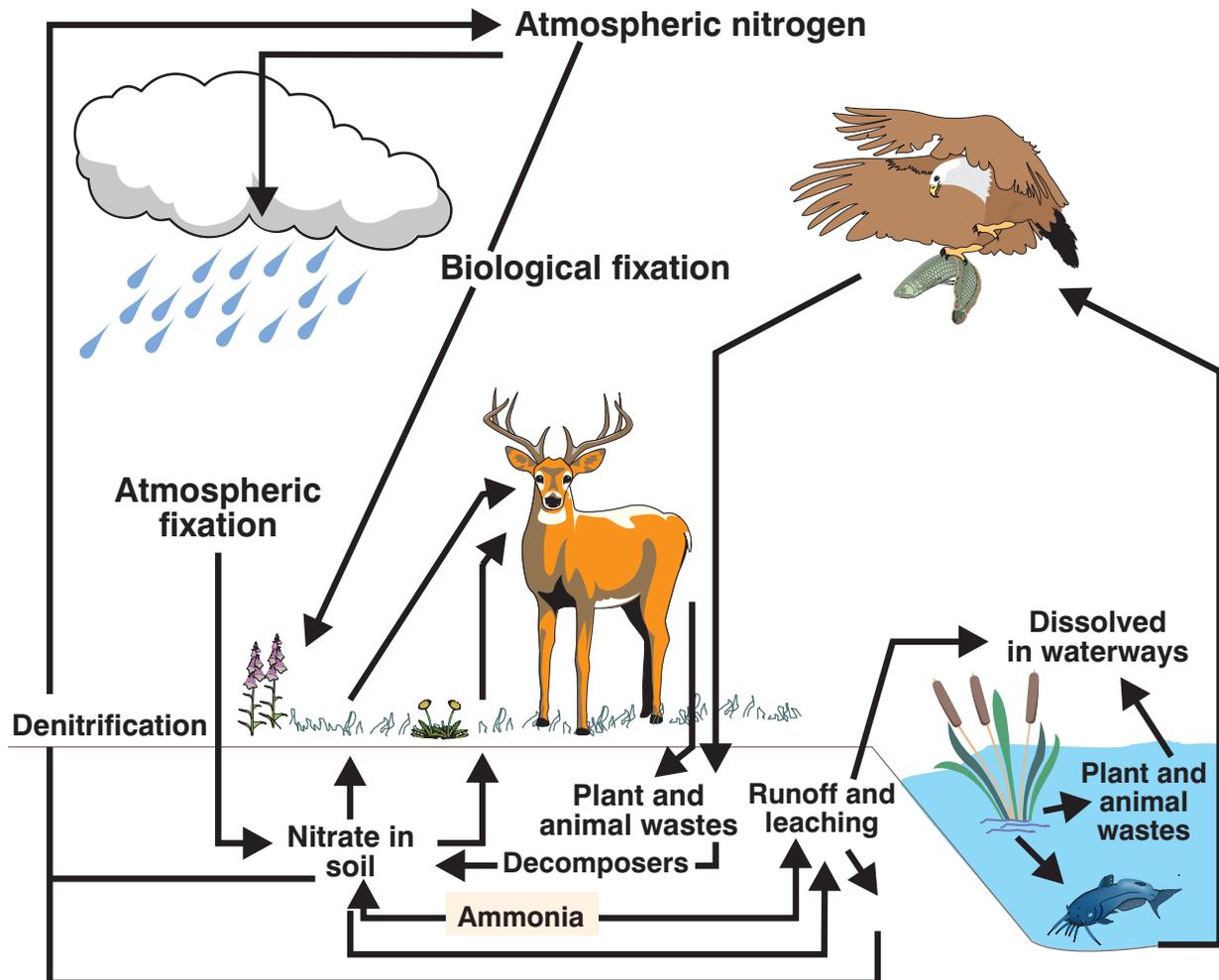
# **FACTORS THAT AFFECT WATER QUALITY**

- ◆ **Water Chemistry**—all molecules dissolved in the water
- ◆ **Water Physical Characteristics**—controlled by temperature
- ◆ **Water Biology**—all living organisms in the water

# COMMON METHODS OF AERATING PONDS

- ◆ **Splashing Water**
- ◆ **Pumping Air or Oxygen into the Water**
- ◆ **Spraying the Water into the Air**
- ◆ **Using Chemicals**

# THE NITROGEN CYCLE



(Courtesy, Interstate Publishers, Inc.)

# **FACTORS AFFECTING AMMONIA TOXICITY**

- ◆ **Increase in Temperature**
- ◆ **The pH becomes more alkaline.**
- ◆ **Dissolved Oxygen Decreases**
- ◆ **Carbon Dioxide Increases**
- ◆ **Salinity Decreases**

# **SOURCES OF COMPOUNDS THAT AFFECT WATER QUALITY**

- ◆ **Phosphorus – waste material including municipal sewage**
- ◆ **Chlorine – municipal chlorinated water**
- ◆ **Heavy Metals – pollution from manufacturing or illegal dumping**