Unit 2 Final Exam Review Package: Aquatic Ecosystems

Introduction

Welcome to your final exam review for Unit 2: Aquatic Ecosystems. This package has been carefully designed to help you consolidate your knowledge and prepare for your upcoming exam. By summarizing the unit's key concepts, defining its critical terminology, and providing a range of practice questions, this document will guide you through a comprehensive review. Use this tool to organize your notes, identify areas for further study, and build confidence in your understanding of the complex and fascinating world of aquatic science.

1.0 Key Terminology Glossary

1.1 Introduction to Key Terms

Mastering the scientific vocabulary of a topic is the first and most critical step toward understanding it deeply. A strong command of the terms listed below is the foundation upon which all complex ecological concepts are built. Knowing these definitions will enable you to interpret questions correctly, formulate precise answers, and discuss aquatic ecosystems with clarity and confidence.

1.2 Glossary Table

Term	Definition
Hydrologic Cycle	A continuous process that describes how water moves through a series of interconnected stages.
Evaporation	The process by which liquid water on the Earth's surface is converted into water vapor and rises into the atmosphere.
Transpiration	The release of water vapor from plants through their leaves.
Evapotranspiration	The combined processes of evaporation and transpiration.
Condensation	The process of water vapor transforming from a gas back into a liquid state, a critical step in cloud formation.
Precipitation	Water that falls back to Earth in various forms, including rain, snow, sleet, or hail, when cloud droplets become too heavy.
Surface Runoff	Water that flows over the land and eventually collects in streams, rivers, lakes, and oceans.
Infiltration	The process of water soaking into the ground, where it can be stored as groundwater.
Freshwater Ecosystem	An aquatic ecosystem characterized by a low salt concentration, typically less than 1%.

Lentic System	An ecosystem in standing water, such as a lake or pond.
Lotic System	An ecosystem in flowing water, such as a river or stream.
Littoral Zone	The shallow area near the shore of a lake where sunlight reaches the bottom, allowing rooted plants to thrive.
Limnetic Zone	The well-lit, open-water surface layer of a lake, dominated by phytoplankton.
Profundal Zone	The deep, dark, and cold area of a lake where no photosynthesis occurs.
Epilimnion	The warm, sunlit, well-mixed surface layer of a thermally stratified lake.
Metalimnion (Thermocline)	The middle layer of a stratified lake characterized by a sharp and rapid drop in temperature, acting as a density barrier.
Hypolimnion	The deepest and coldest layer of a stratified lake, often low in oxygen.
River Continuum Concept	A model used to describe and predict the continuous shift in ecological characteristics of a river from its headwaters to its mouth.
Wetlands	Ecosystems such as marshes, swamps, bogs, and fens.
Marsh	A wetland characterized by herbaceous plants like grasses and reeds, which act as natural filters.
Swamp	A forested wetland dominated by woody plants like trees, which aid in flood control.
Bog	An acidic, nutrient-poor wetland whose primary water source is precipitation.
Fen	A wetland that is less acidic than a bog and is fed by groundwater and runoff.
Marine Ecosystem	Saltwater ecosystems covering over 70% of the planet, with organisms categorized by movement.
Plankton	Passive drifters in the water column, including phytoplankton and zooplankton.
Nekton	Organisms that are free-swimmers, such as fish and whales.
Benthos	Bottom-dwelling organisms, such as crabs and clams.
Estuary	A highly productive transition zone where freshwater from a river meets saltwater from the ocean, serving as a crucial nursery habitat for many species.
Brackish Water	A mixture of freshwater and saltwater found in estuaries.
Riparian Zone	The critical transitional area of land along the banks of a water body that performs numerous ecological functions like filtration and bank stabilization.

Universal Solvent	A property of water, whose polar structure allows it to dissolve a wide range of minerals, gases, and nutrients.
Density (of water)	A physical property of water; it is most dense at 4°C, a key driver of lake turnover.
Turnover (in lakes)	The seasonal mixing of a lake's entire water column, which occurs in fall and spring when the water reaches a uniform density.
Turbidity	A measure of water cloudiness caused by suspended particles like soil or rock silt.
Glacial Flour	Fine-grained rock silt that causes turbidity in mountain-fed rivers.
Dissolved Oxygen (DO)	The amount of oxygen gas dissolved in water, added by diffusion and photosynthesis and removed by respiration and decomposition.
Alkalinity	The ability of a body of water to resist changes in pH; its buffering capacity.
Phosphorus Cycle	The biogeochemical cycle of phosphorus, the primary driver of productivity in many aquatic ecosystems.
Internal Loading	The release of stored phosphorus from bottom sediments back into the water, which occurs under anoxic (no oxygen) conditions.
Nitrogen Cycle	A complex, microbially-driven process involving the conversion of nitrogen between various chemical forms.
Nitrogen Fixation	The conversion of atmospheric nitrogen gas (N_2) into ammonia by certain bacteria.
Nitrification	The conversion of ammonium to nitrate, a process that requires oxygen.
Denitrification	The conversion of nitrate back to atmospheric nitrogen gas (N_2), which occurs in anoxic conditions.
Cultural Eutrophication	The human-caused acceleration of nutrient enrichment in a body of water.
Oligotrophic	Describes a body of water that is nutrient-poor, clear, deep, and has high oxygen levels.
Eutrophic	Describes a body of water that is nutrient-rich, murky, shallow, and has low oxygen (anoxic) conditions in its deeper layers.

1.3 Concluding Transition

Now that you have reviewed the essential vocabulary, the next section will place these terms into a broader conceptual framework, showing how they connect to form the major ideas of this unit.

2.0 Core Concepts Summary

2.1 Introduction to the Unit Outline

This section provides a high-level summary of the entire unit, organized by chapter. It is designed to act as a scaffold for your studying, helping you to connect individual topics into a coherent narrative. Use this outline to structure your review, organize your class notes, and see the big picture of how different concepts relate to one another.

2.2 Chapter 2: The Hydrologic Cycle

- **Key Processes**
    - **Evaporation and Transpiration:** Solar energy drives **evaporation**, turning liquid water into vapor. Plants release water vapor through **transpiration**. Together, this is called **evapotranspiration**.
    - **Condensation and Precipitation:** Water vapor cools in the atmosphere and undergoes **condensation** to form clouds. When water droplets become too heavy, they fall as **precipitation** (rain, snow, etc.).
    - **Runoff and Infiltration:** Precipitation either flows over the land as **surface runoff** into rivers and lakes or soaks into the ground through **infiltration**, becoming groundwater.

2.3 Chapter 3: Types of Aquatic Ecosystems

- **Freshwater Ecosystems** (low salt concentration)
    - **Lentic Systems (Standing Water):** Lakes and ponds are divided into distinct zones.
        - **Light Zones:** The shallow, productive **Littoral Zone** near the shore; the open-water, well-lit **Limnetic Zone**; and the deep, dark **Profundal Zone**.
        - **Thermal Layers (Stratification):** During summer, intense solar radiation heats the surface water, which becomes less dense and floats on top of the colder, denser deep water, creating three distinct layers:
            - The warm, mixed surface layer is the **Epilimnion**.
            - The middle layer with a sharp temperature drop is the **Metalimnion (Thermocline)**.
            - The deep, cold bottom layer is the **Hypolimnion**.
    - **Lotic Systems (Flowing Water):** Rivers and streams are understood through the **River Continuum Concept**.
        - **Zones:** The cold, fast-flowing **Source Zone**; the wider, warmer **Transitional Zone**; and the broad, slow, nutrient-rich **Floodplain Zone**.
    - **Wetlands:**
        - **Marshes:** Dominated by grasses and reeds.

        - **Swamps:** Dominated by woody trees and shrubs.
        - **Bogs:** Acidic, nutrient-poor, and fed by precipitation.
        - **Fens:** Less acidic, fed by groundwater.
- **Marine Ecosystems**
    - Organisms are categorized by movement: **Plankton** (drifters), **Nekton** (swimmers), and **Benthos** (bottom-dwellers).
- **Estuaries**
    - These are highly productive transition zones where freshwater rivers meet saltwater oceans, creating **brackish water**. They serve as crucial nursery habitats.
- **The Riparian Zone**
    - This is the land along the banks of a water body. Its six key functions are:
        - **Water Filtration:** (Plant roots trap sediment and pollutants from runoff)
        - **Bank Stabilization:** (Root networks bind soil to prevent erosion)
        - **Flood Control:** (Acts as a natural sponge, absorbing and storing excess water)
        - **Temperature Regulation:** (Overhanging vegetation provides shade, keeping water cool)
        - **Biodiversity Support:** (Provides critical habitat and corridors for wildlife)
        - **Nutrient Cycling:** (Processes excess nitrogen and phosphorus, preventing them from entering the water)

2.4 Chapter 4: Abiotic Characteristics

- **Physical Foundation**
    - **Universal Solvent:** Water's polarity allows it to dissolve essential nutrients and minerals.
    - **Density:** Water is most dense at 4°C, a unique property that drives seasonal mixing.
    - **Turnover:** In spring and fall, the uniform temperature and density of lake water allows wind to mix the entire water column, distributing oxygen.
    - **Turbidity:** A measure of water cloudiness, caused by suspended particles like soil or **glacial flour**.
- **Chemical Foundation**
    - **Dissolved Oxygen (DO):** Enters water via diffusion and photosynthesis. Cold water holds more DO than warm water.
    - **pH and Alkalinity: Alkalinity** is the water's buffering capacity, or its ability to resist changes in pH.
    - **Phosphorus Cycle:** Phosphorus is the primary driver of productivity. **Internal loading** occurs when phosphorus is released from sediments in anoxic conditions.

    - **Nitrogen Cycle:** This cycle involves three main steps: **Nitrogen Fixation** (N_2 to ammonia), **Nitrification** (ammonium to nitrate), and **Denitrification** (nitrate to N_2).
- **Cultural Eutrophication**
    - This is the human-caused acceleration of nutrient enrichment.
    - It causes lakes to shift from a clear, nutrient-poor (**Oligotrophic**) state to a murky, nutrient-rich (**Eutrophic**) state, as seen in the Lake Winnipeg case study.

Avoiding a Common Error: Nutrient Feedback Loops vs. Demographic Traps

A "Demographic Trap" refers to human populations, a concept from a different unit. In aquatic systems, the equivalent concern is the **"Nutrient Feedback Loop."** This is the dangerous cycle where anoxia (lack of oxygen) in deep water triggers the release of phosphorus from sediments (internal loading), which in turn fuels even more algal blooms and worsens the anoxia.

2.5 Concluding Transition

Having reviewed the core concepts of the unit, you are now ready to apply and test your knowledge with the practice questions that follow.

3.0 Practice Questions

3.1 Introduction to Practice Application

Actively applying your knowledge is one of the best ways to prepare for an exam. This section provides a variety of questions to test different aspects of your understanding. The Fill-in-the-Blanks test your recall of key terms, the Short Answer questions assess your comprehension of core concepts, and the Multiple Choice questions challenge your ability to analyze and synthesize information.

3.2 Part A: Fill-in-the-Blanks

Complete the following sentences with the most appropriate term from the unit.

1. The combined processes of evaporation and the release of water vapor from plants are often referred to as _____.
2. The _____ zone of a lake is the shallow area near the shore where sunlight reaches the bottom, allowing rooted plants to thrive.
3. The middle layer of a stratified lake, characterized by a sharp and rapid drop in temperature, is called the _____.
4. A wetland dominated by woody plants like trees and shrubs is known as a _____.

5. _____ are unique transition zones where freshwater from rivers meets saltwater from the ocean, creating brackish water.
6. Because its polar structure allows it to dissolve many substances, water is known as the _____.
7. _____ is a measure of water cloudiness often caused by suspended particles like soil runoff or glacial flour.
8. The ability of a body of water to resist changes in pH is known as its _____.
9. Under anoxic conditions, the release of stored phosphorus from bottom sediments back into the water is a process called _____.
10. A nutrient-poor, clear, deep lake with high oxygen levels is described as _____.

3.3 Part B: Short Answer Questions

Answer the following questions in 2-4 complete sentences, drawing on your knowledge from the unit.

1. Describe the three zones of a lake (a lentic system) that are based on light penetration.
2. Explain the concept of “lake turnover” and why it is important for a lake’s health.
3. List and briefly explain three ecological functions of a riparian zone.
4. Contrast the characteristics of an oligotrophic lake with those of a eutrophic lake.
5. Explain how anoxia in the hypolimnion can lead to “internal phosphorus loading”.

3.5 Concluding Transition

Take a moment to review your responses before proceeding to the final section, where you will find the complete answer key.

4.0 Answer Key

4.1 Introduction to the Answer Key

Use this answer key as a tool for learning. If you answered a question incorrectly, don't just memorize the right answer. Instead, return to the source material or the concept summaries in this package to understand *why* the provided answer is correct. This process of identifying and correcting misunderstandings is the most effective way to study.

4.2 Answers to Part A: Fill-in-the-Blanks

1. Evapotranspiration
2. Littoral
3. Metalimnion (or Thermocline)
4. Swamp
5. Estuaries
6. Universal Solvent
7. Turbidity
8. Alkalinity
9. Internal Loading
10. Oligotrophic

4.3 Answers to Part B: Short Answer Questions

1. The three light-based zones of a lake are the Littoral, Limnetic, and Profundal zones. The **Littoral zone** is the shallow, near-shore area where light reaches the bottom, supporting rooted plants. The **Limnetic zone** is the well-lit, open-water surface layer dominated by phytoplankton. The **Profundal zone** is the deep, dark, cold bottom area where no light penetrates and life depends on sinking organic matter.
2. Lake turnover is the process where the entire water column mixes, which occurs in the spring and fall. During these seasons, the lake water reaches a uniform temperature and density (around 4°C), allowing wind to mix the oxygen-rich surface water with the nutrient-rich deep water. This process is vital for replenishing oxygen in the deep hypolimnion, which is essential for the survival of many organisms.
3. Three key functions of a riparian zone are **water filtration**, where plant roots trap sediment and pollutants from runoff; **bank stabilization**, where root networks bind soil to prevent erosion; and **temperature regulation**, where overhanging vegetation provides shade that keeps water cool, increasing its capacity to hold dissolved oxygen.
4. An **oligotrophic** lake is nutrient-poor, has high water clarity (clear), is typically deep, and has high levels of dissolved oxygen throughout. In contrast, a **eutrophic** lake is nutrient-rich, has low water clarity (murky), is often shallow, and suffers from low oxygen (anoxic) conditions in its hypolimnion, especially during summer stratification.
5. Anoxia (a lack of oxygen) in the hypolimnion triggers a chemical change in the bottom sediments. Under oxygenated conditions, phosphorus is bound to other molecules in the sediment. When oxygen is depleted due to decomposition, these chemical bonds break, releasing the stored phosphorus from the sediments back into the water column. This process, known as internal loading, provides a new source of nutrients that can fuel further algal blooms.