



AP* ENVIRONMENTAL SCIENCE

AQUATIC BIOMES

Student Packet

Aquatic Biomes

Biomes are large geographical areas that have similar plant and animal communities. The locations of terrestrial biomes are determined by temperature and precipitation. However, aquatic biomes are generally divided into two groups based on the absence or presence of salt. **Marine biomes** generally have a salt concentration greater than 3%, whereas **freshwater biomes** have a salt concentration that is less than 1% .

Several properties of water have allowed life to flourish within these biomes. The ability of water to stabilize temperature depends on its relatively high **specific heat**. The buoyant force that water provides on submerged objects minimizes the energy spent by organisms in the constant struggle against gravity. In addition, dissolved nutrients are easily obtained by aquatic organisms. Nutrient availability, **dissolved oxygen** content, and access to sunlight determine where aquatic organisms can live.

Freshwater Biomes

Runoff of precipitation from **watersheds** provides the water for freshwater biomes. Freshwater biomes can be grouped in two distinct categories. The first category is standing water or **lentic ecosystems**, which consist of lakes, ponds, and inland wetlands.

Lakes are classified by their rate of primary productivity:

1. **Oligotrophic Lake** – very low primary productivity; generally considered nutrient-poor; newly formed or located in cold regions; high dissolved oxygen
2. **Mesotrophic Lake** – fall somewhere between oligotrophic and eutrophic lakes in productivity
3. **Eutrophic Lake** - high primary productivity; contain large communities with diverse populations; often older lakes

Eutrophic lakes are often caused by an influx of limiting nutrients such as nitrates and phosphates. This anthropogenic cause is called **cultural eutrophication**.

The waters of these freshwater lakes can be defined based on thermal characteristics.

Thermal Zones (Fig. 1):

Epilimnion

warm upper layer of water with high levels of dissolved oxygen

Hypolimnion

lower, colder, denser layer that is not exposed to atmosphere which leads to a lower dissolved oxygen content

Thermocline

the region between the two layers that has a rapid temperature change

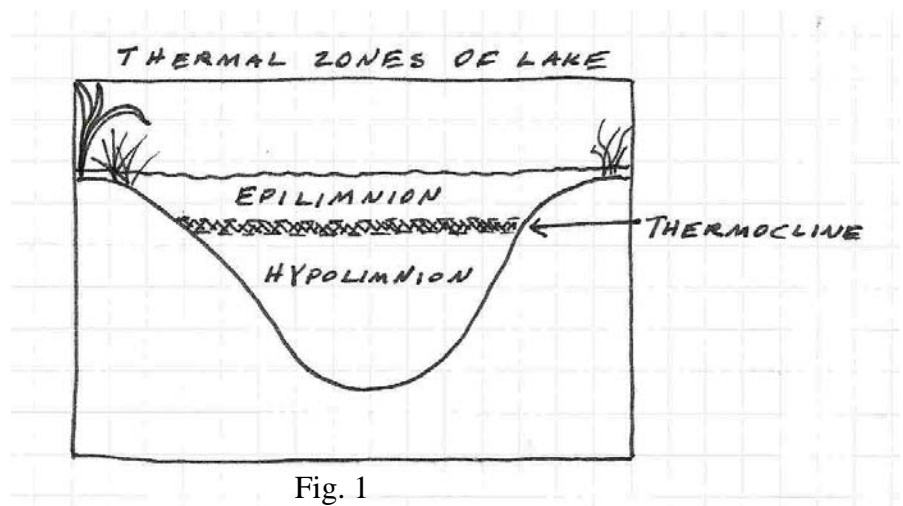


Fig. 1

The waters of freshwater lakes can also be defined based upon depth and distance from the shoreline (Fig. 2). The **littoral zone** is the shallow area near the shore. Plants can take root and thrive in this area. The **limnetic zone** is the open surface water of the lake past the littoral zone. Together the limnetic and littoral zones make up the **photic** or **euphotic** zone (light-penetrating zone). Plankton (small, drifting organisms) are common here. They consist of **phytoplankton** (autotrophic) and zooplankton (heterotrophic). The **profundal zone** is the deep water beneath the limnetic zone and does not receive light (**aphotic**). The **benthic zone** lies at the bottom of the lake. The organisms that live here rely on detritus for energy.

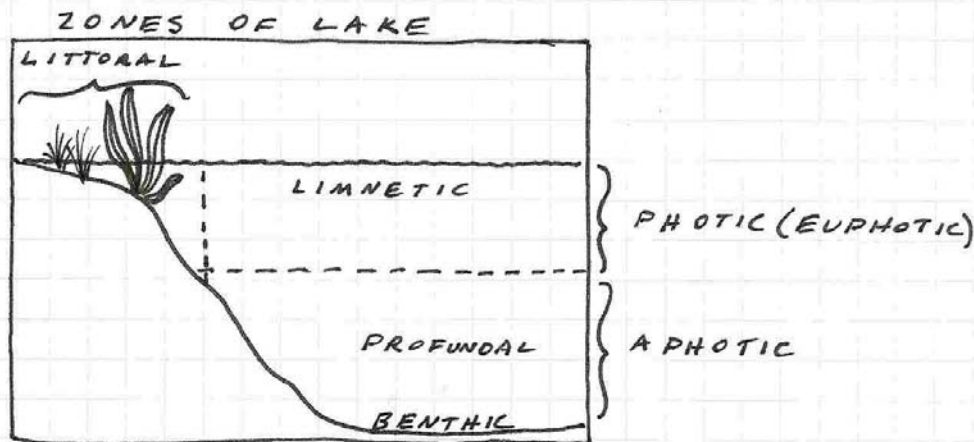


Fig. 2

Inland wetlands are lands covered with fresh water all or part of the year. These include marshes, swamps, bogs, prairie potholes, and floodplains. They have great ecological and economic importance. These include wildlife habitat, charge zones for aquifers, filter water to improve quality, reduce erosion, and contribute to the biogeochemical cycles. Inland wetlands have been greatly reduced by man. Agriculture is the chief contributor to the loss of wetlands. Urban development has also played a role in wetland degradation.

The second category of freshwater biomes is flowing water or **lotic ecosystems**. These include streams and rivers. Rivers typically have three phases that they undergo as they flow towards the sea. Many rivers' headwater or **source** originates in the mountains. The river here is cold, narrow, and turbulent. Dissolved oxygen is high, while primary productivity is low. Organisms found here have to be well adapted to fast-moving water. Further downstream, the river enters a **transition zone** where it slows, widens and often becomes deeper. This promotes production, and supports a more diverse community. Once the river enters the **flood plain** it is very broad and moves very slowly. Dissolved oxygen is much lower at this point.

Marine Biomes

Marine biomes consist of coastal ocean, open ocean, coral reefs, estuaries, coastal marshes, and mangrove swamps.

Oceans cover over 70% of earth's surface. They regulate earth's climate by distributing heat throughout the world on ocean currents. The ocean is divided vertically into the **intertidal** zone, the **neretic** zone, and the **oceanic** zone (Fig. 3). The intertidal zone is the land that is exposed at low tide and covered at high tide. Organisms here must be very tolerant to harsh, extremely varying conditions. The neretic zone is the ocean covering the continental shelf. Although this makes up only ten percent of the ocean, it contains over ninety percent of the ocean's organisms. The oceanic zone is the waters past the continental shelf and is much less productive. **Nektonic** (strong-swimming) organisms swim long distances through this "desert" in search of food. The ocean can also be divided as shown below (Fig. 3). In this way it is separated into the euphotic, aphotic, abyssal, and hadal regions.

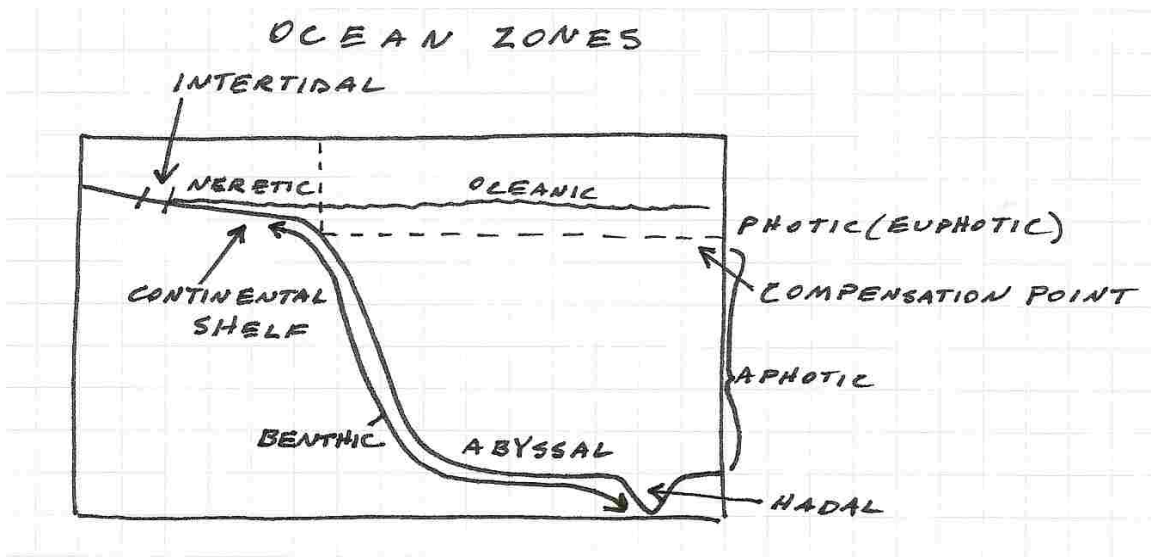


Fig. 3

Coral reefs are found in the clear, warm coastal waters of the tropics and subtropics. These have often been called the "rainforest" of the marine ecosystems due to their high diversity. The foundation of these unique ecosystems is the calcium carbonate exoskeleton secreted by coral. This becomes the backbone of the reef which provides habitat for many species. These reefs are important nurseries for many species of fish. Coral reefs are currently under extreme pressure by man. This includes pollution, destruction for shipping channels, and even bleaching. **Coral bleaching** is due to an increase in water temperature which is attributed to global warming.

Estuaries, coastal marshes, and mangrove swamps are all found along the coast.



Estuaries are areas of coastal water where freshwater from rivers empty into the ocean. This creates brackish water that varies in salinity and temperature. The flowing water does, however, provide a constant supply of nutrients making this ecosystem one of the most productive. Estuaries are vital nurseries for oceanic fish and critical habitat for migratory birds.

Estuaries have been badly abused with pollution from agriculture runoff to over-fishing. Eutrophication has also led to **hypoxia** (reduction of dissolved oxygen) which leads to “**dead zones**”.

Coastal wetlands which include coastal marshes and **mangrove swamps** maintain the integrity of the shoreline by reducing erosion. They also provide areas for breeding and for the rearing of young fish and invertebrates. Mangrove swamps are found in the tropical areas of the world while coastal marshes are found more in temperate areas.

Almost forty percent of the world’s population lives within one hundred kilometers of the coast. This has caused coastal wetlands to be greatly degraded over the years. Habitat conversion, pollution, and introduction of invasive species are among some of the threats.



Multiple Choice

1. Which of the following is a direct cause of Coral Bleaching?
 - A. Increased water temperature
 - B. Acid Rain
 - C. Ozone depletion
 - D. Nuclear waste disposal
 - E. Shrimp trawling

2. Which of the following organisms are producers in aquatic ecosystems
 - A. Nekton
 - B. Zooplankton
 - C. Phytoplankton
 - D. Benthos
 - E. None of the above

3. Which of the following are benefits provided by coastal wetlands?
 - I. Wetlands are nurseries for many aquatic organisms
 - II. Wetlands filter toxic chemicals from water
 - III. Wetlands provide protection from storm surges
 - A. I only
 - B. II only
 - C. III only
 - D. I and III only
 - E. I, II, and III

4. Which of the following terms best describes the area that provides runoff to a stream, river, or lake?
 - A. Surface water
 - B. Watershed
 - C. Inland wetland
 - D. Littoral zone
 - E. Limnetic zone



Questions 5 – 9 refer to the following answer choices

- A. Euphotic Zone
 - B. Profundal Zone
 - C. Estuary
 - D. Intertidal Zone
 - E. Abyssal Zone
5. Area where a river meets the ocean
6. The area of the shore between high tide and low tide
7. The middle area of a freshwater lake in which there is not enough light for photosynthesis.
8. Organisms in this zone rely on dead and decaying material as a source of energy for most of its food chains.
9. The brightly lit portion of the ocean where photosynthesis occurs
10. All of the following are important areas for juvenile organisms to grow in relative safety except
- A. Coral reefs
 - B. Coastal wetlands
 - C. Estuaries
 - D. Euphotic zone
 - E. Mangrove forests



Free Response

1. Cultural Eutrophication is a process in which the natural eutrophication of a body of water is accelerated by human activity.
 - A. Describe the characteristics of oligotrophic and eutrophic lakes.

 - B. Identify and describe two ways that human activity causes cultural eutrophication.

 - C. Identify and describe a negative impact of cultural eutrophication.

 - D. Describe two ways that cultural eutrophication can be reduced.