Aquatic Biomes: Freshwater

Inquire: Aquatic Biomes: Freshwater

Overview

The abiotic factors important for the structuring of aquatic biomes can be different than those seen in terrestrial biomes. Sunlight is an important factor in bodies of water, especially those that are very deep, because of the role of photosynthesis in sustaining certain organisms. Other important factors include temperature, water movement, and salt content.

Freshwater biomes include lakes, ponds, rivers, streams, and wetlands. Estuaries are found where rivers meet the ocean; their shallow waters provide nourishment and shelter for young crustaceans, mollusks, fishes, and many other species. Bogs are also an interesting type of wetland, characterized by standing water, a lower pH, and a lack of nitrogen.

Big Question: What are the characteristics of standing water and flowing water in freshwater biomes?

Watch: Estuaries: Where the Ocean Meets Freshwater

Aquatic habitats at the intersection of marine and freshwater ecosystems have complex and variable salt environments that range between freshwater and marine levels. These are known as brackish water environments. Lakes located in closed drainage basins concentrate salt in their waters and can have an extremely high salt content that only a few and highly specialized species are able to inhabit.

Estuaries are biomes that occur where a river, a source of freshwater, meets the ocean; therefore, freshwater and saltwater are found in the same vicinity and mix, resulting in a diluted (or brackish) saltwater. Estuaries form protected areas of shallow waters where many of the offspring of crustaceans, mollusks, and fish begin their lives. Salinity is an important factor that influences the organisms and the adaptations of the organisms found in estuaries. The salinity of estuaries varies and is based on the rate of flow of its freshwater sources. Once or twice a day, high tides bring saltwater into an estuary. Low tides, occurring at the same frequency, reverse the current of saltwater.

The daily mixing of freshwater and saltwater is a physiological challenge for the plants and animals that inhabit estuaries. Many estuarine plant species are halophytes, which are plants that can tolerate salty conditions. Halophytic plants are adapted to deal with saltwater spray and saltwater on their roots. In some halophytes, filters in the roots remove the salt from the water that the plant absorbs. Animals, such as mussels and clams (phylum Mollusca), have developed behavioral adaptations that expend a lot of energy to function in this rapidly changing environment. When these animals are exposed to low salinity,
they stop feeding, close their shells, and switch from aerobic respiration (in which they use gills) to anaerobic respiration (a process that does not require oxygen). When high tide returns to the estuary, the salinity and oxygen content of the water increases, and these animals open their shells, begin feeding, and return to aerobic respiration.

**Read: Aquatic Biomes**

**Overview**

Freshwater biomes include lakes, ponds, and wetlands (standing water), as well as rivers and streams (flowing water). Humans rely on freshwater biomes to provide aquatic resources for drinking water, crop irrigation, sanitation, recreation, and industry. These various roles and human benefits are referred to as **ecosystem services**.

**Lakes and Ponds**

Lakes and ponds are found in terrestrial landscapes and are therefore connected with abiotic and biotic factors influencing these terrestrial biomes. Lakes and ponds can range in area from a few square meters to thousands of square kilometers. Temperature is an important abiotic factor affecting living things found in lakes and ponds. During the summer in temperate regions, thermal stratification of deep lakes occurs when the upper layer of water is warmed by the sun and does not mix with deeper, cooler water. The process produces a sharp transition between the warm water above and cold water beneath. The two layers do not mix until cooling temperatures and winds break down the stratification and the water in the lake mixes from top to bottom. During the period of stratification, most of the productivity occurs in the warm, well-illuminated, upper layer, while dead organisms slowly rain down into the cold, dark layer below where decomposing bacteria and cold-adapted species such as lake trout exist.

Like the ocean, lakes and ponds have a photic layer in which photosynthesis can occur. Phytoplankton (algae and cyanobacteria) are found here and provide the base of the food web of lakes and ponds. Zooplankton, such as rotifers and small crustaceans, consume these phytoplankton. At the bottom of lakes and ponds, bacteria in the aphotic zone break down dead organisms that sink to the bottom.

Nitrogen and phosphorus particularly are important limiting nutrients in lakes and ponds. Therefore, they are determining factors in the amount of phytoplankton growth in lakes and ponds. When there is a large input of nitrogen and phosphorus (e.g., from sewage and runoff from fertilized lawns and farms), the growth of algae skyrocket, resulting in a large accumulation of algae called an **algal bloom**. Algal blooms can become so extensive that they reduce light penetration in water. As a result, the lake or pond becomes aphotic, and photosynthetic plants cannot survive. When the algae die and decompose, severe oxygen depletion of the water occurs. Fishes and other organisms that require oxygen are then more likely to die.

**Rivers and Streams**

Rivers, and the narrower streams that feed into rivers, are continuously moving bodies of water that carry water from the source, or headwater, to the mouth at a lake or ocean. The largest rivers include the Nile River in Africa, the Amazon River in South America, and the Mississippi River in North America.

Abiotic features of rivers and streams vary along the length of the river or stream. Streams begin at a point of origin referred to as **source water**. The source water is usually cold, low in nutrients, and clear. The **channel** (the width of the river or stream) is narrower here than at any other place along the length of
the river or stream. Headwater streams are of necessity at a higher elevation than the mouth of the river and often originate in regions with steep grades leading to higher flow rates than lower elevation stretches of the river.

The faster-moving water and the short distance from its origin results in minimal silt levels in headwater streams; therefore, the water is clear. Photosynthesis here is mostly attributed to algae that are growing on rocks as the swift current inhibits the growth of phytoplankton. Photosynthesis may be further reduced by tree cover reaching over the narrow stream. This shading also keeps temperatures lower. An additional input of energy can come from leaves or other organic material that fall into a river or stream from trees and other plants that border the water. When the leaves decompose, the organic material and nutrients in the leaves are returned to the water. The leaves also support a food chain of invertebrates that eat them and are in turn eaten by predatory invertebrates and fish.

Some plants and animals have adapted to this fast-moving water. For instance, leeches have elongated bodies and suckers on both ends. These suckers attach to the substrate, keeping the leech anchored in place. In temperate regions, freshwater trout species may be an important predator in these fast-moving and colder rivers and streams.

As a river or stream flows away from the source, the width of the channel gradually widens, the current slows, and the temperature characteristically increases. The increasing width results from the increased volume of water from more and more tributaries. Gradients are typically lower when farther along the river, which accounts for the slowing flow. With increasing volume can also come increased silt, and as the flow rate slows the silt may settle, thus increasing the deposition of sediment. Phytoplankton can also be suspended in slow-moving water. Therefore, the water will not be as clear as it is near the source.

The water is also warmer as a result of longer exposure to sunlight and the absence of tree cover over wider expanses between banks. Worms (phylum Annelida) and insects (phylum Arthropoda) can be found burrowing into the mud. Predatory vertebrates (phylum Chordata) including waterfowl, frogs, and fish may be present. In heavily silt-laden rivers, these predators must find food in the murky waters, and, unlike the trout in the clear waters at the source, these vertebrates cannot use vision as their primary sense to find food. Instead, they are more likely to use taste or chemical cues to find prey.

When a river reaches the ocean or a large lake, the water typically slows dramatically and any silt in the river water will settle. When rivers with high silt content discharge into oceans with minimal currents and wave action, deltas (low-elevation areas of sand and mud) are built as the silt settles onto the ocean bottom. With rivers that have low silt content, or in areas where ocean currents or wave action are high, estuarine areas (where freshwater and saltwater mix) are created.

**Reflect Poll: Aquatic Biomes**

Which aquatic biomes near where you live most affect you and your life?

- Estuaries - provide seafood and places to boat, swim, and fish
- Freshwater - provide drinking water, recreation (such as river rafting and water sports), fishing, and farm irrigation
- Wetlands - provide fishing and shellfish, flood protection, and fruit and grains
Expand: Wetlands

Wetlands are environments in which the soil is either permanently or periodically saturated with water. They are the link between land and water. Wetlands differ from lakes and ponds because they exhibit a near continuous cover of emergent vegetation. Emergent vegetation consists of wetland plants that are rooted in the soil but have portions of leaves, stems, and flowers extending above the water's surface. There are several types of wetlands including marshes, swamps, bogs, mudflats, and salt marshes. Located in southern Florida, Everglades National Park is a vast array of wetland environments, including sawgrass marshes, cypress swamps, and estuarine mangrove forests. There are many programs aimed at restoring, enhancing, and protecting the wetlands.

Freshwater marshes and swamps are characterized by slow and steady water flow. In comparison, bogs develop in depressions where water flow is low or nonexistent and are characterized by standing water, a lower pH, and a lack of nitrogen. Bogs usually occur in areas where there is a clay bottom with poor percolation. Percolation is the movement of water through the pores in the soil or rocks. The water found in a bog is stagnant, not moving, and oxygen is depleted because the oxygen that is used during the decomposition of organic matter is not replaced. As the oxygen in the water is depleted, decomposition slows. This leads to organic acids and other acids building up and lowering the pH of the water. At a lower pH, nitrogen becomes unavailable to plants. This creates a challenge for plants because nitrogen is an important limiting resource. Some types of bog plants (such as sundews, pitcher plants, and Venus flytraps) capture insects and extract the nitrogen from their bodies. Bogs have low net primary productivity because the water found in bogs has low levels of nitrogen and oxygen.

Lesson Toolbox

Additional Resources and Readings

A segment from the program Aquatic Biomes: Oceans, Lakes, Rivers, and Wetlands
- Link to resource: https://www.youtube.com/watch?v=tU2F36Y3AdU;

A video talking about estuaries
- Link to resource: https://www.youtube.com/watch?v=qrYQFdukGMg;

A video talking about animals living in the wetlands
- Link to resource: https://www.youtube.com/watch?v=ShoRQ8D-vwE;

Lesson Glossary

algal bloom: a rapid increase of algae in an aquatic system
channel: the bed and banks of a river or stream
ecosystem services: the human benefits provided by natural ecosystems
emergent vegetation: plants living in bodies of water that are rooted in soil but have portions of leaves, stems, and flowers extending above the water's surface
source water: the point of origin of a river or stream
wetlands: environment in which the soil is either permanently or periodically saturated with water
Check Your Knowledge

1. Estuaries are coastal areas where saltwater and freshwater mix.
   a. True
   b. False

2. Drylands are environments in which the soil is either permanently or periodically saturated with water.
   a. True
   b. False

3. Temperature is not an important abiotic factor affecting living things found in lakes and ponds.
   a. True
   b. False

Answer Key:

Citations

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