Ecosystems & Ecophysiology − Lecture 2

FRESHWATER ECOSYSTEMS

Rivers & Lakes & Ponds& Estuaries

Nearly ¾ of the Earth's surface is covered with water. Oceans, streams, lakes, and marshes contain a wide variety of communities. These aquatic communities are supported by biotic and abiotic factors, including light, nutrient availability, and oxygen. Aquatic ecosystems are determined by the depth, flow, temperature, and chemistry of the overlying water. Only 3% of the surface water on Earth is fresh water.

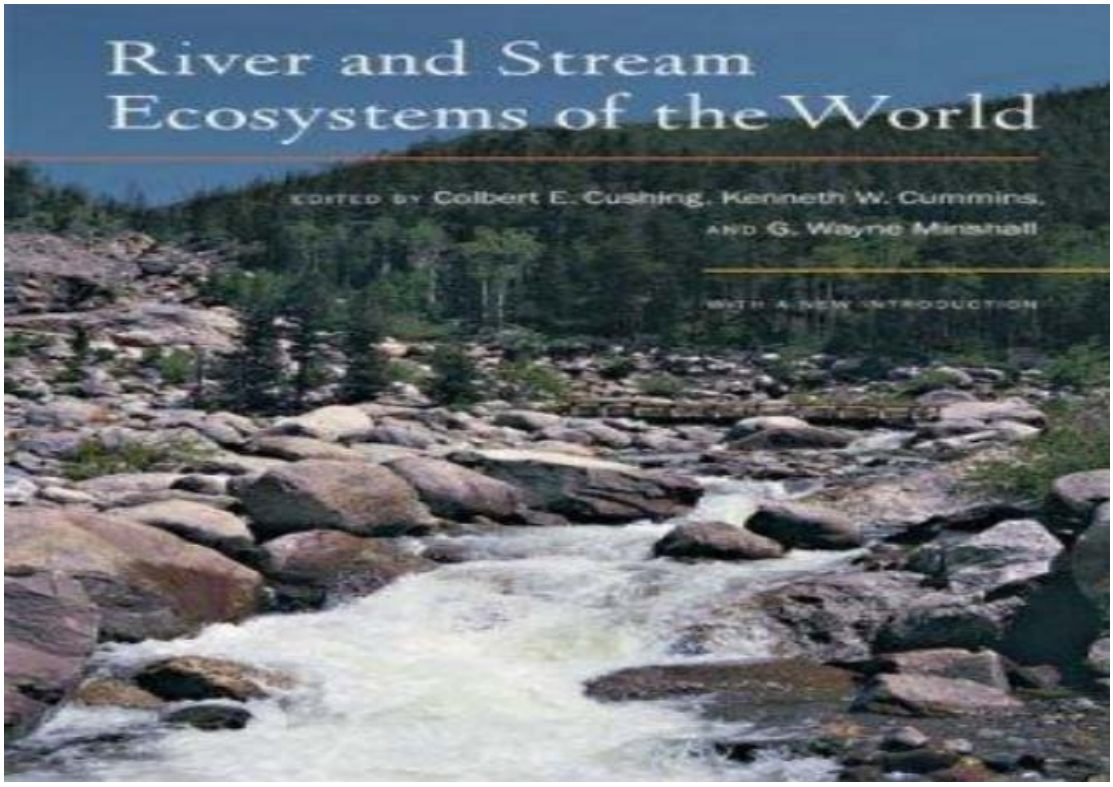
Freshwater ecosystems can be divided into two main types: flowing-water ecosystems and standing-water ecosystems.

1. **Flowing-Water Ecosystems**

This includes rivers, streams, creeks, and brooks which flow over land. The organisms that live in these environments are well adapted to the rate of flow. There is little plant life near the source but plenty of dissolved oxygen. With the flow downhill, sediments are picked up which enable plants to establish themselves. As the flow slows down, animal life such as beavers, otters, and turtles can make their home.

Rivers

Rivers have small volume but important for biodiversity, including evolution of several invertebrate groups. Average River replaces its water 20 times per year. Biology of a river depends on rate of flow and quality of water. The basic feature of river ecosystems is a predictable change of physical characteristics, habitats and organisms with stream order.



Energy inputs

1.Primary production :

Phytoplankton is not limited by nutrients. Often a bloom where a river enters a lake shows that its water had sufficient nutrients. **Attached primary producers** limited by low light in higher order streams, from turbidity and sediments. **Flowering plants** may also be damaged by high flow, macroalgae more resistant. **Moss** may be important, especially at low light levels in shaded streams, also **Attached algae**. **Algae** are the most important primary producers in most streams & rivers, including **filamentous** green algae, & **unicellular** green algae & **diatoms**.

2.Secondary production

Detritus is often the most important energy source, especially in shaded streams, imported as dead leaves from surroundings. **Detritivores** are most important consumers in rivers. Detritus is low quality food, low nitrogen & high cellulose and lignin which animals cannot digest. **Macrophytes** usually consumed as detritus after death, not as live tissues.

2.Standing-Water Ecosystems

This includes lakes and ponds. Water flows in and out and circulates within. This helps to distribute oxygen, nutrients, and heat. Plankton live in these environments since there is standing water.

Plankton is a general term for the tiny, free floating organisms that live in both freshwater and saltwater environments. Unicellular algae or phytoplankton are supported by nutrients. Planktonic animals, or **zooplankton** feed on the phytoplankton.

lakes & ponds

Separation of lakes & ponds attempted by penetration of light to bottom , or development of thermal stratification. Lake needs a source of water & a depression. Africa has 20 times greater volume of lakes than S. America, but lower rainfall.

Geologically three types:

1. Depressions in bedrock:

a) **Glacial**– Northern Europe & North America. Great Lakes of the USA. Low nutrients
b) **Volcanic**– crater lakes, often large inorganic inputs
c) **Tectonic**– Rift lakes , where sections of crust sink or rise along faults.

2. Depressions in sediment, more nutrients available:

a) **Glacial** sediments – meres in Lake District
b) **Fluvial** sediments – oxbow lakes, isolated bends of river

3. Barrier lakes, usually less permanent:

a) Inland– landslides, lava flows, ice barriers, glacial moraine
b) Coastal sand bars– lagoons with fw inflow (i.e. estuaries) eventually become fw if connection to the sea is closed.

Light Little sediment or turbidity in lakes, light restricted by humic solutes or phytoplankton. Dense algal bloom can limit light to top few cm. If light reaches bottom then macrophytes & benthic algae grow.

Nutrient status determines productivity in lakes:

1. Oligotrophic lakes have low nutrients, low phytoplankton, clear water, well oxygenated as little detritus to decompose.
2. Eutrophic lakes have high nutrients, high phytoplankton or macrophytes, reduced oxygen (even anoxia) if deep.

Depends on ponds size:

1. **Small** ponds limited by disturbance. Only support tolerant species, and those best adapted for dispersal.
2. **Medium** ponds determined by competition, as large numbers of snails build up, consume available plant food.

Freshwater Wetlands

A **wetland** is an ecosystem in which water either cover the soil or is present at or near the surface of the soil for at least part of the year. Can be flowing, standing and fresh, salty, or brackish. Are productive ecosystems that serve as breeding grounds for insects, fishes and other aquatic animals, amphibians, and migratory birds.

There are three main types of freshwater wetlands:

1.Bogs

Dominated by sphagnum moss and form in depressions where water collects.

2.Marshes

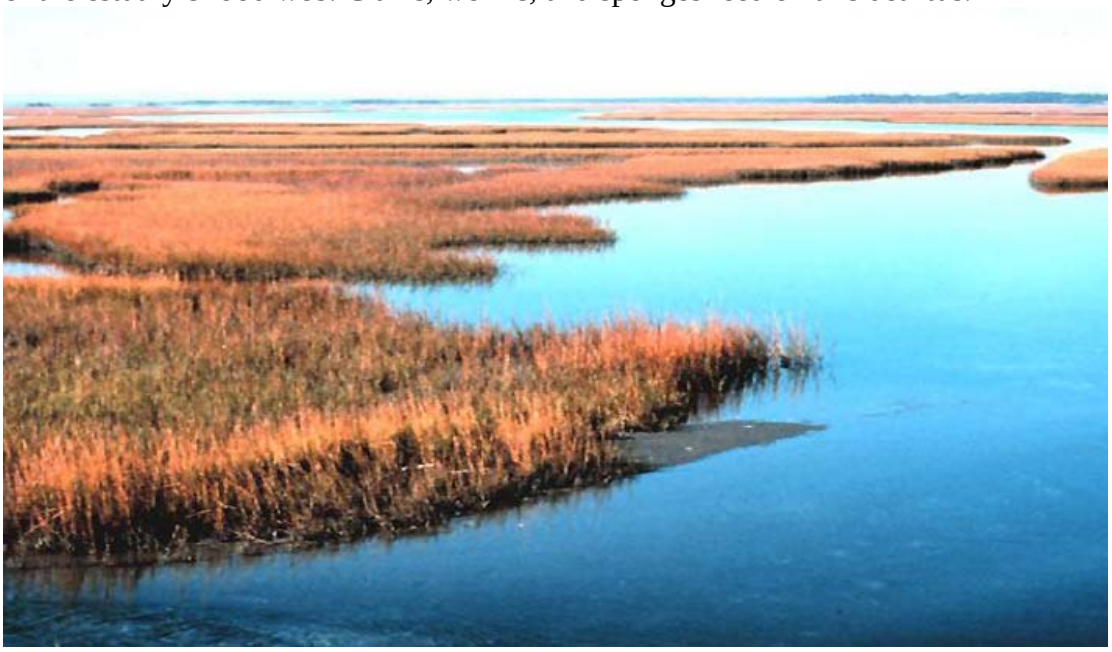
Shallow wetlands along rivers that contain grasslike plants.

3.Swamps

Water flows slowly through this and looks like flooded forests. The presence of trees and shrubs is what distinguishes a swamp from a marsh.

Estuaries

Estuaries are wetlands formed where rivers meet the sea. Contain a mixture of fresh water and salt water. Affected by the rise and fall of ocean tides. Many are shallow to sunlight can reach the bottom to allow photosynthesis. **Primary producers** are algae, plants, and photosynthetic and chemosynthetic bacteria.Much of the organic material enters the food web as detritus. **Detritus** provides food for the organisms at the base of the estuary's food web. Clams, worms, and sponges feed on this detritus.



There are two key features affecting organisms:

1. variable salinity levels from mixing waters, and
2.sediment deposition & movement. Estuaries are heterotrophic, respiration > production, especially where turbidity limits light.

Types of estuary

Four types based on salinity profiles:

1. Salt-wedge. River flow strong, > tidal flows. Fw less dense than sw so spreads over sea, with a sharp change in salinity between the two.

2. Well-mixed. River flow low, < tidal flows. Tidal flows play the major part in mixing fw and sw.

3. Partially-mixed. River flow strong, strong tidal flows. Tides force **sw** upwards, and **fw** pulled down by turbulence.

4. Negative. River flow low & high evaporation, only in the tropics. Creates hypersaline water at head of estuary, more dense than sw, sinks and flows seaward along bottom

Energy inputs

1.**Primary production**

Estuaries are productive. **Phytoplankton** often higher than fw or the sea, limited by light, not nutrients. Turbidity gives low light penetration, but nutrients often abundant. Fw often deficient in phosphorus, while sw lacks nitrogen & silica, so mixing increases productivity in estuary. **Macrophytes** also limited by low light, &

macroalgae also by soft sediments. **Diatoms** & **cyanobacteria** form mats on surface of mud. Diatoms live at surface of mud; migrate to surface at low tide to photosynthesis . **Diatoms** may make up a large proportion of surface sediments, important productivity.

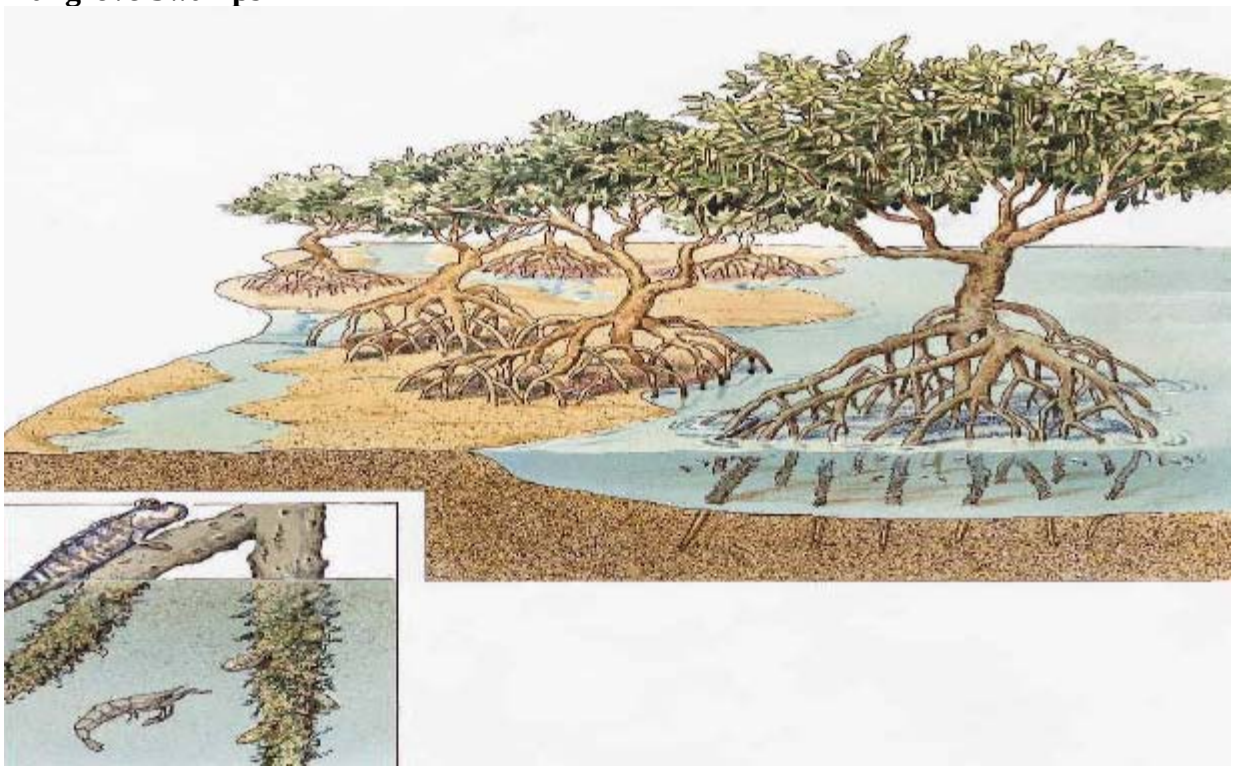
2.Secondary production

Detritus: Dead organic matter (DOM) produced by the breakup of organisms, as small particles suspended in the water or resting on the bottom. Is the other main energy input - the dominant source of energy in many aquatic systems.

Salt marshes

Salt marshes are temperate zone estuaries dominated by salt-tolerant grasses above the low tide line and by sea grasses under water.

Mangrove Swamps



Coastal wetlands found in tropical regions such as Florida. Dominant plants are salt-tolerant trees called mangroves. Sea grasses common at low tide. Largest example is the Everglades.