

Ch. 8 - Aquatic Ecology

Coral Reefs: the aquatic equivalent of the tropical rain forests

The two major aquatic life zones are determined by salinity:

saltwater or marine (estuaries, coastlines, coral reefs, coastal marshes, mangrove swamps, ocean over the continental shelf, deep ocean)

freshwater (lakes, ponds, streams, rivers, inland wetlands)

Aquatic Life Zone Organisms

plankton - weak swimming, free-floating

phytoplankton - photosynthetic cyanobacteria, algae; producers

nanoplankton - recently discovered

zooplankton - nonphotosynthetic primary consumers (herbivores); feed on phytoplankton or secondary consumers that feed on other zooplankton.

nekton - strong swimming consumers (fish, turtles, whales)

benthos - bottom dwelling creatures (barnacles, oysters, worms, lobsters)

decomposers (bacteria) - break down organic compounds into simple nutrients.

Unique Properties of Water - How they affect aquatic life.

buoyancy - provides physical support

limited fluctuation in temperature - reduces risk of freezing or overheating

nutrients - are soluble and readily available

potentially toxic material - is diluted and dispersed

Factors that limit aquatic life at different depths (surface, middle and bottom layers)

temperature - little fluctuation; organisms have limited ability to withstand temperature fluctuations.

access to sunlight - can penetrate onto to a depth of 100 feet; confined to upper layer - euphotic zone

dissolved oxygen content - enters from the atmosphere & photosynthesis; removed by aerobic respiration; can vary widely; $[O_2]$ and $[CO_2]$ vary with depth due to differences in rates of photosynthesis and respiration.

availability of nutrients (CO_2 , NO_3^- and PO_4^{3-}) - NO_3^- (nitrate) and PO_4^{3-} (phosphate) are sufficient in shallow waters; but in short supply in open ocean;

PO_4^{3-} is most limiting nutrient in freshwater ecosystems.

NO_3^- is the most limiting nutrient in saltwater ecosystems

Saltwater Life Zones

Oceans

71% of earth's surface

currents distribute solar heat

regulate the earth's climate

participate in nutrient cycles

reservoir for carbon dioxide - thus help regulate temperature of the troposphere

250,000 known species of marine plants and animals

disperse and dilute human produced wastes

two major life zones in the oceans:

coastal zone - 10% of ocean area; 90% of all marine species; warm nutrient rich shallow water extending from high tide mark to edge of continental shelf

open sea - 90% of ocean area

Estuaries and Tidal Ecosystems

Estuary - partially enclosed area of coastal water; seawater mixes with freshwater from rivers, streams and runoff from land; an ecotone; constant water movement stirs up nutrients in silt; highly variable salinity and temperature;

Coastal Wetlands

Areas of coastal land covered all or part of the year by salt water.

breeding grounds and habitats for waterfowl and other wildlife

popular recreational areas (boating, hunting, fishing)

maintain quality of coastal waters by diluting, filtering and settling out sediments, excess nutrients and pollutants.

protect lives and property during floods

buffer against damage and erosion during storms

constitute only 3% of wetland area in the US. (97% is inland wetlands)

In temperate area (US): bays, lagoons, salt flats, salt marshes

grasses - dominant vegetation

serve as nurseries and habitats for shrimp and other animals

Mangrove Swamps

along tropical coasts where there is too much silt for coral reefs to grow

dominated by salt-tolerant trees or shrubs (mangroves)

protect coastline from erosion and reduce damage from typhoons and hurricanes

trap sediment washed off the land

provide breeding, nursery and feeding grounds for 2000 species of fish, invertebrates and plants

Rocky and Sandy Shores

Intertidal Zone - shoreline area between high and low tides

stressful area for organisms; must cope with waves, being left high and dry; changing levels of salinity (high and low)

most organisms hold on to something, dig in or hide in protective shells

Rocky Shores

Barrier Beaches/Sandy Shores

organisms burrow into the sand

sand dunes on barrier beaches - first line of defense against the ravages of the sea

Barrier Islands

long, thin, low offshore islands of sediment running parallel to the shore

protect the mainland by dispersing the energy of approaching storm waves

constantly shifting beaches: built up by gentle waves; flattened and eroded by storms

longshore currents (run parallel to the shore)

Coral Reefs

form in clear, warm coastal waters of the tropics and subtropics
among the most biologically diverse life zones
ecologically complex interactions among the organisms that live there.

Human Impacts on Coastal Zones

Coastal development - two-thirds of world's population lives within 100 miles of a coast

55% of estuaries and wetlands in US destroyed by dredging, filling and waste contamination

Coastal ecosystems are vulnerable to toxic contamination because they trap pesticides, heavy metals and other pollutants (concentrating them to high levels).

37% of coastal shellfish beds are closed to fishing due to contamination from sewage treatment plants, septic tank systems and urban runoff

10% of coral reefs are dead; 30% in critical condition; 30% are threatened; 30% are stable.

Beach Erosion

most methods intended to reduce beach erosion have failed

solutions are temporary at best - see p.197)

solutions usually cause more damage than they prevent

Open Sea

Divided into three zones based on sunlight penetration:

Euphotic - where photosynthesis occurs; low nutrient levels; high DO levels; 90% of ocean surface; 10% of world's commercial fishing

Bathyal - dimly lit; no photosynthesis

Abyssal - dark; very cold; v. little DO; high nutrient level on ocean floor

deposit feeders - take mud into their gut and extract nutrients

filter feeders - pass water over their bodies and extract nutrients

primary and net productivity is low in the open sea - except for the occasional equatorial upwelling

Freshwater Life Zones

Dissolved salt concentration is <1% by volume; about 1% of Earth's surface water; 41 % of world's known fish species

Lentic - standing bodies of water - lakes, ponds and inland wetlands

Lotic - flowing bodies of water - streams and rivers

Aquatic Life Zones in Freshwater Lakes

Lakes - depression caused by glaciation, crustal displacement and volcanic activity

ZONES - defined by 1) depth and 2) distance from shore

Littoral Zone - shallow area near shore to a depth at which rooted plants stop growing

- abundant sunlight and nutrients

- most productive zone in a lake

- high biodiversity

- large numbers of decomposers

Limnetic Zone - the open sunlit water surface layer away from the shore

- extends to depth penetrated by sun

- contains varying amounts of phytoplankton, zooplankton and fish; depending on available nutrients

Profundal Zone - deep open water; too dark for photosynthesis

- cooler darker water

Benthic Zone - bottom of the lake; inhabited mostly by decomposers, detritus feeding clams, wormlike insect larvae, catfish

How Plant Nutrients Affect Lakes

Lakes are classified according to their nutrient content and primary productivity

Oligotrophic Lake - poorly nourished

newly formed lakes

small supply of nutrients

low productivity

crystal clear blue or green; small populations of phytoplankton and fish (small mouth bass and trout)

Eutrophic Lake - well nourished

older lakes; shallow

sediment for plants to grow;

large or excessive supply of nutrients (nitrates and phosphates)

murky brown/green with poor visibility

high primary productivity

contain large populations of phytoplankton, many zooplankton and diverse populations of fish (bass, sunfish and perch)

Mesotrophic Lakes - most lakes fall somewhere between the two extremes of oligotrophic and eutrophic

Seasonal Changes in Temperate Lakes

When ice freezes, it floats on liquid water (which is more dense)

If lakes froze from the bottom up, fish and other organisms would be pushed up and die in winter.

Thermal stratification of deep lakes in northern climates. - resist mixing because (in summer) warmer less dense water is on top.

Epilimnion - upper layer of warm water with high levels of DO

Hypolimnion - lower layer of colder, denser water with low level of DO (not exposed to atmosphere)

Thermocline - middle layer where water temperature changes rapidly with increased depth;

- acts as a barrier to the transfer of nutrients and DO

Fall overturn -

Spring overturn -

Freshwater Streams and Rivers

Surface Water - Precipitation that doesn't sink into the ground or evaporate -

Runoff - when surface water flows into streams and eventually the ocean

Watershed / drainage basin - the land area which delivers water, sediment and dissolved substances via streams to a larger stream or river and ultimately to the sea

Flow of surface water occurs in three zones:

Source Zone - headwater or mountain highland streams of cold clear water; waterfalls and rapids

high DO; coldwater fish (trout) which need lots of DO

Transition Zone - wider deeper streams flowing down gentler slopes with fewer obstacles

warmer water; supports more producers with slightly lower oxygen requirements

Flood Plain Zone - wider and deeper rivers that meander across broad

Freshwater Inland Wetlands

Lands covered with fresh water all or part of the time and located away from coastal areas

include marshes, prairie potholes, swamps, mud flats, floodplains, bogs, wet meadows, wet arctic tundra

Seasonal wetlands - covered only part of the year

provide food and habitats for fish, migratory waterfowl, and other wildlife

improve water quality by filtering, diluting and degrading toxic wastes, excess nutrients, sediments and other pollutants.

floodplain wetlands near rivers reduce flooding and erosion by absorbing stormwater and releasing it slowly; absorb overflows from streams and lakes.

help replenish groundwater supplies

play significant roles in the global carbon, nitrogen, sulfur and water cycles

provide recreation (waterfowl hunting)

grow crops (blueberries, cranberries and rice)

Human Impacts on Inland Wetlands

They are drained, dredged, filled in or covered over.

As a result of agriculture, mining, forestry, oil and gas extraction, highways, urban development

Only 8% of remaining inland wetlands are under federal protection

Mitigation Banking - wetlands can be destroyed if equal areas of the same type of wetland are created or restored; Most attempts are ineffective.

Sustainability of Aquatic Ecosystems

Seasonal stratification of temperate freshwater lakes demonstrates how different resources are limiting in different places

Corals Reefs - most biologically diverse of the aquatic zones (tropical rain forests)

Estuaries - most productive aquatic zones

Open ocean - most expansive and least productive (the desert)

Aquatic ecosystems are connected to everything upstream; and accumulate both direct abuses and indirect abuses from human activities.

Each stream, river and lake reflects the sum of all that occurs in the watersheds above.

Aquatic ecosystems are constantly being renewed and water is purified by natural hydrologic processes.