Major Ecosystems of the World
Overview of Chapter 6

- Earth’s Major Biomes
- Aquatic Ecosystems
  - Freshwater ecosystems
  - Estuaries
  - Marine Ecosystems
Wildfires and Ecosystems

- Wildfire – unexpected fire in grass, shrub, or forests
  - Understory needs to dry for prolonged period (i.e. dry season)
- Many plants need or have adapted to fire
  - Some seeds need fire to sprout
  - Cleans out understory
- Altered wildfire regime changes forests
Earth’s Major Biomes

- Earth has many climates and characteristics organisms have adapted forming biomes

- Biome
  - A large, relatively distinct terrestrial region with a similar climate soil, plants, and animals, regardless of where it occurs in the world
  - Nine major biomes

- Location of each biome is primarily determined by:
  - Temperature (varies with both latitude and elevation)
  - Precipitation
Distribution of Terrestrial Biomes

1. Tundra
2. Boreal forest
3. Temperate rain forest
4. Temperate deciduous forest
5. Temperate grassland
6. Chaparral
7. Desert
8. Savanna
9. Tropical rainforest
Tundra

- Arctic or alpine tundra
- Treeless biome in the far north with harsh, cold winters and extremely short summers

- Precipitation
  - 10–25 cm/yr

- Temperature
  - Short growing season
  - 50–160 days
Tundra

- Nutrient poor soils with little organic material
  - Permafrost present
- Low species richness
  - Vegetation is mostly grasses and sedges
  - Very simple food web
- Low primary productivity
Boreal Forests (Taiga)

- A region of coniferous forests in the northern hemisphere
  - Just south of tundra
- Covers 11% of land
- Growing Season
  - A little longer than tundra
- Precipitation
  - ~ 50 cm/yr
Boreal Forests

- Soils are acidic and mineral poor, patchy permafrost
- Vegetation comprised of drought resistant conifers
  - White spruce
  - Balsam fir
  - Eastern larch
- Mostly small animals and migrating birds
- Some large animals are present (caribou, moose)
Temperate Rainforest

- Coniferous biome with cool weather, dense fog and high precipitation
  - Ex: Northwest U.S.
- Precipitation
  - > 127 cm/yr
  - Heaviest in winter
- Temperature
  - Winters are mild
  - Summers are cool
Temperate Rainforest

- Soils are nutrient-poor, but high in organic material (dropped needles)
  - Cool temperatures slow decomposition
- Dominant Vegetation
  - Large evergreen trees
  - Old-growth forest
- Variety of cool climate animal life
- Very high species richness
Temperate Rainforest

- Heavily logged
- When logged, replanted as monoculture
  - Does not undergo succession to old-growth forest
  - Harvested in 40-100 year cycles
- Many endangered species live in old-growths
Temperature Deciduous Forests

- Forest biome that occurs in temperate areas with a moderate amount of precipitation

- Precipitation
  - 75–150 cm/yr

- Temperature
  - Seasonality
  - Hot summers and cold winters
Temperate Deciduous Forest

- Topsoil is rich in organic material and underlain by clay
- Vegetation is primarily deciduous
  - Oak, maple, beech
- Animals
  - Deer, bear, and small animals
- Most of biome has been regenerated after farming and timber harvest
Grassland

- Grasslands with hot summers, cold winters and too little precipitation to support trees
- Precipitation
  - 25–75 cm/yr
- Tall grass prairies
- Short grass prairies
- 90% of this biome has been lost to farmland
Grassland

- Soil has thick, organic material rich organic horizon
- Periodic fires prevent tree and shrub growth
- Animals
  - Once covered with bison - no longer
  - Smaller animals are still present (ex: prairie dogs)
Chaparral

- Also called a Mediterranean Climate
  - Ex: Southern California
  - Ex: Greece

- Temperature
  - Mild, moist winters
  - Hot, dry summers

- Frequent fires
Chaparral

- Soil is thin and often not fertile
- Vegetation
  - Dense growth of evergreen shrubs
  - Lush during the growing season
- Animals
  - Mule deer, chipmunks, many species of birds
ENVIRONEWS

- 6000 wildfires each year in California
- Goats as a means to fight wildfires
  - 350 goats denude an acre of brush per day
- As part of a plan, goats can be a tool for forest and property protection
Deserts

- Biome where lack of precipitation limits plant growth
- Temperature
  - Can vary greatly in 24-hr period, as well as yearly (based on location)
- Precipitation
  - < 25 cm/yr
Deserts

- Soils low in nutrients and high in salts
- Vegetation sparse
  - cactus and sagebrush
- Animals are very small to regulate temperature
Savanna

- Tropical grassland with widely scattered trees
- Temperature
  - Varies little throughout the year
- Precipitation
  - Seasons regulated by precipitation, not temperature
  - 76-150 cm/yr

![Graph showing average monthly temperature and precipitation in °C and cm respectively.](image)
Savanna

- Soil low in nutrients due to leaching
- Vegetation
  - Wide expanses of grass, occasional Acacia trees
  - Have fire adaptive characteristics
- Animals
  - Herds of hoofed animals
  - Large predators - lions, hyenas, etc.
Tropical Rainforest

- Lush, species-rich biome that occurs where climate is warm and moist throughout the year
- Precipitation: 200–450 cm/yr
- Very productive biome
- Most species-rich biome
Tropical Rainforest

- Ancient, weathered, nutrient-poor soil
  - Nutrients tied up in vegetation, not soil
- Vegetation
  - 3 distinct canopy layers
- Animals
  - Most abundant insect, reptiles and amphibians on earth
Increasing in elevation has similar effect on ecosystem as traveling to higher latitudes.
Aquatic Ecosystem

- **Fundamental Division**
  - Freshwater
  - Saltwater

- **Aquatic Ecosystems also affected by**
  - Dissolved oxygen level, light penetration, pH, presence/absence of currents

- **Three main ecological categories of organisms**
  - Plankton - free floating
    - Phytoplankton – photosynthetic
    - Zooplankton – animal-like
  - Nekton - strong swimming
  - Benthos - bottom dwelling
Freshwater Ecosystems

- Includes:
  - Rivers and streams (lotic or flowing waters)
  - Lakes and ponds (lentic or standing water)
  - Marshes and swamps (standing water)
- Represent 2% of earth’s surface
- Assist in recycling water back to the oceans
Rivers and Streams

Headwater streams

Larger streams and rivers
Rivers and Streams

Estuaries, deltas, coastal ocean

Physical nature of aquatic ecosystems changes significantly
River continuum concept

- Water moves from headwaters to rivers to coastal ocean
  - Change in physical features and food sources (abiotic differences)
  - Results in change in biological features and ecosystem function
- In streams, organisms adapted to fast flowing water (hooks, suction, flattened bodies)
- In rivers, adaptation for swimming (streamlined)
Lakes and Ponds

- Body of freshwater that does not flow
- Three zones
  - Littoral
  - Limnetic
  - Profundal
- Experience thermal stratification (depending on depth)
Lakes and Ponds

- Littoral Zone - shallow water area along the shore
- Limnetic Zone - open water beyond the littoral zone
- Profundal Zone - beneath the limnetic zone of deep lakes
Thermal Stratification

- Temperature changes sharply with depth

- Thermocline
  - Temperature transition between warmer surface water and colder water at depth (difference in density)
  - Only present in warm months
Fall Turnover

Spring turnover

Entire lake 3° – 10°C

Winter

Ice 0°C

4°C

Summer

15° – 20°C

4° – 10°C

Thermocline

Fall turnover

Entire lake 3° – 10°C

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Marshes and Swamps

- Land with shallow, fresh water for at least part of the year
- Characteristic soil and vegetation
- Were once regularly filled
  - More recently, ecosystem services have been better recognized
    - Flood protection, water filtering, etc.
Protection of ecosystem (organism) services

"We're a protected species and an endangered species, but when I see a person, I don't know if he's protecting us or endangering us."
The Everglades

Original extent

Today, after extensive construction and draining of wetlands
Estuaries

- Where freshwater and saltwater mix
- Highly variable environment
  - Temperature, salinity, depth of light penetration
- Highly productive
  - Nutrient transported from land
  - Tidal action circulates
  - High level of light penetrates shallow water
  - Plants provide photosynthetic carpet
Salt marshes

- Usually in temperate estuaries
- Shallow wetlands dominated by a few species of salt-tolerant grasses
  - Were seen as worthless, filled in, and constructed over
- Services are extensive
  - Buffer land from storm energy (Superstorm Sandy)
  - Large cycling of organic matter for coast
  - Habitat (particularly birds)
Mangrove forests

- Tropical equivalent of salt marshes
- Should cover >70% of coastlines

Services

- Buffers storm energy (saves lives)
- Nurseries for fish and organisms
Marine Ecosystems

- Subdivided into life zones
  - Intertidal zone
  - Benthic zone
  - Pelagic environment
    - Neritic Province
    - Oceanic Province
Marine Ecosystems
Intertidal Zone

- Area of shoreline between low and high tide
- Biologically productive habitat
- Stressful habitat
  - Splash zone
  - Wave action
  - Flooding
  - Drying out
Benthic Zone

- Ocean floor, extending from tidal zone to deep sea trenches
- Sediment is mostly mud
  - Burrowing worms and clams
- Three zone
  - Bathyal: 200m – 4000m deep
  - Abyssal: 4000m – 6000m deep
  - Hadal: 6000m – bottom of deep sea trenches
Productive Benthic Communities

- **Seagrass Beds**
  - Present to depth of 10 m
  - Provide food and habitat to ecosystem

- **Kelp Forest**
  - 60-m long brown algae found off rocky shores
  - Large Biodiversity

- **Coral Reefs (essential fish habitat in ocean)**
  - Built from accumulated layers of CaCO$_3$
    - Colonies of millions of tiny coral animals
    - Similar to upside down jelly fish
  - Found in shallow warm water
  - Most diverse of all marine environments
Productive Benthic Communities

Left: Seagrass Bed

Right: Kelp Forest
Coral Reef Environments

- Three types of coral reefs
  - Fringing reef - directly attach to continent - no lagoon
  - Atoll - circular reef in a lagoon
  - Barrier reef - separates lagoon from ocean
Human Impact on Coral Reefs

- Sedimentation
  - From clear-cutting, coastal construction
- Overfishing, destructive fishing
- Coral bleaching (stress condition)
- Mining of corals as building materials
- Runoff and sewage pollution
- Ocean acidification and rising sea temperatures
Pelagic Environment

- All the open ocean water
- Main divisions based on depth and light penetration
  - Euphotic zone
    - Surface to 150m
    - Sufficient light for photosynthesis
    - Organisms are all floaters or swimmers
Pelagic Environment

- **Neritic Province**
  - Organisms are floaters or swimmers (zooplankton, whales)
  - Water that overlies the continental shelf (to depth of 200m)
Pelagic Environment

Oceanic Province

- Water that overlies depths greater than 200 m
- Organisms are filter feeders, scavengers and predators
  - No light for photosynthesis, organisms adapted for darkness
  - Marine snow (food particles falling from euphotic zone) support some life
- Hydrothermal vent communities in deep ocean support life too
National Marine Sanctuaries

- Protected areas in the world's oceans
- NOAA administers in the U.S.
- “no take” and other restrictions for use
Human Impacts on the Ocean

**Nonpoint Source Pollution (runoff from land)**
Example: Agricultural runoff (fertilizers, pesticides, and livestock wastes) pollutes water.

**Invasive Species**
Example: Release of ships’ ballast water, which contains foreign crabs, mussels, worms, and fishes.

**Overfishing**
Example: The populations of many commercial fish species are severely depleted.

**Bycatch**
Example: Fishermen unintentionally kill dolphins, sea turtles, and seabirds.

**Aquaculture**
Example: Produces wastes that can pollute ocean water and harm marine organisms; requires wild fish to feed farmed fish.

**Point Source Pollution**
Example: Passenger cruise ships dump sewage, shower and sink water, and oily bilge water.

**Coastal Development**
Example: Developers destroy important coastal habitat, such as salt marshes and mangrove swamps.

**Habitat Destruction**
Example: Trawl nets (fishing equipment pulled along the ocean floor) destroy habitat.

**Climate Change**
Example: Coral reefs are particularly vulnerable to increasing temperatures and ocean acidification.