UNIT 1
SUSTAINING ECOSYSTEMS

Chapter 3

Sustaining Terrestrial Ecosystems

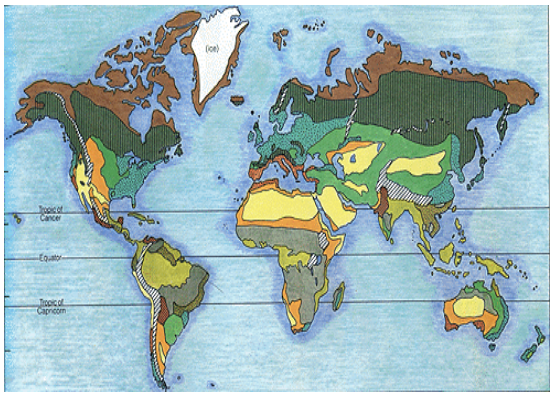
Science 1206 / 2200

Sustainable Systems

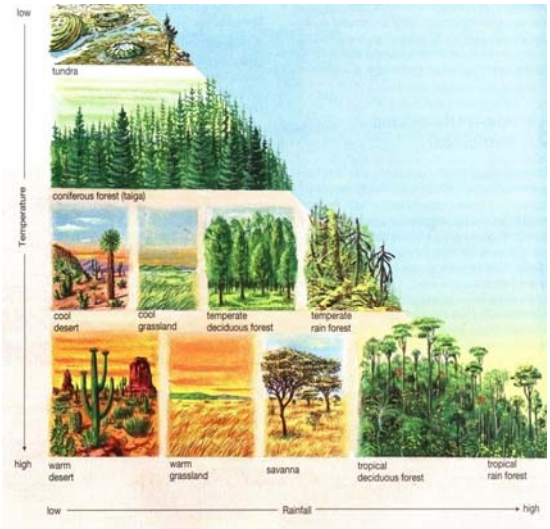
- One that survives and functions over time
- In human terms
  - One that meets the needs of present and future generations
  - We must not sacrifice short-term benefits for long-term gains
- Short Activity:
  - In pairs
  - Each pair will look at 2 of the 6 pictures on page 86 in your textbook
  - In your notebook
    - Answer the Reflect on You Learning Questions on page 87.
  - After a few minutes to answer the questions we will have some brief discussion

What is a Biome?

- Ecosystems can be grouped into larger categories called biomes
- Biome
  - A Collection of ecosystems that are related to each other, usually based on the type of places they support and the average temperature and rainfall amounts



Major World Biomes



- Biomes exist based on the average temperature and rainfall amounts
- Ranging from cold and dry to hot and wet

Canadian Biomes

- Canada has four major terrestrial biomes which will each be studied in depth throughout this chapter
- Each has specific biotic and biotic factors that determine the types of plants that are able to survive in the respective ecosystems
- These biomes are:
  - Tundra
  - Boreal Forest (Taiga)
  - Temperate Deciduous Forest
  - Grasslands (Prairies)
- Remember, there are marine and aquatic biomes too, these will be discussed in more detail in chapter 4.

Tundra Abiotic Factors

- Located in Canada's Northern-most regions
- Is a cold desert
  - very low rainfall (10 – 12 cm per year) with cold temperatures as low as -55 plus windchill
- Permafrost
  - Layer of soil that never thaws
  - **Active layer** is the top few centimetres that does thaw, allowing some plant growth
- 2 month growing season
- Poor soil quality

Tundra Biotic Factors

- Slow decomposition rate because of the cold temperatures
- Vegetation
  - Fast-growing plants, mosses, lichens
- Animals
  - Ptarmigan, lemmings, arctic foxes, caribou, polar bears
- Summer sees migrations of birds to feed on insects

Boreal Forest Abiotic Factors

- Located just south of and is warmer than the tundra
- No permafrost, soil contains some water
- Rapidly changing weather
- 3 - 4 month growing season
- 40 cm/yr or more of rainfall
- Soil is acidic because of the decomposition of coniferous needles
  - Causes leaching of nutrients – lost to the ground water

Boreal Forest Biotic Factors

- Wide diversity of plants and animals that have adapted to the long, cold winters and hot, drier summers
- Animals
  - Elk, moose, deer, black bears, grizzly, porcupines, hares, lynxes, grouse, wolf, fox
  - Fewer insects in soil litter lay slows down rate of decay
- Vegetation
  - Mostly coniferous trees (fir, spruce, pine)
  - Ferns and mosses
  - Some deciduous and shrubs that are adapted to acidic soil

Adaptations of Conifers in the Boreal Forest

- Needle-like leaves
  - Reduce surface area and of the leaves to minimize water-loss during winter
- Waxy cuticle
  - Waxy leaves protects against water loss and frost damage
- Thick bark
  - Protects against water – loss and forest fires
- Pyramid / cone shape
  - Allows snow to slide off, preventing breakage of branches
- Flexible Branches
  - Weight of snow causes bending removing the weight
- Bear leaves all year
  - Ready to photosynthesize as soon as spring arrives

Temperate Deciduous Forest Abiotic Factors

- Located south of the Boreal forest in eastern Canada and the USA
- Cold winters, long hot summers
- 75 – 150 cm/ yr rainfall
- 5 – 6 month growing season
- Brown forest, nutrient rich soils
- Thin litter layer due to high rate of decomposition
- Mildly acidic surface soil, decreasing with depth
- Increased decomposition, increases nitrates and other nutrients in the soil

TD Forest Biotic Factors

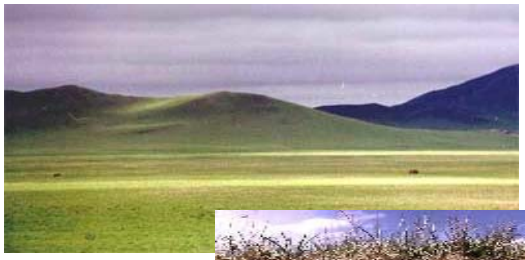
- More shrubs due to increased light reaching forest floor
- Large, flat leaves allow for more photosynthesis to take place
- Vegetation
  - Chiefly deciduous trees (maples, birch, poplar, oak)
  - Lots of shrubs (ferns, mosses)
- Animals
  - Huge diversity of insects and birds
  - Many burrowing rodents
  - Wolves, weasels, deer, mice, snakes, rabbits

Grassland Abiotic Factors

- Also located south of the boreal forest, but in central and western Canada and USA
- Very hot, dry summers (up to 40°C) lead to forest fires
- Very cold, dry winters (down -45°C) lead to lots of frost-bite :-p
- 25 – 75 cm/yr of rainfall
- Rich, fertile soil results from high rate of decomposition
- 5 – 6 month growing season

Grassland soils

- Deep, rich soil makes it the best farmland on earth
- Chernozem, or black earth soil
  - Organic matter accumulates in the upper portion of the soil, making it dark
- Neutral or slightly basic (pH of 6 – 8)



Grassland Biotic Factors

- Chiefly fescue grasses
- Animals
  - Snakes and burrowing rodents
  - Bison, hawks, wolves
  - Variety of insects
- Vegetation
  - Prairie clover, salvia, oats, wheat, barley, coneflowers

Biogeography – Plant Adaptations

- Tundra plants must withstand low temperatures and minimize water loss during the dry winter, and only small amounts of surface water is available during summer
  - Growing close to the ground minimizes exposure and water loss
- Root systems
  - Root structures are adapted for the type of soil and amount of water in the plants' habitat
  - Long roots reach water deeper in soil
  - Long, fibrous roots allow absorption of a constant supply of water
  - Short roots suggest water is only available near the surface of the soil
- See pg 96 – fig. 5

Components of soil

- Litter
  - Decomposing leaves or grasses. Acts as a blanket limiting temperature changes in soil
- Topsoil
  - Small particles of rock mixed with decaying plant and animal matter called **humus**
  - Humus is black, so topsoil is usually dark
  - Also has spaces for air and water between rock particles
  - Oxygen is needed by bacteria to completely decompose dead organisms
  - If no oxygen is present, decay is slow and a layer of **peat** forms
- Subsoil
  - Mostly stones mixed with small amounts of organic matter
- Bedrock
  - Marks the end of the soil – made of rock
- See pg.98, figure 2

The Basic Soil Profile

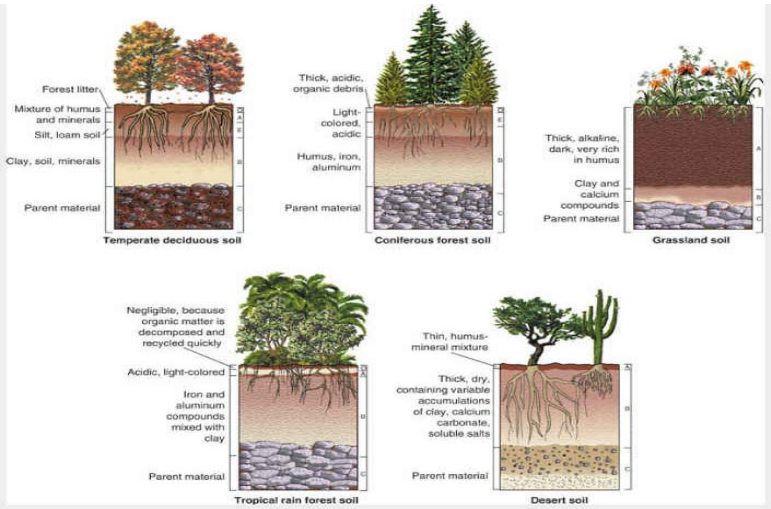
← Litter Layer

← Top Soil with humus

← Subsoil

← Bedrock

Comparing Soil Profiles



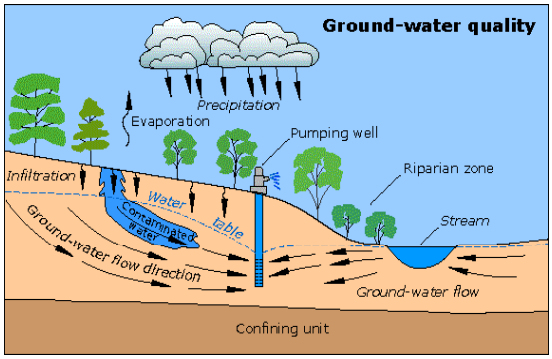
Steps to Soil Formation

- Beginning with bare rock
  1. Weathering by wind, rain, snow, frost breaks rock into smaller particles
  2. Small particles allows lichen to grow – produces acid that breaks down rock even further
  3. Particles accumulate allowing plants to grow
  4. Plants die and decompose adding to the newly forming topsoil
  5. Enrichment and increased depth allows for larger plants to grow
  6. After 100's or 1000's of years soil is thick enough to support a forest
- This process is called **succession**
- As the soil changes, so does the community of organisms living there

REMINDER:
SHOW SOIL FORMATION ANIMATION

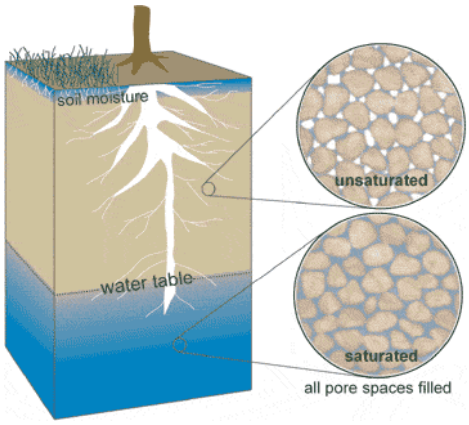
Water Beneath the Soil

- Surface water
  - Precipitation that collects and flows above the ground
  - Ponds, lakes, streams
- Ground water
  - Surface water that has seeped into the ground through the pores (openings) in the soil
  - Pulled though the soil by **percolation**. The speed this occurs at is called the **percolation rate**
  - Larger soil particles = fast rate smaller soil particles = slow rate
- Water table
  - Water accumulates and saturates the soil on the layer of bedrock or dense clay



Changes in the Water Table

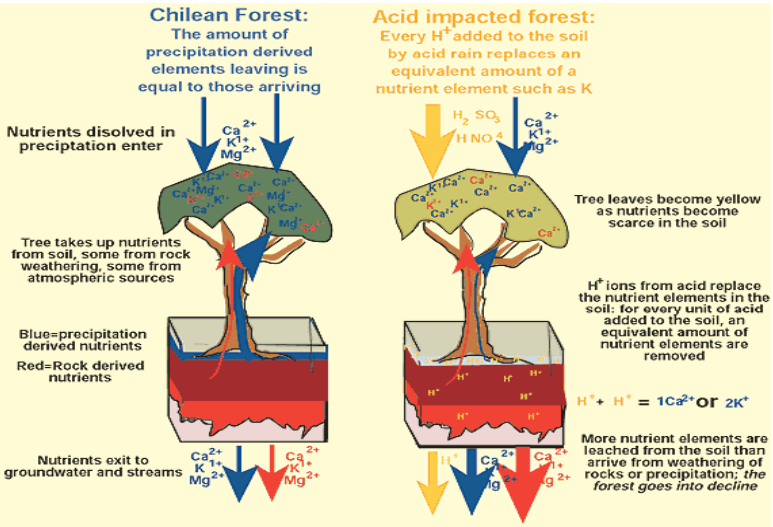
- After a heavy rain the water table will be higher (close to the surface)
- Low water table may result in areas where there has been drought or areas at higher elevation since the water tends to flow downhill



Nutrient Leaching

- Leaching
  - As water seeps downward nutrients become dissolved in the water
  - These nutrients then get carried deeper into the soil
- Why is this a problem?
  - Plants need the nutrients for growth and development
- Plants often try to compensate by branching and extending root systems deeper into the soil to help pump nutrients back up to the surface

Leaching Examples



Soil pH

- Soil can be acidic (pH < 7) or basic (pH > 7)
- Typically this is determined by the type of rock making up the soil and the types of plants growing in it
  - Decomposition of litter layer produces acids
- Acid precipitation plays a major role in acidity of soil
  - Caused by burning of fossil fuels leading to acidic compounds accumulating in the atmosphere, dissolving in rain and falling to the earth where it accumulates in soils
- Acidic soil causes nutrients to be held in water leading to increased leaching

Soil pH and Plant Diversity

- pH of soils determines which plants will grown best
  - Conifers, while adapted to mildly acidic soils, will turn yellow and brown in highly acidic soil
  - Mosses generally flourish in acidic soils because of decreased compositions (peat bogs)
- Adding calcium / limestone raises the pH by neutralizing the acids
- Grassland soils are rich in lime and acidity is rarely a problem
- Many plants prosper in mildly alkaline (basic) soils