Unit III: ECOSYSTEMS

Ch. 6: Life Systems (pg. 92 – 109)

3.1.1: Define the term Ecosystems:

- The network of relationships among plants, animals and the non-living constituents in an environment.
- View **fig 6.3 on page 94 of your text** and you can see that there are a lot of living things (plants & animals) and non-living things (soil, water sun, temperature etc.) that affect each other.
- It is the system of relationships between the organisms and between the organisms and the non-living environment that makes up the ecosystem.

Organisms in an Ecosystem:

1. **Producer**: a plant which can synthesize carbohydrates using carbon dioxide and the sun's energy.
   - For example in **fig. 6.3 on page 94** all the plants, like Duck weed, Willow, cat tails etc. are producers and convert the sun's energy into carbohydrates (**food energy**) for all other organisms in the ecosystem.
   - Producers are so named because they actually produce the food for the ecosystem.

2. **Consumers**: All those organisms in trophic levels other than producers. Consumers eat their food.
   - For example in figure 6.3 on page 94 all the animals, Raccoon, bass, duck etc. are consumers.
   - Consumers are so named because they have to eat or consume their food.
   - **1st-order or primary consumers eat producers.**
   - **2nd-order or secondary consumers eat primary consumers.**
   - **3rd-order or tertiary consumers eat secondary consumers.**

3. **Decomposers**: Simple organisms that obtain their food from dead organisms and wastes.
   - For example in Figure 6.3 on page 94 of your text the colony of bacteria, protozoa, and flatworms are all decomposers.
   - Decomposers are so named because they are actually responsible for decomposing dead organisms.

- *Similarities:* all three are terms referring to the way organisms obtain food & energy.

- *Differences:* the way they obtain food. Producers make it, consumers eat it, and decomposers feed on wastes & dead material.

3.1.2: Food Chains & Food Webs

- **Food Chain**: linear sequence representing the flow of energy & nutrients from the simplest plant to the top carnivore.

✓ An example of a food chain from **fig. 6.4. pg. 95**:

Sun → Tree → insect → insect-eating bird → hawk

  - **Producer**: Tree
  - **1st-order consumer**: insect
  - **2nd-order consumer:** insect eating bird
  - **3rd-order consumer**: hawk

- **Food web**: a series of interconnecting food chains in an ecosystem.

✓ **Fig 6.4 on pg 95** of your text book depicts a food web in a temperate deciduous forest.

- *Similarity:* both food chains and food webs show the flow of nutrients and energy in an ecosystem.

- *Differences:* Food webs are: more complex; composed of several food chains; a more realistic picture of an ecosystem.

3.1.3: Energy Flow in an Ecosystem

- Using **fig 6.5 on pg. 95** you can summarize the main energy flows in an ecosystem:

  - the Sun is the source of all ecosystem energy;
  - producers make food via photosynthesis;
  - consumers eat plants and other consumers to get energy;
  - each time energy moves from one organism to another, energy leaves the system in the form of heat;
  - decomposers return nutrients to the soil but energy is not recycled.

Food Pyramid*:*

- is a diagram showing each **TROPHIC** level as a horizontal bar;
- producers are located on bottom & higher trophic levels are placed on top of each other;
- each bar is drawn in proportion to the mass of organisms, giving the triangle shape.

Pyramid of Numbers:

- There are fewer organisms at each increasing trophic level:

    - less energy available at each increasing level;
    - fewer organisms can obtain energy to live;
    - therefore fewer organisms at increasing levels.

Pyramid of Energy:

- There is a high degree of energy loss at each trophic level.
    - The producers only store **1%** of the sun's energy as food energy.
    - Each consumer level loses energy for several reasons:

        - much of the energy is lost as heat;
        - most of the energy is used to carry out life functions: i.e. we burn many calories of energy each day. so do all organisms;
        - if an organism dies without being eaten the energy goes to the decomposers and not up the trophic levels;
        - consequently only about **10 - 15%** of the energy is stored as usable food energy at each level..

    - If we look at this in terms of units of energy and we start with **1000** units of energy at the producer level then:

        - the primary consumers would only have 100-150 units of food energy stored for the next level;
        - the secondary consumers would only have 10-15 units of food energy stored for the next trophic level;
        - the tertiary consumers would only have 1-1.5 units of food energy stored as food energy—it is easy to see why we do not often see a quaternary trophic level

3.2.1: Magnification of Toxin Levels

- **Biological Amplification** is the term used to describe the fact that higher trophic level receive a higher dose of food chain toxins.
- This problem has occurred in our environment. The most common case was that of DDT which was used to control insect populations

    - DDT was a particularly dangerous toxin because it is fat soluble and stays in an animal's fat. (Some poisons are water soluble and can be excreted from the system.)
    - Lower order organisms ingest some poison which may or may not affect them.
    - Higher order organisms eat large numbers of lower order organisms. "*A small amount in a frog becomes large in a hawk that eats 100 frogs.*"

3.2.4: The Effect of a new organism in an Ecosystem

- Ecosystems are in a very delicate balance.
- Changing one thing in the ecosystem will have a domino effect through the system because of the relationships that exist.
- There are several good questions in your text that address this issue.
- They ask you to analyze the current relationships in the ecosystem and then determine the effect of changing one relationship.

Question #13 on page 98 is about a pond ecosystem with blue gill sunfish. This is a sample question. Any question could be asked where we have to predict possible outcomes. Read the question (#13 on page 98) and see what you think would happen. Use your background knowledge that there are inter-relationships in all ecosystems. Read below to get one person's perspective on the possible changes. Remember experts differ on the possible impacts in real situations. However they all make sound arguments based on inter-relationships.

- Sun fish move to reeds
- Plankton pop. Decrease
- Sun fish decrease in size
- Larvae pop. increase

- The introduction of Large mouth bass would cause:

1. Sun fish move to reeds to escape predation by the large mouth bass
2. The Plankton population might decrease because the bluegill sunfish would be feeding on them more now that they can not stay in the open and eat the larva
3. The Sun fish might decrease in size and abundance because the plankton is not as full of energy.
4. The Larvae population might increase due to less feeding by the sun fish.

3.3.1 – 3.3.3: World Ecosystems

Climax Vegetation

- Is the natural vegetation in the last possible stage of vegetation development.
- Climax vegetation is stable and in balance with the climatic conditions.
- It should change very little if left undisturbed.
- Ecosystems are largely defined by the climax vegetation that grows in it.
- The type of vegetation is largely determined by the climate.
- We will look at **THREE** major type of ecosystems found in high latitude regions. Look at **fig 6.8 on pg. 102** of your text book and you will see the variety of ecosystems in the world.

1. <u>Coniferous (Boreal) Forests</u>:

- The climax vegetation in coniferous forest is Evergreen trees with:
  - needle-like leaves;
  - thick bark;
  - conical shape;
  - dense growing which blocks sun.

- The location of the Boreal forest can be seen by analyzing the world ecosystem map (figure 6.8) on page 102.
- It is found only in the northern hemisphere and is located in a broad band across Northern North America and Northern Eurasia.
- Coniferous trees are well adapted to lack of water in winter (it is all frozen):
  - needle leaves reduce surface area for transpiration;
  - drooping branches and conical shape allow heavy snow to fall off relieving the pressure;
  - thick bark reduces water loss.

- The climate in the boreal forest is temperate cold winter. Look at figure 6.8 on page 102 and locate the boreal forest; then turn to page 75 and locate the temperate cold winter (subarctic) climate region. the two match very closely.

2. <u>Tundra</u>:

- The climax vegetation in the Tundra is grasses, shrubs and low plants with:
  - shallow roots;
  - fast reproduction/flowering cycles.

- The location of the Tundra can be seen by analyzing the world ecosystem map (figure 6.8) on page 102. It is found only in the northern hemisphere and is located north of the Boreal forest across Northern North America and Northern Eurasia.
- The shrubs and bushes are well adapted to the extreme climate of the north where winter is long and summer is very short:
  - shallow roots are needed because 1-3 meters below the surface the soil is completely frozen (Permafrost);

  - the fast flowering and reproduction cycle is needed because the growing season is very short, lasting only 1-2 months.

- Animals have a variety of adaptations to the harsh Tundra climate.
  - hibernation from the cold winter;
  - migration in for the summer season and out for the winter season is a common strategy for Birds and even larger animals like caribou;
  - the development of insulating features like thick fur & fat insulation is common among polar bears and other mammals;
  - white fur/feathers to help with camouflage is another common adaptation.

- The climate in the Tundra is so definitive of the tundra that it is called Tundra climate. Look at figure 6.8 on page 102 and locate the Tundra; then turn to page 75 and locate the Polar (Tundra) climate region. the two match very closely.

3. <u>Polar Ice Caps</u>:

- The climax vegetation in the Polar Ice Cap is Phytoplankton beneath the ice.
- The location of the Polar Ice Caps can be seen by analyzing the world ecosystem map (figure 6.8) on page 102. It is found only in both hemispheres and is located only in the extremely high latitudes.
- The adaptation of producers to this ecosystem is extreme. There is no land for the producers to grow in so there are only small phytoplankton to form the base of the food chain.
- Animals have a variety of adaptations to the harsh Polar ice cap climate.
  - migration in for the summer season and out for the winter season is a common strategy for Birds and even larger animals like caribou;
  - the development of insulating features like thick fur & fat insulation is common among polar bears and other mammals;
  - white fur/feathers to help with camouflage is another common adaptation.

- The climate in the Polar ice cap is so definitive of the Polar ice cap that it is called Polar (ice cap) climate. Look at figure 6.8 on page 102 and locate the Polar ice cap; then turn to page 75 and locate the Polar (Ice cap) climate region. the two match very closely.

4. <u>Temperate Grasslands</u>:

- The “climax vegetation” in Temperate Grasslands is grass with:
  - shallow roots;
  - a small water requirement.

- The location of the Temperate grassland can be seen by analyzing the world ecosystem map (figure 6.8) on page 102. It is found in North America, South America, Australia and Eurasia.
- Grasses are well adapted to lack of water:
  - the small size of the plant means that it requires less water.

- The climate in the Temperate grassland is semi-arid in most locations but in some regions it is temperate cold winter. Look at figure 6.8 on page 102 and locate the Temperate grassland; then turn to page 75 and locate the semiarid climate region. The two match very closely.

5. Temperate Deciduous Forests:

- The "climax vegetation" in Temperate forests is deciduous trees like oak, birch and maple which:
    - lose leaves in summer

- The location of the Temperate Forests can be seen by analyzing the world ecosystem map (figure 6.8) on page 102. It is found predominantly in North America and South America but is present in Australia and Europe and Asia.
- Deciduous trees are well adapted to lack of water in winter.
    - losing their leaves in winter helps them reduce water loss. Most water loss occurs through the leaves.

- The climate in the Temperate Forest is temperate mild winter. Look at figure 6.8 on page 102 and locate the Temperate forests; then turn to page 75 and locate the temperate mild winter climate region. The two match very closely.

6. Tropical Rain Forests:

- The climax vegetation in The Tropical Rain Forest is Tall Evergreen Broadleaf Trees with:
    - Butress roots.

- The location of the Tropical Rainforest can be seen by analyzing the world ecosystem map (figure 6.8) on page 102. It is found in South America, Africa, Australia and South East Asia. and is contained within the tropics.
- The tall trees are well adapted to the thin soil with buttress roots (figure 6.15 on page 108) to help support their height. Some plants are epiphytes which are well adapted to the rain forest. They reach the sun by lying in the canopy while they get water through roots that hang in the air and absorb moisture. Some animals are adapted to spend their entire life in the canopy.
- The climate in the Tropical rain forest is Tropical wet in most locations but in some regions it is tropical wet and dry. Look at figure 6.8 on page 102 and locate the Tropical rain forest; then turn to page 75 and locate the tropical wet climate region. The two match very closely.

7. Savanna Grasslands:

- The climax vegetation in the savanna is grass with:
    - shallow roots;
    - small water requirement.
- The location of the Savanna can be seen by analyzing the world ecosystem map (figure 6.8) on page 102. It is found in South America, Australia, Africa and Southeast Asia.
- Grasses are well adapted to lack of water:
    - the small size of the plant means that it requires less water.

- The climate in the Savanna is tropical wet & dry in most locations but in some regions it is semi-Arid. Look at figure 6.8 on page 102 and locate the Savannas; then turn to page 75 and locate the Tropical Wet and dry climate region. The two match very closely.

8. <u>Deserts</u>:

- The climax vegetation in the Desert is cacti and fleshy plants with:
    - long roots;
    - water storage capability;
    - leaves modified as needles.

- The location of the Desert can be seen by analyzing the world ecosystem map (figure 6.8) on page 102. It is found in North America, South America, Australia, Africa and Asia. Deserts are mostly concentrated in two bands around the earth 10-30 North and South of the equator.
- Cacti are well adapted to lack of water. They are often referred to as Xerophytes:
    - long roots help them obtain water deep in the water table;
    - water storage capability gives them the ability to endure long periods without rain;
    - leaves modified as needles reduces the surface area for transpiration and helps reduce grazing which would severely increase water loss.

- Many animals have unique adaptations to the desert:
    - deer mice can get all the water they need from the food they eat;
    - toads have the behavioural adaptation of hibernating thorough the driest seasons;
    - some Reptiles reduce water loss by excreting solid uric acid crystals instead of water containing urine;
    - some mammals have the behavioural adaptation of nocturnal behaviour, which keeps them out of the day time heat.

- The climate in the Desert is Arid. Look at figure 6.8 on page 102 and locate the Deserts; then turn to page 75 and locate the arid climate region. The two match very closely.

9. <u>Mountain Ecosystems</u>:

- Mountains ecosystems are not exclusively low latitude, on the contrary they occur in most latitudes and as you will see in figure 6.10 on page 104 mountains can contain all types of ecosystems from all latitudes.
- Figure 6.10 on page 104 well-illustrates the fact that latitudinal succession closely parallels altitudinal succession.
- The changes we see in ecosystems as we move north from the equator are generally, tropical rain forest, Temperate forest, Coniferous forest, shrubby tundra and then polar ice cap. The same changes in ecosystem can be seen as you move up a tropical mountain.
- Mountain ecosystems are not very unique—they vary with altitude and temperature.

Ch. 8: Life Systems (pg. 135 – 143)

Soil Characteristics:

There are several characteristics of soil that affect its value for farming and growing vegetation.

- **Organic Content**: a soil's fertility is determined as a ratio of the organic content to the content of ground bed rock.
- **Mineral content**: varies with precipitation because heavy rains tend to leech soils removing minerals from the root region of soil.
- **Soil Texture**: this will be discussed in the next lesson but refers to the mixture of fine particles (sand), very fine particles (silt) and extra fine particles (clay). The best texture for agriculture is an even mixture of each.

Soil Profile

To understand about different soils you must understand that there are fairly distinct layers within soil.

- Top Layer: Dark color & Rich in Humus
- 2nd Layer: Mineral layer deposited from above
- 3rd Layer: weathered bed rock
- 4th Layer: Bed rock

As you can imagine the thickness and quality of the top humus layer is very important for plant life.

Three Types of Soil

- **Podzol**: soils which predominate the boreal forest and tend to be somewhat acidic
- **Chernozem**: soils which tend to be the best for agriculture. They are found in grasslands which are semi-arid resulting in less leeching and a mineral rich soil.
- **Latosol**: soils which are very infertile due to the high amount of leeching. They are found in tropical rain forests with high amounts of rain which result in leeched mineral-poor soil.

Environmental Factors Affecting Soil

- Temperature: affects the development of humus. Too cold and the decay of organic matter is slowed considerably.
- Precipitation: affects the mineral content of soil. Too much rain and minerals are leeched beyond the reach of plant roots. Too much rain also results in eluviation which moves small particles down through the soil

Soil texture refers to the size of particles in the soil. While you don't have to memorize the exact sizes given on p.138 you should realize that:

- stones are approximately baseball-sized;
- gravel is small stones;
- sand is fine particles;
- silt is very fine particles;
- clay is extremely fine particles.

Soil is predominantly composed of sand, silt and clay. Its texture is determined by the mixture of these three. The best agricultural soils are an even mixture of all three and are referred to as Loam

While the earth's surface is covered in soil the amount of fertile soil valuable for agriculture is limited and is dwindling yearly. Poor soil management can lead to loss of fertile soil.

Grasslands are semi-arid regions with extremely fertile soil. However, if proper soil management is not practiced these are among the most fragile places. Globally desertification of grasslands adjacent to deserts has been a problem.

Agricultural land on slopes/hills or mountains are very susceptible to water erosion.

Urban expansion has also been a factor in the loss of agricultural land. People have traditionally settled in rich farmland and increasing urbanization is covering up good farmland.

Overgrazing, flooding and deforestation have also lead to the degradation of arable land.

<u>Soil Texture</u>:

- Key component in determining the value of soil.

- **Texture** refers to the type of particles in the soil; both particle size and the extent to which particles bond to one another affect soil quality.

- <u>Characteristics of particles determine</u>:

    i. How much water will flow through soil.
    ii. Water-holding capacity of the soil.
    iii. Air movement through the soil.

<u>Soil Texture</u>:

- Fig: 8-8, pg. 138 – <u>How to identify particle size</u>:

- Main particles are:

    a. Stones
    b. Gravel
    c. Sand
    d. Silt
    e. Clay

- Three smallest; **sand**, **silt**, **clay** – are principal components of soil.

1. **Sandy Soil**:

- >85% sand
- Soil texture:
    - Loose and course (sand not bonded together)
    - Water and air penetrate easily.
    - Easy drainage and rapid warming.
    - Moisture not retained.

2. **Clay Soil**:

- >40% clay particles.
- Soil texture:
    - Fine grains of silicate containing aluminum and water which enables bonding.
    - Absorbs and holds water like a sponge.
    - Not permit air penetration: nitrogen missing (nutrients)
    - Soil slow to warm up, slow to drain, hard to work.

3. **Silty Soils**:

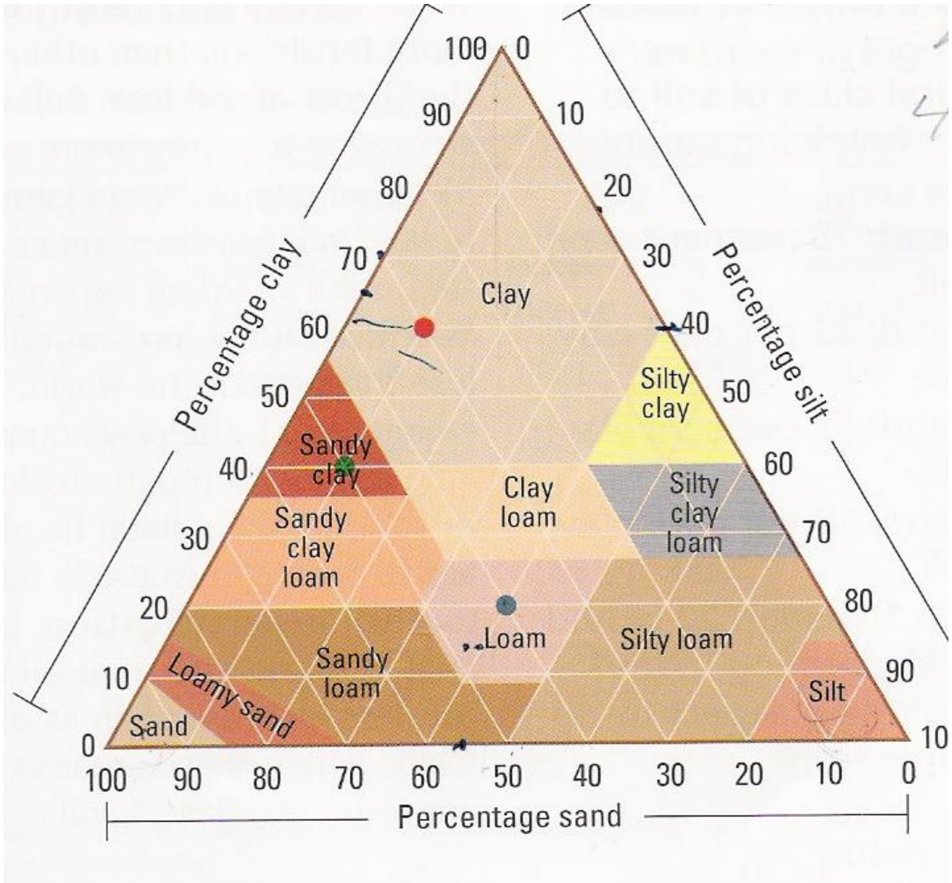
    - Characteristics of both sandy and clay soils.

Most desirable soil texture for FARMING – balanced combination of sand, clay, and silt forming LOAM.

<u>Types of loam</u>:

- Based on which type particle predominates.
- Sandy loam and clay loam:
- Allows easy penetration of plant roots and nutrients.
- Plenty of air, water and nutrients, and drainage.

Look at triangular graph (Fig: 8-9, pg. 139)


Percentage clay
Percentage silt
Percentage sand
100 0
90 10
80 20
70 30
60 40
50 50
40 60
30 70
20 80
10 90
0 100
100 90 80 70 60 50 40 30 20 10 0
Clay
Silty clay
Sandy clay
Clay loam
Silty clay loam
Sandy clay loam
Loam
Silty loam
Sandy loam
Loamy sand
Sand
Silt