Principles of Ecology
2.1 Organisms and Their Environment

A. **What is Ecology?**

- The study of **INTERACTIONS** among and between organisms in their environments.

B. **Aspects of Ecological Study**

**Biosphere**: parts of the planet where organisms live (ranges from 11 km below the ocean’s surface to 8 km above the Earth’s surface → air, land, freshwater, saltwater).
1. **Abiotic Factors**: nonliving factors –
oxygen
temperature
water
Light

2. **Biotic Factors**: biological influences on an ecosystem; **ANY** living, recently living, organism or product of a living thing that interacts within an ecosystem.

Dead and living organisms
Animal waste
<table>
<thead>
<tr>
<th>Abiotic</th>
<th>Biotic</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Stone" /></td>
<td><img src="image2" alt="Forest" /></td>
</tr>
<tr>
<td><img src="image3" alt="Lightning" /></td>
<td><img src="image4" alt="Cat" /></td>
</tr>
<tr>
<td><img src="image5" alt="Water" /></td>
<td><img src="image6" alt="Bacteria" /></td>
</tr>
<tr>
<td><img src="image7" alt="Storm" /></td>
<td><img src="image8" alt="Leaf" /></td>
</tr>
</tbody>
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Levels of Organization in Biology
(from smallest to largest):

1. atom
2. molecule
3. cell
4. tissue
5. organ
6. organ system
7. **ORGANISM**

8. **POPULATION** - group of organisms of same species that interbreed and live in the same place at the same time.

9. **COMMUNITY** – collection of interacting populations

10. **ECOSYSTEM** – interactions among the populations in a community and the community’s physical surroundings (ALL biotic & abiotic factors in region)

**Biomes**: Ecosystems that share similar characteristics.
   a. terrestrial: land
   b. aquatic: fresh water/ salt water

11. **BIOSPHERE** – World of life!
   - Ecologists are mostly interested in the levels from
   - *organism* to *biosphere*.
Figure 2.4
Ecology deals with several levels of biological organization, including organisms, populations, communities, ecosystems, biomes, and the biosphere.
Organisms in Ecosystems

**Habitat**

- Location where an organism lives.

_AKA_ - the organism’s address.
Niche

• All organisms have “occupations” (roles) within their habitats

*Example*: Sometimes the role of the organism is to be the predator in other cases it is to be the prey.
Ecological “Living” Relationships

Predator/Prey Relationship:
someone eats and someone gets eaten

Symbiosis – *living together*
-Relationship between species of organisms that enhances the chances of survival for one or both species
Mutualism

• Relationship in which both species benefit
• (+, +) Relationship
Commensalism

- Relationship in which one species benefits and the other is neither harmed nor benefited
  - (+, ?) relationship
Parasitism

- Relationship in which one organism is harmed, but the other organism benefits
- Parasites usually harm, but they do not kill the host. (host dies – they die!)
- (+, -) relationship
# Summary of Symbiosis

<table>
<thead>
<tr>
<th></th>
<th>Organism 1</th>
<th>Organism 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mutualism</strong></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>Commensalism</strong></td>
<td>+</td>
<td>?</td>
</tr>
<tr>
<td><strong>Parasitism</strong></td>
<td>+</td>
<td>−</td>
</tr>
</tbody>
</table>
Today you will be given a card with a picture and name of a particular species. You will find your “buddy”, the other person in the class with whom you have the symbiotic relationship with.

You will answer the following questions:

Ø What type of symbiosis is our relationship?
Ø Why do we live together?
Ø What advantages and disadvantages do we provide for each other?
Ø What would happen if one of us were to become extinct?

You and your buddy will then give a short presentation to the class explaining what your relationship is.
2.2 Nutrition and Energy Flow

Q: What is the ultimate source of energy for all living things on earth?

A: All energy on earth comes from the sun
Photosynthesis – *Process used by photoautotrophs* by which sunlight (light energy) is captured to make food (chemical energy).

**Formula**

\[ \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2 \]

carbon dioxide + water $\rightarrow$ glucose sugar + oxygen
**Autotrophs** (also called *producers*)
organisms that can make their own food using photosynthesis (or can use chemosynthesis (chemicals instead of light like at the ocean bottom))

**Heterotrophs** (also called *consumers*)
consume autotrophs or other heterotrophs to supply their energy needs
Types of Consumers:

carnivores – meat-eating (cats, hawks)

herbivores – plant-eating (deer, rabbits)

omnivores – eat both plants and animals (humans, pigs)

scavengers – eat already dead organisms (vultures, opossums)

detritivores - feed on detritus (earthworms, most beetle larvae)

decomposers – breakdown dead/decaying organic matter (bacteria and fungi)
Name that Heterotroph!
2.2B. Cycles and Energy Flow in Ecosystems

Cycles and complex linear interactions are common in nature. Examples include:

- Food chains
- Food Webs
- Trophic Levels / Ecological Pyramids
- Nutrient Cycles
Food Chain:
One way transfer of energy between organisms

*it usually has 3-5 trophic levels

Trophic level = feeding or energy level
Food Web: A complex view of energy transfer including several different food chains; includes all possible feeding relationships.
Ecological Pyramids:

- Primary (1st) Consumer
- Secondary (2nd) consumer
- Tertiary (3rd) consumer
- Quaternary (4th) consumer

Usually no more than 5 levels because 90% of energy is lost at each level.
Energy Transfer in Food Webs
(Ecological efficiency)

• “Law of 10% = about 10% of the energy is passed on from trophic level to trophic level.

• 90% of the energy is lost from the system usually in the form of heat.
Ecological Pyramid

- A diagram that shows the relative amounts of energy or matter contained within each trophic level in a food chain or food web.
- Energy, biomass, and population numbers can all be represented by a pyramid.
Pyramids...

**Energy Pyramid:** Shows the relative amount of energy available at each trophic level. Organisms use about 10 percent of this energy for life processes. The rest is lost as heat.
Pyramid’s…

- **Energy Pyramid**

For every trophic level you move up, you lose 90%!
ONLY 10% moves UP

As you lose energy where does it go?
Biomass Pyramid:

- Represents the amount of organic matter in kilograms at each trophic level. Typically, the greatest biomass is at the base of the pyramid.
Pyramid of Numbers

Shows the relative number of individual organisms at each trophic level

For every trophic level you move up,
Pyramid of Numbers
Shows the relative number of individual organisms at each trophic level

Organism # decreases as you go up
Trouble in the trophic levels...

- Some compounds are not recycled by decomposers, nor are they released into the environment like energy.

- Instead, they remain in the ecosystem in virtually unchanged form as they are passed from one organism to another by predation.
Bioaccumulation

• The accumulation of substances, such as nutrients and vitamins that is stored long term in the fat of an organism

• Bioaccumulation occurs when an organism absorbs a substance at a rate greater than that at which the substance is lost.
• This can be good when organisms only eat vitamin rich foods occasionally, has broccoli lately?
• Or this can be bad if the substance is a bioaccumulating toxin like mercury, lead or a pesticide
Biological Magnification

- Increasing concentration of a substance (often harmful) in organisms at higher trophic levels in a food chain or food web.
Biological magnification of DDT in a food chain.
BIOMAGNIFICATION

Biomagnification video 1

biomagnification video 2
Biomagnification vs. Bioaccumulation

- Bioaccumulation occurs within an organism.
- Biomagnification occurs across or up trophic levels (a food chain).
3.1 COMMUNITY interactions

Communities are made up of:
-interacting populations of different species in the same area (your backyard, PRHS)

Limiting Factors – any biotic or abiotic factor that restricts the existence, numbers, reproduction, or distribution of organisms. Can be dependent or independent of population size (density)
Community Interactions

- **Competition**: Occurs when members of the same or different species attempt to use an ecological resource in the same place at the same time.
  - What is a resource?
    - A necessity of life:
      - water, nutrients, light, food, space, mates
Community Interactions

- **Competitive Exclusion Principle** - no two species can occupy the same niche in the same habitat at the same time
  - Direct competition in nature often results in winner and loser – winners live while the losers die.
  - Or at least move somewhere else
Intraspecific competition:

- Competition among members of the same species
  - Example: dominance hierarchy (the fight to be the alpha male)
Interspecific competition:

Competition between different species

- Example: Lions fighting with Hyenas for catch of the day.

  (Where is Simba when you need him).
Keystone Predator

- A *keystone predator* is an animal that is important for maintaining the number of species (species richness) in a community.
density dependent | density independent
Density Dependent or Independent Review

1-Which pictures did you put with the density dependent category?
2-Which pictures did you put with the density independent category?
3-Give one example of interspecific competition?
4-Give one example of intraspecific competition
5-There is a picture of two bears. What kind of competition is this – interspecific or intraspecific?
Soil Formation

• Soil is a thin layer of material, such as weathered rock, decayed plant and animal matter, and microorganisms on the Earth's surface in which plants have their roots.

• Soil is formed over a long period of time; usually less 1 inch per 100 years.

• Soil Formation takes place when many things interact, such as air, water, plant life, animal life, rocks, and chemicals.
Succession:

B. *(Ecological) Succession:* 
*Environmental changes over time*

- orderly natural changes and species replacements that take place in the communities of an ecosystem.
- occurs in stages (can take decades or centuries for one type of community to completely succeed another).
Pioneer Species-

**Pioneer species** are species which colonize previously lifeless land or water. They are the first organisms to start the chain of events leading to a livable area.

*Pioneer species like lichen form soil or sediment providing food and substrate for other organisms.*
Pioneer Species- *Lichen*
Primary vs. Secondary Succession

- Primary succession is when there is **NO LIFE** present

- Secondary succession is when there is **SOIL OR SEDIMENT** present
Succession

**Primary Succession**
- Volcano erupts leaves BARE rock behind
- Pioneer species like lichen and moss come in and begin to break down the rocks to make soil
- Once soil is made, smaller plants and animal move in.
- Newly enriched soil give rise to climax communities

**Secondary Succession**
- Begins with a disturbance which can be man made or natural.
  - Ex. Fire, hurricane, mowing
- Because the soil is left intact, plant life returns quickly
- After plants are established, animals move in
- Climax community reforms
Secondary Succession

Succession

succession video
4.1 Population Dynamics

A  **Principles of Population Growth**
- an increase in the size of a population over time.

1. **How fast do populations grow?**
- Populations do not experience linear growth instead initially they experience **Exponential Growth** - as a population gets larger, it also grows faster and faster (population explosion) → this produces a J curve
Graphs: Exponential – vs – Linear

\[ y = 2^x \]

Graphs of Exponential Functions

Linear Function Graph

Extension ratio as a function of time

Extension ratio (L)

Time (s)
Population Terms

- **Biotic potential** - the greatest possible reproductive rates in ideal conditions
- **Environmental resistance** - external conditions that limit population growth (limiting factors)
- **Carrying capacity** - the maximum expected population size for an area and with its conditions for supporting the population
Normal Population Growth

- Exponential growth only occurs for a short time, limiting factors and carrying capacity slow growth
- Sooooo...A NORMAL growth curve is a S curve or logistic growth
Four Factors Affect Population

• Emigration
• Immigration
• Birth rate
• Death rate
Population Curves

- **J** and **S** population curves.

- Biotic potential
- Environmental resistance
- Carrying capacity

- Population
- Time

- J curve
- S curve
Limiting Factors -

Density - Dependent
- Competition: for food, space, & resources
- Predation cycles
- Disease

Density-independent
- Temperature
- Habitat destruction
- Natural disaster
Population Curves

- What about the human population?

- [human population video](#)
What is an adaptation?

- An adaptation is an inherited trait that increases the success of an organism in its environment.

  - [adaptation video](#)
  - [adaptation video](#)
Examples of Plant Adaptations

- **Phototropism**
  Movement of plant toward light

- **Geotropism**
  Root growth of plants toward gravity (down) while top grows up

- **Thigmotropism**
  the directional response of a plant to touch