UNIT 1
SUSTAINING ECOSYSTEMS

Chapter 1
Diversity in Ecosystems

Science 1206 / 2200

What is a Paradigm? (para-dime)

□ Definition
  ■ "A philosophical and theoretical framework of a scientific school or discipline within which theories, laws, and generalizations and the experiments performed in support of them are formulated."

□ Are you going to be able to remember this?

I Didn't Think So….

- The Simple Definition
  - "Set of values, beliefs and knowledge that we bring the assessment of any situation or decision that we make."
- Example:
  - The beliefs and expectation that people in Newfoundland had 20 years ago suggested that the cod fishery would last *forever*.
  - These values, beliefs and the knowledge that these people held is their *paradigm*.

More Examples

- For 100's of years people believed that the world was flat.

- People once believed that the sun revolved around the earth

- Can you think of any more examples of paradigms that people have or had?

Paradigm Shift

- Definition
  - A *shift* or change in paradigm. These are RARE and usually result in some controversy that settles after people become more accepting of new scientific knowledge.

- Example
  - After the research was completed scientists had to convince the government, and the fishermen that the cod fishery would be lost if they kept up at the current rate.
  - Many are struggling to change their values and believes to match the new knowledge.
  - These people have to change their values and beliefs and knowledge about the cod fishery because they cannot fish as much as they could, and there is much less fish. – This resource is not an endless supply as once thought

More Paradigm Shift Examples

- After many people sailed away, "fell off the earth" and returned, people began to accept that the earth was round not flat

- Early astronomers studied the skies and were able to determine that the earth revolved around the sun… as do all the other planets

- New telescopes and closer observation of the skies indicates that the earth is not the centre of the universe, but rather only a small speck

- Can you think of any other paradigm shifts that are creating some controversy today?

Sustainability

- Definition
    - Living in a way that will enable the earth to be used indefinitely without depleting its energy resources.

- Can you think of any ways that we help to sustain our ecosystems?

- How do we know when something is wrong with our ecosystems?

Attitudes Towards Forestry

- **Our forests are a limited resource that needs to be properly maintained to be environmentally and socio-economically beneficial → SUSTAINED**

- **How have our attitudes towards forestry changed with respect to commercial usage? Residential usage? Replanting programs?**

Commercial Usage…

□ Clear-cutting is no longer an option. Other methods, such as selective cutting, strip cutting and replanting must be done to ensure that forests are available for future generations, both for commercial uses (industry and tourism) and environmental purposes (helping to clean water, air, and prevent erosion).

Residential Usage…

□ Limits on how much an individual can remove from the forest that was not there before.

Replanting Programs…

- These were not done by all people who cleared the forest, now it is highly frowned upon to not replant trees, and most companies have strict replanting policies in place to ensure that new-growth forest will be present.

Attitudes Towards Pesticides

- We use less of them, they are not sprayed unnecessarily
- They are weaker than they used to be so that pests are controlled rather than eliminated

- More environmentally friendly – less toxic to people and animals that are not intended to be harmed
- We will talk more about the use of the pesticide DDT in the next week or so.
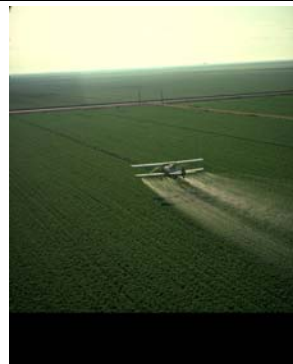
Can we consider these changes in attitude a minor shift in paradigm?

Why have attitudes changed?

- ☐ Correction of the damage we have done to our ecosystem
  - ■ Deforestation
  - ■ Over use of natural resources
  - ■ Burning of fossil fuels
    - ☐ Resulting in pollution of natural environment
  - ■ Careless usage of chemicals (CFCs)
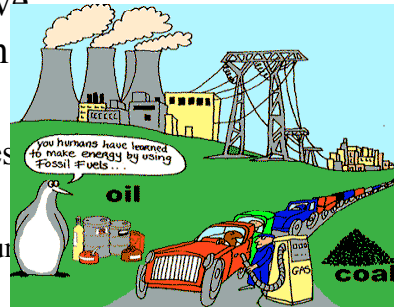
What is our evidence of ecosystem damage?

- ☐ Bioindicators
  - ■ A plant or animal that we can use to reveal the health of our planet.

- ☐ The health of a population of organisms in their natural ecosystem(s) can tell us how much damage we are doing to the earth because of the negative effects that are observed.
  - ■ Example
   - ☐ Frogs are a good bioindicator for freshwater and moist forest ecosystems

Can you think of any other bioindicator species?

Definitions

- Ecology
  - The study of the natural environment and of the relationship of organisms to one another and their surroundings
- Ecosystem
  - All of the interacting parts of the physical and biological worlds
- Environment
  - An organism's surroundings, including the plants and animals that it interacts with

Why use frogs as bioindicator?

- Frogs occupy two different food chains
- Terrestrial
  - 2° Consumer role
- Aquatic
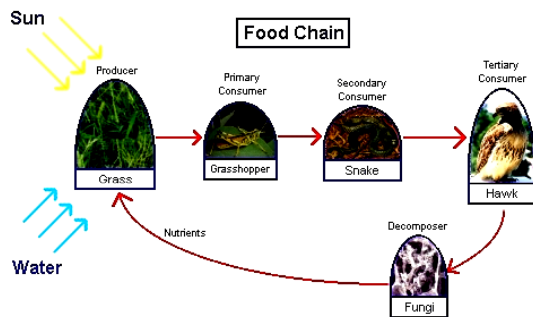 - 1° Consumer role

See page 11 in textbook
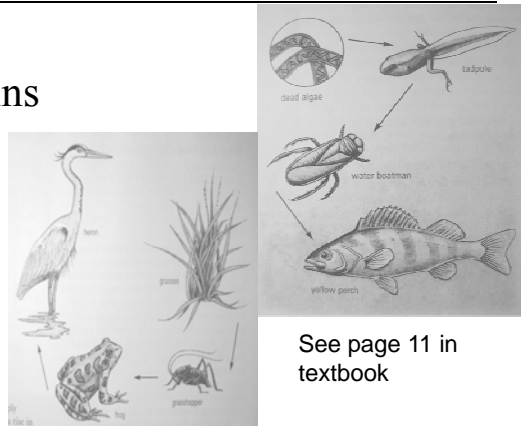
Why Frogs…

- ☐ They are exposed to hazards in both the aquatic and terrestrial ecosystems they inhabit. Any decline in the health of either of the two ecosystems in which they live will have an impact on frogs

What is a food chain?

Leaves → Slug → Frog → Heron
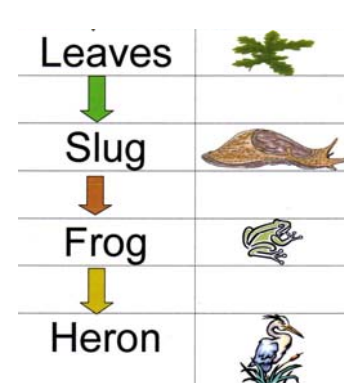
- ☐ Definition:
  - ◼ a step-by-step sequence linking organisms that feed on each other and through which **energy and nutrient**s are transferred

Food Chains

□ Food chains are divided into **Trophic Levels**.

■ Divisions of species in an ecosystem on the basis of their main nutritional sources

Major Trophic Levels

□ Primary (1°) Producers → Plants

□ Primary (1°) Consumers

□ Secondary (2°) Consumers

□ Tertiary (3°) Consumers

Animals, Fungi Bacteria

Primary Producers

□ Autotrophic
- Have the ability to manufacture their own food from simple inorganic substances

□ Most primary producers are photosynthetic organisms that use light energy to synthesize (make) sugars and other organic compounds.
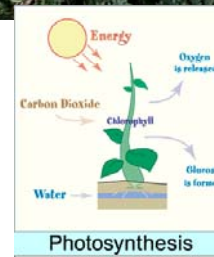
All Consumers

□ Heterotrophic
- Organisms that are unable to make their own food
- Rely on nutrients from other sources

Terminology

- Herbivore
  - Animal which eat only plants
  - Primary consumers only
- Carnivore
  - Animal which eat other animals
  - Secondary, tertiary consumers

- Omnivore
  - Carnivore that eats both plants and animals
- Predator
  - Carnivore that captures and eats prey
- Scavengers
  - Feed on dead organisms

Decomposers

- Also called **saprobes**
- Get their energy from **detritus**, which is organic waste such as feces or fallen leaves and the remains of dead organisms from all trophic levels
- They ensure the return of basic minerals to the soil so the future generations of primary producers may have access to them for the purpose of photosynthesis.

DECOMPOSERS BREAK DOWN MATERIALS AND RETURN NUTRIENTS TO THE SOIL.

Back to the Frogs…

- Aquatic Food Chain
  - Tadpoles are herbivores which consume both living material (algae) and waste and dead plant and animal material (detritus).
  - They form part of the detritus food chains which are critical in the recycling of matter in ecosystems.

- Terrestrial Food Chain
  - Frogs are carnivores which eat mostly insects but may at times eat small fish.

Why are the Frogs Disappearing?

- **Loss of habitat**

  The most common reason, loss of places for the frogs to live. Frogs require wetlands, ponds or lakes with clean water so they can breed and lay their eggs. Adults need forests or meadows where they can catch insects. They also need a safe place between these two locations.

- What are some reasons for loss of habitat?

- **Air and Water Quality**

  Pollution is a major cause of poor air and water quality. Frogs have thin, sensitive skin through which they also breathe. Their thin skin allows oxygen to pass through, so pollution can also pass through. Acidity from acid rain affects the frogs' ability to reproduce (lowers sperm motility), embryos may not develop. If they do develop, ponds may dry up before the tadpoles are fully developed frogs. Tadpoles may develop deformed limbs

More Frog Disappearances

- **Ultraviolet (UV) Radiation**

  Thin frog skin is very susceptible to being burned and damaged by harmful UV radiation. UV radiation can also cause serious cell damage. Increases in human skin cancer rates confirm the importance of using frogs as Bioindicators of the health of our planet.

- **Climate Change**

  Human activities causing climate change are also linked to declining frog numbers. This is strong evidence of global warming.

  Global warming = ecosystems are dryer = less water for frogs to keep moist

- What are some activities that we humans do that are helping to cause global warming?

UV Radiation…

- Life on earth is protected from the damaging effects of UV radiation by the ozone layer in the atmosphere
- Ozone absorbs UV radiation, preventing much of it from reaching the Earth's surface. Satellite studies of the atmosphere suggest the ozone layer has been gradually depleted, or "thinned", since 1975, and that the depletion continues at an increasing rate
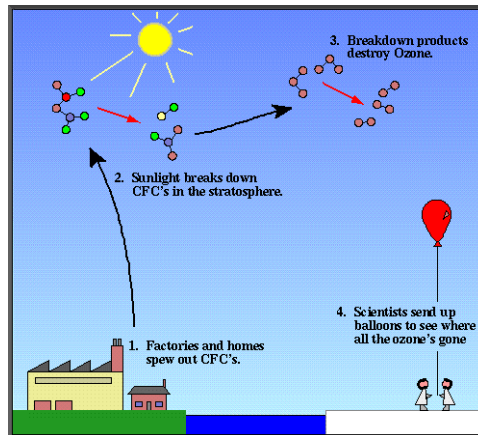
- Increasing exposure to UV radiation will affect food chains and increase rates of skin cancer

- Frogs at higher altitudes have adapted:
  - Black eggs protect embryos
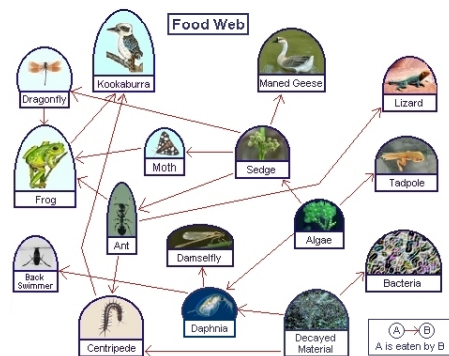 - Black lining on internal organs protects them

- What are causes of ozone depletion?

What Causes Ozone Depletion?

3. **Breakdown products destroy Ozone.**

2. **Sunlight breaks down CFC's in the stratosphere.**

4. **Scientists send up balloons to see where all the ozone's gone**

1. **Factories and homes spew out CFC's.**

Food Webs

- Groups of interconnected food chains
- Shows the movement of **energy** in ecosystems

Food Web

Dragonfly
Kookaburra
Maned Geese
Lizard
Moth
Sedge
Tadpole
Frog
Ant
Damselfly
Algae
Bacteria
Back Swimmer
Daphnia
Centripede
Decayed Material
A → B
A is eaten by B

Short Assignment

□ Page 13
  ■ Understanding Concepts

□ Questions:
  ■ 1, 2, 3, 4 (a), 5

□ Create a list of plants and animals from a forest ecosystem (6 animals, 4 plants)

□ Create two food chains, identifying the trophic levels in each

□ Create a food web using all of the organisms in your list

Climate Change

□ Climate change can bring about significant changes in local ecosystems.

□ In some cases these changes may be so significant, a local ecosystem is no longer a suitable habitat for a given species.

□ The major cause of climate change is believed to be global warming.

Global Warming

- Refers to the gradual increase in global temperatures which have been observed over the past 150 years.

- Various methods have estimated that the average CO_2 concentrations in the atmosphere before 1850 was about 274 parts per million (ppm).

- In 1958, the CO_2 concentration was 316 ppm.

- Today, the concentration of CO_2 exceeds 357 ppm, an increase of about 13% since the measurements began

- If CO_2 emissions continue to increase at the present rate, by the year 2075, the atmospheric concentration of this gas will be double what it was at the start of the Industrial Revolution.

- Mathematical models predict a doubling in CO_2 levels would result in an average temperature increase of 3 to 4 degrees Celsius

Effects of Global Warming

1. The altering of the geographical distribution of precipitation, making major agricultural areas much drier.

2. Changes in climate, which in turn, will affect plant and animal distribution

3. Worst-case scenario suggest the warming would be greatest near the poles; the resulting melting of polar ice will cause a significant rise in sea levels, gradually flooding coastal areas. This would flood most of the world's major cities, located as they are along the sea coasts

Greenhouse Effect
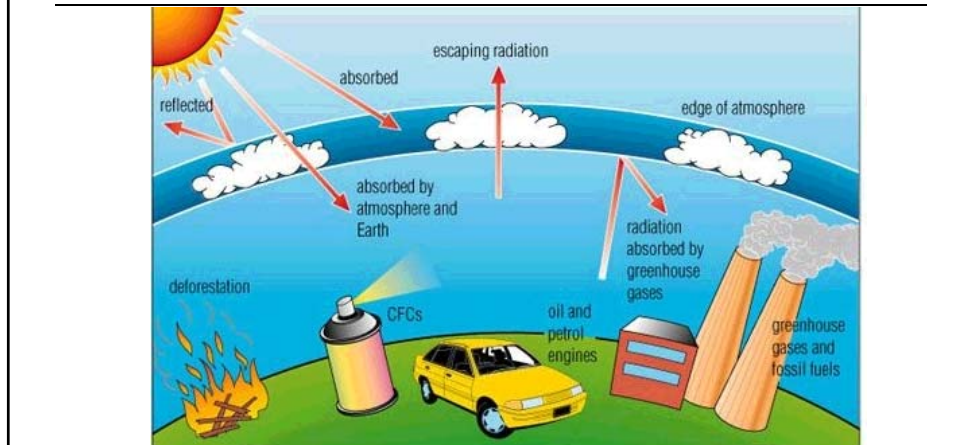
Ecology

- Ecology
  - The study of how organisms interact with each other.
- How do organisms interact?
  - Reproduction, competition, etc
- What do organisms interact with?
 - Air, water, minerals, nutrients, etc.

Pests

- Pests are organisms that cause problems for humans (bees, wasps, ants, cockroaches).
  - Wouldn't you enjoy life without them?
- Why don't we try to eliminate pests rather than control their numbers?
- What problems could arise if we completely eliminated
  - Mosquitoes?
  - Mice?
  - Crab grass?

Parts of the Ecosystem

- Includes all the organisms as well as air, soil and water that surrounds the organism
- **Biotic Components**
  - Living things that an organism interacts with – predator / prey, competition, symbiosis, parasitism
- **Abiotic Components**
  - Non-living physical and chemical factors that influence an organism's survival
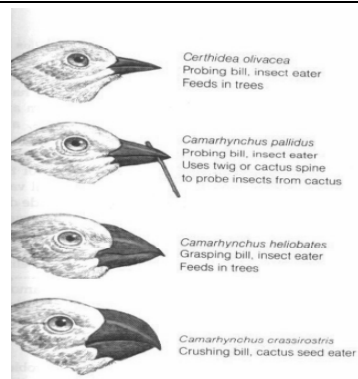   - Water, air, nutrients, light, temperature, humidity, soil, etc.

Organizing Interactions

organism   population   community   ecosystem
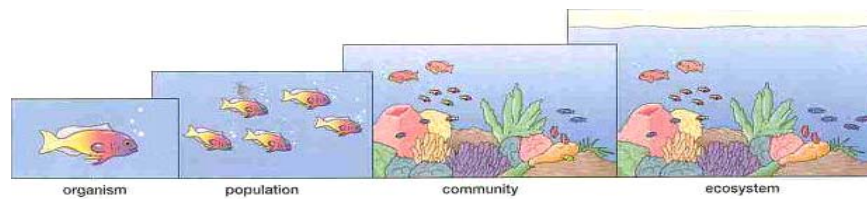
Organizing Interactions

- **Populations**
  - A group of individuals of the same species, living in the same geographical area. The size of the area depends on how fast or how far the organism can travel
  - Differences in abiotic conditions account for different populations of the same species showing different behaviors – These variations have evolved over time

Certhidea olivacea
Probing bill, insect eater
Feeds in trees

Camarhynchus pallidus
Probing bill, insect eater
Uses twig or cactus spine
to probe insects from cactus

Camarhynchus heliobates
Grasping bill, insect eater
Feeds in trees

Camarhynchus crassirostris
Crushing bill, cactus seed eater

Communities

- All of the organisms in all of the interacting populations in a given area

- Influential interactions include:
  - Competition, predator-prey relationships, and environmental factors (ie. Amount of sunlight)

- Dynamic – number and type of organisms in a community change over time
  - This is called **Succession**
  - We will talk about this later…

Ecotone

- Transition areas between two ecosystems
- Contain species from both bordering ecosystems, so they contain a greater biodiversity than either of the two.
- Are less fragile than either ecosystem, as predators often have another food option

Above: Grassland – forest ecotone

See page 22 in textbook.

Comparing Ecosystems

Artificial Ecosystem	**Natural Ecosystem**
☐ An ecosystem that is planned and maintain by humans 　■ Ex. Parks, zoos, farms and managed forests	☐ An ecosystem that has occurred over time due to the effects of nature. ☐ It is a living community free to interact with the physical and chemical environment

In-Class Questions

☐ Answer the following questions

　■ Page 23

　　☐ 1, 2, 3, 4, 5

　■ Page 29

　　☐ 1, 2, 3

Species at Risk

- Species at risk can be classified into different categories based upon their population size
- There are 5 levels of classification

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1. Extinction

- A species no longer found anywhere.

- At the rate of 80 species per year.

- It is caused by climate change, the pressure of competition (adapt or die), and human interference with ecosystems

- Dinosaurs
- Blue Walleye (fish)
- Woolly Mammoth
- Doe-Doe Bird
- Passenger Pigeon

2. Extirpated

□ Species that are extinct in one part of Canada, but may be present in another part of Canada.

□ Grizzly Bear
  ■ No longer found in Manitoba and Saskatchewan, but still found in the mountains of Alberta and B.C

□ Wolf
  ■ No longer found in Newfoundland, but is still in other parts of Canada

3. Endangered

□ A species that is close to extinction in all parts of Canada or in a significantly large location.

□ **Bald Eagle**
□ Whooping Crane
□ **Newfoundland Pine Martin**
□ Tasmanian Devil
□ Panda
□ White Tiger
□ White Rhino

4. Threatened

- A species that can become endangered if factors that make it vulnerable are not reversed

- Wood Bison
- Fowler's Toad
- Peregrine Falcon
- Hooded Warbler
- Beluga Whale
- Humpback Whale
- Killer Whale
- Woodland Caribou

5. Vulnerable

- Any species that is at risk because of low or declining numbers at the fringe of its range or in some restricted area.

- Atlantic Cod
- Blue Whale
- Harbour Seal
- Polar Bear
- Grey Fox
- Barn Owl
- Monarch Butterfly

Energy in Ecosystems

- The source of <u>all</u> energy for ecosystems is the sun.
  - Warms the water and land, melts ice and snow, causes evaporation to occur
  - See figure 1, page 32 in text

- Energy breakdown from sun
  - 70% - Warms the earth
  - 30% - reflected by clouds and earths surface
  - 0.023% absorbed by green plants

- Photosynthesis
  - Process by which green plants use solar energy to produce carbohydrates (sugars)

- $6\,CO_2 + 6\,H_2O + energy \rightarrow C_6H_{12}O_6 + 6O_2$
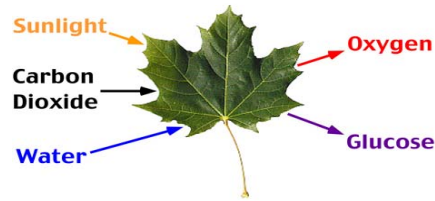
Albedo Effect

- Measure of the amount of light energy an object reflects
  - Snow – High albedo
    - Reflects lots of light, little is absorbed

  - Trees – Low albedo
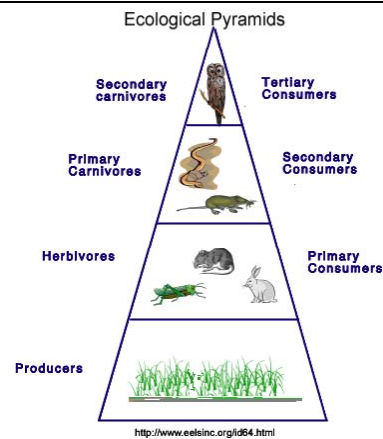   - Reflects little light, as it is absorbed
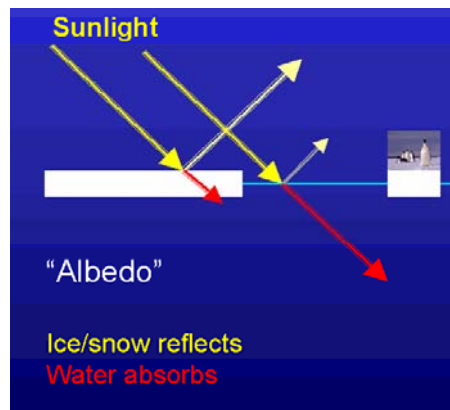
Laws of Thermodynamics

1. Although energy can be converted from one form to another, it cannot be created or destroyed

See Figure 4 and 5 on page 36

2. During transformation, some energy is converted into an unusable form (mostly heat) that cannot be passed on. Each time energy is transformed some energy is lost from the system. Thus, the amount of energy is always less than the previous transformation.
   2. This also applies to food chains

Pyramid of Energy

□ Trophic levels are stacked in blocks with primary producers forming the foundation of the pyramid. The size of each block is proportional to the amount of energy at that level.
 ■ Refer to page 37, figure 6

Ecological Pyramids

Secondary carnivores — Tertiary Consumers

Primary Carnivores — Secondary Consumers

Herbivores — Primary Consumers

Producers

http://www.eelsinc.org/id64.html

The 10% Rule

- □ If 10% of the energy can be transferred from one trophic level to the one above it, each trophic level must have 10x the energy as the one above it.

- □ The number of trophic levels depends upon the number of primary producers in the first trophic level.
- □ Biomes with small numbers of primary producers have short food chains

# Energy Pyramid for 10% Rule
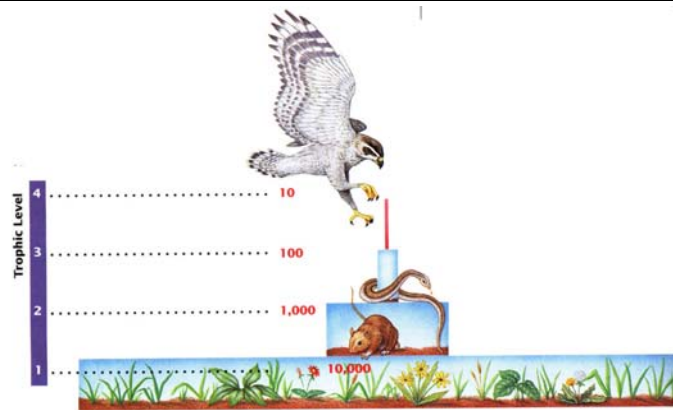
One More Example
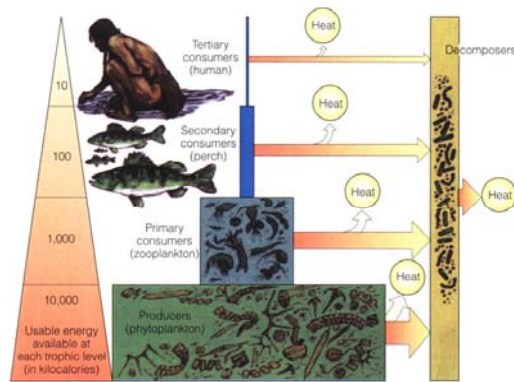
How much energy is available for the humans at the top of the food chain?
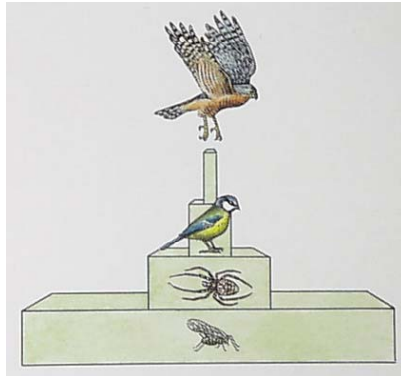
What does this mean?

Pyramid of Biomass

□ Each tier represents the standing biomass (**total dry weight of all organisms**) in a trophic level.

□ Biomass pyramids generally narrow sharply from primary producers at the base to top-level carnivores at the apex because energy transfers between trophic levels are so inefficient.

□ See text page 38, figure 9
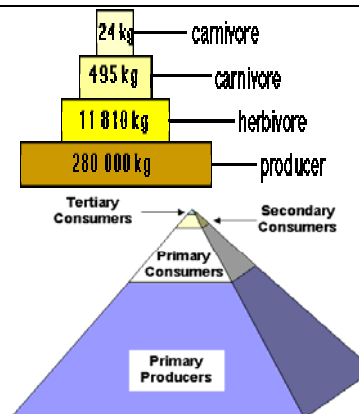
Pyramid of Numbers

- The size of each tier is proportional to the number of individual organisms present in each trophic level. Like biomass pyramids, numbers pyramids usually narrow sharply from primary producers at the base to top level carnivores at the apex

- Populations of top level predators are typically very small, and the animals may be widely spaced within their habitats. As a result, predators are highly susceptible to extinction.
    - see text page 37, figure 7

Habitat vs. Ecological Niche

- **Habitat**
    - the place where a species lives. Plants and animals live where they can satisfy their needs. Every habitat includes factors that limit the kinds and numbers of organisms that live there.
    - In some cases, creatures can adapt themselves to a changing habitat.

- **Communities**
    - A single area may satisfy the needs of many kinds of plants and animals.

- **Ecological Niche**
    - An organisms place within the food web; its habitat, feeding area, and the time of day it is most active
    - The niche an organism fills in an ecosystem includes everything it does to survive and reproduce
    - Also, what it does to aid the survival of other organisms).

Competition

Interspecific Competition	Intraspecific Competition
☐ Occurs when individuals of different species compete for the same essential resource, such as food, water, or living space	☐ competition between members of the same species. This allows for "survival of the fittest". The result is a healthier overall population

Can you think of any example of each type of competition?

Chapter 1 - Complete

☐ Chapter Review questions

   ■ Due NO LATER than Friday, Sept. 26

☐ Chapter 1 Test date:

   ■ FRIDAY, SEPTEMBER 26, 2008