BIO 1101 Lecture 20
Chapter 20: Community Ecology

- Community: "an assemblage of species living close enough together for potential interactions"
- How do organisms of different species interact?
- Click for video Intro:

Interspecific Interactions

- Interactions between different species
  - Competition
  - Predation
  - Herbivory
  - Parasitism
  - Mutualism

- Interspecific Competition
  - The simultaneous demand for a limiting resource by more than one species
  - A “lose-lose” situation (each individual’s access to that resource is limited by individuals of the other species)

Although they may compete for some resources, no two species can have exactly overlapping habitat requirements

<u>Competitive Exclusion Principle</u>

– “*Populations of two species cannot coexist in a community if their niches are nearly identical. Using resources more efficiently and having a reproductive advantage, one of the populations will eventually outcompete and eliminate the other*.”

What's a "niche"?

"The sum total of a population's use of the biotic and abiotic resources of its habitat"

An organism's "ecological role"

- Predation
  - A relationship in which one species, the predator, consumes another species, the prey
  - A "win-lose" (+/-) relationship for the individuals involved

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How do prey avoid being eaten?

- Hide
- Run away
- Alarm Calls
- Mobbing

- **Cryptic coloration (camouflage)**

- **Warning coloration**

- **Batesian mimicry**
  - A harmless species mimics a poisonous one
  - Example: Monarch (contain toxins) & Viceroy (non-toxic) butterflies; eastern coral snake (venomous) & scarlet king snake (non-venomous)
  - Click for Audio: 

- **Müllerian Mimicry**

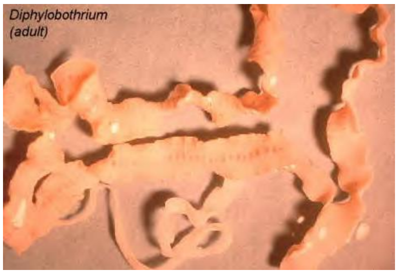
Two or more unpalatable species resemble each other

Because several poisonous or potentially harmful species look alike, animals learn more quickly to avoid all of them

Example: Many bees resemble each other (Cuckoo bee and yellow jacket pictured)

- Herbivory
  - A win/lose (+/-) relationship, in which an animal eats a plant (or algae)
  - Often not fatal to the plant, but usually harmful
  - Plants have evolved many defenses against herbivores, including:
    - Spines and thorns
    - Chemical toxins
      - Examples: strychnine, produced by a tropical vine; morphine, produced by poppies; and nicotine, produced by tobacco plant
      - Some chemical defenses are not toxic to us; we may use them as spices, such as peppermint, cloves, and cinnamon

- Parasitism
  - Another relationship where one species benefits at the expense of another (+/-)
  - Usually the parasite lives in or on the other organism (the host)



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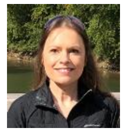


- Mutualism
  - An interspecific relationship in which both species benefit
  - A “win-win” (+/+) situation for both individuals
  - Examples:
    - Acacia trees provide food for ants, and ants defend the trees against herbivores
    - Ox pecker birds eat ticks and other parasites from the backs of rhinos and zebras, cleaning them of their parasites
    - Bees pollinate flowers, and in the process get nectar as food

- Commensalism
  - An interaction in which the individual of one species benefits, while the individual of the other species is neither helped nor harmed (+/0)
  - Example: barnacles growing on whales (barnacles gain access to food and have a place to live; whale is neither harmed nor helped)

Disturbances and Succession

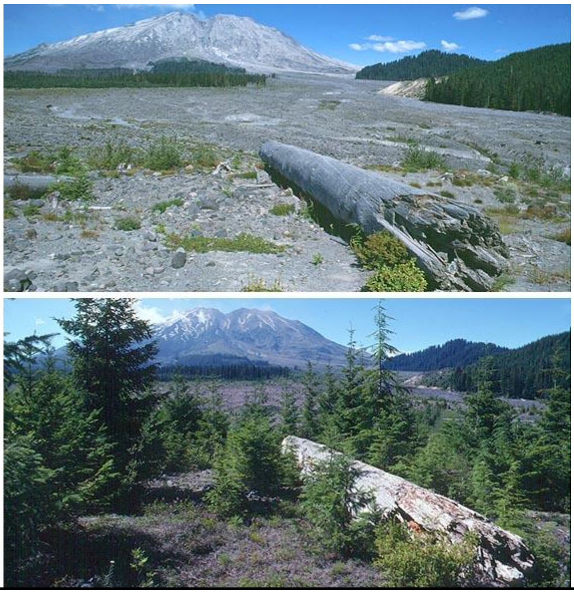
- A disturbance is an event that changes a biological community, usually removing organisms from it
- Examples: fires, volcanoes, and floods

- Ecological Succession
  - When a community is disturbed, a variety of species may colonize the area
  - Which species? Depends on the severity of the disturbance, and which species are present in surrounding areas
  - Succession is the gradual process of progressive community change and replacement

Primary Succession

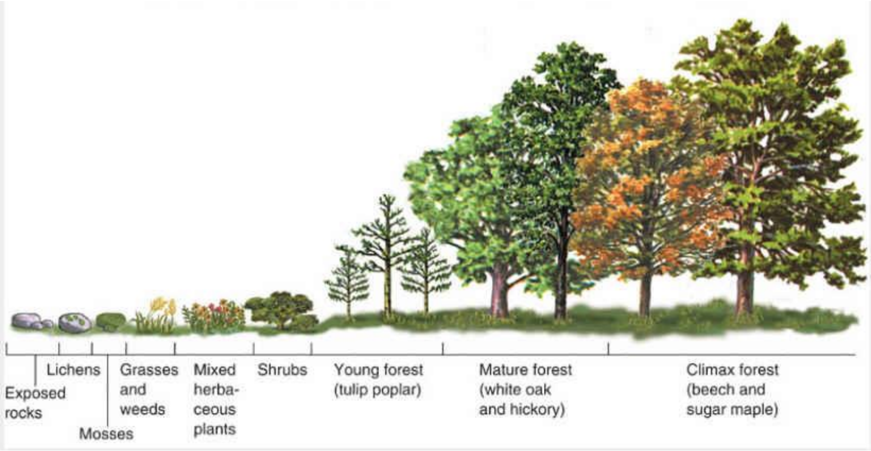
- Occurs after severe disturbance
- No soil is present
- Example: Volcano or glacial retreat
- 1st to colonize: autotrophic microorganisms, lichens, and mosses
- Next: grasses… then shrubs and trees…
- Each successive colonizing species modifies the habitat, making it favorable for colonization by the next species

- Primary succession after 1980 eruption of Mount St. Helens (photos taken in 1988 and 2001)



Secondary Succession

- Occurs after a less severe disturbance
- Most of the species have been lost, but soil remains
- Examples: fire, or clearing of land for agricultural use
- 1st to colonize: usually herbaceous (non-woody) plants



- Disturbances – both large and small – occur all the time in natural communities
- They may be beneficial…
  - Frequent small-scale disturbances can increase habitat diversity, and prevent more severe, large-scale disturbances (e.g. fires)
  - The scientific basis for the use of “controlled burns”

A recently burned forest; after the fire, lupine grows readily – it is adapted for disturbance; has a deep taproot that is not harmed by the fire

- Lodgepole Pine trees produce pine cones that won't open unless exposed to high temperatures from a fire
  - "serotinous" – seeds that require an environmental trigger to be released
  - The cones are sealed with a resin that melts away during fire

- Kirtland's Warbler – one of first listed endangered species; nests only in a few counties in Michigan and Wisconsin, and Ontario
  - Overwinters in the Bahamas
  - Nests in vegetation under limbs of 5-to-20-year-old jack pine trees
  - Jack pine trees grow when older ones have died from fire; heat from the fire opens the jack pine's cones, releasing seeds, and prepares the soil for germination of the seeds.
  - Lack of forest fires resulted in lack of young-to-middle-aged trees for the warblers
  - Michigan DNR created four areas of jack pine forest in late 1950s-early 1960s for controlled burns and management for Kirtland's warblers. More areas were set aside in the 1970s through the 1990s.

- Karner Blue Butterfly – Listed as an endangered species in 1992
  - Caterpillars feed only on leaves of wild blue lupine
  - If fires don't periodically suppress the other vegetation, the competition and shade of other plants eliminates the lupine
  - Lupine is an early-successional plant; after a fire, their seeds in the seed bank sprout, and plants may grow from the underground rhizomes (stems)
  - If fires are suppressed too much, not enough lupine and therefore not enough food for the Karner Blue Butterfly

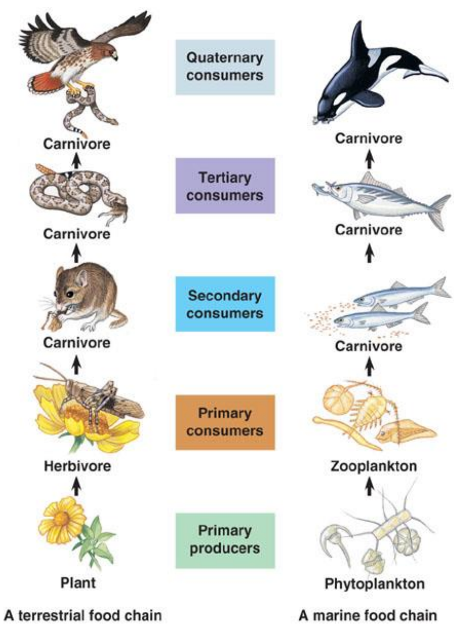
Ecosystem Dynamics

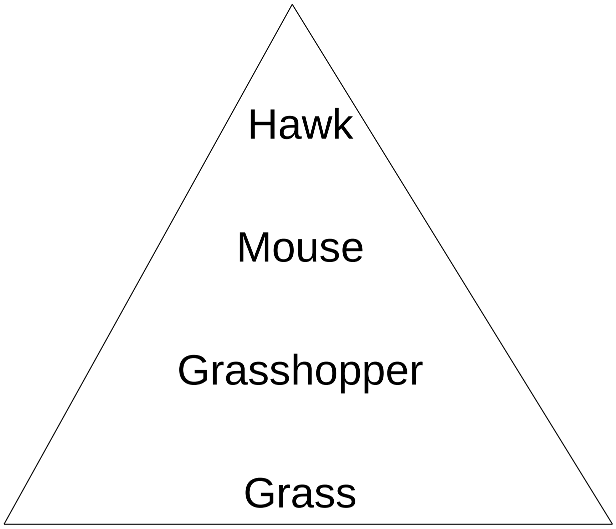
- Ecosystems: highest level of biological organization (short of the entire planet, or "biosphere")
- Ecosystem Ecologists are often concerned with how energy and nutrients flow through the ecosystem
- Remember, sunlight is the ultimate energy source for nearly all ecosystems

- How does energy flow through an ecosystem?
  - Through feeding interactions
  - “Up” trophic levels
  - Can be diagrammed as food chains or food webs

- Food chains:
  - linear feeding relationships
  - simplified
  - The bottom of a food chain starts with the producers (autotrophs)
    - All other organisms depend on these
    - On land, these are usually plants
    - In aquatic systems, usually phytoplankton (protists and bacteria that are photosynthetic)
  - Second level includes herbivores, animals that consume autotrophs
  - Third level includes animals (carnivores) that eat the herbivores

- Primary, secondary, tertiary consumers… (and so on)
- The biomass (the amount of organic material) at any given trophic (feeding) level is determined by the amount of energy available
- Leads to an energy pyramid

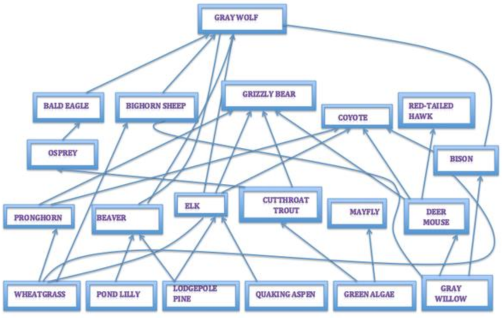




- Only about 10% of the energy in one trophic level is transferred up to the next level
  - What happens to the lost energy?
    - Remember, energy is neither created <u>nor destroyed</u>
  - Energy is used by organisms to do work (run, grow, cell division, etc.), and energy is given off as heat from metabolic activity. Relatively little is stored as chemical energy in the tissues of the organism.
  - Not all of the organism can be digested by the one that eats it

- Ecosystems are much more complex than can be shown in a simple food chain
- Food webs can show some of the more complex interactions (but even these are usually greatly simplified)

- Food web example: Yellowstone National Park, where the gray wolf is an apex predator
  - Watch video on wolves of Yellowstone:
    - https://wosu.pbslearningmedia.org/resource/a58e3ca2-52ab-45f5-87ac-26ee0d681146/wolves-of-yellowstone-earth-a-new-wild/#.XpnSmTaB73g



- Wolves eliminated from the park in the 1930s, causing a trophic cascade
  - *When removal or addition of a top predator results in changes in prey populations, and dramatic changes in ecosystem structure*
- Lack of large predators resulted in boom in elk populations, and the elk populations stayed in place (rather than moving about to avoid predators)
- Large elk populations devastated the aspen, willow and cottonwood trees
- Beaver populations suffered, as they need those trees to survive
- Wolves reintroduced to Yellowstone in 1995
- Today, the trees, beaver and other species are recovering

- Biological Magnification
  - Some toxins accumulate as they pass through the food chain
  - Compounds that are lipid-soluble stick to fat tissue; the higher the organism is in the food chain, the higher the levels of these compounds in its fat tissues
  - DDT was a pesticide that bioaccumulated, leading to the decline of many bird species
  - Mercury and PCBs also bioaccumulate
  - Arctic food chain example (Fig. 20.17)

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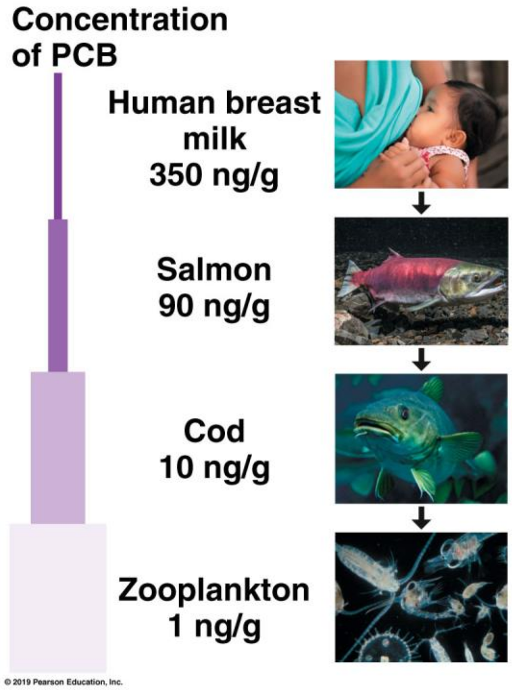
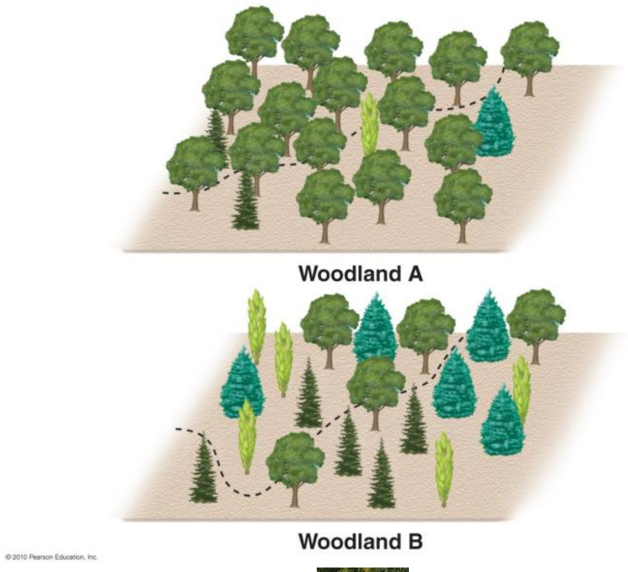


Species Diversity in Communities

- Two components of species diversity:
  - Species richness: the number of different species in the community
  - Relative abundance: the proportional representation of each species in the community
- Two communities may have equal species richness, but different levels of “diversity” depending on the relative abundance of each species (see Fig. 20.19)



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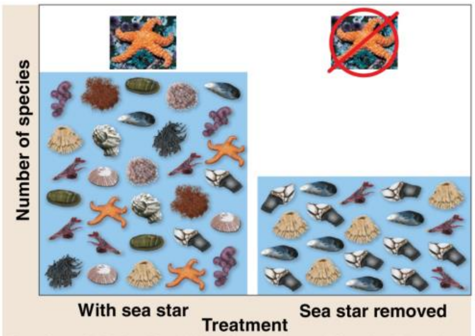
- Keystone species: a species whose impact on its community is much larger than its total mass or abundance
  - It plays a large role in holding the rest of its community in place
  - Example: a sea star species within the intertidal zone of the Washington coast
  - Researchers experimentally removed the sea star and observed what happened to the community…

- The sea star fed on mussels
- When sea star removed, the mussel population increased drastically
- The large mussel population outcompeted many other species (algae, barnacles, and snails) for resources, and these organisms drastically declined
- Species richness declined from 15 to fewer than 5

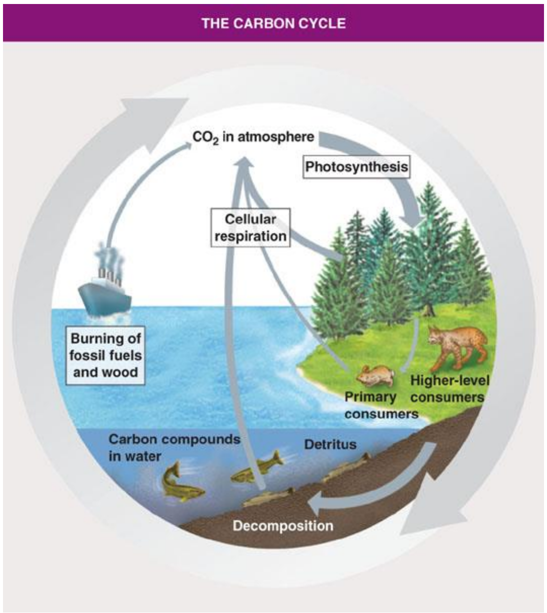


Data from: R. Paine, Food Web Complexity and Species Diversity. *The American Naturalist* 100 (910): 65–75 (1966).

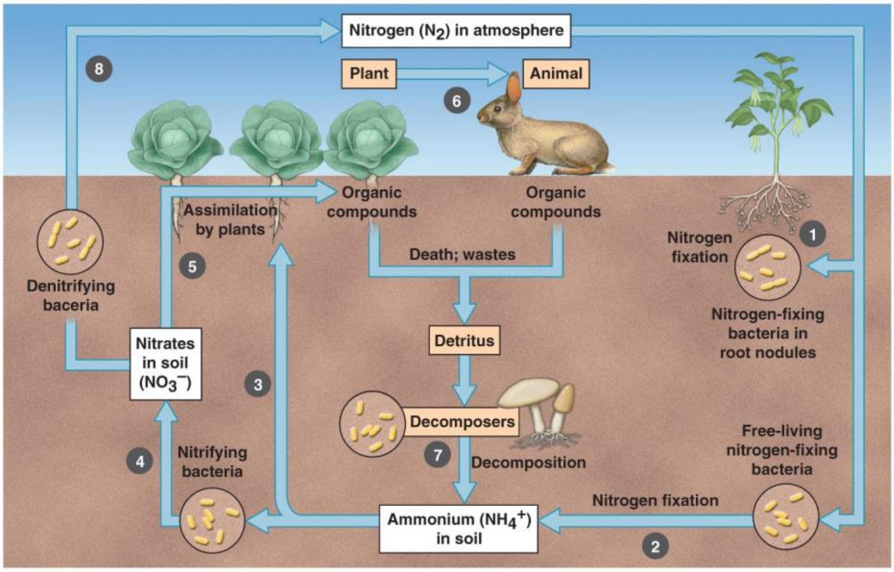
Chemical Cycles

- Energy flows through a system (enters as sunlight and exits earth as heat).
- Chemicals "cycle" through systems
  - See figures 20.32, 20.33, and 20.34
  - Carbon, nitrogen, phosphorous, and water

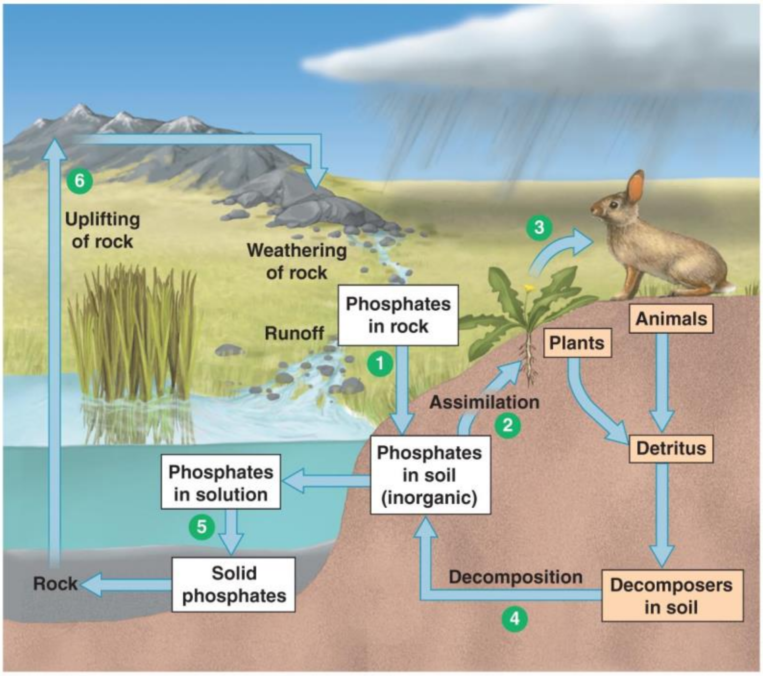
Carbon cycle, for example, cycles mainly through the processes of photosynthesis and cellular respiration



- Nitrogen is a critical component of our genetic material (remember, "nitrogenous bases" – those A's, T's, C's and G's). Although the atmosphere is 80% Nitrogen gas, it isn't in a usable form for most organisms
  - We need bacteria to convert the gas to ammonium and nitrates, which can be used by plants



- <u>Phosphorous</u> is required for synthesis of nucleic acids, phospholipids, and ATP
  - The phosphorous cycle does not include an atmospheric component; rocks are the only source for terrestrial ecosystems
  - Weathering of rock releases phosphate to the soil
  - Plants absorb this phosphate and use it to build organic compounds
  - Consumers acquire it by eating plants
  - Decomposition returns phosphorous to soil



Conservation Biology

- Conservation biology is “science in the service of conservation”
- It is “goal-oriented” science that seeks to understand reasons for the loss of biodiversity, and to counter that loss
- May involve the restoration of damaged habitats (“restoration ecology”)
- All organisms play a role in their communities

- Why care about species & habitats?
  - The intrinsic value of all organisms
  - Ecosystem services
    - Bees that pollinate our crops
    - Wetlands that purify our water, recharge aquifers, and prevent flooding
    - Maintaining soil fertility
    - A source of food (fish, wild game, or plants that may be cultivated)
  - Biophilia – people have an affinity for plants, animals (wild or pets), nature, etc.

Most people would rather look at this…

…than this!

- In our homes, we surround ourselves with lush house plants, or have pets, showing that we have an innate attraction to living things

- Spending time outdoors can help fight fatigue, stress, and lower blood pressure
- Having pets lowers our risk of developing allergies, reduces depression, and lowers blood pressure

"To Keep Every Cog and Wheel…"

- Aldo Leopold worked for the US Forest Service, and wrote many books and essays on nature, including one of my favorites, "*A Sand County Almanac*" (1949)
- He understood that each organism has a role to play in the ecosystem
- He promoted a "land ethic"

- One of my favorite quotes from Aldo Leopold:
  - "*The outstanding scientific discovery of the twentieth century is not television, or radio, but rather the complexity of the land organism. Only those who know the most about it can appreciate how little we know about it. The last word in ignorance is the man who says of an animal or plant: "What good is it?" If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering*."


That’s all ☺