Education

ENVS 200 Midterm Prep

Disclosure: This material is for educational purposes only and is intended to supplement course content. Please ensure you review the class materials independently.

Table of Contents

1.0 Week 1

Ecology: The scientific study of the distribution and abundance of organisms, the interactions that determine that distribution and abundance, and the relationships between organisms and the transformation and flux of energy and matter.

- Everything is connected to everything else, interactions and understanding is scale dependent.
- Ecological phenomena occur at a variety of scales.
- Ecological evidence comes from a variety of different sources.
- Ecology relies on truly scientific evidence.

Science: The systematic study of the structure and behaviour of the physical and natural world through observation and experiment.

- Science is a process.
- Science does not provide proof, but tests alternative explanations.
- Scientific inquiry can be applied to social and natural worlds.

Theory ("big T"): A relatively well-supported explanation (not just a theory, which is closer to hypothesis).

Environmentalism: A social movement through ecology, a broad philosophy regarding concerns for environmental protection and improvement of the health of the environment.

Applied ecology: Considers application of the science of ecology to real-world questions.

Population ecology: Trends and fluctuations in # of individuals of a particular species at a particular time and place.

- Determined by birth and death rates and interactions between the populations themselves (such as predators and prey).

Community ecology: Focuses on questions such as what controls the diversity of a species in a given area.

Ecosystem ecology: Strives to understand the functioning of entire lakes or other portions of the earth in terms of energy and material inputs/outputs.

1.1 Hierarchy of Ecology

Biosphere → ecosystem → community → population → organism

Anthropocene: The current geological age - period where human activity has been a dominant influence on climate and environment.

- More than 75% of ice-feed land is altered.

1.2 10 Earth-System Processes

- Climate change.
- Ocean acidification.
- Stratospheric ozone depletion.
- Nitrogen cycle.
- Phosphorous cycle.
- Global freshwater use.
- Change in land use.
- Biodiversity loss.
- Atmospheric aerosol loading.
- Chemical pollution.

Scientific method: A process for experimentation used to explore observations and answer questions. (Observation, question, hypothesis, predictions, test, evaluation, reject or accept hypothesis).

Scientific names: *Genus species.*

Ecological Succession: Successive and continuous colonization of a site by certain species populations, accompanied by the local extinction of others.

Pre-zygotic isolation: Prezygotic isolation prevents the fertilization of eggs.

Post-zygotic isolation: Prevents the formation of fertile offspring.

2.0 Week 2

Evolution: Change over time in the heritable characteristics of a population or species.

2.1 Evolution by natural selection (Survive, grow, reproduce)

- Individuals are not identical.
- Some variation is heritable.

- All populations could grow at a rate that would overwhelm the environment, but most die before reproducing or reproduce less.
- Some do better than others, depending on the environment.
- Those that do better, have more descendants, which will do better.

Variation in survival and reproduction: Those that do better leave more descendants.
→ Ex. Copper underwing moth evolves crypsis to keep them hidden and decrease predation.

- Australia isolated from placental mammals in earlier eras have marsupial mammals (pouches)
- Birds and bats both fly but do not share common ancestral origin.

Fitness: The success of individuals in the process of natural selection.

Social Darwinism: The idea that humans, like animals and plants, compete in a struggle for existence in which natural selection results in survival of the fittest.

- More common in our history for men to reproduce with multiple mates and have more young on average than females.
    - More female ancestors than male, Y chromosome, Mitochondrial DNA.

2.1.1 Genetic Variation within a species

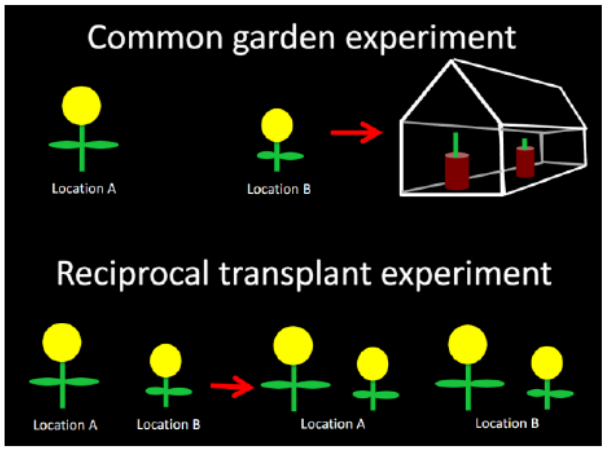
- Individuals are not identical.
- Some variation is heritable.

2.1.2 Geographical variation within species

- Characteristics of populations will diverge only if there is sufficient heritable variation on which selection can act.
- Forces are strong enough to counteract the mixing and hybridization of individuals from different sites.

Countergradient Variation: Genetic influences on trait oppose environmental influences.
Hybridization: Act or process of mating organisms of different varieties or species to create a hybrid.

- Genes influence form, function, and fate, and variations contribute to variations in features/forms/behaviors.



2.2 Common Garden experiment

- High and low elevation plants were grown together in a common garden, eliminating the influence of contrasting environments.
- Low elevation plants were much more drought tolerant, had significantly better "water use efficiency":
    - The rate of water loss through leaves was low compared to the rate at which carbon dioxide was taken in.

2.3 Reciprocal transplant experiment

- Comparing an organism's performance when they are grown "at home" with their performance "away".

Industrial Melanism: The phenomenon in which black or blackish forms of species of moths and other organisms have come to dominate populations in industrial areas.

2.4 Alternative Explanations

- **Mutationism:** Random production of variation.
    - Change occurs in discrete jumps. (not gradual)
- Inheritance of acquired characteristics. (Lamarck)
- Creationism. (god buried fossils, etc.)

Microevolution: (evolutionary changes within species over a short period) = adaptation.
Macroevolution: (major evolutionary change whole taxonomic group over long periods) = speciation.

Species: Can breed together in nature to produce fertile offspring.

Biospecies: A species for which it has agreed that members of species can interbreed with one another and produce fertile offspring, but cannot do so with individuals that do not belong to that biospecies.

Speciation: Formation of new and distinct species in course of evolution.

Ecological speciation: Speciation where there is both an ecological source of divergent selection and a means of reproductive isolation.

Allopatric phase: Occurring in different places; usually refers to geographical separation of species.

Sympatric phase: Presence of 2+ species living in such proximity that breeding should be possible, but being separate species indicates doesn't normally happen.

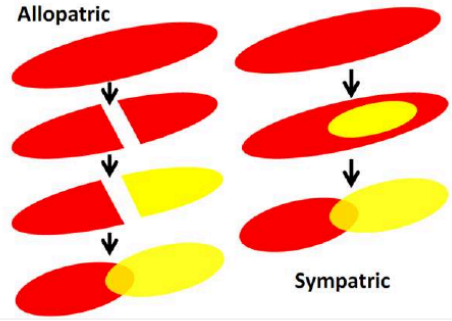
- Contrast with allopatry which regional isolation normally denies possibility of interbred

Allopatric speciation: Speciation that occurs when biological populations of the same species become vicariant or isolated from each other which interferes with genetic interchange.

Sympatric speciation: Process through new species evolve from single ancestral species while inhabiting the same geographic region.

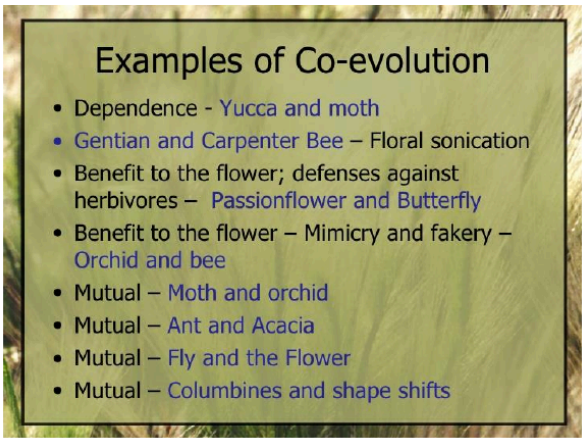
Endemics - having their habitat in a specified district or area, or the presence of a disease at relatively low levels all the time.

- Cichlid fish: those of the East African Great Lakes, have more than 1500 endemic species



Coevolution: Process by which members of 2+ species contribute reciprocally to the forces of natural selection that they exert on each other

- Ex. parasites and their hosts



Mutualism: Interaction between individuals of 2+ species in which the growth, growth rate, and/or population size are increased in a reciprocal association.

Parallel evolution: Evolution along similar lines of systematic groups that had been separated geographically at an earlier stage in their history.

Convergent evolution: Process by which organisms of different evolutionary lineages come. to have similar form or behaviour.

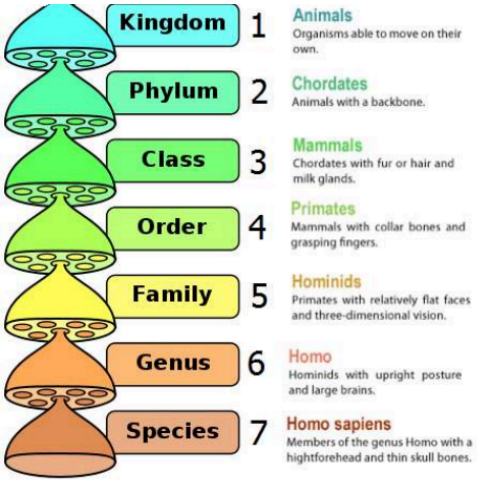
Homologous trait: Share a trait due to common ancestry.

Analogous trait: Traits that are similar due to reasons other than relatedness.

Plant defense against herbivory: Describes range of adaptations evolved by plants which improve their survival and reproduction by reducing the impact of herbivores.

- Constitutive chemicals (always in plants).
- Induced chemical (created by stress/ damage).

3.0 Week 3

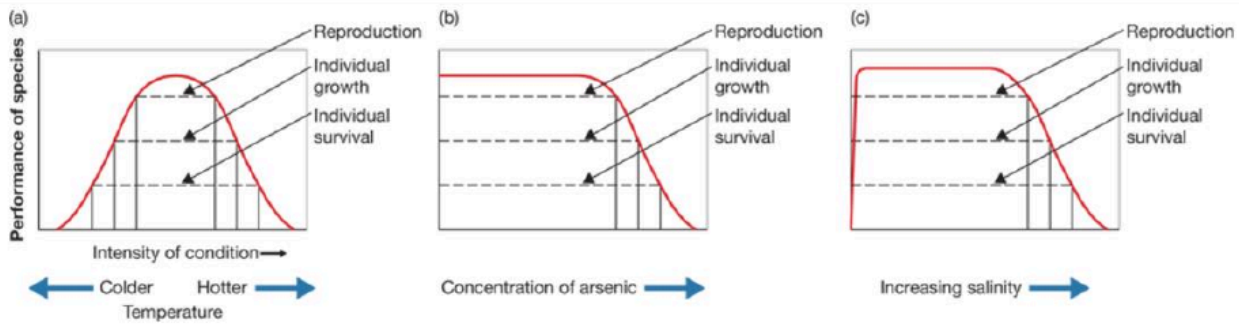


- We need to name things in order to study them
- Management and conservation is done typically at the species level
    - E.g. Almost all wolf species in north america are defined on distribution and morphology
- There are about 2-11 million predicted animal species, 600,000 to 10 million predicted fungi, and 307,700-450,000 predicted plants

Conditions: Physicochemical features of the environment such as its temperature, humidity, pH, or salinity (for aquatics).

Resources: May be consumed by an organism and as a result becomes unavailable to another (eg. food, water, nesting sites, etc.).

Response curves: Temperatures, relative humidity, other physicochemical conditions induce a range of physiological responses in organisms, which determine whether the physical environment is habitable for them or not.



- Development usually increases more rapidly with temperature than does growth, such that final size tends to decrease with rearing temperature.

- Harsh climates for us are favorable to locally adapted species. We need to consider species we are interested in when we talk about biomes or habitats.

3.1 How do species respond to their environment?

E.g. Frozen frogs adapt to survive over the winter and come back to breed in spring. Not just conditions but how individuals respond to them.

- Response Curves (bell curves) of performance of species on y, and intensity of condition on x
  Y = dependent variable (performance).
  X = independent variable (condition).

3.1.1 Complexity of conditions → timing is really important

Ex. frozen frogs, if there was a late winter snowstorm that may affect when they unfreeze and their breeding capacity.
Generalist species: Able to thrive in a wide variety of environmental conditions with a variety of resources.
Specialist species: Can thrive only in a narrow range of environmental conditions or has a limited diet.

3.1.2 Resources for primary and secondary producers

- Plants need water, nutrients, CO_2, and sunlight.

Avoiders: Have a short lifespan: photosynthetic activity is concentrated during periods when water is relatively available.

- For remainder, they are dormant as seeds, a stage that requires neither photosynthesis nor transpiration.

Tolerator: Where modification of the environment by early occupants has little/no effect on subsequent performance of late-successional species.

Autotrophs: Organisms that are independent of outside sources for organic food materials and manufactures its own organic material from inorganic sources. Ex. algae, phytoplankton.

Primary producers: The rate at which biomass is produced per unit area by plants.

Heterotrophs: Organisms with requirement for energy rich organic molecules (animals, fungi, most bacteria).

1. **Decomposers:** Feed on already dead plants/animals.

2. **Parasites:** Feed on one of few host plants/animals that are alive but do not usually immediately kill their hosts.
3. **Predators:** Eat many prey organisms, typically killing them.
4. **Grazers:** Consume parts of prey organisms, don't usually immediately kill them.

E.g. Oxpecker feeding on parasites on giraffes, however sometimes will also feed on open wounds/blood. Mutualist or parasite?

Mutualistic Association: Interaction between the individuals of two (or more) species in which the growth, growth rate, and/or population size are increased in a reciprocal association.

Intraspecific competition: Competition of individuals of the same species.

Exploitation: Competitors depleting each other's resources.

Interference competition: Between 2 organisms in which one physically excludes the other from a portion of habitat and hence from the resources that could be exploited there.

Density dependant: Tendency for the death rate in population to increase or birth growth rate to decrease as the density of population increases.

3.2 Mimicry

Aposematic colouration: Describe colours and / or patterns that act as a warning to predators that a potential prey species is unpalatable, toxic, or dangerous.

Batesian mimicry: Harmless/harmful.
Mullerian mimicry: Harmful/harmful.

Niche: Limits for all important environmental features within which individuals of a species can survive, grow, reproduce.

Habitat: Place where a microorganism, plant, or animal lives.

Biomes: Very large ecological areas on the earth's surface, with fauna and flora (animals and plants) adapting to their environment.

- Defined by abiotic factors such as climate, relief, geology, soils, vegetation.
    1. Desert biomes.
    2. Aquatic biomes.
    3. Forest biomes.
    4. Grassland biomes.

5. Tundra biomes.

Novel ecosystems: human built, modified, or engineered niches of the Anthropocene.

3.3 Ontario vs Patagonia - Forests

- Variation depending on latitude, moisture regime, and “aspect” (oak and fire).
- Associations of species.
- Canopy layers.
- Gap-phase dynamics/shade tolerance.
- Leaf fall and litter input.
- Mast production.
- Spring ephemeral flora.
- ‘Older growth’ forest features (logs and snags and species).

3.4 Mean vs variance

- Consider not just measure of central tendency but also variation around them.
    - (this matters to species that germinate under really narrow temperature conditions).
- Also relevant if there's thresholds on reproduction/survival. Important from a climate change perspective.
    - E.g. fungal pathogen that develops faster at warmer temps, but then stops completely at a certain threshold.
    - Grasshoppers can bask in the sun to increase their temperatures and decrease chances of pathogens.

3.5 Making food

- 85% of plants carry C3 photosynthesis (C3 is a type of carbon molecule used).
- CO2 taken up is transported to the calvin cycle.
- The Calvin cycle produces a three-carbon compound from C3 photosynthesis.
- C4 photosynthesis produces an intermediate four-carbon compound that splits into a three-carbon compound for the Calvin cycle.
- Plants that use CAM photosynthesis collect sunlight during the day and fix CO2 molecules at night.
- Bogs are nutrient poor (limited availability for plant growth). Some species have adapted to this by consuming insects (pitcher plant, venus fly traps.

3.5.1 C3 pathway 73

- Their first product of photosynthesis is a sugar containing three carbon atoms.
    - Wasteful of water.
    - Reaches max rates of photosynthesis at low intensities of radiation and are less successful in arid areas.

3.5.2 C4 pathway 73

- Produces 4 carbon sugar as the initial product, efficient with the use of CO2 and water.

3.5.3 CAM 74 (crassulacean acid metabolism)

- Very efficient at photosynthesis.
- CAM plants open their stomata at night and absorb carbon dioxide and fix it as malic acid. They close their stomata during the day and release the carbon dioxide internally for photosynthesis.

4.0 Week 4

- Environmental conditions vary across the world in somewhat predictable ways at broad scales.
- These conditions influence resources available for biotic components.
- Resources subsequently influence distribution and abundance of species.
- Variation across time and spatial scales.

Population: Group of individuals of the one species

Group: Some boundary (lake, mountaintop), Some criteria (what is being studied)

Important factors affecting size: birth, death & movement

4.1 What are individuals

Unitary: Predictable and determined. (A spider has 8 legs, young or old.)
Modular: Repeated production, usually rooted or fixed (leaves, individual cells).

Genet (genetic individual): Organism developed from a zygote.

- Used for modular organisms and members of a clone to define the genetic individual

Zygote 126: Single-celled “seed” or fertilized egg.

Ramet: Potentially physiologically independent part that may arise from the iterative process by which modular organisms grow.

Field ecology: How big is the population.

- When you can't measure by density (# per area by subsamples)

Mark-recapture: What if the wildlife moves?

- E.g. Bands around geese legs.

Marked / total population = recaptured / total recaptured

- Can use this number to estimate total population size.

4.1.1 Assumptions

- Estimates of population size.
- Random mixing of individuals in a population.
- Influenced by sample size.
- Population closure.
- No marks lost.

C/N = R/M
Captured / number (x) = recapture / marked

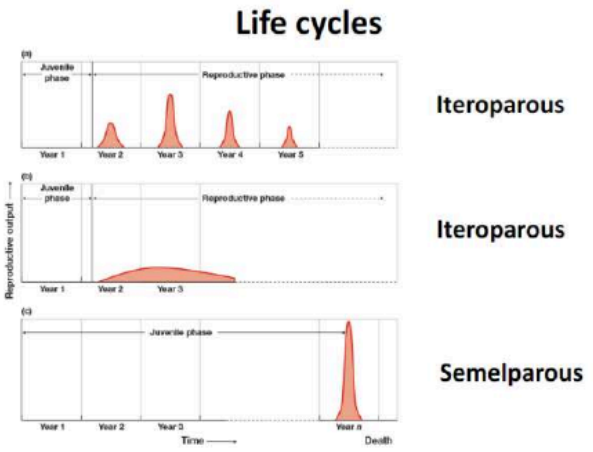
4.1.2 Largest organism in the world: Pando, the Trembling Giant, Utah (aspen trees)

- Single clone of trembling aspen.
- Heaviest known organism, 6 million kg.
- One of oldest known organisms (14,000 - 18,000 yrs old).
- 43 ha and 47,000 trees.
- 8 km long.

4.1.3 Armillaria ostoyae Fungi

- Oregon blue mountains (NE).
- 965 hectares.
- 2,400 - 8,6450 yrs old.
- 30 million kg.

4.2 Life cycles

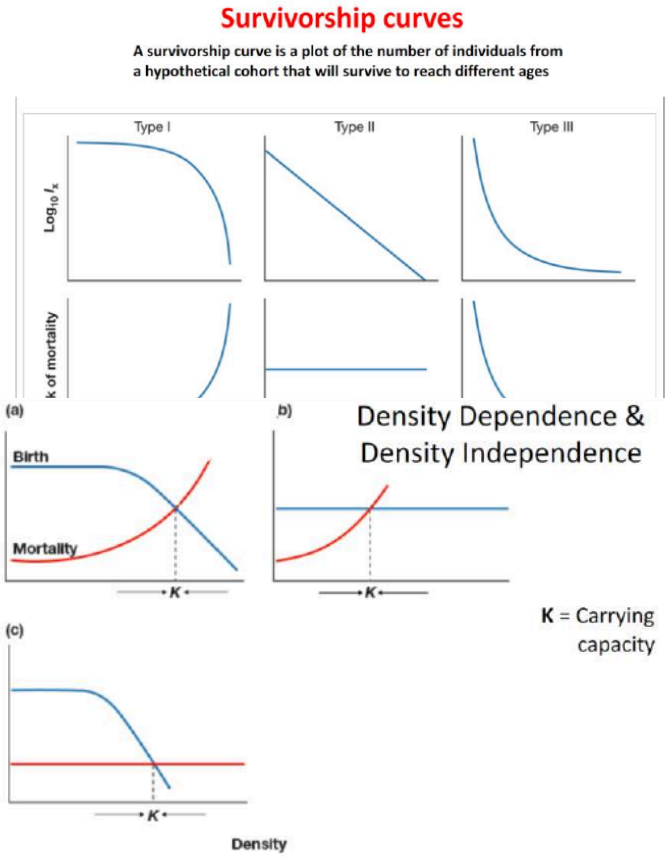


Annuals, biennials, perennials
(sunflowers)(beets)(trees).

Semelparous: Reproduce once (ex. Agave plant).

Iteroparous: Reproduce more than once.

Semelparous annuals: Seedbanks.



- Red = exponential
- Blue = logistic

Basic reproductive rate (Ro): Average # offspring produced by individuals in a population over course of their life.
-(Births - Deaths) + (Immigration - Emigration)

Dispersal: How individuals spread out.

Migration: Mass directional movement.

R-species

- Colonize new habitats.
- Lots and small.
- Fast growth rate (bunnies, mice) live fast and die young.

K-species

- More competition for limited resources
- Fewer and larger (whales, bears)

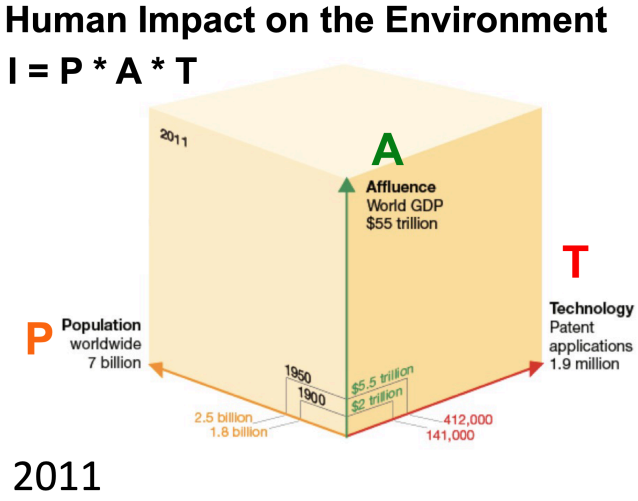
R = intrinsic rate of natural increase

- The per capita rate of increase of a population which has reached a stable age structure without competitive or other restraints

K = carrying capacity
N = population size

4.3 Human impact on environment

I = P*A*T



2011

5.0 Week 5

Ecological communities: Where organisms live, a group of actually or potentially interacting species living in the same place.

Intra-specific interactions: Interact within the same species (ex. Birds mating calls)

Inter-specific interactions: Interact with different species (ex. Predator prey)

Interference competition: One organism prevents other from using the resource (food, females)

Exploitation competition: Organisms use up resources directly (ex. Two trees benefiting from sunlight)
Apparent competition: Indirect competition between two or more victim species that share a common natural enemy. (E.g. Mice and squirrels share seed food sources, both being preyed on by eagles).

Character displacement: Morphological response to competition from another species.

5.1 Ecological effects

1. Competition excludes species from areas they could be in:
    - **Realized niche:** Combo of conditions/resources that allow species to exist, grow, reproduce, in presence of other species. (Where they actually exist)
    - **Fundamental niche:** Combo of conditions/resources that allow species to grow, reproduce, exist in isolation.
2. **Scale:** Species co-exist at some spatial scale but are separate at another.
3. Experiments are needed (ecosystems are so complex).

Competitive exclusion principle: Two species can't coexist if they're competing for the same resource in stable environments.

Competition trade off: When one improves, it tends to be at the expense of the other (better colonizers are worse competitors).

Niche complementarity: Same niche on one axes, different on another.
- Resource use does not change

Niche differentiation: Differentiation of realized niche
- Shift in resource use (ex. behaviour)

5.1.1 How does predation structure ecosystems

Predation: Any organism that consumes all or part of another living organism (reducing growth, fecundity aka ability to produce abundant offspring or growth, or survival.
True predation: Kill their prey, eat many.
Grazers: Attack many, eat part.
Parasitism: Attack one or few, eat part.

5.1.2 How do mutualisms structure ecosystems

Mutualism: Symbiotic interaction where both or all individuals benefit from the relationship.

- E.g. agriculture, ant-plant, pollination

Facultative: Species can survive apart.
Obligate: Species cannot survive apart (seen less in nature).

Commensalism: Bird nesting in a tree.

Amensalism: Cattle trampling grass.

Joseph Grinnel: Emphasizing "address" of species. Abiotic factors. Can a species live here?

Table 13.1 : Population Interactions

Species A	Species B	Name of Interaction
+	+	*Mutualism*
–	–	*Competition*
+	–	*Predation*
+	–	*Parasitism*
+	0	*Commensalism*
–	0	*Amensalism*

Charles Elton: Emphasizing "profession" of species. Biotic factors. What function does a species perform in this community?

George Hutchinson: "Can a species thrive in the community?"

Botany of Desire: Apples, potatoes, marijuana, tulips → our actions increased its growth

6.0 Lab 2

Binomial Nomenclature: Genus species L. ex. *Quercus rubra L.*

- Herbarium is library of mounted plant specimens filed in particular order

Dendrochronology: The study of tree ring growth:

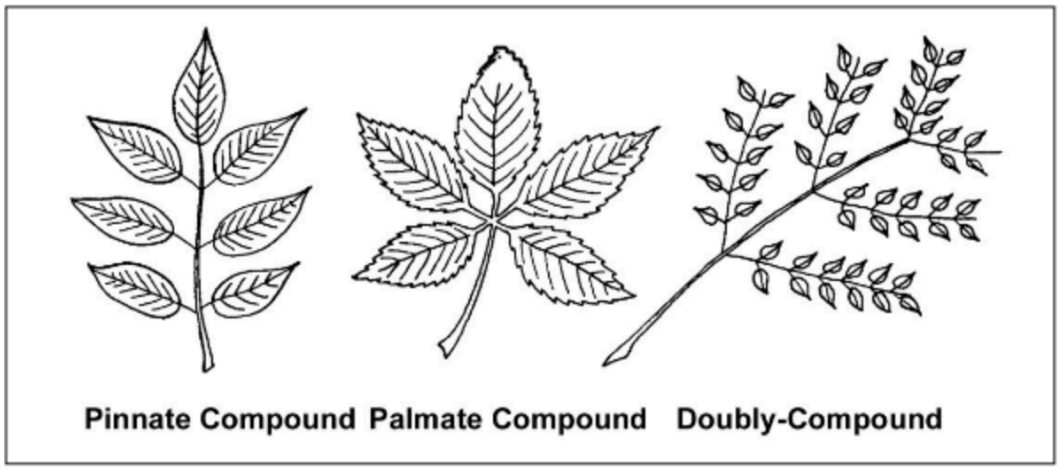
- Tree age
- Wildfires, volcanic activity
- Avalanche
- Insect infestations

Paleoclimatology: The study of the relationship between growth and climate.

- Past local climate (temp, light, precipitation)

White pines: Bundles of 5 needles on a twig.

White spruce: Single needle into raised pegs on a twig.



7.0 Lab 3

Succession: The sequence of replacement of one community by another until a relatively stable community occupies the area.

- This stable community is in the state of dynamic equilibrium.

Primary succession: The development of an ecosystem that begins on an area that has not been previously occupied by a community, e.g., exposed rock.

Secondary succession: The development of an ecosystem after an incomplete disturbance of an area that was previously occupied by another ecosystem, e.g., forest fire, tree dying.

Species richness: # of unique species

Species evenness: Relative abundance of species

Essential plant nutrients: Nitrogen, phosphorus, potassium