1. Introduction

September-06-12
5:30 PM

Audio recording started: 5:30 PM September-06-12

Introduction

- Lectures are posted after class
- Change in marking scheme
  - Two computer labs
  - 3 discussions (or 4)
  - Hike
- Mark=multiple scheme
  - If midterm is terrible, mark is dropped and exam and labs only are counted
  - Final exam include lab material
- Midterm(multiple choice, maybe short ans)

- What is ecology? Understanding daily effects of competition, resource usage.... On multiple organisms
  - Forest-bird competition theory:
    - Competition arises with limited resources and multiple species
    - Example: warblers feed on insects on trees
      - 5 species of warblers feed on different places on tree (marked by yellow)
      - Birds are partioning the location of which resources are being obtained (less competition)
      - Result- completion is reduced
      - Possibility: prior competition might have led to this portioning of resources
      - How they make sure rules are obeyed? These birds are violent and peck on birds which feed on wrong locations
      - When competitor is absent, birds can change their feeding location -i.e "Competitor release"(removing species from a certain community causing species left behind to expand feeding zones)
        - Proves that competition is responsible for partioning of resources

- What are the other questions and research in ecology?
  - Nutrient budgets: determining how much nutrients is being transferred to different organisms
  - EXAMPLES BELOW

  - Hubbard brook experiment:
    - Red arrow=stream A(deforested valley); yellow arrow=B (forest valley)
    - Water sample were collected at the end of stream
    - After cutting trees, water sample didn't change for about a year; eventually nutrients were found at the bottom (why? Loss of tree -->dead animals-->decomposers form organic layer on soil--->no trees to take up organic nutrients--->washed off as it rains
      - In stream with forest, nutrients were absorbed by trees and kept within the area

  - Experimental lake are W. Ontario
    - Separate lake into two
    - Add phosphorous to one--->eutrophication(process by which clear lake turns pea green. This is induced by added chemicals which increase algal growth
      - Lead to reduction of phosphorous based substances

- Vegetation change, pollen and models
  - Lake sediments are arranged at the bottom of lakes (oldest-newest)
  - Sediments are removed and analysed using micros. To find preserved items
    - Example: spruce found at the bottom and chestnut found on top
      - Exp? Lake env shifted from cold to warm(spruce grow in cold env)
- Making sense of marine algae
  - Satellites can used to measure conc of chlorophyl
    - High intensity green colour=highly productive area
    - Why is production high in oceanic zones near land? Nutrients are found on land
- Nature and scope of ecology
- Why do birds sit on eggS?
  - Can be answered in multiple perspectives
    - Population eclogy(what are consequences of sitting), comparative (why do birds do the sitting) , physiological (why sit) and evolutionary (Why eggs)

2. Life on land

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Life of land

Examples of ties among organisms

- **Why horses and cattle help restore guanacaste forest?**
  - Colonization caused degeneration of forest (native Americans)
  - Europeans brought cattle and re-colonized forest and regeneration occurred
  - Guanacaste fruit is large
    - For fertilization to occur, large animal must eat the fruit to liberate the seed with defecation occurs
      - Animal acts as a dispenser
  - When native American came native camel-like animals in that location became extinct (might not be linked to arrival of natives); Europeans brought their own animals and so recultivation occurred
  - In text book, Scientist Jansen wanted to restore forest
    - Knew hat tree produced large fruit that falls next to it
      - Proposed this isn't attributable to their growth b/c parent tree will compete for nutrient with younger tree beside it
        - Therefore disperser must be present(see historical story above);
      - Knowledge of dispersers allowed his to use life stock as a plan to restor this tropical forest

Soils

- Important/most obvious foundation of life on land= soil
- Ingredients for climate= precipitation and temperature
- Soils form different horizon (see different colours from top to bottom)
  - O= organic= litter on top(fallen pieces of plants, dead organisms, pollen
    - Fine litter is deeper due to decomposers
  - A= see slide
  - B= things that seep from A
  - C: rock fragment
    - TOP TO BOTTOM= organic to mineral
- Warm and humid climate : litter will decompose quickly (less organic mater, more mineral matter)
- Canadian artic: cold temp accumulates organic matter
  - May happen in tropic in wet tropic areas (swamp)
  - Animals that dig can bring organic matter deeper into the A horizon
- Africa , Asia: thin layer of top soil, due to reduced organic layer

Air circulation and climate

EXTRA(pg 16)

- *location at which the sun's rays hits the earth changes with time b/c the earths rotation around the sun isn't fully perpendular (the earth is slightly tilted as the rotates about the sun)*
- *Cause of winter:*
  - *Northern winter occurs when the northern hemisphere is titled away from the sun (sun's solar energy is conc. on southern hemisphere)*
- *Cause of Wet and dry area*
  - *ascending air flowing north and south is dry(therefore it draws air from land over which it flows, creating deserts)*
  - *equator gets rain, area close to it= desert*
  - Trivia fact: North of equator: Sahara desert; south: Kalahari desert
- Prevailing winds and ocean current are affected by the earth's rotation
- **Which direction does earth rotate in?**
  - Sun rotates from west to east
- **Where is the Earth Surface movement fastest?**
  - Equator is the earth's surface that moves the fastest

- **Latitudinal differences**
  - Consequences: Coriolis force: inertia associated with moving from fast lane to slow lane?
  - Explains why winds doesn't move directly N and S
    Coriolis effect: "phenomenon caused by the rotation of the earth, which produces a deflection of winds and water currents to the right of their direction of travel in the Northern Hemi and to the left of travel in the Southern Hemisphere.
    - See animation: http://www.astro.umass.edu/~arny/images/cor_curv1.mov

Major Biomes

- What factors, do in the terms, determine distribution of biomes (1M03)?
  - CLIMATE= PRECIP AND TEMP
- We can predict a biome from a climate diagram
  - Climate graph on the midterm: know what type of plant, animal and soil found in that location
- Trade winds(water current) moves tropical forest a lil bit away from the equator
- Ephihytes are found a lot on tropical rain forest due to lots of water presence
  - Bormeliads= pineapple family

Me

Biome	Type of Plant	Animal	Soil	Climate	Location		
Tundra	- Moss - Lichen - Dwarf willos	- reindeer - Caribou - Musk - Ox - Bear - Wolves - Artic fox - Weasel - Leaming - Ground squirell - Ptarmigan - Snowy owl	- Slow soil devel - Slow decom b/c of cold weather, so organic matter accumulates - Surface soil thaws in summer (lower layer is permafrost	- Cold and dry - Winter isn't as cold and summer isn't as warm as the boreal - Short summers - Precipitation exceed evap - Prec(<200 to >600	- North arctic circle - Scandinavia, northern European Russia, northern Siberia and across northern Alaska and Canada.		
Boreal forest /Taiga (forest-water-forest-water)	- Evergreen conifers (spruce, fir, pines) - Willows (near shores of river and lakes)	Wolf= major predator - Black and grizzly bears - lynk, wolverine, snowshoe hare, porcupine and red squirrel	- Low fertility - Thin - Acidic - Nutrients are found on top due to slow decomposition - Plants have shallow roots	- Winters too long; short summer months - Mod precipitation (200-600 mm) - Low temp and long winter--> low evap	- Cover over 11% of earth's land area - Central locations of areas above		
Temperate Forest							
Temperate Grassland							
Mediterranean Woodland and Shrubland							
Desert							
Tropical Savanna							
Tropical Dry Forest							
Tropical rain forest							

Lecture 1

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3. Life on land (fix)

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Lecture 3

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Predicting Biomes from climate diagram
- Possible
- Precipitation line>temperature line = wet conditions; associated with certain biomes
    - Opposite= dry conditions

Rain forest: life on trees
- High branches cover smaller plants
- Nutrients from air or other animals
- Lots of epiphytes

Tropical dry forest: in between rain forest and desert
- Greater variation in temp and water availability

Favorite Biome for plp= tropical dry forest
- Rain forest: plp avoid (good: b/c it is the most diverse; disruption by humans is not good at all)
    - Madagascar: erosion (fallen trees --->soil erosion)

Deserts
- Sahara, gobi, kalahri are some ex
- Drought all year drown
- Lowest mean temp
- Lithosoil= rocky fragments on soil

Medeterenian:
- Drought in summer
- Has moist and cool season
- Plants are able to resist fire with thick bark

Mountains (Islands on Land)
- Have diff climatic cond. Different from areas they arise from
- Affect reguonal climate
- Main features
    - Orientation: americas-> north to south (due to plate tectonics
        - Af/eur/asia: ordered in an almost horizontal way
    - Gradients of climatic condtion (moving from bottom to top (cold))
    - Isolation
- Boreal forest isn't vastly found in the south b/c of little land available

- Why chickades have great memory?
    - Behavioural adaptation to winter survival
    - Cache food in dfferent location during warm periods and retrieve them in winter --->Good memory
        - Deposit single food item / location
            - Benefits: reduces their vulnerability to theives, good memory b/c they must think of where they previously stored food.
    - Look in the book (pg 47)
-

4. Life on water

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Lecture 3

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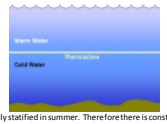
LAND IN WATER-CHAPT 3

- What is diff?
  - Less O2
  - Less light as depth inc.
  - Pressure increases as depth inc
  - Fish that lose water due to different ion conc. (salinity outside > salinty of fish)
- How much ?
  - 97% in ocean; 2% glacial and 1% freshwater
    - Freshwater (1/5 lake baikal, gl=great lakes, rift valley(in africa) -->2/5 in the rest of the world (streams and other lakes)
- Ocean depth?
  - 4000 meter=ave. depth

Question: Are chem and phys cond in the ocean similar at different latitudes?

- Yes. Ex. Temp differs --->(changing Oxygen solubility, evaporation rate, density of water)
- **What about longitudes?**
  - Ask Dr. Kolasa: Yes b/c?
- Red lines= major currents
  - Ex. Humboldt current moves right and deflects bring cold water to the gulf of chile
  - Yellow= area in which currents bring warm water
- Textbook extras:
- Tropical ocean is always thermally stratified.-->Stable physically and chemically (all nutrient is at the top layer, no mixing of water occurs) --->crystal clear waters
  - i.e. sun rays warms surface layer of waters (increasing kinetic motion and reducing density), as a result, warm water forms a layer above cold water
    - Thermocline= layer of water at which temperature rapidly changes with depth



- Temperate ocean: only statified in summer. Therefore there is constant mixing of water (+ high nutrients) in upper level to the lower levels of the ocean. As a result the temperate ocean is more productive-->blue-green water
- HIGHEST PRODUCITIVITY NEAR COASTLINE
- Oceanic zones
  - **Remember oceanic zones names: intertiddal, neritic, epipelagic, mesopelagic, abysall and hadal**
    - **INEMBAH**
      - **I=**
      - **N= extend to continental shelf margin**
      - **OCEANIC ZONE**
        - **E= 200 m**
        - **M=200-1000**
        - **b=1000-4000**
        - **A= 4000-6000**
        - **H= deepest**
  - Rapidly lose light as depth inc
  - Less oxygen. Why?O2 comes from photosynthesis and diffusion from atmosphere(this is only accessible to the top zone-productive zone)
  - Open water: not a lot of algea and organisms that feed on them
  - Intertidal: shallow shoreline, influenced by high and low tides
  - Epipelagic: deep zones that spans the ocean (photosythesis>metabolism)
  - Mesophelagic: some light (no primary productivity possible, some organisms live there)
  - Abyssall (deepest, darkest and coolest zone)
  - Volcanic vents(compressed water, interact with rock, high temp; hits cool water and metal precipitates; organisms can live in these vents

- Adaptations
  - Angler fish
    - Attracts fish with light
    - Males are attached to female
    - Every phylum in the dark oceanic zone have developed ability to produce light (used as a communication means

- Finding food is a problem but would being found as food be a problem too?
  - Defense: spines on crusteasean larvae
  - Translucence: almost invisible
  - Body shape
  - How do these organisms survive under high pressure at the bottom of the ocean? Water is incompressible (cells contain mostly water, so tissues cannot be compressed)

Diversity

- Phytoplankton: (found in epipelagic zone, brightly lighted) plant light creatures with pigments that fix carbon
- Zooplankton: eat phyto or other zoop
- Larger pred: whales, fish, squid, crabs -->
- Benthos: not a taxonomical category (organisms found in bottom areas;)
  - Fish that crawl in the bottom
  - Mollusks, crusteaceans, worms
- Corals: animals that grow like plants (how do they gain energy to photosynthesize --->on test
  - Contain algae: see next lecture
- Algae(kelp):
- Many other invertebrate phyla
- Bacteria and viruses also likve in water
- Endemic vs non endemic (endemic= unique to particular location)

- Only one endemic phylum on land: velvet worm
- No endemic organism in freshwater

Kelp:
Vesicle filled with 02
Other algea grow on them- under water ephiphyte (plant on plant)

Coral

- Why are they green? Incorporate algea into their tissues which photosynthesize (ON TEST)
  - Coral=animal produces nitrogen fertilizer(via pee;...hard to obtain N in ocean); algea attaches to coral-and uses N to produce sugar. Coral needs sugar to grown
  - Grow 1mm-10cm/year
    - Takes longg to recover from damage
  - Coral bleaching
    - Cause by stress (pollution, temp) --->CAN BE USED AS INDICATOR FOR POLLUTION
      - They don't know how to handle it. So they blame algea and expel it
        - No photosynthesizing pigment, turn white
          - Lose makor source of food
          - They don't live long
          - Die/is attacked by parasite if algea doesn't return
        - When original stimuli that causes bleaching is removed, bleaching can still continue

5. Life on water

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Atolls: coral islets that have built up from a submerged oceanic island and a ring lagoon
- Coral reef form in any shallow area on island
- Island without growth= erosion
  - If erosion progresses, island disappear and the ring of coral remains
    - Why? Coral is still growing

Life in water: corals and kelps
- Both seaweeds and reef-building corals only grow in surface areas where there is enough light to support photosynthesis
- Oceanic currents deliver oxygen and nutrients and remove waste product
- Corals are found in warms water (tropical latitudes
- Red areas on map of world= area with coral abundance(Fig 3.12)
  - Deep sea corals can be found in temperate locations, i.e. Nova Scotia
  - Abundant in Philippines, Indonesia
- Green= kelp forest (very huge marine algae)
  - Abundant in west coast of Europe and north America
  - Structural features similar to terrestrial forest
  - Stems= stipes
  - Stipes have epiphytic algae and sessile invertebrates
- Salt tolerance:
  - Corals grow in water with stable salinity (heavy rain/ river runoff that reduces salinity can be lethal for them)
  - kelp : can tolerate runoff (b/c they are used to constant mixing of upper and lower levels of water in the when summer is over)

Life in water: tidal zone
- Upper tidal zone: most exposed area to air (animal s here have different abilities to cope with this env)
- Intertidal zone: exposed to air in low tides and covered with water at high tides

Life in water: tidal zone
- Starfish and seas urchin
  - Dangerous b/c of spins (protein on the surgace of sea urchin, iritate skin->made of calcium carbonate, hard to dissolve

Can trees grow in the ocean?
- Mangroves are trees that grow in the ocean (shallow waters and warmth)
  - Nurseries for many species. Capture solar energy
  - Hard wood
  - Removal=erosion of soil
  - Not much oxygen within sediments in water; have pores that they can breathe from
    - Have some root that can stick out into the air, to absorb O2
  - Geographical location: tropical and subtropical (warmer areas; highly sensitive to frost)

Can grasses grow in ocean?
- Yes some grass plants do grow in the ocean
  - Yes: salt marshes
- Salt marshes: made up of grasses and sages(grow in cooler climate)
  - Channels (aka: tidal creeks): fill and empty with tides
- Geographical location: sandy shores from temperate to high latitudes
- Fluctuating tides move water between up and down the channels (about once or twice daily)
- Creeks are bordered by levees
- Marsh flats include salt pans that periodically collect water that eventually evaporates, leaving a layer of salt.

Why carnivorous plants are commonly found in fresh water bog habitat?
- Pitcher plant see lecture slide
- Carnivorous plants are found there due to slow decomposition rates. Plants need to find another method to gain N

What type of freshwater wetlands have you heard of?

Estuary:
- Area where river becomes an ocean
- Which water is denser?
  - Salt vs. fresh
    - (salt water is denser; dead sea= dense, cannot drown in this water)
- Salt water from ocean enters the bottom of river water
  - River fresh water, flows to top of ocean
- Increase tide= in ocean level, therefore more ocean waster can enter river
- Aerial view: darker blue= more salty
- Amazon river, shown (darker blue)

Life in fresh water
- Remember freshwater is a heterogenous env(has characteristics of differen habitats, can hold a diverse range of organisms)

Do tropical rivers flow differ from temperate ones? Yes, flow varies in tropics: low flow in dry season, high flow in wet season; temperate is constant(b/c of even distribution of rain fall during the year)
- Orange graph: tropical river, uneven flow (un predictable)
- Evolution of amazon dolphin= no dorsal fin b/c of navigation through vegetative env
- What causes un even flow?
  - Extra precip, overcoming of surrounding landscape carryun capacity for water,

Do desert rivers differ In nutrients from rivers fraining in wetter areas?
- Desert rivers have higher salinity; b/c of less precipitation

Kelps found in temperate latitudes
Corals found in tropical latitude

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Lecture 4

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6. Life in Freshwaters

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6. Life in Freshwaters
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Running waters
- River chemistry
  - Influenced by land and climate
- Tropical rivers have lowest salinity: Why? High precipitation leaches ions--> few minerals enter amazon; Also age of areas might be different; nutrient capture by vegetation
  - Rio Negro: near amazon, clear and dark
- Temperate: Columbia river in B.C. (3rd biggest river that drain to PACIFIC ocean in N.A.)
- Desert: Pecos river

River continuum Concept (not applicable to tropic; or deserts which has no riparian vegetation)
- Consider a temperate climate river
  - Start usually in forested areas or mountains
  - Leaf falls in water==>shreders chop leaf and allow bacteria to decompose it==>lazy bump(collectors: feed of shredders)==>waste is generated===>
    - Ecology and physical
    - Sequence of event initiated at the beginning of the stream: biological and physical activity interact to shape the distribution of nutrients in the stream
      - Food is passed from forest to stream-->
  - Functional group= bunch of organisist that have a collective function
    - Collectors
    - Shredders
    - grazers

Standing water
- Great lakes outside Canada?
  - Michael, great slave lake, Baikul, RLC?
- Lakes
  - Top waters are warm and full of oxygen or food
  - Hypolimnion= dark and deepest layer
- Diversity
  - Vegetation adapt to varying conditions
    - Cat-tails and wild rice-->emergents
  - Floating unattached (water lettuce, water hyacinths)
- Nutrients
  - Small hypolimium, large upper layer--> hard to nutrient distribution to occur
  - Small lakes have large production: increase relatviely large nutrient/volume
  - Eutrophic lake: fertile
    - Store enough O2 to suffice for all the decompostion processes that occur in time for winter or summer
      - Will suffer if amount of O2 consumed is greater than the amount of rq O2

Which country has the greatest exoanses of werlands in the world?
- Canada
- Carp, sea mussel

7.Temperature

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- Temp affects organisms in many ways
  - Metabolism
  - Changing habitat
- How can temperature affect organisms via habitat
  - Causing current: ocean/air currents
  - Stratifying lake
  - Freezing water
  - Drying the soil

Log3=

Can plants regulate temperature?
- Yes, plants can regulate their temperature (not all)
- E.g. Dryas flowers
  - If air temp is 15 deg, flower cup maintain temp at 25. Insect is attracted to this warmth
    - It tracks position of sun, to orient itself in a way to absorb sun's heat

If plants can regulate temp, can they affect the temperature of their env?
- Yes, by providing shades (cooling env)
- They can also warm up env
- Winter: trees increases temperature around to your house
- Summer: promote cooling via shading
- Pic:
  - Greater leaf density, soil temp decreases--> good for plant(they can absorb more water)
  - 48 deg soil will dry up quickly
  - Accumulating litter(organic matter etc.) helps to retain water---> makes soil cooler
    - Affects O horizon

Habitat differences
- Different habitats have different thermal regime
- Black sand is hotter, b/c it absorbs all the light
- White sand reflects sun's rays

Habitat differences
- Shallow riffle: faster moving water
- Highest variation in the air
- Deep pool-->aquatic habitat have little variation in temp
  - Main point: more exposure to air= greater temperature variation
- Climate change?
  - Climate change deniers claim that ocean isn't being affected my global warming
    - Since ocean water has high heat capacity, you can't really see the effects of heat at the moment

How does stream temp affect Chinook Salmon reproduction and survial
- Red text in chapter 5
- Increasing stream temperature has effect on younger salmon that live in streams (anadromous, older ones live in ocean->not affected by changing temperatuer; spawn in stream).
- Temp too high affects their ability to reproduce
- Small streams most affected
  - Logging--->fewer trees-->less shading----> more sunlight heating water

Can organisms optimize their physiology and growth for the typical range of temperature?
- Yes, but evidence is abundant and consists of a variety of ...

Example:
- Different plants photosynthesize best at preffered T
  - Max temp for boreal moss = 13
  - Max temp for desert shrub= 44

Acclimation
- Organism can adjust and optimize performance at different temperatures
  - Depends on physiological experience of an organism--> maybe embryological cond (Dr. Scott's paper)

Thermal regulation: main terms
- Poikilotherms: no or poor regulation
- Ectotherms: external sources of warmth
- Internal sources of warmth: endotherm
  - All organisms produce metabolic heat (pokilotherm produce little)
  - Conduction: direct transfer from other things
  - Convection: heat lost to water (similar to conduction, but specific to water)
  - Radiation heat: electromagnetic radiation
  - Evaporation: water to vapour
    - **MCCRE:**

Body temp (Poikilotherms)
- Methods used by poikilotherms:
  - Colouration change:
    - Darker: absorb light energy to become hotter(e.g. grasshoppers)
  - Hair: prevent loss of metabolic heat(reduces convection loss)
  - Waxes: stop evaporation (don't lose water and heat)
  - Antifreezes:
    - Invertebrate have some chemical that prevent ice crystals from growing
  - Clustering: more appropriate for plants

Behavioural methods
- Basking (grasshoppers)
  - Grasshoppers with access to light bask their body temp about 10 deg above air tenoo
  - Crocodiles also do this
    - During cool nights: heat up in the water

Are all mammals equally capable of regulating their body temperature?
- Mamals that live in lower temp, have better abiltiy to thermoregulation
- Tropical creatures can maintain a constant metabolic rate over a narrow range of temp

Can insects be endotherms as well as poikilotherms?
- Yes, bumble bees can regulate temp via shivering

Regulation Exp
- Alive
- Moth= subject
- Cut off the wings, aim infa red light at the thorax
  - The more heat you send to thrax, the more heat is distributed to the abdomen

Part 2:
Dead:
- Thorax reaches high temp, abdomen doesn't
  - Shows moth can thermoregulate.

Free flying moth: circulation of heat from thoraz to abd
Tie belt around moth(block circulation): moth thorax temp increases===> b/c of blocked circulation,

8. Water Essentials

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The Cicada puzzle

- Sonora desert (N. America)
  - Air temp 46 deg(extremely unhealthy)
  - Rocks and sands/ground= 70 deg (deadly for organists)
- Cicadas : sit on trees; make a lot of noise
  - How can they be active at those temp (i.e. how can they do this and not dry out)?
    - Sing only when there isn't a predator: mating call

Physics

- Graph of relationship btwn temp and saturation of water vap in atm (a. in pressure, b: grams/cm^3--> similar)
- Saturated air: maximum hold of water: air can't hold more water b.c it has reached max capacity
- High saturation occurs at higher temp (vapour)
- Cool down air (Water will return to liquid from
- Evaporation cools (energy used)
  - Needed to take molecule of water and put it into air (i.e. separate it from other H20 molecule)
  - 100% humidity, ecaporation cannot take place and this no cooling
    - Thus intorder for cicada to cool, they must lose water?
      - Chew on roots and tuber underground
      - Insects can expel water through pores on skin
      - Exp. Graph: tolerate 30-37
- Cicada ans
  - Puncture bark, water comes from soil and water enters mosly into the abdoment (not throrax as shown via blue arrow)
  - Water loss is related to regulation of temp

Some adapatations

- Desert beetles: droplet of water between lef and mouth
  - Expose abdomen to wind

Beetle water budget

- Gain most water from drinking condensed fog, then food ox and finally food moisture
- Losses are due to evaporation and waste

What causes water to move? - Gravity?
But how does water get up to trees?

- Water flows from area of high density to low den
- Water potential= capacity of water to do work
-
- Soil has high water potential, move to roots. Roots now have high water potential; stomata is opened and air is exposed(low water in airr allows water to move up. However if there is 100% humidity water cannot move)

Some adaptations

- Plants growth root at diff length, depending on water length
- Find 9 mechanism to keep or gain H2O
  - Saguar cactus and camel

Aquatic Organism adaptation

- Isoosmotic: concsolutes inside= outside
- Hyperosmotic: higher solute inside, lower in water--->water absorbtion
  - Catfish: has to put kidney to work by expeling a lot of water. Need adaptation to retain salt
- Hyposomotic: marine fish, drink water; remove salt
-

Is sea water
Sharks are different:

- Slightly hyperosmotic: more like freshwater fish

9.Energy and nutrients

September-26-12
5:31 PM

Audio
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- Sources of energy: light, organic and inorganic molecules
  - Rate of energy acquisition is limited

How is life being "fed" on earth?

- Energy use and Kingdoms
  - 5 kingdoms
  - How is energy obtained?
    - Heterotrophic: uses organic matter
      - All kingdoms are hetertropic(mainly bact, prot, fung and animal)
    - Photosynthetic: uses light energy
      - (All except fungi, some animals are photosynthetic) -->mainly plants and protists
    - Chemotropic: molecule consumption
      - Bacteria only
      - Animals(lower invertebrates) use tissue symbiotic algea to absorb photosynthetic energy (worms
    - Most bact are heterotrophic
  - **What is PAR?**
    - Photosynthetically active radiation: energy that pigments can use and convert to organic matter
    - Measure by photon flux
    - 400-700 nm of visible light
    - 3 pathways for using energy
      - C3 (photosynthesis)--> done by C3 plants
      - C4
      - CAM

What ecological implications to these biochemical pathways of photosynthesis have?

- C4 vs C3
  - C4 plants use lower [CO2]
    - Special architecture allows them to absorb more CO2 and retain more water (do better in hot,/drier climate)
    - Study: want to determine is C4 plants are moving Northward
      - Result: yes, b/c north is dry
- CAM plants are strongly adapted to dry env
  - Focus on losing as little water as possible and absorbing as much CO2 as possible
  - Open stomata at night and absorb CO2 to store it (cooler at night, water potential btwn plant and air is less than during the day; as a result they lose less water)
  - Grow slowly and steadily

Are needs for nitrogen different btwn plants and animals? If yes, why?

- Animals need more protein b/c we move more (structural components of many tissue)

Why does N take center stage?

- Can plants get N from the air? No
- Humans get it from plants and other animals
- Do all organisms contain the same amount of N in their tissues? No, remember plants need less N, therefore they have less N in their tissues
- C: N ratio (concepts)
  - More carbon compared to N
  - Plants have most C
  - Bacteria and Animals have most N
  - Tells us if the biomass is rich in protein
  - Why are branches better than trunks? Have a greater amount of living tissue (therefore higher N content compared to trunk)
  - Herbaceous: easy to eat; include leaves etc...

But what is the plant's perspective on the preference for greens?

- Predation shapes plant chemistry:
  - Produce thorns, toxic chemicals and etc...
- Tropical plants are better defended than temperate plants
  - Why? Much more attacks on plants in tropic b/c of greaer diversity of animals and reduction constraints to animal eating plants. Thus plants are under pressure to create these defence mechanisms in order to survive.
  - Grass have grains of silica embedded within their tissue: - causes abrasion in animals teeth
- Flexibility in resources
- Chemical energy
  - Tube worm (related to earthworms)
    - Depend on chem energy
  - Found in undersea thermal vents
    - Volcanic activity close to ocean floor, hits it up. High pressure allows 400 deg water to be liquid.
      - Metals and rocks can be dissolved
    - Sulfur block hemoglobin O2 site (but doesn't come off)
    - Red part of worm=tissue loaded with bacteria
      - Bacteria (chemoautotropic): combines H2S with O2 to produce energy
        - Similar to photosynthesis
    - Symbiosis: worm and tissue bacteria

10. Marvin Gunderman Guest Lecture

September-27-12
5:27 PM

Marvin Gunderman...
Audio recording started: 5:32 PM September-27-12

Amazing Arthropods

- 32 phyla: arth=largest
- Beetles: 4 wings(2sets)
- Flies: 1 set of wings
  - Big compound eyes small antenna=flies
- Insect noise is usually male
- Bees collect pollen on protein, wasps have to feed on prey (through stinging)
- Butterfly have balls at the end of the antenna
  - Moth don't have any

11. Energy and Nutrients + 12. Population Distribution and Abundance

October-01-12
5:29 PM

Energy and Nutrients
Audio recording started: 5:30 PM
October-01-12

Chemical energy

Does the amount of food consumed change depending on how much is available?
Is this change regular or can it take different forms? Yes(3 curves)

- Functional responses:
  - How much pred eats depends on prey density (food availability)
    - 3 types of respond curves (don't need to know which is which)
      - Type 1: liner (mechanical- mindless eating, the more there is, the more you eat)
      - Type 2: gradually saturating (glutton- the more you eat the less dramitical you food pursuing is)
      - Type 3: slow to start (connoisseur- not sure, trying to eat something new)

Optimal foraging theory

- Organisms can choose "which food is better"
- Organsms invest in "safe activities"
  - Won't look for food where predator is found
- Balacing energy invested and energy obtained
- Can be applied to plants
  - When theyproduce sugars and obtain energy, they need to decide on how to distribute it (i.e. grow more leave, increase roots etc.)
- Prey with low capture rate and high search effort= energy wastage

Optimization in plants

- Root-shoot ratio: relative importance of above and below ground parts
- More nitroge= less roots (more above ground production) b/c no need to make structures to absorb N, when it is already readily available

Ca a simple theatrical index (C:N ratio) help with management of environment problems?

Applu ing C:N ratio knowlefe

- CN removed from gold mine ore
  - C:N=1:1
- BACTERIA eating cynide
  - c:n=5

POPULATION DISTRIBUTION AND ABUNDANCE (Ch.10)

Text book terminology:

- Population= group of individuals in the same species that can interbreed and live in the same location
- Density: # of individuals per unit area
  - Ecological density: # of individuals per unit suitable habitat (takes into account for differences in density caused by favourable environmental conditions that allows certain populations to thrive)
  - Absolute density: same as density

Does habitat quality determine geographical distribution of species?

- Answer= Yes. See Kangaroo distribution example below

Climate and distribution of Kangaroo species

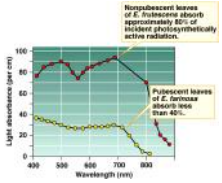
- Main idea: physical environment limits geographic distribution of species
- 3 related species (maintain location for centuries):
  - Red= (eastern kanagroo): found in tropical north; temperate forest south-->little seasonal variation in precipitation and summer dominance
  - Blue=(western Kangaroo): temperate woodland and shrubland biome--> winter precipitation
  - Green= (red Kangaroo)= desert/arid env--> hot and dry
  - Beige area(North most): no Kangaroos are found there-->tropical area
    - Too wet for red Kangaroo
    - western kangaroo: to hot in the summer and too dry in winter
    - Too hot for eastern kangaroo
      - These organisms have adaptations that allow them too survive in their respective habitat
- Temperature preference isn't constant

Tiger beetle and cold climate

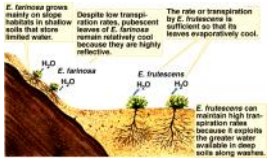
- Tiger bettle prefer to live in cold areas (not too cold)
  - Map distribution: they prefer temperate and boreal forest regions in Canada
  - When found in southern areas, they occupy areas of higher elevation (mountains) which have similar climatic conditions to boreal forest
- Constant temperature preference for those living N and S
  - Experiment shows that they have highest metabolic rate at prefered temp

Distribution of related species with different Temperature and Water requirement

- Encelia: distributed along a temp/moisture gradient from Cali coast to death valley (p. 127)
  - E. carlifornica (lack hairs, reflects less light): found in cool area
  - E. actoni (found inland in fryer and warmer areas)
  - E. farinosa and E. fructrans: live in hotter areas inland



    - Compensation
      - E.farinosa : highly pubescent and reflect a lot of light
        - Hotter env-->more hair--->more light reflectio
      - What about E. fructeans? How do they cope with high heat, Shouldn't they overheat since they aren't pubescent?
    - Even though these two species in the same environment, they have different microhabitats
      - What? Explain further please? ...See diagram below



- Physical and chemical factor affects Encelenia distribution

Distribution of two barnacles within the intertidal zone

- Barnacles= closest to shrimp
- Live in intertidal zone
  - Organisms in upper intertidal zones are exposed to all tides
  - Lower= low tides alone

- Two species (pg 259 fig 10.6)
  - Balanus:
    - Larvea can settle anywhere
    - Adult is constrained (limited to middle and lower)
  - Chatalamus:
    - Adult restricted at upper intertidal layer
    - Larvea: can settle in middle and upper zone

Baloowww
Chatup

12. Population Distribution & Abundance

October-03-12
5:28 PM

Audio Rec...

Audio recording

Distribution of two barnacle within the intertidal zones

- Why are they distributed like this?
  - Ability to cope with different exposures to air
    - Balanus: greater mortality when exposed to air (juvenille; more prominent in adults)
      - chtalamus higher on shore die at lower rate than balanus
        - Explains why Balanus is restricted to bottom and middle area
  - But why is chatalamus excluded from the bottom (lower intertidal)?
    - Remember: its larvea settles at the bottom, so why can't adults survive there?
    - Answer= competition.
      - Scientist put Chatalmus in lower intertidal zone --> they survived
        - Why are the excluded :s
          - Ahaha! It is b/c of its competitive interaction with the evil Balanus!!
            - Shows that Biological factor can limit organisms distribution

Does a pattern of distribution provide info on what an individual does?

- Two types of distribution
  - Large scale: distribution across continent, mountain range (usually clumped b/c environment varies and indv aggregate in favourable areas)
  - Small scale: distance no more than few 100 meters (little env change significant to organism under study)
    - Microscale patterns: Random, Regular, Clumped
- Random pattern of distribution(ignore)= neutral interaction between individual and env
- Regular pattern (repel) : could be antagonistic or due to exhaustion of resources
  - Ex. Plant seed s, watch them grow, add disturbance, weaker ones will die, leaving the alive ones in a regular patter
- Clumped pattern(attract): attraction btwn indv and attraction to common resourse
- Example:
  - Regular and random dist of stingless bee colony in tropical dry forest
    - Regular distribution--> aggressive bees (territorial for nesting trees): equidistant
    - Random= less interactive; ignore each other
- These interactions can change overtime
  - Shrubs start out clumped distribution.
  - Mortality reduces clumping and they have random distribution
  - As competition increases random becomes regular

  Clumped(new growth in area with lots of resources) -->random (deaths)---> regular (competition as years go by)

Below ground competition in plants

- Large Scale
- Root distribution of Creosote bush
- Grow in a pattern that reduces overlap between roots of adjacent plants

Abundance of 3 tree species on a moisture gradient in smoky moutain

- Large scale
- Greatest abundance is in the middle: showing populations are concentrated in "hot spots"

Organism Size and Population density

- Increased organism size --> decreased population density
- In picture: mice are more numerous than deer
- All organism Size/density curve
  - Same findinds above with some exceptions
  - Exceptions
    - Aquatic invertbrates of a given body size tehnd to have higher population densitites than terrestial vertebrates of similar size
      - Why?Me: Aquatic vertebrate have more room to hold more population
    - Mammals tend to have higher population density than birds of similar size
      - Textbook exp: taxonomic differences

Commonness and Rarity

- Knowledge of species distribution and abundance help in assessing its conservation needs
- Common species: extensitive geographical distribution, broad habitat tolerance and high population (dandelion)
- Rare--opposite (like Mountain gorrilla) -> resitricted, narow, low
- Strong positive corelation of geograpical range size and population size
  - Species are more abundant in spaces with higher geographic range

13. Population Structure

October-04-12
5:31 PM

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Audio recording started: 5:32 PM October-04-12

- Population structure= number of factors that affect individual populations
  - Patterns of mortality, age distribution, sex ratio and dispersal

Do all born individuals have the same probability of survival? Does this differ among species?

- 1M03 example
  - Unlike other lizards, Lacerta vivpara gives birth to live young (normal lizards lay egges)
  - High rate of survival during birth, low rate in adult (Type I curve)

TABLE 52.1 Life Table for *Lacerta vivipara*

Year	Number alive	Survivorship	Fecundity	Survivorship × fecundity = average number of offspring produced per female born
0	1000	1.000	0.00	0.00
1	424	0.424	0.08	0.03
2	308	0.308	2.94	0.91
3	158	0.158	4.13	0.65
4	57	0.057	4.88	0.28
5	10	0.010	6.50	0.07
6	7	0.007	6.50	0.05
7	2	0.002	6.50	0.01

Data are from Strijbosch [redacted] $R_0 = ?$

- The case of dall sheep
  - Wolfs kill them
  - Study showed wolves killed young and old
  - Type 1 survivorship= greatest mortality at older age

Survivorship curve:

- Gives estimate of pattern of survival in an organism
- 3 method of measurement:
  - Cohort life table: study individuals born at at the same period and keep records of them from birth to death
    - Disadvantage: difficult to obtain data (might take too long for organisms with high life expentancy; organism might be mobile or aggressive)
  - Static life table: record age at death for large number of individuals for a certain period of time (need to estimate initial number of survivors: used for Dall sheep example above)
    - Disadvantage: might not be accurate
  - Age distribution: record age of individuals in certain location
    - Disadvantage: assumes no immigration or emigration

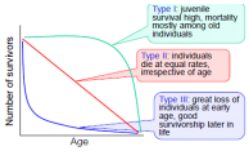
Survival curve reflect different life strategies

- After 7 days, the mortality rate increases in rotifers (type 1)
- American robin and white crowned sparrow (mortality is unrelated to age) (type 2)

Reproduction mode vs. Survival

- Plant (concave: mortality is highest at young age; reduces in adulthood) ->cleome droserifolia
  - Concave=caves in (
    - Type 3

Survivorship curve



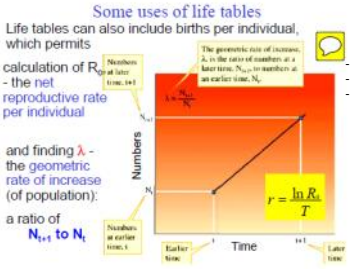
Using survival curve to infer the state of a specie

- Whit oak example
  - More trees btwn 1-50 years and tree # reduces as age group increases
  - Distribution suggests that older trees are being replaced by younger ones
    - GROWING POPULATION
- Cottonwood example
  - Less young, more old
  - Insufficient replacemnt
    - DYING POPULATION
  - Textbook explanation for low reproduction
    - They need seasonal floods to grow b/c
      - Floods create beare soil without surface organic matter--> eliminates competing vegetation
      - Flood keep area moist until cottonwood seedlingss can grow their root enough to tape into the shallow water table
        - PROBLEM:
          - Seed bed preparation is interuppted by construction of dams in Rio grande

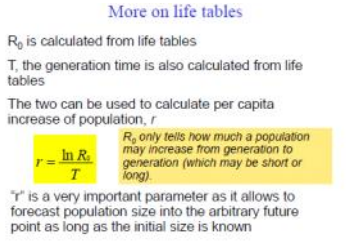
Shifting age distributions in a variable climate

- Cactus finch example
  - Drought in 1984-85=low reproduction
  - 1983 (rainy year)= largest reproduction

Uses of Life tables



- Lamba=geometric rate of increase (b-d)
- Ratio of population size at 2 point in time
- N t+1= population size time 1
- Nt= population size in time 2



SEX RATIOS

- Depends on relative fitness of genders
- Male to female ratio is often close to 1 in humans. Why?
  - Frequency dependent selection: selection favours rarer sex, to allow balance within sexes
    - When ratio is 1:1 fitness benefit for producing one of more sex over the other is reduced
      - E.g. 1 female : 99 males, selection will favor production of more females

14. Population structure/ Population Growth

October-10-12
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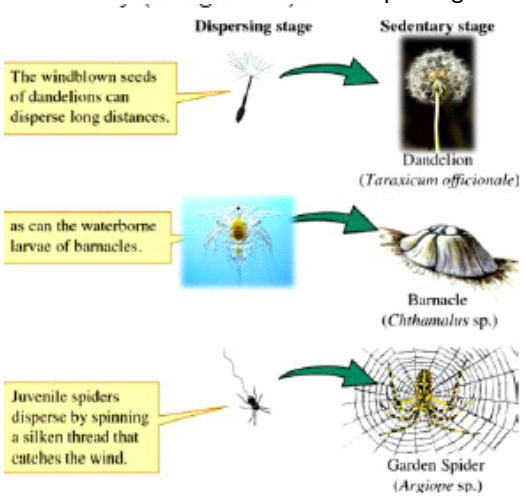
POPULATION STRUCTURE CONTINUATION

DISPERSAL

- Leads to inc or decrease of population density
- Organisms have diffferent methods of dispersing



Unwanted dispersal

- Africanized honey bee= cross of African bees and european beas
- Very aggressive and disperse quickly and form colonies
- If environment warms, they'll continue to move up north

- Plant example
  - Maple moved north slowly (like cold environment, moving upward as climate warms)
    - Took 8000 years
  - How do we know?
    - Pond sediments: pollen falls down into pond sediment and it can be used to estimate the time period in which pollen lived near env
      - A lot of pollen= pollen grew in that area
      - Few pollen= it flew from another area

Species do not disperse with equal ease

- Factors responsible for differences
  - Physical obstaccel
  - Mode of dispersal
  - Active dispersal
  - Hitchhicking
    - Ex. Method is used by clams that cpme from caspian sea-->colonize great lakes
      - Intoduced great modification to local system
      - Larvae attaches to end of boat--->introduction to new environment
- Rates of dispersal differ
  - Africanized bee- highest rate
- Disperson occurs as a result of
  - Food supply:
    - Density of predator and prey graph: vole and owl example
      - Difference btwn this graph and lynx-hair graph
        - This one is due to predator moving to area with plenty of food
        - Lynx/hare graph is based on mortality of prey

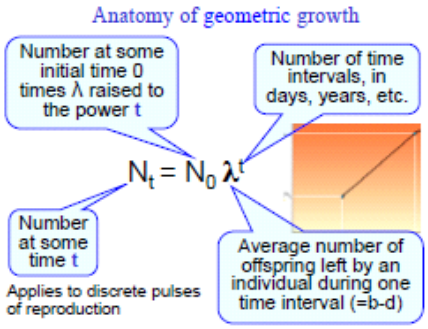
Drift requires upstream dispersal

- Most species of fish cannot resist water movement (esp small ones)--->washed downstream
- Have adaptations that allow them to mve back to upper portion of stream when they become adults
- Lay eggs in upper portion and cycle begins

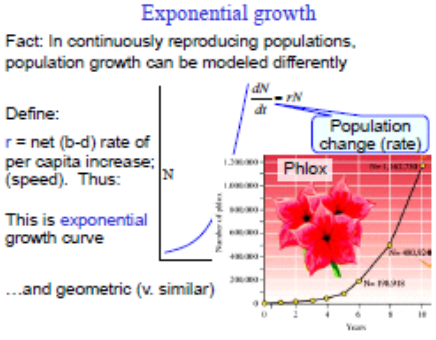
POPULATION GROWTH (C. 12)

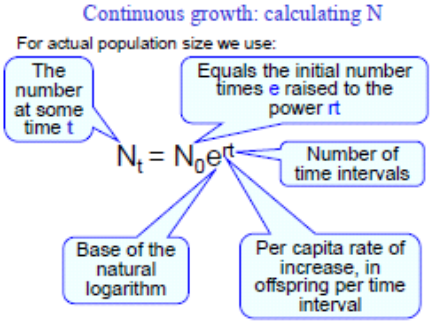
- Populations can grow at different ways:
  1) Geometric (exponential rates)
  2) Logistic (something limites their growth)
- Allometry= small organisms grow faster than larger ones

- Geometric growth
  - N(t)= N0 lamda^(t); lamda= birth rate-death rate (DISCRETE GROWTH- reproduce at set times)



Geometric growth when population doesn't grow in discrete time stpes (for individuals that reproduces anytime)





15. Population Growth

October-11-12
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Audio Recording - 3
Audio recording started: 5:30 PM October-11-12

Logistic growth

Wat cause the growth to slow down in the logistic pop growth?
- See general classes of causes below
- Differ, but deal with general issue

Example:
- Paramecium: rapid increase in beginning, slow down (oscillation at carrying capacity)
- What causes slow down? Unknown. Probably increasing metabolites
  - Why is osciallation present?
    - Overshoot carrying capacity-->death-->remaining population reproduce->increase popultion and cycle begins again.
- Yeast
  - Smother increase due to less mortality
  - Reduction is due to change in carrying capacity (consume sugar, change to alchohol. If alcohol is too much, carrying capacity will go down.)
  - Carrying capacity can change? Example: Cow in meadow: 100 cows in meadow that is enough to feed them. After 5 years of being on meadow, they reduce soil capacity; less grass is formed and carrying capacity is reduced

Rm is reduced by N
- Maximum growth rate = rM
- K= carrying capacity
- r<0= negative growth rate= shrinking population
- Example:
  - Daphnia pulex: Water fleas (crusteacean; graze on algea and yeast; fast reproduction rate)
    - Plot growth rate as a function of density
      - R declines when N declines (therefore higher density populations can be predicted to grow slowly)

Carrying capacity can fluctuate
- See paramecium ex.
- Change as environmental condition change
- Finch example
  - Icnrease in rainfall= increase in finch population size
  - Rain-->more food-->more insect-->more protein and energy for finches
    - Very large wet year= recoverable of population
  - R was changing to match K
- Additional data
  - Desiity of caterpillar depends on water
    - Large increase in caterpillar population during wet year
  - Also during wet year, population of large finches increases
    - Physiological impact:
      - More rain, more resources, increase egg clutches
- Finches damage cactus
  - Dry years % damage flower was small; rapid increase during wet years
  - More rain, more plant, finch explore more food

Does the rate of populaton growth depend on how long it takes from birth to reproduction?
Does this depend on some obvious factors? Yes

Generation time:
- Varies with body size
- Generation time is lower in smaller animals (reproduce faster)
  - Within the same sized animal you can have 10x difference (the statement above isn't always true)

Cross-taxa comparison
- Pop growth rate /capita declien with size
- Homeothermic animals reproduce faster than ectotherm for the same size? Why?
  - Homeotherms have higher metabolic rate which is tied to reproductive late

Consequences of different r
- Tunicas (invertebrate relatives)
- Some are attached in colonies, or float in water
- Compared to whale (very slow growth rate)

16. Population growth contin...

October-15-12
5:24 PM

16. Comp…

Audio recording started: 5:27 PM October -15-12

Multiple choice:
- Up to chapter 12
- 40 questions
  - 40 more difficult: work 2 more marks (2 short answers)
    - Two questions
- Study lecture specific content in textbook
  - Things in textbook, but not in lecture --> don't study
- Sample questions tomorrow

Human population- distribution
- Not many people in sahara and amazon (too dry and too wet)
- Huge density, China, Europe, Northern Africa
- Absecne of human->related to envrionment
- High presence of humans--> related to historical populations

Human population: diffferent r
- Shape of pyramid tells you whether population is stable, expanding or shrinking
- 0-5 small, population can only keep decreasing as years increase
  - Declining b/c 0-5 population is only getting smaller, cannot replace older generation
  - Lithuania
- Rwanda
  - Growing population
  - Younger generation, high and will be able to replace older generation
    - Rwquire large amount of resources to maintain population

Prediction (extrapolations)
- r= b-d
- Assumption of population growth assuming parameter are the same

Summary
- Rrapid growth in human population
- Can it reach carrying capacity and fall?
  - Humans , unlike other organisms can change their own carrying capacity and the cost of the environment
- Percent of Change:
  - 49% of global increase in africa; 4% in Canada
  - Shrinking in Europe
- ----------

COMPETITION (13)
A= O; B= triangle
Types of interactions
- Exploitation: Species A has positive effect on B; species B has negative effect on A
- Mutualism: both species have positive benefit on each other
- Commensalism: one species has no effect on other; while the other has a +ve effect on the other
- Amensalism:species A has -ve effect on B while B has no effect on A
- Neutralism: both have no effect on each other
- Competition: both have -ve effect on each other

(CAN; 0,+; 0,-; 00)
Would all species have the same carrying capacity, when they live in the same habitat?
- No, Why? See below
- b/c of competition/ species interaction
- One species will dominate others
- Even if they share resources, one will somehow limit the growth of the other

Population density, soil N and grass size
- N= first limiting nutrients (limits population growth first; second is Phosphorous)
- Plants in low densities grew larger as more N was added
- IN high plant densities, increase N didn't increase the growth to plant
  - *Problem: intraspecific competition: competition among individuals of the same species*

If intra-specific competition matters, what would be its ecological outcome, particularly among plants?

Intraspecific comeptition in plants (pg 333)
- Hypothetical expectation: Self thinning in plant populations
  - As plant density increases; individual plants begin to uptake more nutrients
  - Losers die
    - Usually Small plants
    - Result: lower density is achieved through "thining"
  - Plant population is less dense competition for nutrients is reduced
    - Plant population grwth can occur

- Self-thinning rule
  - As plant density decrease, total biomass increases (less thining)
  - Or; as plant density increases, total biomass decreases (due to death of "loserS"

- Alfalfa Population example
  - Average weight of individual plant as a function of density
  - Increase density--->reduce plant mass

INTRASPECIFIC COMPETITION FOR LIMITED RESOURCES IN PLANT (HIGH DENSITY)---->thining
RESOURCE COMPETITION

Would competition affect health (performance) and survival in animals in a ways comparable to plants?
- Isopod example
  - Given same amount of food, different densities
    - Greater survival when density is low
  - Interference competition
    - If one isopod interfere with another isopod , the stronger will eat the weaker
  - Unlike the plant population where nutrient availability is reduced w/ increased density; here we see that nutrient availability is the same for both densities but same effect is produced
    - Therefore this isn't eresource competion
    - It is interference competition

The Niche concept (pg 243)
- Niche summarizes factors that influence grwth, survival and reproduction of a species
  - What the species needs and what it uses (what affects its performance?)
    - Ecological space used by species
    - Pred
- Fundamental niche: physical conditions under which a species may live in absence of interaction w/ other species
  - Kolasa ex: Fundamental niche: amount of time you get remote from tv room
- Relaized niche: interaction w/ other species which influence environment species are found (reduced version of fundamental niche)
  - Kolasa ex. Realized niche: amount of time you negotiate with famility to get remote.
- Diagram 9.27 PG 244

17. Competition (Ch. 13)

October-17-12
5:30 PM

Be able to interpret equation and recognize type of equation

Audio Rec…

Audio recording started: 5:31 PM October-17-12

What is the link btwn the niche of a species and its morphology?
- Developing morphological traits that allow organism to be suitable for its nich
  - Example: human population.
    - Overall build is shorter and stockier, lighter skin: cold climate
    - People in hot climate: taller and slimmer (darker skinned). Less (SA) for sun penetration
  - Galapagos finches

Body size and seed size (pg 244)
- Body size and seed size are correlated
- Big seeds are preferentially eaten by big finch and vice versa
  - Bigger seeds are harder to crack
- Selection for larger body size during drought
  - Drought produces larger size which are harder; bigger birds can eat them (according to Kolasa)
  - During drought (1977) birds ate the smallest and softest seeds first (as seed pop was depleting), leaving the larger and tougher ones behind (texbook)
    - Thus mortalitity of small beak birds increased as they cannot crack seed
  - When rainy season occurs, seed b/cms smaller and smaller birds are selected for

Seed depletion and average seed hardness
- Before drought (before 1977); finch reduced seed abundance via feeding
- Increase feeding---> increase seed hardness (mainly preffered soft seed? Or population small beak bird >)
- During drought (1977); seed abundance declined and Seed hardness was hight
- Before drought: mainly small birds dominated; after large birds dominated

If carrying capacity differ among species, what consequences that may have for their numbers/densities?
- Reduction in carrying capacity

- Paramecium (pg 340)
  - Two related species that can be grown invidually or together
  - Grow separately half strength medium (low bacteria conc)
  - Grow seperately in full strenght medium (higher bacteria conc)
    - Increase carrying capacity from 1st
  - Why are carrying capacities different across both species?
    - Maybe one is bigger, or has lower metabolism at certain temp
  - Put both together:
    - Caudtum population decreased (went exinct at a faster rate in half -strenght medium)
      - What is going on: competition: reduced food suppy increased competition strenght
        - Growth alone is dependent on food availability; food competition increases and one species dominates (here winner=aurelia; loser= caudatum)

Is competitive superiority fixed for any pair of specie that we compare?
- Answe with flower beetle population

- *Tribolum confusum vs T. castaneum*
- At 34 deg and 70% humidity both grow well seperately
  - Grown together: castaneum wins
- At 24 deg and 30% humidity; grown seperately (confusum wins)
  - Grown together: confusum wins
  - Dr. Kolasa's revision to this exp
    - If experimeters know that castaneum cannot grow in this conditions; they could have put the temp and humidity up alittle bit (not enough so that it is optimal for casataneum).
    - This will give a better representation of the competition
- Confusum grows better in lower temp and humidity

Chtalmus and Balanus
- Factors restriciting distribution of Chthamalus
  - Lower intertidal zone: below water colum (in ocean); both species are subjected to predation
  - Middle intertidal xone: balanus=winner; competes w/ Chtmalus
    - In absence of balanus, chtmalus can grow very well
  - Upper intertidal zone: chtmalus wins
  - They desicate at much higher levels w/ less water

Character displacement in beak size
- Character displacement: changes in the physical characteristics of a species' population as a consequence of natural selection for reduced interspecific competition.
  - Purple graph alone= species 1 alone: beak length intermediate (8-12)
  - Green graph alone= species 2 alone: beak length 6.4-9.5
  - When together to reduce competition, nat selection allowed both populations to have distinct (non-overlapping beak sizes)
- Lack (1947) found that when the two species *Geospiza fortis* and *G. fuliginosa* occurred on large islands together, they could be distinguished unequivocally by beak size. When either one occurred by itself on a smaller island, however, the beak size was intermediate in size relative to when the two co-occurred.

Pasted from <http://en.wikipedia.org/wiki/Character_displacement>

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18. Competition (Chapter 13)

October-22-12
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October-22-12

Competition theory
- Lokta and Volterra mathematical model (used to model competition)
  - Predicts specific outcomes
  - Incorporates interspecfic competition w/ logistic population growth equation
    - Used competition coefficient: to include interspecific comp into logistic grwth equation
      - -a(12)N2 and -a(21)N1
      - -a(12)=3 means one individual in species 2 has a per capita effect of population growth of species 1 equivalent to 3 inidivisuals of species 1
      - What happens when alpha is * by N
        - Not a measurement of per capita effects
          - Now equal to population level effects of one species to another
        - Example: a(12)=3; N2= 25
          - Therefore 25 indivuals in species 2 is has the same effect of 75 indivuals in in population 1 (on pop 1 grwth rate)

Logistic growth
- For intraspecific competition
  - K=reflects intraspecific competition
- Finite env, allow population to grow
- Shaped curve: constant growth adter K
- Only models intraspecific competion
  - dN/dt = rmaxN (K-N/K)
    - Rmax=intrinsic rate of increase

What happens when two species share one resource?
  - Carrying capacity of one species will depend on the K of the other
  - Example below

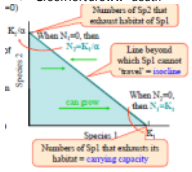
Two species in finate environment
- 13 green plants were added to env, K=13
- Red species can fit 65 individual in the same environment; K=65
- One avergae, 1 green species can replace 5 red individuals
- Why do different species have different K in the same env?
  - Allometry: small species usually have a greater carrying capacity
  - So what?

Two species finite env
- Increase in N fruther limits growth
- Inbibiotry effect of species 1 on 2 and vice versa: 1 green prevent growth of 5 red; 5 red prevents growth prevents growth of 1 green]

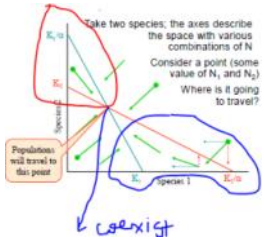
Two species equation
- Quantitative model
- Use logistic growth function that reflects variables for both species present in the environment (I.E. logistic growth to determine how one species affects the growth rate of the other)
  - dN1/dt = [r1*N1 (K1-N1-a12* N2)] / [K]
    - A12= effect of species 2 on 1
    - Here is the equation of the growth rate of species 1 (in an environment with species two)

Analysis
- Equation ca be solved visually?
  - Can be graphed
- What happens when both species stop growing (When they reach K)
- Mathematical meaning: rate of change of both populations is 0
  - dN1/dt=dN2/dt=0
    - Why?
      - r= 0; no reproduction or they are dying r= b-d
        - Rmax= max potential population grwth rate
      - K1-N1-a12*N2 must be 0

Isoclines
- K1-N1= N2 + a12
  - If you let one species population (N1 or N2) Into 0, you'll get Nof one species without the effects of the other
    - N1=K1 and N2=K1/a
  - Area blue= species can approach blue line, if it goes past It, it must return
    - Boundary to blue line is limited by K= carrying capacity
      - Species population must beat or below K
  - Green right arroun=growt
  - Green left aroww=death



Interpretation : outcomes
- Green point
  - Greater than species 1 carrying capacity (K1): must travel left
- K1/(a12) > K2: inter specific interaction of 1 and 2 > Intra specific interaction of species 2
  - Here no species can dominate/c of the high inter specific interaction
- K2/a(21) > K1: inter specific interaction of 1 and 2 > Intra specific interaction of species 1
  - Here, no species can dominate b/c of the high inter-specific interaction
- **Green diagonal pointing towards text, species 1 and 2 can coexist (aka. Isocline intercept)**
  - **Stable co existance: beyond this point no species can thrive b/c of the high interspecific competition on both sides (blue and red)**



Benefit and limitation
- Species can co existw hen intra specific competition is stronger that inter
- One species will exclude theother when isoclines do not cross
- An opposite effect when intra-specific competition is weaker

Inverting isoclines
- K2 > K1/a = intra specific competition 2 > inter specific interaction 1 and 2
  - Here species 2 grows better and excludes 1
- K1 >K21/a= intra specific competition of 1 > interpsecfic interaction 1 and 2
  - Here species 1 reaches it carrying capacity and excludes species 2
- Middle points where isoclines is an UNstable equilibrium
  - Why?
    - Once you cross this point, one species starts to dominate/exclude the other
    - Thus they both species can only grow in the middle

Situation 3
- Species 1 wins
  - Species 1 has greater intraspecific interaction b/c K1 > K2/a
  - Species 2 loses b/c K1/a > K2 (thus interspecific interaction is greater than intra)

Intra specific interaction= competition within species: If this is greater, that species can grow better
Interspecific: both species are fighting each other: NO GROWTH

19. Hebivory and predation (Ch 14)

October-24-12
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Predation, Herbivory, parasitism, Disease
- Predation and herbivory are linked
  - Other animals feed on/attack plants

Life cycle of plagiorhynchus cylindraceus
- **Pg 386**
- Spin head worms
- Predation and paratism combined
- Worm eggs are released from bird feces
- There are ground insects that can eat the bird feces (isopods)
  - Worms grow within isopod
- Starling bird eats isopod,

Starling predation on isopod, Armadillium vulgare
- Observations (uneddedcted isofods are much less prey on that others)
- Why do infected one's get eaten?
  - Affected isopods don't change a lot to

Biomass of algae and grazing caddisfly
- Caddisfly larvae graze on algea
- Caddisfly larvae grow in large densities(make up 25% of the total biomass of benthic species)
- Want to test if its high population density can affect food supply (algae)
- Experiment
  - Large ceramic tiles were placed at the bottom of the creek
  - Algae colonized the tiles, reaching peak density 2wks later
  - 1 w/k later caddissfly population grew (highest density)
  - This lead to a reduction in algal density
  - Few weeks later caddisffly population began to decline and algal density rose up again
- Scientist were trying to make sure result wasn't affected by other species in the ocean so they made some adjustment to the experiment
  - Exclusion experiment
    - Two sets of tiles:
      1) Same as before
      2) Slightly elevated to exclude larvae and adult (b/c you don't want them to lay eggs and affect algal growth). Other invertebrates were not excluded
    - Result:
      - In absence of caddisfly (elvated tile)---->higher abundance of algae and bacteria

Biological control of prickly pear
- Prickly pear spread in Australia and invaded lots of rural land
  - Rendered them useless for agriculture
  - Couldn't be removed w/ pesticide or by mecahnical means
- Solution: Cactoblastis
- **cactoblastis** (*Cactoblastis cactorum*):larvae that tunnels into and devours the inside of the plant.
  - Almost wiped out cacti population

Foxes and mountain hares in Sweden
- Fox: mange disease, killed them (causes the fox to lose hairs)
- Caused their decline and hare population rose

Fluctuations in lynx and noshwoe hare populations
- Hundson bay company kept this record when trappers were hunting hares and lynx
- Obvious pattern
  - Peaks are aligned
- Hidden pattern
  - Blue peak Is a bit later in time than red
    - When hare pop is high, lynx population grows the following years
- Different hypothesis were created to explain patter
  - Sunspot-> Rejected
    - Increase solar radiation associated w/ sunspot cycles altered plant growth
      - Hare feed on plant--->its growth---> lynx poplution respond by reducing snowshoe hare pop and increase their in the process
  - Overpopulation theories:
    - Period of high population grwth are followed by: decimation by disease and parasitism, physiological stress @ high density leading to increase mortality and starvation due to reduced food
- Real cause: combination of food quality, weather and predation
  - Reduced food avalability-->starvation and weight loss ---> population decline
  - Decline is ensured and accelerated by high mortality rate due to preddation
  - Hare pop decline--->lynx pop declination
  - Plant pop recover.
    - Stage is set for another increase in hare population and for cycle to continue

20. Herbivory and predation (Ch. 14) X

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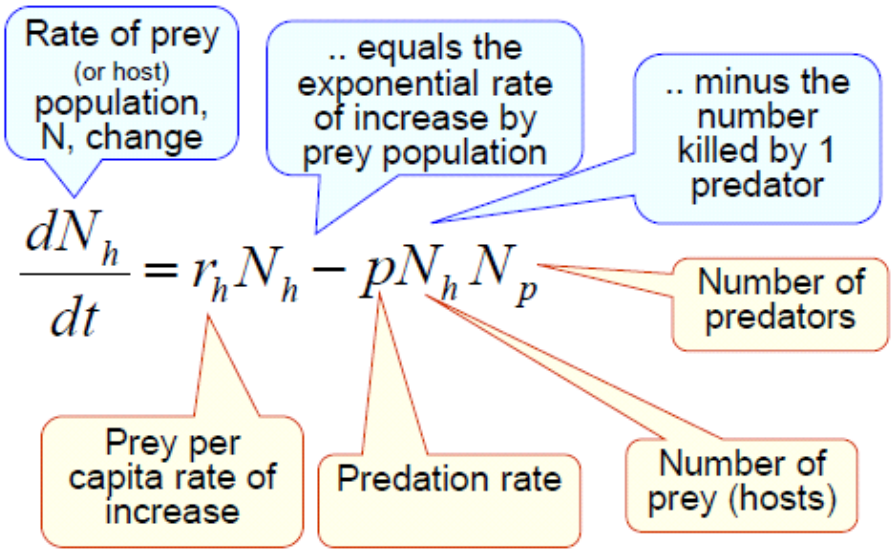
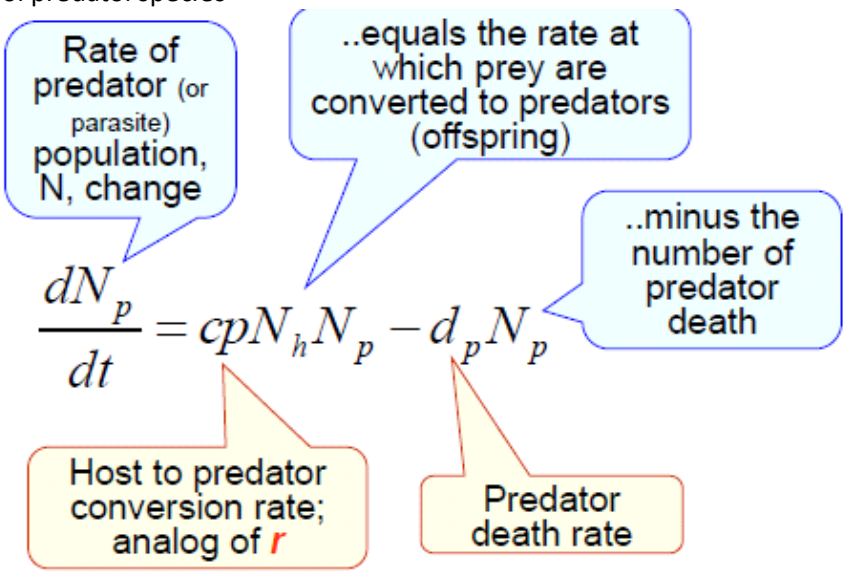
Anatomy of Lotka-Voltera equations

- For prey species



- For predator species



- Two ways of plotting them:
  - Plot prey and predator against time
  - Polt prey and predator against eachother
- Whwen predator increases, prey pop decreases and vice versa
- Outcomes:
  - Ossiclations: in predator/prey vs time curves
  - Unlikeley that they will always follow the same path
    - i.e. eternal oscillations in narrrowly defined path is unrealistic
      - Carrying capacities of prey and predator can change over time and this can ave a drastic effect on the other population

Laboratory populations of hosts and parasites

- Parasitewasp kills the beetle
- Wasp lay eggs in beetle, larvae eats beetle from inside
- Generally peaks and dips don't overlap
- Reciprocal fluctuations w/ delay (Even w/ no dimetic impacts)

Refuges and persistence of predator=prey oscillations

- Paramecium and didmium in the absence of refuges and immigration, predator persists
  - Prey declines while predator increase, then predator has no prey left and it dies
- w/ refuge, prey persists, predator loses
  - Refuge: layer of sediment where prey can hide (predator cannot find them, therefore predator dies)
- w/ immigration both persists and oscillate
- Conditions are good for prey when there are few predators
- Conditions good for predator if there is a lot of prey
- Can this be produced w/o human intervention

Environmental ccomplexity and oscillations

- Arrange oranges in particular array, introduced mites that feed on them
- Each orange had an 'island' on them (mites were placed on these)
  - There were also predatory mites which could move everywhere
- The prey don't move between oranges except by "flying" (no wings but have thread- "aerial balloning" stand of silk thatcancatch windcurrents)
- Refer to slide- graph (cycling)
- If no resource (fpr pred) or refuge (for prey) the pop will reach 0
- Therefore this population obey Lotka and volterra equation

Cicada pop. Size and predation rates

- Picture shows adult cicada emerging from nymph skin
- Ex. Predator satiation (prey escape from predator through numbers)
  - Ex. Gazelles-> all give birth at the same time---> driven by predation(lions can't eat all of them)---> lions and hyenas have little or no impact on gazelle pop
- Find out density of cicada pop. By trapping them in emergence trap
  - Cicadas nymphs live underground and emerge from underground every 13-17 years as adults
  - Emergence trap used to catch them
- Inverted emergence trap caught wings and whole ccicada (Dead): estimated predation rate
  - If only wings caught, means they were consumed
  - If whole body caught, could be they were attacked, infected (or other causes)

Cicada pop density and mortality

- % killed by predators doesn't equal number killed by predators, it's the fraction of those caught that were consumed
- When it reaches 0, doesn't mean that no cicadas were eaten, it means so many cicadas that it showes as if 0 were consumed
- When there is few cicadas then a higher % gets eaten
  - You already have few of them so eating 1 makes it seem like a lot has been eaten
    - Total population of 100 vs 50.
      - High pop vs low: eat 1
        - 1/100=0.01 vs 1/50=0.02
        - High pop 10% has been eaten; while low pop 20%has been eaten

Large mussels eaten infrequently; escape from predation by size

- Paine experimented w/ predation by starfish on mussels on the rocky shores of pacific
- Small starfish eat mussels that are about 5 cm
- Bigger starfish eat mussels that are about 10 cm in length
- Yellow are= size most consumed by starfish (high predation
- One ex. Remove all seastars fromintertidal zone, allow mussels to grow
  - Large mussels were not eaten by seastars

At a larger scale

- In the savanah, lions normally attack young elephants b/c thecost of going toadult Is too high
- The adult elephant is huge and can attack lion

21. Operation Wallacea

October-29-12
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Travis:

- Indonesia:
- Jungle training
    - Dung training
    - Great diversity
        - Wallacea line:
            - Alfred Walace: Bio-geogrpaher
        - Lots of endemic species
- Habitat degradation
    - SE asia= lots of deforestation
    - Soltuon: Butterfly catching
        - 557 butterfly species (43% endemic)
    - Used butterfly an bioindicator
- Catching buterfly
    - Lure them with mashed banana
    - Banana and Fanta attracted the most butterflies
    - Highest abundance: farm--->fgirf anf Bala
        - Too much disturbance: species cannot form population
        - Too little: one species will dominate= no abidnace
        - Medium: highest diversity

Katrybne Forbes

- Amazon
- Rio amazonas
- Samira river one of many amazon rivers
- 3 birds: Wading, Macaws and Mist-netting
    - Macaw surverys in early morning
- Misnetting: large nets hung btwn trees with pockets for birds to land in
- Birds are identified
    - Gender identified
    - Weigned
    - Tail length
    - Beak measurement
- Camera traps
    - Motion sensor cameras set in forest
    - Found 3 jaguars

Michelle

- Honduras
- Chyrtid fungus
    - most ginigicant disease affecting biodiversity in the world
    - Affects entre class of animals
    - Pter factors result in pop decline as well
- Transmission
    - Airbone zoospores
    - Wind-driven rain (transported through long distances)
    - Trade
    - Data inconclusive
- Set up traps to catch rain
- Sumptoms:
    - Rarely visible
    - Skin lesions
    - Fatal ddehyration

    - Neurological functon
    - Some infected individuals show immunity to disease
- Global warming might be the result of increases chytrtid gincgis
- 120 amphibias(44% are endagered, maybe b/c of fungs)

Melanie: Buton Macaque Project

- Began by Dr. Nancy Prsition, since 1998
- 3 sites: Lapago (least disturbed), Kakenwaw, Kaweli (most disturbed, farm area)
- Less raiding than percieved
- Expecatoons: easier access to food inc Kaweli should mean less forageing time
- Results:
- KAWELI: more social (grooming, playing, fighting)
- Kakaneaure: more time foraging, moving

Dung beetles in Indonesia

- Bio indicator species
- Results:
    - 8 distincts warieties collected
        - Characterized by size, colour, lef shape and head shape
    - MORPHOSPECIES:
        - HORNED male, horned femal, yellow antanea
    - More distritbution
    - Yeloow anteane and small
    - Less disturbance
        - Large and hored

Charlene Williams

- Quantifuing Biomass in Cusuco
- Honduras: most heavilty foreserd courntryin allof central Am
- Clinometer: meaure angle or elevation of a particular area
    - Estimate tree height, volume
        - Djsta ce from observer to tree
        - Angle to the top and base of the tree
        - Measure od ange from the observer…..
    - Tree volume
        - Estimates tree height
        - Measure tree diameter from breat height (1.3 m from base)

22. Hebivory and Predation (Ch 14) + Mutualism (Ch 15)

October-31-12
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Chapter 14 continues

Posturing by emphermid fly

- picture is storm fly that eats may fly.
- May fly take postur that makes them look bigger and point tail towards enemy.
    - Prevent them from being eaten
    - Present themselves as scorpions
- their larvae form resembles the adult form

Mimicry

- mullerian: resemble an unpleasant org
    - Have aposematic colouration
    - All mullerian mimics are toxic/noxious
- batesian: similar unpleasant organism look the same way, and reinforce the fear
    - Harmless non-toxic species takes form of noixous species that lives in the same area
- cryptic: look like background
- aposematic : not really mimicry. Yellow black and red. These colour actions are used to tell other organisms that they are poisonous.

Seahorse mimicry

- resembles algea
- What type of mimicry
    - Cryptic: looks like background

Parasite Schistosoma

- schistosoma: females lies in the groove of the body of the male.
- Feed on blood in tissues.
- Two species in africa
    - No need to know which species leaves where, <u>just know they live in the tropics</u>.
- Have cilia on body surface hat allows them to swim.

Life cycle of schitosoma

- egg in water, expelled through infected human digestive system.
- Hatches, attacks snail penetrate skin, larvae divide and multiply.
    - Larvea can survive only in snail
- Break out of snail and come out as cerciria.
- Person drinks water and they enter blood vessel and feed on blood. I mm
- Effects on humans= swelling of abdomen.
- Ecology aid.
- get rid of snails/host.
- Introduce American crayfish, aka predator of snail.
- Where crayfish did survive they ate all of the snails.

Summary: exploitation comes in a variety of forms

<u>Chapter 15 mutualism</u>

- Birds and flower
    - Humming bird feed on flower: gain nutrients
    - Pollen gets transferred from tree to tree by bird: higher reproductive success
    - Non symbiotic relationship: bird doesn't spend most of its life w/ flower
        - Facultative mutualism: bird can live w/o plant
- Grazers are ruminants, symbiotic micro ogranisms helps to process cellulose into digestible material.

- Fungus and root symbiotic relationship
    - roots of plants inimatelly connected w/ fungi in associations called **Mycorrhizae**
        - Fungus allows plant to forage for nutrients (goes deeper into soil)
            - Fungi can draw large amounts of sugar from plant
                - Both benefit
                - Obligate mutualism: both species depend on this mutualism for survival

Are there species that do not engages in mutualism or, how common mutualism us?

- Humans

Plant performance and mycorrhizal fungi

- ectomytoryzhae live outside the plant tissue, endo lives on the inside
    - Forms mantle around roots and a netlike strucure around root cells
- Arbuscular mycorrhizal fungi
    - Fungal struture for exchange of mineralsw/root of the hostplant
    - Mycorrhizal fungi produces arbuscules (site of exchange btwn plant and fungus)
        - Also produce hypae: fungal filaments
        - Vesicles: fungal storage organs w/ rootcortex cells

- plants with mychorrizrs have larger water potential esp at midday.
- The plants without it have to shut down during midday.
- Fungi helps plant to obtain nutrients easier
    - Nutrients= P andN, copper, zinc and water
        - Not all are normally easily accessible by plant alone

Which other organsosms do this

Nitrogen fixing bacteria, live with plants and obtain nutrients

Plant-animal mutualism

- ant and acacia
- acacia
    - only one colony of ants can live in the same tree
    - Has Foliar nectaris on stem
        - = source of sugar and liquid for plant
    - Has swollen thorn w/ soft and easily excavated pith
        - Provides living space for ants
    - Year roundleaf production--> benefiitial for ants
        - Leaflet tips modified into concentrated food sources= beltian bodies -->sources of oils and proteins
- Ants are predators that attack other herbivores that try to eat plant
    - Fast and agile runners
    - Good vision

23. Mutualism (Ch 15)

November-01-12
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Audio Recording ...
Audio recording started: 5:31 PM November-01-12

Ants life cycle
- Colony starts with one fertilized "ant queen"
  - Newly mated
  - Role: find unoccupied seedlings or shoots of bullshorn acacia
- Produces offsprings that are taken care off by "sister ants"
- Lays egg in acacia
  - Form colony
    - After colony is formed queen ant shifts to reproductive funciton as abdomen enlarges and sheb/cm sedentary
  - Feed on beltian bodies-->growth

How does acacia plant benefit from ant colonies
- Difficult to observe immediately
- Experimentation is required to determine this
- Ants are predators, attack other organisms that may attack plant
  - Hypothesis; see exp
- Exp
  - No ants, 40% of acacia shoots have other insect that can attack them
  - w/ Ants; only 5%
    - This benefits the acacia plants
- Exclusive to tropics?
  - This example cane be in temperate env too
  - Acacias are normally found in drier tropical and subtropical env
- There are some ants that protect insects that do not do a lot of damage on plant.
    - In exchange, they provide food to ant
    - Example?
      - Aphids and ants.
        - Aphids tap into sugar flow in bark
          - Ants tickle their abdomen to obtain the sugar
          - Ants can normally eat aphids, but won't due to the benefits they are obtaining
        - Ants cannot normally obtain sugar from bark themselves (no piercing aparatus)
- Picture: ants carrying belcian body into acacia bullshorn thorn
- Obligate mutualism: both cannot survive w/o the other

Benefits for plants
- Acacia shoots also survived better w/ ants
- Shoot w/ ants grew faster than those w/o ant
- Survival of young acacia is increase when they are protected by the ants
- Growth rate
  - With ants, growth rate of acacia is increased
  - Why?
    - Maybe affected by increased grazing insects that are present in absence of ants

Acasia/ ant mutualism
- Ants attack non-acacia plants around near acacia environment
- Acacia s that are attacked by grazers(i.e. giraffes) can produce chemicals (pheromones? Don't need to worry about the type of chemical being used) that can warn nearby acacias of attack
  - Result: they produce defensive chemicals

Mutualism can be flexible
- Temperate system=>alpine aspen sunflowers
- Have extra floral nectaries ---> provide sugar for ant
  - Do not provide living spaces
- Camas quamash another plant that has multiple pollinators
  - Increase its reproductive success

What benefit does ant provide for Aspen sunflower?
- Grey sunflower seed weevil and banded sunflower moth eat sunflower seeds
  - Attack aspen sunflower
  - Damage over 90% of seed produce
- Solution=high density of ants which deter predators
- This mutualism is facultative
  - Why? Environment fluctuation: decouples/ disrupts ant and sunflower relationship
    - Cold temp, kills exrrafloral nectaroes (can't survive frost.)
    - Thus If ants had to solely rely on them as food source, they will have periods w/o food
- Don't study mathematical models for mutualism

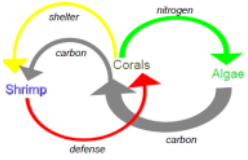
Mutualism and aquatic organisms
- Coral reefs have high species richness : 0.5 million
  - Among highest of any natural system
- Paradox: tropicalsea (where most coral reefs are found) is nutrient poor
- So how is it possible for the species richness in this env to be high?
  - Corals are the key
- Corals: animals; algea grows in them
- Very productive (coral reefs), even though water is poor in nutrients
- Blue weird looking creature(top left): sea slug (poisonous -->bright colours)
-

Overview of coral and algea relationship
- Close up of coral tissues with algea embedded in them
- Coral grow next to surface: keep coral near the sun
- Isolated algea are eaten by zooplankton
- Algea within tissues cannot be eaten by zooplankton b/c they'll get eaten by coral
- Algea obtain N from coral (animals are filled with N, protein degradation)
- Corals get energy from algea(zooxanthellae)
  - In the form of organic compounds
    - Coral induce them to relase organic compunds using "signal compounds"
    - Alters permeability of zooxanthellae cell membrane
- What benefit do the zooxanthellae get out of their relationship w/ corals?
  - Corals feed on zooplakton
  - Protein metabolism produced N-based waste
  - Excreted as ammonioum
    - Zooxanthellae immediately takes it up
- Evidence
  - Zooxanthelle= algea in coral tissue
    - Coral + zooxanthele: less N in aquarium
    - Coral alone: alone of N in aquarium

Other examples
- Acanthaster planci eat corals like there is no tomorrow
  - Pacillopora and Acropora are both examples of corals that it eats
- Pistol shrimp, fast moving claws, attack predators of coral
  - Crustaceans can protect corals
- When crustacean is present w/ both coral pop, its predation rate is reduced
- Why does shrimp gain?

- CORALS have a tightlyy branched growth form that offers shetler against shrimp redators
- Produced high energy mucus which shrimp and crab can feed on.

- Crabs can stimulate mucus flow from corals
  - Trapezia crab, can insert their leg into coral polyp
- Why is mucus good?
  - 30-40% lipid
  - Produced by zooxantheles



24. Mutualism (Ch 15)+ Species Abundance and diversity (Ch 16)

November-05-12
5:27 PM

Audio
Recording ...
Audio recording started: 5:30 PM November -05-12

Cleaning station
- Grouper fish: shrimp picks up dirt from tooth
- The blind creature(shrimp) digs a hole so when danger comes, the goby notices the predator first and shrimpe sense the gobby and hides
  - Shrimp has antennas tha is attached to gobby

- Lichen: algae and fungus (grow on rocks)
  - Fungus is heterotropic like us by also has a vareity of chemicals that can break down rock

Mutualism and pollination
- Flowering plants rely on organisms for pollination
  - No pollination= lose most vegetabtion and beans

Chapter 16: Species Abdundance and diversity
- Diversity is higher ni complex env and those with modest levels of distubance (natural level)
- Regularity and order to commonness and rarity of species?

Longnormal distrubution
- Few species are very rare and few are very common
- Number withintermediate abundance is the greatest
- Double sample sieze, more will be found towarsd the left
  - More sample size-->complete lognormal distribution

Community metrics
- Richness- the number of species - S
- Evveness- the degree of equality among abiundanceds, E
- A and B: same number as species, different evenness
  - How to represent this
    - Rank abundance curves

Rank Abundance curves
- Community B is much more even than A
  - Either Com A has env that is more suibtable for the one abudnace species
  - Or there is something hindering the growth of the others

- **Rank abdundace ex.**
  - Mountain stream has more species than the coastal ponds
  - Most abundanct species is only between one tenth of the scale (for red)
  - The coastal pond: most abindant species is almost 80% of total population
    - Costal pond is dominated by one species and moutain is more dispersed

- **Spatial complexity**
  - Larger 3-d structure= larger habitat-->more species
  - As habitat increased in volume there was more species
    - In pic: each colour is a different species
  - As foliage volume increased more species were found in env
  - Plan community w/ low foliage height diversity--->support low bird diversity
  - Greter foliage diversity---->inc bird species diversity

- **Follow up**
  - Compared foliage height at differrn stages of development
    - Diversity was increasing rapidly with height on tree
  - Therefore they found that the more spatially complex the env is, the more species are found

- **Niches and herogeneity**
  - Si/P ration in fresh water algae
  - Both asteriolnelle and cylotella require silica
    - C is more dependent by silicate, A is more dependent on P
    - A: uptakes phosphate at a much higher rate
    - High Si/P ratios, A can uptake more P and elimiate C
    - When Si/P ratios are low, SI limits growth rate of A and thus it cannot deplete phosphate
      - Optimal env c= high silica
      - Optimal env for a= high P
    - At low ratios silica limits growth rateof A, whilePlimits growth reate ogC
    - In th emiddle, there is no dominating species b/c none can thrive fullu

Nutrient complexity
- Subtantial variation in nutrient varibility in lake
  - Thus algeal species can co exist in this env
- Paradoxal algae study
  - Middle of ocean-->greatest algal diversity. Why?
    - Less nutrients available here
      - Thus one species cannot competitively exclude others

Terrestial heterogeneity
- Nitrate and soil humidity very at small scale
- Diffferentiate plant performance
  - Result: allows coexistence of several species
- Over short distances, changes insoil type and depth to groud water produces differences overtime
  - Bana and campina(short vegetation): sandy soil
    - Not enough organic layer (less accesible to nutrients and not enough access to water)
  - Castinga and flood plain
    - Close torun of water-->a bit taler
  - Near clay soil/ a bit farther from ground water---> taller plant

25. Species Abundance and diversity (Ch 16)

November-07-12
5:25 PM

Chapter 16

Audio recording started: 5:44 PM November-07-12

Soil fertility affects plants S
- Lowest fertility is associated with higher number of plant species
- Possible hyp:
  - Two species
  - Remove growth limitation---> (high carrying capacity)
  - Both will have different grwth rate
  - Allow them to grow in this env , the one that grows faster overwhelms the other
  - If you increase the amount of nutrient, the one that grows the fastest overwhelms the other species and as a result eliminates the abundance of others (explains high nutrient -->low species)
  - Remove major item over which the plant competes, the one that grows faster will shift competition to other dimension such as light or water.

Effect of fertilization
- Britain at peak of imperial power: Goal->improve agriculture (wanted to measure productivity of land)
  - Set up research station to increase agricultural yield
    - Collected sample of soils for many year
- Result
  - Each dot= 1species of herbes or grass in meadow
  - Time=arrow; greenest=greatest diversity; yellow=lower diversity
    - Increase fertilizer, species diversity in meadow declined
      - Lead to change in abundance distribution
        - Most abundant species in unfert area: around 10%
          - Add fertilizer: almost 100% (whole meadow b/cm homogenous for one species)
            - THUS, fertilization has negative impact on diversity

- *Does this affect the paramecium?*

Productivity richness hypothesis
- Common graph obtain when there is some measure of productivity
- Peak= greatest diversity is at some level of productivity due to fertilization
- Initial portion of curve:
  - 0 nutrient=few species
  - Increase nutrient: diverisy increases until it reaches a point where one species starts to dominant and overwhelmes the other
  - Experiment (British one) only looked from peak to decline

Along what other gradient might you expect richness?
Disturbance
- Intermediate disturbance hypothesis
  - Intermediate level of interference with living ocnition produces greatest diversity
  - Frequency of disturbance: length of interval btwn disturbances
  - Why does diversity decline as you imporve env?
    - Low levels of disturbance
      - Allow competition to take over and one/few species will dominate

Hypothetical: homogenous habitat with one speciec, burn it and allow other species to move to burnt area
- First H' 1 species, no disturbance
- H' 2 and H'3: burn another quarter, add species
- H5' burn all
  - Observe intermediate disturbance hypothesis

Example: Rocky shore boulders
- Rocky shore boulder have different levels of disturbance
- Data shows intermediate disturbance hypothesis works
- Intermediate disturbance--->high species
  - Doesn't mean all species are in their highest growth capacity under this conditions
  - It just means that there is not one species that inhibits the growth others

Prairie dogs example
- Disturbance of praiprie dog and plant species show intermediate dist hyp
- When they eat plant, they create fertilizers to help plant grow, leading to increase in diversiy
- Too much disturbance, species divesity reduces

Pollen Record: Panama
- Plants have unique pollen
  - Can identify plant by pollen that falls into lake sediment
    - Pollen found in lake in abundance is usually in proximity ot lake
- Sediment core=red, yelow, blue rectangle
  - + signs=human distrubance
    - Zea: maize (corn)
    - Cecropia: increase: colonize area that are typically distubed by fire (Can grow any where; pioneer plant: occupies newuly formed soil)
    - Soothe (particulate carbon) icnreases over the years
    - Fillicales (ferns): growth coincides with abandonment of corn farms as human moved out of env. Initial high abudnace:- no disturbance by humans
      - When human cut trees, these plants cannot grow (explains their reduction in abundance

Summary
- Few common species, many rare species
- Diversity is higher environments that are:
  - Complex (bird complexity relationship: 3D complexity)
  - Nutrient poor env: (middle of ocean)
  - Moderately disturbed:
- species

26. Food Webs(Ch 17) X

November-08-12
1:21 PM

- Food web= summary of the feeding interactions in a community of species
    - Few keystone species may control the structure of a community
    - Exotic predatior may simplify food web?

Feed relations

- Ex. Antartic foodweb
    - Diatoms (green algea: use silica) on bottom
        - Food for krill
    - Krill: foundation o foodweeb
        - Most animals feed on them
    - Bluewhale: one of the large animals that feed on krill
    - Small animals are fed on by the larger fish/animals (Seal)
- Ex. Artix
    - Food web of Bear Island, Artic
        - Combination of terestial and aquatic animals
            - On land: grasses, insects and birds
            - Semi aquatic animals= seal
                - Its Main predator= polar bear
            - Commonalities (between artic and antartic poles)
            - Body size increases as you go from herbivores to predators
                - Density increases as the body size decreases
            - In the diagram arrow shos movement of the energy level
            - All links are the same?
                - The species are diff, so need different amounts of food
- Ex. Tropical stream
    - Cano volcan in costa rica and its food web:
        - If you look@ the
            - 10 mot common fish species andtheir food items--> simplier to analyse
                - Only 10 strong interactions are linked
                - Weak links removed
- What may inflence food web properties in space and time?
    - Two food web comparisons?
        - Subttropical: some snails are higher in the web)wider)
            - Diverse
            - Higher proportion of predatory species
            - More complex--->greater diversity
                - More testing required to confirm this
        - Temperate: only one intermediate species (middle level predator)
            - Low proportion of predatory species
                - Only two
                - Top predator= pisaster
            - Limited diversity

Keystone species experiment

- Removing a starfish acting as a top predator in intertidal food web reduced the # of species both in Mukkaw Bay, Washington and New Zealand
    - About half of species lost
- Starfish removal causes a diversity decline in 2 areas of the world

Do top predators determine the rest of the community?

- Food webs are easy to distrupt
    - Distruption= loss of species

- Yes, because everything in the food web is connected
    - Predators define # of species that are presyed upon by them

Stream web and fish keystone species

- Steelhead- top predator
    - Feed on predatory insects, roach fly and stickle back
    - Adults can get verylarge
- Experiment: deos Steel head control structure of its ecosytem foodweb?
    a) Protect algal communities on stomes (Where insects live) by using cages (3mm mesh) or
    b) Or add fish(steelhead) in other cages
- Impact of steelhead?
    - Depending on whether steelhead was added or excluded amount of algea changes
    - Enclosure:indcluded predatory fish
        - Result= lower algae density
        - Why?
            - Predatory fish eats roach fry and stickle back fry
                - Significance: bothfry insect normally eat chironomids (aka, algea predator)
            - Now that fry is absent, there is an increase in chironmids and thus they can now consume a lot of algea
    - Excluding predatory fish increased the algal density
        - Why?
            - Roach fry and stickle back fry population increased inabsence of the predatory fish
            - Fry consumed chironomids
                - Thus algea population icnreased

27. Food Webs (Ch 17) + Primary production & Energy flow (Ch 19)

November-12-12
5:25 PM

Audio Rec…

Audio recording started: 5:33 PM November-12-12

Keystone vs. dominant species

- Above diagonal line; smaller biomass and greater impact
- Below line: higher biomass and lower impact
- Keustone species: have great influence on community regardless of the abundance
  - Have regulatory roles
- Dominant species:
  - Constitutes foundation of the community
  - Significant b/c of their high biomass

Lake Victoria: invaders

- Orginial fish species in lake were thought to be "boring"
- New species: Nile perch was introduced (see pic; big as man).
  - Result:
    - Ate all small species of fish
    - New dominant species: Nile perch, Nile tilapia, and omena
    - Colourfish on slide= original species
    - Introduced when they were small and grew to very huge size

Are humans important keystone species?

- They hunt herbioveres
  - Herbivores ex. Deer
    - Eat herbs and small plants (reproducing treess)
      - Too many deer: no plant regeneration; all produced seed will be eaten by deer
- Role of humans, by regulating size of herbivores, plant regeneration can occur
  - "appearance of health" due to increase in plant adundance w/o deer, forest appears healthy
    - But in reality the ecosystem has been distrupted

Chapter 19 (Primary production and energy flow)

- Primary productin
- Tropic level 1: organisms that obtain sun energy
  - 2: animals that consume plants

Productivity vs. water and temperature

- Index that allows you to measure water and temp: AET
- Creosote bush desert: N.A.
- When more water passes through the plant, the more productivity you get

Nutrients also affect productivity

- No it doesn't mean tundra has been underestimated b./c if you added nutrient to all of them, the relative off would still be

Are evapotranspiration andn utrients also the amina controls in the aquatic system?
No evapotranspiration d/n occur in water

Aquatic systems: in most freshwater ecosytems one nutient limits primary production?

- Answer= Phosphrous(needed more than N, but is not as abundant)
- Addind more P===> More algea growth
  - Not good: b/c algea will ocnsume all O2 in the lakes

- Greatest diversity in the middle, at the lower range. Red circle

Primary production & Energy flow (Ch 18) X

November-14-12
9:58 PM

Causes ofhigh algal biomass + 13 moreslides Question slide

Chapter 19 – Primary production and energy flow

- Outline
  - Terrestrial PP is primarily limited by temperature and moisture
  - Aquatic PP is generally limited by nutrient availability
  - Consumers affect the PP rates
  - Energy losses limit the no. of tropic levels in ecosystems
- Primary production – definitions
  - PP – energy fixed (biomass produced) by autotrophs (plants, algae, chemosynthetic microbes)
  - Rate of PP – amount of energy (biomass) fixed over a time interval
    - Usually given for a particular area
    - Usually expressed in kcal or J/square/year
  - Gross PP – total amount of energy that is fixed
  - NPP – the amount of energy left after autotrophs have met their energetic needs
  - Trophic level – a position in the food web determined by the number o energy transfers from the primary producers.
- What are the main controls of PP?
- Productivity vs. water and temperature
  - Actual evapotranspiration, AET, and net aboveground PP – various ecosystems
  - Terrestrial PP increases with actual evapotranspiration
    - Most is it in tropical forest
    - Least in creosote bush desert → it's in North America
  - AET increases with precipitation and temperature
    - Low AET= low preceipitation, cold weather or both
      - Ex. Tundra and desert
    - Intermediate level: temperate forest, temperate grasslands, woodlands and high elevation forest
  - Plants need more than just C02 and sunlight, they need other nutrients too
  - Recall the link between the climate and biomes
    - Specific effect on biomes will depend on other things too.

- Nutrients also affect productivity
  - Experimental addition of several nutrients (tundra)
    - Adding fertilizers nearly double primary production in these tundra study plots
  - Does this mean that the tundra has been underestimated?
    - No! All biomes are limited by nutrients in a similar fashion but evapotranspiration exerts dominant control
  - Also the range for all ecosystems: 50-3200

Are evapotranspiration and nutrients also the main controls in the aquatic systems?

- Aquatic systems
  - In most freshwater ecosystems, one nutrient limit primary production
    - Phosphorus → needed in greater concentrations than nitrogen
    - Higher phosphorus concentrations are associated with greater algal biomass
  - If you recall Si:P ratio and competition among diatoms, you could predict where the greatest diversity is going be…
    - In the middle: where both Si and P are limiting

        - Remember low P allows A to grow and low Si allow C to grow
    - Aquatic systems: in most freshwater ecosystems one nutrient limits primary production?
    - Answer= Phosphorus(needed more than N, but is not as abundant)
    - Adding more P===> More algae growth
        - Not good: b/c algea will consume all O2 in the lakes
        - Greatest diversity in the middle, at the lower range. Red circle

- **Causes of high algal biomass**
    - Why are algae are abundant at high P?
        - Productivity would be greater
        - Phosphorous is needed for conversion of light energy to ATP during photosynthesis
    - Algal biomass and rate of PP are linked → in temperate links
        - As algal biomass increases so does the rate of PP
    - Possible alternative:
        - Longevity of cells combined with the absence of grazing (cell accumulation)

- **Experimental evidence**
    - A whole lake experiment demonstrates the effect of nutrient additions on phytoplankton biomass
    - There are spikes in fertilized lake in 1975
        - High level was maintained for 4 years and then it dropped down
    - Before fertilizing, the two lakes supported similar phytoplankton biomass.
    - After fertilization, phytoplankton biomass increased in the experimental lake.
    - When fertilization stopped, phytoplankton biomass decreased in the experimental lake.

- Therefore, where should one expect greatest productivity in the oceans?
    - Near the coast line, the land fertilizes the ocean;shallow seas
    - West coast of S. America; peru, chile. Because the pacfic ocean deep water is well in contact with deep water contact.
    - Lowest= mid ocean
- Geographic variation in marine PP
    - Where should productivity be highest
        - Highest rates of production are on continental shelf and in shallow seas

- If you recall the effects of steelhead on algae in a stream, do you think they represent a rule or an exception?
- **The trophic cascade hypothesis**
    - Proposes that feeding by piscivores and planktivores affects rates of primary production in lakes
    - Picsocivoes eat planktivorous fish, which normally eat large herbirovers
        - Large herbivores eat phytoplankton
- Specific predictions: the operational hypothesis
    - The trophic cascade model predicts that manipulating piscivore biomass (numbers) will lead to changes in biomass and production of planktivores, herbivores and phytoplankton
    - If you increase piscivore biomass, planktivore biomass will decline in number
        - However production has an arch shape, how does this happen?
    - With herbivores, they increase in numbers with the increase of piscivore biomass
        - Less predation b/c piscivore eats their predator (planktivores)
        - But production still follows the same curve
            - When there are few of them, they gain a lot
            - But when they are a lot of them, they stop producing

    - This phytoplankton biomass decreases w/ increasing pictovores
        - Production follows the curve again.

- Are terrestrial communities and ecosystem similar in their responses to change of the top predator?
- **Predators can restoreforests**
    - Canadian wolves were re-introduces (~1995) to Yellowstone. The diagram below summarizes their impacts:
        - Wolf lowers elk → which improves willows and aspens → which restores beaver
        - Makes it greener!

- Is consumption of plants always bad for plants?
- **Effects of grazing on plant biomas**s
    - Experiment: wildebeests are excluded from some areas. Compensatory growth occurs where the graze
    - Biomass increases on grazed areas but decreases on ungrazed areas
- Grazing and PP: Serengeti
    - If grasses are not too old and grazing starts early in development there is compensatory growth.
    - This compensatory growth is highest at intermediate level of grazing
        - Compensatory growth was likely caused by;
            - Redueced self-shading
            - Improved water balance due to reduced leaf area
            - Reduced respiration
    - Relative grazing intensity vs primary production
        - Low intensity grazing is associated with low production
        - Areas grazed at mediu intensity have the highest PP
        - High intensity grazing is also associated with low production
        - ANalgous to intermediate disturbance hypothesis
    - Light grazing insufficient to stimulate
    - Heavy grazing stresses plants
    - Granzing has great impact on overall PP
    - Why??
        - Improved water balance, lower respiration, self shading, saliva.

- **Annual Production by trophic level in 2 lakes**
    - Usually, 85-95% of energy is used at a given trophic level for respiration (or just decays)
    - This means that approx 10% is available to the next level
    - So if grass is 100% of energy, the grazers can only have 10% of that energy, predators that feed on the grazers can only take 10% of 10% so only 1%
    - Energy losses at each trophic level, and at each transfer of each transfer of energy between trophic levels, produce a pyramid-shaped distribution of production.
    - Cedar Bog Lake vs. Lake Mendota
        - Lake Mendota has a 4^{th} trophic level

Primary production & Energy flow (Ch 18)+ Nutrient cycling and retention (Ch 19)

November-15-12
5:29 PM

Chapter 18

Audio recording started: 5:30 PM November-15-12

Annual production by trophic level in two lakes
- Primary producer>2ndry> tertiary (rate of productivity)
  - As you move up the trophic level, energy is lost
- As you increase trophic levels, population increases
  - Organisms at higher tropic levels tend to be larger(big teeth, body mass)
- In acquatic ecosystems energy loss is mainly limited by nutrient availability

How about terrestrial systems- do they follow similar patterns?
- Yes and no
  - Not as regular (energy is lot everywhere)
- Take input of energy into T ecosystem as 100%, majority of solar energy is lost as heat and evapotranspiration (41 and 42 %)
  - 1.2% lost to plant resiration
  - 15% reflected
- Net primary production= 1%
  - Total plant production-plant respiration= 2.2 %- 1.2% = 1.0%
- Above ground mass=12%
- Organic matter to a depthof 36 cm= 18%
- Living stream biomasss=0.003%
- Less energy is avaible to be used by organisms at higher tropic levels (conusmers)
  - Only 0.7% is left to them. But they lose most of it as well
- Kolasa random fact: Energy contained in all caterpillars in forest is several time greater than all the energy contained in the vertebrates
  - 160 kcal/m^2 vs. 1 kcal/m^2
  - Explains why vertebrates eats caterpillars

What do we do if there is a horizontal transfer of carbon between ecosystems?
- Use Stable isotopes track flow of energy
- Comparing system A abd B with different compositions
  - Add stable isotope to A and see if it will be detected in B
- Example: There are multiple isotopes of C in co2, some plants are selective to the CO2 isotope they select (i.e., 13,14 or 12)
- Bar below zero line: plant reject c13
- Bar above: they prefer S 34

Stable isotopes say: diet changes among sites
- 12354: furthest away from lake
- Arrow points towards increasing phytoplankton

Summary
- Ocean productivity is limited by N (not abundant here) and iron (b/c it precipitates, and isn't soluble)
  - Spread iron dust on ocean---> increase productivity

Chapter 19 (Nutrient cycling and retention)
- Understanding how nutrients are used, transformed and reused

Why do we need P?
- Important since it is found in ATP, RNA and DNA
- P is recovered through weathering of rock (usually buried in rocks)
- Small scale: cycle is through food chain and sediments
- Global scale:
  - Fresh water= largest P storage site (then ocean)
  - Next is plant, then animals
  - P from water, plant and animals are stored in sediments
    - Additionally P from plant and animals can be returned back to water to continue cycle

Why do we need N?
- Found in amino acids, RNA, DNA, chlorphyl and hemoglobin

- N2 cannot be obtained directly from the air even though it is the most abundant gas in the atmosphere
- Animals obtain N from plants

Nutrient x

November-22-12
9:59 PM

Chapter 20 (Nutrient cycling and retention)

- Understanding how nutrients are used, transformed and reused
- Why do we need P?
    - Important since it is found in ATP, RNA and DNA
    - P is recovered through weathering of rock (usually buried in rocks)
- What is nitrogen needed for?
- Which organisms can obtain nitrogen directly from air?
    - Nitrogen is in lower concentration in plants.
    - Proteins have nitrogens
    - Plants that have a lot of proteins: beans, grains (eat the wholegrain)
    - So how do plants get nitrogen?
        - They certainly don't get it from air
        - They get it from the soil via their root systems
            - Roots bring whatever is dissolved in water in the form of some ions.
- Nitrogen: main pathways and storage
    - Needed for AA, RNA, DNA, chlorophyll, haemoglobin
    - Details in fig 20.3
    - Main storage?
        - 70% of atmosphere
    - Air à soluble compounds: nitrate, ammonia à plants à animals à sediments (including organics)
        - In salt form, it can be absorbed by plants à then used in building of organic molecules and ultimately when there is death of organism, some of it returns in soluble or almost soluble form back to the form which can be processed further.
        - From the sediments, in a process called dinitrificaiton, it can go back into the atmosphere.
        - N fixers (bacteria free and symbiotic, blue-green algae), lightning, synthetic fertilizers
            - Are the ones who can actually use the N in the air
        - Nitrate and ammonia are picked up by the plants which are produced by N-fixers.
    - Mean biotic life of nitrogen is 600 years
        - So if a molecule of N is being captured by living creatures, it likes to stay there.
    - Additional chemical details:
        - Nitrogen cycle (not in textbook)
            - Nitrogen fixation bacteria à ammonia à assimilation + CO_2 à protein
            - Animals when they consumer protein and reduce it back to ammonia, it is recycled in the cycle.
- Bloom due to nitrogen (Oct 2000)
    - Remote sensing of green pigments permits tracking of algal blooms in the ocean.
    - Such blooms result from land originated nutrient, mostly N.
        - Chlorophyll-a
- Question: which element is most abundantly used? CARBON.
    - How do we lose carbon? à via CO_2
- Carbon cycle: main points
    - Building material of life: lost via respiration
    - Cycles fast in organic molecules and carbon dioxide
    - There's a slow and fast component
        - Slow component = in the rocks, lots of carbons locked here
    - Exists in many forms: in water à carbonate; exchanges with plants and atmosphere.
    - Fig 20.4
    - Marine creatures that capture calcium carbonate out of solution, make skeletons, deposit
    - In rocks: calcium carbonate – very slow recycling via volcanic activity, uplifting and erosion
    - Humans add a lot: from fossil fuels; processing of plants and animals; accelerated rock weathering

    - Most violent cyclones a few years ago: more energy accumulated in the oceans.
        - Eventhough we don't see the huge rise because of ocean's huge heat capacity, remember that one or two degrees is quite a lot
- Decomposition
    - Re-use of P, N, C by a new batch of creatures requires Decomposition (or respiration)
    - Decomposition depends on water availability
    - Litter bags
    - Dry forest
        - Biomass remaining
        - At begininning of experiment, everything was there, reference of 1—
        - But after 24 months, goes down to about 40%
    - Wet forest
        - Much more irregular pattern à because it depends on the amount of water
        - 90% + of material lost by 24 months
- Question:
    - Moisture à diversity à Air à Aliveness
    - In addition to water, what other factors may routinely affect deposition?
- Regional differences
    - In the trophics anuual leaf mass loss (of dead leaves) is 3 x that f temperate forest
    - Annual leaf mass loss in tropical forests is about 3 times that occurring in temperatre forests.
    - This allows for fast nutrient recycling and high production
    - In tropical forests, when there is sufficient humidity, there is almost no carbon in the soil,
    - Which factor may be responsible for the difference?
        - Moistureand temp
        - Higher Actual evapotranspiration

- Streams are supplied by leaves
    - Do leaves have different lives?
        - We eat lettuce but would we eat oak leaves?
    - Daily mass loss (y axis) vs. lignin content (x axis)
        - Leaves with higher lignin content decomposed at much slower rate.
        - We should eat ash (lower lignin content)
            - Decomposed at a faster rate
    - Thus streams with different riparian vegetation will deal with different problems at different speeds
    - Changing forest composition may lead to destruction of orginal stream communities and ecosystem properties (because different aquatic species specialize in different leaves)
- Nutrient Spiraling
    - Same as cycling but except if you try to cycle along a stream, you never cycle in the same location so you create a cycle.
    - See diagram in textbook
    - Amount of time phosphorus stays in a lake is about 1 min
        - Picked up very fast because there are thousands of algal cells in microareas
        - In streams, algae are usually rare because the streams are shaded
    - In streams, each particle as it cycles, it also moves downstream, hence it spirals
    - Retenion in living tissue and current velocity determine how long a nutrient particle stays in the stream
- Pocket gophers move great amounts of soil
    - Activities of animals (e.g. pocket gophers) may create great heaterogeneity in distribution of N, light, temp and humidity
    - Some plats say bingo! To gopher latrines
- Gopher: chain of effects
    - Deposition of nitrogen leads to better growth og frasses
    - Grasses near gopher mounds have also more nitrogen in their tissues
    - Graph: Uncolonized prarie, praire dog colony vs. grass nitrogen content (%)
        - Grasses growing on parie dog colonies have higher average nitrogen content
    - Grases near gopher mounds invite intensive grazing by bison

        - Bison grazing stimulates growth of young grass
- Effects of animal grazing on nutrient cycling
    - Large grazers speed up nutrient cycling on the Serengeti ecosystem
    - Biomass turnover refers to replacement time for the current vegetation
    - Proportion gazed vs. turnover time
        - In ungrazed plots, several years are required to turn over plant biomass
        - When a substantial proportion of annual production is consumed plant biomass turns over in less than 1 year.
    - Turnover time decreases with intensity of grazing:
        - Production is both accelerated and consumed (transferred to animals)
- In fynbos: plants play a role of their own
    - Plants that are fertilizers
    - Acacia (Acacia saligna) is an introduced species
        - Nitrogen content under acacia is much higher à acacia littler contains approximately 10 times more N than litter of Leucospermum
    - Why?
        - Consequences: change in nutrient availability will change the competitiveness of plants à change in composition
- How do humans affect systems?
- Hubbard Brook Experiment watershed
    - Change in vegetation cover (clear cutting) led to different concentration of N in stream water...meaning?
        - Clear cutting the experimental basin increased losses of nitrates more than 10 times.
        - Peaks which coincide with seasons à when leaves decompose, you see spike in N.
        - Delay between time the forest was cut and the time when nutrients came into the stream.
- Weather interacts with stream nutrients:
    - As annual stream flow increases, so does the ratio of export ot import
        - If exports < inputs = value is less than 1
        - Exports = inputs: value is 1
        - Exports > inputs = value is more than 1
    - During years of low flow, Bear brock stores phosphorus so exports < inputs
    - If there is more flow then phosphorus is exported and transported to mirror lakes. Receives less than it exports.
- Human impacts are like rain J
    - No matter what measures are taken, when there are more people and more technology, nitrate exports increase.
    - As human population density increases, nitrate exports from river basins increase too.
    - This nitrogen always ends up in the coastal waters and fertilizes the oceans
- Humans – the same story again
    - Human density and landscape use intensity are correlated with phosphorus exports
        - Phosphorus export increases as land use intensives
        - So phosphorus export is highest in urban areas.
    - Excessive P in freshwater is harmful
- Summary
    - Important nutrients and elements ‘cycle’, with storages in rocks, air, oceans or biota.
    - Decomposition rates depend on temp, water, organisms and other conditions.
    - Plants and animals can modify and change nutrient movement through environment.
    - Disturbance increase nutrient loss from ecosystems while natural vegetation retains them.
    - Human activities produce major and undesirable changes in nutrient behaviour.

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Chapter 18 – Succession

- Learning Objectives
  - Community changes include increases in species diversity and changes in species composition
  - Ecosystem changes include increases in biomass,, PP, respiration and nutrient retention.
  - Mechanisms of succession include facilitation, tolerance and inhibition.
  - Community...
- Definitions
  - Succession – gradual accumulation and change in plant and animal communities in an open area.
  - Primary – succession on newly exposed geological substrates.
  - Secondary – succession following disturbance that does not destroy all life.
  - Climax community – late successional community → remains stable until disrupted by disturbance.
- Glacier Bay primary succession
  - Reiners et al studied changes in plant diversity during succession
  - Total no. of plant species increased with plot age
  - Species richness increased rapidly in early years of succession and more slowly during later stages.
  - At a given location, you will only have a limited fraction of the pool of species so relationship is complicated.
  - Not all groups of plants increased in density throughout succession.
  - The number of plant species increased rapidly at first (200 years) and then began to level off.
  - Different plant forms reach greatest diversity at different stages of succession
    - Trees, tall shrubs and mosses, liverworts and lichens attained maximum diversity in about one century
    - Low shrub and herb diversity continued to increase through 1500 years of succession.
    - Tall shrubs are ultimately surpressed, they were peaking 40-100 years then declining
    - Mosses and liverworths increase and then fluctuating between 108-1500
    - Low shrubs and herb, major peak 1500 years
- Succession and nutrients
  - Hubbard Brook deforestation lead to nutrient loss
  - Plant biomass increases with succession
  - Vegetation starts to recover → biomass accumulates
  - Exports of calcium, potassium and nitrate decline to the pre-disturbance levels
  - Succession protects the soil from losing fertilizers
- Succession in temperate forests
  - Patterns of diversity similar to Glacier Bay for plants
  - Number of woody plant species begin to level off after about 100-160 years
    - Initially increasing.
  - Notice that this scale is 200 years rather than thousands of years.

- Number of bird species increased with the years and leveld off after 50-100 years of forest succession.
- Recall the connection between bird diversity and habitat complexity?

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Succession in stream

- Creak env
- Has frequent flash floods that can disrupt community --> succession
- Graph on left: comparing effect of flooding on algea and diatom species diversity
    - Low population for both few days after flood
    - After 20 days algal diversity level off and then slightly declined
- Graph on right: invertebrate vs dominant species
    - Dominant species= cranefly (cryp...something; red dot)
        - Its diversity wasn't affected by flood
    - When dominant species diversity decline invertebrate species diversity inc

Biomass accumulation mod

- When forest is disturbed, series of recovery phases occur
- See slide for graph
    - Begin w/ undisturbed system; biomass inc
    - When system is disturbed, reorganization phase occurs
        - Takes long(many years; around 20)
            - Losos of nutrient and biodiversity
    - Then aggradation phase
        - Biomass increases;
        - Longer durination that reorganization phase
        - Peak/ max biomass is reached
    - Transition pahse
        - Biomass declines from peak; but not too much
    - Strady state
        - Fluctuation of biomass (not huge drop or huge increase)

Flow chart figure of succession mechanism

- Space available to colonize--> initiates succession
- Early successional species and those who survive as adults are first to modify environment
- 3 things can occur after modificantion
    1) Facilitation: env b/come less favourable for early species -->death; new species can establish here
    2) Tolerance : env b/come less favourable for early species ;deosn't really affect later specied
    3) Inhition: no species can establish here
- Climax occurs
    - Can be destroyed by disturbance and space will b/come available for colonization again