24.11.15: Biodiversity

Diversity: small to large

- Genetic Diversity: genetic variation among individuals in a population (e.g. redheads, blondes, black hair)
- Species Diversity: number of species in an ecosystem (moose, wolf, bear)
- Habitat Diversity: number of habitats in an ecosystem (forest, plains, swamp)

Genetic Variation:

- Genetic variation occurs because reproduction is always a combination of factors: genetics, environment, even lifestyle (kinin potentiation: health impacts genetic variation)
- When a population suffers a massive reduction in population (e.g. whales being hunted) the total genetic variation in the remaining population is lower.
- This is called a **Population bottleneck**
- This makes them vulnerable to disease and threats that apply to that limited gene pool.
- A greater genetic variation, like ideas, makes for a richer population, able to survive and thrive in different challenging conditions.
- They are also able to diversify food sources, shelter and the ability to withstand environmental challenges.
- The opposite of this biodiversity has a perfect example: monocropping, where one threat can wipe out an entire group of crops (no diversity)
- Habitat diversity has two categories: specialists and generalists
- Specialists can only live in certain limited conditions, and tend to be located in niches
- Generalists can live in many conditions, and many invasive species tend to be generalists
- **Species richness** means many different species in an ecosystem
- **Species evenness** means no one species takes over

Example
Both of these have 4 species (richness) but community 1 (left side) has more evenness:

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Diversity, local to global:

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Link to Biodiversity lab:

http://10.14.4.85:6875/books/ap-environmental-science/page/biodiversity-lab

Recall our main themes: energy->water->food->culture

Food!

Three main groups:

- **Proteins**: always include Nitrogen
- **Carbohydrates**: CHO in chains (starches) or simple (sugars)
- **Fats**: CHO again, but in a special branch structure (glycol backbone) that is good for energy storage and insulation (e.g. killer whales, eskimos)

Proteins: complex molecules of CHO and N.

- Look up amino acids, note the common structure.
- Now look up the amino acid methionine.
- What element does it contain as well?
- Why do rotten eggs, swamps (and Kilauea volcano) stink?

CHO=carbohydrates (clever name),

- usually in a chain, short chains are sugars (used for fuel),
- longer ones are starches and can be used for structures (e.g. cellulose in plants) or pasta...
- smallest: sugars, all end in -ose (glucose, sucrose) LOOK THESE UP, CHECK OUT THEIR MOLECULE SHAPE
- glucose is a "monosaccharide" created by photosynthesis
- longer chains: starches (rice, pasta) slowly digested (see diabetics, and glycemic index)
- structural CHO: cellulose-little boxes with goo inside, need enzymes to break these down (cows)

- ENZYMES ALL END IN -ASE

Fats/lipids: same chemical structure as CHO, but built along a glycol (alcohol) backbone.

- If the fats have long carbon chains with only single bonds, they are saturated (lots of Hydrogen atoms) and can hold together (e.g. animal fat)
  https://en.wikipedia.org/wiki/Saturated_fat
- If the long chains have double bonds and don't fit together, they melt easier (e.g. oils) and are called "unsaturated", usually better for your health.
- n.b. McDonalds® got into real hot water a while ago for frying all of their stuff in "supersaturated fats". Ugh...

Notes: Frog book

- Frog 12.3 Agriculture
- Frog 12.4 Food Production

Big picture:

- Trophic pyramids in nature are sustainable
- Planet is nearing carrying capacity (K)
- Think of how many "earths" your global footprint represents
- To meet this food demand, current farming and fishing is industrial, not sustainable

Nutritional needs-what humans on our planet need, and what they lack

- **Undernutrition**: lack of calories
- **Malnutrition**: lack of critical part of diet, usually protein (Kwashiorkor)
  https://en.wikipedia.org/wiki/Kwashiorkor
- **Food security:** not just in lesser developed countries ("LDC"), also in the US"Food deserts"-what are these?
- **Famine**: one of these impacting a large group, often from crop failure, drought or war/displacement

- **Overnutrition**: common in the US, look up the US obesity rate-how is this determined? Why? Seen any food ads lately?

Look up US obesity rate-----
Meat diet: high in protein, also in fat (energy store) and cholesterol-these contribute to heart disease

- Wait-Eskimos eat lots of blubber, why don't they have heart disease?
- How is this different from Kalahari bush tribes?Climate
- Wait, wait-what happened to Japanese health care system when they moved from their traditional diet?
- What impact does this have globally?
- Diet for a small planet 1971: planet can sustain population using fewer calories while supplying protein, vitamins and calories. Not by relying on meat.Vitamins="vital amines"

Food energy subsidy (cost factor):
20 kg of grain to produce 1 kg of beef (20:1 factor, or subsidy factor 20x)
2.8 kg of grain to produce 1 kg of chicken (2.8:1 factor, or subsidy factor of 2.8)
Better to eat beef, chicken, fish or tofu? (you need protein in some form)



Industrial Farming (and fishing)
Agribusiness:

- Just what it sounds like, the larger conglomerates taking over instead of smaller privately owned family farms.
- Often use monoculture crops to increase profits (economy of scale), as well as patented seeds and herbicides (e.g. "roundup ready corn")

Hybrid crops vs. GMO crops:

Started as a good thing:

Hybrid crops"Selective breeding" works for animals (dogs, etc.) and crops called "hybrid crops" created by mixing pollen from one breed of plant (e.g. large kernel corn) with another breed of the same plant (e.g. short stalk corn) to form a "hybrid".
Green Revolution, Norman Borlaug-Mexican famine averted by development of hybrid (not GMO) wheat, called dwarf wheat (large kernel, short stalk).dwarf wheat
GMO crops:in the beginning were just to withstand frost, now into a larger patent issue with GMO seeds and "round up ready crops"What is the impact on lesser developed countries of this business model?

Genetically modified organisms (GMO) are different: they are done by splicing one part of a gene from an organism (like a frost resistant bacteria) into a totally different species (like a tomato) to make it frost resistant."IP" means intellectual property

- Monsanto spends money creating GMOs, so they patent the process, meaning using their seeds requires an IP license from them (just like software).If your farm has these seeds, intentionally or by accident, you have to pay them.
- You also cannot "re-use" seeds in the next season without paying for them.
- This is just like software in that you could buy the software or pay a monthly fee to use it.
- Which makes more money for the company?
- What is the impact on poorer countries?

Roundup ready corn: seeds genetically modified to resist roundup (a herbicide)

- Result: plant their seeds, spray their herbicide and save money on weeding, more crops, more money (to whom?)
- Issue: exposure to roundup (a carcinogen) and possible impacts of mutated food
- Labeling? Where is this done so far?
- Transgenic seeds?
- Can you patent life?
- GMO from Food inc.

Ethanol:
Any fruit or grain can be fermented with yeast to produce ethanol (C2H5OH)
Give examples...
Can also be used as a fuel: "gasahol" or E85 (85% ethanol, 15% gasoline)
Brazil: sugar cane->ethanol for cars
Iowa: corn->ethanol for cars

Difference:
Brazil: sugar cane just needs water and sunlight
Iowa: corn needs petrochemical fertilizers, pesticides and GMO seeds
Net energy: 2 units of energy in for 1 unit of transportation fuel
Why?
"domestic energy supply"
Iowa primary (this week): no politician will ever go against corn or the corn lobby
Not really "domestic" if we use crude oil from Saudi Arabia to grow corn in Iowa.
Fun fact: "E-Free" gasoline (needed for small engines and all marine engines) has more power, better mileage and more energy per liter.

It is heavily taxed to promote E10 fuel (10% ethanol) or E85 (85% ethanol)

Why marine engines?
Ethanol dissolves fuel lines (ouch!)

High Fructose Corn Syrup: HFCS

- Corn Lobby is very powerful (Iowa=presidential primaries)
- Corn: HFCS (food, meat, fish) and Corn Ethanol (energy, fuel)
- HFCS is in everything
- Corn is used to feed cattle, pork, poultry, even fish
- Cattle are not used to metabolizing corn, it makes them sick
- Bad for humans, increases incidence of diabetes
- HFCS from Food inc.

Main farming problems:

- Irrigation-desertification
- Pesticides-persistent organic pollutants (POPs)
- Fertilizers-eutrophication

Waterlogging: too much water in the soil, roots die (see hydroponics demo at elab, cycles water and air)
Salinization/desertification: using well water for irrigation, salts build up in the soil, infertile soil resultsSoil degradation:Dirt 00-8:00

Look up Wangari Maathai

Pesticides and herbicides:

- Can be persistent or not (DDT, round up)
- Invented during WWII to kill humans (nerve gases, nazis), ("homicides")
- Modified to kill pests ("pesticides") or insects ("insecticides")
- Special cases include rodent poisons ("rodenticides") and others, like plants ("herbicides")
- Pesticide resistance-much like COVID: genetic variation in a rapidly multiplying pathogen will eventually overcome the stress (recall evolution) by replicating only those with immunity to the stress (vaccine, pesticide, drug resistant TB)

Here's one pesticide that changed malaria around the world:

DDT:https://en.wikipedia.org/wiki/Dichlorodiphenyltrichloroethane



Inorganic fertilizers: also something from war (Haber process, WWI)

Chemically uniting Nitrogen from the air into fertilizers, dyes, or explosives
Fertilizers: lots of crops around 1910 in Germany
Dyes: enabled them to tap into the huge market for dyed textiles (UK), so lots of $
Explosives: enabled Germany to go to war with Europe
You might ask some of your German friends or your history teacher what "Lebensraum" really means...

Haber process enabled nitrogen from the air (N2) to be chemically grouped with other compounds to form fertilizers like Ammonium nitrate: NH4NO3

This process uses huge amounts of petrochemicals, so these fertilizers are attached to the cost of oil and natural gas (not coal)

Ammonium nitrate and fuel oil (diesel) can also be combined to make explosives, look up ANFO bombs and terrorism.

Fishing:

- **Aquaculture** means fish or other water animal farmed in the ocean
- **Hydroponics** means growing plants in a water/air medium
- **Fisheries**: population of fish, look up Atlantic Cod fisheries collapse in 1990
- **Bycatch**: unnecessary death of animals caught in fishing nets/traps (dolphins, sharks, etc.)

Mod 33: Sustainable agriculture (fishing too)

- **Desertification** (see above)
- **intercropping** vs. monocropping, see "the three sisters"
- **Contour cropping:** saves space, reduces runoff, preserves top soil (e.g. our garden, most of Asia)
- **No-till ag:** same idea, retains organic material in topsoil, reduces erosion by wind and water
- **IPM**: integrated pest management (see Lalamilo Farmers)
- **Organic agriculture** (also mentioned in Portlandia and Colin the Chicken)More than just N-P-K, also micronutrients, slower release time, low salinity
- **CAFO**: concentrated animal feed operation (e.g. chickens, pigs, cattle)Usually inorganic feed (purines), hormones and other drugs

http://www.bozemanscience.com/ap-es-020-fishing

http://www.bozemanscience.com/ap-es-019-mining

Fun stuff:

- **Methyl xanthines:** caffeine, theobromine, theophyllineevolved plant poisons for insects:



- **Xanthine**: group name
- **Caffeine**: energy drinks, coffee, soft drinks (to offset drowsiness from insulin spike)
- **Theobromine**: chocolate
- **Theophylline**: tea (also a bronchodilator-helps breathing)

Actually, almost anything that ends in -ine is usually a plant poison evolved to kill insects:

- nicot**ine**: tobacco
- caffe**ine**: coffee, tea
- coca**ine**: coca plants

See also Chapter 11 in the Frog Book (iPad)

Check out windy.com, zoom forward to Wednesday Nov. 29

Tragedy of the commons:

- First use of the term: 1833, village commons overgrazed (what is a commons?)
- Garret Harding 1968: modern use of the term to describe any public resource that is abused (no ownership)
- Think of places like this in your life: dorm commons, locker room, student union
- Basic premise: if nobody "owns" the resource, it eventually becomes abused
- Tragedy: nobody wins (fun fact: look up the Greek origin of this word)
- Is private ownership a solution? Lahaina fires were fed by neglected invasive grasses in the privately owned lands uphill...
- Possible solution: community ownership

Externalities:

- Externality: shedding financial responsibility for your impact the the whole
- If your company produces pollution, and expects the community or government to clean it up, it costs you nothing, you have "externalized" your cost (the cost is "external" to your

business)
- This could also be used to refer to a resource you use without paying for it
- Think of places this happens in our community...
- Create an example here in class: someone makes money doing something, the community pays the price

Minamata: Japanese Battery example (gruesome): https://en.wikipedia.org/wiki/Minamata_disease

Question: The lady in the Poisoned Waters video raised chickens for Purdue farms. She had to take care of the manure, while they profited from the chickens. Who externalized the cost? Who was impacted?

MSY: M**aximum sustainable yield:** max renewable output without compromising the collective future (note the use of the carrying capacity term here)
Think of maximum yield from a corn field, then MSY from the same field...
From your frog book (iPad):

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Note the highest slope (growth rate) in the middle (this also applies to other logistic growth curves, a regular AP exam question)

"Sustainability = thinking about forever"

Also: native peoples: "seventh son of seventh son"

Public Lands: Protected vs. harvested (e.g. forests, rangelands, fisheries)
Global protected areas: terrestrial (land) and marine (ocean)

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In the US, we classify public lands as

- **Rangelands**-open range, enables some ranching with leases (like the series "Yellowstone")
- **National forests**-old growth and new growth, limited forestry
- **National parks**-national treasures, limits on visitors, infrastructure (e.g. Denali)
- **National wildlife refuges**-usually associated with an endangered species or transit/migration path (e.g. wolves)
- **Wilderness areas**-no development, often noise abatement as well (think of helicopters in Waipio or Haleakala)

We have several of these national parks here in Hawaii: https://www.nps.gov/state/hi/index.htm

- Kilauea Volcano (Madame Pele)
- Haleakala ("House of the sun")
- Kaloko-Honokohau ("City of Refuge")
- Pearl Harbor
- Pu'u Kohola (Whale Heiau)
- Papa hanau moku a kea-Northwest Hawai'ian Islands NWHI
- Ala Kahakai (shore trail on this island)

Federal lands: owned by the people, but can be leased to individuals

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Two ethics are in competition:

- **Resource conservation ethic**-maximum use based on greatest good for everyone, usually preservation
- **Multiple use lands**-designated lands for grazing, timber, minerals, leased to individuals or companies for profit

Land Management in the US:
BLM: Bureau of land management
Grazing, ranching, monitors rangeland health, erosion

USFS: Us Forest Service
Manges timber harvesting, where, how, what trees Old growth vs. new growth, replanting, clear cut?
Forests: clear cut vs. selective cut, FSC is a good example:

FSC: Forest stewardship council:
FSC certification:

- no clear cut
- no damage to land
- replanting
- selective cutting
- underbrush considerations

FSC wood: https://fsc.org/en/what-the-fsc-labels-mean
Forest Stewardship Council Certification: all wood in the elab is FSC certified
FSC wood-how different?

https://en.wikipedia.org/wiki/Forest_Stewardship_Council

HUGE debate over underbrush:

- USFS (US Forest Service) believes in regular forest fires to deplete the amount of underbrush (as in nature)
- See also California and Australia wildfires: drought, no regular fires, buildup of underbrush
- See Yellowstone fire of 1988-result of overgrowth of underbrush
- Also 2009 SoCal fires and 2000 Los Alamos fires accident
- https://www.northcountrypublicradio.org/news/npr/94114095/series-overview-yellowstone-s-evolution

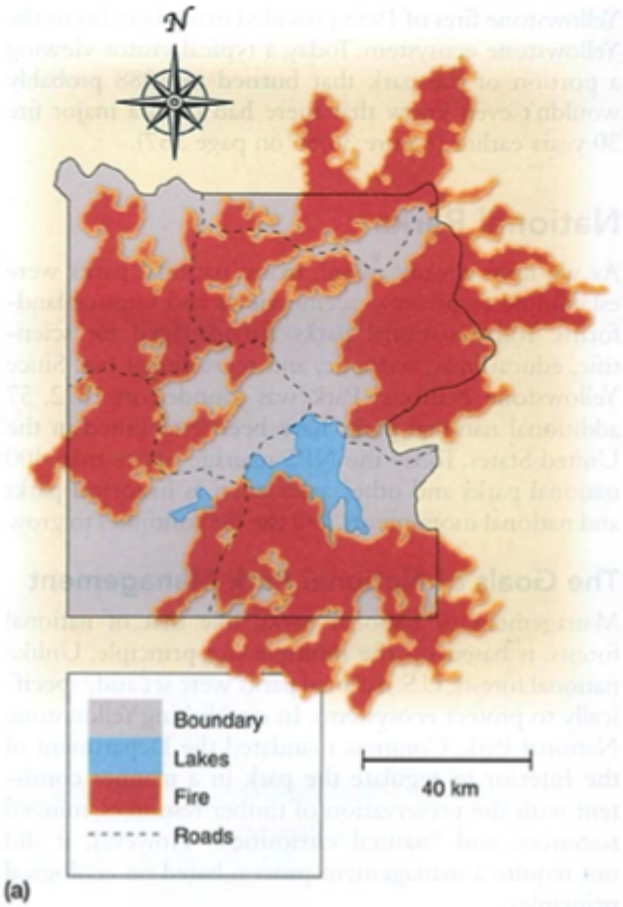




FIGURE 30.5 Yellowstone fires of 1988. (a) As can be seen from the map, extensive areas of the park were burned in this exceptionally hot and dry year. (b) Thirty years later, a casual observer might not know that the forest had burned, except for the sign in the foreground. *(Peter Haigh/Alamy)*

NPS: National park service
Manages parks for recreation, multiple use ethic, preservation of timber, minerals and "natural curiosities"
Also significant native peoples monuments (see above)

FWS: Fish and wildlife service
Manages fishing and hunting on all public lands

Know these:

- BLM: Bureau of Land Management
- USFS: US Forest Service
- NPS: National Park Service
- FWS: Fish and Wildlife Service

NEPA: National Environmental Policy Act 1969 (why then?)

- Mandates an EIS for all development
- EIS (environmental impact statements) are new standard for any project
- ESA endangered species act-often brought in where development could impact ES

Classifications: note recreation is part of each

- US Forest Service: timber, grazing, recreation
- National Park Service: recreation and conservation
- Fish and wildlife service: conservation, hunting, fishing, recreation
- Bureau of land management (BLM): grazing, mining, timber, recreation

Important person: Aldo Leopold 1949 Sand County Almanac: Wisconsin

- Land management, conservation ecology
- "Land Ethic": moral responsibility to protect nature (for all, including next generations)
- Compare with William McDonough: cradle to cradle: "How do we love all the children of all species for all time?" Not just our children. Not just our species. Not just now. All the children, of all species, for all time"

Conservation movement: Important peeps:
Some of these are also covered in your English classes, or they will be in college

Ralph Waldo Emerson-"Nature" "behind nature, throughout nature, spirit is present" 1837
https://en.wikipedia.org/wiki/Ralph_Waldo_Emerson

Henry David Thoreau-Walden "truth in nature and wilderness over the deceits of urban civilization". 1845https://en.wikipedia.org/wiki/Henry_David_Thoreau

Ansel Adams: Photographer championed the National Parks: 1920-1980
http://physics.hpa.edu/physics/apenvsci/videos/ansel_adams.mp4
minutes 0:00-8:00

- "More than any other artist of the century, he would help transform the meaning of "wilderness" in America and change what people thought and felt about their own land"
- "It's a place that you step into, and you don't know what's going to happen, a place that can surprise you, it's a place where you are small, where being small is not a bad thing, where being small is actually a wonderful thing"-Carl Pope, Sierra Club

- "...The world is beautiful, that humanity is part of this larger world, that the concerns of the moment are part but not separate from a larger system of forces that that connect us to all of creation"Jonathan Spaulding, Biographer

Question: How did his photographs change the awareness of the public? People usually care about what they know...
Teddy Roosevelt used this to create parks in the Southwest US...

Aldo Leopold-environmental ethics, wildlife management, conservation, Sand County Almanac (Wisconsin) https://en.wikipedia.org/wiki/Aldo_Leopold

John Muir-started the Sierra Club: "wilderness mirrors divinity, nourishes humanity and vivifies the spirit"
https://en.wikipedia.org/wiki/John_Muir

Rachel Carson-silent spring DDT (persistent pesticide, weakens bird egg shells), 1963:
https://en.wikipedia.org/wiki/Rachel_Carson
https://en.wikipedia.org/wiki/Dichlorodiphenyltrichloroethane
VERY important person-why?

Terms: Review

- Rangeland: open dry grasslands for grazing
- Forests: land dominated by trees
- Clear-cutting: all trees, regrowth is all same age trees, promotes erosion, wildfires (litter)
- Selective cutting: older trees first

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Not sure why the text brings this in here, but let's go:
ESA: Endangered Species Act
1973 protects plant and animal species from extinction, also monitors invasive species

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