

Popular Stories that could be on FRQ

Updated 2019

Experimental Design

- 5 x 5 design
- Emphasis on IV, control, and DV
- Maintain constants
- Null hypothesis also accepted

Experimental Design Diagram

TITLE: The Effect of the (IV) on the (DV)

HYPOTHESIS: If (pick your IV), then (pick your DV) because....)

IV: (and unit)

Levels of IV

Include the control in the first box and label it as control

No. of Trials

DV: (and unit)

CONTROLLED VARIABLES/CONSTANTS: (list variable that stay the same to have a “fair” experiment)

Keystone Pipeline

- Transports unrefined oil from oil sands in Canada (largest producer) to refineries in SE United States
- Replaces older pipeline
- Allows for higher capacity of oil transport
- Possible water contamination – part goes over the Ogallala Aquifer
- Habitat degradation issues – goes through sensitive sandhill ecosystem in Nebraska
- Less incentive to develop sustainable energy



Sources: TransCanada Corp., Natural Resources Defense Council, U.S. Fish and Wildlife Service

Sandhills, Nebraska



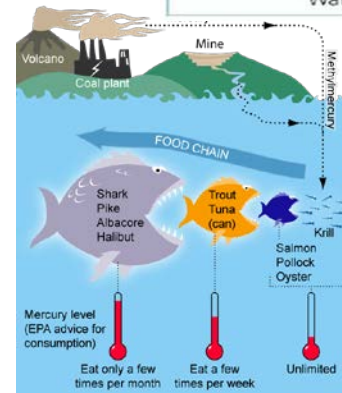
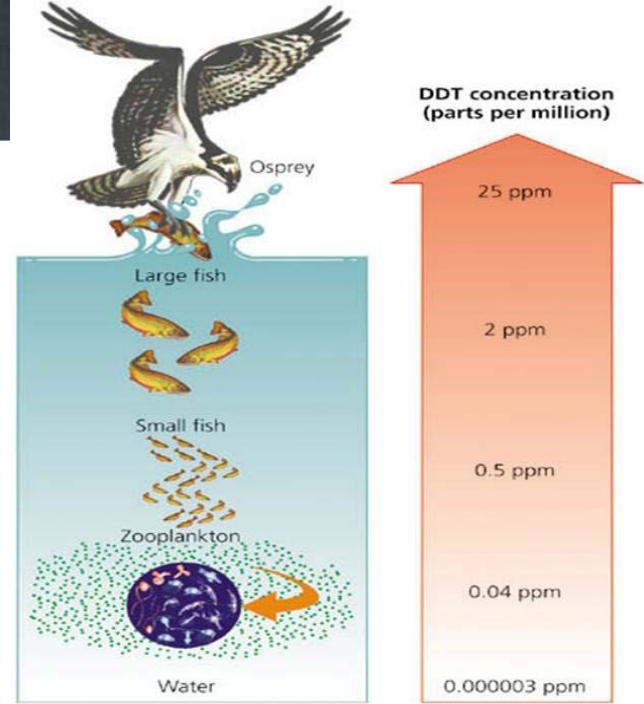
©NEBRASKALand Magazine/Nebraska Game and Parks Commission



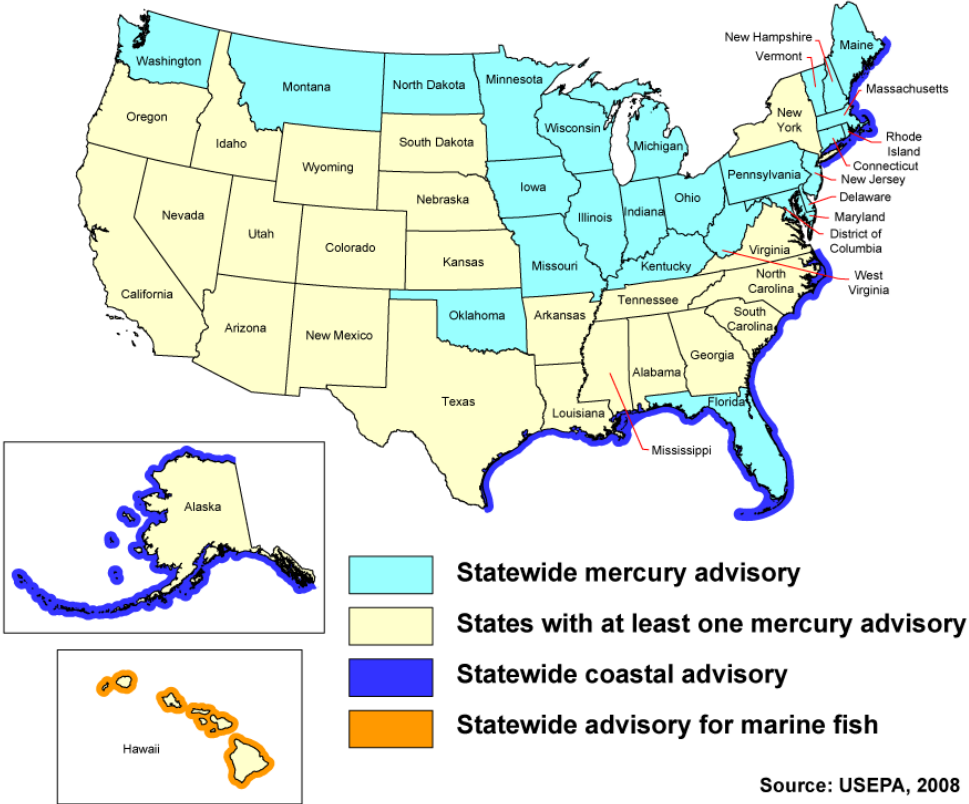
Photo by Joel Sartore/www.joelsartore.com

Mercury deposition

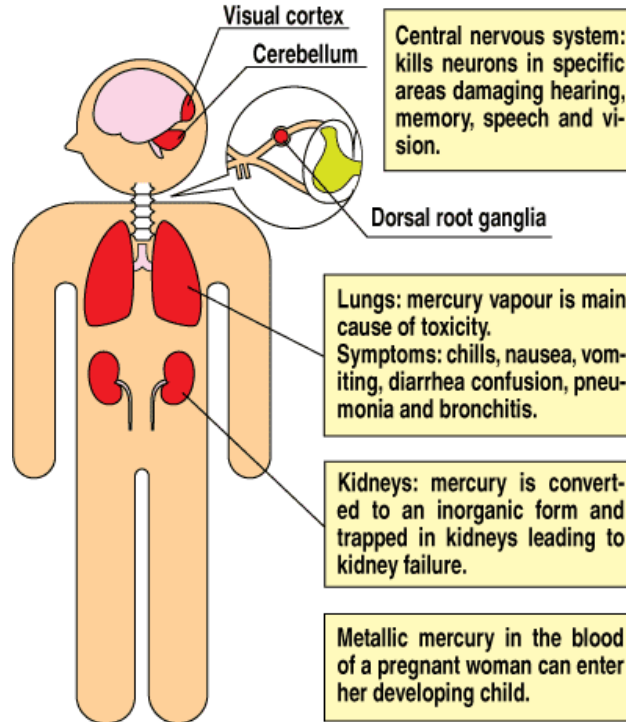
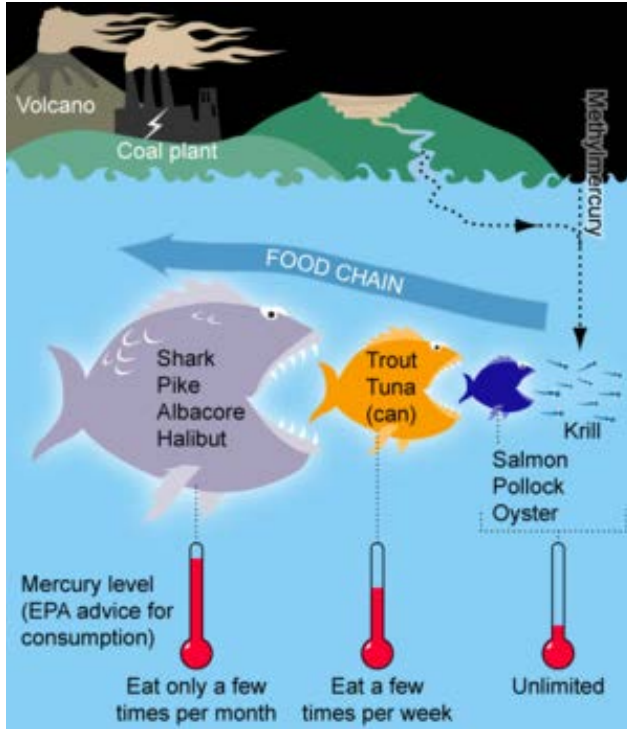
- Hg in air from burning coal
- Deposits into water
- Bioaccumulates and biomagnifies in food web
- Hg is a neurotoxin
- What about deposition on land?
 - Bird songs



Mercury in Fish



Mercury in Fish



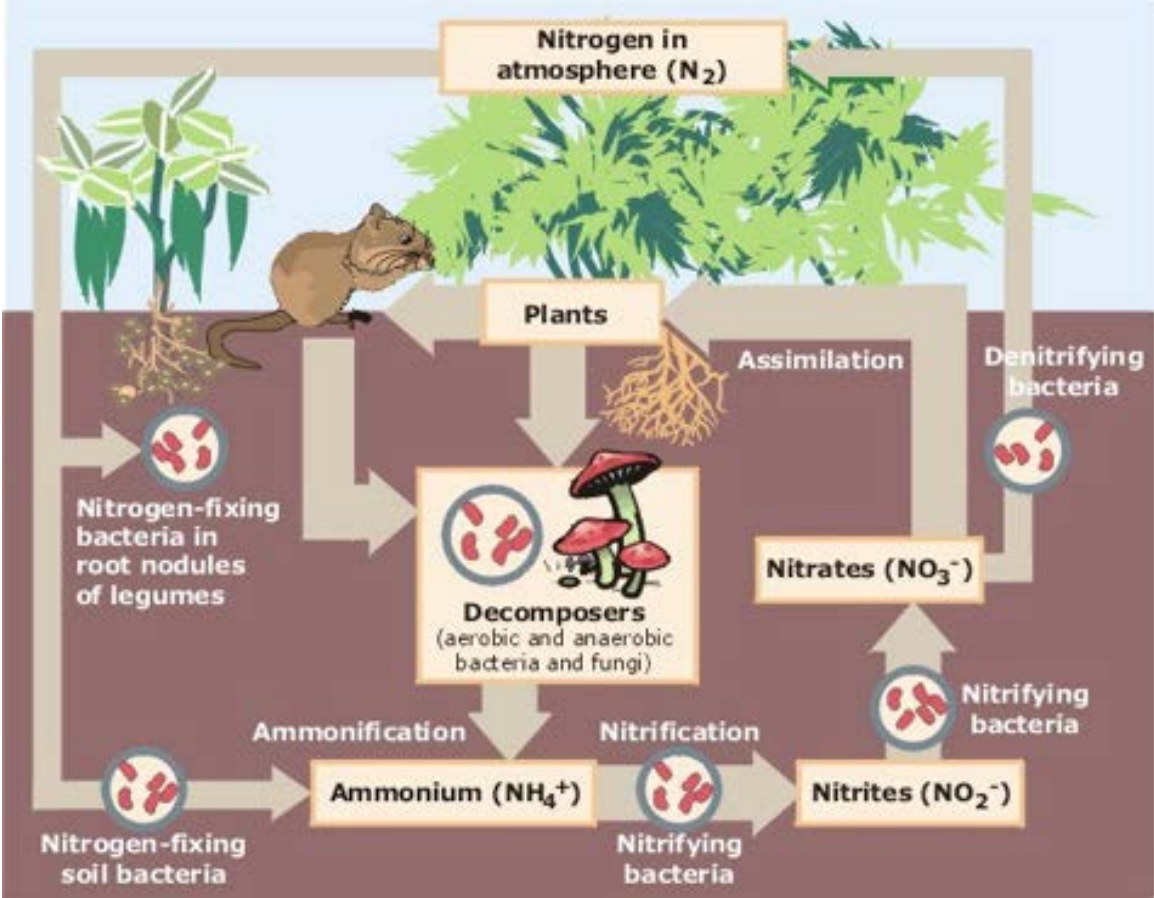
Algal blooms



- Eutrophication/ cultural eutrophication/ nutrient loading
- Causes – fertilizer runoff, sewage, animal waste, N, P
- Chesapeake Bay, Gulf of Mexico, Mediterranean Sea



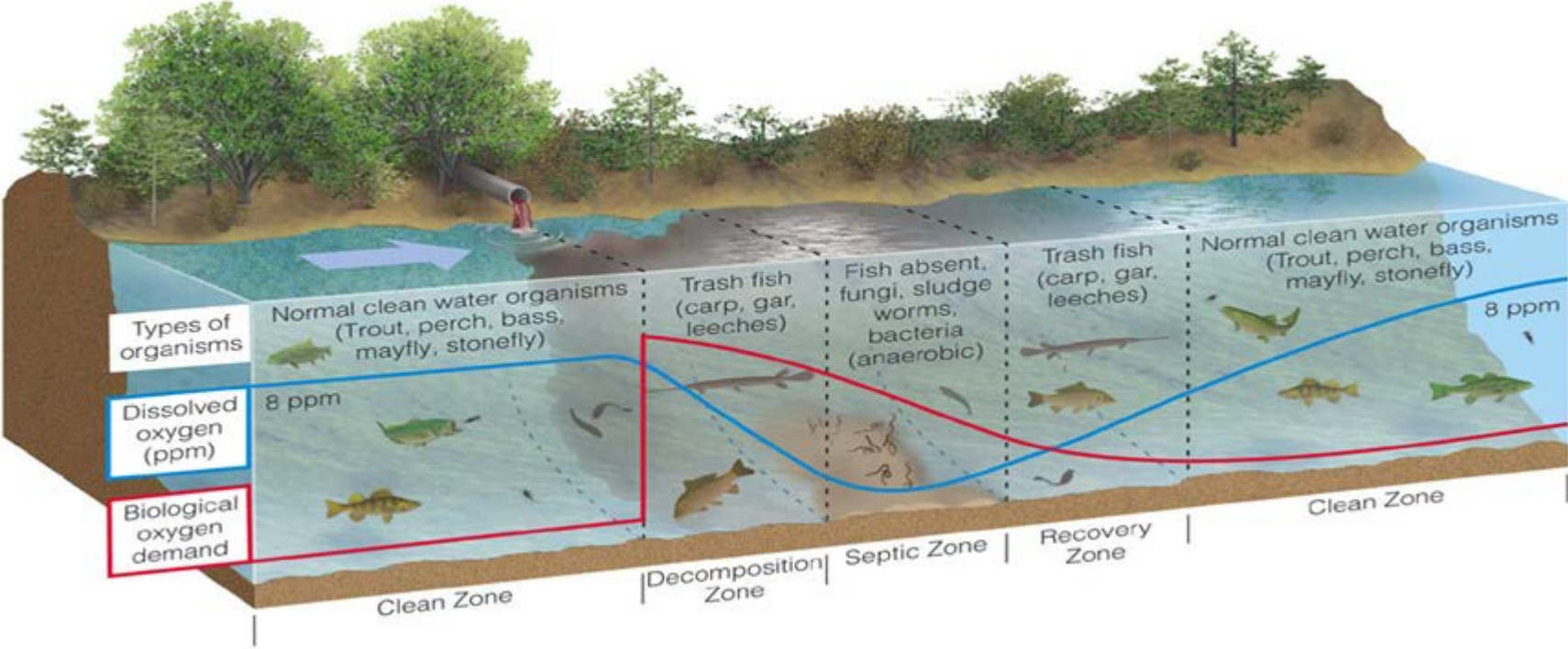
Nitrogen Cycle



Human Impact on Nitrogen Cycle

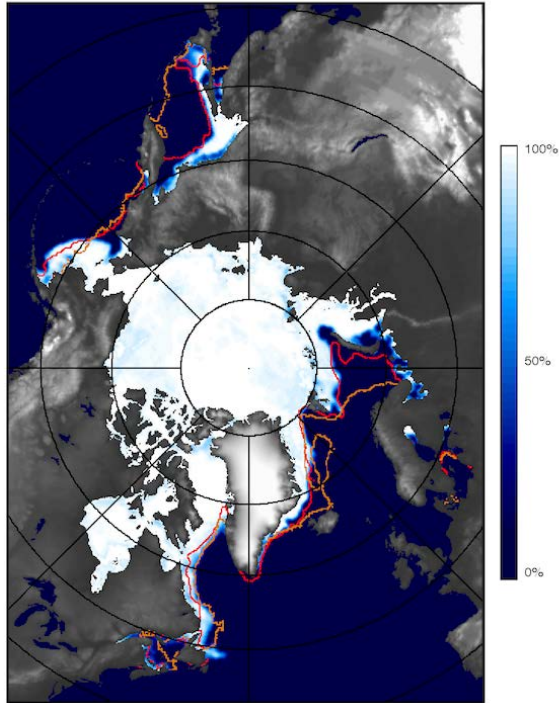
- Excessive use runs off: remedied by riparian zones
- Made up of NPK: Phosphorus is limiting in water, causes algal blooms
- Oxygen sag curve results: hypoxic zones
 - Gulf of Mexico
- Causes eutrophication/cultural eutrophication

Oxygen Sag Curve



Declining Sea Ice

Northern Hemisphere, March 26, 2017



- Sea ice is declining due to increasing temperatures
- Major part of arctic ecosystems - causing loss of biodiversity
- Greenland ice sheets heavily impacted
- Less white ice means areas absorb more radiation, radiates back into the atmosphere, trapping more IR, causing increasing melting → positive feedback loop
- Receding polar ice may also cause an increase in sea level rise (although due primarily to thermal expansion)

Possible FRQ topics

- Pollution, water: The Great Pacific Garbage Patch

- Mostly plastic
- Between CA and China
- PCBs, bisphenol A,
- Photodegradation of pl
- More plastic than plankton
- Tiny pieces ingested by zooplankton
→ bioaccumulation in the food chain
- Plastic bag bans



Microplastics on 2017

The Great Pacific Garbage Patch

Is an area of marine debris, laying approximately 135° to 155° West and 35° to 42° North. Although it shifts every year and exact position is hard to tell. It lies within North Pacific Gyre and does not go anywhere, as it is confined by its currents.

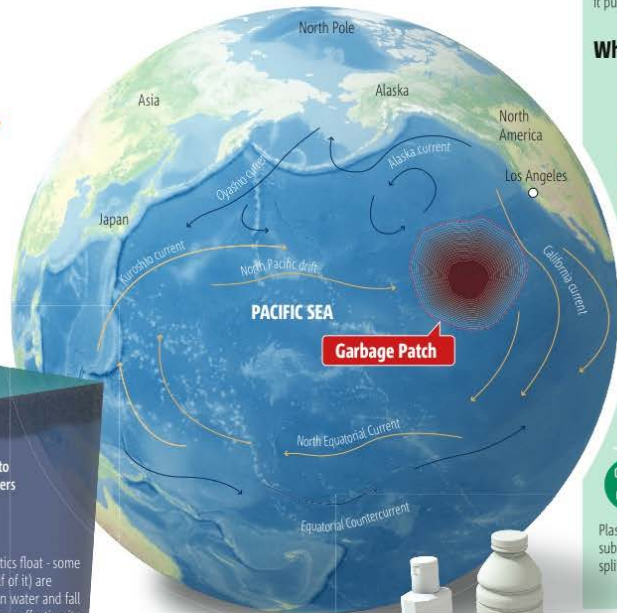
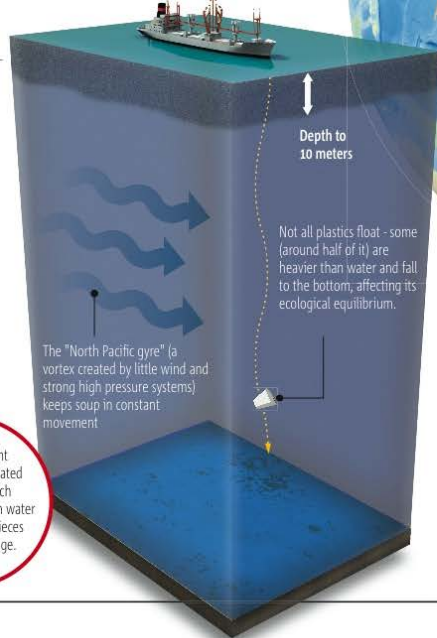
The area

The Patch is around 2200 kilometers long and 800 kilometers wide



Plastic Soup

Consists of both larger and disintegrated plastic objects and particles, both on the surface, in the water column below it and on the bottom.



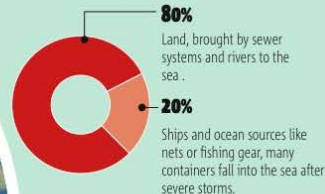
Problems created by plastic:

- It fouls beaches worldwide and scares tourists away.
- Plastic entangles marine animals and drowns them, strangles them and makes them immovable.
- Plastic litter washed ashore destroys habitats of coastal species.
- Plastic litter gets inside ships propellers and keels, making ship maintenance more expensive.
- Plastic does not biodegrade, plastic things make an ideal vessel and enable invasive species to move to further regions.

How does it form?

Currents in the Pacific Ocean create a circular effect that pulls debris from North America, Asia and the Hawaiian Islands. Then it pushes it into a floating pile of 100 million tons of trash.

Where does it all come from?



Interesting facts

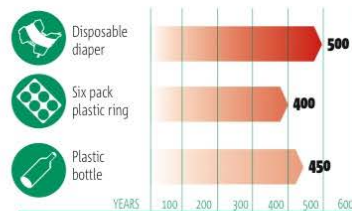
Less than 5% of plastic is recycled. In the Central North Pacific Gyre, small pieces of plastic outweighed surface zooplankton by a factor of 6 to 1 in 1999. But the ratio in 2010 may already be 60 to 1.



Photodegradation

Plastic never biodegrades, it doesn't break down into natural substances. But it goes through a photodegradation process, splits into ever smaller and smaller parts, which are still plastic.

How long does it take to photodegrade plastic:



Plastic Bag Ban or Water Bottle Ban

Problems:

- persistence of plastic in landfill
- energy cost and oil dependence in producing bags
- 2 liters of oil for every one liter bottle
- nonrecyclable plastic bags (bottles are recyclable)

Solution:

- reusable alternatives are pretty simple
- ban or charge? (pricing structure)
- how much of a deposit would change your behavior?
- fake fields, diapers, other products can be made from recycled bottles

Prescription drugs in our surface water

- “pharmapollution”
 - From pee and flushed meds
- Sewage treatment plants not designed to remove drugs from water
- What is the impact on wildlife? Human health?



Photochemical Smog

- Air – Smog
 - Gray, industrial smog
 - From burning coal
 - Sulfur, particulate matter
 - Worst in China
 - Affluence contributes
 - Links to demographic transition?
 - Brown, photochemical smog
 - From cars and heat
 - Ozone, VOCs
 - Worst in CA
 - Solutions?

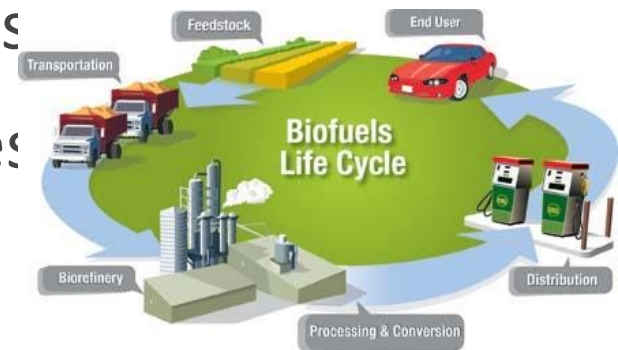


Biofuels

- Usually ethanol from corn or sugarcane
- Cellulosic – from forest and crop residues
 - Cellulose to ethanol
- Palm oil
- Uses LOTS of water, fertilizers, pesticides



are better alternatives



Growing Production of Biofuels

- Biofuels – most often ethanol from corn or sugarcane
- Biofuels highly regionalized--in India, *rice hulls*
- Uses lots of water, fertilizers, pesticides
- Fertilizers associated with eutrophication and “dead zone” in Gulf of Mexico
- Fertilizer runoff with phosphates and nitrates → Causes algal blooms
- Better alternative: Switchgrass and Algae

Overfishing

- More people eating fish
- Bycatch
- CITES , Magnuson-Stevens Fisheries Act



History of the Magnuson-Stevens Act

Originally enacted into law in 1976 to remove foreign fleets from our waters, it led to the rapid expansion of the American fleet and the subsequent over-exploitation of our fisheries resources. Congress reauthorized the Act in 1996 and 2006, adding important provisions to the law which enhanced the sustainability and therefore long-term profitability of our federal fisheries.

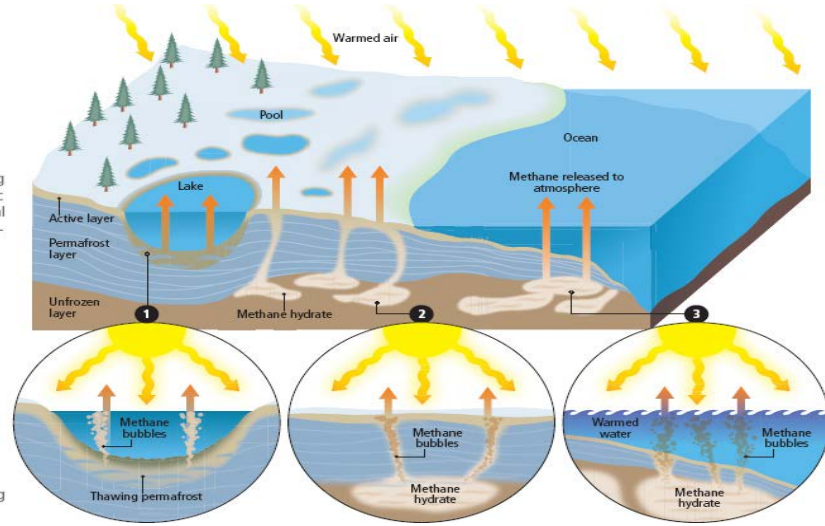


Permafrost

- Melting permafrost due to climate change
 - Positive feedback loop
 - What is permafrost?
 - Tundra ecosystem
 - Releases methane – more powerful than CO2



Triple threat: Warmed air resulting from climate change heats the Arctic surface, releasing methane in several ways. ❶ The top few feet of soil (active layer) thaw each summer, emitting small amounts of methane. But when surface ice melts into pools that combine into lakes, the water melts solid permafrost below. Microbes consume the thawing remains of dead plants and animals there, burping up lots of methane. ❷ In some places, the permafrost covers deep, old deposits of ice and gas known as methane hydrates, but the disintegrating cap can open up escape conduits, enabling a sudden release. ❸ A thinner layer of permafrost caps hydrates slightly offshore, but warming waters can thaw it, too.



Paris Accord

- Keep temps below 2°C
- Rich countries pay \$100 billion
- Developed countries take the lead
- Decreases emissions and increase sinks
- Review every 5 years
- Take effect in 2020

The Paris climate agreement: key points

The historic pact, approved by 195 countries, will take effect from 2020



Temperatures 2100



- Keep warming "well below 2 degrees Celsius". Continue all efforts to limit the rise in temperatures to 1.5 degrees Celsius"

Finance 2020-2025



- Rich countries must provide 100 billion dollars from 2020, as a "floor"
- Amount to be updated by 2025

Differentiation



- Developed countries must continue to "take the lead" in the reduction of greenhouse gases
- Developing nations are encouraged to "enhance their efforts" and move over time to cuts

Emissions objectives 2050



- Aim for greenhouse gases emissions to peak "as soon as possible"
- From 2050: rapid reductions to achieve a balance between emissions from human activity and the amount that can be captured by "sinks"

Burden-sharing



- Developed countries must provide financial resources to help developing countries
- Other countries are invited to provide support on a voluntary basis

Review mechanism 2023



- A review every five years
First world review: 2023
- Each review will inform countries in "updating and enhancing" their pledges

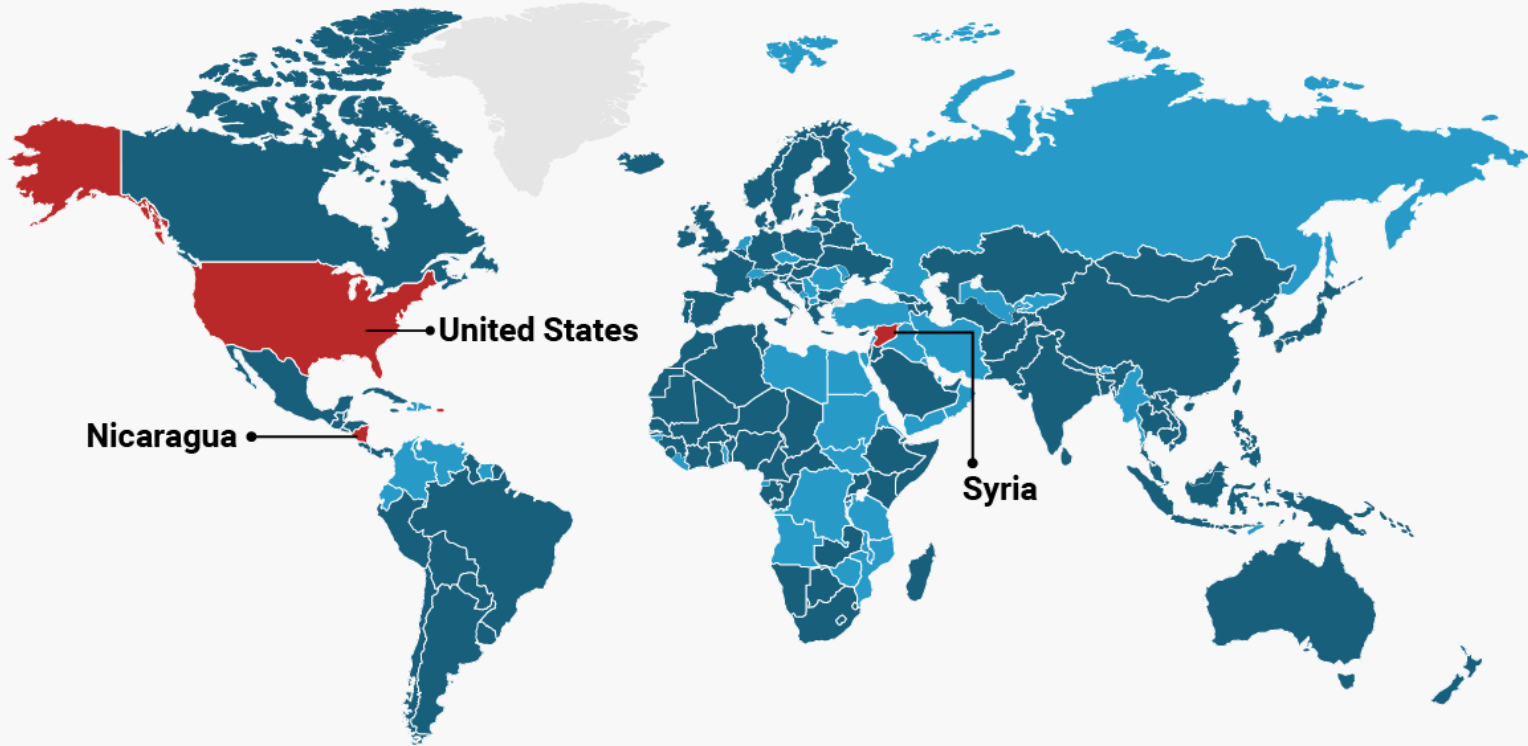
Climate damage



- Vulnerable countries have won recognition of the need for "averting, minimising and addressing" losses suffered due to climate change

COUNTRIES THAT JOINED THE PARIS CLIMATE AGREEMENT

■ Ratified (146) ■ Signed (48) ■ Not signed/Withdrawing (3)



Wind power

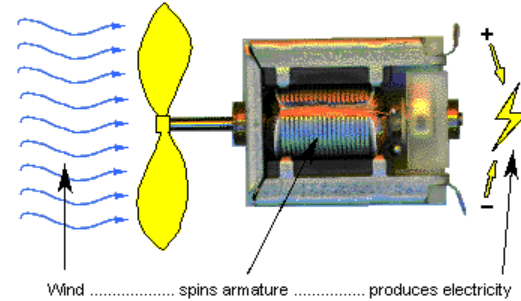


- Wind spins turbine to create electricity
- Risks to birds and bats
- Eyesores?
- Offshore wind farms
- Wind farms and ag can cohabitate

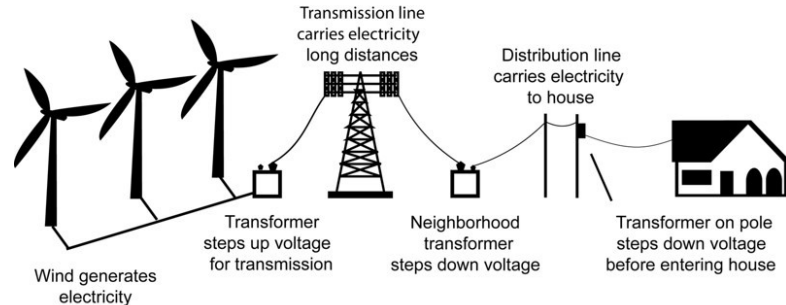
Wind Power

- Wind spins turbine
- Generator produces electricity
- Electricity moves through transmission lines
- Fastest growing renewable (though solar is close)
- Risk to birds – collide with blades (significant, but more deaths attributed to collisions with buildings, predation by house cats, etc.)
- Risk to bats – decreased pressure around blades causes capillaries in lungs to rupture
- Possible math question?

Generator produces electricity

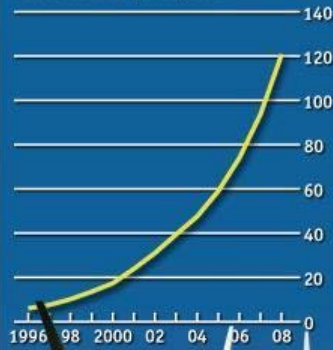


Transporting Wind Electricity

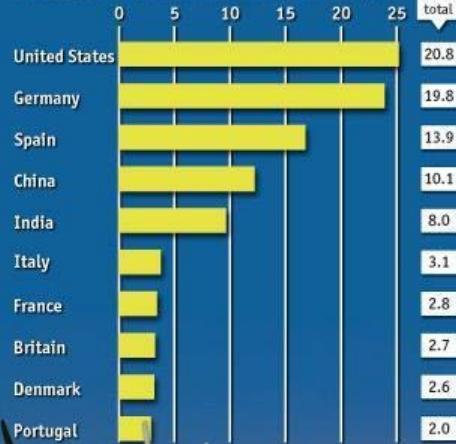


World wind power

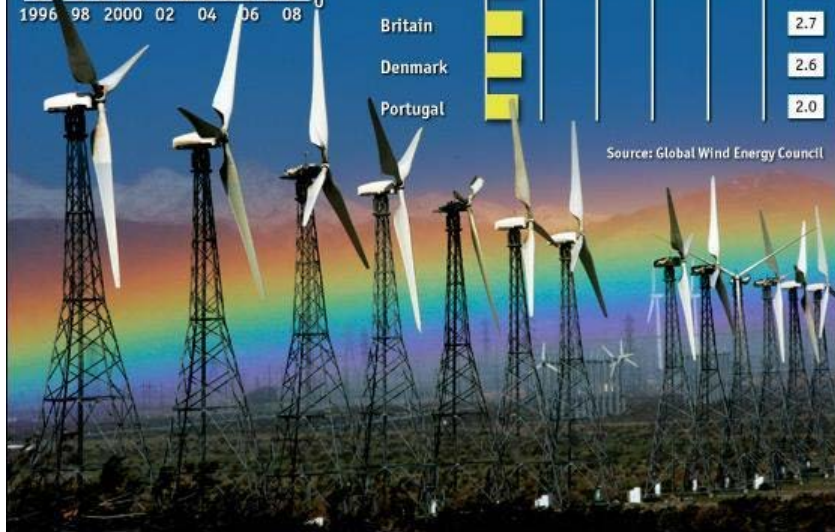
Global installed power, GW



Countries with most installed power, end 2008, GW

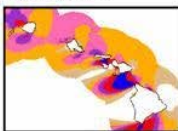
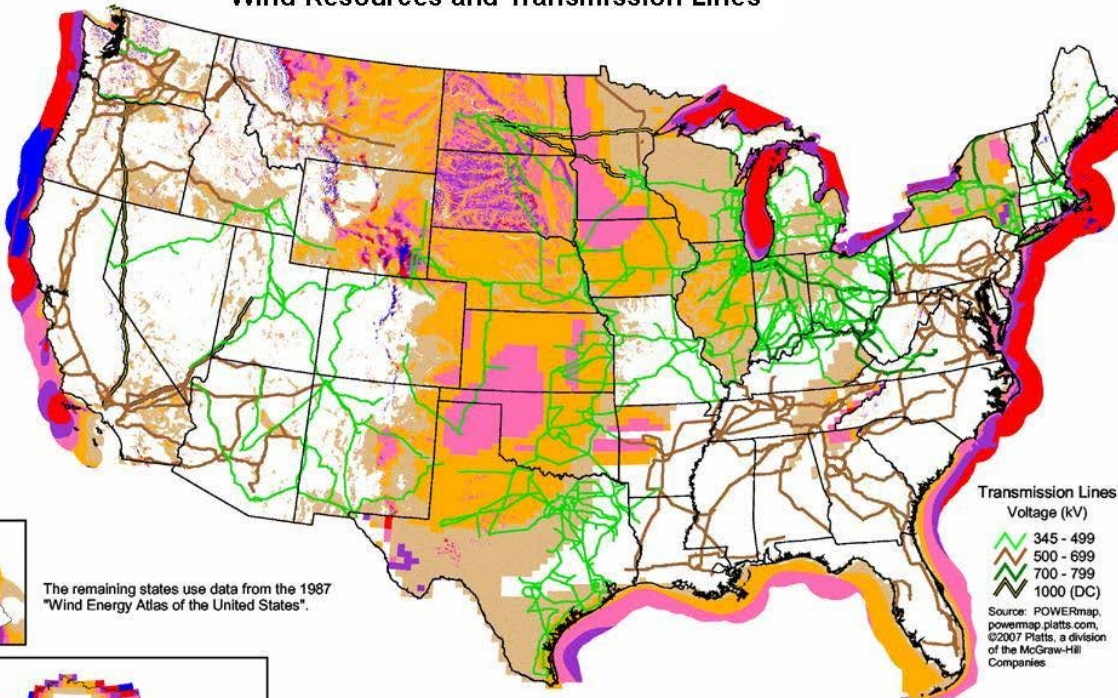


Source: Global Wind Energy Council

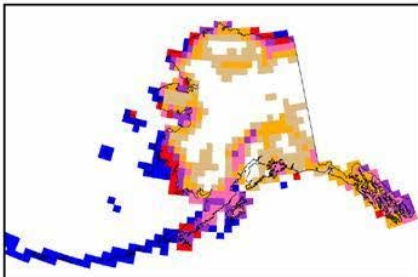


Wind Resources and Transmission Lines

- NREL Updated Maps:
- Arizona (2003)
 - California (2002)
 - Colorado (2004)
 - Connecticut (2001)
 - Delaware (2002)
 - Hawaii (2004)
 - Idaho (2002)
 - Illinois (2001)
 - Indiana (2004)
 - Maine (2001)
 - Maryland (2002)
 - Massachusetts (2001)
 - Michigan (2004)
 - Missouri (2005)
 - Montana (2002)
 - Nebraska (2005)
 - Nevada (2003)
 - New Jersey (2002)
 - New Hampshire (2001)
 - New Mexico (2003)
 - North Carolina (2002)
 - North Dakota (2000)
 - Ohio (2004)
 - Oregon (2002)
 - Pennsylvania (2002)
 - Rhode Island (2001)
 - South Dakota (2001)
 - Texas (2000)
 - Utah (2003)
 - Vermont (2001)
 - Virginia (2002)
 - Washington (2002)
 - West Virginia (2002)
 - Wyoming (2002)



The remaining states use data from the 1987 "Wind Energy Atlas of the United States".



Transmission Lines
Voltage (kV)

- 345 - 499
- 500 - 699
- 700 - 799
- 1000 (DC)

Source: POWERmap, powermap.platts.com, ©2007 Platts, a division of the McGraw-Hill Companies

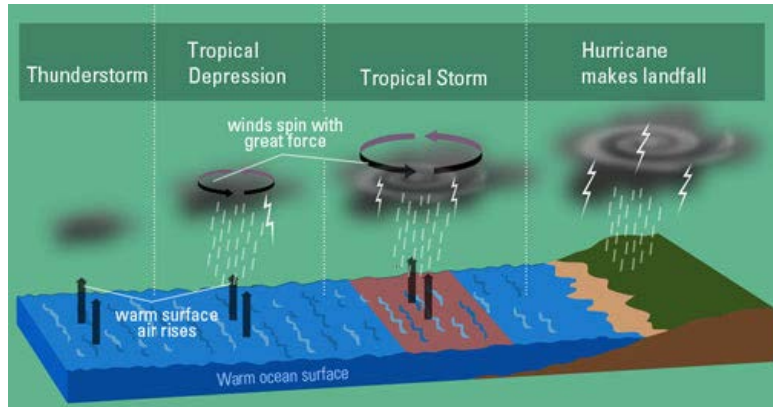
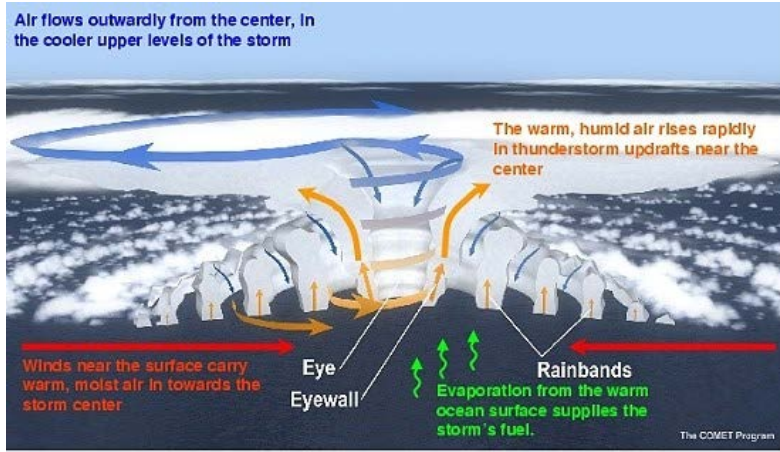
| Wind Power Classification | | | | |
|---------------------------|--------------------|---|-------------------------------------|-------------------------------------|
| Wind Power Class | Resource Potential | Wind Power Density at 50 m W/m ² | Wind Speed ^a at 50 m m/s | Wind Speed ^a at 50 m mph |
| | 2 Marginal | 200 - 300 | 5.6 - 6.4 | 12.5 - 14.3 |
| | 3 Fair | 300 - 400 | 6.4 - 7.0 | 14.3 - 15.7 |
| | 4 Good | 400 - 500 | 7.0 - 7.5 | 15.7 - 16.8 |
| | 5 Excellent | 500 - 600 | 7.5 - 8.0 | 16.8 - 17.9 |
| | 6 Outstanding | 600 - 800 | 8.0 - 8.8 | 17.9 - 19.7 |
| | 7 Superb | 800 - 1600 | 8.8 - 11.1 | 19.7 - 24.8 |

^a Wind speeds are based on a Weibull k value of 2.0

U.S. Department of Energy
National Renewable Energy Laboratory



Coriolis Effect



- Major hurricanes have been increasing in severity due to climate change
- Sandy: New York; Katrina: Off coast of Mississippi and Louisiana
- Katrina: Levees failed and major portions of region flooded, poorest hit regions caused massive environmental refugees
- Ecological impacts included flooded terrestrial habitats, habitat destruction, barrier islands are made to protect coastal regions - we are doing major damage to these areas due to construction which also leads to erosion.

Endocrine disruptors

- PBDEs and flame retardants
- PCBs
- BPA
- Phthalates
- Pesticides like DDT
- Human health effects
 - Learning disorders
 - ADD/ADHD
 - Reduced fertility
 - Feminization

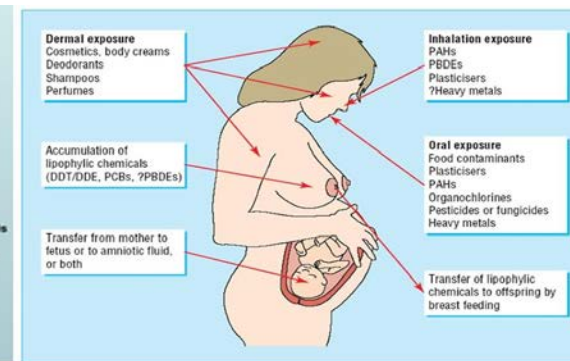
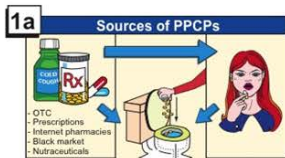


Fig 3 Routes of human exposure to some common environmental chemicals. DDE=1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene, DDT=dichlorodiphenyltrichloroethane, PAHs=polycyclic aromatic hydrocarbons, PCBs=polychlorinated biphenyls

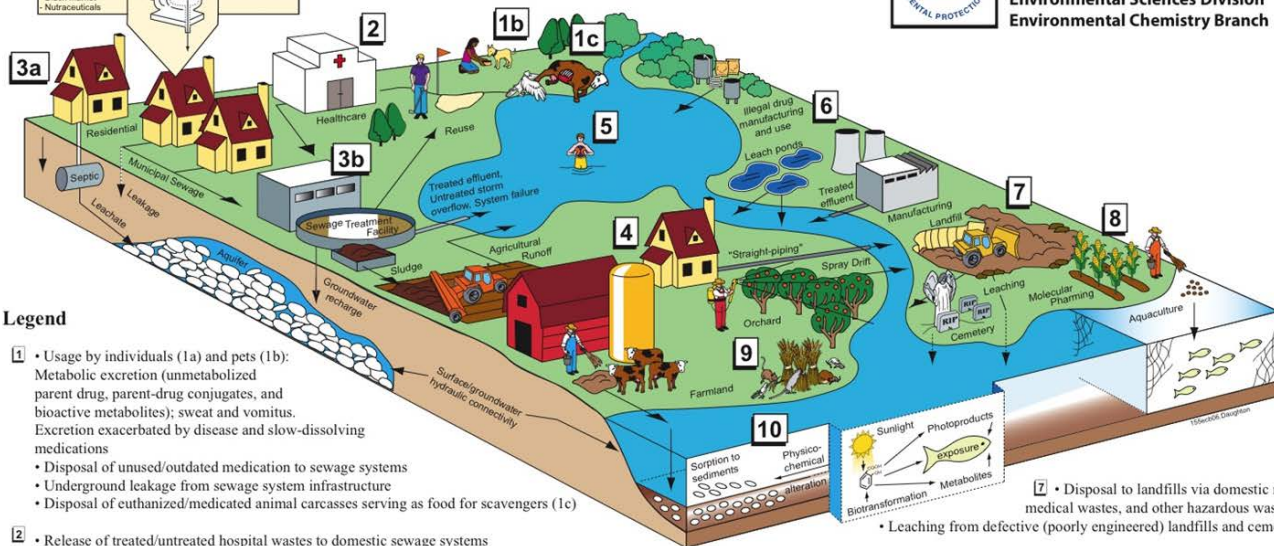


Origins and Fate of PPCPs[†] in the Environment

[†]Pharmaceuticals and Personal Care Products



U.S. Environmental Protection Agency
Office of Research and Development
National Exposure Research Laboratory
Environmental Sciences Division
Environmental Chemistry Branch

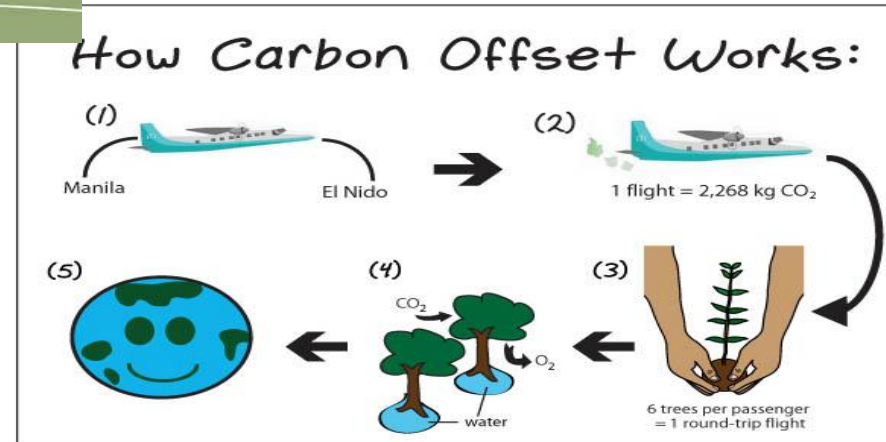
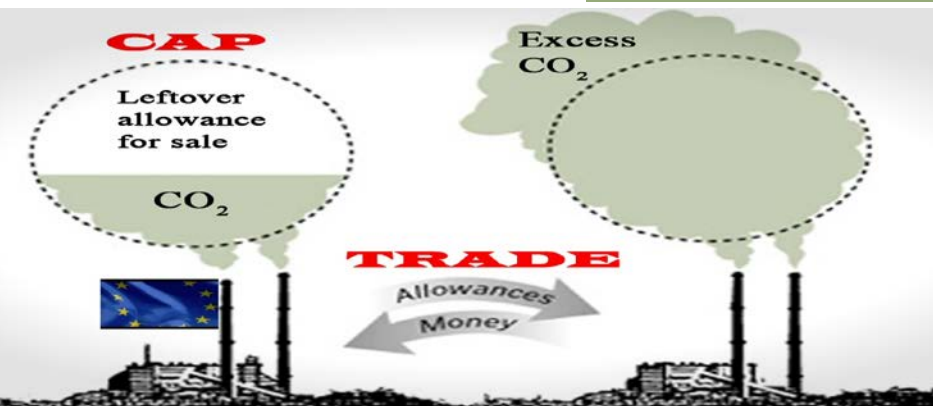
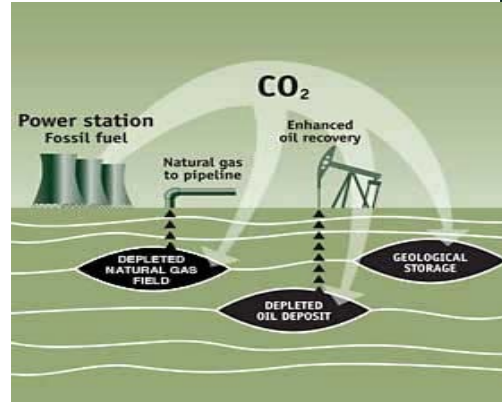


Legend

- Usage by individuals (1a) and pets (1b): Metabolic excretion (unmetabolized parent drug, parent-drug conjugates, and bioactive metabolites); sweat and vomitus. Excretion exacerbated by disease and slow-dissolving medications
- Disposal of unused/outdated medication to sewage systems
- Underground leakage from sewage system infrastructure
- Disposal of euthanized/medicated animal carcasses serving as food for scavengers (1c)
- Release of treated/untreated hospital wastes to domestic sewage systems (weighted toward acutely toxic drugs and diagnostic agents, as opposed to long-term medications); also disposal by pharmacies, physicians, humanitarian drug surplus
- Release to private septic/leach fields (3a)
- Treated effluent from domestic sewage treatment plants discharged to surface waters, re-injected into aquifers (recharge), recycled/reused (irrigation or domestic uses) (3b)
- Overflow of untreated sewage from storm events and system failures directly to surface waters (3b)
- Transfer of sewage solids ("biosolids") to land (e.g., soil amendment/fertilization)
- "Straight-piping" from homes (untreated sewage discharged directly to surface waters)
- Release from agriculture: spray drift from tree crops (e.g., antibiotics)
- Dung from medicated domestic animals (e.g., feed) - CAFOs (confined animal feeding operations)
- Direct release to open waters via washing/bathing/swimming
- Discharge of regulated/controlled industrial manufacturing waste streams
- Disposal/release from clandestine drug labs and illicit drug usage
- Disposal to landfills via domestic refuse, medical wastes, and other hazardous wastes
- Leaching from defective (poorly engineered) landfills and cemeteries
- Release to open waters from aquaculture (medicated feed and resulting excreta)
- Future potential for release from molecular pharming (production of therapeutics in crops)
- Release of drugs that serve double duty as pest control agents: examples: 4-aminopyridine, experimental multiple sclerosis drug → used as avicide; warfarin, anticoagulant → rat poison; azacholesterol, antilipidemics → avian/rodent reproductive inhibitors; certain antibiotics → used for orchard pathogens; acetaminophen, analgesic → brown tree snake control; caffeine, stimulant → *coqui* frog control
- Ultimate environmental transport/fate:
 - most PPCPs eventually transported from terrestrial domain to aqueous domain
 - phototransformation (both direct and indirect reactions via UV light)
 - physicochemical alteration, degradation, and ultimate mineralization
 - volatilization (mainly certain anesthetics, fragrances)
 - some uptake by plants
 - respirable particulates containing sorbed drugs (e.g., medicated-feed dusts)

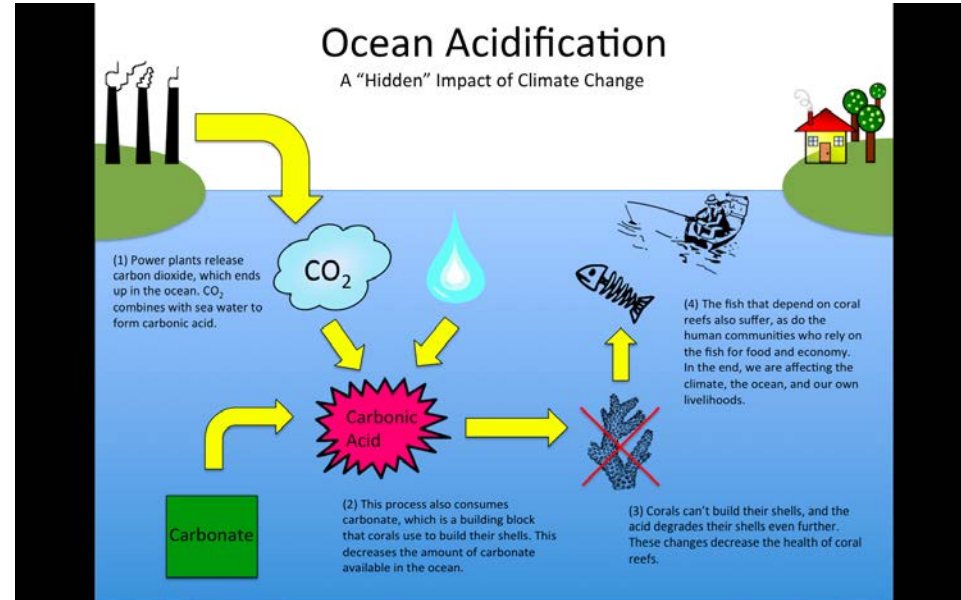
Mitigations for climate change

- Reforestation (and afforestation)
- Carbon offsets
- Cap and trade
- CCS



Ocean Acidification

- **Ocean acidification** is the ongoing decrease in the pH of the Earth's **oceans**, caused by the uptake of carbon dioxide (CO_2) from the atmosphere. An estimated 30–40% of the carbon dioxide from human activity released into the atmosphere dissolves into **oceans**, rivers and lakes.
- Heavily impacts coral and other shell organisms



Consequences of Climate Change

Effect

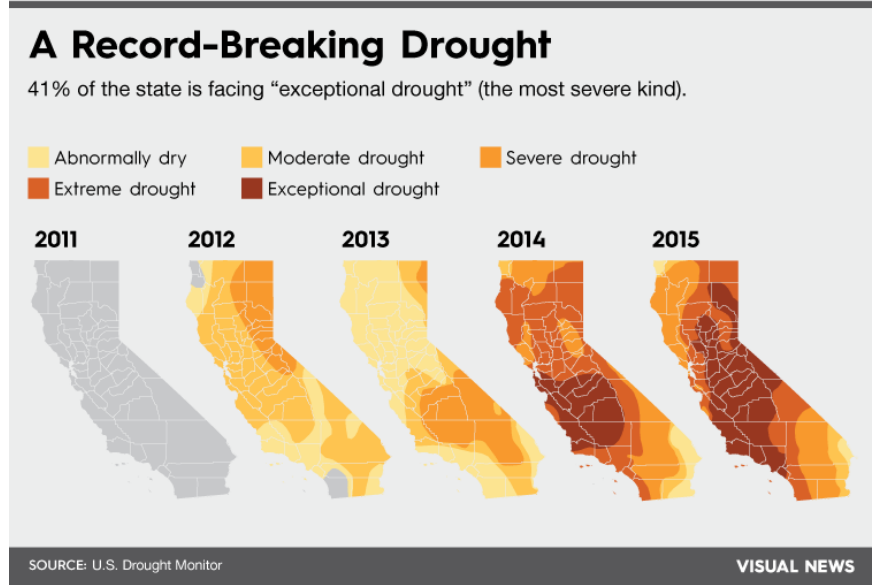
- Receding polar ice caps
- Melting of permafrost
- Changes atmospheric energy balance – why?

Environmental Consequences

- Sea level rise (although due primarily to thermal expansion)
- Messes up transportation routes
- Releases methane – potent greenhouse gas
- Altered climates in various places around the globe

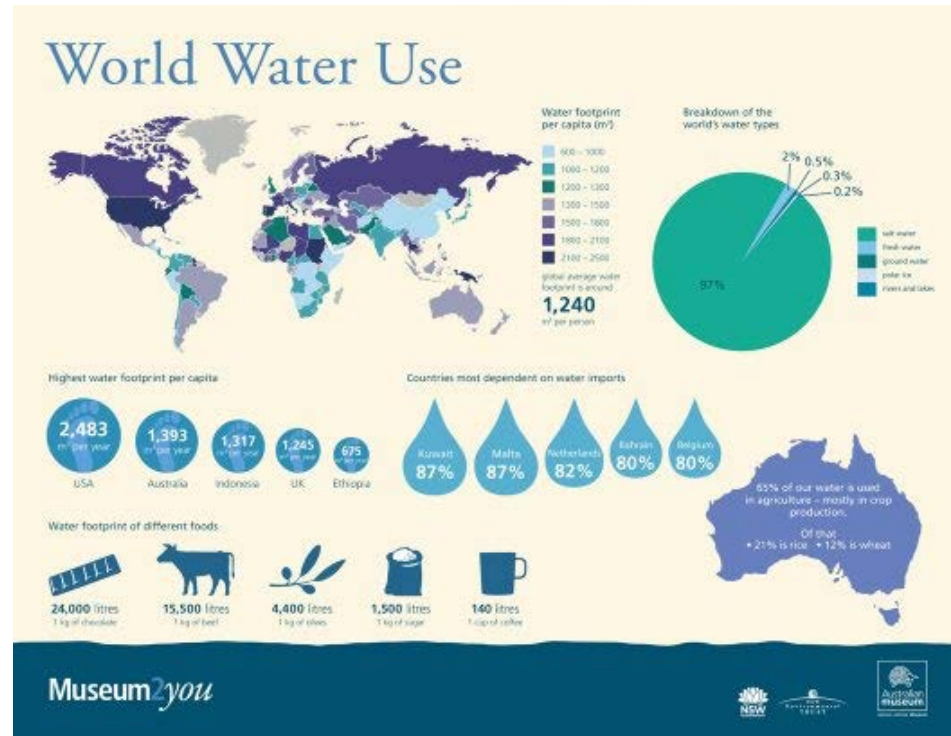
Drought

- Areas facing increasing drought due to climate change and excessive human consumption for agriculture.
 - Texas and California are good case studies
- Require change of behavior
 - Restrictions on water lawns, pools, car washes, etc
- Bottled Water industry is big in California, should we allow water to be bottled and sent elsewhere?



Cape Town Water Crisis - 2018

- Cape Town, South Africa - 2nd largest city
- Due to three years of consecutive drought, the city has been on significant water restriction
 - Municipal water: 13 gallons per person
- Dam levels were dangerously low
- City hopes that annual rains replenish supply
- Poor water management and political instability are significant contributors



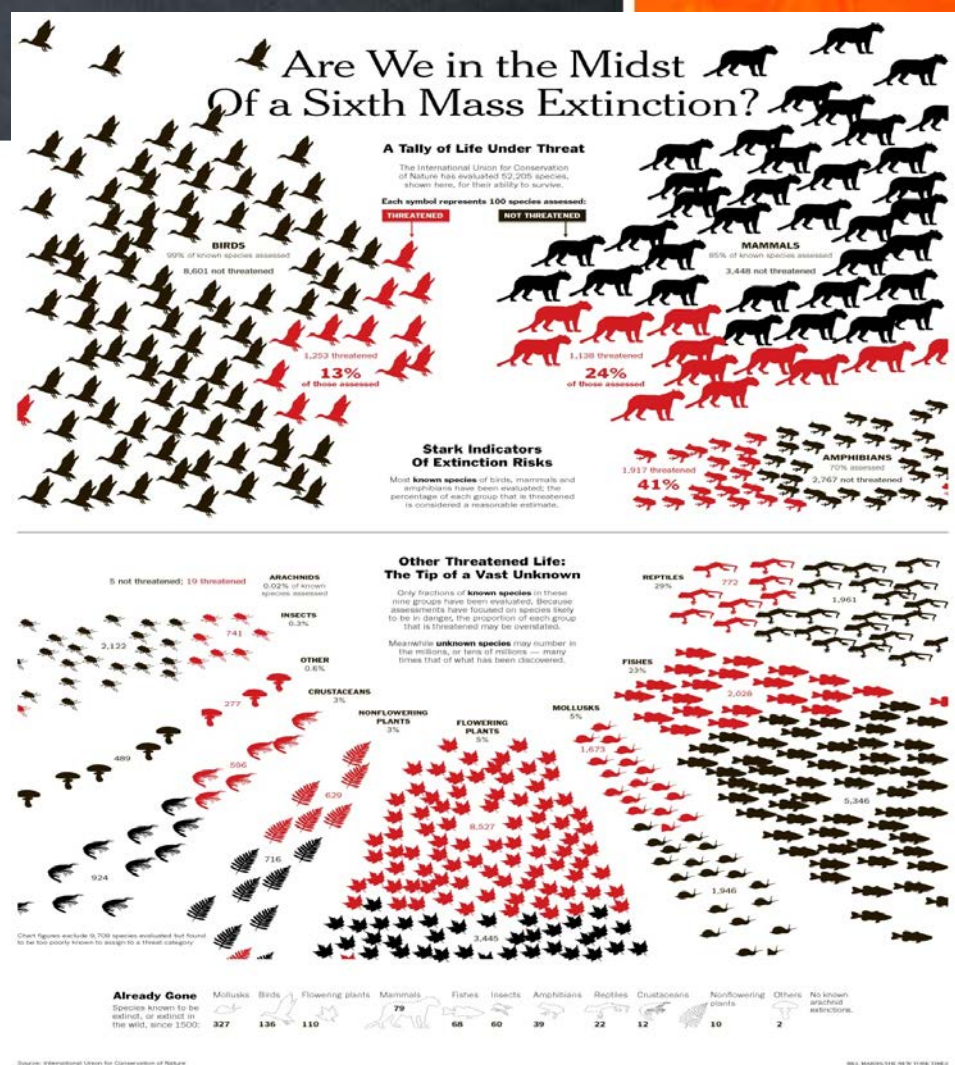
Palm Oil Deforestation

- Palm oil
 - Used in foods and beauty products
 - Replaces partially hydrogenated oils
 - Grown in tropics
 - Deforestation, species loss (orangutans), HIPPCO



Possible FRQ topics

- Mass extinction
 - We are in the middle of the 6th mass extinction
 - This one is being caused by humans
 - HIPPCO
 - Why do we need predators?
 - Why do we need insects?



Mountaintop Removal

- Major form of mining
 - W.V. has seen sig changes to its topography
- Massive habitat destruction
- Regulated by SMCRA



Mining Mountains

How mountaintop mining is done and its effects on the environment:

THE PROCESS

1 Trees are clear-cut, and explosives are used to loosen the rock and topsoil.

2 Huge shovels dig into the topsoil, and trucks start hauling it away.

3 A dragline digs into the rock to expose the coal.

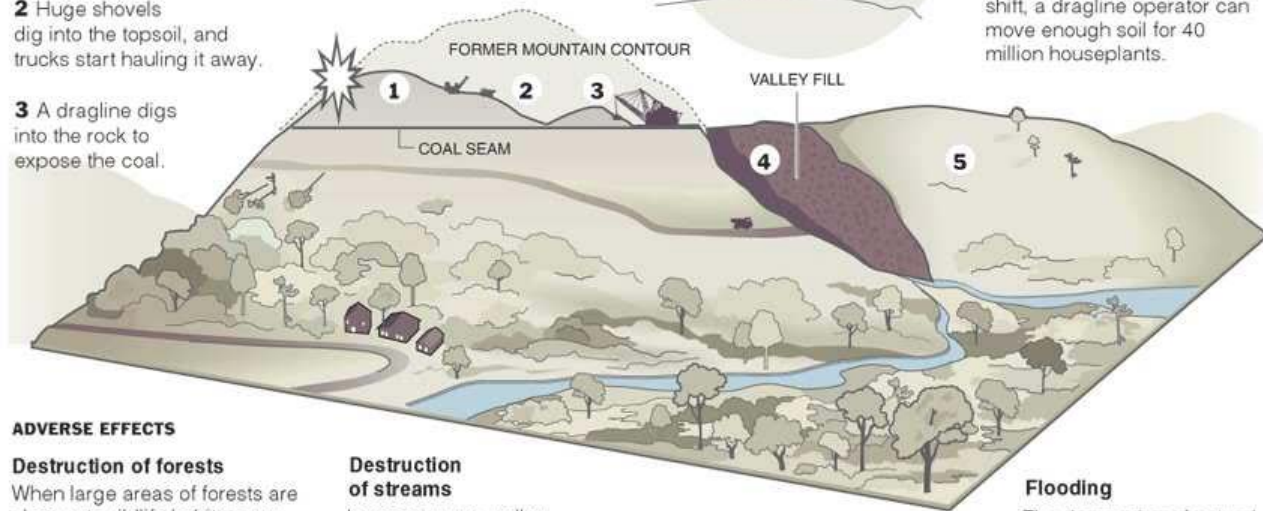
4 The draglines and 250-ton trucks dump the topsoil and rock into areas called valley fills.

5 Coal companies are supposed to reclaim land, but native trees have trouble growing on disturbed topsoil.



Giant earthmovers

In the last decade, the scope and scale of mountaintop mining has escalated with dragline use. These machines can weigh up to 8 million pounds and stand as tall as a 20-story building. In an 8-hour shift, a dragline operator can move enough soil for 40 million houseplants.



ADVERSE EFFECTS

Destruction of forests

When large areas of forests are clear-cut, wildlife habitats are destroyed. Wildlife and plantlife become more vulnerable to predatory species.

Destruction of streams

In recent years, valley fills have buried or damaged 1,200 miles of streams.

Blasting

Explosions can cause damage to home foundations and wells.

Flooding

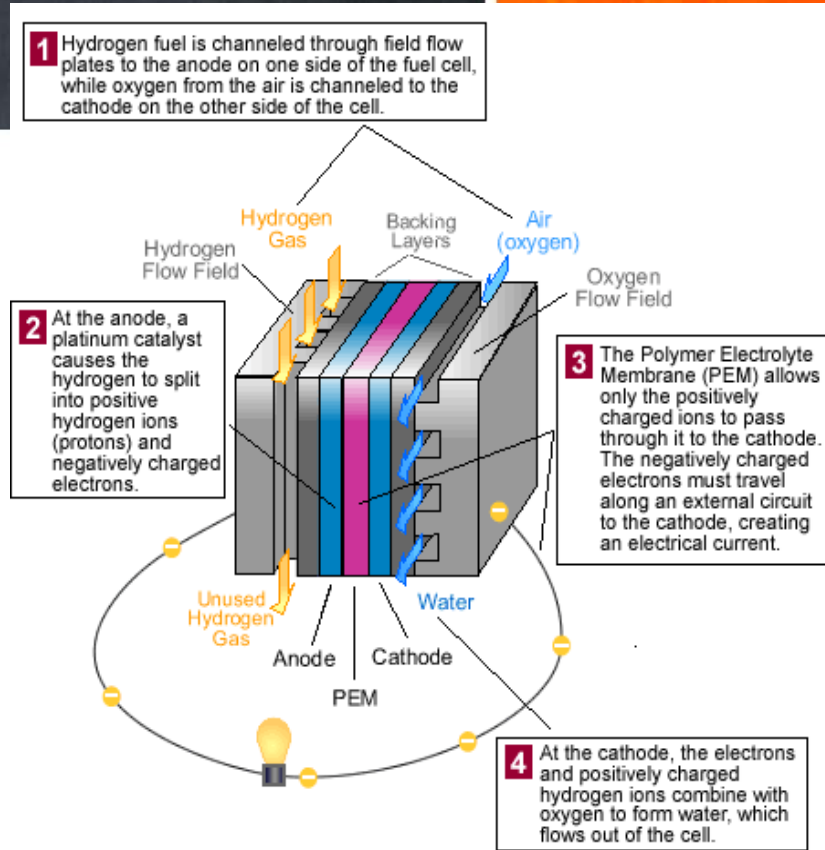
The destruction of natural streams by valley fills and the loss of vegetation can cause flooding.

Sources: Arch Coal Inc., West Virginia Department of Environmental Protection, Ohio Valley Environmental Coalition, Natural Resources Defense Council

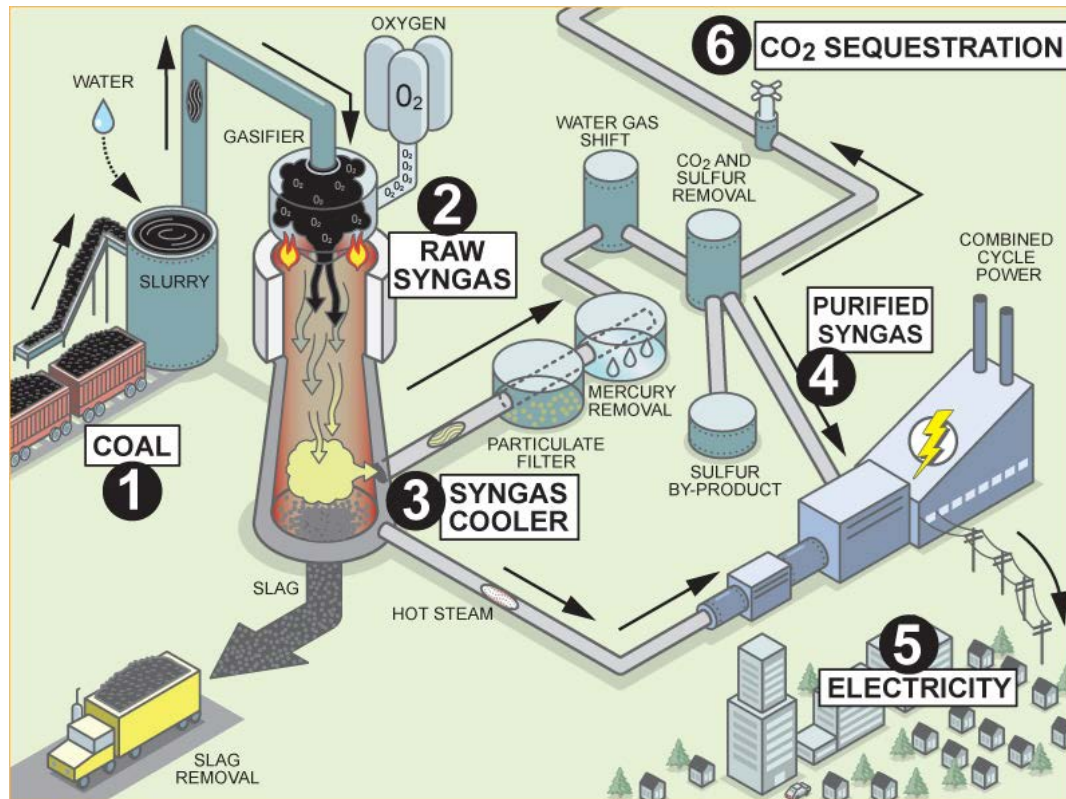
Ailsa Nance/The New York Times

Hydrogen Fuel Cells

- Alternative to combustion engines $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
 - No emissions
 - Silent
 - No recharging
 - Can use renewable fuels to pull H_2 from water - electrolysis
 - Fuel itself is efficient
 - expensive – materials, R&D
 - Need H_2 – takes energy to extract (often fossil fuels used!) – reduces overall efficiency
 - Often pulled from CH_4 - Steam reforming (releases greenhouse gases)
 - Low density – hard to transport
 - Very flammable, no smell

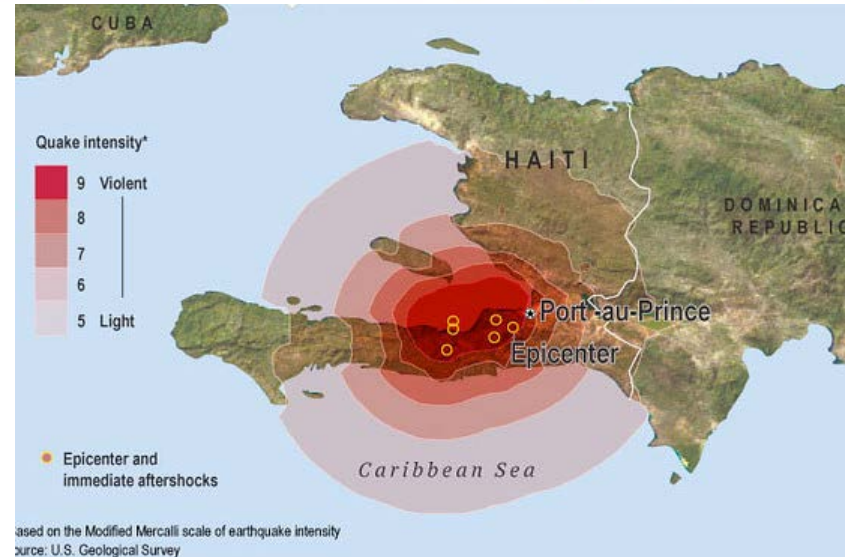


Clean Coal



Haiti Earthquake 2010

- 3 million people affected
- >200,000 killed
- Magnitude 7.0
- Transform Fault Boundary
- Why so bad?
- Focus's shallow depth
- Highly populous area
- Extremely poor country – not well prepared
- Basic infrastructure (communication, transportation, water supply) severely damaged
- Spread of disease – cholera outbreak

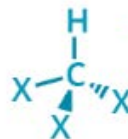


Flint Water Crisis

- Very high levels of lead and fecal coliform found in Michigan town
 - Due to increased use of road salts for melting of snow, poor and outdated piping, and alternative use of water sources (Flint River) that required trihalomethanes due to contamination
- 40% of town lives below the poverty line
 - NIMBY
 - Environmental Refugee?
- Lead is a neurotoxin
 - Shown to cause neurological damage in babies and young children
 - Bioaccumulation, biomagnification

THE FLINT WATER CRISIS

The American city of Flint, Michigan, has been in the news recently due to the discovery of very high levels of lead in its water supply. But how did this lead get there? Here's a brief explainer.



TRIHALOMETHANES

Disinfectant byproducts; formed by the reaction of chlorine (added to disinfect the water) with organic matter.

X = halogen (commonly Cl or Br)

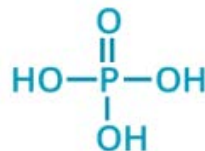
CORROSION: DETROIT VS. FLINT RIVER

0.45 VS 1.60
DETROIT FLINT

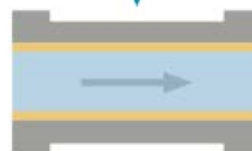
Chloride to sulfate mass ratio (CSMR); 0.45 = low corrosion; 1.60 = very high corrosion.

When high levels of trihalomethanes were detected in Flint's water, ferric chloride (FeCl_3) was added to improve removal of organic matter. However, this increased the water's already high concentration of chloride ions, and as a result made the water more corrosive.

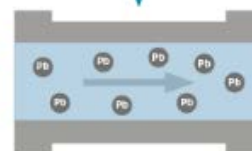
CORROSION CONTROL



WITH PHOSPHATES



WITHOUT PHOSPHATES



Orthophosphates are added to water to reduce the amount of lead leaching into it from pipes. They do this by forming a layer of low-solubility lead-phosphate complexes inside the pipe. This method of corrosion control was not used for the Flint River water supply.



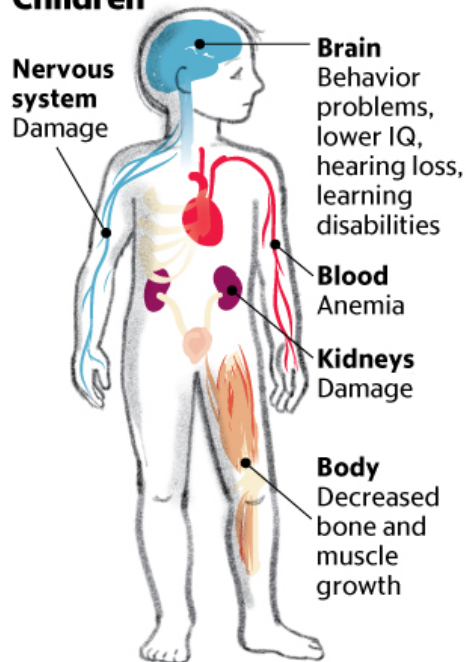
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Lead exposure

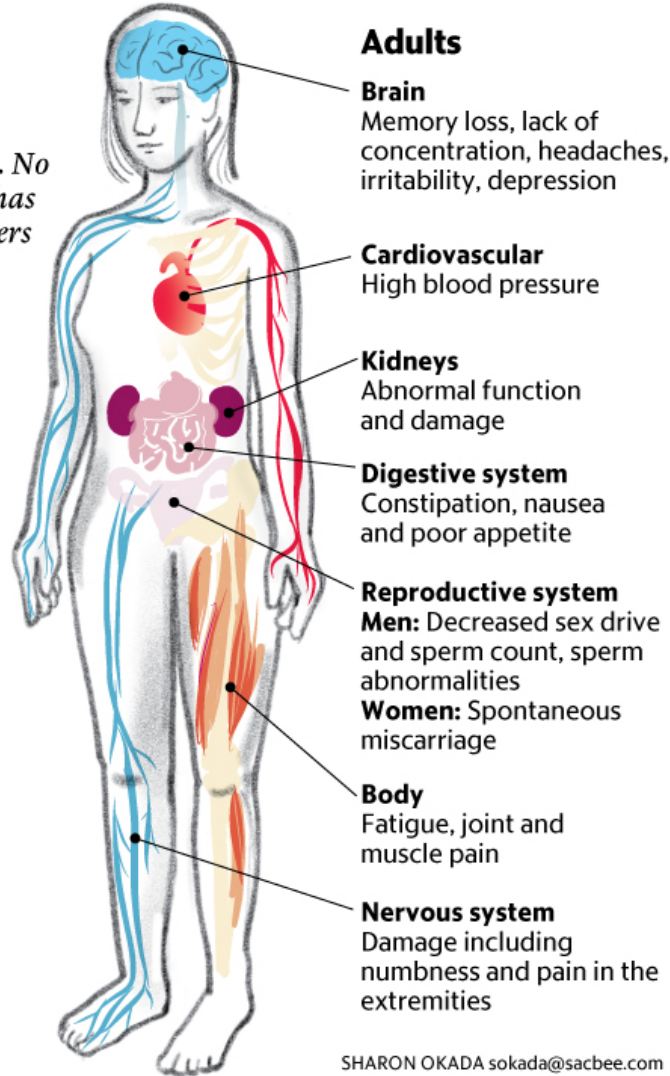
Although often without obvious symptoms, lead exposure can affect nearly every part of the human body. No safe level of lead in the bloodstream has been determined by the federal Centers for Disease Control and Prevention.

Children



Sources: Centers for Disease Control and Prevention; National Institutes of Health

Adults

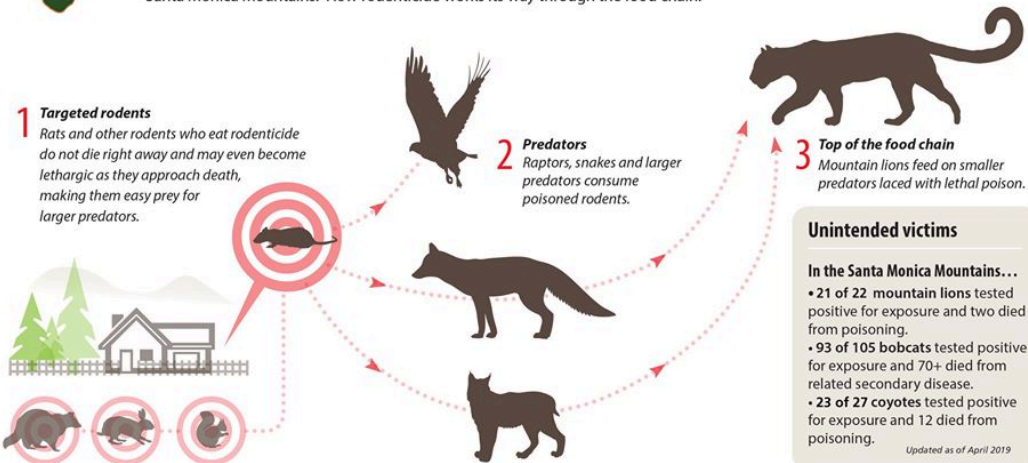


SHARON OKADA sokada@sacbee.com



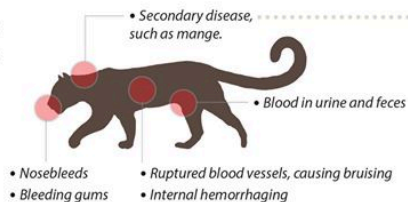
Lethal Dose: Rat Poison & Local Wildlife

Local residents may inadvertently be poisoning wildlife. National Park Service researchers have found a direct link between exposure to anticoagulant rodenticides, commonly known as rat poison, and the deaths of wildlife in and around the Santa Monica Mountains. How rodenticide works its way through the food chain:



How anticoagulant rodenticide kills

These compounds interrupt blood-clotting, which leads to uncontrolled bleeding and death. They may also suppress the animal's immune system, making it susceptible to other diseases. **Symptoms include:**



What is mange?

A microscopic mite that burrows into the skin and causes...

1. Extreme itchiness and skin lesions.
2. Fluid and nutrient loss through the skin.
3. Infection, starvation, hypothermia or other complications, eventually leading to death.



Check the label

Here are the most common anticoagulant compounds:

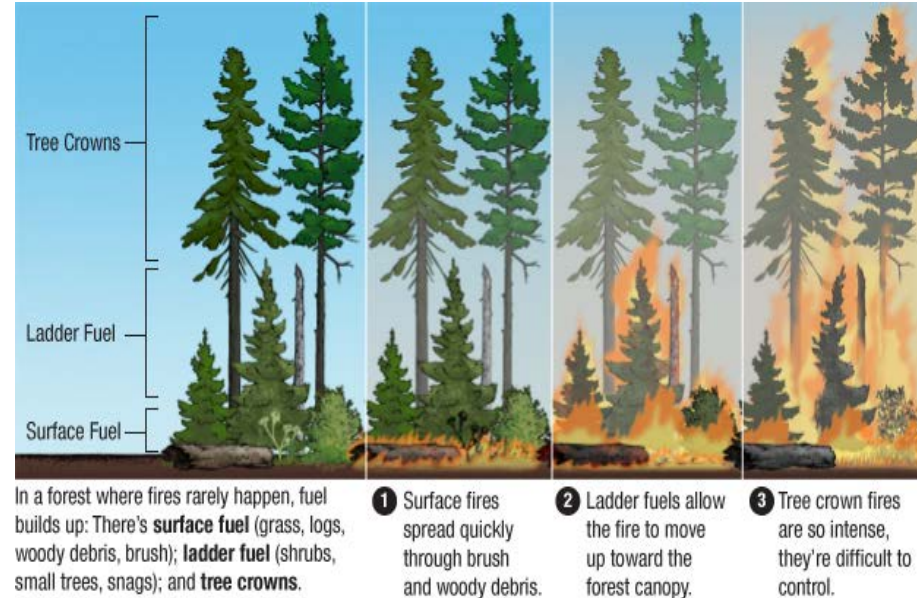
- Bromadiolone
- Brodifacoum
- Diphacinone
- Difethialone

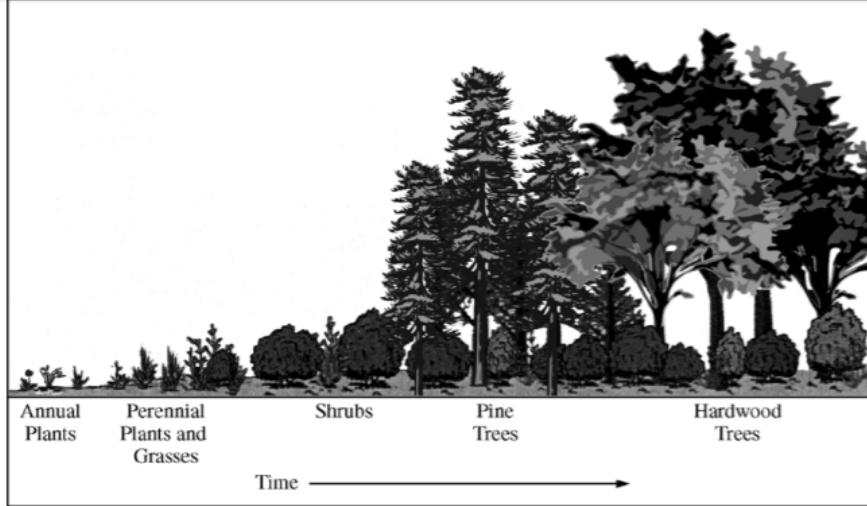


Consider brushing up [using this notable toxins ppt](#)

Wildfires

- Increasing in severity due to climate change
- In rainforest countries - these fires may be part of slash and burn agriculture which uses fires to restore nutrients
- Fire Ecology
 - Setting fires purposefully to maintain ecosystem balance
 - Crown fires: determinantal - burn too hot and are too destructive
 - Surface fires: burn understory and deposit nutrients back → promote secondary succession





The diagram above shows the succession of communities from annual plants to hardwood trees in a specific area over a period of time.

- (a) **Discuss** the expected changes in biodiversity as the stages of succession progress as shown in the diagram above. **(2 points maximum; 1 point per bullet)**

Cannot simply list the organisms depicted (shrubs → gymnosperms → angiosperm hardwoods)

- Biodiversity increases (plants, animals, decomposers).

Explanation of why biodiversity increases/changes are observed:

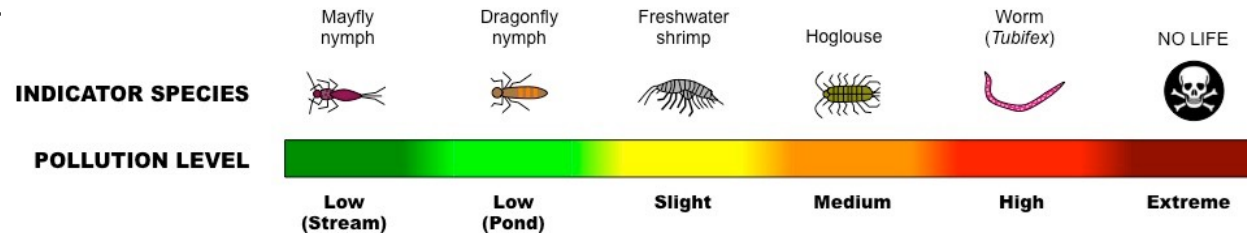
- Some populations *facilitate* biodiversity/succession (by developing conditions more suitable for other species and/or developing conditions less suitable for their progeny).
- Some populations *inhibit* biodiversity/succession (by developing conditions less suitable for other species and/or developing conditions more suitable for their progeny).
- Increase in plant stratification (increased layering of plants; e.g., canopy, understory).
- More *niches/habitats* formed (plants, animals, decomposers).
- Pioneer plant species → dominants (more shade-tolerant plants emerge).
- Increase in producer diversity brings about increase in consumer diversity.

Other:

- Shift from more opportunistic (*r*) to more equilibrium (*k*) species.

Indicator Species

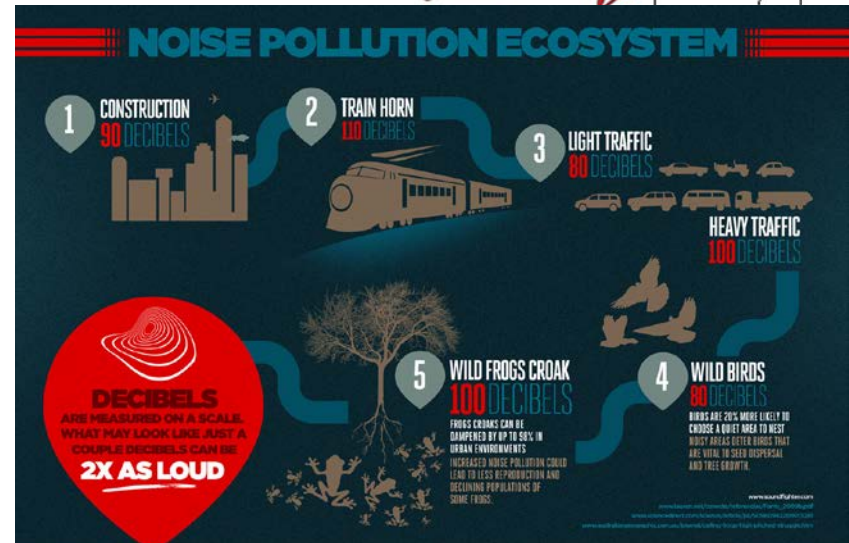
- Species that show early signs of distress in an ecosystem that may shadow a larger problem is at play
 - Frogs are often indicator species as they live in both aquatic and terrestrial environments
 - Birds are indicator species for air quality due to sensitive lungs “canary in a coal mine”
 - Aquatic macroinvertebrates signify water c
 - Scale -->



Noise Pollution

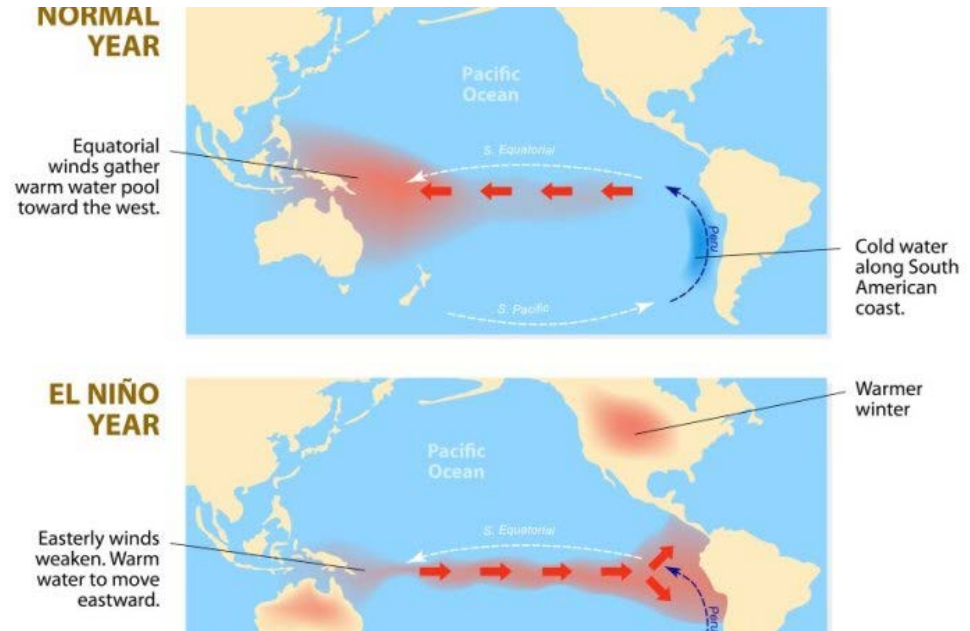


- Anthropogenic usually:
 - Planes, cars, Geothermal energy production, etc.
- Ecological Impacts
 - Birds are unable to hear mating calls, or find suitable nesting locations
 - Whales and dolphins: extensive use of sonar disrupts echolocation faculties
- Human health impacts
 - Can cause hearing problems
 - Anxiety and stress



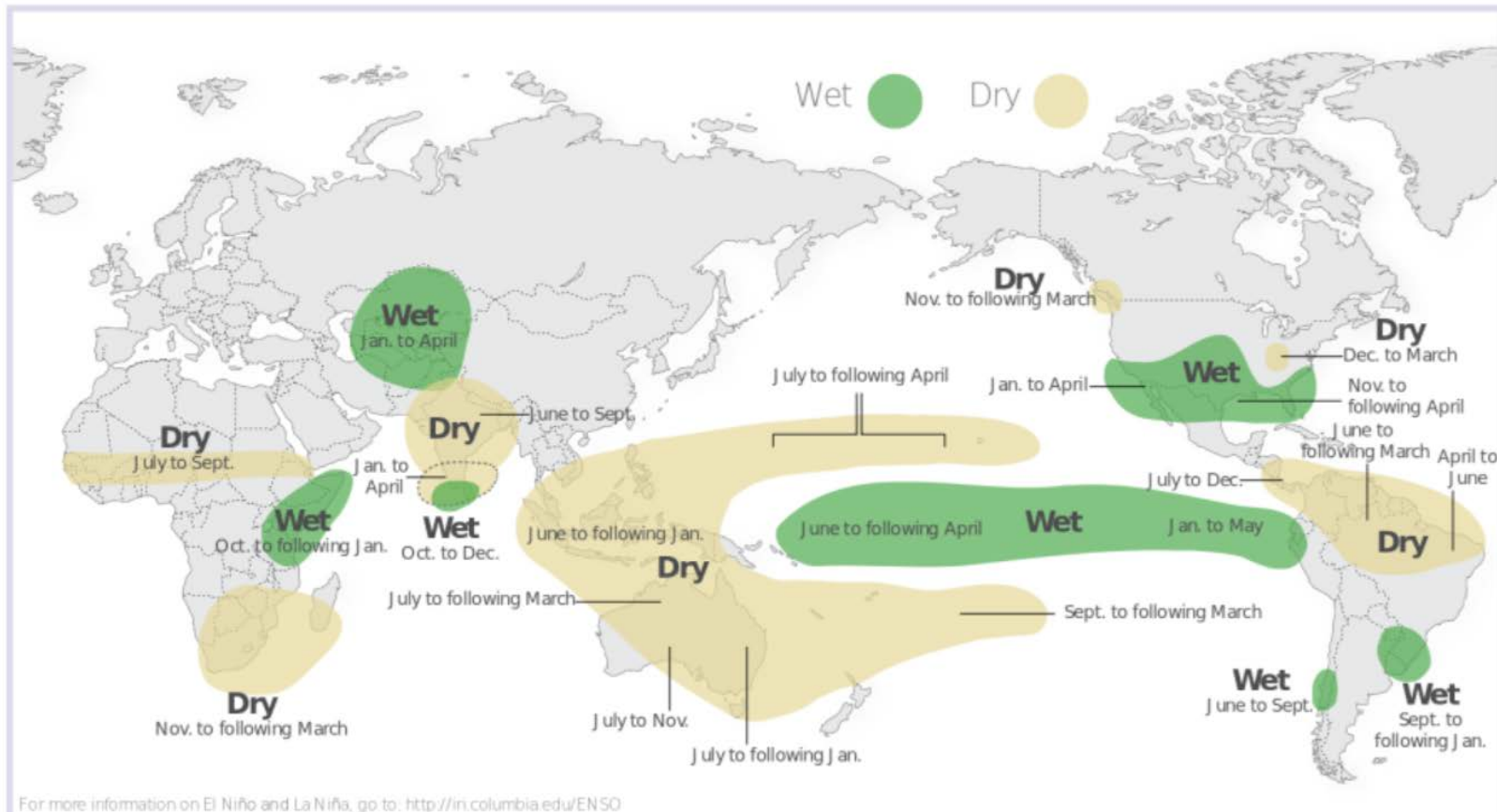
Super ENSO

- Impacted by climate change?
- ENSO - naturally occurring
- Cold, nutrient rich upwelling is suppressed
 - Biodiversity impacted
 - Fishing industry impacted



El Niño and Rainfall

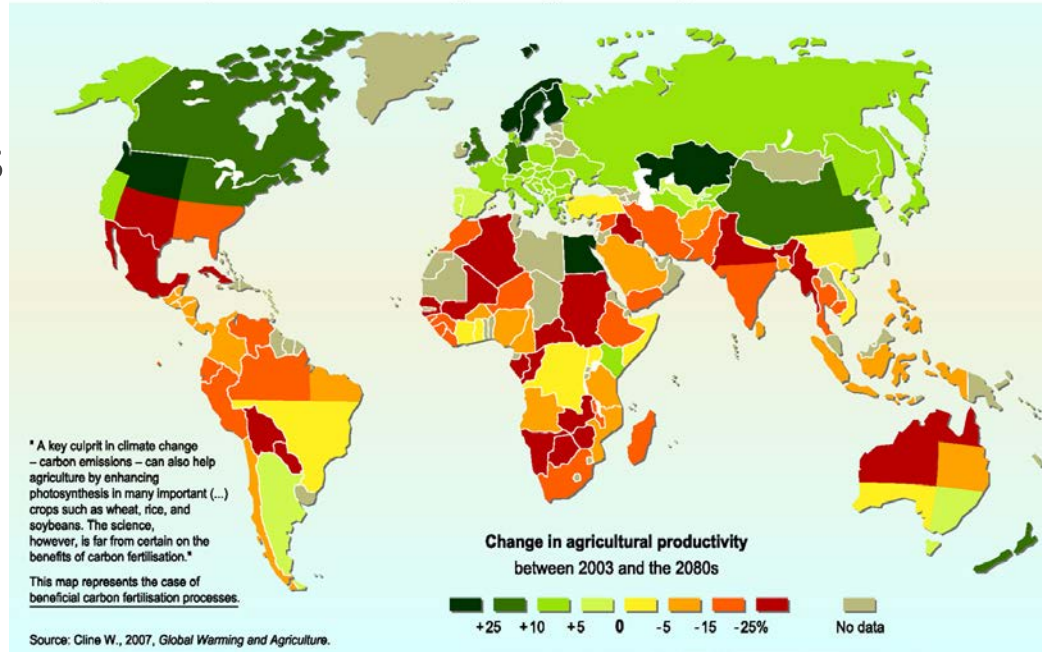
El Niño conditions in the tropical Pacific are known to shift rainfall patterns in many different parts of the world. Although they vary somewhat from one El Niño to the next, the strongest shifts remain fairly consistent in the regions and seasons shown on the map below.



Agriculture/feeding 10 Billion

- Impacted by climate change?
- Factory farming increases production, but has impacts:
 - Animal abuse
 - Fertilizer use
 - Energy intensive
 - Water intensive
 - Antibiotic resistance
 - Importance of bees

Projected impact of climate change on agricultural yields

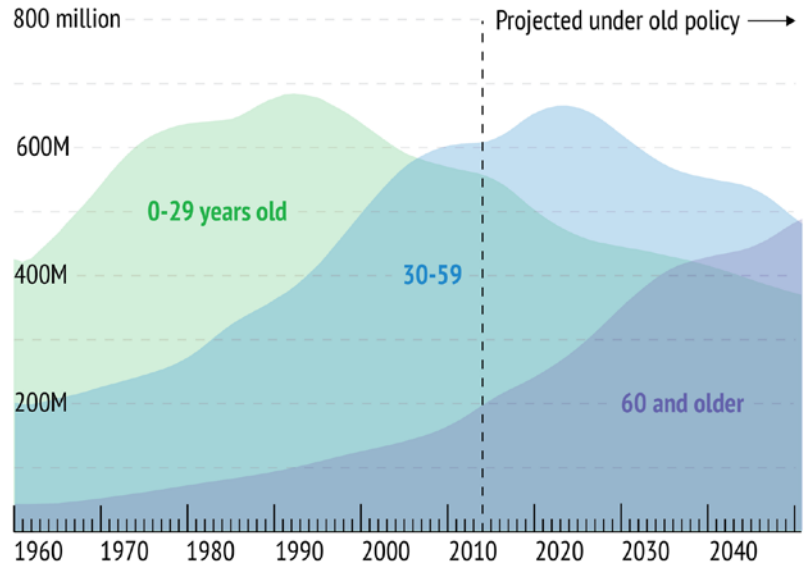


China drops 1-child policy

- Drastically reduced China's fertility starting in 1981
- Smaller workforce
 - Impacts on declining population
- Imbalance in gender
- Who cares for the elderly?

No country for young men

Under the old one-child policy, the senior population in China was growing while the youngest segment of the population was disappearing.



Source: The World Bank, Health Nutrition and Population Statistics: Population estimates and projections database

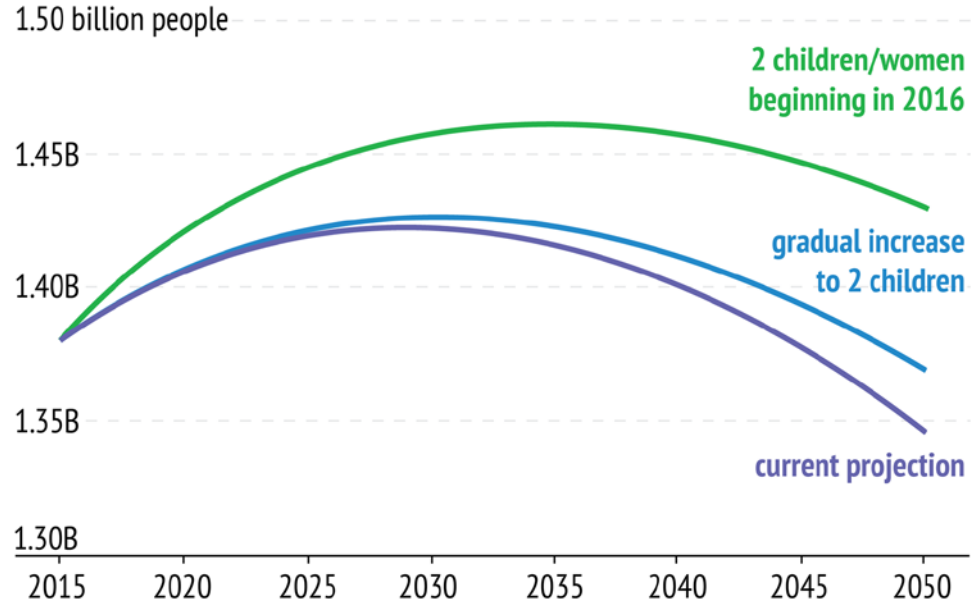


Human Population

- What are the impacts of a declining population?
 - Economic loss
 - Impacts to social security and other programs
 - People unable to retire

Population peaks

Even with the policy change, China is still expected to see a population decline in coming decades.



Source: Projections calculated by Population Reference Bureau Demographer Kristin Bietsch using Spectrum Software.



Human Population

- $I = P \times A \times T$
- I = Impact; P = Population; A = Affluence; T = Technology
- “Affluence Bomb” -- even if P stabilizes, rising A could lead to increased I unless we focus upon sustainable development.
- Rate of change = $[b-d] + [i-e]$
- US population = 310 million & World population = 7.2 billion
- Rule of 70 = $70/\text{growth rate}$ = number of years population will double
- Total Fertility vs. Replacement Level Fertility
- Total Fertility = avg. # children per woman
- RLF = avg. # children per woman needed for zero population growth
- Strategies to reduce population growth?
- Educate/empower women
- Decrease poverty
- Access to family planning

The following topics have already been tested on,
but are good to know...

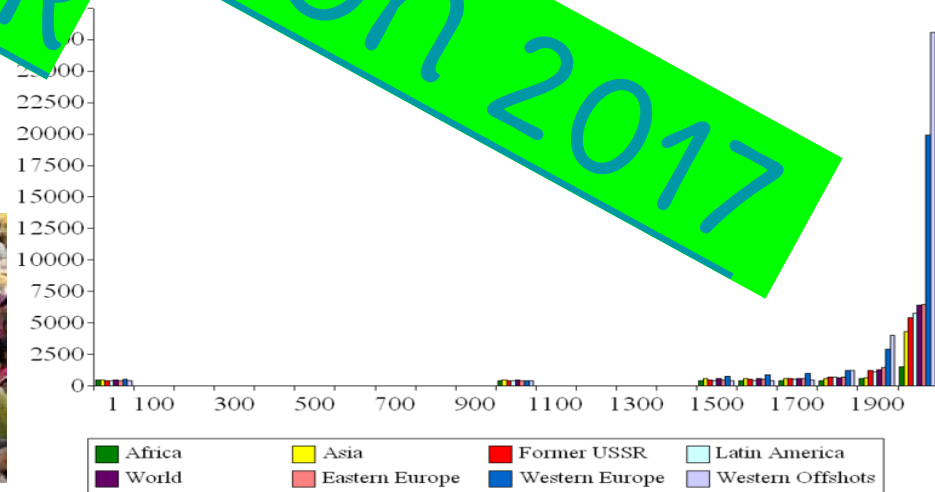
Possible FRC ...

- Humans – in China and

- Demographic trans
- $I = P \times A \times T$
- Influence, population size, affluence, technology
- Footprint
- Solutions?

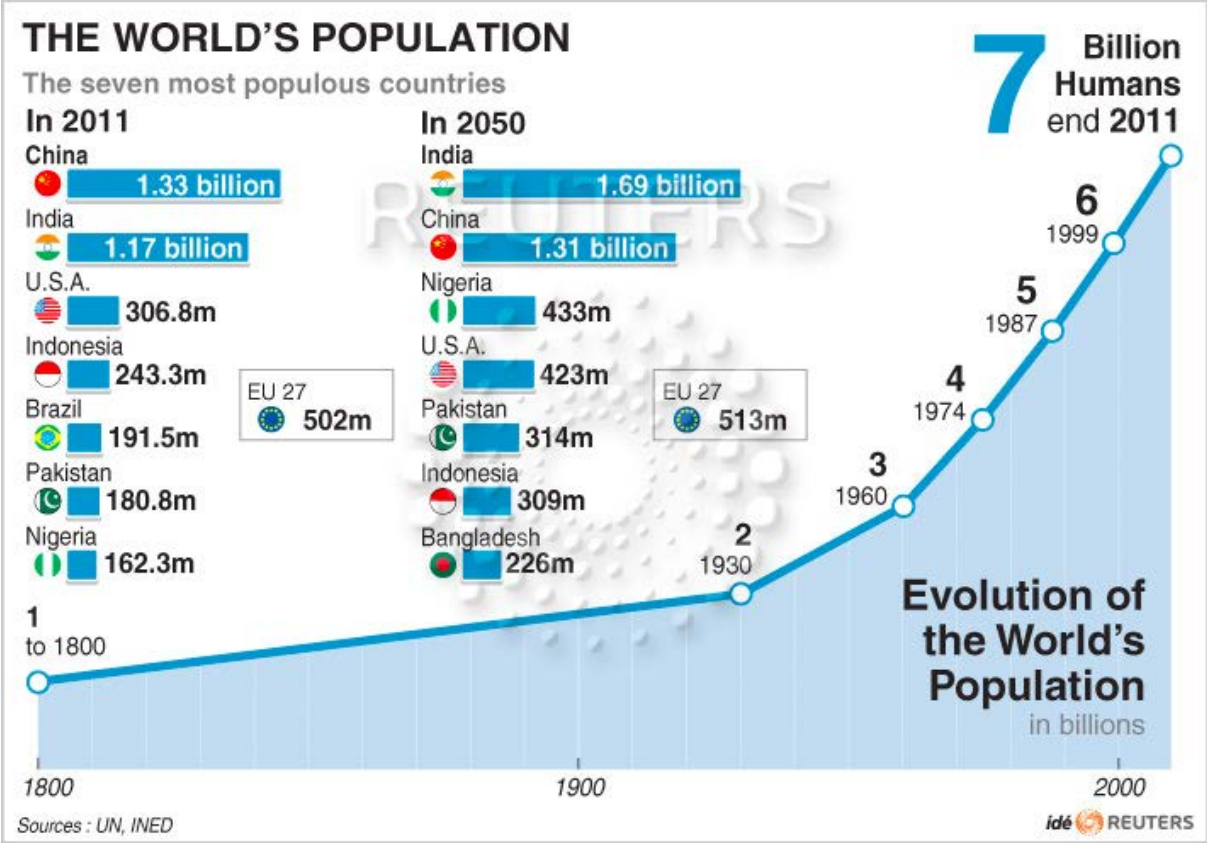


ita 1-2003 A.D.



HUMAN POP ON 2017
ABOUT TFR

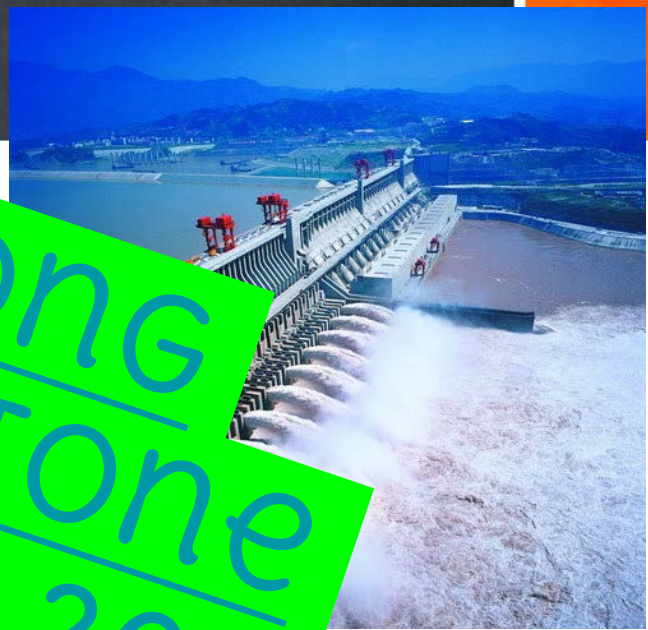
World Population Hits 7 Billion



Dams/ri

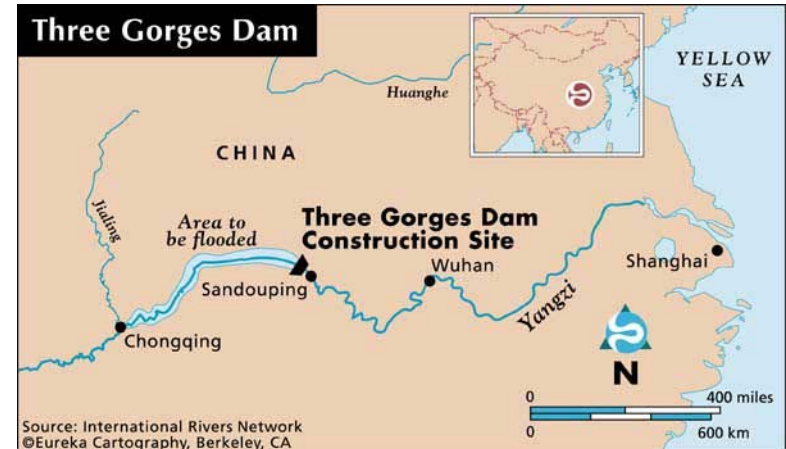
- Three Gorges
- largest
- Displace
- people from their
- Erosion of banks of
- reservoir
- Provides “clean energy”,
- water supply

Dams along
WITH KEYSTONE
SPECIES on 2017



Dams/Rivers

- Three Gorges Dam – Yangzi River in China
- World's largest hydropower project
- Displaced 1.2 million people
- Reservoir is polluted from submerged factories, mines, dumps
- Erosion on banks of reservoir causing landslides
- Worsens drought downstream
- BUT... provides “clean” energy, reliable water source



Keystone

Play a larger role in the ecosystem

- Cause a ripple effect of impacts of the species way down
- Classic examples:
 - Gray wolves of Yellowstone
 - Salmon
 - Otters

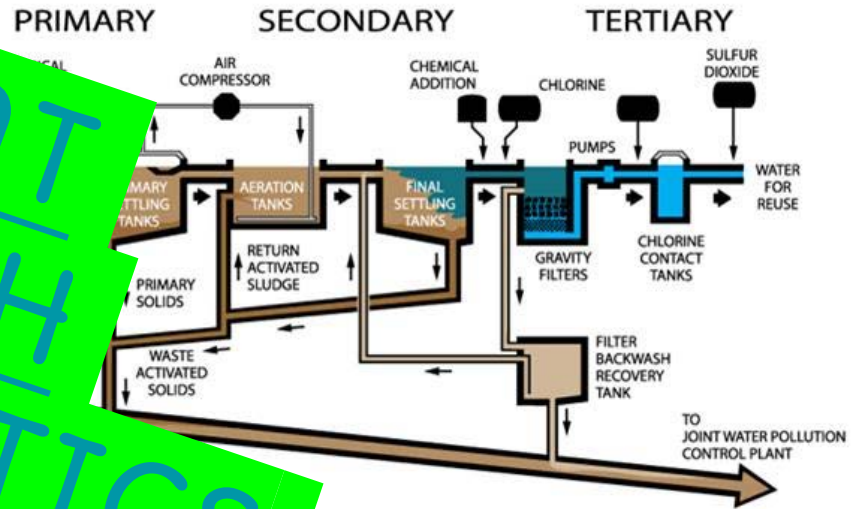
Dams along WITH KEYSTONE SPECIES on 2017



Sewage

- Sewage treatment
- outdated
- P
-
-
- Some may
- All systems lack as
- microplastic, microfleece, pharmaceuticals
- Natural wetlands can help:
phytoremediation, bioremediation

sewage
treatment
along with
microplastics
on 2017



Bee Colony Collapse

Relying on Bees

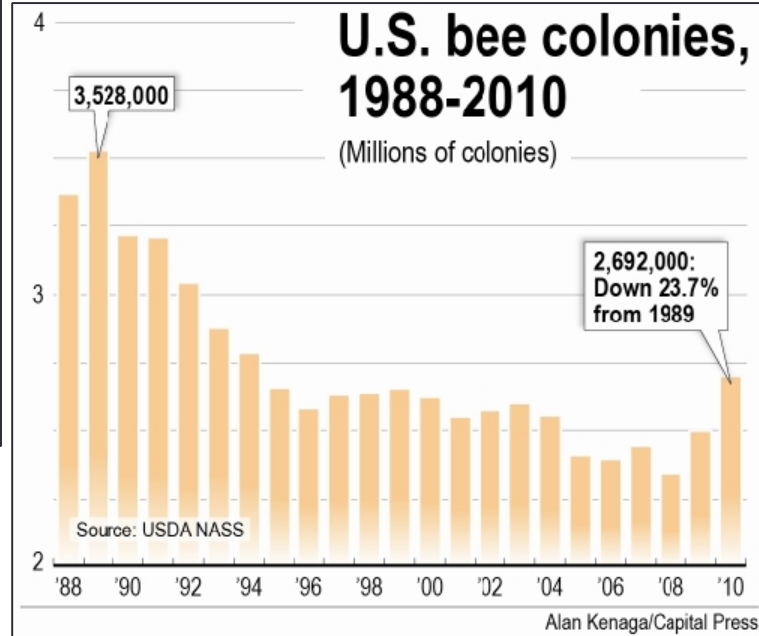
Some of the most valuable fruits, vegetables, nuts and field crops depend on insect pollinators, particularly honeybees.

| | Crop value in billions 2006 | Percentage pollinated by honeybees | Percentage of crop pollinated by ... | | |
|---------------------------|-----------------------------------|--|--------------------------------------|---------------|-------|
| | | | HONEYBEES | OTHER INSECTS | OTHER |
| Soybeans | \$19.7 | 5% | | | |
| Cotton | 5.2 | 16 | | | |
| Grapes | 3.2 | 1 | | | |
| Almonds | 2.2 | 100 | | | |
| Apples | 2.1 | 90 | | | |
| Oranges | 1.8 | 27 | | | |
| Strawberries | 1.5 | 2 | | | |
| Peanuts | 0.6 | 2 | | | |
| Peaches | 0.5 | 48 | | | |
| Blueberries cultivated | 0.5 | 90 | | | |

Besides insects, other means of pollination include birds, wind and rainwater.

Sources: United States Department of Agriculture;
Roger A. Morse and Nicholas W. Calderone, Cornell University

The New York Times



Bee Colony Collapse

Bee decline

Scientists now say one of the causes of colony collapse disorder (CCD), killing honey bees across the U.S., may be parasite-carrying honey bees from Australia.

Symptoms of CCD

- Failure to return to hive; no evidence of dead bodies
- Queen bee and adequate food supplies are left behind
- Other insects, predators don't immediately invade abandoned hive

Mix of causes may sicken bees

Pesticides

- Variety of pesticides used in the different areas reporting CCD
- Difficult to test for all possible pesticides simultaneously

Stress

- Strain from being moved long distances by beekeepers to pollinate crops
- Sudden changes in time zone, climate



Who's in the colony

Queen

- Fertile female, one in each colony; only lays eggs



Drone

- Male; task is to mate with queen, die shortly thereafter



Worker

- Infertile female; thousands in colony, collect pollen, nectar

Parasites

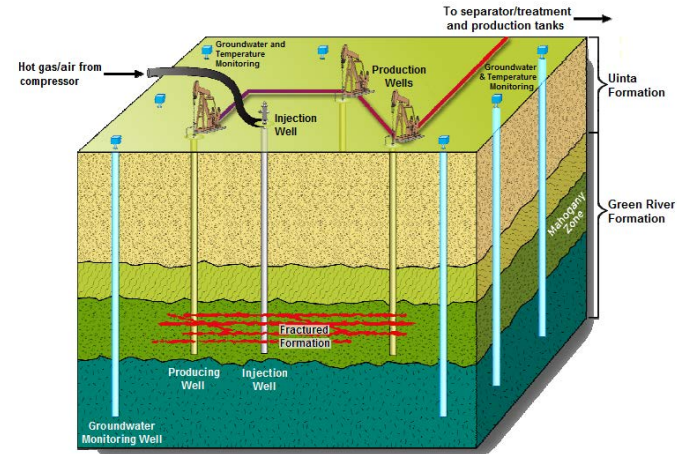
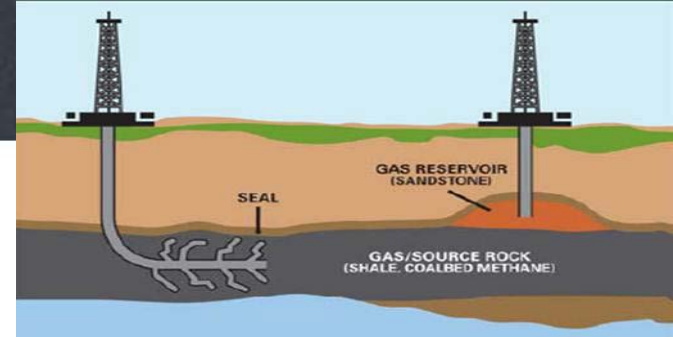
- Varroa mite, a bloodsucking parasite
- Pathogen, Israeli acute paralysis virus
- Not all CCD colonies contain parasites

Nutrition

- Fed corn syrup diet in winter
- Nutritionally inferior nectar and pollen of modified crops
- Little variety in diet; colonies pollinate one crop

Shale oil and fracking

- USA now producing significant amounts of oil from shale oil in North Dakota
- Oil out of rock



Truth Will Out: Fracking Has Tainted Ground Water

Giving the lie to gas drillers' long-standing insistence that hydraulic fracturing to release shale oil and gas has never contaminated drinking water supplies, the Environmental Protection Agency announced that it had [detected chemicals associated with fracking in groundwater in Wyoming](#). Earlier, EWG's own investigation uncovered a long-forgotten 1987 EPA report that found [fracking-related contamination in water wells used by West Virginia residents](#). In the face of mounting public pressure, meanwhile, [regulators decided to postpone action](#) on rules that could open the door to widespread drilling and fracking in the vast Delaware River watershed.

Tar Sands - [on FRQ 2011 #3](#)

- Energy - Tar sands (oil sands)
 - Keystone XL pipeline over prime ag land and Ogallala aquifer
 - Bitumen
 - Found under an old growth boreal forest
 - Ecosystem services of forests – CO2 sink
 - Low net energy
 - Very dirty
 - Surface mining
 - Toxic tailings ponds



The following are general reminders for the exam

Important Vocab

- Conservation
 - Greatest good for greatest number?
 - Controlled use
- Preservation
 - Remaining wilderness areas of public land should be left untouched
- Restoration
 - Bring back to former condition
- Remediation
 - Associated with cleanup of chemical contaminants in a polluted area
- Mitigation
 - Repairing/rehabilitating a damaged ecosystem or compensation for damage – substitute or replacement area (common with wetlands)
- Reclamation
 - Chemical and physical manipulations in severely degraded sites like open pit mines

Important Vocab continued....

- Anthropogenic - man/human centered ie: an anthropogenic source of CO₂
- Mortality - death rate, ie: infant mortality rate during the transitional stage...

Final things to remember. . .

1. Layers of atmosphere: These Spheres Mask The Earth
2. CO₂ is not a traditional air pollutant, it's a GHG.
3. Fertilizers and pesticides are NOT the same. Fertilizers have N,P,K for plant growth. Pesticides kill bugs. Know about problems of each.
4. An ecological/ecosystem "cost" is NOT about money, it's about a problem in an ecosystem. A question about \$ will have the word "economic".
5. Stratospheric ozone thinning (hole) and global warming are NOT the same thing.
6. For air pollution questions, all pollutants except lead cause "respiratory problems such as asthma"
7. Advantage for any biome, ecosystem service, habitat = ecotourism, aesthetic value
8. Ecological impacts can almost always be habitat destruction which leads to a decrease in biodiversity
9. Ways to get people to do things are almost always education.
10. We subsidize behavior we do like, tax things we don't like.

Final things to remember. . .

1. Review experimental design: dependent & independent variables, hypothesis with "increasing/decreasing" in it.
2. Use the words "money" or "jobs" for economic questions. For govt. incentives: subsidies, tax credit/rebates, cap and trade. Disincentives include taxes, fines, legal penalties, property value loss
3. Eutrophication: excess nutrients (N,P) from fertilizer, manure or urban sewage are washed by rain into rivers which flow to the ocean => algal/phytoplankton bloom then die-off from lack of light => decomposed by bacteria who use all the oxygen => hypoxia and fish death => anaerobic mess
4. When talking about change in an ecosystem, use "increasing" or "decreasing". Ex: Invasive species cause native species population to decrease
5. Review the nitrogen cycle! The AP exam LOVES the nitrogen cycle.
6. If you can't think of other possible solutions to problems, use education (but indicate what we should educate about).

Final things to remember. . .

1. An ecosystem service is defined as something nature provides humans for survival or economic benefit. NOT something nature gives itself.
2. #1 way to control population growth is to provide education (literacy) for girls. Girls marry later, and have less children. Lowers poverty.
3. Try the Rule of 70 for growth rate.
4. Food chains always begin with a producer. Arrows point the direction of energy flow (toward the predator).
5. Anthropogenic = human made. Degradation = decline in quality. Synthetic = not natural.
6. Loss of biodiversity → HIPPCO
7. Sustainability = protect natural cycles + true pricing + renewable energy + biodiversity + population control

Important Laws

- Coastal Management Act
- Corporate Average Fuel Economy (CAFE standards)
- Clean Air Act
- Clean Water Act
- Comprehensive Environmental Response, Compensation Liability Act (CERCLA)
- Manages coastal resources (including Great Lakes) – balances economic development with conservation
- Sets minimum fuel economy standards
- Establishes primary and secondary air quality standards for 6 criteria pollutants (SO₂, NO_x, CO, PM, O₃, Pb)
- Regulates discharge into water sources and wetland destruction (water looks)
- Provides funds for clean-up of hazardous substances (Superfund Sites): largely not effective

Important Laws

- Convention on International Trade in Endangered Species (CITES)
- Endangered Species Act (ESA)
- Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
- Kyoto Protocol
- International legislation banning hunting, selling, importing endangered species
- Protects threatened and endangered species and their habitats – involves recovery plan
- Requires that pesticides are registered and approved by the FDA
- Agreement among 150 nations requiring greenhouse gas emissions reduction - USA didn't ratify

Important Laws

- Montreal Protocol
 - Banned production of aerosols and initiated the phasing out of CFCs
- National Environmental Policy Act (NEPA)
 - Requires environmental impact statement for every major federal project
- National Forest Management Act
 - Sets standards for how the Forest Service manages National Forests – requires land management plans for national forests and grasslands

Important Laws

- Resource Conservation and Recovery Act (RCRA)
- Safe Drinking Water Act
- Surface Mining Control and Reclamation Act
- Toxic Substances Control Act
- Management of solid waste including landfills and storage tanks – set minimum standards for all waste disposal (including hazardous waste)
- Sets standards for drinking water quality (how water tastes)
- Requires restoration of abandoned mines
- Tracks 75,000 industrial chemicals – tested for environmental or health hazard and banned if high risk