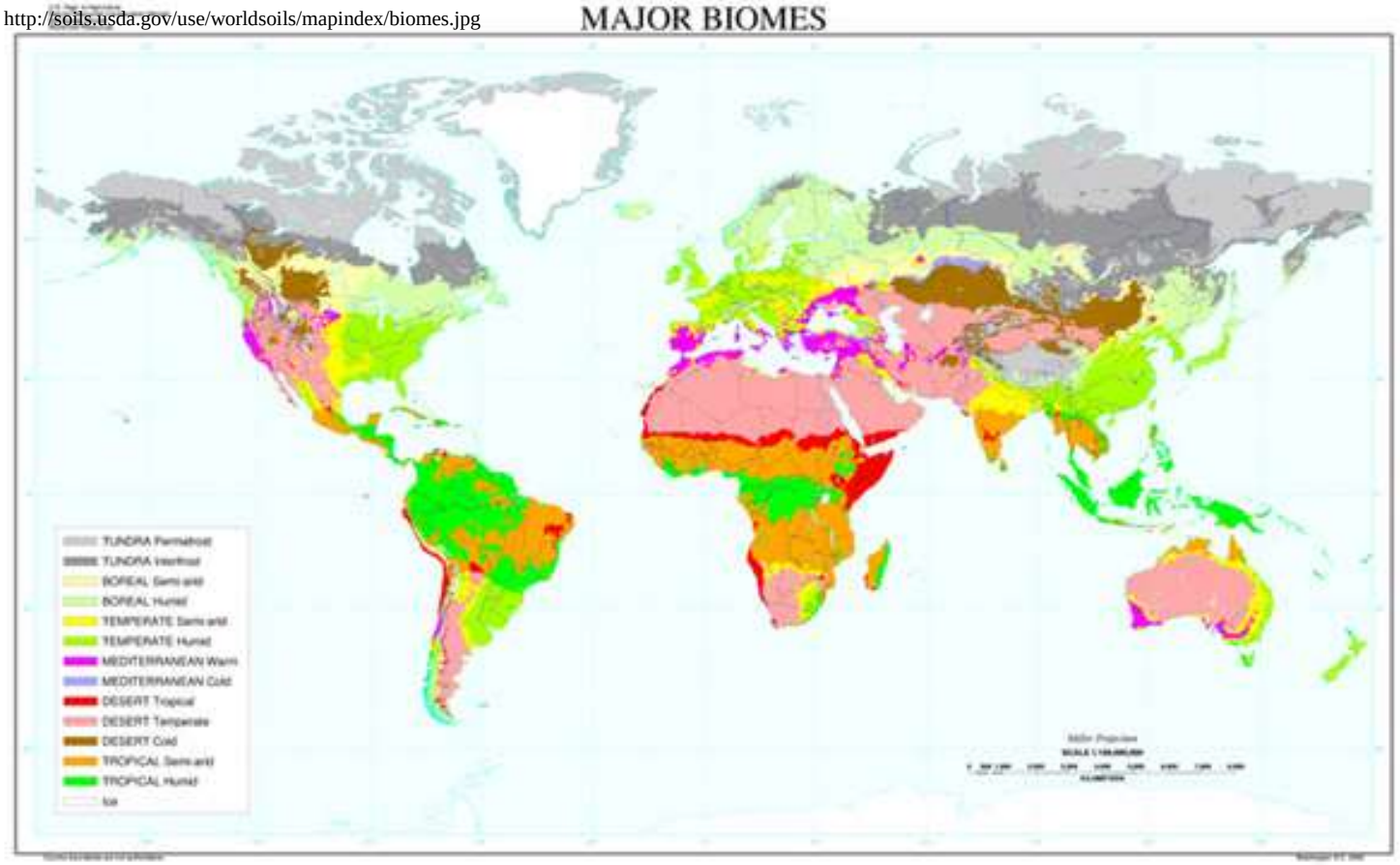
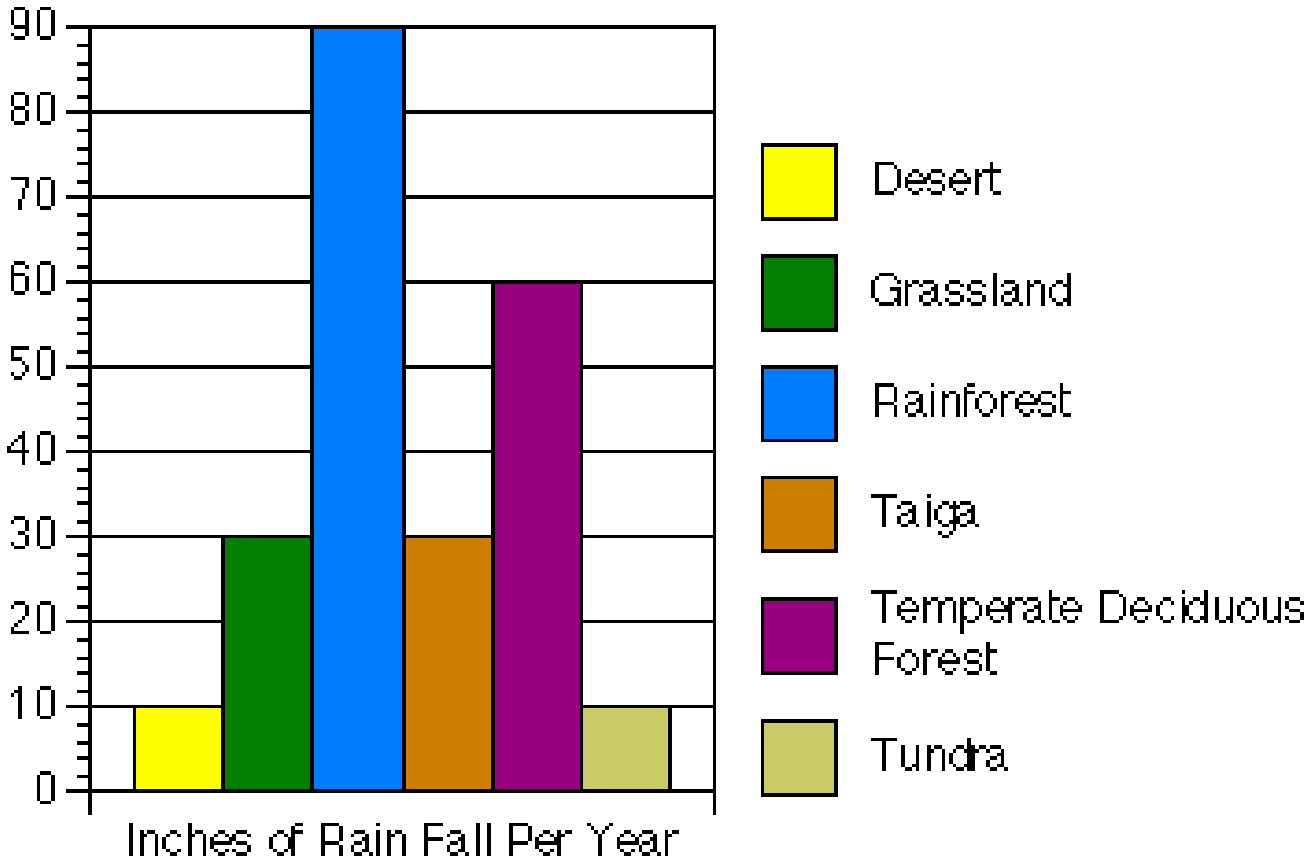
Unit 2: Biomes, Succession and Land Use Management

http://soils.usda.gov/use/worldsoils/mapindex/biomes.jpg



Large geographic areas having similar climates and communities (determined by latitude, altitude, and climate (temp and ppt.)

Land Biomes


90
80
70
60
50
40
30
20
10
0
Inches of Rain Fall Per Year
Desert
Grassland
Rainforest
Taiga
Temperate Deciduous Forest
Tundra

Deserts

- Cover 30% of world land mass
  - Interiors of continents (between 30° N and S latitude)
  - Can be caused by rain shadow effect
  - 0 - 25 cm annual ppt.

- High diurnal fluctuations (night and day differences in temp.) WHY?????

Humans impact deserts

Human Impacts and Deserts

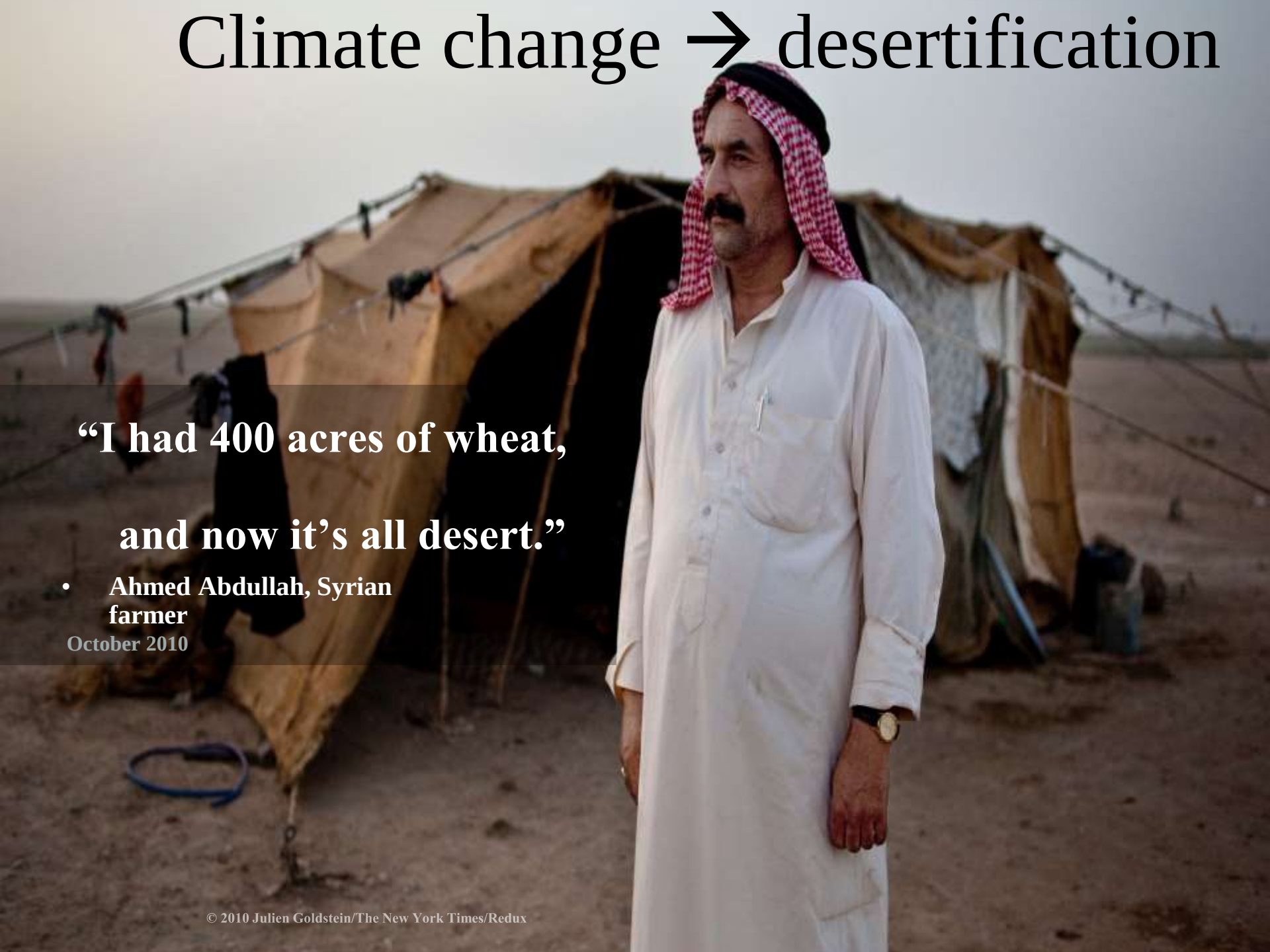
- **Desertification caused by overgrazing and removal of native grasses from grasslands**

Desertification = useful land converted to deserts

- Human activities → increasing size and number of deserts

Overgrazing and climate change → desertification

Climate change → desertification



"I had 400 acres of wheat,

and now it's all desert."

- **Ahmed Abdullah, Syrian farmer**

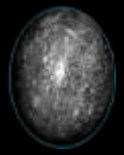
October 2010

© 2010 Julien Goldstein/The New York Times/Redux

© 2008 EPA/Everett Kennedy Brown/Landov

Mercury

333° F

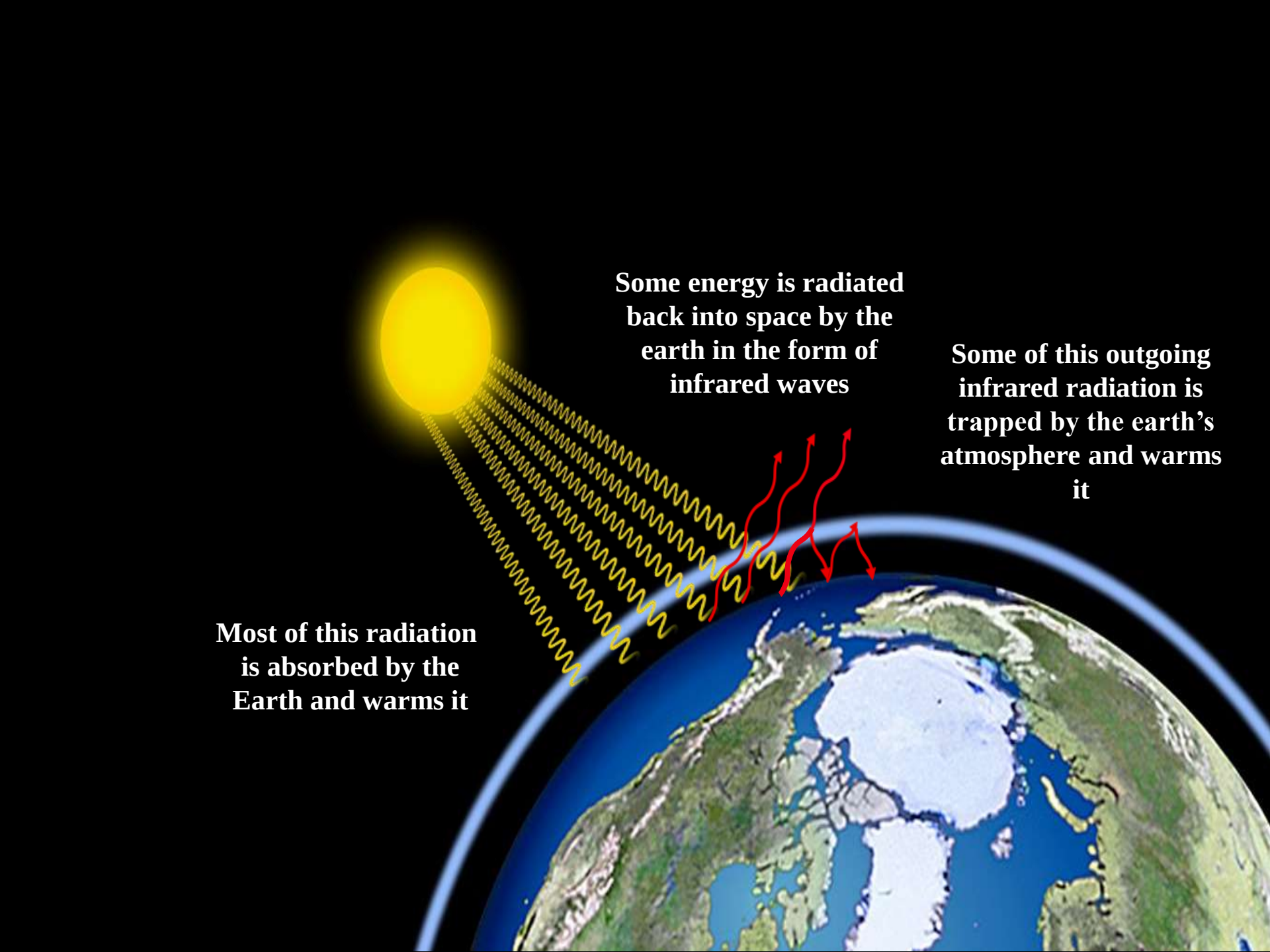


Venus

+855° F

Earth

59° F


Some energy is radiated back into space by the earth in the form of infrared waves
Some of this outgoing infrared radiation is trapped by the earth's atmosphere and warms it
Most of this radiation is absorbed by the Earth and warms it

Extra heat evaporates water from the ocean and pulls moisture even more quickly from the soil

An Inconvenient Truth © 2006 by Paramount Classics, a Division of Paramount Pictures. All Rights Reserved.

Desert adaptions

Desert adaptations

- Plants and Animals adapted to
  - Little water
  - Cold nights and hot days

Causes of desertification

- Burning fossil fuels → Climate change

- Overgrazing = too many farm animals eat too much plant material

Solutions to Human Impacts

- Prevent desertification:
  - Preservation of native species (adapted to drought)
  - Set grazing limits (# animals / acre)

- Prevent/minimize climate change:
  - Decrease burning fossil fuels
  - Forest conservation programs

Leonardo DiCaprio
COP21 Paris - UN talks

- Trailer
- https://www.youtube.com/v/6UGsRcxaSAI
- Final presentation at Paris talks COP 21
- https://www.youtube.com/v/m-FM845giaI

Review quiz

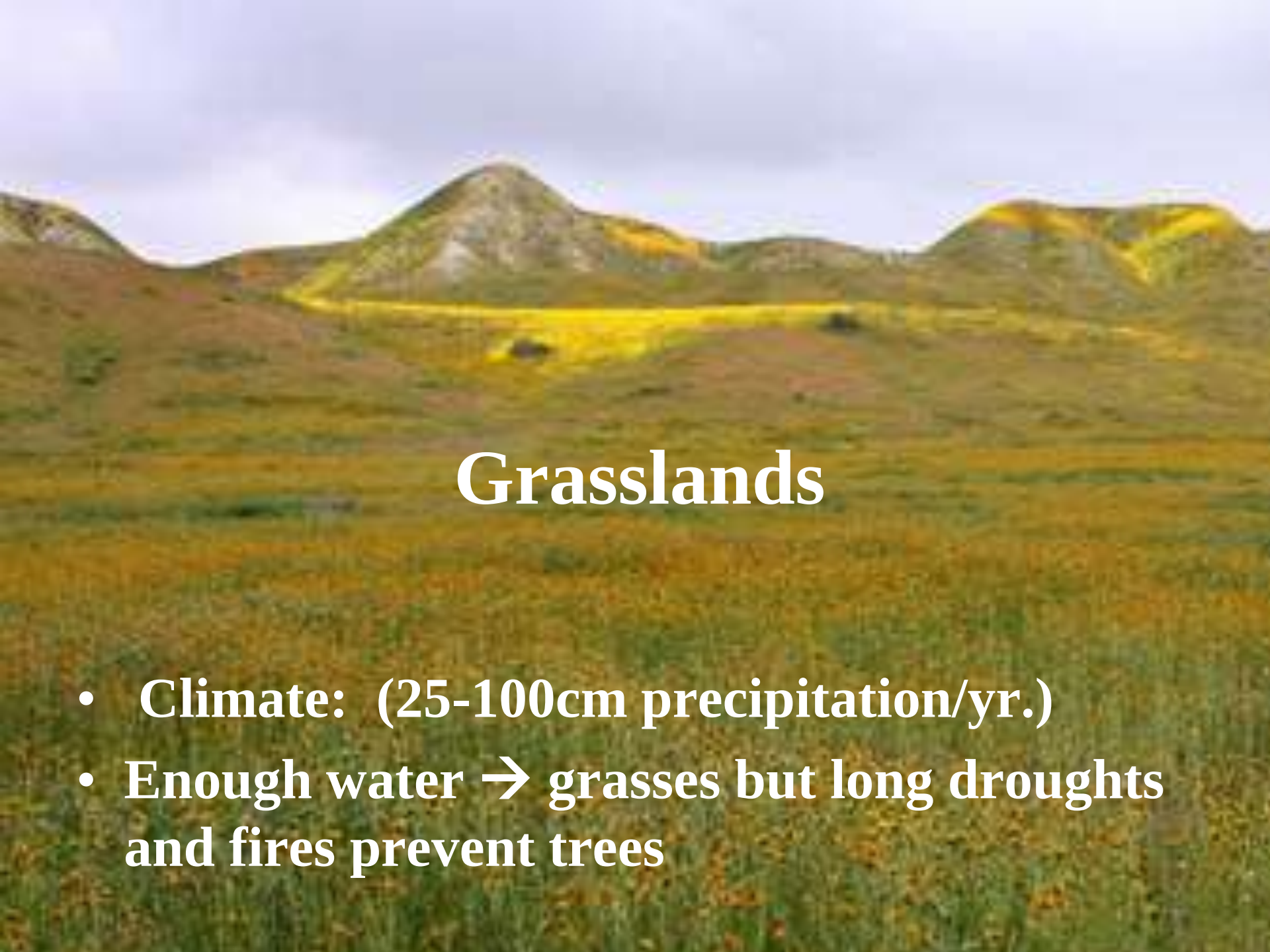
1. Describe the name and characteristics of desert soils
2. 2 causes of desertification
3. Name of winds that increase during a La Nina → intense wildfires in the west.
4. Problem with irrigating in arid region
5. Name a solution to that problem

Grasslands

- Climate: Enough annual ppt. → grasses but long droughts and fires prevent trees (25-100cm ppt/yr.)
- Cover 30% of land mass
- Bread baskets of the world

Grasslands

- Thick fertile soil due to extensive roots of native grasses
- Chaparrals, steppes, grasslands all maintained by????????



Grasslands

- Climate: (25-100cm precipitation/yr.)
- Enough water → grasses but long droughts and fires prevent trees

Maintained by fire

Seasonal droughts

Herbivores

x: prairie dogs, bison…)

Keystone species

More than 90% of US prairies have been lost

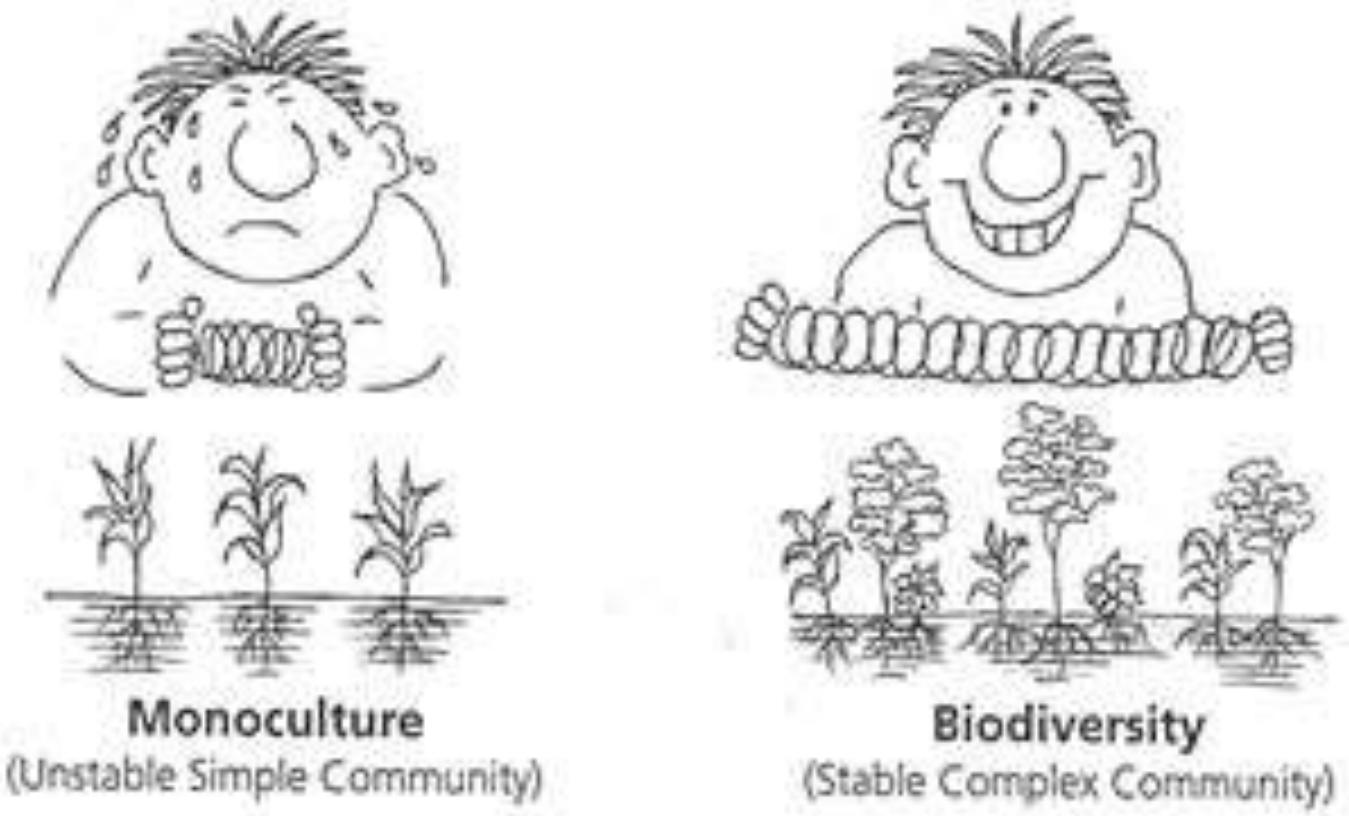
→

agriculture →

Nebraska

Why is this a problem?

- <u>Loss of biodiversity = loss of stability</u>



Ohio

Oklahoma and Texas

Removal of native grasses → increased erosion and loss of topsoil

Grasslands communities in US

- Vegetation (flora): wildflowers, grasses, shrubs with scattered trees

- Fauna: rodents, large hoofed herbivores
- Predators: wolves, coyotes, hawks

https://www.natureworkseverywhere.org/resources/wolves-of-yellowstone/

- Describe the ecological niche of predators
  - prevent herbivore populations from exceeding carrying capacity
- Define keystone species and give an example
  - Keystone species – remove them and the whole ecosystem is affected (ex: wolves)
- Define trophic cascade
  - Ecosystem effects that trickle down from apex predators

Tragedy of the Commons Activity

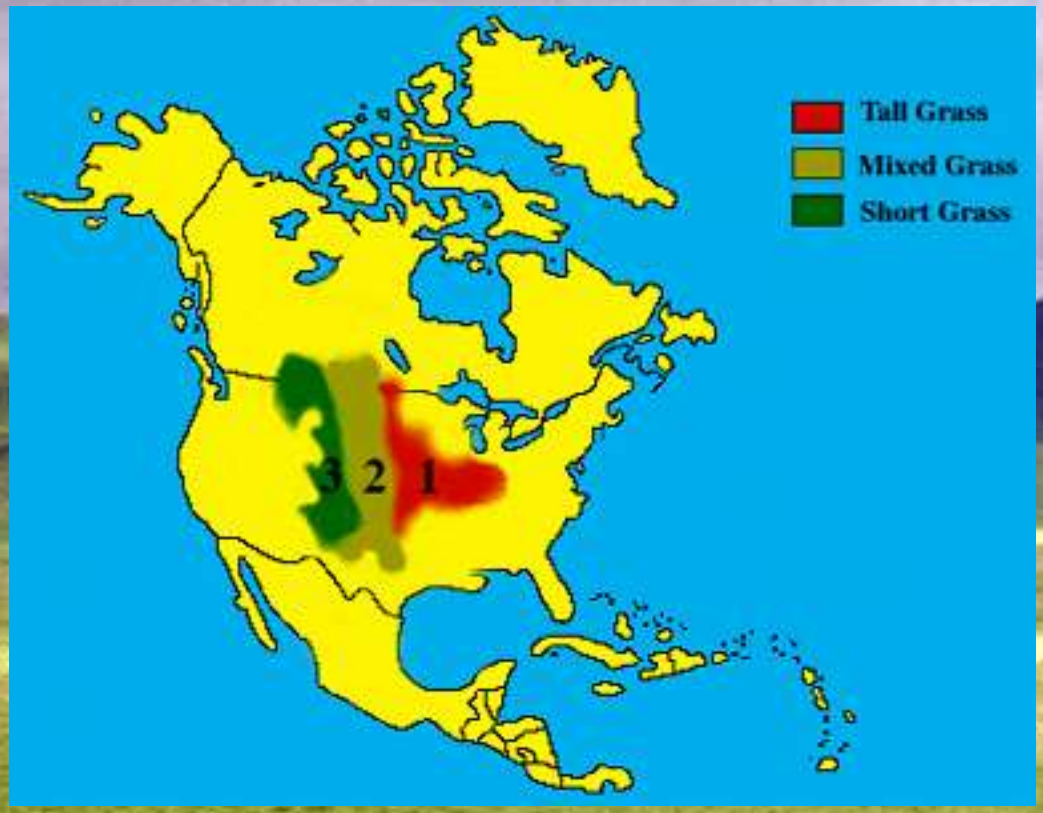
- Define: Tragedy of Commons
  - Unregulated use of public resource → degradation of that resource
- Examples
  - grazing on public land → overgrazing
  - Unregulated use of groundwater → depletion of water supplies
  - Unregulated use of air → air pollution
  - Unregulated use of oceans → overfishing

Technologies → overfishing

- https://www.youtube.com/v/Z4AXnZOsrK8

- https://www.natureworkseverywhere.org/resources/fishing-for-a-future/

3 types of grasslands in US



Human impacts: Grasslands

- More than
- 90% of US prairies have been lost →
- agriculture →
- loss of biodiversity = loss of stability

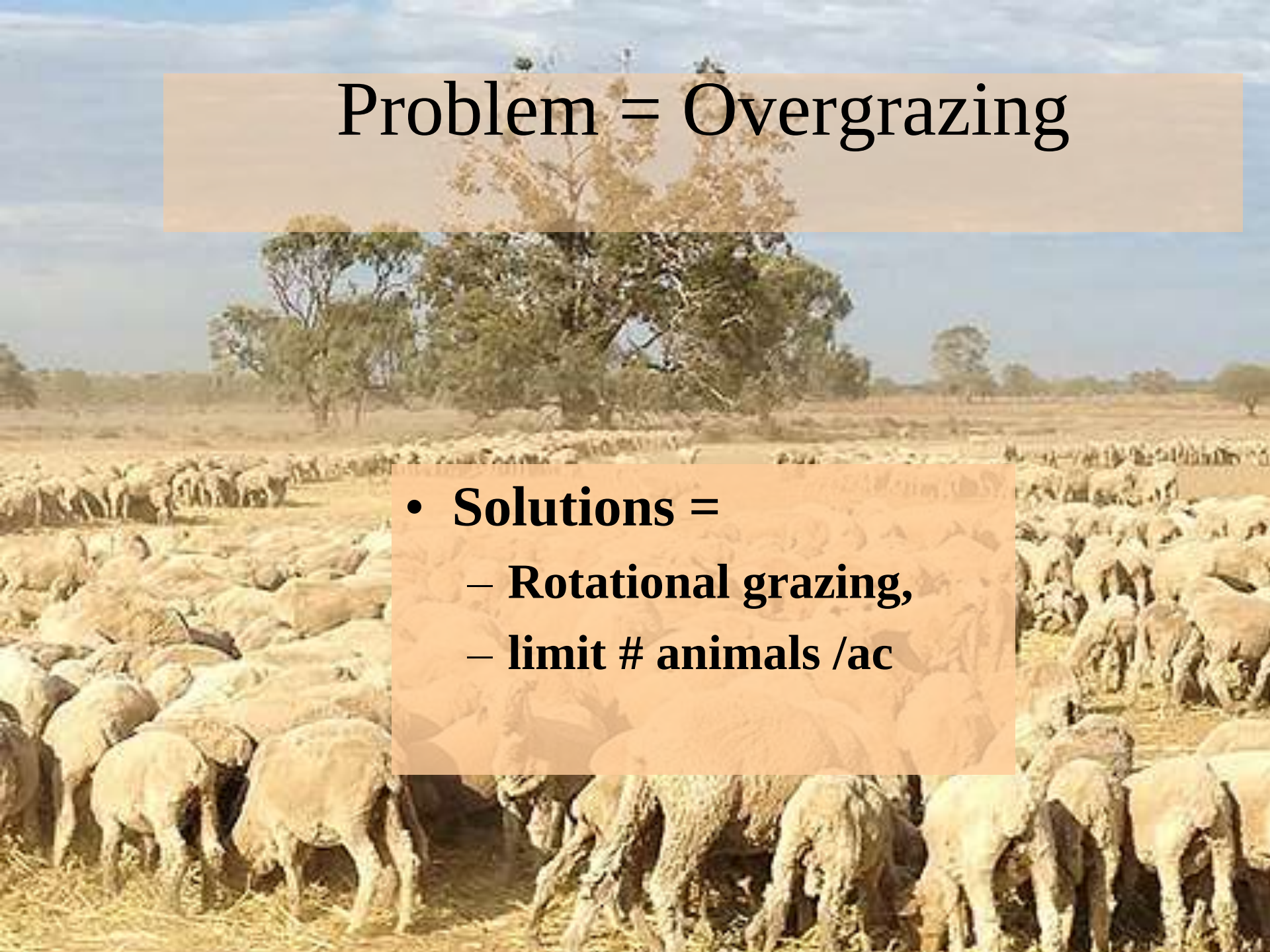
Solutions to Human Impacts

- Problem = Large scale agriculture → fragmentation and habitat loss

- Solution =
  - http://www.bbc.co.uk/programmes/p00b3k5g

Wildlife corridors

Problem = Overgrazing



- **Solutions =**
  - **Rotational grazing,**
  - **limit # animals /ac**

Solutions = plant cover crops

Plant wind breaks (shrub borders)

Problem = Overhunting

- **Solution**
  - Endangered species act – protects habitats of species on the list
  - Amendments allow landowners to modify property only with a habitat conservation plan

Taylor Grazing Act (1934)

- Requires grazing permits on federal land
  - An attempt to prevent overgrazing and erosion
  - Written when we were still trying to settle the West
- Underestimate costs:
  - ***1968 -1986 grazing fees were $1.23 to $1.35 /animal / day***
  - ***1986 - 2010 stayed at $1.35.***
  - ***in 46 years it only increased by 12 cents***
  - permit cost $1.35, actual cost = $10

Management and Laws: Rangelands

- Bureau of Land Management (BLM) in charge of management
- Jobs include:
  - Control # livestock / acre
  - Restore degraded rangeland
  - Protect riparian (shoreline) zones
  - Control invasive species

Review quiz

1. Type of and characteristics of grassland soils
2. Define keystone species and state why wolves are keystone species
3. Loss of diversity = loss of _____
4. What is the tragedy of the commons and give an example using grasslands
5. Describe 3 different farming techniques that help conserve and improve soils

Tundra

- Found at latitudes > 60°
- Water is unavailable during most of the year

©2005 Khanjan Mehta

Permafrost = permanently frozen ground

- Permafrost prevents trees from growing →
- poor drainage → boggy conditions →
- no true soil development and
- very short growing seasons

Meet Elijah Tigullaraq

And His wife Naomi

They live in Pond Inlet in the Canadian province of Nunavat

http://www.turtletrack.org/Issues04/Co05222004/CO_05222004_NunavatElders.htm

TUVAQ

MERCURY
MERCURY

Tundra

- High latitude = high altitude → alpine tundra above tree-line

©2005 Khanjan Mehta

High altitude → alpine tundra

snow

MARINE ARCTIC
MAPS
PEACE SANCTUARY
THIS IS EARTH'S COOLING SYSTEM
PROTECT IT

Human Impacts: Tundra

- Describe 2 positive feedback loops related to climate change in the arctic

©2005 Khanjan Mehta

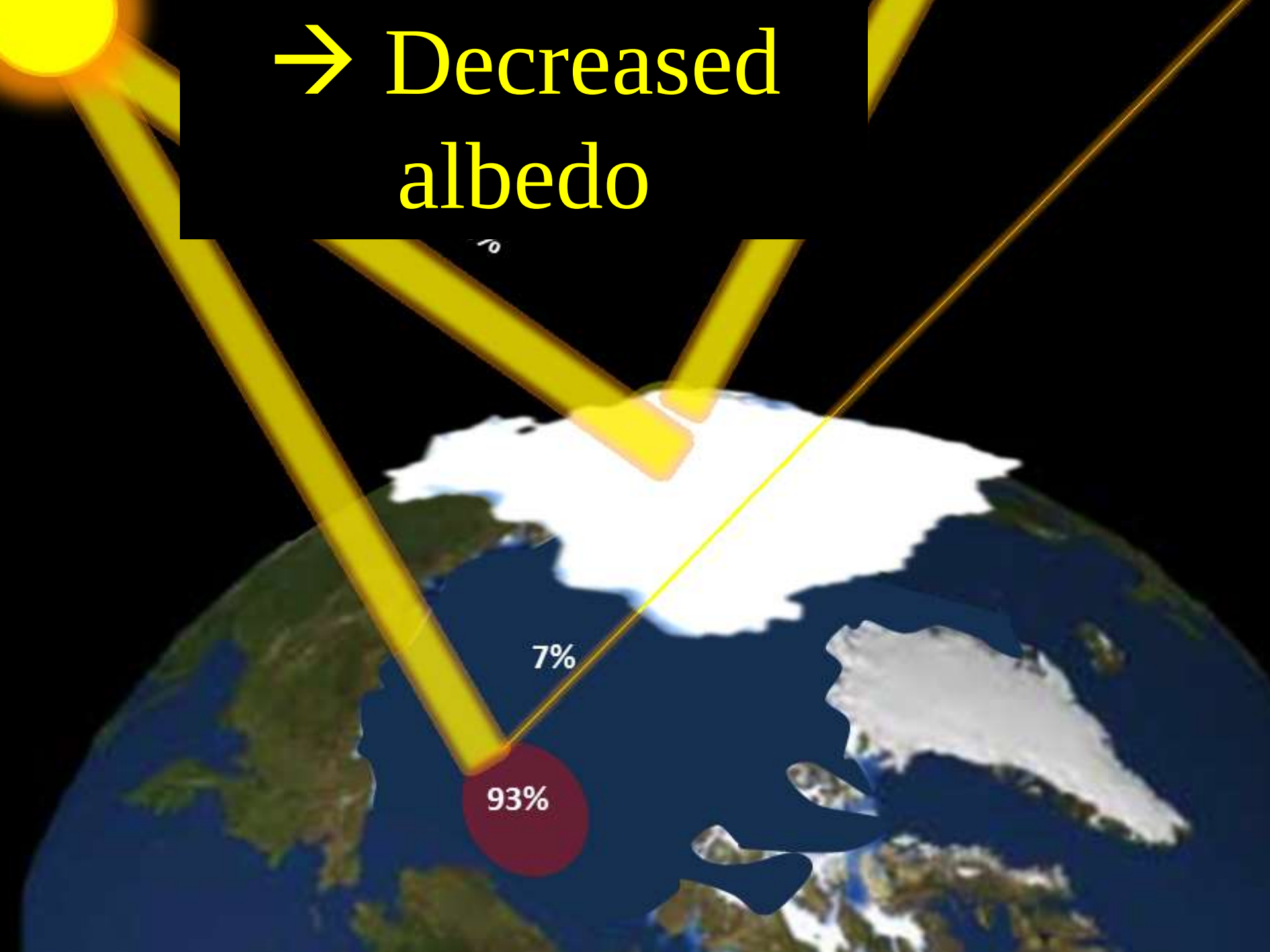
1) Climate change → melting permfrost

poor drainage → boggy conditions

Boggy conditions → methane → climate change

Positive feedback #2

- Climate change → melting ice caps


→ Decreased albedo
7%
93%

→ More climate change

Human Impacts on tundra

- Development and overuse → long lasting effects because the tundra has very slow rates of decomposition and nutrient cycling

©2005 Khanjan Mehta

Ex: Injury from oil drilling

Hiking can destroy alpine tundra

Human Impacts: Tundra

- Impacts in the tundra are long lasting often permanent. Why?
- Cold temps → Slow decomposition → minimal soil development

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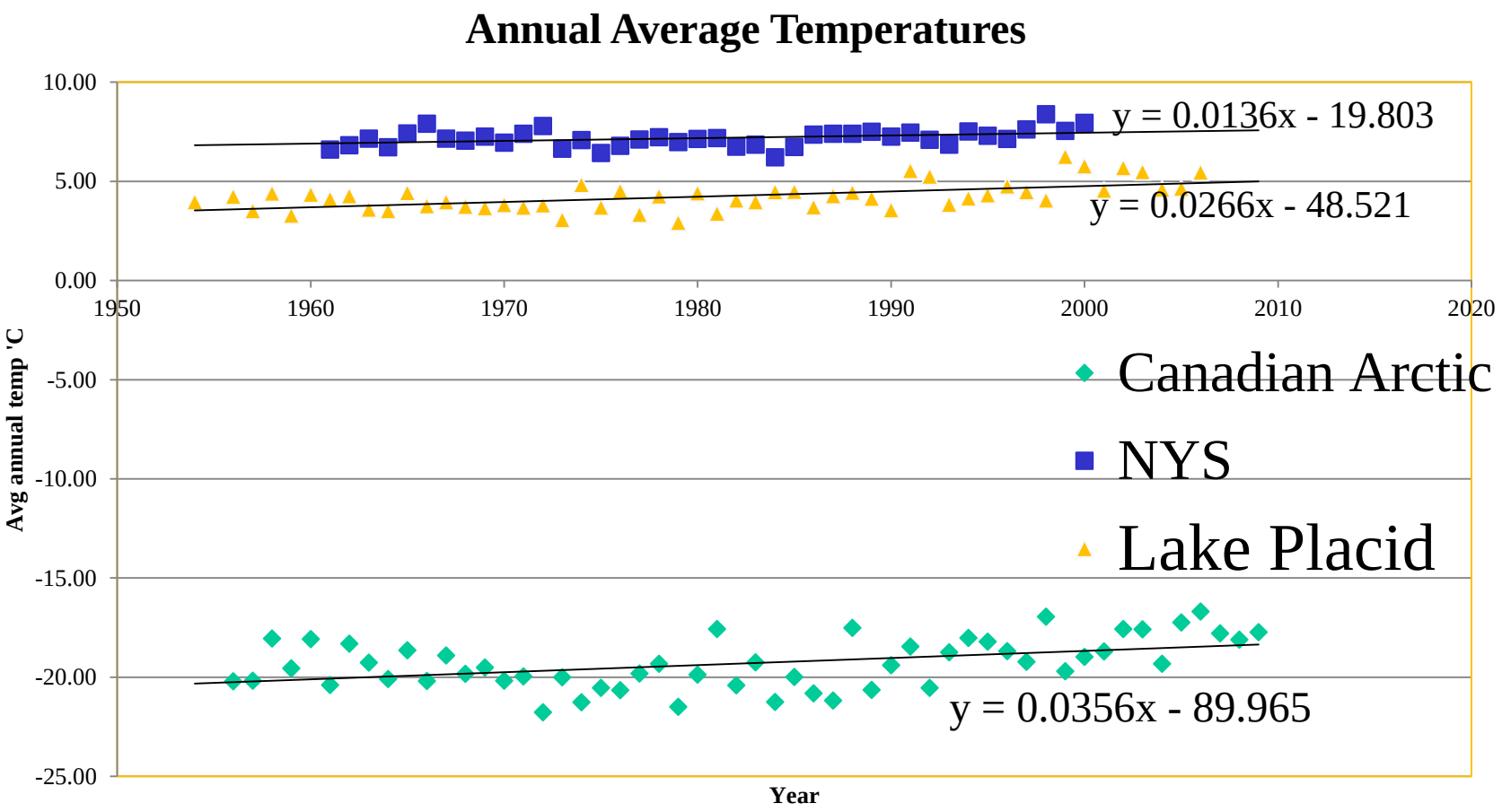
Compare rate of climate change in the Arctic to global rate of change



Conclusions

- Rates of change increase with latitude:
  - NY = 0.01^{0}C /yr = 0.1/decade
  - LP = 0.03’C/yr = 0.3/decade
  - Arctic = 0.04’C/yr = 0.4/decade

- LP compared to the rest of the state = much faster indicating increased rates of change with increased altitude

Review questions

1. How can climate change in the arctic be considered an environmental justice issue
2. Reflection of the sunlight by snow and ice = _____
3. Name a gas released into the atmosphere when permafrost melts. Why is this a concern?

Forest Biomes

1. Coniferous forest (taiga, boreal forest)
2. Deciduous forest
3. Tropical rainforest
4. Temperate rainforest

Coniferous forest (taiga, boreal)

- Climate: extremely long cold winters, lots of snow
- Located between 50º N and the Arctic circle (northern US and Canada, Northern Europe and Asia)

Finland

Acidic soils, patchy permafrost, glacier dug lakes

Plants / flora

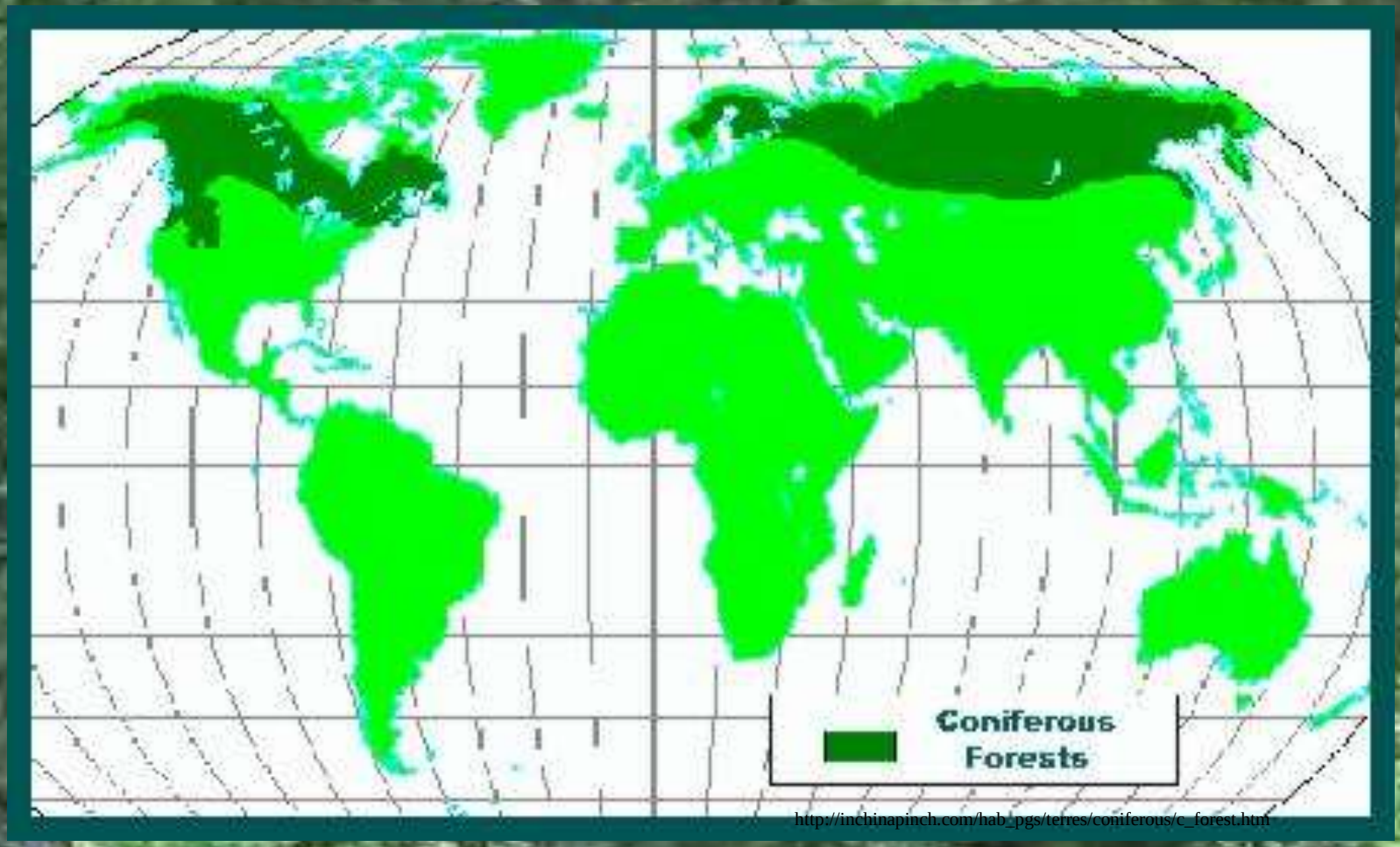
- Hemlock, fir, spruce, pine, larch, shrubs

Coniferous forests

Fauna:

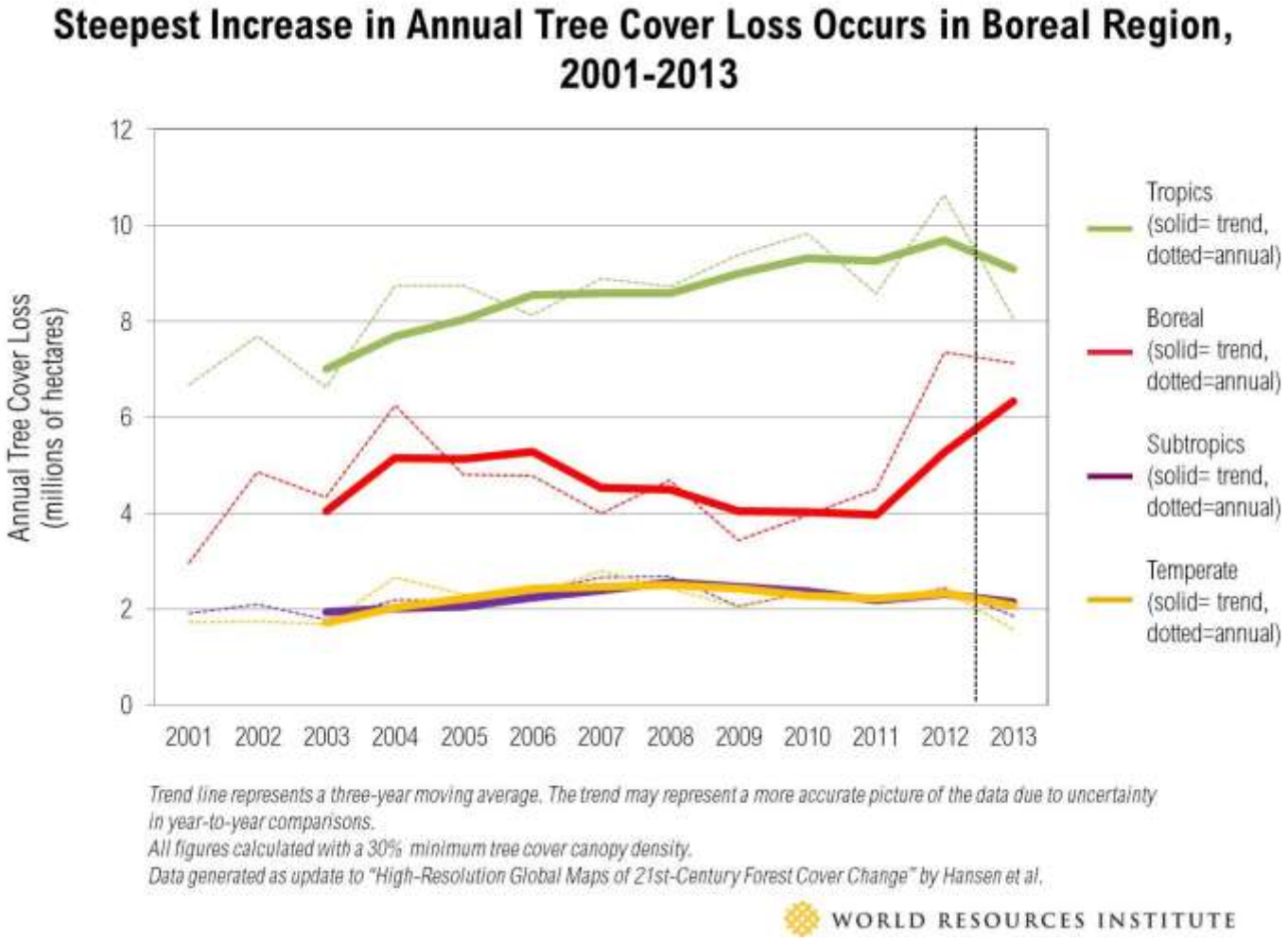
- Large herbivores (moose, elk),
- small herbivores (snowshoe hare, squirrels),
- predators (wolves, foxes, bears, lynx, weasels),
- many insects and birds in the summer

Largest land biome

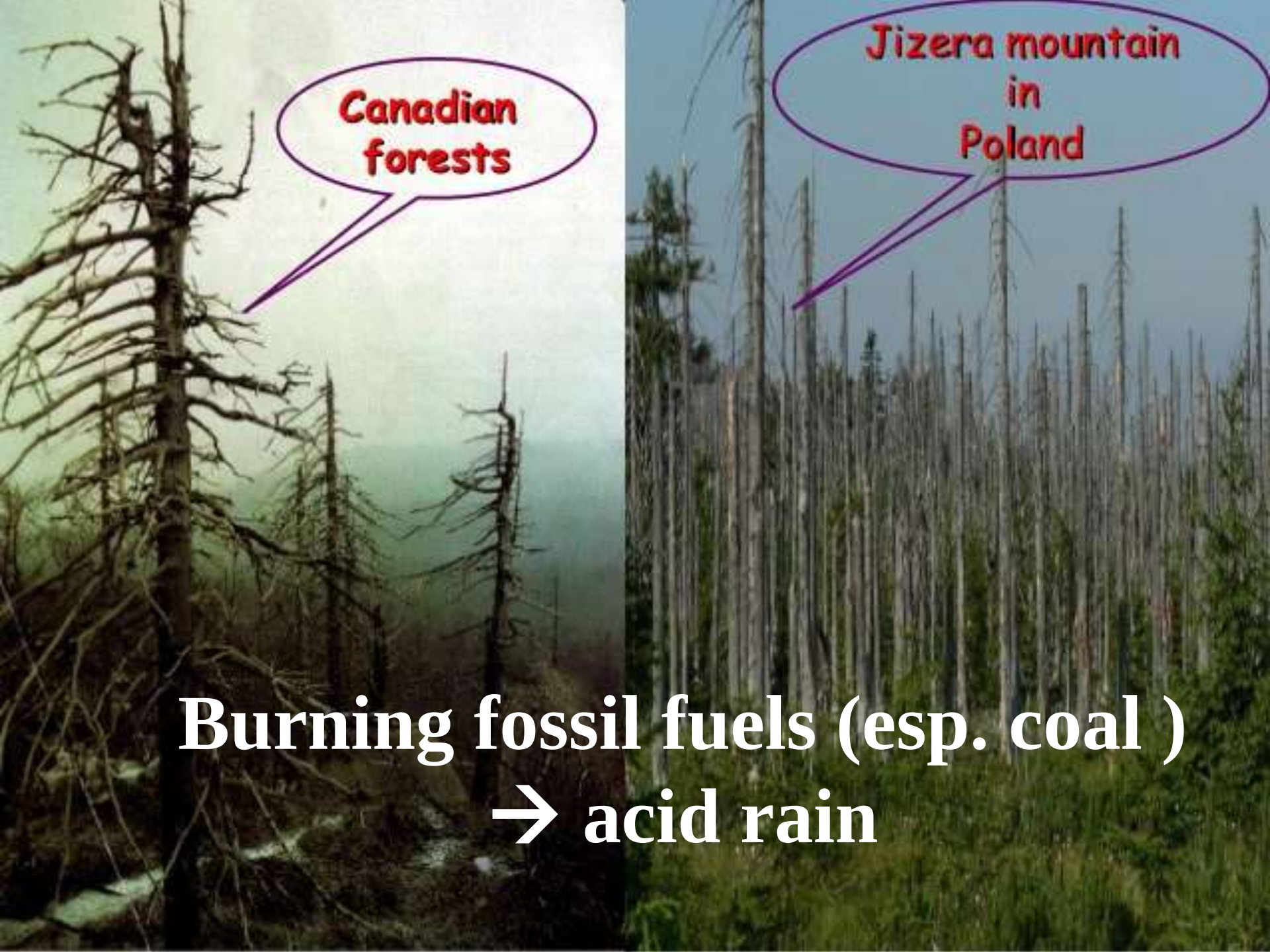


http://inchinapinch.com/hab_pgs/terres/coniferous/c_forest.htm

Human Impacts on boreal forests



Logging



Burning fossil fuels (esp. coal) → acid rain

Acidity Effects on Baby Trout

Abnormal

pH 5.0

Normal

pH 5.5

pH 4.6

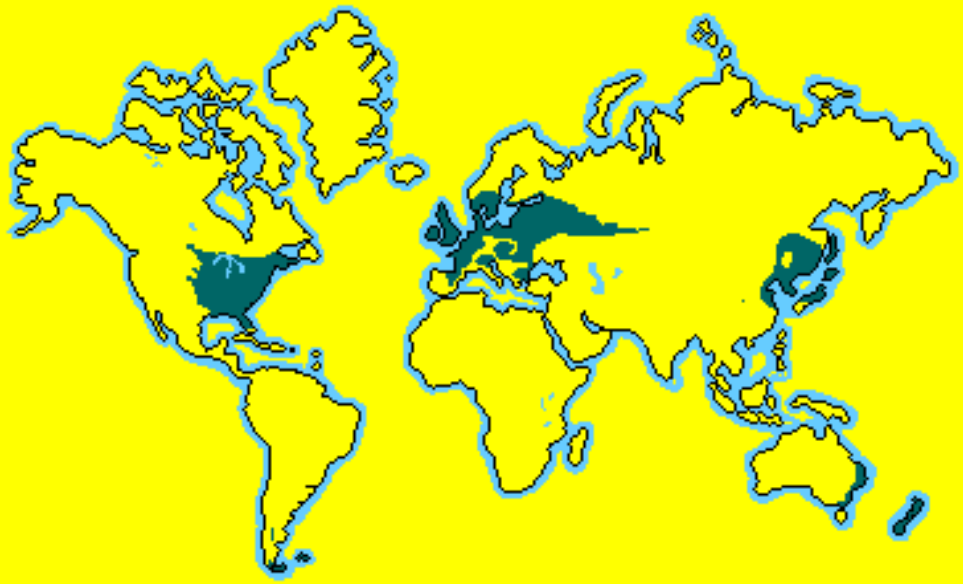
C. Ophardt, c. 2003

Oil and tar sand extraction

Overhunting of predators

Deciduous Forest

- Climate: season with moderate rainfall
- Soil rich in organic matter = alfisols



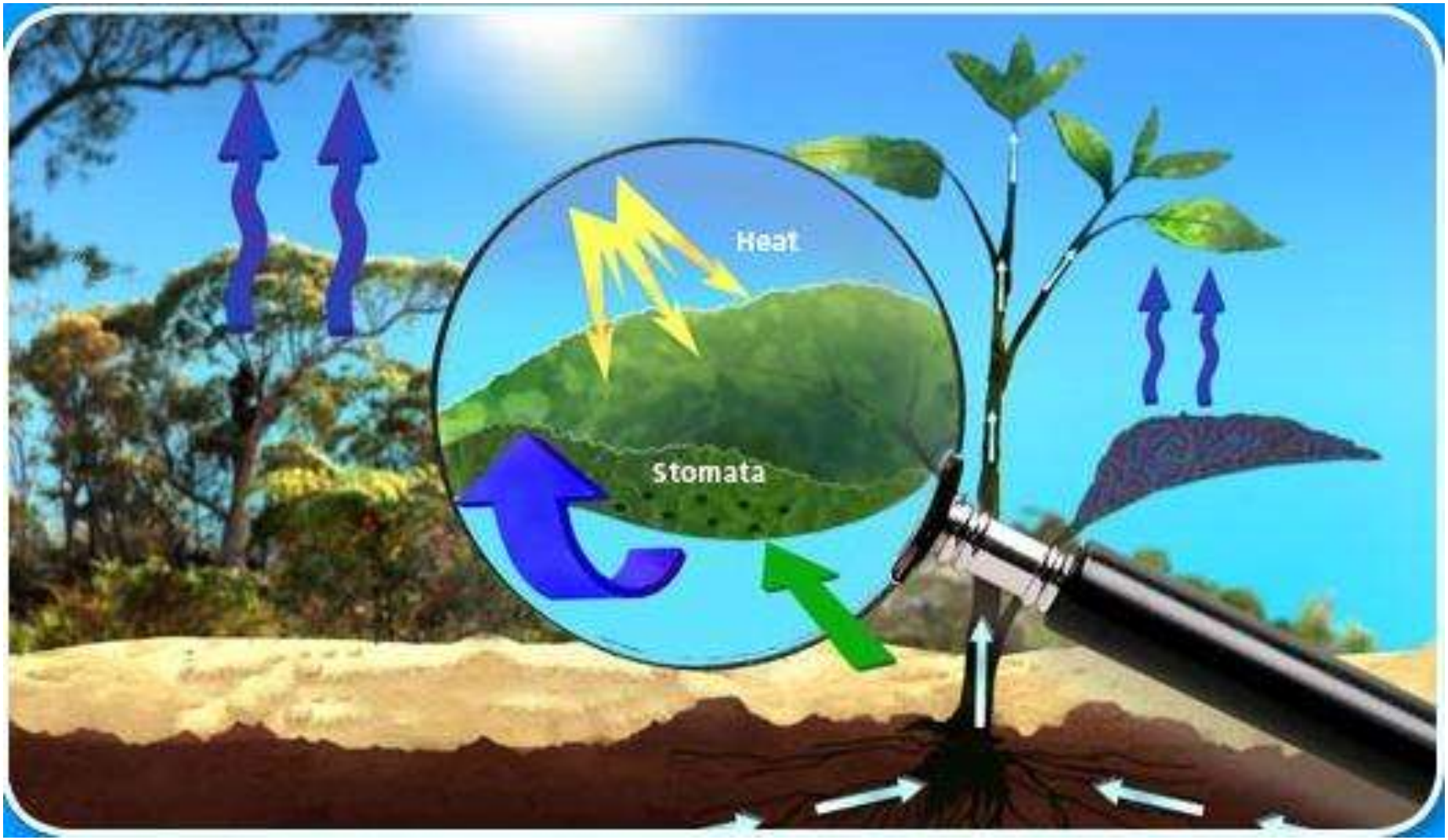
Deciduous Forests

- Flora:
- deciduous trees loose their leaves
- (maple, beech, birch, oak…)
- Fauna:
- adapted to seasons
- (hibernation, migration)
- Human Impact: acid rain, logging, most carnivores eliminated by over-hunting

Human Impacts

- Human Impact:
- acid rain,
- logging,
- most carnivores eliminated by over-hunting

Transpiration = major player in the hydrologic cycle



Review Ecosystem Services of Intact forests

2 types of Rainforests

	Tropical	Temperate
Temperatures	warm	cool
Number of tree species	(hundreds)	(10-20)
Types of leaves	broadleaf	needles
Age of trees	50-100 yr	500-1000 yr
Epiphytes	lots of different kinds including orchids and bromeliads	mostly mosses and ferns
Decomposition rate	rapid	slow

Tropical Forests: Found at or near equator

http://www.srl.caltech.edu/personnel/krubal/rainforest/Edit560s6/www/images/where/whemap.gif

Tropical rainforest

- Warm, moist year round with little seasonality
- ~200cm precipitation / yr

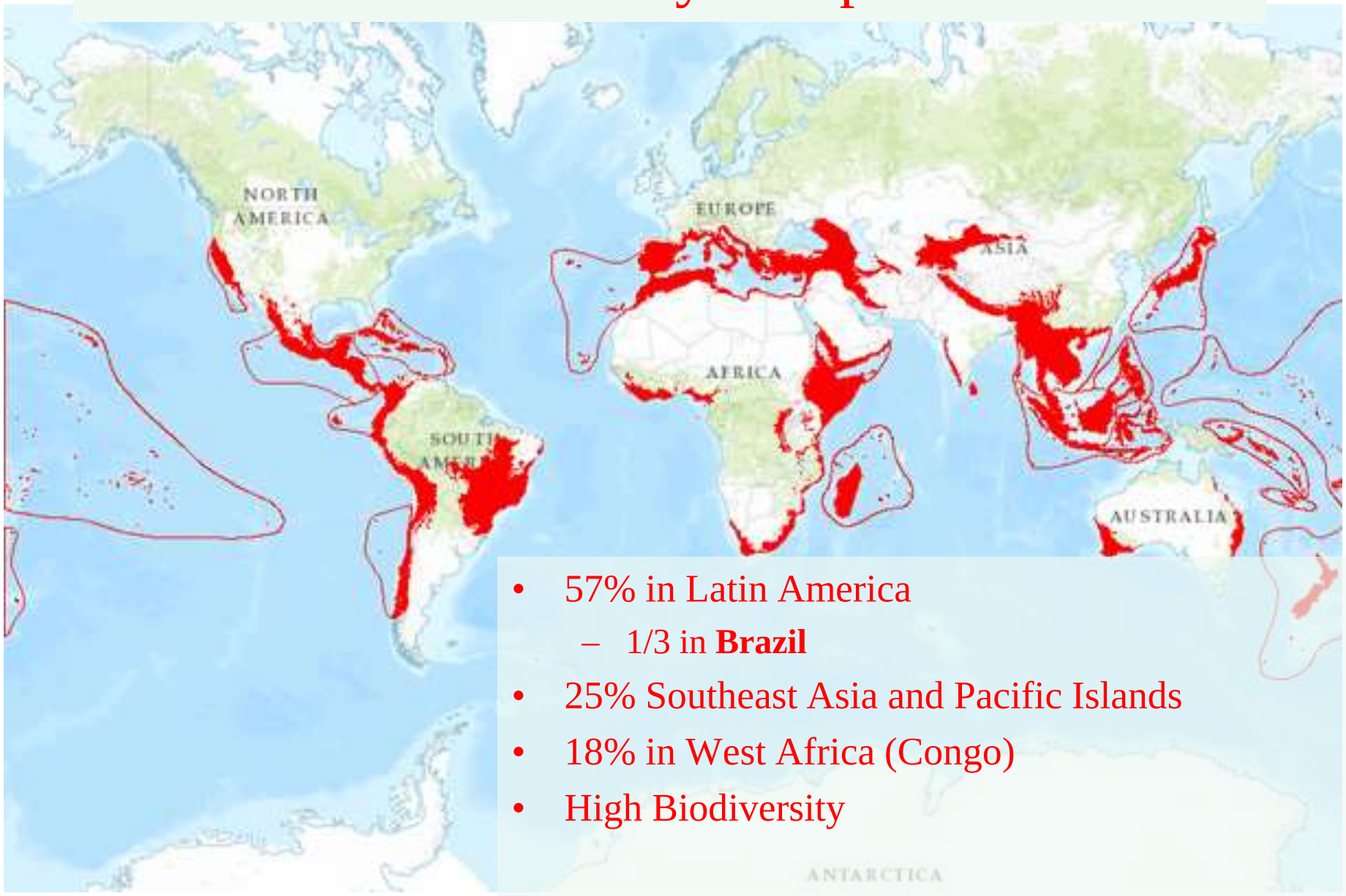
Climate of the Amazon Basin

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall in mm	249	231	262	221	170	84	58	38	46	107	142	203
Temp in °C	28	28	28	27	28	28	28	28	29	29	28	28

Thin nutrient poor soils (Oxisols)

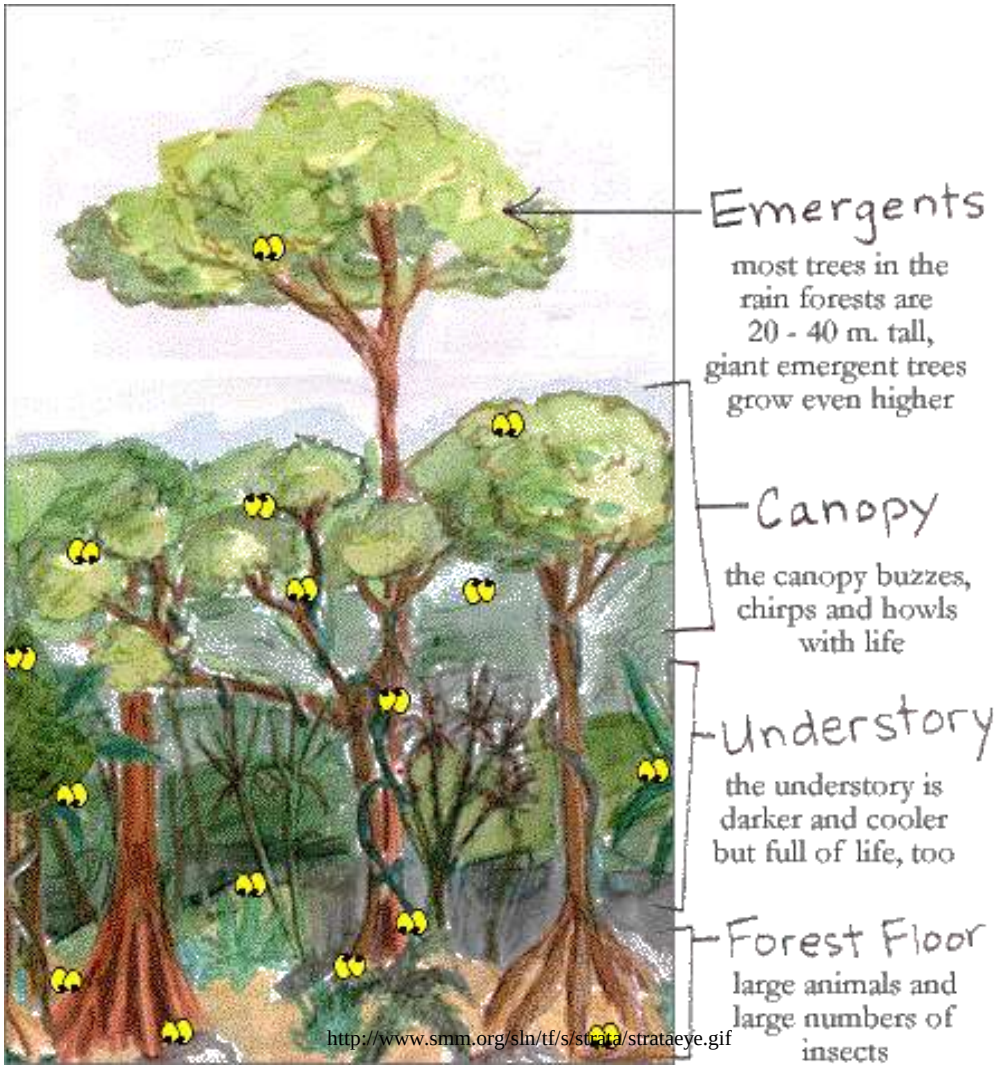
- Minerals washed away = leached
- Organic matter broken down and used immediately → minerals trapped in plants

Tropical rainforests of the world = Biodiversity Hotspots



- 57% in Latin America
  - 1/3 in **Brazil**
- 25% Southeast Asia and Pacific Islands
- 18% in West Africa (Congo)
- High Biodiversity

Layers of the forest



http://www.smm.org/sln/tf/s/strata/strataeye.gif

Lots of sun

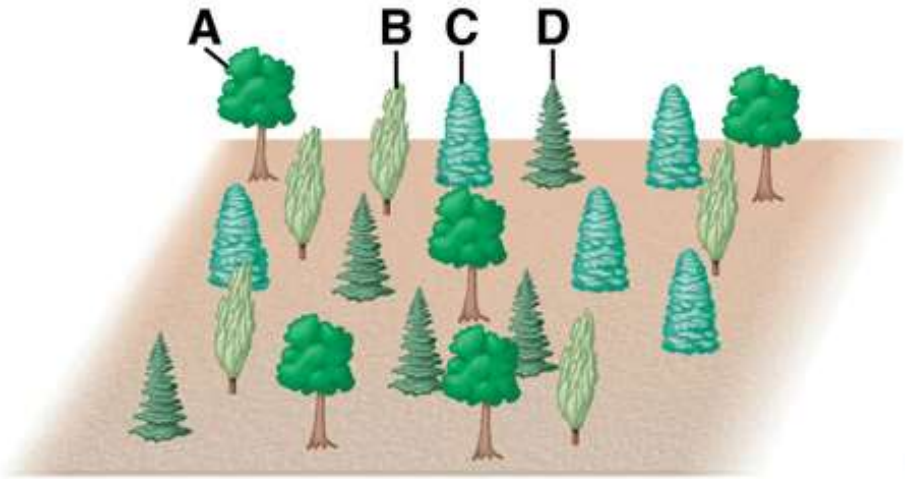
90% of organisms

Dark - lots of decomposition

Define biodiversity in terms of species richness

- 1 and 2 = same richness
- 1 = higher biodiversity

- Note: richness = # species and biodiversity = relative abundance



Community 1
A: 25% B: 25% C: 25% D: 25%

Community 2
A: 80% B: 5% C: 5% D: 10%

© 2011 Pearson Education, Inc.

Define biodiversity in terms of gene pools

- More heterozygous traits → hybrids = higher biodiversity

2 reasons to save biodiversity
• Diversity → stability
• Diversity → resources

Human Impacts

- Deforestation and over-harvesting →
  - Most exploited and endangered biome
- Rainforests are cleared for agriculture, logging, and mining →
  - loss of topsoil and depletion of soil nutrients
- Many organisms that live in rainforests are headed towards extinction

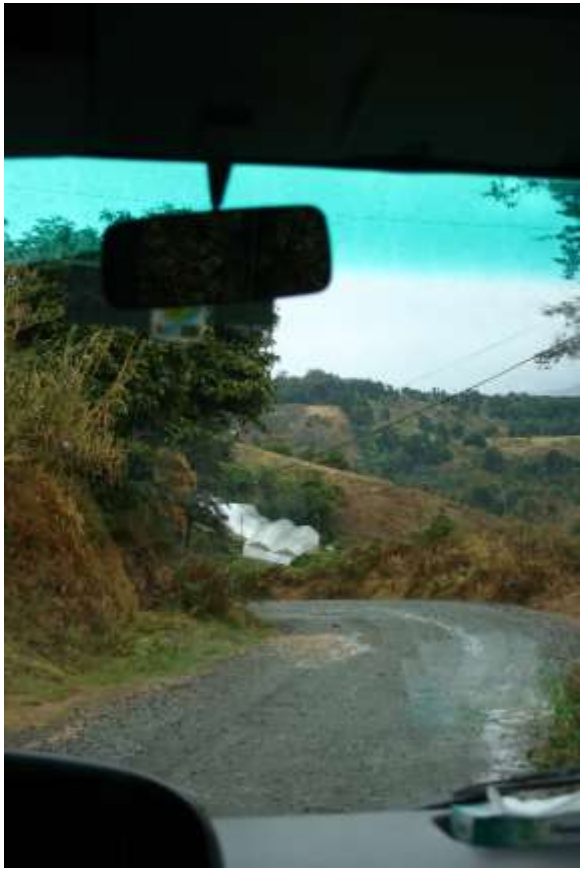
- **Clear cutting → <u>increased erosion</u> →**
- **<u>increased sediment and nitrogen in waterways</u>**

Costa Rica 2014

Old Growth Forest with epiphytes growing on trees

Problem: Forest converted to agriculture

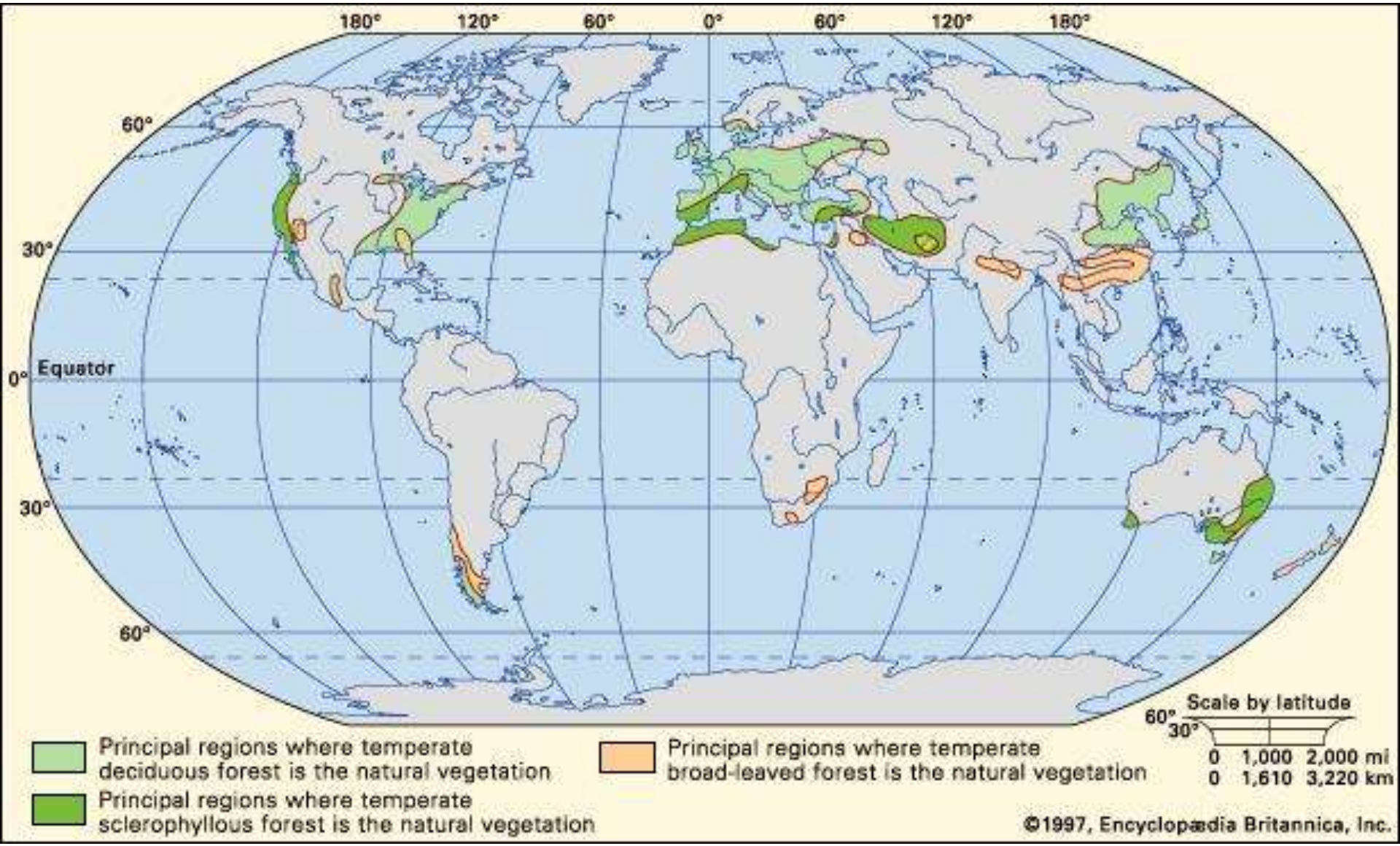
→ Massive erosion and loss of topsoil



- Solutions
- Agroforestry

Composting and increased diversity

Temperate rainforests



Temperate Rainforests

- Climate: coastal, moderate - cool summers, mild winters, wet year round, colder than tropics

- Nutrient poor soil due to leaching but high in organic content due to slow decomposition

Temperate Rainforests

- Flora: Pine, spruce, fir, epiphytes, mosses, lichen, ferns, club moss

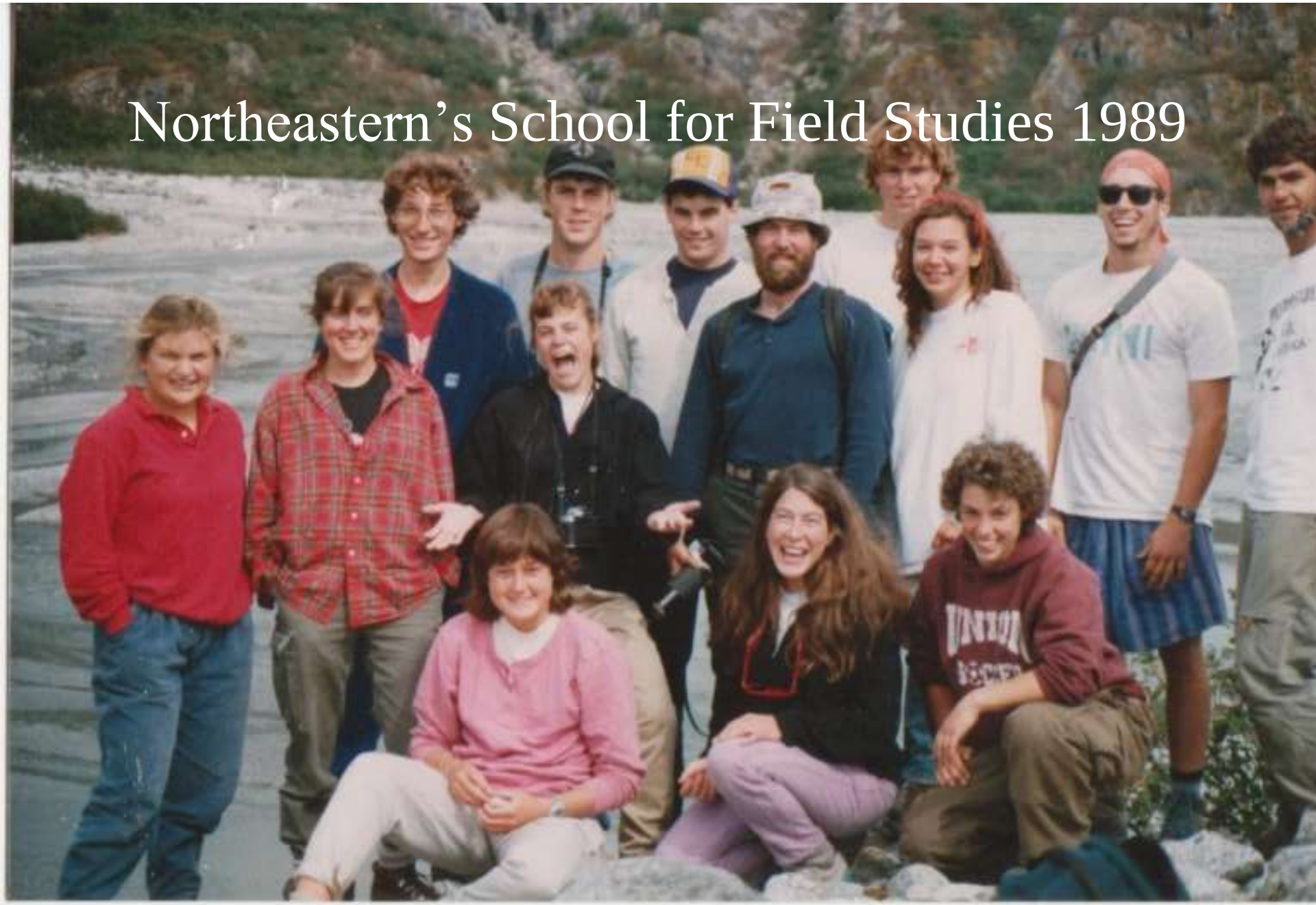
- Fauna: squirrels, mule deer, elk, predators (bear and eagle)

Tongass National Forest

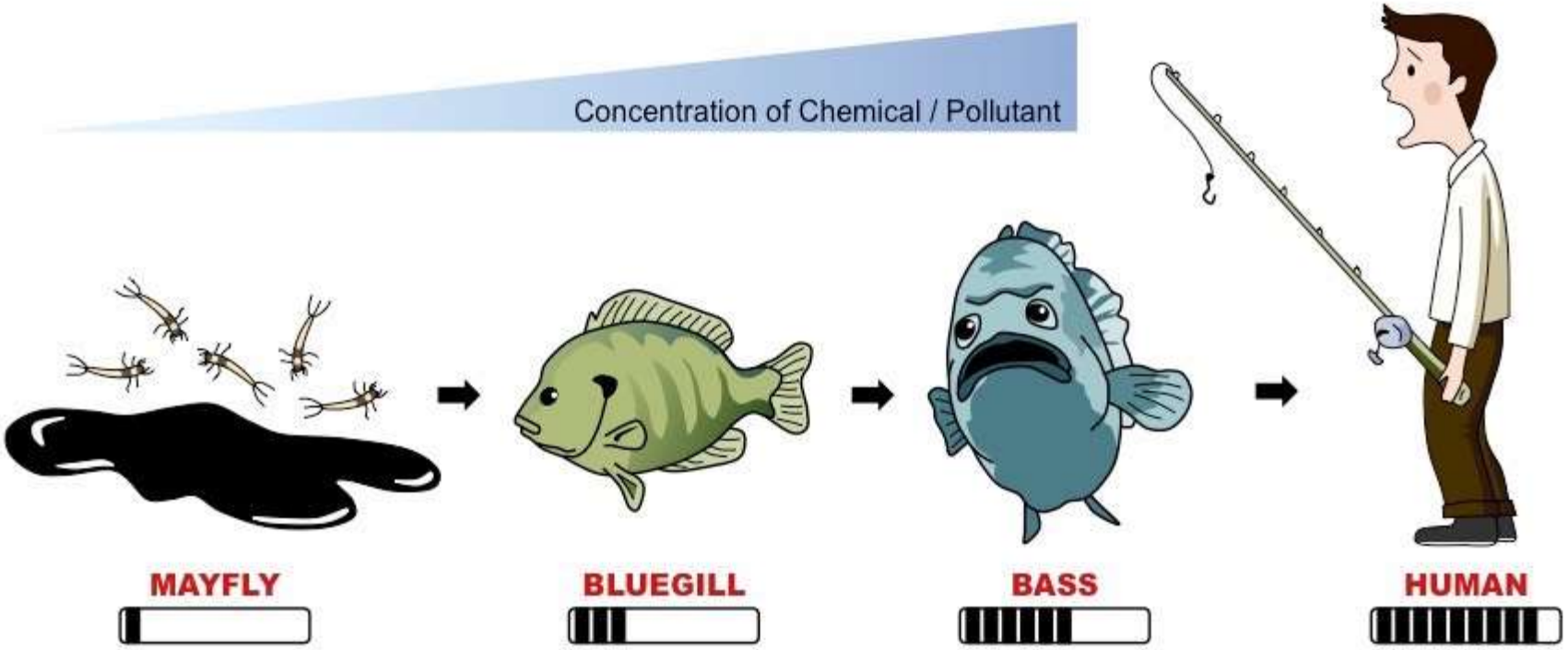
- 17 million acres
- World's largest temperate rain forest
- Resource use vs. conservation

Old Growth

- 90% still in tact
- Timber harvest limited to 10% over the next 100yrs.


Northeastern’s School for Field Studies 1989

Biological Magnification



Ex: DDT = pesticide that bioaccumulates

- Sprayed to kill mosquitoes

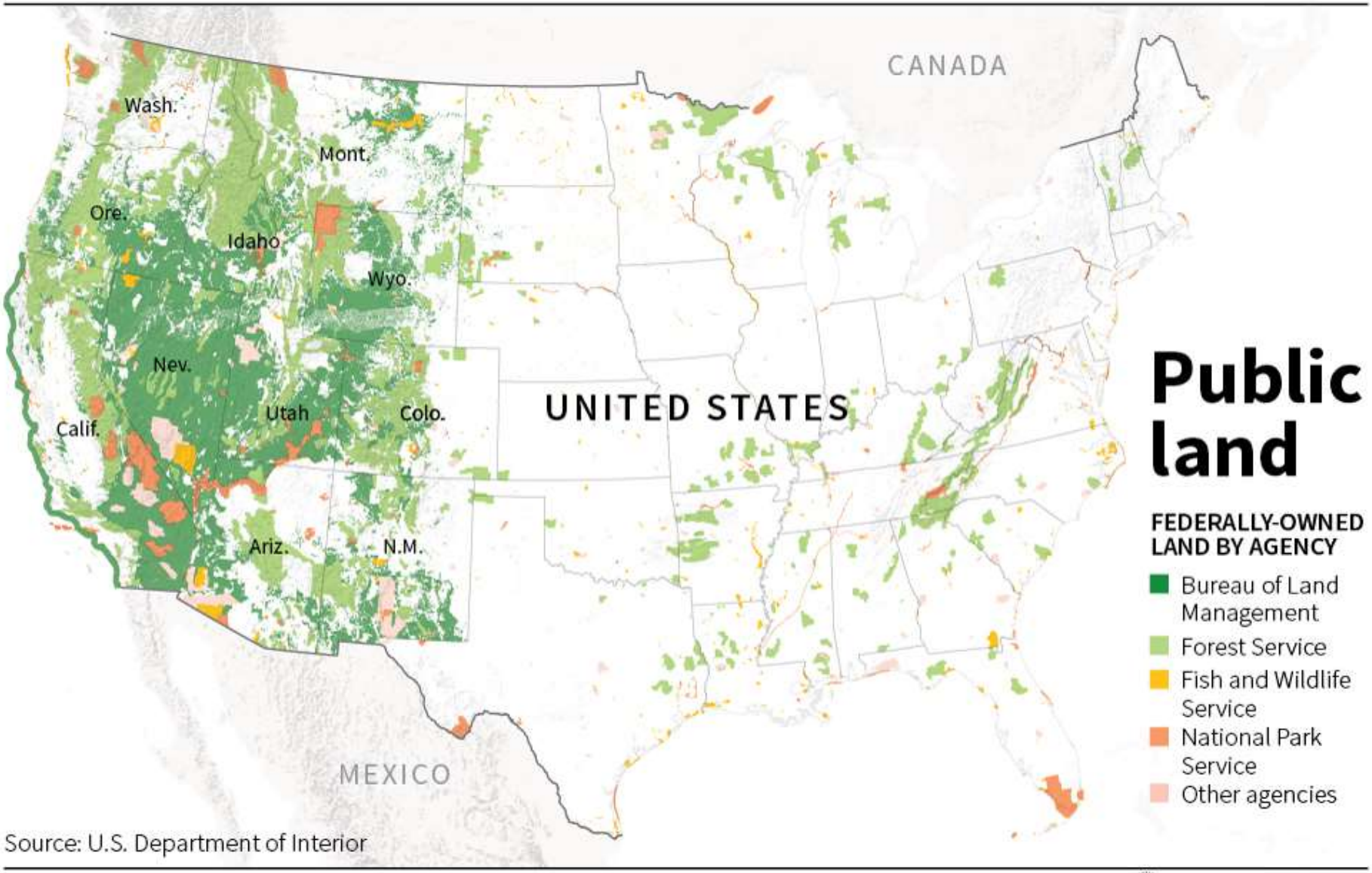
Top predators consume concentrated amounts of toxins
Bald eagles almost went extinct

US public lands

- 42% of nation's land area = public
  - Rangelands
  - National forests
  - National parks
  - National wildlife refuges
  - Wilderness areas

55% in the west

37% is in Alaska (less than 10% in the east)

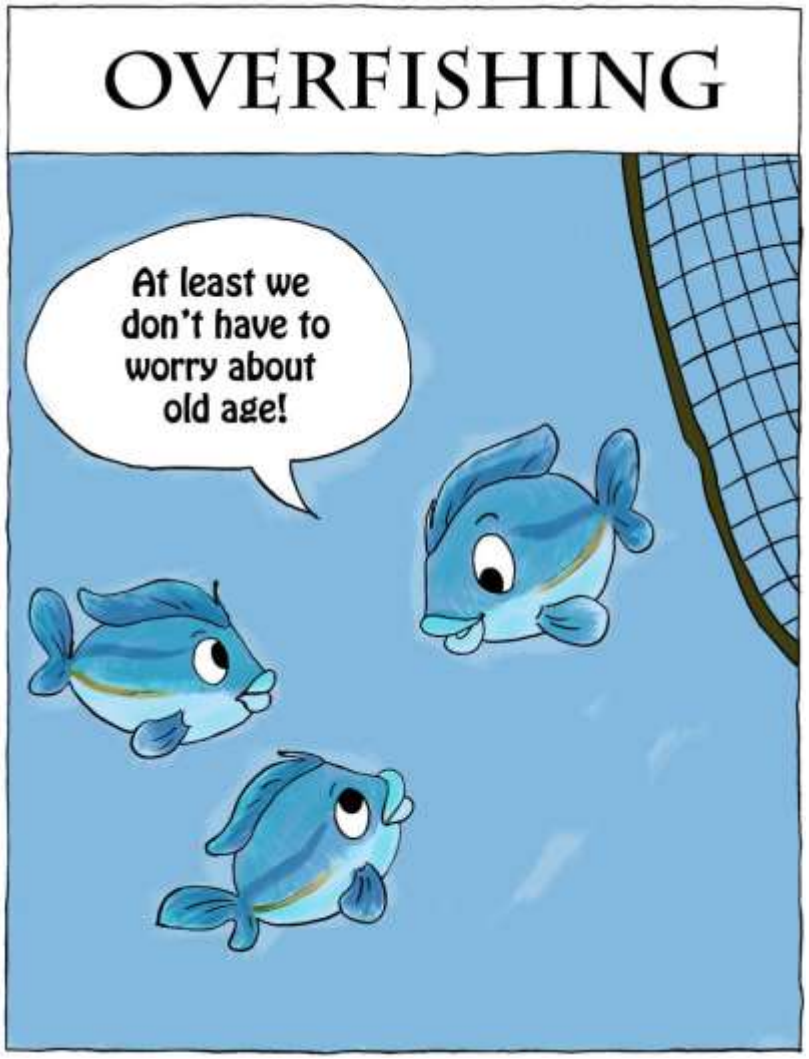


C. Chan, 11/08/2016

REUTERS

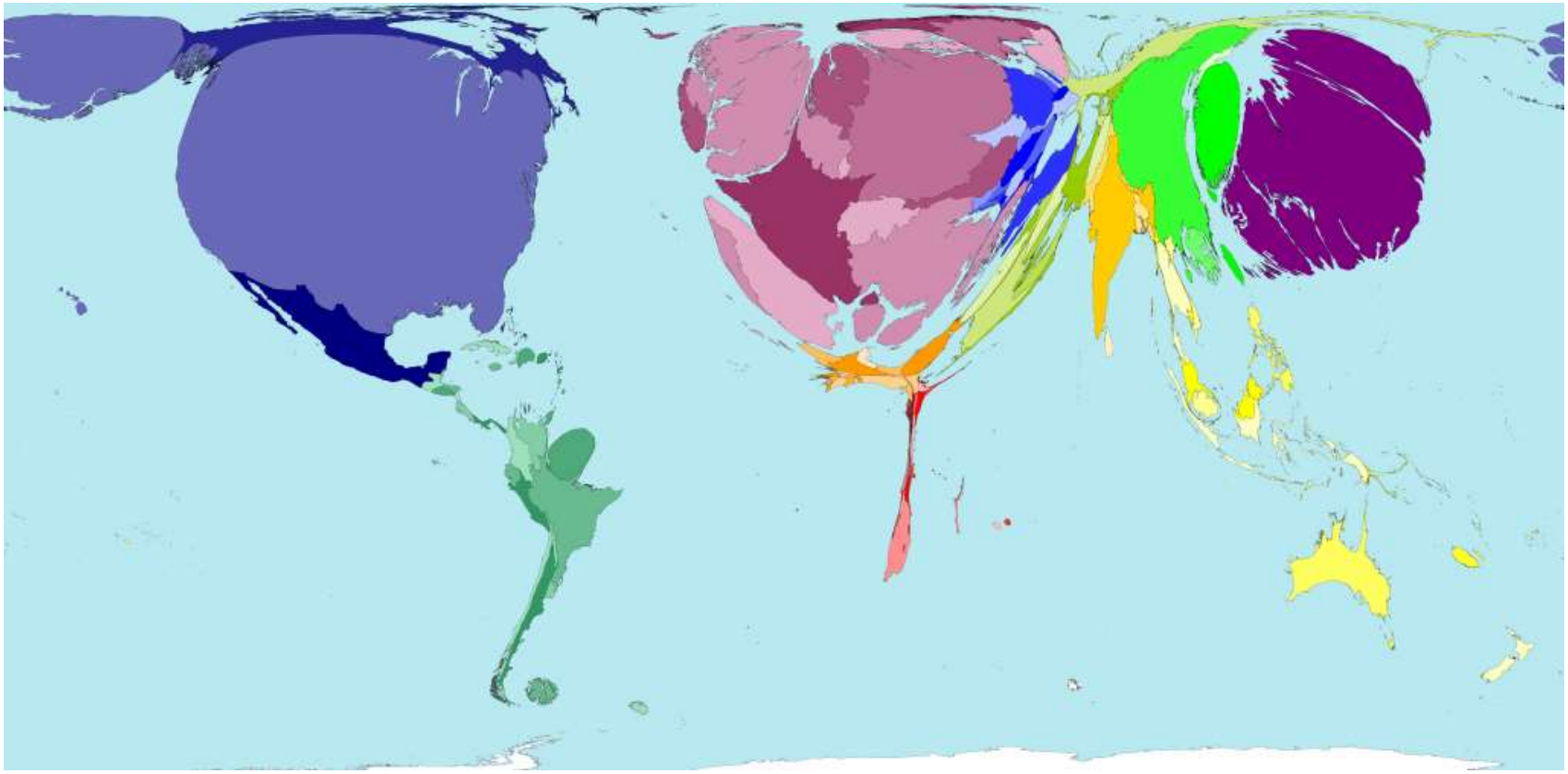
What happens to unregulated public lands?

- Tragedy of the Commons



How is economic development measured?

- **<u>Gross domestic product (GDP)</u>** =<u>Annual market value of all goods & services</u>



What is missing from that formula?

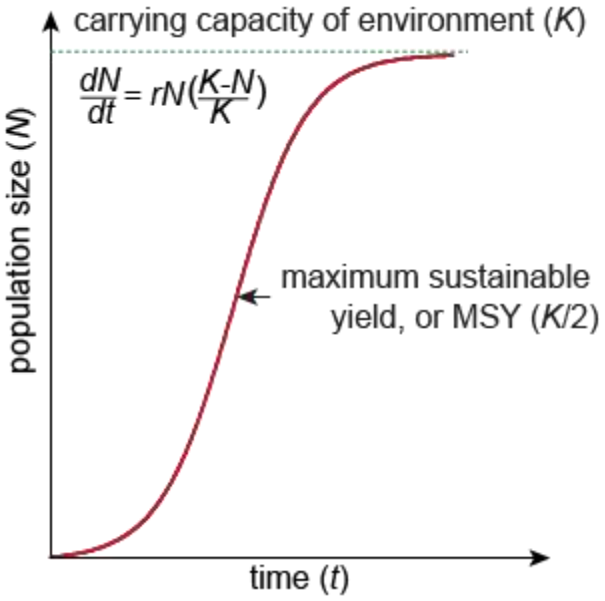
- How development improves living standards (health, food, water, shelter, air…)
- What are these called?
- Externalities

Define externalities and give examples

- Externalities = cost or benefit not included in the price of a product.
- Examples:
  - Positive externality = honey producer's bees pollinate farmers crops
  - Negative externality = coal burning power plant → acid rain in the Adirondacks

Maximum Sustainable Yield

- Amount of a resource that can be sustainably harvested
- In theory = ½ carrying capacity
- In reality tough to assess



Case Study

- Trade offs = an exchange where you give up one thing to get another

What are the trade offs of the following?

- Logging old growth → timber and
- habitat destruction and extinctions
- Erosion and decreased water quality

What are the trade offs?

- Oil drilling in the arctic → oil and
- oil spills and habitat destruction
- Note: Impacts = long lasting due to slow recovery rates in cold climates and low biodiversity in tundra ecosystems

Laws to know

- Endangered species act 1970 = protects species on the list and allows private landowners to modify property with a habitat conservation plan
- Montreal protocol → prevents depletion of ozone layer
- Kyoto protocol → first attempt to address climate change globally
- NEPA = National Environmental Policy Act → requires Environmental Impact Statement (EIS) for federally funded projects
- Wildnerness Act 1964 → wilderness areas = highest level of conservation protection for federal lands

Laws and Management

- NOAA (National Oceanic and Atmospheric Administration)
- 4 Laws
  - Clean Water Act (1972) – bans discharge of pollutants from stationary point sources into navigable waters
  - Marine Protection, Research and Sanctuaries Act (**Ocean Dumping Act)** (1972)– EPA regulates ocean dumping of industrial, sewage sludge and other wastes and bans dumping of radioactive, biological and chemical warfare agents

Laws and Management Continued

- The Oil Pollution Prevention, Response, Liability and Compensation Act (1989) –
  - vessel owners responsible for oil spill clean-up
  - Requires double hulls on tankers
  - Sets up a fund → quicker spill response
- Coastal Zone Management Act (1972)
  - Coastal states must manage nonpoint sources in an effort to protect estuaries (includes Great Lakes)

Key Ideas to focus on

- Mitigation = prevention
- Remediation = clean-up
- Coal → Sulfur → Acidic conditions
- CO_2 → climate change NOT ozone depletion
- Study ENSO (El Nino Southern Oscillating Events)

Land Use Management Review Key Ideas

- Describe the tragedy of the commons

Tragedy of the Commons

- Garret Hardin essay (1968)
- Unregulated use of common resources → degradation
  - Ex: overgrazing, overfishing, deforestation…
- Why???
  - Human nature = short sighted, self-serving

What can we do??

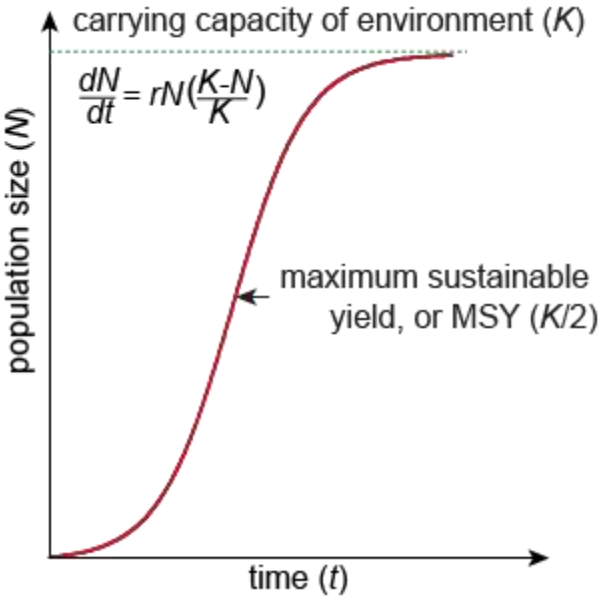
- Include cost of externalities
- Externalities = cost or benefit not included in the price of a product.
- Examples:
  - Positive externality = honey producer's bees pollinate farmers crops
  - Negative externality = coal burning power plant → acid rain in the Adirondacks

STUCK ON AN ELEVATOR WITH THE U.S. AT THE U.N GLOBAL WARMING CONFERENCE

http://steadystaterevolution.org/externalities-and-valuing-non-market-goods/

Maximum Sustainable Yield

- Amount of a resource that can be sustainably harvested
- In theory = ½ carrying capacity
- In reality tough to assess



Review key ideas

- Identify the 4 major public land management agencies in the US and types of public lands

US public lands

- 42% of nation's land area = public
  - Rangelands
  - National forests
  - National parks
  - National wildlife refuges
  - Wilderness areas
- 55% is in the west and 37% is in Alaska (less than 10% in the east)

4 Federal Agencies Govern public land

- Bureau of Land Management (BLM) → manages rangelands
- United States Forest Service (USFS) → manages forests
- National Park Service (NPS)
- Fish and Wildlife Service (FWS) → wildlife conservation, hunting and recreation

Managing rangelands

- Taylor Grazing Act (1934) converted rangelands from commons to permit-based grazing system
- Grazing
  - Pros:
  - maintains grasslands, produce food on marginal land
  - Cons:
  - overgrazing → decreased diversity, desertification, decrease water quality

Managing forests

- Clear cutting =
  - Pros = cheaper and easier harvest technique → lots of sunlight for sun loving species → single aged stand
  - Cons = decreased diversity, increased erosion, decreased water quality, loss of topsoil
- Selective cutting =
  - Pros = fewer environmental impacts
  - Cons = still have to build roads → fragmentation
- Tree plantations
  - Pros = fast growing trees → pulpwood and energy crops
  - Cons = nutrient depletion, decreased diversity
- Prescribed burns clean up debris and release nutrients → reduces risk of uncontrolled forest fires

Managing National Parks

- Biggest threats =
  - Overuse
  - Introduction of non-native ve s
    - Purple loosestrife
    - Japanese knotweed
    - Emerald ashborer
    - Asian longhorn beetle
    - Water chestnut
    - Eurasian water milfoil

Wildlife refuge

- Managed to protect wildlife

Sandhill cranes are a stunning sight as they rise from the prairie of Lake Andes Refuge, South Dakota

http://bestphotos.us/photo/lake-andes-national-wildlife-refuge-4948.php

ANWR

- 19 million acres
- Wildlife refuge and Wilderness areas

ANWR - Putting It in Perspective

2,000 acres < .01%

Estimated footprint of development based on current Arctic technology

1.5 million acre 1002 Area

Specifically set aside by Congress for analysis of oil and gas exploration

Drilling in ANWR

(2,000 Acres out of 19 million)

See the Point?

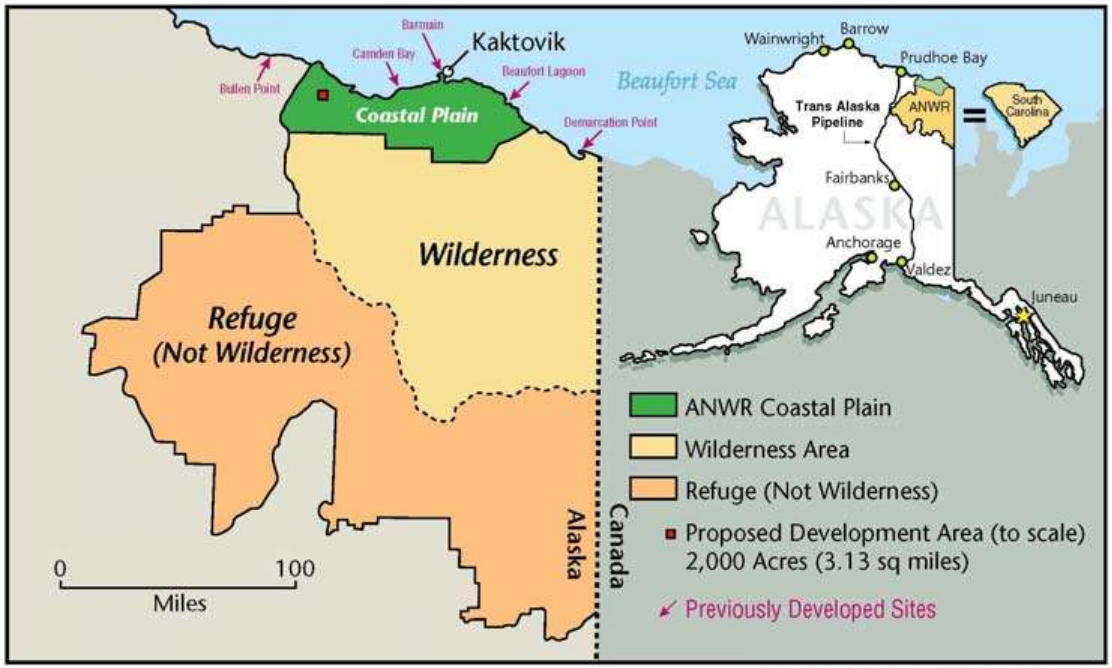
9.16 million acre "Refuge Area"

NO DEVELOPMENT ALLOWED

8 million acre "Wilderness Area"

NO DEVELOPMENT ALLOWED

90% Alaskan revenues = oil and gas development



Source: Alaska Department of Natural Resources

- http://www.rdcarchives.org/newsletters/2011/september/anwrccp.html

ANWR Debate

- https://www.youtube.com/watch?v=EZ4R_hG6DfY
- https://www.youtube.com/watch?v=NfAeXEx4xCE

Prudhoe Bay oil development extends → 80 miles of coast

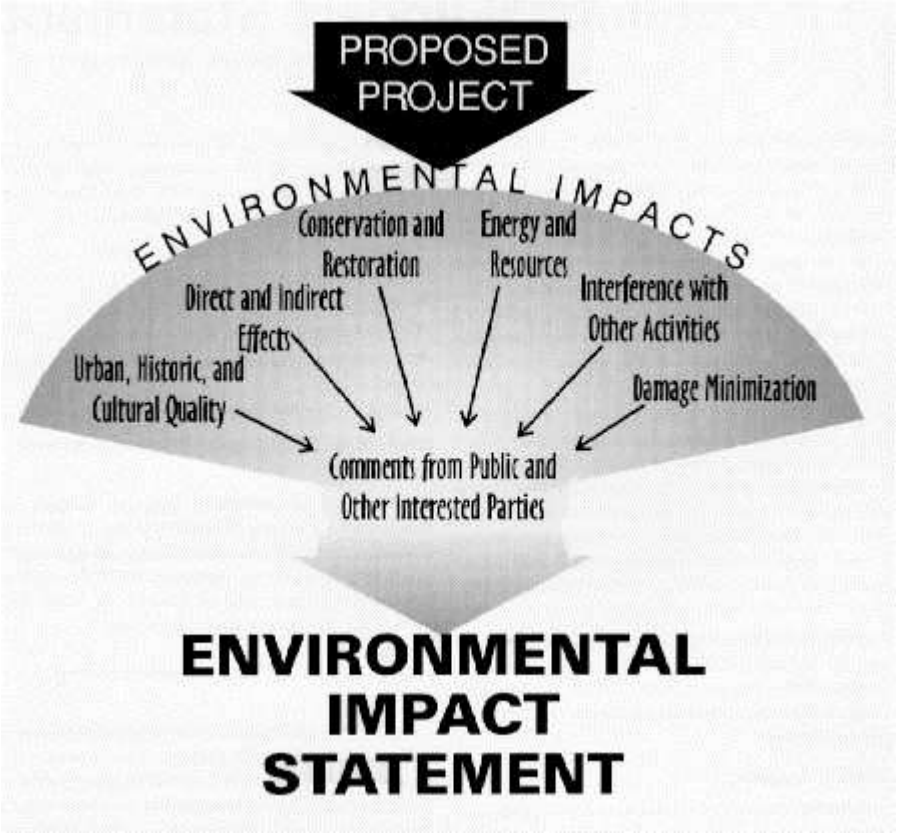
National Wilderness Area

- Highest level of protection → intact unfragmented wilderness
- No development allowed, no new roads built

Denali, National Wilderness, Alaska

Federal legislation

- National Environmental Policy Act (**NEPA**) 1969
  - All federal development projects require **environmental impact statement (EIS)**



http://ohioline.osu.edu/rer-fact/rer_65.html

Mitigation Plan

- Describes how the environmental impact of development will be addressed
  - Ex: building a road across a wetland →
  - create wetland area or pond adjacent to the development

Endangered Species Act of 1973

- Protects animals on the Endangered Species List
- Prevents development in areas where listed species are found

U.S. Endangered Species Act

(1973)

- Protects species identified as endangered or threatened with extinction
- Attempts to protect the habitat on which they depend
- Administered primarily by the Fish and Wildlife Service (U.S. Department of the Interior)
  - The National Marine Fisheries Service (U.S. Department of Commerce) administers the ESA for certain marine species

Review

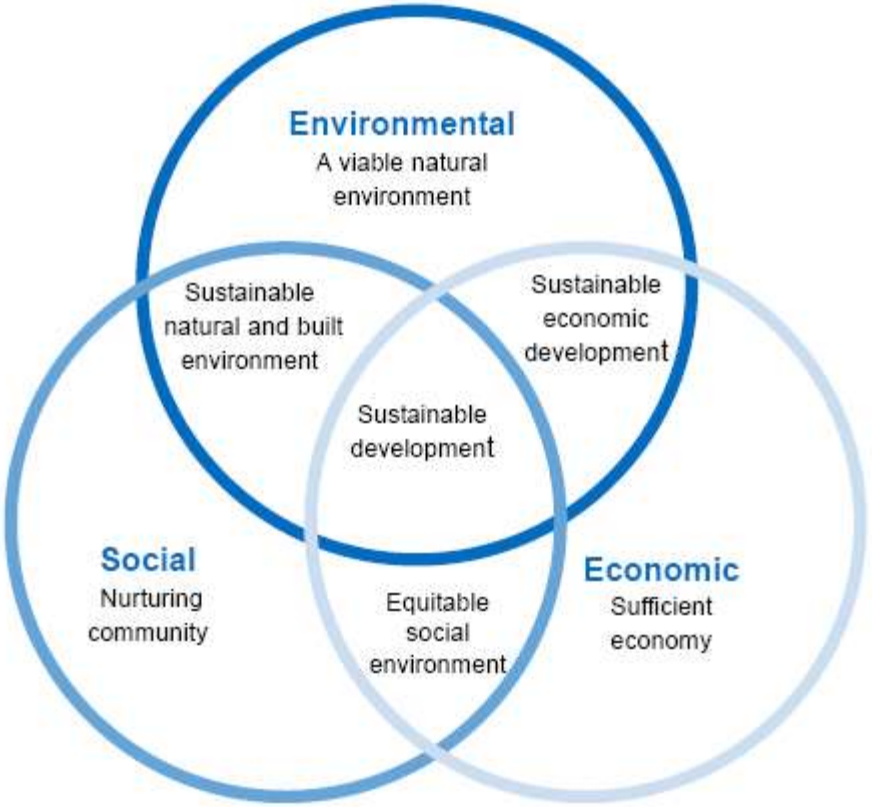
- Describe the tragedy of the commons
- Identify the 4 major public land management agencies in the US
- Describe the following pieces of legislation
  - Taylor Grazing Act
  - NEPA
  - Endangered Species Act

Define Sustainable

- Development that meets the needs of the present without ruining things for future generations

Sustainability requires balance

- Good for the environment
- Good for people / society
- Good for economy / jobs



http://www.ciria.org.uk/complianceplus/sustainability.htm

Stop here for Unit 2 exam