APES
YEAR IN REVIEW

Topics, Potential FRQ Topics, Practice Questions

I. Earth Systems and Resources

A. Earth Science Concepts

Plate tectonics (divergent, convergent transform boundaries)

Volcanism (source of natural sulfur dioxide emission which have a COOLING effect due to albedo effect of sulfuric acid droplets)

I. Earth Systems and Resources

B. The Atmosphere

Composition (78% Nitrogen, 21% Oxygen, Argon 0.9%, CO_2 only 0.03%)

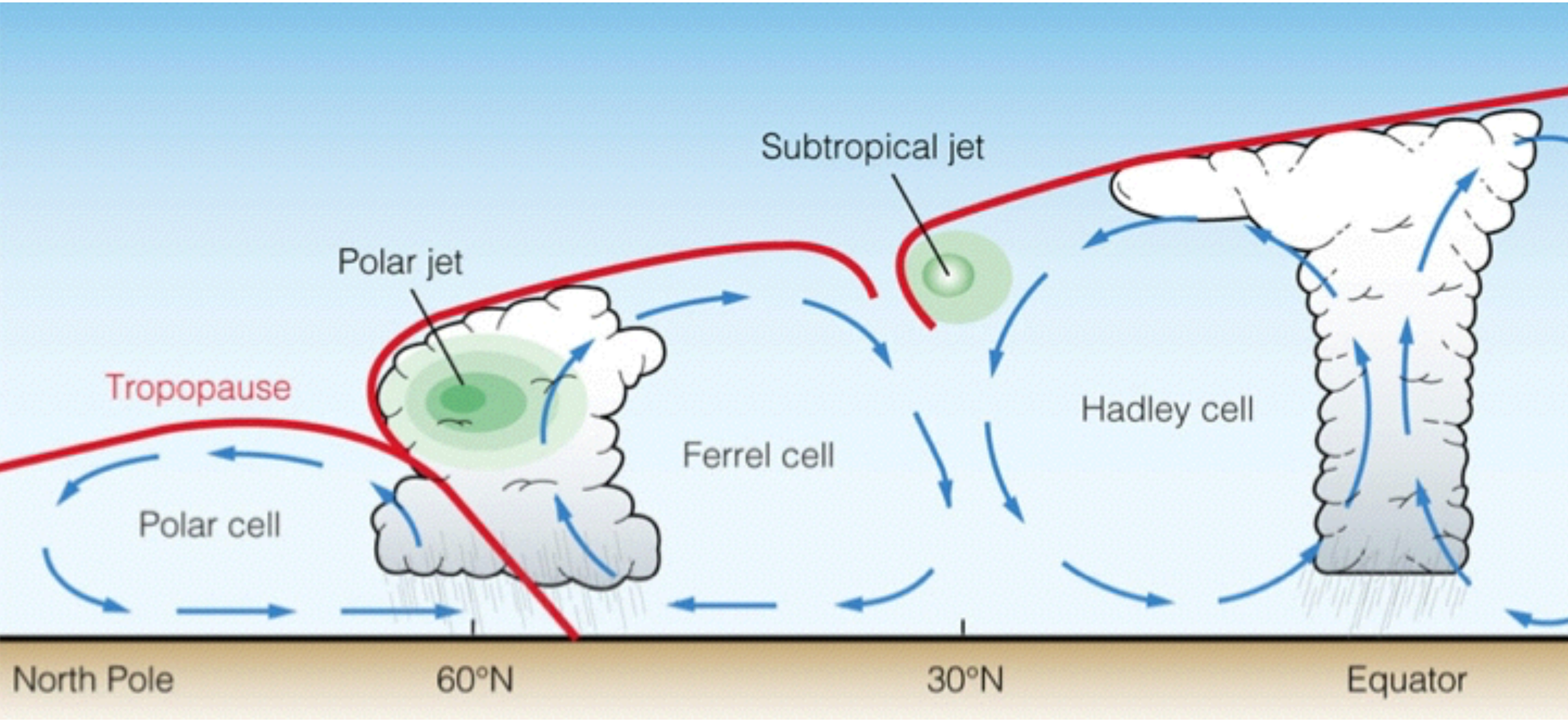
Layers (Troposphere, Stratosphere (location of ozone layer), Mesosphere, Thermosphere, Ionosphere)

Weather and Climate

Atmospheric circulation (polar cells, Farrel cells, Hadley cells)

Coriolis Effect (hurricanes in N. hemisphere rotate counterclockwise, S. hemisphere hurricanes rotate clockwise)

ENSO (El Niño, La Niña)


Subtropical jet
Polar jet
Tropopause
Hadley cell
Ferrel cell
Polar cell
North Pole
60°N
30°N
Equator

ENSO may cause	Problems (e.g.)	Effects (e.g.)
Warming water (primarily ocean)	Habitat destruction Increased algal blooms Coral bleaching Disruption of migration No upwelling of nutrient-rich waters Die-off of species that cannot tolerate the warmth Lowered water-solubility of CO_2 gas Increased storms/shift of zones where storms form	Starvation/die-off of species Loss of food for higher trophic levels Disruption of food webs Loss of biodiversity
Movement of warm ocean waters/increasing depth of warm surface water	Depression of thermocline Suppression of upwelling Disruption of migration Destruction of habitat	Nutrient-rich waters not available for fish Loss of food Starvation/die-off of species
Increased rainfall	Flooding Mudslides Erosion Nutrient leaching	Habitat destruction Plants unable to grow/loss of food production
Decreased rainfall	Drought/lack of water for living organisms Increased risk of fires Less plant growth	Starvation/die-offs Habitat destruction Starvation/die-offs

I. Earth Systems and Resources

C. Global Water Resources and Use

Freshwater (3% of Earth's water, 2/3 in glaciers/ icecaps, 1/3 in ground, surface water mostly in lakes)

Saltwater (97% of Earth's water, 3% salinity)

Water use (Agricultural (70%) > Industrial > Domestic)

Aquifers

I. Earth Systems and Resources

D. Soil and Soil Dynamics

Rock cycle (Igneous, Metamorphic, Sedimentary)

Physical and chemical weathering

Soil horizons (O/surface litter, A/topsoil/humus, E, B/subsoil, C, bedrock)

Erosion (sheet, rill, gully; causes, prevention: windbreaks, strip cropping, terracing, no till and contour farming, agroforestry and cover crops)

II. The Living World

A. Ecosystem Structure

Levels of ecology (population, community, ecosystem, biome)

Niches

Species Interactions (mutualism, commensalism, competition, predation, amensalism)

Keystone species

Habitat fragmentation/Edge effects

Biomes

Biome: Savanna

-Water:

Long dry winter, very wet and humid summer

-Temperature:

Warm year round

-Soil:

Rich, acidic soil

-Plant adaptations:

Fire and drought adapted, deep roots, thick bark, can store water

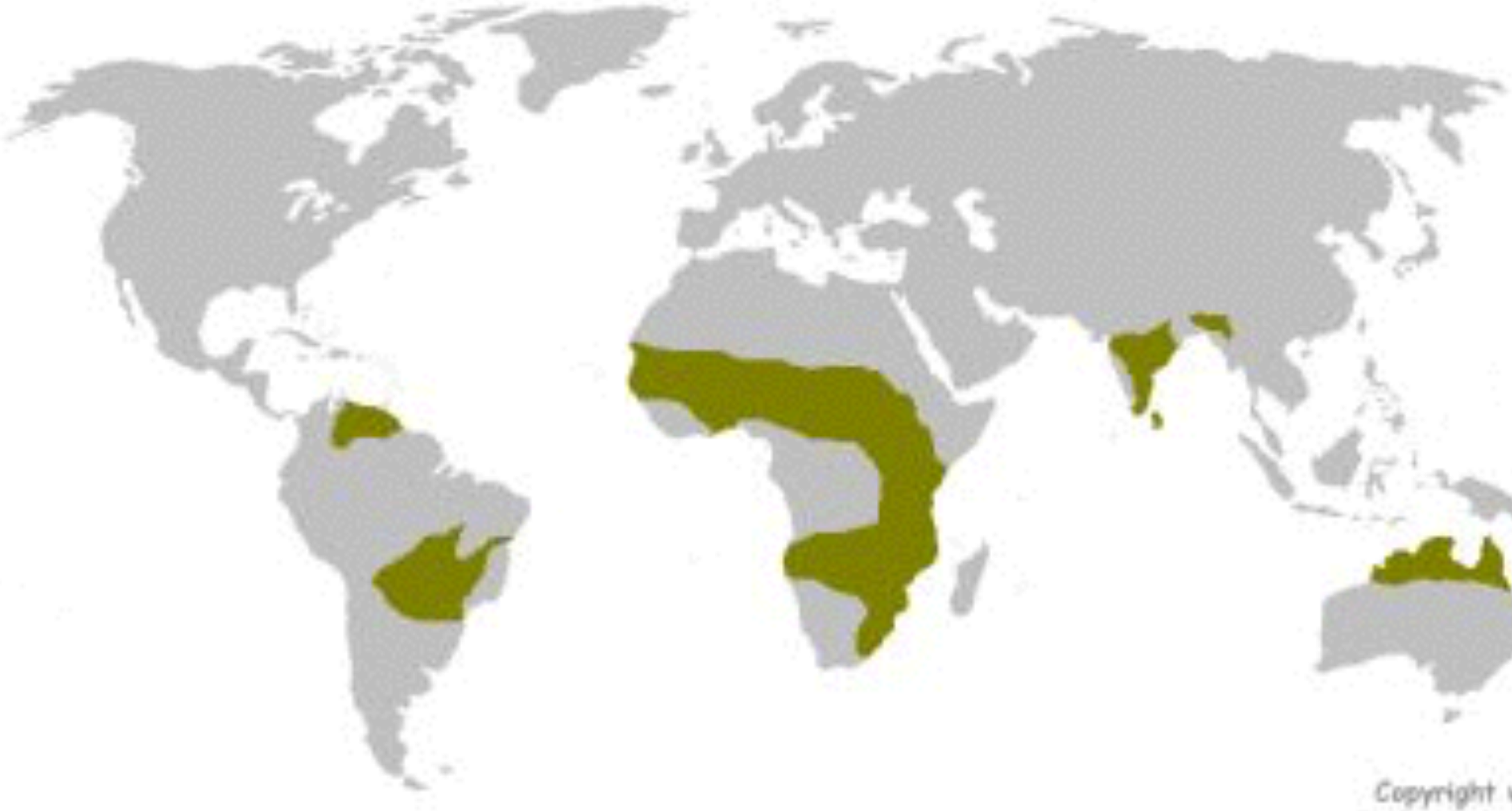
-Animal adaptations: large mammals (megafauna)

Migrate to where vegetation is plentiful

-Anthropogenic threats:

Hunting/poaching, cattle grazing, unsustainable water usage

Biome: Savanna



Hell's Gate, Kenya

Namibia

Uganda

India

II. The Living World

B. Energy Flow

Photosynthesis and Cellular Respiration

Food webs

Trophic levels (producers, consumers, decomposers)

Ecological pyramids (Rule of 10%)

II. The Living World

C. Ecosystem Diversity

Biodiversity

Natural selection and evolution

Ecosystem services (food and water, regulation of climate, nutrients, crop pollination, recreation, etc.)

II. The Living World

D. Natural Ecosystem Change

Climate shifts

Species movement

Ecological succession (primary and secondary)

II. The Living World

E. Natural Biogeochemical Cycles

Carbon Cycle

Nitrogen Cycle

Phosphorus Cycle

Sulfur Cycle

Water Cycle

Conservation of matter

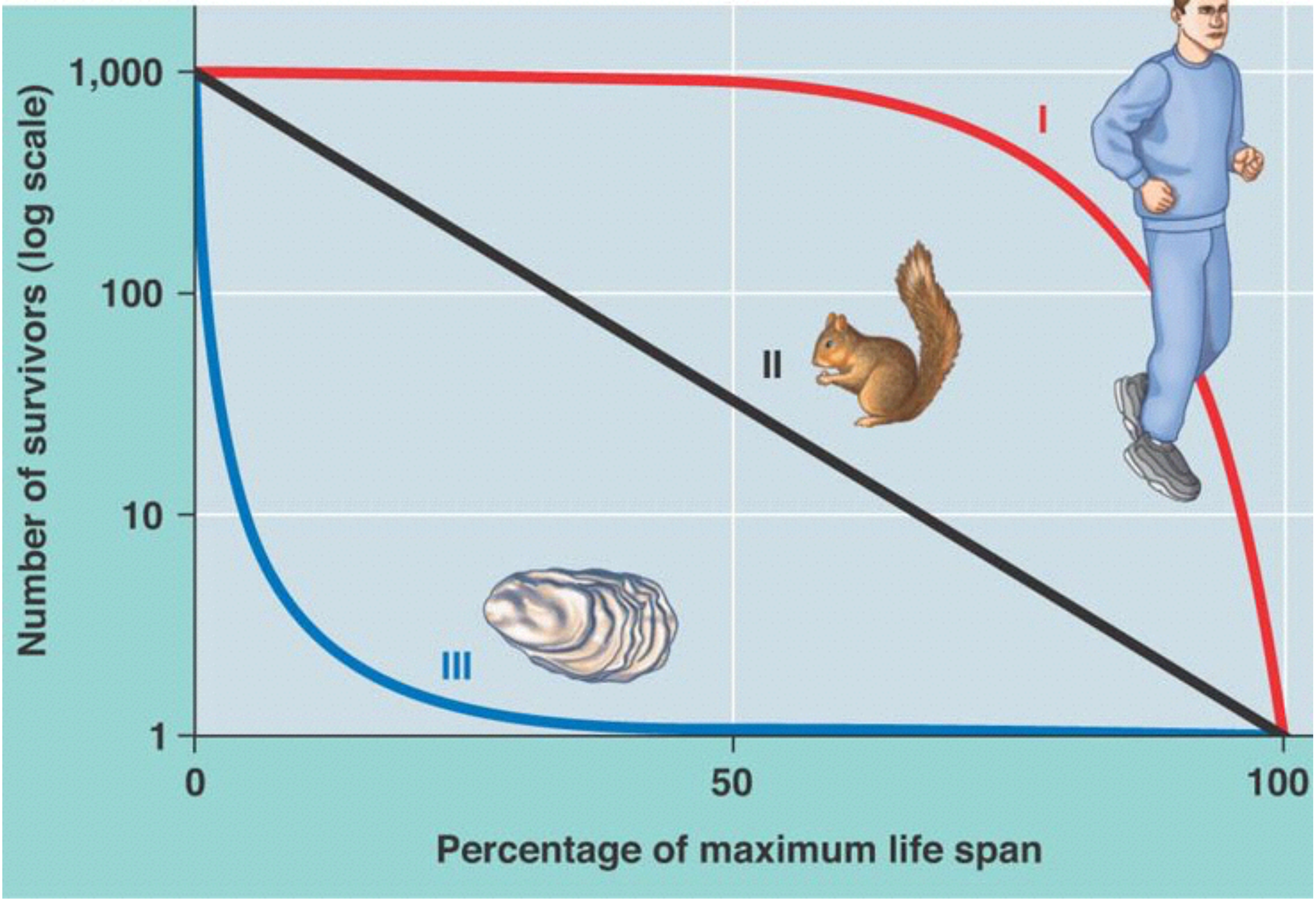
III. Population

A. Population Biology

Carrying capacity (exponential vs. logistic growth)

Reproductive strategies (r-selected, k-selected)

Survivorship curves (Type I, II, III)


Number of survivors (log scale)
1,000
100
10
1
0
50
100
Percentage of maximum life span
I
II
III

III. Population

B. Human Population

Human population dynamics (fertility rates, growth rates, doubling times, demographic transition, age structure diagrams)

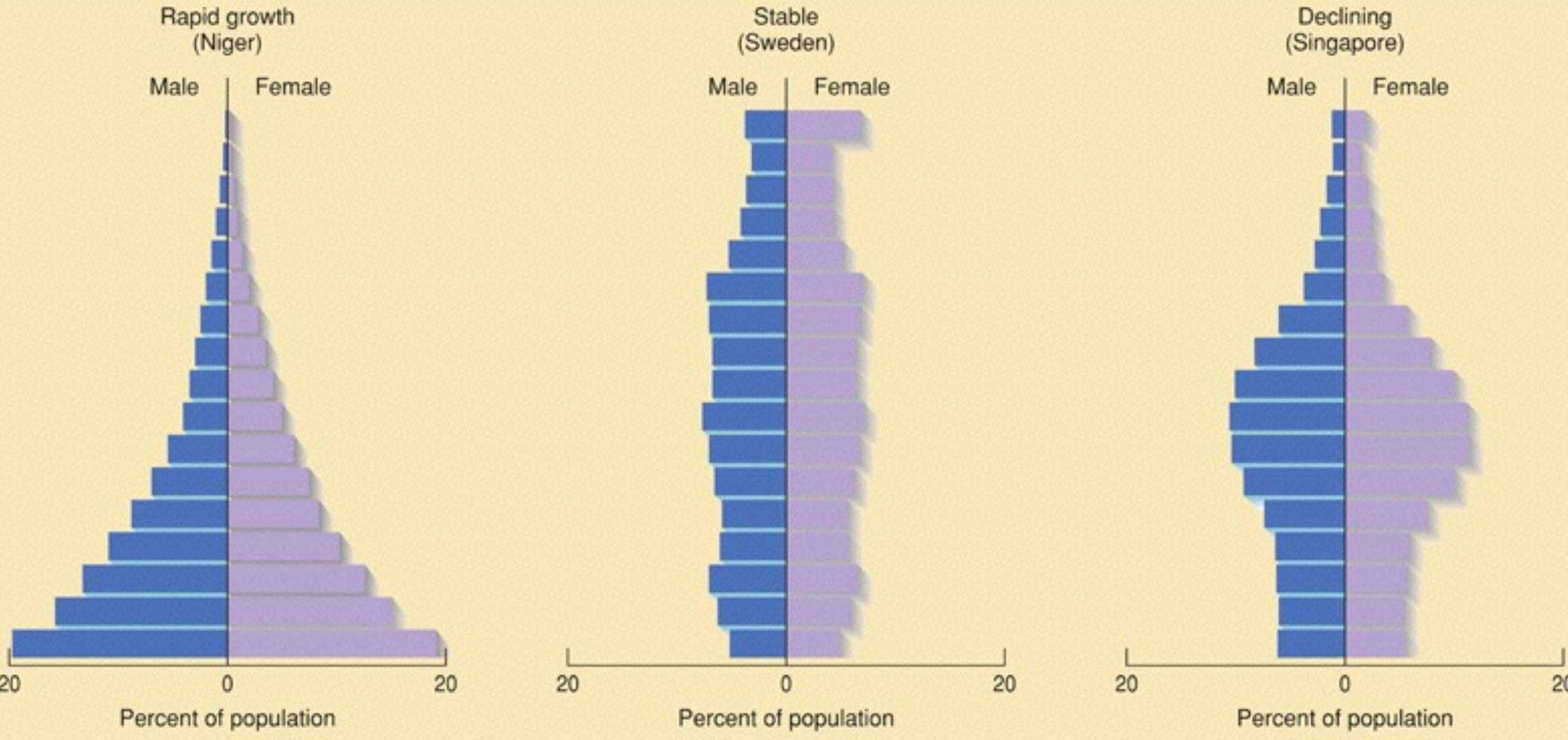
Population size (strategies for sustainable growth, national policies)

Impacts of population growth (hunger, disease, economic effects, economic effects, resource use, habitats destruction)

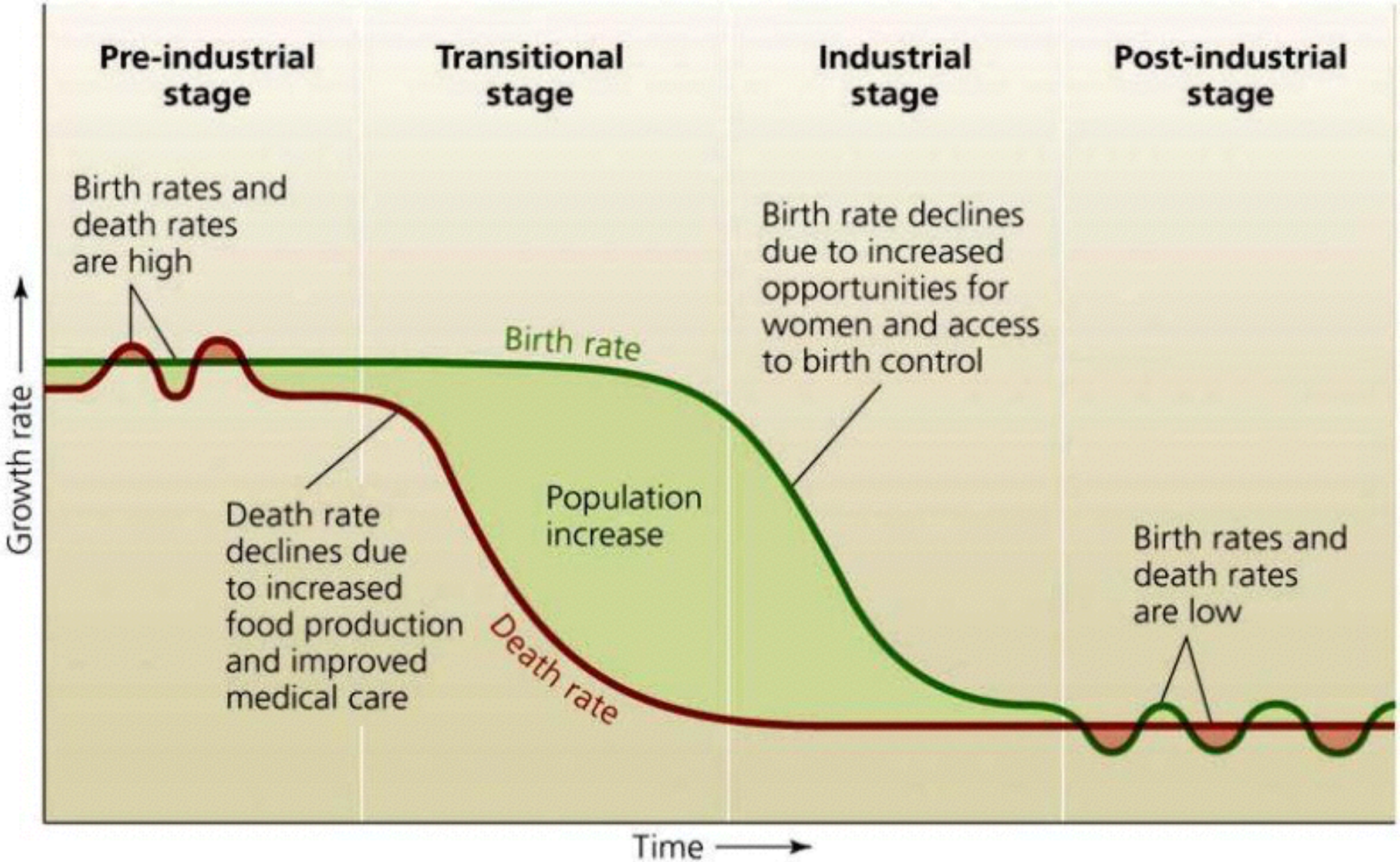
Growth rate (r) =

$$\frac{(\text{births} + \text{immigration}) - (\text{deaths} + \text{emigration})}{\text{Population (1,000)}}$$

Doubling time = 70/r(%) or 0.7/r



Demographic Transition

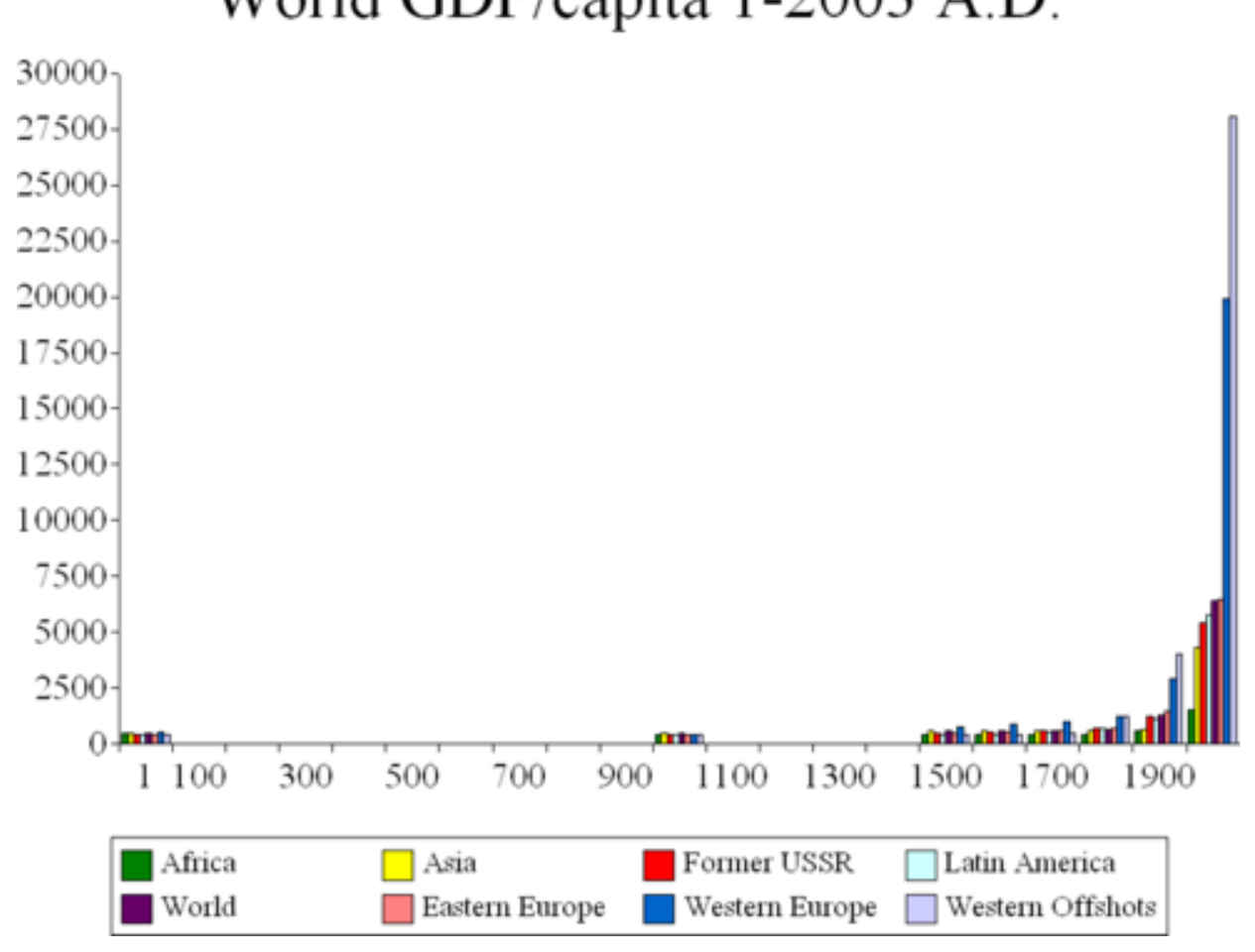


Possible FRQ topics

- Humans – rising affluence in China and India
  - Demographic transition
  - I = PxAxT

Impact = Population x Affluence x Technology

  - Influence, population size, affluence, technology
  - Footprint
  - Solutions?



IV. Land and Water Use

A. Agriculture

Nutritional requirements and deficiencies (iron/anemia, vitamin D/rickets, calories/marasmus, protein/kwashiorkor)

Types of agriculture: monoculture, polyculture, organic

Genetic engineering

Deforestation

Irrigation

Sustainable agriculture

Controlling pests (pesticides, integrated pest management (IPM): physical, biological, chemical)

Honey Bee Decline

- Millions of honey bees are dying because of pesticides and factory chemicals
- Beekeepers have lost over 40% of their bee colonies
- Neonicotinoid products, imidacloprid and clothianidin are the main products killing the bees, which are worth more than $1.5 billion
- Bees are responsible for 80% of pollination worldwide
- 70 out of 100 hundred human crops rely on bees
- No bees = no food, flowers, trees, plants



IV. Land and Water Use

B. Forestry

Tree plantations

Old growth forests

Forest fires (biomes that require fires: chaparral & grasslands)

First management, National Forests (logging and mining are allowed)

Forest violence

IV. Land and Water Use

C. Rangelands

Overgrazing

Deforestation

Desertification

Rangeland management and Federal rangeland

IV. Land and Water Use

D. Other Land Use

Urban planning, suburban sprawl, urbanization

Transportation ecosystem impacts

Public and Federal lands management

Land conservation options (preservation, remediation, mitigation, restoration)

Sustainable use strategies (privatization, permits/fee for use, education)

Legislative Term

Mitigation: Repairing/Rehabilitating a damaged ecosystem, most often by providing a substitute or replacement area; frequently involves wetland ecosystems. Credits are giving for improved conditions and debits are assessed for damage to area

IV. Land and Water Use

E. Mining

Extraction techniques (surface mining: strip mining, open pit mining, mountain top removal, placer mining; subsurface mining)

Acid drainage

Environmental impacts

IV. Land and Water Use

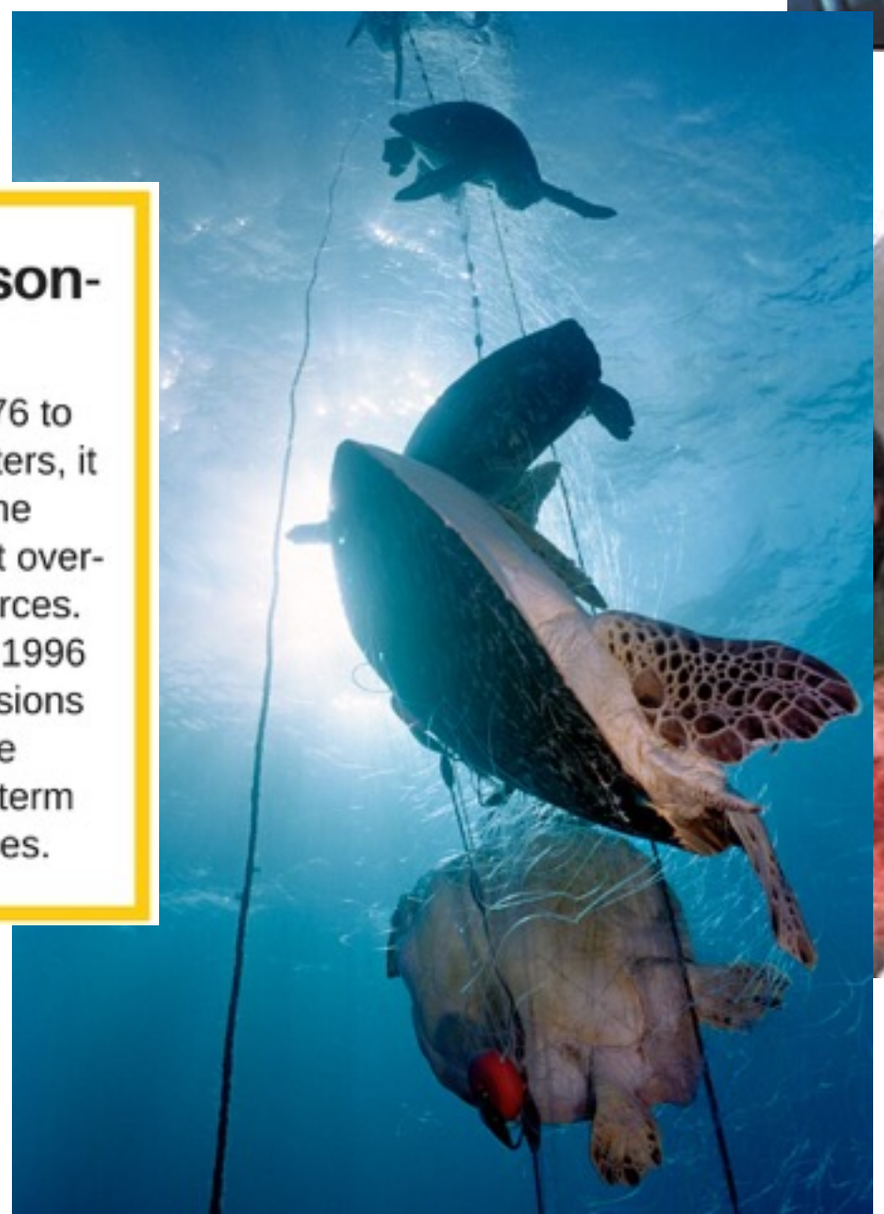
F. Fishing

Fishing techniques (bottom trawling, dredging, longlining, purse seining)

Aquaculture (open pens or closed ponds)

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.

IV. Land and Water Use

G. Global Economics

Globalization

World Bank

Tragedy of the Commons

V. Energy Resources and Consumption

A. Energy Concepts (forms of energy, units, conversions, 1st and 2nd Laws of Thermodynamics)

B. Industrial Revolution, and exponential growth

Present global energy use

Future energy needs

V. Energy Resources and Consumption

C. Fossil Fuel Resources and Use

Formation of coal, oil, and natural gas

Extraction and refining methods (drilling, fracking)

Reserves and demand

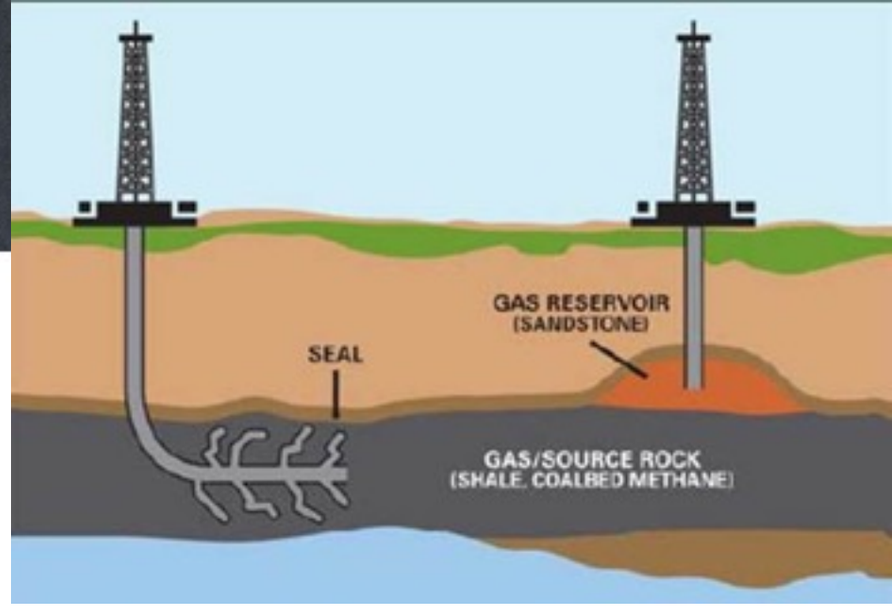
Environmental advantages/disadvantages of sources

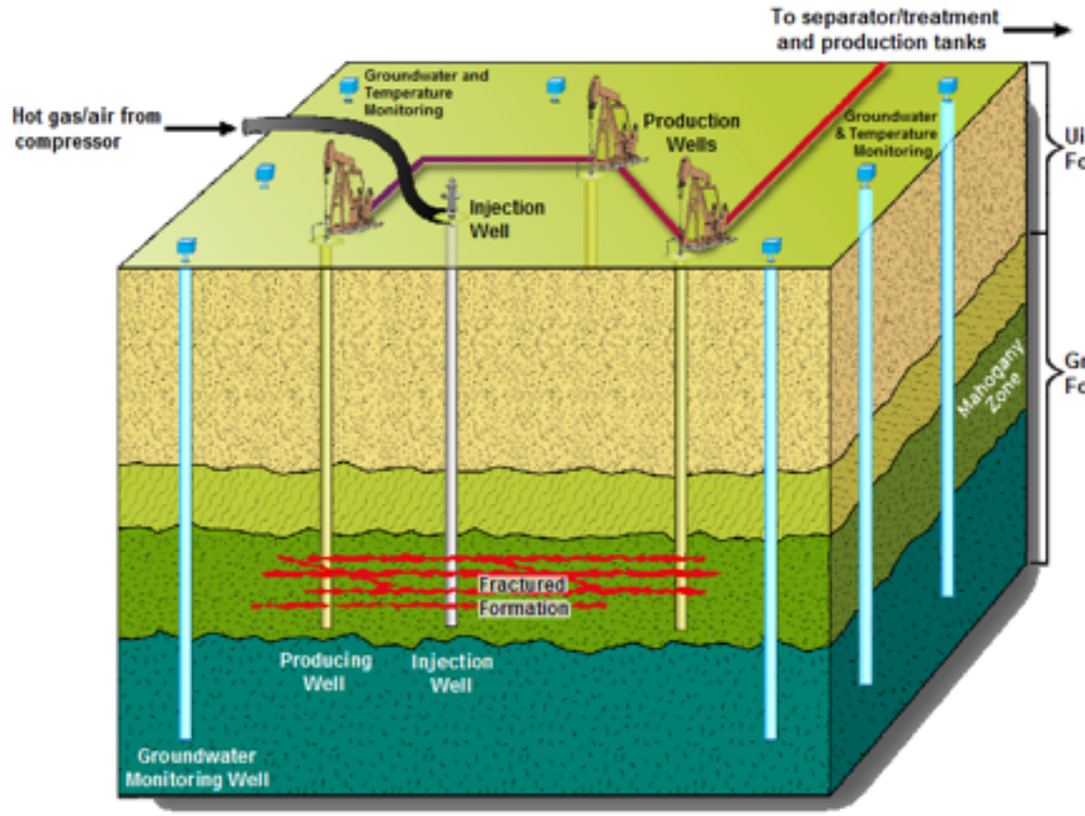
Possible FRQ topics

- 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
  - Continued reliance of oil

Shale oil and fracking

- USA now producing significant amounts of oil from shale oil in North Dakota
- Oil out of rock
- Very expensive to produce
- USA has a lot of shale oil rock





V. Energy Resources and Consumption

D. Nuclear Energy

Fission and fusion

Electricity production

Nuclear reactors

Environmental advantages/disadvantages

Safety issues

Radiation and human health

Radioactive wastes

V. Energy Resources and Consumption

E. Hydroelectric Power

Dams (pros and cons)

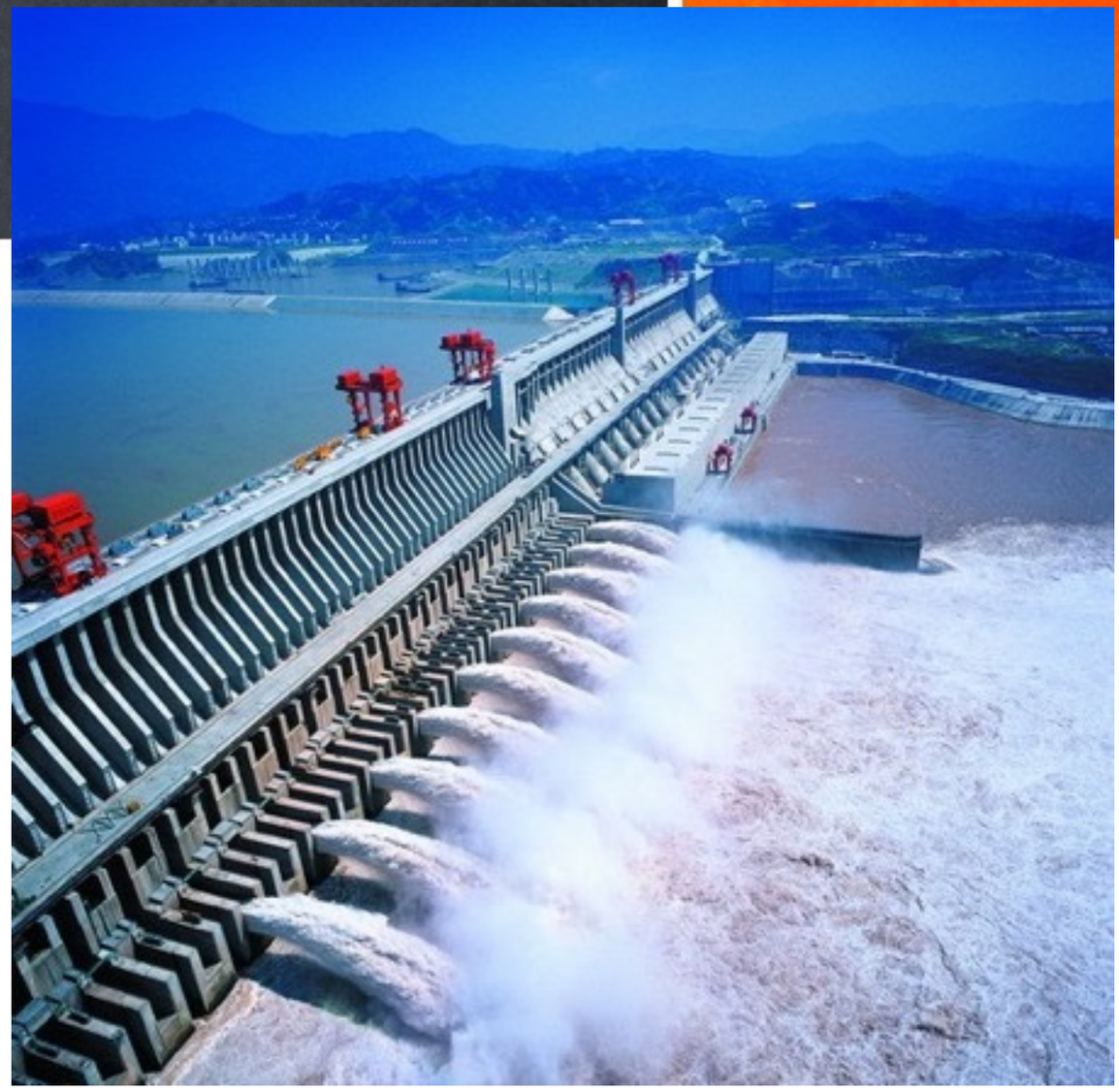
Flood control

Fish migration (i.e. salmon)

Blockage of silt and nutrients from flowing downstream

Dams/rivers

- Three Gorges Dam – largest hydroelectric plant
- Displaced over a million people from their homes
- Erosion of banks of reservoir
- Provides “clean energy”, water supply



V. Energy Resources and Consumption

F. Energy Conservation

Energy efficiency

CAFE standards (Corporate Average Fuel Economy: U.S. regulations to improve the average fuel economy of vehicles, first enacted in 1975)

Hybrid electric vehicles

Mass transit

V. Energy Resources and Consumption

G. Renewable Energy (advantages and disadvantages)

Solar

Hydrogen fuels cells (cars)

Biomass (manure, wood, ethanol, vegetable oil)

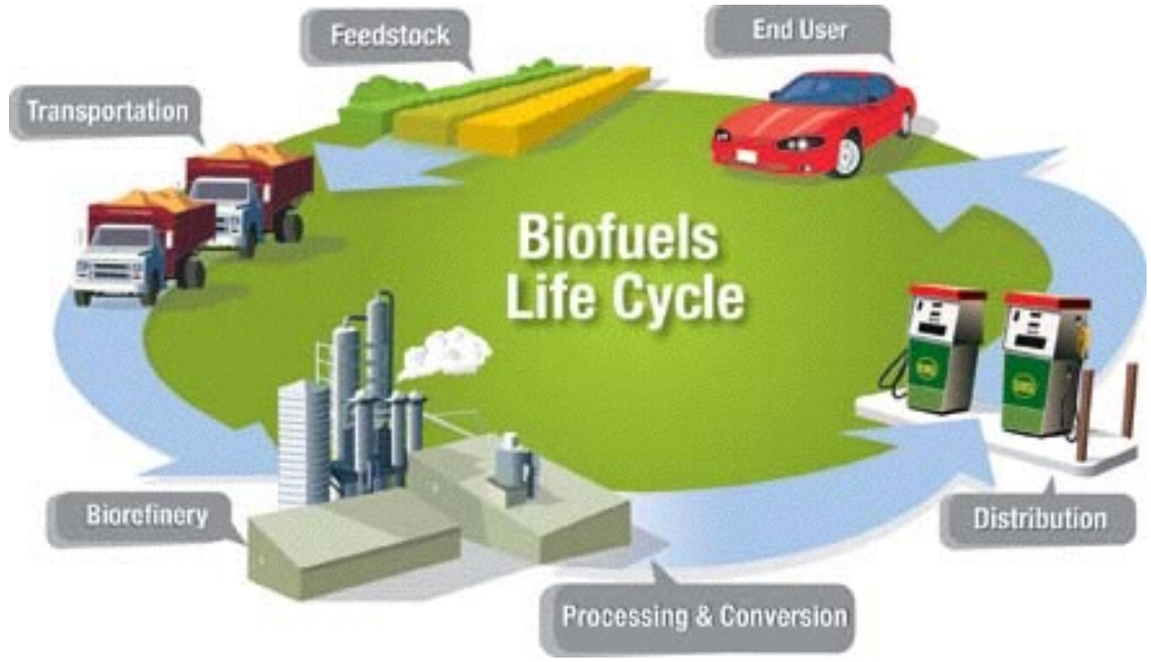
Wind

Ocean waves and tidal energy

Geothermal

Biofuels

- Usually ethanol from corn or sugarcane
- Cellulosic ethanol – from inedible parts of plants
  - Cellulose to ethanol
- Palm oil
- Uses LOTS of water, fertilizers, pesticides
- Switchgrass and algae better alternatives



Wind power

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

VI. Pollution

A. Pollution Types

Air (primary and secondary, criteria air pollutants, smog, acid deposition, heat islands, temperature inversions, indoor air pollution)

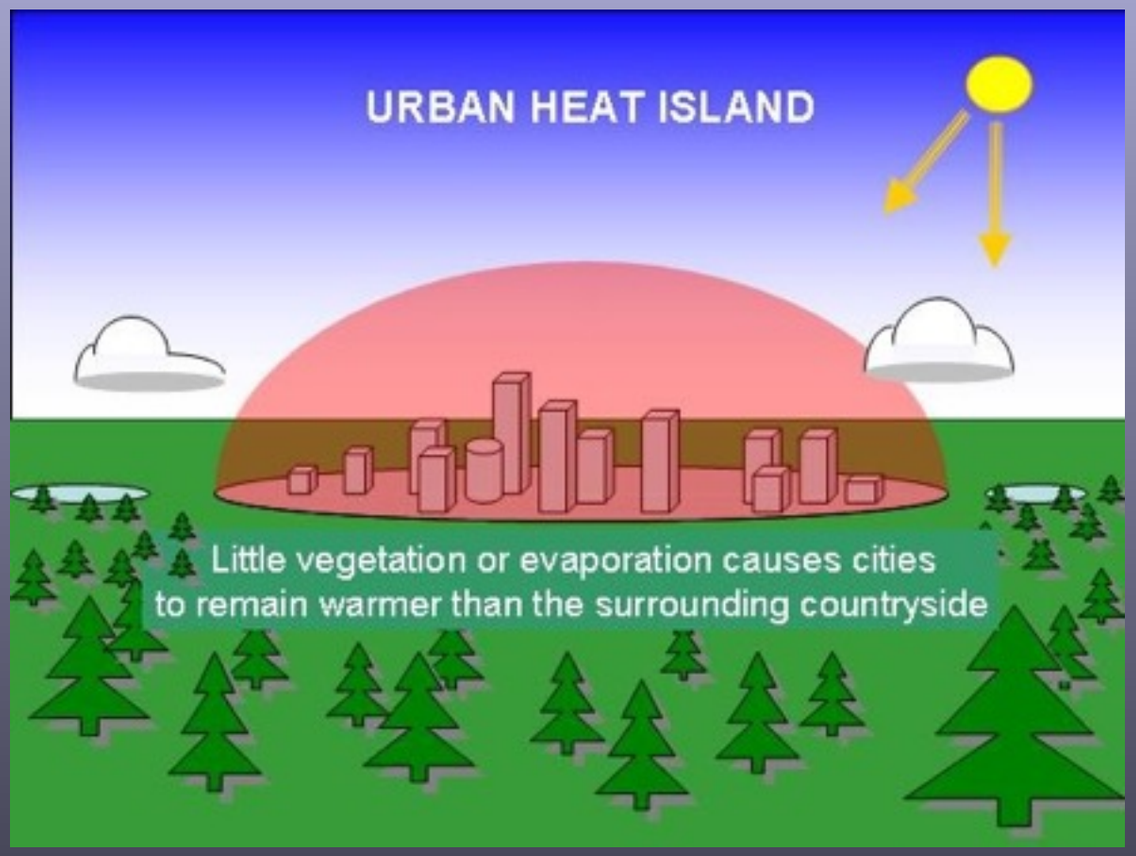
Noise (sources, effects, control)

Water (sources, effects, eutrophication, groundwater pollution, water purification, sewage treatment)

Solid waste (disposal, reduction)

Urban Heat Island

- Metro area where temp is hotter in city vs outside city.
- Caused by buildings blocking cooler air
- Also by asphalt and cement absorbing heat during day and releasing it at night.



Possible FRQ topics

- 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?

Algal blooms

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

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?

Possible FRQ topics

- Pollution, water: The Great Pacific Garbage Patch
  - Mostly plastic
  - Between CA and China
  - PCBs, bisphenol A,
  - Photodegredation of plastics
  - More plastic than plankton
  - Tiny pieces ingested by zooplankton →bioaccumulation in the food chain
- Plastic bag bans

VI. Pollution

B. Impacts on the Environment and Human Health

Hazards to human health

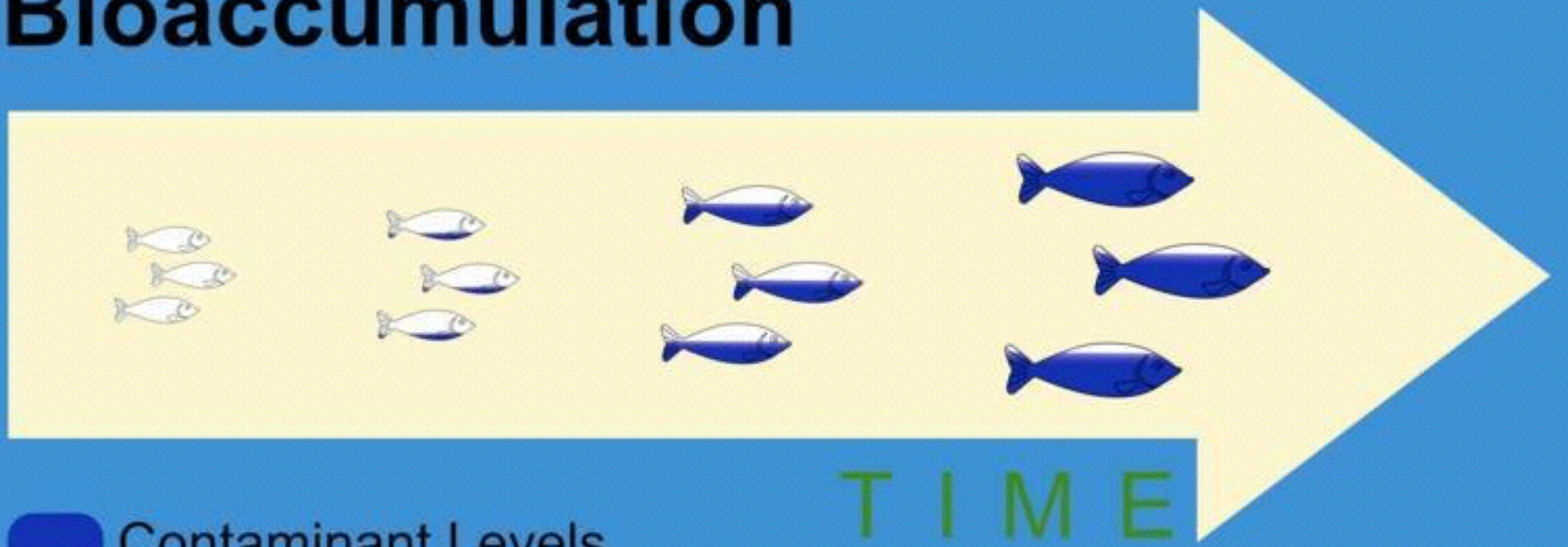
Hazardous chemicals (neurotoxins, endocrine disrupters, etc.)

Cleanup (CERCLA/Superfund)

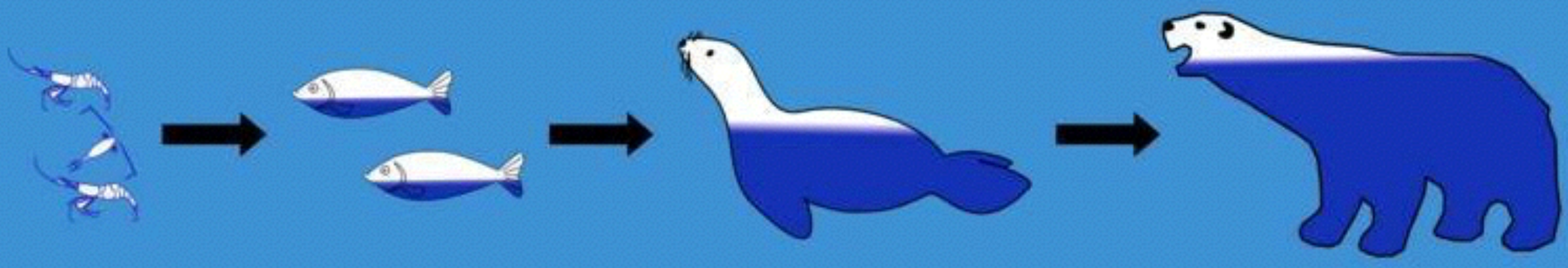
Biomagnification vs. Bioaccumulation

C. Economic Impacts

Bioaccumulation



Contaminant Levels

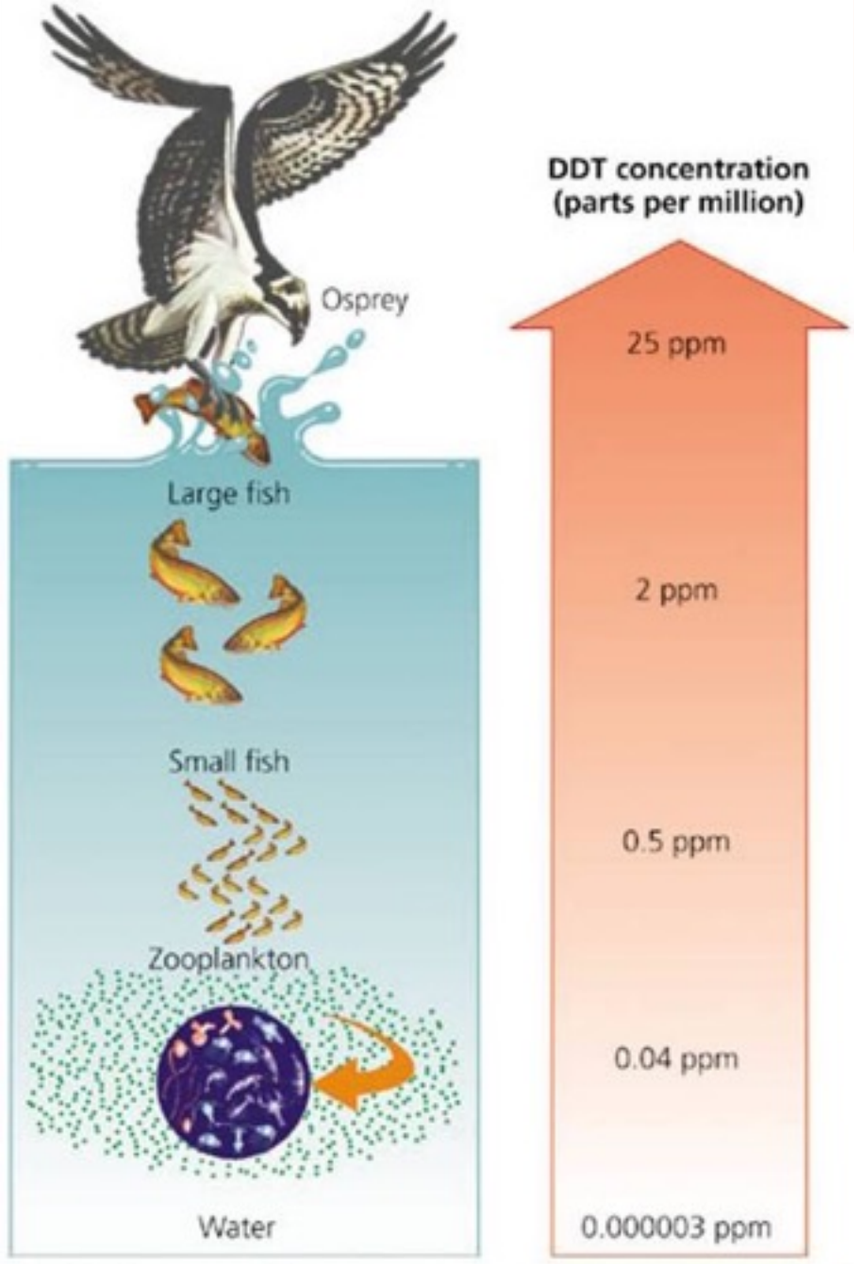


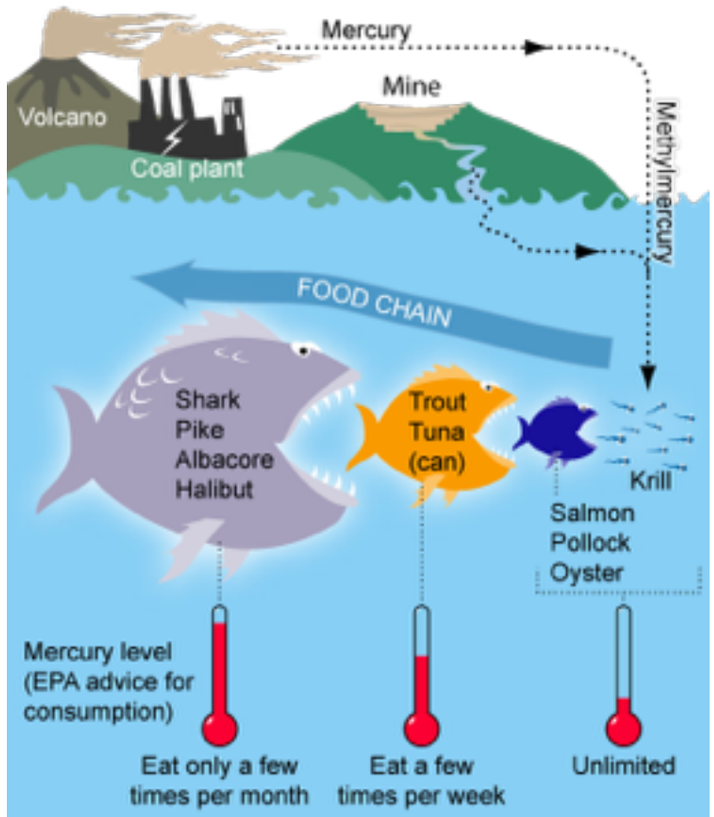
Contaminant Levels

Biomagnification

Mercury deposition

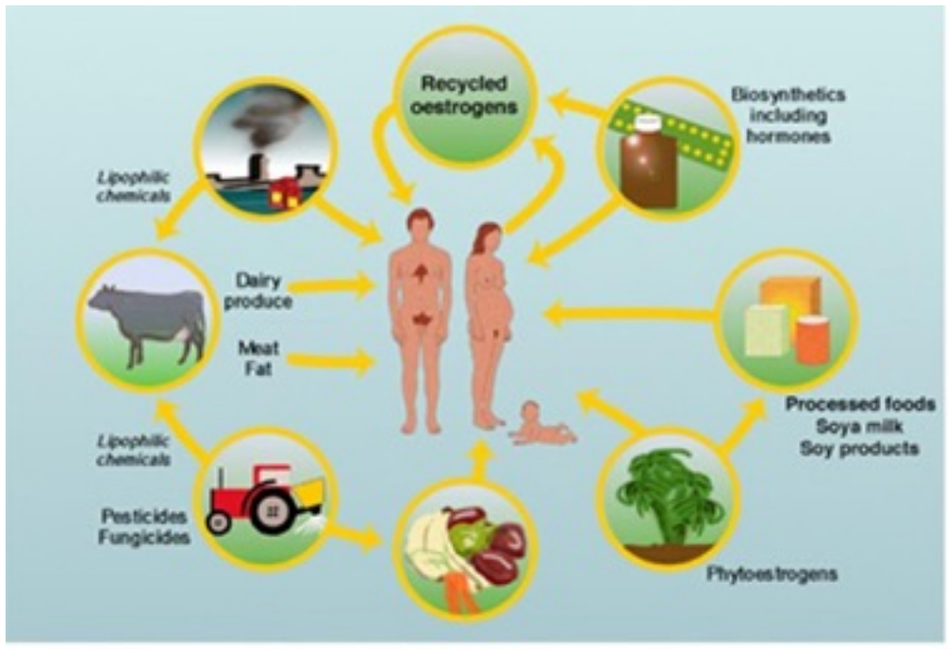
- Hg in air from burning coal
- Deposits into water
- Bioaccumulates and biomagnifies in food web
- Hg is a neurotoxin
- What about deposition on land?
  - Bird songs





Endocrine disrupters

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



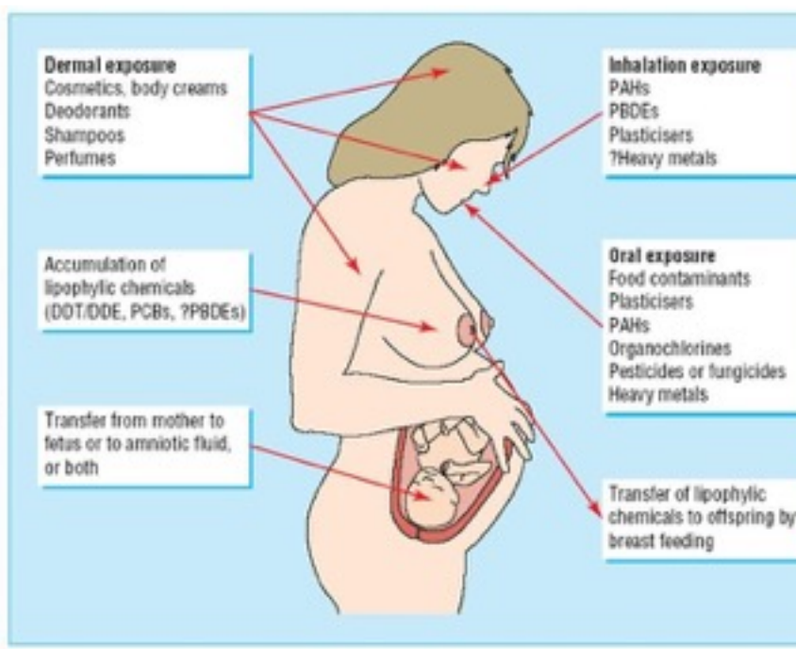


Fig 3 Routes of human exposure to some common environmental chemicals. DDE=1,1-dichloro-2, 2-bis(p-chlorophenyl)ethylene, DDT=dichlorodiphenyltrichloroethane, PAHs=polycyclic aromatic hydrocarbons, PCBs=polychlorinated biphenyls

VII. Global Change

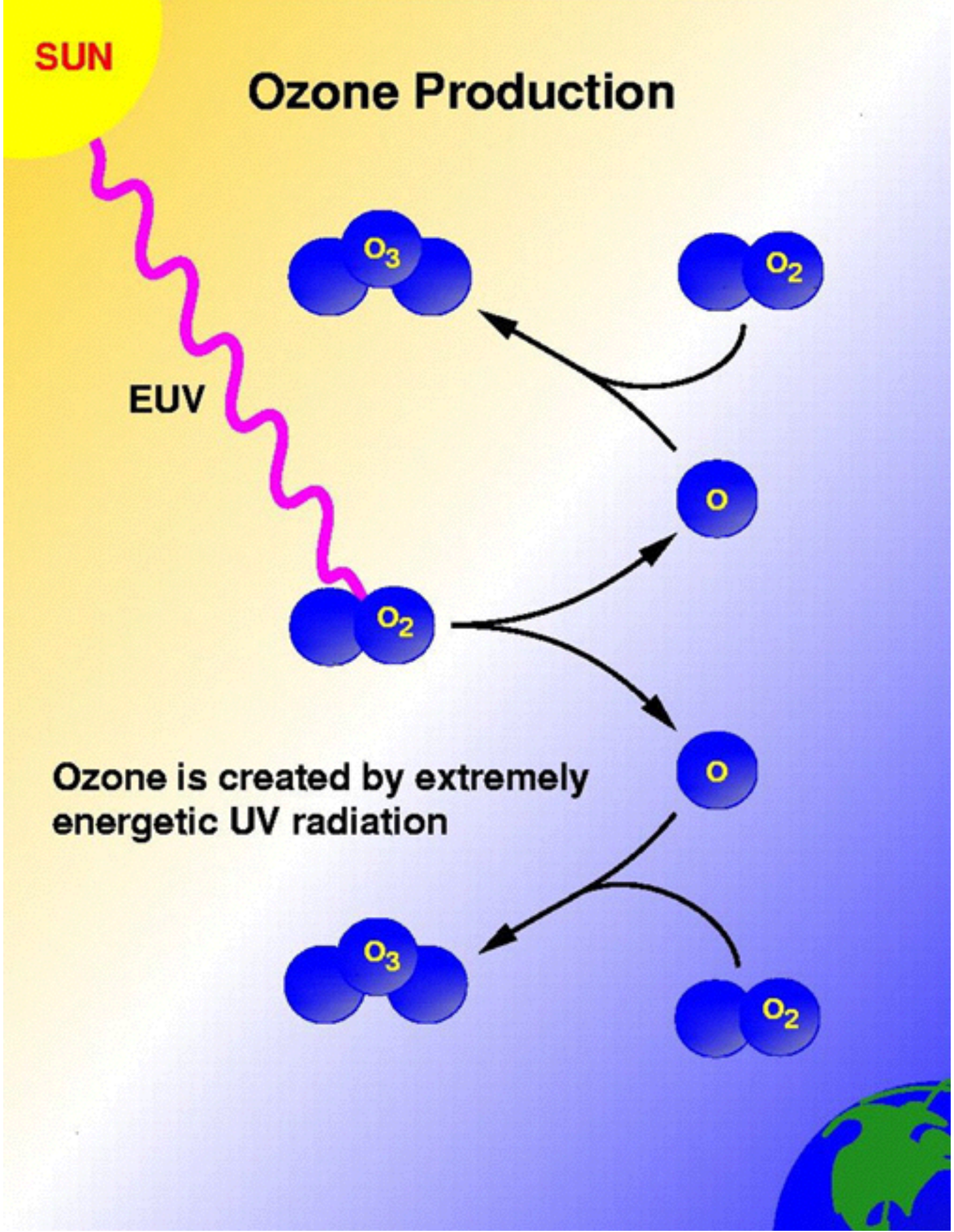
A. Stratospheric Ozone

Formation of stratospheric ozone

Ultraviolet (UV) radiation

Causes of ozone depletion (CFCs)

Strategies for reducing ozone depletion (Montreal Protocol)


SUN
Ozone Production
EUV
O_3
O_2
O
O_2
O
O_3
O_2
Ozone is created by extremely
energetic UV radiation

VII. Global Change

B. Global Warming

Greenhouse gases and the greenhouse effect

Impacts and consequences of global warming

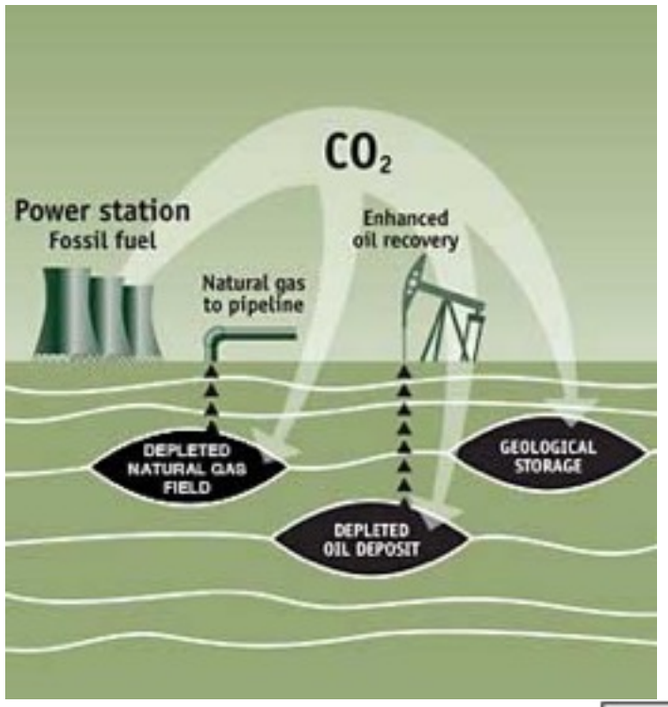
Reducing climate change

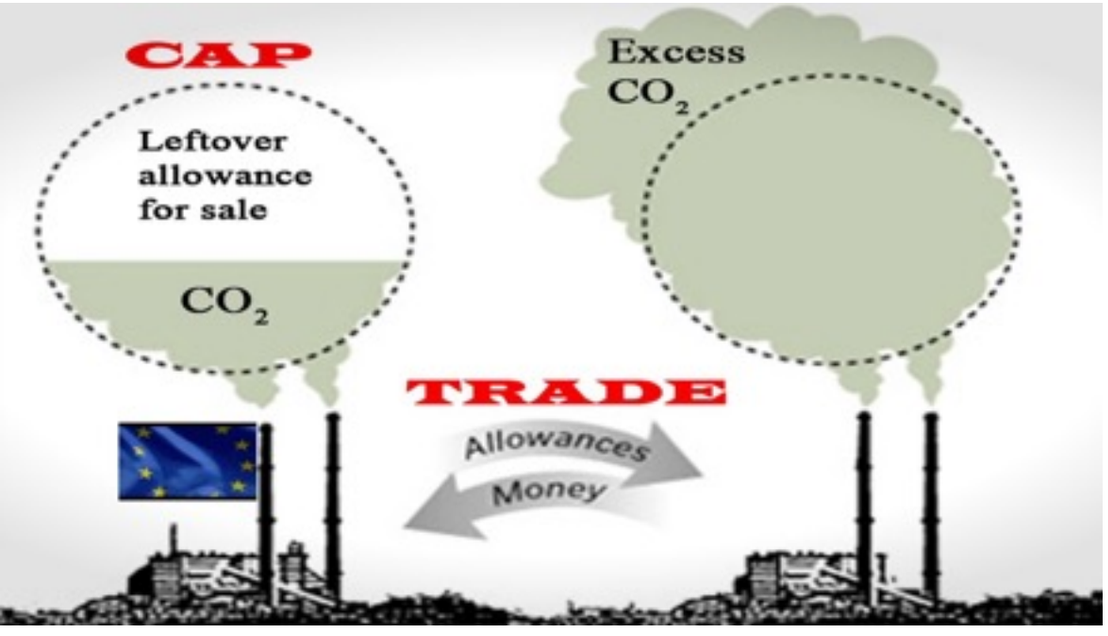
Kyoto Protocol

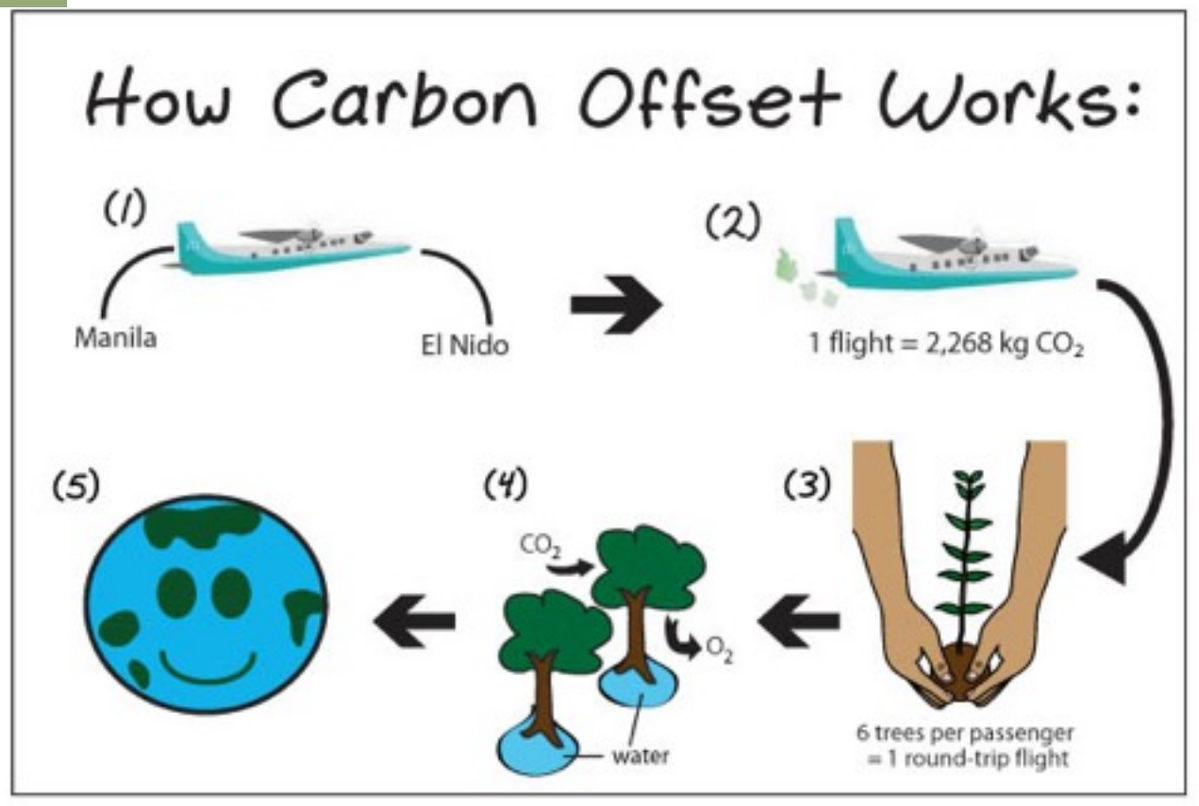
Mitigations for climate change

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

(carbon capture and storage)







VII. Global Change

C. Loss of Biodiversity (causes: HIPPCO)

Habitat loss and overuse

Invasive species

Pollution

Population control

Climate change

Overharvesting

Possible FRQ topics

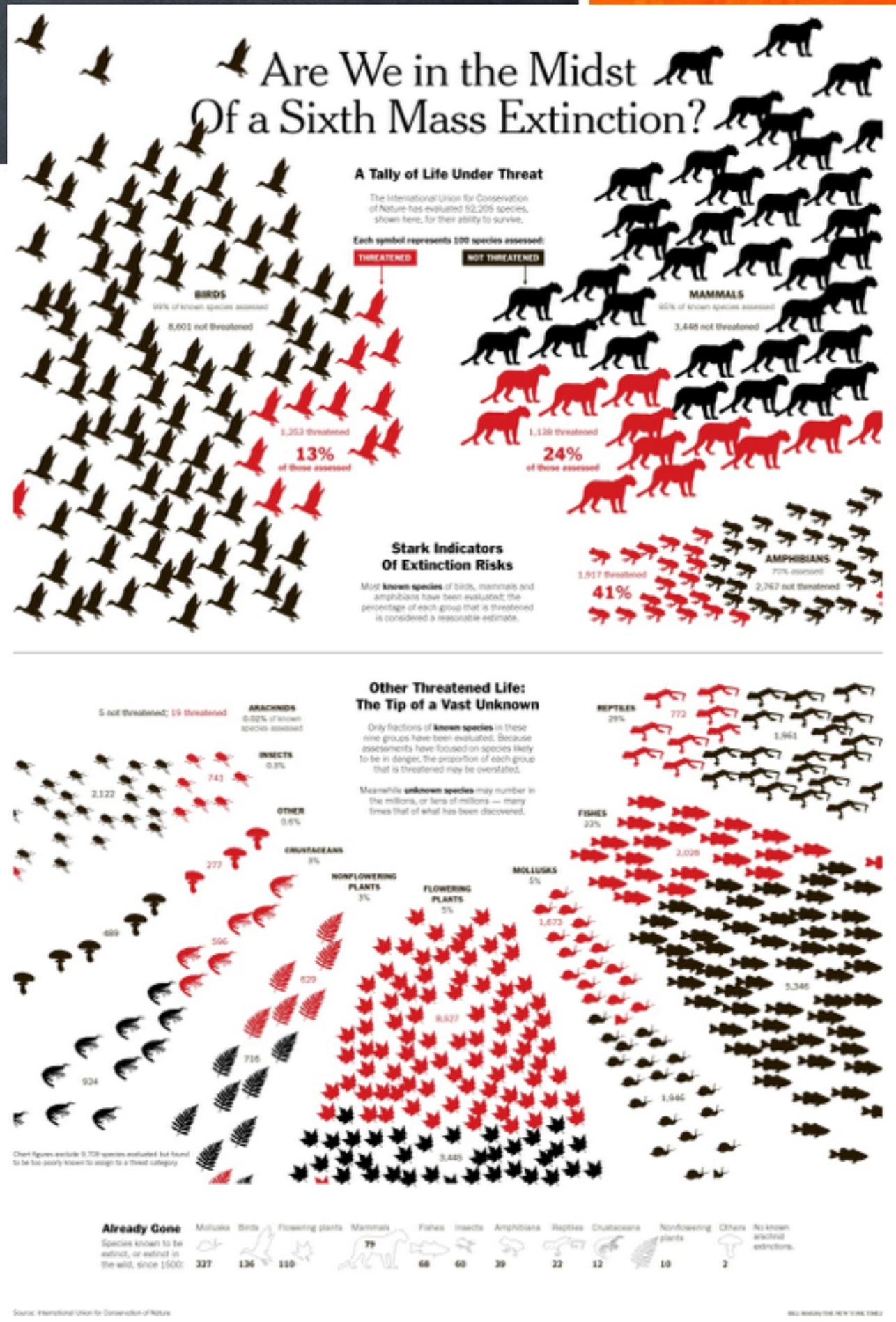
- Palm oil
  - Used in foods and beauty products
  - Replaces partially hydrogenated oils
  - Grown in tropics
  - Deforestation, species loss, HIPPCO

Possible FRQ topics

- Invasive species
  - Links to climate change
    - More tropical diseases spreading to new areas
  - Links to evolution
    - Species being exposed to diseases they have never been exposed to before, no resistance
  - White nose syndrome in bats – fungus that irritates them so they don't hibernate, use all their energy up and die
  - Colony collapse disorder in bees
    - They just suddenly disappear
  - For both species – provide important economic and ecosystem services

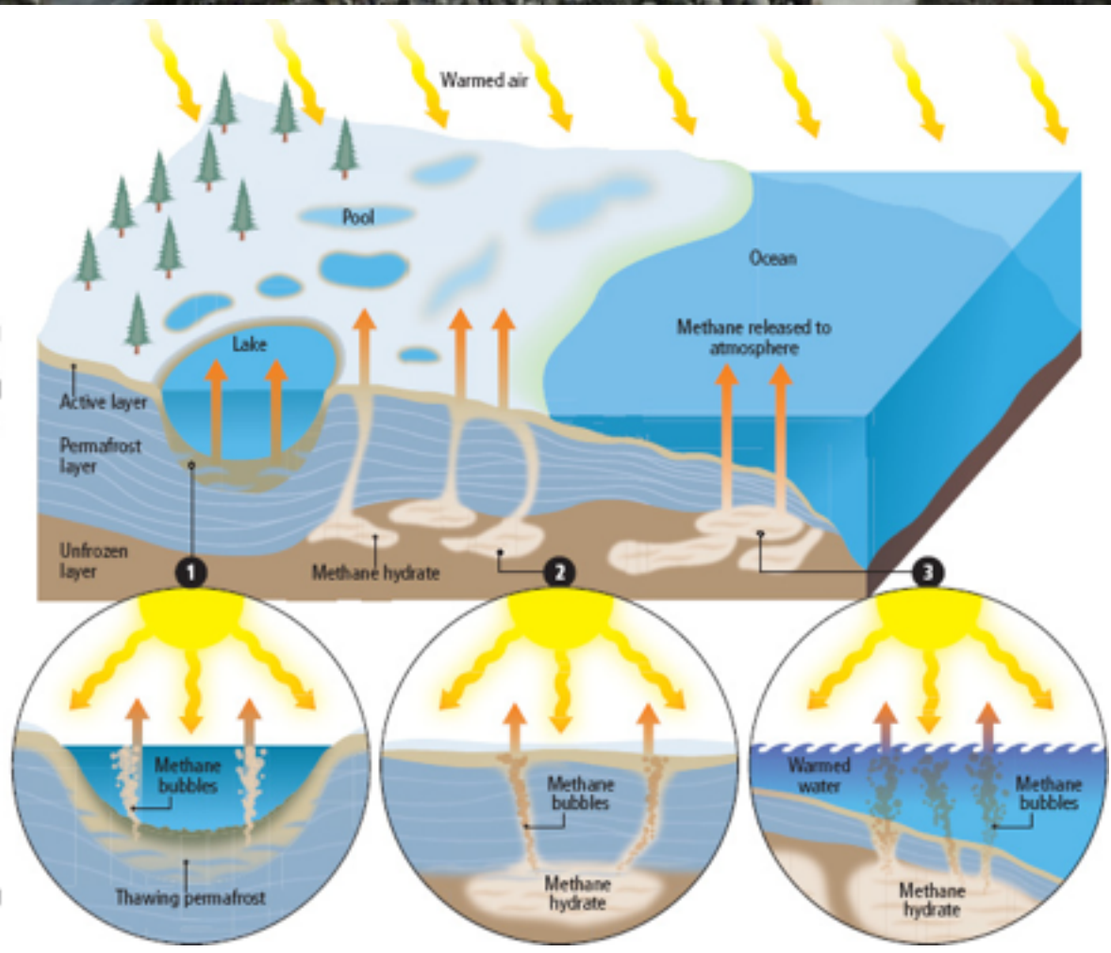
Possible FRQ topics

- 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?



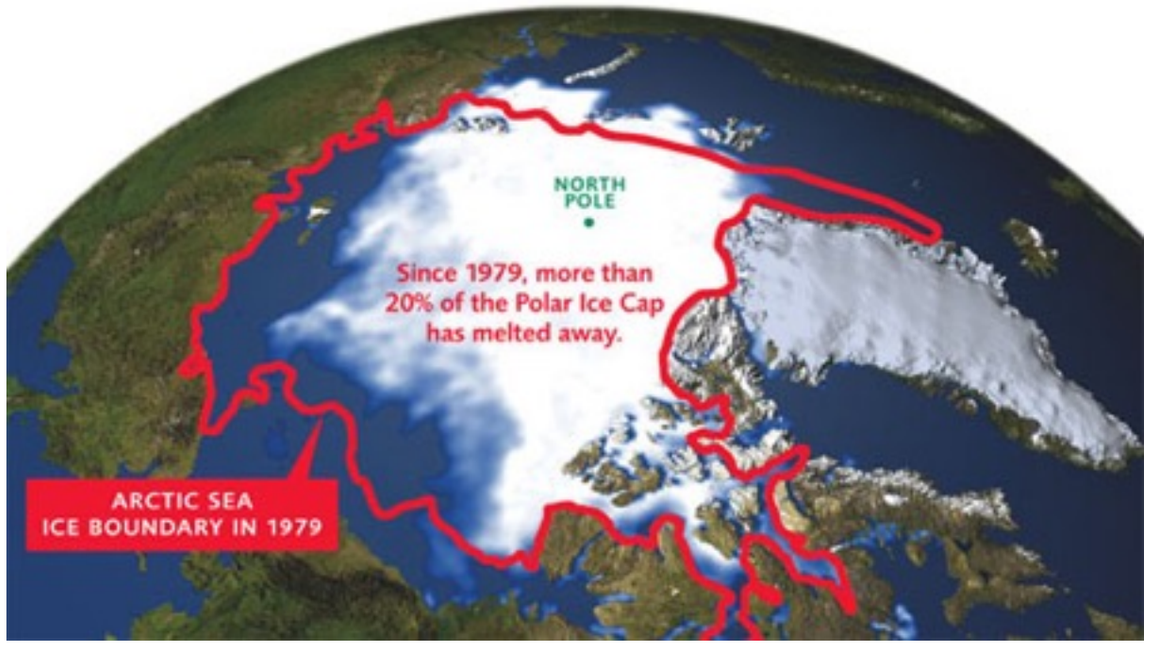
Possible FRQ topics

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

Declining polar ice



- As planet warms → ice thaws → less light reflected back to space → polar north less white → more solar radiation absorbed → more melting → increasing sea levels → decline in polar species