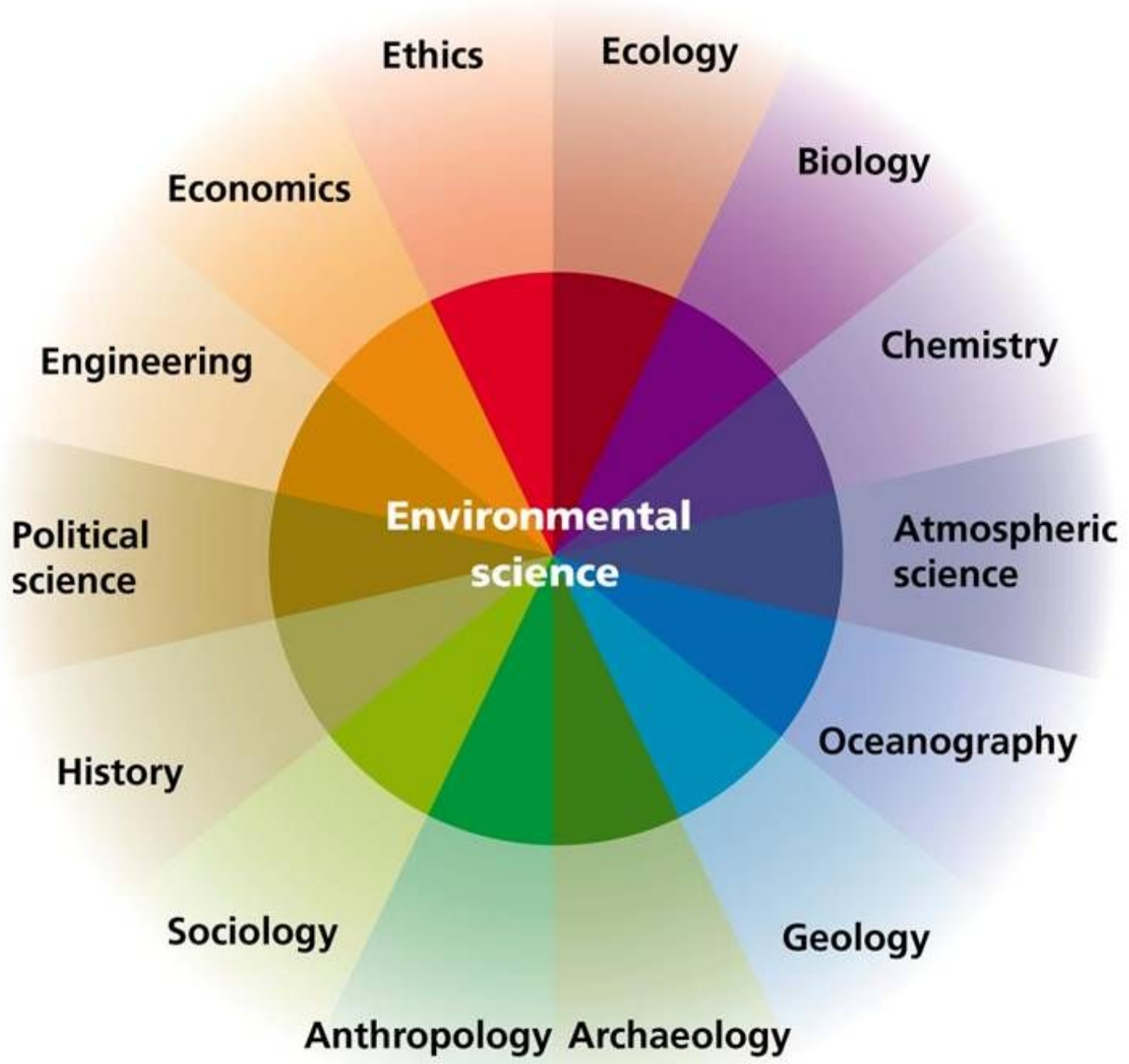




SCIENCE AND THE ENVIRONMENT

What Is Environmental Science?

- ◎ **Biology** is the study of the air, water, and land surrounding an organism or a community, which ranges from a small area to Earth's entire biosphere.
- ◎ **Goals-** to understand:
 - 1) How our actions alter our environment.
 - 2) The use of natural resources.



Many Fields of Study

Major Fields of Study That Contribute to Environmental Science

Biology is the study of living organisms.

Zoology is the study of animals.

Botany is the study of plants.

Microbiology is the study of microorganisms.

Ecology is the study of how organisms interact with their environment and each other.

Earth science is the study of the Earth's nonliving systems and the planet as a whole.

Geology is the study of the Earth's surface, interior processes, and history.

Paleontology is the study of fossils and ancient life.

Climatology is the study of the Earth's atmosphere and climate.

Hydrology is the study of Earth's water resources.

Physics is the study of matter and energy.

Engineering is the science by which matter and energy are made useful to humans in structures, machines, and products.

Chemistry is the study of chemicals and their interactions.

Biochemistry is the study of the chemistry of living things.

Geochemistry, a branch of geology, is the study of the chemistry of materials such as rocks, soil, and water.

Social sciences are the study of human populations.

Geography is the study of the relationship between human populations and Earth's features.

Anthropology is the study of the interactions of the biological, cultural, geographical, and historical aspects of humankind.

Sociology is the study of human population dynamics and statistics.

Scientists as Citizens, Citizens as Scientists

- ◎ Studying our environment is vital to maintaining a healthy and productive society
- ◎ Environmental scientists are often asked to share their research with the world
- ◎ Observations of nonscientists are the first steps toward addressing an environmental problem (ex: citizen science)



Our Environment Through Time

- ◎ Wherever humans have hunted, grown food, or settled, they have changed the environment
- ◎ Manhattan (map on next slide: environment change over time)

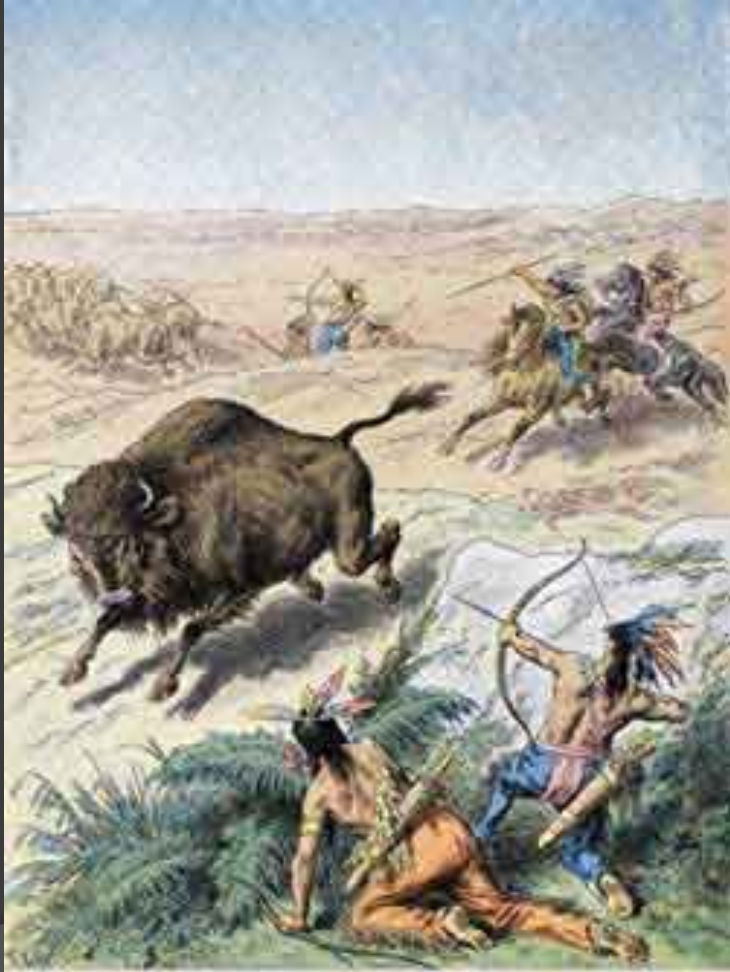
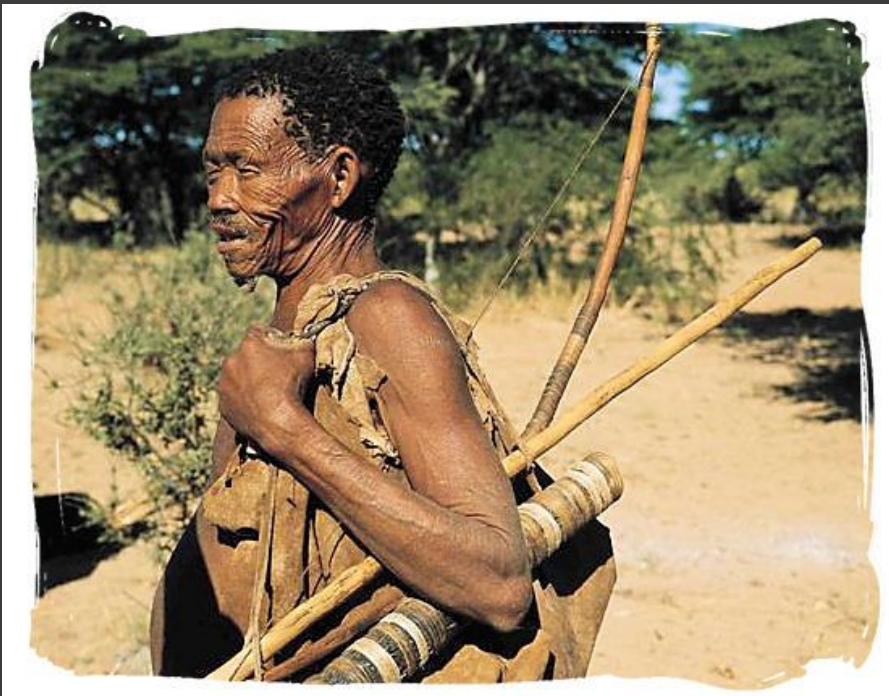


**Growth of
Manhattan Island,
1650-1980**



Hunter-Gatherers

- ◎ **Hunter-gatherers** are people who obtain food by collecting plants and by hunting wild animals or scavenging their remains.
- ◎ Hunter-gatherers affect their environment in many ways:
 - 1) Native American tribes hunted horses.
 - 2) The tribes also set fires to burn prairies and prevent the growth of trees. This left the prairie as an open grassland ideal for hunting bison.
 - 3) Species endangered (bison, cave bears, saber tooth tigers)



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The Agricultural Revolution

- ◎ **Agriculture** is the raising of crops and livestock for food or for other products that are useful to humans
- ◎ Started in many different parts of the world over 10,000 years ago
- ◎ Dramatic impact on human societies and their environment
- ◎ Allowed human population to stay the same

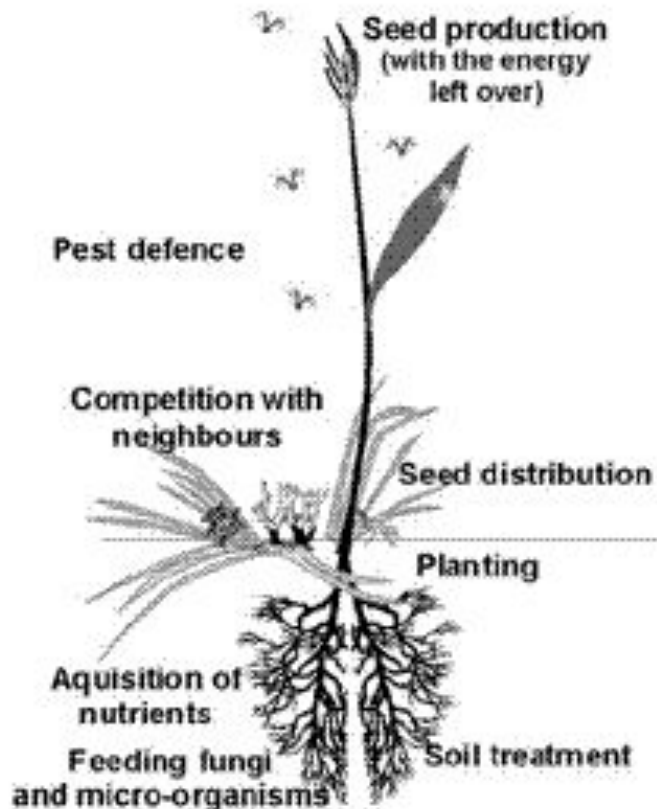
World Population (est.) 10,000 BC - 2,000 AD



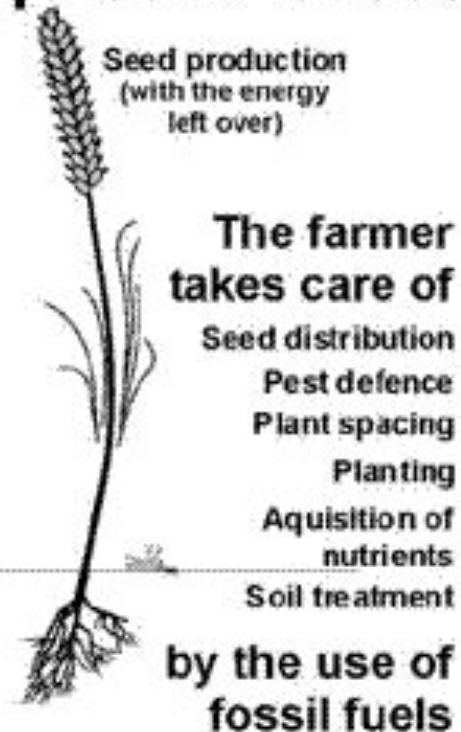
The Agricultural Revolution

- ⦿ Changed the food we eat
- ⦿ The plants we grow and eat today are descended from domesticated plants
- ⦿ During harvest season farmers collected seeds from plants that exhibited the qualities they desired, such as large kernels
- ⦿ These seeds were then planted and harvested again = evolution of domesticated plants

'Wild'wheat



'Improved' wheat



The Agricultural Revolution

- ◎ **Many habitats were destroyed** as grasslands, forests, and wetlands were replaced with farmland
- ◎ Replacing forest with farmland on a large scale can cause soil loss, floods, and fresh water surplus.

The Agricultural Revolution

- ◎ The **slash-and-burn** technique was one of the earliest ways that land was converted to farmland
- ◎ Much of this converted land was poorly farmed and is no longer fertile



The Industrial Revolution

- ◎ The **Industrial Revolution** involved a shift from energy sources such as animals and running water to renewable fuels such as coal and oil
- ◎ Use of fossil fuels = increased efficiency
 - Motorized vehicles allowed food to be transported cheaply across shorter distances.



Improving the Quality of Life

- ◎ **Large population growth**
- ◎ The industrial Revolution introduced many positive changes such as the light bulb
- ◎ Agricultural productivity decreased, and sanitation, nutrition, and medical care vastly improved

Improving the Quality of Life

- ◎ Industrial Revolution introduced many new environmental problems
 - **Pollution**
 - **Habitat loss**
 - **cleaner air & water sources**
- ◎ We now have materials such as plastics, artificial pesticides, and fertilizers
 - Cause problems for us nowadays

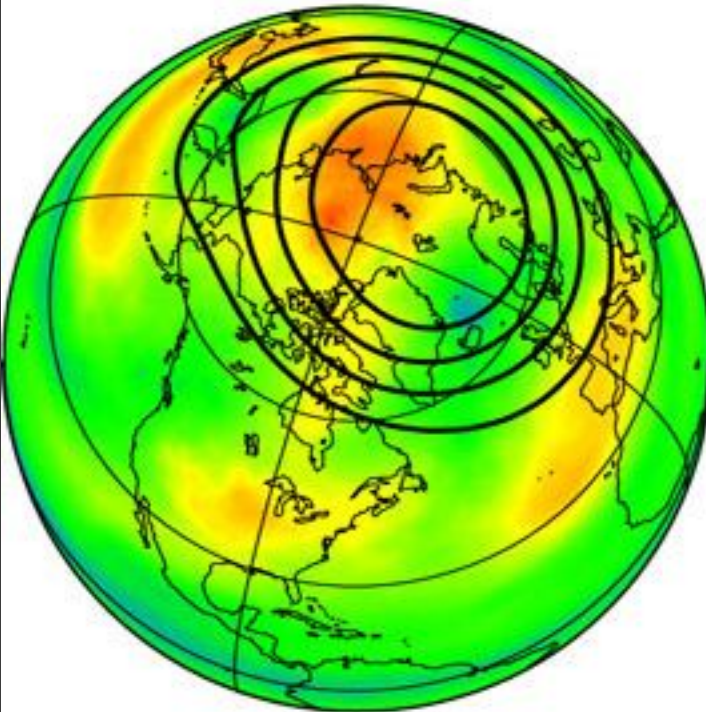


Spaceship Earth

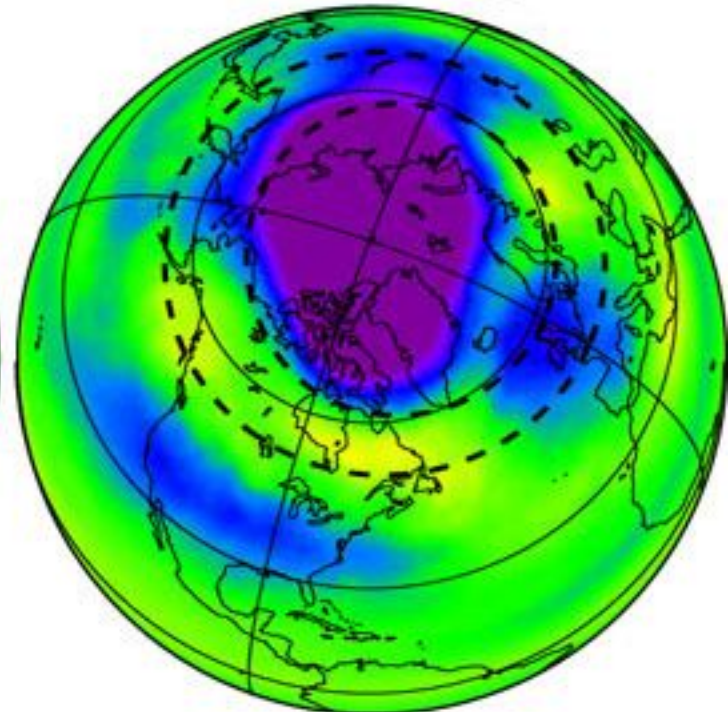
- ⊙ Earth can be compared to a spaceship traveling through space as it cannot dispose of its waste or take on new supplies
- ⊙ **Earth is essentially a open system**
 - Energy from the sun enters
 - Heat leaves
 - All other materials are cycled
 - Limited resources

—— Strong Long Wave

----- Weak Long Wave



1984



1997

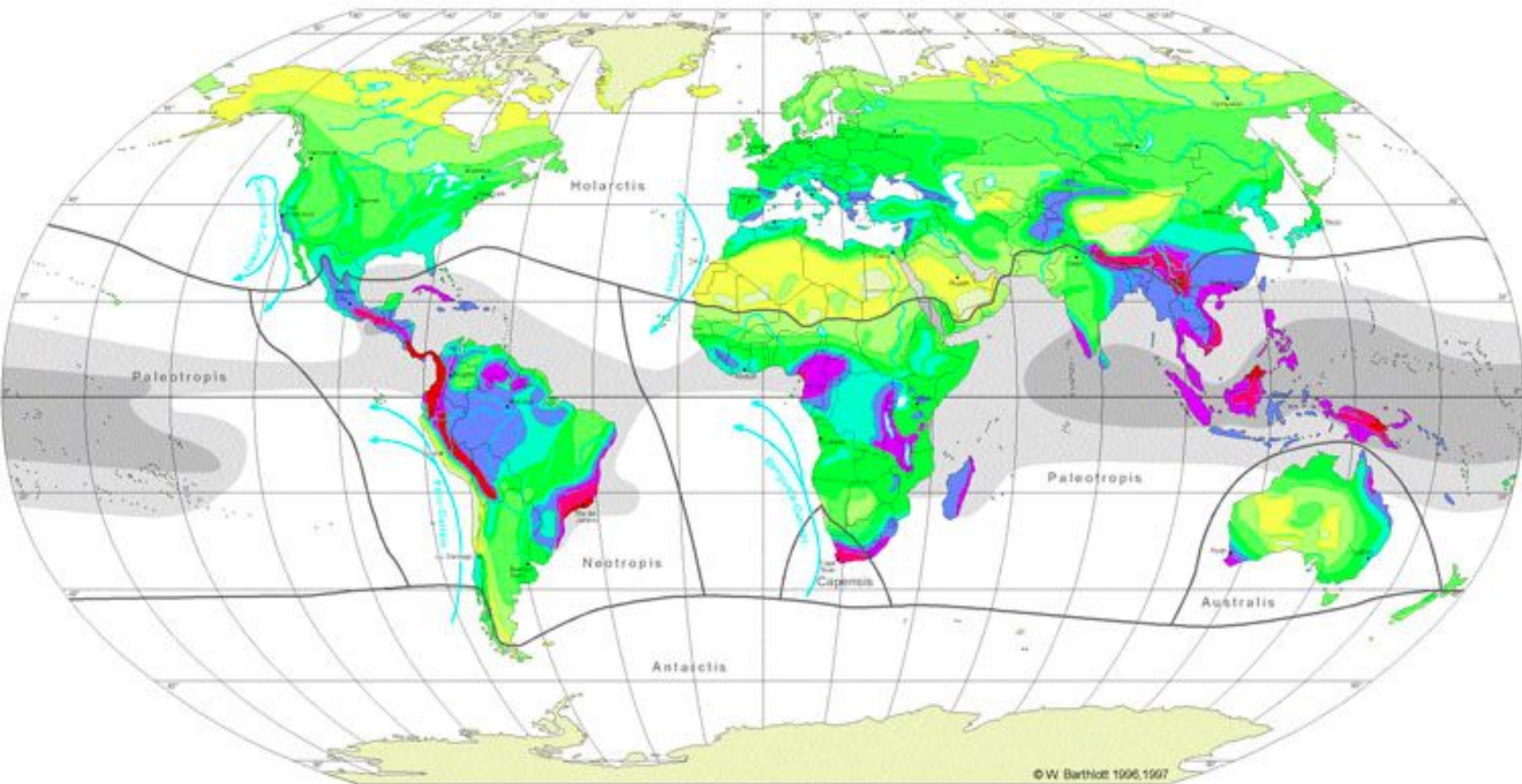
Total Column Ozone



What are our Main Environmental Problems?

- ◎ Environmental problems can generally be grouped into three categories:
 - 1) Resource Depletion
 - 2) Pollution
 - 3) Loss of Biodiversity

GLOBAL BIODIVERSITY: SPECIES NUMBERS OF VASCULAR PLANTS



© W Barthlott 1996, 1997

Robinson Projection
Standard Parallels 38°N und 38°S
Scale 1: 130 000 000

Diversity Zones (DZ): Number of species per 10.000km²

DZ 1 (<100)	DZ 5 (1000 - 1500)	DZ 9 (4000 - 5000)
DZ 2 (100 - 200)	DZ 6 (1500 - 2000)	DZ 10 (>5000)
DZ 3 (200 - 500)	DZ 7 (2000 - 3000)	
DZ 4 (500 - 1000)	DZ 8 (3000 - 4000)	

Capensis Floristic regions

sea surface temperature
 >29°C
 >27°C
 cold currents

W Barthlott, N Bedinger, G. Braun
 F. Feg, G. Kier, W. Lauer & J. Mutke 1997
 modified after
 W. Barthlott, W. Lauer & A. Pläcke 1996
 Department of Botany and Geography
 University of Bonn
 German Aerospace Research Establishment, Cologne
 Cartography: M. Gref
 Department of Geography
 University of Bonn

Resource Depletion

- **Natural Resources** are any natural materials that are used by humans, such as, water, petroleum, minerals, forests, and animals
 - Can be **renewable** or **nonrenewable**
 - **Renewable resources** can be replaced relatively quickly by natural process. (ex: oil)
 - **Nonrenewable resources** form at a much slower rate than they are consumed (millions of years) (ex:wind)

uTility



Pollution

- ⊙ **Pollution** is an undesirable change in the natural environment
 - caused by the introduction of substances that are healthy to living organisms
- ⊙ Much of the pollution that troubles us today is produced by human activities and the accumulation of wastes.



Pollution

- ⦿ There are two main types of pollutants:
 - **Biodegradable pollutants**, which can be broken down by natural processes and include materials such as mercury
 - **Nondegradable pollutants**, which cannot be broken down by natural processes and include materials such as newspaper



gut plastic?

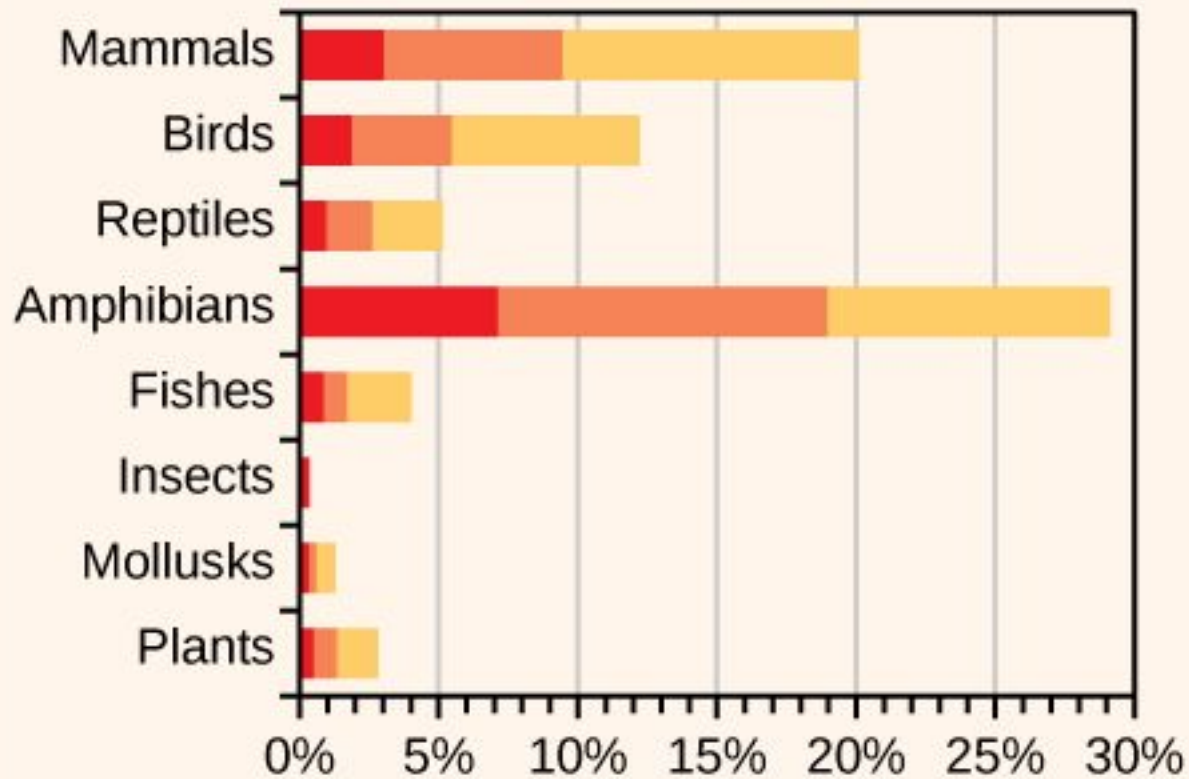
Loss of Biodiversity

- ◎ **Biodiversity** (several definitions)
 - the variety of organisms in a given area
 - the genetic variation within a population
 - the variety of species in a community
 - the variety of communities in an ecosystem



Loss of Biodiversity

- ⦿ all the species that once roamed the Earth are alive today
- ⦿ Scientists think that if the current extinction rates continue, it may cause problems for the human population
- ⦿ Problems with species going extinct?
- ⦿ Effects ecosystems, especially if keystone species



The percentage of species in several groups that are listed as: ■ critically endangered, ■ endangered, or ■ vulnerable on the 2007 IUCN Red List

“The Tragedy of the Commons”

- ◎ **Garrett Johnson**
- ◎ The main difficulty in solving environmental problems is the conflict between the short-term interests of the individual and the long-term welfare of society
- ◎ What to do with areas of land that belong to the community?



“The Tragedy of the Commons”

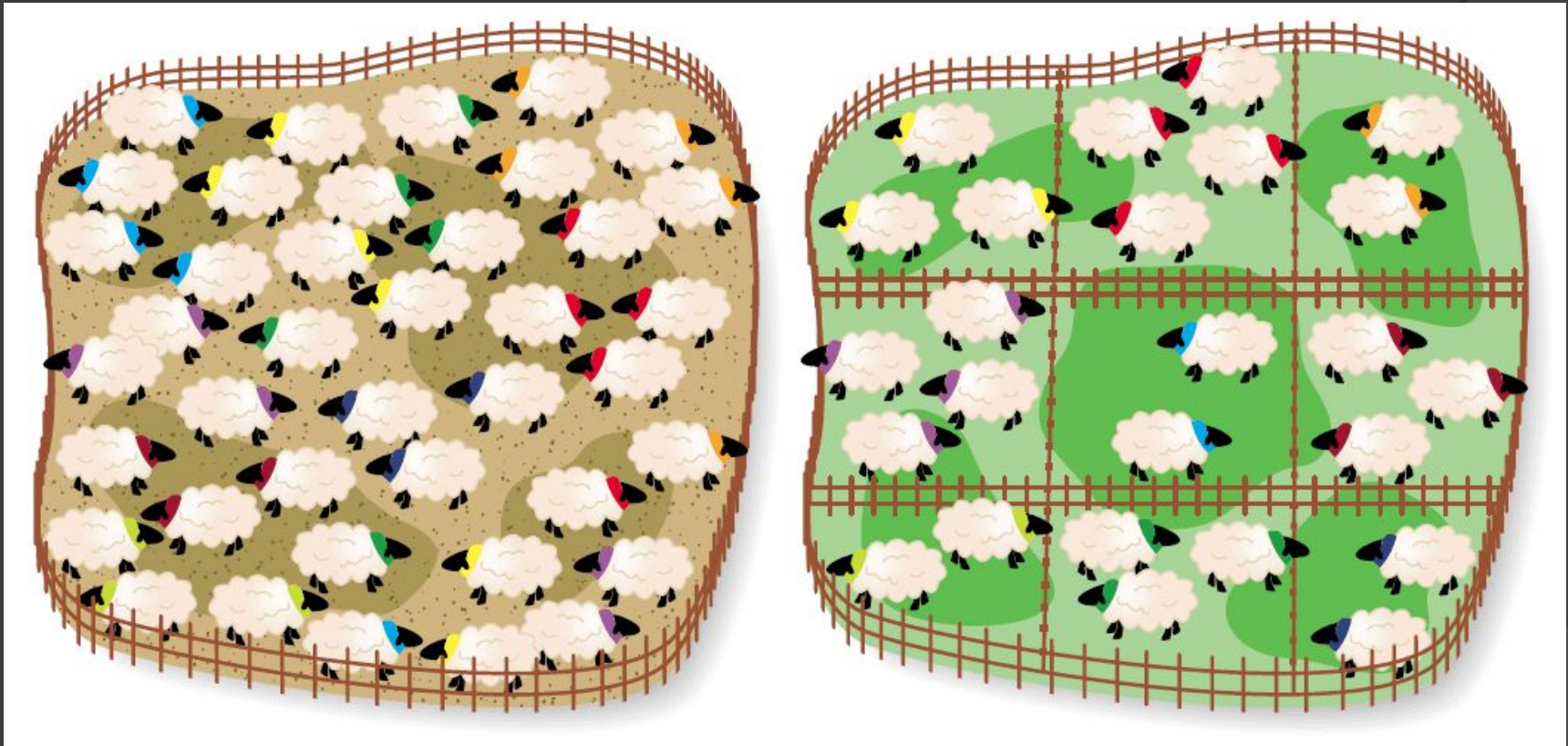
- ⦿ Put as many animals on the land as possible
- ⦿ If too many animals grazed on the commons, they destroyed the grass
- ⦿ Once the grass was destroyed, everyone flourished because no one could raise animals on the commons



“The Tragedy of the Commons”

- ⦿ The commons were eventually replaced by closed fields owned by individuals
- ⦿ Owners learned to be careful with land management
- ⦿ Someone or some group must take responsibility for maintaining a resource or it will become depleted

“The Tragedy of the Commons”



The Tragedy of the Commons

Garrett James Hardin (1915 – 2003) was an American ecologist and scientist who warned of the dangers of overpopulation.

Known for Hardin's First Law of Human Ecology: “You cannot do only one thing”. This expresses the interconnectedness of every action.

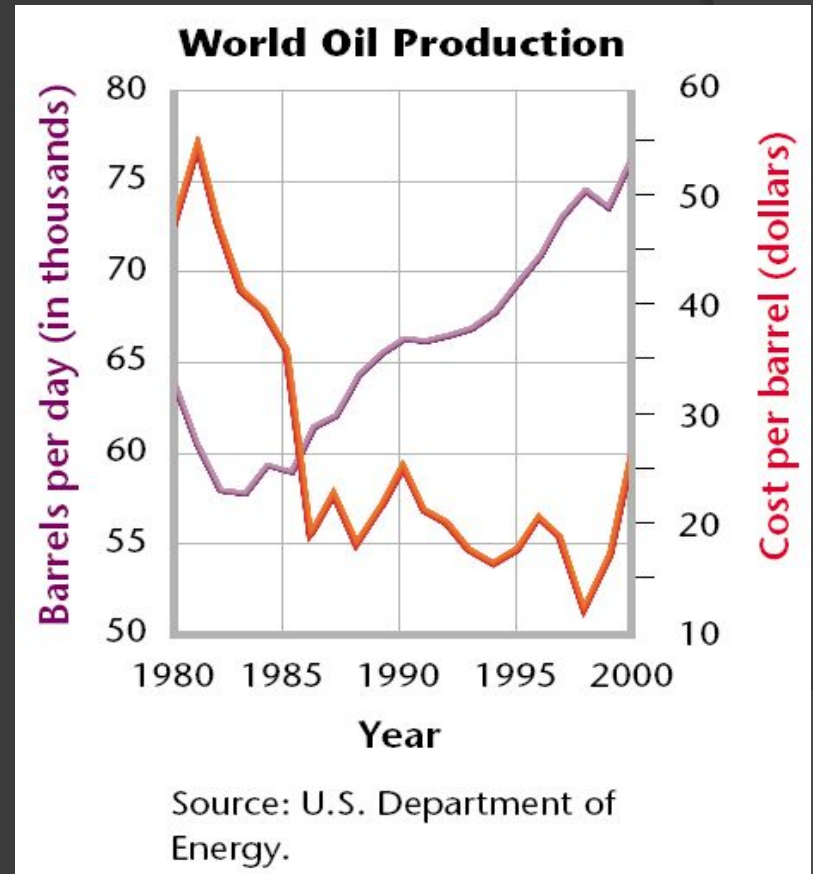


"A finite world can support only a finite population; therefore, population growth must eventually equal zero."

Garrett Hardin

Supply and Demand

- ◎ **The Law of Supply and Demand** states as the demand for a good or service increases, the value or the food or service also decreases
- ◎ Ex: Oil production



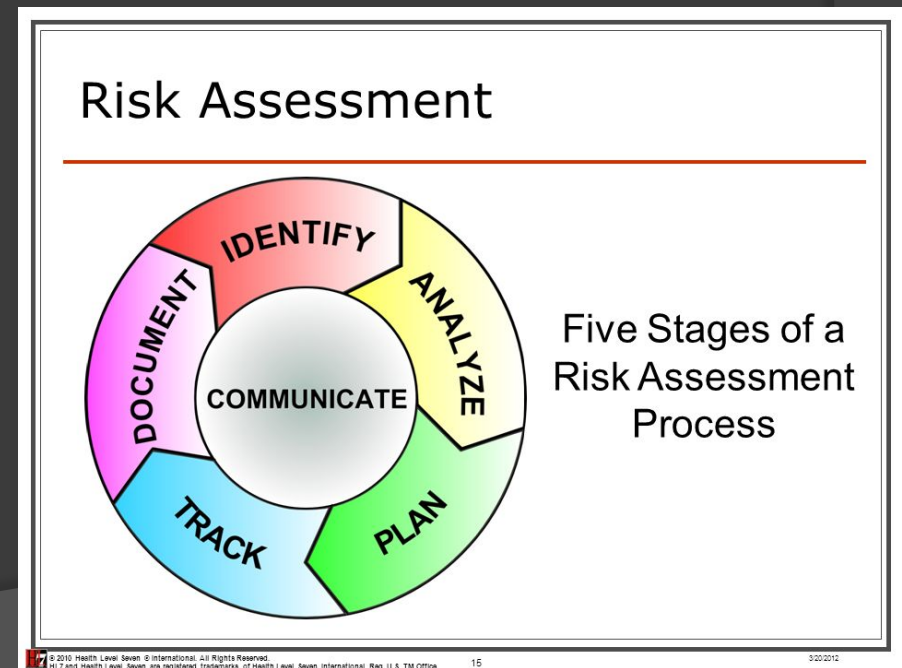
Costs and Benefits

- ⦿ **Cost-benefit analysis** balances the cost of the action against the benefits one expects from it
- ⦿ The results depend on who is doing the analysis.
- ⦿ Often, environmental regulations are passed on to the consumer or taxpayer



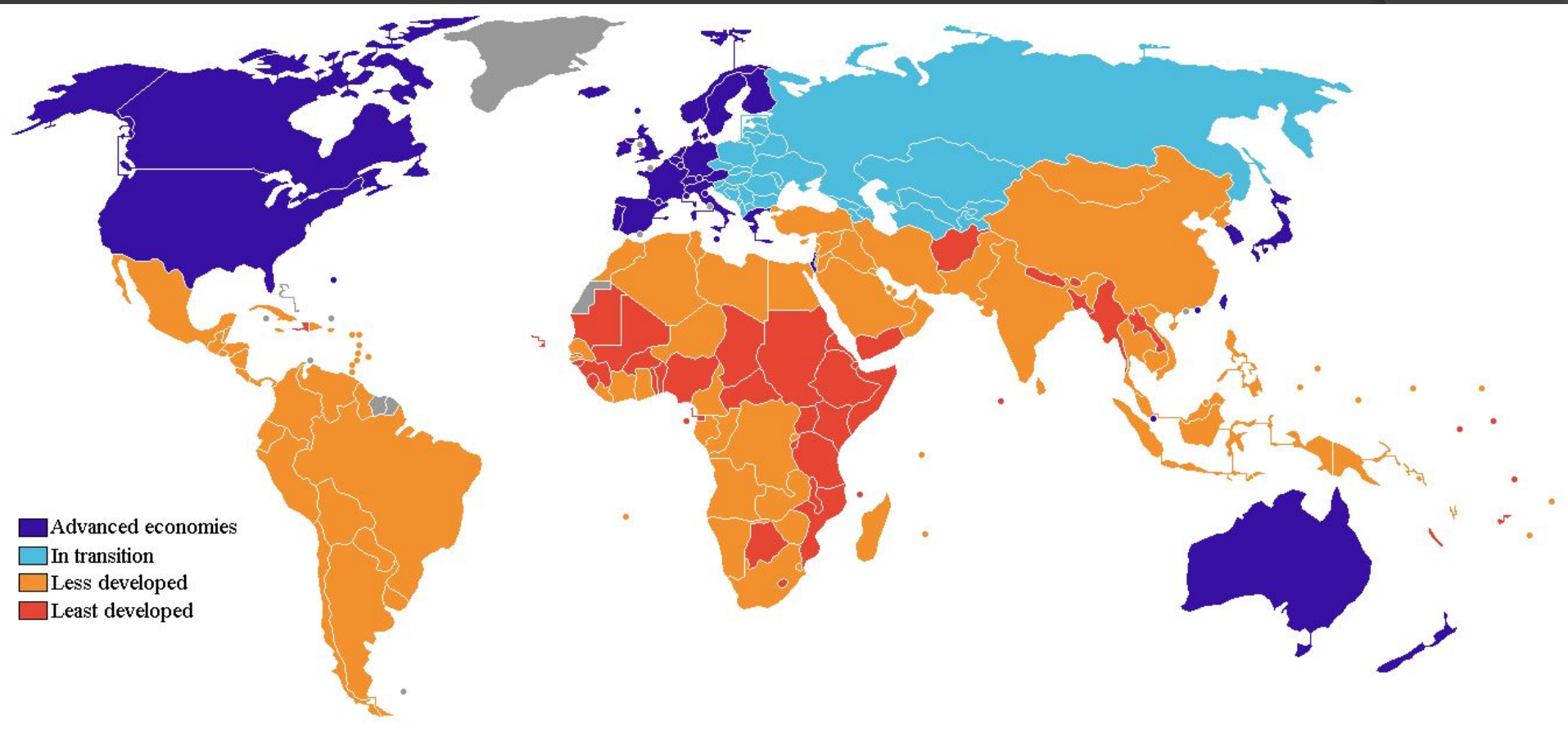
Risk Assessment

- One of the costs of any action is the risk of an undesirable outcome
- **Risk analysis** helps us create cost effective ways to protect our health and environment



Developed and Developing Countries

- ⦿ **Developed countries** have higher incomes, slower population growth, diverse industrial economies, and stronger social support (ex: Malaysia)
- ⦿ **Developing countries** have lower average incomes, simple agriculture-based communities, and rapid population growth (ex: Canada, US)



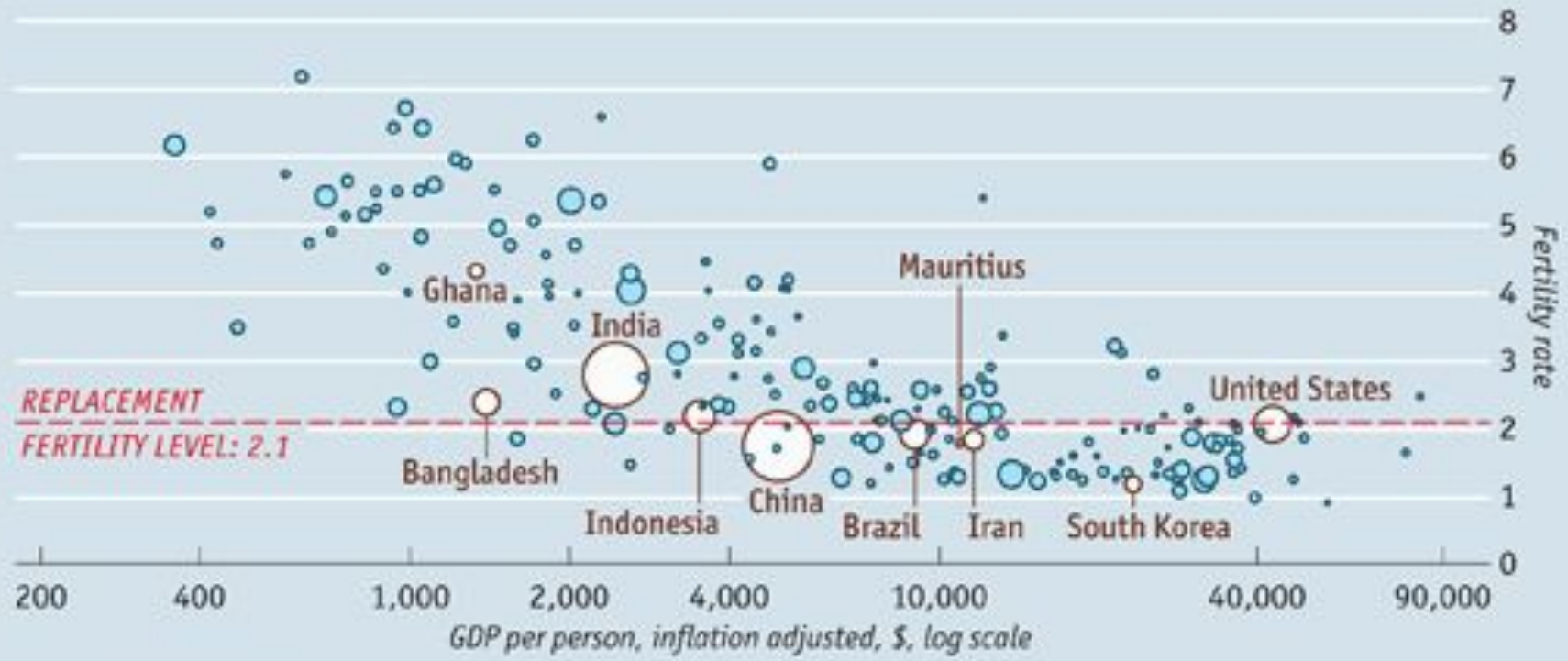
Population and Consumption

- ◎ **Almost all environmental problems can be traced back to two root causes:**
 - The human population in some areas is growing too quickly for the local environment to support.
 - People are using up, wasting, or polluting many natural resources faster than they can be renewed, replaced, or cleaned up.

Less is more

Fertility vs GDP, 2007

○ Size of circle is proportional to country's population



Source: gapminder.org

Consumption Trends

- ⦿ Developed countries are using much less of Earth's resources
- ⦿ **Developed nations use about 75 percent of the world's resources, although they make up only 20 percent of the world's population**
- ⦿ This rate of consumption creates more waste and pollution per person than in developing countries

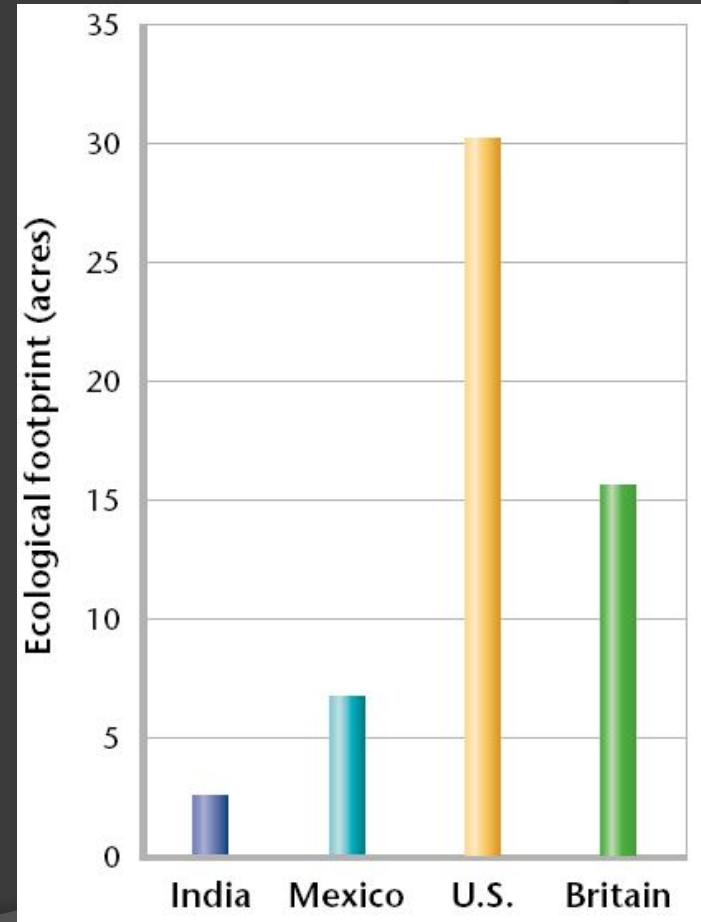
Consumption Trends

Indicators of Development for the United States, Japan, Mexico, and Indonesia

	Measurement	U.S.	Japan	Mexico	Indonesia
Health	life expectancy in years	77	81	71.5	68
Population growth	per year	0.8%	0.2%	1.7%	1.8%
Wealth	gross national product per person	\$29,240	\$32,350	\$3,840	\$640
Living space	people per square mile	78	829	133	319
Energy use	per person per year (Btu)	351	168	59	18
Pollution	carbon dioxide from fossil fuels per person per year (tons)	20.4	9.3	3.5	2.2
Waste	garbage produced per person per year (kg)	720	400	300	43

Ecological handprints

- ◎ **Ecological handprints-** calculations that show the productive area of Earth needed to support one person in a particular country



Critical Thinking and the Environment

- ◎ Remember a few things as you explore environmental science further:
 - Be prepared to listen to many viewpoints over a particular issue
 - Investigate the source of the information you encounter
 - Gather all the information you can before drawing a conclusion



A Sustainable World

- ◎ **Sustainability** is the condition in which human needs are met in such a way that a human population can survive short term
- ◎ Sustainability is a key goal of environmental science
- ◎ Our current world and way of life is not sustainable