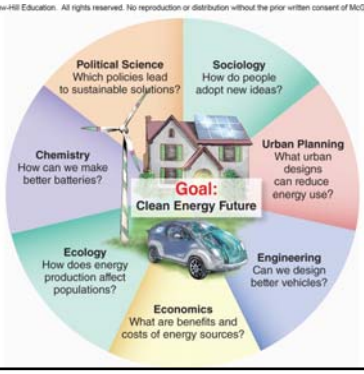
Chapter 1: Environmental Issues

- **Rapid Population Growth**
- **Excessive Consumption/Waste**
- **Unsustainable Resource Use**
- **Poverty**
- **Unsustainable Economic Growth**
- **Lack of Full Cost Pricing**
- **Disconnection from nature**

Many kinds of knowledge contribute to our understanding in Environmental Science



Current Conditions

Human Population is > 7 Billion

- **Climate Change:** burning fossil fuels causes global climate change.
- **Hunger:** food is inequitably distributed across the globe and 2/3 of agricultural lands show signs of degradation.
- **Clean Water:** may be the most critical resource in the 21st century.
- **Energy:** fossil fuel use causes pollution, there is a shift to using more renewable energy resources.
- **Biodiversity Loss**: species are being lost at a rapid rate.
- **Air Pollution**: air quality has worsened dramatically in many areas.

What this class is all about:

- **The meaning of the term environment**
- **The importance of natural resources**
- **That environmental science is interdisciplinary**
- **The scientific method and how science operates**
- **Some pressures facing the global environment**

Environment: the total of our surroundings

- **All the things around us with which we interact:**
  - **Living things**
    - **Animals, plants, forests, fungi, etc.**
  - **Non-living things**
    - **Continents, oceans, clouds, soil, rocks**
  - **Our built environment**
    - **Buildings, human-created living centers**
  - **Social relationships and institutions**

Humans exist within the environment

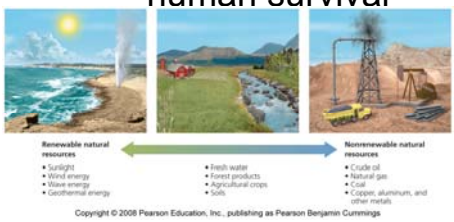
- **Humans exist within the environment and are part of nature.**
  - **Our survival depends on a healthy, functioning planet.**
- **We are part of the natural world.**
  - **Our interactions with its other parts matter a great deal.**
- **This idea is fundamental to environmental science and conservation biology**

Humans and the world around us

- **Humans depend completely on the environment for survival.**
  - **Enriched and longer lives, increased wealth, health, mobility, leisure time**
- **But natural systems have been degraded**
  - **Pollution, erosion, and species extinction**
  - **Environmental changes threaten long-term health and survival.**
- **Environmental science is the study of:**
  - **How the natural world works**
  - **How the environment affects humans and vice versa**
- **With environmental problems come opportunities for solutions.**

Natural resources: vital to human survival

substances and energy sources needed for survival



- **Perpetually available:** sunlight, wind, wave energy
- **Renewable over short periods of time:** timber, water, soil, wildlife?
  - These can be destroyed
- **Non-renewable resources:** Oil, coal, minerals
  - These can be depleted

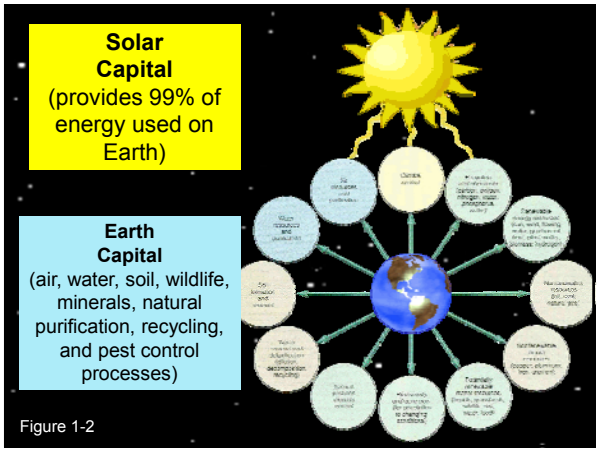


Figure 1-2

What is a Resource?

Anything we get from the environment to meet our needs and wants.

Renewable	Non-Renewable
Can be replenished fairly rapidly (hours to decades)	Exhaustible resource that has a fixed amount. Can be replenished over 100,000's of years.

U.S. ENERGY CONSUMPTION BY SOURCE

BIOMASS	*renewable*	2.9%	PETROLEUM	*nonrenewable*	38.1%
Heating, electricity, transportation			Transportation, manufacturing		
HYDROPOWER	*renewable*	2.7%	NATURAL GAS	*nonrenewable*	22.9%
Electricity			Heating, manufacturing, electricity		
GEOTHERMAL	*renewable*	0.3%	COAL	*nonrenewable*	23.2%
Heating, electricity			Electricity, manufacturing		
WIND	*renewable*	0.1%	URANIUM	*nonrenewable*	8.1%
Electricity			Electricity		
SOLAR & OTHER	*renewable*	0.1%	PROPANE	*nonrenewable*	1.7%
Light, heating, electricity			Manufacturing, heating		

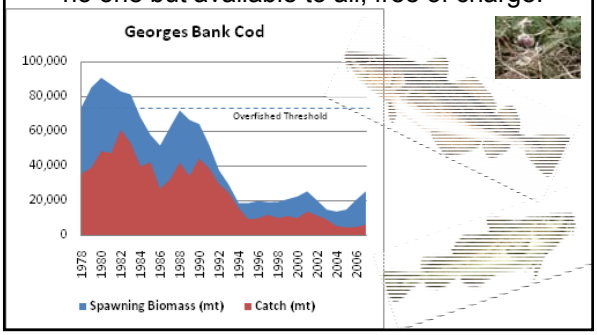
Biodiversity (the different life forms on earth) is potentially renewable.

How is a forest potentially renewable?

Selective Logging Clear cutting

Tragedy of the Commons

common-property resources are owned by no one but available to all; free of charge.



- A **sustainable** system is one with long term survivability and functioning.

  A **sustainable** society satisfies peoples needs without degrading/depleting earth capital and jeopardizing future generations.

Sustainable Development

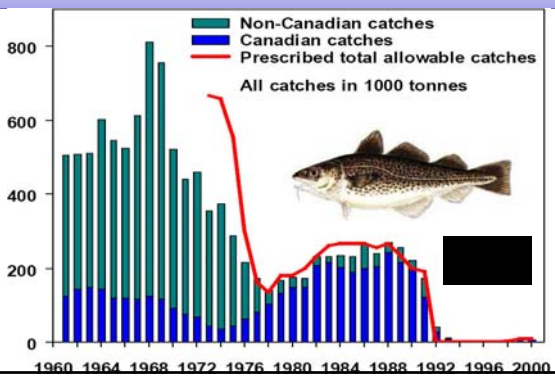
- "Meeting the needs of the present without compromising the ability of future generations to meet their own needs." (Brundtland 1987)
  - Benefits must be available to all humans, rather than to a privileged few.
  - Economic growth alone is not enough. Political stability, democracy, and equitable economic distribution are needed to ensure that all benefit.

Sustainable Development

Many ecologists view continual growth as impossible in the long run due to limits imposed by nonrenewable resources and the capacity of the biosphere to absorb wastes. Others argue that through the use of technology and social organization, we can manage to meet our needs and provide long-term (but not infinite) growth.

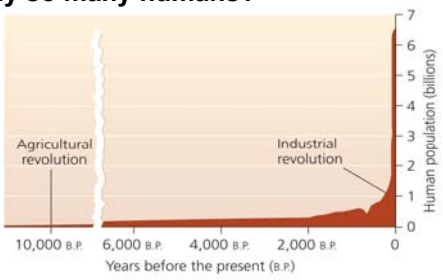
Is this graph showing sustainability?

Cod Harvest Graph in the North Atlantic Showing Sustainability?



Global human population growth

- **More than 6.7 billion humans**
- **Why so many humans?**



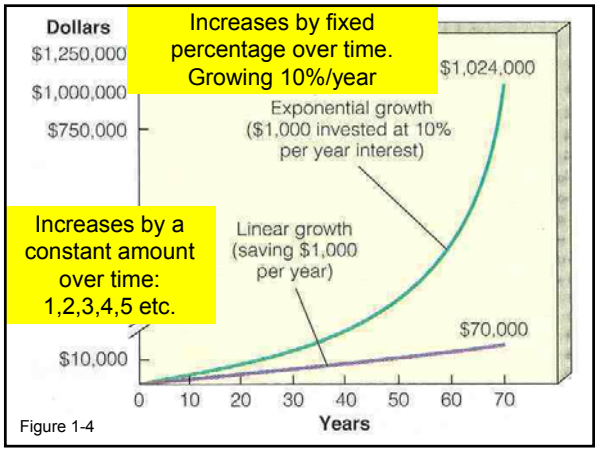


Figure 1-4

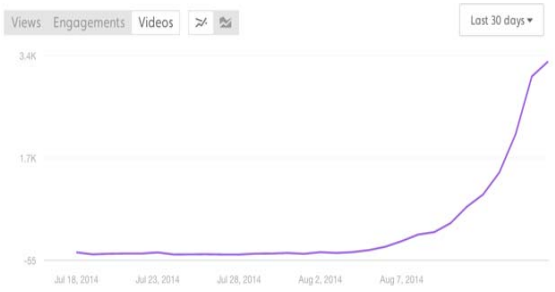
Thomas Malthus and human population


(a) 18th-century London, England


(b) Thomas Malthus

- **Thomas Malthus**
  - **Population growth must be controlled, or it will outstrip food production.**
  - **Starvation, war, disease**
- **Neo-Malthusians**
  - **Population growth has disastrous effects.**
  - **Paul and Anne Ehrlich, *The Population Bomb* (1968)**
    - **Agricultural advances have only postponed crises.**

ALS Ice Bucket Challenge Videos Posted to Social Media



Human Population Growth?

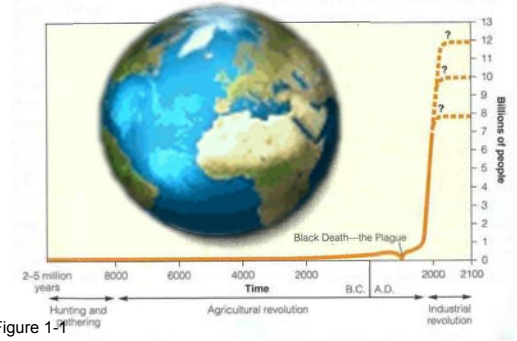
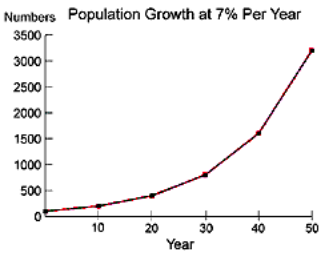


Figure 1-1

RULE OF 70

$$\text{number of years to double} = \frac{70}{\text{annual percentage growth rate}}$$



- What is the population doubling time of a population with an annual growth rate of The Gambia at 6%?
- What is the population doubling time of China with an annual growth rate of .5%?
- What is the population doubling time of the world with an average growth of 1.3%?

Gambian Growth vs. Chinese Growth

RULE OF 70

$$\text{number of years to double} = \frac{70}{\text{annual percentage growth rate}}$$

70 ÷ 6 = 11.7 year doubling time

70 ÷ .5 = 140 year doubling time

Globally 1.3% = 53.8 year doubling time

Gross National Product (GNP)
The market value of all goods and services provided by an economy per year.

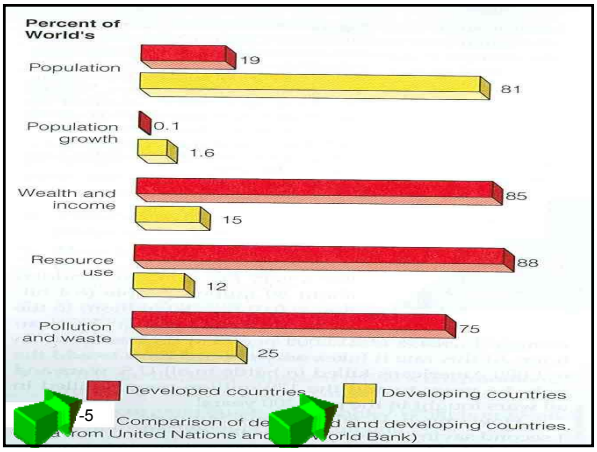
Per Capita = Per Person

Developing Countries

- Low industrialization
- Low per capita GNP
- 15% of World's Wealth
- Use 15% of natural resources
- Produce 25% of worlds pollution and wastes.
- **Examples?**

Developed Countries

- Highly industrialized
- High per capita GNP
- 85% of World's Wealth
- Use 85% of natural resources
- Make 75% of worlds pollution and wastes
- **Examples?**



Full Cost Pricing

- Full-cost pricing = adjusts market prices to reflect not only the direct costs of goods and services, but also their impact on natural capital (i.e. depleting resources, production pollution,)

Differing Resource Use in Different Cultures

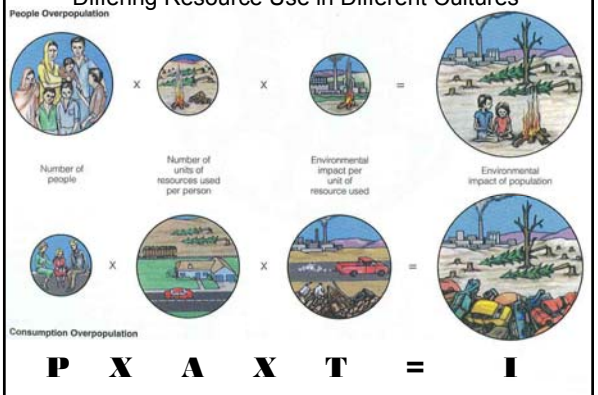


Figure 1-18

Resource consumption exerts impacts

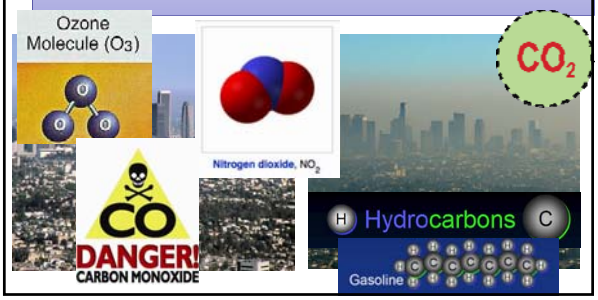
- Garret Hardin's "tragedy of the commons" (1968)
  - Unregulated exploitation causes resource depletion
    - Grazing lands, forests, air, water
  - No one has the incentive to care for a resource.
  - Everyone takes what he or she can until the resource is depleted.
- Solution?
  - Private ownership?
  - Voluntary organization to enforce responsible use?
  - Governmental regulations?

The "ecological footprint"

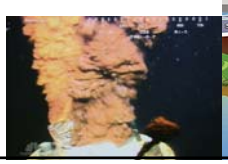
- The environmental impact of a person or population
  - Amount of biologically productive land + water
  - For resources and to dispose/recycle waste
- Overshoot: humans have surpassed the Earth's capacity to support us

We are using 30% more of the planet's resources than is available on a sustainable basis!

Pollution: any addition to air, water, soil, or food that threatens the health or survival of living organisms. What are the pollutants here?



Point Source Pollution orginates from a single, identifiable source.



Nonpoint Source: cannot identify the single source.

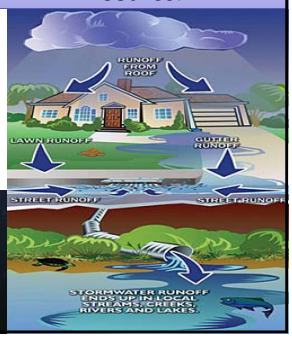
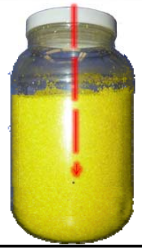


Table 1-1 Equivalents of Some Trace Concentration Units

Unit	1 part per million	1 part per billion	1 part per trillion
Time	1 minute in 2 years	1 second in 32 years	1 second in 320 centuries
Money	1¢ in $10,000	1¢ in $10,000,000	1¢ in $10,000,000,000
Weight	1 pinch of salt in 10 kilograms (22 lbs.) of potato chips	1 pinch of salt in 10 tons of potato chips	1 pinch of salt in 10,000 tons of potato chips
Volume	1 drop in 1,000 liters (265 gallons) of water	1 drop in 1,000,000 liters (265,000 gallons) of water	1 drop in 1,000,000,000 liters (265,000,000 gallons) of water



Concentration of Pollutants

PPM

1 in 1 bottle of a million particles

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PPB
1 in 1,000 bottles

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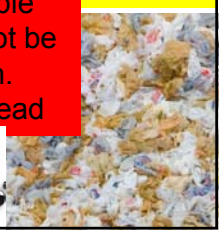
PPT
1 in 1,000,000 bottles

Various types of Pollutants

Degradable, nonpersistent pollutants can be boken down by natural physical, chemical, or biological processes. Ex. Human se

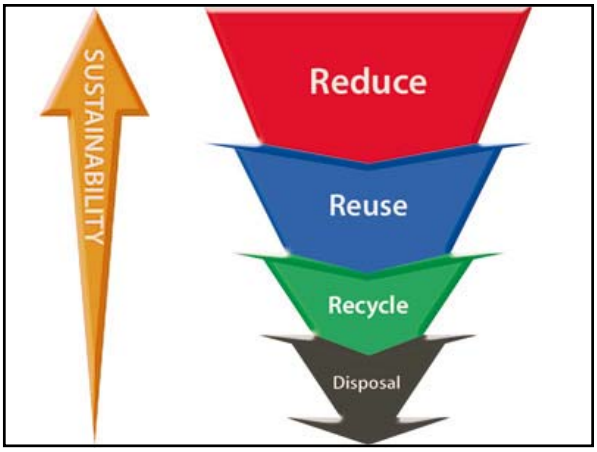
Persistent pollutants such as DDT and Plastics break down wly.

Nondegradeable pollutants cannot be broken down.
Ex. Mercury, Lead



Acid Mine Drainage in Rivers – Sustainable?

Earth Capital cannot absorb, purify, and cycle these toxins quickly enough.
This is NOT SUSTAINABLE



Signs of Hope

Progress has been made on many fronts.

- **Population & Pollution**: Many cities are more livable today than a century ago due to human birth rate stabilization and clean technology use.
- **Health**: Incidence of life-threatening diseases has been reduced in most countries.
- **Information and Education**: Expanding access to knowledge is essential to progress.
- **Sustainable Resource Use and Habitat Conservation**: Tropical forest destruction has slowed & habitat protection has improved in some areas.
- **Renewable Energy**: Progress is being made in the transition to renewable energy sources.
- **Carbon Markets and Standards:** Cap-and-trade programs help limit greenhouse gas emissions.
- **International Cooperation**: Some international environmental protection agreements have been highly successful, while others lack enforcement.

To increase sustainability the first thing you can do is…

reduce

- 30% reduction in packaging materials means less..
  - Trees cut down (less paper for cardboard)
  - Material needing to be disposed of (landfilled or recycled)

Reusing vs. Recycling

Differing Worldviews

Human Centered (Planetary Management)	Earth Centered (Earth Wisdom)
• Humans are number one	• Nature is not just for us.
• There will always be more	• Not always more.
• Economic growth is good.	• Sustainable growth
• Natural Resources are here for our benefit.	• Cooperation with nature/each other

UNLESS someone like YOU cares a whole awful lot nothing is going to get better.... it's not.

Environmental science

- Can help us avoid mistakes made by past civilizations
  - Human survival depends on how we interact with our environment.
  - Our impacts are now global.
  - Many great civilizations have fallen after depleting their resources.

The lesson of Easter Island: people annihilated their culture by destroying their environment. Can we act more wisely to conserve our resources?

Environmental science: how the natural world works

- Its goal: developing solutions to environmental problems
- An interdisciplinary field
  - –Natural sciences: information about the natural world
  - –Social sciences: study human interactions and behavior

Environmental science is not environmentalism

- **Environmental science**
  - **The pursuit of knowledge about the natural world**
  - **Scientists try to remain objective**
- **Environmentalism**
  - **Environmental activism**
  - **A social movement dedicated to protecting the natural world**

The nature of science

- **Science:**
  - **A systematic process for learning about the world and testing our understanding of it**
  - **The accumulated body of knowledge that results from a dynamic process of observation, testing, and discovery**
- **Science is essential:**
  - **To sort fact from fiction**
  - **Develop solutions to the problems we face**

Applications of science

Policy decisions and management practices


(a) Prescribed burning

Restoration of forest ecosystems altered by human suppression of fire

Technology


(b) Methanol-powered fuel-cell car

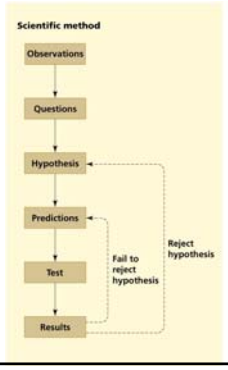
Energy-efficient methanol-powered fuel cell car from DaimlerChrysler

Scientists test ideas

- **Scientists examine how the world works by observing, measuring, and testing**
  - **Involves critical thinking and skepticism**
- **Observational (descriptive) science: scientists gather information about something not well known or that cannot be manipulated in experiments**
  - **Astronomy, paleontology, taxonomy, molecular biology**
- **Hypothesis-driven science: research that proceeds in a structured manner using experiments to test hypotheses through the scientific method**

The scientific method

- **A technique for testing ideas**
- **A scientist makes an observation and asks questions of some phenomenon.**
- **The scientist formulates a hypothesis, a statement that attempts to answer the question.**
- **The hypothesis is used to generate predictions: specific statements that can be tested.**
- **The results support or reject the hypothesis.**



Testing predictions

- **Experiment**: an activity that tests the validity of a hypothesis
- **Variables**: conditions that can be manipulated and/or measured
  - **Independent variable**: a condition that is manipulated
  - **Dependent variable**: a variable that is affected by the manipulation of the independent variable
- **Controlled experiment**: one in which all variables are controlled
  - **Control**: the unmanipulated point of comparison
  - **Treatment**: the manipulated point of comparison
- **Data**: information (more correctly facts) that is (are) generally quantitative (numerical)

Experiments test the validity of a hypothesis

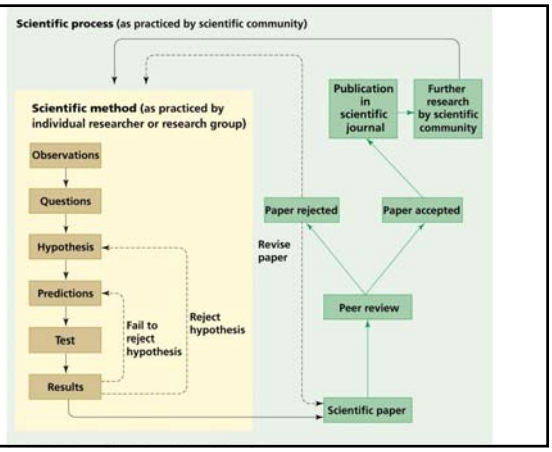
- Manipulative experiments = strongest evidence
  - Provides the strongest type of evidence
  - Reveal causal relationships: changes in independent variables cause changes in dependent variables
  - But many things can't be manipulated: long-term or large-scale questions (e.g., global climate change)
- Natural experiments show real-world complexity
  - Only feasible approach for ecosystem or planet-scale
  - Results are not so neat and clean, so answers aren't simply black and white

The scientific process is part of a larger process

Peer-review: publication requirement demanding other scientists provide comments and criticism

- Guards against faulty science – reject/accept

- Conference presentations improve the quality of the science and generate ideas when scientists interact with their colleagues
- Grants and funding from private or govt. agencies.
  - Can lead to conflict of interest if the data show the funding source in an unfavorable light
  - The scientist may be reluctant to publish or



Theories and paradigms

- **A consistently supported hypothesis becomes a theory, a widely accepted explanation of one or more cause-and-effect relationships**
  - **Has been extensively and rigorously tested, so confidence in a theory is extremely strong**
    - **Darwin's theory of evolution, atomic theory, cell theory, big bang theory, plate tectonics, general relativity**
  - **Differs from the popular meaning of theory, which suggests a speculative idea without much substance**
- **With enough data, a paradigm shift — a change in the dominant view — can occur.**

Ethics

- **Ethics: the study of good and bad, right and wrong**
  - **The set of moral principles or values held by a person or society that tells us how we ought to behave**
  - **Will save most of this discussion for the end of the semester**

Environmental ethics

Should we conserve wildlife for future generations?

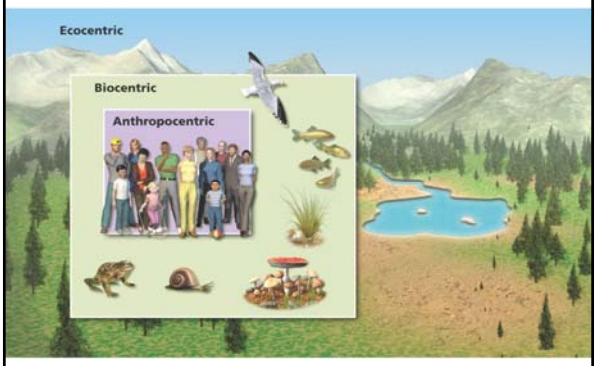
Is it OK to destroy a forest to create certain jobs for people?

Should we drive other species to extinction to maintain economic growth?

Is it OK to hunt or trap animals?

Three ethical perspectives or viewpoints

- **Anthropocentrism:** only humans have rights
  - Costs and benefits are measured only according to their impact on people
  - Anything not providing benefit to people has no value
- **Biocentrism**: certain living things also have value
  - All life has ethical standing
  - Development is opposed if it destroys life, even if it creates jobs
- **Ecocentrism**: whole ecological systems have value
  - Values the well-being of species, communities, or ecosystems
  - Holistic perspective, stresses preserving connections



The preservation ethic

- **Unspoiled nature should be protected for its own inherent value.**
  - **We should protect our environment in a pristine state, because it promotes human happiness and fulfillment.**
  - **John Muir (*right, with President Roosevelt at Yosemite National Park*) had an ecocentric viewpoint.**

The conservation ethic

- **Use natural resources wisely for the greatest good for the most people**
- **A utilitarian standard that calls for prudent, efficient, and sustainable resource extraction and use**
- **Gifford Pinchot had an anthropocentric viewpoint.**

The land ethic

- **Healthy ecological systems depend on protecting all parts.**
  - **Aldo Leopold believed that humans should view themselves and the land as members of the same community.**
  - **We are obligated to treat the land ethically.**
  - **The land ethic will help guide decision making.**

Ecofeminism

- **Female worldview: interrelationships and cooperation**
- **Male worldview: hierarchies, competition, domination, and conquest**
- **Perhaps males need to consider the female perspective when attempting to conserve nature**

Environmental justice (EJ)

- **The poor and minorities are exposed to more pollution, hazards, and environmental degradation.**
  - **Despite progre remain.**

The U.S. exports waste, particularly to poor nations.

Sustainability

- **A guiding principle of environmental science**
- **Living within our planet's means**
  - **The Earth can sustain humans AND other organisms for the future**
  - **Leaving our descendents with a rich, full world**
  - **Developing solutions that work in the long term**
  - **Requires keeping fully functioning ecological systems**

Sustainability

- **We are increasing our burden on the planet each year.**
  - **Population growth, affluence, consumption**
- **Natural capital: the accumulated wealth of Earth**
  - **We are withdrawing our planet's natural capital 30% faster than it is being produced**

Ecological footprints are not all equal

Sustainable solutions abound

- **Sustainable development: using resources to satisfy current needs without compromising future availability of resources**
- **Sustainability involves:**
  - **Renewable energy sources**
  - **Soil conservation, high-efficiency irrigation, organic agriculture**
  - **Pollution reduction**
  - **Habitat and species protection**
  - **Recycling**
  - **Fighting global climate change**

Humanity's challenge is to develop solutions that further our quality of life while protecting and restoring the environment.

Will we develop in a sustainable way?

This is the single most important question we face.