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1 Introducing Environmental Science and Sustainability

Overview of Chapter 1

- Human Impacts on The Environment
- Population, Resources and the Environment
- Sustainability
- Environmental Science
- Addressing Environmental Problems

Food as a Lens for Environmental Study

- Chicken sandwich requires wheat, chicken, other ingredients, energy to manufacture and transport to table, energy to treat generated wastes and packaging.
- Our choices matter and affect the environment
- What do you think about when you make your food choices?

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The Environment (Earth)

- Life has existed on earth for 3.8 billion yrs.
- Earth well suited for life
  - Water over ¾ of planet
  - Habitable temperature, moderate sunlight
  - Atmosphere provides oxygen and carbon dioxide
  - Soil with essential minerals for plants

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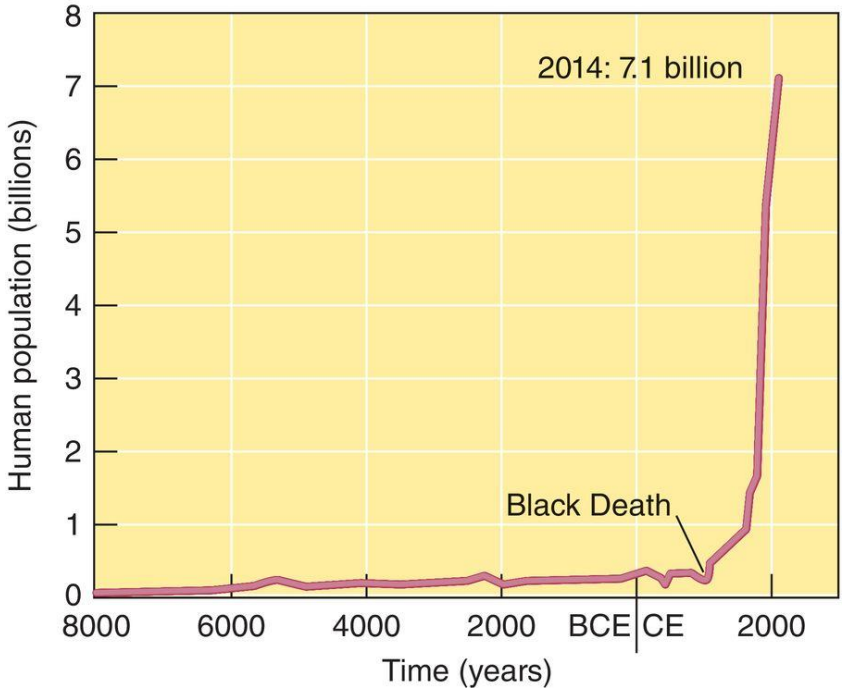
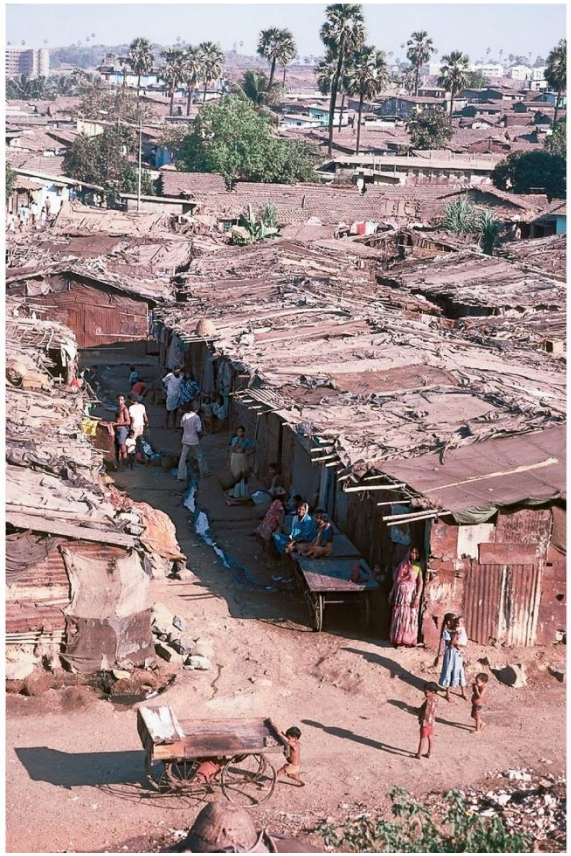
Human Impacts on Environment-Population

- Modern humans appeared ~100,000 years ago in Africa and quickly expanded
- Now, human population is ~7.1 billion
  - Growing exponentially
  - Estimates of 8-11 billion by end of 21st century
- We are the most significant agent of environmental change



Population



Jerry Cooke/Science Source

- More than 1 in 4 people live in extreme poverty
  - Cannot meet basic need for food, clothing, shelter, health
- Difficult to meet population needs without exploiting earth's resources

Gap Between Rich and Poor

- Countries were differentiated based on wealth
- Highly Developed Countries (HDC)
  - Complex industrialized bases, low population growth, high per capita incomes
  - Ex: US, Canada, Japan
- Less Developed Countries (LDC)
  - Low level of industrialization, very high fertility rate, high infant mortality rate, low per capita income
  - Ex: Bangladesh, Mali, Ethiopia

Gap Between Rich and Poor

- Rising income disparity in many countries
  - Large gap between wealthy and poor citizens
    - Differential access to electricity, cars, modern medicine
  - Ex: China, India, Brazil, Mexico

Population and Resource Use

- Essential resources for individual survival are small
  - Rapidly increasing population can quickly overwhelm or deplete, especially locally
- Resource consumption can far outweigh needs of survival
  - Affluent nations use larger portions and can exhaust resources globally

Population and Resource Use

- Movements in highly developed nations are changing demand
- Tiny house movement
  - Houses of typically <1,000sqft

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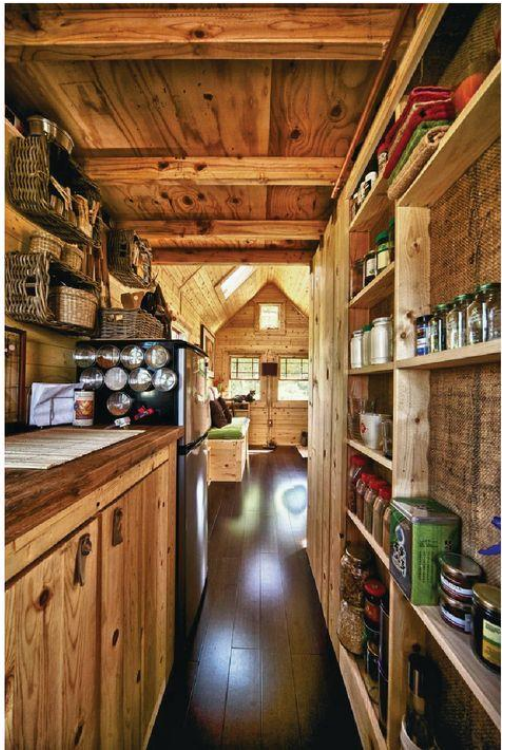

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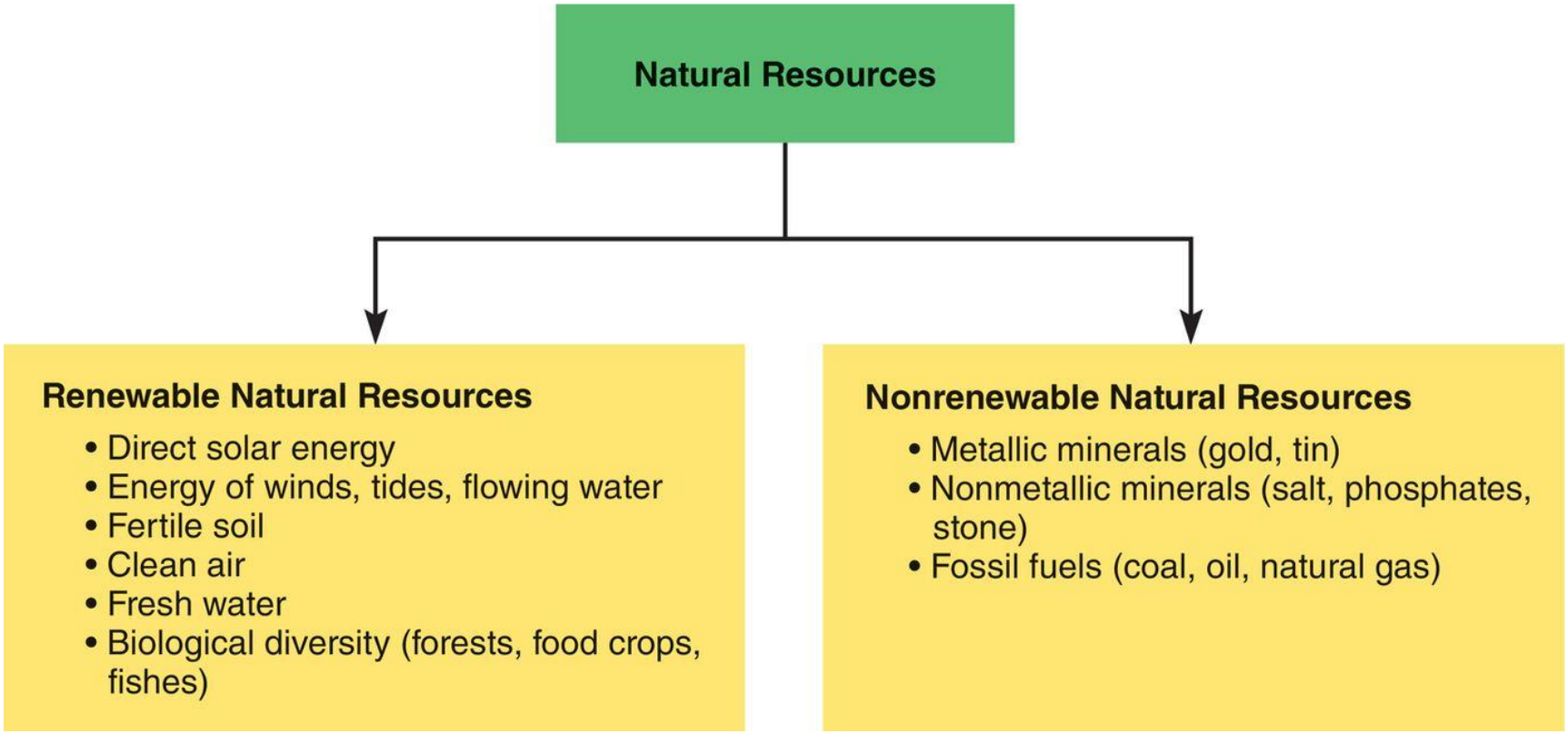
Types of Natural Resources



Consumption

- Consumption
  - Human use of materials and energy
  - People in HDCs are big consumers
- Unsustainable Consumption
  - Occurs when the level of demand on a country's resources damages or depletes the resource enough to reduce the quality of life for future generations
  - Caused by overpopulation and/or overconsumption

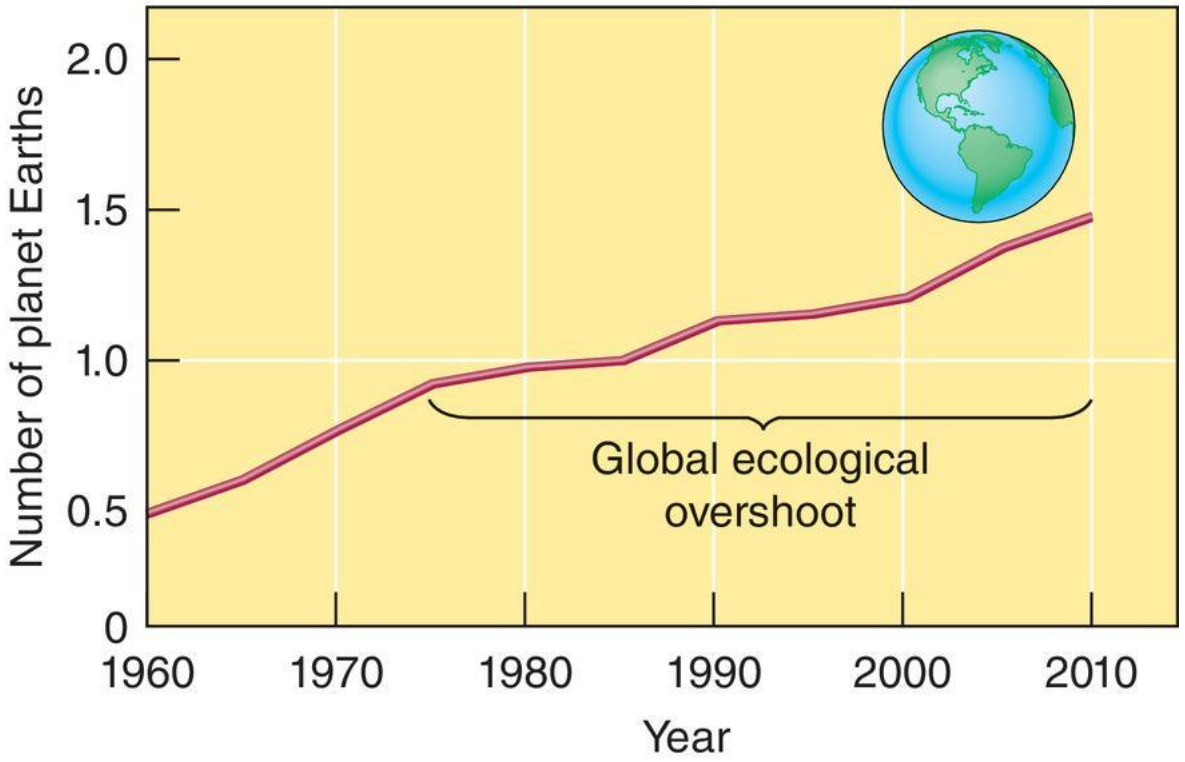
Ecological Footprint

- The average amount of land, water and ocean required to provide that person with all the resources they consume

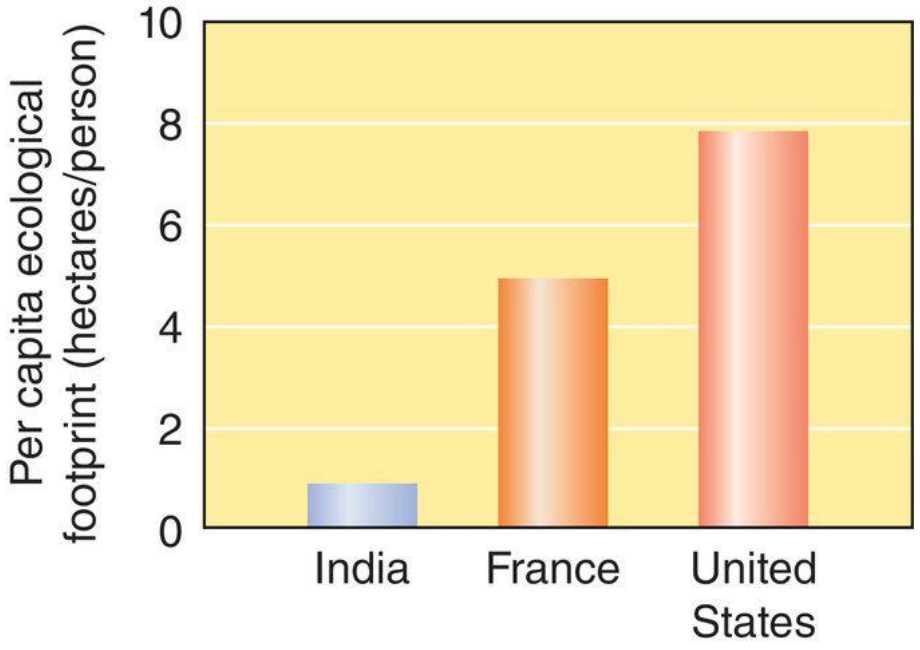
Earth's Productive Land and Water	11.4 billion hectares
Amount Each Person is Allotted (divide Productive Land & Water by Human Pop.)	1.8 hectares
Current Global Ecological Footprint of each person	2.7 hectares

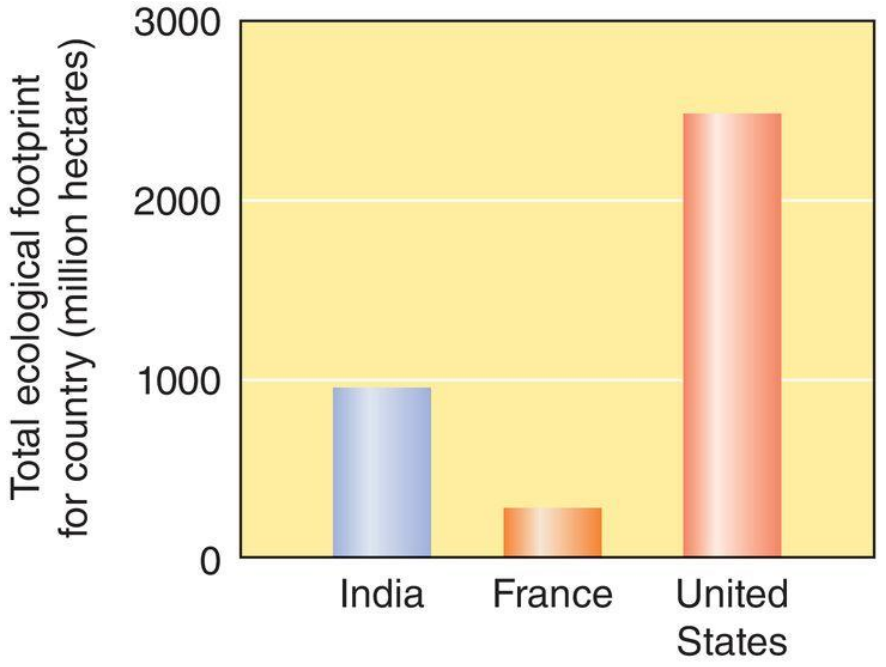
Ecological Footprint

- Humans have an ecological overshoot



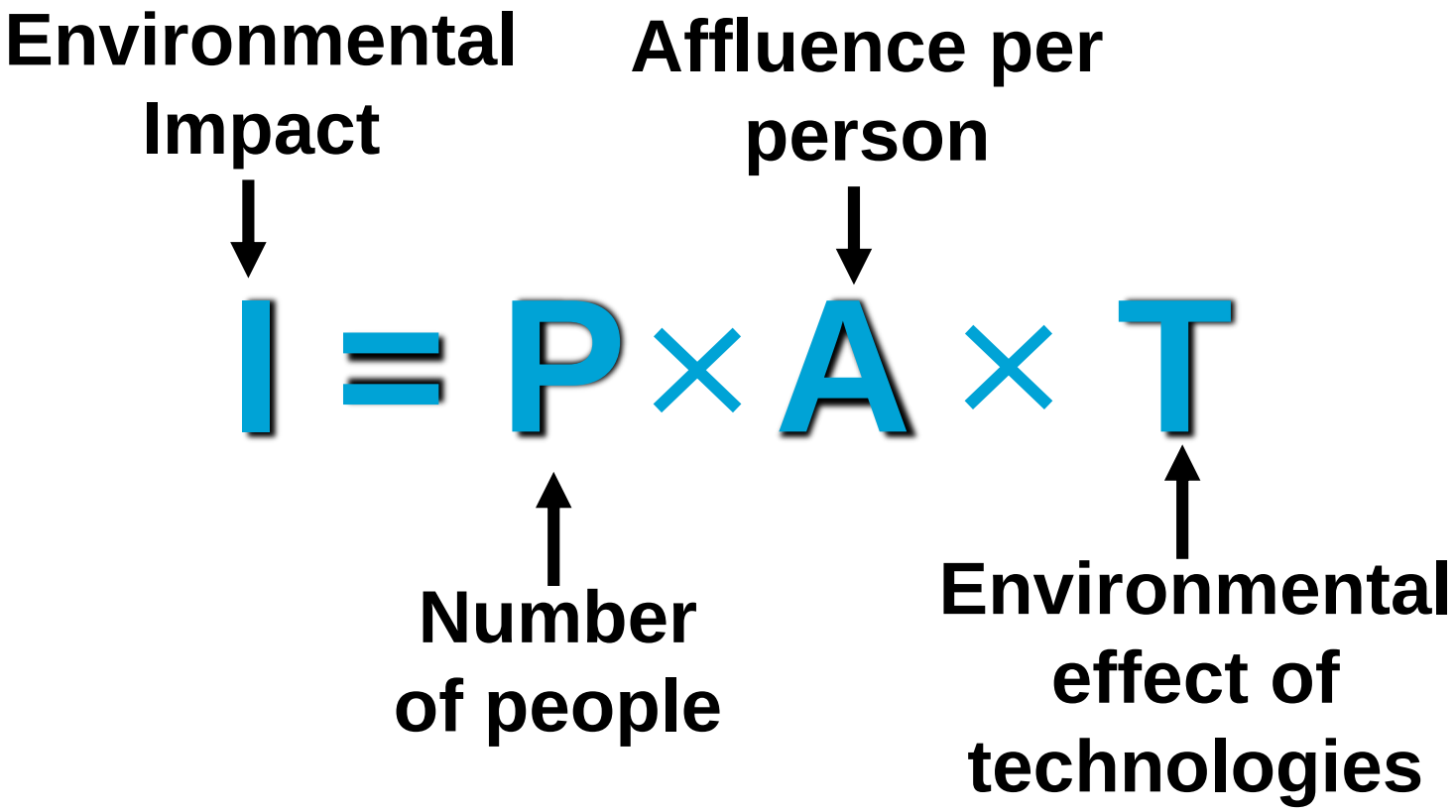
Ecological Footprint Comparison



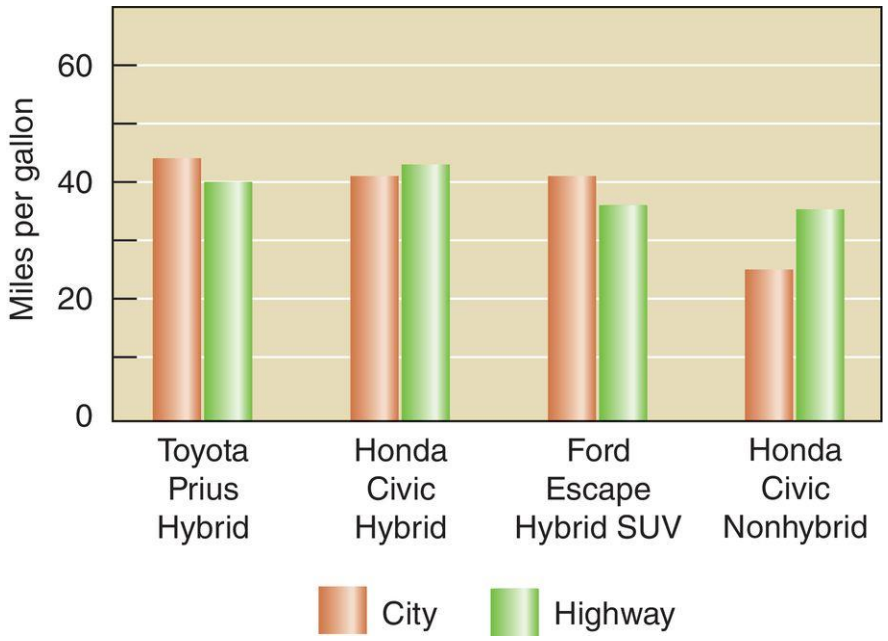


IPAT Model

- Measures 3 factors that affect environmental impact (I)

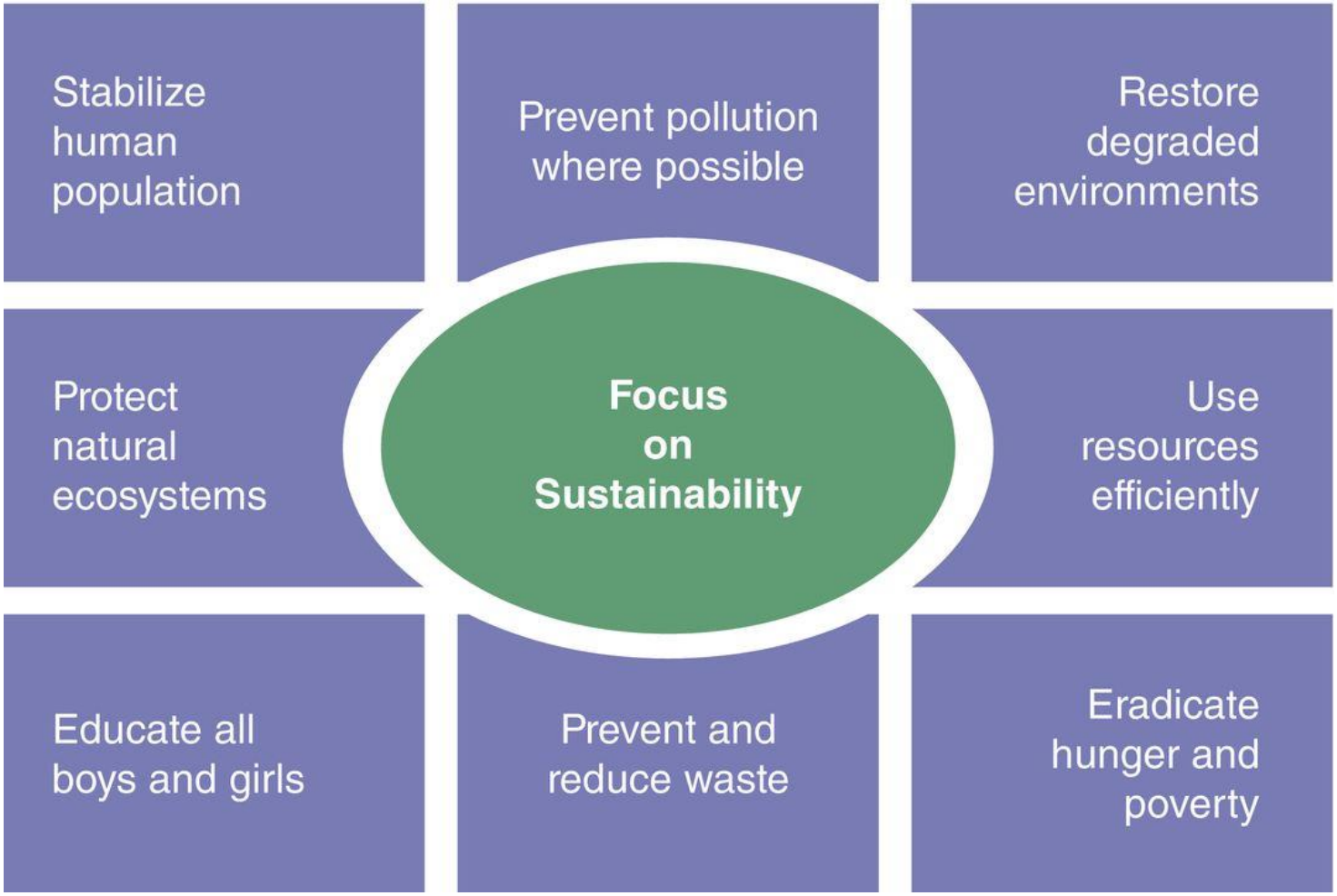


Fuel efficient vehicles



- Average fuel economy
  - 22.1 mpg (1988)
  - 20.4 mpg (2000)
    - SUV popularity
  - Fuel efficient vehicles can lower impact
  - Efficient driving

Environmental Sustainability



Environmental Sustainability

- The ability to meet current human need for natural resources without compromising the needs of future generations
- Requires understanding:
  - The effects of our actions on the earth
  - That earth's resources are not infinite

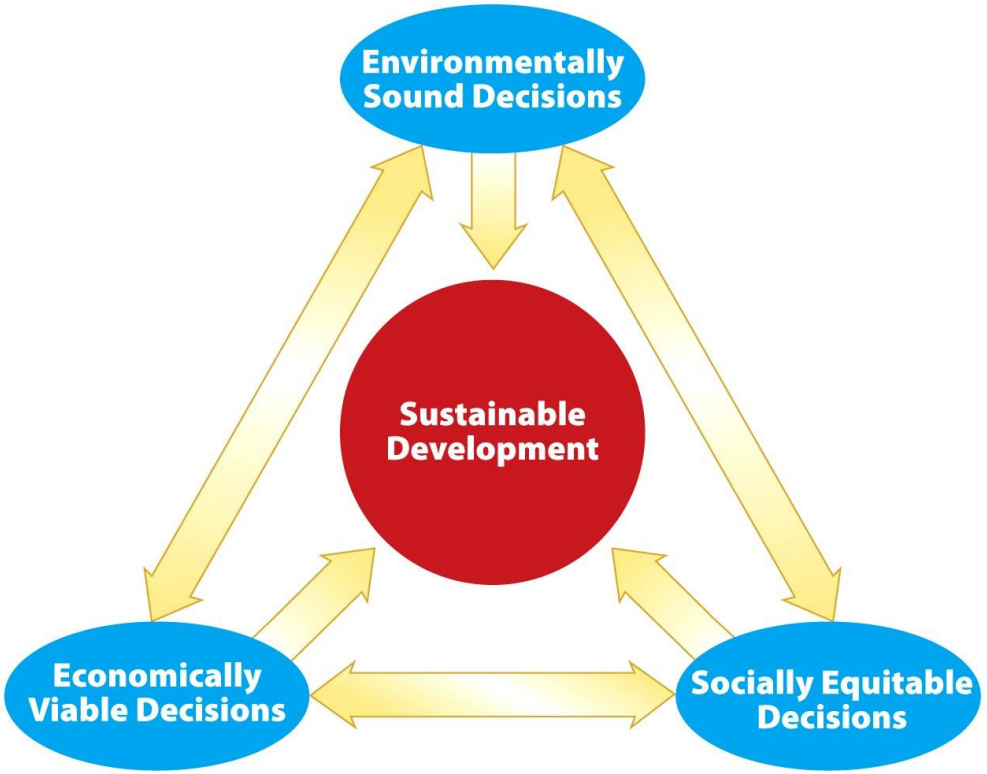
Topham/The Image Works

Tragedy of the Commons

- Garrett Hardin (1915–2003)
- Solving environmental problems is result of struggle between:
  - Short term welfare
  - Long term environmental stability and societal welfare
- Common pool resources
- Garrett used common pastureland in medieval Europe to illustrate the struggle

Sustainable Development-Systems Concept

- Economic development that meets the needs of the present generation without compromising future generations



Environmental Science

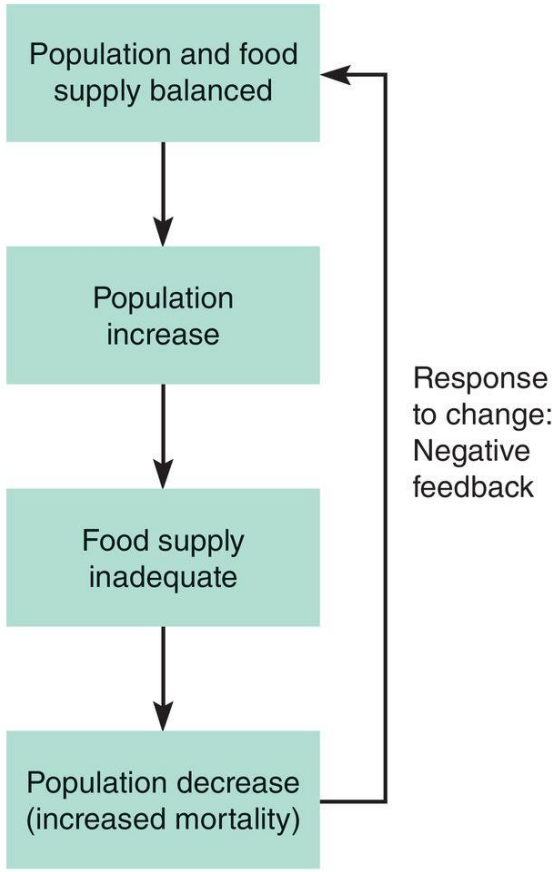
- An interdisciplinary study of human relationship with other organisms and the earth
  - Biology
  - **Ecology**
  - Geography
  - Chemistry
  - Geology
  - Physics
  - Economics
  - Sociology
  - Demography
  - Politics

Earth System and Environmental Science

- System
  - A set of components that interact and function as a whole
- Global Earth Systems
  - Climate, atmosphere, land, coastal zones, ocean
- Ecosystem
  - A natural system consisting of a community of organisms and its physical environment

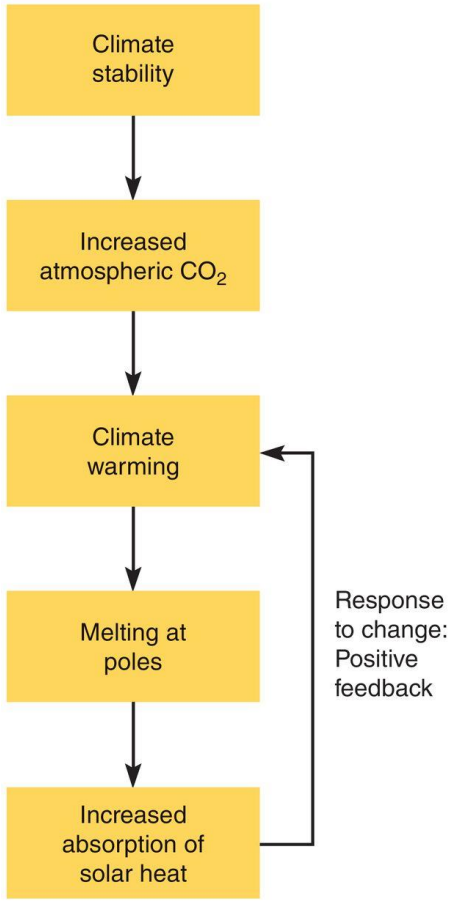
Feedbacks

- Negative feedback
  - Change triggers a response that counteracts (reverses) the changed condition

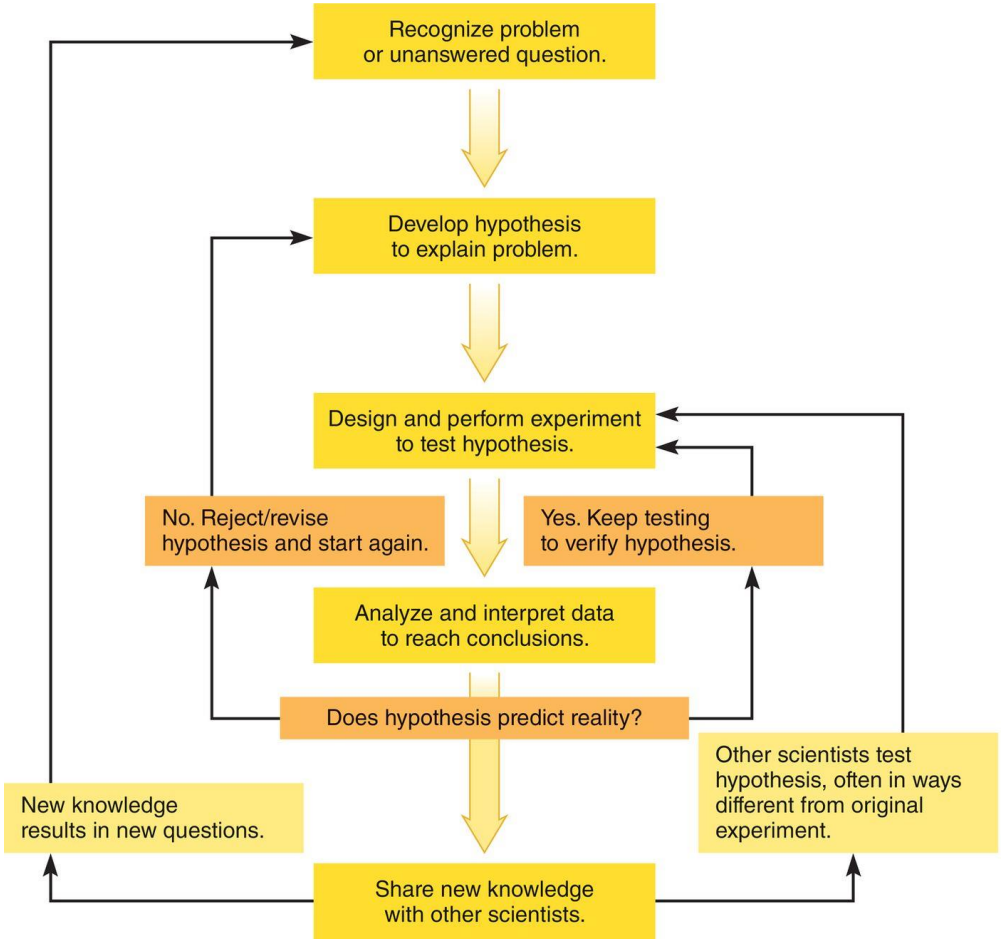


Feedbacks

- Positive feedback
  - Change triggers a response that intensifies the changing condition
  - Ex: polar and glacial ice melt, color change leading to more rapid melting



Scientific Method



Controls and Variables in Experiment

- Variable
  - A factor that influences a process
  - The variable may be altered in an experiment to determine its effect on the outcome
- Control
  - The variable is not altered
  - Allows for comparison between the tests of when we alter the variable and when we do not alter the variable

Scientific knowledge and theory

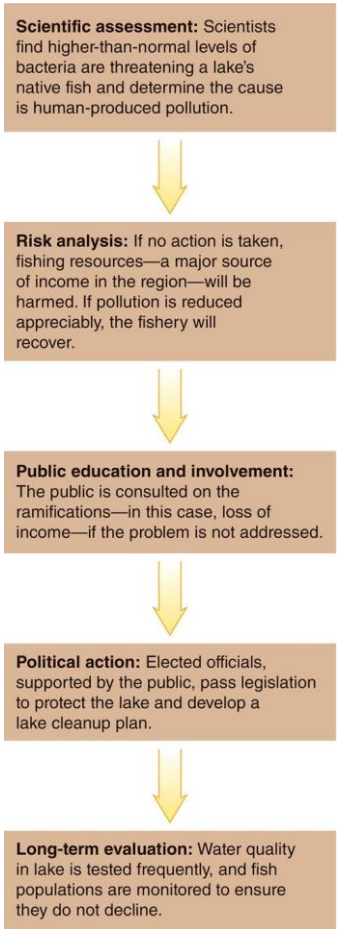
- Theory
  - Integrated explanation supported by large body of observations and experiments, and evaluated by peer review
  - Simplifies, clarifies, and predicts new relationships within the natural world
- Absolute truth is not possible in science
  - Knowledge evolves as new evidence is found

Climate Change

- Hypotheses and theory
  - CO_2 and other gases from burning fossil fuels are affecting climate
- Unable to test or run large experiments globally
  - Must acquire lots of data and adapt theories and understanding with new data
- Many parts of climate theory are tested
  - CO_2 rise in atmosphere and impact on solar radiation

Five Steps to Addressing An Environmental Problem

- Five steps represent ideal approach
- Reality is untidy
- Often, public pushes for a solution



Assessing Environmental Problem Case Study: Lake Washington

- Large, deep freshwater lake
- Suburban sprawl in 1940's
  - 10 new sewage treatment plants dumped treated effluent, high in nutrients, into lake
- Effect = excessive growth of cyanobacteria
  - Bacterial decomposition of cyanobacteria depleted O_2

Assessing Environmental Problem Case Study: Lake Washington

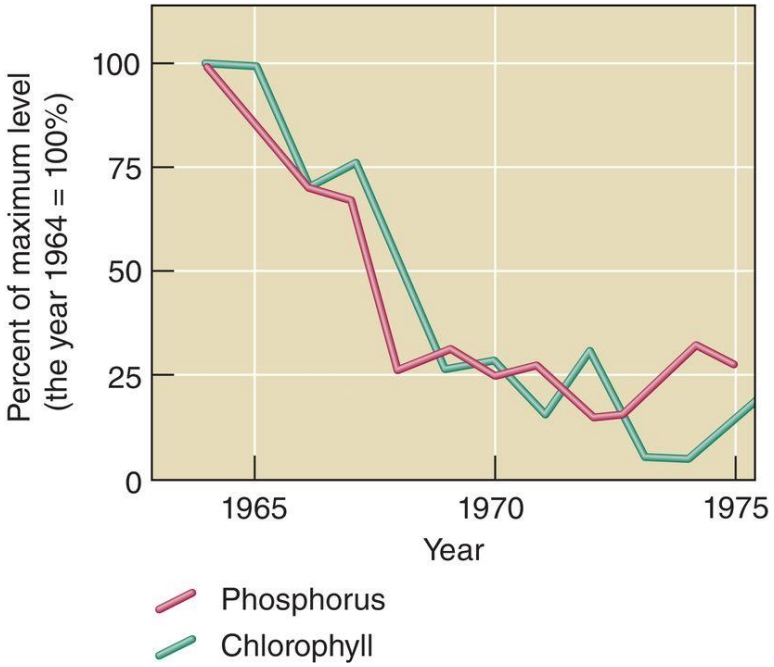
- Scientific Assessment
  - Scientists from University of Washington studied problem and collected data
  - Study informed Washington Pollution Control Commission (1955)
    - Commission concluded that effluents added nutrients, particularly phosphorus
    - Nutrients caused growth of cyanobacteria
    - Cyanobacteria decomposed by bacteria depleting O_2
    - Low O_2 reduced fish and small invertebrates
  - If pollution stopped, lake would recover

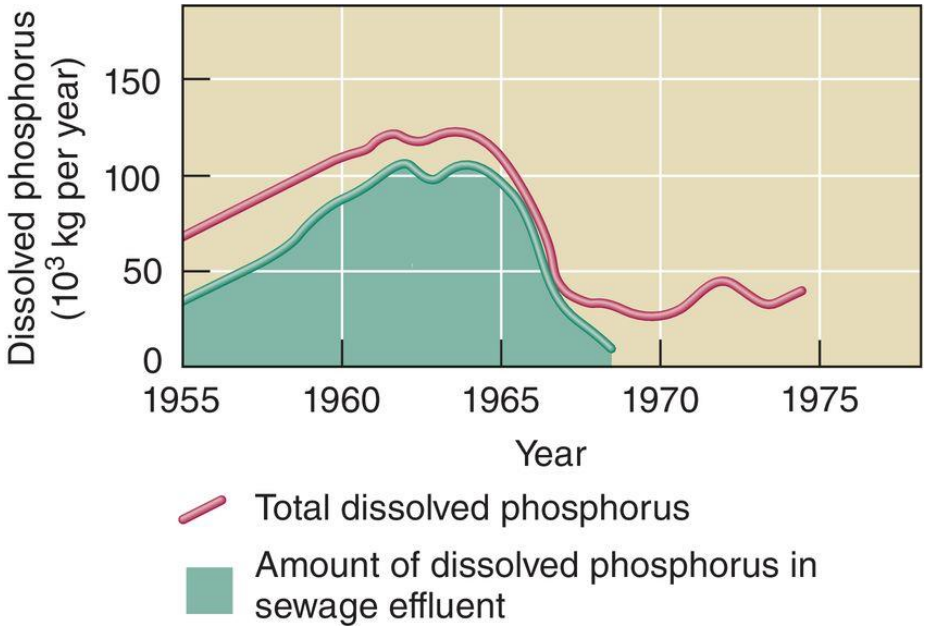
Assessing Environmental Problem Case Study: Lake Washington

- Recovery Plan
  - Many political hurdles in passing a plan
  - Accepted bill was most ambitious and expensive pollution control project in U.S. at the time
    - Treated sewage was diverted into trunk sewer that ringed lake (starting in 1963)
    - Eventually discharged into Puget Sound, where it would have less effect
    - By 1975, lake was heathy and water was clear
    - Today, work to reduce waste generation in view of greater population around lake

Assessing Environmental Problem Case Study: Lake Washington

- Data shows recovery plan working





ENVIRONEWS

- Green roofs or eco-roofs
  - Vegetation and soil on impervious roofs that act as a mini-ecosystem that:
    - Insulates buildings reducing energy costs
    - Filters out pollutants from rainwater
    - Reduces storm water runoff into sewers
    - Provides habitat for wildlife or food for humans
- Largest individual green roof in U.S. on Ford Motor Company factory in Michigan