Chapter 1. Studying the State of Our Earth

I. Environmental Science and Its Importance
   A. Environment
      1. the sum of all conditions surrounding us that influence life
   B. Environmental Science
      1. the field of study that focuses on interactions between human and natural systems
   C. System
      1. any set of interacting components that influence one another by exchanging energy or material
      2. a change in one part of a system can affect the entire system
      3. an environmental system can be human-made or natural
   D. Ecosystem
      1. location on Earth whose interacting components include biotic and abiotic components
         a) biotic: living
         b) abiotic: non-living
   E. Environmentalist
      1. a person who participates in a social movement that seeks to protect the environment through lobbying, activism, and education
      2. different than an environmental scientist
   F. Environmental Scientist
      1. a person who studies the environment by followinig the process of observation, hypothesis testing, and field/laboratory research
      2. environmental science:
         a) encompasses the use of chemistry, biology, Earth science, and physics
         b) part of a broader field called environmental srudies
            (1) includes environmental policy, economics, literature, and ethics

II. How Humans Have (and Continue to) Alter the Environment
   A. Global Environment
      1. composed of large- and small-scale systems
      2. infinitely complex in its interactions
   B. Human manipulation of the environment
      1. Land Conversion
         a) land changed from its natural state to urban, suburban, or agricultural
      2. Air, Water, and Soil Chemistry
         a) pollutants added to the air and water
         b) fertilizers and pesticides added to the soil
      3. Predation

a) humans are efficient hunters
b) have caused numerous extinctions

4. Habitat creation
    a) some species of plants and animals directly or indirectly benefit from human activity
        (1) rats, coyotes, apples, corn, deer, starlings, house sparrows

C. Human Technology
1. modern cities
    a) benefit humans
        (1) electricity, water & sewer systems, Internet, public transportation
    b) come at a cost
        (1) natural habitat must be converted
            (a) species either move, adapt, or go extinct
2. increases in technology, industrialization, and agriculture have induced changes on global climate

D. Human Population
1. exponential growth inevitably impacts the environment
2. in just 130 years, Los Angeles' human population grew from 6,000 to 4,000,000

III. Environmental indicators

A. Ecosystem Services
1. provided by natural systems
2. process by which life-supporting resources are produced
    a) clean water, timber, fisheries, agricultural crops, etc…
3. degraded or stressed ecosystems are unable to provide the same services or goods as a healthy ecosystem

B. Types of environmental indicators
1. conditions or situations that are used to understand the current health and quality of a natural system
2. Biological Diversity (a.k.a., biodiversity)
    a) the mixture of lifeforms within a particular environment
    b) Genetic Diversity
        (1) a measure of the genetic variation within a population
        (2) high GD = better response to environmental change
        (3) low GD = poorer response to environmental change
        (4) overall population reduction results in reduced GD
    c) Species Diversity
        (1) number of species in a particular habitat or region

(2) Species
(a) group of organisms distinct from other groups in morphology, behavior, and/or biochemical properties
(b) can interbreed and produce fertile offspring
(3) speciation
(a) the evolution of a new species
(b) very slow process (maybe 1-3 new species/year)
(4) extinction
(a) the complete loss of a species from the Earth
(5) background extinction rate
(a) average rate of species extinction over the long term
(b) ~1 species/1,000,000 species each year
(6) high SD ecosystem = more resiliency and productivity
(7) low SD ecosystem = less resiliency and productivity
(8) considered a critical indicator of environmental condition

d) Ecosystem Diversity
(1) measure of the variation of ecosystems within a given region
(2) high ED = greater overall environmental health
(3) low ED = lower overall environmental health

3. Food Production
a) the ability to grow food to nourish the human population
b) healthy soil supports abundant and continuous food production
c) amount of grain produced is influenced by many factors
(1) climatic conditions
(2) amount and quality of cultivated land
(3) irrigation
(4) human labor and energy required
(a) planting, harvesting, and distributing
(5) more grain is used to feed livestock than human
(6) governement policies might discourage food production
(a) subsidies for not growing crops
(b) subsidies for growing fuel crops instead of food crops

4. Mean Global Surface Temperature and CO_2 Concentration
a) Stable climate is necessary for biodiversity and abundant food
b) Earth's temperature
(1) relatively stable for about 3.5 billion years
(2) allows for liquid water
c) Greenhouse gases
(1) heat trapping gases that act like a blanket around the Earth

(2) Anthropogenic CO_2
(a) derived from human activities
(b) major sources
(i) burning fossil fuels
(ii) net loss of forests and other habitats

5. Human Population
   a) net increase of 212,000 new people on Earth each day
      (1) 364,000 new infants
      (2) 152,000 deaths
      (3) >1,000,000 additional people every 5 days
6. Resource Depletion
   a) sustaining global human population requires vast resource quantities
      (1) must consider resource use per capita (i.e., per person)
   b) growth of human population = increased resource depletion
   c) extracting natural resources affects environmental health
      (1) mining = pollution and land degredation
      (2) waste needs to be discarded
      (3) fossil fuel combustion increases air pollution
   d) resource availability
      (1) some are nonrenewable & nonreusable
         (a) coal, oil, uranium
      (2) some are nonrenewable but can be reused
         (a) copper, aluminum
      (3) some are renewable
         (a) timber
7. Development
   a) improvement of human well-being through economic advancement
   b) influences personal and collective human lifestyle
      (1) automobile use
      (2) amount of meat in diet
      (3) availability and use of technologies
      (4) increased development = increased resource consumption
      (5) 20% of the global population consumes 95% of teh available resources

IV. Sustainability
   A. Living on Earth in a way that allows us to use resources without depriving future generations of that same resource
   B. Living sustainably requires
      1. environmental systems must not be damaged beyond their ability to recover

2. renewable resources must not be depleted faster than they are able to regenerate
3. nonrenewable resources must be used sparingly

C. Sustainable development
1. development that balances current human well-being and economic advancement with resource management for the benefit of future generations
2. living sustainably
a) acting in a way such that activities crucial to human society may continue
(1) conserving resources
(2) finding and using alternatives to nonrenewable resources

D. Defining Human Needs
1. basic needs
a) air, water, food, shelter
2. complex needs
a) meaningful human uinteraction
b) biophilia
(1) the need to make connections with the rest of life
(a) e.g., through the use of natural areas

E. Ecological Footprint
1. a measure of how much a person consumes, expressed in area of land
2. if our lifestyle demands more land than is available, it is unsustainable
3. can be calculated for individuals, cities, states, and/or nations
4. determining the appropriate metric used in calculation is often debated

V. Science is a Process

A. Science must be:
1. rigorous, objective, and methodical
2. conducted in way that others can understand how data was collected
3. designed so experiments can be repeated

B. The Scientific Method
1. objective way to:
a) explore the natural world
b) draw inferences
c) predict outcomes of events, processes, and changes
2. Observe & Question
a) wondering about something is where the process of scientific research begins
3. Forming a hypothesis
a) a testable conjecture about how soemthing works

(1) speculating a relationship between multiple factors makes a hypothesis able to be tested

b) null hypothesis

(1) a statement or idea that can be falsified (proved wrong)

4. Collecting Data
    a) replication
        (1) taking several sets of measurements
    b) experimental group
        (1) a group that experiences the variable being studied
    c) control group
        (1) a group that experiences the exact same conditions as the experimental group, except for the variable being studied
    d) sample size (n)
        (1) the number of times a measurement is replicated
    e) accuracy
        (1) how close the measured value is to the actual value
    f) precision
        (1) how close the repeated measurements of the sample are to each other
    g) uncertainty
        (1) an estimate of how much a measurement (calculation) differs from a true value
5. Interpreting results
    a) inductive reasoning
        (1) the process of making general statements from specific facts
    b) deductive reasoning
        (1) the process of applying a general statement to specific facts or situations
6. communicating findings
    a) allows other researchers to repeat the original research in order to either verify or challenge the results
    b) critical thinking
        (1) questions sources of information
        (2) consider the methods used to obtain the information
        (3) draw your own conclusions based on the data available
    c) Theory
        (1) a hypothesis that has been repeatedly tested and not unconfirmed by multiple researchers and is widely accepted
        (2) has not been contradicted by any replicable tests

d) Law
(1) an explanation of a natural phenomena that has no known exceptions and has withstood rigorous testing

C. Controlled vs. Natural Experiments
1. not all experiments can be conducted in the highly controlled environment of a laboratory
2. a natural event sometimes acts as the experimental treatment
a) many variables could change all at once - confounding interpretation

D. Science & Progress
1. by following a rigorous process, science can influence change based on confirmed information, rather than supposition, hunches, and beliefs

VI. Challenges and Limitations of Environmental Science

A. Baseline data
1. we have no "control Earth" with which we can compare human influences to conditions without human influence
2. we can only speculate to what were pre-human conditions

B. Subjectivity
1. there is no single measurement of environmental quality
2. our assessments and choices involve value judgements and personal opinions

C. Interactions
1. natural and human dominated environmental systems are some of the most complex known to science
2. due to many varying and interacting parts, a study of one environmental system might notbe applicable to other, similar, systems
3. often human preferences might have as much influence ina system as natural laws
4. environmental science not only encompasses the natural sciences, but also politics, law, and economics

D. Human Well-being
1. environmental equity
a) the fair distribution of Earth's resources
2. environmental justice
a) a social movement that works toward equalk enforcement of environmental laws and the elimination of disparities in how pollutants and other harms are distributed among the various ethnic and socioeconomic groups within human society