Population, Environmental Impacts, and Sustainability
Reminders

**Environment**
- External conditions that affect living organisms

**Ecology**
- Study of relationships between living organisms and their environment

**Environmental Science**
- Interdisciplinary study that examines the role of humans on the earth
Population

- Population: all the organisms of a single species living in the same location at the same time
- Rate of change
  - Positive: births, immigration
  - Negative: deaths, emigration
- 3 types of growth
Linear Growth

- Quantity increases by a constant amount per unit of time
- Ex: 1, 3, 5, 7, 9, ...
- Graph: “straight” line with positive slope
- Global food production follows this model
- Population’s resource requirements?
Exponential Growth (Unrestricted)

- Quantity increases by a fixed percentage - starts off slowly, then grows to enormous numbers
- Graph: J-shaped curve with variable positive slope
- Only exhibited by human population now
- No limiting factor in play
- Resource requirements?

![Population Growth Graph]

- Chart title: Population Growth
- Y-axis: Population
- Data points from 1970 to 2020 showing exponential growth
Exponential Population Doubling--Rule of 70

● How long does it take a population to double?
  ○ Resource use
  ○ Population size

● Rule of 70
  ○ \( 70 \div \% \text{ growth rate} = \text{doubling time (years)} \)
  ○ Currently, the human population growth rate (world wide) is \( \sim 1.2\% \). In what year, do you predict the world population will have doubled?
How rapidly is the human population growing?

- It took 60,000 years to reach 1 billion
- It took 130 years to reach 2 billion
- It took 30 years to reach 3 billion
- It took 17 years to reach 4 billion
- 48% of earth’s land area has been modified by man.
Logistic/Exponential Growth (Restricted)

- Begins with exponential growth then transitions to population stability at **carrying capacity**
- Result is an **S-shaped** curve
- Of natural populations studied, **all eventually** make an S-curve—WHY?
Carrying Capacity

- The maximum number of organisms an environment can support over a specified period of time
- Varies with
  - Time (long- and short-term)
  - Location
  - Technology available to extract and process resources & to deal with problems caused by overpopulation
Environmental Impacts

● Environmental Impact: Any change to the natural environment that results from human actions
● Can be positive or negative
● Environmental Impact Assessment
  ○ Performed prior to beginning a project, implementing a policy, initiating a plan, etc.
  ○ Attempts to predict environmental impacts
  ○ Used for approval, revision of design, & determining mitigation requirements
Synergy vs Chaos

- Synergy occurs when two or more processes interact so the combined effect is greater than the sum of the separate effects.
- Chaos occurs in a system when there is no pattern and it never repeats itself.
  - Noise versus Music
Feedback Loops

- A feedback loop occurs when an output of a system is fed back as an input.
- Two kinds of feedback loops:
  - Positive
  - Negative
Feedback Loops

- **Positive loops** are runaway cycles where a change in a certain direction causes further change in the same direction
  - Melting of permafrost will release methane which will accelerate global warming

- **Negative loops** help to maintain stability in a system
  - Ex. Predator/Prey relationships help to maintain balance in populations... OR... blood sugar/insulin
Model of Environmental Impact

\[ P \times A \times T = I \]

Population (P)
\[ \times \]
Consumption per person (A)
\[ \times \]
Technological impact per unit consumption (T)
\[ = \]
Environmental impact of population

See Fig 1-11, p. 13
$P \times A \times T = I$

**People Overpopulation**
- Number of people
- Number of units of resources used per person
- Environmental impact per unit of resource used

**Environmental impact of population**

**Consumption Overpopulation**
- Environmental impact per unit of resource used
- Quantity of resource used

$= I$
Environmentally Sustainable Society

- **Sustainability**: the ability of a system to survive and function over a defined period of time
- Live off the natural income replenished by soils, plants, air and water without depleting/degrading the natural capital that supplies this income
- Manages environmental impacts to provide for the needs of current and future generations
Four Scientific Principles of Sustainability:

- Reliance on Solar Energy
- Biodiversity
- Nutrient Recycling
- Population Control

Copy Nature
Path to Environmental Sustainability

- Sound science is required at each step
- Involves more than just the environment
  - Economics
  - Morality/values
  - Technology
  - Psychology
Implications of the Four Scientific Principles of Sustainability

**Solutions**

**Principles of Sustainability**

**How Nature Works**
- Runs on renewable solar energy.
- Recycles nutrients and wastes. There is little waste in nature.
- Uses biodiversity to maintain itself and adapt to new environmental conditions.
- Controls a species' population size and resource use by interactions with its environment and other species.

**Lessons for Us**
- Rely mostly on renewable solar energy.
- Prevent and reduce pollution and recycle and reuse resources.
- Preserve biodiversity by protecting ecosystem services and habitats and preventing premature extinction.
- Reduce human births and wasteful resource use to prevent environmental overload and depletion and degradation of resources.

**Current Emphasis**
- Pollution cleanup
- Waste disposal (bury or burn)
- Protecting species
- Environmental degradation
- Increased resource use
- Population growth
- Depleting and degrading natural capital

**Sustainability Emphasis**
- Pollution prevention (cleaner production)
- Waste prevention and reduction
- Protecting where species live (habitat protection)
- Environmental restoration
- Less wasteful (more efficient) resource use
- Population stabilization by decreasing birth rates
- Protecting natural capital and living off the biological interest it provides

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*Figures 1-17 and 1-18*