Environmental Biology

BIOL 2407
Dr. Christopher M. Ritzi
MWF 11-11:50 WSB 109

Outline

- Review Syllabus
- Introductory Video – Overview
- Chapter 1 – Introduction to Environmental Science

Syllabus

- Dr. Christopher M. Ritzi
- Office: WSB 216
- Office hours: M & W 8:30-10:30, T 2-3 or appt.
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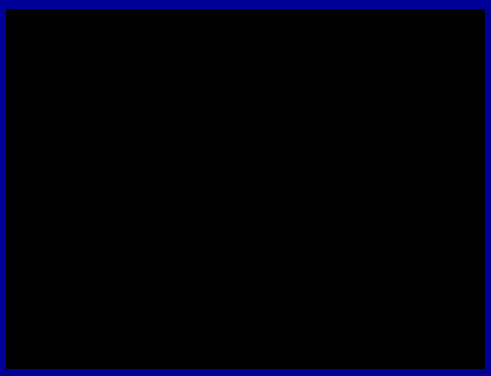
- Lecture: 11:00-11:50 MWF WSB 109
- Lab: 3:30-5:30 W in WSB 109

Introductory Video

Overview of Humanity's
Relationship with the Environment



Chapter 1 - Introduction

- What is the Environment?
- Population – the core of the problem?
- The Lesson of Easter Island
- The Method of Environmental Science
- Scientific Method
- State of the World

The Environment

- The sum total of our surroundings
- Composed of biotic factors
  - Living things we interact with:
    - Animals
    - Plants
- And abiotic factors
  - Nonliving things we interact with:
    - Continents
    - Climate

The Confusion lies here

- We depend on the environment for:
  - Air
  - Water
  - Food
  - Shelter
  - Etc.

Yet

- We have changed the environment by:
  - Air pollution
  - Water pollution
  - Soil erosion
  - Species extinction

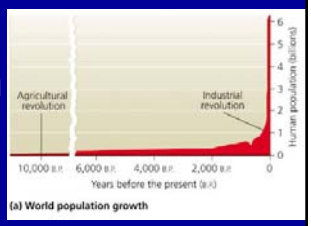
Earth has limited natural resources

- Sunlight, wind, wave, and geothermal are perpetual
- Agriculture, freshwater, timber, and soil take time to replenish

- Crude oil, natural gas, coal, and metals are nonrenewable

Population – The Problem?

- Historically, only a few million people inhabited the earth at any one time.
- 10,000 ya – Agricultural revolution begin a steady increase in population.
- 250 ya – Industrial revolution sparked dramatic increase in population.



(a) World population growth

Thomas Malthus (1766-1834)

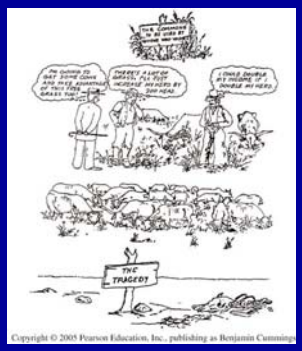
- Saw the growth during the Industrial revolution as dangerous.
- Wrote *An Essay on the Principle of Population* in 1798.
  - Predicted that growing population would be checked by limits in births
    - Moral restraint or contraception
  - Or increases in deaths.
    - Famine, plague, and war for resources
- Has this happened?

Paul Ehrlich

- Wrote *The Population Bomb* in 1968.
- Predicted unchecked population growth would led to widespread famine and conflict in the 20th century.
- This has not happened due to increased food production and technology, but the threat still looms near, although delayed.

Garrett Hardin

- Wrote "The Tragedy of the Commons" in *Science* in 1968.
- Public resources get overused without controls and laws.
- Everyone takes what they can without preserving what is left, until all the resources are used up.
- Argument justifies government regulation of resources, including air and water



Learn from Past Mistakes: The Lesson of Easter Island

- Easter Island (Rapa Nui) was populated by <2,000 natives when "discovered" by European sailors in 1722.
- Evidence shows it used to support a civilization of 6-20,000 people.
- Where did all the people go?

Easter Island

- Island once covered in a palm forest.
- Early Polynesians harvested the palms for fuel, building materials, and rollers/sleds/ and ropes for transporting the famous statutes.

Easter Island

- Timeline to deforestation
  - 750 AD palms decline and ferns/grasses begin replacement
  - 950 AD palms basically extripated
  - 1400 AD all vegetation declines
- Causes of deforestation
  - Overharvest of palms by natives
  - Introduction of rats prevent forest renewal
  - Runoff and erosion increased after palms gone, reducing overall soil fertility

Easter Island

- Other problems
  - Reduced variety in diet
    - Since sturdy sea-going crafts no longer possible, seafood excluded from diet and reduced to what island could provide.
  - Protection of domesticated animals (chicken)
    - Build fortified chicken houses to prevent theft of one of the few meats left on island
  - Breakdown of society
    - Clan warfare over resources, as well as potential starvation, reduced population to what it was in the 1700's.

What is the Lesson to be Learned?

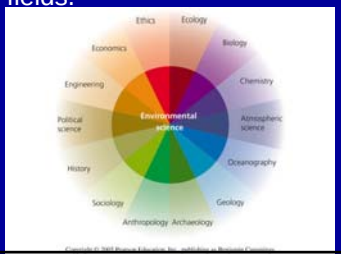
- What happened at Easter Island happened on a small island in the Pacific, but the Earth can also be viewed as an island.
- What happened on a small scale could happen in a grand scale if we waste our resources and not protect what we have.

The Method of Environmental Science

- Environmental science arose to try to understand environmental problems.
- Environmental problems are undesired changes to the environment; however,
  - Problems to one person may not be a problem to someone else.
  - It is partly a matter of perspective.
  - Typically, problems are categorized by one's economic and technological development.
    - Ex. Use of DDT

An Interdisciplinary science

- Environmental science is not just Biology or Sociology, but a broad synthesis of many fields.



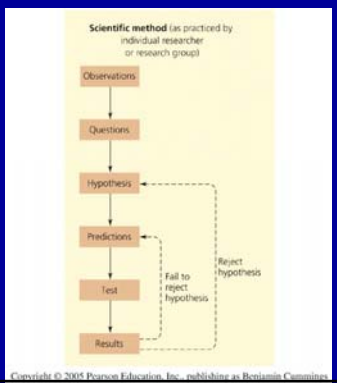
Environmental science is a science

- Environmental science
  - Quest for knowledge
  - Attempts to understand environmental problems, determine causes, and suggest possible solutions through scientific inquiry
- Environmentalism
  - Social movement to protect the natural world
  - Can be useful in spreading ideas and influencing governmental policy
  - Some groups more extreme than others

Scientific Method

- A systematic approach to understanding natural systems.
- Based on 3 assumptions
  - The universe runs along fixed natural laws that do not change over space and time
  - All events arise from some cause or causes, and in turn, cause other events
  - Using observations and reasoning to detect and describe natural laws, we can observe nature and attempt to delineate cause and effect relationships.

Scientific Method



Observations

- The first set of inquiry involves making observations, and noticing that something is happening.
- This is commonly done with the 5 basic senses, but can also be aided by technology (microscopes, weather stations, etc.)

Questions

- Once changes have been observed, question why it is happening.
  - Why are some animals common and others rare?
  - Why do large amounts of algae grow in farm ponds?
  - Do pesticides affect more than just insects?

Develop a Hypothesis

- Hypothesis – an educated guess that explains a phenomenon or answers a question.
- Example – Agricultural fertilizers running into ponds cause algae blooms.

Make Predictions

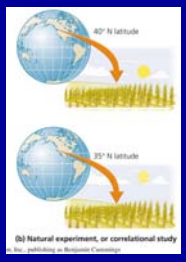
- Use the hypothesis to make predictions
- These must be specific statements that can be directly and unequivocally tested.
- Ex. – If agricultural fertilizers are added to a farm pond, the amount of algae in the pond will increase.

Test the Prediction

- Commonly done through experimentation
- Done by manipulating variables, or conditions.
- Compare various different treatments against a control, or unmanipulated treatment
- Types of variables
  - Independent variable – variable manipulated
  - Dependant variable – variable measured to detect a change due to the independent variable.
- Experiments are repeated several times (called replicates) to reduce the probability of a result occurring by chance.

Test the Prediction

- Not all tests are manipulation experiments, some are correlation studies
- In systems too large or complex to manipulate individual variables, several naturally occurring systems can be compared to one another.
- Ex. Examine 50 ponds (30 receiving fertilizer runoff and 20 without).



Analyze and Interpret Results

- Using mathematical and statistical tests, determine if the results significantly support the hypothesis. Based off of the rules of probability of an event occurring under a particular situation.
- Can be based on quantitative (numerical) or qualitative (not expressed as numbers) data.

Results

- If hypothesis is rejected
- Develop a new hypothesis, make new predictions, and try again

- If hypothesis is not rejected
- Develop another prediction that would test the hypothesis in a different way.
- If this does not reject the hypothesis, hypothesis may be well supported.
- Also good to test alternate hypotheses, to reduce the possibility of error.

Different ways to test Hypotheses

- Not all fields can use manipulation experiments
- Historical sciences
  - Paleontology
  - cosmology
- Natural experiments
  - Testing hypotheses and prediction on what is currently available, or what has already come to pass
  - Ex. Speciation events, ecological studies

Scientific process

- Does not end with the scientific method, as results not shared with others are useless.
- Publication
  - Peer review
  - Paper acceptance or rejection
  - Publication in journal or presented at meeting
  - Questioned and further tested by ones peers in the scientific community (results must be repeatable)
- Grants and Funding
  - Ways of acquiring money to conduct further research.

Models and Theories

- A model is an oversimplification of a complex system to aid in understanding.
  - Commonly based on a successfully defend hypothesis.
  - If a model continues to bear up to testing, may become a theory
- Theory – a widely excepted, well-tested explanation of a cause-and-effect relationship
- Theories can still change, as new information and knowledge can cause a paradigm shift, or a change in previously understood ideas.
  - Ex. – Copernicus' sun centered universe as opposed to the traditional earth-centered one.

State of the World Today

- Various trends influence our environment
  - Human population growth
  - Increased agricultural production at the expense of natural systems
  - Pollution, both natural and artificial contaminants
  - Aquatic ecosystems
  - Biodiversity – (non-repairable)
  - A need for balance between the need for resources and the taking of resources

Trends in 2000-2002

Table 1.1 Selected Environmental Trends 2000–2002

Environmental indicator	Trend/Current status (2000–2002 data)
Global fossil fuel consumption	Increased by 1% in 2001 to highest level ever
Global air and ocean temperatures	In 2001 reached second-highest level since late 1800s
Oil spills from civilian sources	50,000 tons in 2001, the least spilled since 1968
Global automobile numbers	555 million cars, increasing by 40 million each year
Global bicycle production	100 million produced in 2000, the first increase since 1995
Global cropland degradation	~1.5 billion ha (20% of world cropland) are degraded as of 2002
Farmland paved each year	2.5 million acres in the United States, 500,000 acres in China
Irrigated land suffering salinization (excessive amounts of salt due to method of irrigation)	20% of world's total irrigated land
Annual pesticide use	Increased 15 times since 1950
Pesticide poisoning	3 million people poisoned, 200,000 people killed in 2001
Aquaculture/fish farming production	Increased by more than 400% from 1984–2000
Global per capita grain production	1.843 billion tons, down from high of 1.880 billion tons in 1997
Global meat production	Record high of 237 million tons in 2001
Total human population	6.157 billion in 2001, increase of 77 million over 2000 total
Population growth	95% of growth occurs in poor, developing countries

Data adapted from Worldwatch Institute, *Vital Signs 2002: The trends that are shaping our future.*

A Need for Solutions

- We need solutions that are global and sustainable.
- Idea of globalization – Think globally, act locally.
- Sustainable development – use of resources that maintains current needs without compromising future needs .
- Are things getting better or worse?
- Are we thinking in the short term (years or decades) or the long term (generations)?