








- 1  Introduction to Environmental Science & the Scientific Method  
EVPP 110  
Fall 2003  
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- 2  What is environmental science?
  - definition
    - “the interdisciplinary study of humanity’s relationship with other organisms and the non-living physical environment”
  - interdisciplinary because it
    - uses & combines info from many disciplines
      - natural sciences: biology (ecology), geology, chemistry, physics
      - applied sciences: geography, agriculture, engineering
      - social sciences: economics, cultural anthropology, policy, politics, ethics, sociology
  
- 3 
  
- 4  What environmental science is not
  - we need to differentiate between
    - environmental science
      - “science” aspect is emphasized
    - environmental studies
      - “studying”, becoming aware of current environmental issues, environmental ethics, environmentalism
  
- 5  Why is environmental science important?
  - Human domination of earth's ecosystems (from Vitousek et al., 1998. Science: 277: 494-499)
    - to of land surface has been transformed by human action
    - atmospheric CO<sub>2</sub> concentration has ↑ by ~30% since beginning of Industrial Revolution
    - more atmospheric nitrogen is fixed by humanity than all natural terrestrial sources combined
    - > of accessible freshwater is put to use by humanity
    - 1/4 of bird species that ever lived on earth have been driven to extinction
    - 2/3 of major marine fisheries are fully exploited, overexploited or depleted
  
- 6  Why is environmental science important?
  - Sustainability
  - Human population issues
  - Challenges and complexity
  
- 7  Why is environmental science important?
  - Sustainability
    - environmental sustainability
      - “the ability of the environment to function indefinitely without going into a decline from the stresses imposed by human society on natural systems that

maintain life”

- 8 ☐ Why is environmental science important?
- Sustainability
    - environmental sustainability
      - enables humanity’s present needs to be met without endangering the welfare of future generations
      - applies at many levels
        - individual, community, regional, national, global
- 9 ☐ Why is environmental science important?
- Sustainability
    - most experts believe environmental sustainability is not currently being achieved because
      - non-renewable resources (i.e., fossil fuels) are being used as if supplies were unlimited
      - renewable resources (i.e., fresh water) are being used faster than they can be replenished naturally
      - pollutants & toxins are being released into environment as if environment's capacity to absorb them was unlimited
      - human numbers continue to grow despite earth’s finite ability to support us
- 10 ☐ Why is environmental science important?
- Human population issues
    - human population surpassed 6 billion in 1999
      - placing unsustainable stresses on the environment
        - consuming more food and water
        - using more energy and raw materials
        - producing more waste and pollution
      - World Bank estimates that 1.3 billion people live in poverty
        - unable to meet their basic needs for food, shelter, clothing
- 11 ☐ Why is environmental science important?
- Challenges and complexity
    - issues may seem simple
      - why don’t we just stop over-consumption, population growth and pollution?
    - Solutions - challenging & complex because of
      - multifaceted interactions between ecological, social, cultural and economic factors
      - inadequate scientific understanding of how
        - the dynamic environment works
        - how different human choices affect the environment
- 12 ☐ Some Current “Hot” Environmental Issues
- Current “hot” environmental issues
    - Endocrine disrupters
    - Commercial fisheries

- Declining bird populations
  - Ozone depletion
  - Global warming
- 13 ☐ Some Current “Hot” Environmental Issues
- Endocrine disrupters
    - chemicals that may interfere with actions of hormones
      - chemical messengers in organisms
      - regulate growth, reproduction, other activities
- 14 ☐ Some Current “Hot” Environmental Issues
- Endocrine disrupters
    - appear to alter reproductive development in both genders in many species
      - >50% drop in sperm count from 1940-1990 in men (60 studies, 15,000 men, many nations)
      - juvenile alligator density in Lake Apopka (FL) declined 10 fold in 14 years following chemical spill
- 15 ☐ Some Current “Hot” Environmental Issues
- Endocrine disrupters
    - appear to alter reproductive development in both genders in many species cont
      - river otters exposed to synthetic chemical pollutants were found to have abnormally small penises
      - female seagulls in southern CA exhibited behavioral aberrations
        - they paired with other females during mating season instead of paring with males
- 16 ☐ Some Current “Hot” Environmental Issues
- Endocrine disrupters
    - many widely used chemicals fall into this category
    - US EPA plans to test thousands of chemicals for their potential to disrupt endocrine system
      - results will help determine exposure levels, effects, limits
- 17 ☐ Some Current “Hot” Environmental Issues
- Commercial fisheries
    - several have been fished to commercial extinction
      - = fish are harvested faster than they can replace themselves
        - increased world demand
        - high-tech methods increase catches
- 18 ☐ Some Current “Hot” Environmental Issues
- Commercial fisheries
    - Georges Bank closed in 1994
      - 16,500 sq km area off New England in North Atlantic
      - once one of world’s richest fishing grounds
    - Grand Banks cod fishery (off Newfoundland) closed in 1990s

- Peruvian anchovy fishery collapsed in 1970s

19 ☐ Some Current “Hot” Environmental Issues

- Commercial fisheries
  - corrective measures
    - national level
      - 1997 Magnuson Fishery Conservation & Management Act
        - requires National Marine Fisheries Service and 8 regional councils to devise quotas and other strategies to help fisheries recover

20 ☐ Some Current “Hot” Environmental Issues

- Commercial fisheries
  - corrective measures
    - international level
      - 1995 UN Fish Stocks Agreement
        - first international treaty to regulate marine fishing

21 ☐ Some Current “Hot” Environmental Issues

- Declining bird populations
  - population declines seen across North America over past 2 decades
    - particularly among songbirds of forests, shrub lands, grasslands
      - many songbirds are tropical migrants
        - winter in Central America, South America, Caribbean
        - summer, migrate to North America to breed
    - changing environments in both habitats
      - burning of tropical rainforests for cropland
      - fragmentation of temperate forest for development

22 ☐ Some Current “Hot” Environmental Issues

- Ozone depletion
  - evidenced as a large ozone “hole” over Antarctica
    - “hole” is area where ozone concentration is lowest of any place in the world
    - occur in layer of atmosphere called stratosphere
      - layer between 10-45km above earth

23 ☐ Some Current “Hot” Environmental Issues

- Ozone depletion
  - caused by chlorofluorocarbons (CFCs)
    - previously widely used as cooling agents, still used some

- now banned or under phase out by most countries
    - but existing CFCs can survive in atmosphere for 120+ years
- 24 ☐ Some Current “Hot” Environmental Issues
- Global warming
    - caused by “greenhouse” gases
      - allow solar radiation to pass through to earth
      - don’t allow heat to radiate into space
- 25 ☐ Some Current “Hot” Environmental Issues
- Global warming
    - chief among these gases is carbon dioxide
      - CO<sub>2</sub> levels have dramatically increased over past 2 centuries due mainly to
        - burning of fossil fuels
          - natural gas, coal, oil
        - clearing & burning of forests
      - could cause increase in mean temperature (to levels higher than in past 100,000 years)
- 26 ☐ The Scientific Method
- 27 ☐ Extra! Extra! Read All About It...
- “Asteroid Eros Yields Secrets From Time Before Earth Was Born”
  - “Discovery of Armored Viruses May Inspire New Designs for Nanotechnology”
  - “Mechanism Found Behind Drug-Free Acceptance of Transplants”
  - “Combination of Radiation and Hormone Suppression Therapy Shown to Effectively Treat Early-Stage Prostate Cancer”
  - “UF Technique Detects Tiny, Potentially Harmful Airborne Particles”
- 28 ☐ Extra! Extra! Read All About It...cont
- “Research Measures Migraine’s Impact on ‘Typical’ Sufferer, Links Migraine and Depression”
  - “Stress Could Increase Risk of Heart Disease in Women”
  - “Out of Time: Researchers Recreate 1665 Clock Experiment to Gain Insight Into Modern Synchronized Oscillators”
- 29 ☐ Extra! Extra! Read All About It...cont
- all of the above are headlines from science stories posted in a single day (9/25/00) on just one science news web site (ScienceDaily.com)
  - everyday we see or hear in the popular media reports of latest science research findings and how they impact our lives
- 30 ☐ Extra! Extra! Read All About It...cont
- According to a 1999 survey by the National Science Foundation (NSF)
    - Americans have great confidence in science

- but little understanding of the process underlying scientific research
- only ~21% were able to explain what it means to study something scientifically
- only ~33% knew how an experiment was conducted

31 ☐ Extra! Extra! Read All About It...cont

- How can we demystify the process of science?
  - gain an understanding of the basic elements of the process of science

32 ☐ Scientific Thinking

- Science
  - A process
    - used to solve problems or develop an understanding of nature
      - that involves testing possible answers.

33 ☐ Scientific Thinking

- Scientific Method
  - A method
    - of gaining information about the world
      - by forming possible solutions to questions, followed by rigorous testing
        - to determine if the proposed solutions are valid.

34 ☐ Scientific Method

- Presumptions
  - Specific causes for observed events.
  - Causes can be identified.
  - General rules can describe observations.
  - Repeated events have same cause.
  - Perceptions are not individualistic.
  - Fundamental rules of nature are universal.

35 ☐ Scientific Method

- Scientists pose and test hypotheses to answer questions about nature
  - the process of science can be viewed as multi-step process
    - observations
    - questions
    - hypotheses
    - tests

36 ☐ Scientific Method

- Observation
  - senses, or extension of senses, are used to observe and/or record an event.
  - can come from others or results of earlier tests
    - resulting in the raising of a question

37 ☐ Scientific Method

- Question

- about unclear aspects of the observations: how? why? when?
- leads to the development of an hypothesis

38  Scientific Method

- Hypothesis
  - are tentative explanations of a phenomenon phrased in such a way as to be testable
  - logical statement that potentially explains an event, or answers a question.
  - a good hypothesis will take into account all known facts, and will be as simple as possible. (Must be testable)
  - with observations and hypotheses in mind, scientists develop tests (experiments)

39  Scientific Method

- Experiment
  - used to test hypothesis.
  - to determine if predictions are supported (fail to falsify) or falsified
  - have certain important components
    - Controlled: Separate variables and divide experiment into experimental and control groups.
    - Repeatability—Experiment is repeated to eliminate unconscious bias.


40  Scientific Method

- experiments - consist of
  - planned procedure to test hypothesis
  - collect data
  - analyze and interpret data
  - determine if data support hypothesis: accept, reject or modify hypothesis
  - carry out additional testing
  - share data with other scientists
  - if predictions are confirmed by scientific community, idea may become a theory

41  Scientific Method

- Publishing
  - Results must be published for peers to be able to examine and criticize.

42  Scientific Method

43  Development of Theories and Laws

- Theory
  - widely accepted, plausible generalization about fundamental scientific concepts that explain why things happen.
    - Scientific vs. Vague Theory
- Law
  - uniform or constant fact of nature that describes what happens in nature.

44 ☐ Limitations of Science

- Scientists struggle with the same moral and ethical questions as other people.
- Important to differentiate between data collected during an investigation, and scientists' opinions of that data and its meaning.
  - Some scientific knowledge can be used to support both valid and invalid conclusions.
- Science cannot shed light on all issues.
  - It is very easy to confuse hypotheses with fact.

45 ☐ The Process of Science

- the process of science will not “prove” a hypothesis true
- results are used as evidence to support or falsify the hypothesis and usually become new observations in another cycle of investigation

46 ☐