

**Habitat loss and biodiversity**

Despite the hazards posed by pesticides and pollution in the environment, the greatest risk to biodiversity on the planet is **habitat loss and habitat fragmentation**.

**Biodiversity**- all of the species in the biosphere and the processes that sustain them.  
from genetics to ecosystems

G. Bush made this a household word at the Rio conference

-pesticide threats are easy to fix, ban the pesticide. Habitat loss is in many cases irreversible, for example:

- ex) agricultural lands- support few native species and unlikely that they will be restored to natural habitat in many situations
- ex) urban and suburban communities- support very few native species and almost certainly will not be restored
- ex) logging of tropical rainforests often leaves the land devastated and unable to support the native vegetation.

That leaves parks and other uninhabited areas as being our reservoirs of biological diversity. The question is how much does that leave and how many species can that support?

Most of the species diversity on the planet is found in the tropical rainforests. Predictions about the number of species that may go extinct as a result of human activities are mostly based on predictions from rainforests.

-approximately 40% of rainforests are gone- mostly due to human activities. (93% of Madagascar, 99% of Atlantic coastal forest of Brazil. )

-about 1% loss per year (7.6 million hectares or 19 million acres, Humboldt County is 3? million acres= to area of W. Virginia or Costa Rica)

How many species will be lost?

How many are present?

- 1.4 million identified (about 2 are insects, only 3% are vertebrates, many groups are poorly studied)
- Erwin estimates 30 million present based on studies of insects in tropical rainforest canopies.

Simberloff

-12% of 704 birds species (84) in the Amazon Basin, 15% of 92,000 plants (13,800) in S. and central America within a century.

Wilson

- species-area relationship
- for every 10 fold decrease in area, the number of species present declines by half

### DRAW RELATIONSHIP

E. O. Wilson=s calculations of species loss

#### Assume

1. 5 million species in tropical rainforest
2. 2 of species are localized in dsn. so they will be lost immediately when forest is cut
3. rate of loss of forests is 0.7 percent per year

#### Then

no. sp. lost per year =  $5 \times 10^6 \times 0.5 \times 0.007 = 17,500$  species/year or 48 sp/day  
This represents a one thousand fold increase over natural extinction rates.

### **Biodiversity Treaty**

At the Earth Summit in Rio de Janeiro in 1992, the delegates developed a number of treaties including the *Biological Diversity Treaty*. This is the first treaty that recognizes the value of biodiversity and develops specific steps to protect it. One of the provisions outlines a program for pharmaceutical companies to pay royalties to countries for compounds derived from species collected within their borders. 165 countries have signed the treaty and president Clinton signed it in 1993. As of mid 1998, the U.S. senate still has not approved the treaty.

To obtain more information about the treaty, try the following web site:

<http://trc.ucdavis.edu/GAWS/122/1alfa/raessay2.htm>

### **Threatened and Endangered and species**

**Endangered**- a species whose numbers are reduced to the point that it is in danger of becoming extinct.

**Threatened**- species whose numbers are low enough or whose population trend suggests that it may become endangered if corrective action is not taken.

### **Characteristics of endangered species**

1. small range
2. large territory or home range size
3. living on islands
4. low reproductive rate
5. narrow habitat requirements

2 types of rarity

1. **Localized range**- whole species occupies a small area => convert that area and the species is lost.
  - ex) Bay checkerspot butterfly- only on serpentine soils around bay area
  - ex) Tiburon mariposa Lilly- found on one hilltop near SF
  - ⇒ to preserve species, must preserve site
  
2. **Low density**- species who has large area requirements for each individual or pair.
  - ex) Grizzly bear
  - ex) Spotted owl
  - ⇒ to preserve species must preserve suitable habitat over large area

### Causes of endangerment

1. Habitat loss- all over, especially tropics
  - ex) spotted owl, ivory-billed woodpecker
2. Exotic species- especially islands
  - ex) brown tree snake decimated the native birds of Guam
3. Hunting and over exploitation- black rhino, siberian tiger
4. Pesticides and pollution- peregrine falcon, bald eagle

What do we mean when we talk about habitat?

Species are not evenly distributed within their range. Select certain kinds of conditions.

- ex) Redwoods- range is coastal N. Calif. but only found in coastal valleys with abundant rain and fog
- ex) Marbled godwits- mudflats along coast.
- ex) Tailed frogs- in cool clear moving streams

**Habitat-** Habitat is the sum total of the environmental factors, food, cover, and water that a given species needs to survive and reproduce in a given area.

Generally described in terms of vegetation type or physical conditions.

ex) forest habitat and forest birds

ex) alpine habitat and associated species, marmots, pikas, prairie falcons, bighorn

**Niche-** the role of a species within the ecosystem. Includes the habitat that a species needs to survive, the organisms it eats, its predators, and its competitors.

Represents the totality of an organisms adaptations, use of resources, and the species it interacts with.

### **Fundamental vs realized niche**

Fundamental- potential ecological niche

Realized- actual niche

ex) anoles in florida

ex) habitat used by deer and elk is reduced In the presence of cattle

**Competitive exclusion-** no two species can occupy the same niche.  
now controversial

**Limiting factor-** whatever factor that limits the numbers of a species.

ex) plants

1. nutrients, 2. water, 3. sunlight, 4. temperature, 5. competitors, 6. herbivores or parasites

ex) animals

1. food, 2. special habitat req. (nest sites, water temp., soil type), 3. competitors, 4. predators and parasites

### **Habitat Protection and Administration**

We have discussed that habitat loss is the main cause for species loss and endangerment. What laws and regulations are on the books for protecting and managing wildlife habitat?

### **Laws, Acts, and Regulations**

**Endangered Species Act** - passed in 1966 in response to concerns about the loss and decline of plant and animal species.

1. Sec. of Int. prep. list of endangered sp. (birds, mammals, and fish only)

2. study habits and needs of endangered sp.

3. Dept. Agric., Interior, Defense, directed to protect end. sp. when it did not conflict with the primary purpose of the area

4. primary respon. for protecting sp. resided with states- **no penalties for killing an animal** (on the books but no teeth)

1969

1. prohibited importation of foreign endangered species or parts thereof.
2. amended Lacey Act to prohibit the importation of or interstate traffic in fish or wildlife obtained illegally in the country of origin.
3. Directs Sec. of Interior to compile a list of foreign end. sp.

1973

1. included amendment to protect ecosystems upon which threatened and endangered and threatened species depend
2. Provide a recovery plan for each species. Defines criteria for delisting
3. Take steps to achieve purposes of the treaties and conventions dealing with endangered species

1978

The **ESA** was amended again and established a committee to review conflicts between development projects and endangered species (**the God squad**)

**Sweethome case-** Logging companies filed suit against the federal government of the definition of taking an endangered species. The companies argued that taking was synonymous with killing. Scientists and environmental groups argued that habitat alteration or destruction could be considered a taking. The supreme court came down on the side of the scientists.

### How is endangered species act implemented?

**Listing-** process of deciding whether a species is listed as threatened or endangered. Based on biological considerations only.

**Delisting-** Criteria set when species is listed

**Recovery plan-** specific steps that must be taken to recover the population.

### Decisions regarding specific projects

#### Federal programs/lands

All development on federal lands must be assessed for T and E species before development can proceed. If a T or E species is found on the property, the agency must consult with the US Fish and Wildlife Service to determine if the development will harm the species- **this is called a section 7 consultation**. Very few of these consultations have resulted in the halting of a project (out of 22,000?? fewer than 12 have been stopped).

#### Private lands

Private land owners are given a little more leeway. State agencies can impose regulations on how close activities can occur to an endangered species= nest, burrow, etc. For example, California law states that no trees can be cut within 300' of a Spotted Owl nest. Large land owners are sometimes given the right to take some animals if they develop a conservation plan for the species on their lands. Simpson Timber has done this for the No. Spotted Owl on their lands. The problem with this approach is that the company has to do this for every endangered species that occurs on their lands.

### Criticisms of the ESA

1. Not working, species are being listed more rapidly and not being delisted
2. Causes undue economic harm
3. It takes the emergency room approach (median no. of individuals was 119 for animals, 999 for plants). Therefore most species are already doomed when they are listed.
4. Single species approach is not viable, must consider ecosystems.

### Response

#### 1. Not working?

It works but slowly and has prevented many species from going extinct. With more funding it could work.

#### 2. Economic Harm

Federal- Actually has prevented few federal projects,

Private- some private landowners have been hurt but overall relatively little (GNP is still increasing at a healthy rate)

### **3. Emergency room**

It is the only approach that we have right now so we better keep it.

### **4. Ecosystem management-** has been offered as an alternative to the single species approach. If you protect the ecosystem then the species that depend on the ecosystem will also be saved. The problem is we often do not know how to manage ecosystems to maintain all of the species.

### **Convention on Trade in Endangered Species of Wild Fauna and Flora (CITES)**

1973 The most significant innovation of CITES treaty was its recognition of the varying degrees of vulnerability to endangerment and its provision for regulatory measures designed to reflect those varying vulnerabilities. It requires participating countries to establish scientific and management authorities to determine the legality of any trade in a species recognized as endangered.

### **National Environmental Policy Act (NEPA) 1970-** sets out federal environmental policy.

NEPA directs all federal agencies to carry out programs with following aims:

1. each generation is a trustee of the environment for succeeding generations
2. assure safe, healthful, productive, and pleasing surroundings
3. attain beneficial uses without degrading the environment
4. preserve important historic, cultural, and natural aspects of our natural heritage
5. achieve a balance between population and resource use
6. enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources

Requires environmental impact statements (EISs) for federally assisted projects likely to have environmental effects. Each EIS must include:

1. enviro. impact of action including nature of program and why needed
2. alternatives to proposed action
3. relationship between local short-term uses and enhancement of long-term productivity
4. any irreversible and irretrievable commitments of resources that would be involved

### **Procedure for EIS**

1. Write draft
2. Public comment period
3. After comments addressed final EIS is written and it accompanies proposal through decision making process.

**NEPA Applies to:**

1. All major federal agencies (USFS, BLM, Army Corps, Army, National Parks, etc)
  - ex) dams built by Corps of Engineers and Bureau of Rec.
  - ex) Forest management plan for USFS lands in No. Spotted Owl range
2. Approval of federal funds for other agencies
  - ex) approval of federal funds for highway construction
  - ex) license for nuclear power plantNRDC- forced all corporations to report to securities exchange commission info on adverse enviro impacts of their activities and efforts to reduce them

**National Forest Management Act-** Requires that the US Forest Service manage its lands to maintain viable populations of native vertebrates@. This means that they must consider all species, not only T and E. Has moved the USFS towards ecosystem management.

### **Global Environmental Problems**

The last environmental crisis we will discuss are global atmospheric changes. Many of these changes have been occurring for many years. It is just in the last few decades however, that we have become aware of the changes and the potential consequences of these changes.

There are three kinds of changes that have received the most attention:

1. Acid rain (or more properly acid deposition)
2. Ozone depletion
3. Global warming

**Acid Deposition-** Highly acid rain, fog, or snow that is produced as a result of release of sulfur and nitrogen dioxides into the atmosphere. It is estimated that acid deposition results in about \$8 billion in damage each year.

1. Acid deposition is produced when sulfur and nitrogen dioxides are released into the atmosphere combine with water and form hydrochloric and sulfuric acid.

Sources of SO<sub>2</sub> and NO<sub>x</sub> (burning of fossil fuels)

1. motor vehicles
2. electrical power plants
3. large smelters

Note: Taller smokestacks were used on many electrical power plants in the E. US to reduce pollution levels in the surrounding community- this essentially exported the problem to other areas (Scandinavian countries- from England and Canada- from the US)

2. The sulfur and Nitrogenous oxides are transformed into sulfuric and nitric acids when they combine with H<sub>2</sub>O in the atmosphere.
3. When these compounds reach the earth in the form of rain, snow, sleet, or hail, they can have devastating impacts.

**pH-** a measure of the relative acidity or alkalinity of a substance.

measures the availability of H<sup>+</sup> ions in the substance. More H<sup>+</sup> => lower pH

Varies from 0-14

logarithmic scale (for every unit decrease the conc. of H<sup>+</sup> increases 10 fold.

- 7- neutral (distilled H<sub>2</sub>O)
- 5-6- normal rain
- 4- tomato juice
- 3- vinegar
- 2- lemon juice

acid deposition in NE averages 4 but is often less than 3

### **Consequences of acid rain**

1. May have direct toxic effects of fish, mussels, and other aquatic animals (200-400 lakes have lost fish in the Adirondacks) **FIGURE 20-2**
2. Heavy metals such as cadmium and mercury become soluble in acidic lakes and streams (may be cause of decline of some aquatic org.)
3. Reduced  $\text{Ca}^+$  effects birds
  - acid rain washes calcium from soil
  - plants take up less Ca
  - insects take up less Ca
  - birds have thinner eggshells
4. Effects on plants is more controversial
  - Research suggests that soil changes resulting from acid depos. can reduce plant vigor
  - Ca and Mg are washed out of acidic soil
  - N may become more available
  - Heavy metals (Manganese (Mn) and Aluminum become more available for absorption- these can be toxic in low amounts

### **Politics of acid deposition**

-it doesn't stay where it was produced hence it is often difficult to make the perpetrators pay

### **Control**

relatively straight forward- use scrubbers, use fuels (gas) that produce less  
could be long-term effects

### **OZONE DEPLETION**

$\text{O}_3$  is a natural part of the stratosphere (10-45 km above the earth) (also human produced in the troposphere where it can cause problems for humans and animals)  
- absorbs ultraviolet radiation and shields earth from harmful rays.  
- if ozone is completely depleted, earth would become uninhabitable for most life

### **Depletion of Ozone**

There has been evidence of depletion of the ozone layer for a couple of decades  
-most notable in the Antarctic where ozone holes appear every winter (1995 was similar to 1994 and are some of the worst on record)  
-predicted by chemist in early >60's received a Nobel Prize in 1995  
-first noted by ground based detectors in Antarctic (ice crystals and cold temps enhance loss  
-note problem with observing depletion from satellites (data with low values thrown out)

**The process****Ozone production**

$O_2 \rightarrow O + O$  (caused by UV radiation)

$O + O_2 \rightarrow O_3$  (ozone)

**Ozone loss**

$Cl + O_3 \rightarrow ClO + O_2$

$ClO + O \rightarrow Cl + O_2$  (hence more destruction can occur)

**FIGURE 20-15**

Chlorofluorocarbons (CFCs) have been identified as the culprits

Where are CFCs found?

1. refrigerants
2. propellants (banned in US in 1978)
3. insulation foam (styrofoam)
4. methyl bromide (agriculture)
5. halons- fire extinguishers
6. carbon tetrachloride- industrial uses

**Effects of Ozone depletion**

1. increased skin cancer (UV-B increasing at 5% per year in Toronto 1989-1993)
2. crop damage (little effect at present levels of ozone depletion)
3. phytoplankton production has declined in antarctic

**Protection**

1987- Montreal Protocol- reduce CFC production by 50% by 1998

1990- 90 countries agreed to phase out CFCs completely by 2000

1994- US plans to completely stop production by 1996

-relatively easy to address this problem

-predict that worst depletion will occur in 2000, then things will start to get better

**GLOBAL WARMING**

The accumulation of trace gasses in the atmosphere may be causing world wide temperature increases.

Concentrations of CO<sub>2</sub>, Methane, CFC-12, CFC11, and Nitrous oxide have all increased substantially since the industrial age started

**OVERHEAD- Table 20.1**

These gases retain infrared radiation which normally would dissipate into space. This works in much the same way as glass in a greenhouse hence it has been dubbed the Agreenhouse@ effect.

Increases in the concentration of these gases is not disputed.

**OVERHEAD Figure 20-6**

Note the cyclic nature of the increase- Why? Respiration and photosynthesis!

The consequences of these increases is highly disputed.

Most atmospheric scientists suggest that these increases will lead to global warming.

They expect a doubling of the CO<sub>2</sub> levels will cause a 2-5° C warming before the end of the 21st century. Some say we the warming over the last 15 years is a result of global warming.

The National Assessment Synthesis Team (NAST) is a committee of experts drawn from governments, universities, industry, and non-governmental organizations and published an assessment of global climate change. Below is a quote from the overview of the report.

<http://www.usgcrp.gov/usgcrp/default.htm>

**Long-term observations confirm that our climate is now changing at a rapid rate.**

**Over the 20th century, the average annual US temperature has risen by almost 1°F (0.6°C) and precipitation has increased nationally by 5 to 10%, mostly due to increases in heavy downpours. These trends are most apparent over the past few decades. The science indicates that the warming in the 21st century will be significantly larger than in the 20th century. Scenarios examined in this Assessment, which assume no major interventions to reduce continued growth of world greenhouse gas emissions, indicate that temperatures in the US will rise by about 5-9°F (3-5°C) on average in the next 100 years, which is more than the projected global increase. This rise is very likely to be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions.**

Others (usually with political motives) have disputed this contention saying it is too soon to tell and that there are other explanations for the recent rise in global temperatures.

Here is a quote from the American Petroleum Industry web site.

**“API’s view about global warming begins with awareness that the scientific evidence available for assessing the phenomenon is still highly uncertain. We know enough to take the possibility seriously, but not enough to inflict the economic harm which would result from implementation of the Protocol.”**

<http://api-ec.api.org/environ/index.cfm?bitmask=001003004000000000>

## OVERHEAD OF TEMPERATURE INCREASES

### What are the sources?

CO<sub>2</sub>

1. burning fossil fuel
2. burning forests

Methane-  
Cows!

### What are the consequences?

1. Effects on plants and wildlife- could drive some plants and animals on mountaintops extinct.  
ex) Fritillary butterfly (*Boloria acrocneuma*) limited to NE snow moistened slopes of mtn tops in the San Juan Mtns. of SW Colorado. It has been declining in the >80's as a result of the warm, dry years.
2. Rising sea levels- could rise 0.2-2.2 m with huge consequences
3. Changes in precipitation- U.S. breadbasket could get drier  
ex) in 1988 US wheat production declined by 40%, used more than we produced
4. effects on agriculture- pests could increase

What to do?

Prevention, mitigation, adaptation

### Prevention

Prevention difficult- fossil fuels are the basis of our economy

Clinton has signed legislation to reduce CO<sub>2</sub> emissions to 1990 levels by yr 2000

### Mitigation

Plant trees- would have to plant an area the size of the US each year to offset

deforestation and current levels of CO<sub>2</sub> production.

Fertilize the oceans- Some have suggested putting nutrients such as iron in the open ocean to increase rates of photosynthesis. Iron has been found to be a limiting nutrient in many areas of the open ocean and experiments have shown that adding iron increases photosynthetic rates thereby reducing atmospheric CO<sub>2</sub>.

### **Adaptation**

1. Move people in low lying coastal areas.
2. Shift agricultural areas

=> Both are expensive and shortsighted

### **Kyoto conference on Global Climate Change**

The Kyoto conference was the third global environmental conference and focused on approaches to slowing global climate change. Unfortunately, the goals for CO<sub>2</sub> reduction were rather weak but the conference did raise awareness of the problem.

### Kyoto Protocol

By 2010 cut emissions of CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O by 5% relative to emissions in 1990. The Bush administration is opposed to the Kyoto protocol and has proposed a voluntary measure that would only reduce the rate of increase in greenhouse gas emissions.

To learn more, go to the following web site:  
<http://unfccc.int/resource/convkp.html>

## Quotes to consider

ΔWe end, I think, at what might be called the standard paradox of the twentieth century; our tools are better than we are, and grow better faster than we do. They suffice to crack the atom, to command the tides. But they do not suffice for the oldest task in human history, to live on a piece of land with spoiling it@.

Aldo Leopold 1938

ΔPerhaps the most serious obstacle impeding the evolution of a land ethic is the fact that our educational...system is headed away from, rather than toward, an intense consciousness of land@.

The ethos of natural resource management-

ΔThere seem to be few fields of inquiry where the means are so largely of the brain, ends so largely of the heart@.

ΔI have no illusions about the speed or accuracy with which an ecological conscience can become functional. It has required 19 centuries to define decent man-to-man conduct and the process is only half done; it may take as long to evolve a code of decency for man-to-land conduct. In such matters we should not worry too much about anything except the direction in which we travel@.

Aldo Leopold

ΔWe love to point fingers when we try to deal with difficult problems such as the environment, to lay the blame on industry or science or politicians. And there is no question that industrialization has polluted our surroundings. But who buys the products? We do, you and I and the general public. Each of our actions has a global impact.

That is why each of us must do our part, no matter where we live, in a city, or countryside, in Africa, America, or elsewhere....

Therein lies our hope- more and more people are opening their hearts to the desperation they see around them and springing to action. For this is how we can attain our human potential for compassion. And for love@.

Jane Goodall

National Geographic 1995. 188 (6):129.