Lecture 05, 06 Sept 2005

Conservation Biology
ECOL 406R/506R
University of Arizona
Fall 2005

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Kathy Gerst

Conservation Biology 406R/506R

1. Ethics and Philosophy
2. Leopold
3. Role Playing for Thursday
   (please get your powerpoint files to KEB by 1130am on Thursday - and bring with you as well)
4. Lab Friday, meet at van S-side BSE
   - Going to West Branch Santa Cruz river
   - Readings on line today

Shift Burden of Proof/Responsibility (precautionary principle)

SMS (safe minimum standard)

<table>
<thead>
<tr>
<th></th>
<th>-Developers</th>
<th>-Conservationists</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Instrumental</td>
<td>B of P</td>
<td></td>
</tr>
<tr>
<td>2 Intrinsic also</td>
<td>B of P</td>
<td></td>
</tr>
<tr>
<td>3 BCA</td>
<td>B of P</td>
<td></td>
</tr>
<tr>
<td>4 SMS</td>
<td>B of P</td>
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</tr>
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Values, Ethics, Philosophy...

Rolston Essay (p. 35 in Van Dyke text)
- species vs. species in the system (definition of species)
- value of evolutionary trajectory
- extinction and doors (temporal and spatial scales)

Anthropogenic perturbations:
... fast rate and large spatial scale.

(Cited in Callcott 1997)
The tragedy of the commons develops in this way. Picture a pasture open to all. It is to be expected that each herdsmen will try to keep as many cattle as possible on the commons. Such an arrangement may work reasonably satisfactorily for centuries because tribal wars, poaching, and disease keep the numbers of both man and beast well below the carrying capacity of the land. Finally, however, comes the day of reckoning, that is, the day when the long-desired goal of social stability becomes a reality. At this point, the inherent logic of the commons remorselessly generates tragedy.

As a rational being, each herdsmen seeks to maximize his gain. Explicitly or implicitly, more or less consciously, he asks, "What is the utility to me of adding one more animal to my herd?" This utility has one negative and one positive component.

1. The positive component is a function of the increment of one animal. Since the herdsmen receives all the proceeds from the sale of the additional animal, the positive utility is nearly +1.

2. The negative component is a function of the additional overgrazing created by one more animal. Since, however, the effects of overgrazing are shared by all the herdsmen, the negative utility for any particular decision-making herdsmen is only a fraction of -1.

Adding together the component partial utilities, the rational herdsmen concludes that the only sensible course for him to pursue is to add another animal to his herd. And another; and another. . . But this is the conclusion reached by each and every rational herdsmen sharing a commons. Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit— in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all.

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**Ethics:**

- constrain self-serving behavior in deference to some other good

**Tragedy of the Commons**

**Role of religions?**

**Values, Ethics, Philosophy...**

**Table 1.3** Seven Major Worldviews that Shape Environmental and Conservation Ethics

<table>
<thead>
<tr>
<th>WORLDVIEW</th>
<th>TYPE OF VALUE</th>
<th>MOTIVATION FOR CONSERVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Judeo-Christian stewardship</td>
<td>Ethnocentric</td>
<td>Preserve the natural system that God has entrusted humanity to care for, as exemplified by the parable of the Good Shepherd.</td>
</tr>
<tr>
<td>2. Deep ecology and related value systems</td>
<td>Ecocentric</td>
<td>Recognize the intrinsic value of nature that transcends human needs and must be respected.</td>
</tr>
<tr>
<td>3. Utilitarian/transactional</td>
<td>Anthropocentric</td>
<td>Respect the ethical value of nature, which provides a basis to prevent self-destructive actions and ensure human flourishing.</td>
</tr>
<tr>
<td>4. Capitalist economics</td>
<td>Anthropocentric</td>
<td>Respect the ethical value of nature, which provides a basis to prevent self-destructive actions and ensure human flourishing.</td>
</tr>
<tr>
<td>5. Scientific rationalism</td>
<td>Ecocentric</td>
<td>Recognize the intrinsic value of nature that transcends human needs and must be respected.</td>
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<tr>
<td>6. Eschatological</td>
<td>Anthropocentric</td>
<td>Recognize the ethical value of nature that transcends human needs and must be respected.</td>
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<tr>
<td>7. Polytheistic/animistic</td>
<td>Anthropocentric</td>
<td>Recognize the intrinsic value of nature that transcends human needs and must be respected.</td>
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1. Should conservation biologists explain the value of biodiversity in purely instrumental terms or should they also include reasons invoking intrinsic value?

2. How should we respond to the question of “What good is it?”

3. How do we know that humans, or anything, have intrinsic value?

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**Science, Vol 162, Issue 3859, 1243-1248, 13 December 1968**

**The Tragedy of the Commons**

Garrett Hardin

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**Personal Example? Virtue?**

(Van Dyke p. 75)

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**1887-1948**

Aldo Leopold Foundation
Plastic Trees in Los Angeles? Knowledge -> advocacy?

“Perhaps our grandsons, having never seen a wild river, will never miss the chance to set a canoe in singing waters.”

-Leopold

“Objectivity is only possible in matters too small to be important, or in matters too large to do anything about.” (p. 226)

-Leopold

Leopold

Thinking like a mountain
“a mountain lives in mortal fear of its deer”

Escudilla
progress?
“It’s only a mountain now.”

The planet will survive, will we?

“A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise”

Aldo Leopold

Aldo Leopold Land Ethic
-land ethic enlarges the community to include biota
-processes
-evolutionary/ecological biology
-scale of perturbation (temporal, spatial)
-violence
-What is “land-health?”

Aldo Leopold Land Ethic
-land pyramid
Aldo Leopold Land Ethic

- **social evolution** (social disapproval for wrong actions)

- human as plain member and citizen, not ruler

- Conquerer self defeating because falsely thinks s/he understands how the system works and can control it

Evolution of rights...

monarchs
white males
“all men”
humanity
sentient beings
nature

Leopold

- Property vs. propriety

- Role of land in human history
  (Diamond, *Guns Germs and Steel*)

- Sacrifice
- Obligation of private landowner
- Livestock, Violence

- Economics?

"In our attempt to make conservation easy we have made it trivial" (p. 298)

“Whether you will or not
You are a King, Tristram, for you are one
Of the time-tested few that leave the world,
When they are gone, not the same place it was.
Mark what you leave.”

As quoted in Leopold, 1949 p. 261 (The Land Ethic)

What is biodiversity?

Thanks to Chuck Price
How many species on earth?

~12.14 million total species (50-90% in tropical forests)
~1.7 identified

Thanks to Chuck Price

Biodiversity

1. Genetic (nat. sel.)
2. Species
3. Ecological forests, deserts, lakes, wetlands, reefs etc.
4. Functional energy flow nutrient cycling etc.

Levels of Biological Organization.
Scaling.

Costanza et al. 1997

The value of the world’s ecosystem services and natural capital

Costanza et al. 1997
Biodiversity (Biological Diversity)
“structural and functional variety of life forms at genetic, population, community, and ecosystem levels”

What factors correlated with high diversity?

- Energy
- Precipitation
- Temperature
- Area
- Habitat heterogeneity (e.g., foliage height and birds)
- Stable environment
- Moderate (intermediate) disturbance level (shifting mosaic, no climax)
Terrestrial Biomes
(Forest, Desert, Grassland, Tundra, etc.)

Biotic (~Vegetative) Communities

Climate
1. Temperature
2. Precipitation
(3. Soil type)

- Latitude
- Altitude

Species Focus --- > Biodiversity and Process Focus (ESA)
What being lost vs. why...

Species = ?

Biological Species Concept (Mayr)
"a group of interbreeding populations that are reproductively isolated from other such groups"

2-morphological/typological species concept (plants)
3-evolutionary species concept
4-genetic species concept
5-paleontological species concept
6-cladistic species concept

- Organism
- Population
- Species

for sexual species under natural conditions: group of individuals which actually (or potentially) interbreed, producing live, fertile offspring
Conserve Species as

**TYPES**
or as

**EVOLUTIONARY UNITS**

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Biological Species Concept

1. Testable and operational
2. Definition compatible with established legal concepts
3. Focus on level of biodiversity that agrees with tradition of conservation

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Aspidoscelis (Cnemidophorus)
Species vs. Parthenospecies...

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Galapagos Finches

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Brassica oleracea

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Dessaur et al. 2000
Hybridization in Whiptail Lizards

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Dessaur et al. 2000
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Hybridization in Whiptail Lizards

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Conserve Species as

**TYPES**
or as

**EVOLUTIONARY UNITS**

**Alpha species within a community**
- all populations occupying a given area at a given time - often broken into taxonomic groups or functional roles

**1) Species Richness (# of species)**
**2) Species Evenness (how many of each type?)**

**Shannon Diversity Index** (richness and evenness)

\[ H' = -\sum p_i \ln(p_i), \quad (i = 1, 2, 3 \ldots S) \]

- \( p_i \) = proportion of total community abundance represented by \( i \)th species

**Table 4.3** Abundance (indiv spp abundance/rel to total abundance)

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>SITE A</th>
<th>SITE B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common yellowthroat</td>
<td>2.40</td>
<td>2.40</td>
</tr>
<tr>
<td>Field sparrow</td>
<td>2.36</td>
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</tr>
<tr>
<td>Red-winged blackbird</td>
<td>0.29</td>
<td>0.29</td>
</tr>
<tr>
<td>Brown-headed cowbird</td>
<td>2.06</td>
<td>1.82</td>
</tr>
<tr>
<td>American pipit</td>
<td>1.67</td>
<td>1.67</td>
</tr>
<tr>
<td>Rough-billed woodpecker</td>
<td>0.90</td>
<td>1.67</td>
</tr>
<tr>
<td>Mockingbird</td>
<td>1.18</td>
<td>1.67</td>
</tr>
<tr>
<td>Robin</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Grasshopper sparrow</td>
<td>—</td>
<td>6.58</td>
</tr>
<tr>
<td>Northern Mockingbird</td>
<td>—</td>
<td>2.84</td>
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**Shannon diversity (H')**

- SITE A = 1.56
- SITE B = 2.25

**Shannon Index in Tallgrass Prairie**

(Indiv spp abundance relative to total abundance)

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**Process and Pattern**

1. **Functional Types**
2. **Functional Analogs**

Increase either to increase biodiversity

Which to preserve?

**Niche:**
Ecological role of a species in a community

**1. Competition**

Anolis

Ecomorphs on Caribbean Islands
Pisaster (predatory sea star)
Paine
15 vs. 8 spp. (mussels)

2. Predation

3. Parasitism

4. Mutualism

See 4-2 in Miller 2003

5. Commensalism

Florida

Bromeliads

Ecuador

Stalk Eyed Flies

Sexual Selection
**Mistletoe in Mesquite (Bisbee, AZ)**

**Indicator Species**
- migratory birds
- amphibians

**Keystone Species**
- top predators
- key pollinators

**Native Species**
vs.
**Nonnative, exotic, alien**

**Beta Diversity**
1) quantitative measure of diversity of communities that experience changing environmental gradients
2) are species sensitive, or not, to changing environments? are there associations of species that are interdependent (plants, pollinators, parasites, parasitoids)?
3) how are species gained or lost across a TIME gradient?

**Measuring Biodiversity**
- alpha  - beta  - gamma

**Beta**
area or regional diversity (beta richness)
diversity of species among communities across landscape gradient
- slope, moisture, temperature, precipitation, disturbance, etc.

Whittaker's Measure = \( \frac{S}{\alpha} - 1 \)
where \( S = \# \) spp in all sites, \( \alpha = \) avg. \( \# \) spp/site
a) if no community structure across gradient = 0
- broad ecological tolerances, niche breadth
b) 100/10 - 1 = 9 high beta diversity
Measuring Biodiversity
- alpha  - beta  - gamma

**Gamma**
rate of change of species composition with distance (geography, rate of gain and loss of species)
alpha rarity with increased number of species (fewer of each type)
beta rarity with habitat specialists
gamma rarity if restricted to particular geographic areas

Pricing Biodiversity
\[ R_I = (D_i + U_i)(\Delta P_i/C_i) \]
D = distinctiveness
U = utility
\( \Delta P \) = enhanced probability of survival
C = cost of strategy

Direct limited funds…
Ecological Contribution?

**Rhynchocephalia**
- evolved before dinosaurs
- world-wide distribution in Mesozoic
- most extinct at end Cretaceous (65mya)

Sphenodontidae
- 1 extant genus (*Sphenodon*)
- 2 extant species
- restricted to small islands of New Zealand
- long lived

Missing?
Species role in ecosystem?
Rarity
Phylogenetic Representation
Edges vs. Interior (e.g., fragmentation)
(spp richness increases, but are broad generalists, not interior habitat specialists)

All species are not equivalent (normative valuation?)

See Fig. 2-1 (Pough et al., 2001)
Species-Area Relationship

3 step loss of biodiversity
(Rosenzweig)
1. Endemics
2. Sink populations
3. Stochasticity

Therefore end up with lower steady state species richness and loss of biodiversity

Endemism and Islands (Tuatura, Silversword)
Island Biogeography

\[ S = cA^2 \]

\( S \) = species richness
\( c \) = taxon-specific constant
\( A \) = area
\( Z \) = extinction coefficient for taxon

Biodiversity Tid Bits

Species or DNA out of context?

Umbrella Species
Indicator Taxa (or structure or function, redundancy)
Keystone Species (bison)

Areas of high endemism for one group may not be high areas of endemism or BD for another group

Where is biodiversity?
One tree in Peru with same ant diversity as Britain