Monday 30 January 2006, 8th class meeting
(Miller Chapters 4 [some of 3]; Leopold)

Environmental Biology (ECOL 206)
U. Arizona, spring 2006

Kevin Bonine, Ph.D.
Alice Boyle, Kristen Potter, Graduate TAs

1. Aldo Leopold
2. Populations → Ecosystems

3. Outside this week! Bring hats, jackets, etc. (binoculars?)
4. 206 Lab Website for handouts and assignments
   (bring small notebook to lab)

5. Read Dillard excerpt available on course website
   (for Wednesday)

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Transpiration and Photosynthesis

**Photosynthesis**: \[ \text{CO}_2 + \text{H}_2\text{O} + \text{energy} \rightarrow \text{Glucose} + \text{O}_2 \]

**Aerobic Respiration**: (Producers and Consumers)

\[ \text{(C}_6\text{H}_{12}\text{O}_6) + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{energy} \]

\[ \text{Glucose} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{(ATP)} \]
Leopold

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

“In wildness is the salvation of the world”
-Thoreau

“trimming the herd to fit the range”
-carrying capacity

Scale in both space and time
Relate Aldo Leopold’s writing to *Ishmael*

The World Belongs to Man vs.
Man Belongs to the World

Leavers vs. Takers

- Human hubris

1887-1948

http://www.aldoleopold.org/Biography/Biography.htm

Aldo Leopold Foundation
“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

-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

Aldo Leopold Land Ethic

-land ethic enlarges the community to include biota

-processes
-evolutionary/ecological biology

-What is “land-health?”
“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)

Invasives:
Buffel grass
Bullfrog
Brown Tree Snake
Tamarisk
Cane Toad
Electrical Outages: Approximately every third day there is a snake-caused power outage somewhere on Guam. While most of these affect a limited area, some are widespread or island-wide blackouts. Everything from school lighting, computers used by retail outlets, traffic signals, to refrigeration of perishable goods are subject to these power interruptions. The costs due to direct damages and lost productivity are conservatively estimated at $1-4 million dollars each year.
Female can carry fertilized eggs 7 years after mating.

Jack Russel terriers in Guam to detect snakes before leave island.
The **Brown Tree Snake** (*Boiga irregularis*) was accidentally introduced to Guam in the late 1940’s or early 1950’s on U.S. military cargo. The native range of the snake is Northeastern Australia, New Guinea and some of the islands around New Guinea. It is thought that the Guam snakes originated from the island of Manus, a small island in the Solomons.

By the late 1950’s/early 1960’s it was well known that Guam had a snake population, often referred to as the "Philippine Rat Snake". What was not known was the devastating effect this introduced snake was having on Guam’s native species, especially birds.

Not having evolved with a nighttime arboreal (tree climbing) predator, the native birds had no behavioral or physical defenses. As a result, birds began disappearing with the smaller species being affected first. By the mid 1980’s, 9 of 11 native forest birds were gone from Guam’s forests. Two of these birds, the Micronesian Kingfisher and the Guam Rail, were found only on Guam (endemic) and to this day only exist in zoos. Guam’s forests had become silent.

Due to the loss of bird life, insect populations are much higher on Guam (many birds eat insects). Because many birds pollinate plants and spread seeds, Guam will probably exhibit vegetation changes in the forests. Guam is rightly termed one of the modern day eco-disasters.
Levels of Biological Organization.

Scaling.

- Organism

- Population

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

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

What ecological concepts does the figure to the right illustrate?

Niche:
Ecological role of a species in a community
Niche vs. Habitat

Occupation vs. address

-Tolerance to physical and chemical conditions
-Types and amounts of resources used
-Interactions with biotic and abiotic environment
-Role in energy and matter cycling

Generalist vs. Specialist

Narrow niches:

1. red-cockaded woodpeckers
2. giant pandas

Niche

Figure 5-6: Overlap of the niches of two different species: a specialist and a generalist. In the overlap area the two species compete for one or more of the same resources. As a result, each species can occupy only a part of its fundamental niche and thus occupy its realized niche. Generalist species have a broad niche (right), and specialist species have a narrow niche (left).

Miller 2003
Cockroaches, Amazing Generalists

Cockroaches, the bugs many people love to hate, (1) have been around for about 350 million years and (2) are one of the great success stories of evolution. The major reason they are so successful is that they are generalists. The ability of cockroach species to (1) eat almost anything (including algae, dead insects, fingernail clippings, salts in tennis shoes, electrical cords, glue, paper, and soup) and (2) live on and breed almost anywhere except in polar regions. Some species can (3) go for months without food, (4) survive for a month on a drop of water from a dishpan, and (5) withstand huge doses of radiation. One species can survive being frozen for 48 hours. They usually can evade their predators and a human foot in hot pursuit because (1) the antennae of most cockroach species can detect minute movements of the air, (2) they have vibration sensors in their knee joints, and (3) their response times are lightning-fast (faster than you can blink). Some cockroaches can stay alive for several days in an oven at 150 degrees. They have high reproductive rates. In only a year, a single Asian cockroach can give rise to about 10 million new cockroaches to the world. Their high reproductive rate also helps them quickly develop genetic resistance to almost any poison thrown at them.

Logistic growth (S vs. exponential J)

Population growth limited at Carrying capacity (K)

Fig 4-6,7,8 in Miller 2005
\[ r = \text{intrinsic rate of increase} \]

Rate that population could grow with unlimited resources

“\( r \)-selected” organisms:
1. Reproduce early and often
2. Short generation times
3. Many offspring

\[ K = \text{carrying capacity} \]

1. Limited by
   - resources
   - competition
   - predators

Therefore have intraspecific competition.

**r-selected** Rabbits in Victoria, Australia

1859 -- European Rabbits (12 pairs) introduced on ranch

1900 - Hundreds of millions of rabbits
Rangeland destruction

1950 - Myxoma virus introduced
99.8% mortality
recovery then 80% mortality
recovery then 50% mortality

recovery resistant
millions and millions

What ecological concepts does the figure to the right illustrate?

Species Interactions
1. Competition
2. Predation
3. Parasitism
4. Mutualism
5. Commensalism

Intraspecific vs. Interspecific Competition
- migration
- adaptation
- extinction

Resource Partitioning
- time, space, method

Warblers in Maine
-diff location in spruce and diff prey species

Miller, 2003
1. Competition

*Anolis*

*Pisaster* (predatory sea star)
Paine
15 vs. 8 spp.
(mussels)

http://www.washington.edu/research/pathbreakers/1969g.html
2. Predation
3. Parasitism

4. Mutualism

See 4-2 in Miller 2003
5. Commensalism

Florida

Ecuador

Bromeliads

Mistletoe in Mesquite (Bisbee, AZ)
Indicator Species
- migratory birds
- amphibians

Keystone Species
- top predators
- key pollinators

Umbrella Species
- their protection helps protect other components of ecosystem

Native Species
vs.
Nonnative, exotic, alien

Ecological Succession

1. Primary
bare rock -->
“climax community?”

2. Secondary

- diversity
- structure
- niches
- nutrient cycling
- energy flow
- disturbance

Figure 4.4: Starting from ground zero, primary ecological succession over several hundred years of plant communities on bare rock exposed by melting glaciers on Isle Royale in northern Lake Superior.

Miller, 2003
EVOLUTION: A Series of Seven Lectures Exploring our World and Ourselves

Location: Center for Creative Photography Auditorium, 1030 North Olive Road
Parking is available in the Park Avenue Garage
Time: All lectures begin at 7:00 pm

All the sciences, from astronomy to biology, have worked together to discover the processes that create the current state of our universe, our world and ourselves. These evolutionary processes define the origin of the atoms that make up all matter, the origin of stars and planets, and the development of life itself.

The University of Arizona College of Science is proud to present these seven lectures. Each will illustrate this vision of evolution and demonstrate how we know that evolution represents reality.

Tuesday, February 21. Biological Evolution: What It Is and What It Isn't (Joanna Masel, Assistant Professor, EEB)
Tuesday, March 7. Cosmic Evolution: From Big Bang to Biology (Chris Impey, Distinguished Professor, Astronomy)
Tuesday, March 21. Earth Evolution: The Formation of Our Planet (Joaquin Ruiz, Dean of COS and Professor, Geosciences)
Tuesday, March 28. Social Evolution: Cooperation and Conflict From Molecules to Society (Rick Michod, Professor, EEB)
Tuesday, April 11. Animal Evolution: Recycling Ancient Genes For New Uses (Lisa Nagy, Associate Professor, MCB)
Tuesday, April 18. Human Evolution: Tracking Our Origins with DNA (Michael Hammer, Research Scientist, ARL/EEB)
Tuesday, April 25. Disease Evolution: The Example of HIV (Michael Worobey, Assistant Professor, EEB)

Call 520.621.4090 or go to cos.arizona.edu for more information.

Speaker Series Tomorrow!

Please join us at the kick off of our Speaker Series with Peter Warshall

"The Sky Island Legacy: An Introduction to the Region and Its Major Conservation Issues"

Sky Island Alliance is hosting a speaker series that will run from January-May 2006 with a speaker event each month. Our first event will be held on

Wednesday, January 18th
at the University of Arizona Rogers College of Law,
1201 E. Speedway Blvd. Room 140
(Please note the room change)

The presentation will begin at 6 p.m. with an opportunity to ask questions and interact with our speaker afterward. Free. Call Sky Island Alliance 624-7080 x209 for more information.

With an academic background in biology and anthropology, Warshall works globally with highly diverse people and ecosystems. His expertise includes natural history, natural resource management (especially watersheds, wastewater, and wildlife), conservation biology, biodiversity assessments, environmental impact analysis, and conflict resolution and consensus building between divergent economic and cultural special interest groups. He has worked in Africa for various organizations and in Arizona for several Native American tribes and as an adjunct research scientist with the Office of Arid Lands Studies (University of Arizona). Warshall has a special interest in producers of commodities (loggers, farmers, ranchers, fishermen, miners) as they are the link between the materials flows of our economy and the natural world.

In addition to his role as Editor-At-Large with Whole Earth, he is Sky Island Alliance's newest board member and is the founder of Peter Warshall and Associates, a consulting firm specializing in complex economic/ecological systems, especially those that impact water resources and wildlife populations. He has written two major articles on Sky Island ecology and biogeography and is an expert on the Mt. Graham Red Squirrel. He is also the current Research Director on Pinaleno Inventory.

We hope to see you there!

Our next speaker event will be on February 15th, with speaker Guy McPherson from the University of Arizona discussing Land Use and Ecology in the Sky Islands.