1. Annie Dillard
2. Populations $\rightarrow$ Ecosystems

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

5. Discussion of Biodiversity and Extinctions on Friday in lecture, read Costanza 1997 for Monday

AZDStar 29 Jan 2006
Logistic growth (S vs. exponential J)

Population growth limited at Carrying capacity (K)

Fig 4-6,7,8 in Miller 2005
r = 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 = carrying capacity

1. Limited by
   - resources
   - competition
   - predators

Therefore have intraspecific competition.

Darwin and elephants

There is no exception to the rule that every organic being naturally increase at so high a rate that if not destroyed, the earth would soon be covered by the progeny of a single pair .... The Elephant is reckoned to be the slowest breeder of all known animals, and I have taken some pains to estimate its probable minimum rate of natural increase: it will be under the mark to assume that it breeds when thirty years old, and goes on breeding till ninety years old, bringing forth three pairs of young in this interval; if this be so, at the end of the fifth century there would be alive fifteen million elephants, descended from the first pair - (Darwin, 1859, On the Origin of Species, p.64)

Shortly after this, the eminent physicist William Thompson (later Lord Kelvin) pointed out that Darwin got the math wrong. After about 500 years, there should only be about 16 thousand elephants, not 15 million. Indeed, the engineer Fleeming Jenkin referred to another of Darwin's calculations as guessing at the half and multiplying by two (Fide Burchfield, 1990 p.74). The basic problem, however, remains, a few elephants can produce lots of elephants.
Annie Dillard 1974
Pilgrim at Tinker Creek

Fecundity
- Reproduction
- Exponential Growth
- 9,000 vs. 3 train engines
  “It’s a hell of a way to run a railroad”
- Animal vs. Plant
  - Age of Reproduction
  - Role of old age?
    Gall gnat (fly)
    Miastor (fly)
  - Aphids (1/10 inch long)
    in one year 2,500 light years
- Role of the individual?
- What evolves? Is death necessary?
- Emotions and values (humans vs. nature)

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

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

Nemo?
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
Distribution of Organisms ~Community Composition

Figure 2-16 Range of tolerance for a population of organisms to an abiotic environmental factor—in this case, temperature. Miller, 2003

Range of tolerance of abiotic factor(s)

Distribution and Abundance

Terrestrial Ecosystems
- Sunlight
- Temperature
- Precipitation
- Wind
- Latitude (distance from equator)
- Altitude (distance above sea level)
- Fire frequency
- Soil

Aquatic Life Zones
- Light penetration
- Water currents
- Dissolved nutrient concentrations (especially N and P)
- Suspended solids

Figure 4-12 Key physical and chemical or abiotic factors affecting terrestrial ecosystems (left) and aquatic life zones (right). Miller 2003
Terrestrial Biomes

(Forest, Desert, Grassland, Tundra, etc.)

Biotic (~Vegetative) Communities

Climate
1. Temperature
2. Precipitation
3. Soil type

- Latitude
- Altitude
Biomes

Figure 6-18: Generalized effects of latitude (right) and altitude (left) on climate and biomes. Parallel changes in vegetation type occur when we travel from the equator to the poles or from lowlands to mountaintops.

Terrestrial Biomes

Figure 24: The world’s major biomes—the main types of natural vegetation in different undisturbed land areas—are usually affected by differences in climate and other environmental factors. In some areas, people have also affected biomes by removing or changing much of the natural vegetation for farming, livestock grazing, lumber and fuelwood, mining, and construction.
Other Correlates of Diversity

- Intermediate Disturbance
  (shifting mosaic, no climax)

- Habitat Heterogeneity
  (e.g., foliage height and birds)

“I felt a great disturbance in the Force, as if millions of voices suddenly cried out in terror and were suddenly silenced.” - Obi Wan, 1977
Aquatic and Marine Environments

A. Salinity

B. Layers:
1. Temperature
2. Sunlight
3. Dissolved O₂
4. Nutrients
   - carbon
   - nitrogen (nitrate)
   - phosphorus (phosphate)

Marine Environments

71% earth’s surface is ocean

costal vs. open sea

1. Estuaries
2. Coastal Wetlands
   - mangroves
   - salt marshes
3. Coral Reefs

- Role of sunlight
- Not very productive per unit area
- Lots total NPP
Aquatic Environments

Only 1% earth’s surface:

1. Lakes
   - oligotrophic
   - eutrophic
   nutrients, clarity, NPP

2. Streams
   - Watershed
   - Runoff
   - Erosion

3. Rivers

4. Inland Wetlands
   Marshes, swamps, floodplains

Marine Environments
Aquatic Environments

- oligotrophic

- eutrophic

Freshwater Ecosystem Services

*Figure 3-18 Natural capital: major ecological and economic services provided by freshwater systems.*
**Marine Ecosystem Services**

![Diagram showing Marine Ecosystem Services and Natural Capital](image1)

Figure 3-15 Natural capital: major ecological and economic services provided by marine systems.

**Marine Ecosystem Degradation**

![Diagram showing Marine Ecosystem Degradation and Natural Capital Degradation](image2)

Figure 3-17 Natural capital degradation: major human impacts on the world's marine systems.

Miller 2005

Half of coastal wetlands lost to agriculture and urban development

Over one-third of mangrove forests lost since 1980 to agriculture, development, and aquaculture shrimp farms

About 10% of world's beaches eroding because of coastal development and rising sea level

Ocean bottom habitats degraded by dredging and trawler fishing boats

Over 25% of coral reefs severely damaged and 11% have been destroyed

Miller 2005
Human Ecosystem Modifications:

1. Degrade and fragment habitat
2. Simplify (monocultures)
3. Removing large percentage of NPP from biosphere
4. Pests and disease (also pesticides, antibiotics etc.)
5. Eliminating top predators
6. Introducing nonnative species
7. Overharvesting
8. Altering chemical cycling and energy flow

How would you respond to the statement:
“We should not worry about air pollution because through natural selection the human species will develop lungs that can detoxify pollutants.” - Miller 2005 p.62

-Generation time
-Variability
-Strength of selection

Define FITNESS.
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.