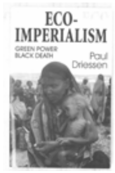
Lecture 05, 04 Sept 2007
Leopold, Biodiversity

Conservation Biology
ECOL 406R/506R
University of Arizona
Fall 2007

Kevin Bonine
Cathy Hulshof



Upcoming Readings
today: Leopold readings, Text Ch. 4, Costanza et al. 1997, Driessen 2004
Thurs 06 Sept: Walther et al. 2002, Peak Oil Link, (optional: National Geographic)
Tues 11 Sept: Text Ch. 4, and pp. 207-213

Conservation Biology Lab 406L/506L

Next Lab Friday 07 September
1230 S or W side BSE
(4th and Highland)
Hat, water, sunscreen, close-toed shoes
Readings on Course Website

07 September - Sabino Canyon
VAN
Flooding, Wilderness, Forest
Management, Nuisance Wildlife

Especially relevant for 506 students:

Conservation Seminar

If you are interested in participating in the Conservation Seminar (RNR696a – but you don't need to enroll) please attend Wednesday at 3:30 in BSE 218.

Chris McDonald
cmcdon@email.arizona.edu
(contact for readings)

Public Water Lecture with Peter Gleick

Fresh water availability is a growing issue of concern across the world, butno where more than in arid lands. Tucson is no exception.

Will projections of our water supply in the distant future - even in the next decade or two - be accurate? How will prolonged drought affect both water quantity and quality? What impacts will water supply have on the region's economic viability?

Sustainable Tucson is co-host of a public lecture by international water expert, Peter Gleick, along with the Water Resources Research Center (WRRC) and Institute for the Study of Planet Earth (ISPE) at the University of Arizona, and the Southern Arizona Leadership Council (SALC).

A **MacArthur Fellow** and widely published in leading scientific journals, Dr. Peter Gleick is one of the world's top experts on the impacts of climate change on water supply. His work with communities and governments across the Southwest and the world brings a broad perspective to the local discussion.

How can we define **sustainable water policies**, based on sound laws and science? To what extent will water transfers and markets - the economics of shifting water - help us reconcile growth and supplies which are limited, keeping in mind that global warming, as well as land-use changes, will likely affect both surface and groundwater systems?

Sustainable Tucson believes Dr. Gleick's vision can help inform local planning by bringing the experience of many communities to bear on Tucson's creative solutions to long-term water security.

Dr. Gleick will address water experts and other leaders at the Arizona Hydrologic Society's regional conference, "Sustainable Water, Unlimited Growth, and Quality of Life: Can We Have It All?" to be held August 27 – 30 in Tucson.

The joint planning of this public lecture amongst university departments, civic, business, and community groups, points to exciting new dialogue over water and sustainability taking place in our community.

The lecture will take place in **Tucson on August 30, at 7:30 p.m. at Temple Emanu-El - 225 N. Country Club Rd.**

Contact Madeline Kiser (mkiser@dakotacom.net)
or Susan Williams (susanleewilliams@cox.net) for more information.

Debate 20 Sept 2007:
Should the flat-tailed horned lizard (*Phrynosoma mcallii*) be ESA listed?

Slight Schedule Change:

Three groups – one will debate, another will evaluate, third will observe, then we rotate.

406	506
Debate 1 (20 Sept.)	Debate 1 (20 Sept.)
Group A debate	506 A assist
Group B evaluate	506 B assist
Group C observe	506 C observe
Debate 2 (23 Oct.)	Debate 2 (23 Oct.)
Group A observe	506 A observe
Group B debate	506 B assist
Group C evaluate	506 C assist
Debate 3 (15 Nov.)	Debate 3 (15 Nov.)
Group A evaluate	506 A assist
Group B observe	506 B observe
Group C debate	506 C assist

AZDStar 03 Sept 2007


'And God created humankind in God's image ... having dominion* over the earth.'

Genesis 1

Faith goes green

By Stephanie Innes

With a belief that they must speak out for the silent, some people of faith in Tucson are giving a voice to Mother Nature.

Fueled by heightened media attention to global warming, worshippers and congregations are turning their attentions to the environment. They view protecting the Earth as a justice issue, infusing it with a passion that many historically devoted to ending racial, gender and economic inequality.

Nationally, the Sierra Club

See CHURCHES, A4

On StarNet: Read StarNet's "Desert Beliefs" blog for more coverage of faith and values at go.azstarnet.com/desertbeliefs

* Some theologians and religious leaders say the word 'dominion' should not be understood as a license to dominate and exploit nature, but rather as a vocation of stewardship of the Earth.

AZDStar 03 Sept 2007

Student gov't goals: ecology, book costs

UA leader hopes ASUA will be seen as more relevant

By Eric Swedlund
ARIZONA DAILY STAR

Finding ways to make the campus more environmentally sustainable and continuing work to reduce the cost of textbooks highlight this year's student government agenda at the University of Arizona.

Building on past student government work on solar energy, one major goal is to establish a university committee on sustainability to review what can be done in the areas of improved recycling, "green" roofs, solar energy and water runoff, said

Tommy Bruce, UA student body president

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

-Leopold

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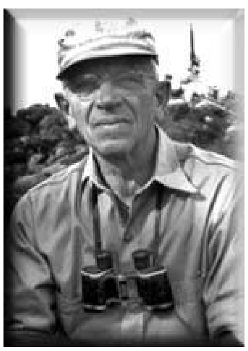
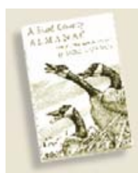
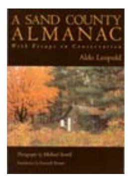
1887-1948







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

Aldo Leopold Foundation

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Aldo Leopold:

Thinking Like a Mountain
Escudilla

The Land Ethic

The Outlook for Farm Wildlife
The Land-Health Concept and Conservation

10

Aldo Leopold

"An ethic, ecologically, is a limitation on freedom of action in the struggle for existence.

An ethic, philosophically, is a differentiation of social from anti-social conduct."
(p. 238)

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Aldo Leopold Land Ethic

-social evolution (social disapproval for wrong actions)
-land ethic enlarges the community
to include biota

-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

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Leopold Land Ethic

-Property vs. propriety

-Role of land [biology] in human history
(Diamond, Guns Germs and Steel)

-Sacrifice
-Obligation of private landowner
-Livestock, Violence

-Economics?
Farm as Factory or Place to Live?

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Aldo Leopold Land Ethic

-What is "land-health?"

-processes
-evolutionary/ecological biology

-complexity & quality
-invasives

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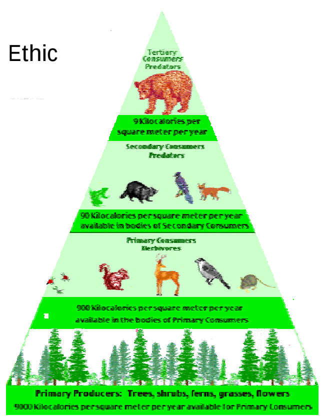
Aldo Leopold Land Ethic

-land pyramid



"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

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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?

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"In our attempt to make conservation easy we have made it trivial" (p.246)

-Leopold

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The Land-Health Concept and Conservation

Conservation is a series of ecological predictions made by beginners because ecologists have failed to offer any.

Leopold, p. 220

"Whether you will or not

You are a King, Tristram, for you are one

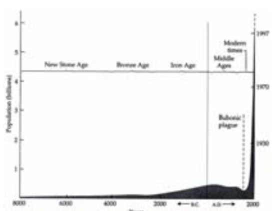
Of the time-tested few that leave the world,

When they are gone, not the same place it was.

Mark what you leave."

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

Human Population?



Discussion:

1. How do conservationists respond to the question, "What good is it?"
2. How do we verify that humans, or anything, has intrinsic value?
3. "Enclosed/Private" Goods, or "Common" Goods - Which of these is a better approach for conservation? Why?
4. What is the conservation role of the world's religions?

Costanza et al. 1997

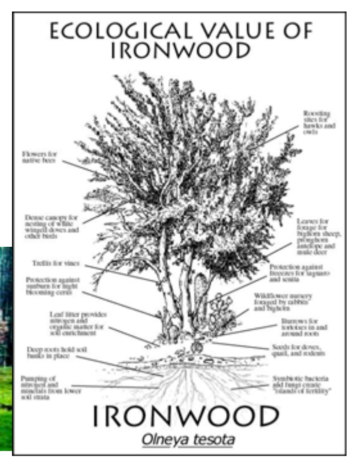
The value of the world's ecosystem services and natural capital

Robert Costanza*†, Ralph d'Arge‡, Rudolf de Groot§, Stephen Farber‖, Monica Grasso†, Bruce Hannon¶, Karin Limburg#☆, Shahid Naeem**, Robert V. O'Neill††, Jose Paruelo‡‡, Robert G. Raskin§§, Paul Sutton‖‖ & Marjan van den Belt¶¶

* Center for Environmental and Estuarine Studies, Zoology Department, and † Insitute for Ecological Economics, University of Maryland, Box 38, Solomons, Maryland 20688, USA
‡ Economics Department (emeritus), University of Wyoming, Laramie, Wyoming 82070, USA
§ Center for Environment and Climate Studies, Wageningen Agricultural University, PO Box 9101, 6700 HB Wageninengen, The Netherlands
‖ Graduate School of Public and International Affairs, University of Pittsburgh, Pittsburgh, Pennsylvania 15260, USA
¶ Geography Department and NCSA, University of Illinois, Urbana, Illinois 61801, USA
\# Institute of Ecosystem Studies, Millbrook, New York, USA
** Department of Ecology, Evolution and Behavior, University of Minnesota, St Paul, Minnesota 55108, USA
†† Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831, USA
‡‡ Department of Ecology, Faculty of Agronomy, University of Buenos Aires, Av. San Martin 4453, 1417 Buenos Aires, Argentina
§§ Jet Propulsion Laboratory, Pasadena, California 91109, USA
‖‖ National Center for Geographic Information and Analysis, Department of Geography, University of California at Santa Barbara, Santa Barbara, California 93106, USA
¶¶ Ecological Economics Research and Applications Inc., PO Box 1589, Solomons, Maryland 20688, USA

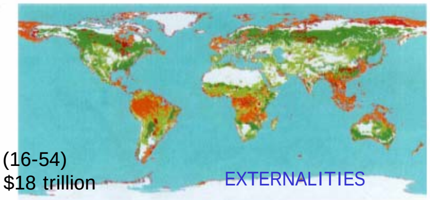
The services of ecological systems and the natural capital stocks that produce them are critical to the functioning of the Earth's life-support system. They contribute to human welfare, both directly and indirectly, and therefore represent part of the total economic value of the planet. We have estimated the current economic value of 17 ecosystem services for 16 biomes, based on published studies and a few original calculations. For the entire biosphere, the value (most of which is outside the market) is estimated to be in the range of US\$16–54 trillion (10^{12}) per year, with an average of US\$33 trillion per year. Because of the nature of the uncertainties, this must be considered a minimum estimate. Global gross national product total is around US\$18 trillion per year.

Lesser long-nosed bat (*Leptonycteris curasoae*) pollinating saguaro flower (*Carnegia gigantea*)



Costanza et al. 1997

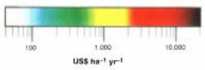
Figure 2 Global map of the value of ecosystem services. See Supplementary Information and Table 2 for details.



$33 trillion/yr (16-54)
Global GNP = $18 trillion

EXTERNALITIES

[excluded non-renewable]



Gas regulation $1.3 trillion
Disturbance reg. $1.8 trillion
Waste treatment $2.3 trillion
Nutrient cycling $17 trillion

Marine Services $20.9 trillion
(coastal $10.6 trillion)
Forests $4.7 trillion
Wetlands $4.9 trillion

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Costanza et al. 1997
Table 1

Table 1 Ecosystem services and functions used in this study

Number	Ecosystem service*	Ecosystem functions	Examples
1	Gas regulation	Regulation of atmospheric chemical composition.	CO_2/O_2 balance, O_3 for UVB protection, and SO_x levels.
2	Climate regulation	Regulation of global temperature, precipitation, and other biologically mediated climatic processes at global or local levels.	Greenhouse gas regulation, DMS production affecting cloud formation.
3	Disturbance regulation	Capacitance, damping and integrity of ecosystem response to environmental fluctuations.	Storm protection, flood control, drought recovery and other aspects of habitat response to environmental variability mainly controlled by vegetation structure.
4	Water regulation	Regulation of hydrological flows.	Provisioning of water for agricultural (such as irrigation) or industrial (such as milling) processes or transportation.
5	Water supply	Storage and retention of water.	Provisioning of water by watersheds, reservoirs and aquifers.
6	Erosion control and sediment retention	Retention of soil within an ecosystem.	Prevention of loss of soil by wind, runoff, or other removal processes, storage of silt in lakes and wetlands.
7	Soil formation	Soil formation processes.	Weathering of rock and the accumulation of organic material.
8	Nutrient cycling	Storage, internal cycling, processing and acquisition of nutrients.	Nitrogen fixation, N, P and other elemental or nutrient cycles.
9	Waste treatment	Recovery of mobile nutrients and removal or breakdown of excess or xenic nutrients and compounds.	Waste treatment, pollution control, detoxification.
10	Pollination	Movement of floral gametes.	Provisioning of pollinators for the reproduction of plant populations.
11	Biological control	Trophic-dynamic regulations of populations.	Keystone predator control of prey species, reduction of herbivory by top predators.
12	Refugia	Habitat for resident and transient populations.	Nurseries, habitat for migratory species, regional habitats for locally harvested species, or overwintering grounds.
13	Food production	That portion of gross primary production extractable as food.	Production of fish, game, crops, nuts, fruits by hunting, gathering, subsistence farming or fishing.
14	Raw materials	That portion of gross primary production extractable as raw materials.	The production of lumber, fuel or fodder.
15	Genetic resources	Sources of unique biological materials and products.	Medicine, products for materials science, genes for resistance to plant pathogens and crop pests, ornamental species (pets and horticultural varieties of plants).
16	Recreation	Providing opportunities for recreational activities.	Eco-tourism, sport fishing, and other outdoor recreational activities.
17	Cultural	Providing opportunities for non-commercial uses.	Aesthetic, artistic, educational, spiritual, and/or scientific values of ecosystems.

*We include ecosystem 'goods' along with ecosystem services.

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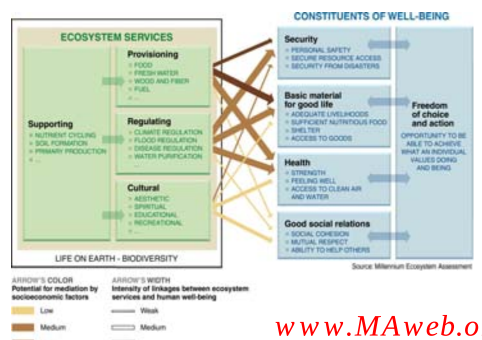
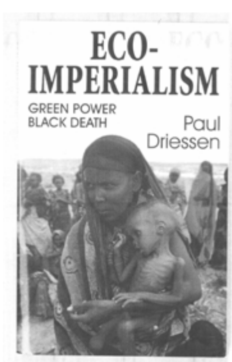
Costanza et al. 1997 Table 2

Millenium Ecosystem Assessment

Focus: Consequences of Ecosystem Change for Human Well-being



www.MAweb.org



2004

5

Sustainable Mosquitoes – Expendable People

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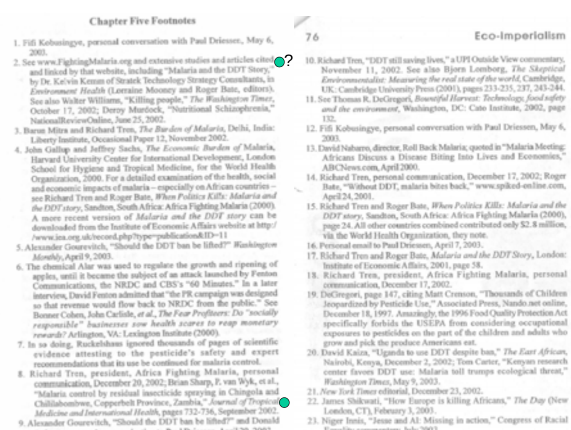

Biodiversity (Biological Diversity)

"structural and functional variety of life forms at genetic, population, community, and ecosystem levels"

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Nothing in biology makes sense except in the light of evolution.

THEODOSIUS DOBZHANSKY

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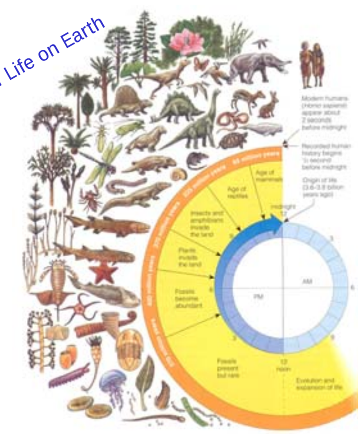
Evolution of Life on Earth



Miller 2003

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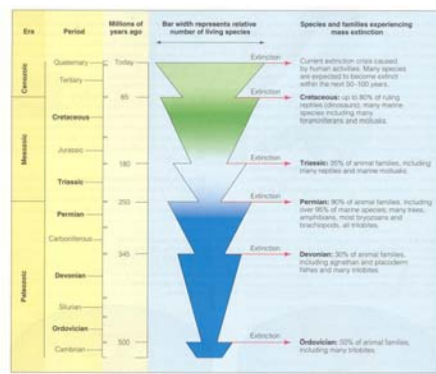


Miller 2003

Major Extinction Events

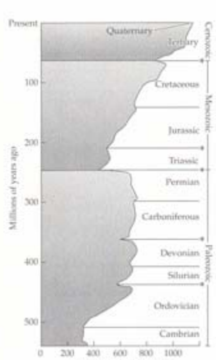


Figure 2.5 Diversity of marine families from the Cambrian to the present. The asterisks mark the five major mass extinction events.

Groom et al. 2006

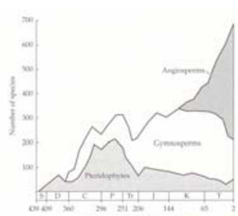


Figure 2.6 Terrestrial plant species richness. Ferns, gymnosperms, and angiosperms have, in turn, dominated the world's flora. (Modified from Signor 1990.)

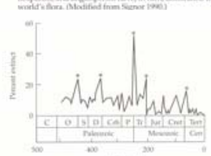
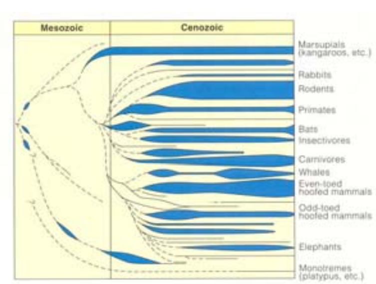


Figure 2.7 Extinctions of families through geologic time. The five historical mass extinction events are marked with an asterisk.

Adaptive Radiation

Figure 5-10 Adaptive radiation of mammals began in the first 10–12 million years of the Cenozoic era (which began about 65 million years ago) and continues today. This evolution of a large number of new species is thought to have resulted when huge numbers of new and vacated ecological niches became available after the mass extinction of dinosaurs near the end of the Mesozoic era. (Used by permission from Cecie Starr and Ralph Taggart, *Biology: The Unity and Diversity of Life*, 8th ed., Belmont, Calif.: Wadsworth, 1998)

Miller 2003



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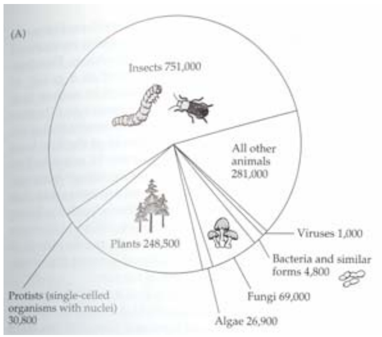
What is biodiversity?



Primack 2006, Fig 3.6

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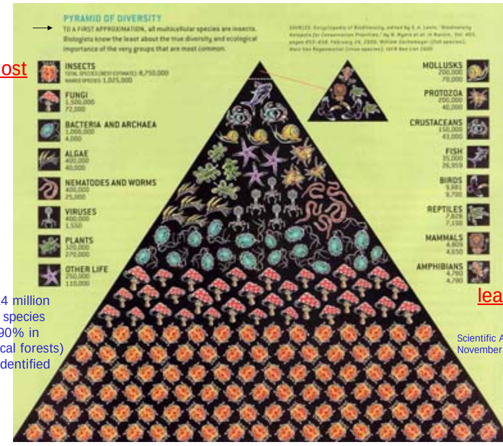


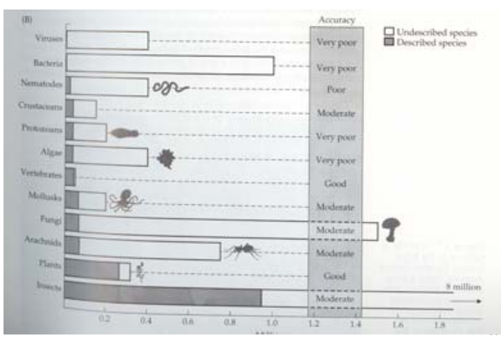
most

least

~12-14 million
total species
(50-90% in
tropical forests)
~1.7 identified

Scientific American
November 2001

How many species on earth?



Primack 2006, Fig 3.6

Research Focus?

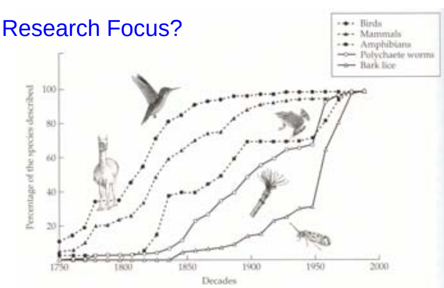


FIGURE 3.10 For five groups of Chilean animals, the cumulative percentage of the known species described from 1750 to 2000. Note that the majority of birds and mammals were largely described by 1900, and probably few new species remain to be discovered. In contrast, polychaete worms and bark lice were largely neglected by early taxonomists and are only now being investigated and described. Amphibians are intermediate in their intensity of study. (After Primack et al. 2001.)

Primack 2006

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Mother Nature's DNA

The Human Genome Project has not cured any diseases yet—but it's revolutionizing

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Biodiversity

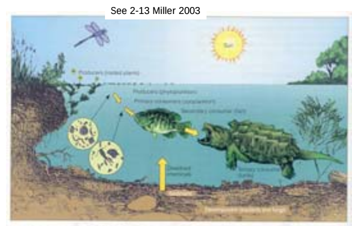
1. Genetic
   (nat. sel.)

2. Species

3. Ecological
   forests, deserts, lakes, wetlands, reefs etc.

4. Functional
   energy flow
   nutrient cycling
   etc.

See 2-13 Miller 2003



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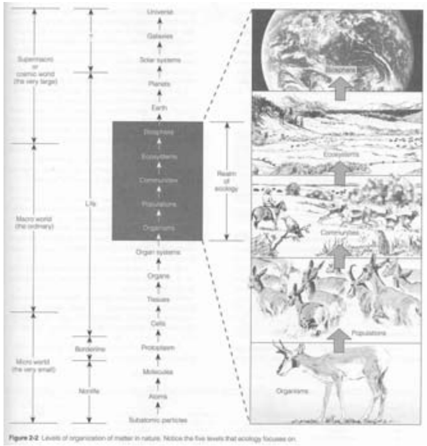
Levels of Biological Organization.

Scaling.



Miller, 2003

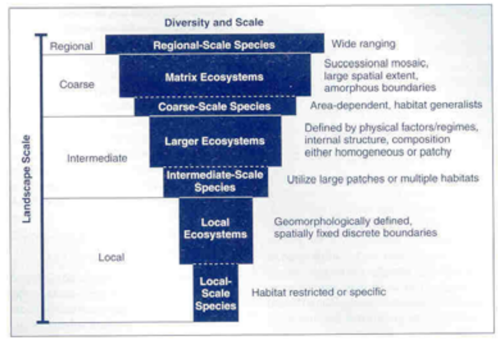


Figure 4.15 Van Dyke 2003

Biodiversity and scale. A method of categorizing biodiversity at regional, coarse, intermediate, and local geographic scales.

Modified from Poiani et al. (2000). © 2001 American Institute of Biological Sciences.

Groom et al. 2006

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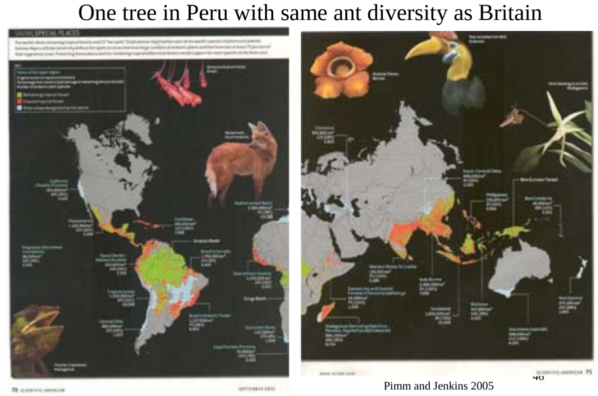
Where is biodiversity?

One tree in Peru with same ant diversity as Britain



Pimm and Jenkins 2005

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Species Richness and Latitude

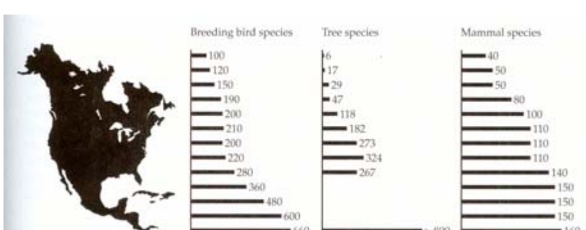

FIGURE 3.5 In North America, as in all the continents, the numbers of bird, tree, and mammal species increase toward the Tropics. The numbers of species indicated in the bar graphs correspond to latitude in the map at left. Tree species diversity is not available for some lower latitudes. (From Briggs 1995.)

Altitude?

Primack 2006

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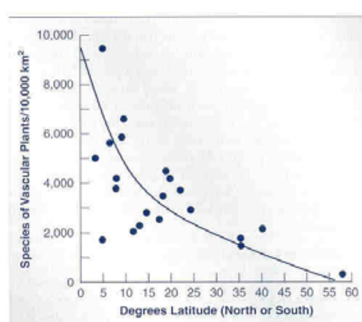

Figure 4.12

Latitudinal patterns in species richness from tropical to temperate regions. In most taxa the number of species increases from temperate to tropical regions. Van Dyke 2003

After Reid and Miller (1989). Reprinted from Huston (1994).

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