
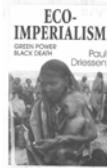


Lecture 05, 04 Sept 2007
 Leopold, Biodiversity

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

Kevin Bonine 
 Cathy Hulshof



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



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

1

2

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)

3

Public Water Lecture with Peter Gleick

Fresh water availability is a growing issue of concern across the world, but nowhere 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.**

4

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

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

406

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

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

5

AZDStar 03 Sept 2007



6

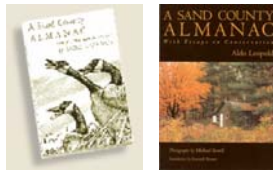


"Objectivity is only possible in matters too small to be important, or in matters too large to do anything about." (p. 226)

-Leopold

8

1887-1948



<http://www.aldoleopold.org/Biography/Biography.htm>
Aldo Leopold Foundation

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)

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

11

12

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?

13

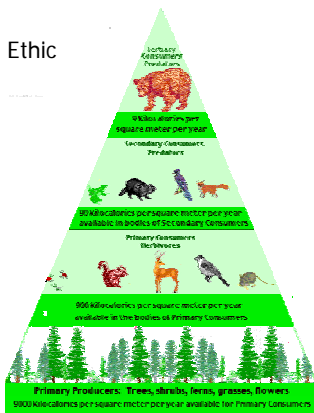
Aldo Leopold Land Ethic

- What is "land-health?"
- processes
- evolutionary/ecological biology
- complexity & quality
- invasives

14

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

16

Leopold

Thinking like a mountain
" a mountain lives in mortal fear of its deer"

Escudilla
progress?
"It's only a mountain now."

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

-Leopold

The planet will survive, will we?

17

18

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,

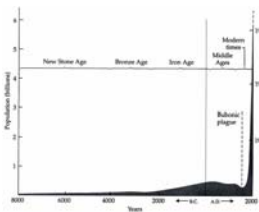
When they are gone, not the same place it was.

Mark what you leave."

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

19

Human Population?



21

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?

22

Costanza et al. 1997

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

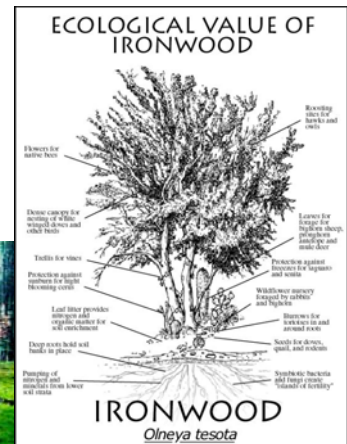
Robert Costanza¹, Ralph d'Arge², Rudolf de Groot³, Stephen Farber⁴, Monica Grasso⁵, Bruce Hannon⁶, Karin Limburg⁷, Shahid Naeem⁸, Robert V. O'Neill⁹, Jose Paruelo¹⁰, Robert G. Raskin¹¹, Paul Sutton¹², S. Marjan van den Belt¹³

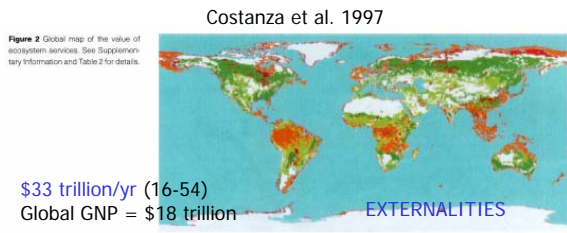
¹ Center for Environmental and Estuarine Studies, Zoology Department, and 1 Institute for Ecological Economics, University of Maryland, Box 38, Solomons, Maryland 20688, USA
² Economics Department (emeritus), University of Wyoming, Laramie, Wyoming 82070, USA
³ Center for Environment and Climate Studies, Wageningen Agricultural University, PO Box 9101, 6700 HB Wageningen, The Netherlands
⁴ Graduate School of Public and International Affairs, University of Pittsburgh, Pittsburgh, Pennsylvania 15260, USA
⁵ Geography Department and NCSA, University of Illinois, Urbana, Illinois 61801, USA
⁶ Institute of Ecological Studies, Middlebury, New York, USA
⁷ Department of Ecology, Evolution and Behavior, University of Minnesota, St Paul, Minnesota 55108, USA
⁸ Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37832, USA
⁹ Department of Ecology, Faculty of Agronomy, University of Buenos Aires, Av. San Martin 4453, 1417 Buenos Aires, Argentina
¹⁰ Jet Propulsion Laboratory, Pasadena, California 91109, USA
¹¹ National Center for Geographic Information and Analysis, Department of Geography, University of California at Santa Barbara, Santa Barbara, California 93106, USA
¹² Ecological Economics Research and Applications Inc., PO Box 1588, 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\$16-94 trillion (10¹²) 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 (*Carnegiea 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. \$2.3 trillion
Waste treatment \$2.8 trillion
Nutrient cycling \$17 trillion

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

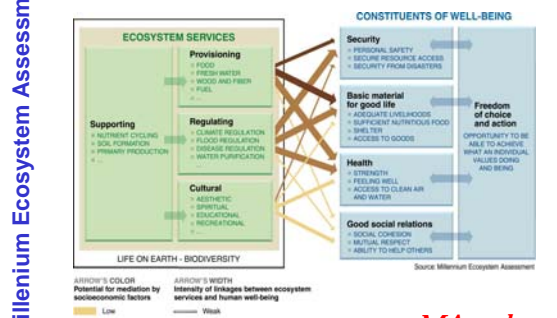
Table 1 Ecosystem services and functions used in this study

Number	Ecosystem service	Ecosystem function	Examples
1	Gas regulation	Regulation of atmospheric chemical composition	CO ₂ , CH ₄ , nitrous oxide, and SO ₂ levels
2	Climate regulation	Regulation of global temperature, precipitation, and other long-term climate processes at global or local scales	Greenhouse gas regulation, ozone production affecting ozone formation
3	Disturbance regulation	Degradation, damping and/or storage of ecosystem responses to environmental fluctuations	Storm protection, flood control, drought recovery and other aspects of resilience responses to environmental fluctuations
4	Water regulation	Regulation of hydrological flows	Prevention of water for agriculture and drinking or industrial (such as mining) processes as hydrological regulation
5	Water quality	Storage and retention of water	Prevention of water for agriculture, recreation and drinking
6	Erosion control and sediment retention	Retention of soil within an ecosystem	Prevention of loss of soil by wind, runoff, or other erosion processes; storage of soil in seas and wetlands
7	Soil formation	Soil formation processes	Weathering of rock and the accumulation of organic matter
8	Nutrient cycling	Storage, internal cycling, processing and acquisition of nutrients	Nitrogen fixation, N, P and other essential or nutrient cycles
9	Waste treatment	Removal of waste materials and removal or transformation of wastes or waste nutrients and compounds	Waste treatment, pollution control, detoxification
10	Pollination	Movement of pollen grains	Prevention of pollinators for the reproduction of plant species
11	Biological control	Trophic dynamic regulation of populations	Regulation of predator control of prey species, reduction of herbivory by top predators
12	Refuge	Habitat for resident and transient populations	Nurseries, habitat for migratory species, regional refuges for mobile forest species or nonindigenous species
13	Food production	Final portion of gross primary production extractable as food	Production of lumber, grass, meat, fish, poultry, hunting, gathering, subsistence farming or fishing
14	Raw materials	Other portion of gross primary production extractable as raw materials	The production of lumber, fuel or fiber
15	Genetic resources	Source of unique biological resources and products	Medicine, products for materials science, genes for resistance to pest pathogens and crop pests, ornamental species, genes and horticultural varieties of animals
16	Recreation	Providing opportunities for recreational activities	Ecotourism, sport fishing, and other outdoor recreational activities
17	Cultural	Providing opportunities for non-recreational uses	Aesthetics, artistic, educational, spiritual, and/or scientific values of ecosystems

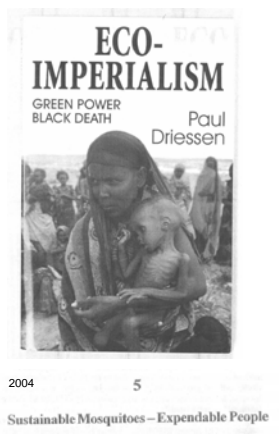
Table 2 Summary of average global value of annual ecosystem services

Service	Value (US\$ ha⁻¹ yr⁻¹)	Value (US\$ 1000 ha⁻¹ yr⁻¹)	Value (US\$ 1000000 ha⁻¹ yr⁻¹)
Gas regulation	1300	1.3	1300000
Climate regulation	2300	2.3	2300000
Disturbance regulation	2300	2.3	2300000
Water regulation	2800	2.8	2800000
Water quality	17000	17	17000000
Erosion control and sediment retention	4900	4.9	4900000
Soil formation	1300	1.3	1300000
Nutrient cycling	17000	17	17000000
Waste treatment	2800	2.8	2800000
Pollination	1300	1.3	1300000
Biological control	1300	1.3	1300000
Refuge	1300	1.3	1300000
Food production	1300	1.3	1300000
Raw materials	1300	1.3	1300000
Genetic resources	1300	1.3	1300000
Recreation	1300	1.3	1300000
Cultural	1300	1.3	1300000

Focus: Consequences of Ecosystem Change for Human Well-being



Costanza et al. 1997 Table 2



Chapter Five Footnotes

1. P. Drissen, personal conversation with Paul Drissen, May 6, 2003.
2. See www.fightingmalaria.org and extensive studies and articles cited and linked by that website, including "Malaria and the DDT Story" by Dr. Kevin Knapp of Stratix Technology Strategy Consultants, in *Environment Health* (Lorraine Mooney and Roger Bates, editors), see also Walter Williams, "Killing people," *The Washington Times*, October 17, 2002; Terry Marwick, "Nationalist Schizophrenia," *NationalReviewOnline*, June 25, 2002.
3. Basem Mitra and Richard Tren, *The Burden of Malaria*, Delhi, India: Liberty Institute, Occasional Paper 12, November 2002.
4. John Gallogly and Jeffrey Sachs, *The Economic Burden of Malaria*, Harvard University Center for International Development, London School of Hygiene and Tropical Medicine, for the World Health Organization, 2000. For a detailed examination of the health, social and economic impacts of malaria—especially on African countries—see Richard Tren and Roger Bates, *When Politics Kills: Malaria and the DDT story*, Sandton, South Africa: Africa Fighting Malaria (2000). A more recent version of *Malaria and the DDT story* can be downloaded from the Institute of Economic Affairs website at <http://www.iea.org.uk/second.php?type=publication&ID=11>.
5. Alexander Gourevitch, "Should the DDT be lifted?" *Washington Monthly*, April 9, 2003.
6. The chemical Alar was used to regulate the growth and ripening of apples, until it became the subject of an attack launched by Fenton Communications, the NRDC and CBS's "60 Minutes." In a later interview, David Fenton admitted that "the PR campaign was designed so that revenues would flow back to NREDC from the public." See Basem Mitra, John Carlson, et al., *The Fear Profiteers: Do "socially responsible" businesses save health scores to reap monetary rewards?* Arlington, VA: Lexington Institute (2000).
7. In so doing, Ruckelshaus ignored thousands of pages of scientific evidence attesting to the pesticide's safety and expert recommendations that its use be confined for malaria control.
8. Richard Tren, president, Africa Fighting Malaria, personal communication, December 20, 2002; Brian Sharp, F. van Wyk, et al., "Malaria control by residual insecticide spraying in Chipinga and Chikalombwe, Copperbelt Province, Zambia," *Journal of Tropical Medicine and International Health*, pages 732-736, September 2003.
9. Alexander Gourevitch, "Should the DDT be lifted?" and Donald Roberts, personal communication to Paul Drissen, April 29, 2003.
10. Richard Tren, "DDT will saving lives," a UPF Outside View commentary, November 11, 2002. See also Bjorn Lomborg, *The Skeptical Environmentalist: Measuring the real state of the world*, Cambridge, UK: Cambridge University Press (2001), pages 223-225, 237, 263-264.
11. See Thomas R. DeGregori, *Biowarfare: Technology, food safety and the environment*, Washington, DC: Cato Institute, 2000, page 122.
12. P. Drissen, personal conversation with Paul Drissen, May 6, 2003.
13. David Nabarro, director, Roll Back Malaria, quoted in "Malaria Meeting: African Experts a Disease Diving Into Lives and Economics," *ABCNews.com*, April 2000.
14. Richard Tren, personal communication, December 17, 2002; Roger Bates, "Without DDT, malaria bites back," www.upf-outside.com, April 24, 2003.
15. Richard Tren and Roger Bates, *When Politics Kills: Malaria and the DDT story*, Sandton, South Africa: Africa Fighting Malaria (2000), page 24. All other countries combined contributed only \$2.8 million, via the World Health Organization, they say.
16. Personal email to Paul Drissen, April 7, 2003.
17. Richard Tren and Roger Bates, *Malaria and the DDT Story*, London: Institute of Economic Affairs, 2001, page 58.
18. Richard Tren, president, Africa Fighting Malaria, personal communication, December 17, 2002.
19. DeGregori, page 147, citing Matt Cronson, "Thousands of Children Impoverished by Pesticide Use," Associated Press, Nando net online, December 18, 1997. Amazingly, the 1996 Food Quality Protection Act specifically forbids the USEPA from considering occupational exposures to pesticides on the part of the children and adults who grow and pick the produce Americans eat.
20. David Kaim, "Lights to use DDT despite ban," *The East African*, Nairobi, Kenya, December 2, 2002; Tom Carter, "Kenyan research center favors DDT use: Malaria toll trumps ecological threat," *Washington Times*, May 7, 2003.
21. *New York Times* editorial, December 23, 2002.
22. James Shikwati, "How Temper is Killing Africans," *The Day* (New London, CT), February 3, 2003.
23. Niger Inis, "Jesse and Al: Missing in action," *Congress of Racial Equality* commentary, July 2003.

Biodiversity (Biological Diversity)

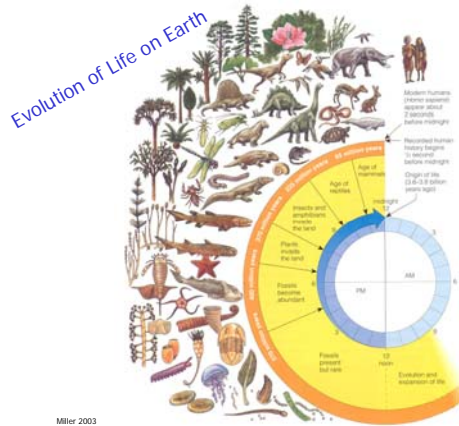
"structural and functional variety of life forms at genetic, population, community, and ecosystem levels"

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

THEODOSIUS DOBZHANSKY

31

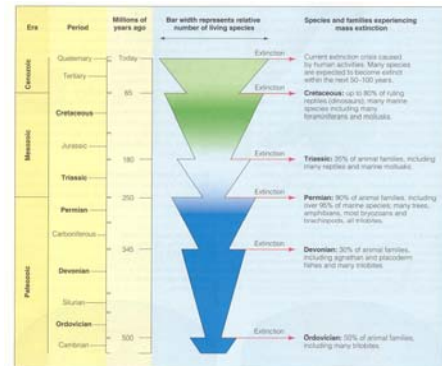
32



Miller 2003

Figure 5-3 Greatly simplified overview of the biological evolution of life on the earth, which was provided by

33



Miller 2003

Figure 5-8 Fossils and radiocarbon dating indicate that five major mass extinctions (indicated by arrows) have taken place over the past 500 million years. Mass extinctions leave large numbers of organisms that have become extinct and create new ones. As a result, each mass extinction has been followed by periods of recovery (represented by the wedge shapes) called adaptive radiations. During these periods, which last over 10 million years or more, new species evolve to fill new or vacated ecological roles (niches). Many experts believe that we are now in the midst of a sixth mass extinction, caused primarily by human activities.

Major Extinction Events

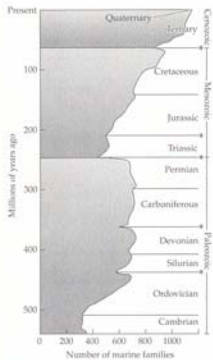


Figure 2-5 Diversity of marine families from the Cambrian to the present. The asterisks mark the five major mass extinction events.

Groom et al. 2006

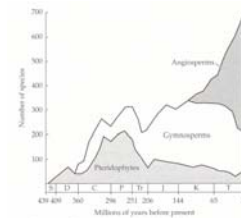


Figure 2-6 Terrestrial plant species richness. Ferns, gymnosperms, and angiosperms have, in turn, dominated the world's flora. (Modified from Steiner 1983.)

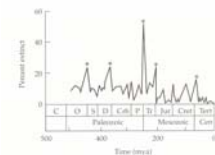
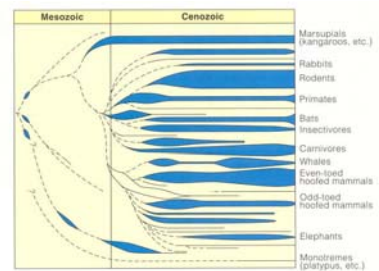


Figure 2-7 Extinctions of families through geologic time. The five historical mass extinction events are marked with an asterisk.

Adaptive Radiation

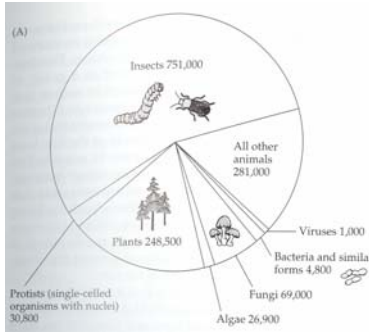
Figure 5-10 Adaptive radiation of mammals began in the first 10–12 million years of the Cenozoic era (which began about 65 million years ago) and continues today. This evolution of a large number of new species is thought to have resulted when huge numbers of new and vacated ecological niches became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

Miller 2003



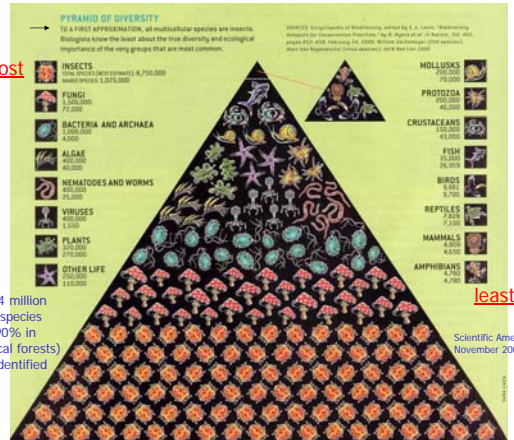
36

What is biodiversity?



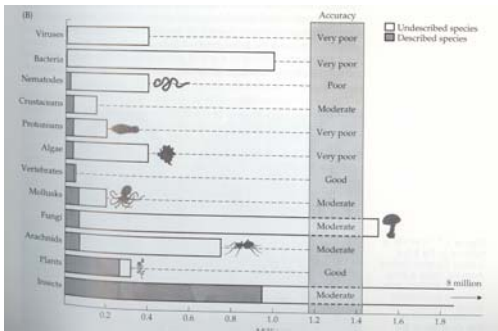
Primack 2006, Fig 3.6

37



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

How many species on earth?



Primack 2006, Fig 3.6

Research Focus?

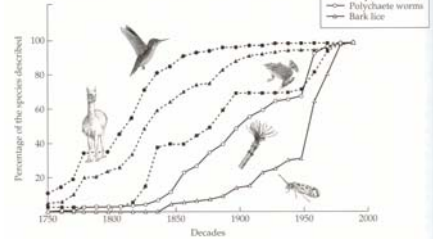


FIGURE 3.10 For five groups of Chilean animals, the cumulative percentage of the known species described from 1750 to 2000. Note that the majority of birds and mammals were largely described by 1900, and probably few new species remain to be discovered. In contrast, polychaete worms and bark lice were 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

40



41

Biodiversity

1. Genetic (nat. sel.)

2. Species

3. Ecological

forests, deserts, lakes, wetlands, reefs etc.

4. Functional

energy flow
nutrient cycling
etc.

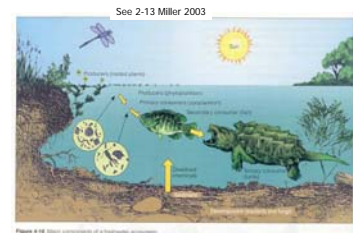
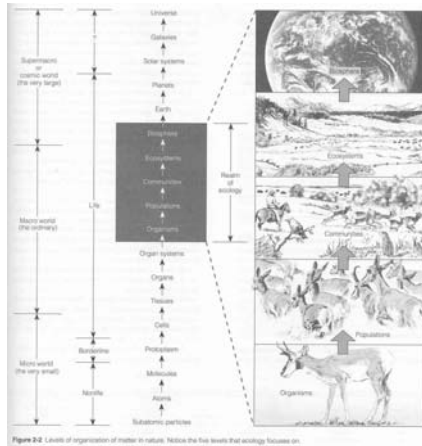


Figure 2.18 Non-complexity of a freshwater ecosystem

42

Levels of Biological Organization.
Scaling.



Miller, 2003

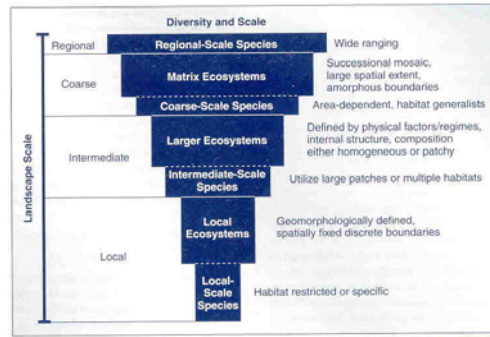


Figure 4.15 Van Dyke 2003
Biodiversity and scale. A method of categorizing biodiversity at regional, coarse, intermediate, and local geographic scales.
Modified from Polani et al. (2000). © 2001 American Institute of Biological Sciences.

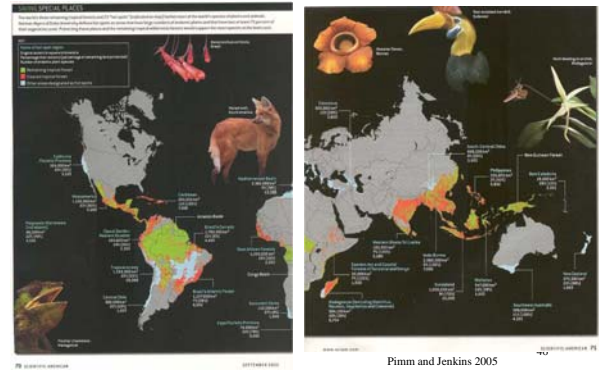
TABLE 4. Hierarchical Indicators for Monitoring Sustainability

LEVEL	INDICATORS
GENETIC	<ul style="list-style-type: none"> Genetic diversity and ongoing gene flow and heterozygosity Genetic diversity and population structure Genetic diversity and population structure Genetic diversity and population structure Genetic diversity and population structure
POPULATION SPECIES	<ul style="list-style-type: none"> Population size and density Population growth rate Population structure Population viability Population sustainability
COMMUNITY ECOSYSTEM	<ul style="list-style-type: none"> Community structure and composition Community dynamics and processes Community resilience and stability Community sustainability Community sustainability
ECOSYSTEM	<ul style="list-style-type: none"> Ecosystem structure and composition Ecosystem dynamics and processes Ecosystem resilience and stability Ecosystem sustainability Ecosystem sustainability
LANDSCAPE	<ul style="list-style-type: none"> Land use and land cover Land cover change Land cover sustainability Land cover sustainability Land cover sustainability
REGIONAL	<ul style="list-style-type: none"> Regional development and growth Regional sustainability Regional sustainability Regional sustainability Regional sustainability
GLOBAL	<ul style="list-style-type: none"> Global development and growth Global sustainability Global sustainability Global sustainability Global sustainability

Groom et al. 2006

Where is biodiversity?

One tree in Peru with same ant diversity as Britain



Pimm and Jenkins 2005

Species Richness and Latitude

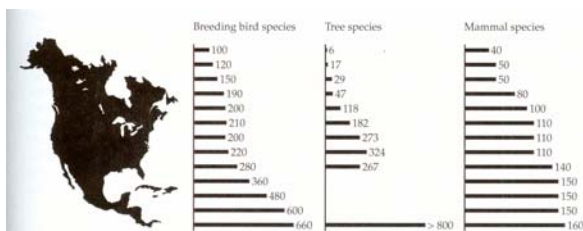


FIGURE 3.5 In North America, as in all the continents, the numbers of bird, tree, and mammal species increase toward the Tropics. The numbers of species indicated in the bar graphs correspond to latitude in the map at left. Tree species diversity is not available for some lower latitudes. (From Briggs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

Altitude?

Primack 2006

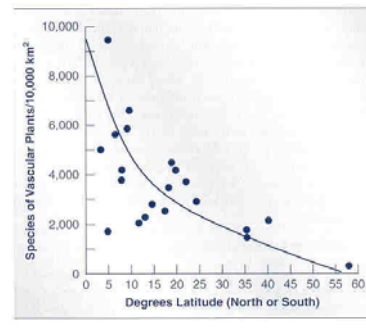


Figure 4.12
Latitudinal patterns in species richness from temperate to tropical regions. In most taxa the number of species increases from temperate to tropical regions.
After Reid and Miller (1989). Reprinted from Huston (1994).
Van Dyke 2003