Lecture 02, 23 Aug 2007
Ecological Footprint
What is Conservation Biology?

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

Kevin Bonine
Cathy Hulshof

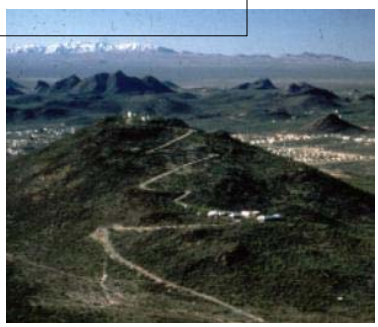
1. If not in lecture Tuesday, please see us after class.

Upcoming Readings
today: Textbook, chapter 1; Noss 1999
Tues 28 Aug: Textbook chapter 3; Callicott 1997 (from Meffe and Carroll)
Thurs 30 Aug: Textbook Ch. 3, Leopold readings
[Q1 due 30 Aug if you choose to answer.]

Conservation Biology 406L/506L

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

24 Aug. Tumamoc Hill and Introduction, VAN
ecological research, study plots, geology, Tucson basin, desert vegetation, introductions and schedules



2

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.

3

sustainable tucson

http://www.sustainabletucson.org/

ECOalition

http://www.ecoalition.org/index.html

Think Globally, Act Locally

4

Quiz:

What were two of the four questions that the Noss (1999) paper attempts to address?

conservation biologists today: 1) are there any robust principles of conservation biology? 2) Is advocacy an appropriate activity of conservation biologists? 3) Are we educating conservation biologists properly? 4) Is conservation biology distinct from other biological and resource management disciplines? I answer three of these

Distinguish between Conservation and Preservation (as defined in the Noss paper).

from what it means today. Conservation, in America at least, was strictly utilitarian and was opposed to "preservation," which meant protecting the wonders of nature, mostly for the spiritual and aesthetic enrichment of mankind (Fox 1981). Preservation today is interpreted as a hands-off approach, one option in a

5

Figure 1.5 The first issue of the journal *Conservation Biology*, published in May 1987. (Photograph courtesy of E. P. Pister.)

Meffe and Carroll 1997

What is Conservation Biology?

When and what were the origins of the discipline?

6

Van Dyke Chapter 1 (p. 4)

Ethical and Conceptual Roots

1. Intrinsic Value (revisit in Ch.3)

2. Ecosystem services

3. Aesthetic, spiritual enrichment

7

Table 2.1 Ecosystem Services and Functions

Ecosystem service*	Examples
Gas regulation	Carbon dioxide/oxygen balance, ozone for protection against ultraviolet light
Climate regulation	Greenhouse gas regulation, dimethyl sulphide production affecting cloud formation
Disturbance regulation	Storm protection, flood control, drought recovery, and other aspects controlled by vegetation structure
Water regulation	Provisioning of water for agricultural (such as irrigation) or industrial (such as milling) processes or transportation
Water supply	Provisioning of water by watersheds, reservoirs, and aquifers
Erosion control and sediment retention	Prevention of loss of soil by wind, runoff, or other removal processes; storage of silt in lakes and wetlands
Soil formation	Weathering of rock and the accumulation of organic material
Nutrient cycling	Nitrogen fixation, nitrogen, phosphorus, and other elemental or nutrient cycles
Waste treatment	Waste treatment, pollution control, detoxification
Pollination	Provisioning of pollinators for the reproduction of plant populations
Biological control	Keystone predator control of prey species; reduction of herbivory by top predators
Refugia	Nurseries, habitat for migratory species, regional habitats for locally harvested species, or overwintering grounds
Food production	Production of fish, game, crops, nuts, and fruits by hunting, gathering, subsistence farming, or fishing
Raw materials	The production of lumber, fuel, or fodder
Genetic resources	Medicine, products for materials science, genes for resistance to plant pathogens and crop pests, ornamental species (pets and horticultural varieties of plants)
Recreation	Ecotourism, sport fishing, and other outdoor recreational activities
Cultural	Aesthetic, artistic, educational, spiritual, and/or scientific values of ecosystems

*Ecosystem "goods" included in ecosystem services.
Source: Adapted with permission from Robert Costanza et al., "The value of the world's ecosystem services and natural capital," *Nature*, May 1997.

Brennan and Withgott 2005

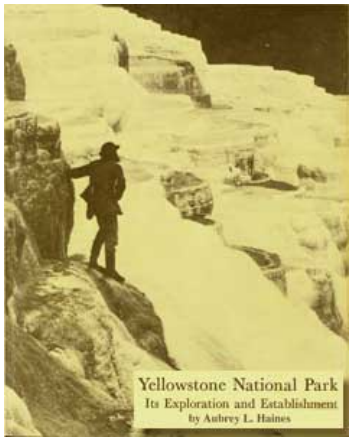
Van Dyke Chapter 1 (p. 5)

"Genuine and enduring conservation can occur only when humans knowingly use resources at less than maximum sustainable rates or forgo the use of some resources altogether." [RESTRAINT]

-Philosophy (e.g., Plato)
-Religion (e.g., Judaism)
-Nobility and their Forests

9

Modern Con Bio starts in Colter's Hell…

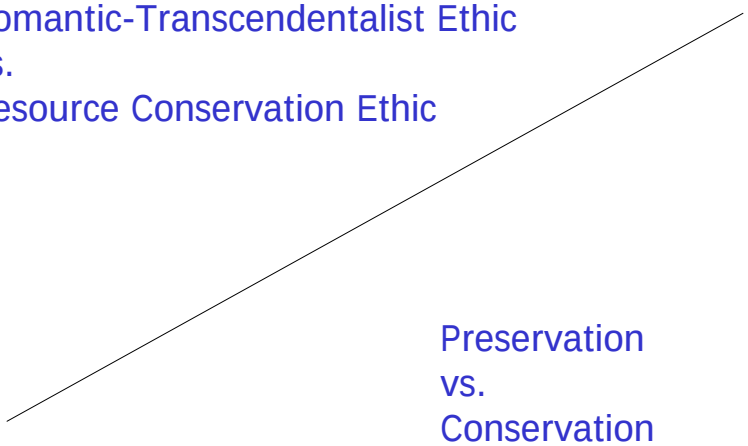


Thomas Moran on the Mammoth Terraces
Photograph by William H. Jackson, 1871.
(National Park Service)

John Colter 1807
(~Lewis and Clark)
Yellowstone Area

10

Romantic-Transcendentalist Ethic
vs.
Resource Conservation Ethic



Preservation
vs.
Conservation

11

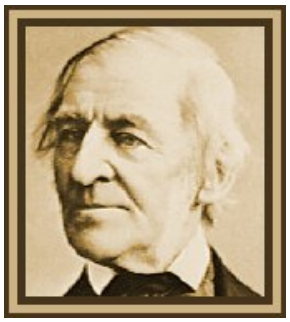
~Romantic-Transcendentalist Ethic:

Ralph Waldo Emerson
Henry David Thoreau
John Muir
- -Sierra Club 1892
- -NGO
- -Education, Lobby, Law/Politics

Yellowstone National Park 1872
Yosemite National Park 1890

ESA 1917 --> Nature Conservancy 1950

12



Ralph Waldo Emerson
1803-1882

A Successful life

"To laugh often and much; to win the respect of intelligent people and the affection of children; to earn the appreciation of honest critics and endure the betrayal of false friends; to appreciate beauty; to find the best in others; to leave the world a bit better, whether by a healthy child, a garden patch, or a redeemed social condition; to know even one life has breathed easier because you have lived."

- Ralph Waldo Emerson -

13

Henry David Thoreau
(1817-1862)

"Many go fishing all their lives without knowing that it is not fish they are after."

"Beware of all enterprises that require new clothes. "

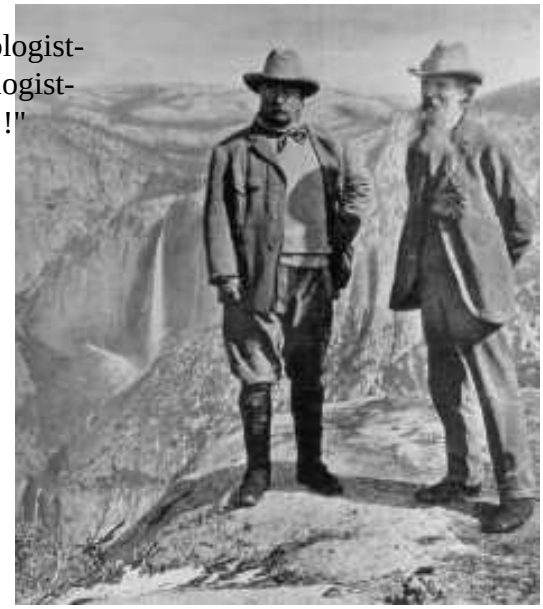
"It is not worthwhile to go around the world to count the cats in Zanzibar. "

"Wherever a man goes, men will pursue him and paw him with their dirty institutions, and, if they can, constrain him to belong to their desperate oddfellow society. "

14

"poetico-trampo-geologist-botanist and ornithologist-naturalist etc. etc. !!!!"

John Muir
(1838-1914)



15

Teddy Roosevelt
(president 1901-1909)

~resource conservation ethic:

Figure 1.3 VanDyke 2003
Theodore Roosevelt, the twenty-sixth president of the United States (1901–1909), greatly supported the role of the federal government in conservation.

"To Roosevelt, it was clear that a handful of individuals and their companies were reaping most of the profits from natural resources that rightfully belonged to all citizens." Van Dyke 2003, p. 10

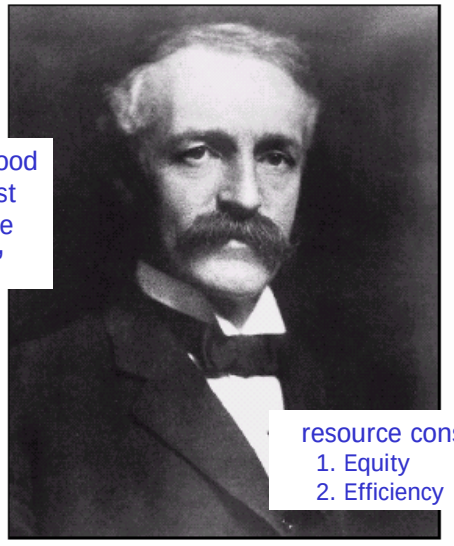
early 1900s "Trustbuster"

Resources for use, but forever.

National Wildlife Refuge System (52 designations by TR)

17

"The greatest good for the greatest number for the longest time"



Gifford Pinchot

resource conservation ethic:
1. Equity
2. Efficiency

Figure 1.4 VanDyke 2003
Gifford Pinchot, early head of the U.S. Forest Service and father of the resource conservation ethic. From an original staff of only 123 in 1898, Pinchot built the Forest Service to an organization of 1,500 people administering 150 million acres of public land within 10 years.

18

Sustainable Use
Maximum Sustained Yield

USE those resources!

19

Modern Conservation Biology
- National Parks
- U.S.

Transferable?

20

Figure 1.5 Van Dyke 2003
Aldo Leopold, early twentieth-century conservationist and father of the modern land ethic.

Aldo Leopold

Game Management 1932

A Sand County Almanac (1966)
-evolution/ecology land ethic

Land Health and the A-B Cleavage

Commodities (A)
vs. Processes (B)

21

Rachel Carson
Silent Spring 1962

-Bioaccumulation

-Levels and scale

-Environmental degradation threaten *human health*

-Increased Public Awareness

Figure 1.6 Van Dyke 2003
Rachel Carson, U.S. Fish and Wildlife Service biologist and author of *Silent Spring* (1962), a seminal book in the modern environmental movement.

The Science behind the Story

Pesticides and Child Development in Mexico's Yaqui Valley

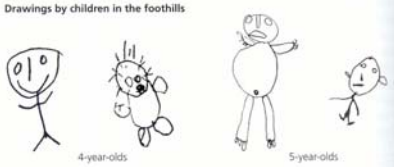
With spindly arms and big round eyes, one set of pictures shows the sorts of stick figures drawn by young children everywhere. Next to them is another group of drawings, mostly disconnected squiggles and lines, resembling nothing. Both sets of pictures are intended to depict people. The main difference identified between the two groups of young artists: long-term pesticide exposure.

Children's drawings are not a typical tool of toxicology, but Elizabeth Guillette, an anthropologist, wanted to try new methods. Guillette was interested in the effects of pesticides on children. She devised tests to measure childhood development based on techniques from anthropology and medicine. Searching for a study site, Guillette found the Yaqui Valley region of northwestern Mexico.

The Yaqui Valley is farming country, worked for generations by the indigenous group that gives the region its name. Synthetic pesticides arrived in the area in the 1940s. Some Yaqui embraced the agricultural innovations, spraying their farms in the valley to increase their yields. Yaqui farmers in the surrounding foothills, however, generally chose to bypass the chemicals and to continue following more traditional farming practices. Although differing in farming techniques, Yaqui in the valley and foothills continued to share the same culture, diet, education system, income levels, and family structure.

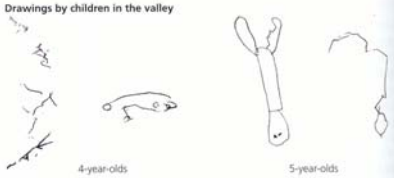
At the time of the study, in 1994, valley farmers planted crops twice a year, applying pesticides up to 45 times from planting to harvest. A previous study conducted in the valley in 1990, focusing on areas with the largest farms, had indicated high levels of multiple pesti-

Drawings by children in the foothills



4-year-olds 5-year-olds

Drawings by children in the valley



4-year-olds 5-year-olds

Elizabeth Guillette's study in Mexico's Yaqui Valley offers a startling example of apparent neurological effects of pesticide poisoning. Young children from foothills areas where pesticides were not commonly used drew recognizable figures of people. Children the same age from valley areas where pesticides were used heavily in industrialized agriculture could draw only scribbles when asked to draw people. Adapted from Elizabeth A. Guillette, et al., *Environmental Health Perspectives*, 1998.

Brennan and Withgott 2005

23

Table 2.1 Ecosystem Services and Functions

Ecosystem service*	Examples
Gas regulation	Carbon dioxide/oxygen balance, ozone for protection against ultraviolet light
Climate regulation	Greenhouse gas regulation, dimethyl sulphide production affecting cloud formation
Disturbance regulation	Storm protection, flood control, drought recovery, and other aspects controlled by vegetation structure
Water regulation	Provisioning of water for agricultural (such as irrigation) or industrial (such as milling) processes or transportation
Water supply	Provisioning of water by watersheds, reservoirs, and aquifers
Erosion control and sediment retention	Prevention of loss of soil by wind, runoff, or other removal processes; storage of silt in lakes and wetlands
Soil formation	Weathering of rock and the accumulation of organic material
Nutrient cycling	Nitrogen fixation, nitrogen, phosphorus, and other elemental or nutrient cycles
Waste treatment	Waste treatment, pollution control, detoxification
Pollination	Provisioning of pollinators for the reproduction of plant populations
Biological control	Keystone predator control of prey species; reduction of herbivory by top predators
Refugia	Nurseries, habitat for migratory species, regional habitats for locally harvested species, or overwintering grounds
Food production	Production of fish, game, crops, nuts, and fruits by hunting, gathering, subsistence farming, or fishing
Raw materials	The production of lumber, fuel, or fodder
Genetic resources	Medicine, products for materials science, genes for resistance to plant pathogens and crop pests, ornamental species (pets and horticultural varieties of plants)
Recreation	Ecotourism, sport fishing, and other outdoor recreational activities
Cultural	Aesthetic, artistic, educational, spiritual, and/or scientific values of ecosystems

*Ecosystem "goods" included in ecosystem services.
Source: Adapted with permission from Robert Costanza et al., "The value of the world's ecosystem services and natural capital," *Nature*, May 1997.

Brennan and Withgott 2005

Journal of Wildlife Management (1937)
Wildlife Society Bulletin

vs.

Conservation Biology
Biological Conservation

(~movement from individual game species to large scale and generalized approaches)

Figure 1.5 The first issue of the journal *Conservation Biology*, published in May 1987. (Photograph courtesy of E. P. Pister.)

Meffe and Carroll 1997

1985

the founding of the Society for Conservation Biology (SCB), with the explicit mission "to help develop the scientific and technical means for the protection, maintenance, and restoration of life on this planet – its species, its ecological and evolutionary processes, and its particular and total environment."

(from Noss 1999)

26

Is conservation biology a distinct discipline?

-Biodiversity (levels and scales)

-Prevent degradation and loss

1. Scarcity and Abundance

2. Value laden and mission driven

3. Diversity and complexity good

   Untimely extinction bad

4. Evolution is good (genotypic variation)

   -process

5. Biotic diversity has intrinsic value

(~Soulé's normative postulates)

(see 8 traits in Van Dyke Ch1, p. 15)

27

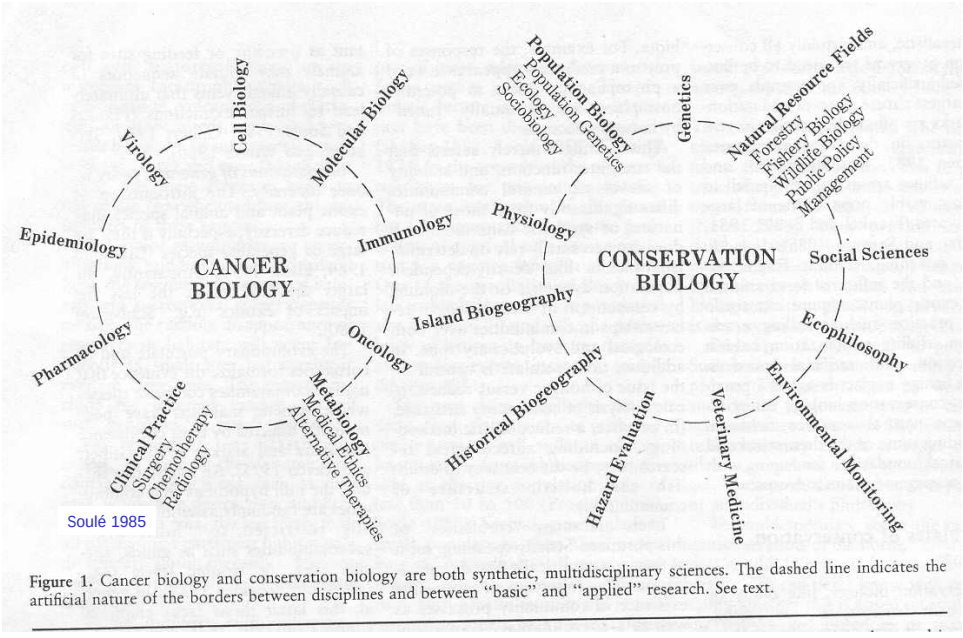


Figure 1. Cancer biology and conservation biology are both synthetic, multidisciplinary sciences. The dashed line indicates the artificial nature of the borders between disciplines and between "basic" and "applied" research. See text.

6. Crisis Discipline?

28

"In crisis disciplines, one must act before knowing all the facts; crisis disciplines are thus a mixture of science and art, and their pursuit requires intuition as well as information" (Soulé 1985).

-Noss 1999

29

Problems Addressed by Conservation Biologists:

1 Genetic Diversity
- variation, inbreeding, drift, hybridization

2 Species
- MVP, PVA
- small populations
- declining populations
- metapopulations

3 Habitat
- loss, fragmentation, isolation, heterogeneity

4 Ecosystem Processes
- scale

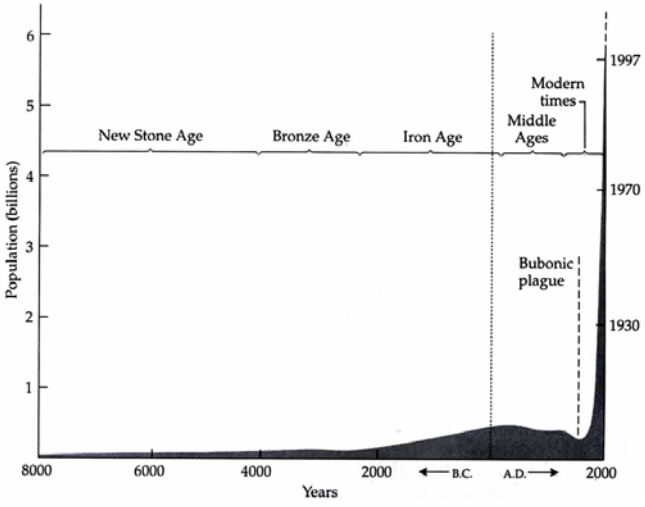
5 Human sustainability
- the crux

systems. Nevertheless, conservation biologists increasingly recognize that the proximate and ultimate threats to biodiversity virtually all have to do with humans.

Noss 1999, p. 118

31

Humans on planet Earth



Meffe and Carroll 1997

32

1948!!!

In 1948 G. Evelyn Hutchinson warned of the dangers of the expanding human population and the disruption of geochemical cycles, one outcome of which could be global warming.

(from Noss 1999)

33

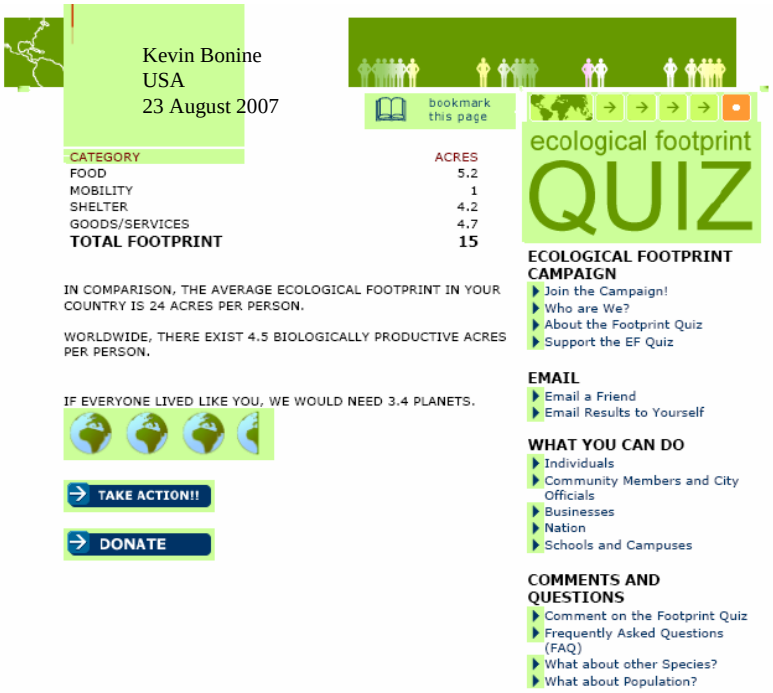
For Today, please calculate your ecological footprint TWICE:

Once for your life here in the U.S.
A second time using the same information, but choose a different country.

http://www.earthday.net/footprint/index.asp

Frequently Asked Questions re: Ecological Footprint:
http://www.rprogress.org/ecological_footprint/footprint_FAQs.htm)

Bring the Numbers to Class on Thursday.
Convert to Acres.



35

Ecological Footprint

The big choices seem to matter the most:

- -transportation
- -food (unprocessed, local, trophic level)
- -housing
- -reproduction

Figure 1-5 Relative ecological footprints of the United States, the Netherlands, and India. An *ecological footprint* is the amount of land needed to produce the resources needed by an average person in a country. It would take the land area of about three planet earths if all the world's 6.2 billion people consumed the same amount of resources as is consumed by the 288 million people in the United States.

Recycling etc. important, but not as big an impact

Paper or Plastic? - Bring your own.

36

Kevin Bonine
Peru
23 August 2007

bookmark this page

CATEGORY	GLOBAL HECTARES
FOOD	0.5
MOBILITY	0.7
SHELTER	0.9
GOODS/SERVICES	0.7
TOTAL FOOTPRINT	**2.8**

2.8 x 2.47 = 6.9 acres

IN COMPARISON, THE AVERAGE ECOLOGICAL FOOTPRINT IN YOUR COUNTRY IS 1.2 GLOBAL HECTARES PER PERSON.

WORLDWIDE, THERE EXIST 1.8 BIOLOGICALLY PRODUCTIVE GLOBAL HECTARES PER PERSON.

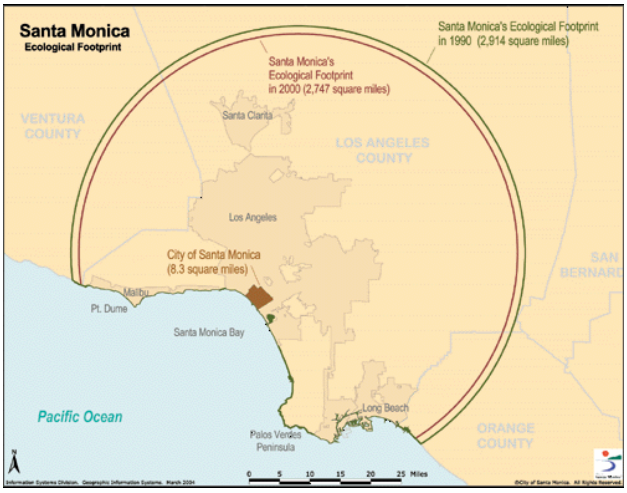
IF EVERYONE LIVED LIKE YOU, WE WOULD NEED 1.6 PLANETS.

Infrastructure and Lifestyle

37

Ecological Footprint

-Reproduction
-Housing
-Travel
-Food
-Etc.



(Commoner, Ehrlich, early 1970s)

Developed Countries
1.2 billion people (~19%)
high average per capita purchasing power
have 85% world's wealth
use 88% natural resources
generate 75% waste and pollution

I = P A T

Environmental Impact = Population x Affluence x Technology
(of a society) (consumption)

Developing Countries
81% of the people
have 15% world's wealth
use 12% world's natural resources
produce 25% waste and pollution

Poor parents in a developing country need to have 70-200 children to equal the impact of 2 U.S. children

39

One of Commoner's lasting legacies is his four laws of ecology, as written in *The Closing Circle* in 1971. The four laws are:

1. Everything is Connected to Everything Else. There is one ecosphere for all living organisms and what affects one, affects all.

2. Everything Must Go Somewhere. There is no "waste" in nature and there is no "away" to which things can be thrown.

3. Nature Knows Best. Humankind has fashioned technology to improve upon nature, but such change in a natural system is, says Commoner, "likely to be detrimental to that system."

4. There Is No Such Thing as a Free Lunch. In nature, both sides of the equation must balance, for every gain there is a cost, and all debts are eventually paid.

40

Theoretical Basis of Conservation Biology?

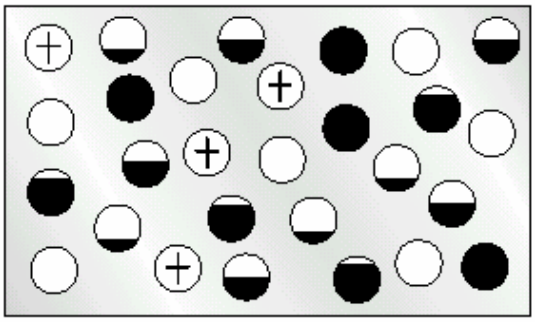


Figure 1.8
Diagrammatic representation of an arrangement of local populations ("metapopulation") based on Andrewartha and Birch (1954). Empty circles represent favorable habitats that individuals do not occupy. Partially or completely filled circles represent favorable habitats and relative densities of individuals in them as a proportion of the habitat's maximum capacity. Crosses indicate habitats in which local populations recently became extinct.

Van Dyke 2003

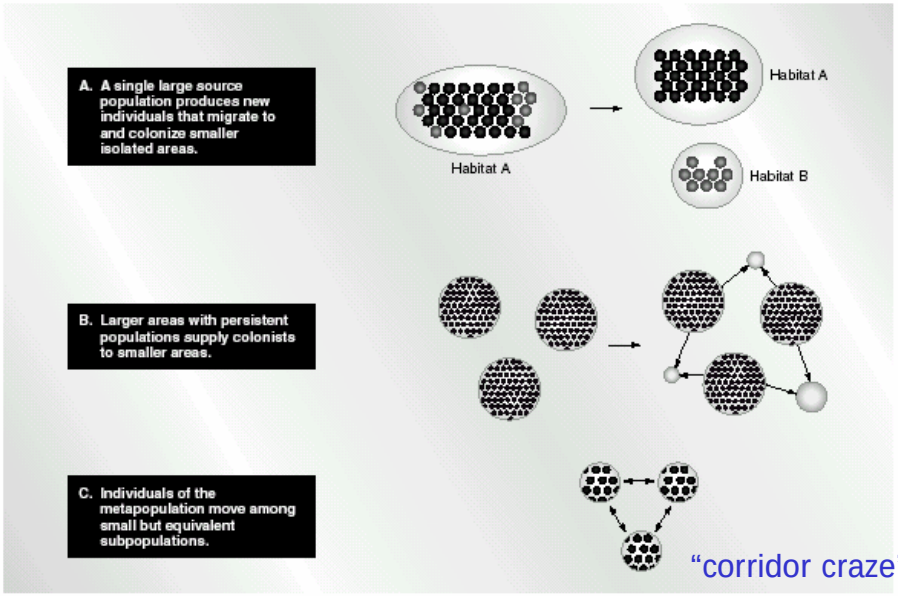
-Metapopulations

-Island Biogeography
MacArthur and
Wilson 1963

-Testable Hypotheses

-Thresholds

41



"corridor craze"

Figure 1.9 Van Dyke 2003
Three variations of the metapopulation concept. Although different in detail, all represent metapopulations as spatially distinct groups (subpopulations) that disperse to or among physically separated habitats.

Noss 1999

Is there a special conservation biology?

Origins

Soulé et al. 1978+

SCB 1986

Conservation Biology 1987

Ideas

-Precautionary Principle

-Value Laden

-Species differences...

-Umbrella species

-Advocacy

Pattern and Generality vs. Special Case

p. 116, Noss 1999

44

Responsible Advocacy?

Ethical Advocacy?

p.117, Noss 1999:
tropical rainforest
vs.
economic development program

Is ConBio distinct discipline?

45

Science

Management — Policy

46