Lecture 08, 14 Sept 2006
Ch4&2

Conservation Biology
ECOL 406R/506R
University of Arizona
Fall 2006

Kevin Bonine
Kathy Gerst

Biodiversity

Legal Foundations

No Lab this Friday (15 Sept 2006),
meet S side BSE 1230 on 22 Sept, return 24 Sept.
(see website for lab readings)

Housekeeping, 14 September 2006

Upcoming Readings

today: Text Ch.4 and Ch.2, ESA, NEPA on website

Tues 19 Sept: Text Ch. 2, SDCP on website
Thurs 21 Sept: See website (David Hall, guest)

Short oral presentations
14 Sept Susie Qashu
19 Sept Grant Rogers and Jeremy Daniel
21 Sept Tara Luckau and Allison Buchanan
26 Sept Jacklyn Hendrickson & Larissa Gronenberg

3) Is the endangered species act (ESA) the correct approach for US conservation efforts? Why or why not?

-OR-

Why is biodiversity important? How would you defend any one species to a non-conservationist? (due 19 Sept)

Suggestions: Define terms, include examples, avoid pronouns, etc.

CFI Community of Southern Arizona Public Forum

Beyond the Headlines: Prospects for Humanity as Earth Heats Up
There remains virtually no doubt: Earth is warming, and humans are partly to blame. What are the causes and consequences of global warming? Can we employ technology and modify behavior to stop the warming, or have we entered an arena of positive feedbacks so strong that humanity itself is threatened? World-class Earth-system scientists from the U of A will address these questions in a comprehensive series of presentations and interactive discussion with the audience. A must program for all of us, the stewards of Planet Earth.

Speakers
Dr. **Guy McPherson**, Moderator, conducts research in conservation biology and sustainability of the human endeavor.
Dr. **Roger Angel**, Astronomer and one of the world's foremost minds in modern optics is Director of world renowned Steward Observatory Mirror Laboratory at U of A. Recently he has applied his knowledge of optics and space in an exciting proposal for reducing the impact of Global Warming.
Dr. **Travis Huxman**, Plant Physiological Ecologist interested in plant evolution and global change. He is trying to understand how climate change may affect population, community and ecosystem processes. Recent research focuses on how ecosystem carbon balance is influenced by climate.
Dr. **Melanie Lenart**, Research Associate for the Institute for the Study of Planet Earth (ISPE), focuses on identifying and evaluating climate impacts on humans and natural systems in the Southwest.
Dr. **Thomas Swetnam**, Dendrochronologist whose research reconstructs the histories of fire, insect outbreaks, human land uses and climate. He is presently studying disturbances and climate histories in the Southwestern U.S., as well as in many other selected world locations.

Date: **Sunday, September 17, 2006**
Time: 1:30 5:00 pm
Location: The InnSuites
475 N. Granada
Cost: **Students & CFI Friends FREE**
Others - $6.00
For additional information, please contact Paul Taylor at pmtaylors@cox.net, 648-7231, or Jerry Karches at JKarches@swhaz.com, 297-9919.

Lorax-inspired poetry:

http://www.ippnw.org/MGS/V5N2Lorax.html

http://tobiesrandomrants.blogspot.com/2005/06/lorax-parody.html

Measuring Biodiversity
- alpha - beta - gamma

Alpha
species within a community

community
- all populations occupying a given area at a given time
- often broken into taxonomic groups or functional roles

1) Species Richness (# of species)
2) Species Evenness (how many of each type?)

Shannon Diversity Index (richness and evenness)

$H' = -\sum_i p_i \ln(p_i)$, ($i$ = 1, 2, 3 ... S)

p_i = proportion of total community abundance represented by ith species

Table 4.3 Abundance (individuals/10 ha) and diversity (Shannon index, $H' = -\Sigma(p_i \ln p_i)$) of avian species from two tallgrass prairie sites at DeSoto National Wildlife Refuge, Iowa. Note that site A, with fewer species (8) and two highly abundant species (common yellowthroat and field sparrow), has a lower value of diversity than site B, which has more species (11) that are more equally abundant. Van Dyke 2003

SPECIES	SITE A	SITE B
Common yellowthroat	8.24	1.21
Field sparrow	2.94	2.84
Dickcissel	1.18	2.23
Red-winged blackbird	0.29	0.81
Brown-headed cowbird	2.06	1.82
American goldfinch	1.47	1.02
Ringneck pheasant	0.59	1.63
Mourning dove	1.18	0.61
Eastern kingbird	—	1.60
Grasshopper sparrow	—	4.48
Northern bobwhite	—	2.64
Shannon diversity (H')	1.64	2.25

Shannon Index in Tallgrass Prairie

(indiv spp abundance relative to total abundance)

What if removed three species from B?

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1.64			
a	prop	ln	propxln
8.24	0.459053	-0.77859	-0.35741
2.94	0.163788	-1.80918	-0.29632
1.18	0.065738	-2.72208	-0.17894
0.29	0.016156	-4.12546	-0.06665
2.06	0.114763	-2.16488	-0.24845
1.47	0.081894	-2.50233	-0.20493
0.59	0.032869	-3.41522	-0.11226
1.18	0.065738	-2.72208	-0.17894
17.95	1		**-1.64391**

2.25			
b	prop	ln	propxln
1.21	0.057922	-2.84865	-0.165
2.84	0.13595	-1.99547	-0.27128
2.23	0.10675	-2.23727	-0.23883
0.81	0.038775	-3.24999	-0.12602
1.82	0.087123	-2.44043	-0.21262
1.02	0.048827	-3.01947	-0.14743
1.63	0.078028	-2.55069	-0.19902
0.61	0.029201	-3.53357	-0.10318
1.6	0.076592	-2.56927	-0.19678
4.48	0.214457	-1.53965	-0.33019
2.64	0.126376	-2.06849	-0.26141
20.89	1		**-2.25177**

drop top 3			
b	prop	ln	propxln
0.81	0.055441	-2.89243	-0.16036
1.82	0.124572	-2.08287	-0.25947
1.02	0.069815	-2.6619	-0.18584
1.63	0.111567	-2.19313	-0.24468
0.61	0.041752	-3.176	-0.13261
1.6	0.109514	-2.2117	-0.24221
4.48	0.306639	-1.18208	-0.36247
2.64	0.180698	-1.71093	-0.30916
14.61	1		**-1.8968**

drop bottom 3			
b	prop	ln	propxln
1.21	0.099425	-2.30835	-0.22951
2.84	0.233361	-1.45517	-0.33958
2.23	0.183237	-1.69697	-0.31095
0.81	0.066557	-2.70969	-0.18035
1.82	0.149548	-1.90014	-0.28416
1.02	0.083813	-2.47917	-0.20779
1.63	0.133936	-2.01039	-0.26926
0.61	0.050123	-2.99327	-0.15003
12.17	1		**-1.97163**

8

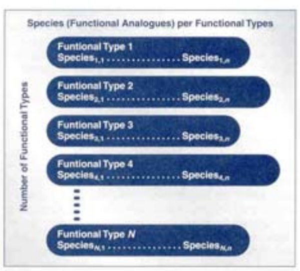

Figure 4.3
Total species diversity can be measured as the product of the number of functional types and the number of species per functional type. Two populations may have the same species diversity and still differ. For example, one may have many functional types and few functional analogues, and the other may have many analogues but few functional types. The relative number of functionally analogous species within each functional type is indicated by the width of the oval. Van Dyke 2003

Process and Pattern

1 Functional Types
2 Functional Analogs

Increase either to increase biodiversity

Which to preserve?

Niche:
Ecological role of a species in a community

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Measuring Biodiversity
- alpha - beta - gamma

Beta
area or regional diversity (beta richness)
diversity of species among communities across landscape

gradient
- slope, moisture, temperature, precipitation, disturbance, etc.

Whittaker's Measure = (S/alpha) - 1

where S = # spp in all sites, alpha = avg. # spp/site

a) if no community structure across gradient = 0
-broad ecological tolerances, niche breadth

b) 100/10 - 1 = 9 high beta diversity

Beta Diversity

1) quantitative measure of diversity of communities that experience changing environmental gradients

2) are species sensitive, or not, to changing environments?
are there associations of species that are interdependent
(plants, pollinators, parasites, parasitoids)?

3) how are species gained or lost across a TIME gradient?

Succession, community composition, effects of disturbance

Alpha and Beta Diversity Hotspots

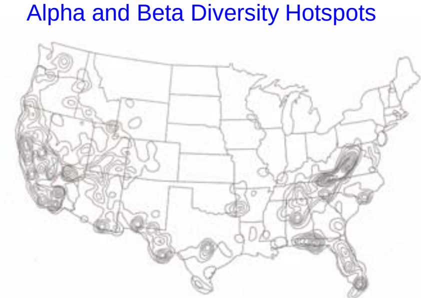

Figure A Hot spots of rarity and species richness in the lower 48 United States. Read as a topographic map with concentric circles showing higher values of the rarity-weighted species richness index (RWRI). Hotspots are found in CA, the Death Valley region of Nevada, the Appalachian Mountains, and the Florida panhandle and Everglades. Many other regions of higher diversity are found in other parts of the U.S., and the Hawaiian islands (not shown) have the greatest concentration of range-restricted species by far. To achieve a high RWRI both α- and β-diversity must be high. (Modified from Stein et al. 2000.)

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Groom et al. 2006

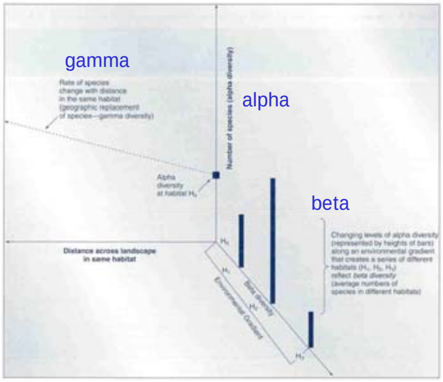

Figure 4.2

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Measuring Biodiversity
- alpha - beta - gamma

Gamma

rate of change of species composition with distance
(geography, rate of gain and loss of species)

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alpha rarity with increased number of species
(fewer of each type)

beta rarity with habitat specialists

gamma rarity if restricted to particular geographic areas

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Measuring Biodiversity
- alpha - beta - gamma

Missing?

Species role in ecosystem?
Rarity
Phylogenetic Representation
Ecological Redundancy

Edges vs. Interior (e.g., fragmentation)
(spp richness increases, but are broad generalists, not interior habitat specialists)

All species are not equivalent (normative valuation?)

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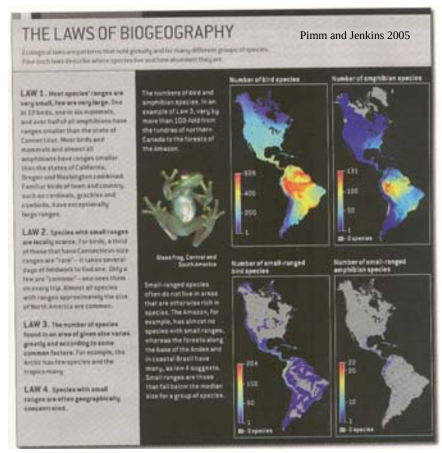

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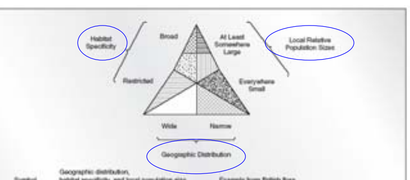

Symbol	Geographic distribution, habitat specificity, and local population size	Example from British flora
	Wide, broad, at least somewhere large	*Deschampsia caespitosa*, tufted hair-grass
	Wide, broad, everywhere small	*Hypochoeris maculata*, spotted goatsbeard
	Wide, restricted, at least somewhere large	*Ammophila arenaria*, marram grass
	Wide, restricted, everywhere small	*Draba muralis*, wall whitlow grass
	Narrow, broad, at least somewhere large	*Primula scotica*, Scottish bird's-eye primrose
	Narrow, restricted, at least somewhere large	*Agrostis setacea*, bristle-leaved bent
	Narrow, broad, everywhere small	(no example)
	Narrow, restricted, everywhere small	*Lloydia serotina*, alpine lily

Figure 4.9
Eight categories of species abundance in British plants based on geographic range, habitat use, and relative population size. Note that only one category (broad habitat specificity, wide geographic distribution, and large local population) can truly be considered "common." Species in the other seven categories are rare in one or more dimensions.
Adapted from Rabinowitz, Cairns, and Dillon (1986). VanDyke 2003

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Cyprinodon macularius

Desert Pupfish

Photograph Courtesy of John Rinne

Desert pupfish declined due to the introduction and spread of exotic predatory and competitive fishes, water impoundment and diversion, water pollution, groundwater pumping, stream channelization, and habitat modification.

Healthy population of almost 10,000 fish inhabits this oasis. This last refuge of a unique fish is being actively managed.

Cyprinodon macularius

Desert Pupfish

Family Cyprinodontidae

-1-1/4 inches long
max. age of three years

-females are gray and drab
males are bluish, turning bright blue during spring breeding season.

-feed on insect larvae and other organic matter from pond bottom.

-prefer shallow pond depths, about 12 to 18 inches deep.

Quitobaquito pupfish (Endangered since 1986)

This tiny fish was once part of a widespread population, the range of which included the Colorado, Gila, San Pedro, Salt and Santa Cruz rivers and their tributaries in Arizona and California. The ancestors of the Quitobaquito and Sonoyta river pupfish are believed to have been cut off from their relatives in the Colorado River drainage about one million years ago.

The warm, slightly brackish water at Quitobaquito is ideal habitat for pupfish. Pupfish can tolerate salinity levels ranging from normal tap water to water three times saltier than the ocean. Therefore, they are well suited to desert environments where high evaporation rates create water with high salinity levels.

Although the water temperature at the spring is a constant 74°F, the water temperature in the pond fluctuates greatly during the year, from about 40°F or cooler in January to almost 100°F in August, especially in shallow areas... very tolerant of rapid temperature change and low oxygen content due to summer heat.

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Pricing Biodiversity, Choosing Projects

$R_I = (D_i + U_i)(\text{delta}P_i/C_i)$

D = distinctiveness
U = utility
delta P = enhanced probability of survival
C = cost of strategy

Direct limited funds...
Ecological Contribution?

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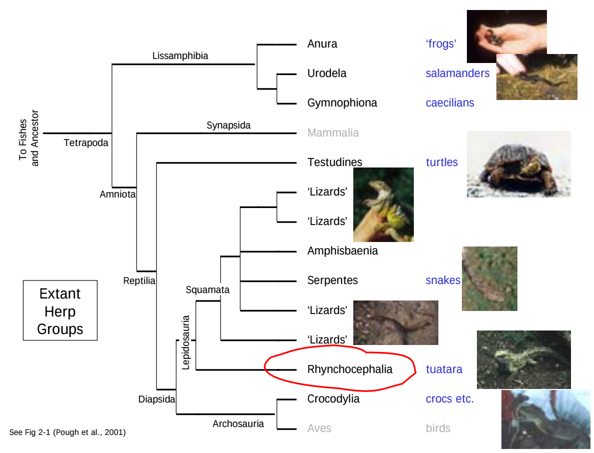

See Fig 2-1 (Pough et al., 2001)

Rhynchocephalia

- evolved before dinosaurs

- world-wide distribution in Mesozoic

- most extinct at end Cretaceous (65mya)

Sphenodontidae
- 1 extant genus (*Sphenodon*)
- 2 extant species

- restricted to small islands of New Zealand

- long lived

Pricing Biodiversity, Choosing Projects

$R_I = (D_i + U_i)(\text{delta}P_i/C_i)$

D = distinctiveness
U = utility
delta P = enhanced probability of survival
C = cost of strategy

Direct limited funds...
Ecological Contribution?

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Discussion:

Biodiversity vs. Wilderness

"no essential contradiction between social interests and biodiversity conservation"

p.109, VanDyke (Sarkar, 1999)

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Van Dyke Ch.2 Laws and Regulations

Con Bio:
- Regulatory Science?
- Legally Empowered Discipline?

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Domestic

Laws arose 1970's following concern of 1950s+

Laws reflect current social values but also persist into the future…

Advocacy

ConBio: science and empirical data + law/policy?

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1872 Yellowstone NP
1891 Forest Reserve Act
1916 NPS

1964 Wilderness Act
1965 Land and Water Conservation Fund Act
    -acquire lands, use resource revenues
1969/1970 NEPA (EIS)
    -think about environment up front
1970 Clean Air Act
1972 Clean Water Act
1973 ESA (species focus)
    endangered, threatened, critical habitat
    recovery plan
1980 Superfund (1995 Brownfields)

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Successful Laws:
- -Inspirational and radical?
- -Growth in influence?
- -Science and Monitoring?

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