

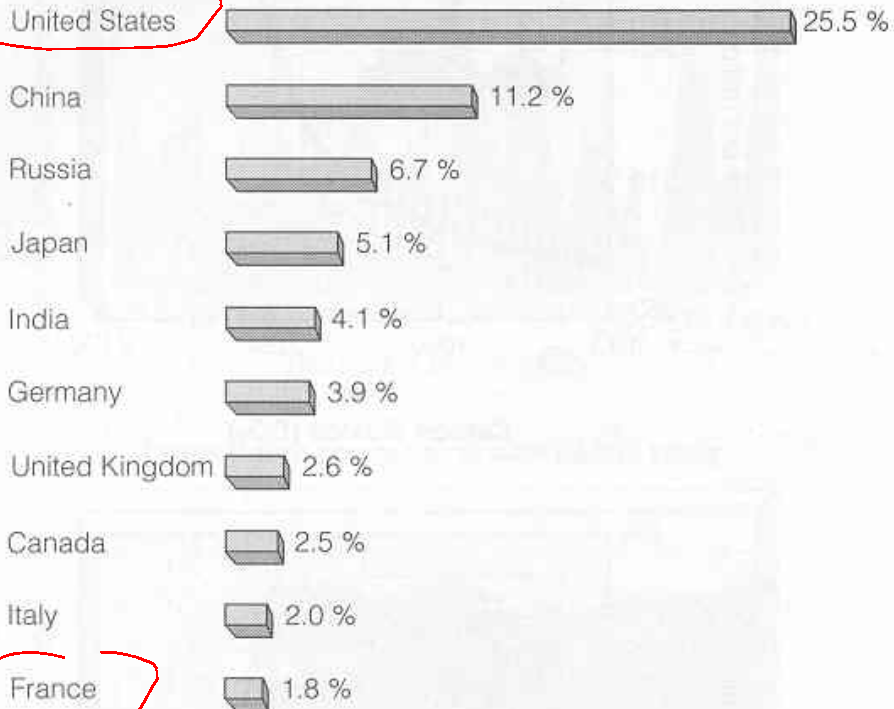
Lecture 09, 29 Sep 2003  
Chapter 4, (Role Playing Wrap Up?)

Conservation Biology  
ECOL 406R/506R  
University of Arizona  
Fall 2003

Kevin Bonine

1. Biodiversity, Scale (Ch4)
2. Exams Returned Wed

Contribution to Global Total (%)

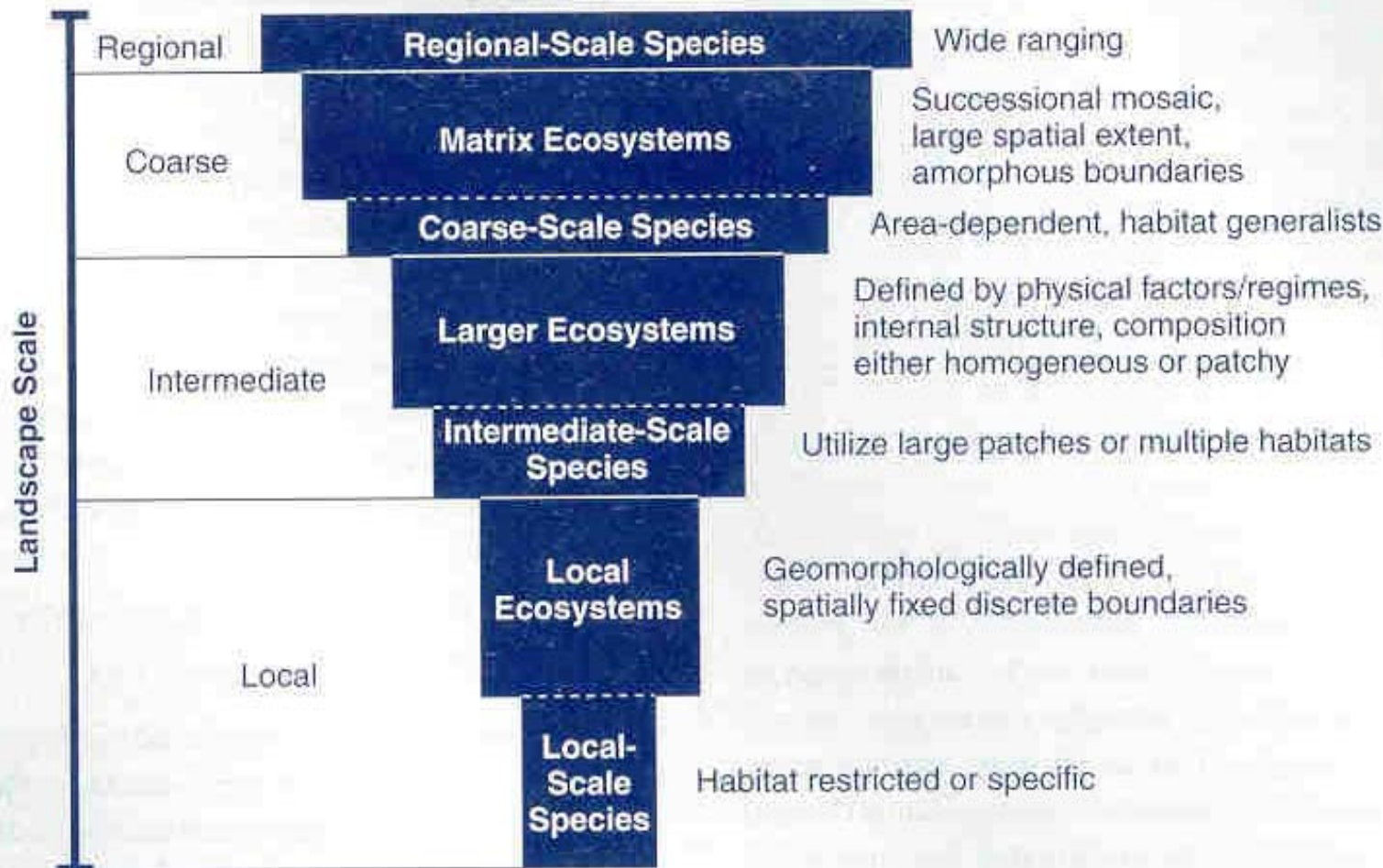


Per Capita Emissions (metric tons)



**Figure 11-9** The top ten nations in terms of total (left) and per capita (right) emissions of CO<sub>2</sub> in 1999. (Data from World Resources Institute)

## Diversity and Scale

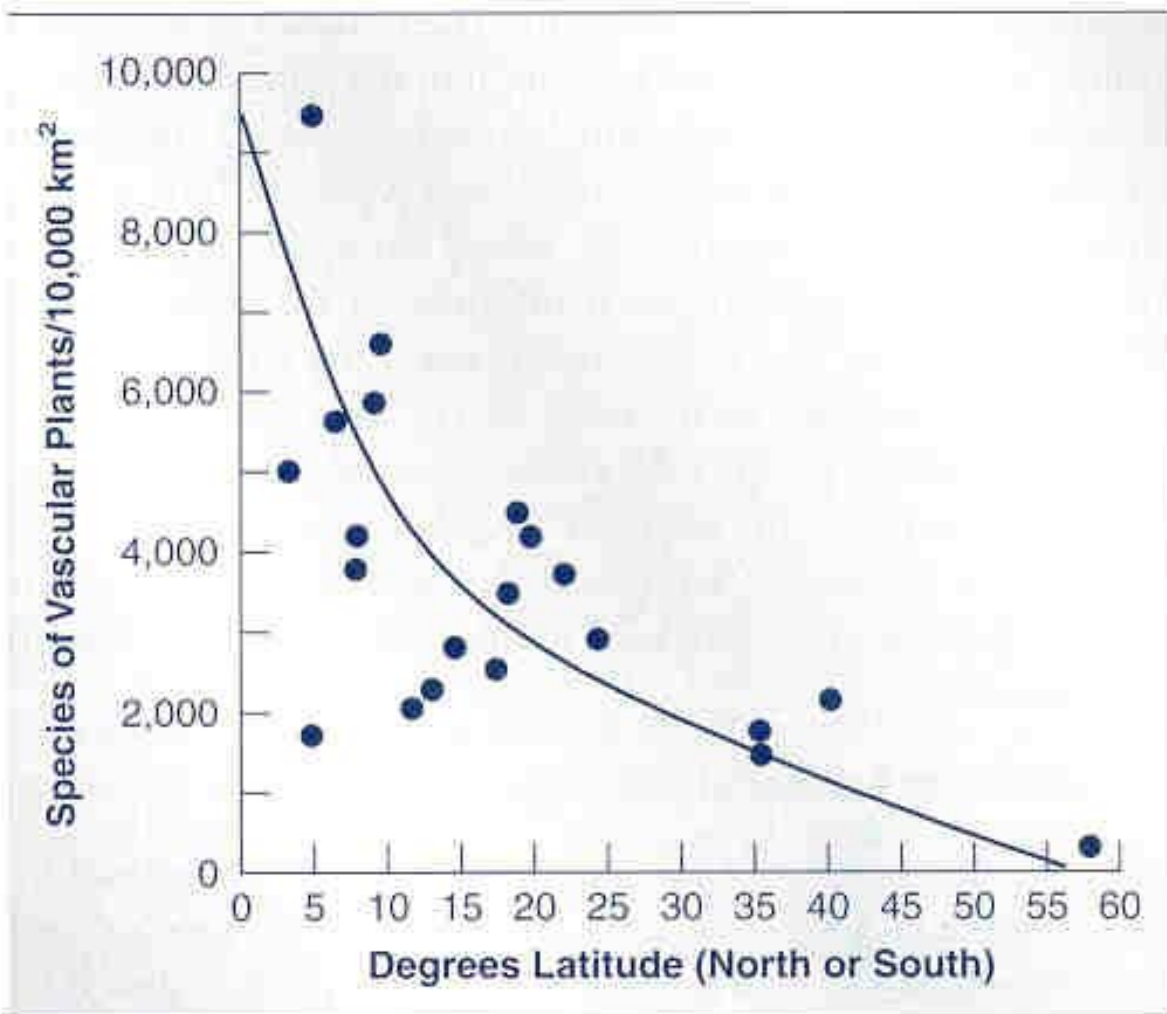


### Figure 4.15

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.



## 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).*

Species Focus ---> Biodiversity and Process Focus  
(ESA)

What being lost vs. why...

Biodiversity (Biological Diversity)

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

Note different levels (scale)

Species = ?

## Biological Species Concept (Mayr)

“a group of interbreeding populations that are reproductively isolated from other such groups”

2-morphological/typological species concept (plants)

3-evolutionary species concept

4-genetic species concept

5-paleontological species concept

6-cladistic species concept

## Biological Species Concept

1. Testable and operational
2. Definition compatible with established legal concepts
3. Focus on level of biodiversity that agrees with tradition of conservation

Conserve Species as

**TYPES**

or as

**EVOLUTONARY UNITS**

# 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 Index

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

$p_i$  = proportion of total community abundance represented by ith species



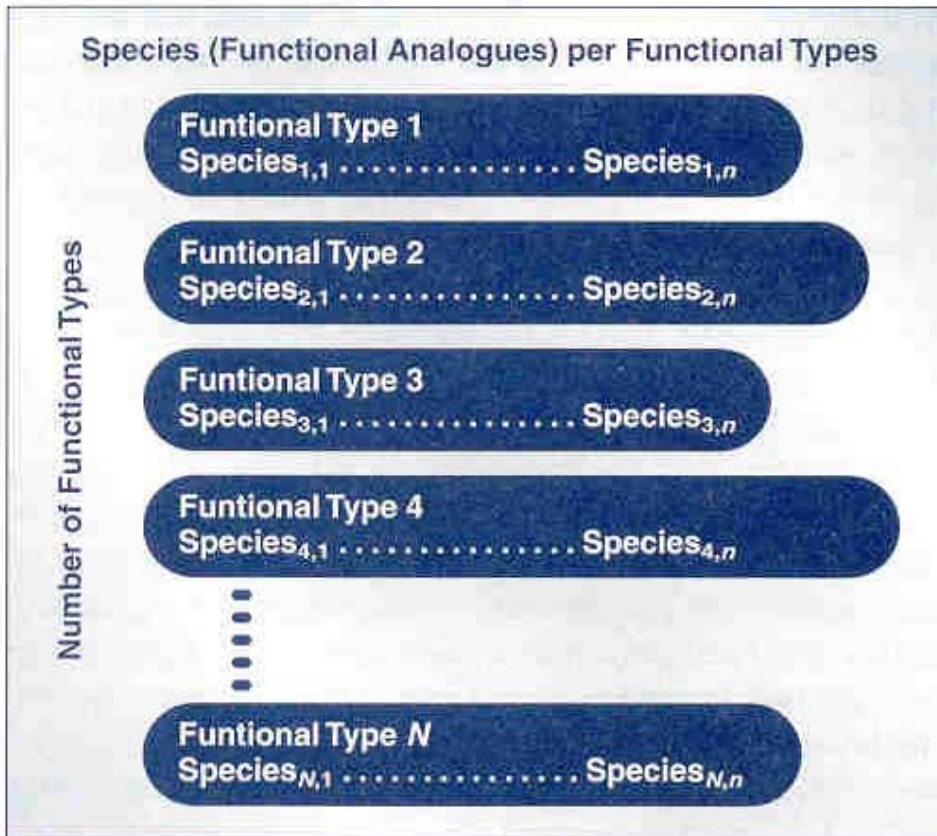
**Table 4.3** Abundance (individuals/10 ha) and diversity (Shannon index,  $H' = -\sum(p_i \ln p_i)$ ) of avian species from two tallgrass prairie sites at DeSoto National Wildlife Refuge, Iowa. Note that site A, with fewer species (8) and two highly abundant species (common yellowthroat and field sparrow), 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
Dickeissel	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?



Functional types

**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.

# 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**

# Measuring Biodiversity

- alpha      - beta      - gamma

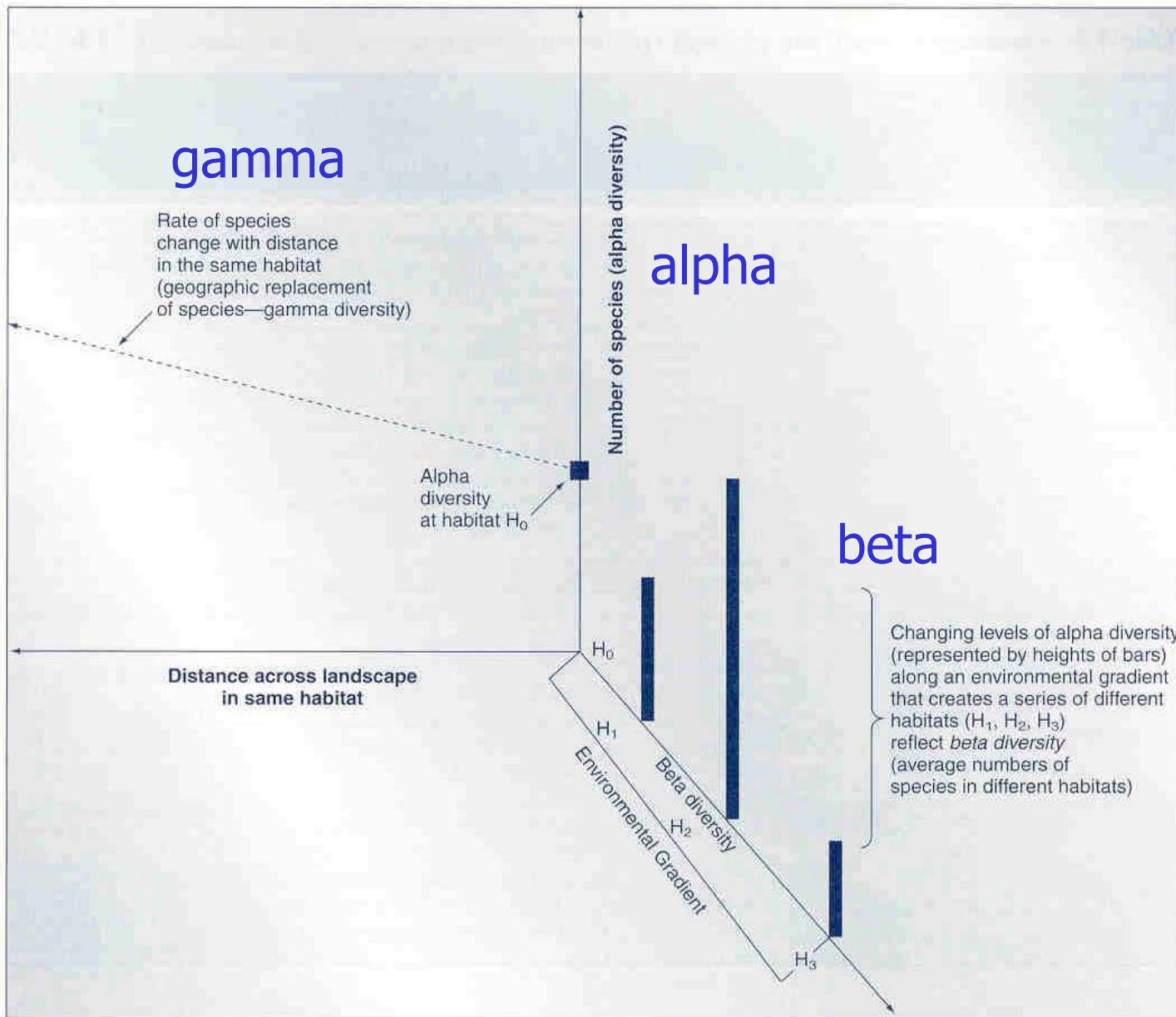
## Gamma

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

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

beta rarity with habitat specialists

gamma rarity if restricted to particular geographic areas



Van Dyke 2003

**Figure 4.2**

The number of species on a given site in one kind of habitat is a measure of alpha diversity (species richness). The average number of species per site along an environmental gradient (number of species per habitat) is a measure of beta diversity. The rate of species change over landscape scale distances in the same habitat is a measure of gamma diversity (geographic replacement of species).

# Measuring Biodiversity

- alpha      - beta      - gamma

## Missing?

Species role in ecosystem?

Rarity

Phylogenetic Representation

Edges vs. Interior (e.g., fragmentation)

(spp richness increases, but are broad generalists, not interior habitat specialists)

All species are not equivalent (normative valuation?)

## “Madagascar Periwinkle Argument” (leukemia)

What is it and why do many conservation biologists dislike it?

Callicott:

“Some things have a price, others have a dignity”



## Pricing Biodiversity

$$R_i = (D_i + U_i)(\Delta P_i / C_i)$$

D = distinctiveness

U = utility

$\Delta P$  = enhanced probability of survival

C = cost of strategy

Direct **limited funds...**

Ecological Contribution?

END