Biodiversity

What is Biodiversity?
‘The total variability of life on earth’

Knowledge of biodiversity, its loss, patterns of loss and effects of that loss will provide us with a greater understanding of future threats to our livelihoods.

This is a class about Global Environmental issues, and one of the best ways to understand human effects on the environment is to understand species loss and the destruction of biodiversity across the globe.

Issue 1: What level of biodiversity should be protected?
population? genes? Species? Genera? What is the appropriate unit for conservation?

Types of Biodiversity:

- Genetic Diversity ‘
  - variation within populations of animals measured in variation between genes or DNA sequences

- Species diversity – ‘alpha’ biodiversity’:
  - Diversity within a given place or area
  - ‘richness’ (number of species) versus ‘evenness’ (relative abundance, question of species dominance)

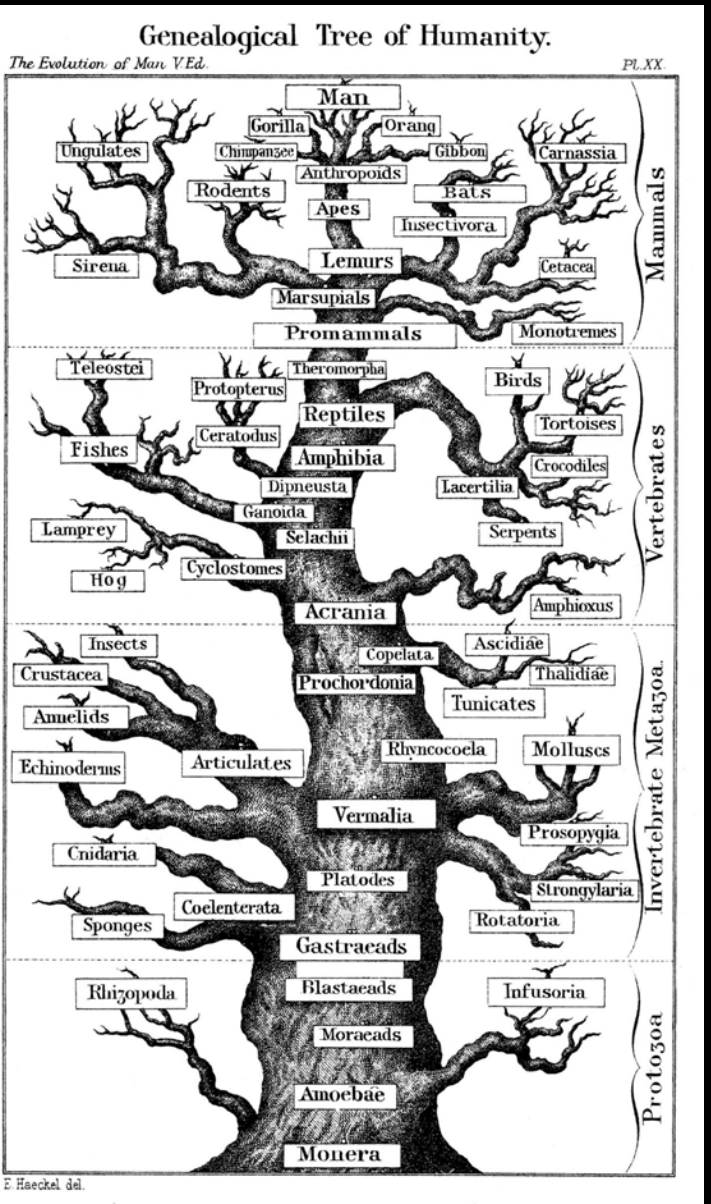
- Ecological diversity (community diversity, beta diversity’): how much does diversity vary across space?

- landscape biodiversity – ‘gamma biodiversity’
  - biodiversity by increasing the complexity of niches across space

Where does diversity come from?

1. Evolutionary mechanisms produce biodiversity

i. Variation
ii. selection

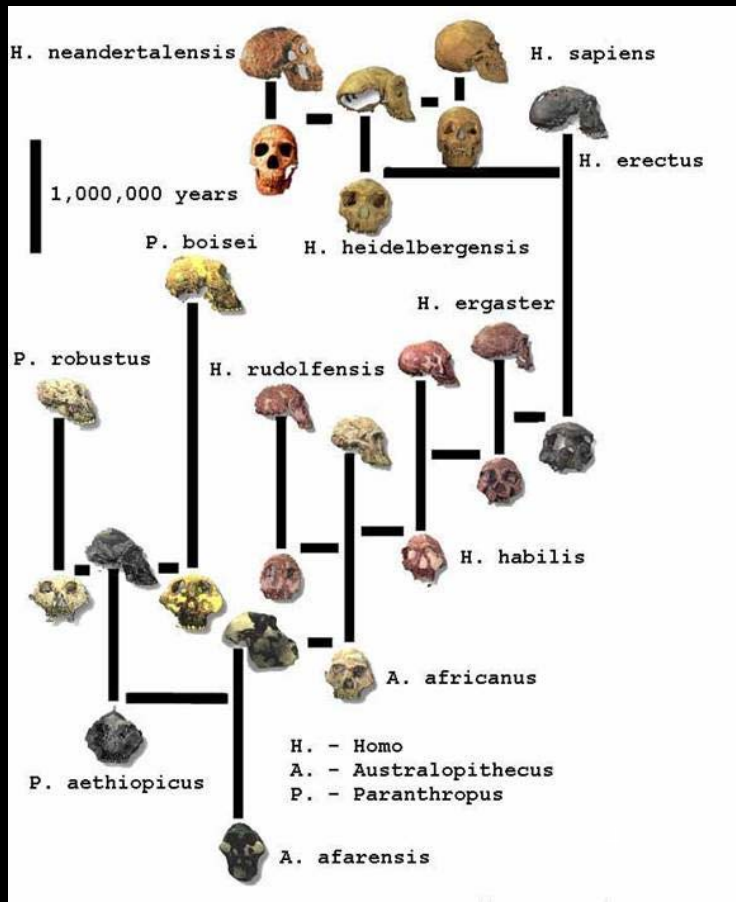


Human evolution and diversity:

Views of evolution:
Fig 1:
Tree (dated, but important – reflects a particular View of nature)

versus

bush (contemporary view)



History of biodiversity:
500 Million Years ago: the Cambrian Explosion

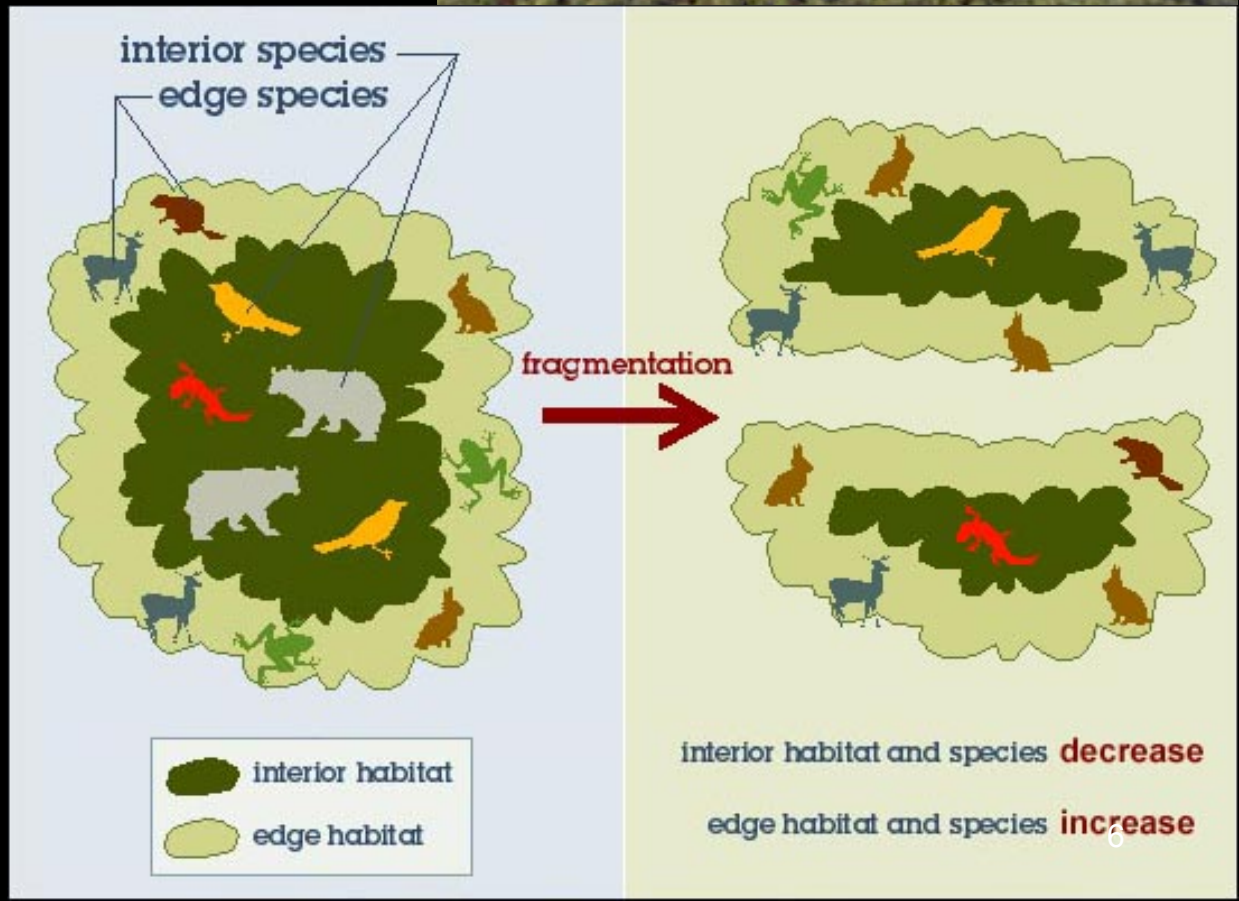
In the image above, trilobites (1) live among many species that are not normally preserved. A typical Cambrian outcrop might produce only trilobites, brachiopods (2), mollusks (3), and crinoids (4). That is a tiny fraction of the full Cambrian biota, better represented by the roster of the Burgess Shale Cambrian Konservat-Lagerstatten. That community includes sponges *Vauxia* (5), *Hazelia* (6), and *Eifellia* (7); brachipods *Nisusia* (2); priapulid worms *Ottoia* (8); trilobites *Olenoides* (1); other arthropods such as *Sidneyia* (9), *Leanchoilia* (10), *Marella* (11), *Canadaspis* (12), *Helmetia* (13), *Burgessia* (14), *Tegopelte* (15), *Naraoia* (16), *Waptia* (17), *Sanctacaris* (18), and *Odaraia* (19); lobopods *Hallucigenia* (20) and *Aysheaia* (21); mollusks *Scenella* (3); echinoderms *Echmatocrinus* (4); and chordates *Pikaia* (22); among other oddities, including *Haplophrentis* (23), *Opabinia* (24), *Dinomischus* (25), *Wiwaxia* (26), *Amiskwia* (27), and *Anomalocaris* (28). ©2002 by S.M. Gon III (composition & linework) & John Wherrall (color rendering)

The original 'diversity-through-interaction' symbiosis: Mitochondria as a symbiotic organism within the genome:

'powerhouse of the cell', Separate DNA, Permitted the rise of genetic complexity by allowing mitochondrial simplicity!

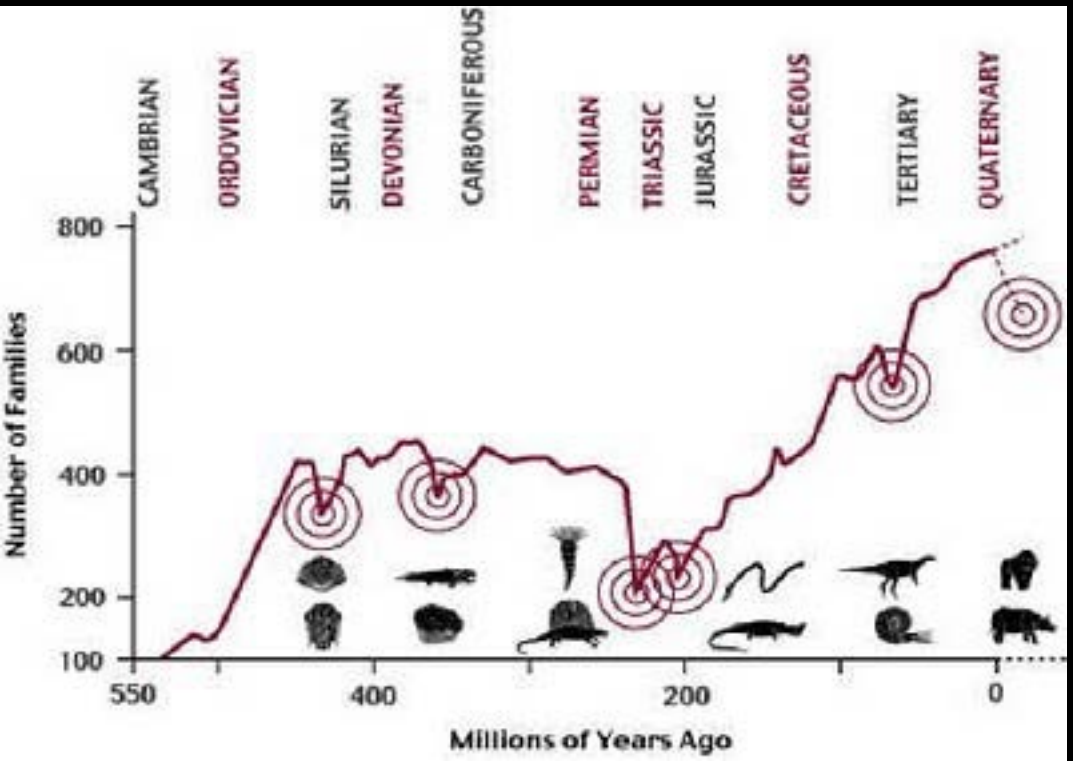
Where does Biodiversity come from?

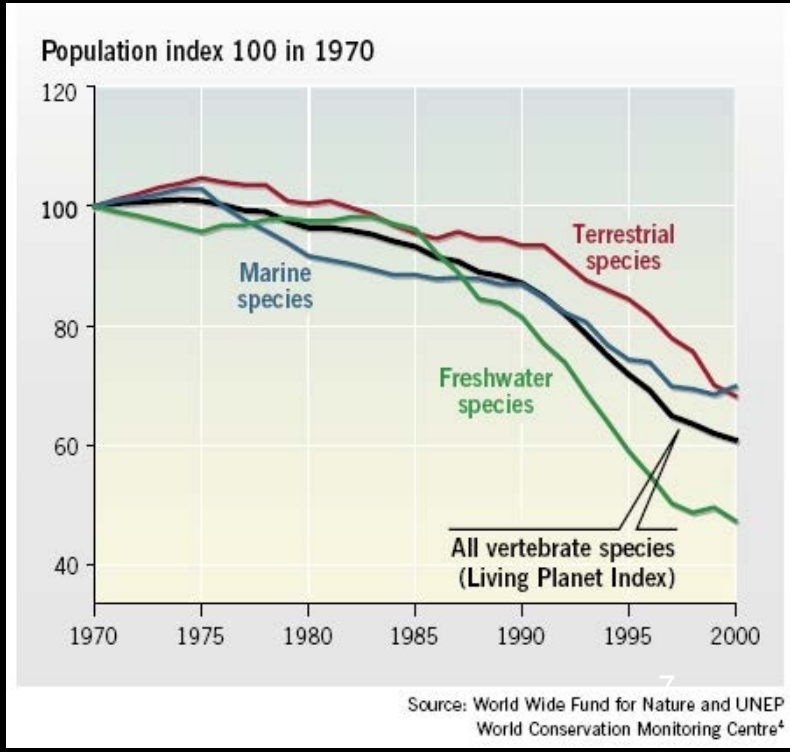
2. Relations *between* species:
- **coevolutionary relationships: mutualism, symbiosis,**
- **Allopathy – Separation of species**



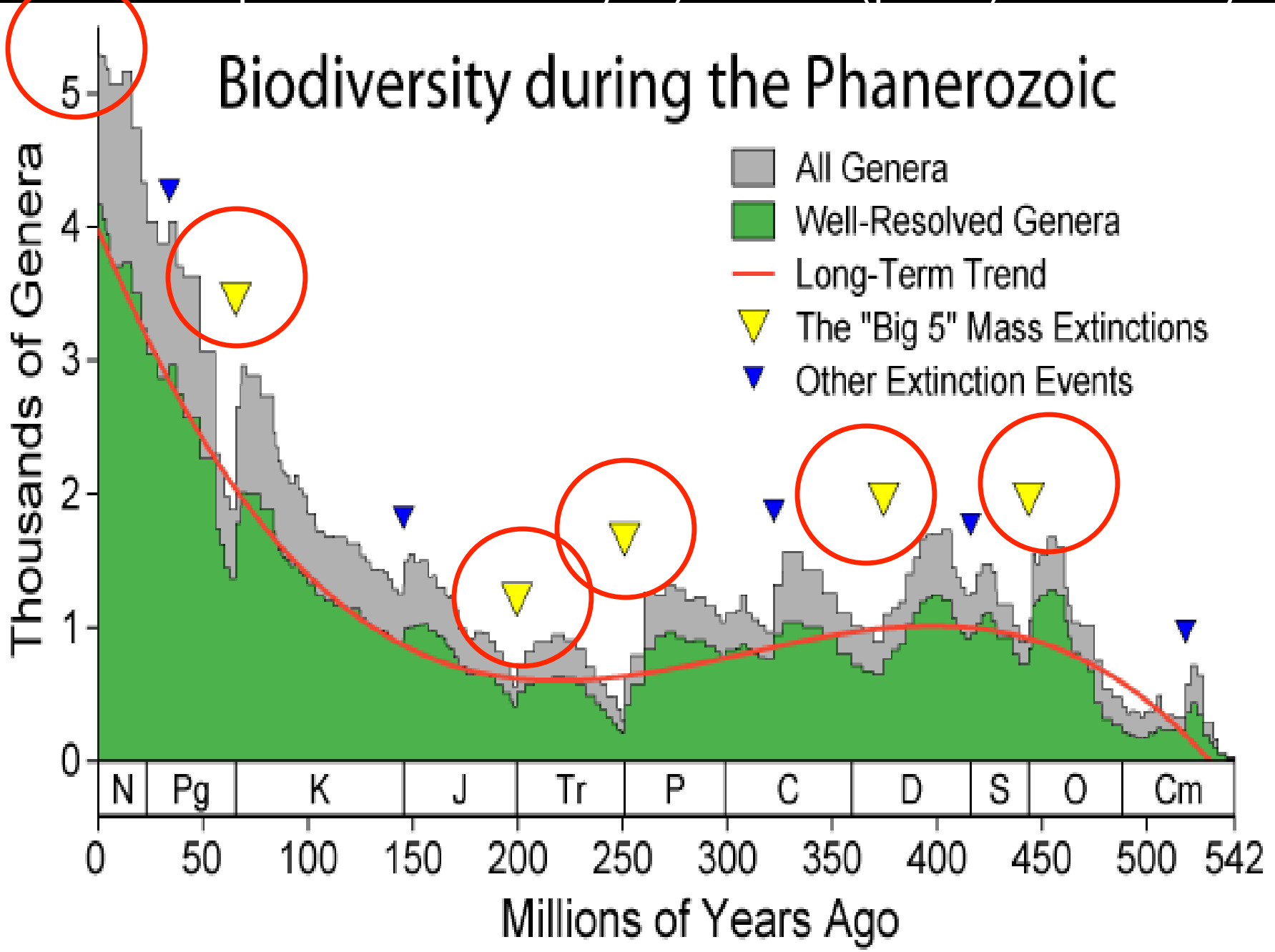
BIODIVERSITY LOSS:
Question of our age: Are humans causing the sixth great (anthropogenic) mass extinction?

Are we on the verge of triggering a sixth worldwide collapse in species diversity?





Examples of Biodiversity: 1) ancient (paleo) biodiversity



So what?
why should we care about biodiversity?
What has biodiversity done for me lately?

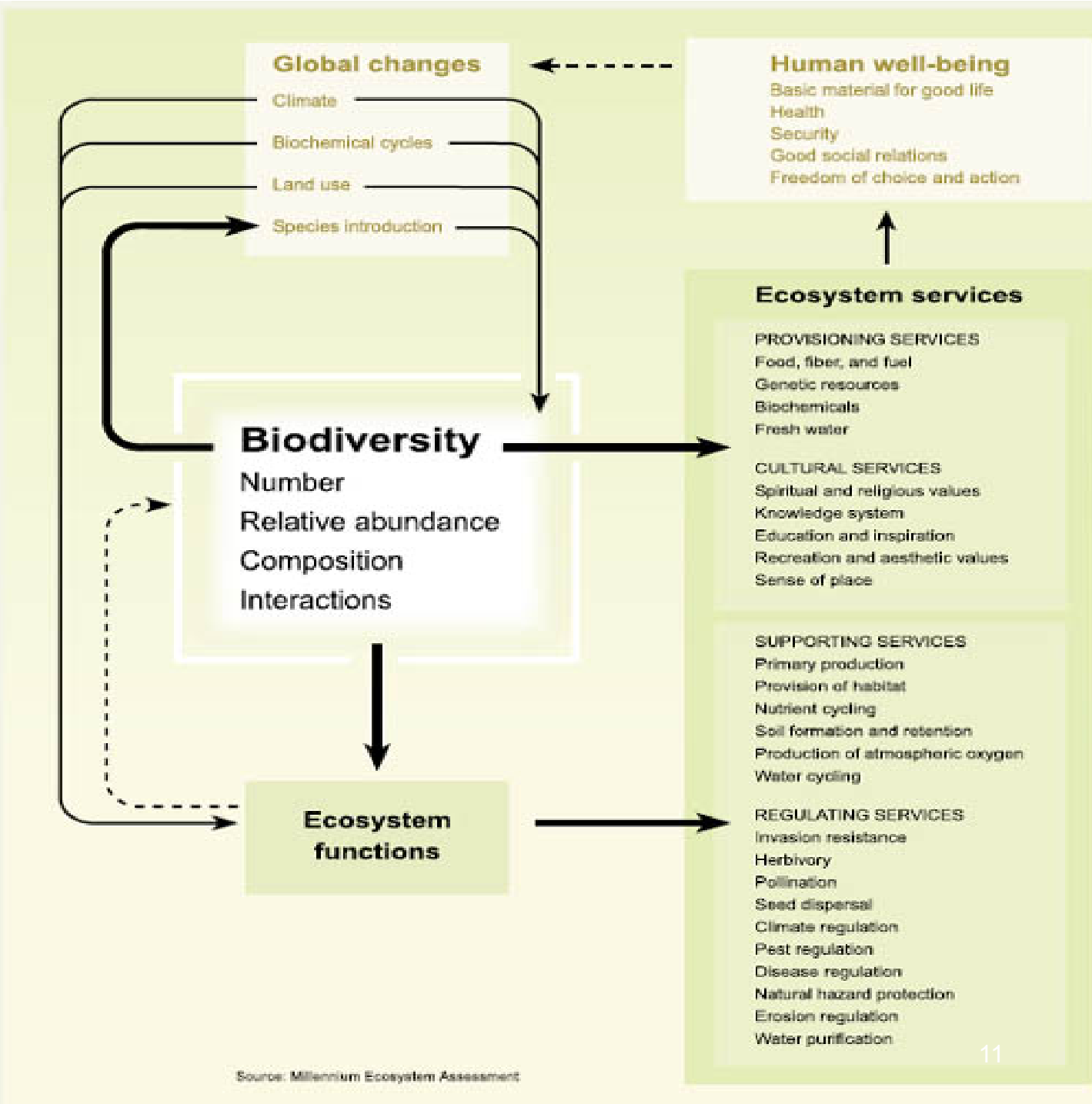
a. **beauty of biodiversity, the 'spice of life', children develop better when exposed to greater diversity, both microbiologically and psychologically.**

Diversity is beautiful!

b. Lifeforms provide important sources for medicines, fibers, materials: losing biodiversity means also a loss in access to important biologically active compounds

25% of medicines currently in use are plant-based

c. Biodiversity provides important environmental services such as carbon sequestration and water capture.



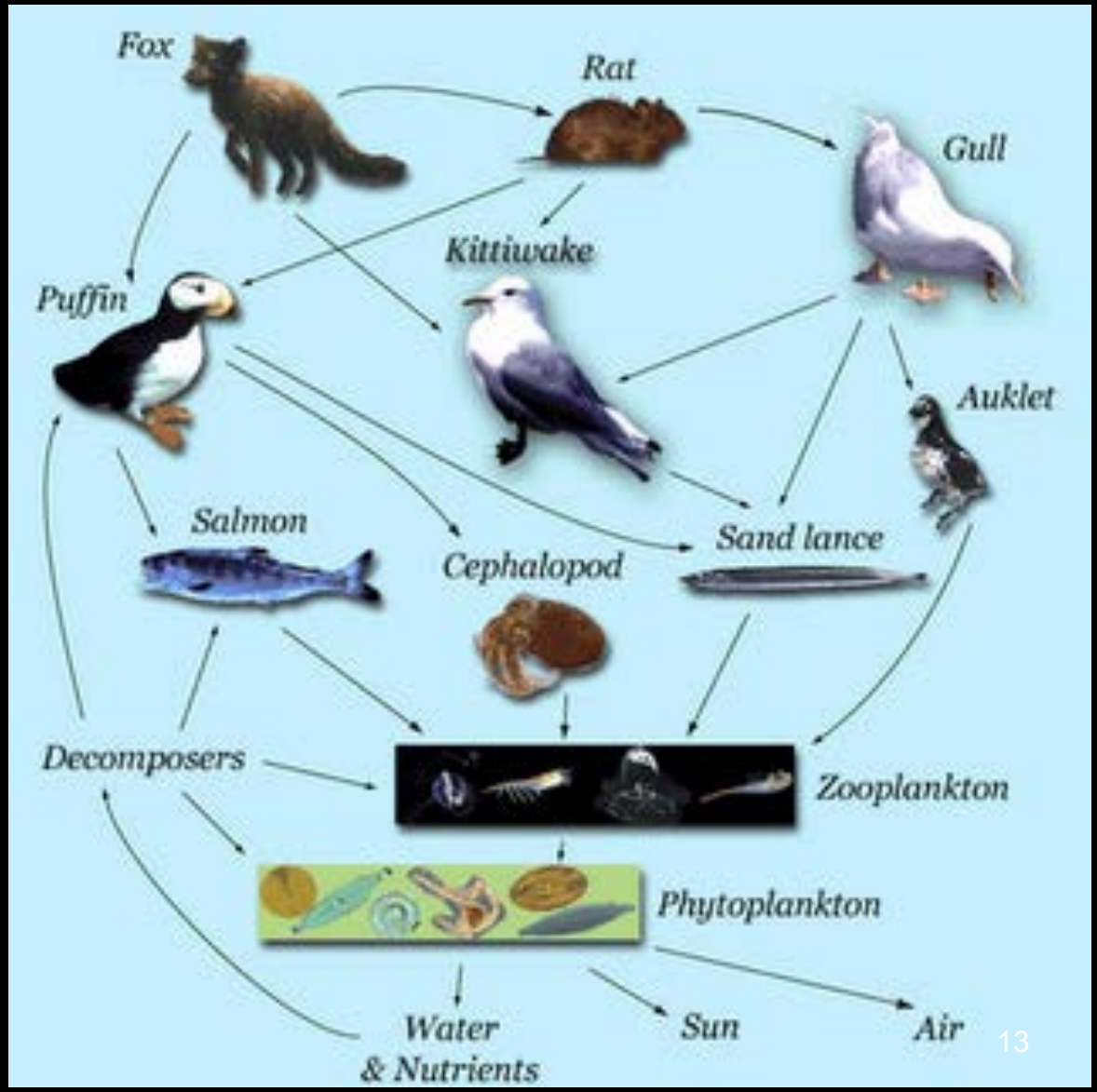
d. Biodiversity in number of crops increases total productivity by 10% by making better use of space: polycultures

- **Genetic diversity in crop plants and plants increases the stability of both global and local food sources by protecting populations from diseases.**

Banana variety risks wipeout from deadly fungus wilt

World's most popular banana variety could disappear because of a fungus spreading across the globe, and FAO warns it could cost $47m to save the species

e. A final concern for biodiversity: Collapse due to ecological dependency or species interrelations: how many species may be lost before the web of life begins to collapse?



Biodiversity moral: no reason not to expend necessary resources to protect existing diversity of life:

- **there is plenty of food, fiber, and other items without expanding acreages under cultivation or stripping old-growth forests, or drilling new oil wells**
- **We can't replace lost biodiversity**

Biodiversity part 2
analyzing biodiversity

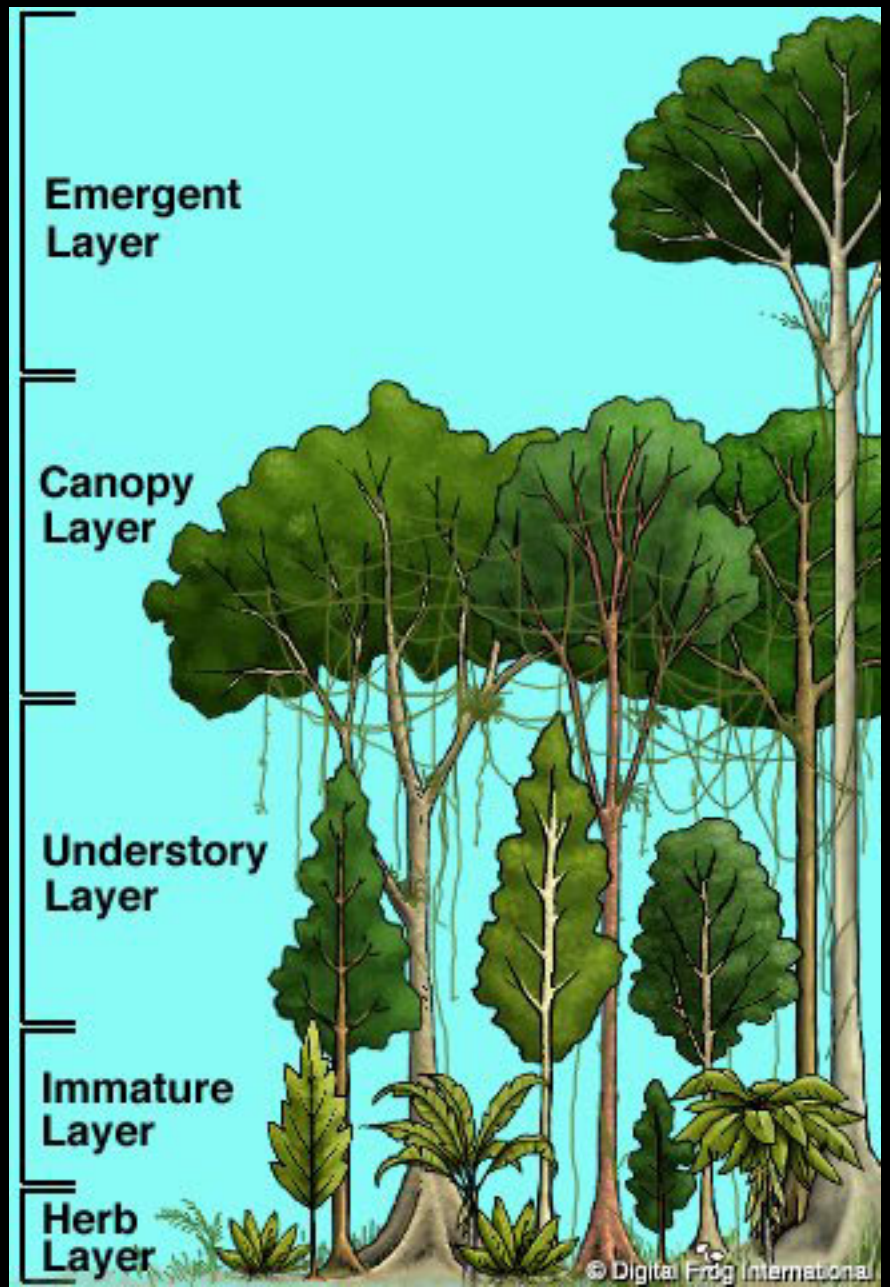
How do we measure biodiversity?

1. Uncertainty is a central problem
Numbers of species
1.75 million species scientifically identified.
estimated 30 million species on earth.
estimated 40,000 species rendered extinct annually.

Table 2 Approximate numbers of described species (in thousands) currently recognized and estimates of possible species richness for groups with more than 20 000 described species and/or estimated to include in excess of 100 000 species. The reliability of all estimates is likely to vary greatly. (After Hawksworth and Kalin-Arroyo 1995.)

		Number of estimated species			
	Described species	High	Low	Working figure	Accuracy of working figure
Viruses	4	1000	50	400	Very poor
Bacteria	4	3000	50	1000	Very poor
Fungi	72	2700	200	1500	Moderate
'Protozoa'	40	200	60	200	Very poor
'Algae'	40	1000	150	400	Very poor
Plants	270	500	300	320	Good
Nematodes	25	1000	100	400	Poor
Arthropodsi					
Crustaceans	40	200	75	150	Moderate
Arachnids	75	1000	300	750	Moderate
Insects	950	100 000	2000	8000	Moderate
Molluscs	70	200	100	200	Moderate
Chordates	45	55	50	50	Good
[Others	115	800	200	250	Moderate]
Totals	1750	111 655	3635	13 620	Very poor

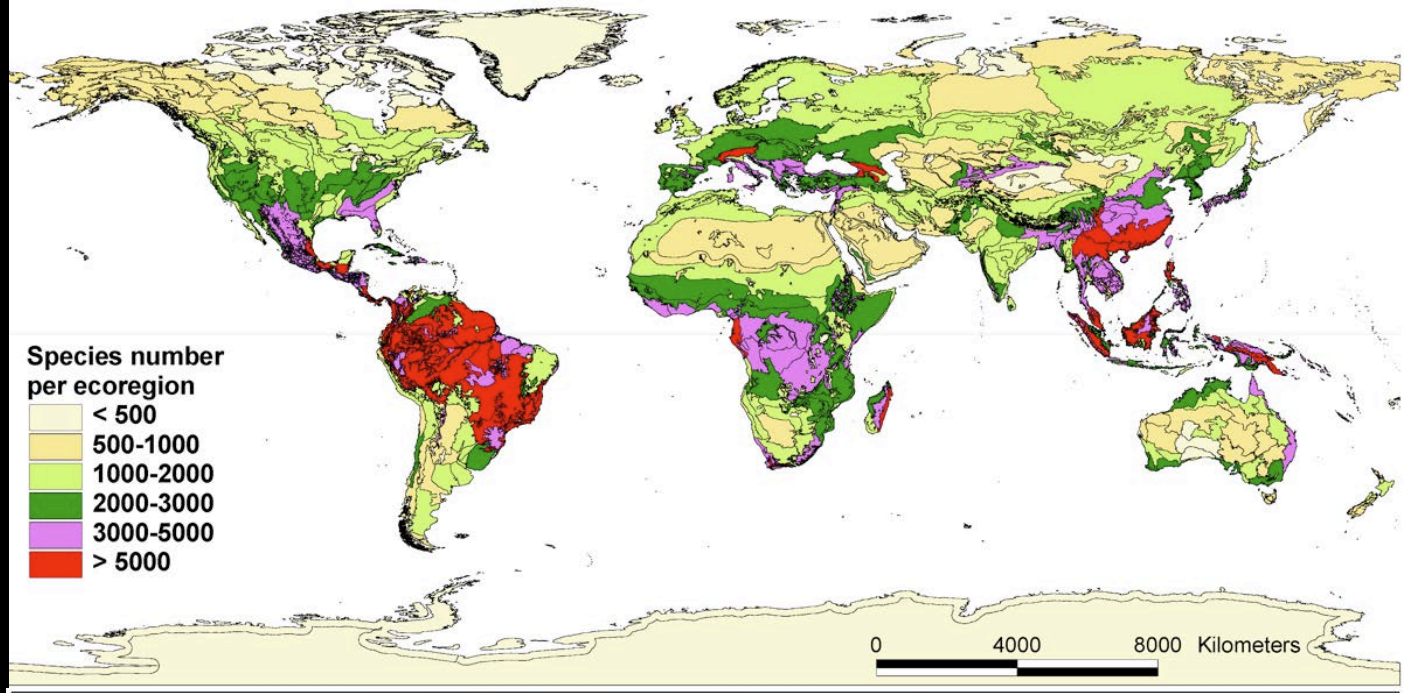
Issue 2:
Niche complexity & spatial distribution within a patch, what biodiversity do we protect? How are they interrelated?

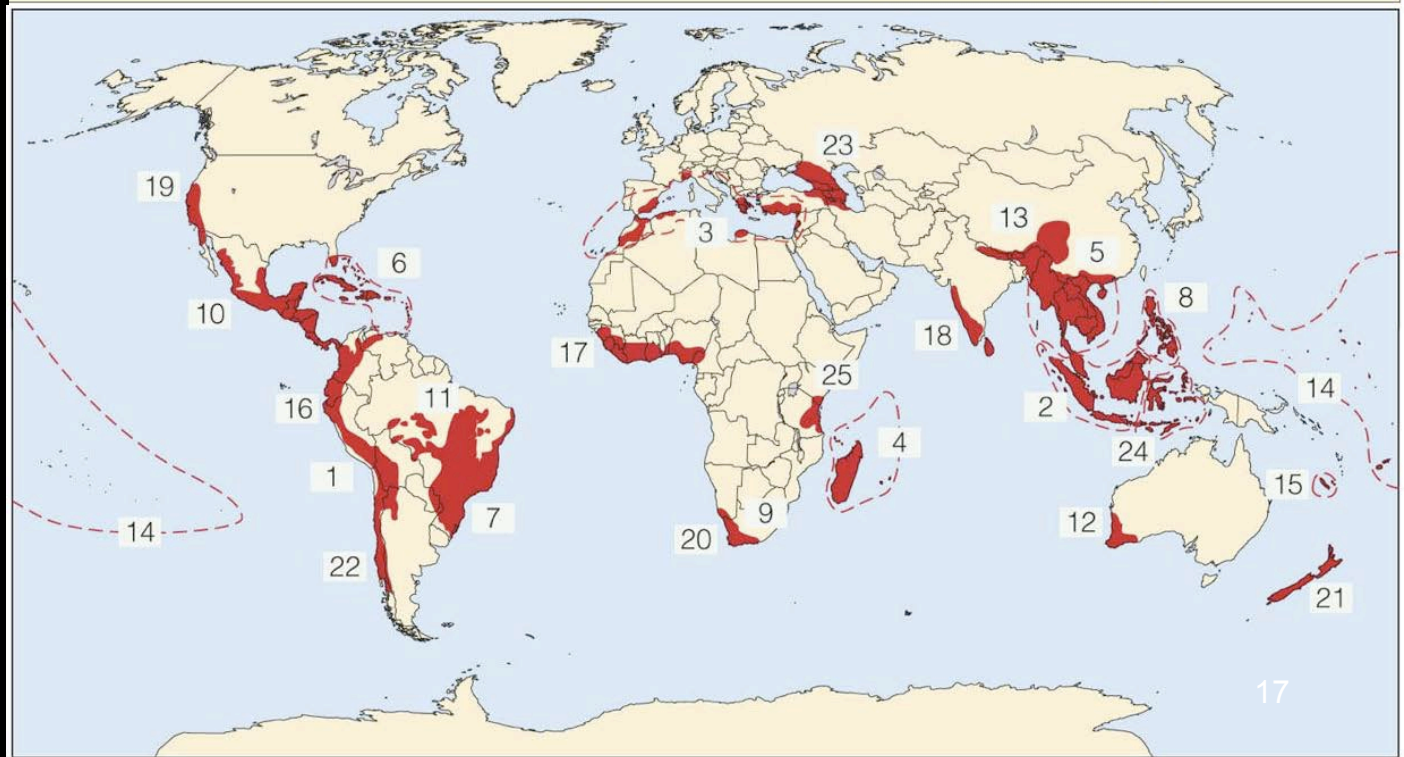


Issue 4: biodiversity hot spots:

what is a biodiversity 'hot spot'?

how do types of biodiversity and processes of bio-diversification create in hot spots?

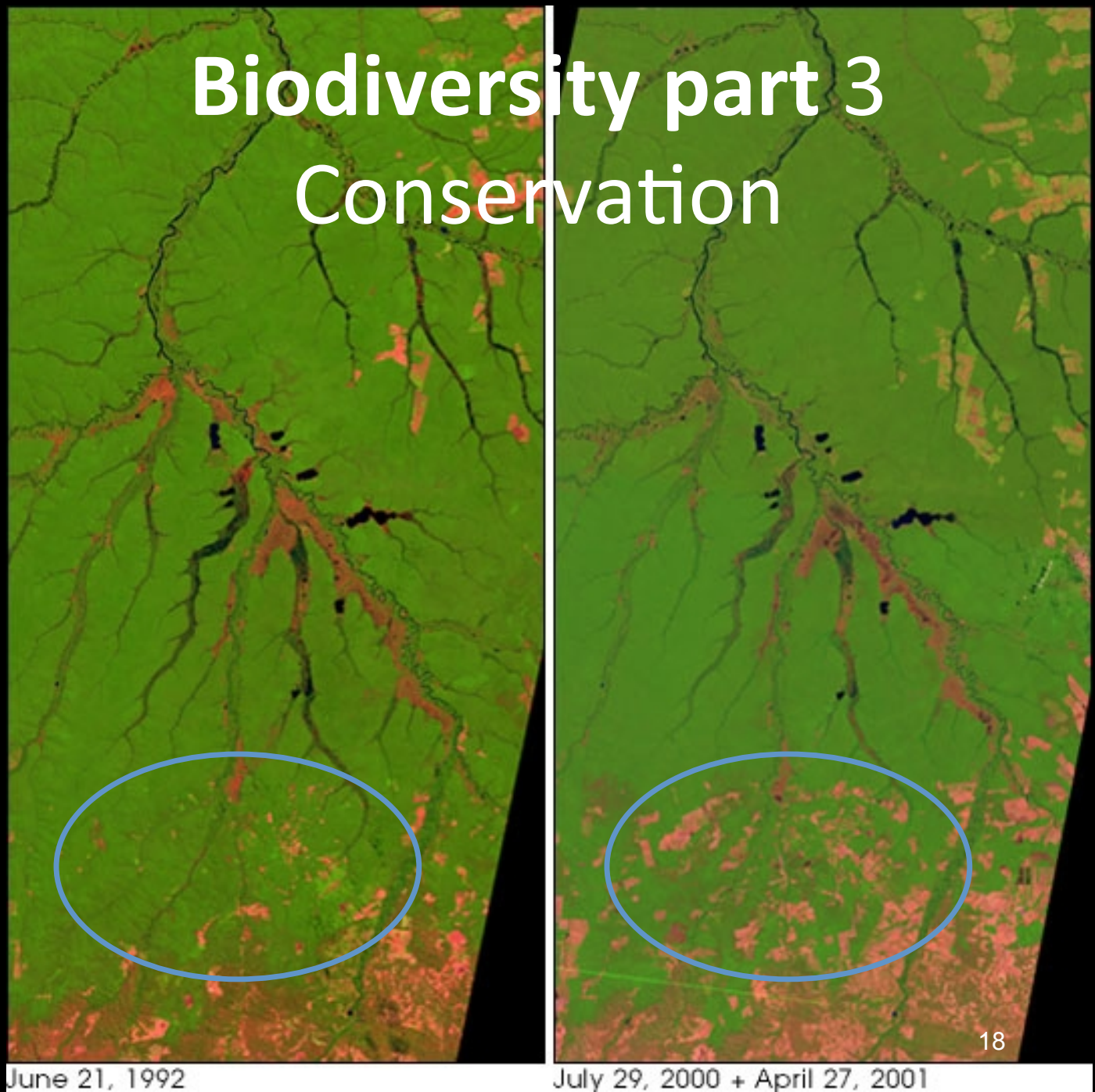




Biodiversity part 3
Conservation

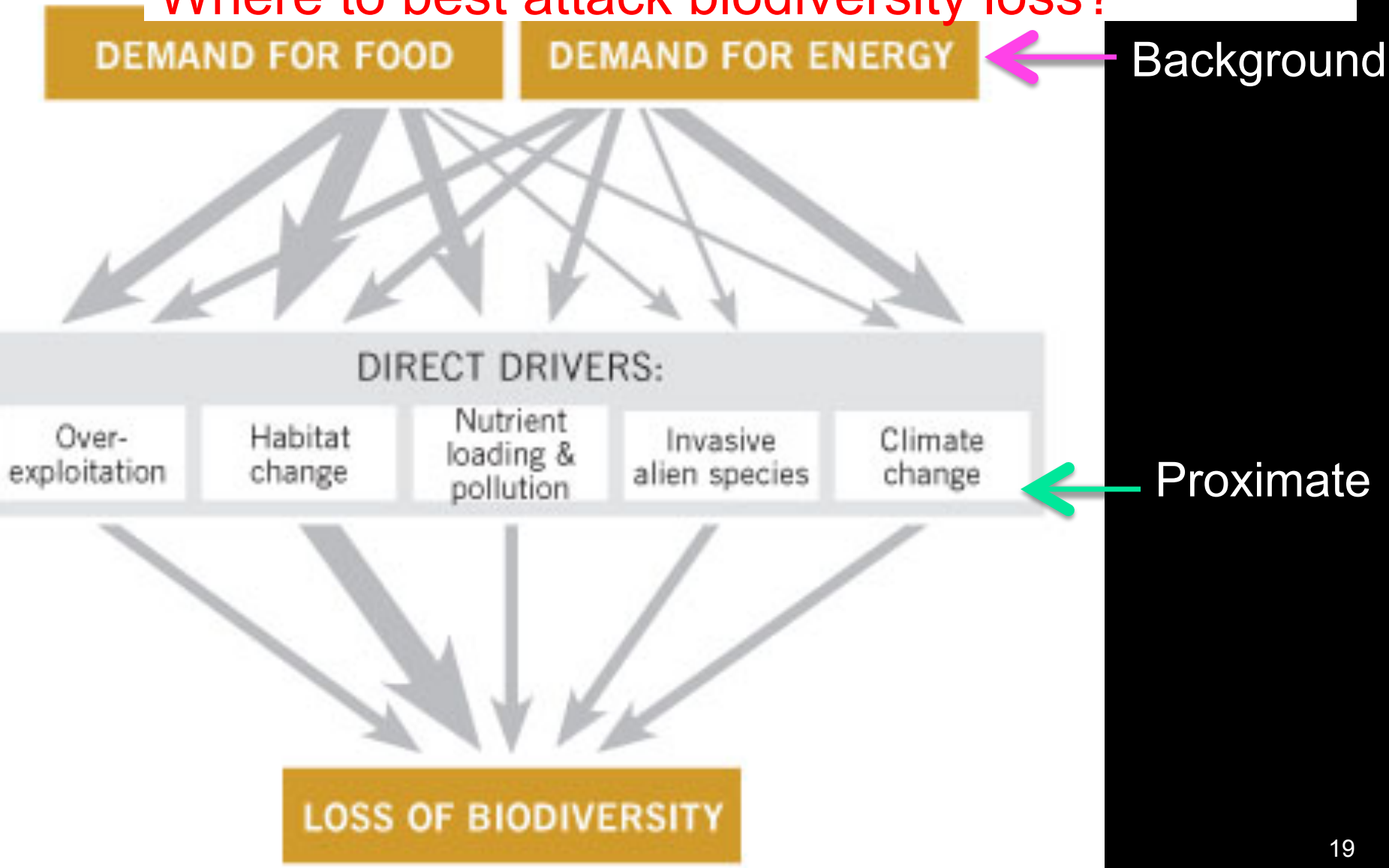
Conservation 1:

Balancing between human exploitation and habitat conservation



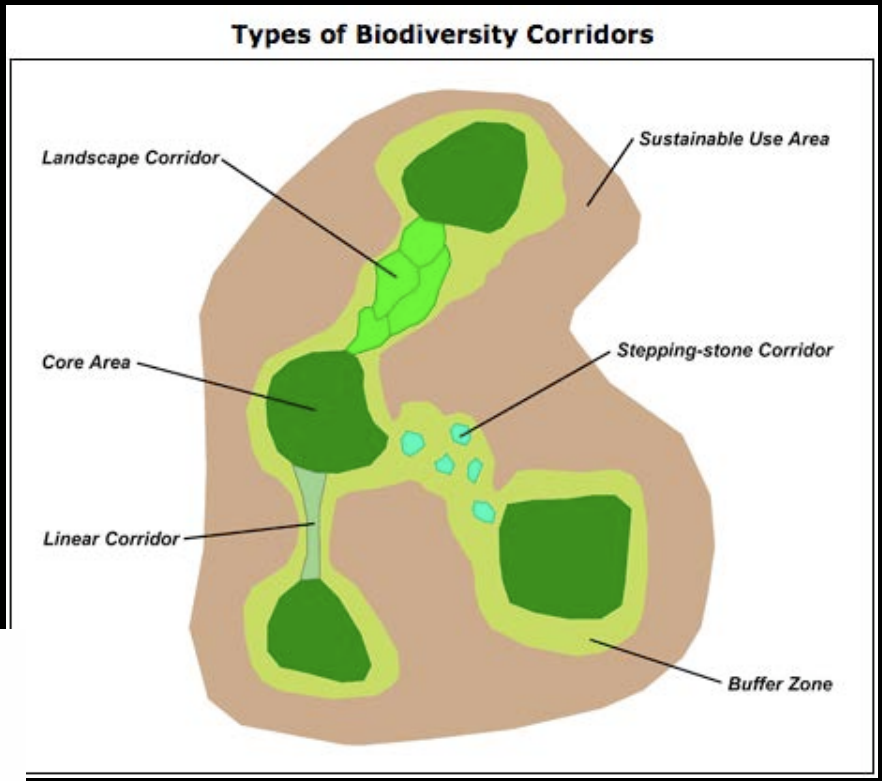
Satellite Photo: Spread of farming

Conservation 2: separating background versus Proximate Causes:
Where to best attack biodiversity loss?



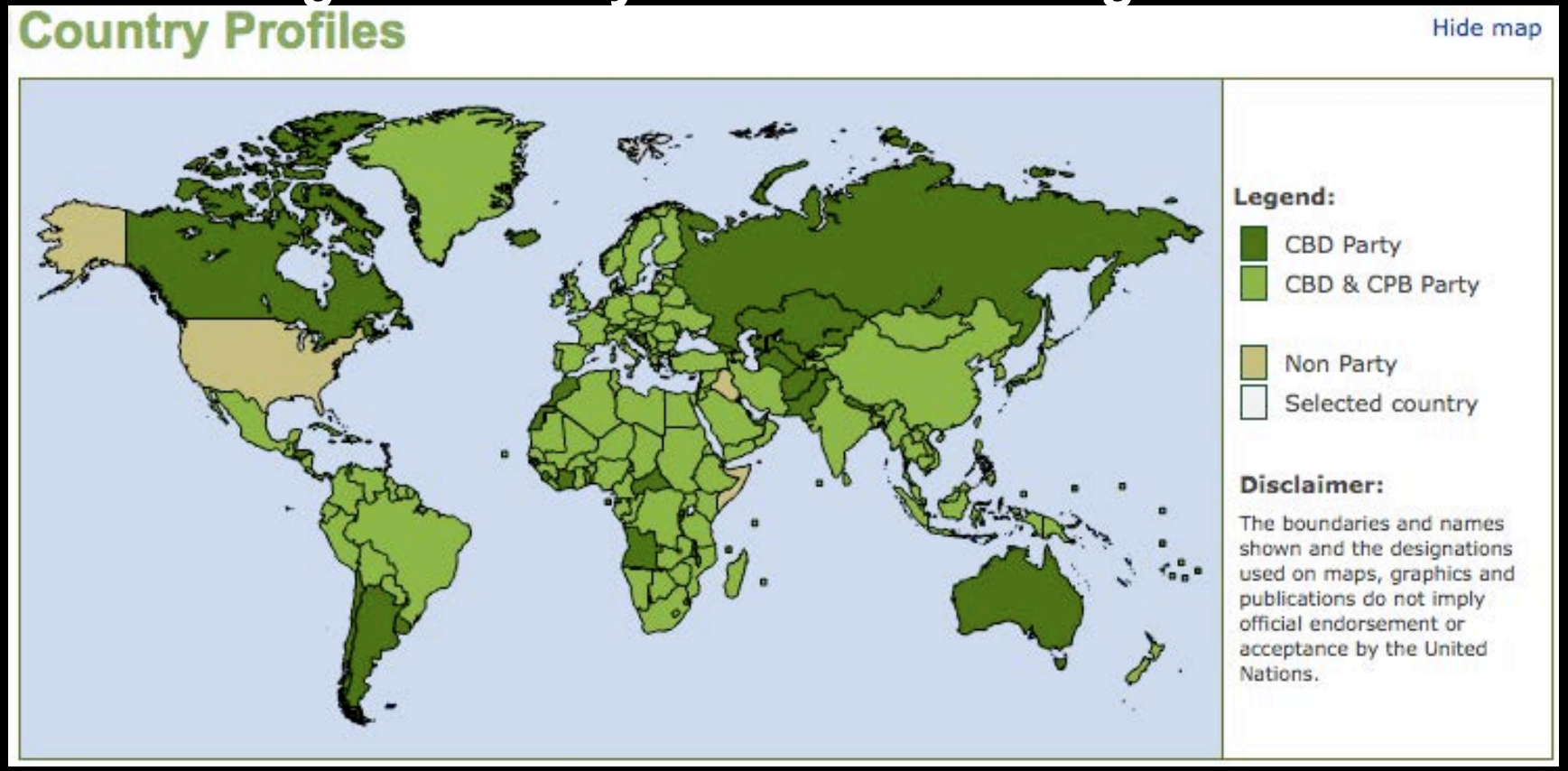
Issue 3: how to use our knowledge of biodiversity mechanisms to design functional conservation schemes?

Do we mitigate?
When to Design conservation areas and policies
Without addressing background causes?



Mesoamerican bio-corridor

Issue 4: The politics of biodiversity:
What do we know? How do we know it?
Convention on Biodiversity: the US is supposed to measure biodiversity, but has limited funds for the US Biological Survey and HAS NOT signed the



Review: 1. Biodiversity, what is it good for?

a. Genetic Diversity Within Species: protecting from disease and permitting adaptation

vulnerable

Versus

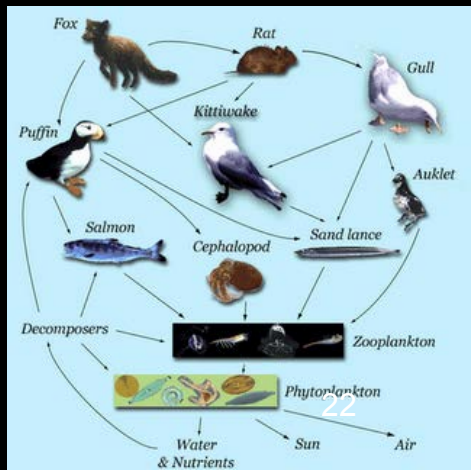
robust

b. Species Diversity: stabilizing environments

agroecological

c. Ecological Diversity

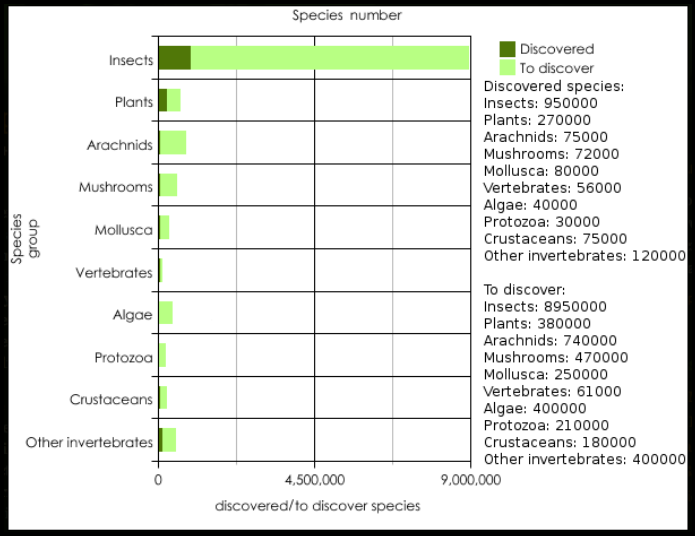
Web of Life: More connections = reduced likelihood of collapse



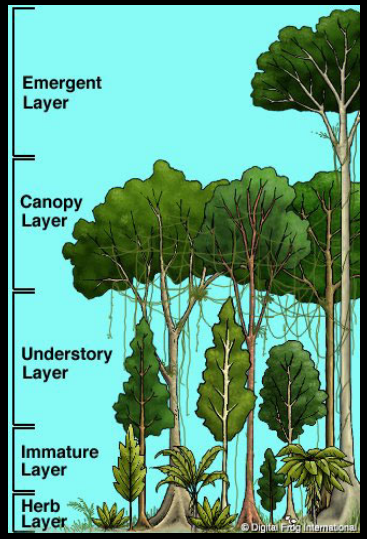
Review: 2. Biodiversity, Where is it?

a. Problem of knowledge: measuring and surveying

Species numbers



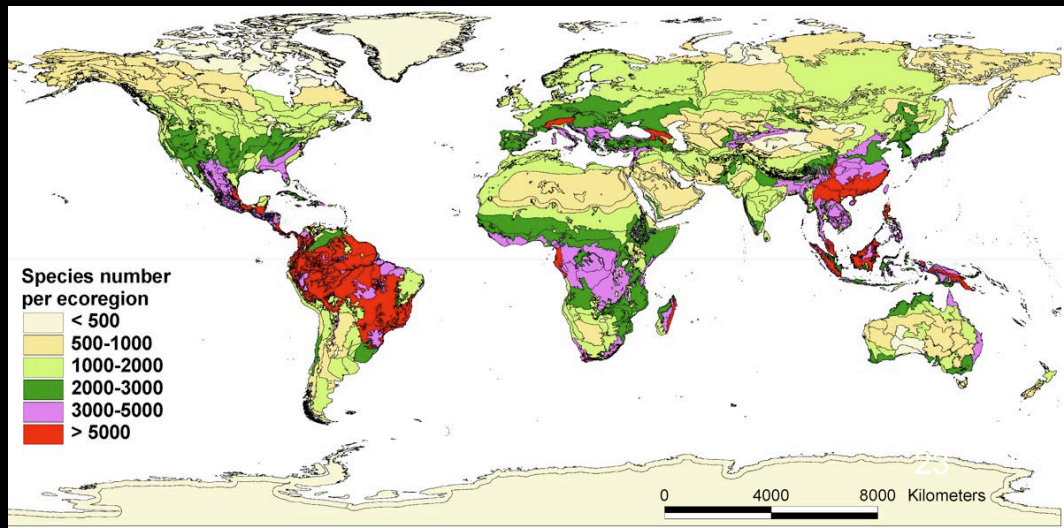
spatiality



temporality

b. Global Distribution

Biodiversity hot spots

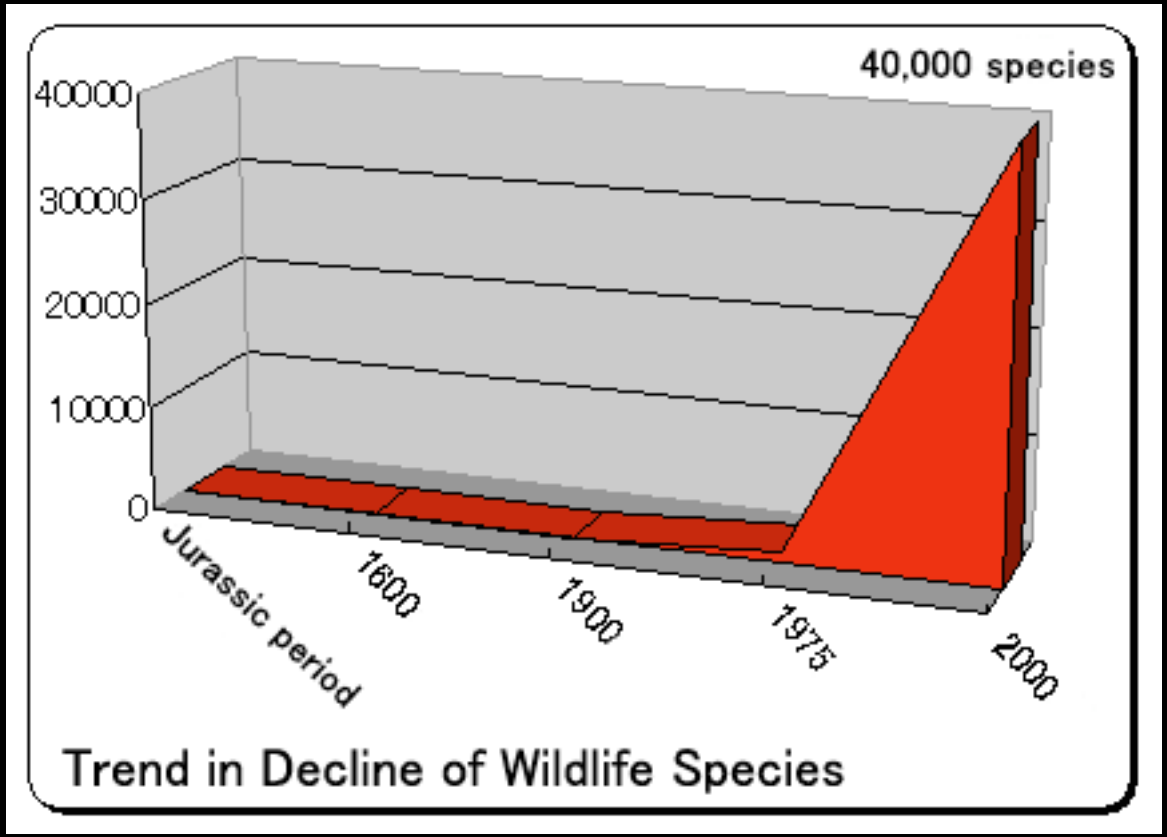


“All that is solid, Melts into air…
all that is holy is profaned, and [we are]
at last compelled to face with sober senses
[our] real conditions of life”

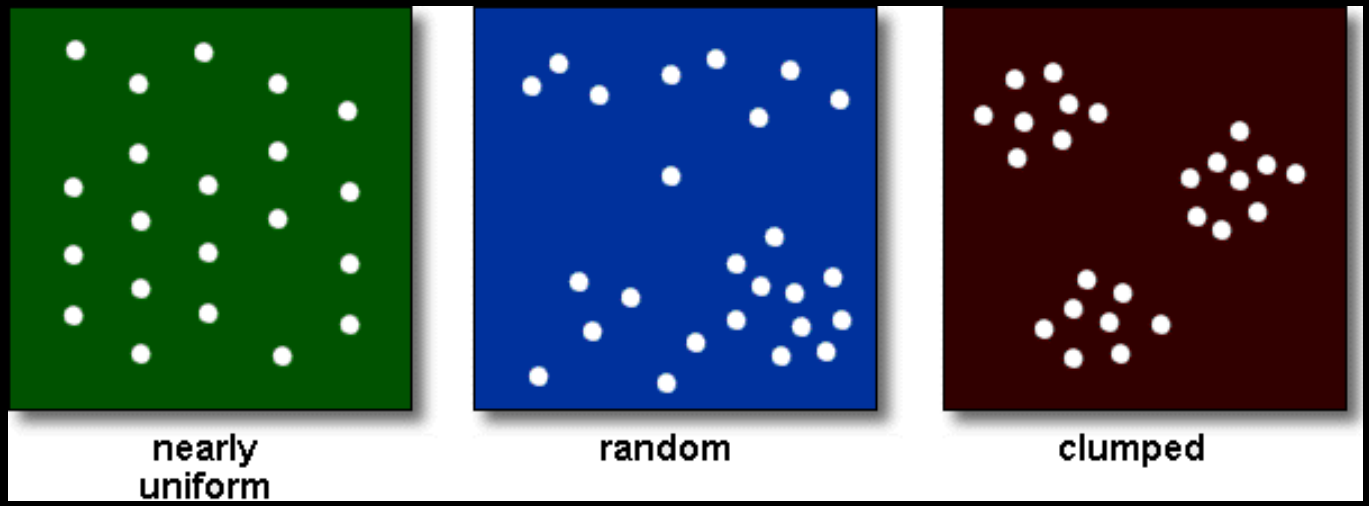
— ??

FIN

i. species loss rates
   a. absolute loss

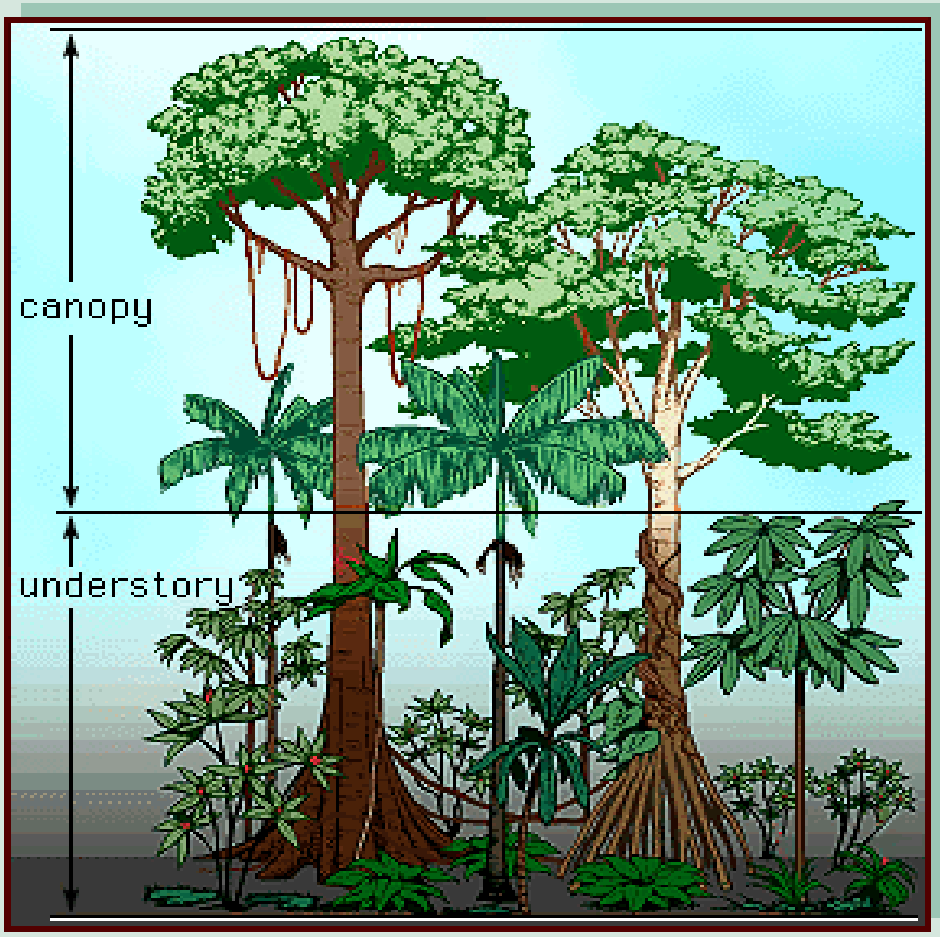


Issue 3: Distribution of populations and sampling problematic

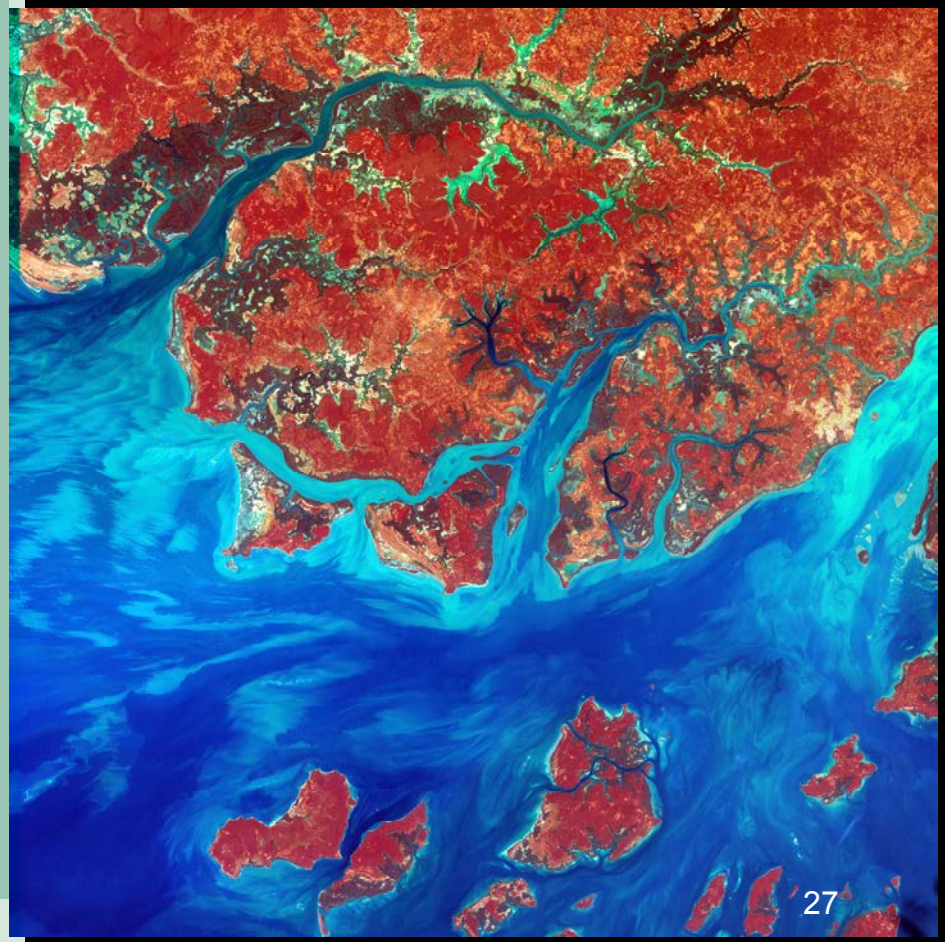


Biodiversity across landscapes: The importance of landscape organization

Rainforest canopy



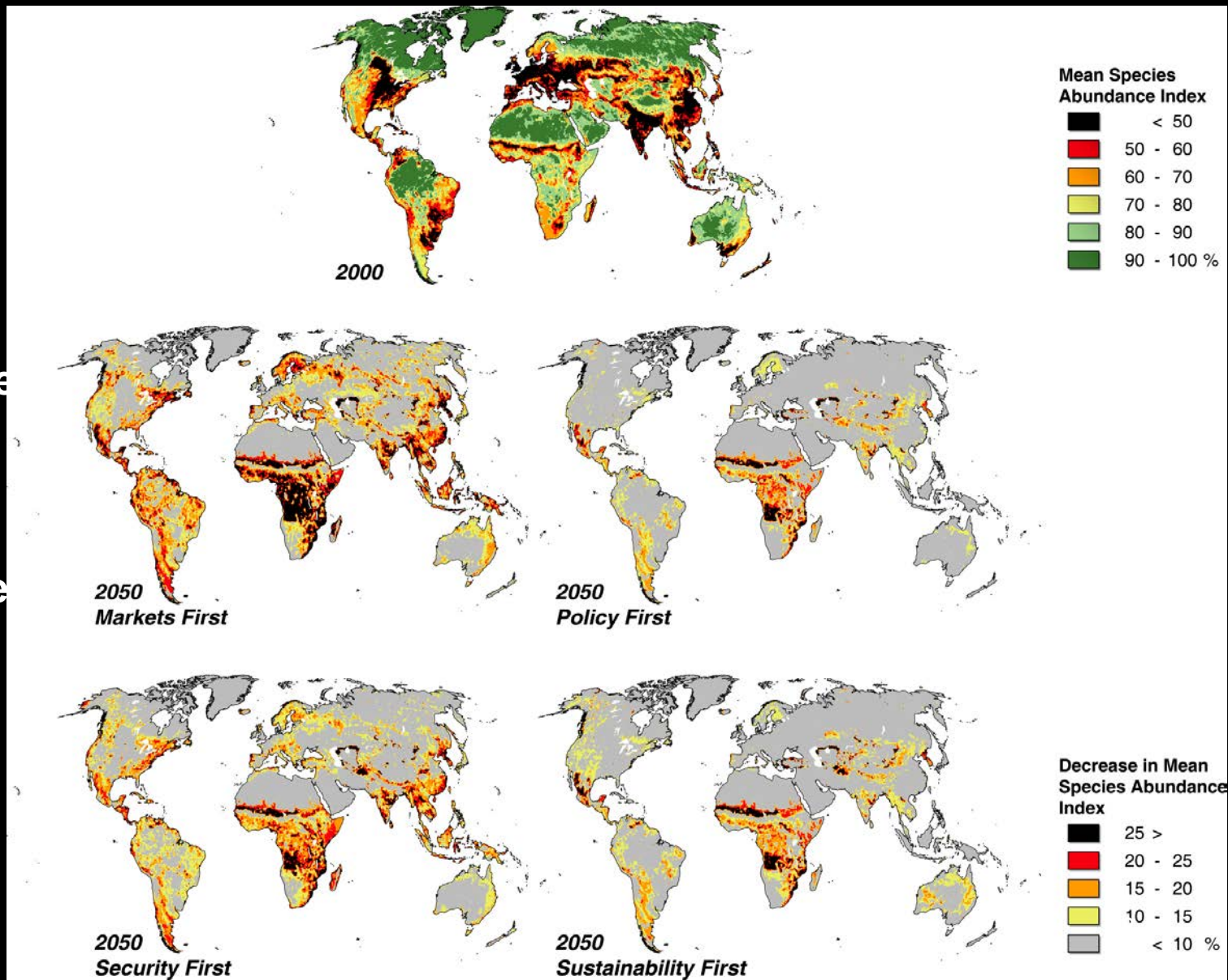
Biodiversity in spatial heterogeneity: Guinea-Bissau coastline



Global Background Economic Drivers, what about the future?

MAP: Biodiversity loss:
4 Scenarios for 2050.

i. **Markets unfettered**
ii. **(growth) Policy-drive**
iii. **(military) security driven**
iv. **Sustainable economies**

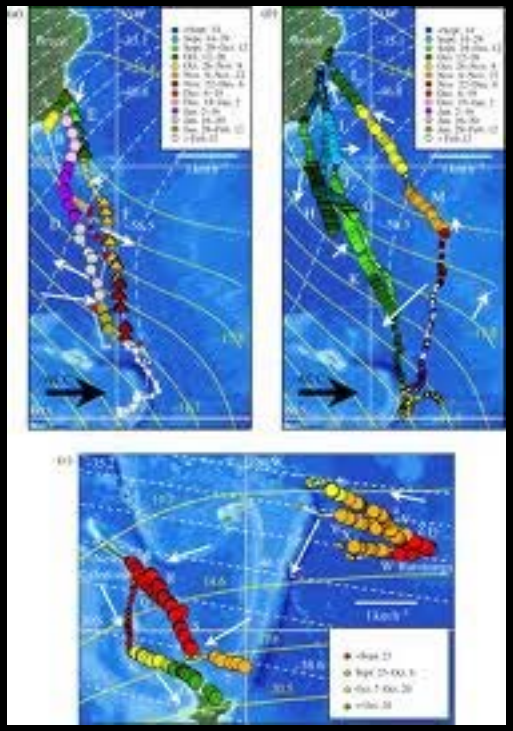


United Nations environmental program Study

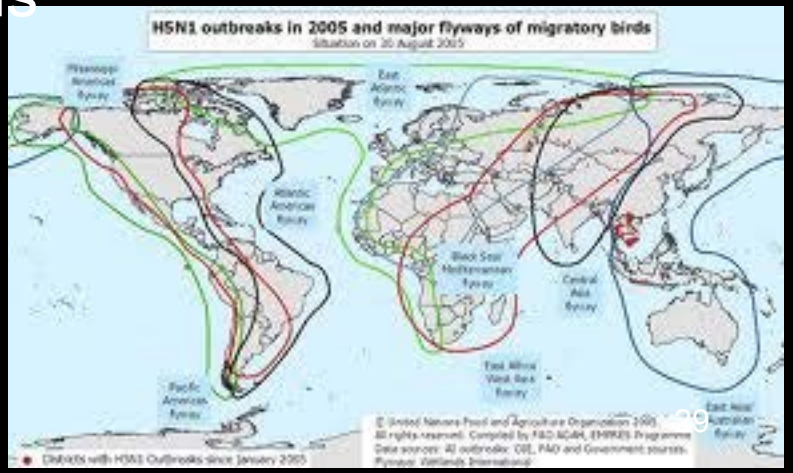
Design: biological corridors, species migrations, conservation

butterflies

whales

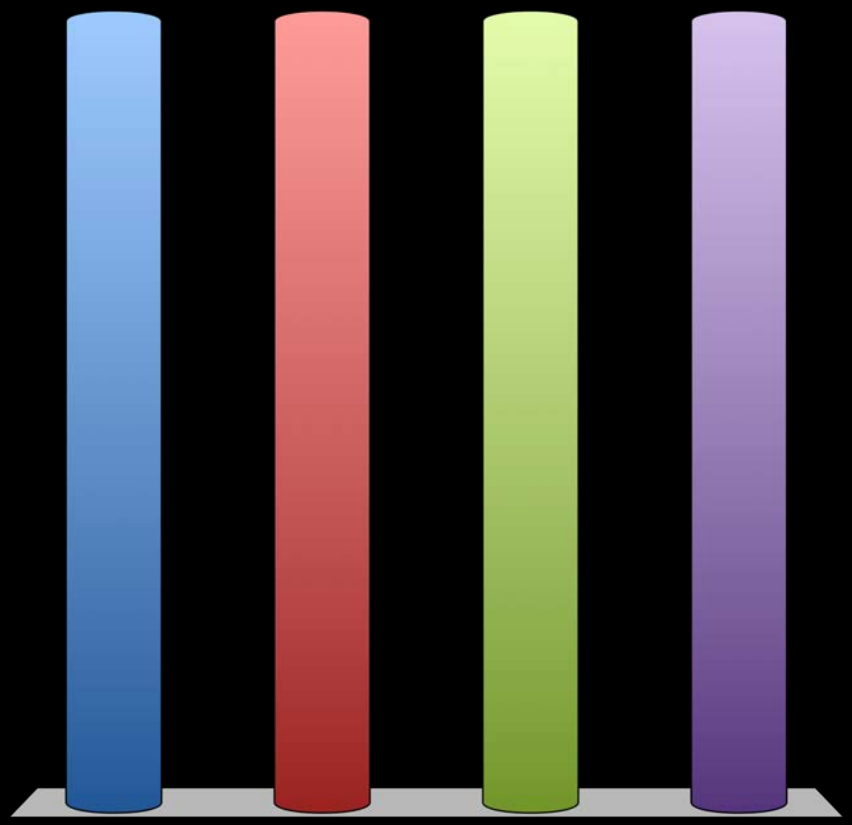


birds



Which group has the greatest percentage of endangered members?

A. amphibians
B. birds
C. reptiles
D. mammals



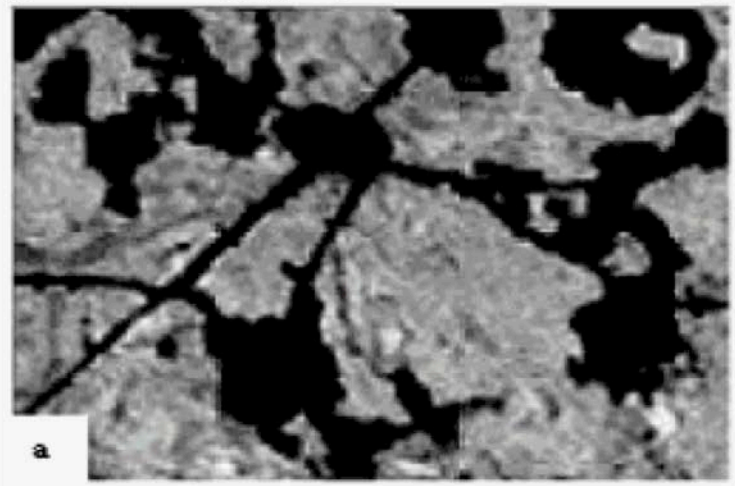
Issue 2: Scale and Geography: evenness versus dominance:

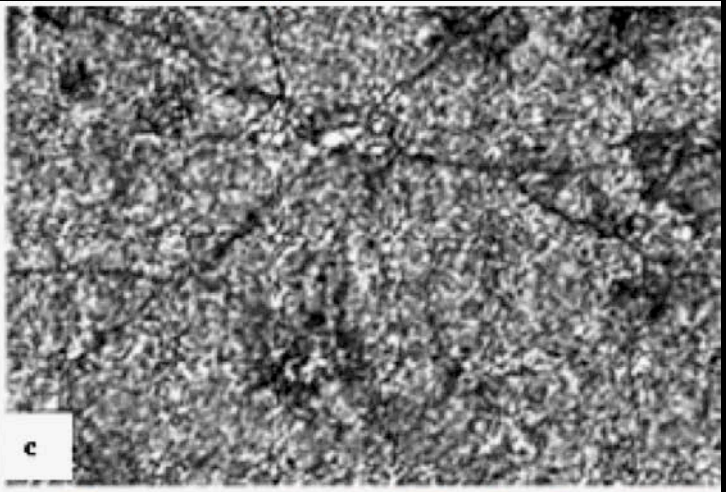
oaks versus lilies.

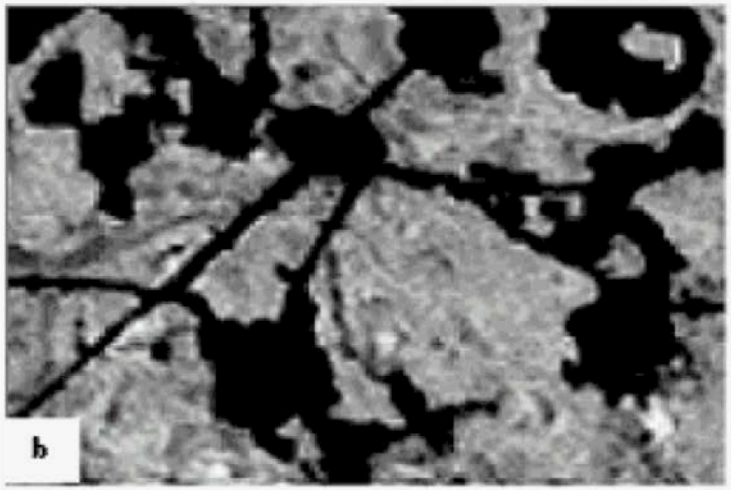
Patch versus Matrix:

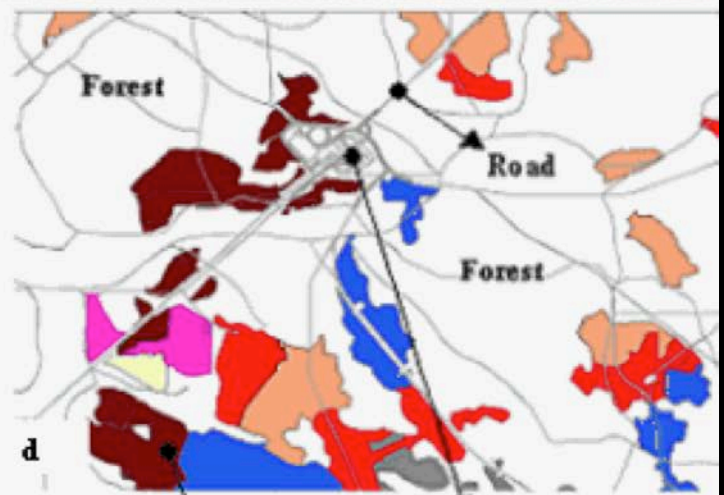
dimensions

geometry: edge effects









Example: Distribution of Biodiversity in Africa:

Biodiversity Differs By Group (e.g., birds, Plants, Mammals Each have Own biogeography

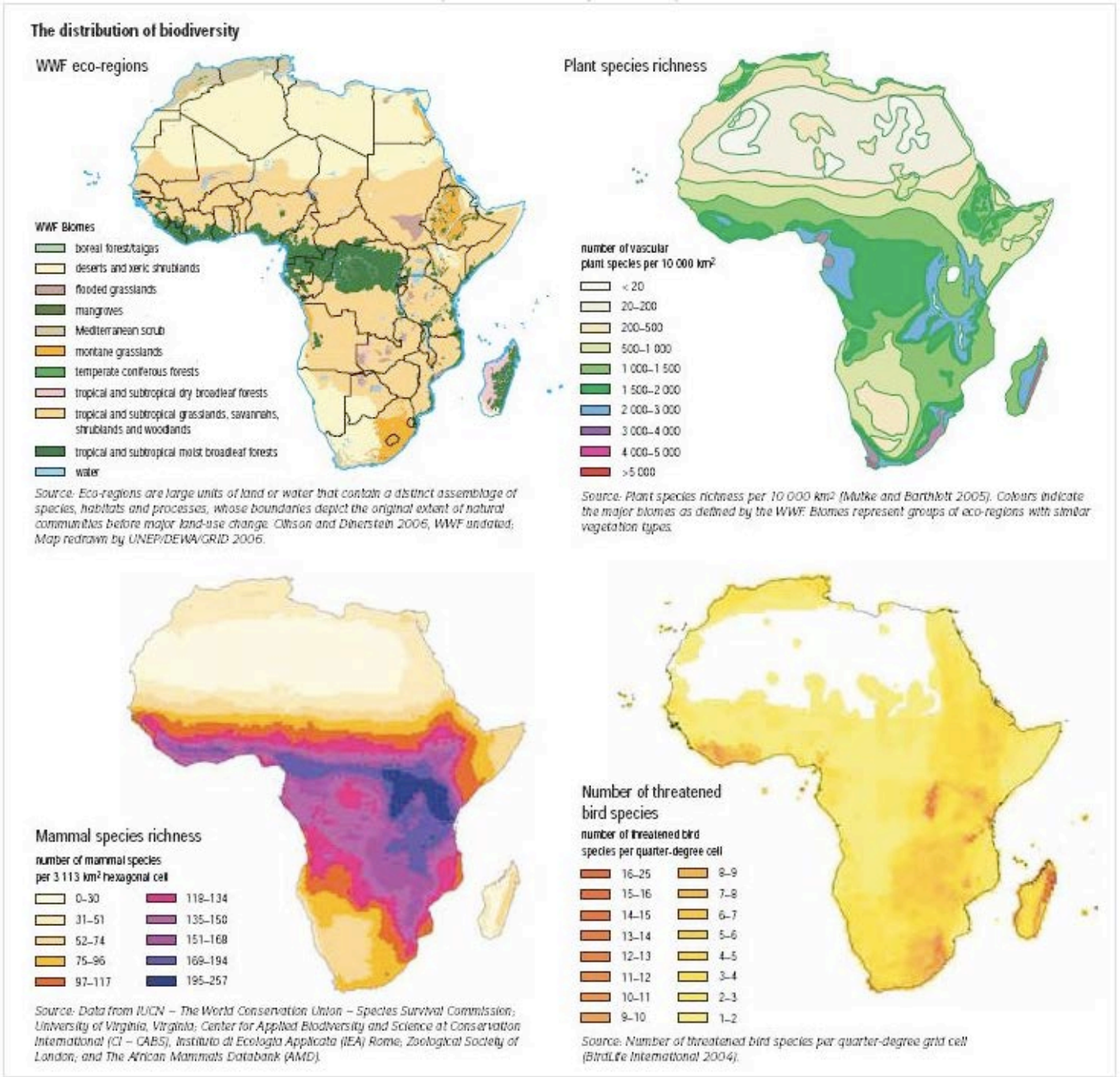


Figure 1: Distribution of biodiversity

f. Finally, let's recollect again:
Biodiversity isn't just 'out there' but also 'in here'!

A concern for any environmental course: How to avoid the creation of artificial distinctions between 'the environment' over there and 'humans' in here?

i. Biodiversity within: the human gut
   symbiosis of digestion and disease
   90% of cells in human body are non-human
   play critical role in digestion and disease prevention
ii. Food, air, allergens, environmental disease
iii. Over-medication through antibiotics can promote ecological imbalance in the human intestine
iv. CASE: Fecal transplants—recent research on fecal transplants shows that some diseases may be cured by changing intestinal bacteria: weight-loss, cancer, even autism? (I remain dubious on this one…)