



COURSE AIM

To introduce the principles of modern scientific biodiversity and conservation biology.

MAIN FOCUS

The basic biological under-pinning of conservation

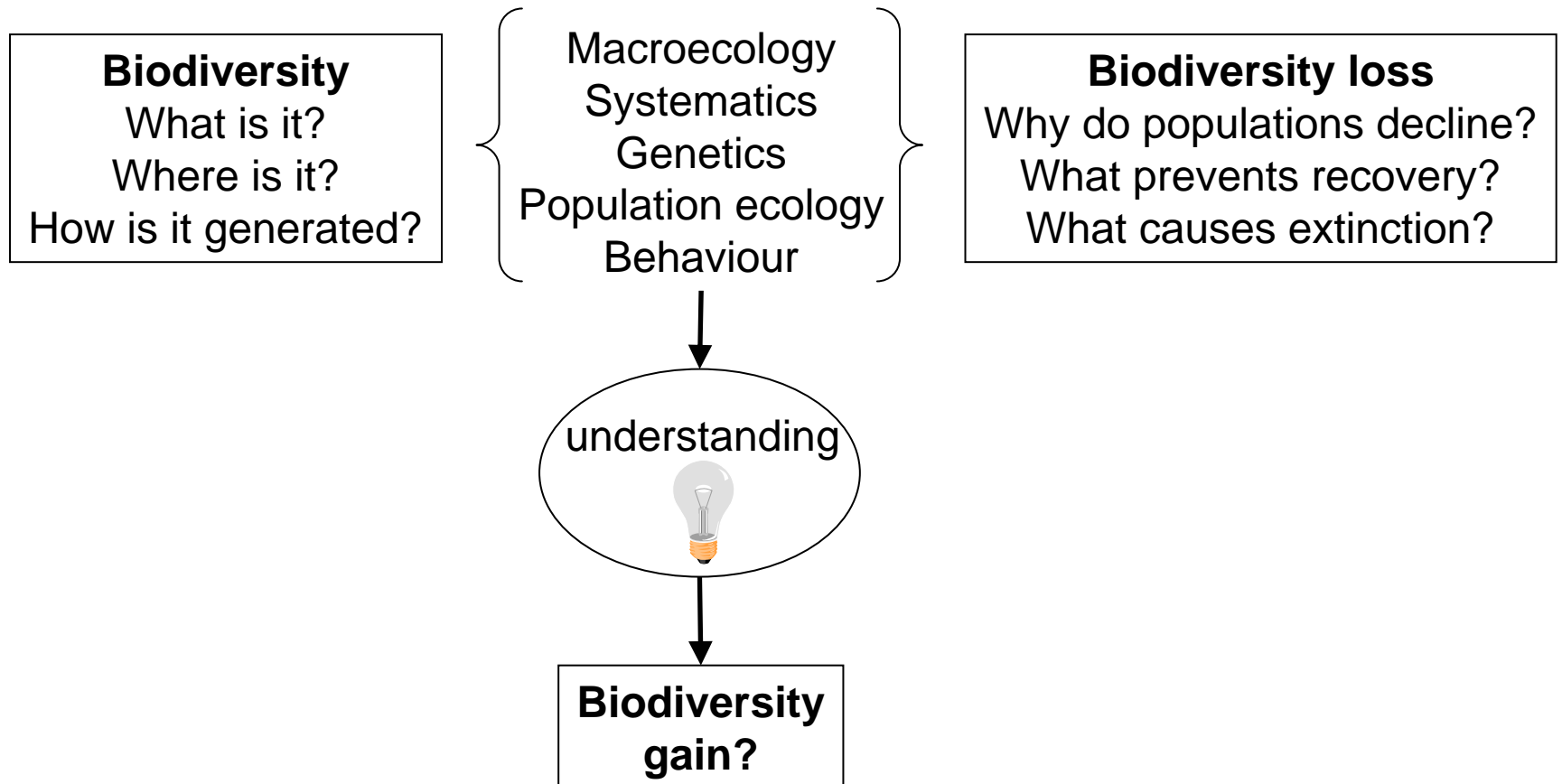
We will also explore some of the inter-disciplinary approaches that are required in order to apply the principles to real conservation problems.

Course rationale



Conservation biology rests on the understanding of:

- What we have to conserve (biodiversity); and
- Why it is threatened (processes of biodiversity loss)





- 1) To **describe** patterns of diversity in the biology, ecology and distribution of animal species and their habitats at regional and global scales.
- 2) To test hypotheses about the ecological processes that may **explain** the origins and maintenance of this diversity.
- 3) To work on the practical **application** of this knowledge in setting priorities for biodiversity conservation.

Outline of my lectures



This week

1. Introduction to biodiversity and macroecology
2. Global patterns
3. Extinction
4. Determining extinction risk

What is biodiversity?



- Biological diversity
- Quote - “The variety of life”
- Quote - “The sum of:
 - Genetic diversity – variation of genes across species
 - Species diversity – variation in the number of species in a given area
 - Ecosystem diversity – the broad range of ecosystem and habitat types”

What is macroecology?



- Large-scale ecology
- Describing biodiversity patterns
- Determining the evolutionary, ecological and environmental processes that generate and maintain these patterns
- Quote - “The integration of ecology, biogeography and macroevolution to answer basic questions about the abundance, distribution and diversity of living things” - James Brown (1995) ‘Macroecology’

The importance of biodiversity



- United Nations Environment Program quote:-
- “Biodiversity is the defining characteristic of planet Earth
- Human beings dominate all other species
- We divert more than one third of the sun's life-giving power to feed ourselves and our livestock
- We have transformed around one third of land to agriculture
- We capture probably more than half the fish production of the oceans and seas every year”

Issue at Hand – Number of species??



Bacteria	4,760
Fungi	46,983
Algae	26,900
Bryophytes	7,000
Gymnosperms	876
Angiosperms	250,000
Protozoans	30,800
Sponges	5,000

Corals and jellyfish	9,000
Roundworms/earthworms	24,000
Crustaceans	40,000
Insects, etc.	950,000
Molluscs	70,000
Fishes	28,100
Amphibians	5,578
Reptiles	8,134
Birds	9,932
Mammals	4,842

Estimated that 30 million insects yet to be described

However – few trained taxonomists/systematists, especially for tropical taxa.

Global issues need large-scale studies



- Major challenges in conservation biology and ecology at present concern phenomena at large spatial scales
- We need to:
 - predict and respond to effects of global environmental change
 - maintain biodiversity
 - control diseases and their vectors
 - monitor and prevent spread of alien invasive species

Growth in 'Human Enterprise'



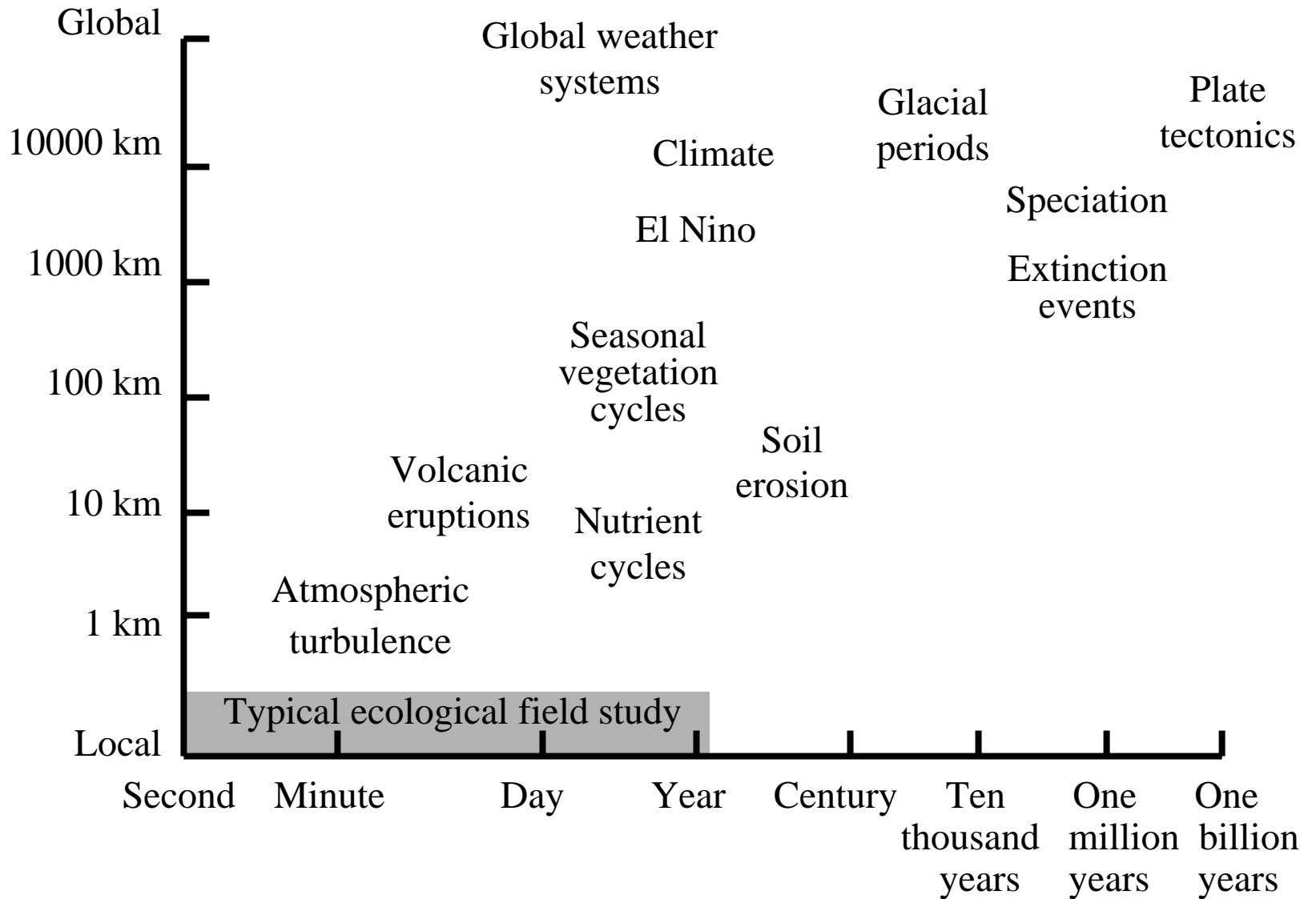
These issues are of concern because of:

- growth in global human population
- associated growth in resource demands
- increase in habitat destruction and degradation
- in movement of people and goods



- Focus historically is on short-term small-scale studies of single species
- Spatial scale of study plots in ecological field work
 - typically a few square metres
 - sometimes ‘tennis-court sized’
 - rarely woodland plots
- Temporal scale of ecological studies
 - Usually 3 years, the length of typical research grants
 - long-term studies are rare

Spatial & temporal scales of Earth processes



Biodiversity - hierarchical levels of analysis



Regions ←

Ecosystems

Communities

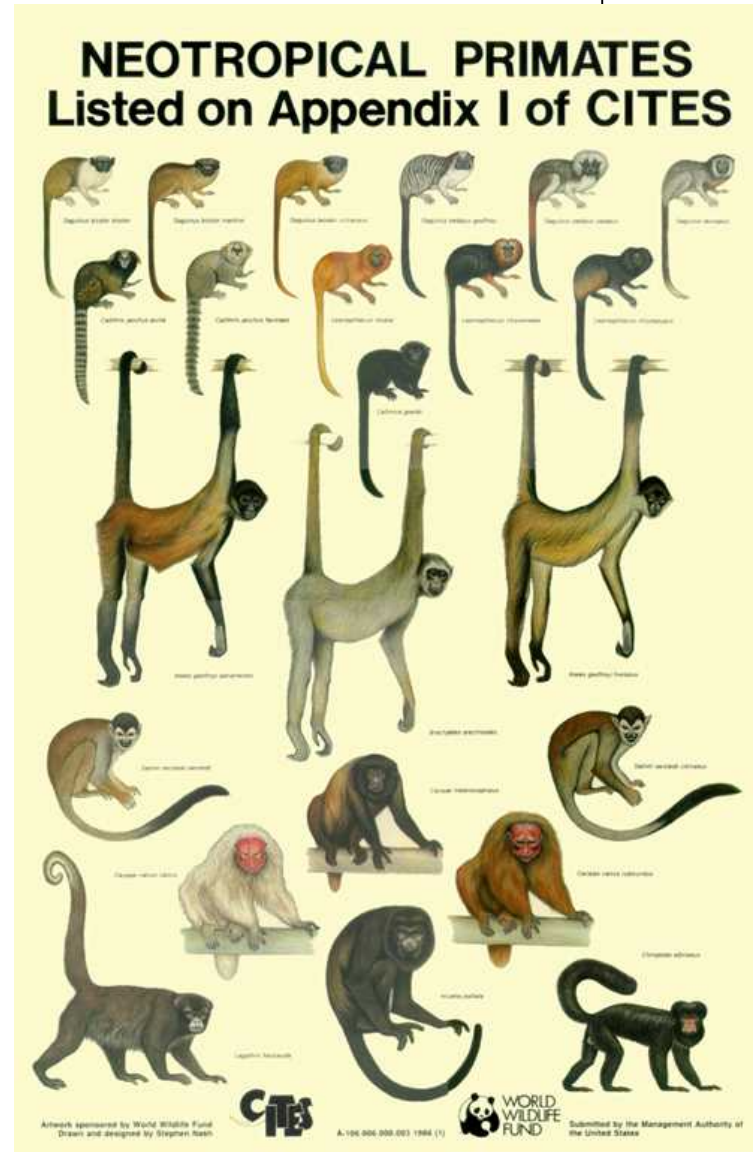
Species ←

Populations

Individuals

Genes

Molecules



Explaining biodiversity: two approaches



- Ecological studies and conservation projects mostly focus on a single species or area
 - Reveal **unique** mechanisms operating at a local scale
- Comparisons among species assemblages or regions often on global scale
 - Reveal **general** processes that determine inter-specific or inter-regional variation



Techniques for detecting patterns



Last 20 years had seen rapid development in techniques for detecting patterns in:

- **Abundance** > Huge increase in census or monitoring schemes
 - E.g. Breeding Bird Surveys in Britain & N. America
 - In Britain alone - monitoring of aphids, moths, butterflies, birds & mammals
- **Distribution** > Development of atlas schemes
 - National and international maps of species distributions
- **Environmental data** > Remote-sensing techniques - satellite imagery
 - Global data on geology, climate, soils, productivity, vegetation etc.
- **Species life-history and ecology** > Huge increase in field work
 - Collations of species accounts in handbooks and databases
- **Evolutionary relationships** > Application of molecular methods
 - Phylogenetic reconstructions of relationships between taxa

Techniques for analysing patterns



Last 20 years has also seen growth in techniques for analysing patterns:

- **Powerful computers**

- Atlas of Breeding Birds in UK
- 551,370 point localities for presence of species in 10x10km grid squares

- **Analytical software packages**

- Statistical packages
- GIS - Geographical Information Systems

- **Formal comparative methods**

- Comparing species to test hypotheses using robust methodology

BUT - Data quality is a big problem

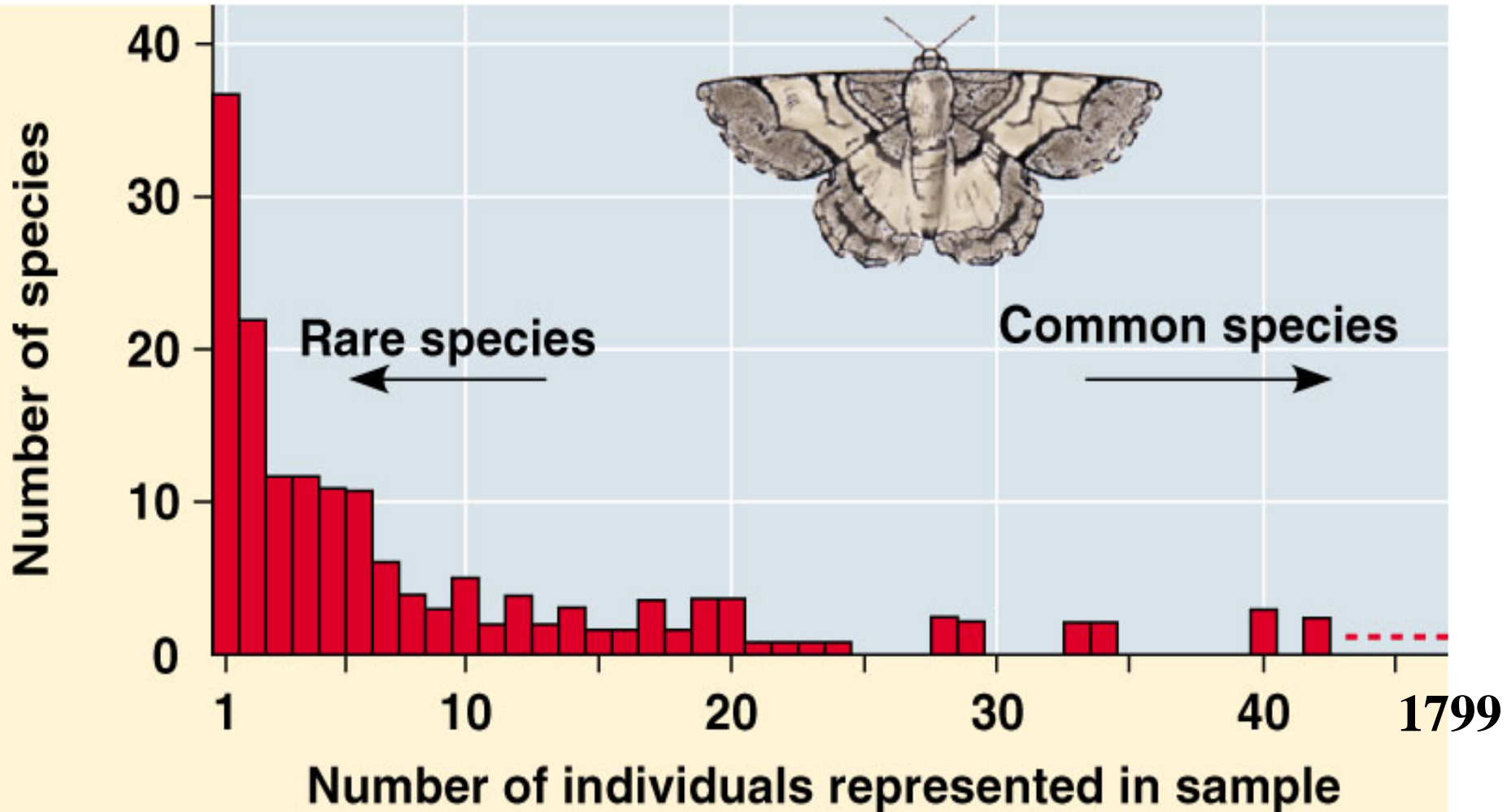


- Uneven sampling efforts lead to replication bias and inaccuracy in many biodiversity datasets
 - rare species are difficult to observe
 - surveys are biased towards easily accessible areas
 - poor coverage of oceans, soils, rainforests
 - surveys are biased towards easily observable organisms
 - E.g. birds, butterflies
 - not insects, marine taxa, nocturnal animals, tropical species
 - repeat surveys are rare (annual monitoring needed)
- Need to distinguish genuine changes in occurrence from differences in sampling effort and methodology
- Hence, rediscovery of 'extinct' species

Bias - Rare species are difficult to count



Relative abundances of moths in Rothamsted, England (data from light trap)



Summary



- Several different levels of organization (genes to ecosystems/regions) of biological variation can be distinguished
- But most analyses of spatial variation concern biodiversity as measured by the number of species observed or estimated to occur in an area (**species richness**)
- This results from:-
 - widespread recognition of the significance of the species as a biological unit
 - the practical issues of the ease and magnitude of data acquisition

Review of global biodiversity studies



- Last decade - explosion of biodiversity studies. Most are:
- **Either** descriptions of species distribution patterns
 - hotspots and ‘coldspots’ of species richness
 - variation with spatial scale
 - species-area relationships
 - between local and regional richness
 - along gradients across space or environmental conditions
 - latitudinal gradient in species richness
 - longitude, altitude, ocean depth
 - peninsulas, bays, isolation, colonisation (‘island biogeography’)
 - productivity/ energy flow
 - climate: rainfall, aridity, temperature range & fluctuation (‘seasonality’)
- **Or** comparisons across species traits (e.g. body size versus other traits)



E.O. Wilson –

- “How the human species will treat life on Earth, so as to shape this greatest of legacies, good or bad, for all time to come, will be settled during the next 10 years.”

“The diversity of life”

1988

Still very much an unsettled issue.

A Christian Perspective?



How does the commission to be “stewards” of the planet affect our view of biodiversity issues?

How does a belief in a “New Earth” affect our view of biodiversity issues?











