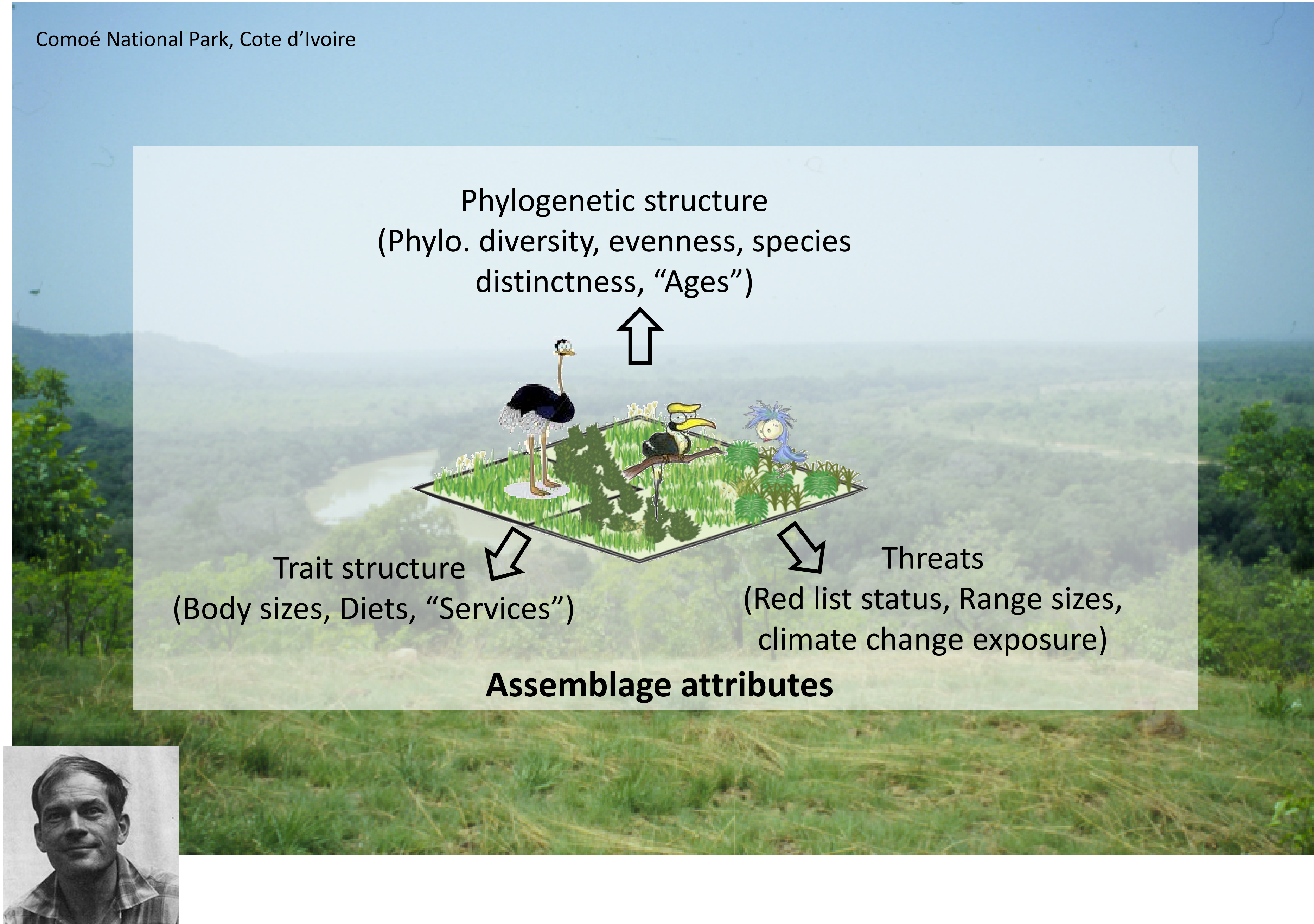
Global Biodiversity

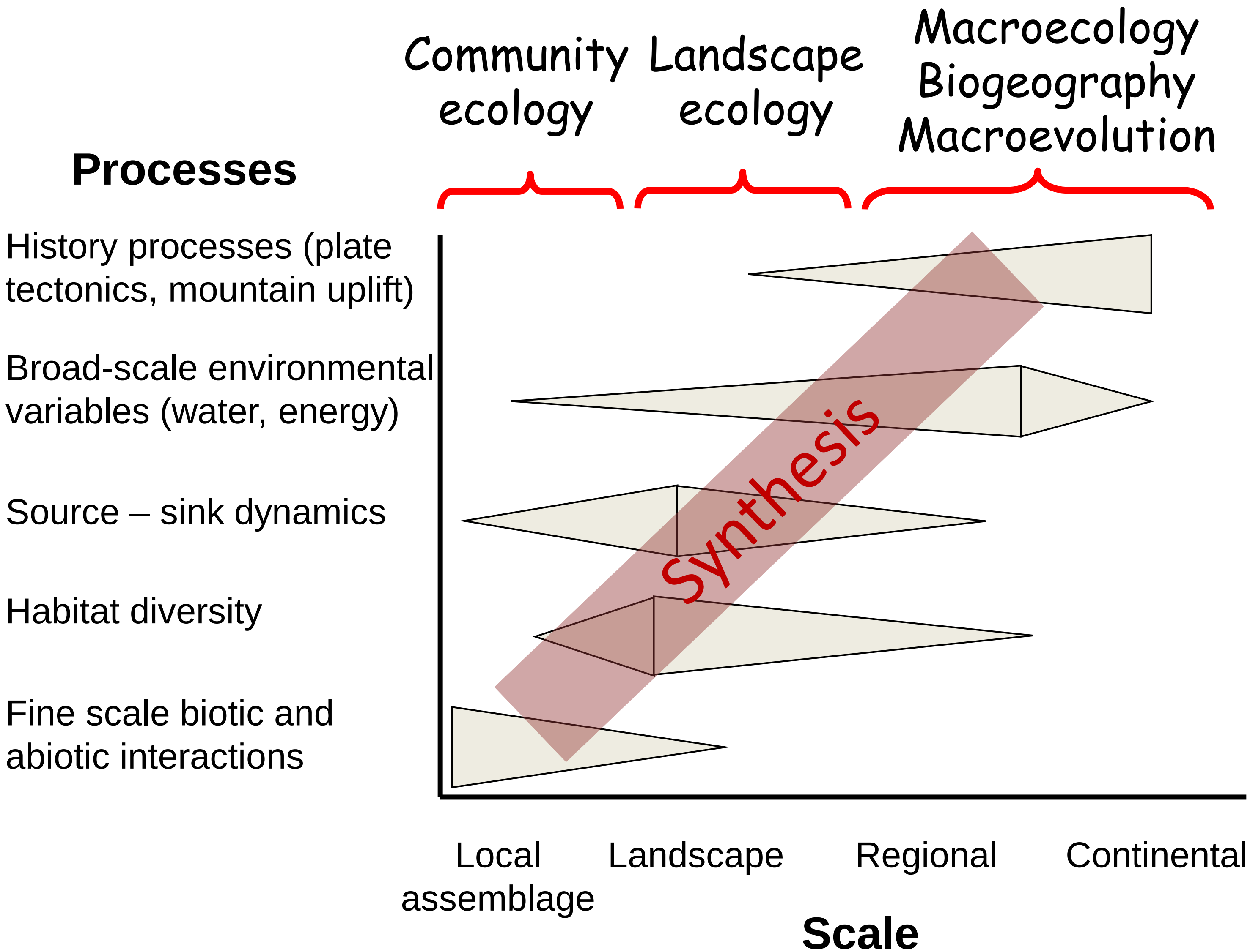
Walter Jetz
Yale University

Comoé National Park, Cote d’Ivoire


Comoé National Park, Cote d'Ivoire
Phylogenetic structure
(Phylo. diversity, evenness, species distinctness, "Ages")
Trait structure
(Body sizes, Diets, "Services")
Threats
(Red list status, Range sizes, climate change exposure)
Assemblage attributes

Expanding perspective, scale

Bridging scales and disciplines



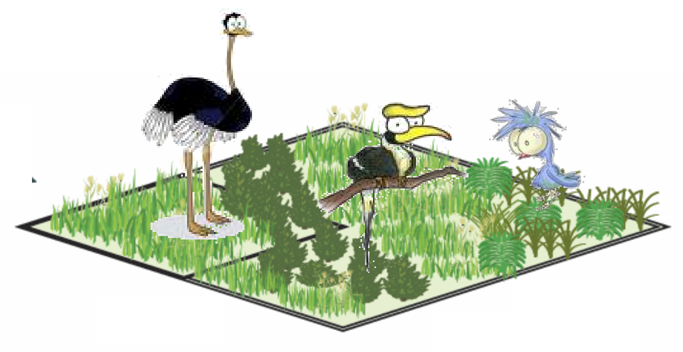
Adapted from Shmida & Wilson 1985

Global Integrative Biodiversity Science

The opportunities of integrating the dimensions of biodiversity at *global* scale for *whole* clades

General, unbiased (global) inference about

Assemblages



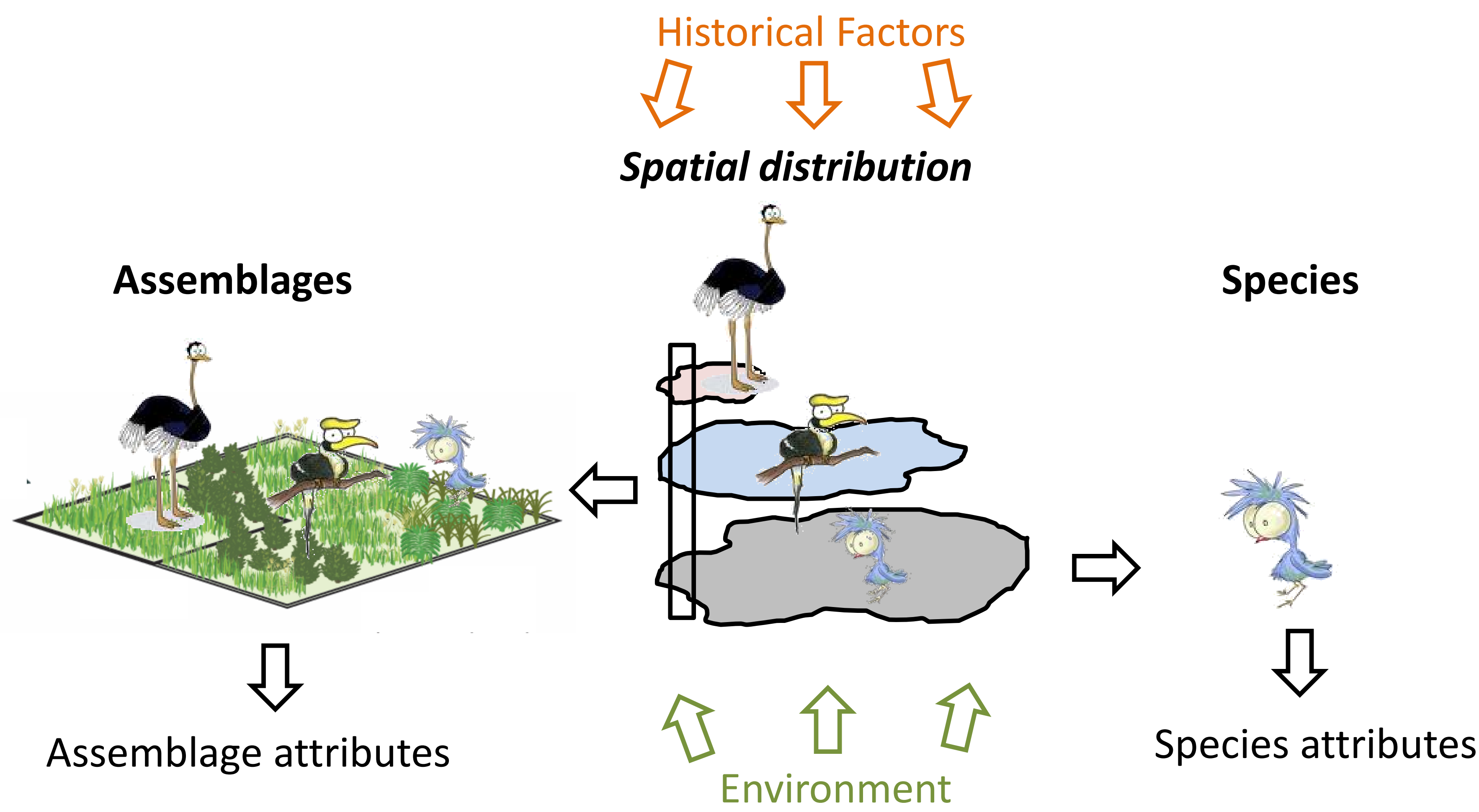
Assemblage attributes

Species

Species attributes

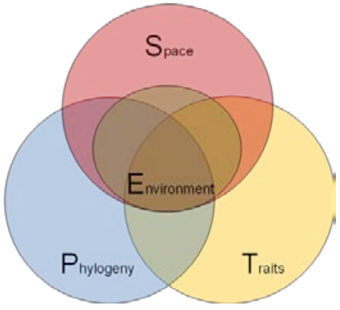
Global Integrative Biodiversity Science

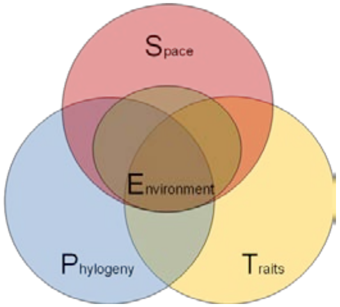
The opportunities of integrating the dimensions of biodiversity at *global* scale for *whole* clades



Global Integrative Biodiversity Science

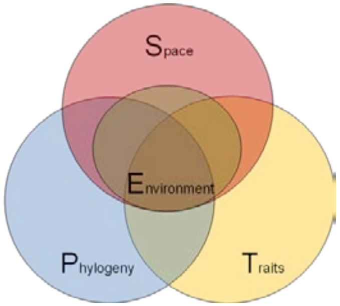
- **Phylogenies**: dramatic growth, individual level
- **Environment**: Remote sensing, globally contiguous data down to 30m, 5m
- **Traits**: strong growth, increasingly population, individual level through collaborative efforts, semantic web
- **Spatial**: efforts for integration, dramatic growth of museum/amateur/tracking data
- **Big Data** to **generalize, connect scales**
- Need for strong, **cross-scale/-discipline science**

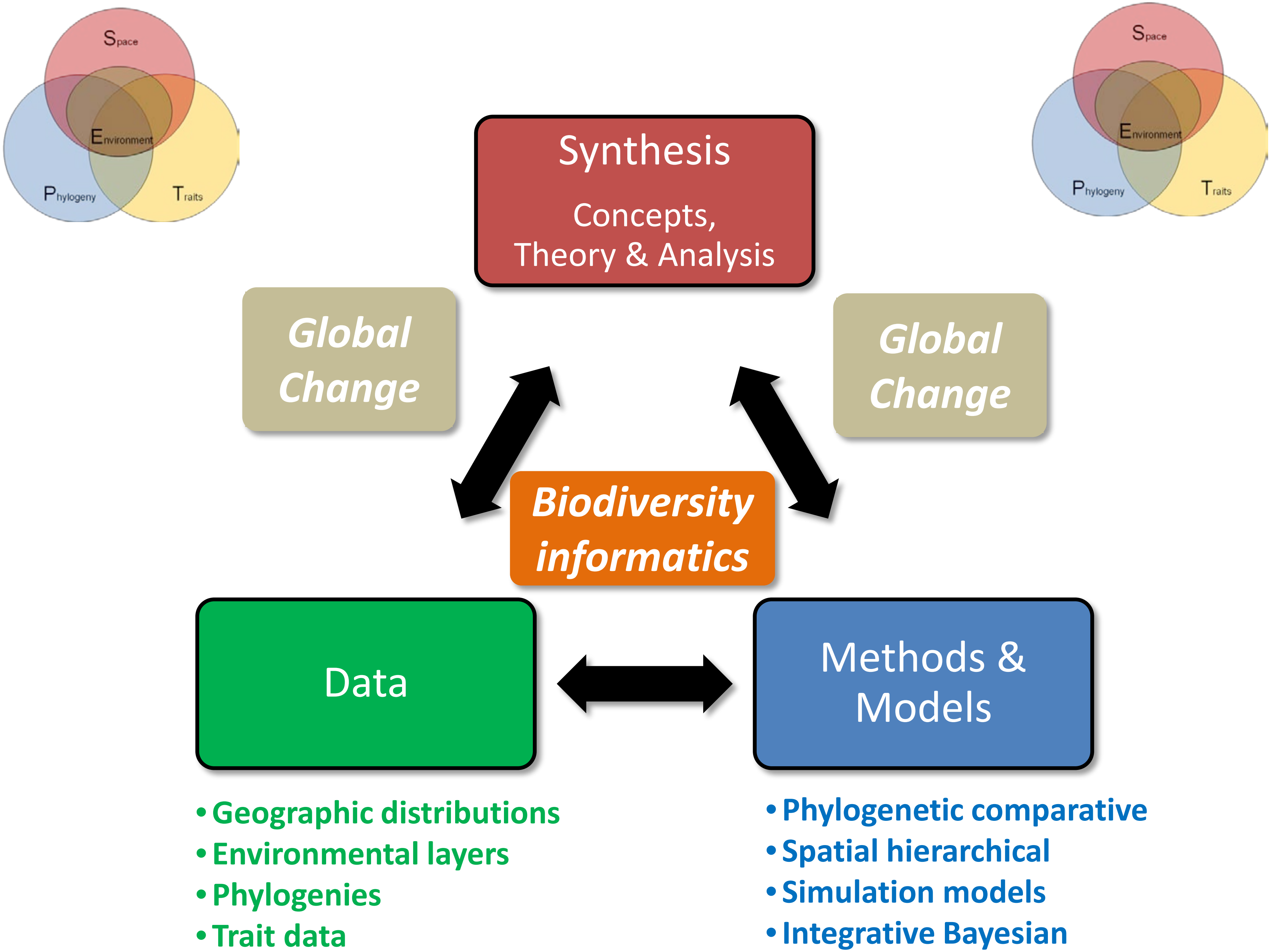




Synthesis

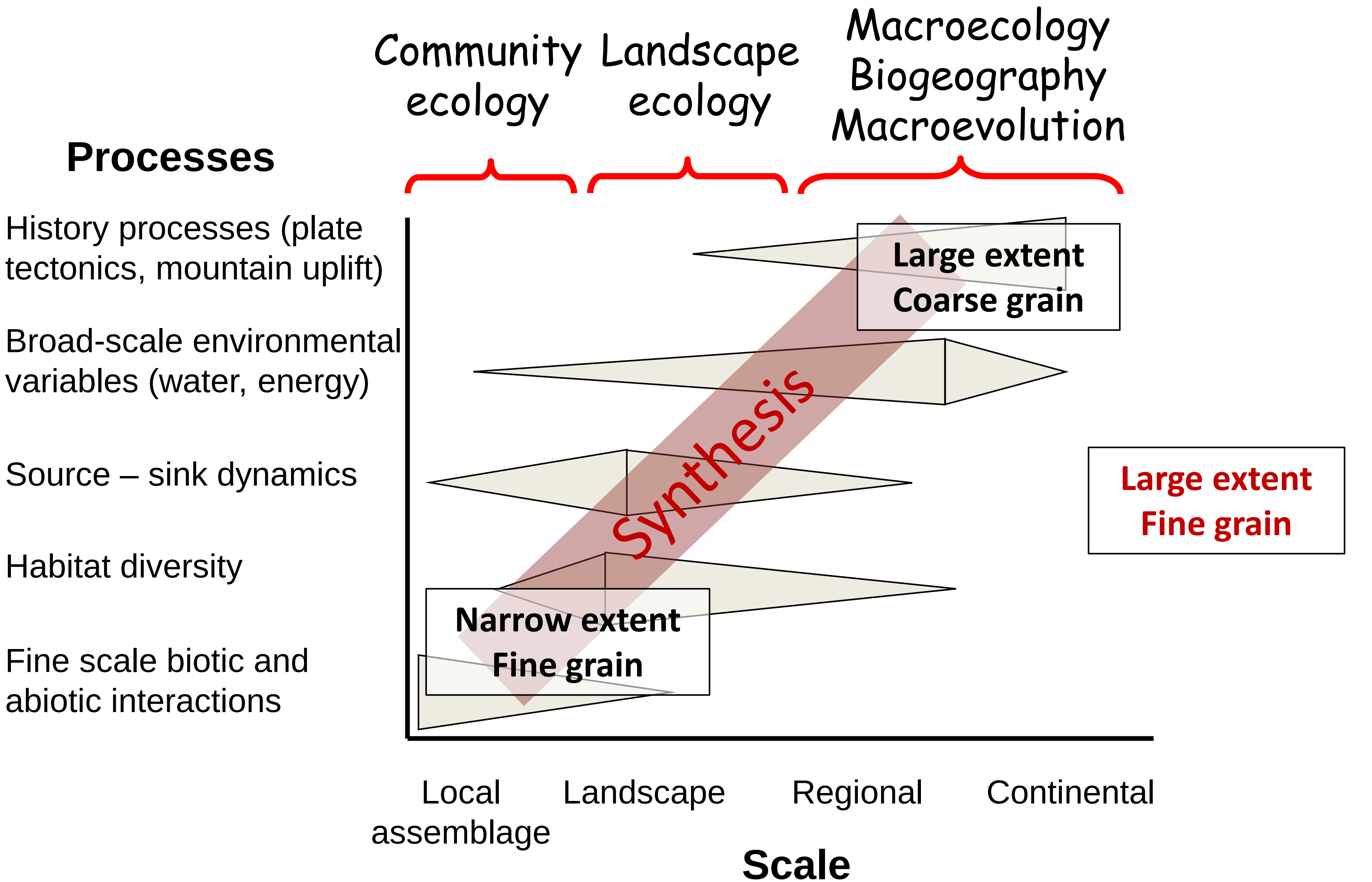
Concepts,
Theory & Analysis





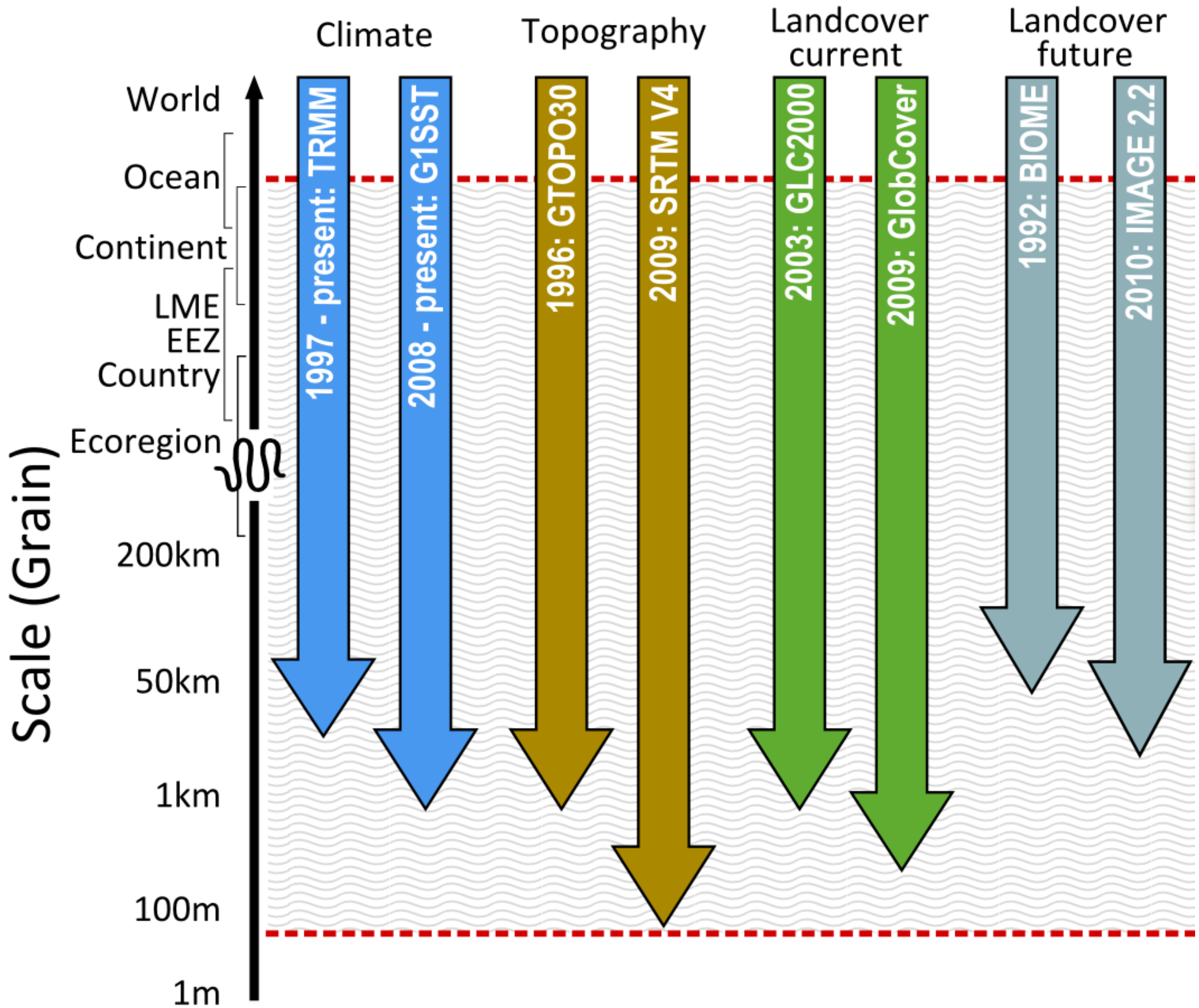
Space
Environment
Phylogeny
Traits
Synthesis
Concepts,
Theory & Analysis
Space
Environment
Phylogeny
Traits
Global Change
Global Change
Biodiversity informatics
Data
Methods & Models
• Geographic distributions
• Environmental layers
• Phylogenies
• Trait data
• Phylogenetic comparative
• Spatial hierarchical
• Simulation models
• Integrative Bayesian

Bridging scales and disciplines



Adapted from Shmida & Wilson 1985

Big, advanced spatial biodiversity data



Hurlbert and Jetz (PNAS 2007)
Jetz et al. (Conservation Biology 2008)

Species distributions – knowledge limits

Point occurrences

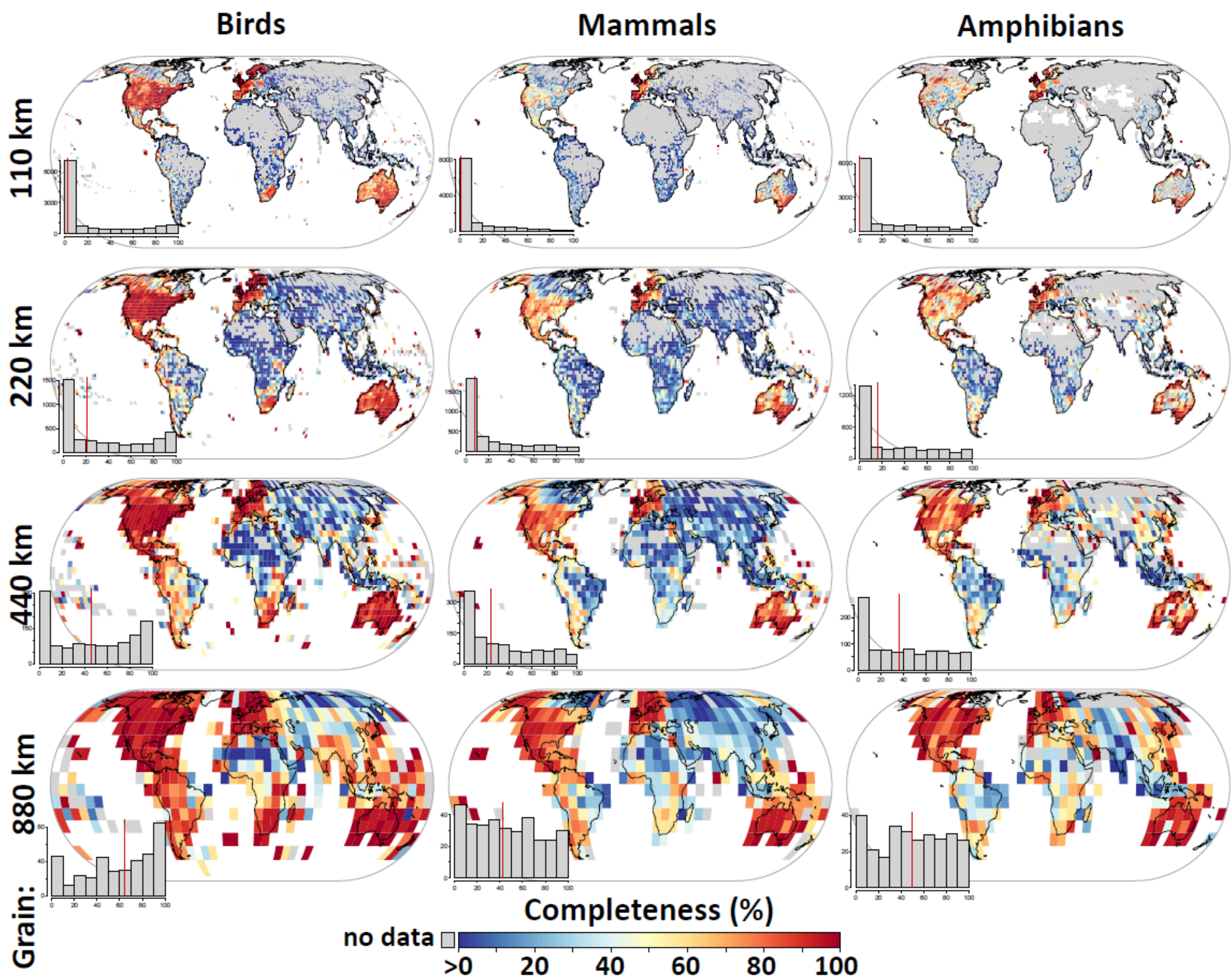
Harvest Mouse
(*Micromys minutus*)

Species distributions – knowledge limits

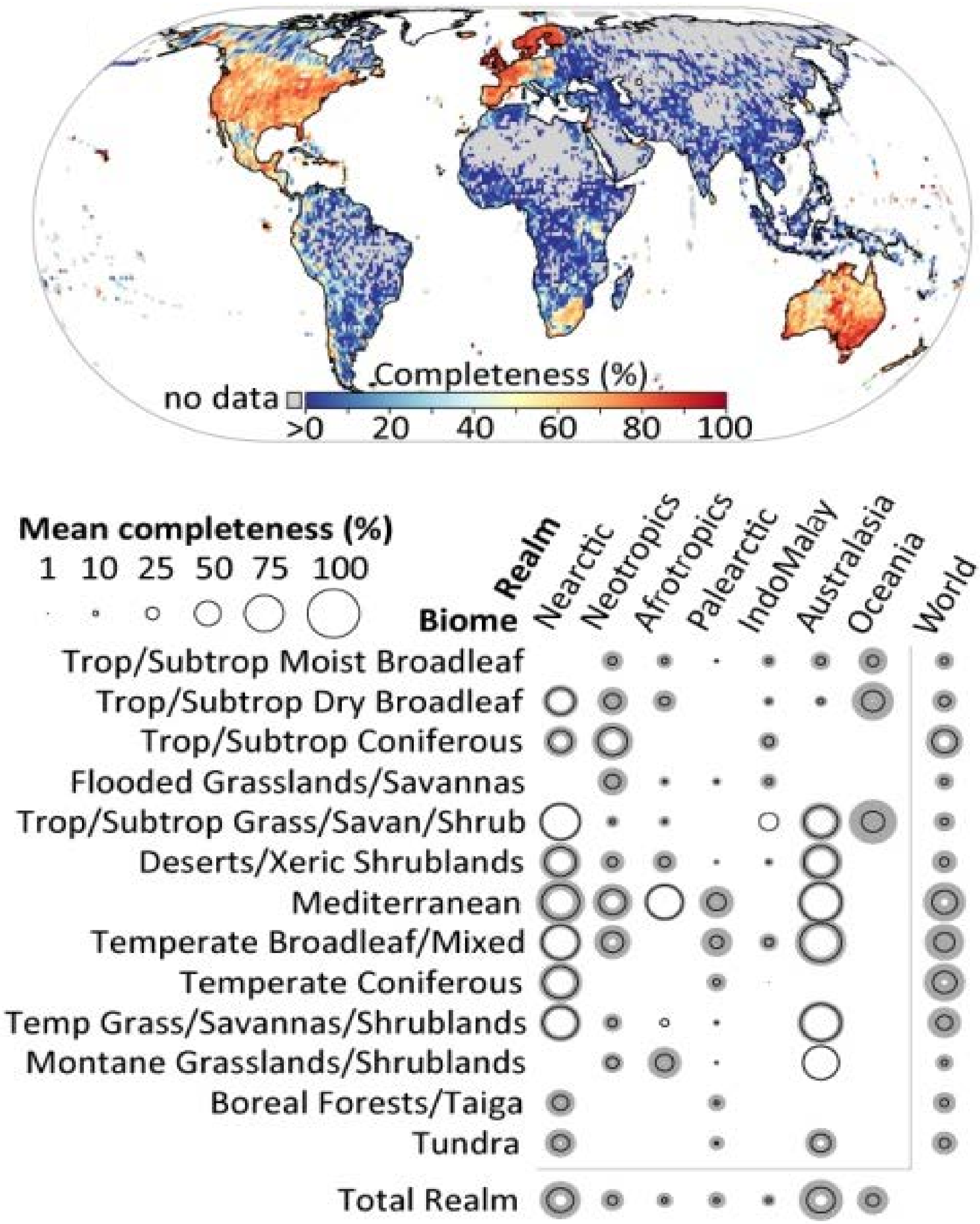
Point occurrences

Harvest Mouse
(*Micromys minutus*)

Point data – riddled by false absences



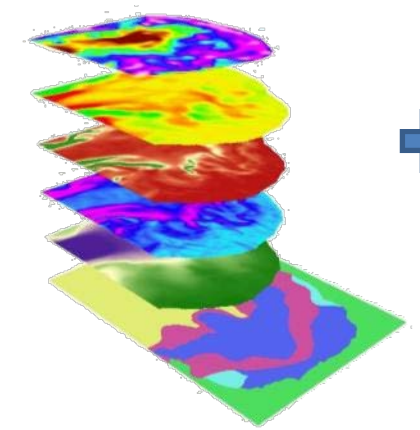
Meyer et al. in review

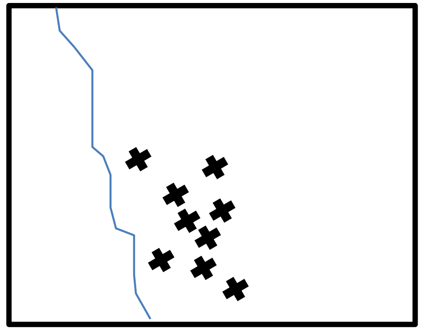


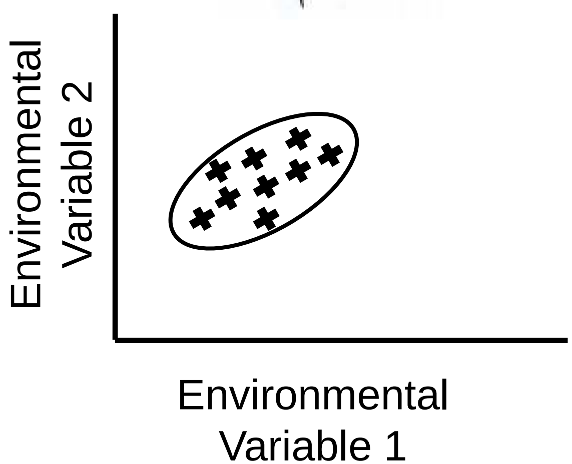
Meyer et al. in review

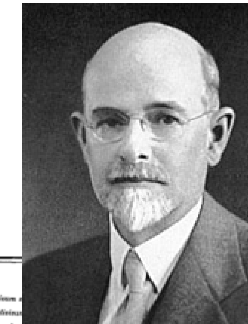
Environmental layers

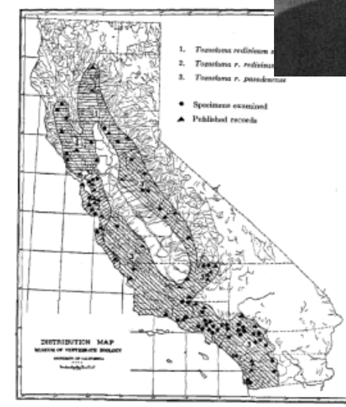
Species 1 distribution



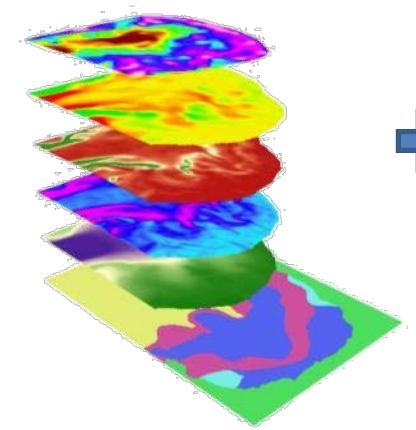




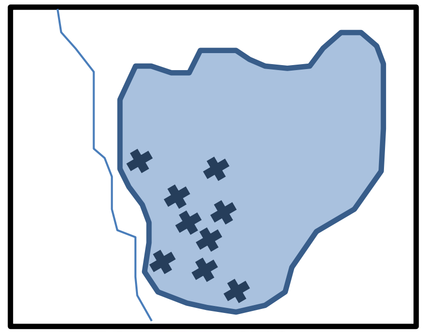


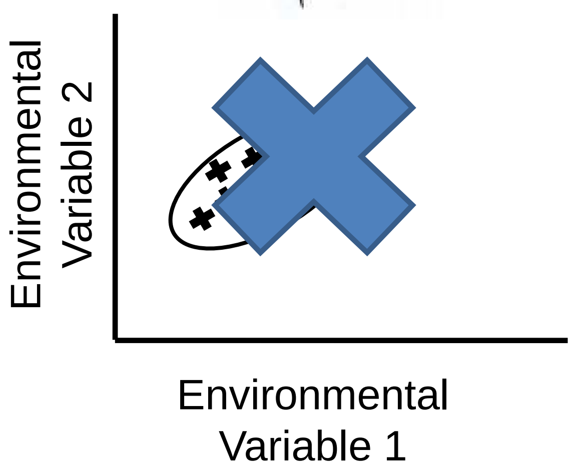


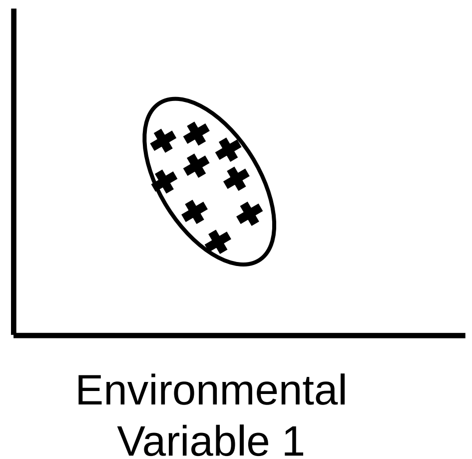
Environmental layers



Species 1 distribution





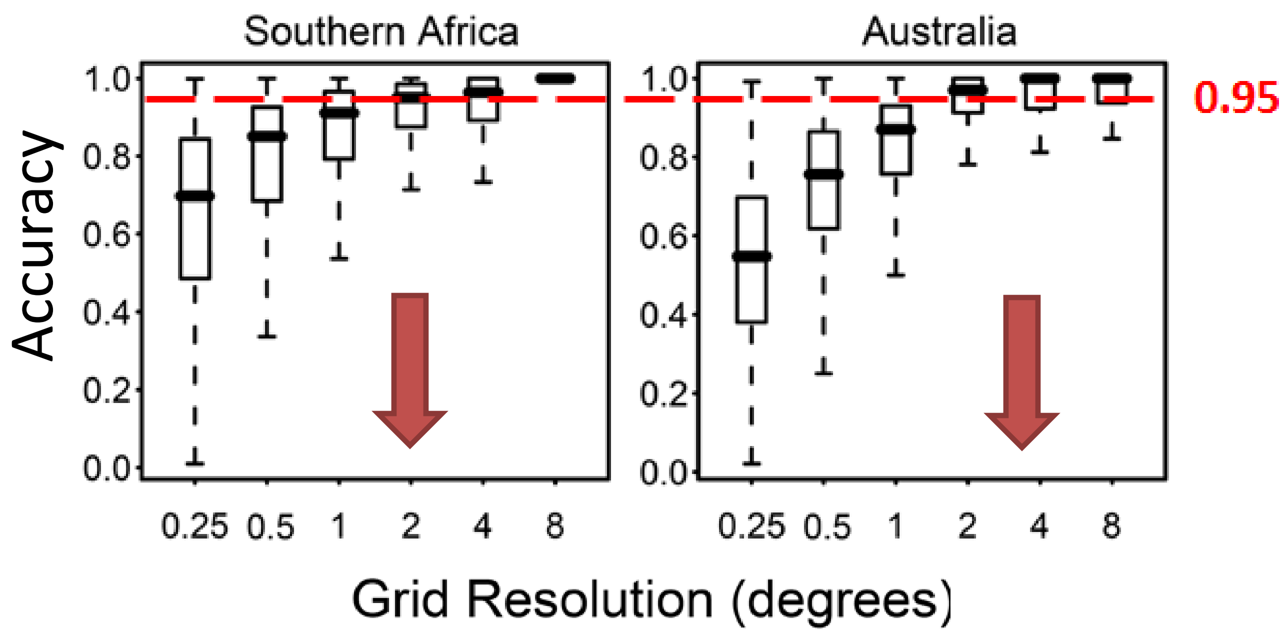


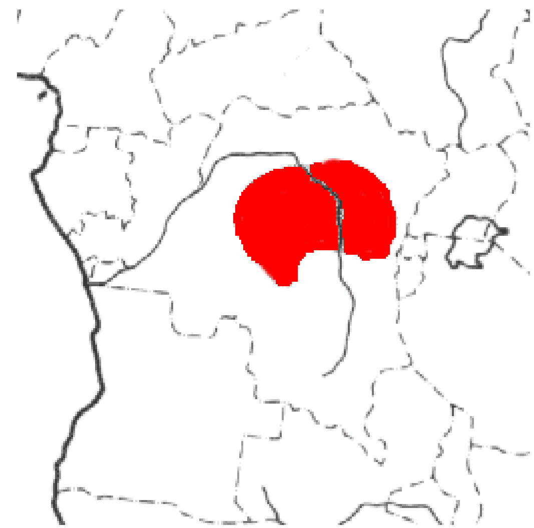
Quantifying the benefit of early climate change mitigation in avoiding biodiversity loss

nature climate change

R. Warren[1]*, J. VanDerWal[2], J. Price[3], J. A. Welbergen[2], I. Atkinson[3], J. Ramirez-Villegas[4,5,6], T. J. Osborn[7], A. Jarvis[4,5], L. P. Shoo[2,8], S. E. Williams[2] and J. Lowe[9]

Expert range maps
usually only accurate > 100km grain



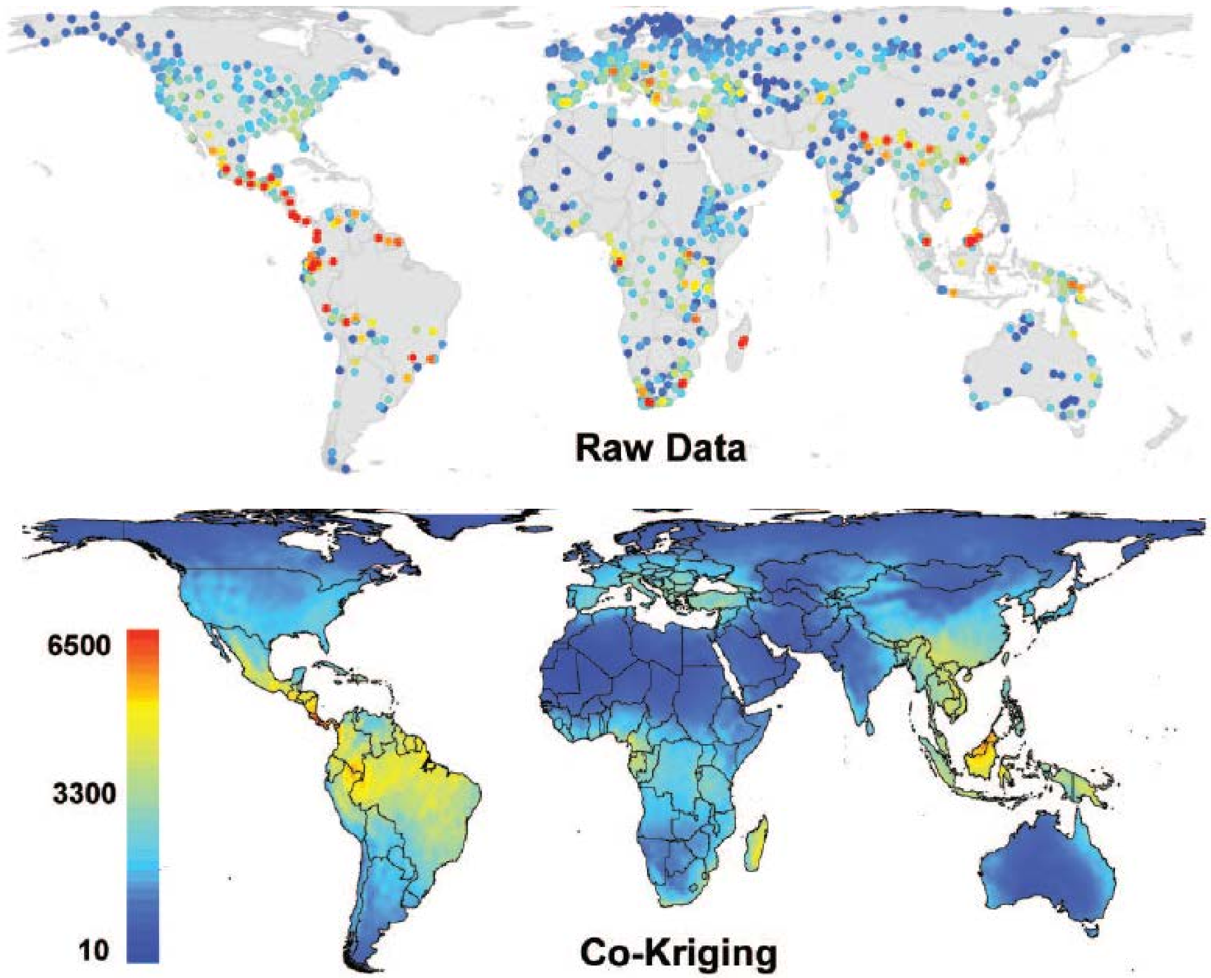


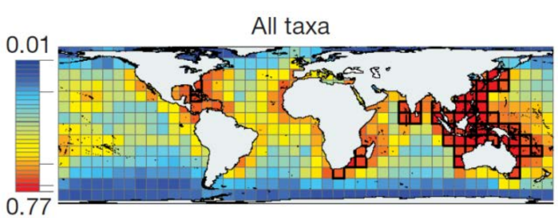
435 bird species

Hurlbert and Jetz, PNAS 2007

Congo Peacock

Vascular plants





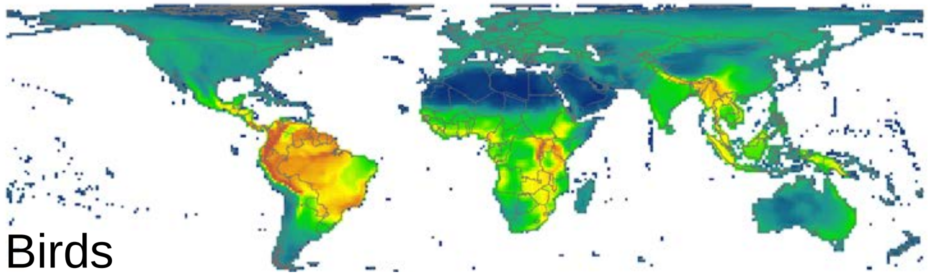
Tittensor et al. (2010)

Global marine biodiversity

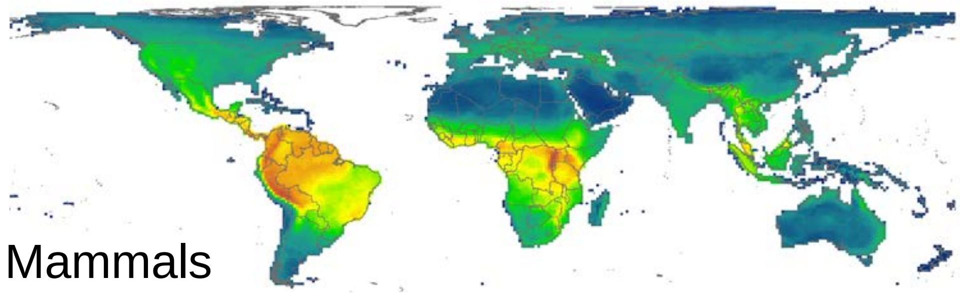
Kreft & Jetz (2007)

Space

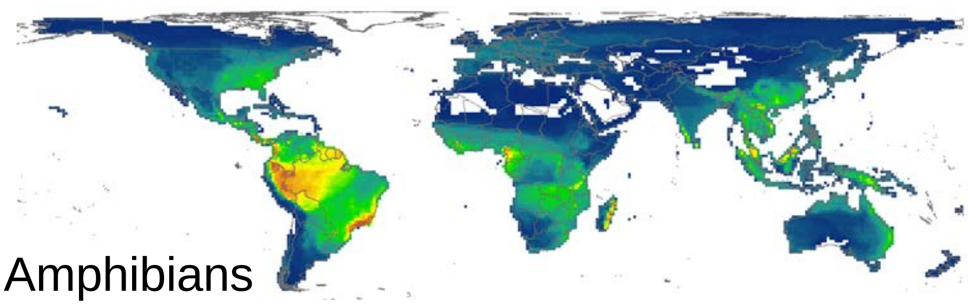
Terrestrial vertebrates



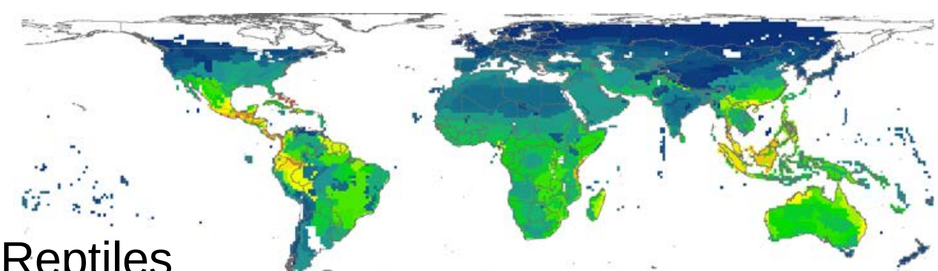
Birds



Mammals

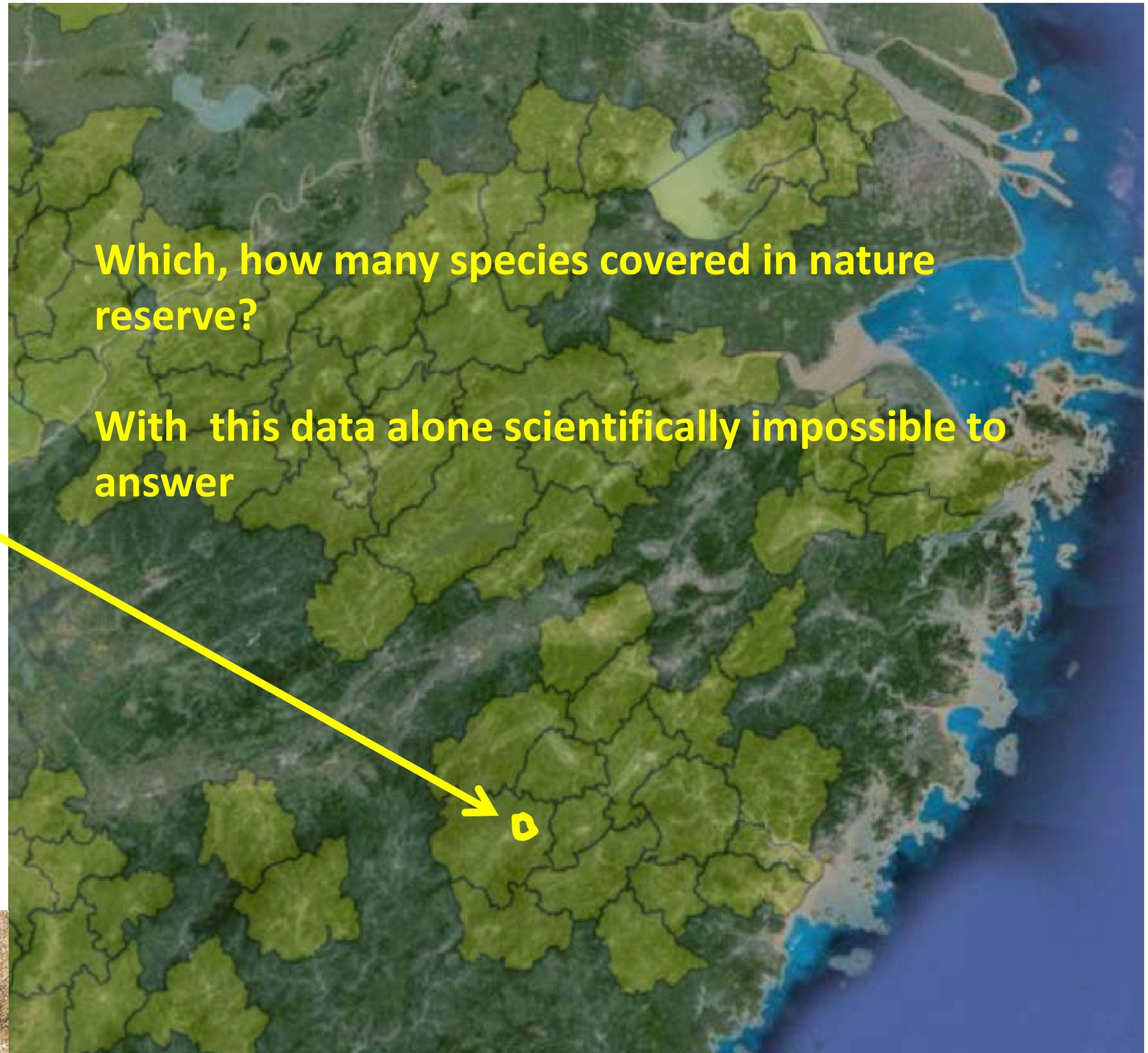


Amphibians



Reptiles

Species inventories: counties



100km

Insular mole

Source: Nanjing Institute of Environmental Sciences, Ministry of Environmental Protection

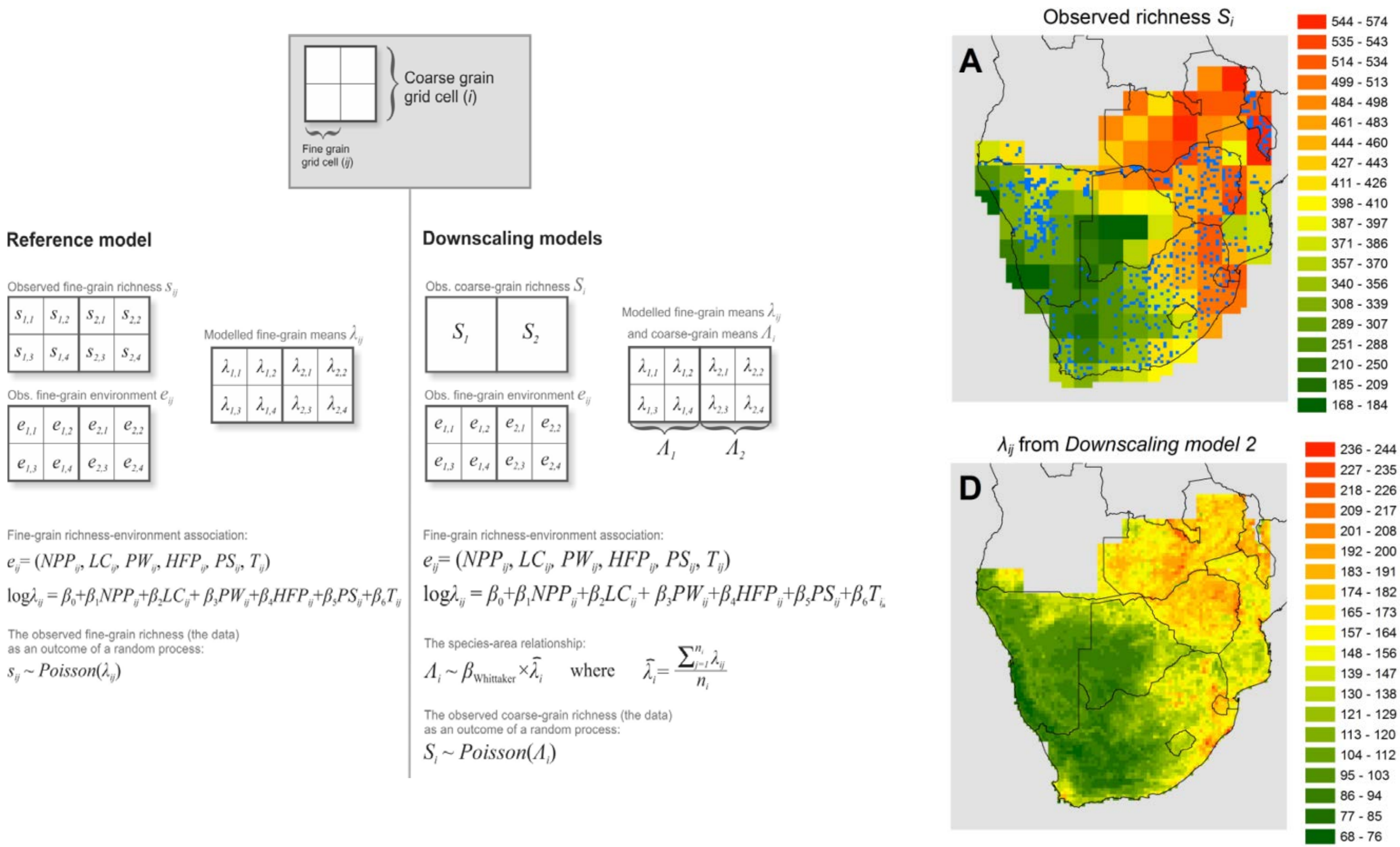
Spatial biodiversity data types

Data type	Spatial grain	Temporal precision	Availability (# species)	Geographic bias	False positive rate	False negative rate	User input potential	Inference	Examples
Regional checklists	<1000km	10-50 yrs.	most	even	high	low	high	A	http://gis.wwfus.org/wildfinder/, http://www.kew.org/wcsp/
Expert range maps	<200km*	10-50 yrs.	many	even	high	low	high	A	http://www.iucnredlist.org/ [19, 61, 78-80]
Modelled distributions	variable	10-50 yrs	some	biased	variable	variable	high	A/P	statistically-derived: [30] expert-derived [20,28]
Focal species point records	<20km	days	some	biased	low	high	medium	P	http://www.movebank.org/, http://www.gbif.org
Allied species point records	<20km	days	some	biased	low	medium	medium	A	http://www.iobis.org http://www.gbif.org
Area inventories	<100km	10-50 yrs.	some	biased	medium	low	medium	A/P	http://ice.ucdavis.edu/project/bioinventory
Survey & atlas data	<1km	1-10 yrs.	some	biased	low	variable	medium	A/P	http://sabap2.adu.org.za/ http://www.pvrc.usgs.gov/BBS
Habitat suitability	<1km	10-50yrs.	some	even	medium	low	high	A	http://www.iucnredlist.org/initiatives/amphibians/analysis/habitat
Species dependencies	variable	100+ yrs.	select	biased	variable	variable	high	A/P	[70-71]
Dispersal capacity & related traits	variable	days-yrs.	select	even	variable	variable	medium	A	[72-73]
Detectability	<1km	days-yrs.	select	biased	low	low	medium	A	[76-77]
Phylogenetic Relationships	<1000km	100+ yrs.	select	even	high	low	medium	A	http://www.treebase.org/ [74]

* likely coarser for marine taxa

Jetz, McPherson & Guralnick 2012, TREE

Integrating data and scales with hierarchical models



Keil et al MEE, 2013
Keil & Jetz, Eco. Appl. 2014
Keil et al., in revision

MOL MAP OF LIFE

An infrastructure for integrating and analyzing global species distribution knowledge

GROUP ON EARTH OBSERVATIONS

National Center for Ecological Analysis and Synthesis

Jetz et al. 2012, TREE

Biodiversity Monitoring

Platform work programme 2014–2018: Objectives and associated deliverables

Objective 1: Strengthen the capacity and knowledge foundations of the science-policy interface to implement key functions of the Platform:

(a) Priority capacity-building needs to implement the Platform's work programme matched with resources through catalysing financial and in-kind support
(b) Capacities needed to implement the Platform work programme developed
(c) Procedures, approaches for participatory processes for working with indigenous and local knowledge systems developed
(d) Priority knowledge and data needs for policymaking addressed through catalyzing efforts to generate new knowledge and networking

Objective 2: Strengthen the science-policy interface on biodiversity and ecosystem services at and across subregional, regional and global levels:

(a) Guide on production and integration of assessments from and across all scales
(b) Regional/subregional assessments on biodiversity, ecosystem services
(c) Global assessment on biodiversity and ecosystem services

Objective 3: Strengthen the science-policy interface on biodiversity and ecosystem services with regard to thematic and methodological issues:

(a) One fast track thematic assessment of pollinators, pollination and food production
(b) Three thematic assessments: land degradation and restoration; invasive alien species; and sustainable use and conservation of biodiversity and strengthening capacities/tools
(c) Policy support tools and methodologies for scenario analysis and modelling of biodiversity and ecosystem services based on a fast track assessment and a guide
(d) Policy support tools and methodologies regarding the diverse conceptualization of values of biodiversity and nature's benefits to people including ecosystem services based on an assessment and a guide

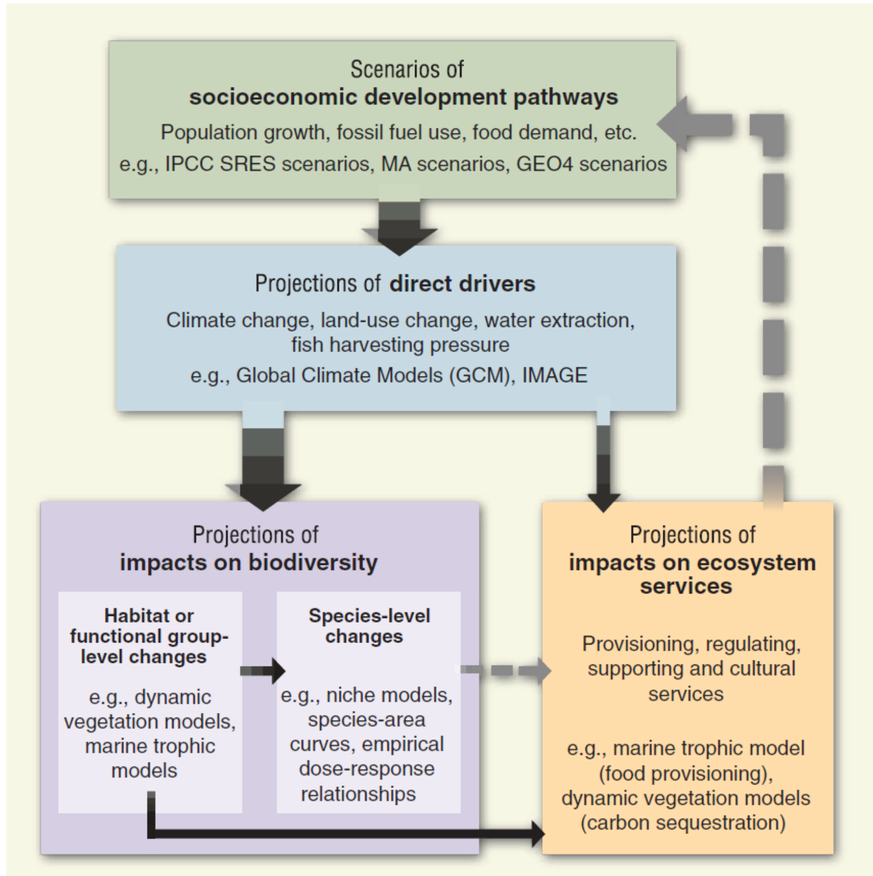
Objective 4: Communicate and evaluate Platform activities, deliverables and findings:

(a) Catalogue of relevant assessments
(b) Development of an information and data management plan
(c) Catalogue of policy support tools and methodologies
(d) Set of communication, outreach and engagement strategies, products and processes
(e) Reviews of the effectiveness of guidance, procedures, methods and approaches to inform future development of the Platform

Intergovernmental Platform on Biodiversity & Ecosystem Services

ipbes

Science and Policy for People and Nature



Suitable data, parameters, models?

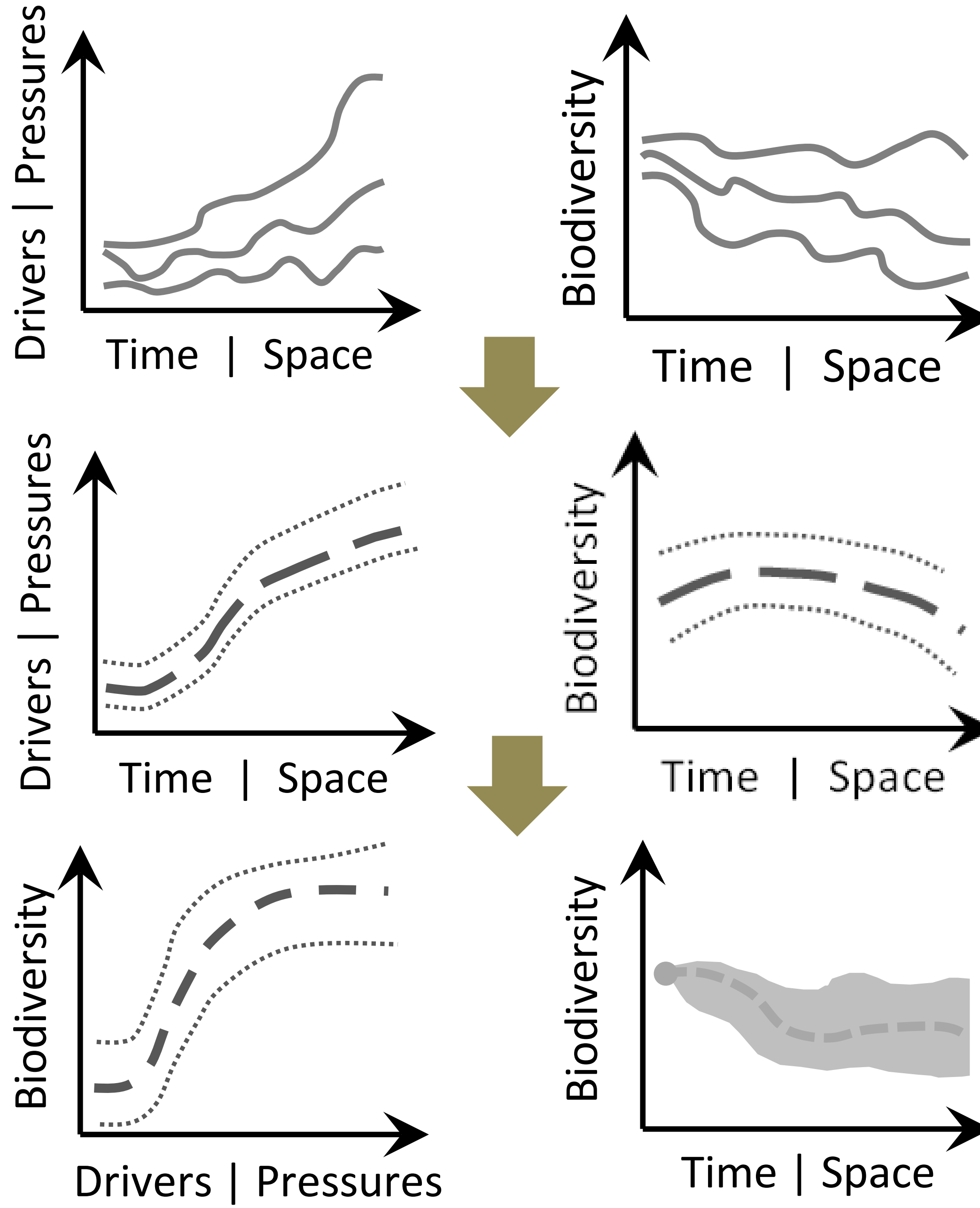
?

Data Monitoring

Indicators Metrics

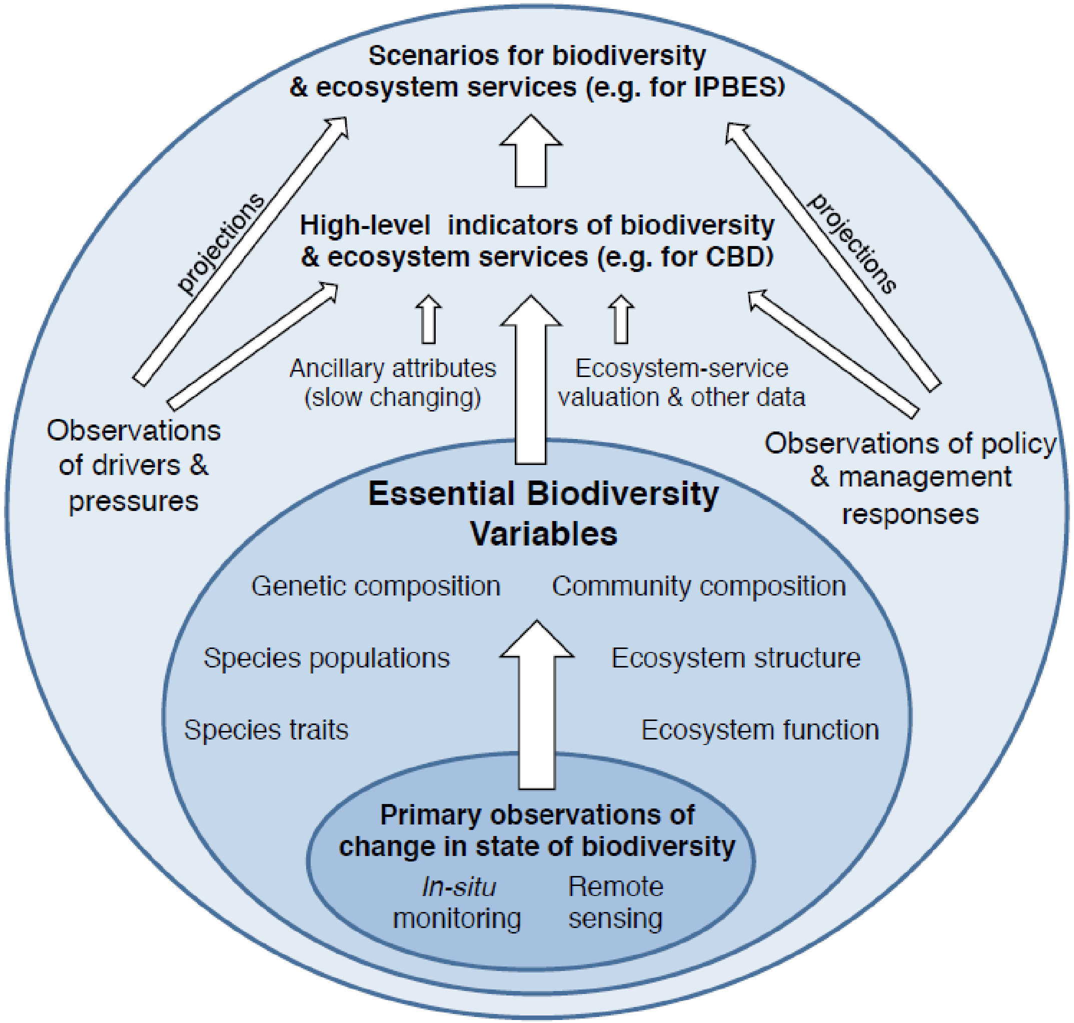
Response

Projection (Future)



From: IPBES Guide on Assessments, Draft

Essential Biodiversity Variables



ECOLOGY

Essential Biodiversity Variables

H. M. Pereira,[1*†] S. Ferrier,[2] M. Walters,[3] G. N. Geller,[4] R. H. G. Jongman,[5] R. J. Scholes,[3]
M. W. Bruford,[6] N. Brummitt,[7] S. H. M. Butchart,[8] A. C. Cardoso,[9] N. C. Coops,[10] E. Dulloo,[11]
D. P. Faith,[12] J. Freyhof,[13] R. D. Gregory,[14] C. Heip,[15] R. Höft,[16] G. Hurtt,[17] W. Jetz,[18] D. S. Karp,[19]
M. A. McGeoch,[20] D. Obura,[21] Y. Onoda,[22] N. Pettorelli,[23] B. Reyers,[24] R. Sayre,[25]
J. P. W. Scharlemann,[26,27] S. N. Stuart,[28] E. Turak,[29] M. Walpole,[26] M. Wegmann[30]

Essential Biodiversity Variables

Examples of Candidate Essential Biodiversity Variables

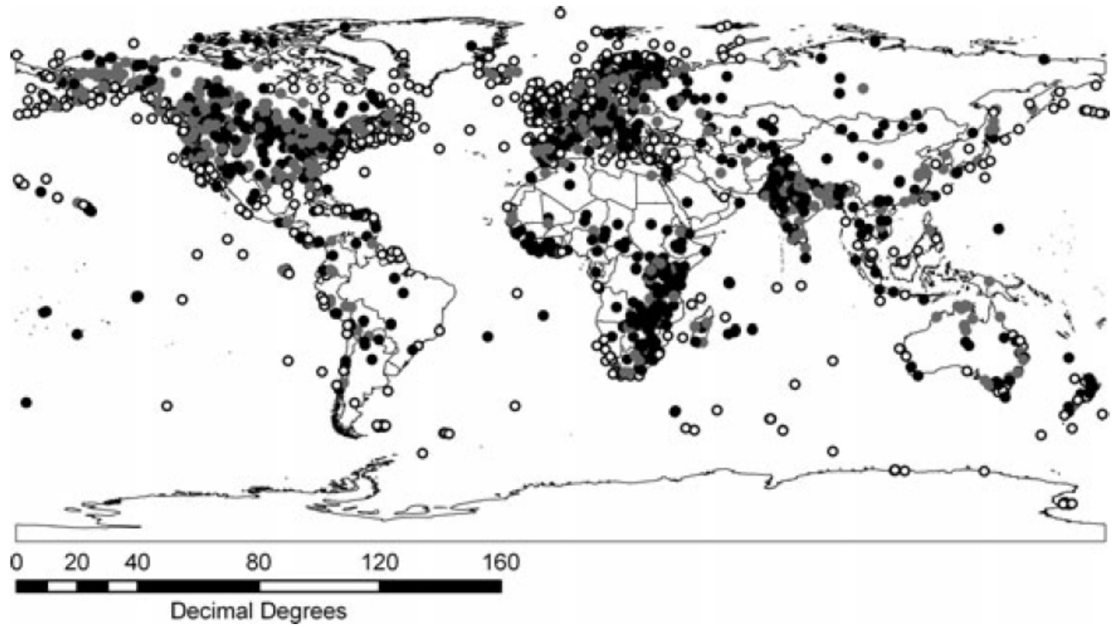
EBV class	EBV examples	Measurement and scalability	Temporal sensitivity	Feasibility	Relevance for CBD targets and indicators (*1*,*9*)
Genetic composition	Allelic diversity	Genotypes of selected species (e.g., endangered, domesticated) at representative locations.	Generation time	Data available for many species and for several locations, but little global systematic sampling.	Targets: 12, 13. Indicators: Trends in genetic diversity of selected species and of domesticated animals and cultivated plants; RLI.
Species populations	Abundances and distributions	Counts or presence surveys for groups of species easy to monitor or important for ES, over an extensive network of sites, complemented with incidental data.	1 to >10 years	Standardized counts under way for some taxa but geographically restricted. Presence data collected for more taxa. Ongoing data integration efforts (Global Biodiversity Information Facility, Map of Life).	Targets: 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15. Indicators: LPI; WBI; RLI; population and extinction risk trends of target species, forest specialists in forests under restoration, and species that provide ES; trends in invasive alien species; trends in climatic impacts on populations.
Species traits	Phenology	Timing of leaf coloration by RS, with in situ validation.	1 year	Several ongoing initiatives (Phenological Eyes Network, PhenoCam, etc.)	Targets: 10, 15. Indicators: Trends in extent and rate of shifts of boundaries of vulnerable ecosystems.
Community composition	Taxonomic diversity	Consistent multitaxa surveys and metagenomics at select locations.	5 to >10 years	Ongoing at intensive monitoring sites (opportunities for expansion). Metagenomics and hyperspectral RS emerging.	Targets: 8, 10, 14. Indicators: Trends in condition and vulnerability of ecosystems; trends in climatic impacts on community composition.
Ecosystem structure	Habitat structure	RS of cover (or biomass) by height (or depth) globally or regionally.	1 to 5 years	Global terrestrial maps available with RS (e.g., Light Detection and Ranging). Marine and freshwater habitats mapped by combining RS and in situ data.	Targets: 5, 11, 14, 15. Indicators: Extent of forest and forest types; mangrove extent; seagrass extent; extent of habitats that provide carbon storage.
Ecosystem function	Nutrient retention	Nutrient output/input ratios measured at select locations. Combine with RS to model regionally.	1 year	Intensive monitoring sites exist for N saturation in acid-deposition areas and P retention in affected rivers.	Targets: 5, 8, 14. Indicators: Trends in delivery of multiple ES; trends in condition and vulnerability of ecosystems.

ECOLOGY

Essential Biodiversity Variables

H. M. Pereira,[1*†] S. Ferrier,[2] M. Walters,[3] G. N. Geller,[4] R. H. G. Jongman,[5] R. J. Scholes,[3] M. W. Bruford,[6] N. Brummitt,[7] S. H. M. Butchart,[8] A. C. Cardoso,[9] N. C. Coops,[10] E. Dulloo,[11] D. P. Faith,[12] J. Freyhof,[13] R. D. Gregory,[14] C. Heip,[15] R. Höft,[16] G. Hurtt,[17] W. Jetz,[18] D. S. Karp,[19] M. A. McGeoch,[20] D. Obura,[21] Y. Onoda,[22] N. Pettorelli,[23] B. Reyers,[24] R. Sayre,[25] J. P. W. Scharlemann,[26,27] S. N. Stuart,[28] E. Turak,[29] M. Walpole,[26] M. Wegmann[30]

Living Planet Index



The Living Planet Database (LPD) holds time-series data for over **11,000 populations of more than 2700 vertebrate species** from around the world. The global LPI is **calculated using over 9000 of these population time-series which** are gathered from a variety of sources such as journals, online databases and government reports.

Collen et al 2009

How to achieve a globally representative and generalizable biodiversity monitoring for scientifically rigorous assessment and projection of impacts and change?

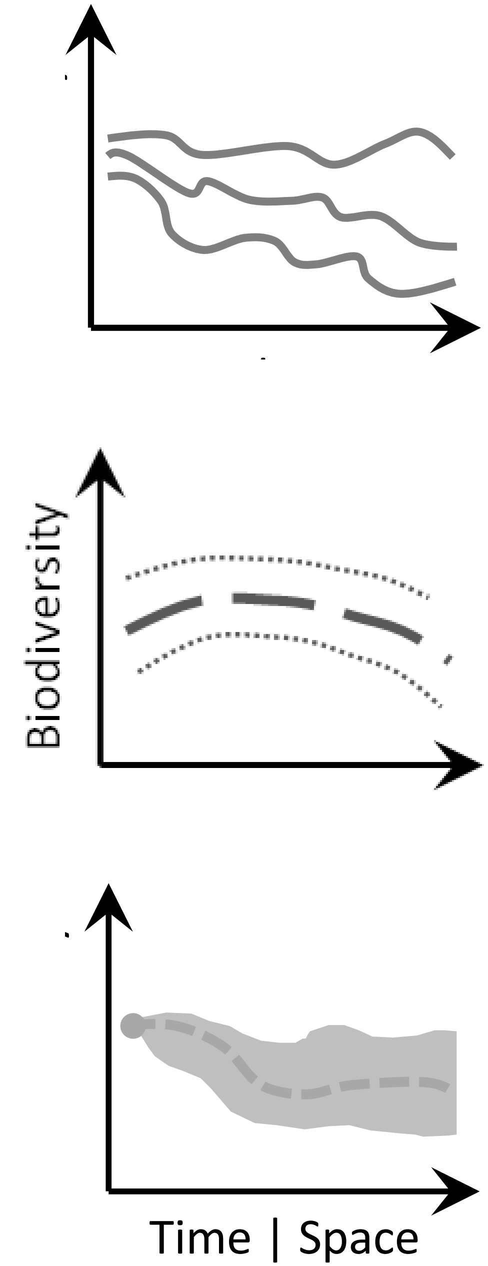
Biodiversity data suited for monitoring is …

Not mobilized

Spatially, temporally coarse

Limited to only certain attributes

Taxonomically, geographically, environmentally biased



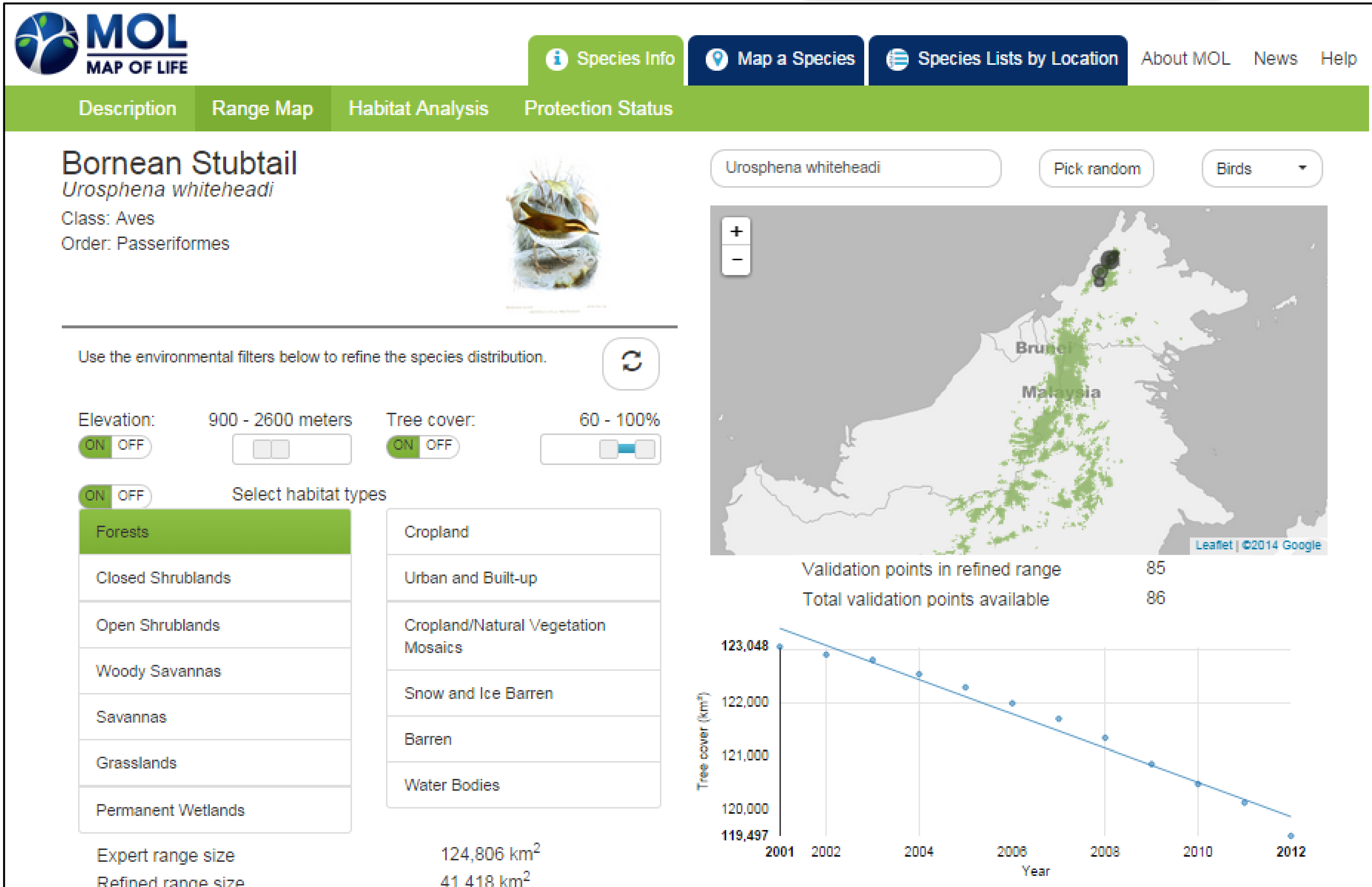
Geographical, environmental bias

Promise of citizen science

Squacco Heron

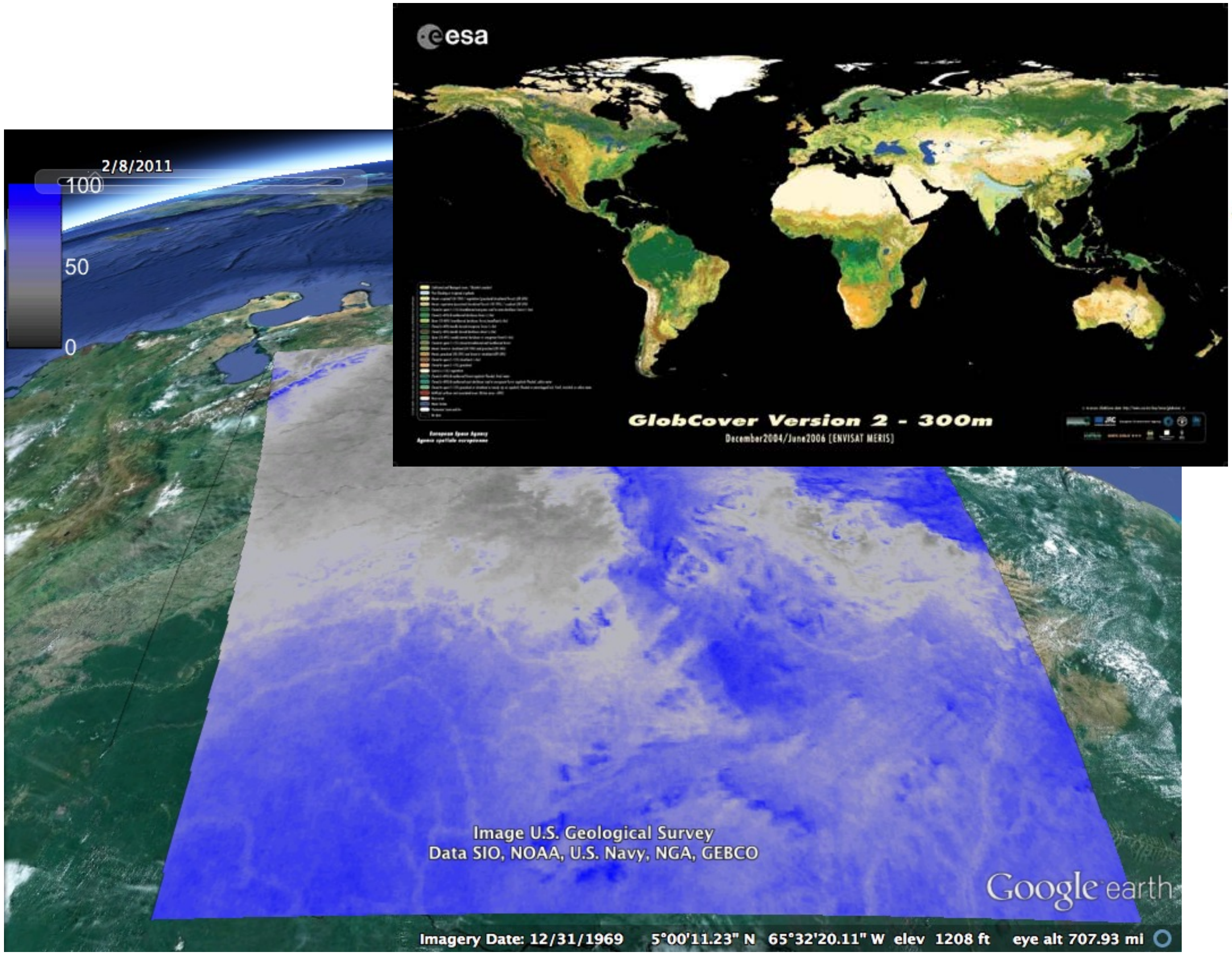
Promise of remote sensing

Promise of citizen science

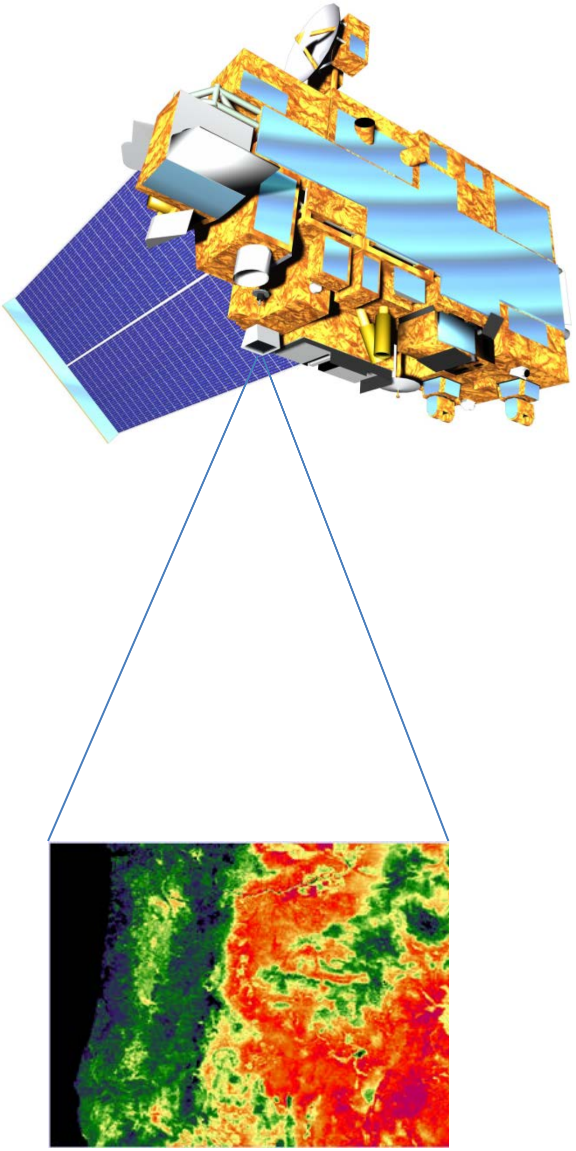


Remote sensing

Global land cover



Venezuela: cloud cover



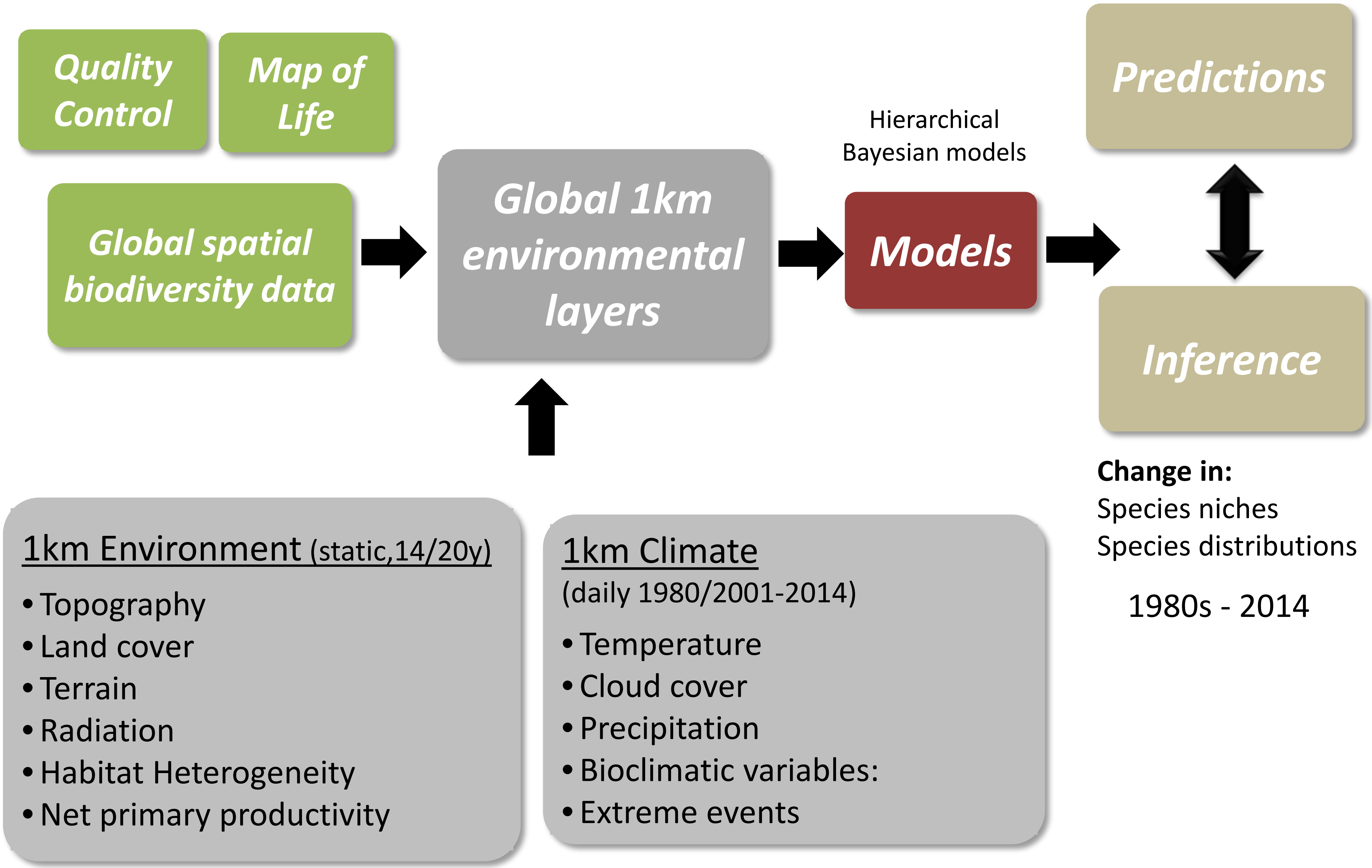
Global Biodiversity Monitoring

I. Providing representative baselines: species distributions, communities, environment

II. Quantifying environmental change

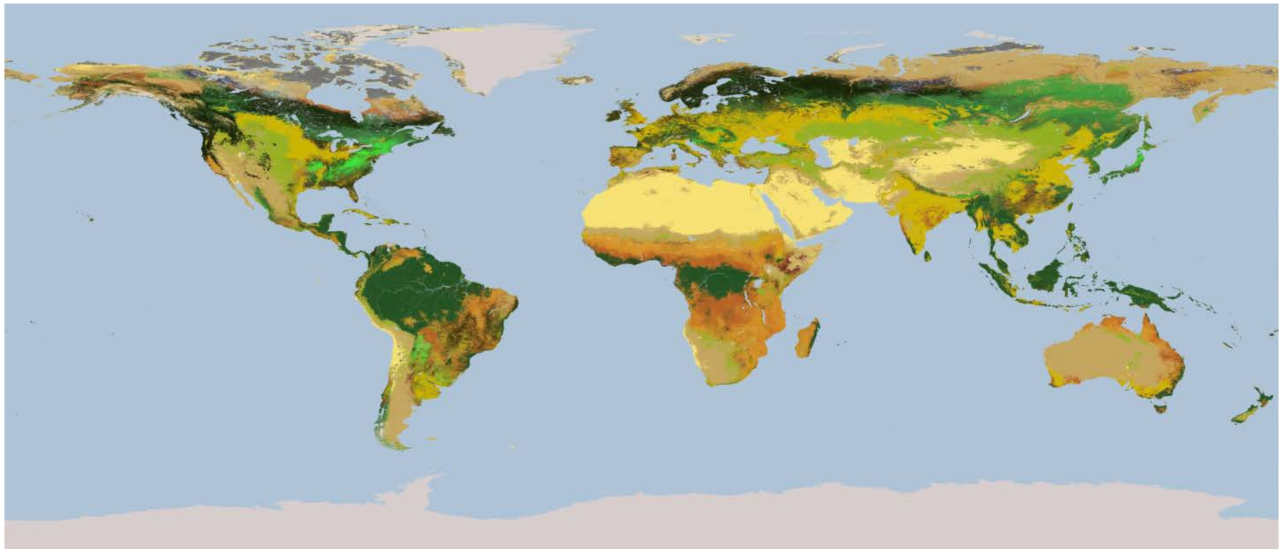
III. Detecting, monitoring biodiversity change

I. Sample- and model-based Biodiversity Monitoring

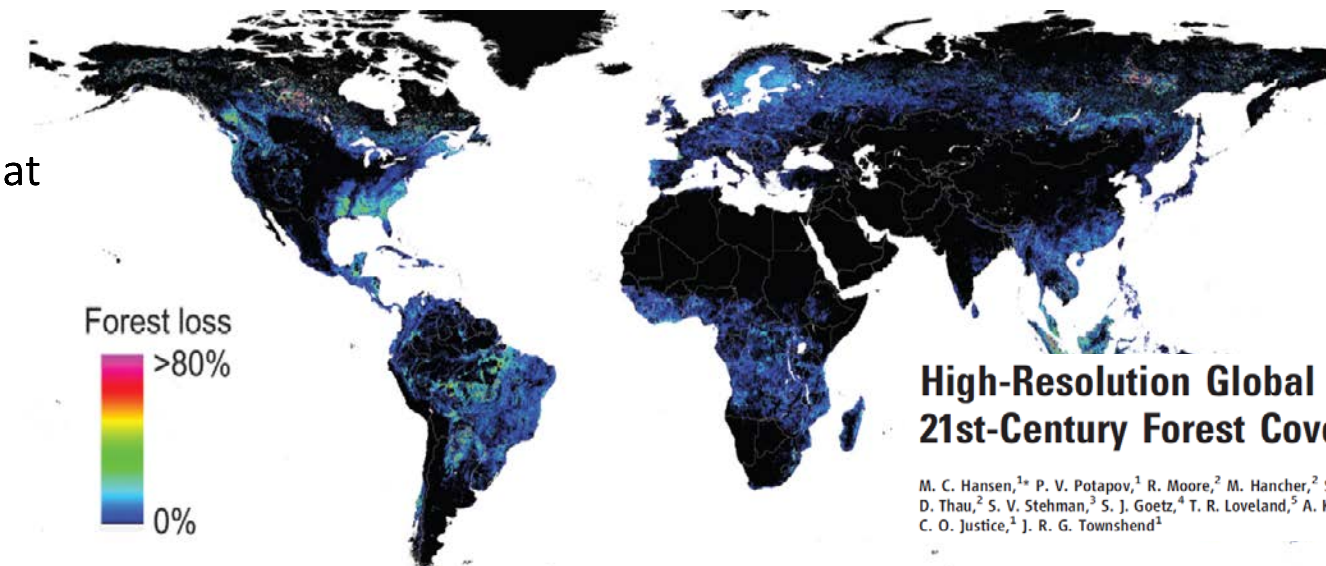


II. Range-, Land-cover based Biodiversity Monitoring

1km MODIS
Land cover



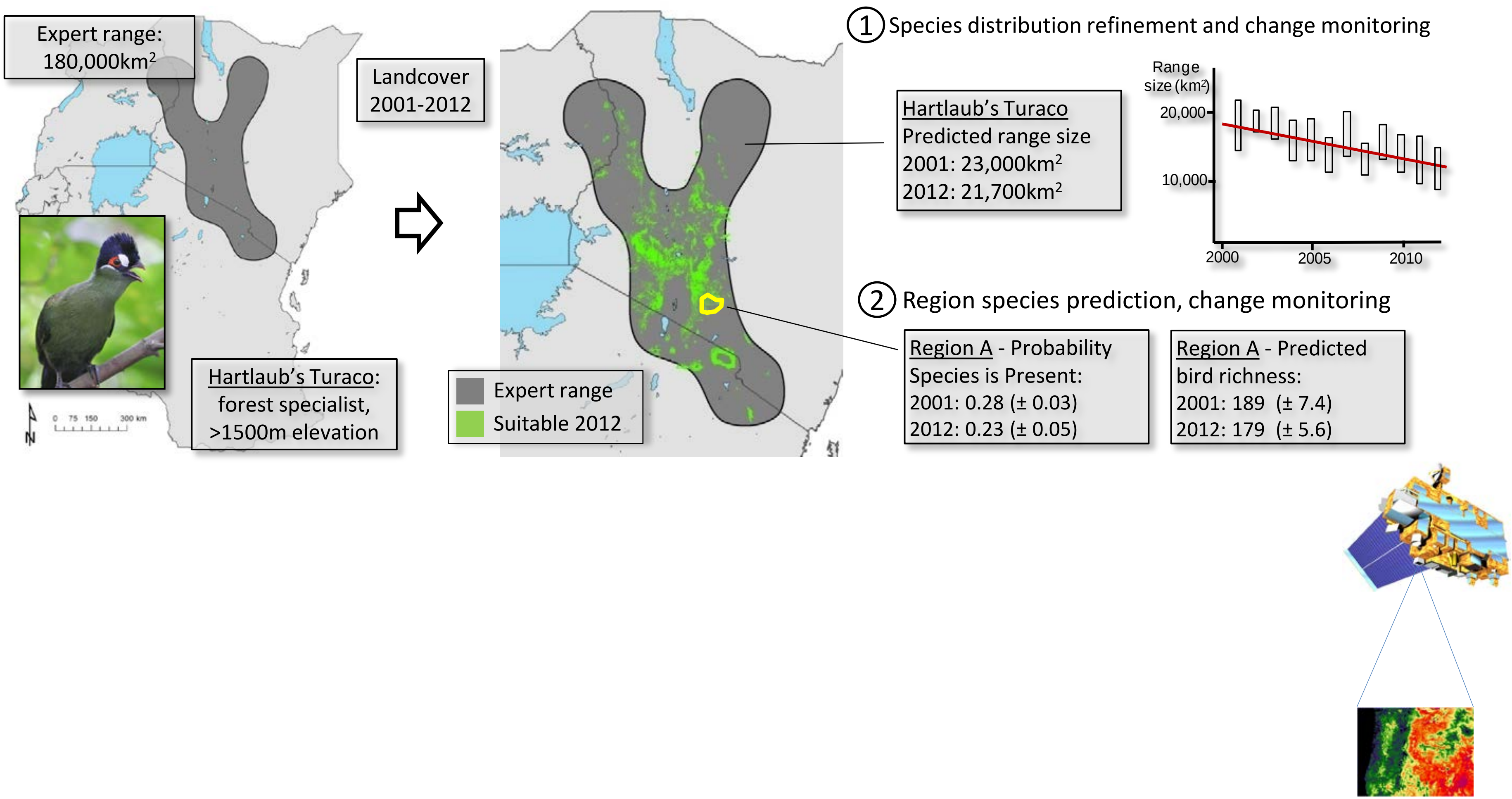
30m Landsat
Tree cover



High-Resolution Global Maps of 21st-Century Forest Cover Change

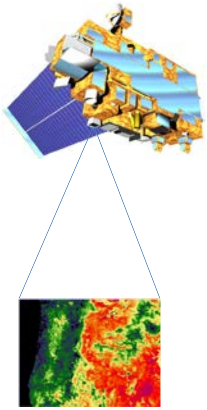
M. C. Hansen,[1*] P. V. Potapov,[1] R. Moore,[2] M. Hancher,[2] S. A. Turubanova,[1] A. Tyukavina,[1] D. Thau,[2] S. V. Stehman,[3] S. J. Goetz,[4] T. R. Loveland,[5] A. Kommareddy,[6] A. Egorov,[6] L. Chini,[1] C. O. Justice,[1] J. R. G. Townshend[1]

II. Range-, Land-cover based Biodiversity Monitoring



Challenges

How do gaps, biases in biodiversity data affect inference, decision-making, projection ?



How to achieve a globally representative and generalizable biodiversity monitoring for scientifically rigorous assessment and projection?

Global Biodiversity Monitoring, Prediction & Reporting

Challenges

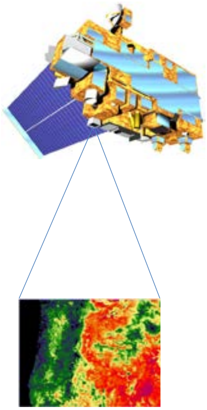
Data needs, data gaps

Data mobilization, attribution, citation

What/where/when/how to sample representatively?

Role of (remote) sensing, citizen science

Role of models to support representative indicators, knowledge products



Global Biodiversity Monitoring, Prediction & Reporting

Thanks!