Biodiversity and human well-being

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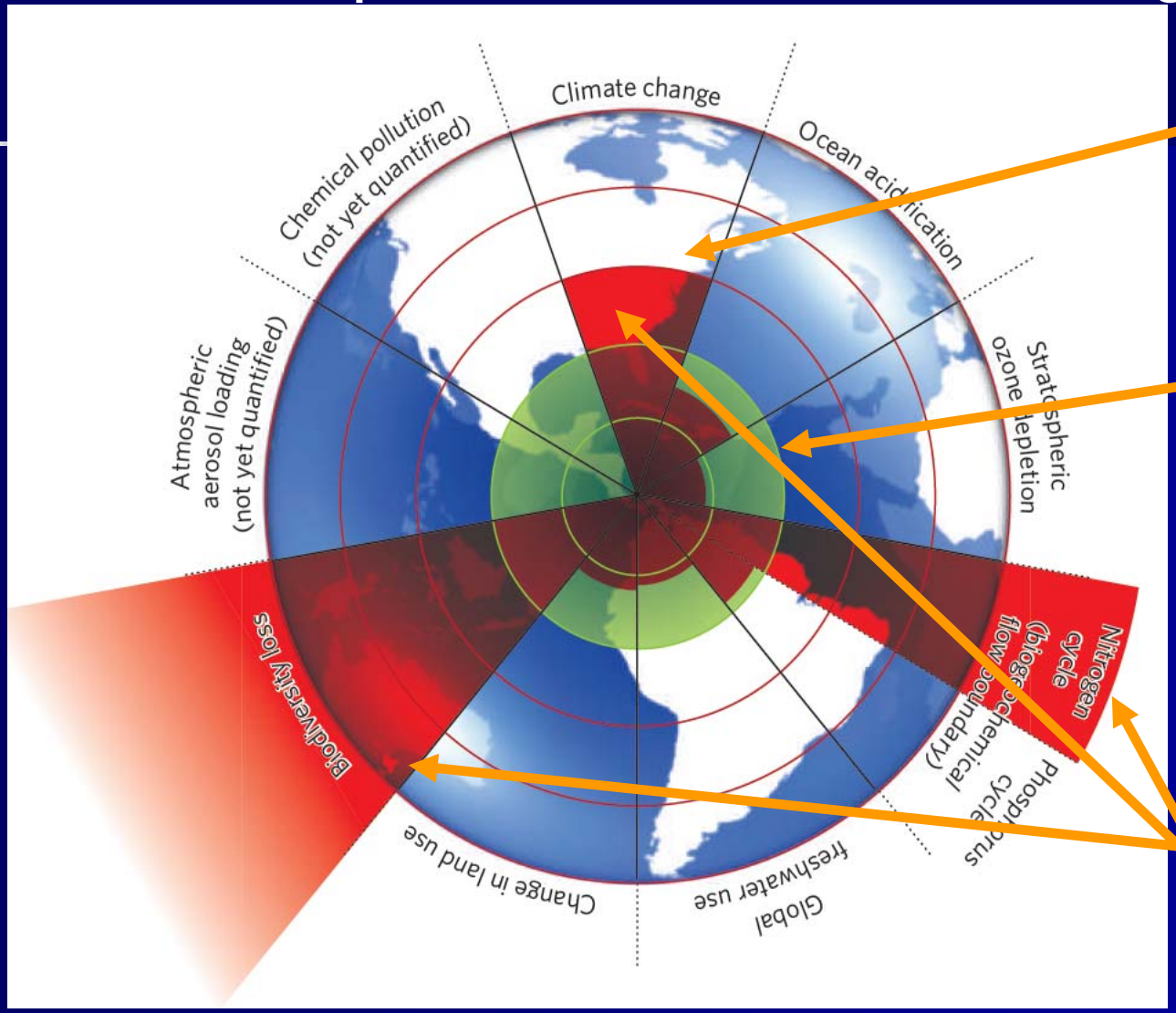
Our planet has been deeply transformed to cope with the increasing demand from human societies

We have crossed various planetary boundaries of unacceptable environmental change



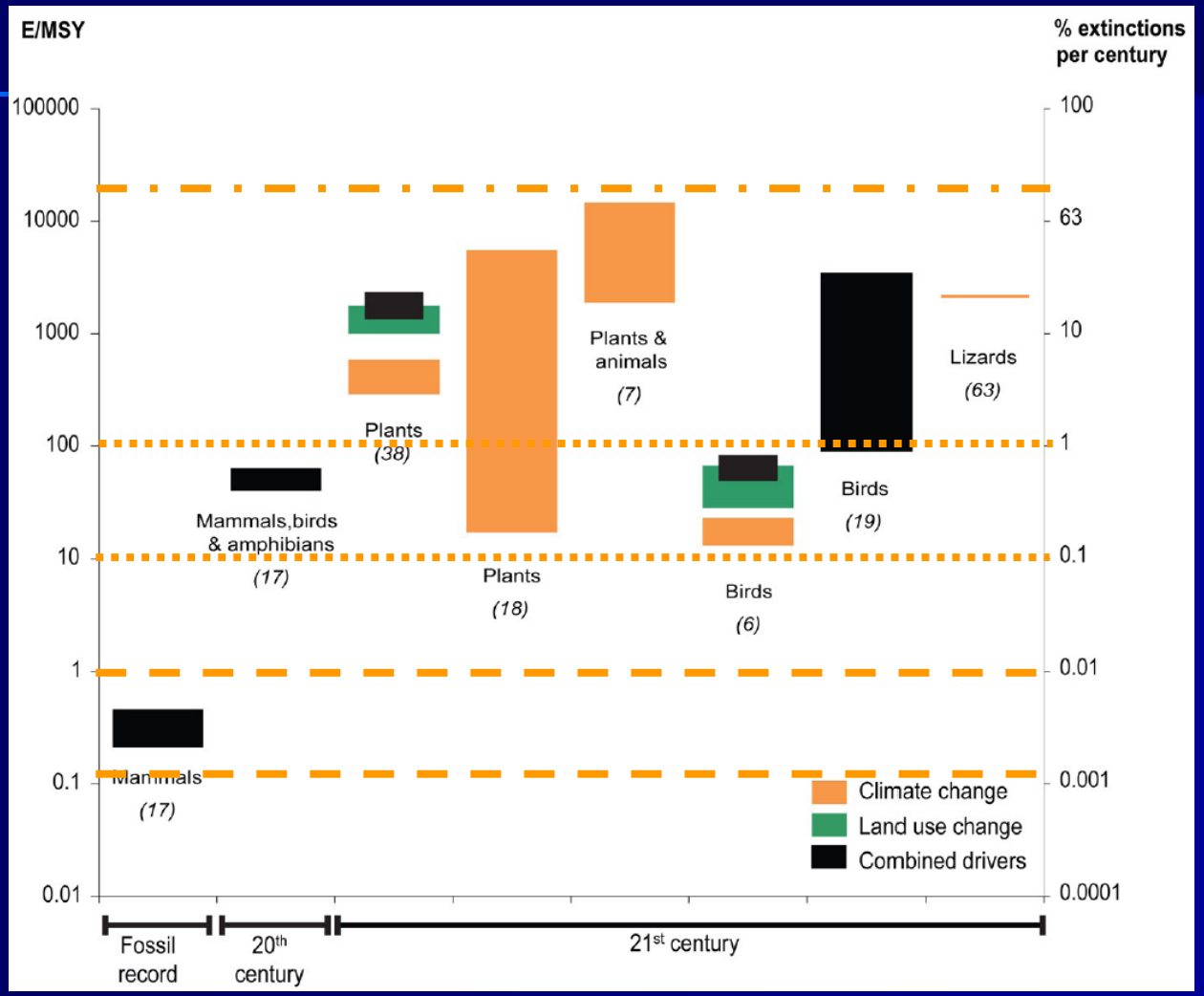
Current condition

Safe operating space

Exceeded boundaries

Rockstrom et al. 2009 Nature 461: 472-475

Extinction rates are much higher today than in the past and will increase in the near future



Number of extinctions per million years per species

Future
Similar to
1000 times
higher

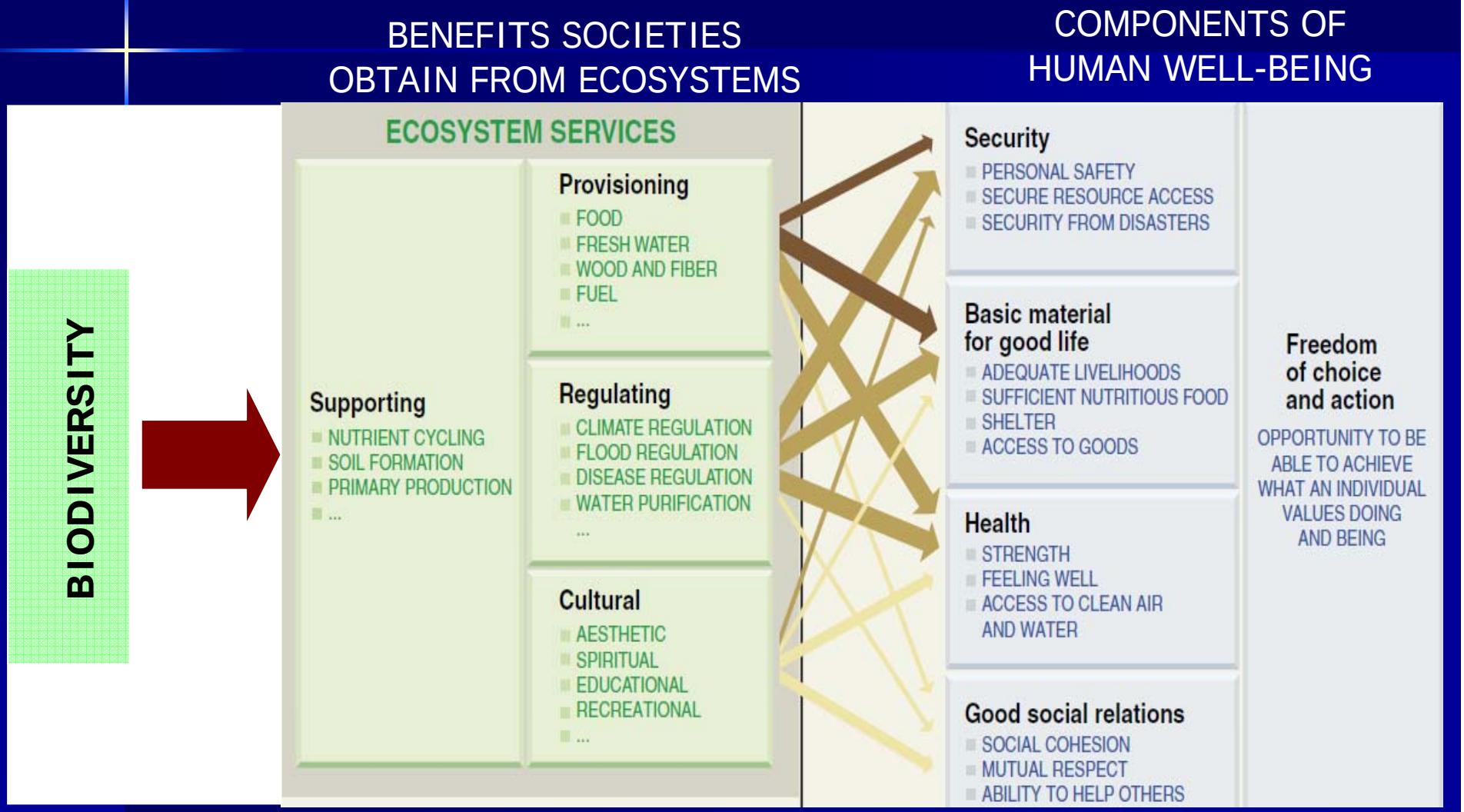
Present rates
10 to 100
Times higher

Past rates

Pereira et al. 2010. Science DOI science.1196624

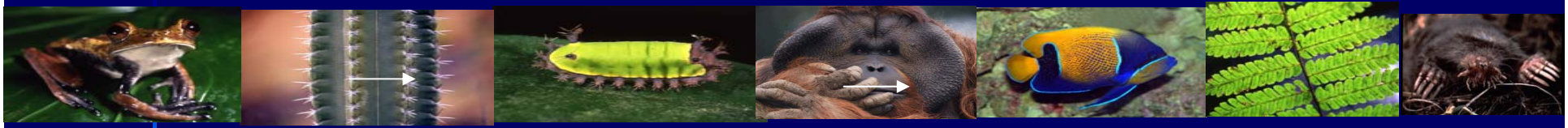
This biodiversity loss is likely to have negative consequences on human well-being

Biodiversity is linked to human well-being because it affects the ability of ecosystem to provide benefits or services to societies

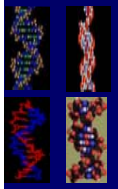


Millennium Ecosystem Assessment 2005

Biodiversity is the variability among living organisms



Diversity at different levels of organization

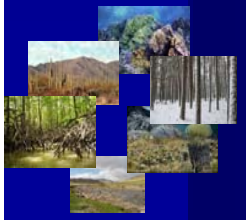


Genetic diversity within populations

Population diversity within species

Species diversity within communities

Community diversity within landscapes



Biome diversity

Different types of diversity

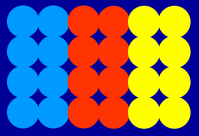
Number of species

Relative abundance

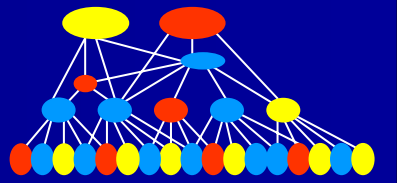
Composition

Range of functional traits

Spatial distribution



Vertical diversity



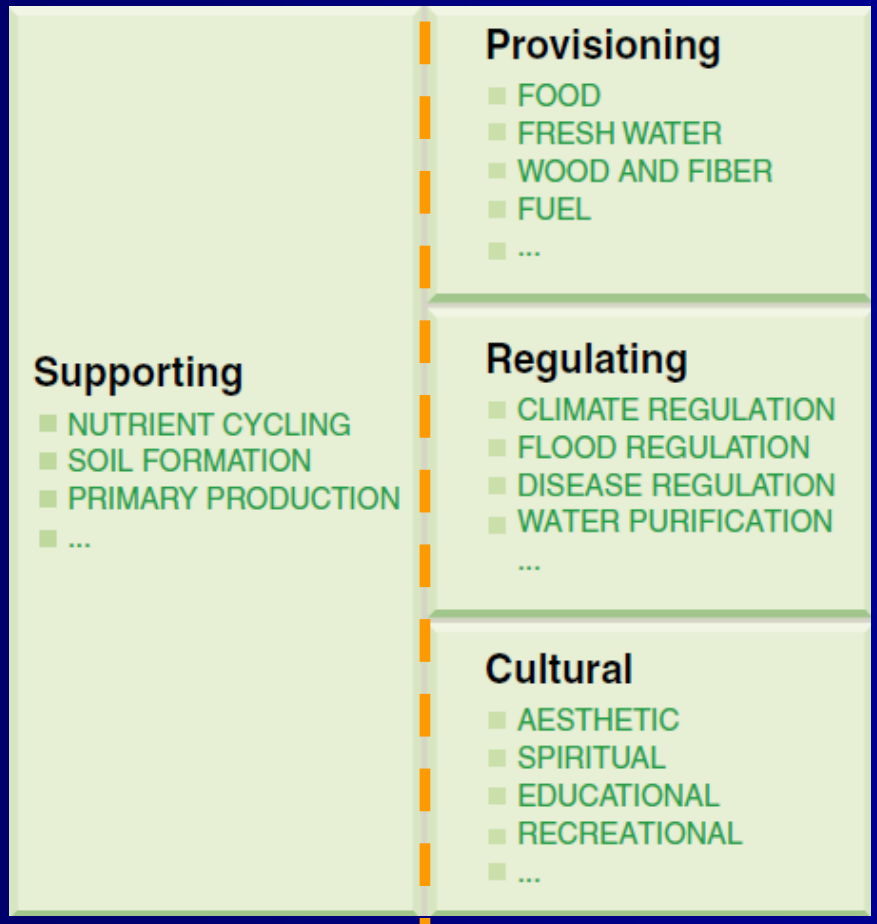
Díaz et al. 2006 PLOS 4:277

Ecosystem processes and services underpin well-being

Ecosystem processes: interactions among abiotic and biotic components of ecosystem

Ecosystem services: the benefits people obtain from ecosystems

Basic ecological processes that underpin ecosystem functioning and the ability to deliver ecosystem services



Resources that can be consumed, accounted for

Processes that regulate the variability in ecosystem conditions

Benefits that arise from Human-ecosystem relationships

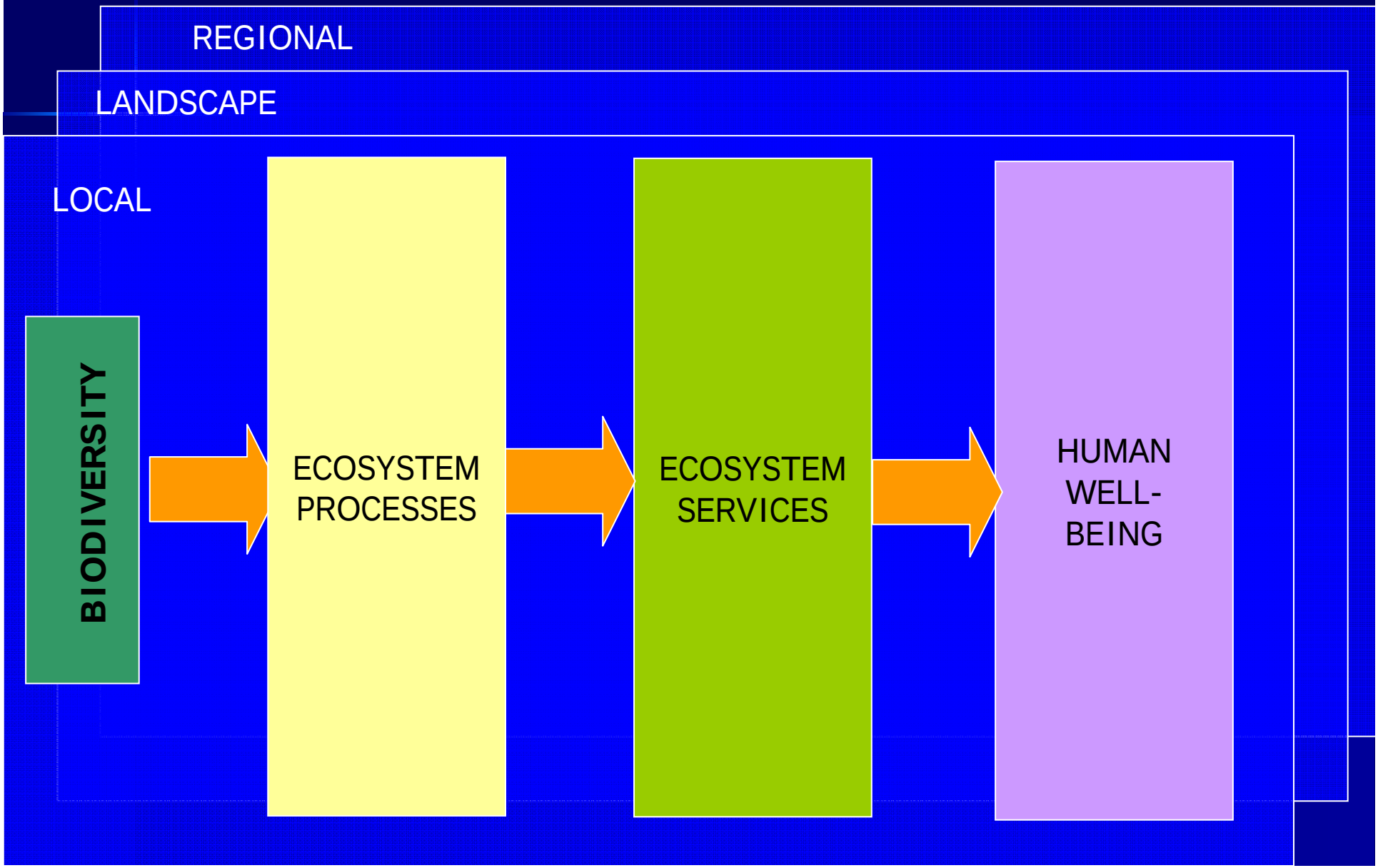
Millennium Ecosystem Assessment 2005, Maass et al 2005, Chan et al. prep.

Human well being can be assessed through its constituents

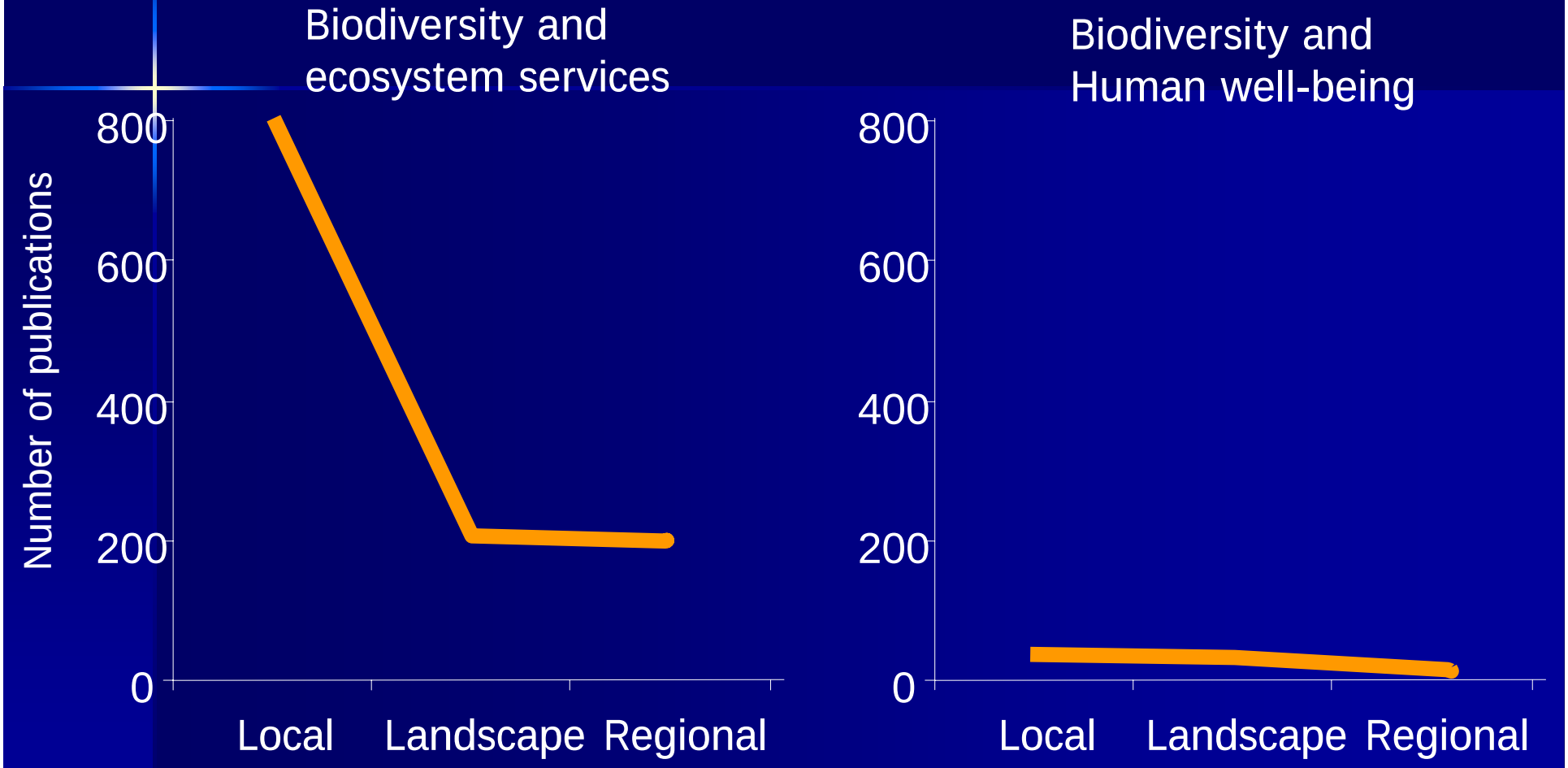
The relative importance of these constituents of well-being varies among stakeholders and among societies

Millennium Ecosystem Assessment 2005

We will analyze what we know about the links between biodiversity and well-being at various spatial scales



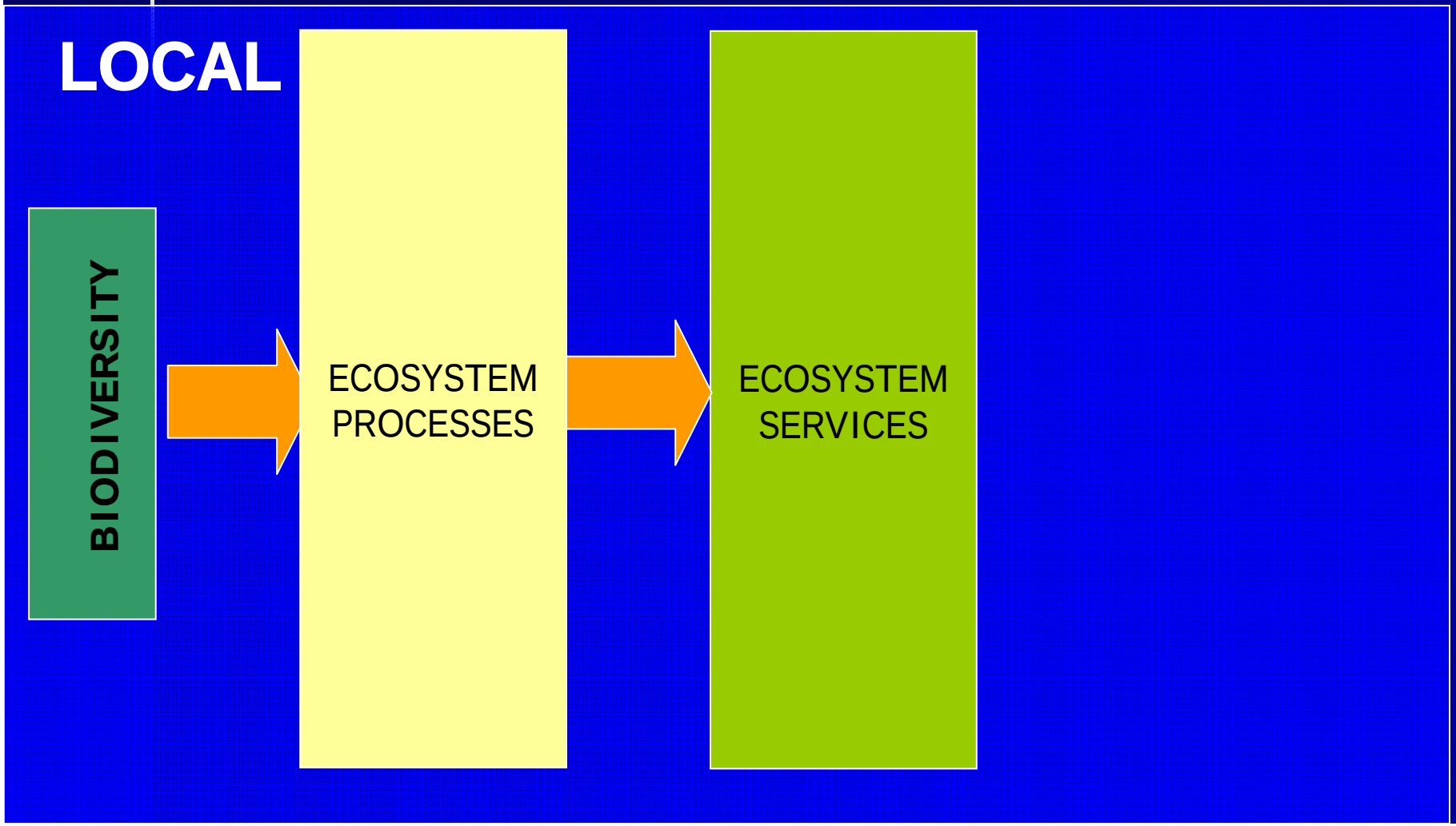
The availability of information on the topic is uneven



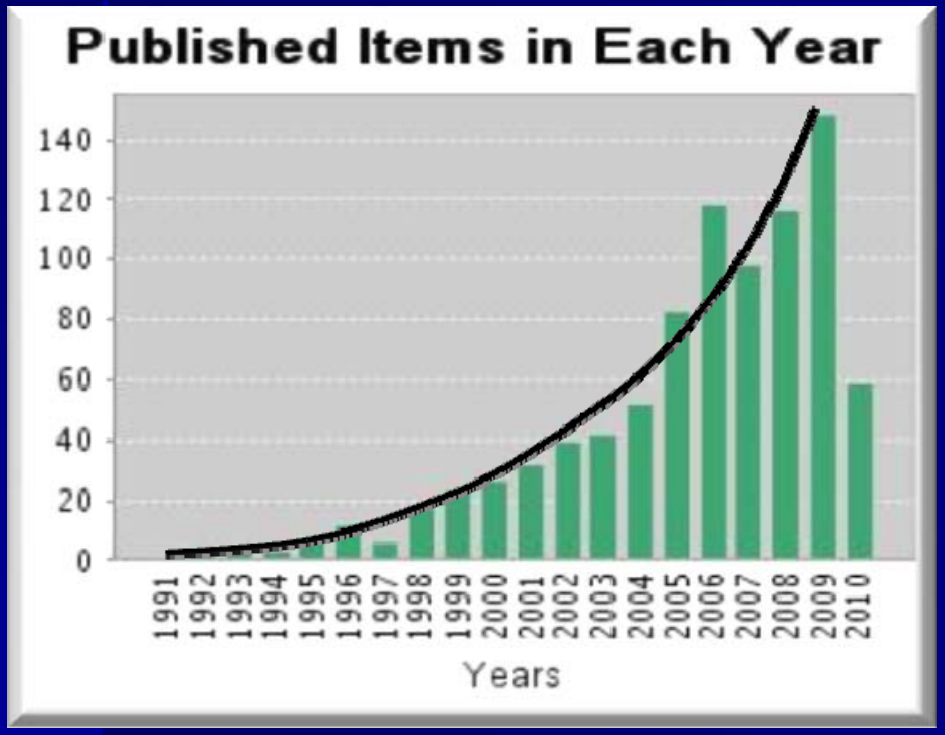
Only a small fraction of these references provide information relevant to the posed question

ISI Web of Knowledge 2010

The links between biodiversity and ecosystem processes is very well know.
That for ecosystem services is not so well known

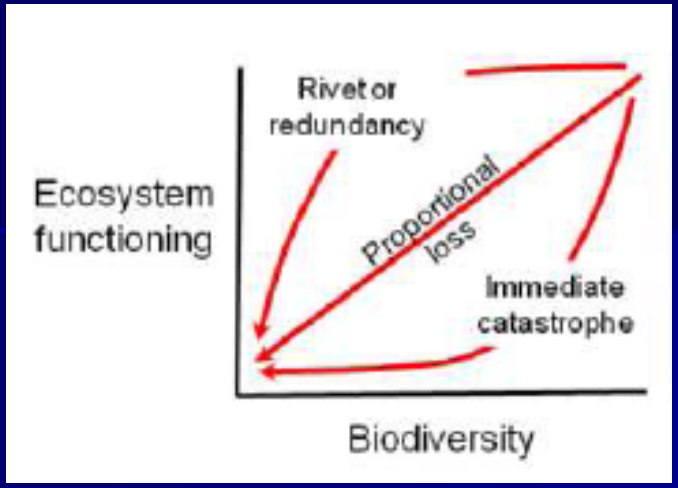


Experimental studies have allowed the exploration of the links between biodiversity and ecosystem functioning

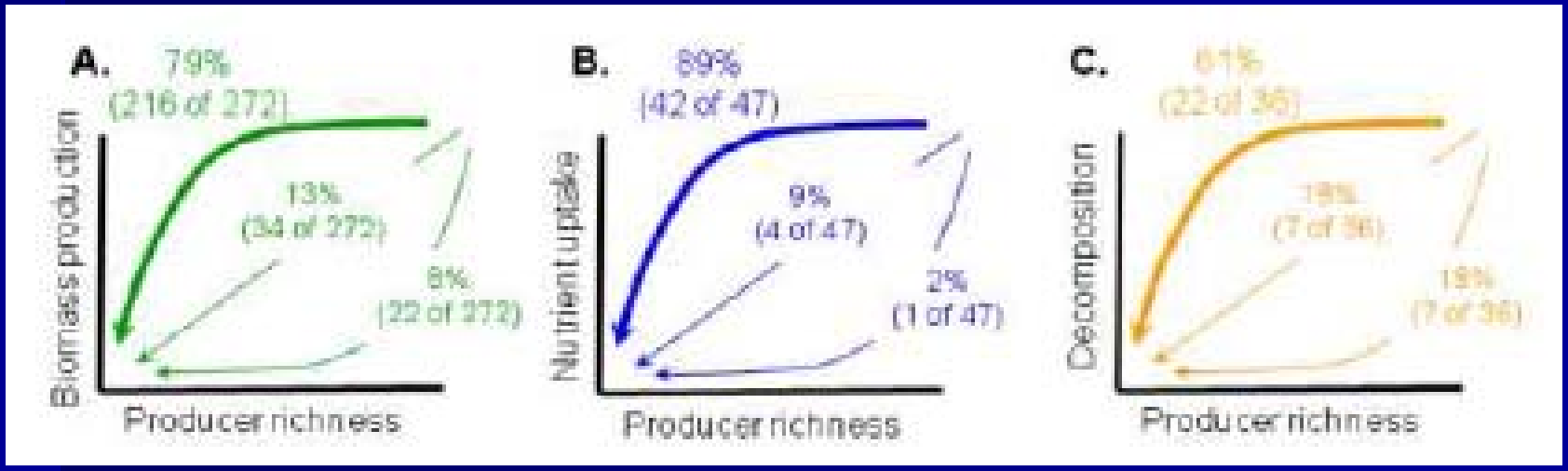


There has been an exponential increase in the number of publications from experiments

What is the shape of the relationship?



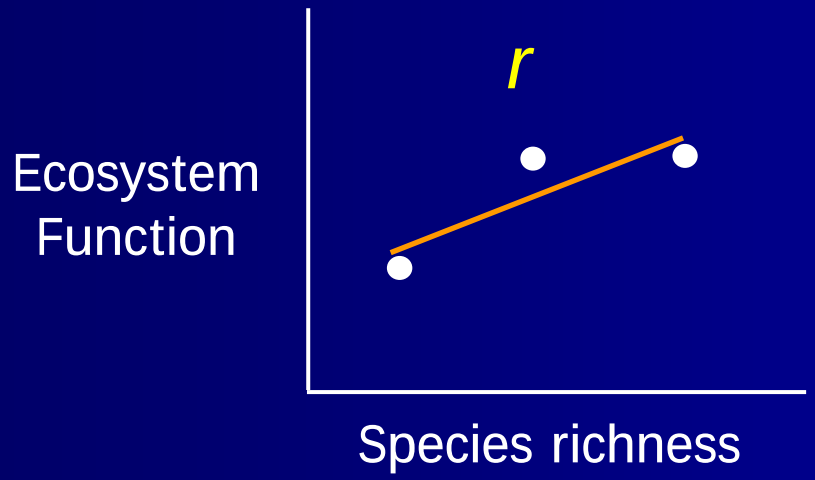
The dominant shape has been the rivet one



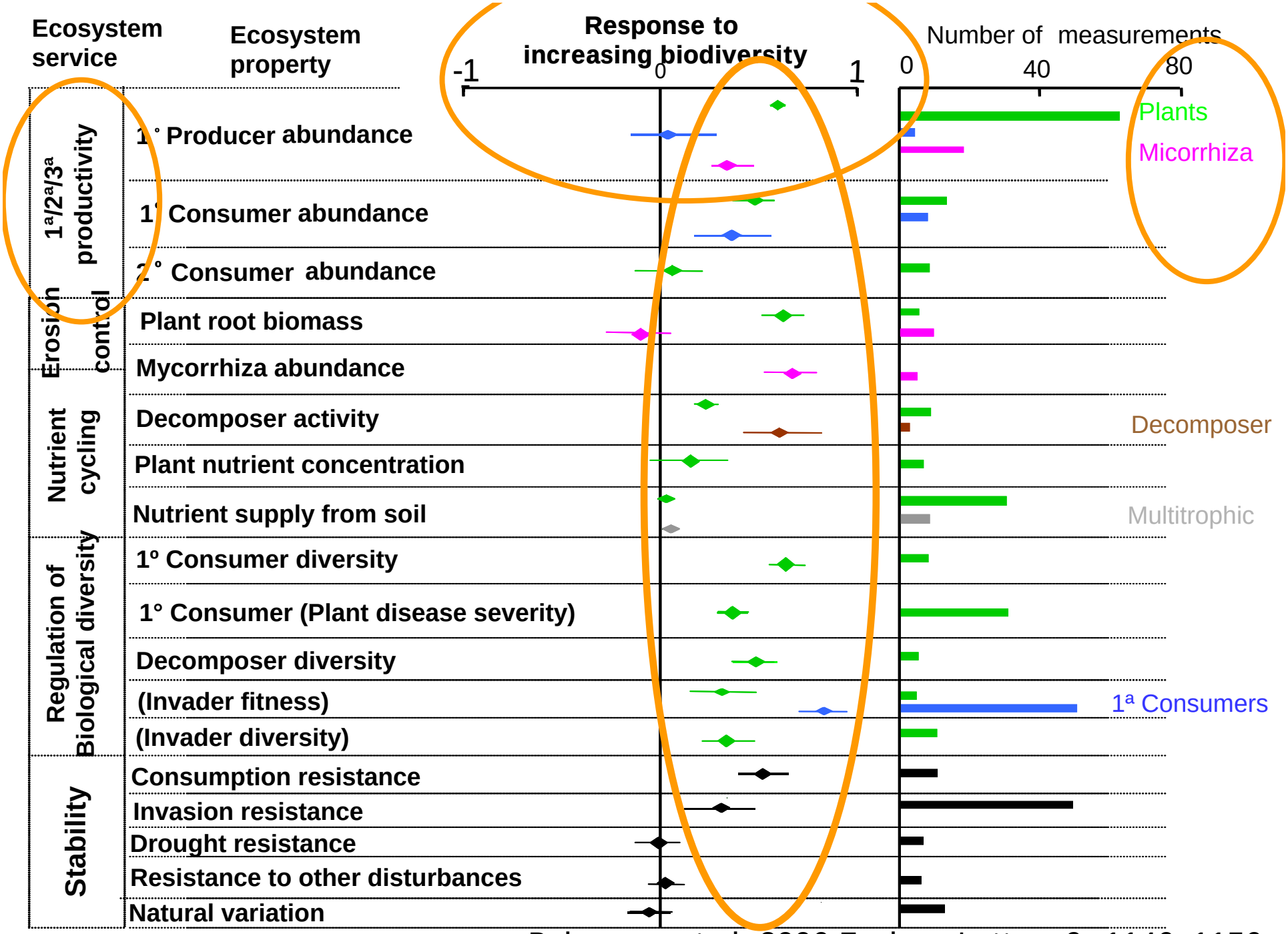
Cardinale et al. in press American Journal of Botany

What is the direction of the relationship?

103 studies (1954-2004)
ca. 450 diversity “effects”



Balvanera, Pfisterer, Buchman, He, Nakashizuka, Rafaeeli, Schmid
2006 Ecology Letters 9: 1146–1156



Balvanera et al. 2006 Ecology Letters 9: 1146–1156

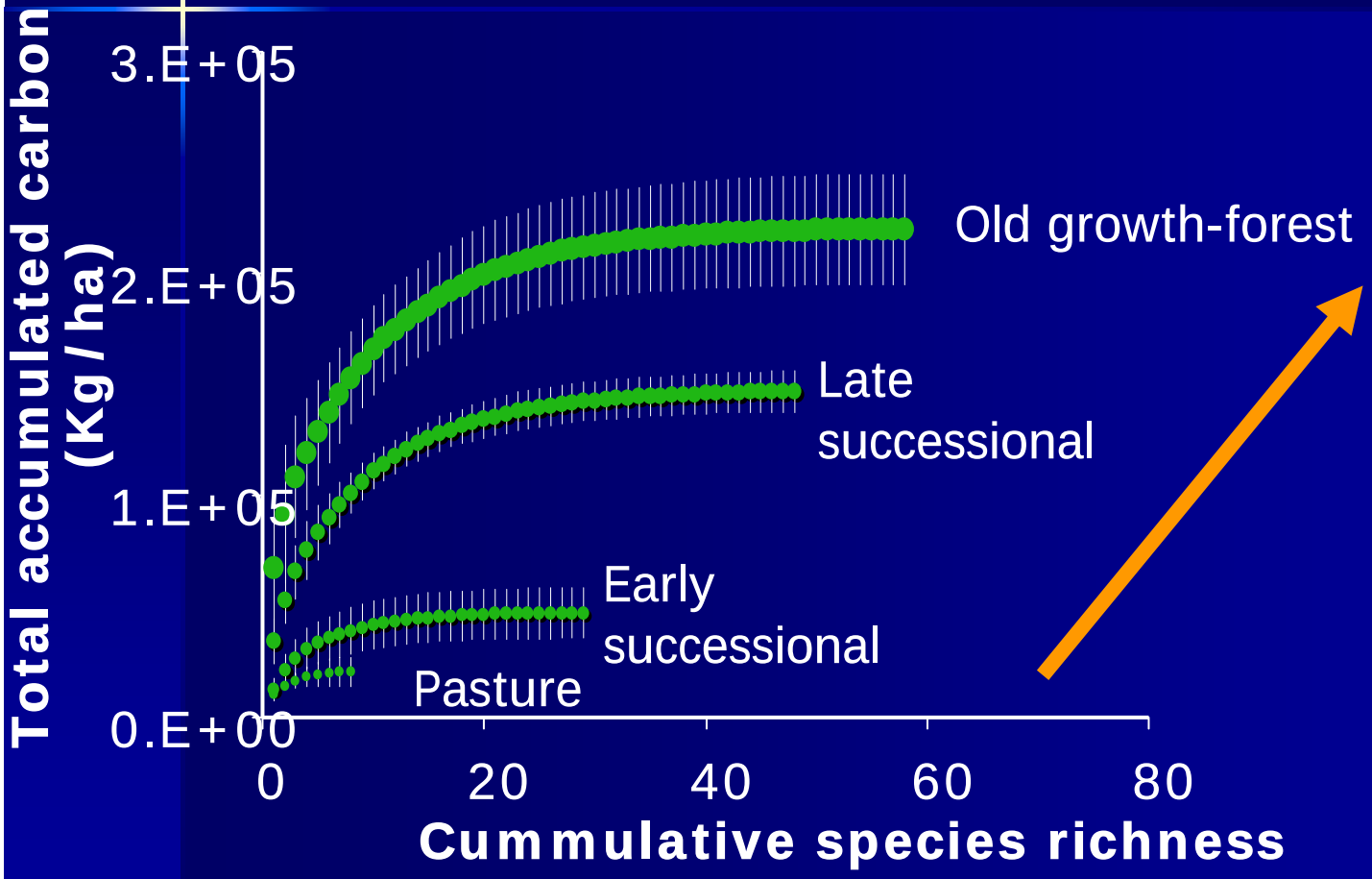
We found clear positive effects of biodiversity on most ecosystem services analyzed

These effects were analyzed accross multiple ecosystem types, multiple trophic levels, and multiple functions pointing towards consistency

Yet, little is known for many types of ecosystems, e.g. very diverse systems such as tropical forests

We are analyzing links between biodiversity and ecosystem services for successional tropical forests

Aboveground carbon storage

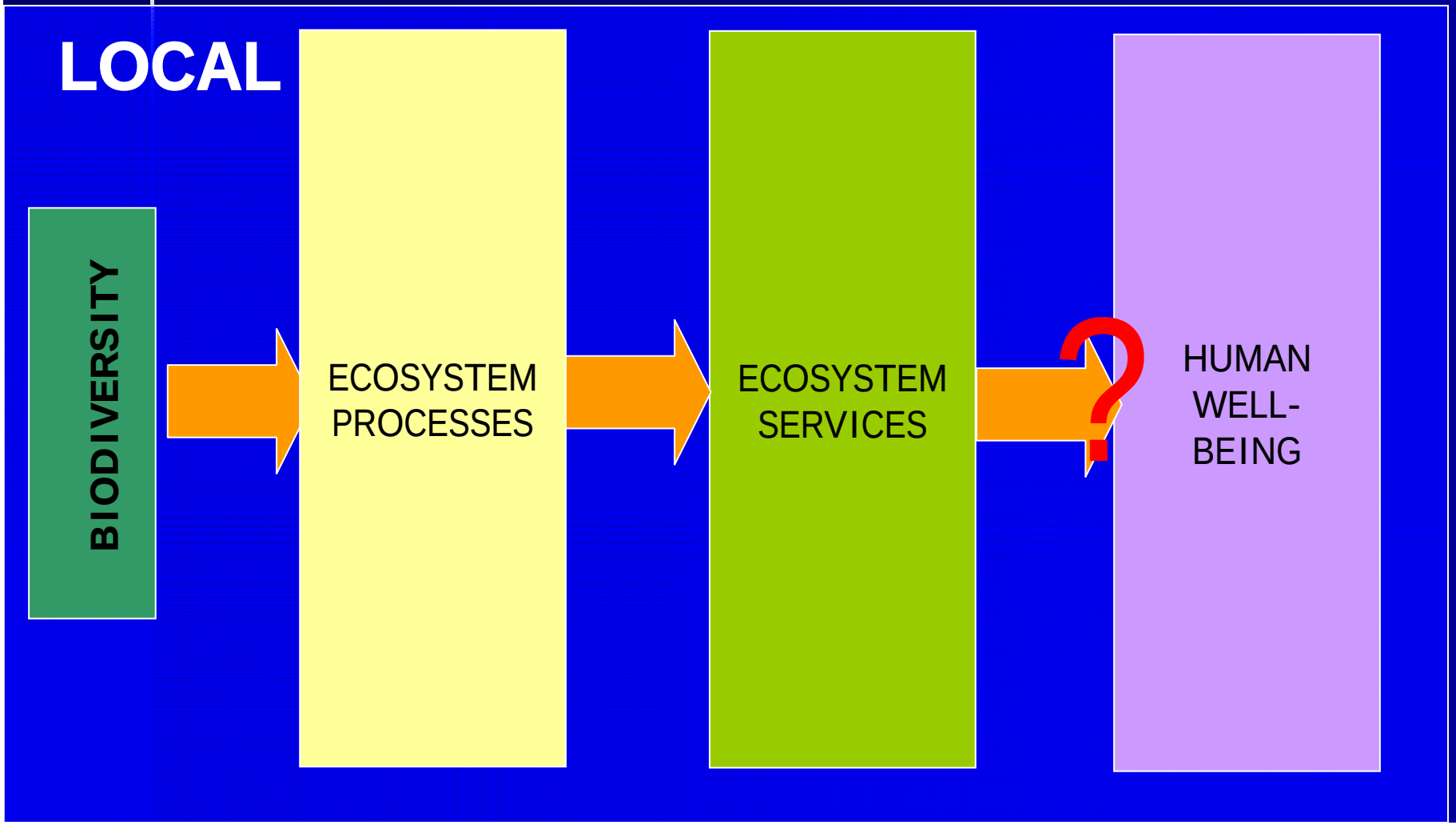


Increasing richness and magnitude of service along succession

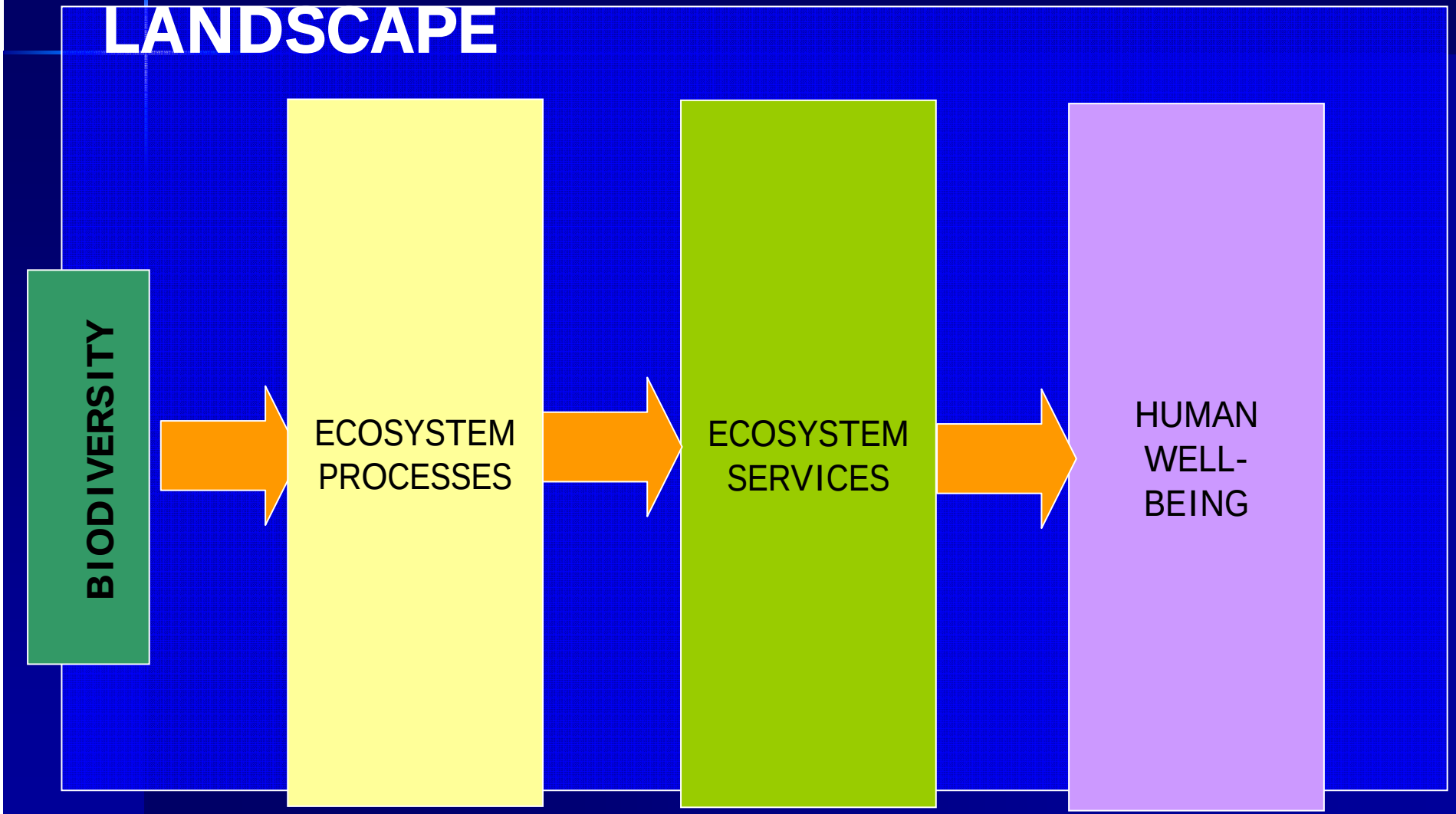
Balvanera et al 2005 Ecological Applications 15:360-375, Balvanera et al in prep.

Much less is known for the links to well-being at the local scale

How different components of well-being are related to biodiversity?

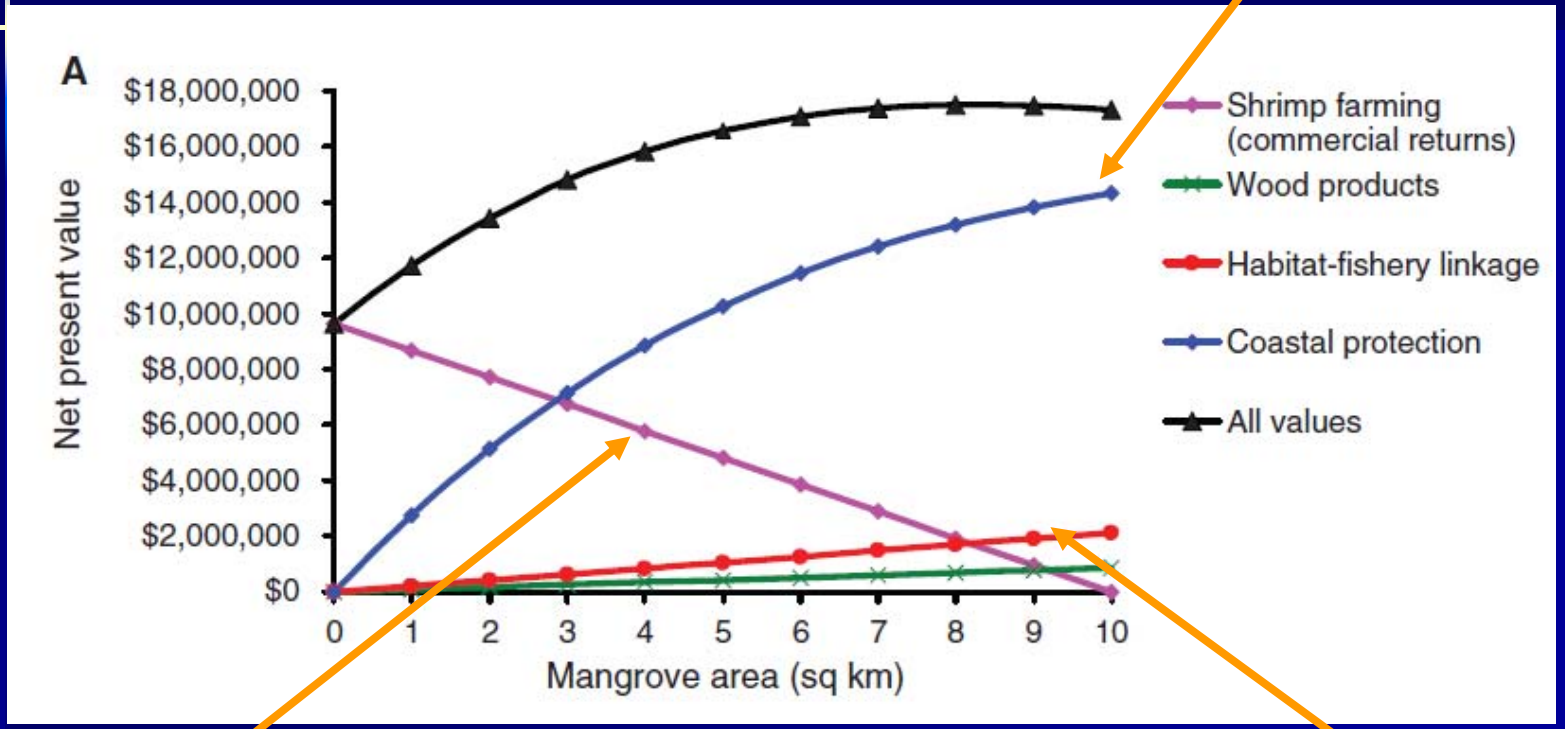


Little is known on the links between biodiversity, ecosystem services and well-being at landscape scales



Biodiversity within mangroves provides human well-being

Coastal protection



Decreasing shrimp farming
Profit as mangrove area increases

Mangroves provide habitat for fisheries

Barbier et al. Science 319: 321

Biodiversity is a direct source of food, fuel, medicine for rural populations of the world

EXAMPLE	NUMBER OF NON-TIMBER FOREST PRODUCTS	NUMBER OF PEOPLE BENEFITED
San Lorenzo Pápalo	397	200
Mexico	Ca 7,000	22,000,000
World		300,000,000

Various components
Of well-being

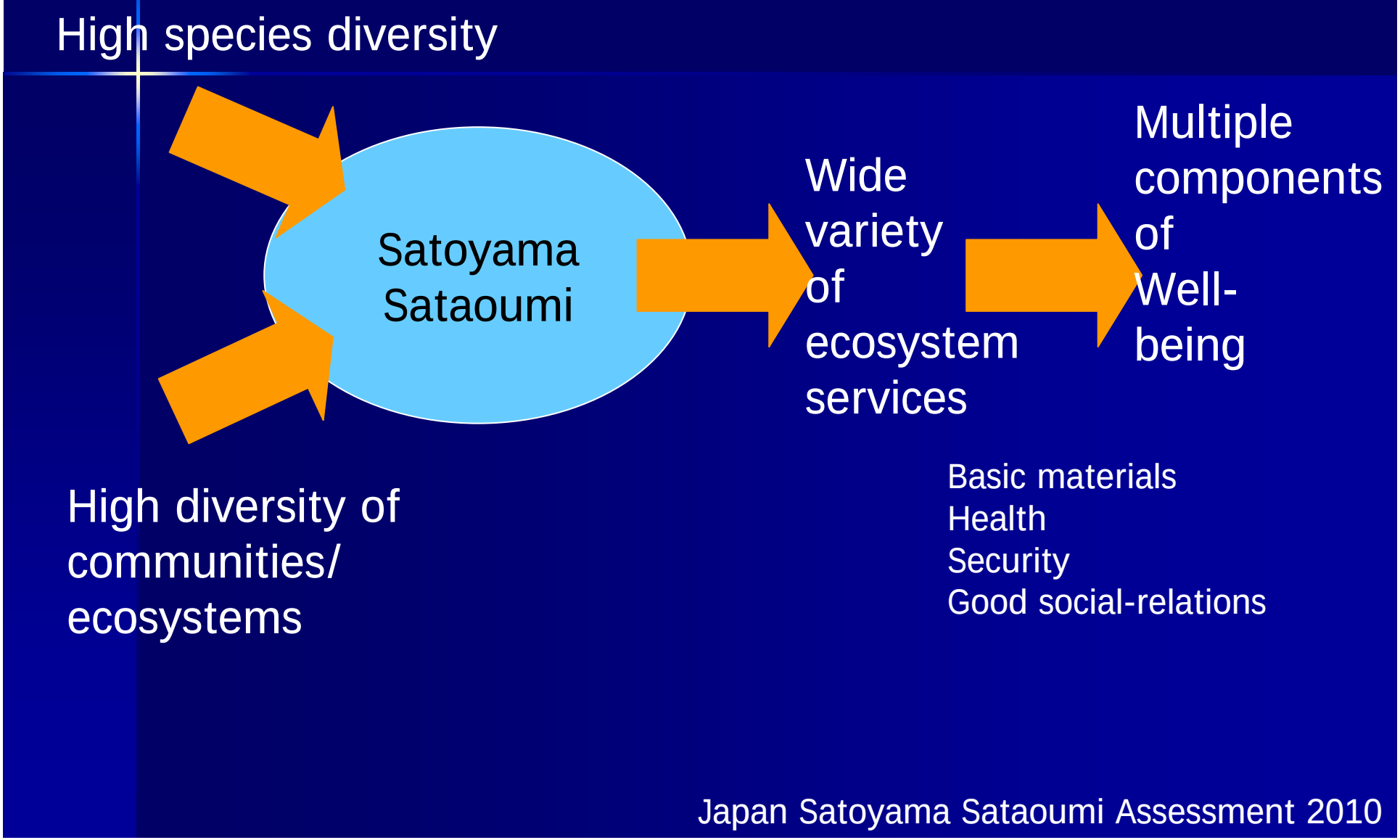
Basic materials
Health
Security
Good social-relations






Solís 2006 MSc Thesis, Balvanera et al. 2009 Capital Natural de México

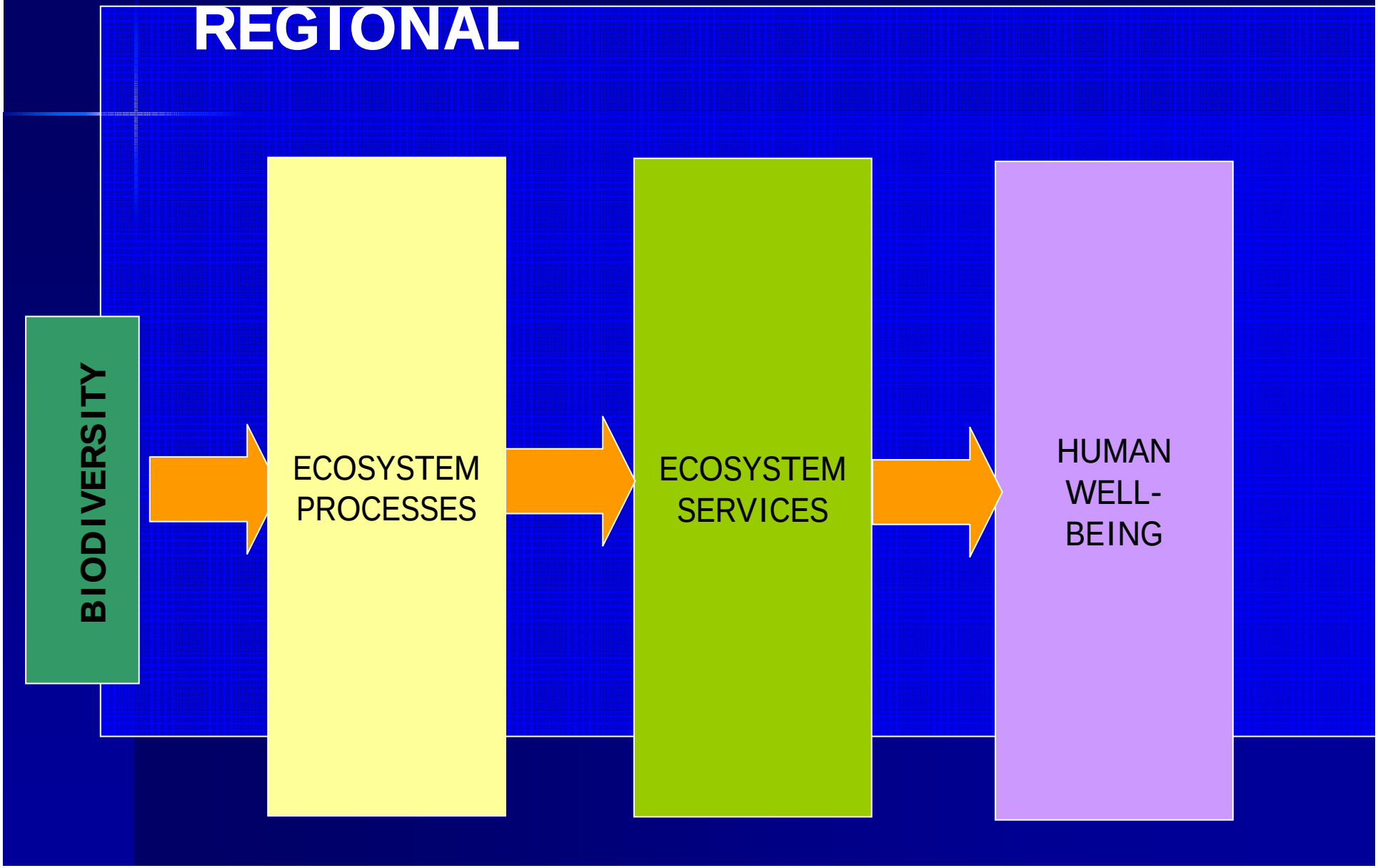
Biodiversity within Satoyama and Sataoumi is important for human well-being

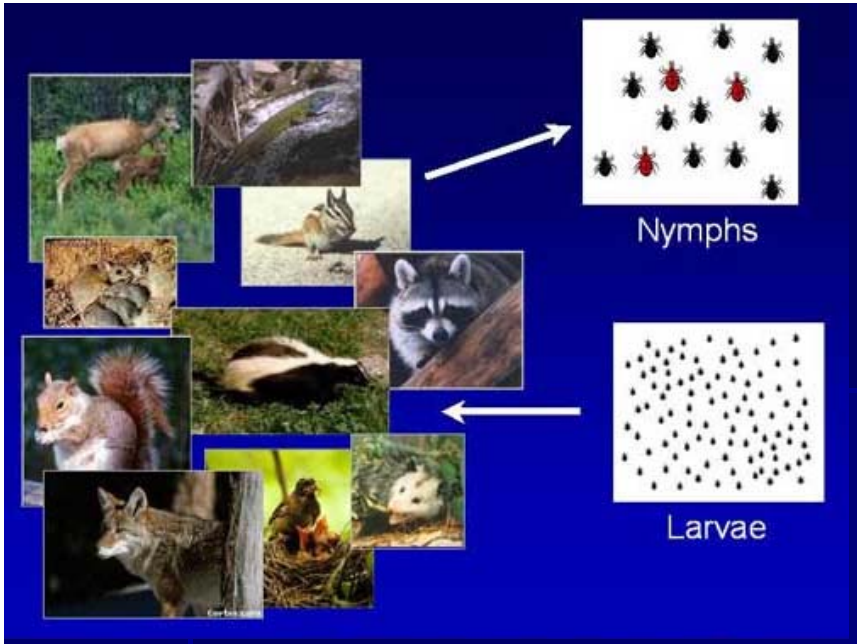


Japan Satoyama Sataoumi Assessment 2010

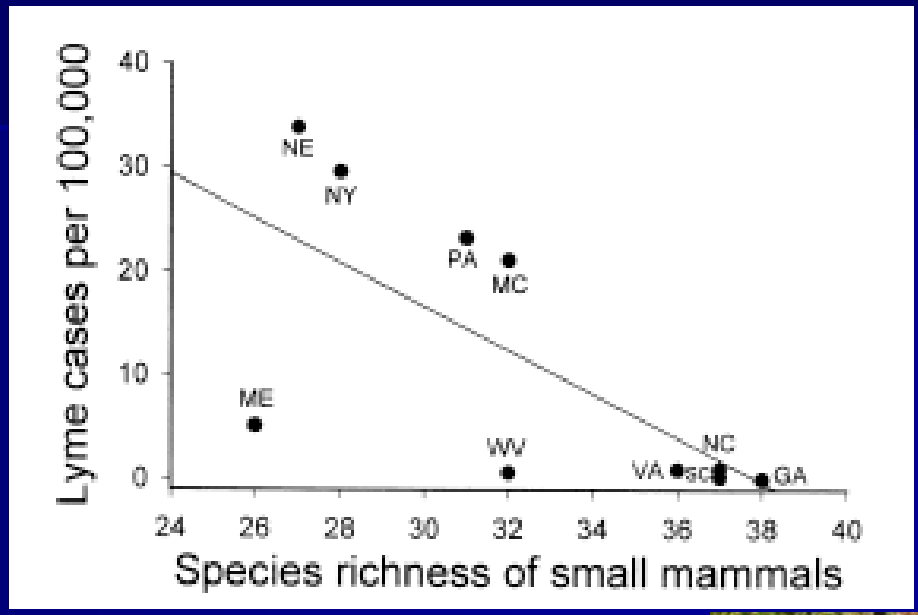
Biodiversity is important to services and well-being at landscape scales, though the patterns are not simple

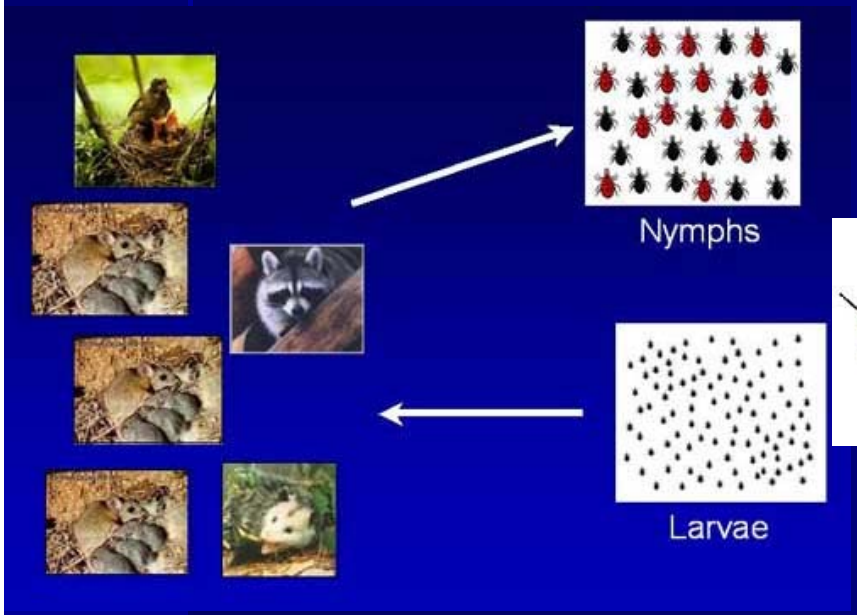
Some studies have analyzed the link between biodiversity, ecosystem services and well-being at regional scales





The higher the biodiversity the lower the disease incidence

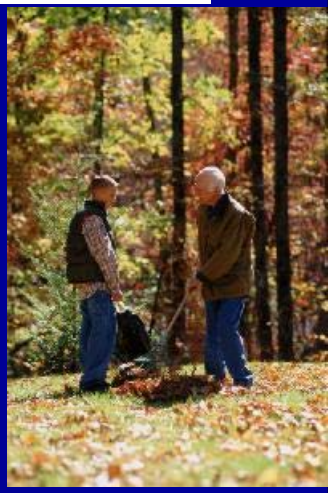




White-footed mouse
(*Peromyscus leucopus*)

Tick

Bacteria
Borrelia burgdorferi



Ostfeld & Keesing. 2000. Conservation Biology 14: 722–728

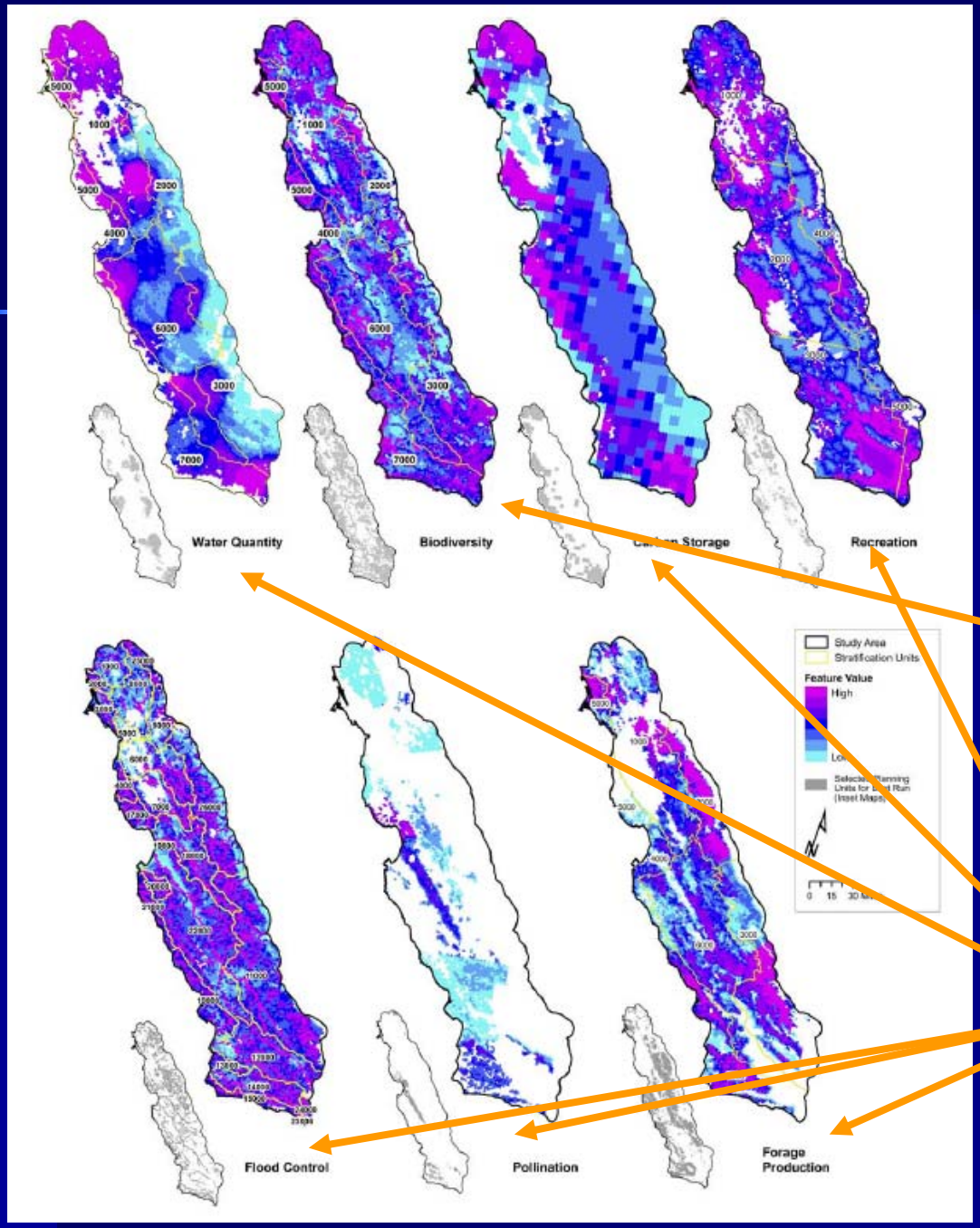
Many studies have now confirmed the links between biodiversity loss and increased disease transmission

Table 1 | Biodiversity loss can increase transmission

Disease	Mechanism	Reference
Amphibian limb malformation	B	12
Bacteriophage of *Pseudomonas syringae*	B	52
Coral diseases	A	53
Fungal disease of *Daphnia*	B	54
Hantavirus disease	A, B	23,55–57
Helminthic parasite of fish	A*	58
Lyme disease	A, B	18,22,59
Malaria	A	60
Puccinia rust infection of ryegrass	A*	10
Schistosomiasis	B	12
Trematode diseases of snails and birds	B	61–63
West Nile fever	A*, B*	7–9,64

A- host/vector abundance
B- host/vector/parasite behaviour

Kessing et al. 2010 Nature 468:647-652



Many studies to date have mapped **biodiversity** and delivery of multiple **ecosystem services**

Patterns of corrrelations between biodiversity and ecosystem services are not clear cut

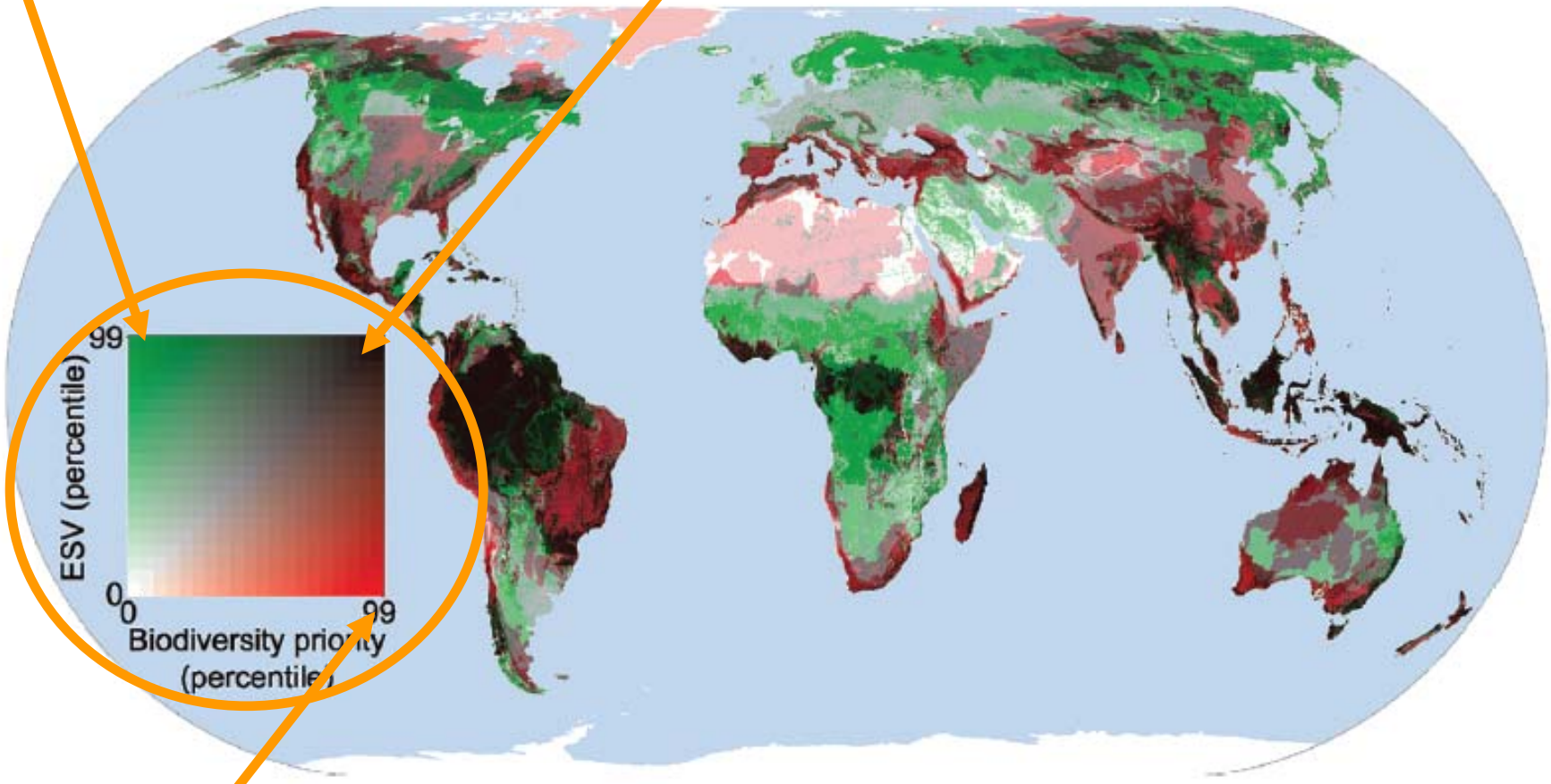
A	Carbon Storage	Pollination	Recreation	Water Storage	Flood Control	Forage Production	Bio-diversity
Carbon	1						
Pol'n	0.04	1					
Rec'n	0.19	-0.01	1				
H20	0.58	0.02	0.27	1			
Flood	0.21	0.00	0.24	0.17	1		
Forage	-0.07	-0.05	-0.07	-0.12	0.04	1	
Biod'y	0.03	-0.01	0.12	0.10	0.02	-0.04	1
Averages	0.16	0.00	0.12	0.17	0.11	-0.05	0.04
Overall	0.08						

Low overall correlation between biodiversity and services- California

Chan et al 2006 PLOS 4 e379

Only services

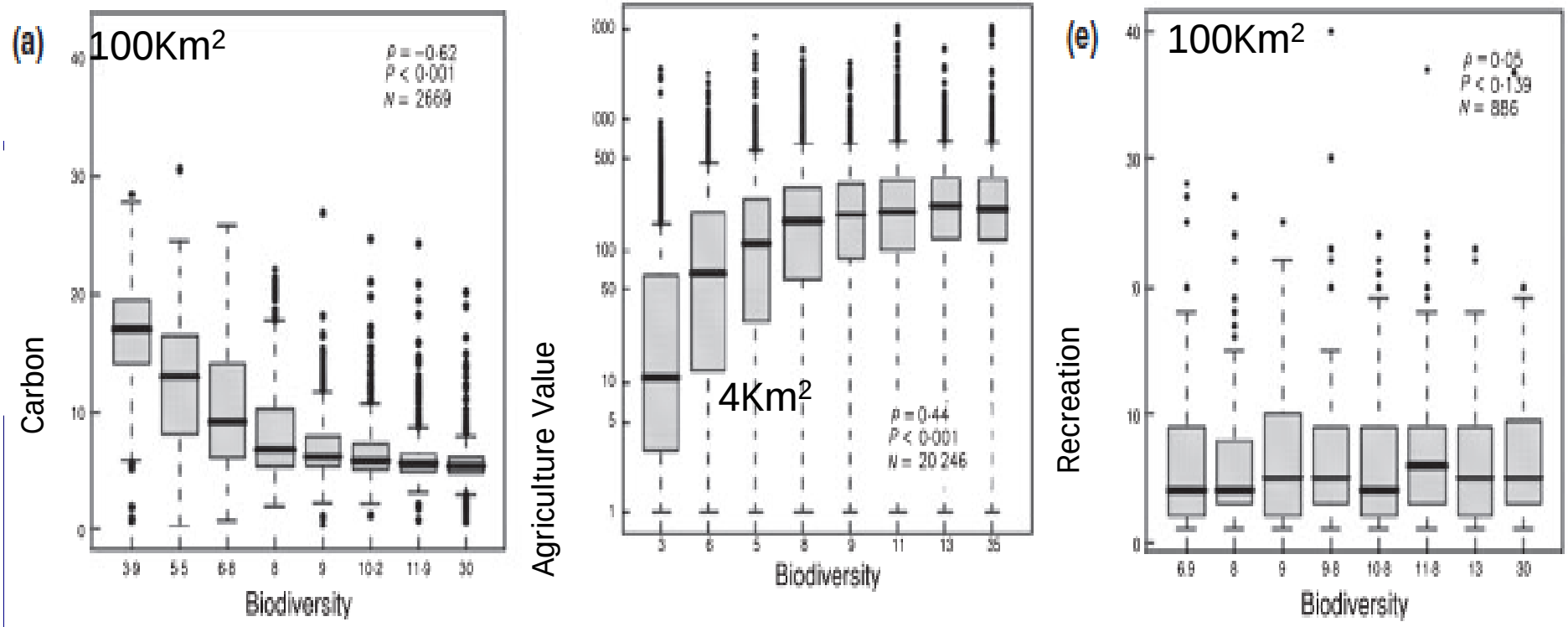
Both



Only biodiversity

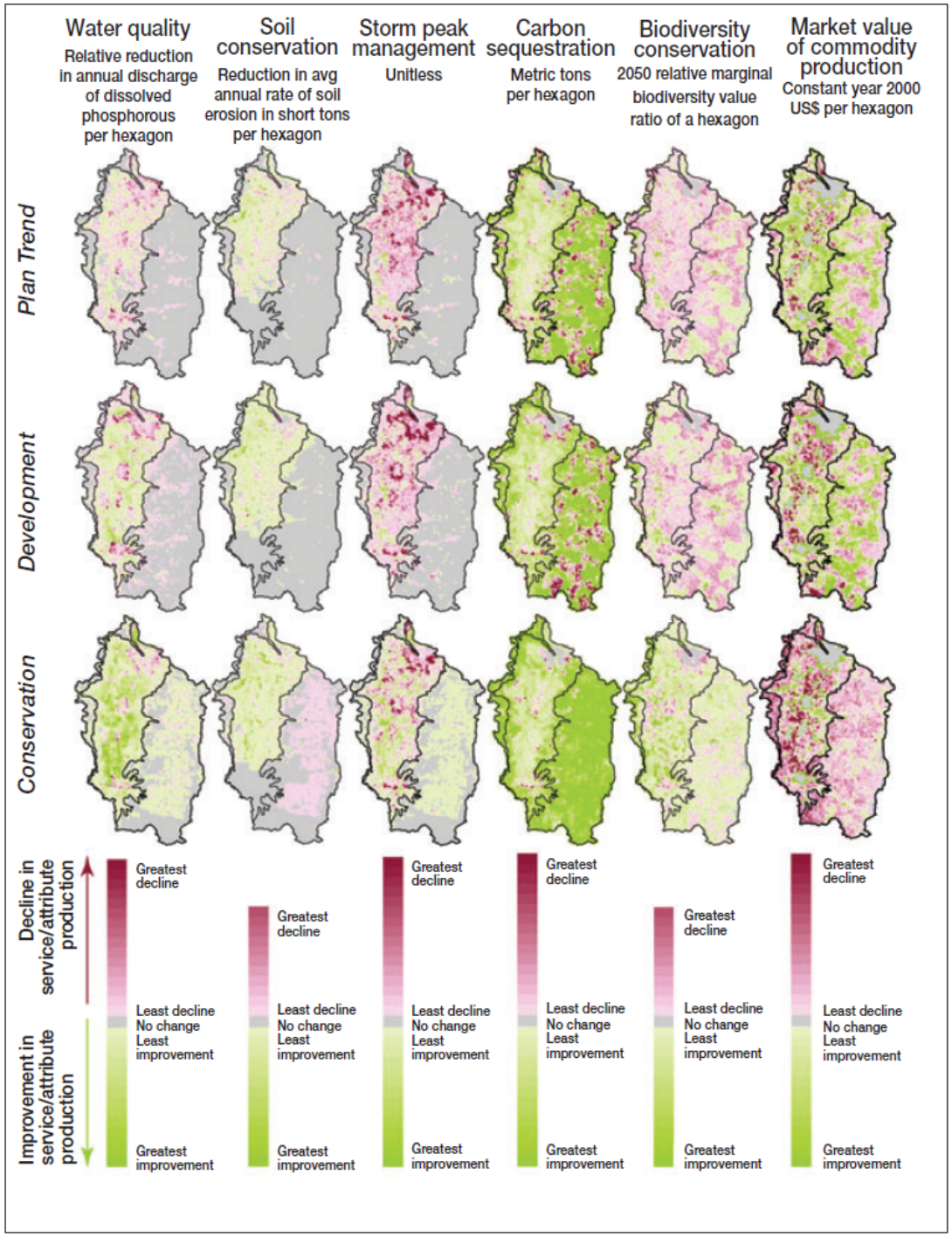
High spatial variance in concordance or discordance

Turner et al 2007 BioScience 57: 868-873



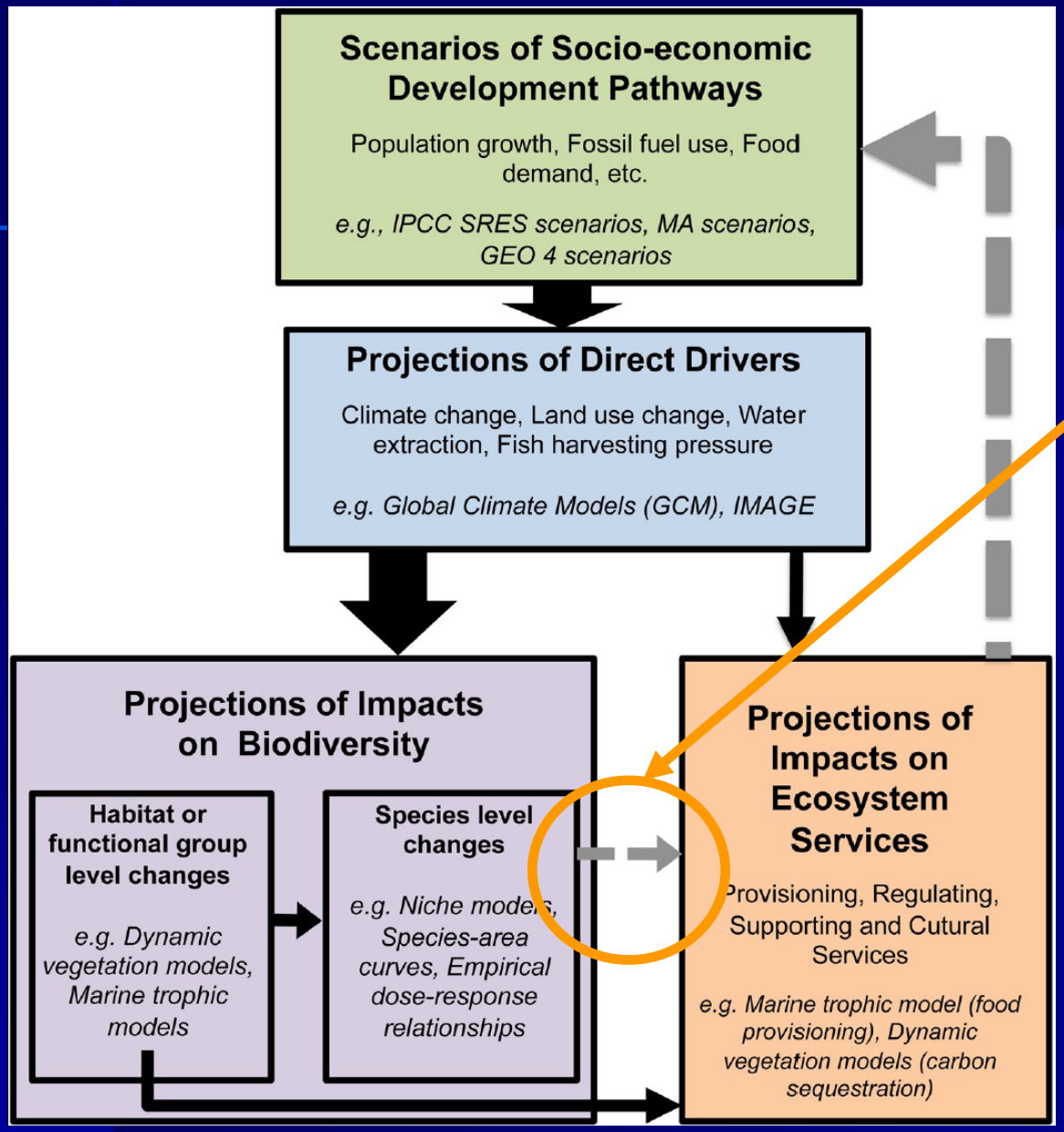
Spatial co-variance among services change with resolution and service - UK

Anderson et al 2009 J Appl Ecol 46 888–896



Future scenarios for biodiversity and for ecosystem services have been developped to inform decision making

Nelson et al 2009 Front Ecol Environ 7: 4–11



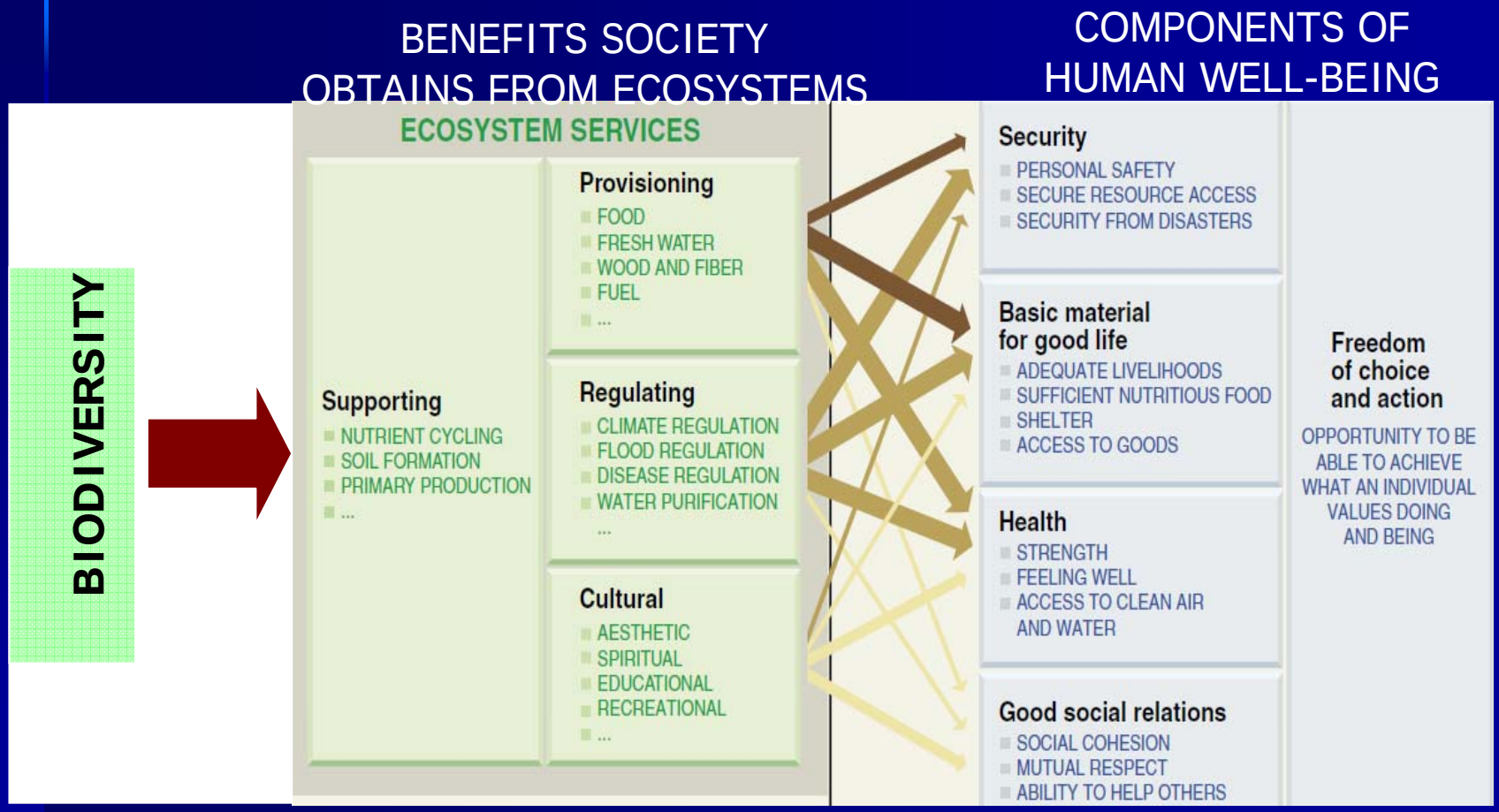
Yet models that predict impacts on ecosystem services based on changes in biodiversity are not yet available

Pereira et al. 2010. Science DOI science.1196624

Biodiversity is important to ecosystem services and well-being, yet the relationship at regional scales is very complex

Biodiversity underpins the delivery of ecosystem services and human well-being

Yet the relationship between biodiversity and human well-being is scale dependent and complex



Millennium Ecosystem Assessment 2005

What do we need to know?

- Role played by a range of biological groups and different diversity components
- Impacts on a wider range of ecosystem services
- Explicit links to human well-being
- Relationships and relative importance at multiple spatial scales
- Synthesis to understand generalities and particularities

We have shown that biodiversity loss will threaten ecosystem services delivery and human well-being

In the face of the new Platform for Biodiversity and Ecosystem Services much more information is needed to explicitly link biodiversity to well-being at multiple spatial scales

Ackowledgements

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