Services écosystémiques:

Contribution de la nature au bien-être humain

Markus Fischer
Université de Berne et Forum Biodiversité Suisse

UNIVERSITÄT BERN

Qu’est-ce que les services écosystémiques?

Définition et origine

'Ecosystem services' (ES) are the ecological characteristics, functions, or processes that *directly or indirectly* contribute to human wellbeing: that is, the benefits that people derive from functioning ecosystems (Costanza et al., 1997; Millennium Ecosystem Assessment (MEA), 2005).

The term 'nature's services' first appeared in the academic literature in a 1977 paper in *Science* by Walter Westman titled 'How Much Are Nature's Services Worth?' (Westman, 1977). The synonymous term 'ecosystem services' first appeared in Ehrlich and Ehrlich (1981) and more systematically in Ehrlich and Mooney (1983). However, related ideas had been brewing in the academic literature for decades, and one could argue that the idea that natural systems provide benefits that support human wellbeing is as old as humans themselves.

What changed in the second half of the 20th century was that the loss of these ecosystem services became much more apparent, as natural capital was quickly being depleted (Beddoe et al., 2009).

Costanza et al. 2017 Ecosystem Services

En pratique

(Définition implicite)

MEA 2005

	Costanza et al., 1997	Millennium Ecosystem Assessment, 2005	TEEB, 2010	CICES (v. 2017?)
Provisioning	Food production *(13)*	Food	Food	Biomass - Nutrition
	Water supply *(5)*	Fresh water	Water	Water
	Raw materials *(14)*	Fibre, etc.	Raw materials	Biomass - Fibre, energy & other materials
		Ornamental resources	Ornamental resources	
	Genetic resources *(15)*	Genetic resources	Genetic resources	
		Biochemicals and natural medicines	Medicinal resources	
	X	X	X	Biomass - Mechanical energy
Regulating & Habitat	Gas regulation *(1)*	Air quality regulation	Air purification	Mediation of gas- & air-flows
	Climate regulation *(2)*	Climate regulation	Climate regulation	Atmospheric composition & climate regulation
	Disturbance regulation (storm protection & flood control) *(3)*	Natural hazard regulation	Disturbance prevention or moderation	Mediation of air & liquid flows
	Water regulation (e.g. natural irrigation & drought prevention) *(4)*	Water regulation	Regulation of water flows	Mediation of liquid flows
	Waste treatment *(9)*	Water purification and waste treatment	Waste treatment (esp. water purification)	Mediation of waste, toxics, and other nuisances
	Erosion control & sediment retention *(8)*	Erosion regulation	Erosion prevention	Mediation of mass-flows
	Soil formation *(7)*	Soil formation *[supporting service]*	Maintaining soil fertility	Maintenance of soil formation and composition
	Pollination *(10)*	Pollination	Pollination	Life cycle maintenance (incl. pollination)
	Biological control *(11)*	Regulation of pests & human diseases	Biological control	Maintenance of pest- and disease-control
Supporting & Habitat	Nutrient cycling *(8)*	Nutrient cycling & photosynthesis, primary production	X	X
	Refugia (nursery, migration habitat) *(12)*	'Biodiversity'	Lifecycle maintenance (esp. nursery) Gene pool protection	Life cycle maintenance, habitat, and gene pool protection
Cultural	Recreation (incl. eco-tourism & outdoor activities) *(16)*	Recreation & eco-tourism	Recreation & eco-tourism	Physical and experiential interactions
	Cultural (incl. aesthetic, artistic, spiritual, education, & science) *(17)*	Aesthetic values Cultural diversity	Aesthetic information Inspiration for culture, art, & design	
		Spiritual & religious values	Spiritual experience	Spiritual and/or emblematic interactions
		Knowledge systems Educational values	Information for cognitive development	Intellectual and representative interactions

Costanza et al. 2017
Ecosystem Services

Contexte économique et questions controversées

The value of the world's ecosystem services and natural capital

Robert Costanza*†, Ralph d'Arge‡, Rudolf de Groot§, Stephen Farber‖, Monica Grasso†, Bruce Hannon¶, Karin Limburg#☆, Shahid Naeem**, Robert V. O'Neill††, Jose Paruelo‡‡, Robert G. Raskin§§, Paul Sutton‖‖ & Marjan van den Belt¶¶

The services of ecological systems and the natural capital stocks that produce them are critical to the functioning of the Earth's life-support system. They contribute to human welfare, both directly and indirectly, and therefore represent part of the total economic value of the planet. We have estimated the current economic value of 17 ecosystem services for 16 biomes, based on published studies and a few original calculations. For the entire biosphere, the value (most of which is outside the market) is estimated to be in the range of US$16–54 trillion ($10^{12}$) per year, with an average of US$33 trillion per year. Because of the nature of the uncertainties, this must be considered a minimum estimate. Global gross national product total is around US$18 trillion per year.

Nature **387**, 253–260 (15 May 1997)

Biens publics et privés

The Tragedy of the Commons

The population problem has no technical solution; it requires a fundamental extension in morality.

Garrett Hardin

W. F. Lloyd, Two Lectures on the Checks to Population (Oxford Univ. Press, Oxford, England, 1833)

Science 13 Dec 1968: Vol. 162, Issue 3859, pp. 1243-1248

Ostrom, Elinor. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge, UK: Cambridge University Press.

———. 2010. "Polycentric Systems for Coping with Collective Action and Global Environmental Change." *Global Environmental Change*. 20:550 – 557.

"Tragedy of the non-commons"

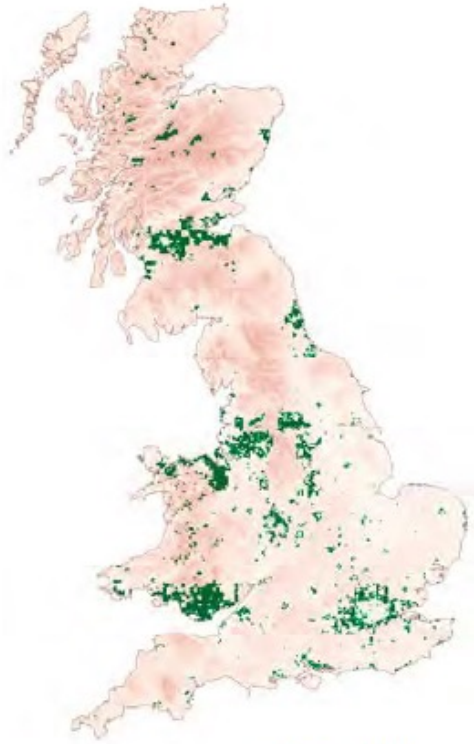
Where should we plant Britain's new forests?

We could...
maximise market value...

Net cost/benefit: -£65 million p.a.

Implementation cost: +£79 million p.a.

...and now consider...
green house gases and recreation



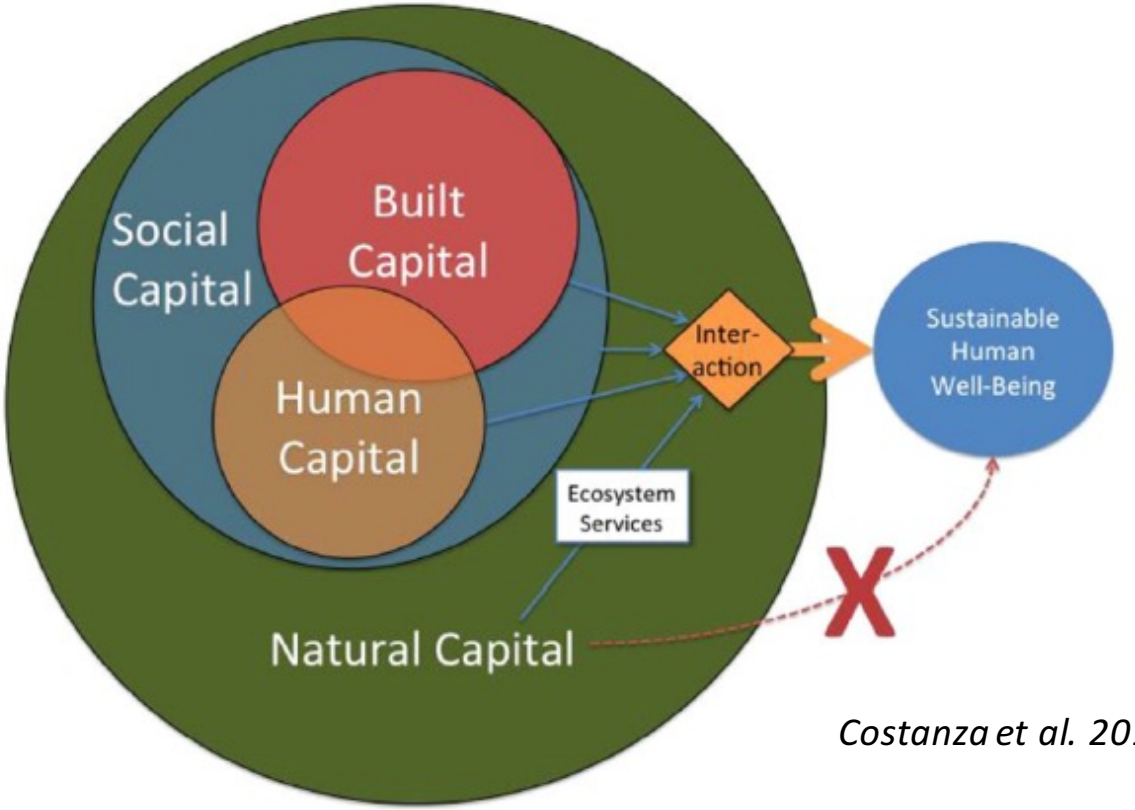
+£546 million p.a.

+£231 million p.a.

UK NEA follow-on 2014

Quels liens entre capital naturel et services écosystémiques?

Quels liens entre capital naturel et services écosystémiques?



Costanza et al. 2017 Ecosystem Services

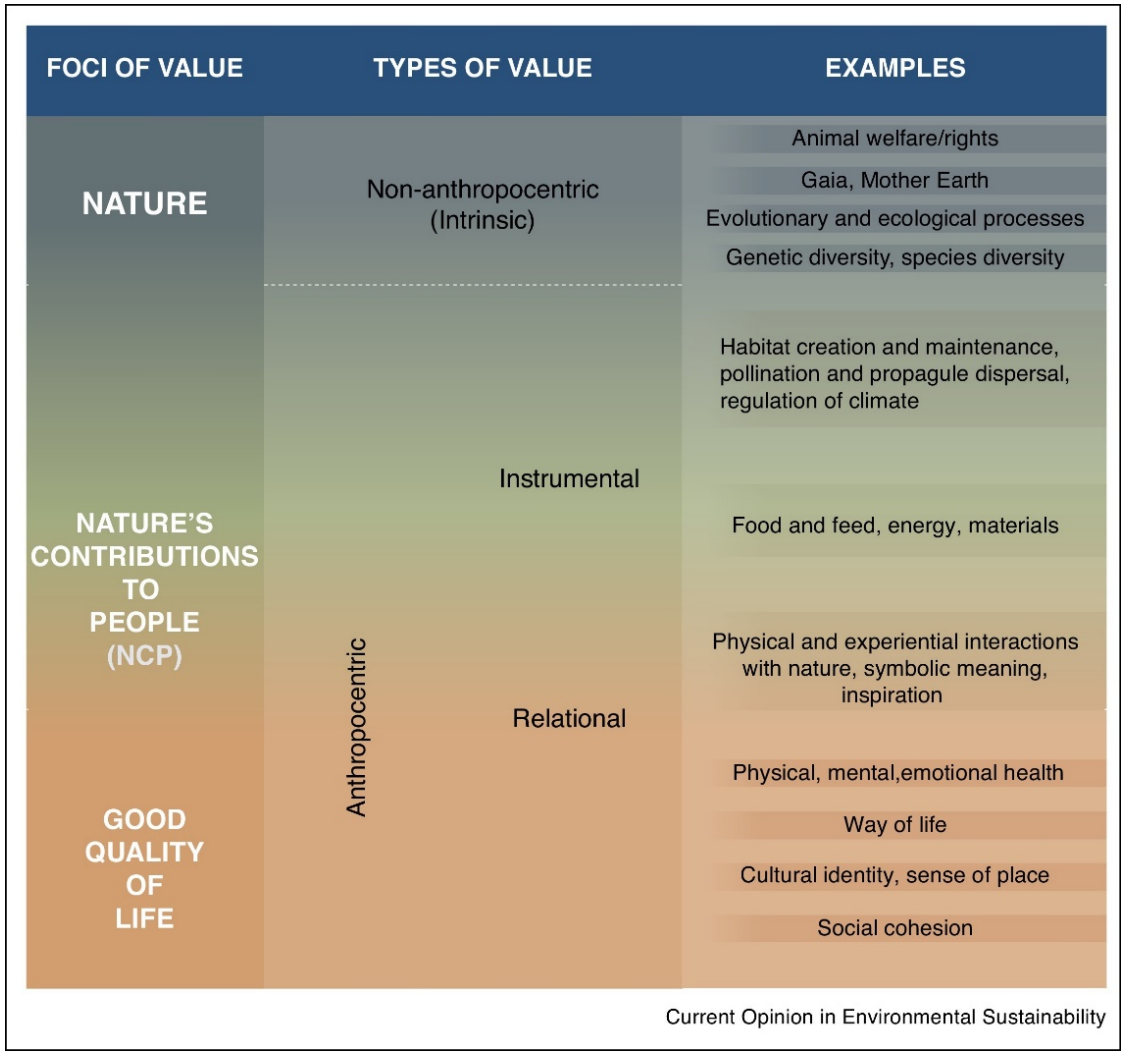
Carlowitz, Hannß Carl von: Sylvicultura Oeconomica oder haußwirthliche Nachricht und Naturmäßige Anweisung zur Wilden Baum-Zucht (1713)

Nachhaltigkeit - Starke Nachhaltigkeit

Ott, Döring 2008

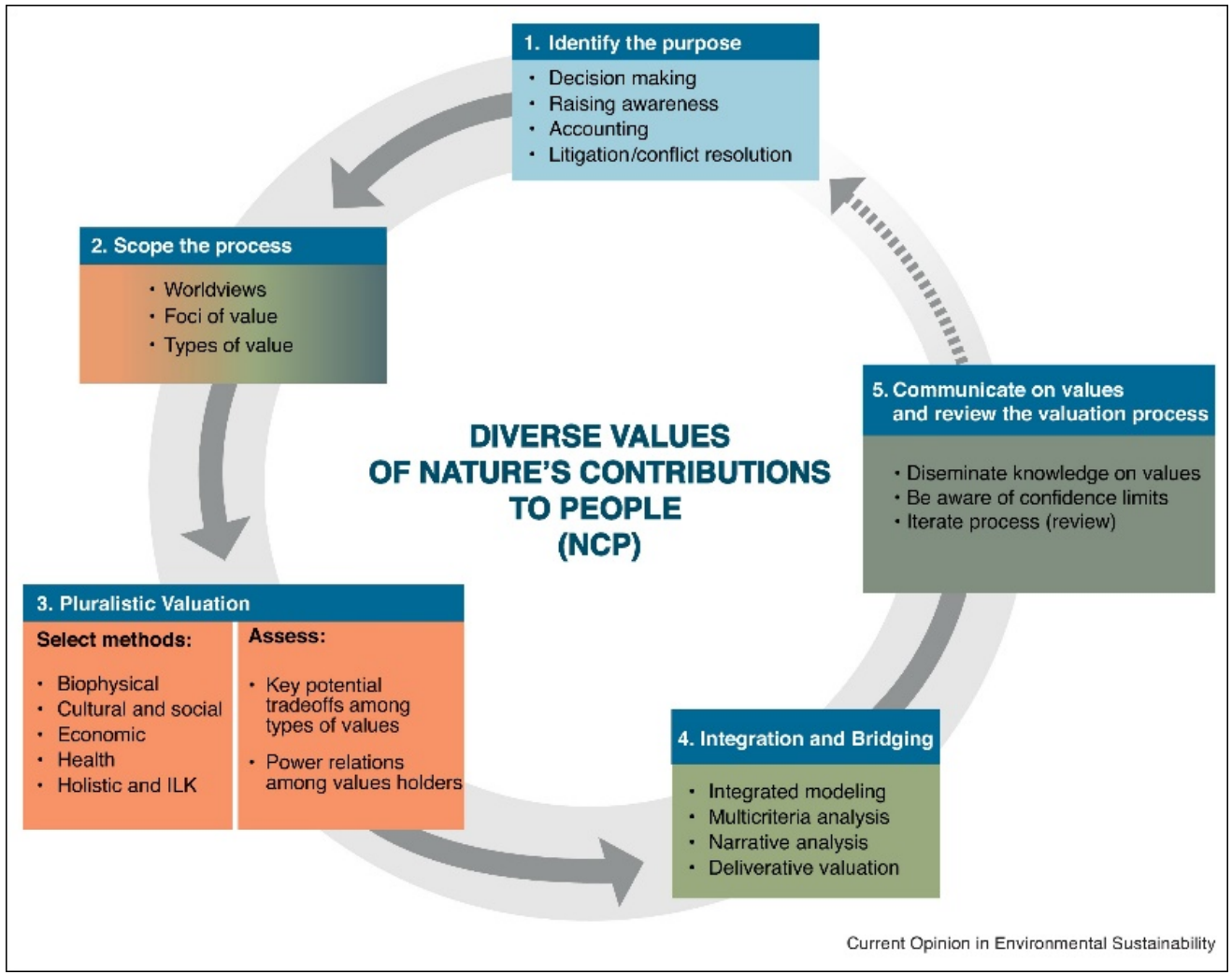
„Nature’s contributions to people“
plutôt que services écosystémiques

„Nature's contributions to people" plutôt que services écosystémiques



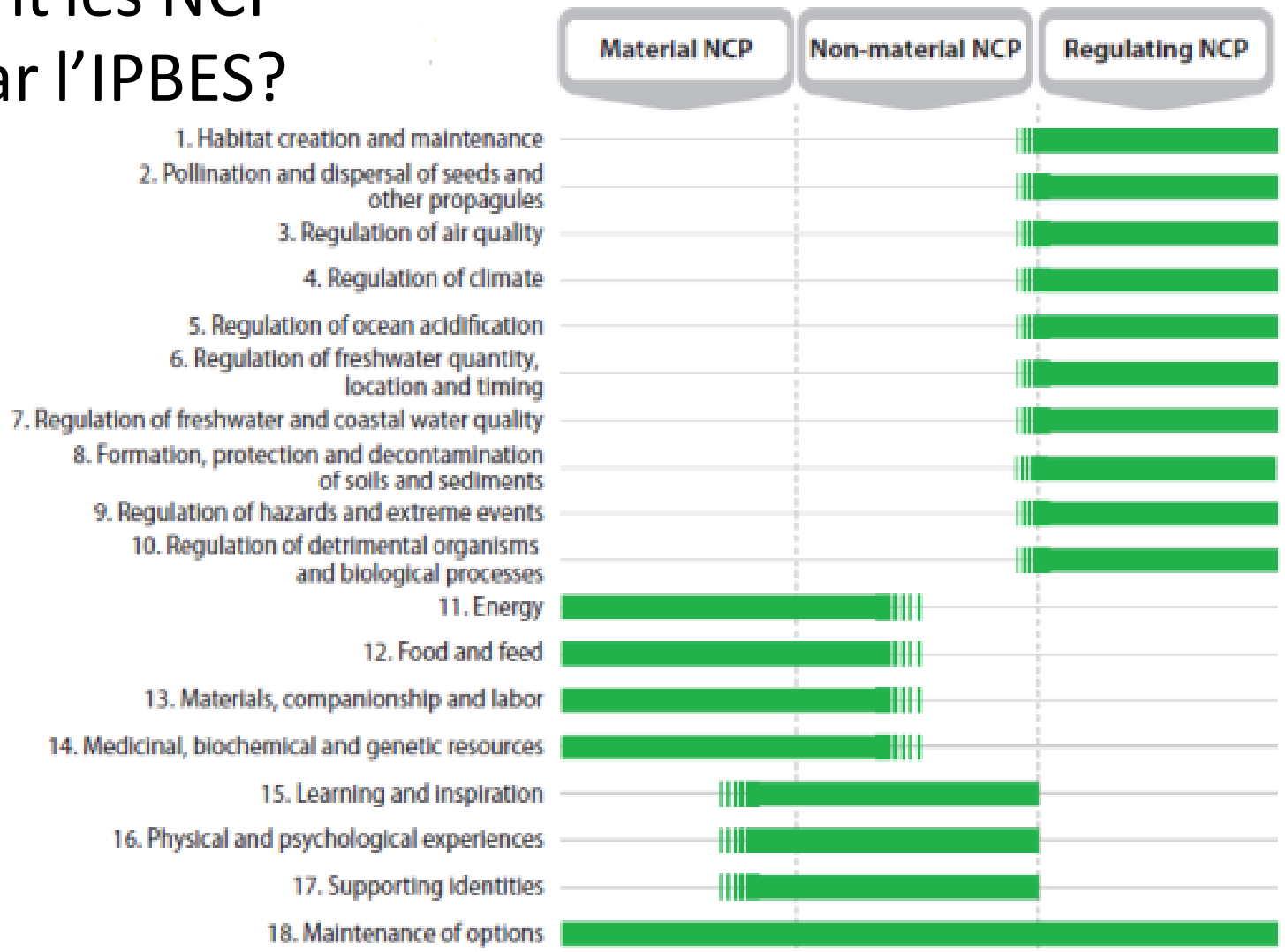
Pascual et al. 2017

„Nature's contributions to people" plutôt que services écosystémiques

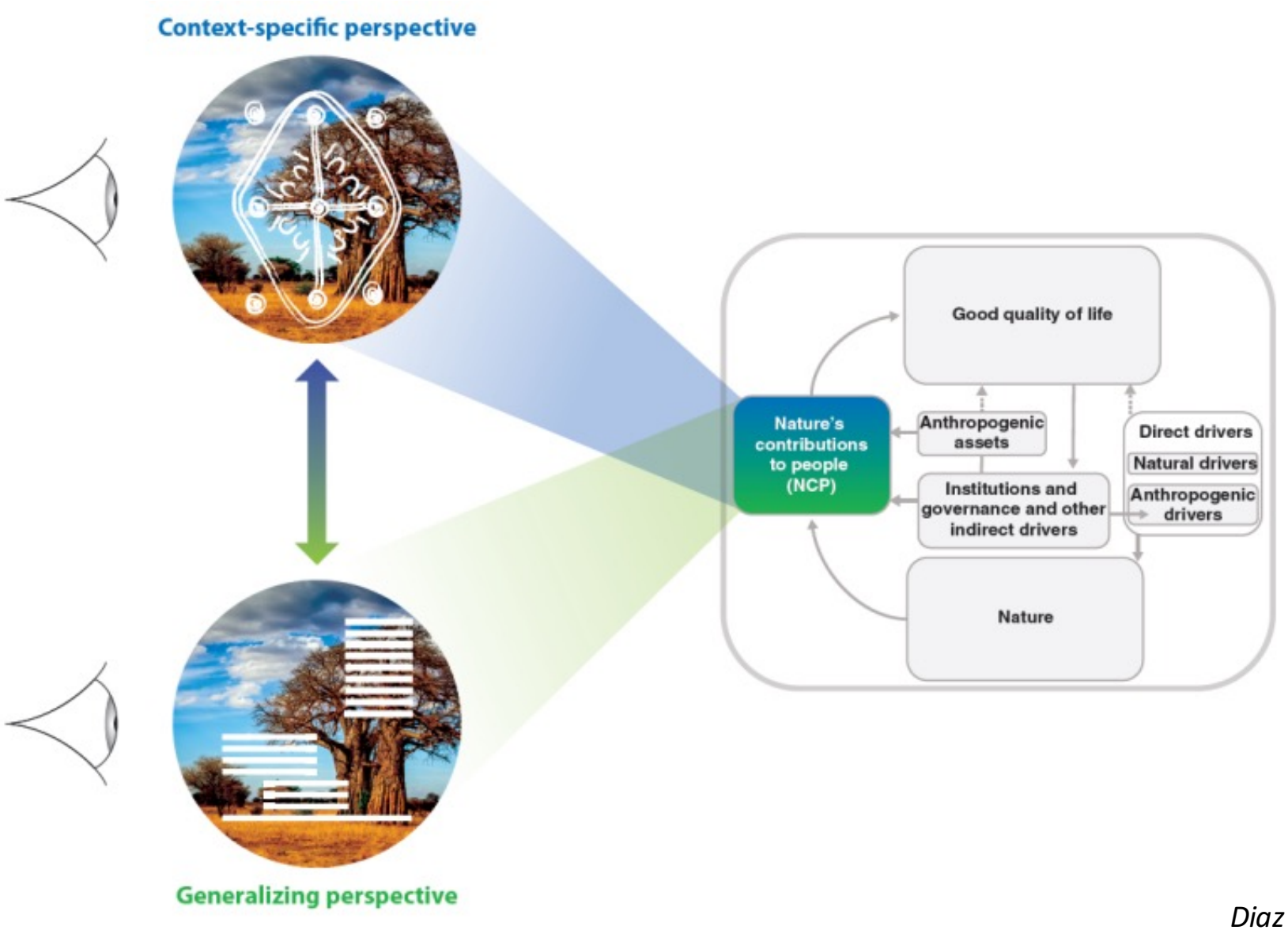


Pascual et al. 2017

Quelles sont les NCP utilisées par l'IPBES?



Diaz et al. 2018 Science



Diaz et al. 2018 Science

Quels liens entre services écosystémiques et biodiversité?

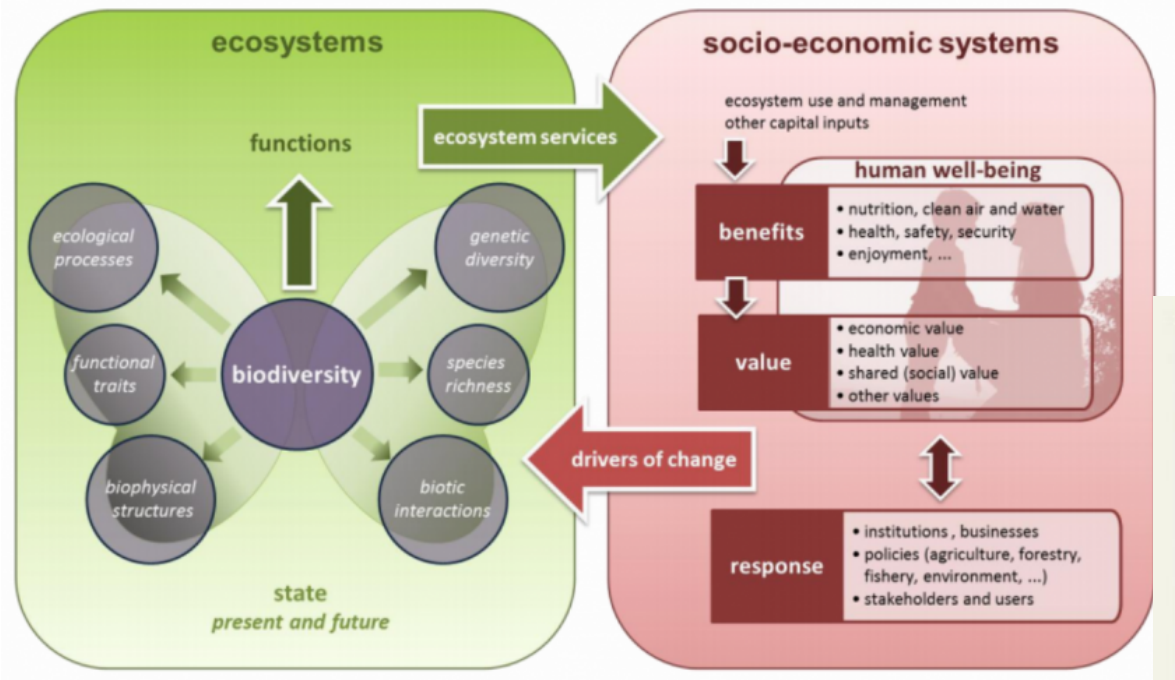
Extinction, Substitution, and Ecosystem Services

Paul R. Ehrlich and Harold A. Mooney

The loss of services to humanity following extinctions ranges from trivial to catastrophic, depending on the number of elements (populations, species, guilds) deleted and the degree of control each exerted in the system. Most attempts to substitute other organisms for those lost have been unsuccessful, to one degree or another, and prospects for increasing the success rate in the foreseeable future are not great. Attempts to supply the lost services by other means tend to be expensive failures in the long run. A conservative approach to the maintenance of services through minimizing anthropogenic extinctions is recommended. (*Accepted for publication 20 October 1982*)

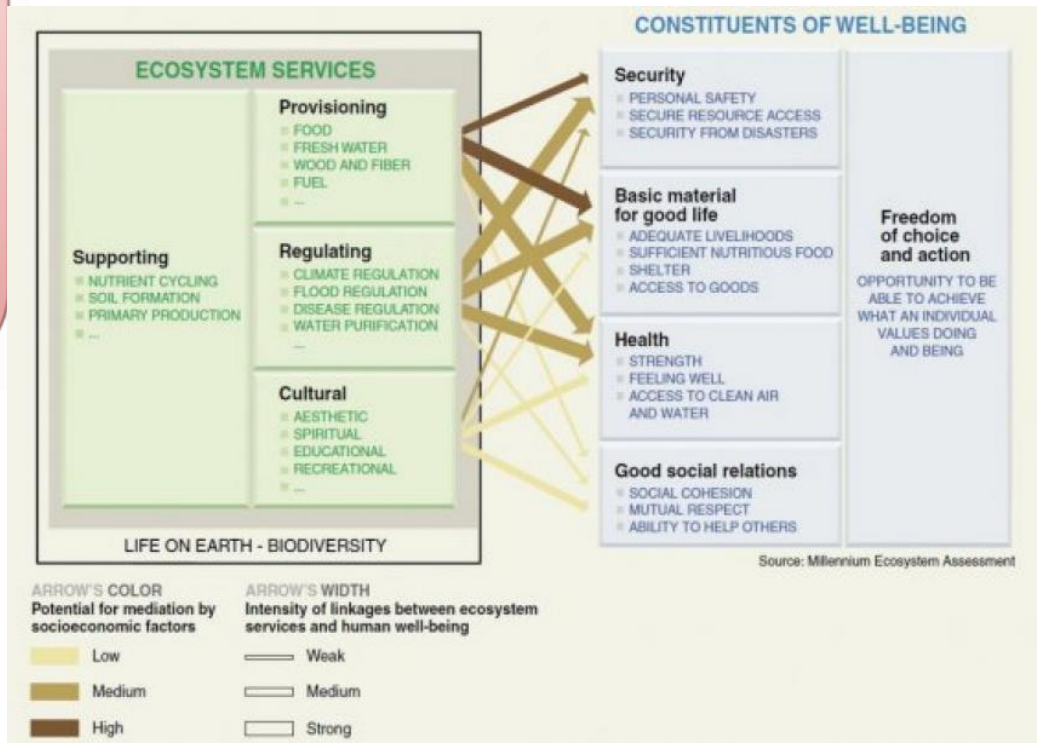
BioScience, Vol. 33, No. 4 (Apr., 1983), pp. 248-254

Quels liens entre services écosystémiques et biodiversité?



MAES

MEA



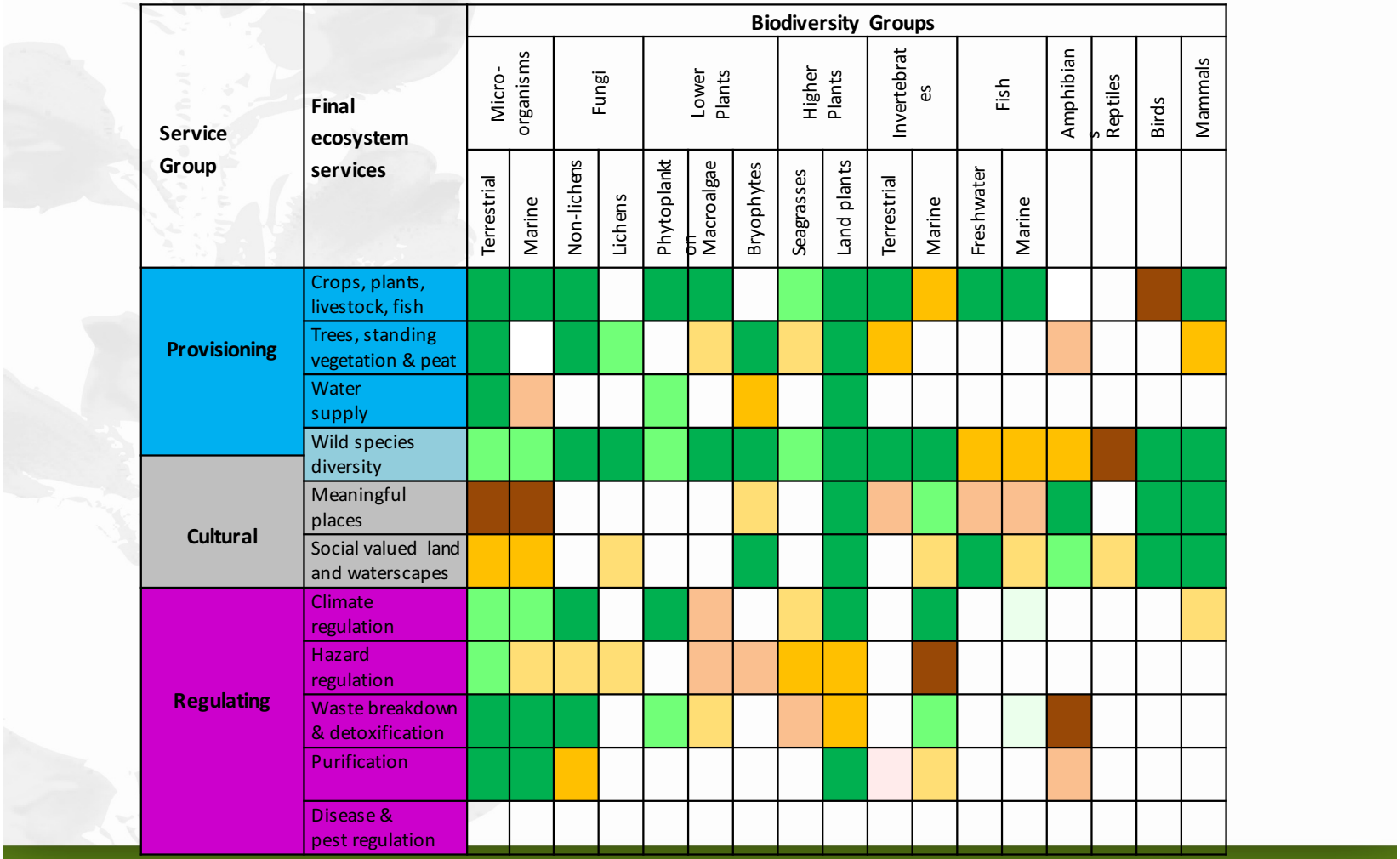
Importance of habitats in delivering UK Ecosystem Services

The importance and trends are likely to differ at National, Regional and Local scales

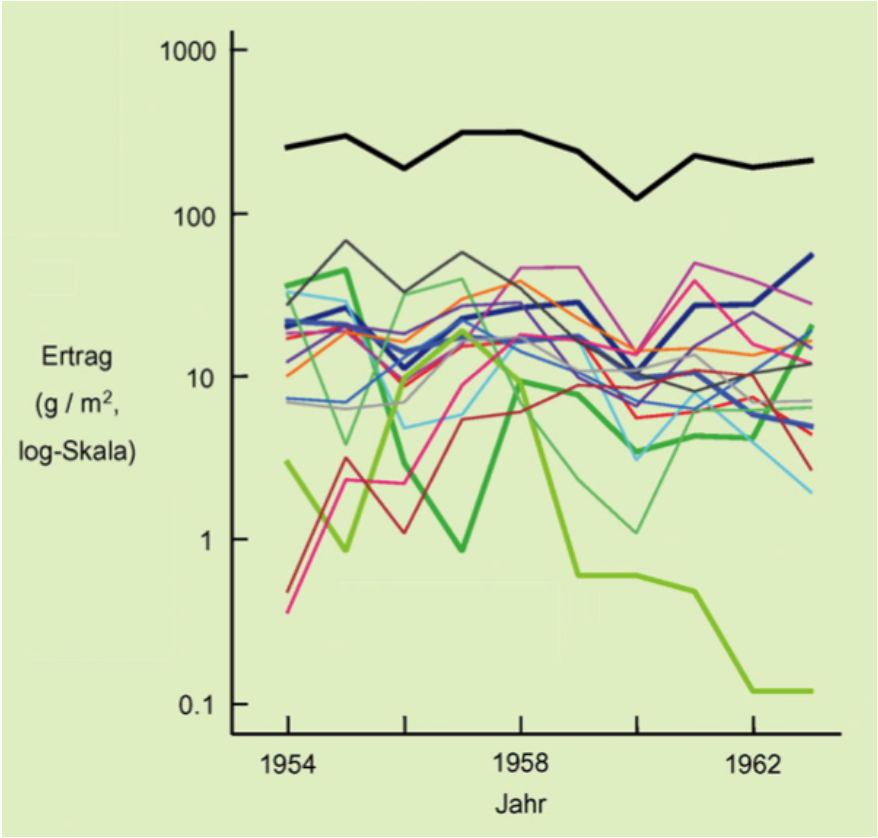
Service group	Final Ecosystem Service	Urban	Marine	Coastal margins	Freshwater & Wetlands	Farmland	Woodland	Semi-natural grassland	Mountains, Moors, Heaths
Provisioning	Crops			↘		↑		↗	
	Livestock			↘		↔	↔	↘	↓
	Fisheries		↓	↘	↘	↗			
	Trees, standing vegetation, peat	↔		↔		↗	↗	↔	↘
	Water supply	↘		↔	↘	↘	↔	↘	↔
Cultural	Wild species diversity	↔	↘	↘	↘	↓	↗	↓	↔
	Local places	↔	↔	↔	↗	↔	↑	↔	↔
	Landscapes/ Seascapes	↔	↔	↗	↔	↗	↗	↔	↗
Regulating	Climate	↘	↓	↔	↔	↘	↗	↔	↔
	Hazard	↘	↓	↘	↘	↘	↗	↔	↘
	Diseases & pests	↔	↓	↔	↘	↓	↔	↔	↔
	Detoxification & purification: Water quality	↔	↔	↘	↗	↔	↔	↗	↔
	Detoxification & purification: Soil quality	↓		↗	↘	↘	↔	↔	↔
	Detoxification & purification: Air quality	↔	↔	↔	↔	↗	↗	↔	↔
	Noise	↘	↔	↔	↔	↔	↗	↔	↔

KEY	Importance of ES
	High
	High - Medium
	Medium - Low
	Low
	Not applicable
Direction of Change	
↑	Improving
↗	Some Improvement
↔	Equivocal changes
↘	Some Deterioration
↓	Deteriorating

Biodiversity – critical to delivery of ecosystem services



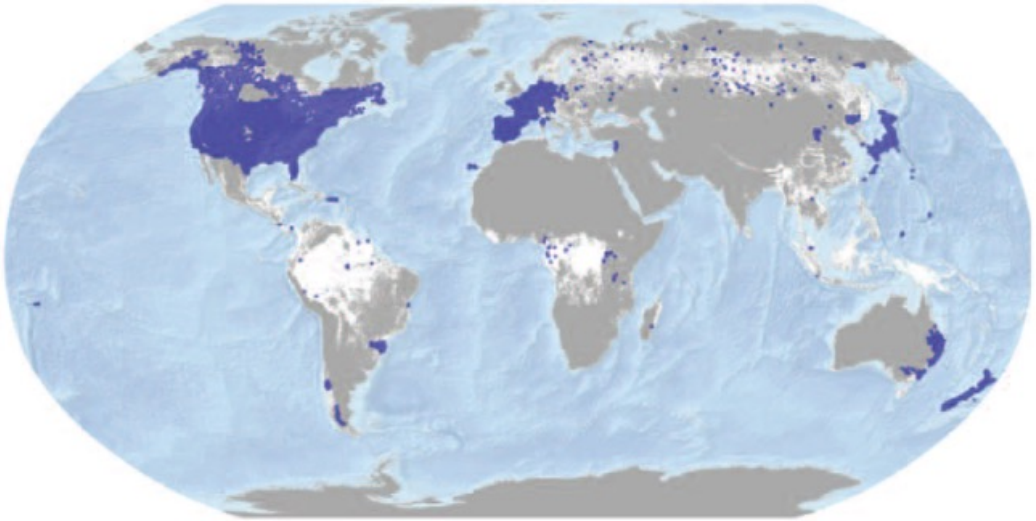
La biodiversité comme assurance

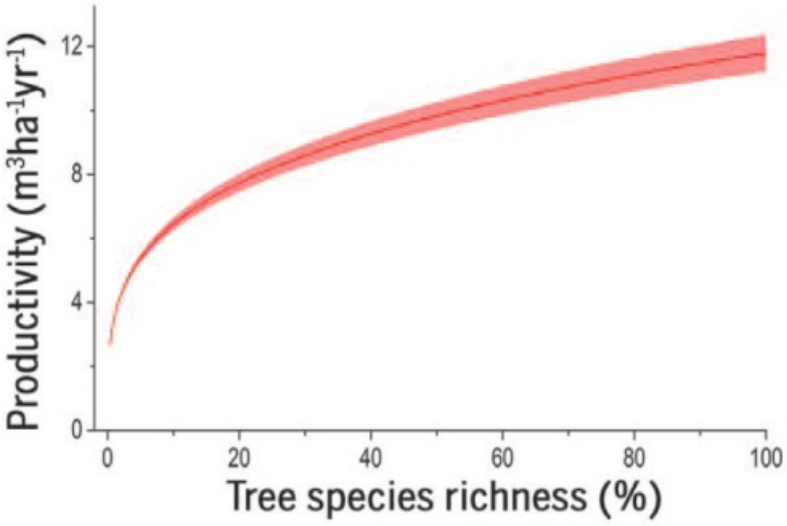


Spehn, Körner (ed) 2010

Schmid 2003, Biologie in unserer Zeit 6

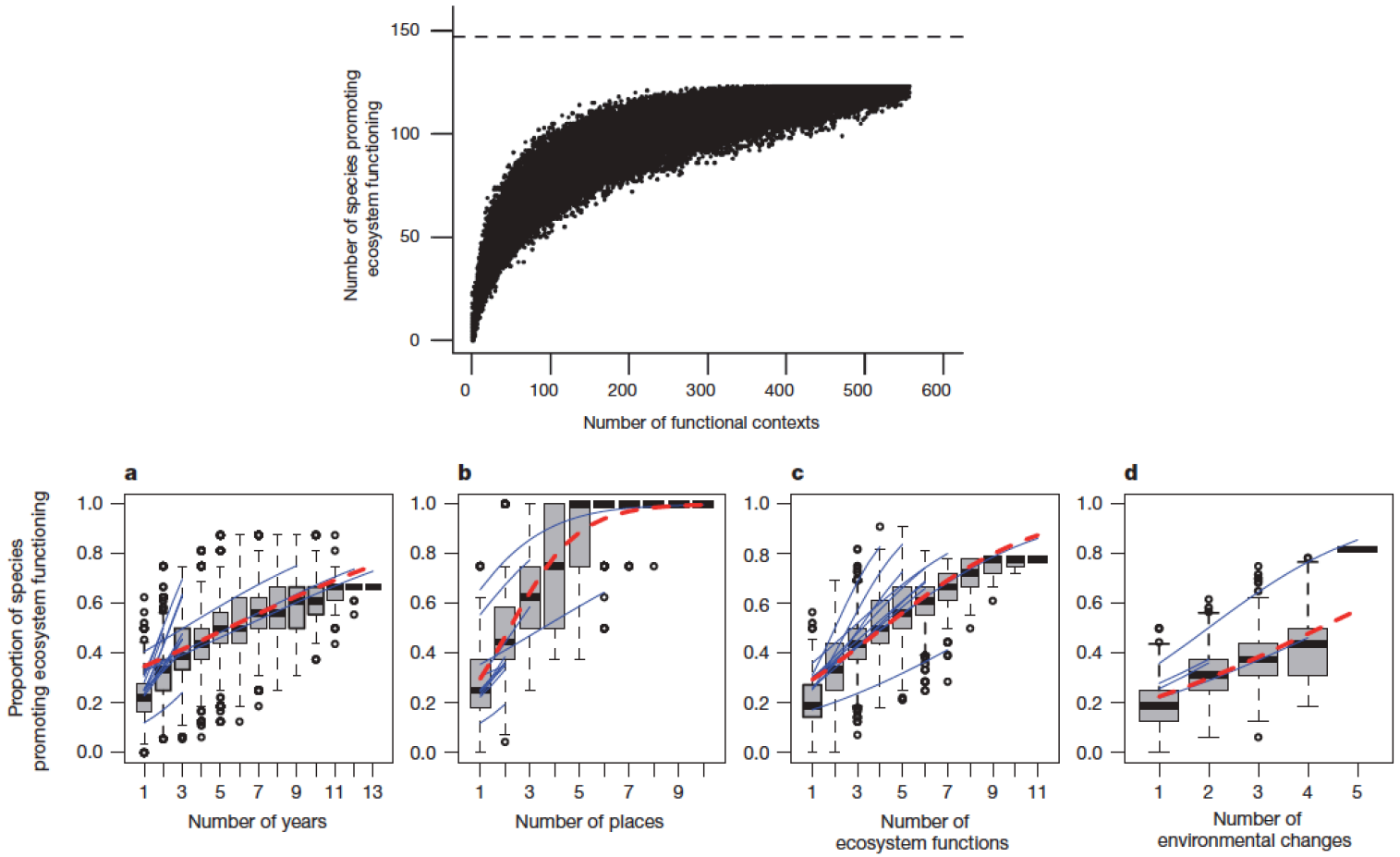
Une plus grande diversité d'arbres augmente la productivité





Liang et al. Science 2016

Afin d'assurer les services écosystémiques à long-terme dans des environnements changeants, il faut une diversité élevée («chaque espèce compte»)



Isbell 2011, Nature

Biodiversity loss and its impact on humanity

Bradley J. Cardinale[1], J. Emmett Duffy[2], Andrew Gonzalez[3], David U. Hooper[4], Charles Perrings[5], Patrick Venail[1], Anita Narwani[1], Georgina M. Mace[6], David Tilman[7], David A. Wardle[8], Ann P. Kinzig[5], Gretchen C. Daily[9], Michel Loreau[10], James B. Grace[11], Anne Larigauderie[12], Diane S. Srivastava[13] & Shahid Naeem[14]

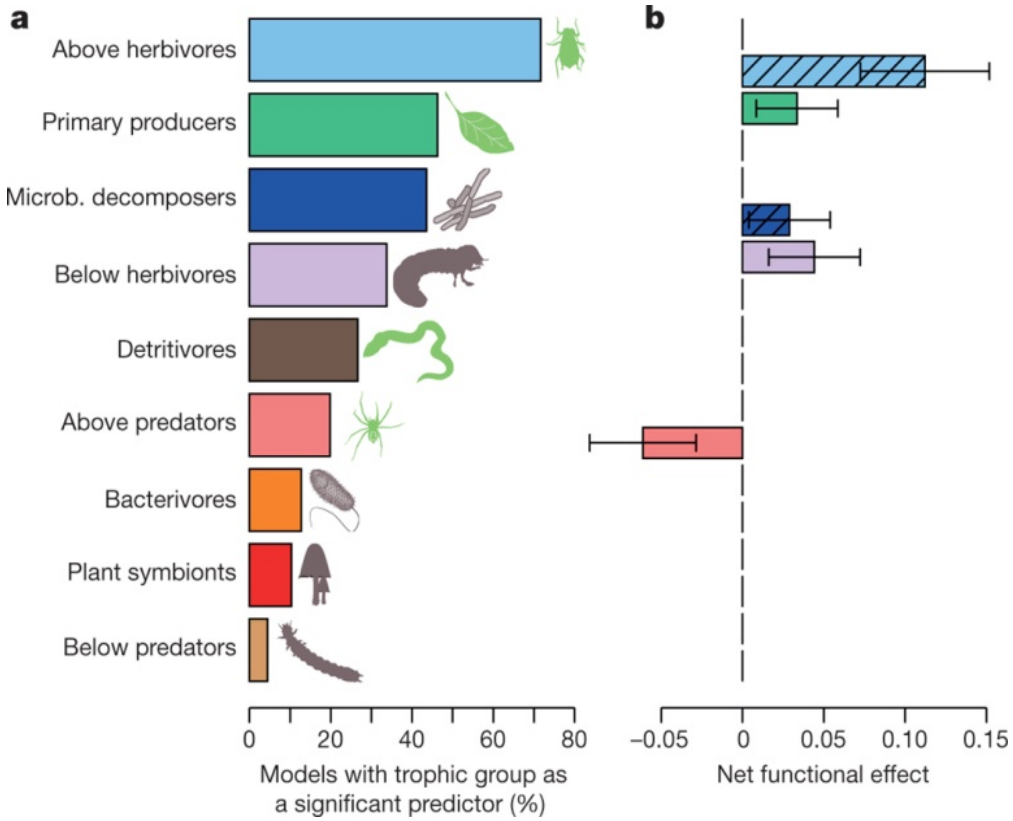
Table 1 | Balance of evidence linking biodiversity to ecosystem services

Category of service	Measure of service provision	SPU	Diversity level	Source	Study type	*N*	Relationship	
							Predicted	Actual
Provisioning								
Crops	Crop yield	Plants	Genetic	DS	Exp	575	↗	↗
			Species	DS	Exp	100	↗	↗↘
Fisheries	Stability of fisheries yield	Fish	Species	PS	Obs	8	↗	↗
Wood	Wood production	Plants	Species	DS	Exp	53	↗	↗
Fodder	Fodder yield	Plants	Species	DS	Exp	271	↗	↗
Regulating								
Biocontrol	Abundance of herbivorous pests (bottom-up effect of plant diversity)	Plants	Species	DS*	Obs	40	↗	↗
		Plants	Species	DS†	Exp	100	↗	↗
		Plants	Species	DS‡	Exp	287	↗	↗↘
		Plants	Species	DS§	Exp	100	↘	0
	Abundance of herbivorous pests (top-down effect of natural enemy diversity)	Natural enemies	Species/trait	DS*	Obs	18	↗	↗
		Natural enemies	Species	DS†	Exp/Obs	266	↗	↗
		Natural enemies	Species	DS‡	Exp	38	↗	↗↘
	Resistance to plant invasion	Plants	Species	DS	Exp	120	↗	↗
	Disease prevalence (on plants)	Plants	Species	DS	Exp	107	↗	↗
	Disease prevalence (on animals)	Multiple	Species	DS	Exp/Obs	45	↗	↗↘
Climate	Primary production	Plants	Species	DS	Exp	7	↘	0
	Carbon sequestration	Plants	Species	DS	Exp	479	↗	↗
	Carbon storage	Plants	Species/trait	PS	Obs	33	↘	↗↘
Soil	Soil nutrient mineralization	Plants	Species	DS	Exp	103	↗	↗
	Soil organic matter	Plants	Species	DS	Exp	85	↗	↗
Water	Freshwater purification	Multiple	Genetic/species	PS	Exp	8	↘	0
Pollination	Pollination	Insects	Species	PS	Obs	7	↘	↗↘

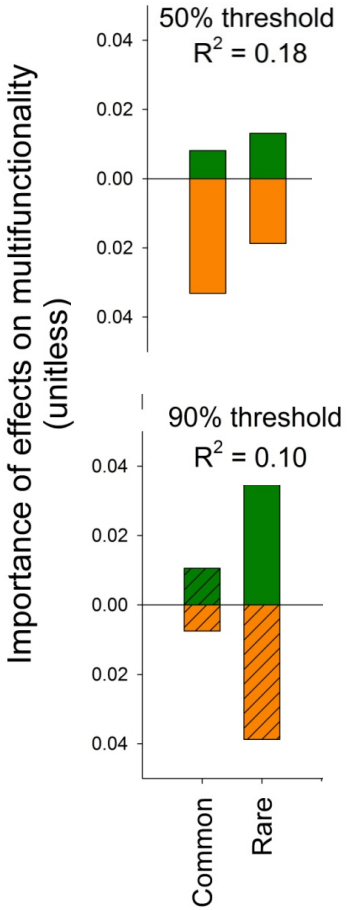
For each ecosystem service we searched the ISI Web of Knowledge for published data syntheses (DS). The footnote symbols in the 'Source' column refer to different syntheses. When a synthesis was not available, we completed our own primary search (PS, see Box 2). Detailed results are given in Supplementary Table 2. Data presented here are summarized as follows: green, actual data relationships agree with predictions (whether service increases or decreases as diversity increases); yellow, Data show mixed results; red, data conflict with predictions. Exp, experimental; *N*, number of data points; Obs, observed; SPU, service providing unit (where natural enemies include predators, parasitoids and pathogens). Note that 13 ecosystem services are not included in this table due to lack of data (<5 relationships, see Supplementary Table 2).

Cardinale et al. 2012 Nature

De multiples groupes trophiques, ainsi que les espèces localement rares sont importants pour assurer de multiples fonctions écosystémiques en milieu prairiaux

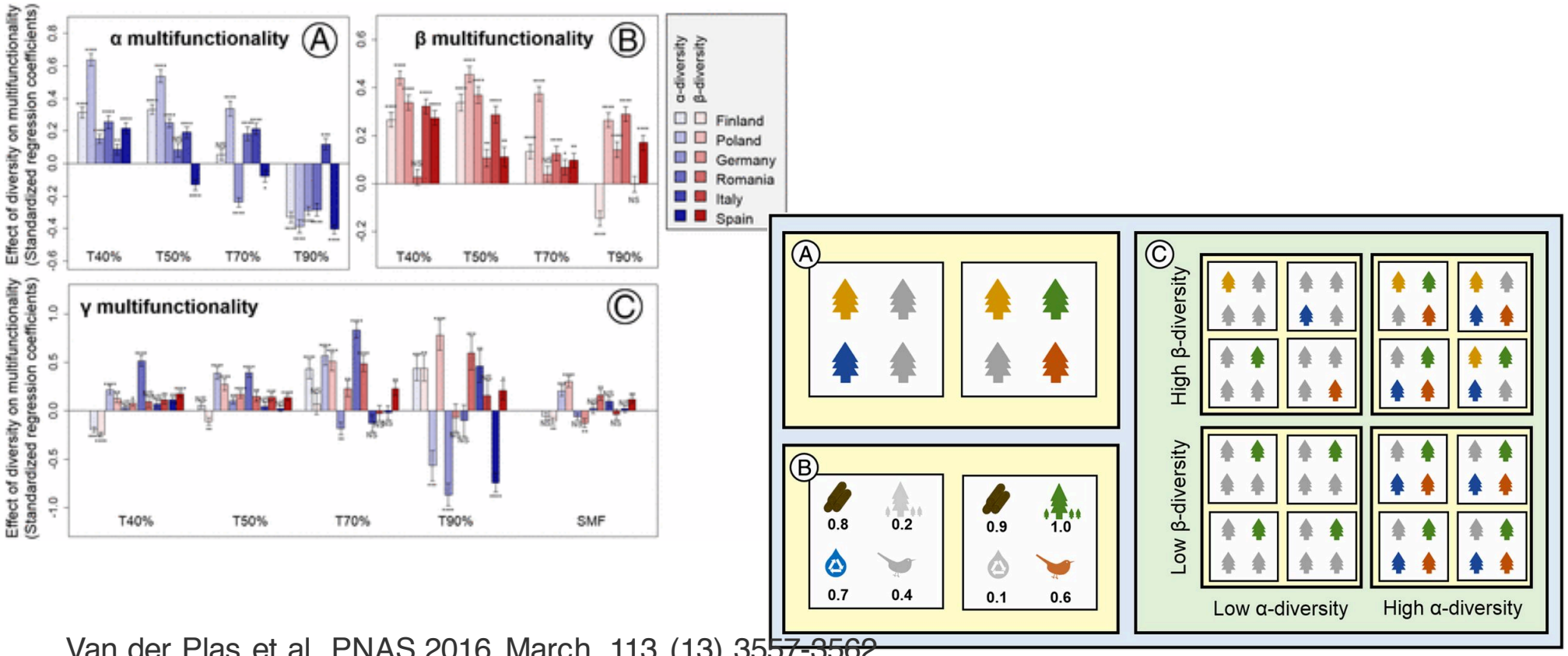


Soliveres et al. (2016) Nature



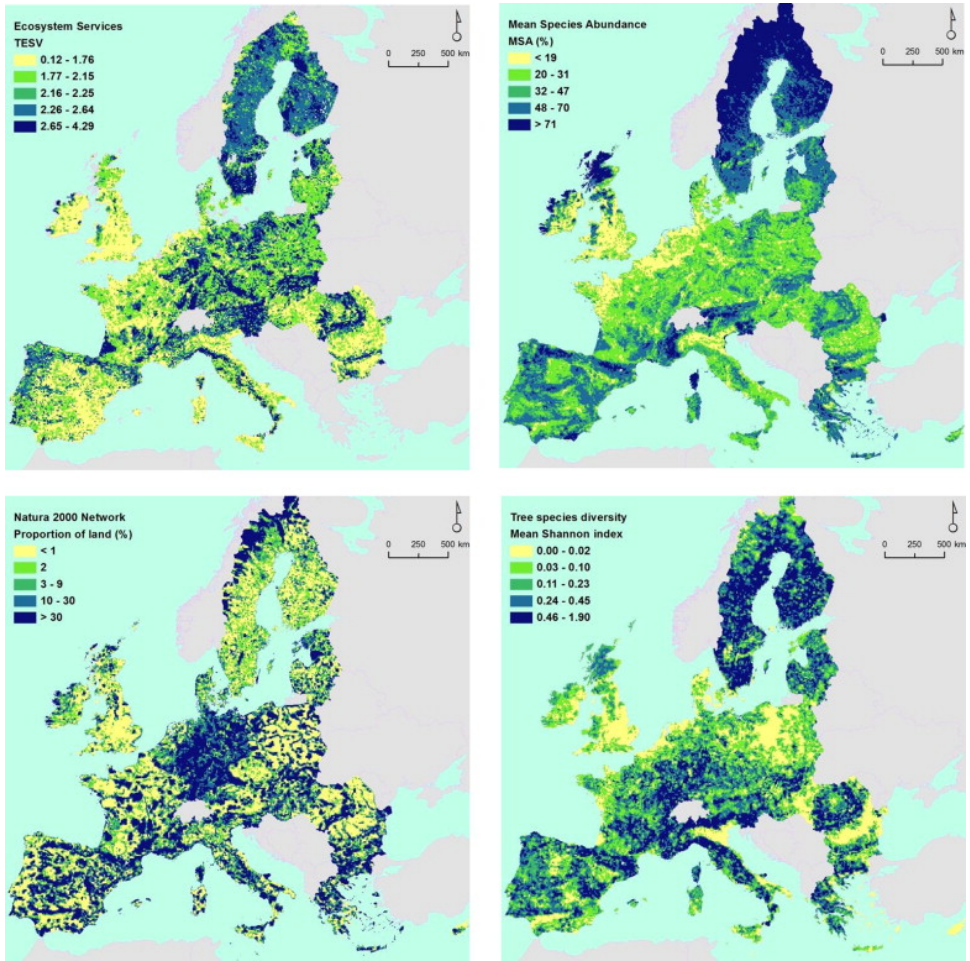
Soliveres et al. (2016) Phil Trans B

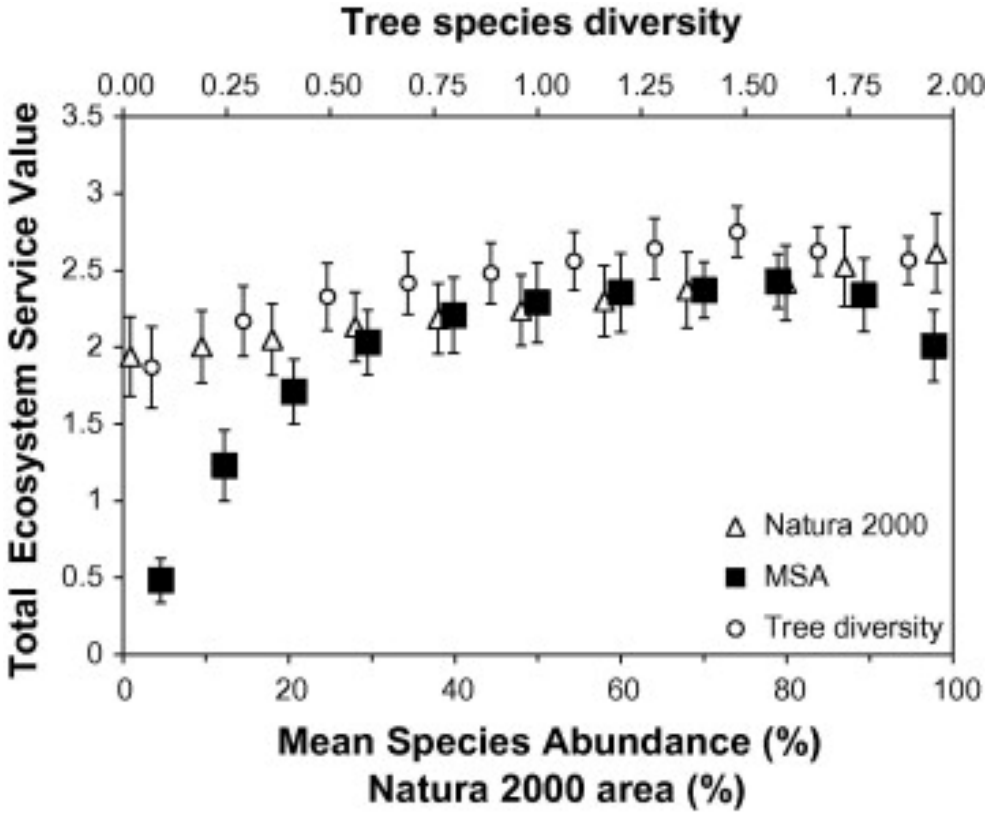
La β-diversité à l'echelle du paysage est indispensable pour assurer la multifonctionnalité



Van der Plas et al. PNAS 2016 March, 113 (13) 3557-3562

Relations entre biodiversité et services écosystémiques à large échelle au sein de l'UE





Maes et al. 2012

Où sont les synergies et les trade-off?

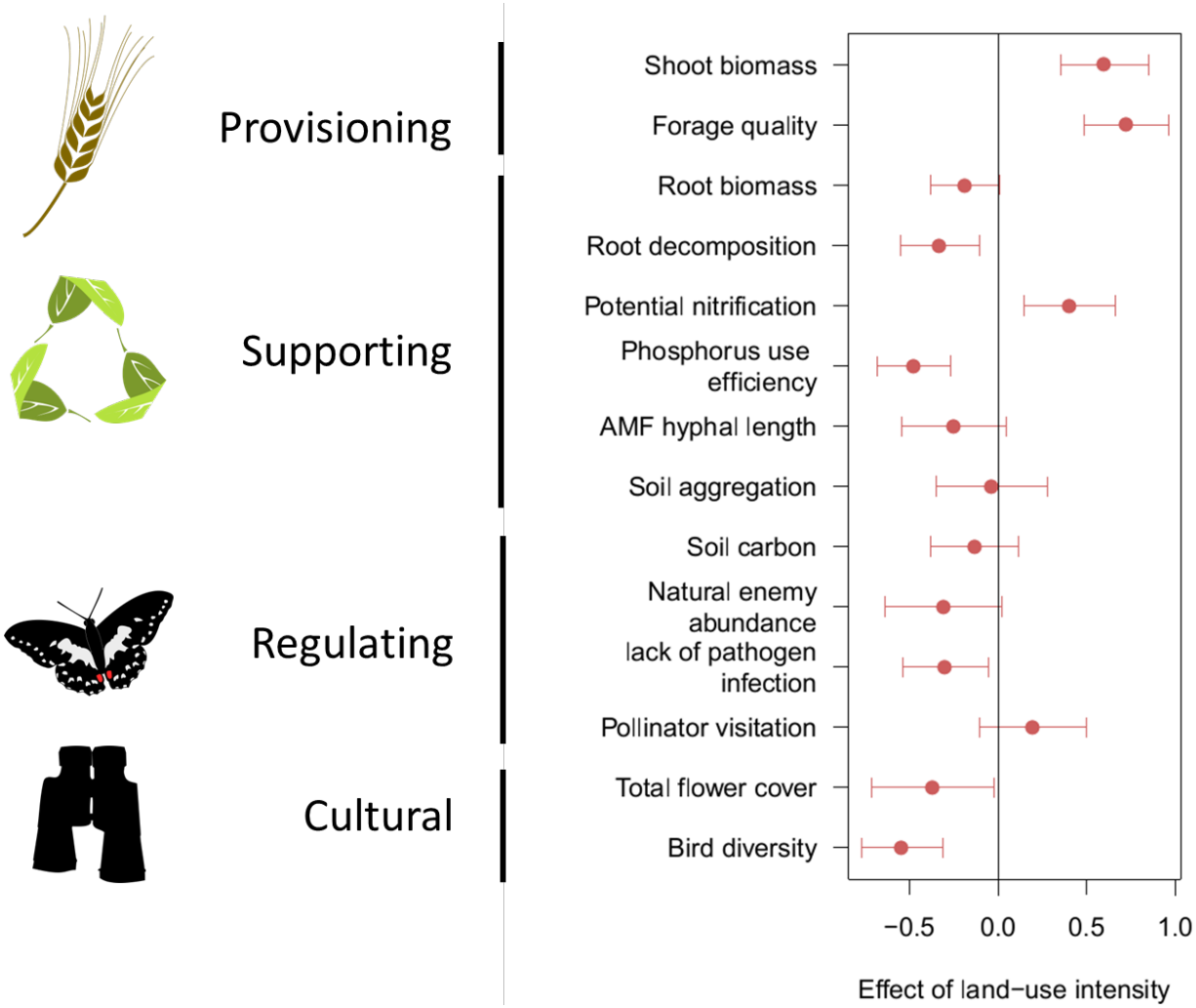
Untangling the Environmentalist's Paradox: Why Is Human Well-being Increasing as Ecosystem Services Degrade?

CIARA RAUDSEPP-HEARNE, GARRY D. PETERSON, MARIA TENGÖ, ELENA M. BENNETT, TIM HOLLAND, KARINA BENESSAIAH, GRAHAM K. MACDONALD, AND LAURA PFEIFER

Table 3. Summary of evaluation of hypotheses.

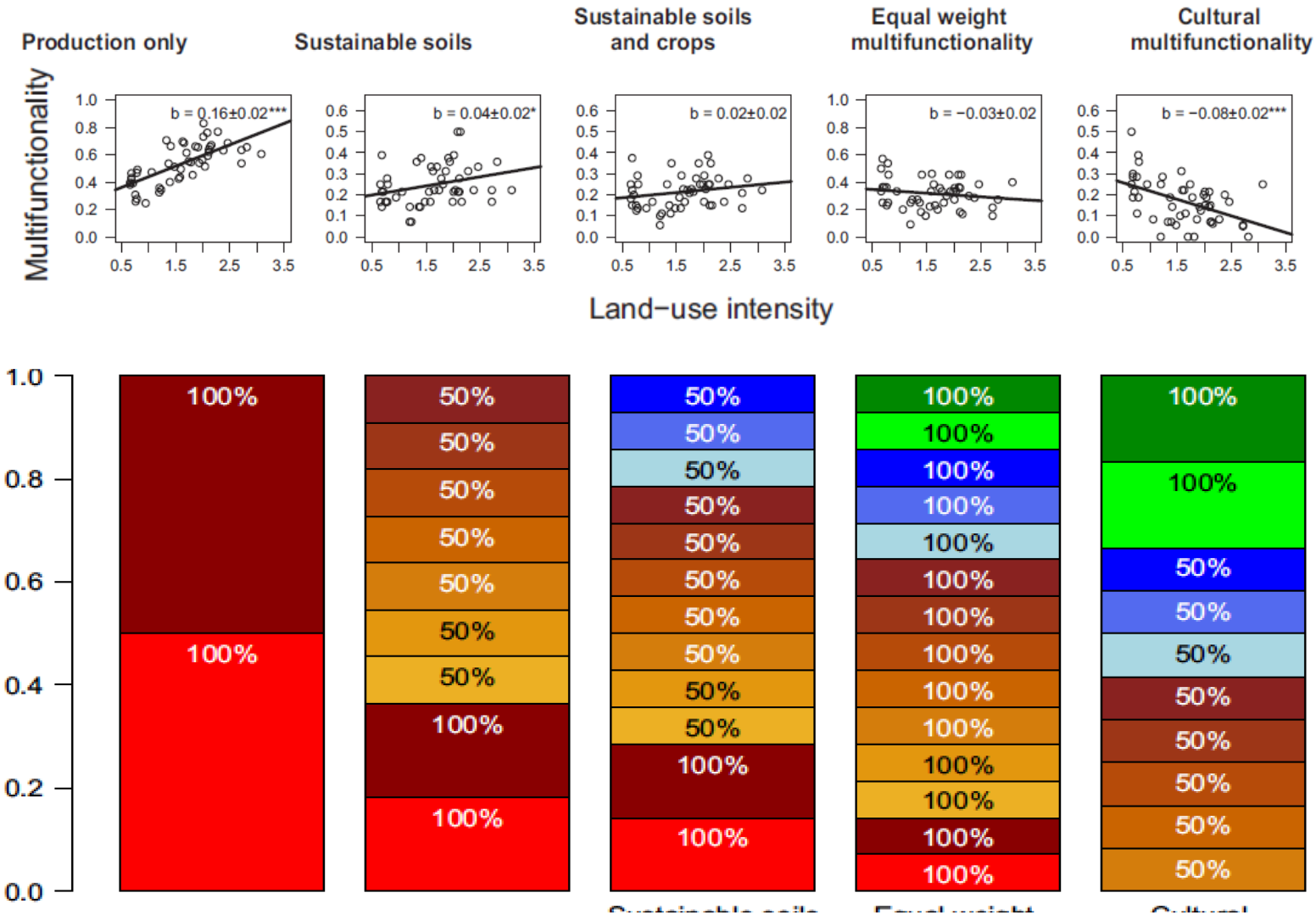
Hypothesis	Evaluation	Supporting evidence
1. Critical dimensions of declining human well-being are not captured adequately	Rejected	Empirical, strong
2. Only provisioning services are important for human well-being	Supported	Empirical, strong for importance of food Lack of data to address importance of other ecosystem services
3. Technology and social innovation have decoupled human well-being from ecosystem conditions	Decoupling of society and ecosystem condition theory rejected Support for enhanced efficiency of ecosystem service use	Empirical, strong against decoupling of society and ecosystems, and for long-term increases in efficiency
4. There is a time lag after ecosystem service degradation before human well-being is affected	Mixed evidence	Weak empirical support mainly on the basis of regional case studies with limited general power Strong support from theory and modeling Difficult to identify counterevidence, therefore strong warning signs

Intensification agricole et services écosystémiques (prairies)



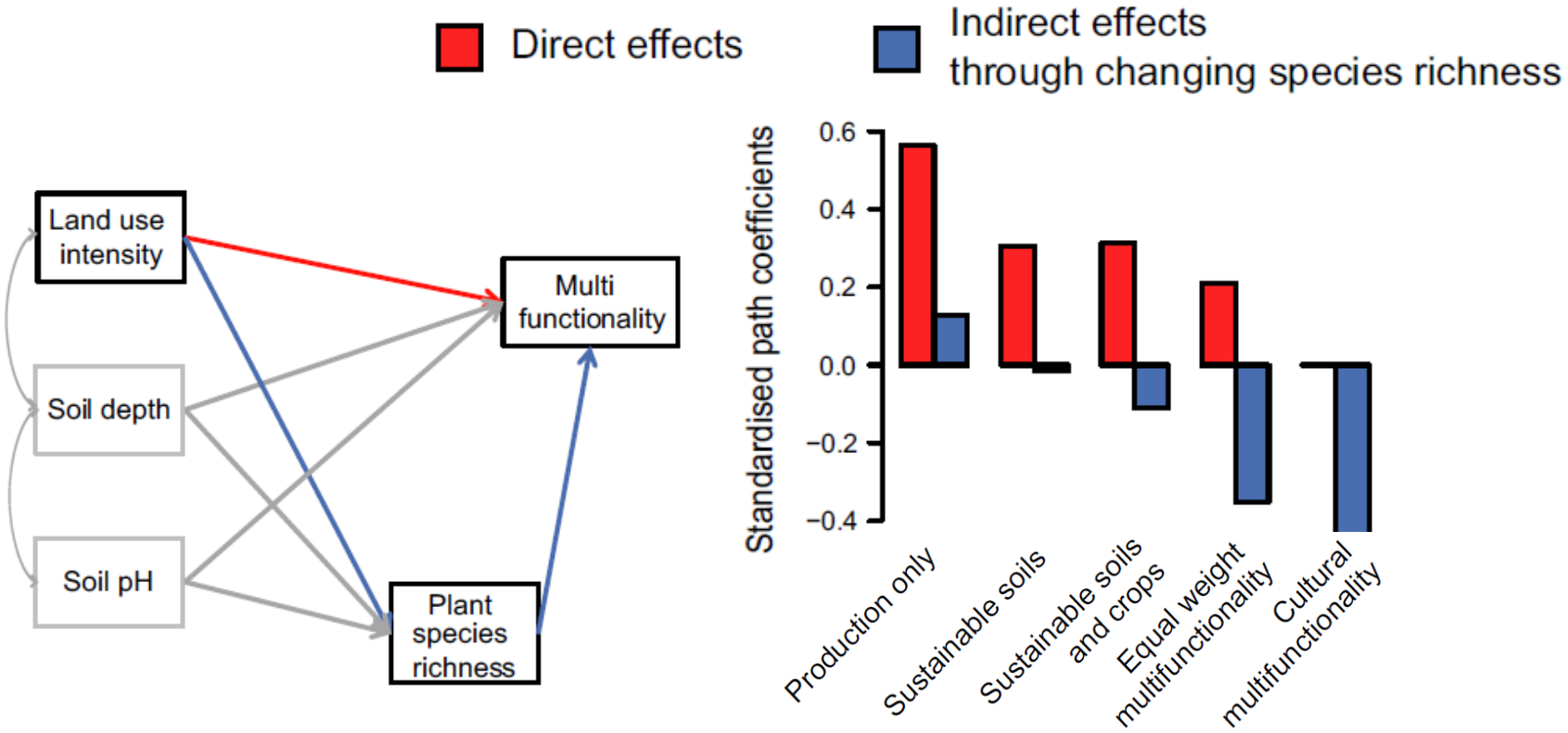
Allan et al. (2015) Ecol Lett, Soliveres et al. (2016) Nature

Effets de l'intensification agricole sur de multiples services écosystémiques



Allan et al. (2015)
Ecol. Letters

Intensification, biodiversité et services écosystémiques



Allan et al. (2015)
Ecol. Letters

Conclusions

Services écosystémiques: le génie est sorti de la lampe, et c'est une bonne chose.

Cependant, une approche monétaire restreinte ne semble pas utile, en particulier pour les biens publics.

Une approche inclusive, avec de nombreux aspects et valeurs semble être plus appropriée.

En général, la biodiversité augmente les services écosystémiques, mais pas toujours, surtout lorsque les services sont considérés individuellement.

Certains services ont une échelle plutôt locale, d'autre une plus large échelle.

Il est important de comprendre quelles sont les options de chacun des acteurs.

La Suisse n'a pas de programme national de recherche sur la biodiversité et les services écosystémiques, ni d'institution responsable pour la rédaction de rapports nationaux.

To value or not to value: That is *NOT* the question