Biodiversity and ecosystem services: How are they linked in the real world?

James Bullock

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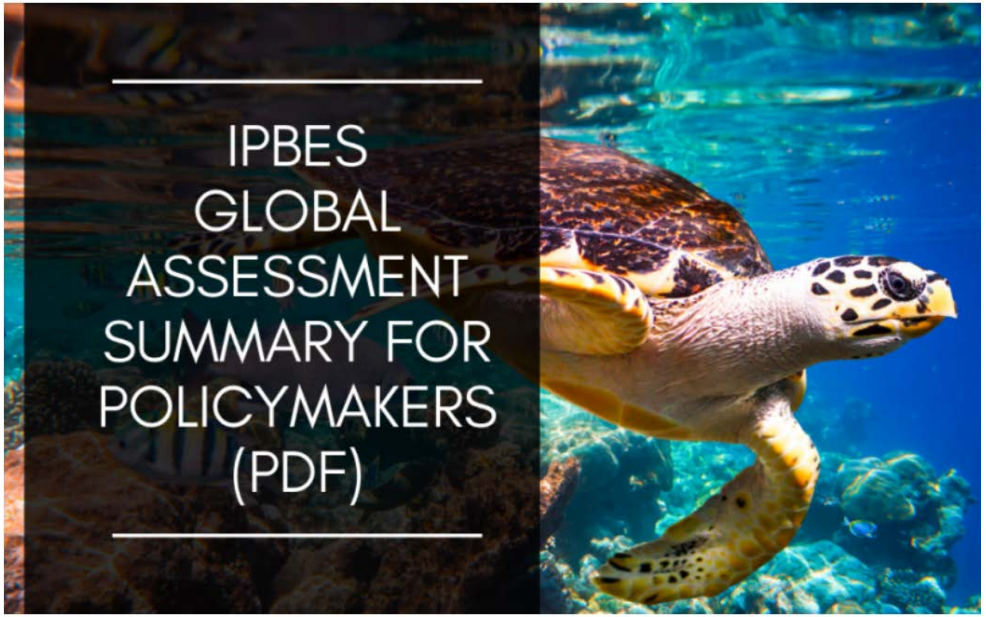
IPBES Global Assessment



"Nature and its vital contributions to people, which together embody biodiversity and ecosystem functions and services, are deteriorating worldwide"

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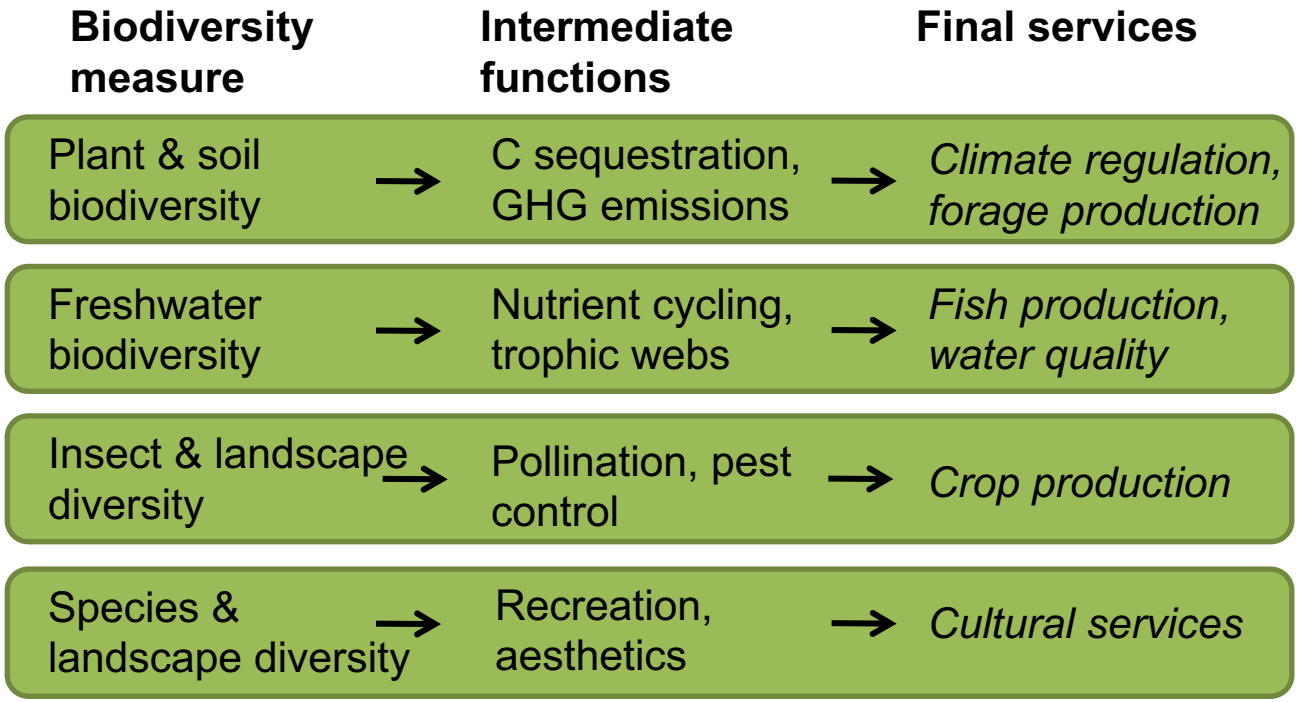
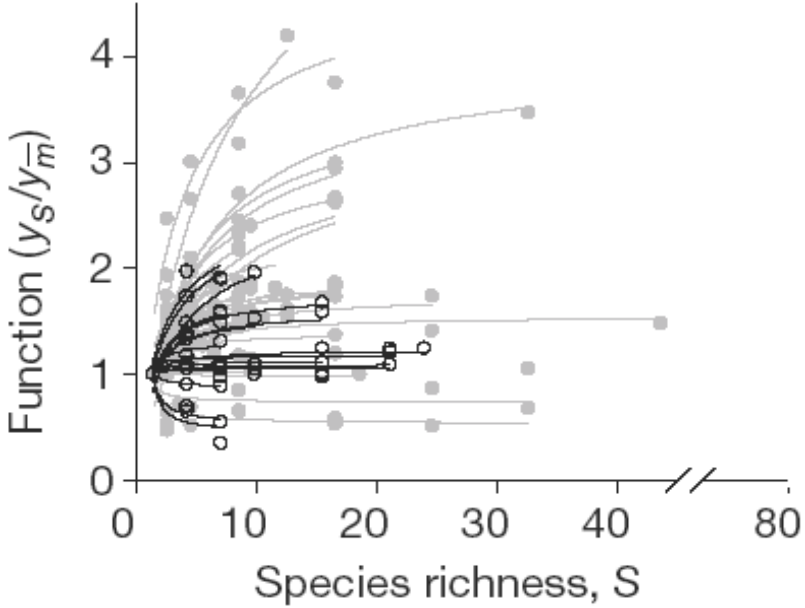
Biodiversity, ecosystem functions & ecosystem services



Adapted from UK National Ecosystem Assessment

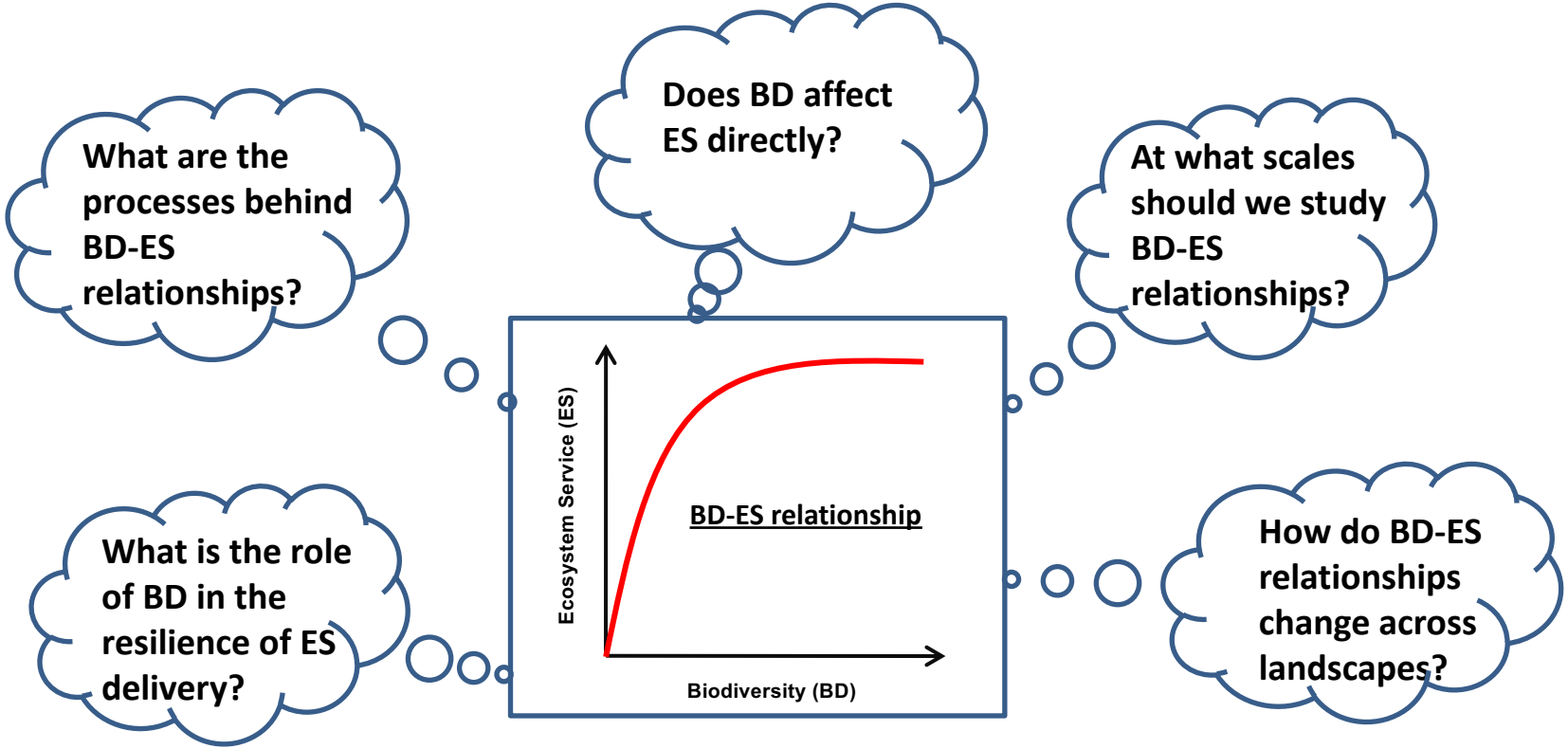
Evidence for (positive) BD-ES relationships

- from pot or plot scale species richness – ecosystem function (BD-EF) experiments
- often EF = production or related measure



Cardinale et al. (2006) Nature; Tilman et al (2014) ARES

Concepts in linking biodiversity and ecosystem services



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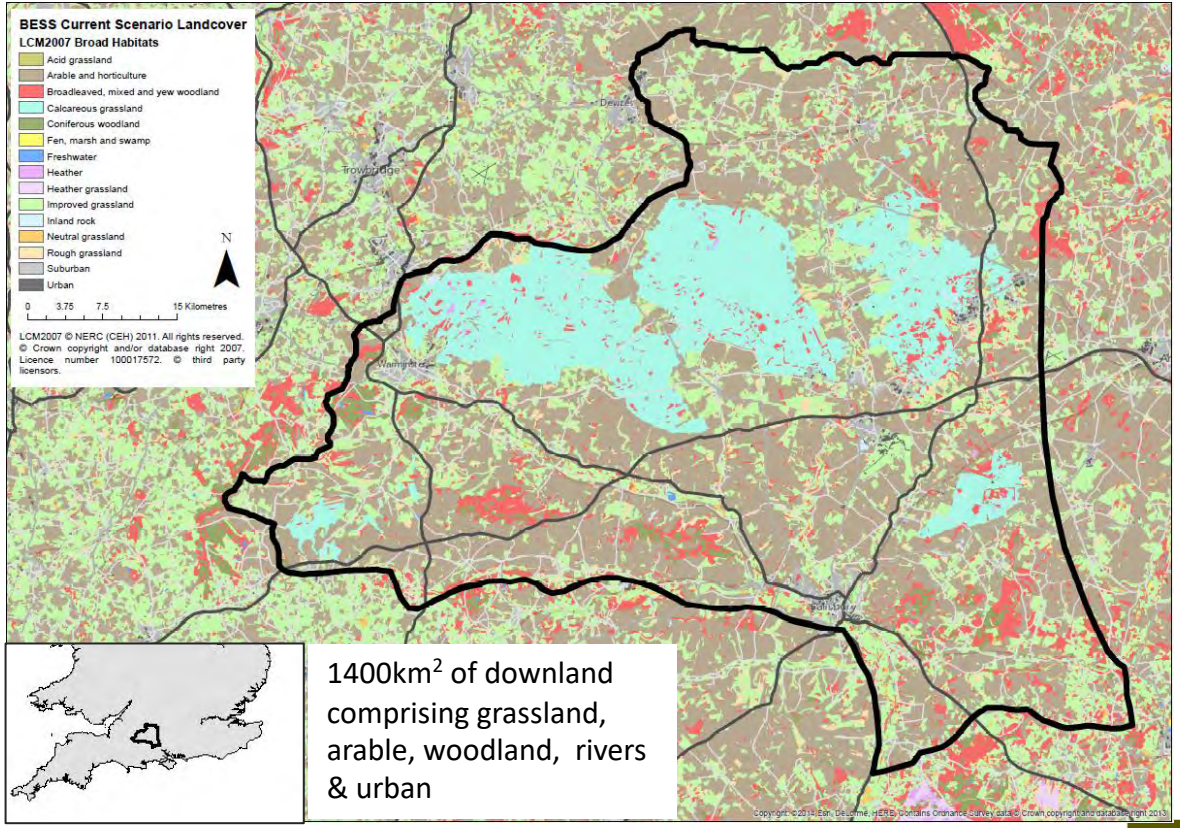

1400km^2 of downland comprising grassland, arable, woodland, rivers & urban

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A varied lowland landscape

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Research along a biodiversity gradient

Semi-natural **Restoring** **Intensive agriculture**

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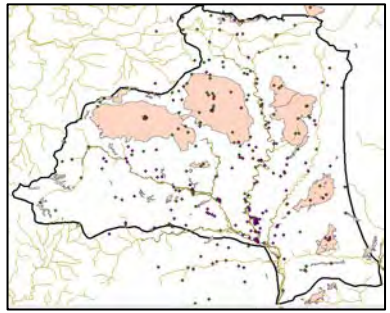
A variety of ecosystem services

GHG
& soil processes

Clean water
& fisheries

Pollination
& pest control

Cultural
services



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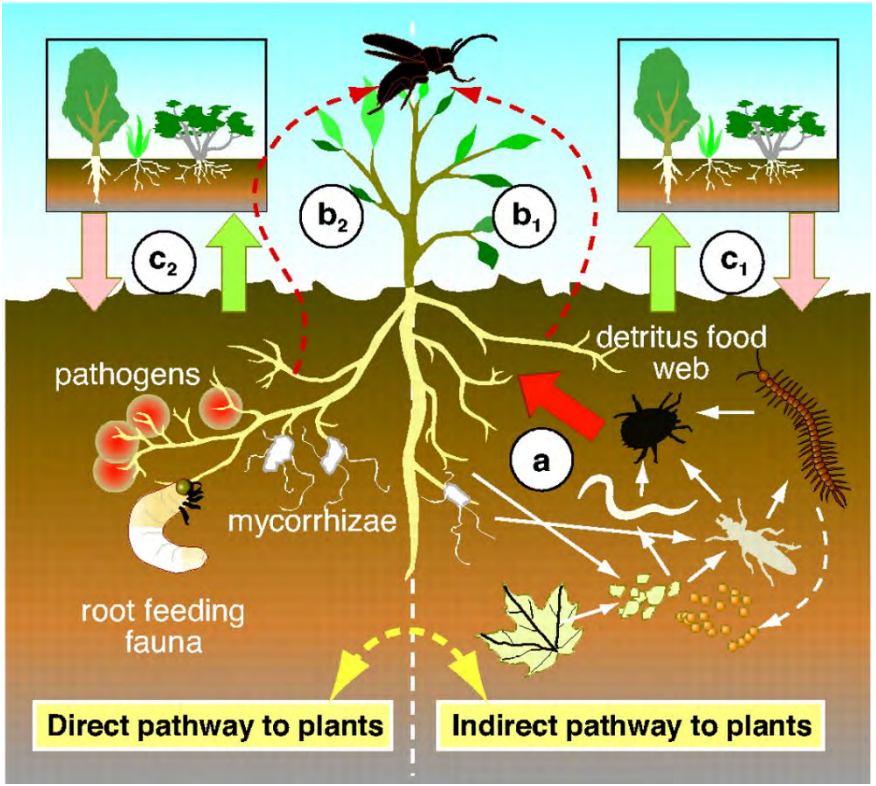
Greenhouse Gases & Soil Processes



Wardle et al Science 2004

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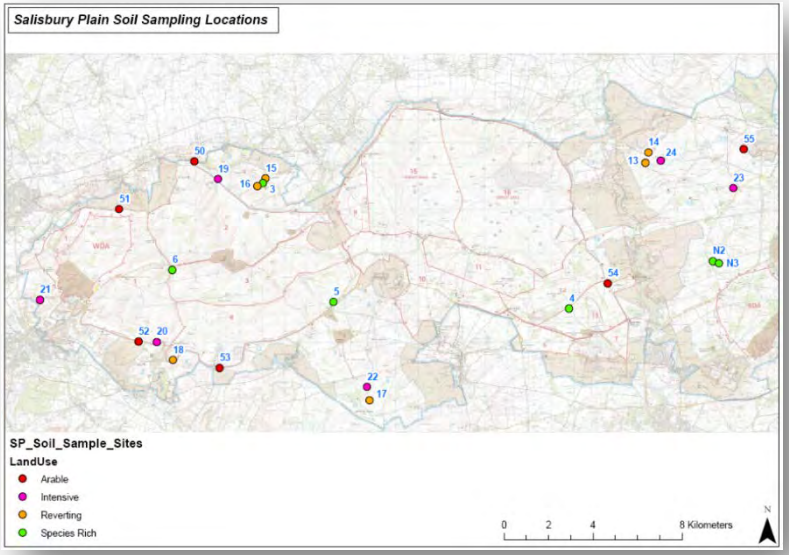
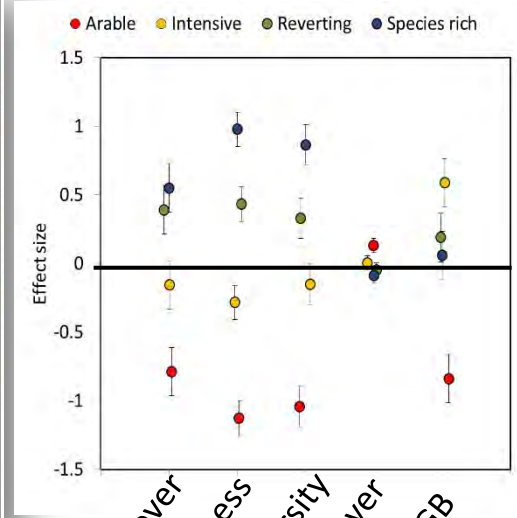
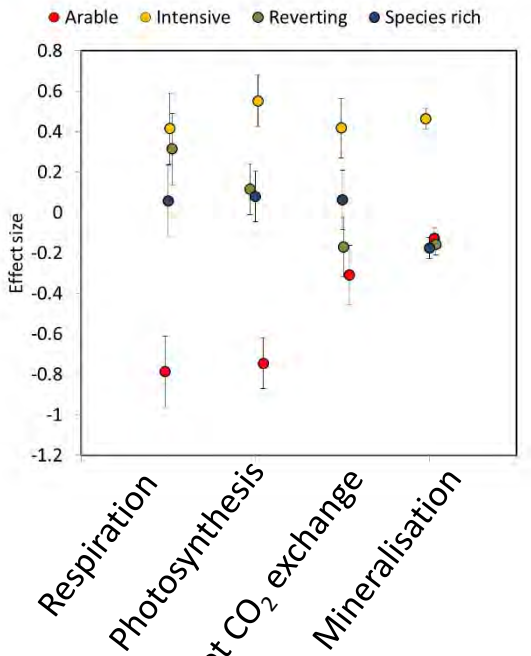
Greenhouse Gases & Soil Processes

Landscape gradient study.
No clear relationship between plant diversity & soil processes







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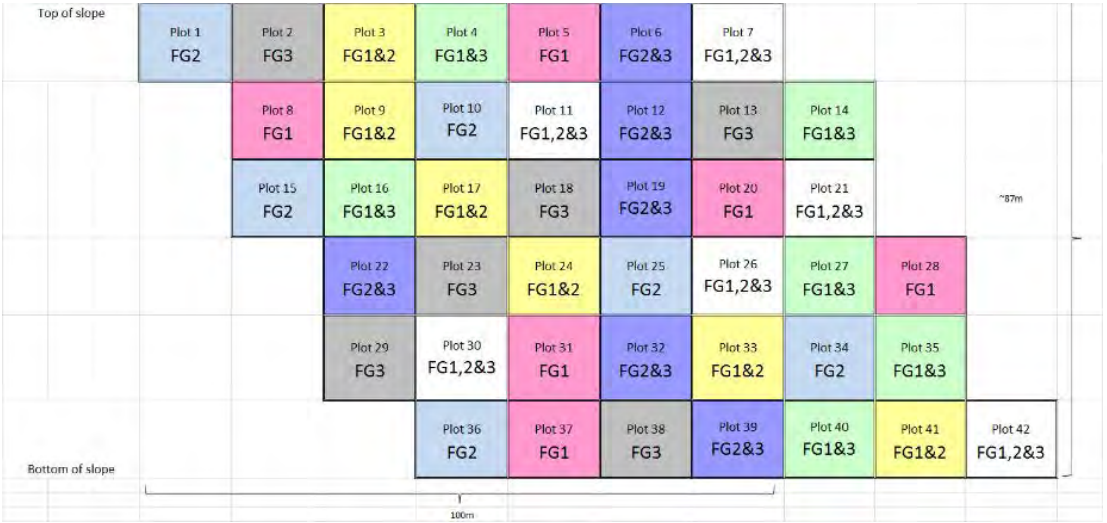
Greenhouse Gases & Soil Processes

Experiment – functional diversity in restored grassland



FG1: Variable longevity, deep roots, large leaves
FG2: Long lived, small rosettes, shallow
FG3: Long lived, shallow roots, thick leaves

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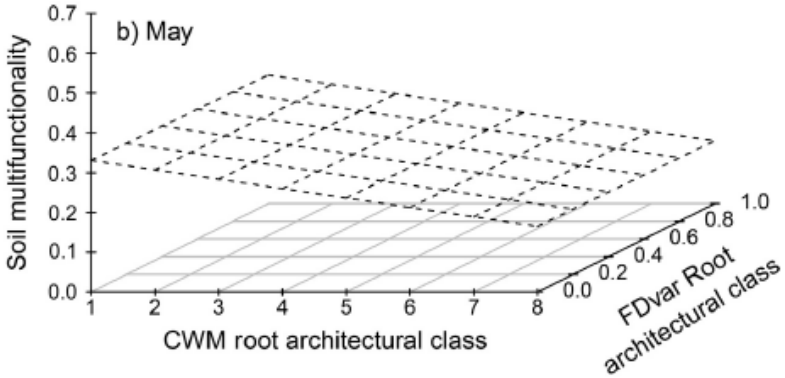
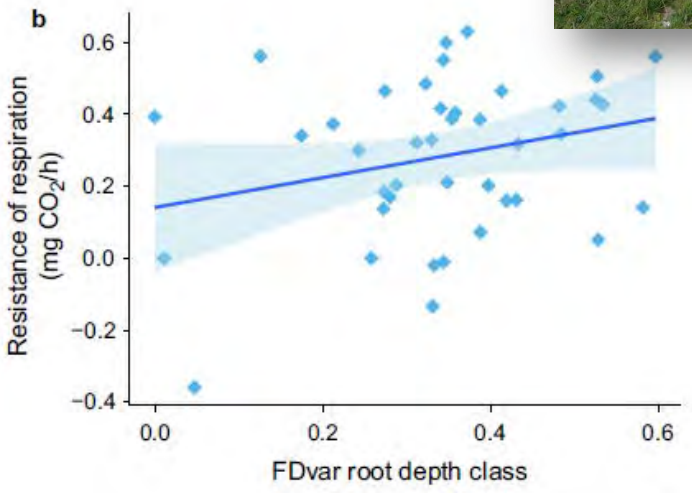
Restoration experiment – functional diversity

Trait values & diversity drive soil functions & resilience





Multifunctionality = respiration, soil nutrients, N emissions, Carbon

Fry, E.L., Savage, J., Hall, A.L., Oakley, S., Pritchard, W.J., Ostle, N.J., Pywell, R.F., Bullock, J.M. & Bardgett, R.D. (2018) Soil multifunctionality and drought resistance are determined by plant structural traits in restoring grassland. Ecology, 99, 2260-2271.

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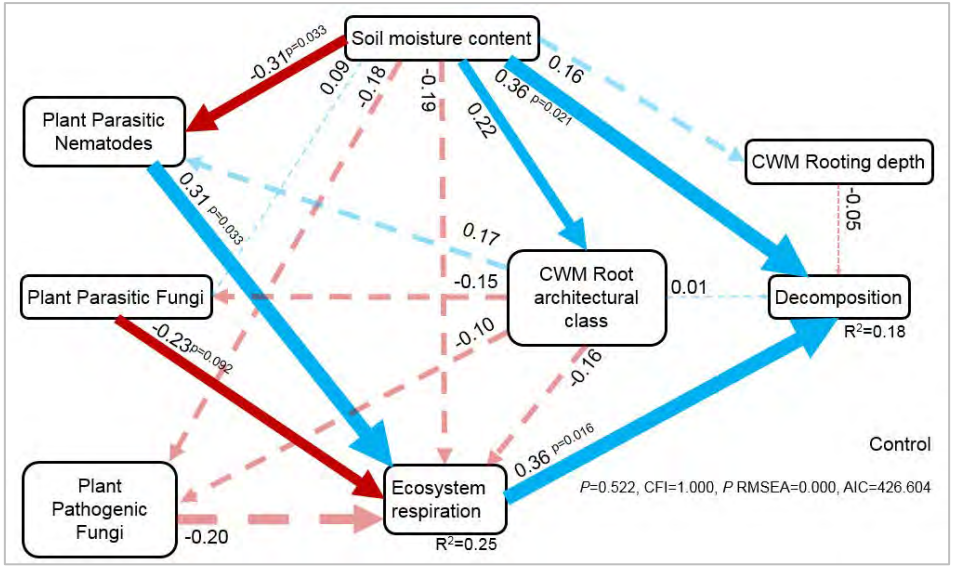
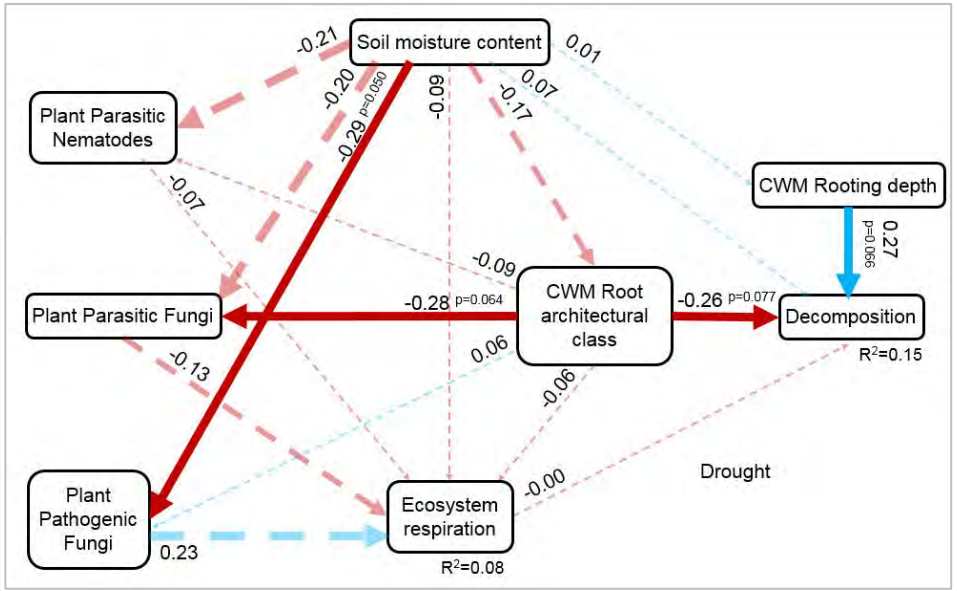
Functional diversity & the soil food web

No drought: strong relationships between soil food web & ecosystem processes – respiration & decomposition





Drought: decoupling of relationships. But plant root traits become important

Fry et al. (in prep)

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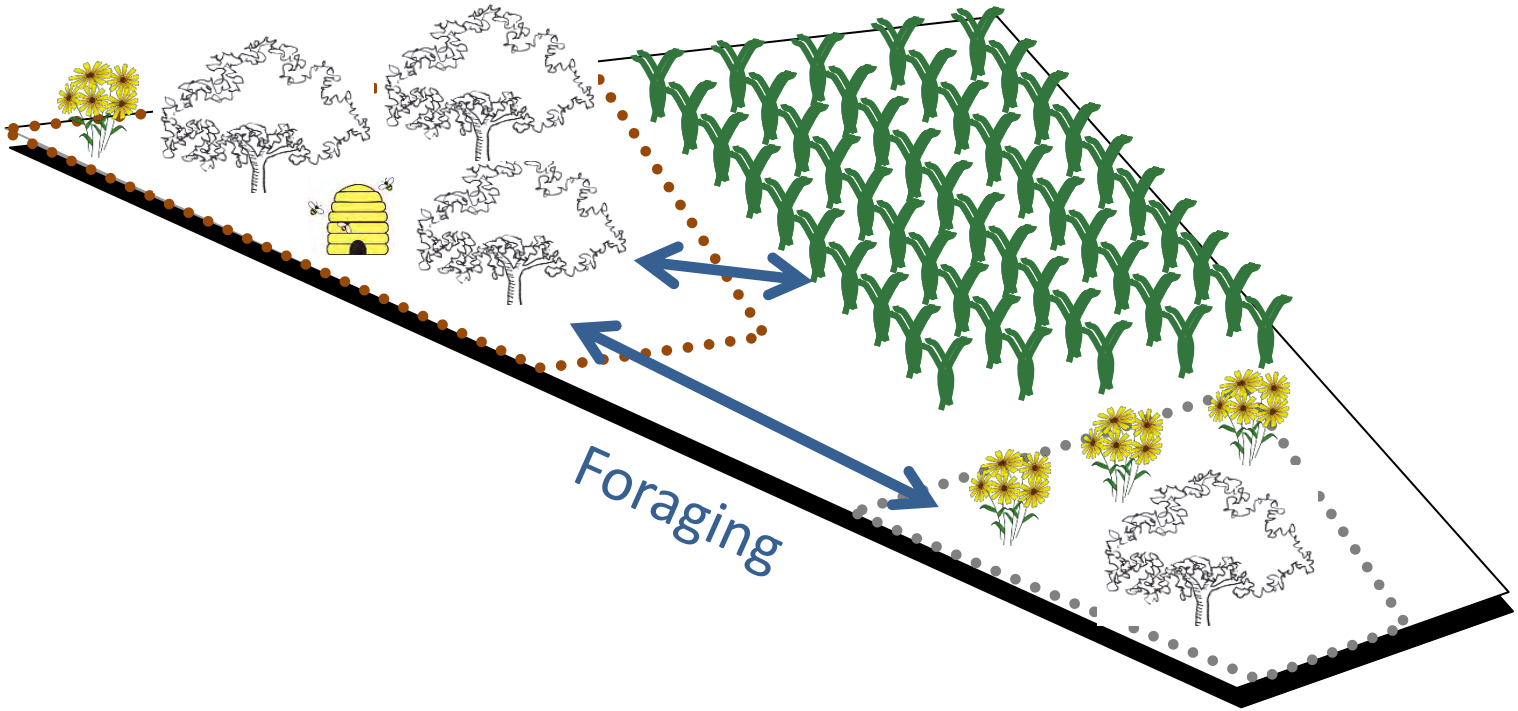
Pollinators, crop pollination and landscape diversity



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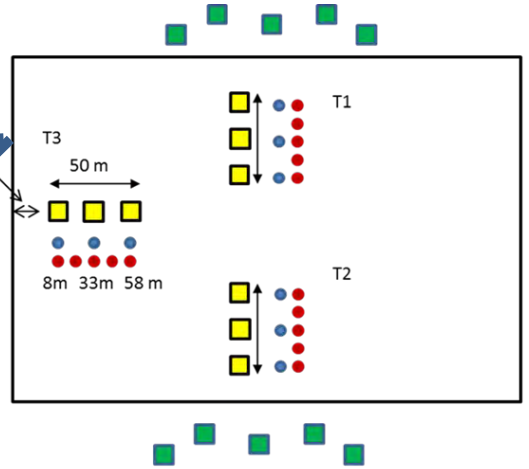
Landscape structure & crop pollination

Oilseed rape fields with different amount of semi-natural grassland



Pollinator quadrat

Pitfall trap and water trap

Natural enemy count

Suction sampling point

Plants marked for yield

Margin plant survey (if margin)

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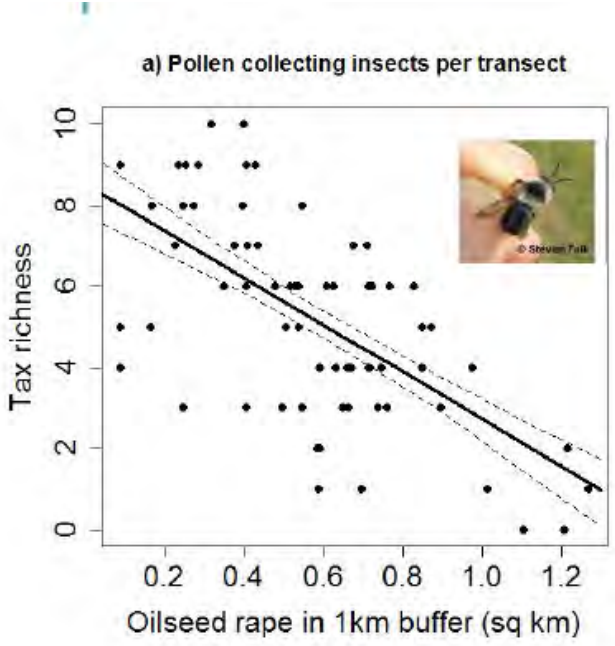
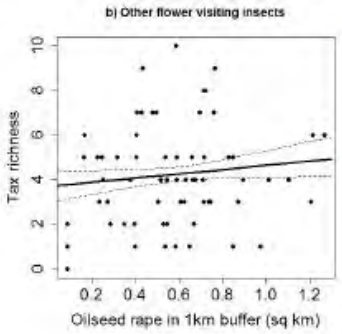
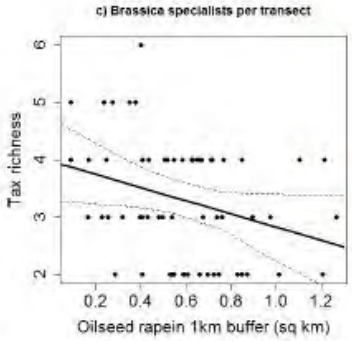
Pollinators not driven by semi-natural land cover

Main landscape driver = oilseed rape crops







Amount OSR: taxonomic group, $F_{3,96} = 12.74^{***}$

Shaw et al. (in review)

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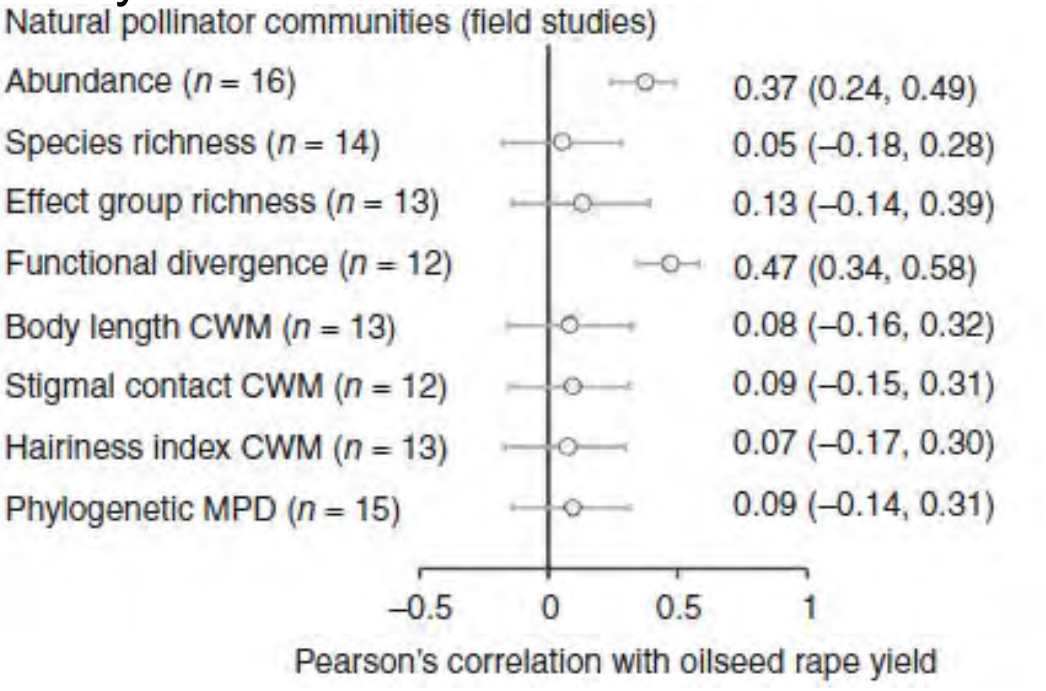
Oilseed rape yield increased by pollinator abundance and trait diversity

Meta-analysis



Woodcock, B. A., …, J. M. Bullock, and R. F. Pywell. 2019. Meta-analysis reveals that pollinator functional diversity and abundance enhance crop pollination and yield. Nature Communications 10:1481

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Cultural services, species and landscape diversity

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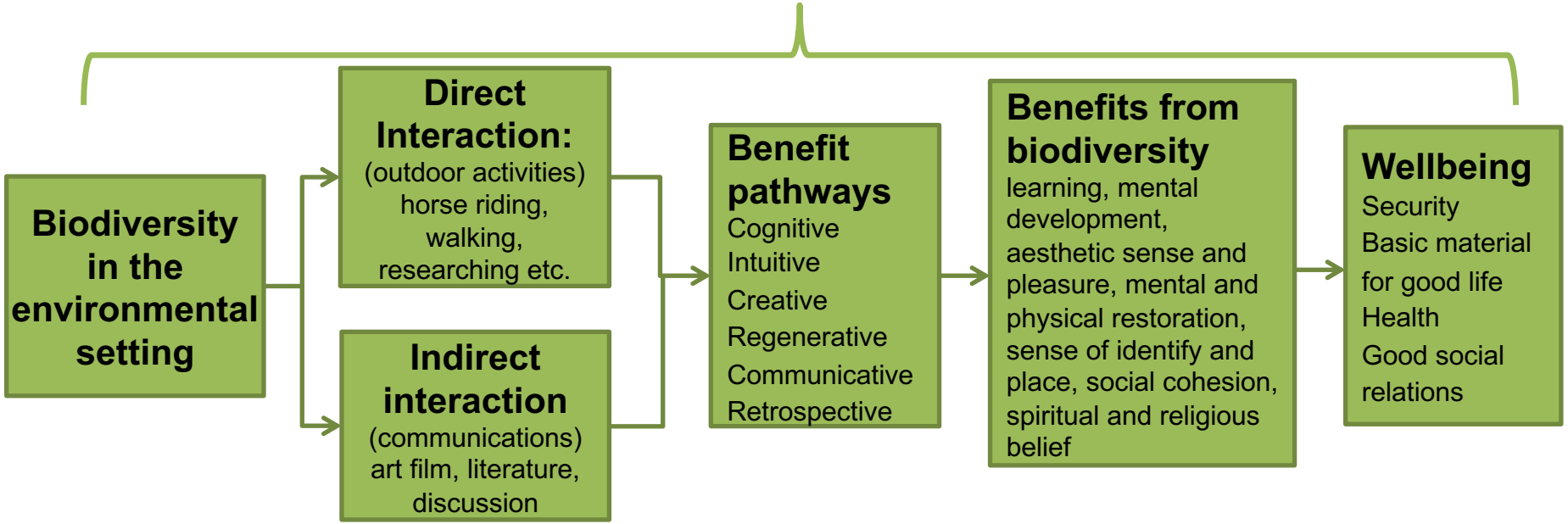
Cultural services & biodiversity

Mechanisms by which people benefit from biodiversity



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King, H.P., Morris, J., Graves, A., Bradbury, R.B., McGinlay, J. & Bullock, J.M. (2017) Biodiversity and cultural ecosystem benefits in lowland landscapes in southern England. *Journal of Environmental Psychology,* 53, 185-197.

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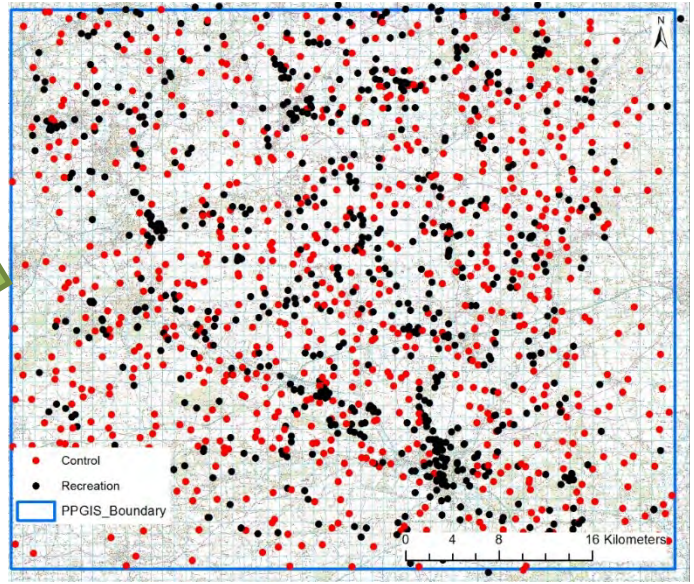
Landscape scale – reported important places

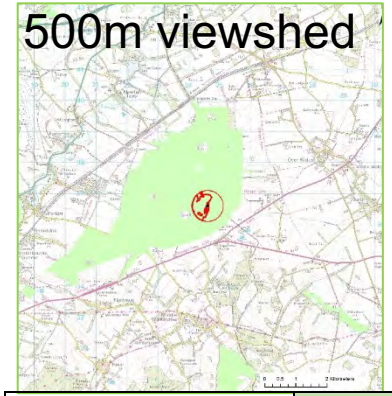
Public Participation GIS (PPGIS)

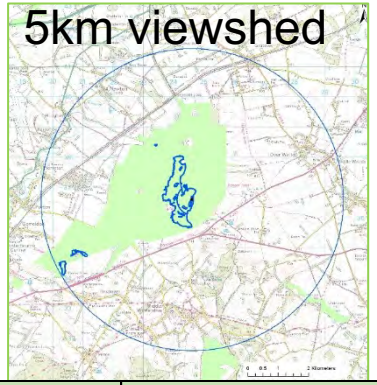
"Mark on the map 3 outdoor places of personal importance to you"



466 selected points

Important spaces relate to landscape variables





	500m viewshed buffer	5km viewshed buffer
Altitude		
Distance to urban		
Grassland	Coefficients from multi-model inferencing	
Historic		
Land cover diversity		
Protected area		
Protected area diversity		
River		
Urban cover		
Viewshed area		
Woodland		

- Protected areas, accessibility, land cover and land form influence the delivery of cultural services
- Some variation over different visual scales
- Also depending on form of engagement; e.g. + rivers for recreation, + historic monuments for cognitive benefits
- Need for landscapes of high ecological quality, diverse and near to towns

Ridding, L.E., J.W. Redhead, T.H. Oliver, R. Schmucki, J. McGinlay, A.R. Graves, J. Morris, R.B. Bradbury, H. King, and J.M. Bullock. 2018. The importance of landscape characteristics for the delivery of cultural ecosystem services. *Journal of Environmental Management* 206, 1145-54.

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Self-reported satisfaction with species types

- 549 face-to-face interviews across study area
- Aims:
  1. Quantify the satisfaction that members of public get from particular species groups
  2. Relate variation in benefits to the charisma of species groups

	Effect on enjoyment or satisfaction from the countryside						
	Very negative	Quite negative	Slightly negative	Neither positive nor negative	Slightly positive	Quite positive	Very positive
	←						→
Present as they are now	○	○	○	○	○	○	○
No longer present at all	○	○	○	○	○	○	○
Decreased presence*	○	○	○	○	○	○	○
Increased presence**	○	○	○	○	○	○	○

*a halving (50% less) ** half as many again (50% more)

McGinlay, J., Parsons, D.J., Morris, J., Hubatova, M., Graves, A., Bradbury, R.B. & Bullock, J.M. (2017) Do charismatic species groups generate more cultural ecosystem service benefits? *Ecosystem Services,* 27, 15-24

People report benefits from biodiversity






High charisma → ***Lower charisma/ ambiguity***

- More benefits from more “charismatic” species
- Greater benefits reported by people engaged in ‘nature activities
- Less charismatic species liked by people engaged in nature activities
- *Biodiversity in the local landscape gives benefits to the public*

McGinlay, J., Parsons, D.J., Morris, J., Graves, A., Hubatova, M., Bradbury, R.B. & Bullock, J.M. (2018) Leisure activities and social factors influence the generation of cultural ecosystem service benefits. *Ecosystem Services,* 31, 468-480; McGinlay, et al. (2017)

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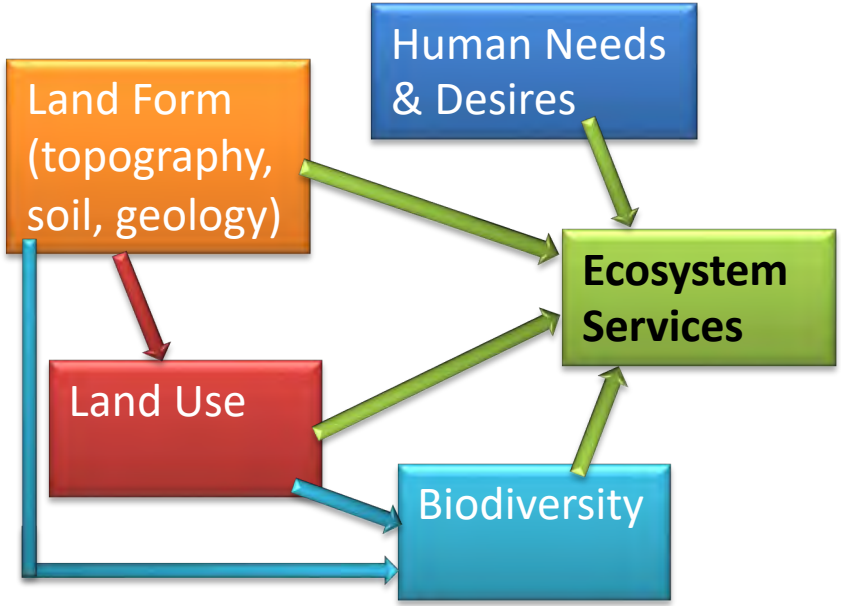
Conclusions: Biodiversity-EF-ES relationships

- Ecosystem services ≠ ecosystem functions
- Ecosystem services require large-scale research and variety of methods
- Land use is a primary driver of ecosystem services
- Biodiversity sometimes adds to ecosystem services



Project team & funding

bess biodiversity & ecosystem service sustainability

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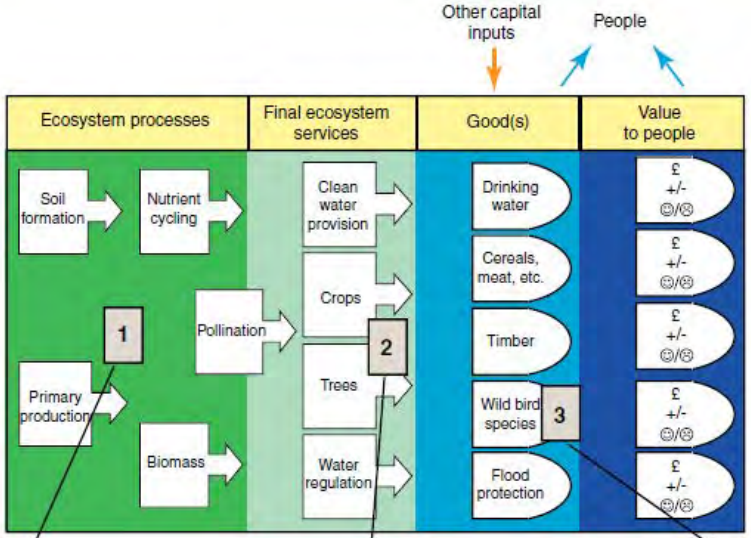
Are biodiversity and ecosystem services linked?



Pollinators

Cultivated apples

Mauritian kestrel

TRENDS in Ecology & Evolution

"Biodiversity might have a role as:
(1) a regulator of ecosystem processes
(2) a final ecosystem service
(3) a good that has value of its own"

Mace et al. TREE 2012

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