



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

James Bullock

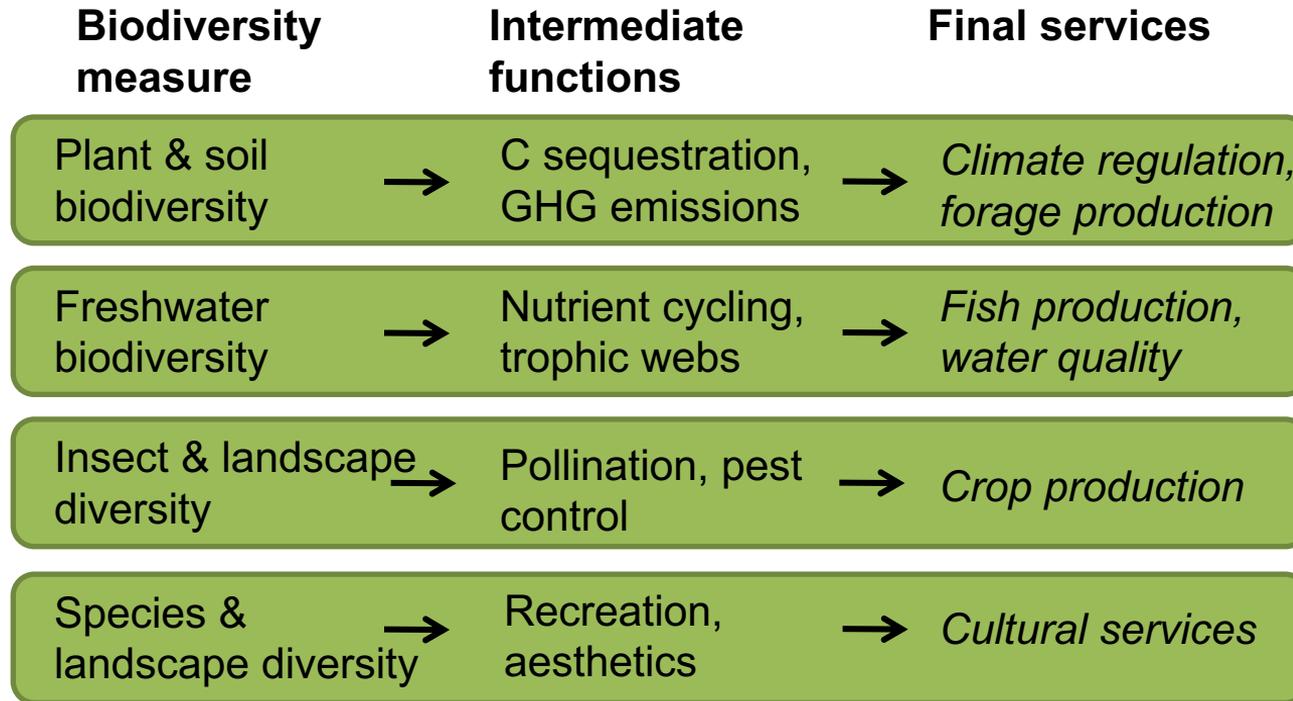
IPBES Global Assessment



IPBES
GLOBAL
ASSESSMENT
SUMMARY FOR
POLICYMAKERS
(PDF)

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

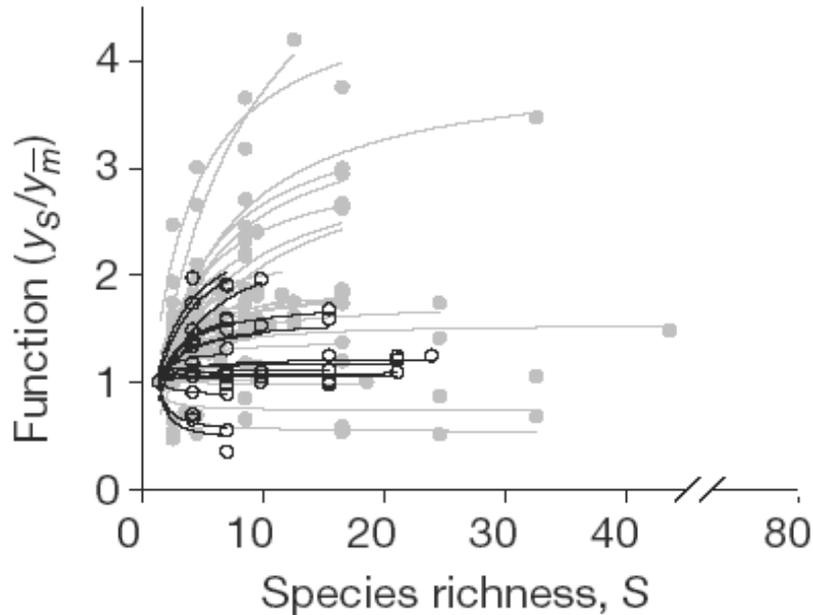
Biodiversity, ecosystem functions & ecosystem services



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

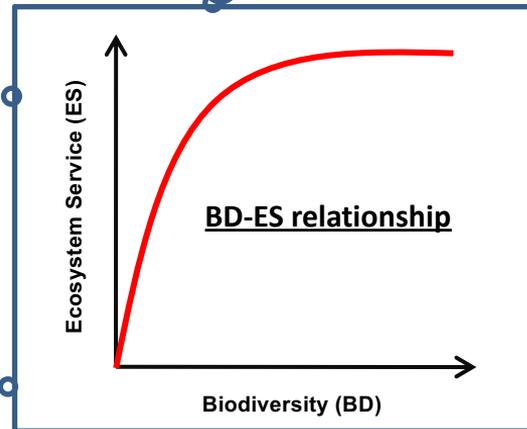
Concepts in linking biodiversity and ecosystem services

What are the processes behind BD-ES relationships?

Does BD affect ES directly?

At what scales should we study BD-ES relationships?

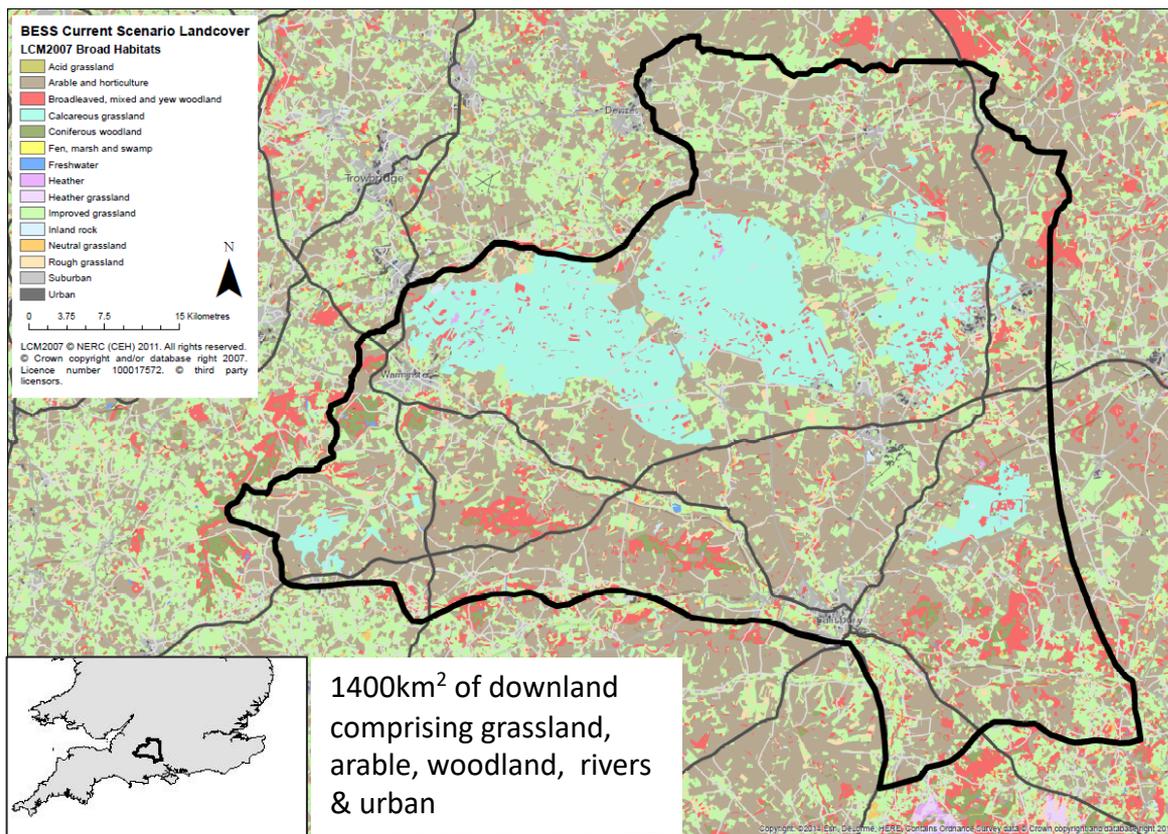
What is the role of BD in the resilience of ES delivery?



How do BD-ES relationships change across landscapes?



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Research along a biodiversity gradient



Semi-natural



Restoring



**Intensive
agriculture**



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A variety of ecosystem services

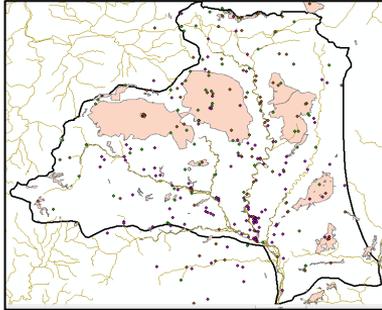
GHG
& soil processes



Clean water
& fisheries



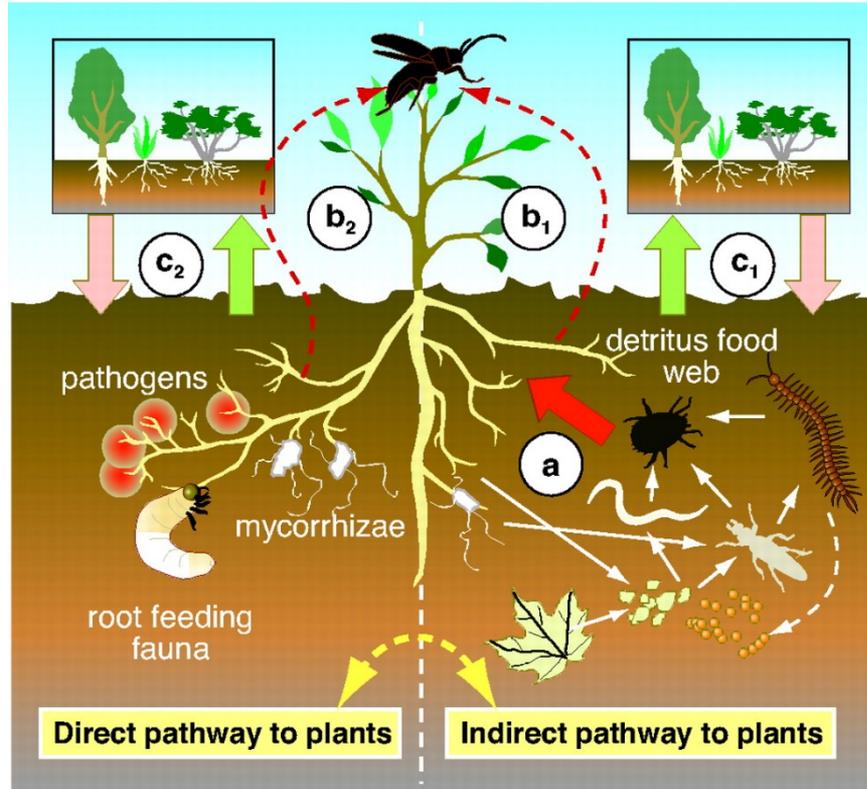
Pollination
& pest control



Cultural
services



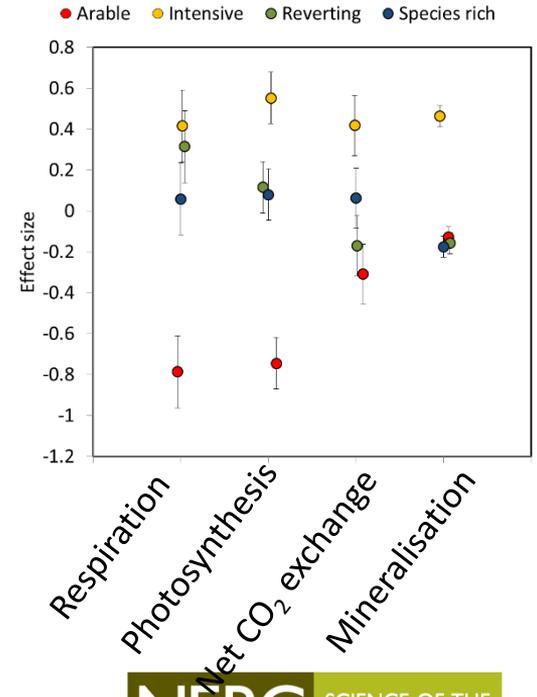
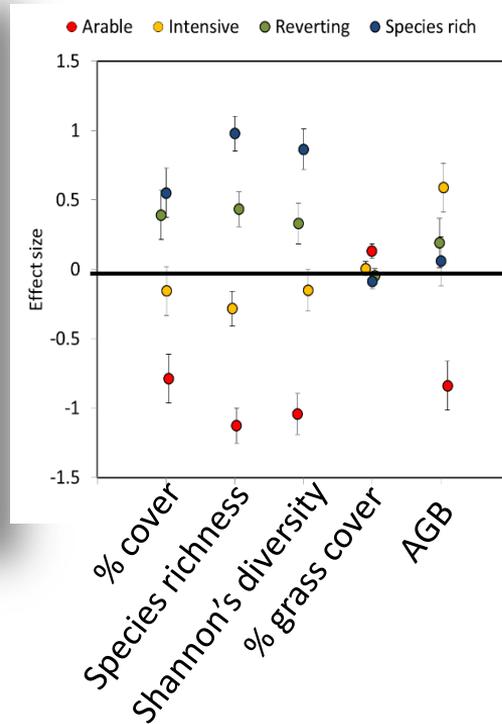
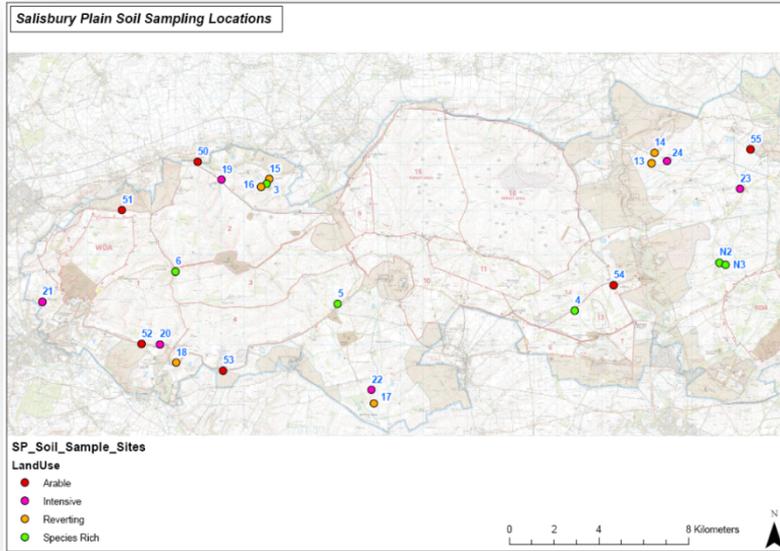
Greenhouse Gases & Soil Processes



Wardle et al Science 2004

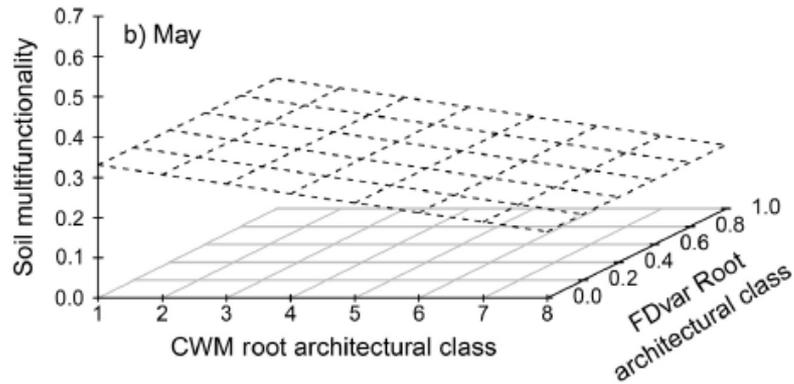
Greenhouse Gases & Soil Processes

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

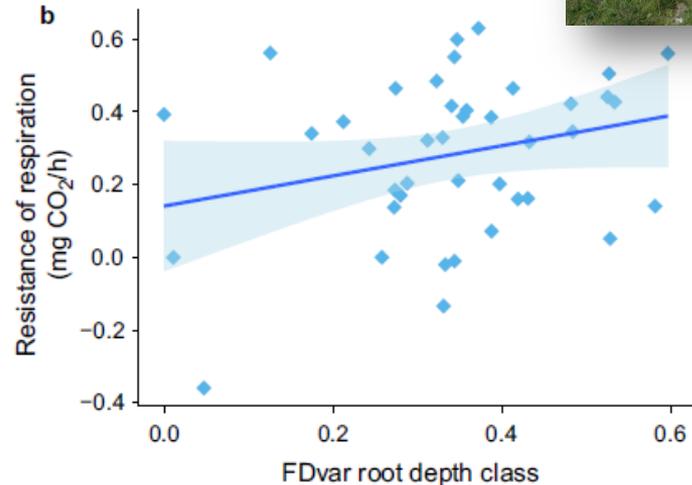


Restoration experiment – functional diversity

Trait values & diversity drive soil functions & resilience



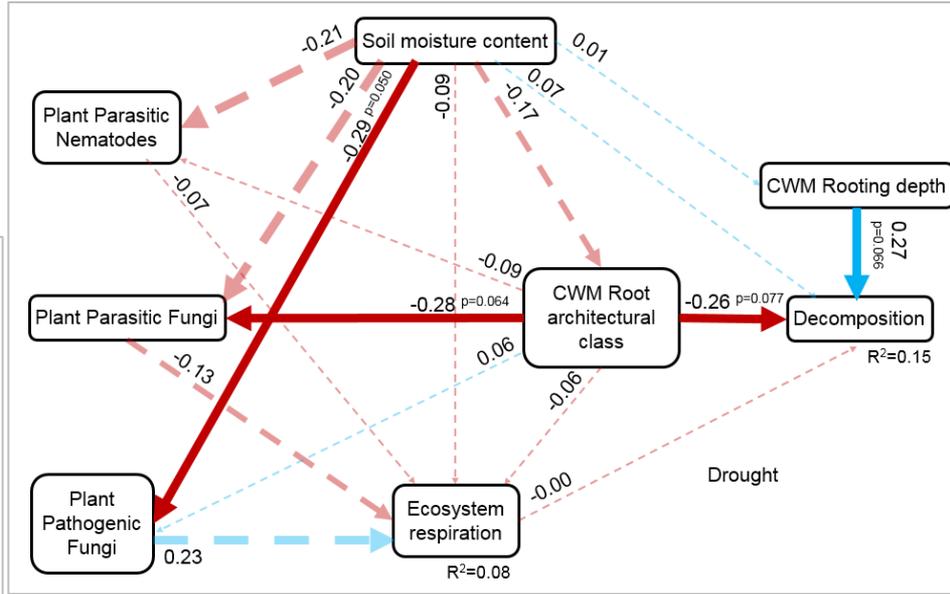
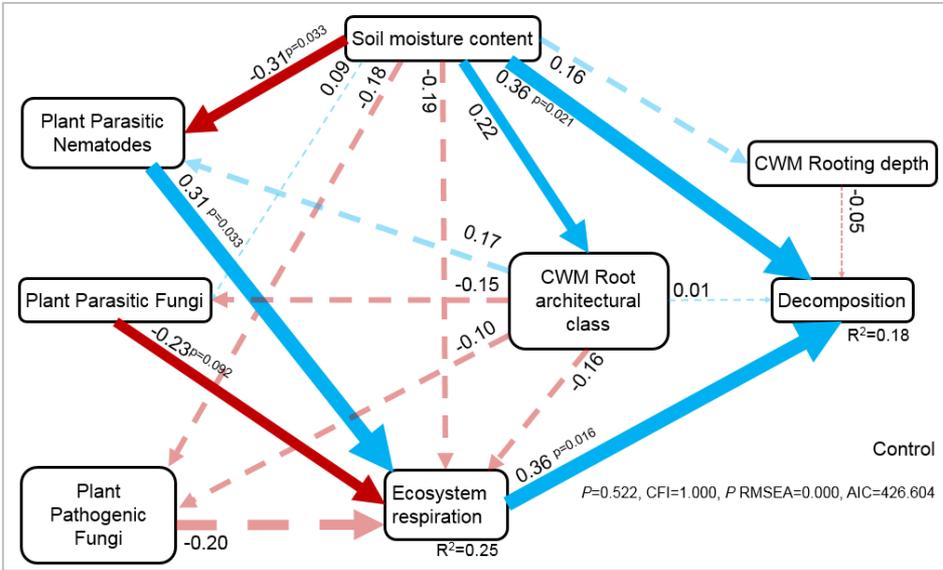
Multifunctionality = respiration, soil nutrients, N emissions, Carbon



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.

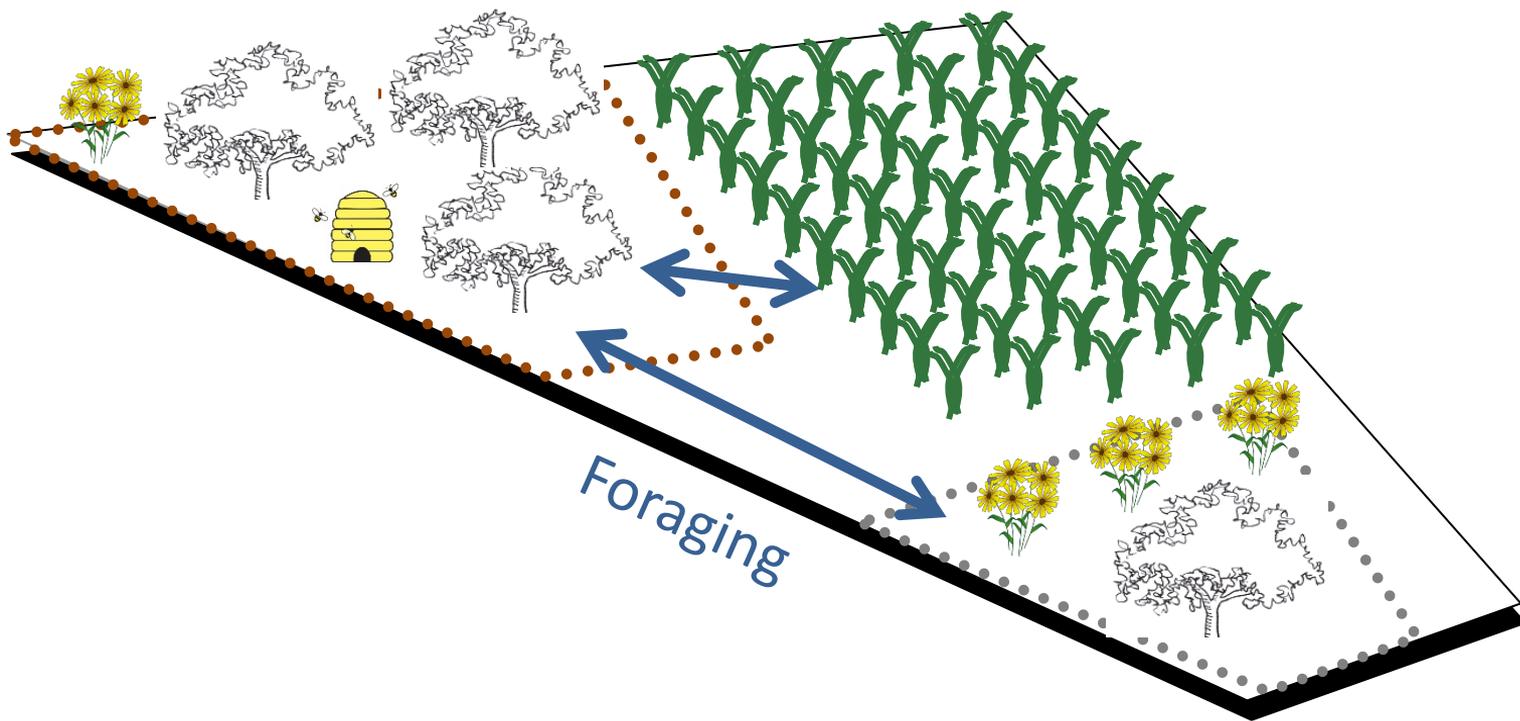
Functional diversity & the soil food web

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



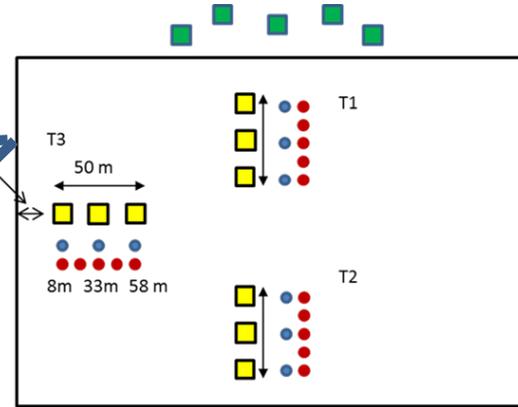
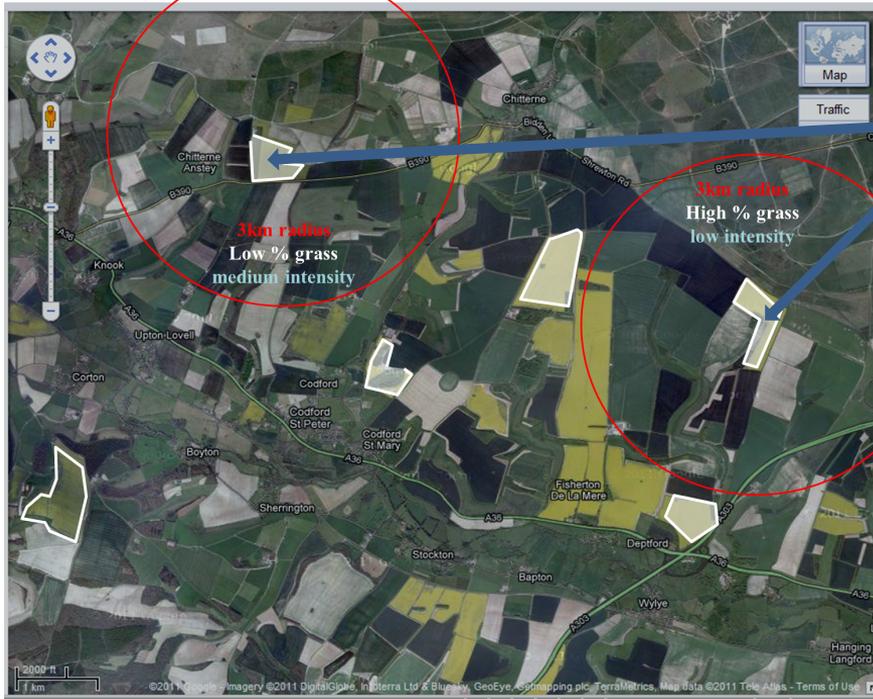
Drought: decoupling of relationships. But plant root traits become important

Pollinators, crop pollination and landscape diversity



Landscape structure & crop pollination

Oilseed rape fields with different amount of semi-natural grassland

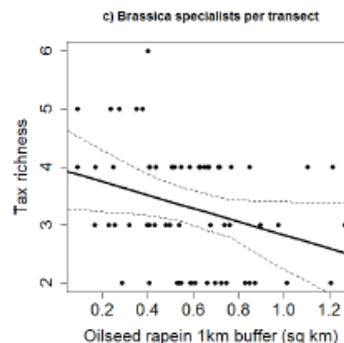
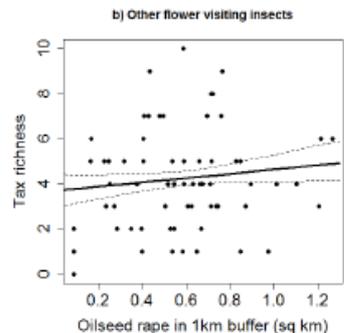
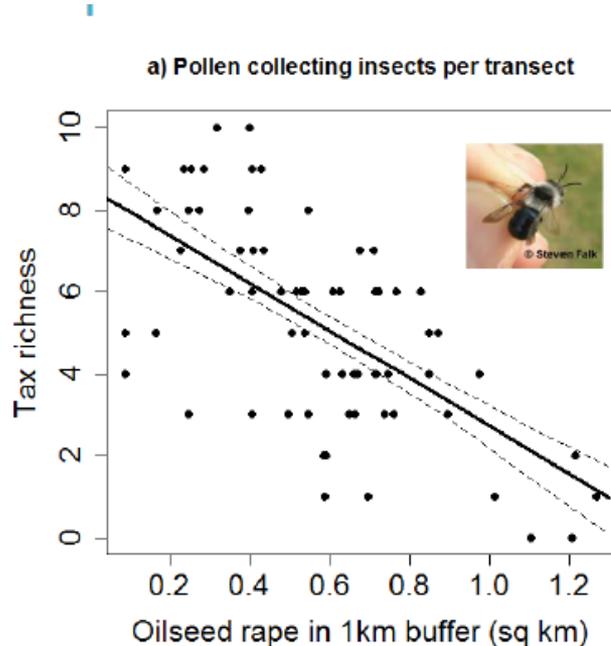


- Pollinator quadrat
- Pitfall trap and water trap
- Natural enemy count
- Suction sampling point
- Plants marked for yield
- Margin plant survey (if margin)



Pollinators not driven by semi-natural land cover

Main landscape driver = oilseed rape crops



Shaw et al. (in review)

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



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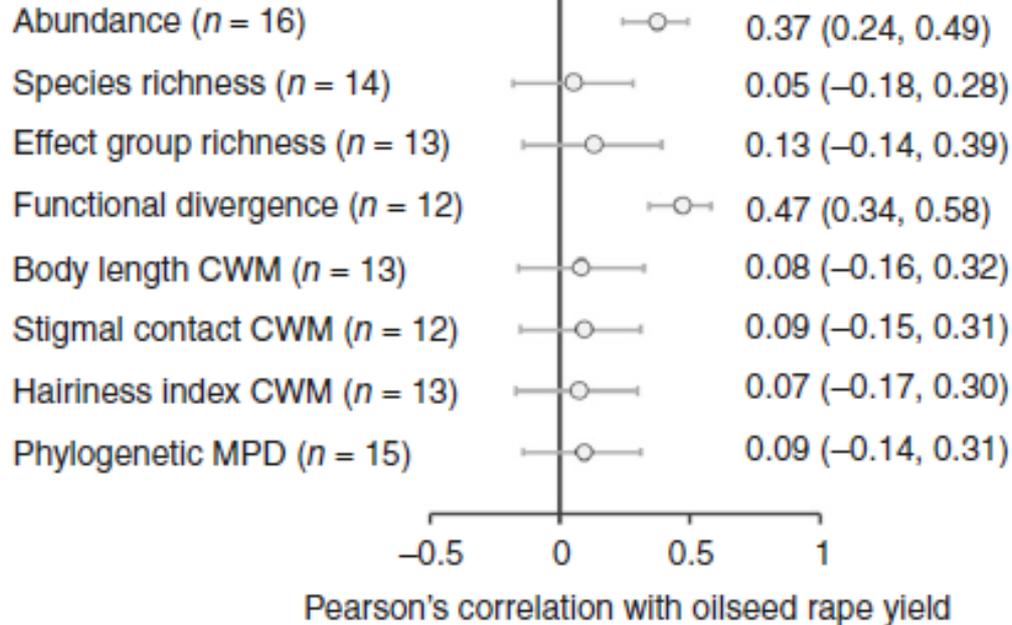
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Oilseed rape yield increased by pollinator abundance and trait diversity

Meta-analysis

Natural pollinator communities (field studies)



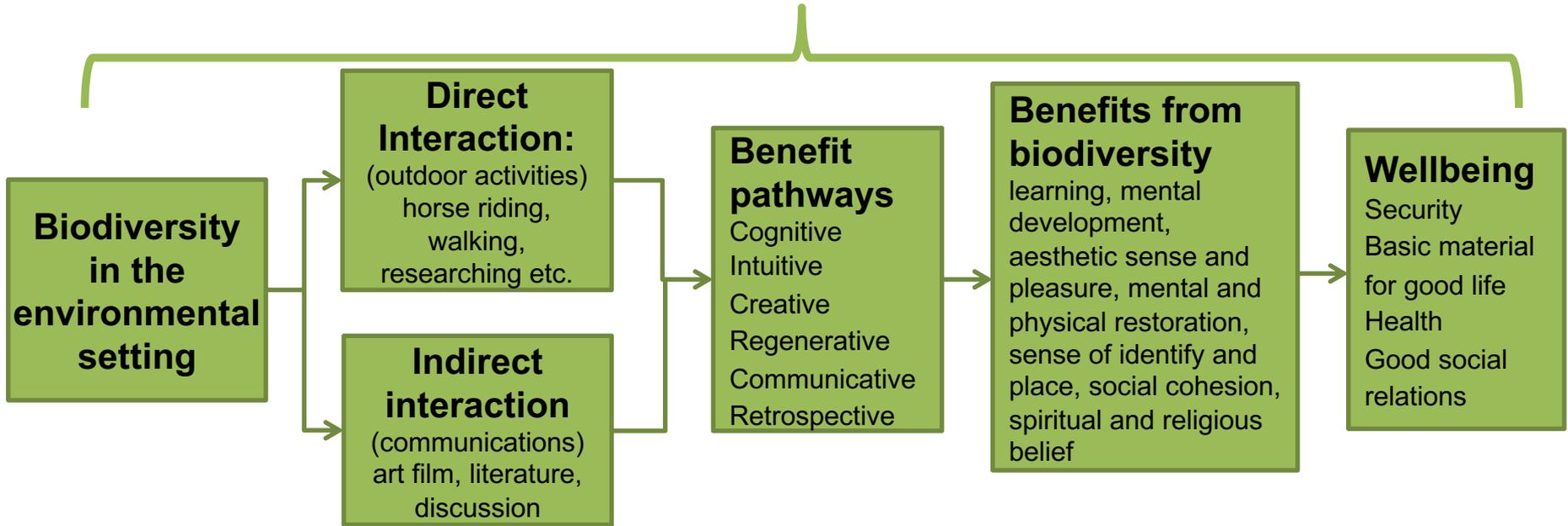
Woodcock, B. A., ..., J. M. Bullock, and R. F. Pywell. 2019. Meta-analysis reveals that pollinator functional diversity and abundance enhance crop pollination and yield. *Nature Communications* 10:1481

Cultural services, species and landscape diversity



Cultural services & biodiversity

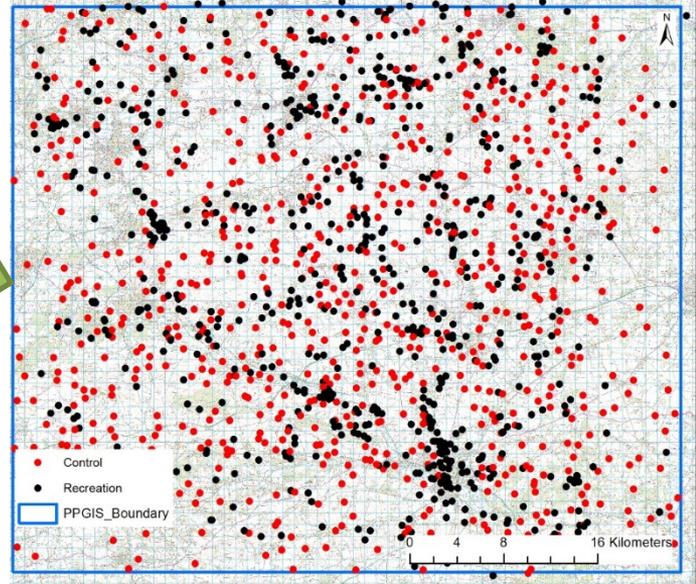
Mechanisms by which people benefit from biodiversity



Landscape scale – reported important places

Public Participation GIS (PPGIS)

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



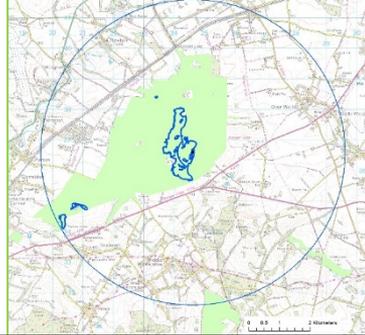
466 selected points

Important spaces relate to landscape variables

500m viewshed



5km viewshed



	500m viewshed buffer	5km viewshed buffer
Altitude		
Distance to urban		
Grassland		
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.

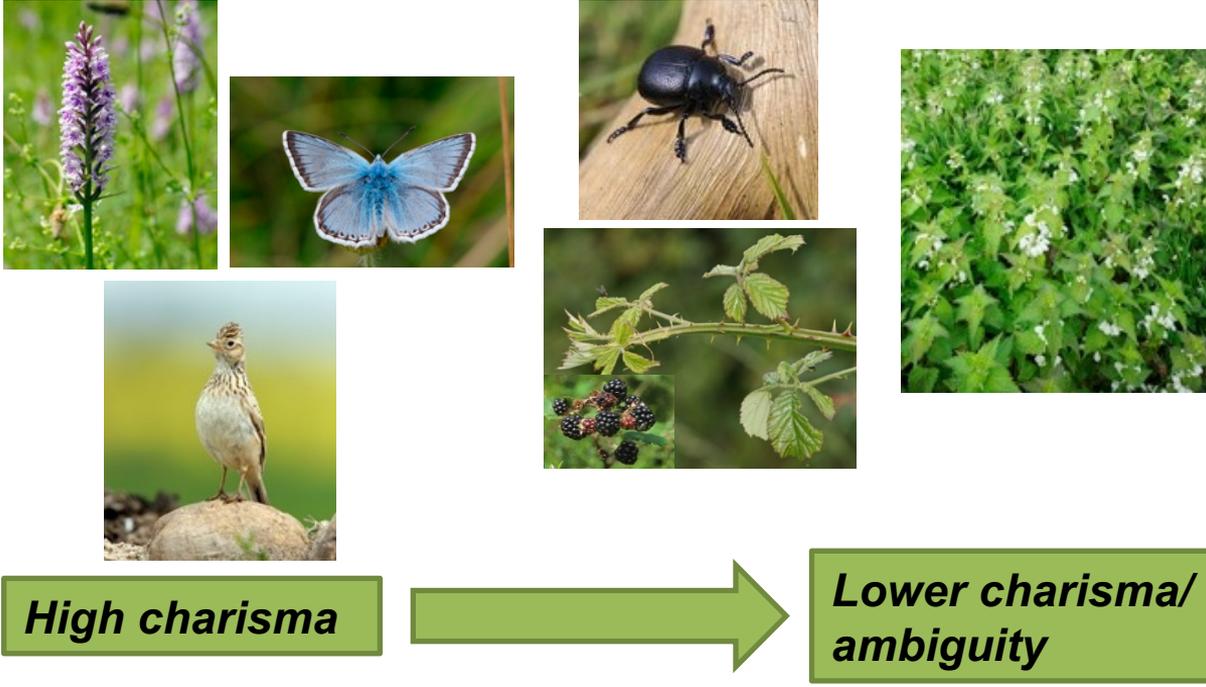
Self-reported satisfaction with species types

- 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

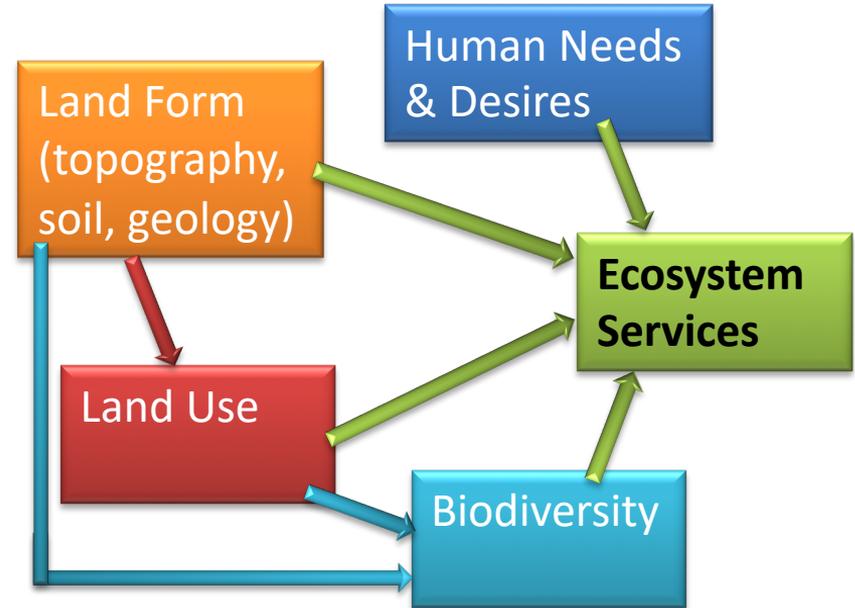


- More benefits from more “charismatic” species
- Greater benefits reported by people engaged in ‘nature activities’
- Less charismatic species liked by people engaged in nature activities
- *Biodiversity in the local landscape gives benefits to the public*

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)

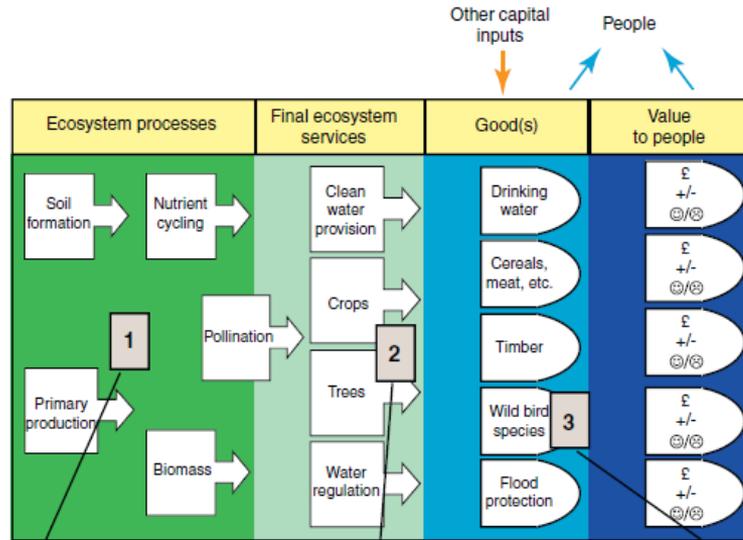
Conclusions: Biodiversity-EF-ES relationships

- Ecosystem services \neq 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





Are biodiversity and ecosystem services linked?



“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”

Pollinators



Cultivated apples



Mauritian kestrel

