Soil Biodiversity & Ecosystem Services

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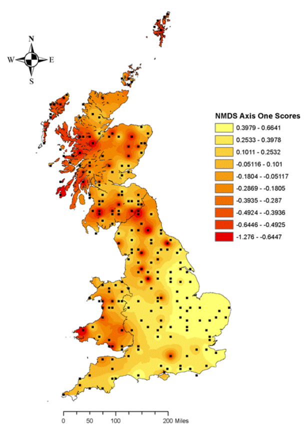
unprecedented rate. In order to protect soils we must identify and promote the benefits they provide to society. The Natural Capital / Ecosystem Services framework is one way to do this, and in Great Britain data from Countryside Survey supports the ecosystem approach and helps identify change. This unique dataset is now being used to model relationships between ecosystem services.

MONITORING – Countryside Survey

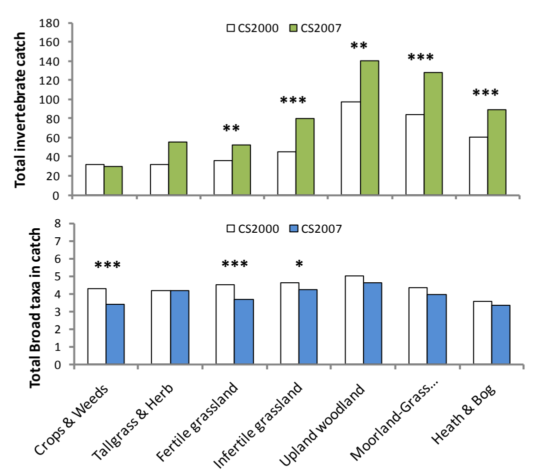
- First survey in 1978
- Great Britain-wide environmental surveillance scheme.
- Stratified and randomly selected sample of 1km² that represents the main habitats.
- Habitats mapped within each 1km square; vegetation, water bodies and soil sampled.
- Provides a globally unique dataset used to monitor ecological and land use change at a national scale.

	Survey Year		
Variable	1978	1998	2007
Bulk density	No	Yes	Yes
Moisture	No	Yes	Yes
pH	Yes	Yes	Yes
Loss-on-ignition	Yes	Yes	Yes
Carbon conc./stock	Yes	Yes	Yes
Nitrogen conc./stock	No	Yes	Yes
Phosphorus (Olsen-P)	No	Yes	Yes
Heavy metals	No	Yes	Yes
Soil Invertebrates	No	Yes	Yes
Microbial diversity	No	No	Yes

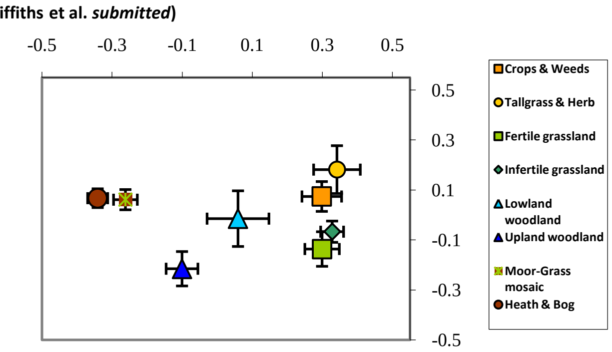
Soil measurements from Countryside Survey



Spatial mapping of soil bacterial communities across Great Britain, sampled as part of CS2007. Predominant changes in soil bacterial community structure based on TRFLP correlate with general environmental, climatic and land-use differences (Griffiths et al. *submitted*)



Changes in soil invertebrate abundance and number of broad taxa recorded from 0-8cm soil depth between the 1998 (CS2000) and 2007 surveys; classified by vegetation type. Asterisks indicate significant difference between surveys, * = P > 0.05; ** P > 0.01; *** P > 0.001.



Differences in soil microarthropod composition between major vegetation types across Great Britain. Data from ordination of Oribatid mite species recorded in the 1998 survey (CS2000). (Keith et al. *in prep*)

ARE THE RELEVANT SOIL BIOLOGICAL INDICATORS BEING MONITORED?

- 13 candidate indicators were deemed fully deployable by Black et al. (2005) including Microbial TRFLP and microarthopods (both in CS)
- The discriminatory power of, and surrogacy between, these indicators is currently being testing using 100 locations from Countryside Survey.

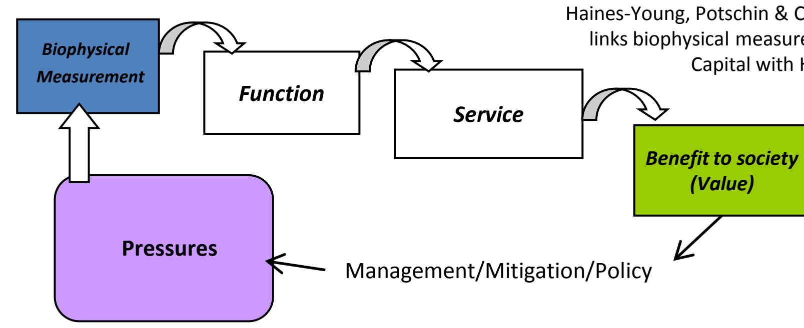
MEASURING – Natural Capital & Ecosystem Services

Summary of the 'mass, energy, organization' soil natural capital framework and its primary subdivisions.

1) MASS	Solid	*Inorganic material*	*I) Mineral stock and*
			II) Nutrient stock
		Organic material	*I) OM/Carbon stock and*
			II) Organisms
	Liquid	*Soil water content*	
	Gas	*Soil air*	
2) ENERGY	Thermal Energy	*Soil temperature*	
	Biomass Energy	*Soil biomass*	
3) ORGANIZATION / ENTROPY	Physico-chemical Structure	*Soil physico-chemical organization, soil structure*	
	Biotic Structure	*Functional groups, food webs and biodiversity*	
	Spatio-temporal Structure	*Connectivity, patches and gradients*	

Modified from Robinson et al. 2009.

Ecosystem Service cascade adapted from Haines-Young, Potschin & Cheshire 2006 that links biophysical measurements of Natural Capital with Human well-being



SUPPORTING

- Soil formation
- Nutrient cycling
- Primary production

Examples of Soil Ecosystem Services (adapted from MA, 2005; Haygarth & Ritz, 2009).

Biodiversity and activity of soil organisms underpins the majority of Regulating and Provisioning Services.

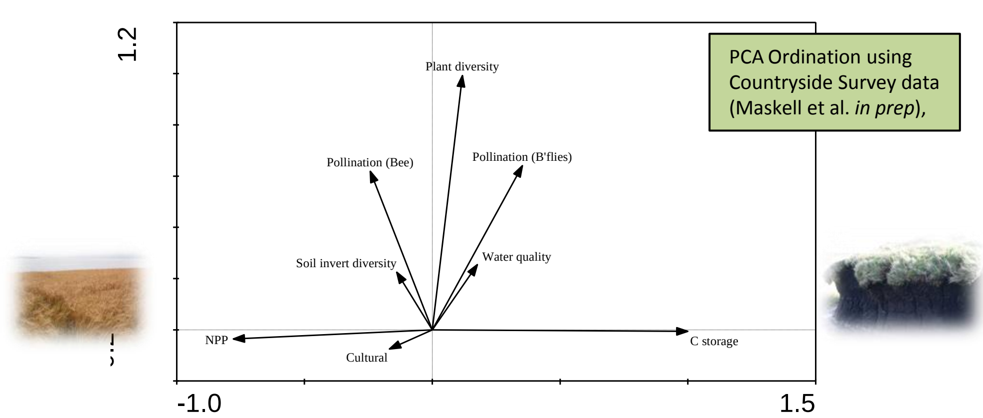
PROVISIONING

- Platform/Physical support
- Food supply
- Biomaterials (e.g. timber, fuel, fibre)
- Raw materials (e.g. sand/peat)
- Water storage
- Biodiversity and genetic resources
- Refugia (providing habitat for populations)

REGULATING

- Waste recycling & detoxification
- Water quality
- Water supply (including flood control)
- Climate/Gas (including Carbon storage)
- Biological control of pests & diseases
- Erosion control

MODELLING - Tradeoffs between Ecosystem Services



CAN MULTIFUNCTIONAL SOILS BE MAINTAINED AT THE LANDSCAPE-LEVEL?

- Biophysical measurements were translated to represent selected ecosystem services.
- Productivity and Carbon storage directly oppose one another along axis 1.
- Both plant and invertebrate diversity are correlated with Axis 2.

ISSUES

- General lack of quality data on soil organisms that underpin supporting, regulating and provisioning services for use in assessing status and trends.
- Limited mechanistic understanding of how the Natural Capital of different groups of soil organisms translates to Ecosystem Services.
- Complex relationships between soil organisms, processes, and services makes valuation of soil biodiversity difficult.

NEEDS

- Development of appropriate and harmonised monitoring of soil organisms including relevant indicators.
- Further meta-analyses and experimentation to better understand the shared and unique contributions of different groups of soil organisms to Ecosystem Services.
- Models that capture the complex relationships, trade-offs and scale-dependencies between soil and Ecosystem Services.

REFERENCES: Black et al. (2005) Defra Report No. SP0529; Haines-Young, Potschin & Cheshire(2006) Defining and identifying Environmental Limits for Sustainable Development. A Scoping Study. Final Overview to Defra, 44pp, Project Code NR0102; Haygarth & Ritz (2009) Land Use Policy26S: S187-S197; MA [Millenium Ecosystem Assessment] (2005) Ecosystems and Human Well-being: Synthesis; Robinson et al. (2009) Soil Science Society of America Journal 73: 1904-1911.

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