ARE BIOLOGICAL INDICATORS OF SOIL QUALITY RELIABLE ENOUGH FOR MONITORING?

H.I.J. Black[1], C.M. Cameron[1], C.D. Campbell[1], P.M. Chamberlain[2], R.E. Creamer[3], J.A. Harris[3], M. Pawlett[3], K. Ritz[3] and B.K. Singh[1]
[1]The Macaulay Land Use Research Institute, [2]CEH Lancaster, [3]Cranfield University

ISSUES

- Soil is fundamental to sustaining economic livelihoods, social well-being and environmental quality
- Governments are seeking reliable information to improve soil protection and environmental management policies and guidance
- National soil monitoring needs reliable indicators that can assess status and change in soil functioning across different land uses[1]

THE POTENTIAL OF SOIL BIOLOGICAL INDICATORS?

- Soil biological indicators could provide useful information on the status and dynamics of processes that underpin the soil functions.
- Outstanding questions over the reliability of these indicators in national-scale monitoring, for example:
  - *Does temporal variability in biological indicators confound responsiveness to distinct environmental pressures?*
  - *Are there characteristic land use responses in biological indicators at a national-scale?*
- In the Defra SQID project, we have been testing the responsiveness and reliability of a candidate set of soil biological indicators (Fig 1) across a range of spatial and temporal scales[2].

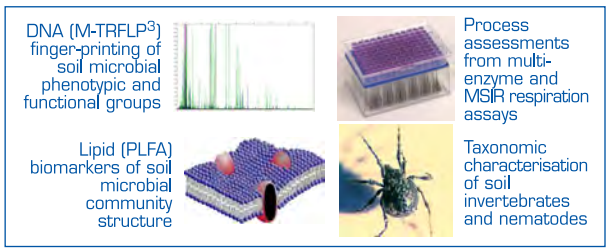

Fig 1. Characteristics of the candidate biological indicators of soil quality

RESULTS FROM TRIAL 1: SENSITIVITY TO ENVIRONMENTAL PRESSURES OVER TIME

- Bi-monthly sampling over 12 months at long-term experimental sites reflecting three pressures: heavy metals in sludge, atmospheric N deposition and land restoration (Fig 2).
- Significance of temporal variability determined in the responsiveness of each indicator to each pressure using single metrics (Fig 3) and multivariate analyses (Fig 4).

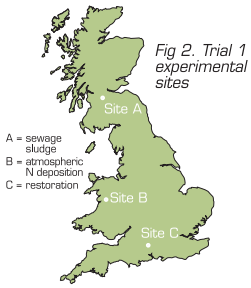

Fig 2. Trial 1 experimental sites

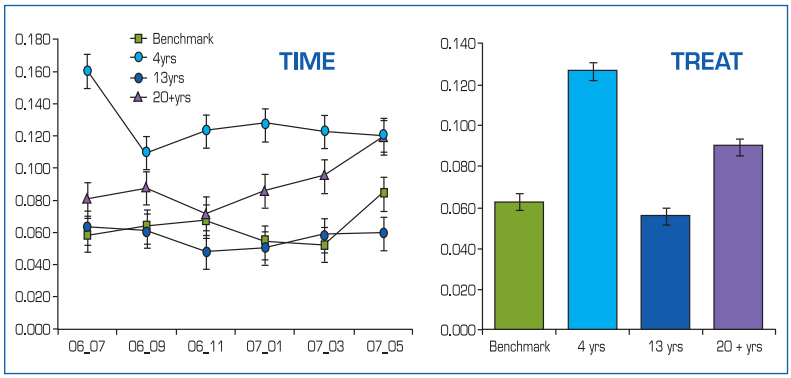

Fig 3. Responsiveness of PLFA derived bacterial-fungal ratio to restoration age

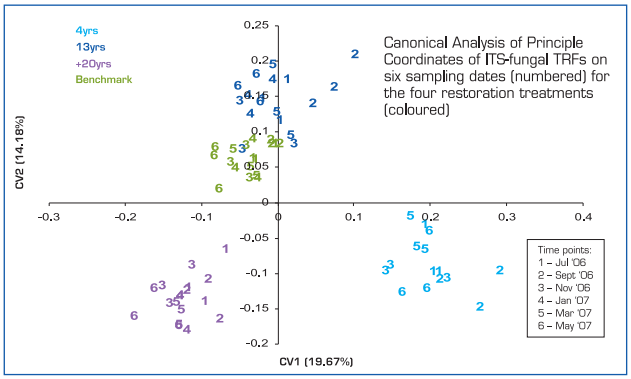

Fig 4. Response of the fungal community to different restoration ages

OUTCOMES SO FAR FROM THE SENSITIVITY TRIAL:

- Temporal dynamics can be significant but do not always interfere with the sensitivity of an indicator
  - Optimal sampling windows to maximise signal detection (spring?)
- Sensitivity to pressures varies with indicator type
  - Indicators for specific pressures?
- Sensitivity of an "indicator" varies with the metrics
  - Focus on defining an indicator using meaningful metrics

Indicator metric	Indicator method	sludge Zn heavy metals		atmospheric N deposition		restoration age	
		treat	time	treat	time	treat	time
bacterial community structure	M-TRFLP	Y	n	n	n	Y	n
fungal community structure	M-TRFLP	Y	n	n	n	Y	n
archaea	M-TRFLP	n	n	n	n	Y	n
total biomass	PLFA	n	n	n	n	n	n
bacteria:fungi ratio	PLFA	Y	Y	n	n	Y	n
enzymes	multienzyme assay	n	Y	n	Y	n	Y
MSIR	MicroResp	n	Y	Y	Y	Y	Y
nematodes (log n)	wet extract	n	Y	n	Y	Y	Y
collembola (%)	dry extract	n	n	Y	n	n	n
mites (%)	dry extract	n	n	Y	n	n	n

Table 1. Summary of temporal variability and responsiveness of indicator metrics. Y, ANOVA P<0.05; n, ANOVA P>0.05

Acknowledgements: This research is funded from Defra SQID projects (SP0529/SP0534). We would like to thank Adas Pwllpeiran/CEH Bangor and Didcot Power Station for access to their field sites.

References: [1]UK Soil Indicators Consortium: www.defra.gov.uk/Environment/land/soil/research/indicators/consortium/index.htm; [2]Black,Ritz,Campbell,Harris,Wood,Chamberlain,Parekh,Towers,Scott . SQID: Prioritising biological indicators of soil quality for deployment in a national-scale soil monitoring scheme: http://randd.defra.gov.uk/Document.aspx?Document=SP0529_7244_OTH.pdf. [3]Singh. Thomas. *Nature Protocols*, 2006, 1(5), 2428-2433.