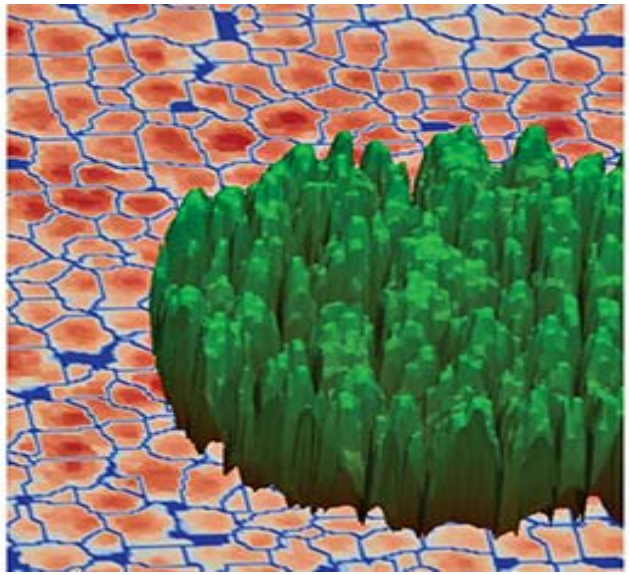
Growing confidence in forestry's future Research Programme

SCION
FORESTS | PRODUCTS | INNOVATION

A frame work for assessing the biological health of forest soils across New Zealand

Steve A Wakelin, Mathis Richard, Graham Coker, Simeon Smaill, Loretta Garrett, others….



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FOREST GROWERS RESEARCH

Overview

- What is meant by soil health.
- Why healthy soils are important.
- How we currently monitor soil health in New Zealand (**spoiler: no biology**!).
- What biology we could measure.
- Drivers to include biology in soil health monitoring / assessments.
- How we might approach doing this.
- It's the right time to begin.

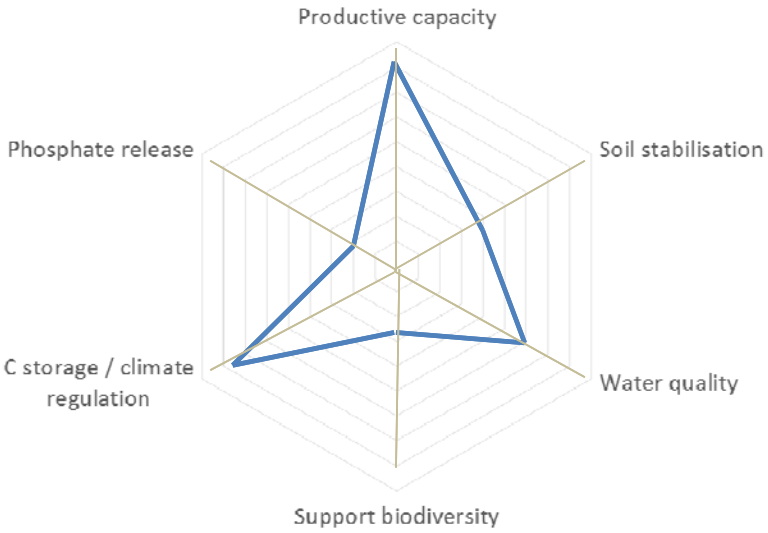
How <u>not</u> to assess soil health

What is meant by soil health?

Soil ‘health’ and ‘quality’ often used interchangeably

Myriad of definitions; many highly contextual to a single land-use or end-point ’ e.g.:

- Dairy: ability to grow lots of grass
- Sheep: steep land erosion control/stability
- Native: support endemic biodiversity & clean water



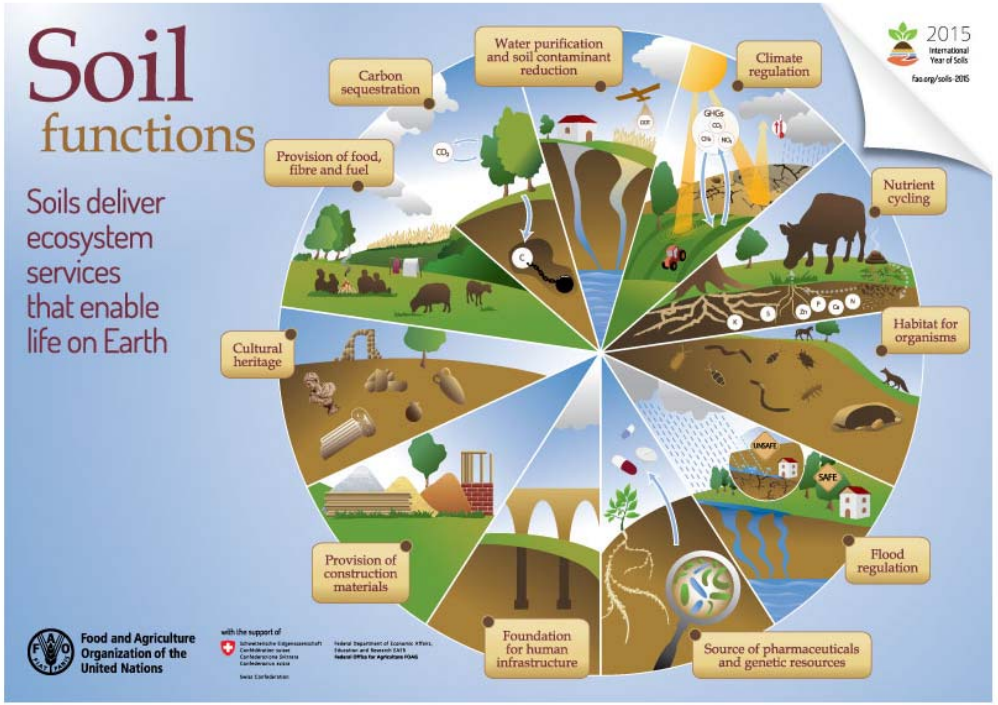
Broad definition often used:

Soil health is “*the continued capacity of soil to function as a vital living system, within ecosystem and land use boundaries, to sustain biological productivity, to promote the quality of air and water environments, and to maintain plant, animal, and human health*”.

Why are healthy soils important?

Ecosystem functions supported by forest soils:

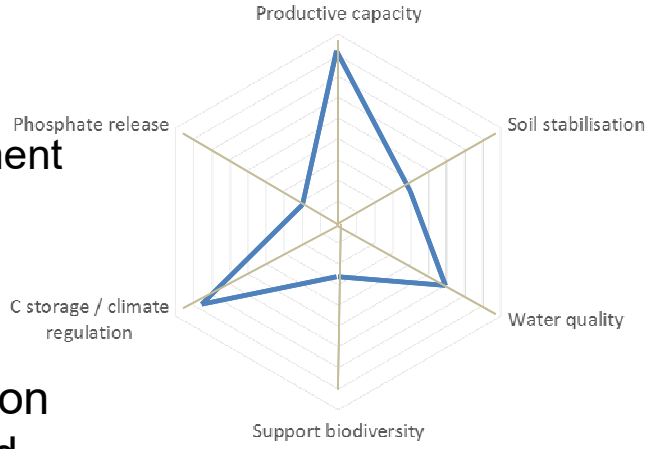
- Timber production (fiber, fuel, construction)
- Water quality
- Resistance to wind storms
- Erosion
- Carbon sequestration
- Supporting biodiversity – above and below ground
- Nutrient and energy regulation
- Food (plant products, fungi, etc)
- Source of new chemicals and reservoir of genetics
- Cultural



Demands and drivers on soils are varied and dynamic

In order to maintain collective ecosystem services, we need to understand how soils will respond to:

- Demands for production intensification.
- Transitioning between land uses conversion (billion trees etc).
- Different types of planted forestry: alternative species, altered management systems.
- Effects of climate change, including fire, heavy rain, drought.



When monitoring soils and soil functions: Integrate tree production and health, effects of management systems, influence of climate and variation, environmental pressures (e.g. N limits), and sociocultural needs.

How do we monitor soil health?

New Zealand is signatory to international conventions on environmental performance

Soil quality information is needed for reporting at national and regional levels (OECD, 1996; MFE 1997).

Legislative tool for environmental regulation is the RMA (NZ Govt, 1991):

- Administered across 17 autonomous Regional Authorities.
- Requires effects-based criteria to determine if a particular activity has a detrimental effect on the environment.
- **Does not specify properties to be monitored, nor provides an interpretative framework.**

Regional Authorities currently:

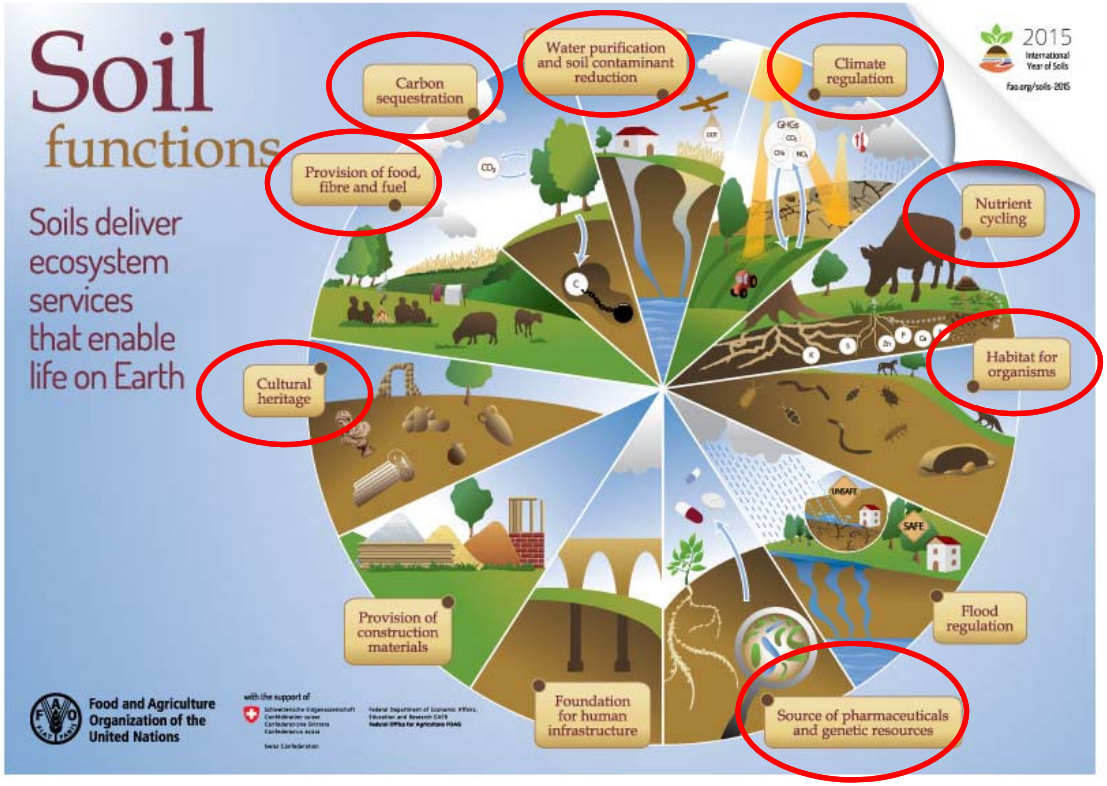
- Collect data from 500 soils across a range of physicochemical characteristics (pH, total C, total N, Olsen P, bulk density, macroporosity).
- This data gets used for State of the Environment reporting.

Complete absence of biological metrics in soil health/quality monitoring!

- Current monitoring (500 soils) only assesses chemical and physical properties of soils.

- **Yet most ecosystem services or attributes are:**
  - **Entirely biological in nature.**
  - **Strongly biologically mediated.**
  - **Occur through interaction of biology x environment x management.**

- Lack of biological data is recognized as a key gap in soil health/quality assessments nationally and internationally.
- Previously seen as too difficult to undertake or interpret the results.



No shortage of biological taxa we can measure…

Soil biodiversity

Archaea

Bacteria

Protists

Collembola

Protura

Diplura

Fungi

Lichens

Plants

Tardigrades

Formicidae (ants)

Termites

Isopoda

Myriapoda

Rotifers

Nematodes

Enchytraeids

Acari (mites)

Earthworms

Coleoptera (beetles)

Soil insect larvae

Ground and litter-dwelling macrofauna

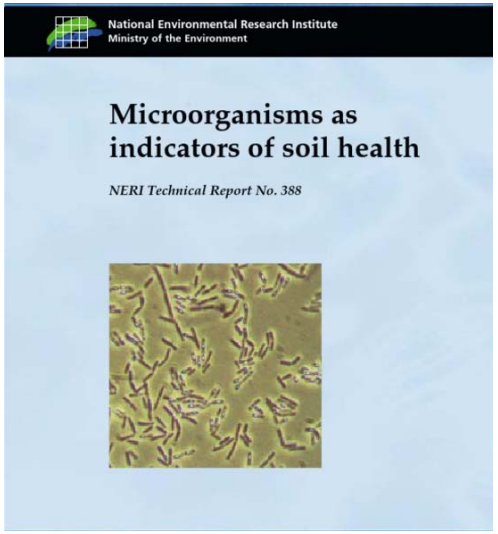
No shortage of biological functions we can measure…

Microbial respiration
Metabolic stress
Contaminant reduction
Ecophysiology
Mycorrhizal symbiosis
Decomposition
Enzymes
Phosphate mobilization
N-fixation
Microbial biomass
Soil carbon cycling
Degradation pathways
Stress and resilience
RNA / gene expression

>150 endpoints

Well described.

Standard methods.

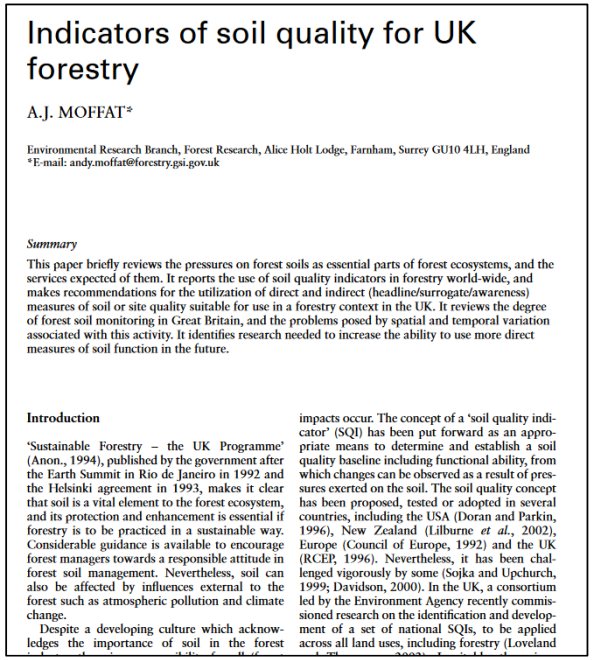


It is happening overseas…

Fundamental importance of soil biology and activity in ecosystem function is driving efforts to include biology-based metrics into soil quality testing. UK, OECD, EU, US…

Provisions for environmental benchmarks are also an increasingly important component of bi- and multilateral trade deals (MFE, 2016).

Overseas trade and market access will pull us towards delivering these.



Indicators of soil quality for UK forestry

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Summary

This paper briefly reviews the pressures on forest soils as essential parts of forest ecosystems, and the services expected of them. It reports the use of soil quality indicators in forestry world-wide, and makes recommendations for the utilization of direct and indirect (headline/surrogate/awareness) measures of soil or site quality suitable for use in a forestry context in the UK. It reviews the degree of forest soil monitoring in Great Britain, and the problems posed by spatial and temporal variation associated with this activity. It identifies research needed to increase the ability to use more direct measures of soil function in the future.

Introduction

'Sustainable Forestry – the UK Programme' (Anon., 1994), published by the government after the Earth Summit in Rio de Janeiro in 1992 and the Helsinki agreement in 1993, makes it clear that soil is a vital element to the forest ecosystem, and its protection and enhancement is essential if forestry is to be practiced in a sustainable way. Considerable guidance is available to encourage forest managers towards a responsible attitude in forest soil management. Nevertheless, soil can also be affected by influences external to the forest such as atmospheric pollution and climate change.

Despite a developing culture which acknowledges the importance of soil in the forest

impacts occur. The concept of a 'soil quality indicator' (SQI) has been put forward as an appropriate means to determine and establish a soil quality baseline including functional ability, from which changes can be observed as a result of pressures exerted on the soil. The soil quality concept has been proposed, tested or adopted in several countries, including the USA (Doran and Parkin, 1996), New Zealand (Lilburne *et al.*, 2002), Europe (Council of Europe, 1992) and the UK (RCEP, 1996). Nevertheless, it has been challenged vigorously by some (Sojka and Upchurch, 1999; Davidson, 2000). In the UK, a consortium led by the Environment Agency recently commissioned research on the identification and development of a set of national SQIs, to be applied across all land uses, including forestry (Loveland

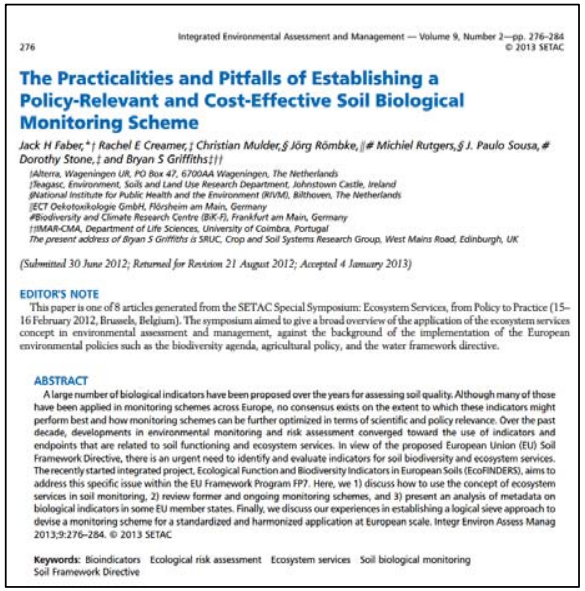
Technical Report - 2010 - 049

Soil biodiversity: functions, threats and tools for policy makers

February 2010

EUROPEAN COMMISSION

environment



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The Practicalities and Pitfalls of Establishing a Policy-Relevant and Cost-Effective Soil Biological Monitoring Scheme

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(Submitted 30 June 2012; Returned for Revision 21 August 2012; Accepted 4 January 2013)

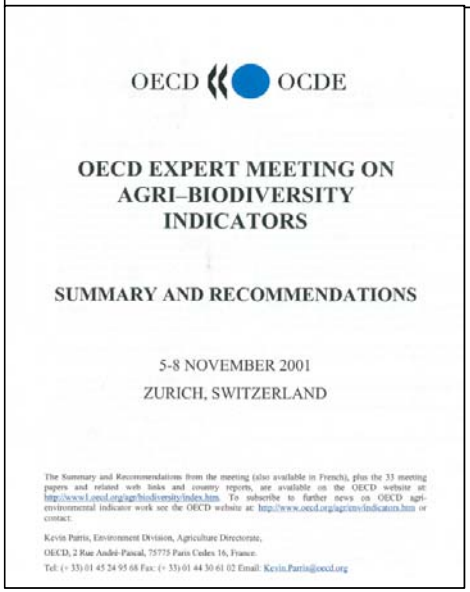
EDITOR'S NOTE

This paper is one of 8 articles generated from the SETAC Special Symposium: Ecosystem Services, from Policy to Practice (15–16 February 2012, Brussels, Belgium). The symposium aimed to give a broad overview of the application of the ecosystem services concept in environmental assessment and management, against the background of the implementation of the European environmental policies such as the biodiversity agenda, agricultural policy, and the water framework directive.

ABSTRACT

A large number of biological indicators have been proposed over the years for assessing soil quality. Although many of those have been applied in monitoring schemes across Europe, no consensus exists on the extent to which these indicators might perform best and how monitoring schemes can be further optimized in terms of scientific and policy relevance. Over the past decade, developments in environmental monitoring and risk assessment converged toward the use of indicators and endpoints that are related to soil functioning and ecosystem services. In view of the proposed European Union (EU) Soil Framework Directive, there is an urgent need to identify and evaluate indicators for soil biodiversity and ecosystem services. The recently started integrated project, Ecological Function and Biodiversity Indicators in European Soils (EcoFINDERS), aims to address this specific issue within the EU Framework Program FP7. Here, we 1) discuss how to use the concept of ecosystem services in soil monitoring, 2) review former and ongoing monitoring schemes, and 3) present an analysis of metadata on biological indicators in some EU member states. Finally, we discuss our experiences in establishing a logical sieve approach to devise a monitoring scheme for a standardized and harmonized application at European scale. Integr Environ Assess Manag 2013;9:276–284. © 2013 SETAC

Keywords: Bioindicators Ecological risk assessment Ecosystem services Soil biological monitoring Soil Framework Directive



OECD OCDE

OECD EXPERT MEETING ON AGRI–BIODIVERSITY INDICATORS

SUMMARY AND RECOMMENDATIONS

5-8 NOVEMBER 2001

ZURICH, SWITZERLAND

The Summary and Recommendations from the meeting (also available in French), plus the 33 meeting papers and related web links and country reports, are available on the OECD website at: http://www1.oecd.org/agr/biodiversity/index.htm. To subscribe to further news on OECD agri-environmental indicator work see the OECD website at: http://www.oecd.org/agr/env/indicators.htm or contact:

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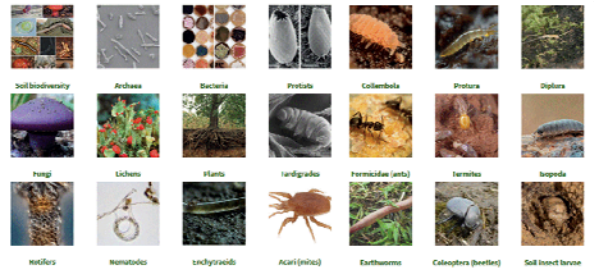
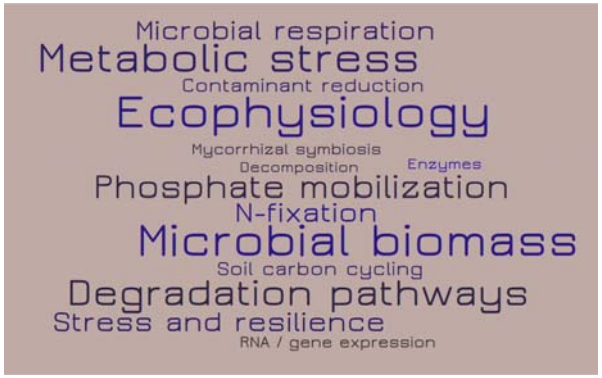
Building biology into soil health measurements in NZ

- ***Question 1: Who, and for what purpose, are we doing this?***
  - **Who**: Maori, customers of wood and forest products here and overseas, forest owners in NZ, recreational users, etc.
    - different agents may put different weight on different metrics → from productive, to sustainability, to cultural, and biodiversity.
  - **Purpose**:
    - Comparing among land use types in NZ? Forestry v dairy v native v …?
    - Monitoring planted forests over time and management x environment x tree effects?
    - Protecting and opening markets by aligning measurement with international environmental reporting standards (international comparability)?

Building biology into soil health measurements in NZ

- *Question 1: Who and for what purpose are we doing this?*
- ***Question 2: How do we decide what to measure?***
  - As well as identifying the ‘metrics’, need to consider:
    - Cost
    - Scalability (throughput)
    - Reproducibility
    - Sensitivity/responsiveness to purpose of application
    - Technological readiness
    - Ease-of-use
    - Policy readiness
    - Standardization
    - Infrastructure availability.





‘meaningfulness’, and
‘understadabilitiy’ by end-users

Building biology into soil health measurements in NZ

- *Question 1: Who and for what purpose are we doing this?*
- *Question 2: How do we decide what to measure?*
- ***Question 3: Testing, validation, deployment.***
  - The testing framework/infrastructure is likely in place
  - Accelerator trials, LTSP series, new forest trials, and many others.
  - Some aspects of soil biology are already being assessed within these trials.
    - In particular, temporal information is essential, preferably over rotation(s).
    - Metrics can be of low value if not integrated with productivity data and measures of other ecosystem services.
  - Excellent opportunity to build on existing investment in trial networks and scheduled analysis.

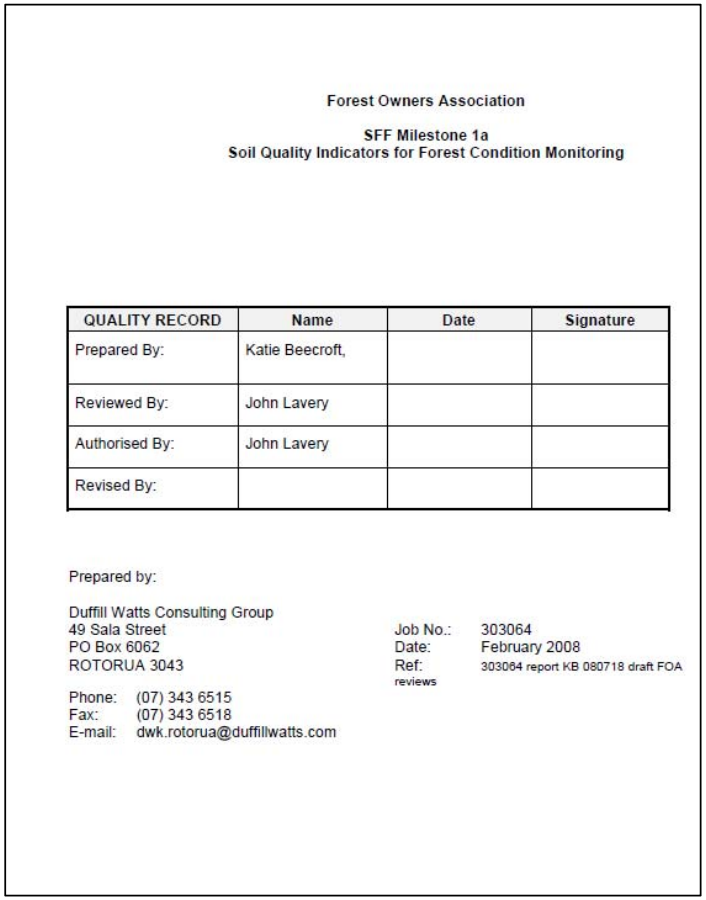
SFF Milestone 1a: Soil Quality Indicators For Forest Condition Monitoring (2008)

Soil biological parameters:

- ✓ Early and sensitive indicators of soil quality change.
- ✓ Biological indices yield evidence of how a soil functions and interacts with plants, animals, and the climate that comprise ecosystems.

However:

- × Interpretation of biological effects on forest condition and sustainability is not well developed.
- × Testing for most indicators is laborious and expensive.
- × These suggest <u>they are not suitable for long-term SQI for forest soils.</u>



Forest Owners Association

SFF Milestone 1a
Soil Quality Indicators for Forest Condition Monitoring

QUALITY RECORD	Name	Date	Signature
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Reviewed By:	John Lavery		
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Job No.: 303064
Date: February 2008
Ref: 303064 report KB 080718 draft FOA reviews

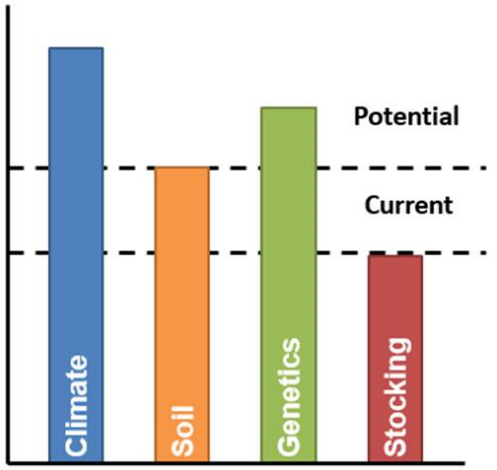
A decade later

Soil biological parameters:

- ✓ Early and sensitive indicators of soil quality change.
- ✓ Biological indices yield evidence of how a soil functions and interacts with plants, animals, and the climate that comprise ecosystems.

In addition:

- ✓ International drivers to include soil biology as part of environmental reporting, SLO, stewardship etc.
- ✓ Improving soil biological resources, from nursery to forest, is one key to improve site ‘potential’.
- ✓ Managing soil biological resources can enhance delivery of ecosystem services.
- ✓ Testing is increasingly rapid and cost effective.
- ✓ It is timely and imperative we include biological indices in forest soil quality monitoring.
- ✓ If we don’t develop fit-for-purpose indices, we may be given ones from overseas, or for different sectors, that aren’t useful.



Mathis Richard:

- AGROSUP DIJON, France
- 20 week internship
- Mission:
  1. Define and engage with stakeholders, partners, and end-users (agents)
  2. Identify key outputs for biological indicators for different agents
  3. Determine which indicators align to the outputs
  4. Rank indicators for cost, scalability, understandability, etc.

Survey will be used to canvas YOU for your thoughts. If you want to opt-out, please let myself, Annette or someone else know. Otherwise, we have your email address…..

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11th April, 2018

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