Soil Biodiversity in California Agriculture: Framework and Indicators for Soil Health

Legislative Briefing, Sacramento December 8th, 2023

Dr. Margaret Smith-Kopperl, Manager, Lockeford Plant Materials Center, Natural Resources Conservation Service, U.S. Department of Agriculture USDA-NRCS

Dr. Eoin Brodie, Associate Adjunct Professor and Deputy Director of Climate and Ecosystem Sciences, Lawrence Berkeley National Lab, UC Berkeley

Dr. Daniel Rath, Soil Scientist, Natural Resources Defense Council and Researcher, UC Davis

Soil Biodiversity in California Agriculture:

Framework and Indicators for Soil Health Assessment

Prepared by:

California Department of Food and Agriculture Belowground Biodiversity Advisory Committee

July 2023





Biodiversity Definition

"The variety of life belowground, from genes and species to the communities they form, as well as the ecological complexes to which they contribute and to which they belong, from soil micro-habitats to landscapes " (UN FAO) Soils contain up to 60% of the planet's biodiversity¹

¹Anthony, M.A., Bender, S.F. and van der Heijden, M.G., 2023. Enumerating soil biodiversity. *Proceedings of the National Academy of Sciences of the United States of America*, *120*(33), pp.e2304663120e2304663120.





Soil Biodiversity is one of the main drivers behind the functioning of terrestrial ecosystems

Life in soil exists across a vast range of sizes....







.... each contributing to important soil functions

These organisms do not exist in isolation...



...they work together as part of an interdependent network

This biodiversity is under threat



Soil Health & Biodiversity - Protect the living network



Healthy soils function as a vital **living ecosystem**

that sustains plants, animals, and humans.

Benefits for Agriculture

- Increased water-holding capacity
- Increased infiltration
- Decreased erosion
- Potential for increased organic matter and carbon storage
- Reduce nutrient run-off and greenhouse gas emissions
- Pest and disease suppression



California Department of Food and Agriculture Belowground Biodiversity Advisory Committee (BBAC)

Mandate:



Executive Order (EO) N-82-20 direction to CDFA "...advance <u>efforts to conserve biodiversity</u> ...with existing authority and resources... to enhance soil health and biodiversity".

BBAC Goals:

- Identify biodiversity indicators relevant to soil health in agroecosystems
- Develop a framework and provide example CA-based case studies to assist in biodiversity indicator selection.
- Provide recommendations and identify opportunities for collaboration, outreach and future



DR. KATE SCOW Distinguished Professor of Soil Science and icrobial Ecology, UC Davis



DR. EOIN BRODIE

Associate Adjunct Professor And Deputy Director Of Climate And Ecosystem Sciences Division, Lawrence Berkeley National Lab, UC Berkelev



DR. MARGARET **SMITHER-KOPPERL** Manager Lockeford PlantMaterials Center, Natural ResourcesConservation Service, U.S. Departmenbf Agriculture



DR. HOWARD FERRIS Distinguished Professor Emeritus of Nematology, Department of Entomology and Nematology, UC Davis

DR. TIM BOWLES Assistant Professor of groecology and Sustainable Agricultural Systems, Co-Associate Director of the Berkeley Food Institute, UC Berkeley

Belowground **Biodiversity Advisory Committee Members**



DR. STEVEN FONTE

Professor for the Department of Soil and Crop Sciences, Colorado State University

DR. DANIEL RATH

Soil Scientist, Natural Resources Defense Council Research Affiliate, UC Davis

DR. AIDEE GUZMAN

National Science Foundation and UC Chancellor's Postdoctoral Fellow. Department of Ecology and Evolutionary Biology, UC Irvine

DR. JENNIFER PETT-RIDGE

Distinguished Member of Technical Staff, Lawrence Livermore National Lab, Adjunct Full Professor, UC Merced



DR. AMÉLIE GAUDIN

Associate Professor, Endowed Chair in Agroecology, Department of Plant Sciences, UC Davis

DR. CRISTINA LAZCANO

Assistant Professor of Soils and Plant Nutrition, Soil Biodiversity and Health Lab, Department of Land, Air and Water Resources, UC Davis



DR. AMANDA HODSON

Assistant Professor, Entomology and Nematology, UC Davis



DR. JAVIER CEJA NAVARRO

Associate Professor, Department of **Biological Sciences and Center for** Ecosystem Science and Society, Northern Arizona University

DR. KABIR G PEAY

Associate Professor of Biology and Senior Fellow at the Woods Institute for the Environment. Stanford University











Figure 4.2. Categories of biodiversity indicators in soil ecosystems. Under each indicator category are listed some examples of methods (marked as bullets) used to measure these indicators.

How do we measure soil biodiversity?

Indicators!

- How many living organisms are present?
- Who are they?
- What functions do they contribute?
- How do they work together to influence the function of soils?
- What are the outcomes of their work?



We developed criteria for selecting the most appropriate biodiversity indicators

CORE CRITERIA OF A USEFUL INDICATOR

Four fundamental criteria emerge. An indicator should be:

- 1. Meaningful and targeted to the goal(s) of the assessment,
- 2. Relevant to the scale and biology of the organisms,
- 3. Feasible to measure and easy to interpret at both scientific and policy levels, and
- 4. Have an established and standardized sampling plan and/or methodology.

- Only measure biodiversity indicators that are most relevant for a use-case
 - o all organisms, or just key species
 - key processes that those species perform - e.g., nitrogen fixation

- Should be quantitative but also practical, affordable, and the data should be actionable
- Methods of sampling, measurement and data analysis need to be standardized so comparisons can be made and lessons learned

One size does NOT fit all: A <u>Framework</u> is needed to select biodiversity indicators.

Need for Framework

- Hard to identify
 indicators without
 defining why and how
 they will be measured
 and used
- 2) #1 requires input from multiple stakeholders, (Growers, NGOs, tribal members, State officials, academia, and others)

Framework for Indicator Selection

Part 1

a. Define problem being addressed
b. Identify goals of assessment
c. Identify intended audience
Part 2
d. Convene experts to apply criteria to

potential indicators

e. Evaluate and arrive at final indicator selection for a use-case

Output: Selected indicators for application

We developed a template to facilitate these convserations and biodiversity indicator selection



Four example scenarios or "use cases" for soil biodiversity assessment

- **1. General assessment of California soil biodiversity**: Creating an inventory of California state biodiversity under different land uses, including agriculture.
- 1. Assess impacts of the CDFA Healthy Soils Program (HSP) on soil biodiversity: Monitoring soil biodiversity as part of the HSP.
- Assist growers to manage the functions of healthy soils: Providing information that supports adaptive management for growers and ranchers.
- **1.** Enliven soil biodiversity for growers, gardeners, ranchers, and consumers: Engaging the general public on soil biodiversity.

Case Study: How do we better manage N in soils?

Problem:

How to manage N more efficiently in healthy soils?

Goal: Adjust N

management to meet crop needs while reducing losses

Audience:

Growers, TA providers, land managers

Recommendations: Measure amount of N cycling microbes and N flux



Recommendations

Invest in Soil Biodiversity as a metric in CA's Climate and Sustainability Goals and the Healthy Soils Program

Soil Biodiversity in California Agriculture:

Framework and Indicators for Soil Health Assessment

Prepared by:

California Department of Food and Agriculture Belowground Biodiversity Advisory Committee

July 2023





THE OFFICE OF ENVIRONMENTAL FARMING & INNOVATION



Continue to refine the method of selecting and interpreting soil biodiversity indicators

Summary of the ISF Process

Part 1

- a. Define problem being addressed
- b. Identify goals of assessment
- c. Identify intended audience

Part 2

- d. Convene experts to apply criteria to potential indicators
- e. Evaluate and arrive at final indicator selection

Output: Selected indicators and application





Stakeholder listening sessions



Field trials and demonstration projects

Use biodiversity data to refine management

Develop regional, statewide and global partnerships to promote California soil biodiversity



Build state capacity (public and private) to analyze and interpret soil biodiversity







The California State University



BERKELEY LAB

Lawrence Livermore National Laboratory



NATURAL

AGENCY

RESOURCES

California is on the frontier of soil biodiversity in the US

California Senate Bill 859 (Prior Session Legislation)

CA State Legislature page for SB859

Bill Title: Public resources: greenhouse gas emissions and biomass.

Spectrum: Unknown

Status: (Passed) 2016-09-14 - Chaptered by Secretary of State. Chapter 368, Statutes of 2016. [SB859 Detail]

2016

SB-859 established the Healthy Soils Program *** 2024 ?**

Questions?



https://www.cdfa.ca.gov/oefi/biodiversit y/docs/Soil_Biodiversity_California_Ag_Ju ly_2023.pdf

Contact information: <u>margaret.smither-</u> <u>kopperl@usda.gov</u> <u>elbrodie@lbl.gov</u> <u>drath@nrdc.org</u>

Soil Biodiversity in California Agriculture:

Framework and Indicators for Soil Health Assessment

Prepared by:

California Department of Food and Agriculture Belowground Biodiversity Advisory Committee

July 2023

