Pacific Northwest
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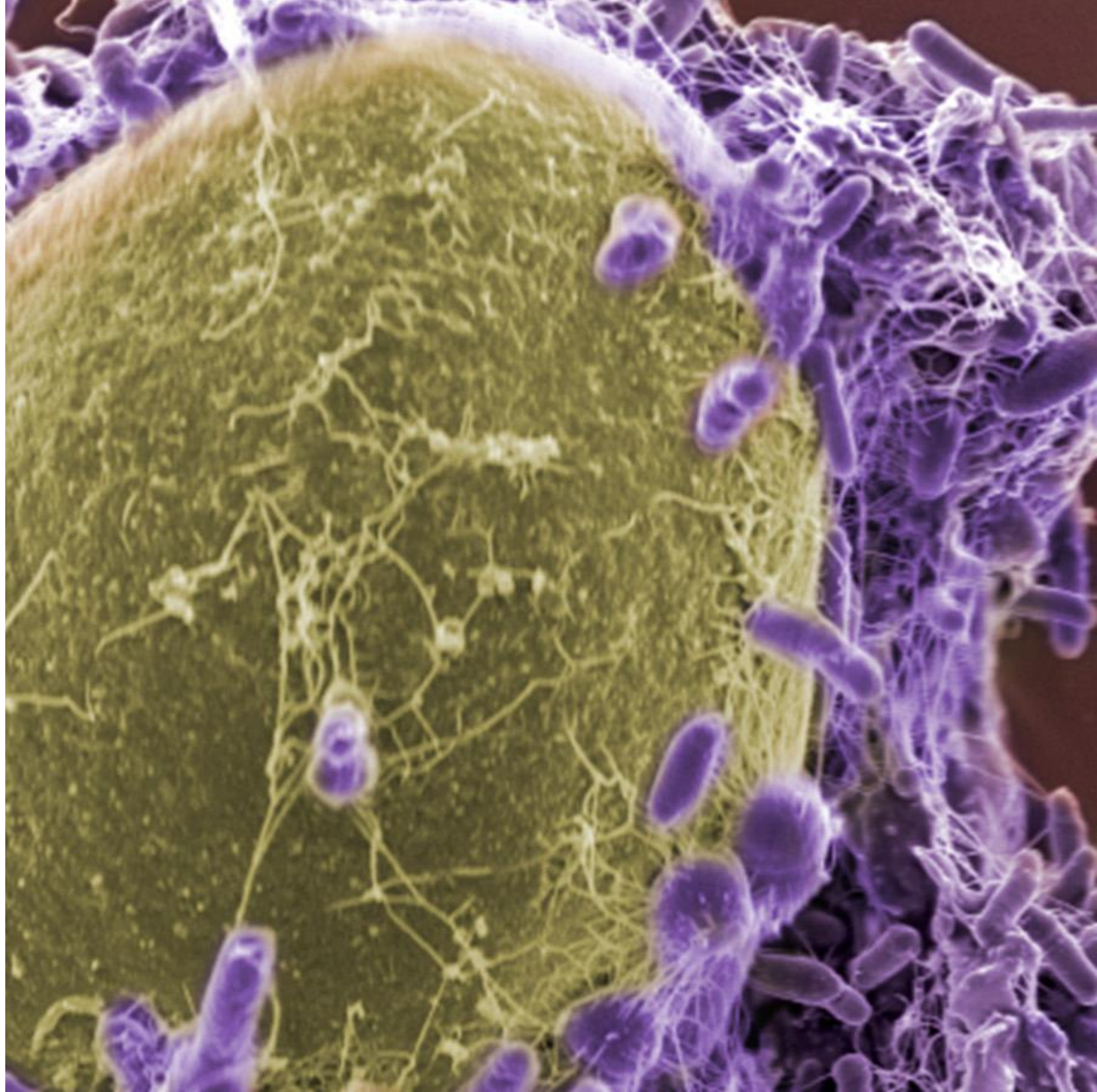
Soils are Alive!

Dr. Aditi Sengupta

Postdoctorate Researcher

Ecosystem Science

Pacific Northwest National Laboratory



U.S. DEPARTMENT OF ENERGY BATTELLE

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https://www.surveymonkey.com/r/PNNL060920

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1 of 17

U.S. Department Of Energy Labs

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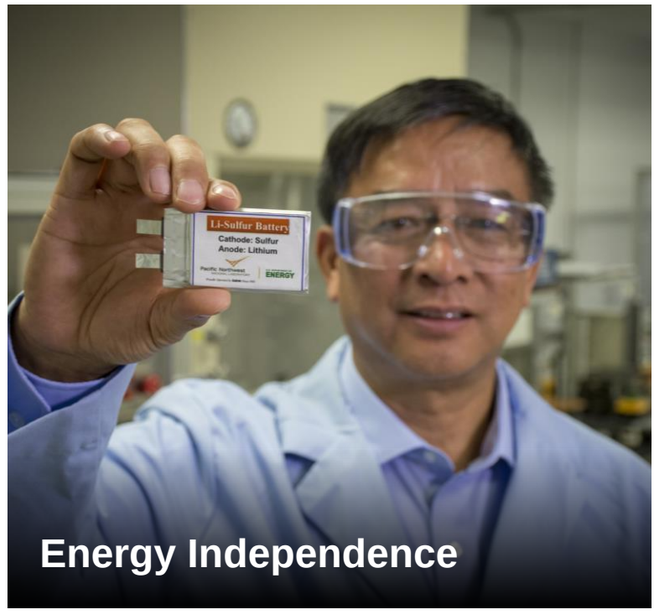
PNNL is Focused on **DOE's MISSIONS** and Addressing Critical **NATIONAL NEEDS**

Scientific Discovery



Energy Independence


National Security

Environmental Management

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PNNL is an
ECONOMIC ENGINE

4,722
Employees

265
Inventions

$1.46B
Total Economic Output

$1.01B
Annual Spending

88
Patents

7,180
Jobs Generated
in Washington

$465M
Total Payroll

34
Licenses

193
Companies
with PNNL Roots

Pacific Northwest
NATIONAL LABORATORY

50+ Years

Developing Goodwill

Decades **$28.5M**

FY19 **$0.52M**

Philanthropic Investments

347,000

30,000

Team Battelle Volunteer Hours

>120

56

Community Organizations

About me

This Photo by Unknown Author is licensed under CC BY-SA

- Bachelor of Science (Biochemistry)
- Master of Science (Environmental Studies)
- Doctor of Philosophy (Environment and Natural Resources with specialization in Soil Science)

Soils is not dirt!

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Soil is **NOT** dirt!

Dirt is what gets on our clothes and under our fingernails!

What is soil?

The thin layer of mineral or organic matter on the surface of the Earth

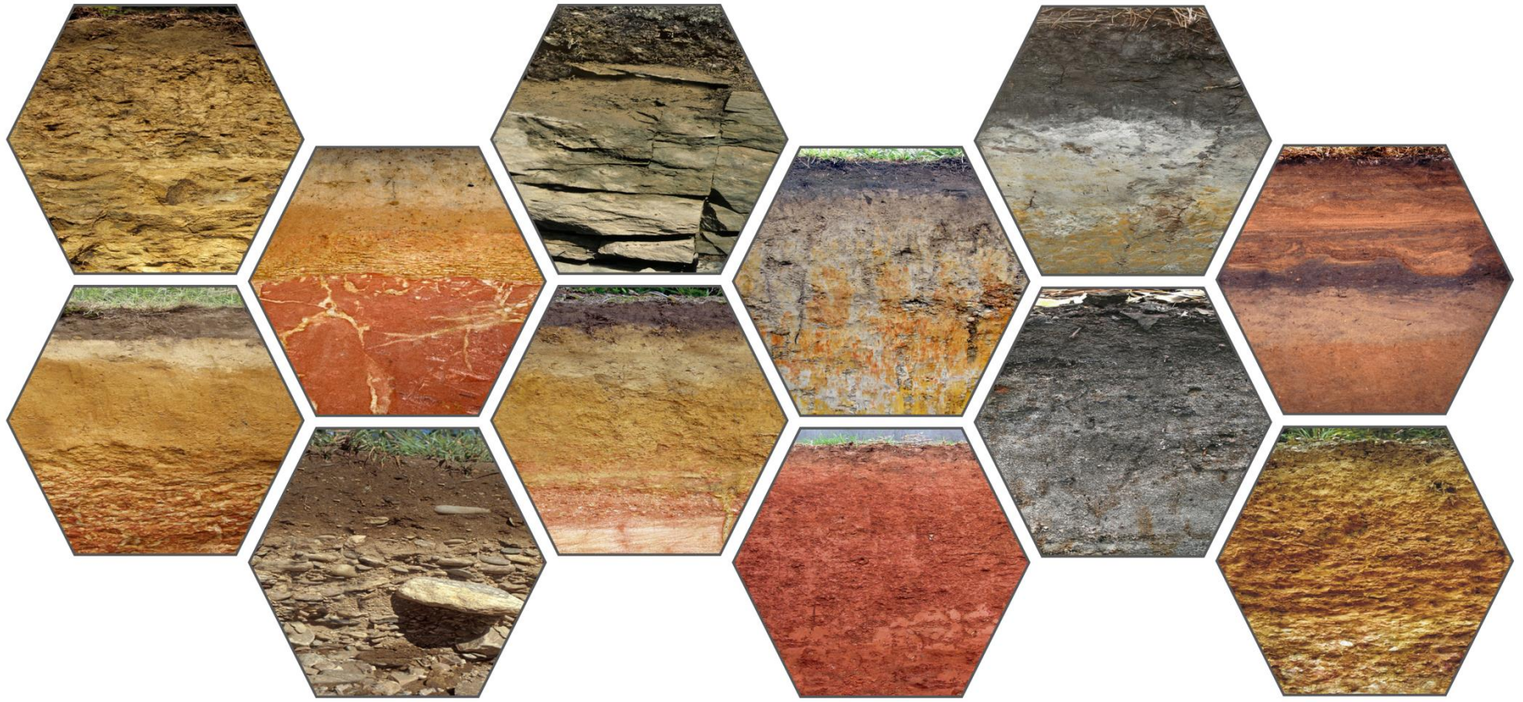
Climate

Organism

Topography

Parent Material

Time



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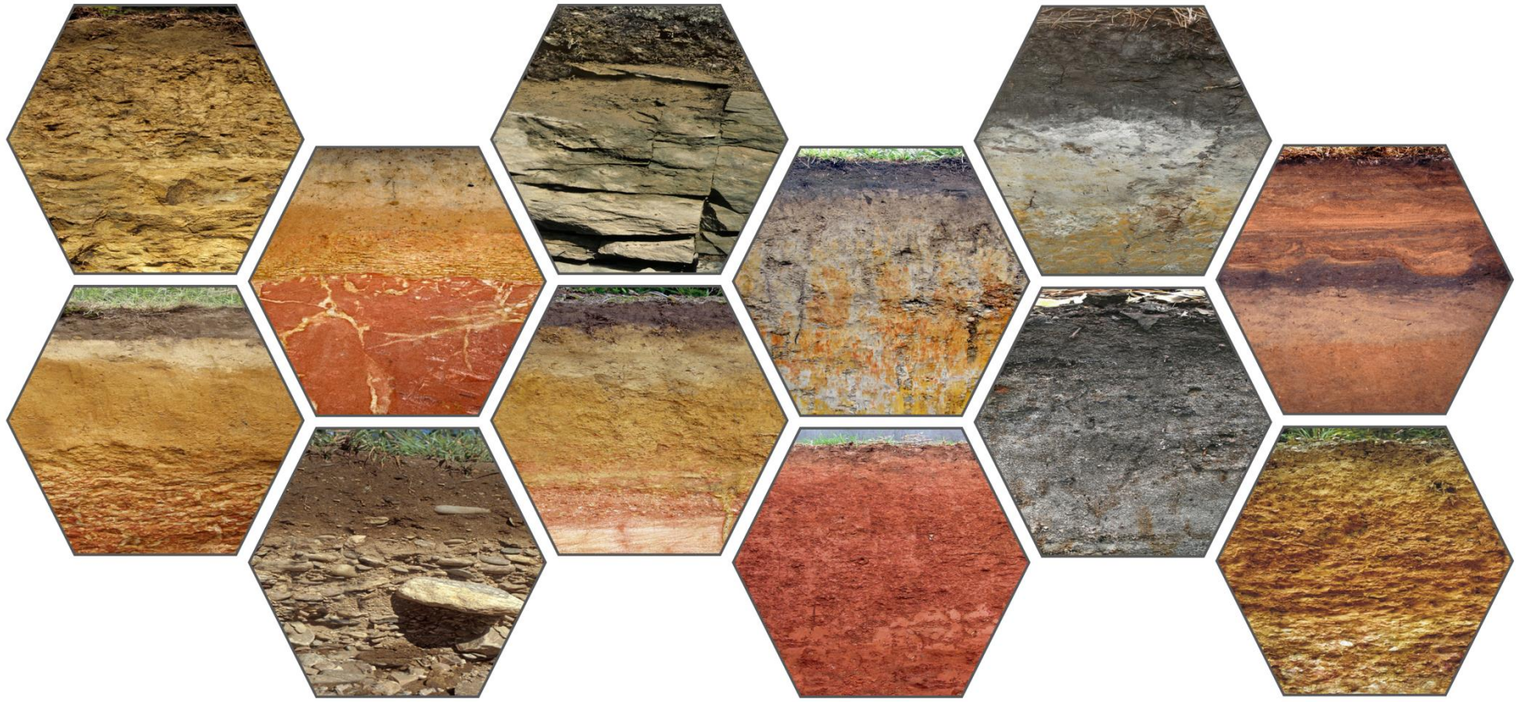
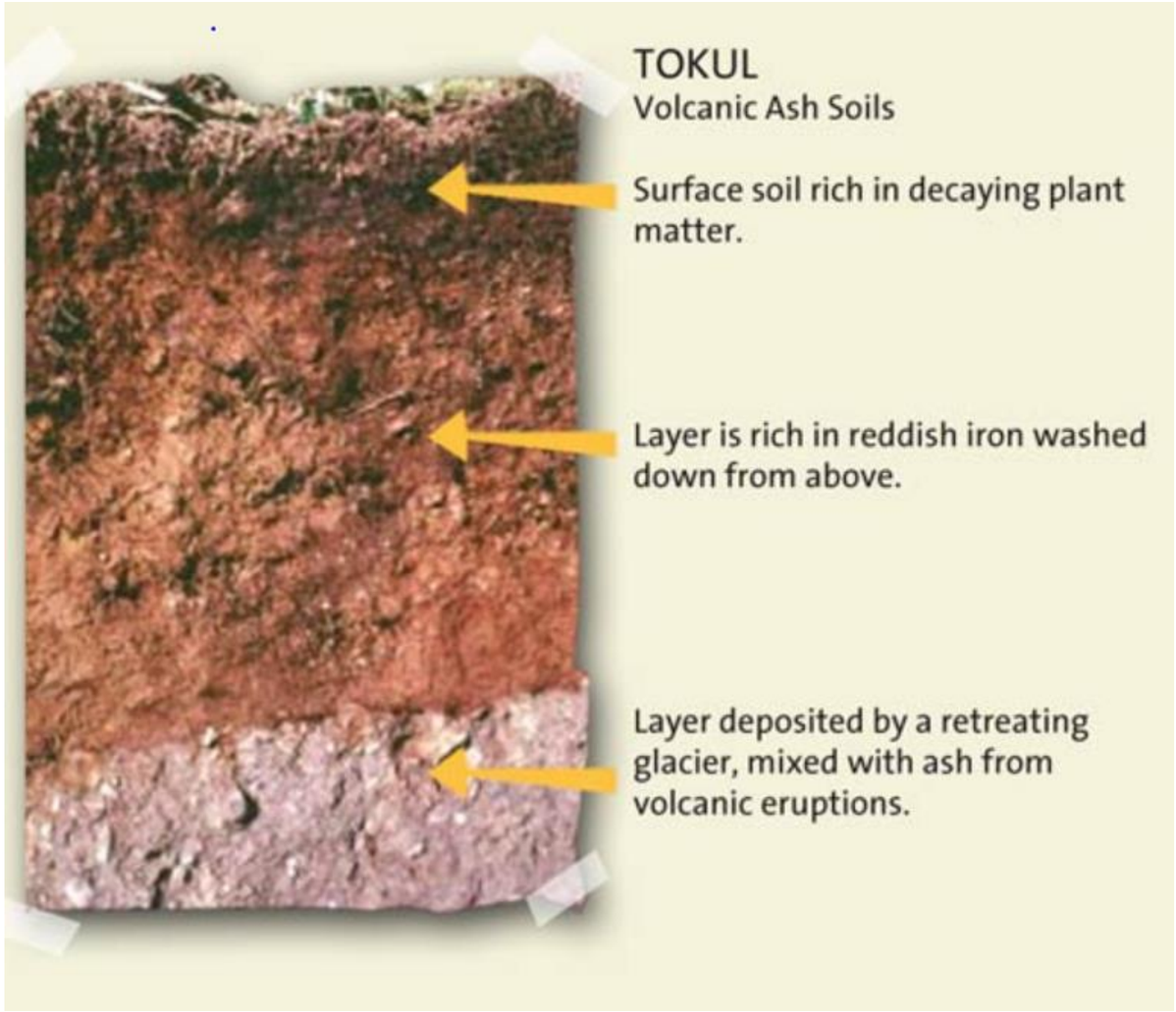


Soil Genesis

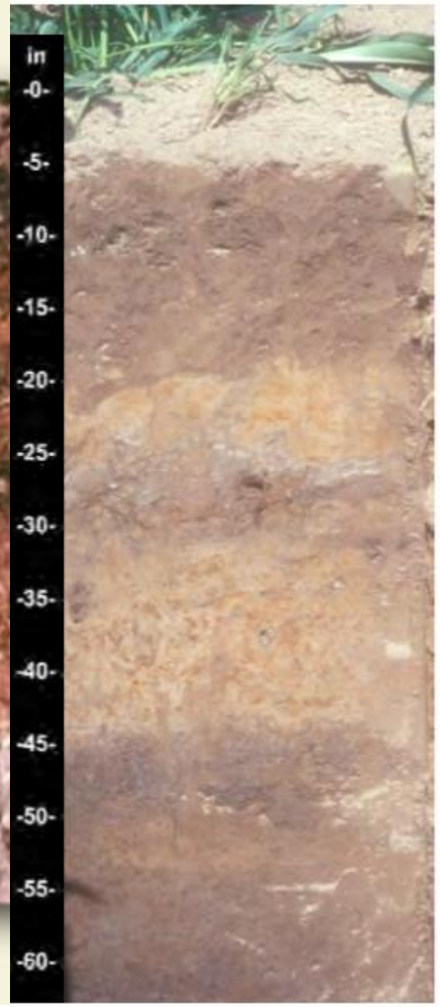
Soils of Washington



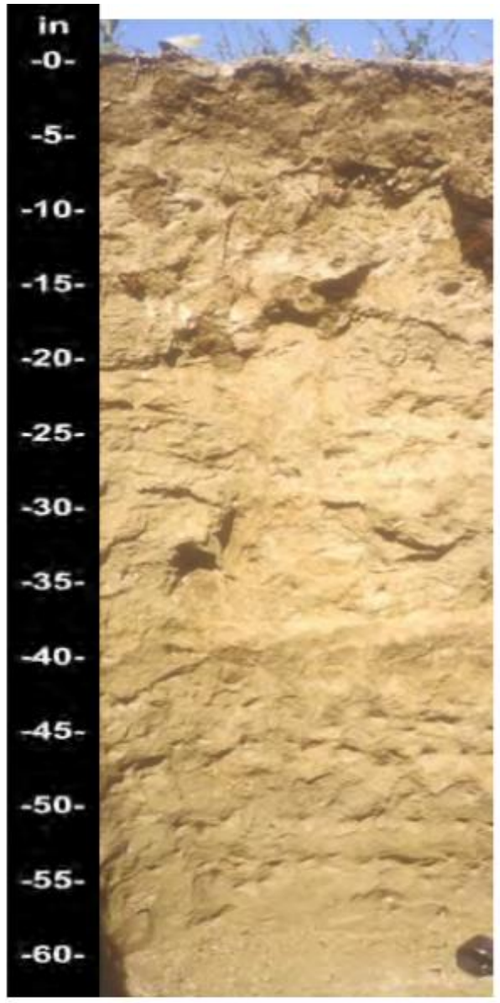
Snohomish County

Soils of Washington

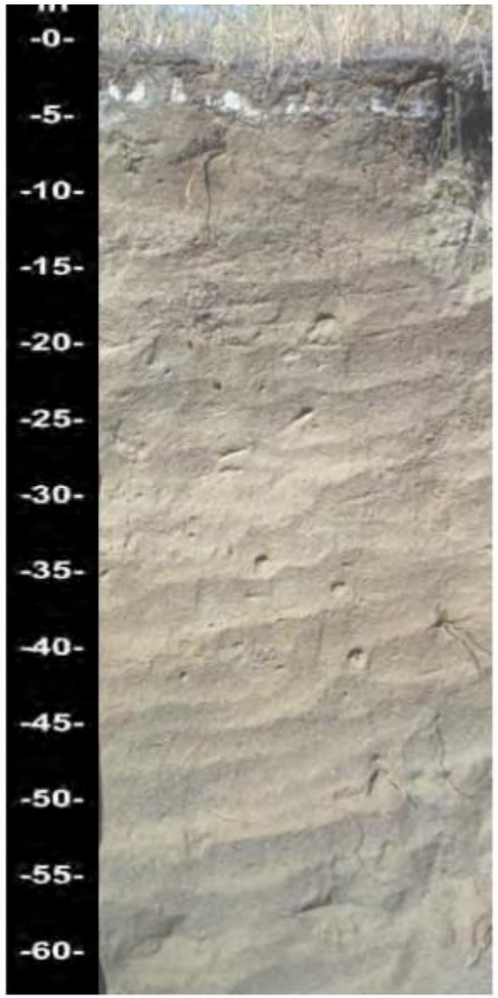
Tokul, Snohomish



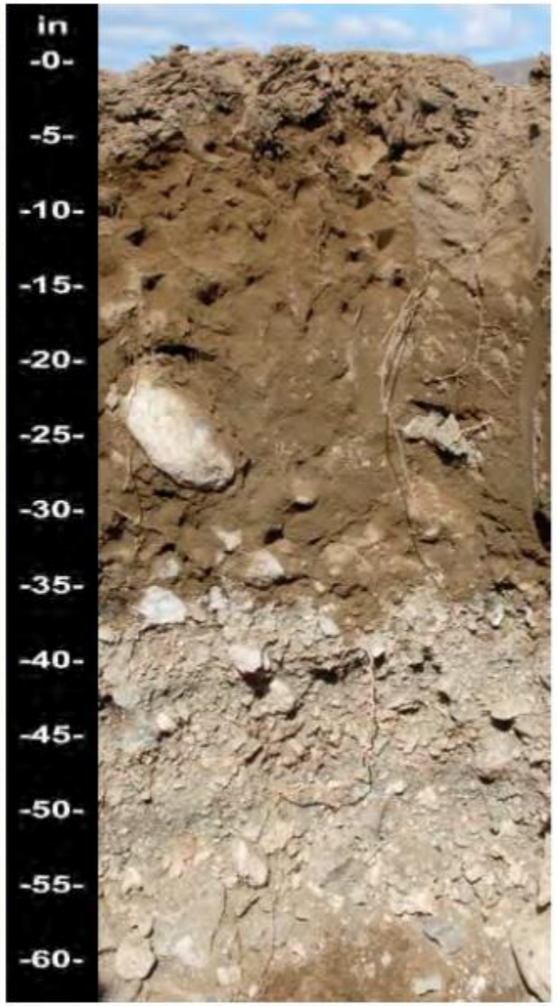
Caples, Cowlitz



Cedonia, (Ferry, Spokane, Stevens)



Quincy, Benton



Scooteney, Benton

Soils provide critical ecosystem services

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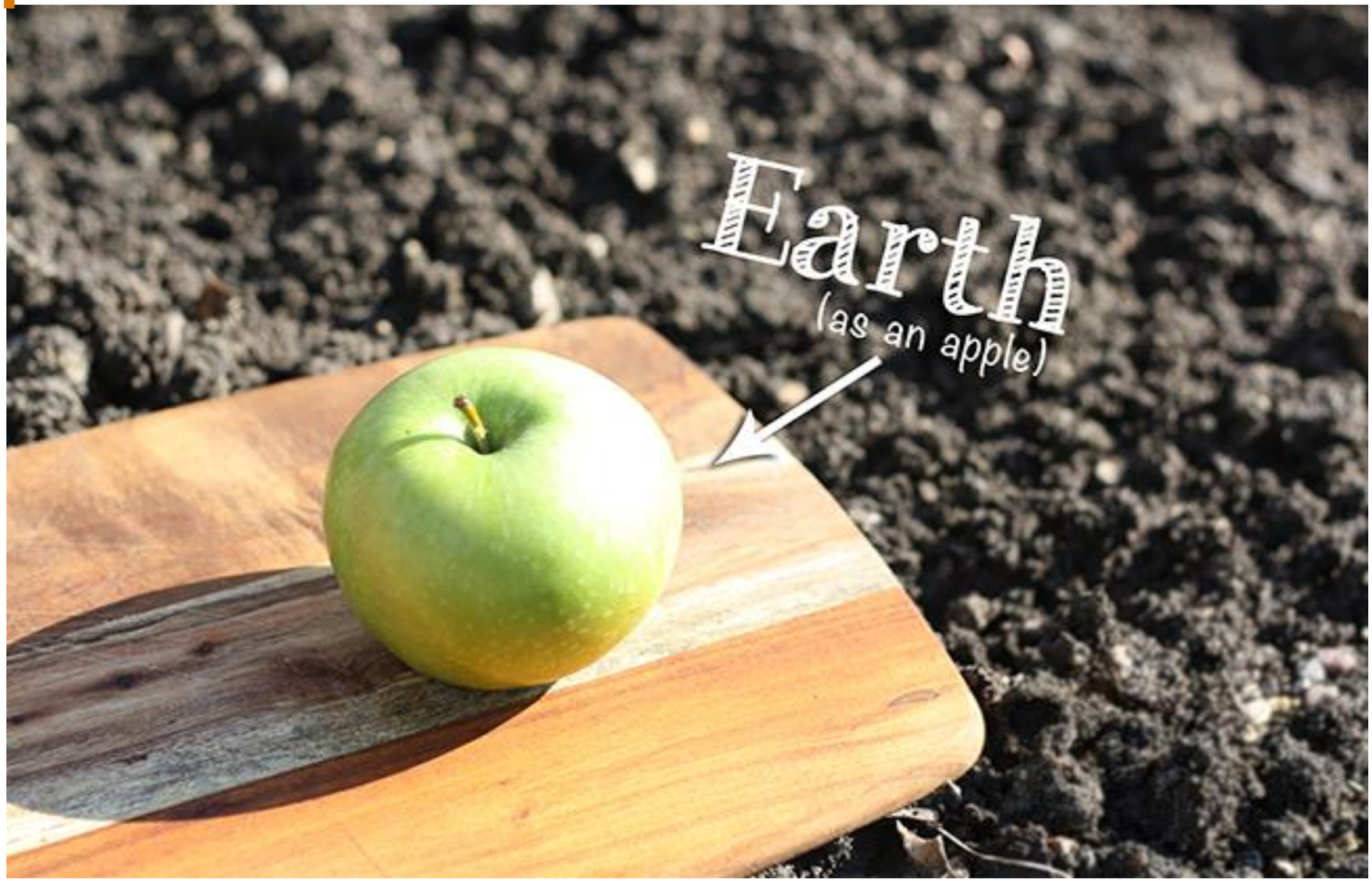
How much soil do we have for food production?



Credit: Dr. Karen Vaughan, fortheloveofsoil.org

How much soil do we have for food production?

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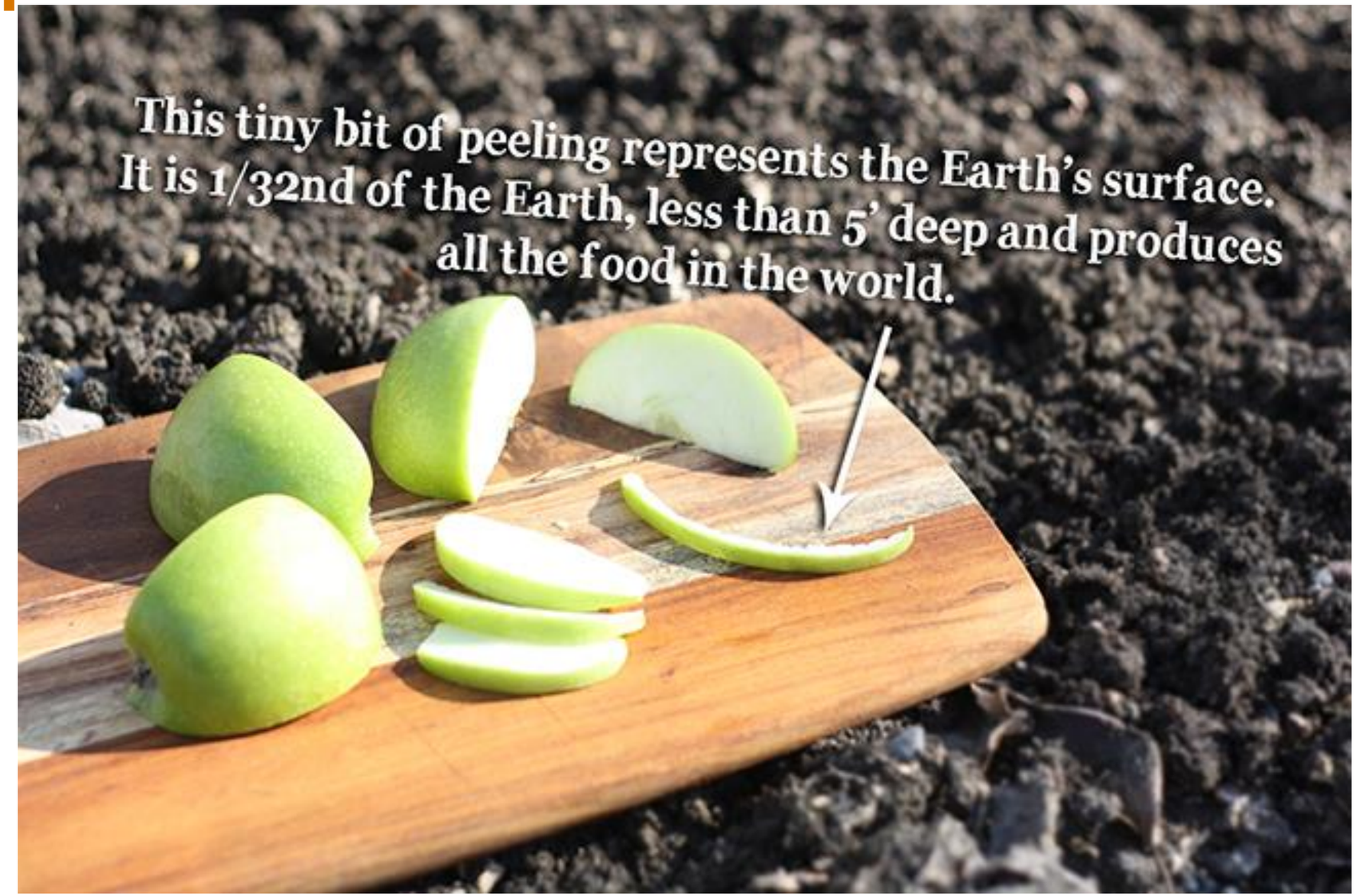


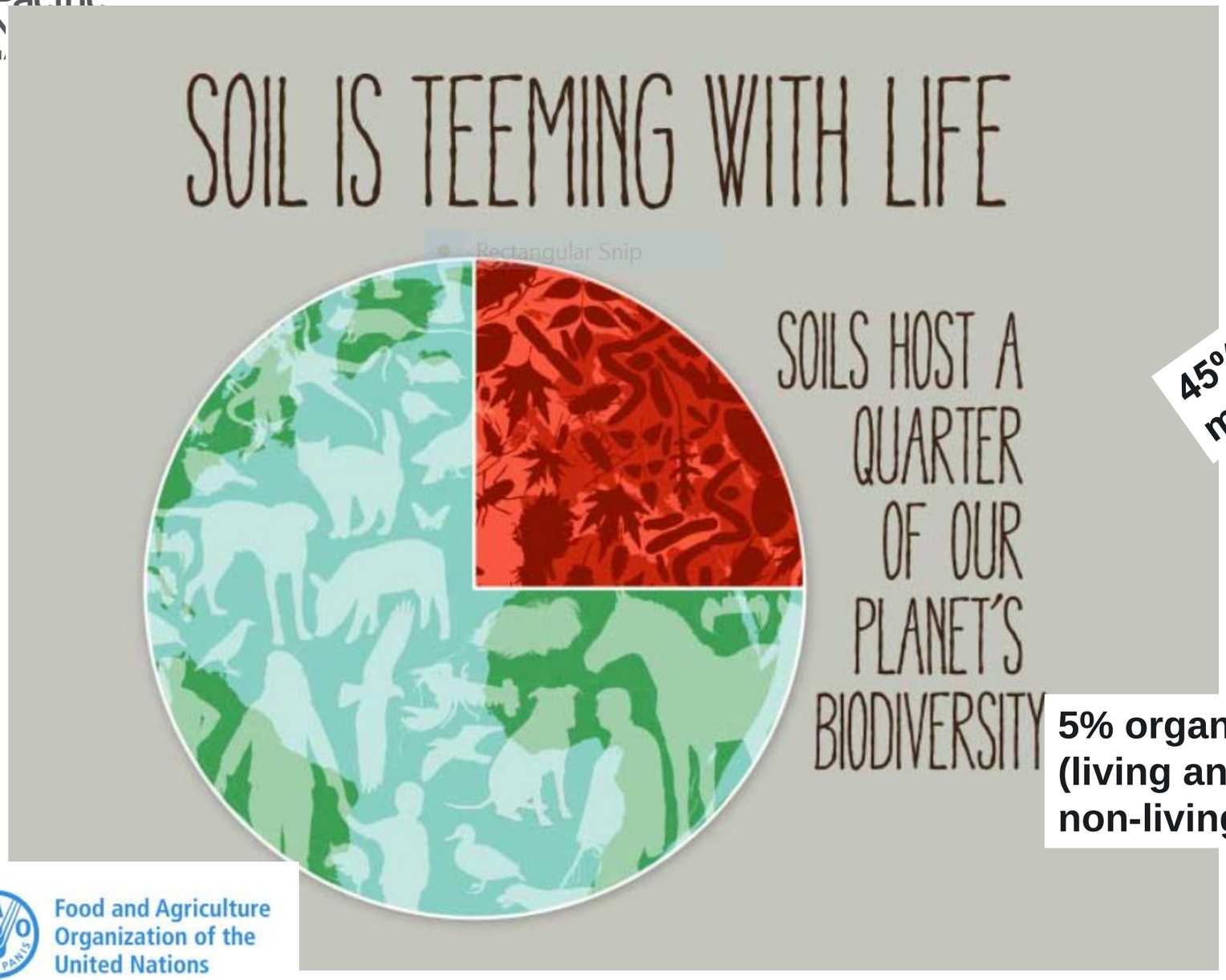
Soils are alive

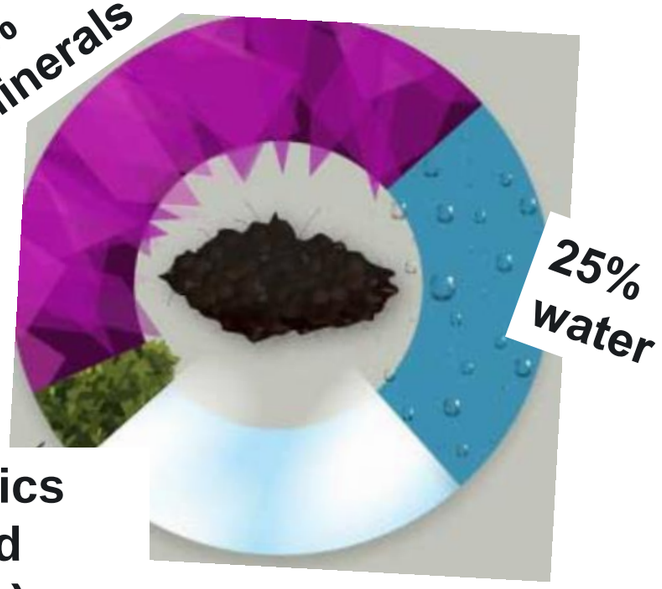
Sensors for recording the ground noise.

Specially developed recording device.

https://www.soundingsoil.ch/en/research/

Soils are alive!





5% organics (living and non-living)

25% air

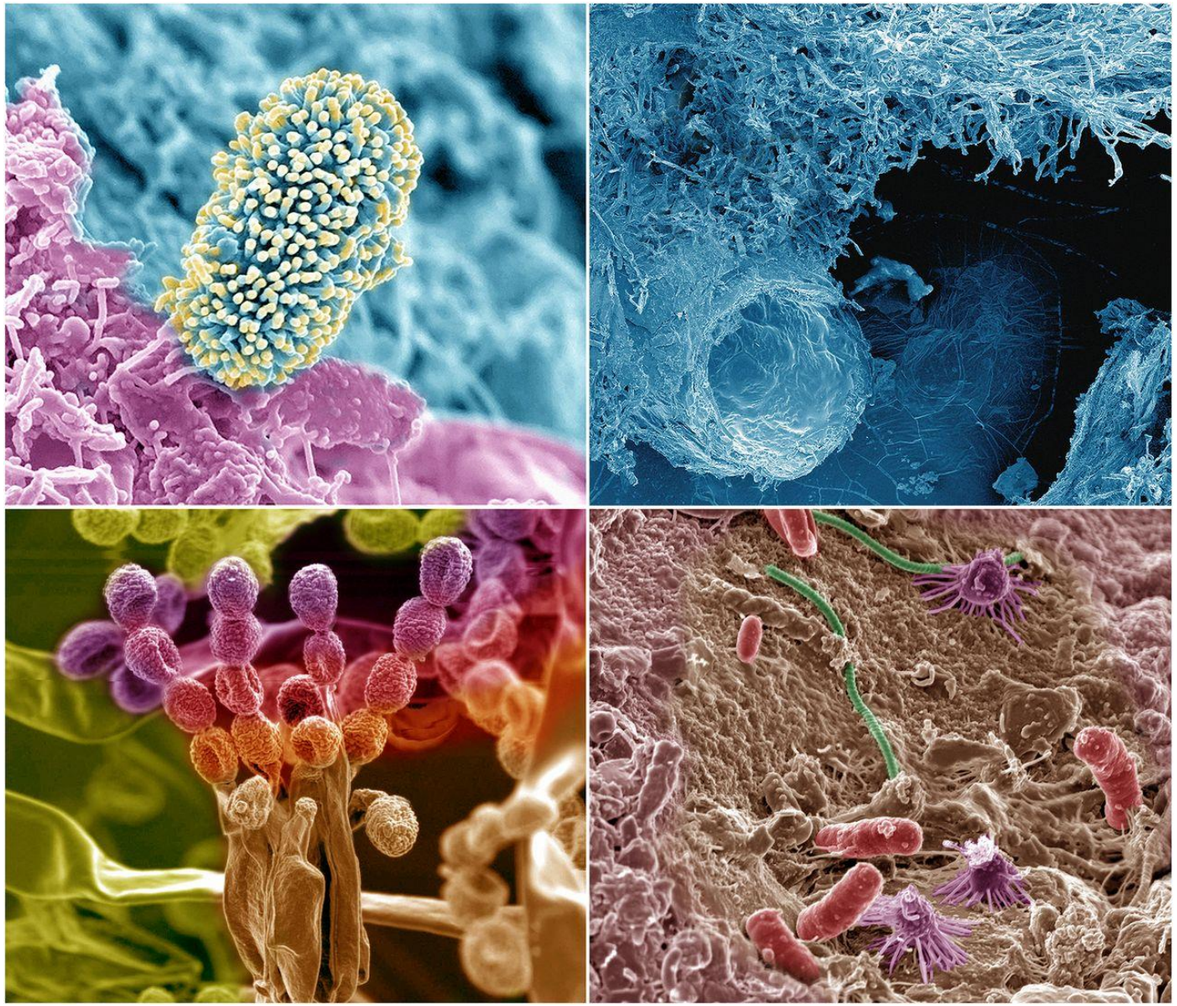
Food and Agriculture Organization of the United Nations

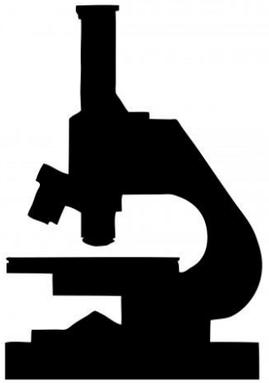
Soils are alive – Mesofauna

https://www.chaosofdelight.org/overview

Soils are alive with microorganisms

<0.1mm in size (bacteria, fungi, algae, protozoa)





Carey, 2016. Images provided by PNNL

Soil organic matter contains organisms

Food and Agriculture Organization of the United Nations

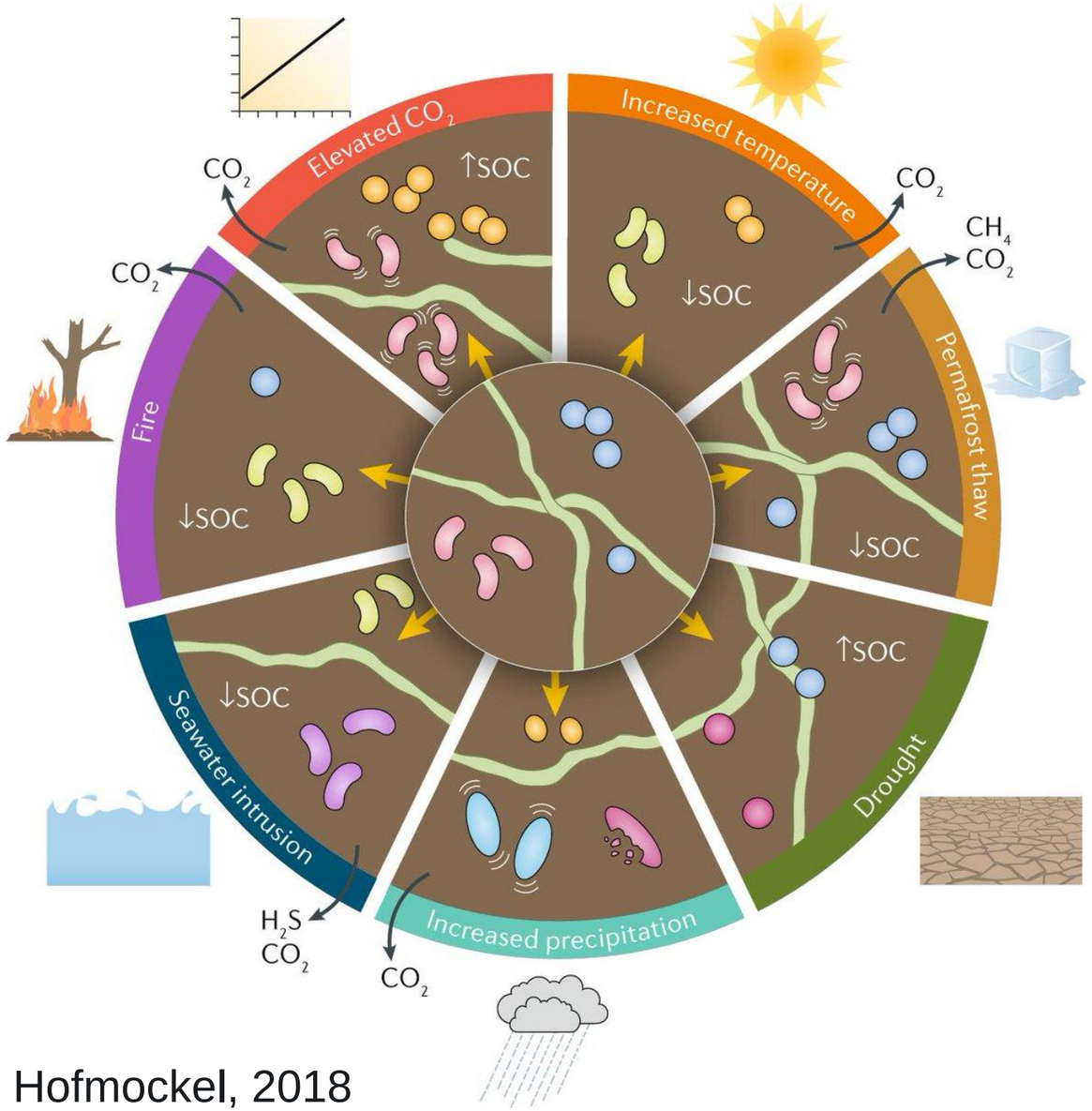
Soil Microorganisms are important

- impact storage and release of soil carbon
- influence soil greenhouse gas exchange (e.g. carbon dioxide CO_2, methane CH_4 emissions)
- affect biochemical changes in soil organic matter
- potential to improve predictive understanding of environment

Soil microorganisms contribute to soil respiration

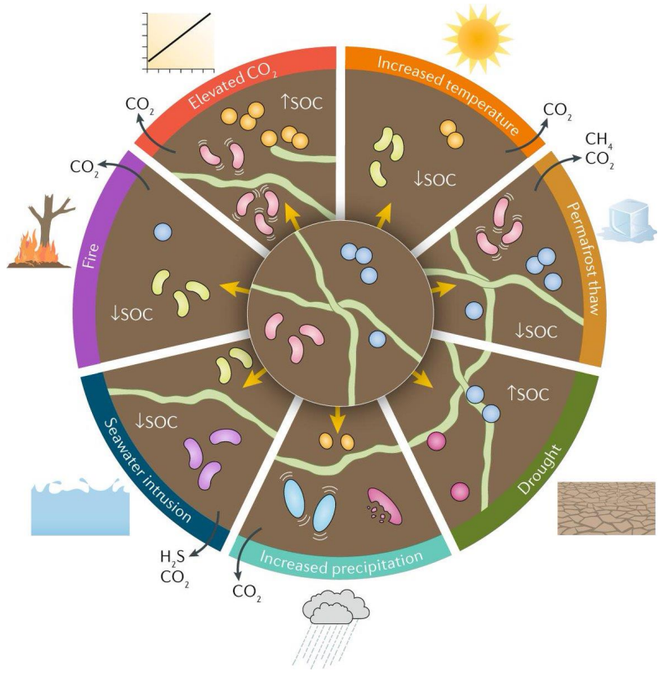
Belowground activities including that of soil microorganisms impacts the release of these gases into atmosphere

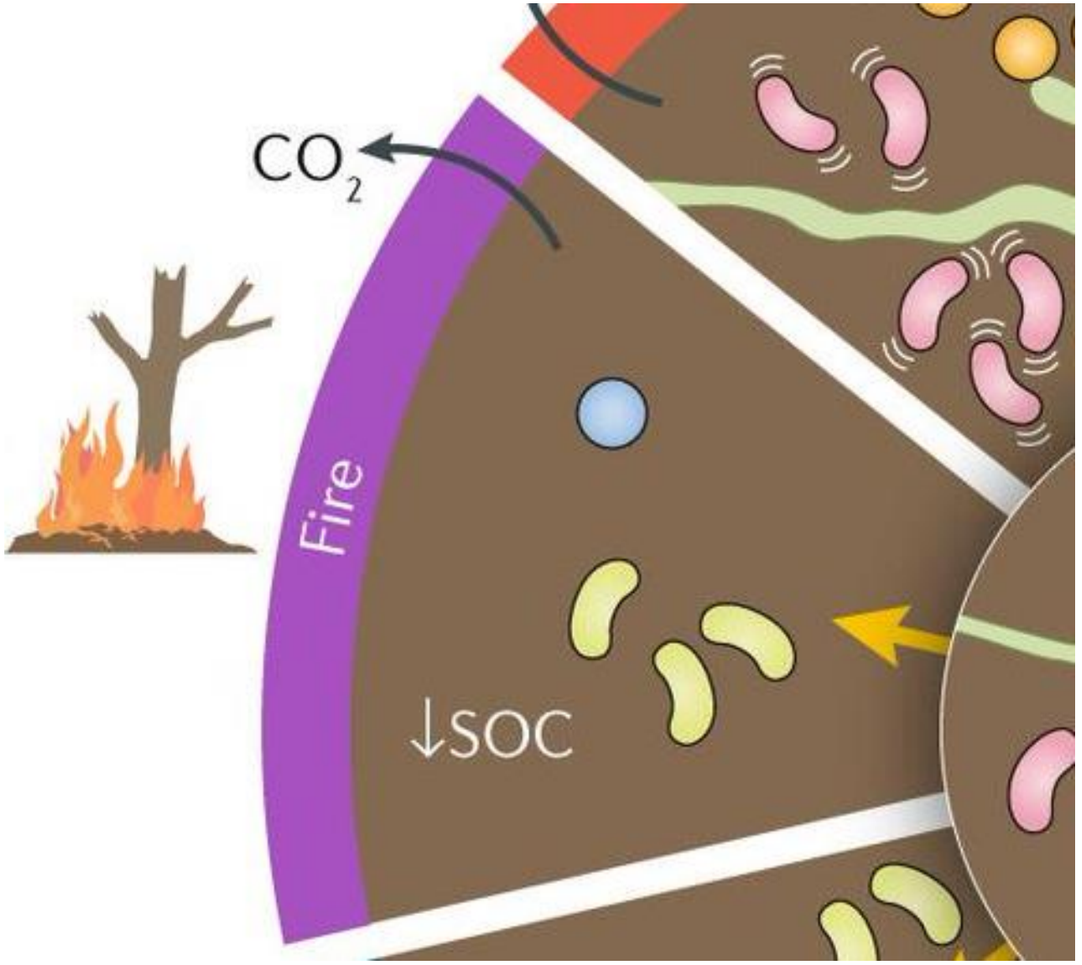
CO_2 and CH_4 gases which are known to cause global warming



Jansson and Hofmockel, 2018

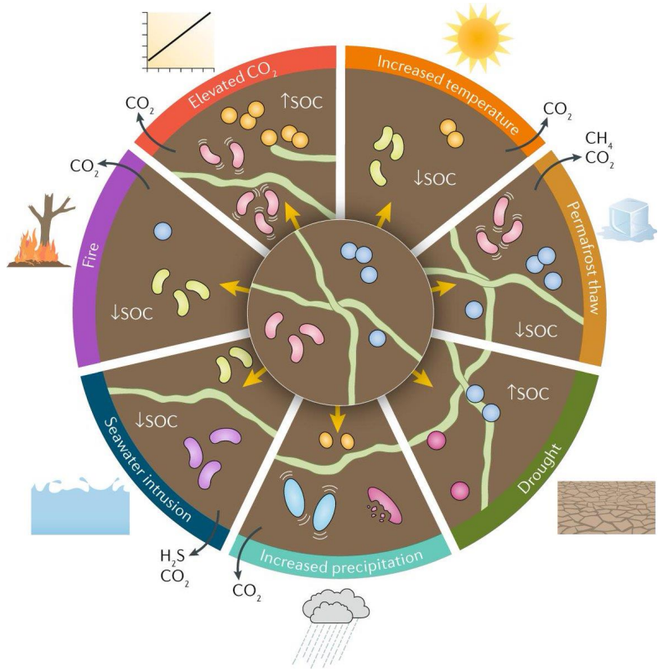
Soil Microorganisms contribute to soil respiration

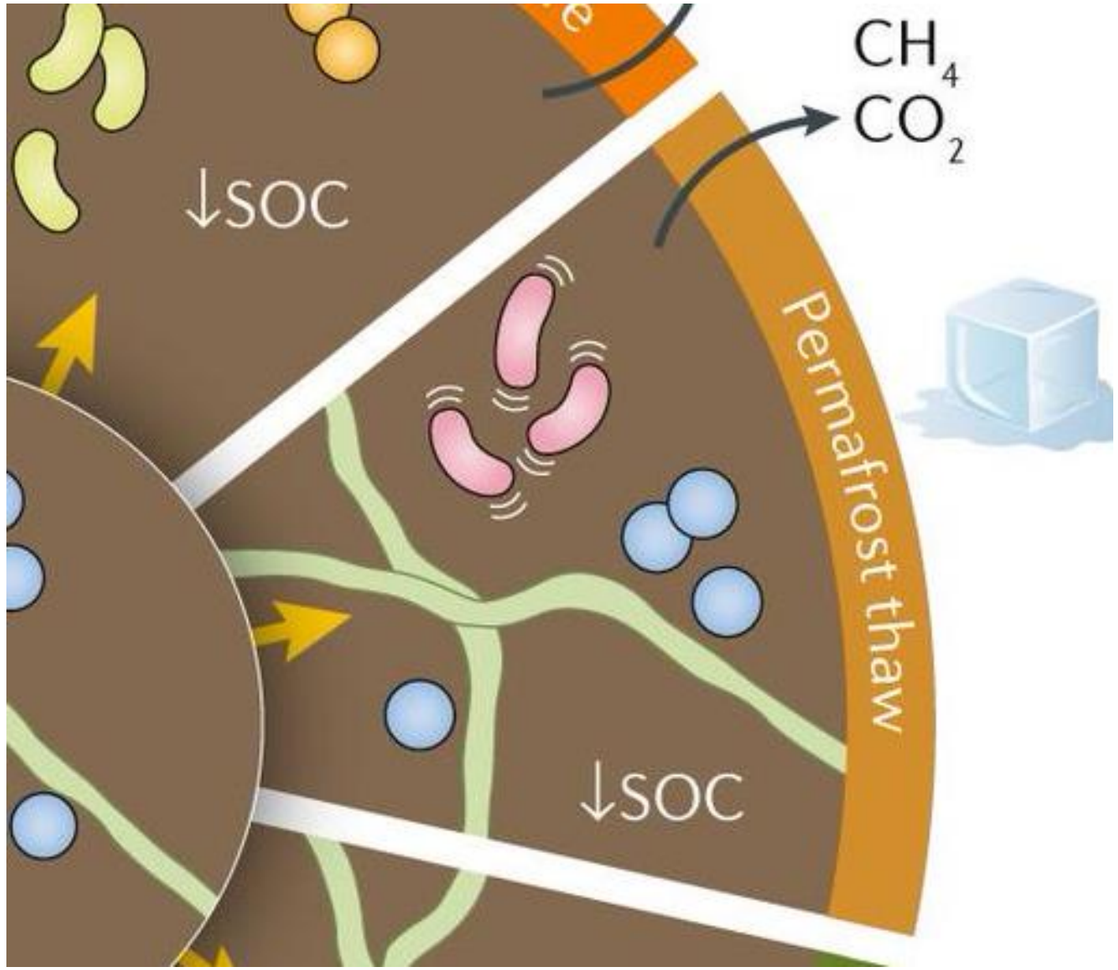




Jansson and Hofmockel, 2018

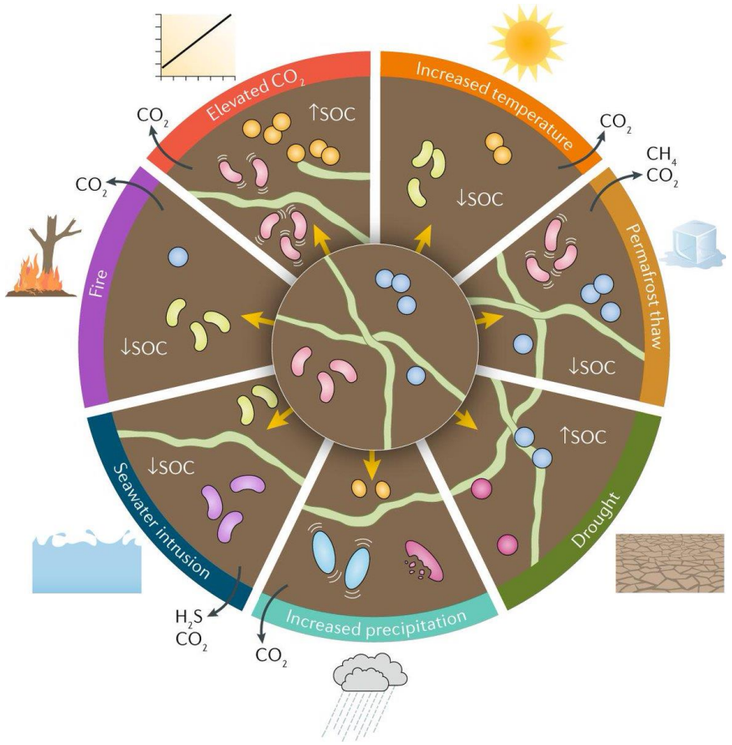
Soil Microorganisms contribute to soil respiration

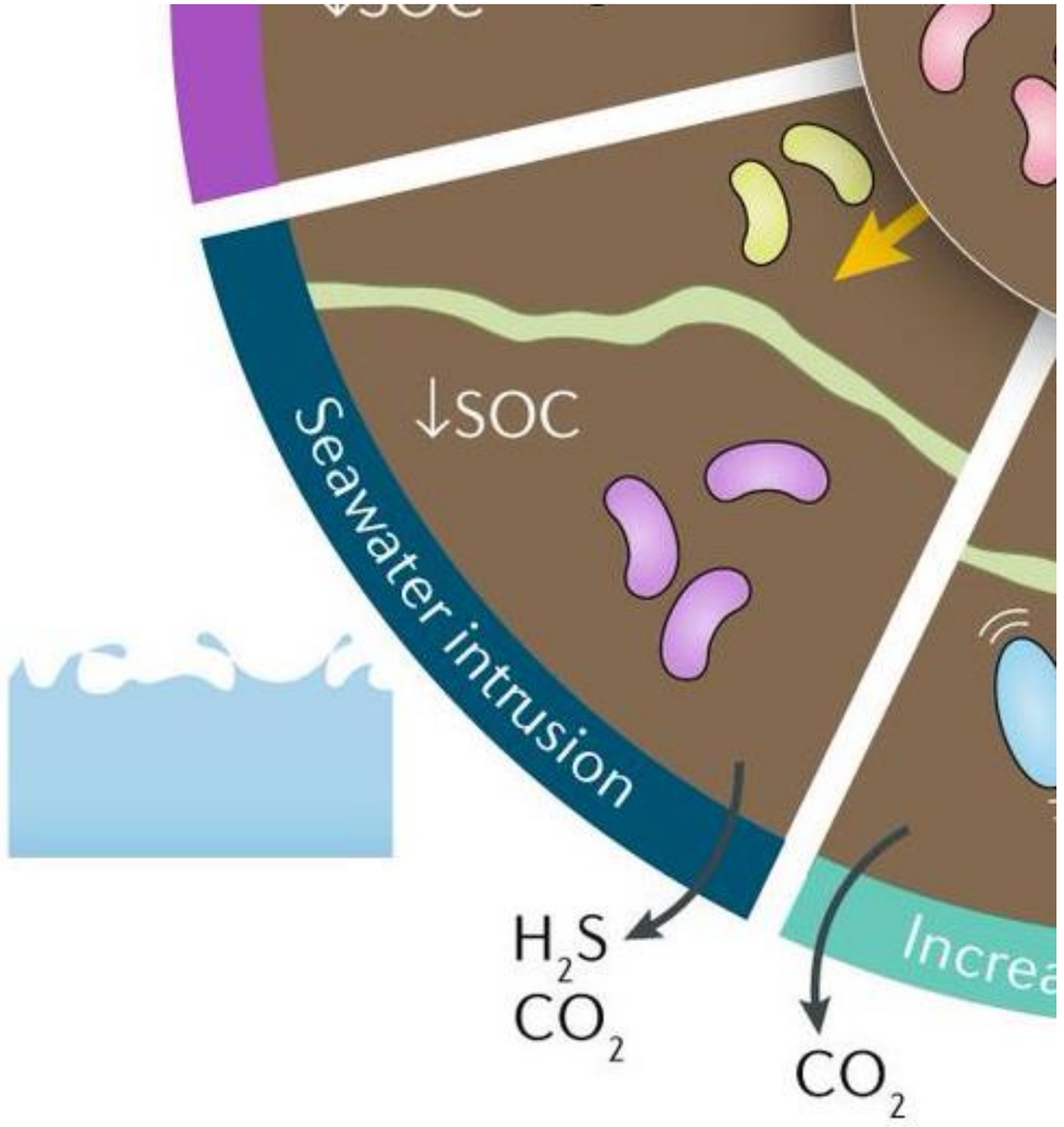




Jansson and Hofmockel, 2018

Soil Microorganisms contribute to soil respiration





Jansson and Hofmockel, 2018

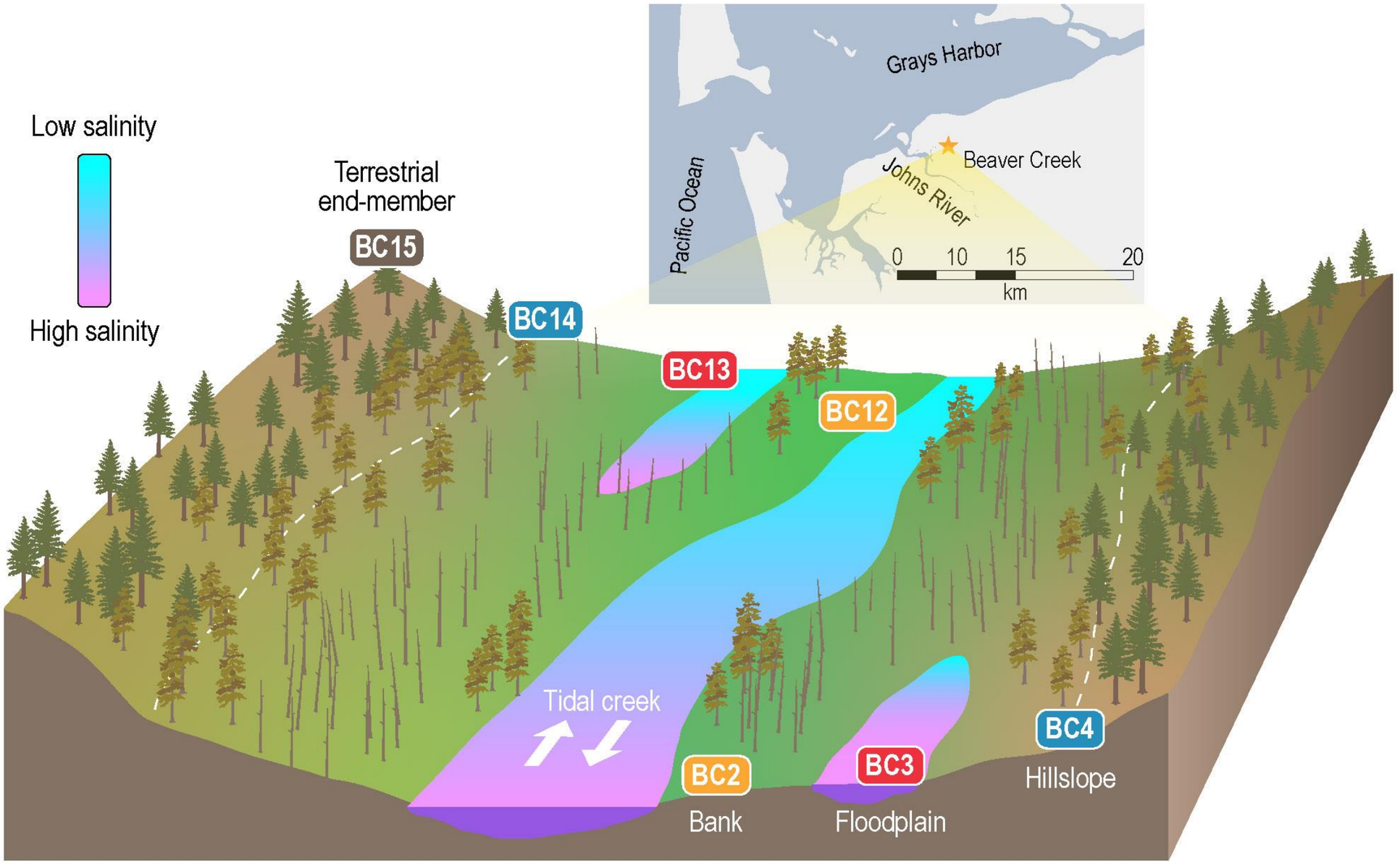
Coastal soil response to environmental perturbation

- DOE and PNNL has a focus on developing a Long-Term Program in Coastal Earth System Science
- PREMIS (Predicting Ecosystem Resilience through Multiscale and Integrative Science) project
  - changes in soil and sediment biogeochemistry that occur along a salinity gradient
  - mechanisms of vegetation change under seawater exposure, and how soil and landscape interact to buffer the exposure
  - Quantitative, predictive understanding of the impact of rapid seawater inundation on carbon and nutrient transformations and fluxes.

Coastal terrestrial-aquatic interfaces are important ecosystems in transition

- Two-way movement of energy, nutrient, and water
- Inland extent of tidal influence predicted to increase in coastal US due to sea level rise and terrestrial and oceanic storms (Ghanbari et al., 2019, Crowell et al., 2010)
- Carbon stored, released, and transformed by pulse events (Capooci et al., 2019)

Biogeochemistry of tidal inundation in Pacific Northwest



Soil sampling

+ PREMIS TEAM (James Stegen, Nick Ward, Jianqiu Zheng, Ben Bond-Lamberty, Vanessa Bailey, Steve Yabusaki)

Laboratory experiment

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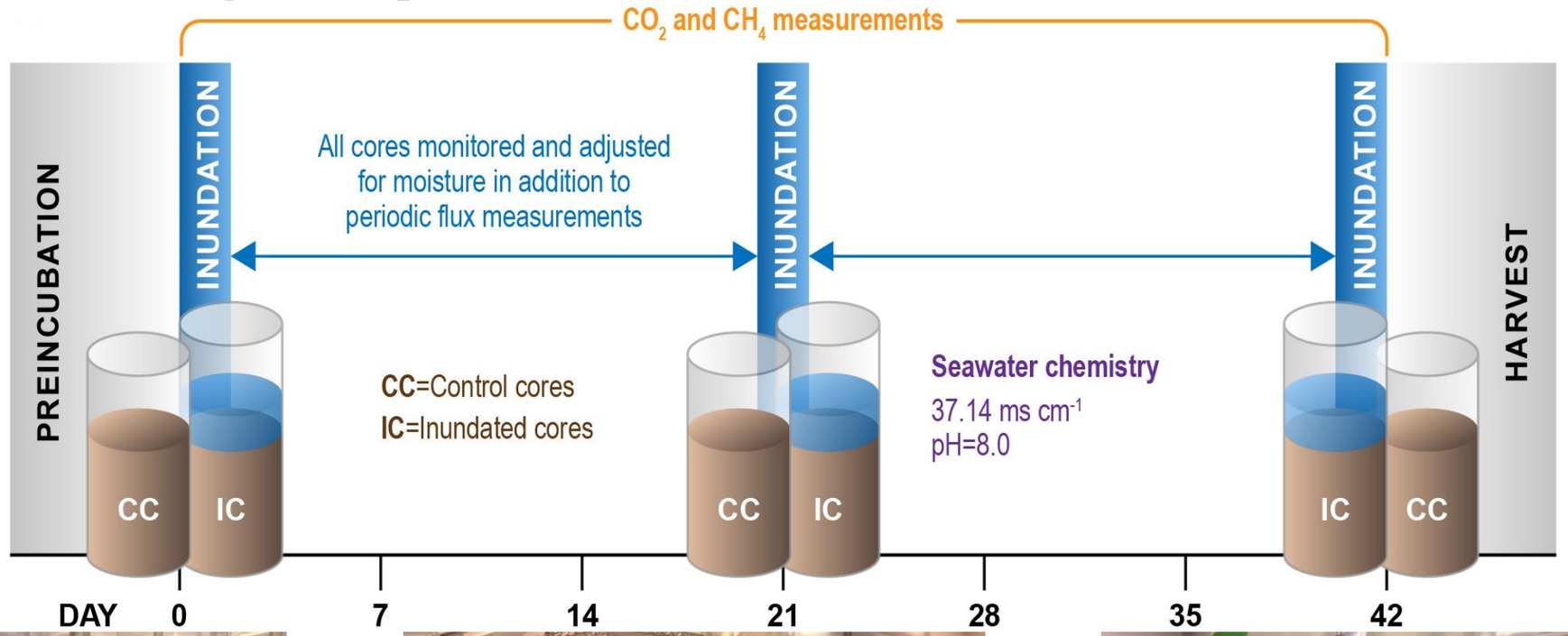
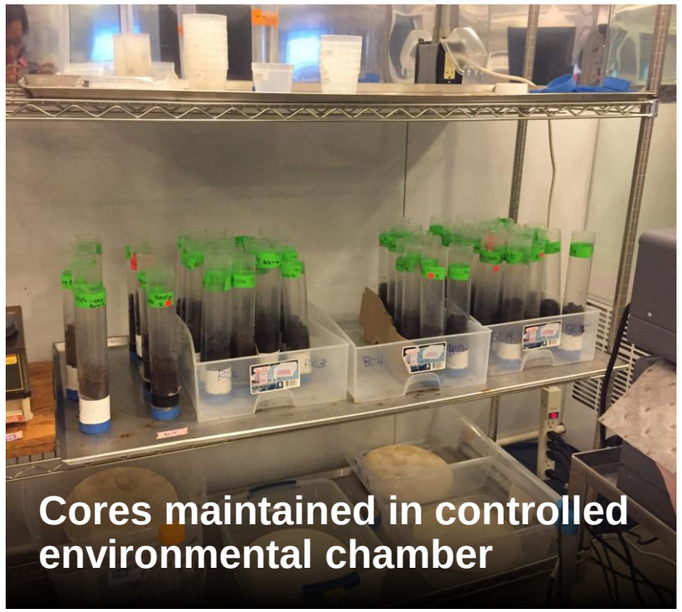
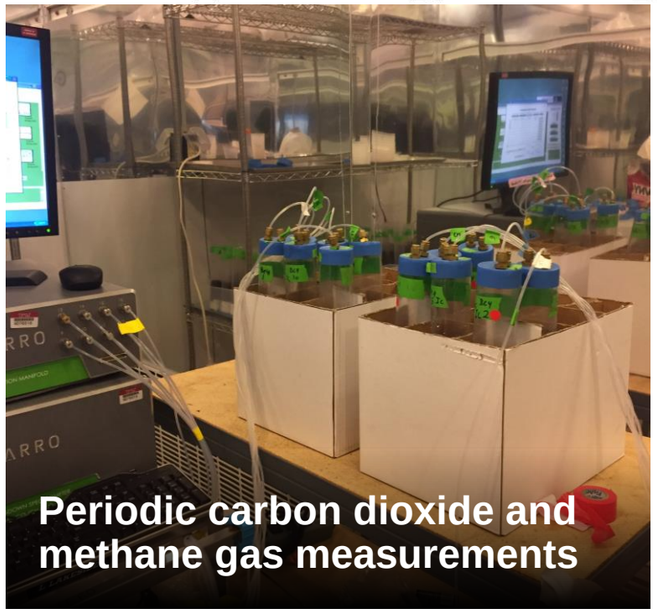
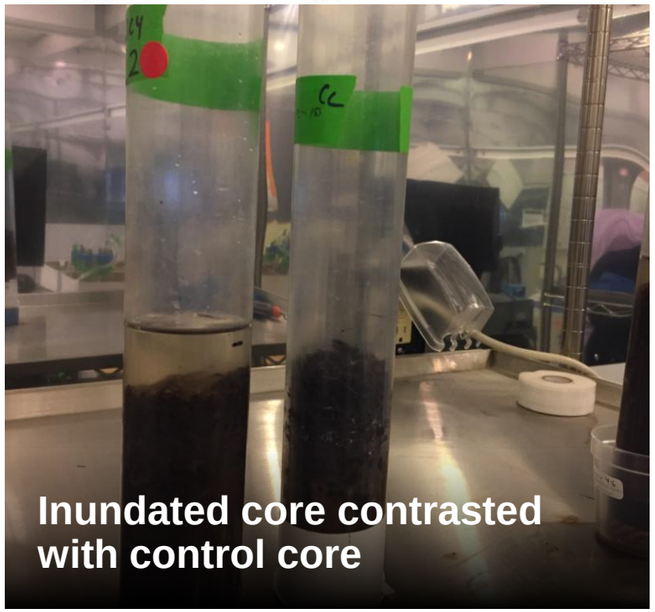
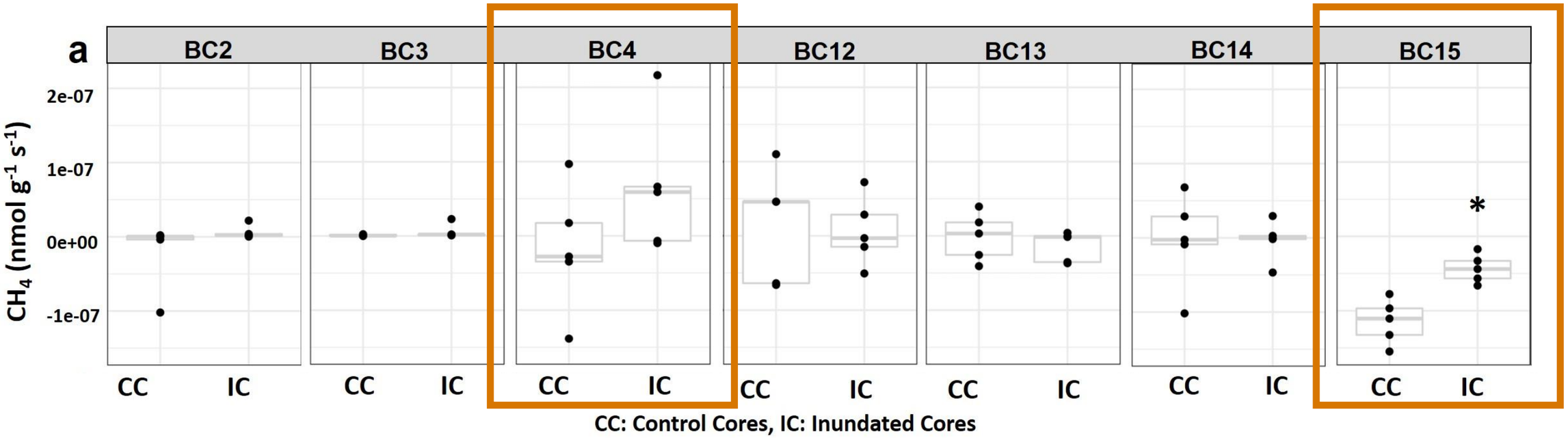



Cores maintained in controlled environmental chamber


Periodic carbon dioxide and methane gas measurements

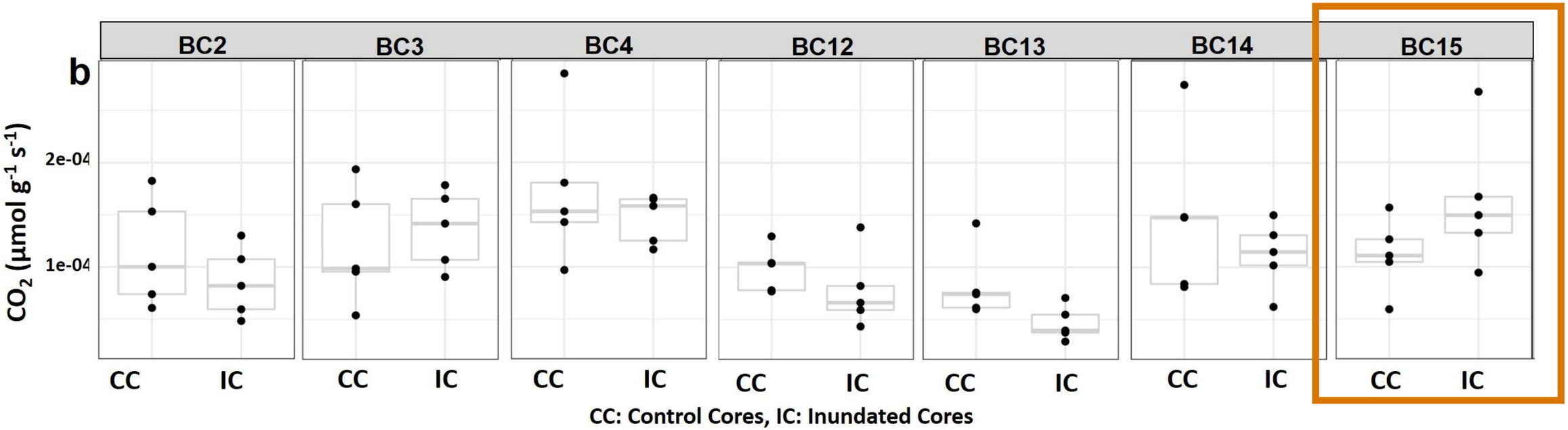

Inundated core contrasted with control core

Methane emissions were highest from terrestrial soil



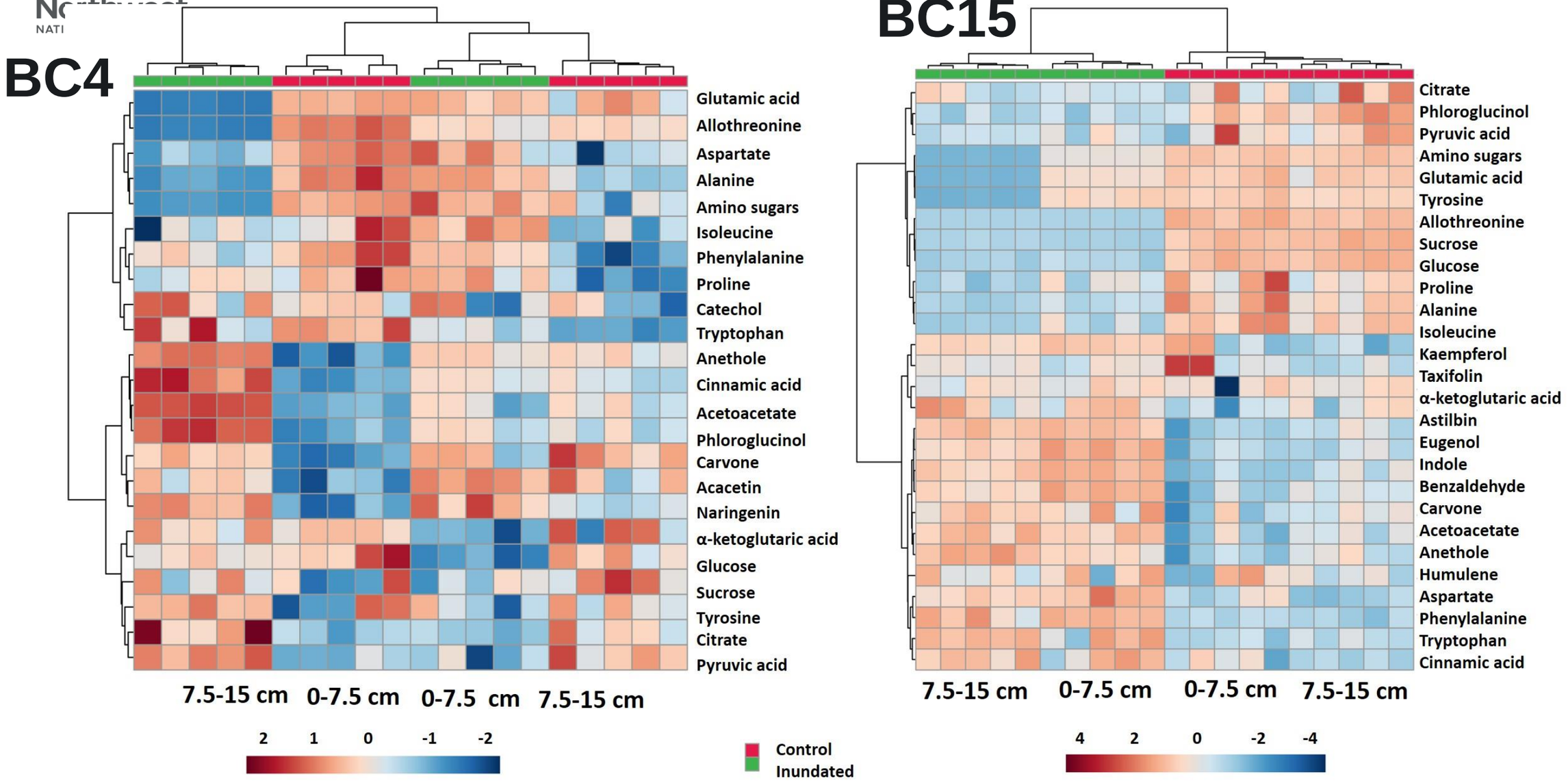
Sengupta et al., in prep

Carbon dioxide emission was highest from terrestrial end-member soil



Sengupta et al., in prep

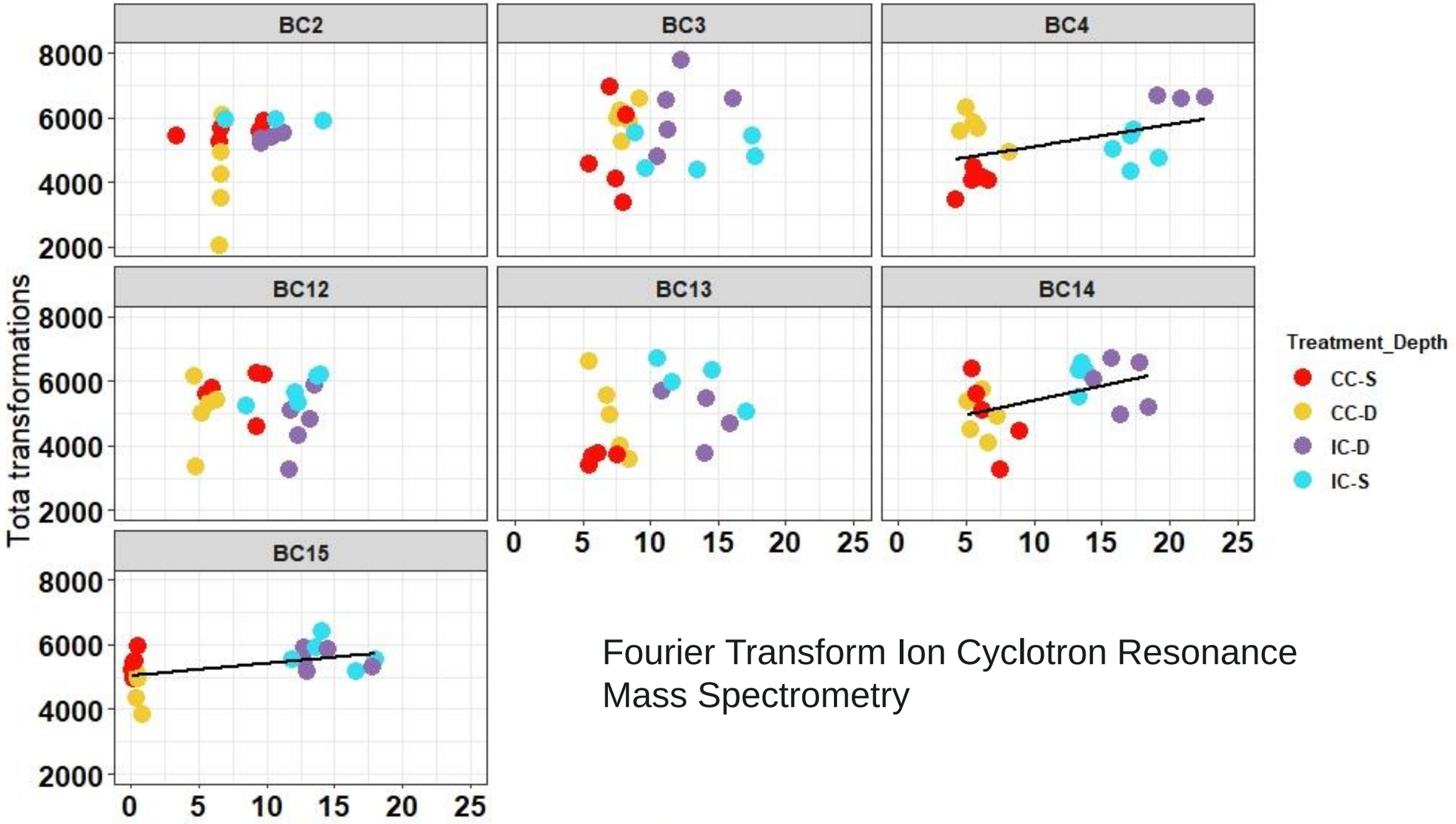
Seawater inundation impacted metabolites in terrestrial soils



Sengupta et al., in prep

Liquid Chromatography-Mass Spectrometry

Biochemical transformations increase with inundation in terrestrial soils



Fourier Transform Ion Cyclotron Resonance Mass Spectrometry

Sengupta et al., in prep

- Periodic seawater inundations preferentially impact low salinity soils
- Surficial soils get enriched in phenolic compounds, hydrophilic compounds are lost
- Biochemical transformations of end-member soils increase with seawater addition; likely suggests higher microbial activity.
- Antecedent salinity determines the biogeochemical response of coastal soils to seawater exposure

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THANK YOU!

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ECOSYSTEM SCIENCE

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Upcoming Seminars

Hacking Biology to Produce Energy and Fuels
Joseph Laureanti
Tuesday, June 16
7:00 pm

Effectiveness of Habitat Restoration in the Lower Columbia River & Estuary
Nikki Sather
Tuesday, June 23
7:00 pm