CALIFORNIA LAND RECYCLING CONFERENCE

Imagine | Innovate | Implement

September 29 – October 1, 2026 | Foster City

Soil, Plants, and Animals

Keystones & Cornerstones of Climate Resilience

September 29, 2026

OFFICE OF BROWNFIELDS

CENTER FOR CREATIVE LAND RECYCLING

SPEAKERS



RANDY MANDEL

Onterris



CUAUHTÉMOC LANDEROS

Kansas State University - Center for Hazardous Substance Research - Tribal Technical Assistance to Brownfields



DR. DANIELLE STEVENSON

Centre for Applied Ecological Remediation



JOHNSTON DUFFEY

Ramboll

Foundation

- ***Nature-based Solutions (NbS)*** *can strengthen ecological resilience through approaches such as enhancing biodiversity, sequestering blue carbon, integrating green and gray coastal engineering, and applying ecological modeling and quantification to verify success.*
- Land recycling unfolds in many phases, each with unique challenges that call for innovative thinking, designs and technology. As shifting environmental conditions reshape our landscapes, we're invited to revisit the earth's original toolkit for time tested ecological solutions.



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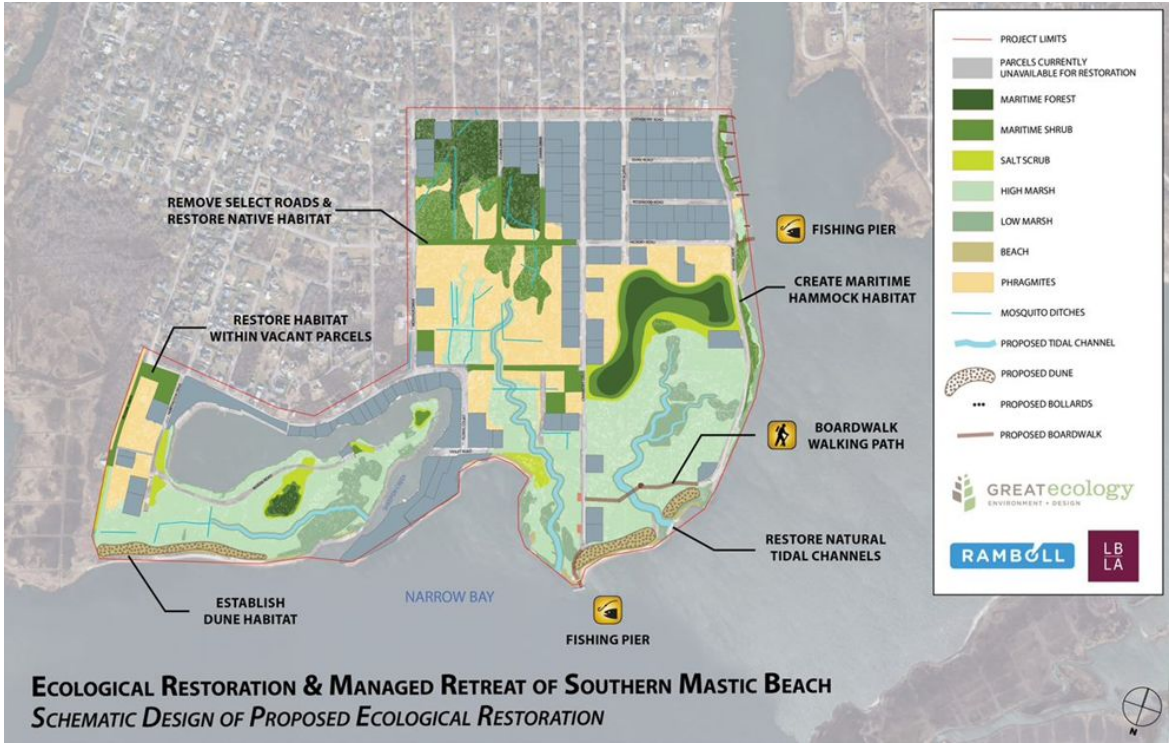
Background

- **Nature-based Solutions (NbS)** are actions that protect, restore, and manage natural or modified ecosystems to address societal challenges such as climate change, flooding, coastal erosion, reclamation challenges, and fire remediation.
- **Ecological resilience** is the capacity of an ecosystem to absorb and recover following disturbance from natural events or human actions.
- **Resistance** is the ability of an ecosystem to withstand damage during a disturbance without losing its ability to provide ecological functions and services.
- **Recovery** is how quickly and comprehensively a system returns to its baseline ecological and services following disturbance.
- **Ecosystem functions** are the natural biological, chemical, and physical processes that occur within an ecosystem such as nutrient exchange, forage production, and habitat.
- **Ecosystem services** are the direct and indirect benefits that ecosystems provide. There are four general types of services: provisioning (e.g., drinking water, timber); regulating (e.g., air and water filtration); cultural (e.g., beauty, health); supporting (e.g., photosynthesis, nutrient cycling).

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Coastal Resilience – Mastic Beach, NY

- Post-Superstorm Sandy flood recovery,Suffolk County, NY.
- Included assessment of ecological conditions and use of hydrodynamic modeling to determine future flood risk potential.
- Provided 30%, 60% and full restoration design to restore the floodplain to a native salt marsh.
- Benefits are provision of a healthy ecosystem to buffer future events and provide habitat for T&E organisms such as the salt marsh sparrow and diamondback terrapin.



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Coastal Resilience – Belle Isle Salt Marsh, Boston, MA

- Belle Isle is the largest remaining salt marsh in the Boston area.
- Worked with USACE EWN and multiple universities, agencies to assess habitat functionality, resilience, and biodiversity.
- Performed biodiversity assessment focused on comparison of genetic fitness between site-specific genetics and commercial sources.
- Also created production methodologies for dominant salt marsh grasses (smooth cordgrass and saltmarsh cordgrass).



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Flood Recovery – 2013 Colorado Front Range Events

- The Colorado 2013 floods resulted in a 500yr to 1000yr event.18 Counties and 7 watersheds were impacted, resulting in the loss of ~1,850 homes and ~$4B in damages.
- Restored over 49 miles of river and designed and implemented over 57 projects with Federal, State, and local partners.
- Natural habitats were reinvigorated by the collection, production, and installation of local native ecotypes, resulting in re-establishment of ~350,000 plants and 1000’s of pounds of seed.



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Abandoned Mine Land Recovery and Restoration

- Since 1992 have partnered with the USFS to address abandoned mine land (AML) sites through Brownfields clean-up and restoration using locally-collected site-specific native plants.
- Clean-up and restoration has reduced ecological risk, addressed soil erosion, improved water quality, provided watershed-level protection, and enhanced habitat through uplifted ecological functions and services.
- ~74 species were collected by seed, cutting, and division. We planted ~9,800 containers over 10-days.
- Currently monitoring the site to determine survival and provide iterative management.



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Blue Carbon Sequestration and Marine Restoration

Our team has worked with various aspects of coastal resilience that leverages blue carbon sequestration including:

- Performing blue carbon credit feasibility analysis for the State of Washington as an alternative to timber harvest.
- Investigating kelp plantations as a means of carbon sequestration.
- Creating design recommendations that incorporate sea grass meadows combined with bivalve castles to assist with carbon capture and ecological uplift, thereby creating habitat to benefit salmonid and orca populations while increasing coastal resilience.



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Cuauhtemoc Landeros, Tribal Program Manager, KSU

Nature-based / biological framing; ecosystem engineering

cuau1@ksu.edu ; 707.322.4302

- Cuauhtemoc is a regenerative systems practitioner, ecological designer, and Tribal program manager dedicated to restoring healthy reciprocal relationships between people and the natural systems that sustain them. His work centers on soils, water, microbes, plants, and communities, with a focus on building collaborative partnerships that advance sustainable and efficient resource management, land remediation, and the protection and restoration of sacred lands. He believes that some of the most impactful long-term investments communities can make are in nature-based solutions that increase natural capital, improve ecosystem services, and build long-term resilience for today's environmental challenges.



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Danielle Stevenson, Ph.D., Executive Director, Centre for Applied Remediation



Applied mycoremediation / bioremediation

danielle@caer.earth ; 951.394.5800

- Dr. Danielle Stevenson is an environmental toxicologist and applied mycologist specializing in nature-based solutions for contaminated soils. She is the Founder and Scientific Director of the Centre for Applied Ecological Remediation (CAER), where she leads the development and implementation of fungal- and plant-based technologies for restoring contaminated lands, alongside community programs that integrate scientific research, workforce development, and environmental justice to expand access to sustainable cleanup solutions.
- Danielle earned her Ph.D. in Environmental Toxicology from the University of California, Riverside, where her research field-tested phyto-mycoremediation strategies for remediating Los Angeles brownfields. She is passionate about translating cutting-edge environmental science into practical, scalable tools that help communities safely reclaim contaminated land.

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Johnston Duffey, Environmental Engineer, Ramboll



Practical Nature-based Solutions ; phytoremediation

jduffey@ramboll.com ; 614.493.8906

- Johnston Duffey is an environmental consultant and ISA Certified Arborist with expertise in site investigation and remediation, with a particular focus on phytoremediation and nature-based solutions. He brings a multidisciplinary approach to complex environmental challenges, integrating ecological principles with practical engineering strategies. Johnston serves as co-lead of Ramboll's Phytoremediation and Nature-Based Solutions (NBS) Subject Matter Expert Team, where he helps advance innovative, plant-based remediation approaches and supports their application across diverse project types and regulatory settings.

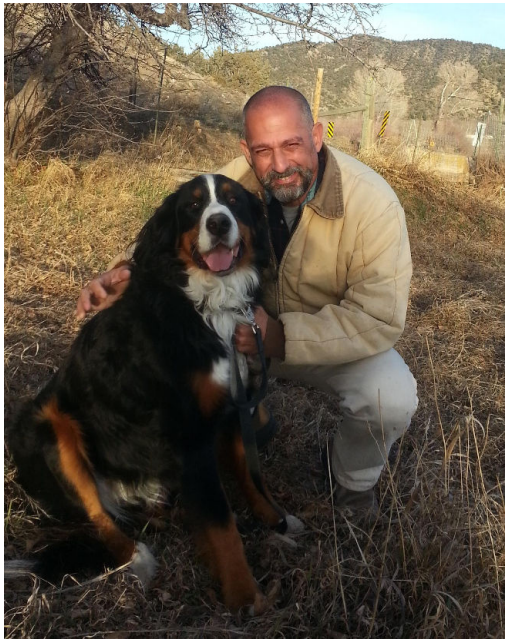
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Randy Mandel, Biodiversity, Nature Restoration, Nature-based Solutions Lead, Onterris

Moderator - Soils, Plants, & Animals: Keystones and Cornerstones of Climate Resilience

randymandel@onterris.com ; 970.379.3169

- Randy is a recognized expert in biodiversity, restoration ecology, and fire remediation with more than 30 years of experience using site-specific native plants, integrating ecological and constructed systems, and incorporating native flora and fauna across more than 5,000 U.S. and international project sites. Randy cofounded Rocky Mountain Native Plants Company and led one of the largest container native plant nurseries in the United States for more than 13 years. He has authored more than two dozen publications, including international journal articles and a stand-alone monograph on wetland plant species for biofiltration. He also contributed restoration plant expertise to the U.S. Army Corps of Engineers Engineering with Nature International Guidelines on Natural and Nature-Based Features for Flood Risk Management and served as Lead Restorationist for the Colorado Watershed Conservation Board Emergency Watershed Protection Program Technical Assistance Team supporting recovery from the 2013 flood events.



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Soils, Plants & Animals: Keystones and Cornerstones of Climate Resilience

By: Cuauhtemoc Landeros

www.tribaltab.org

Kansas State University
Institute for Tribal Environmental Professionals
Alaska Native Tribal Health Consortium

The Tribal Technical Assistance to Brownfields (Tribal TAB) program supports Indigenous communities in protecting and restoring sacred lands.

Who We Are

Tribal TAB is a collaborative partnership between KSU, ITEP, and ANTHC.

Kansas State University | Institute for Tribal Environmental Professionals | Alaska Native Tribal Health Consortium

What We Do

The Tribal TAB network provides free technical assistance to all federally recognized Tribes, Alaska Native Villages, and other Tribal entities.



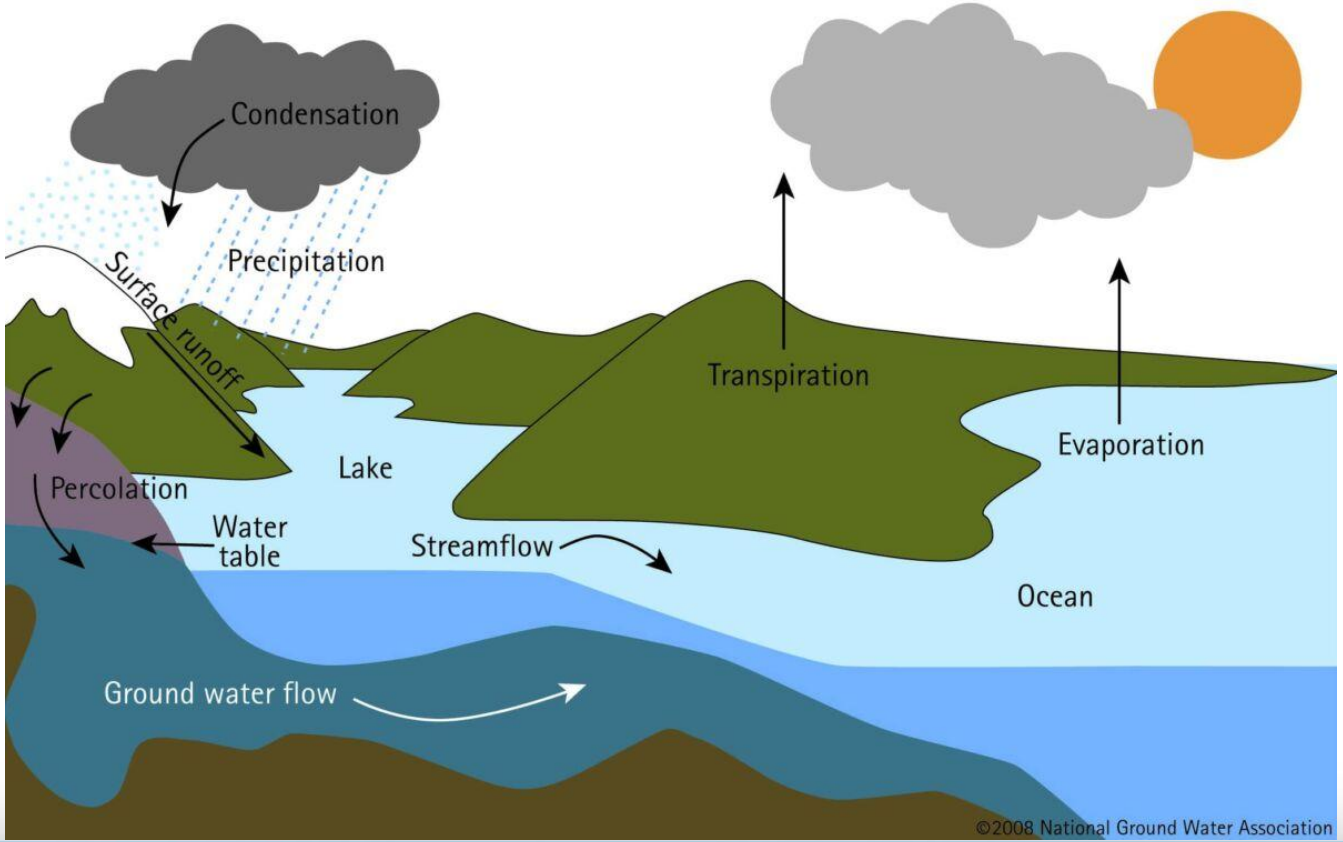
Contact Us

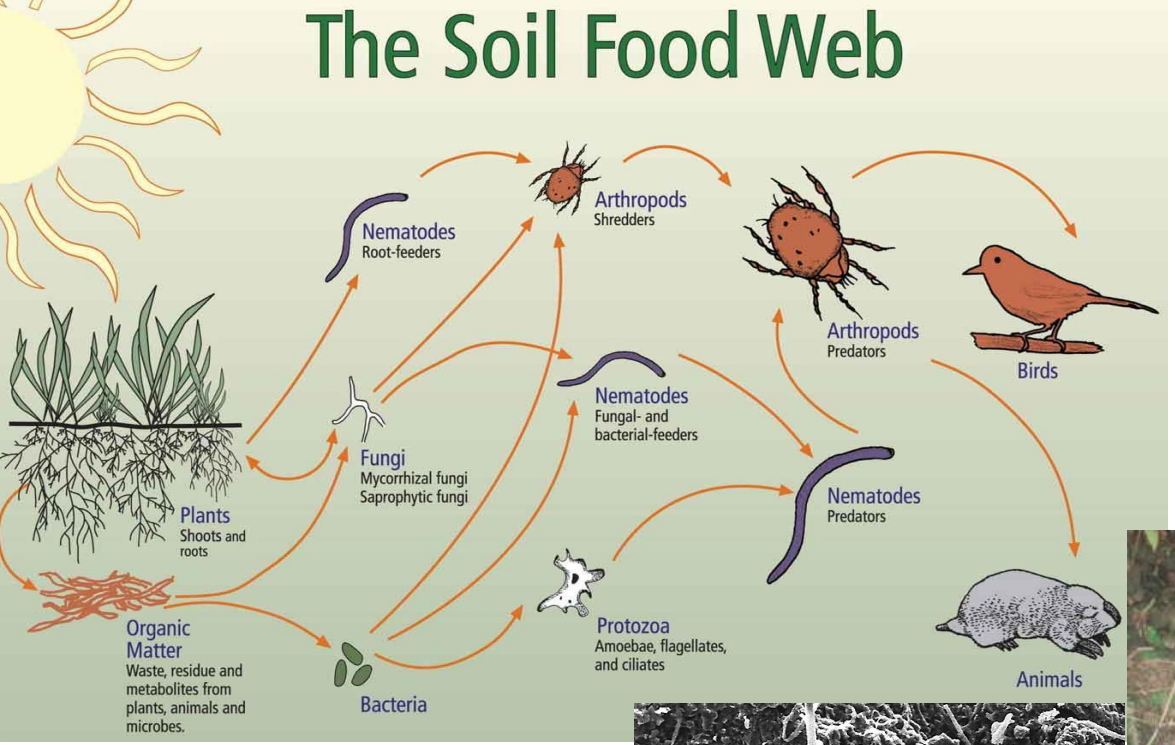
Tribal-TAB@ksu.edu

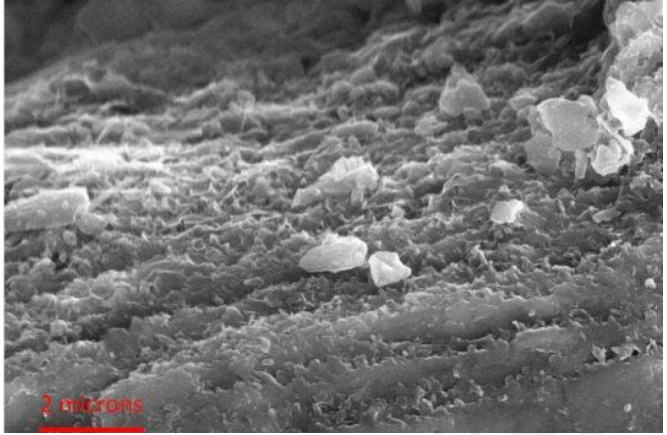
How We Can Assist

- Help identifying & prioritizing brownfields
- Tribal Response Program resources
- Tribal Brownfields Knowledge Circle
- Identify potential funding
- Brownfields for renewable energy & energy sovereignty
- Incorporate culture & tradition in brownfields efforts
- Planning & redevelopment visioning
- Review of technical documents
- And much, much more

Hydrologic Cycle

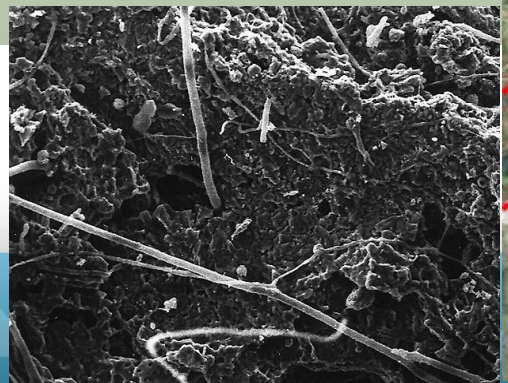




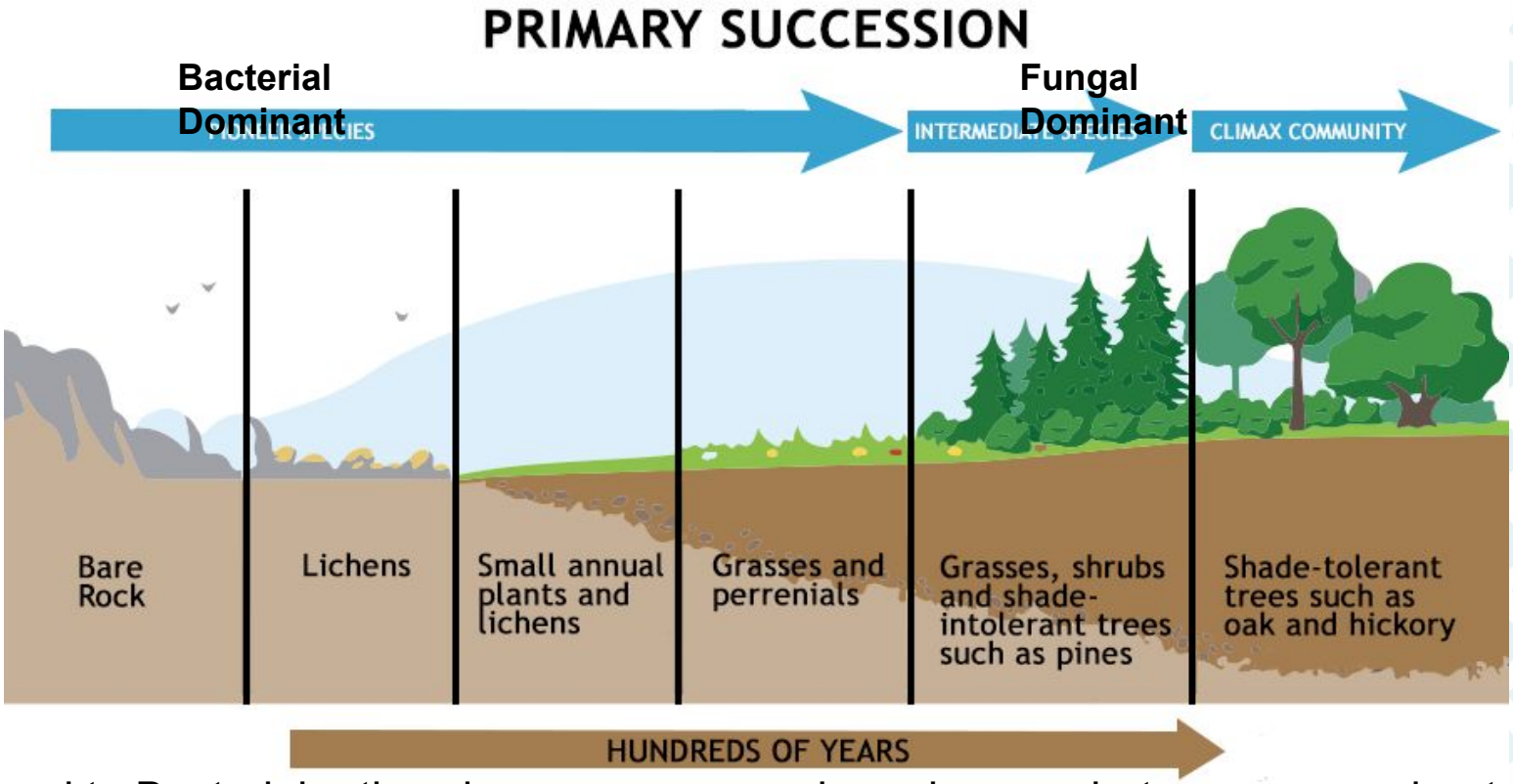


Bacteria consuming rock.
Credit: Napieralski et al. 2020, PR

"Scanning electron micrograph 4–6-mm-thick hyphae entering a calcium feldspar at a granite surface Jongmans 1997.



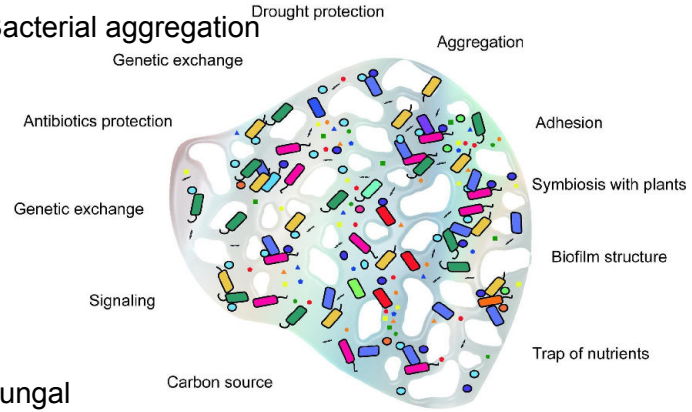




Fungal to Bacterial ratios change as succession advances but we can accelerate this process with plants, compost and organic matter

https://doi.org/10.3389/fmicb.2018.01636

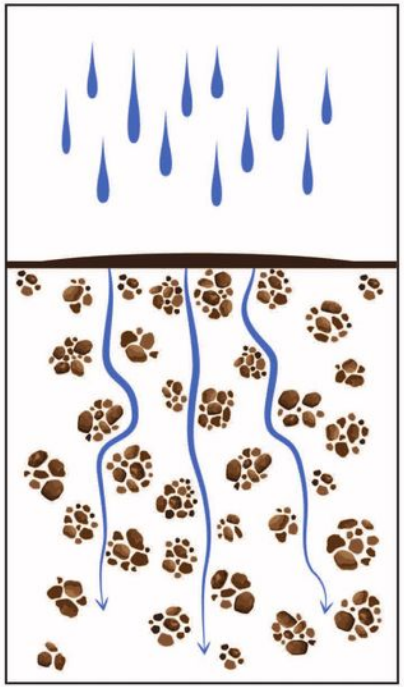
Bacterial aggregation

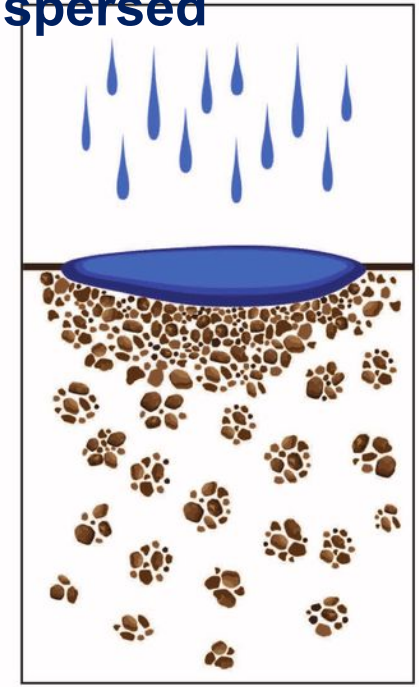


Fungal hyphae



Flocculated (aggregated) Vs. Dispersed



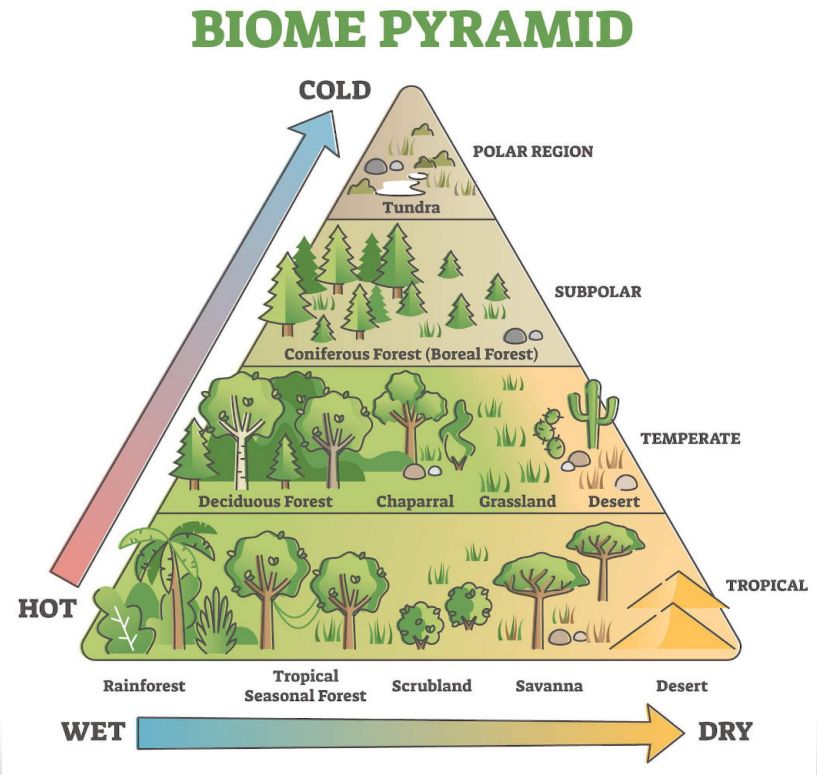


Flocculation is important because water moves through large pores, and plant roots can grow with less effort. Dispersed clays (right) plug soil pores and impede water

Natural Capital → Provides → Ecosystem Services

Benefit 2 People & Greater than Human Relatives

- Forests
- Rivers
- Lakes
- Oceans
- Rain
- Soil
- Sunshine
- Air
- Wildlife
- People
- Biodiversity



- Clean Water
- Clean Air
- Pollination of Crops
- Climate Regulation
- Flood Protection
- Recreation
- Cultural Value
- Climate cooling
- Plant & Animal Growth

What Comes From the Sky: The Lifeblood of Ecosystems

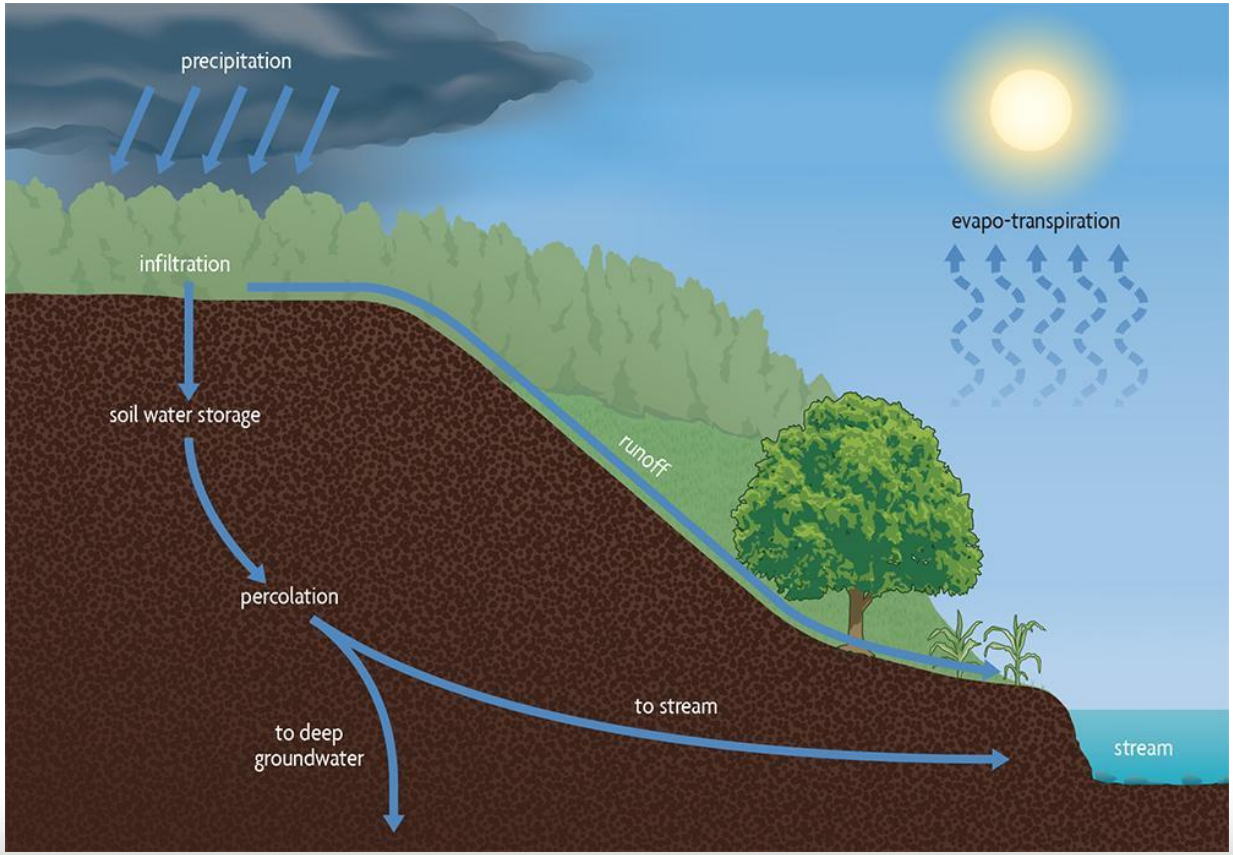


Illustration by:
Vic Kulihin

How water moves through a system reflects its stability and resilience

Soil Health: Building Resilience

Catalyst BioAmendments
REGENERATING SOIL

IRVINE COMPANY
RETAIL PROPERTIES



If we improve soil health, can we effectively reduce water use?

20% Reduction of Irrigation

Achieved on the treatment plots

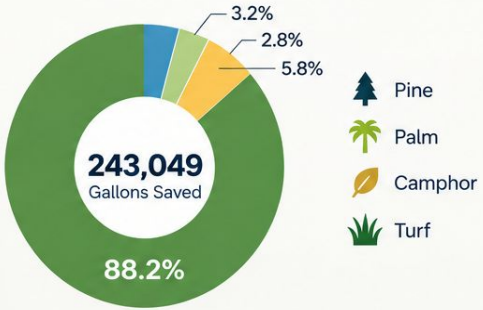


243,000 Gallons Saved To Date
(4 irrigation valves) — over a two year period

This was for an area only
0.16 Acres

Plant Group	Total Water Savings (Gallons)	% of Total
Pine	7,671	3.2%
Palm	6,921	2.8%
Camphor	14,168	5.8%
Turf	214,289	88.2%
Total	**243,049**	**100%**

Share of Total Water Savings



243,000
Gallons Saved
(4 irrigation valves)
over two years

0.16 Acres
Total Area
(6,988 sq. ft.)

20%
Reduction Achieved
on treatment plots

DUNBAR/SPRING NEIGHBORHOOD FORESTERS



Photo credit:
Brad Lancaster

Community action infiltrated 1.25 million gallons of stormwater annually; 1800 native food bearing plants; 30° F cooler than exposed street asphalt. Climate resilience at the community level.

Who's the hardest working, earliest professional hydrologist and engineer?



Photo Credit: National Wildlife Foundation

The time honored beaver is a keystone specie.



Photo Credit: Utah State Beaver Ecology & Relocation Collaborative

Conventional Remediation = Single Outcome Technology

Dig & Haul



Concrete Capping



Thermal



Injection Chemical



What's Beyond Single Outcome Technology?

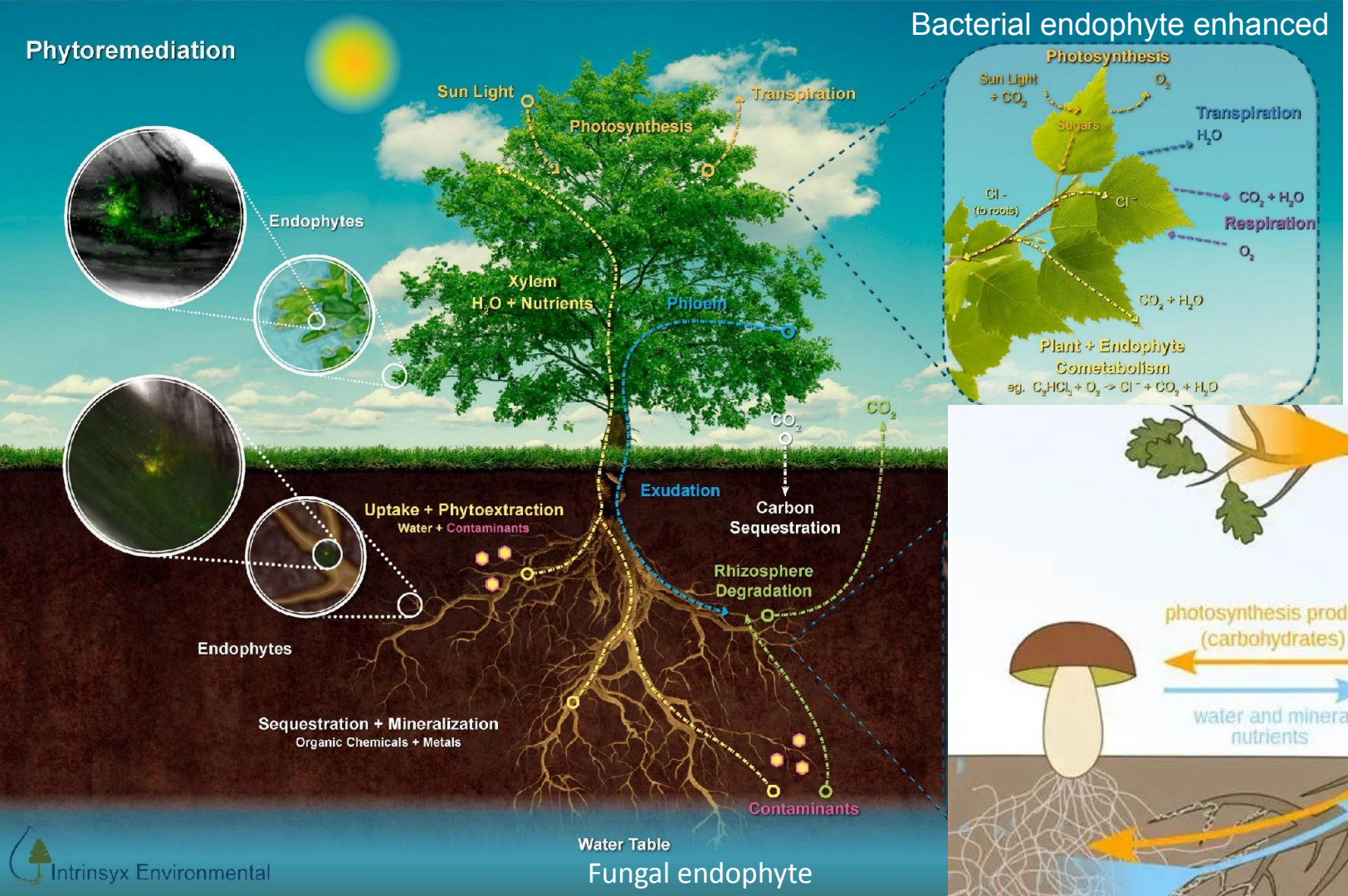
Natural Infrastructure + Nature-Based Solutions + Engineering with Nature



Credit: Reef Ball Foundation



Credit : Intrinsyx

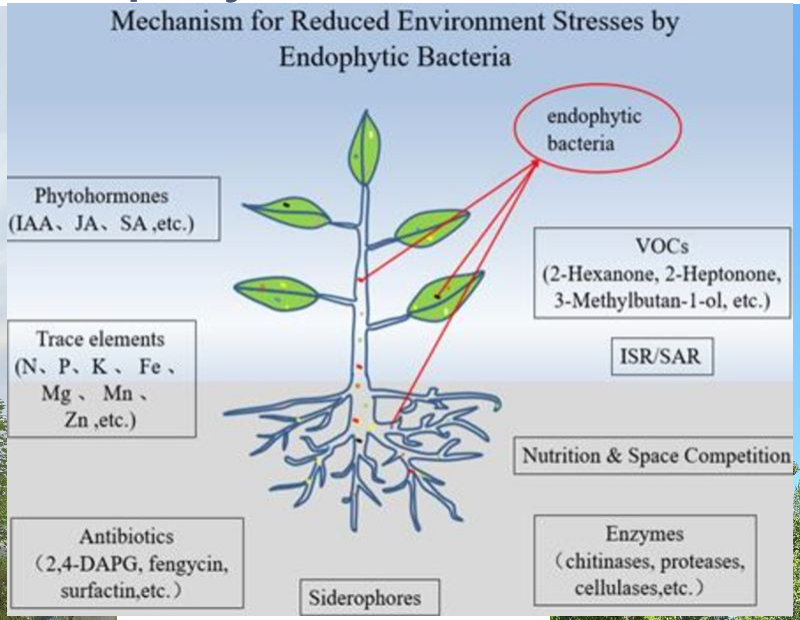


Bacterial endophyte enhanced

Fungal endophyte

From Old Gas Stations to Active Campuses this Technology is Deployable with Enhanced Efficiency







Credit: Intrinsyx Environmental

15 acres, Hybrid Poplar System, 30 Million Gallons Leachate Consumed on Site







Photo credit:
Leachate Management
Specialists





Remediation **Restoration** **Regeneration**



Creating functional and healthy ecosystems can provide a pathway for long-term environmental resilience and financial stability.

Collaborative Partner for Complex Challenges

Secure Technical and Funding Resources

Strategic Development



Master Plans

Co-Create Long-Term Assets

Thank You!

Cuauhtemoc Landeros

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Let's Connect!

Scan to get in touch with a Tribal TAB member or to join our mailing list

SCAN ME!

www.tribaltab.org

This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement (TR-84085401) to Kansas State University. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document.

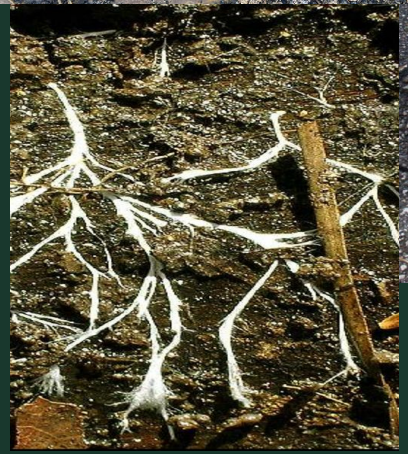
Pairing with nature to support nature

Applied ecological remediation
for soil, communities and parks









Dr. Danielle Stevenson

Centre for Applied Ecological Remediation

Fungi are already on contaminated sites

Contaminated sites in Southern California: *Cladosporium halotolerans, Alternaria chlamydosporigena*. Stevenson et al (2025, STOTEN)







Pure tar: melanized fungus *E. xenobiotica*

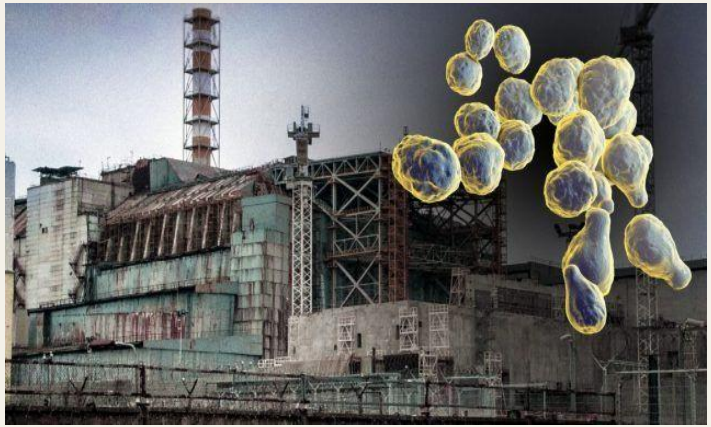
Pure Oil Tailings: the Ascomycete *Trichoderma harzianum.*



Growing plants on oily, nutrient-poor soil using a native symbiotic fungus.

•Timothy S. Repas et al.
•Published: October 19, 2017

Plastics: *Cladosporium cladosporioides*, *Penicillium griseofulvum, Agaricus bisporus and Marasmius oreades* . Brunner et al. (2018) *PLOS ONE.*



Chernobyl: three melanin-containing fungi—*Cladosporium sphaerospermum, Wangiella dermatitidis, and Cryptococcus neoformans*. Dadachova E et al (2007). PLOS ONE.



Plants, fungi and bacteria work together

Decomposer fungi

Break down some carbon-based pollutants.
Example: *Pleurotus ostreatus* (oyster mushroom)

Plant–fungal partnerships

Can help extract or stabilize metals.
Metals are elements and cannot biodegrade.
Example: arbuscular mycorrhizal fungi

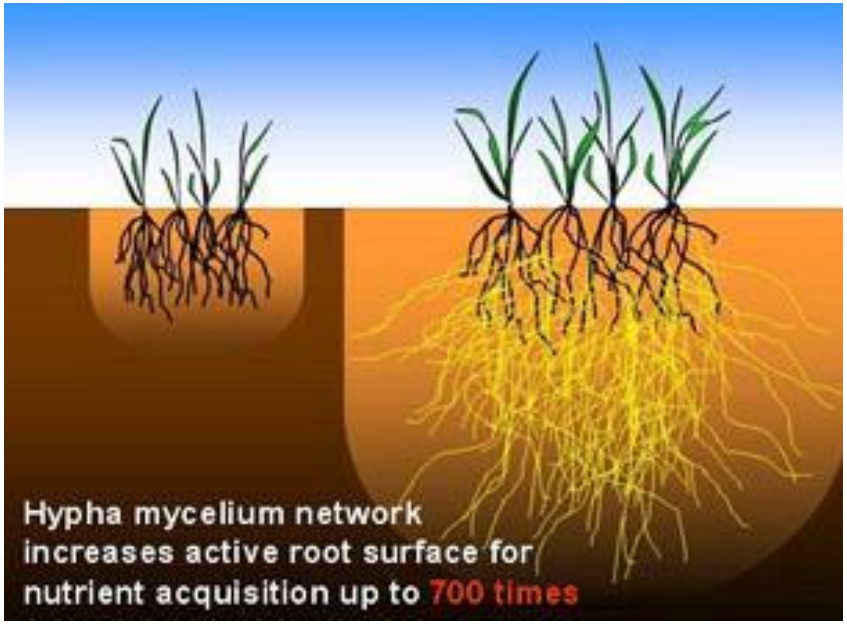
Bacteria and other fungi

Continue breaking down simpler compounds.



Suitable plants, organic material and moisture help support these relationships.

Arbuscular mycorrhizal fungi (AMF) help plants grow and may help them extract more metals and enhance phytoremediation success



Allen, M. Mycorrhizal Ecology, 2021



Thomas et al, 1998. Mycoremediation of Aged Petroleum Hydrocarbons in Soil.

Other fungi who are **decomposers, such as Oyster mushrooms** (*Pleurotus ostreatus*) have been found to be able to break down complex, organic contaminants such as PAH's, diesel and solvents.

A 12-month test on three LA brownfields



Taylor Yard G2

LA Ecovillage

Slauson and Wall

Plants + fungal treatments
(Stimulated vs augmented)
With and without irrigation
Untreated comparisons

Completed field study. Future land uses included parks, gardens and community space.

Measured soil metal reductions after 12 months

Reported mean reduction in metal(loid) concentration



Study averages vary by site and treatment. Concentration reduction alone does not establish safe reuse.

A mushroom farm became a research partner



99.75%

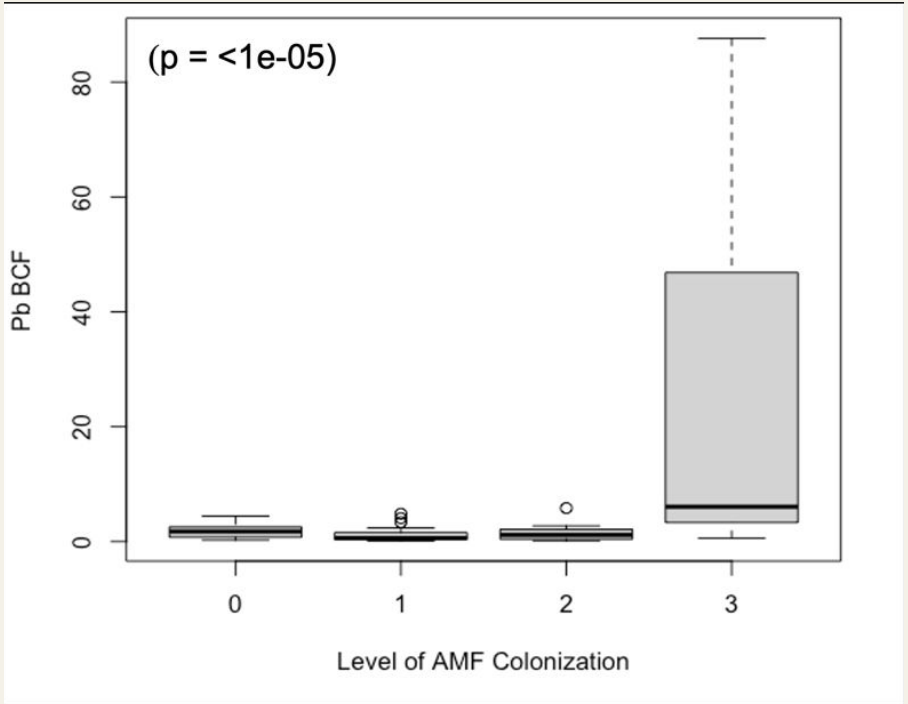
reported average reduction in measured hydrocarbons

Oyster mushroom treatments used spent growing blocks from Smallhold, a local farm.

A study-specific result, not a universal removal rate.

Root-associated fungi supported plant growth

Arbuscular mycorrhizal fungi (AMF)



Metal accumulation

AMF root colonization was the most significant predictor of plant accumulation of lead (Pb).

Plant performance

AMF increased plant survival and biomass.

Root colonization levels
0: none 1: 1–10%
2: 11–50% 3: >50%

Lead shown. BCF = plant metal concentration ÷ soil metal concentration. Findings from the reported study analysis.

Visible recovery, verified through sampling



Before treatment



After establishment

LA Ecovillage study photographs.

Fungal partners helped plants under drought: AM fungal inoculation reduced soil Cr concentration b



Low / trace AM fungi



High AM fungi

Same challenge: High hexavalent chromium + drought

Greater plant growth with root-associated fungi

35% vs. 75%

soil water-holding capacity in the greenhouse experiment

Alfalfa greenhouse study. Photographs illustrate the observed response.



The addition of the fungus P. ostreatus as mulch was correlated with reductions in Cr(VI)

Designing for heat and limited water

Native plants are a starting point

Telegraphweed and California buckwheat were among the plants tested.

Soil cover is part of the design

Living roots and suitable mulch can support moisture retention and protect exposed soil. Establishment water still matters.



Drought response was tested. Cooling and irrigation savings require separate measurement.

Research beyond the cleanup



Fungal materials



Creative reuse experiments

Collected plant and fungal byproducts supported materials and biofuel tests.

Experimental pathways. Contaminant fate and safe handling remain part of the research.

Community involvement shapes the work and builds local workforce



Santa Ana

25 participants

12 weeks

3 residential pilot sites

Soil Lead Practitioner Cohort with Orange County Environmental Justice in its 3rd year

Completed cohort outcomes: local knowledge, soil science and hands-on practice.

STEM learning through youth participation in local



50 youth

completed a bioremediation certificate program

Now in its 5th year!

Field + laboratory + analysis and research mentoring + career development + science communication.

Field and laboratory practice + HAZWOPER

Community-based training links STEM learning with local environmental questions.

Parks connect soil recovery with public life



Completed research

Taylor Yard G2 links soil bioremediation research to a future park (see photos).

Next applications

Post-fire parks and open space
Site assessment and pilots
Continued monitoring

Park benefits depend on contaminant results, maintenance and safe access.

Principles of ecological remediation

Mimic succession	Support natural regeneration by helping ecological processes get started.
Diversity supports resilience	Use complementary organisms to address contaminants and rebuild ecosystem function.
Keystone remediation species	Select organisms with key treatment roles to support effective cleanup.
Waste as a resource	Reuse suitable organic materials to reduce landfill disposal and support circular systems.
Bioregional approaches	Work with locally suited, non-invasive species adapted to site conditions.

Pairing with nature to support nature

A park can support soil recovery while people help shape its future.




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Harnessing Nature for Site Remediation



Johnston Duffey, Environmental Engineer, Ramboll



Why Phytoremediation?

- Sustainability
- Aesthetics
- Enhanced Ecosystem Services
- Permanent
- Non-invasive
- Flexibility
- Effectiveness
- Reduced Capital Cost
- Reduced O&M

Phytoremediation Applications

Sites and Media

- Contaminated Soil and Groundwater
  - Oil and gas facilities
  - Mine sites
  - Industrial sites
  - Military facilities
  - Spill sites and dumping grounds
- Landfill Leachate
- Industrial Wastewater
- Agricultural Runoff

Contaminants

- Petroleum Hydrocarbons
- Chlorinated Solvents
- Heavy Metals
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Polychlorinated Biphenyls (PCBs)
- Pesticides
- Explosives
- Radionuclides
- Excessive Nutrients
- PFAS and other emerging contaminants:
  - active areas of research





Example Applications

- Evaluation of existing common reed for selenium phytoextraction at a former slag-disposal area
- Willow cover system managing alkaline, brackish leachate across uncapped waste tailings while creating inland salt marsh habitat
- Native vegetation used for phytostabilization and ecological restoration at a PCB-impacted site
- Poplar system providing hydraulic control and treatment of pesticide-impacted groundwater
- Phytoscreening used to target intrusive investigation in wooded and dense urban settings
- Constructed treatment wetland addressing landfill leachate

Complementary Remedy Design in a Harsh Environment

Background

- TCE in groundwater at industrial site in Southern California
- Large site with multiple simultaneous remediation approaches

Challenges

- Arid climate
- Impacted GW flowing toward site boundary
- Tight weathered granite and limited shallow groundwater
- Pests (borers, rodents, coyotes)



Solution

- Deep tree borings with deep drippers to encourage root growth to groundwater
- Gravity drip irrigation system with solar powered controls
- Irrigation water sourced from existing extraction system
- Planting design adapted to include multiple species suited to site conditions

Results

- TCE remains non-detect at the downgradient monitoring point
- Greater than 97% TCE reduction in the middle of the plantation
- Results are consistent with the plantation’s intended role as part of the site-wide remedy





Phytoremediation as Sustainable Remediation

Potential life-cycle advantages:

- Uses biological processes to complement mechanical treatment
- May reduce energy, materials, waste generation, and site disturbance
- Can beneficially reuse treated water (irrigation)
- Integrates remediation with the site landscape and future land use
- May provide habitat, stormwater, shade, carbon-storage, and aesthetic benefits

Benefits are site-specific:

- Irrigation, monitoring, plant replacement, and maintenance still have environmental and financial costs

Sustainability depends on net value across the remedy life cycle, not simply the presence of vegetation.

Resilience of a Living Remedy

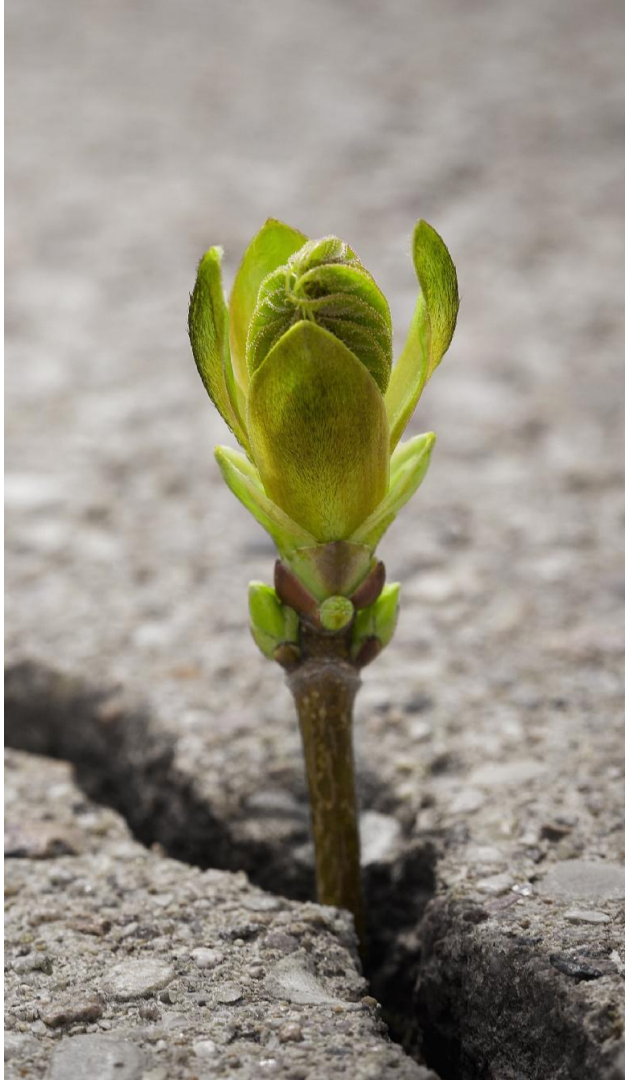
Sources of Resilience

- Site-appropriate species and planting design
- Species diversity
- Engineered redundancy in water delivery and controls
- Monitoring of plant health and remedial performance
- Adaptive irrigation and maintenance

Potential Vulnerabilities

- Drought, extreme heat, wildfire, pests, disease, and changing groundwater conditions

Resilience is not inherent (in human-constructed systems). It must be designed, monitored, and maintained.



CALIFORNIA LAND RECYCLING CONFERENCE

Imagine | Innovate | Implement

September 29 – October 1, 2026 | Foster City

THANK YOU!

IMAGINE, INNOVATE, IMPLEMENT THE FUTURE OF LAND RECYCLING

We appreciate your feedback, follow this QR code to submit an evaluation form on Whova.

Join the conversation, use #CALRC2026 to share your photos, insights and highlights!

OFFICE OF BROWNFIELDS
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