



**The latest, greatest, and
what we don't need to
do again in rangeland
restoration science**

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CSSRM 2021 - 10/7/21



**COLORADO STATE
UNIVERSITY**

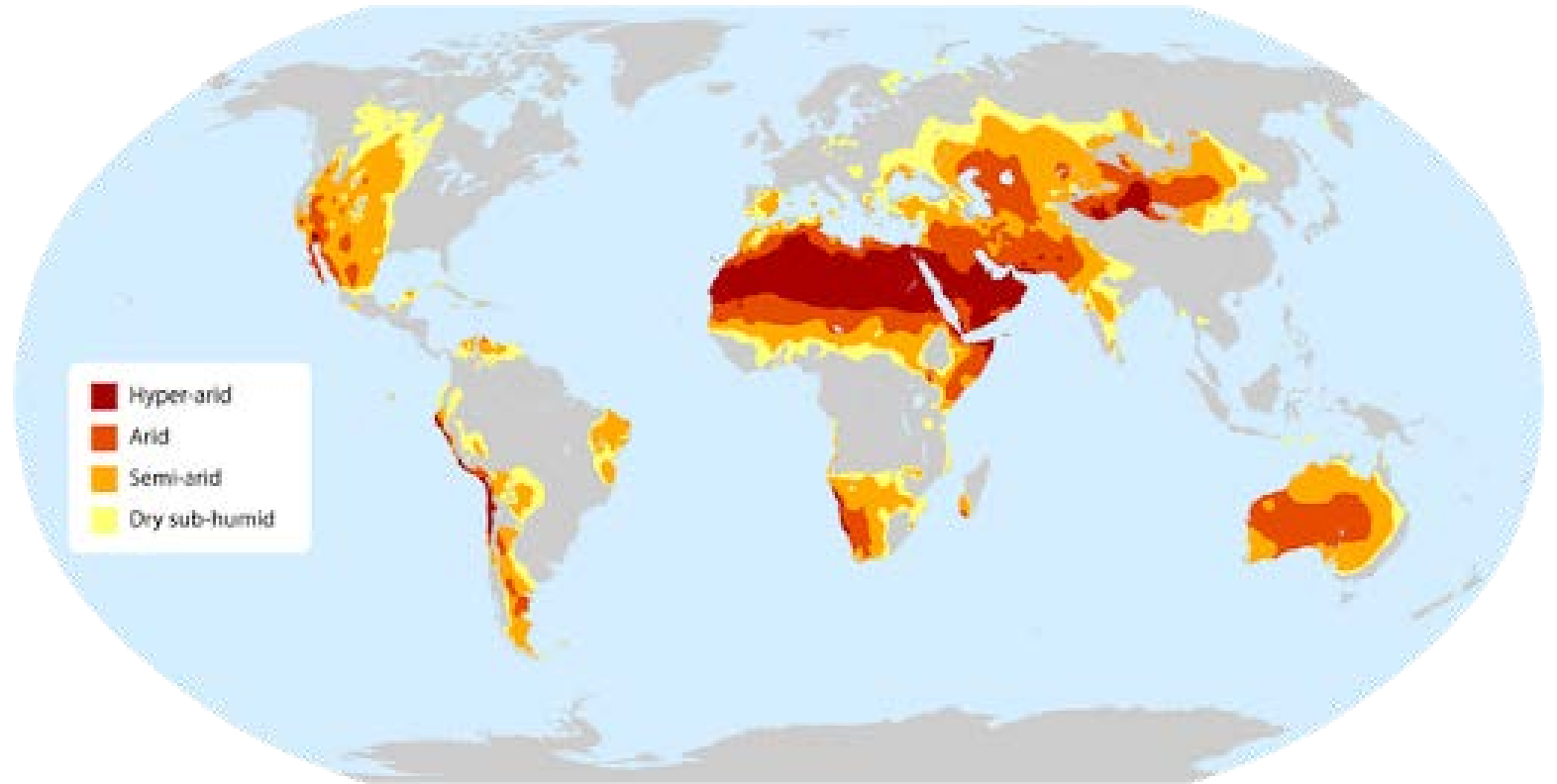


Roadmap

- Challenges – *why is rangeland restoration so tough?*
- What can we do?
 - What we know
 - The latest & greatest
 - What we (maybe) don't need to do again

Dry Rangelands

- 40%+ of Earth's landmass
- Support 1/3 of the global population
- Highly susceptible to degradation

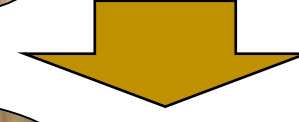
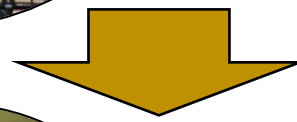
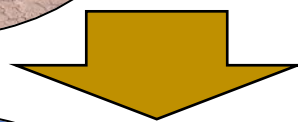
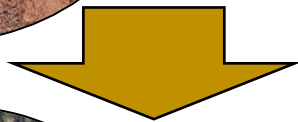


Why are rangelands important?

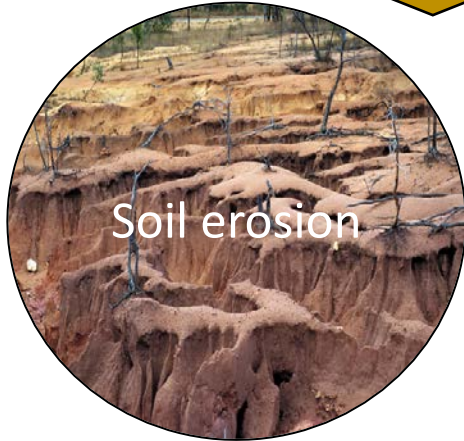


Why do rangelands need to be restored? drivers and impacts of degradation

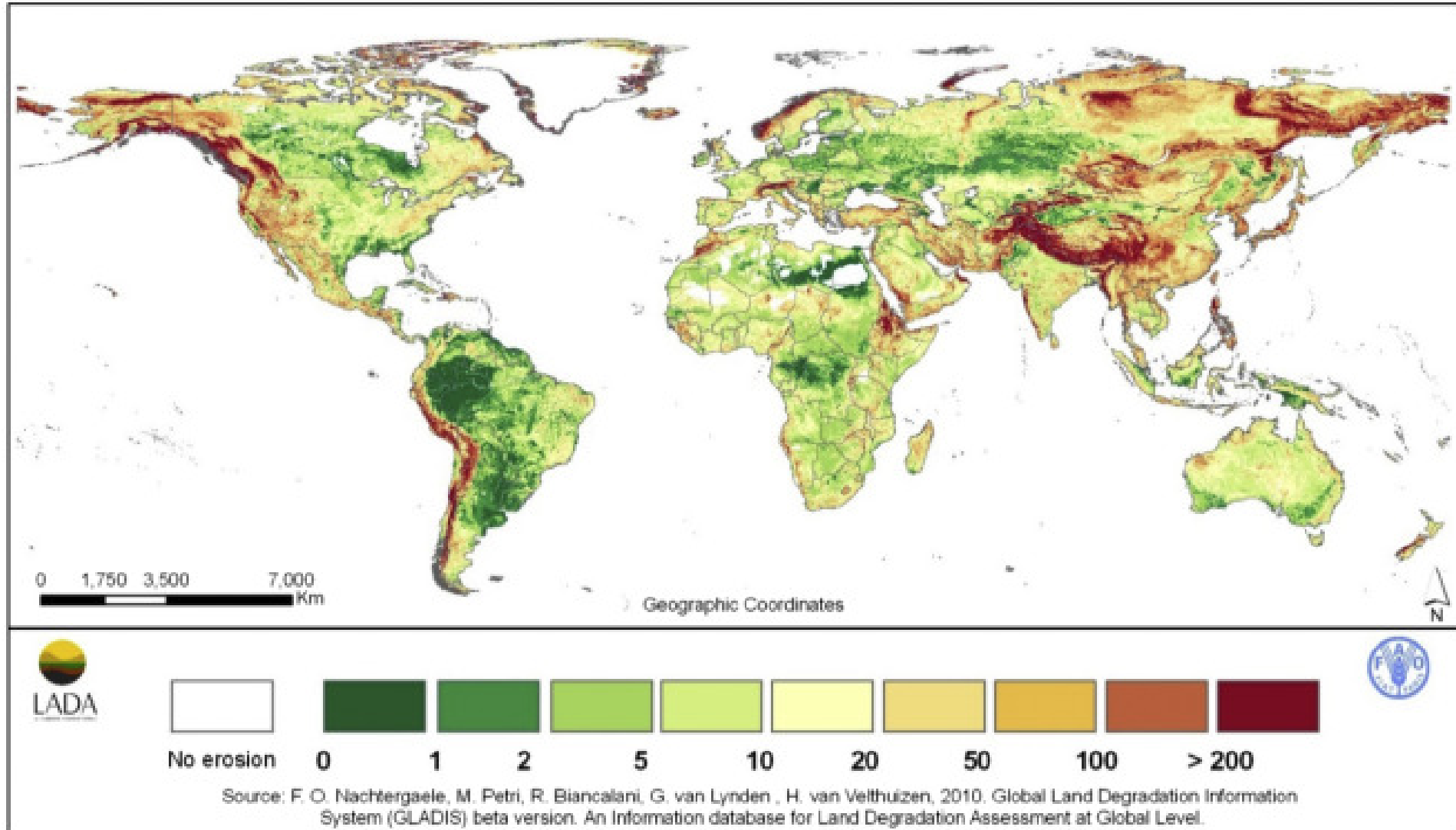
Drivers



Impacts



Rangeland degradation is widespread



Rangeland restoration is tough...



Poll 1:

What is the largest barrier to
rangeland restoration success?
(1 word)



Why is rangeland restoration so tough?



• Challenges

- Water limitation
 - Low, variable precipitation
 - High temperatures
 - Low soil water-holding capacity
- Soil degradation
- Constant change (aridification, variability)
- Low seeding success
 - ~2-7%

Rangeland restoration

What we know

The latest & greatest

What we don't need to do again

Rangeland restoration

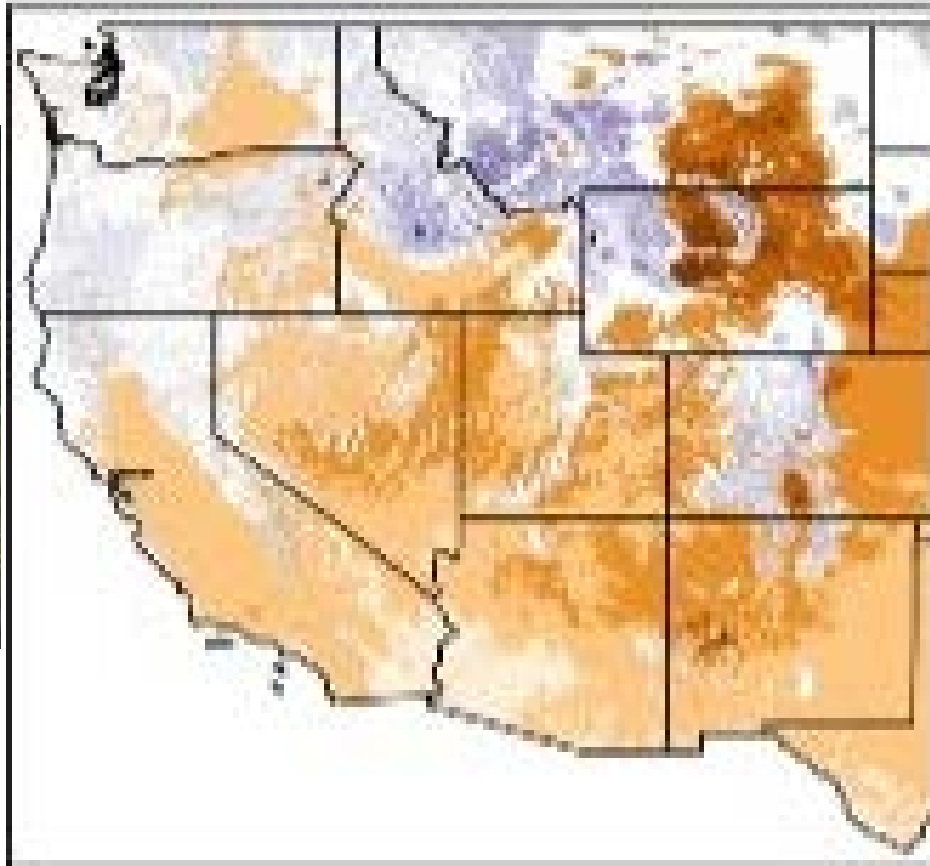
What we know

The latest & greatest

What we don't need to do again

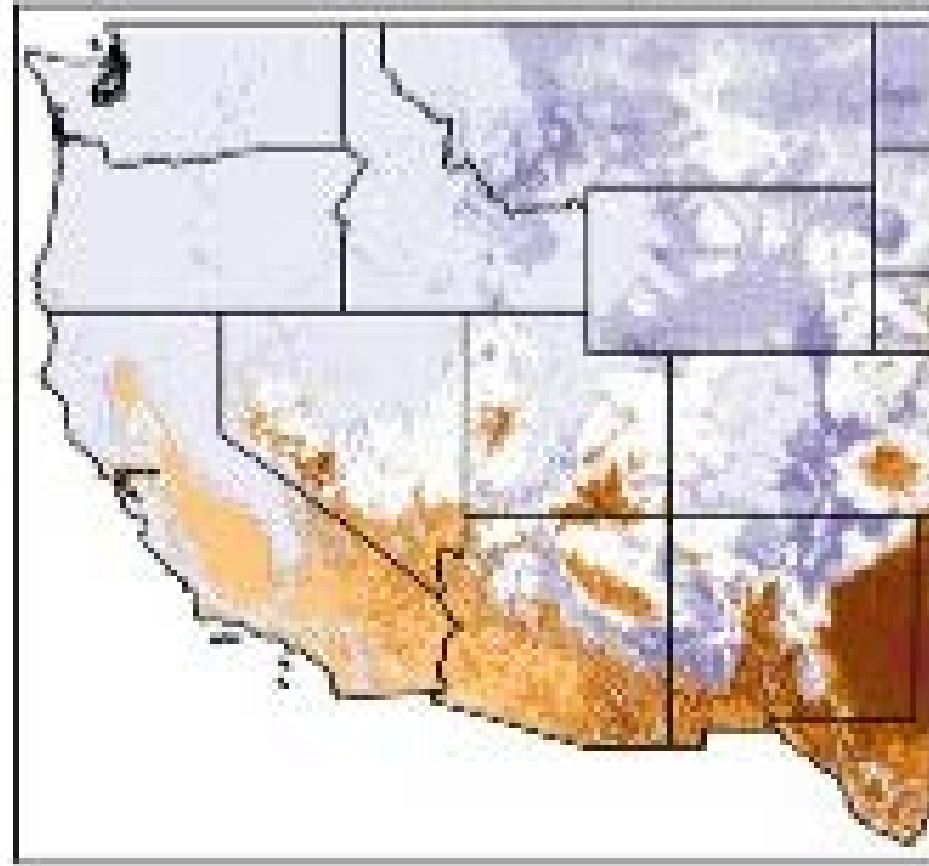
Needle and Thread (C3)

Hesperostipa comata

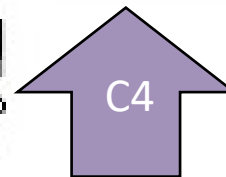
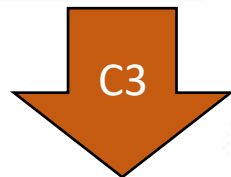


Sand Dropseed (C4)

Sporobolus cryptandrus



Habitat suitability

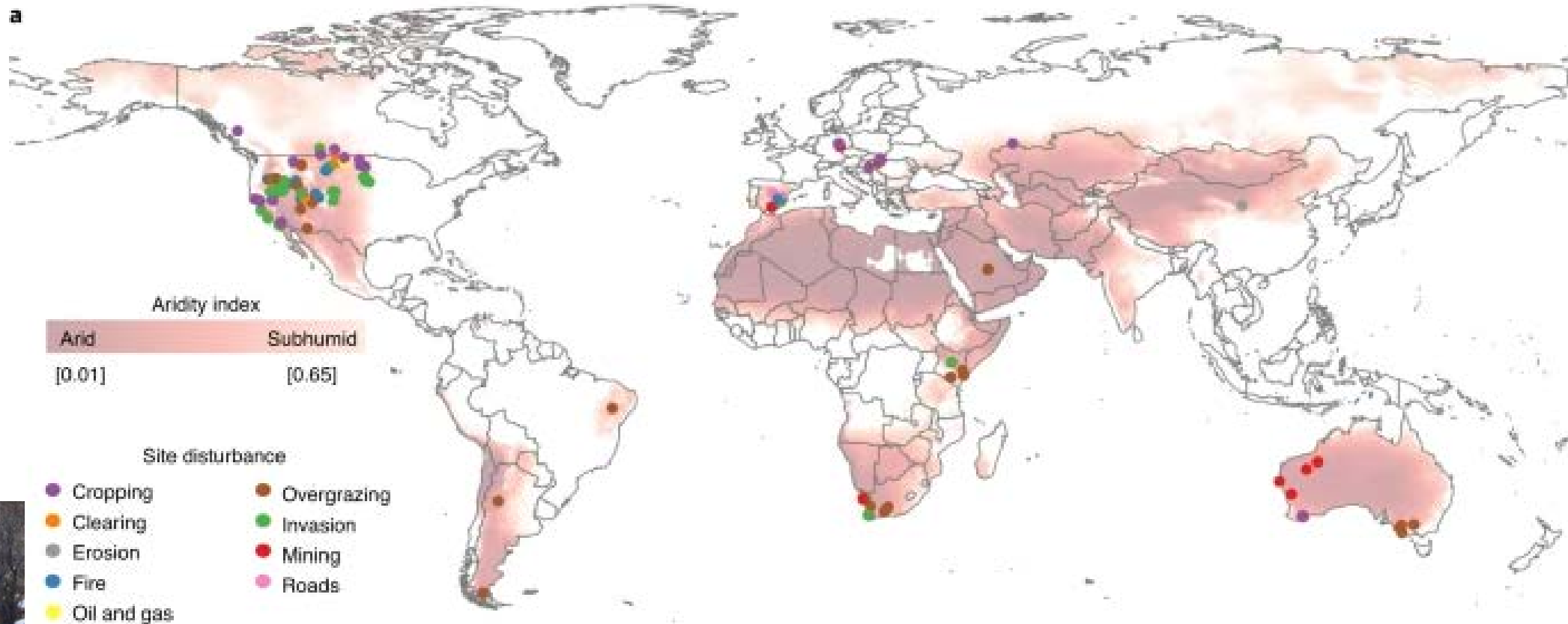


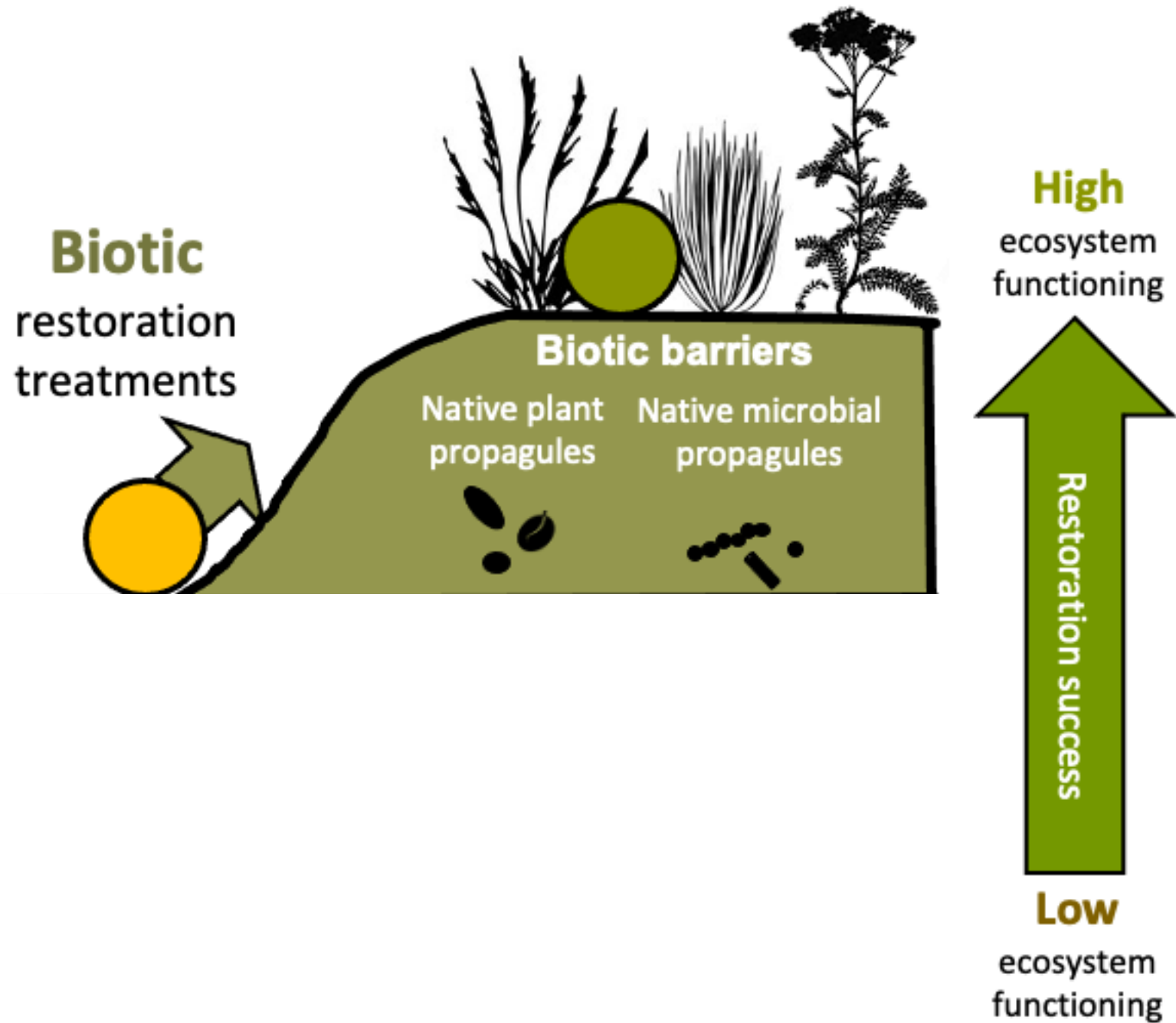
$\Delta \lambda$

Aridification threatens perennial grass productivity

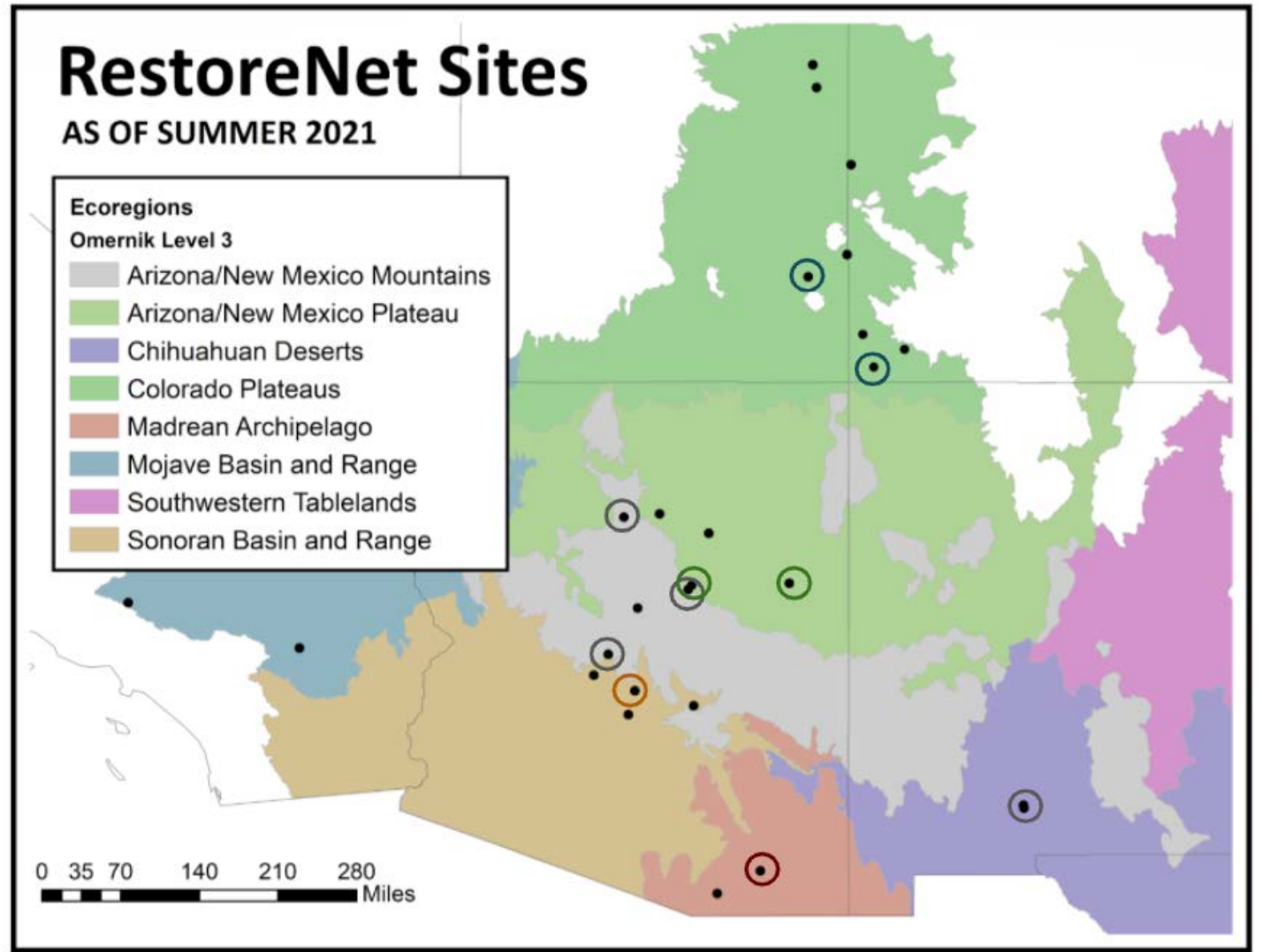


Fig. 1: Restoration seeding in drylands globally showed limited but promising success.





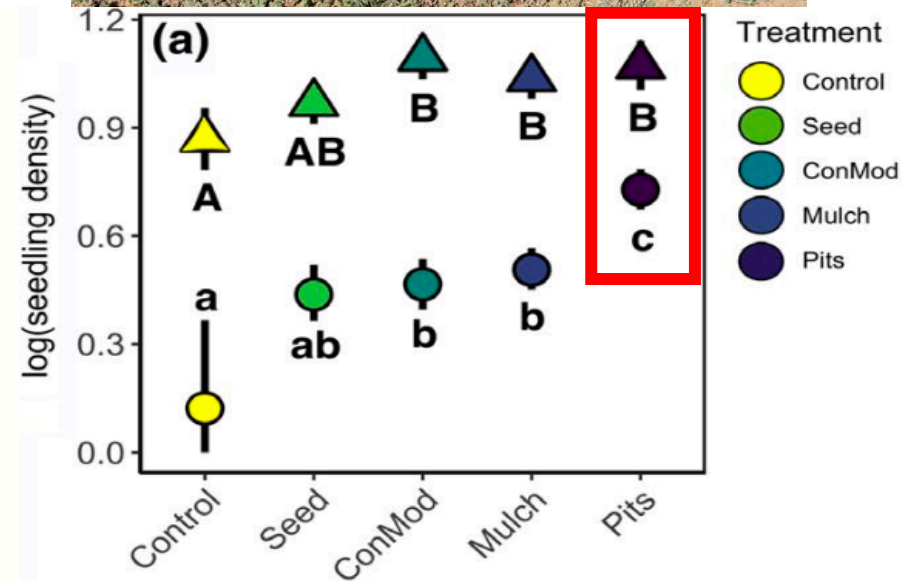
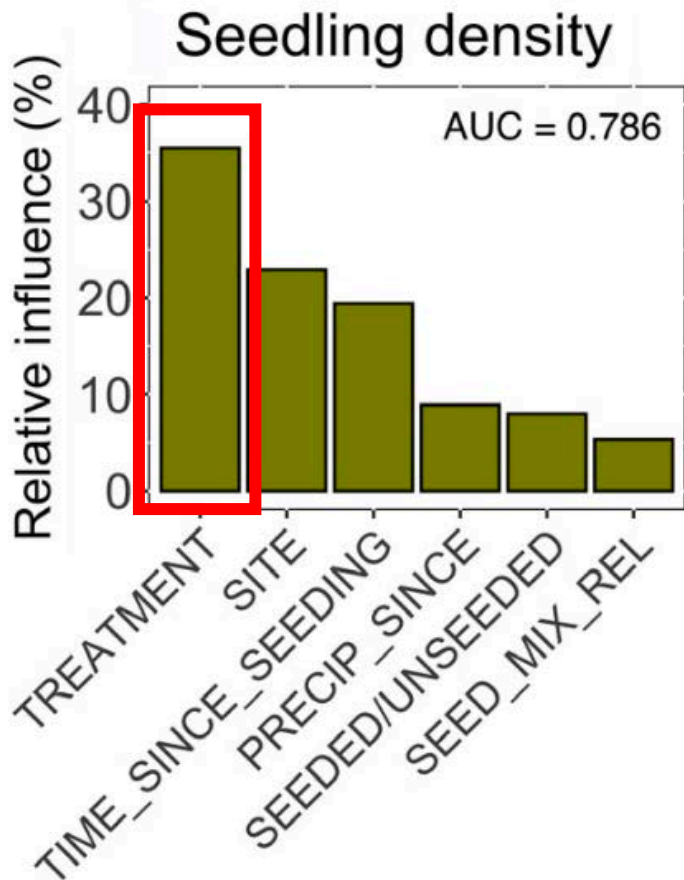
RestoreNet –
restoration
treatments can be
used to overcome
barriers to
recruitment



What we know

RestoreNet –
restoration
treatments can be
used to overcome
barriers to
recruitment

Treatments were
more important
than seed mix type



Treatments that
supported water
capture were
most successful

Rangeland restoration

What we know

The latest & greatest

What we don't need to do again

Rangeland restoration

What we know

The latest & greatest

What we don't need to do again

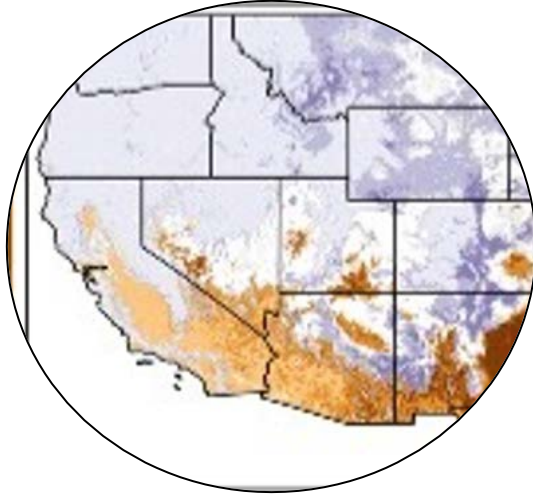
Poll 2:

What's one idea or technique you're really excited about in rangeland restoration?
(1 word)



The latest and greatest rangeland restoration is...

CLIMATE-ADAPTIVE



TRAIT-BASED



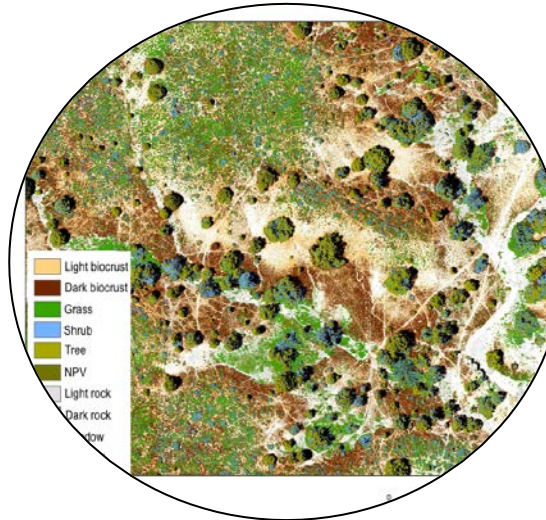
INNOVATIVE



SOIL-CONSCIOUS



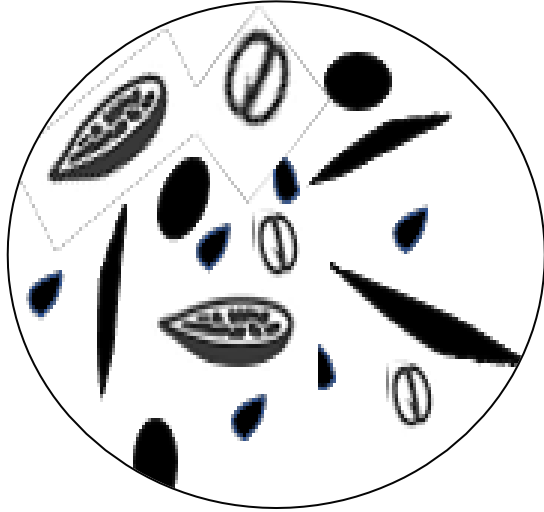
TECH-SAVVY



COLLABORATIVE



WHAT DO I SEED?



WHEN DO I SEED?

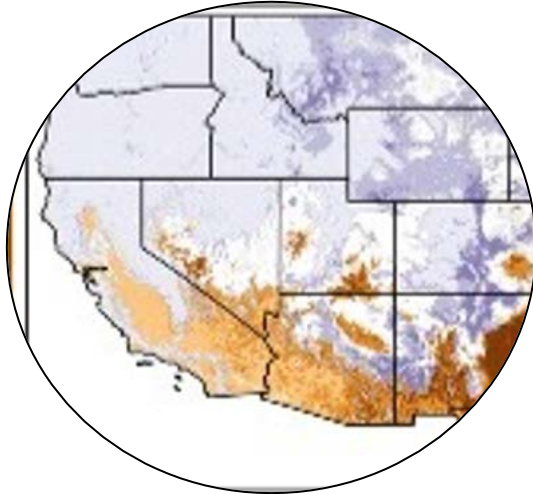


HOW DO I SEED?



The latest and greatest rangeland restoration is...

CLIMATE-ADAPTIVE



TRAIT-BASED



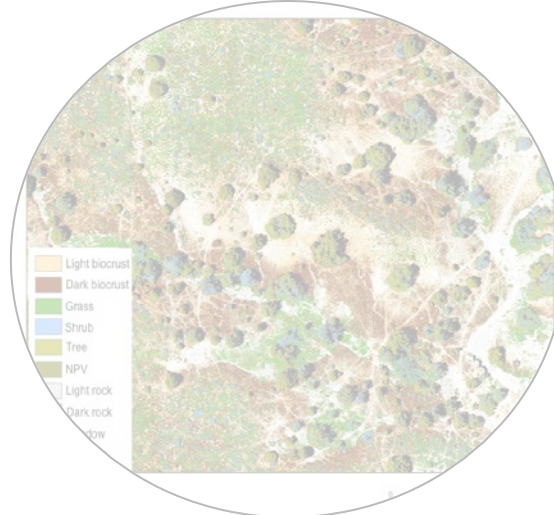
INNOVATIVE



SOIL-CONSCIOUS

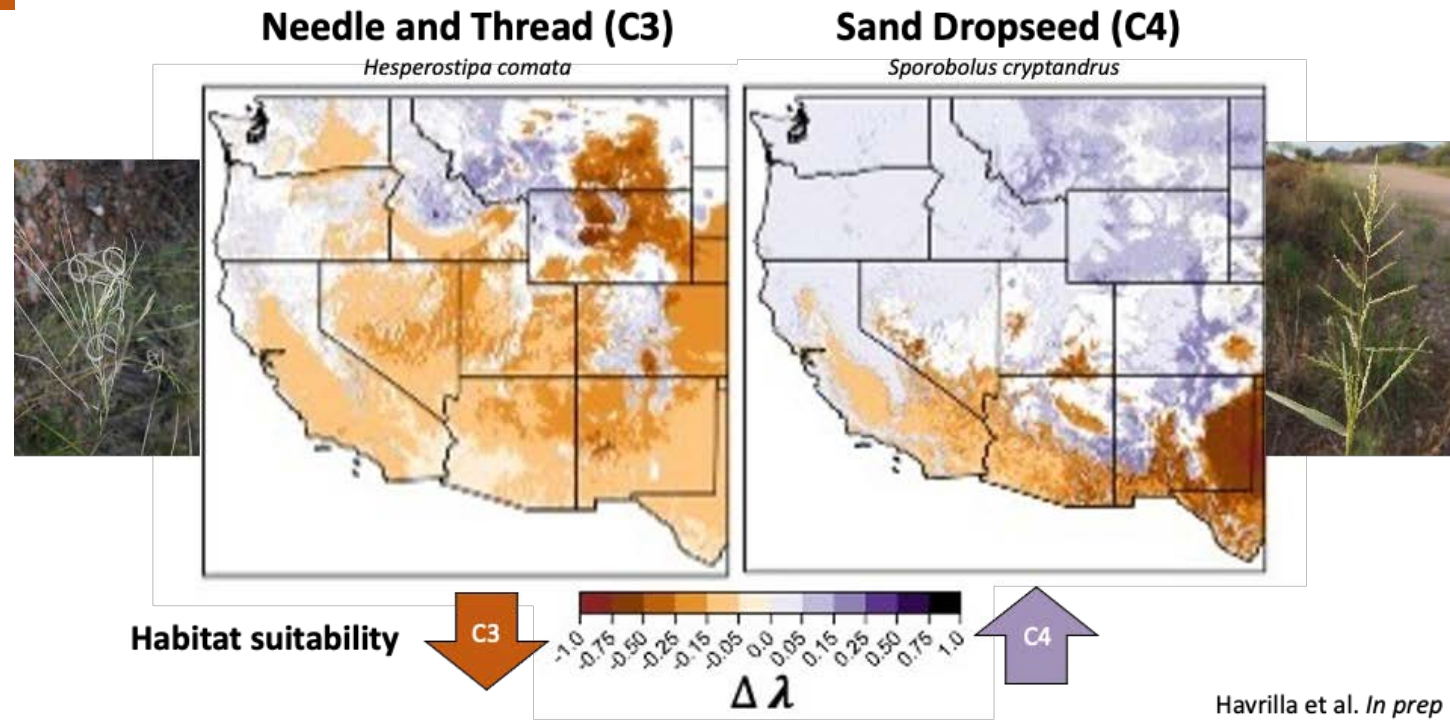


TECH-SAVVY



COLLABORATIVE





WHAT DO I SEED?



Species/functional composition

Use seed sources from warmer regions

WHEN DO I SEED?



Adjust timeframes – dormant seedings?

HOW DO I SEED?



Water-retention treatments

The latest and greatest rangeland restoration is...

CLIMATE-ADAPTIVE



TRAIT-BASED



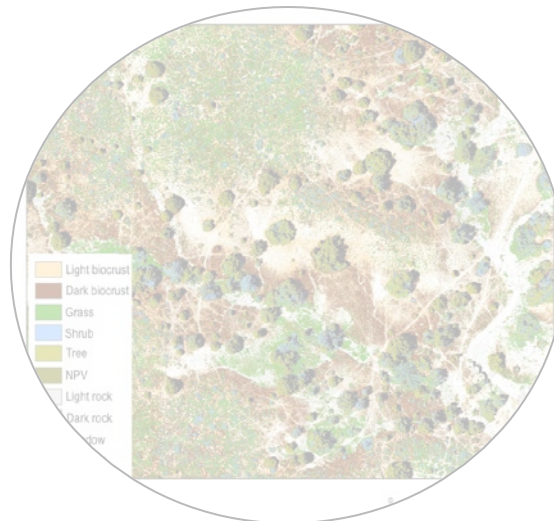
INNOVATIVE



SOIL-CONSCIOUS



TECH-SAVVY

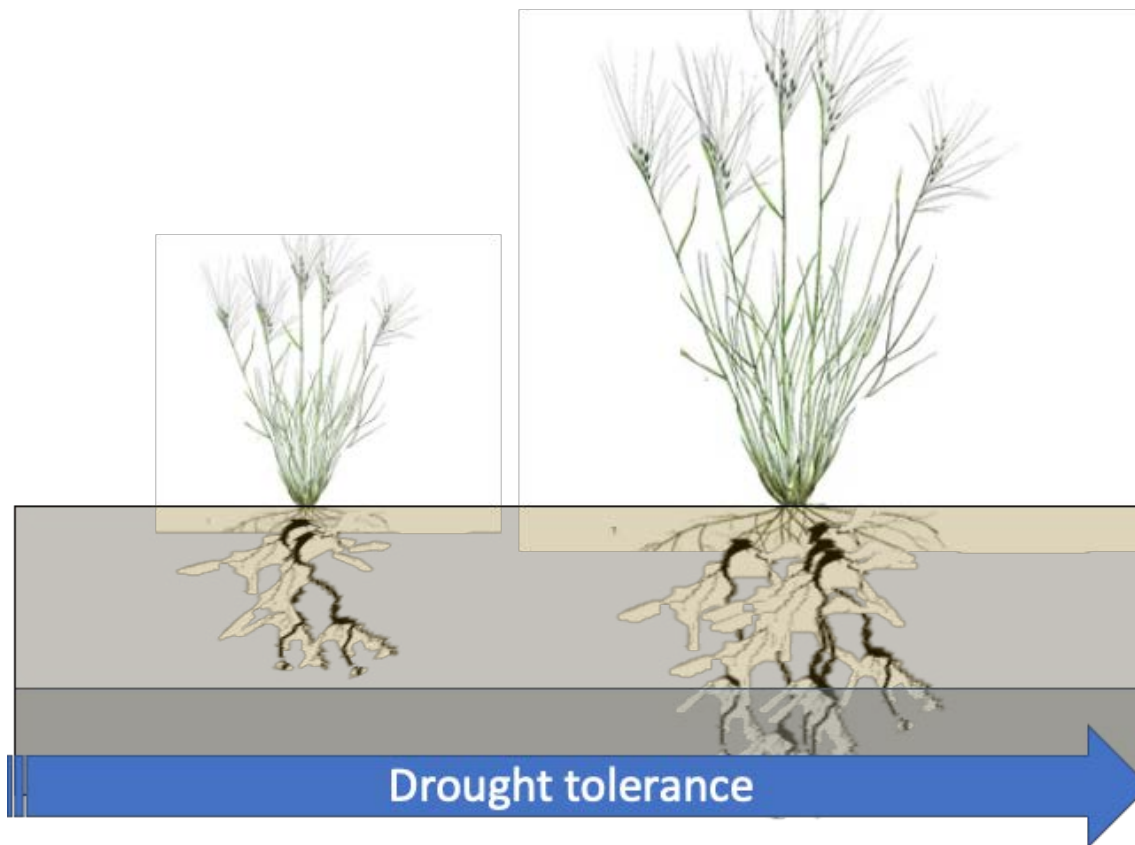


COLLABORATIVE



Beyond species-based restoration (traits)

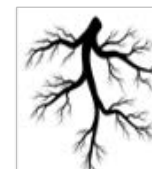
TRAIT-BASED



Low leaf area (SLA)
Lower leaf water losses



Higher root:shoot ratio (RSR)
Higher water foraging capacity



Deeper, heartier roots
Greater access to deeper soil moisture, water conservation

WHAT DO I SEED?



Traits suited for drought adaptation

Competition with invasives

The latest and greatest rangeland restoration is...

CLIMATE-ADAPTIVE



TRAIT-BASED



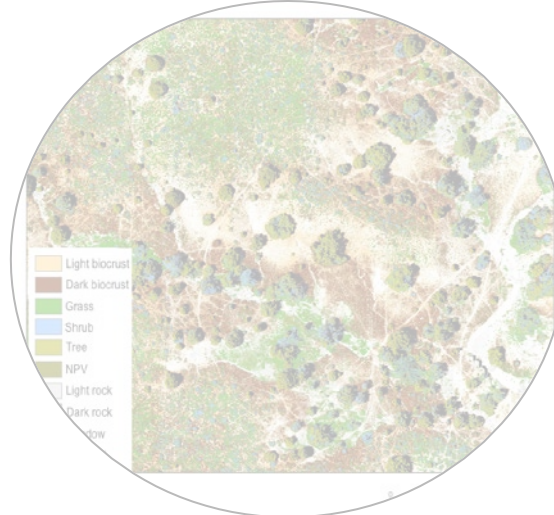
INNOVATIVE



SOIL-CONSCIOUS



TECH-SAVVY

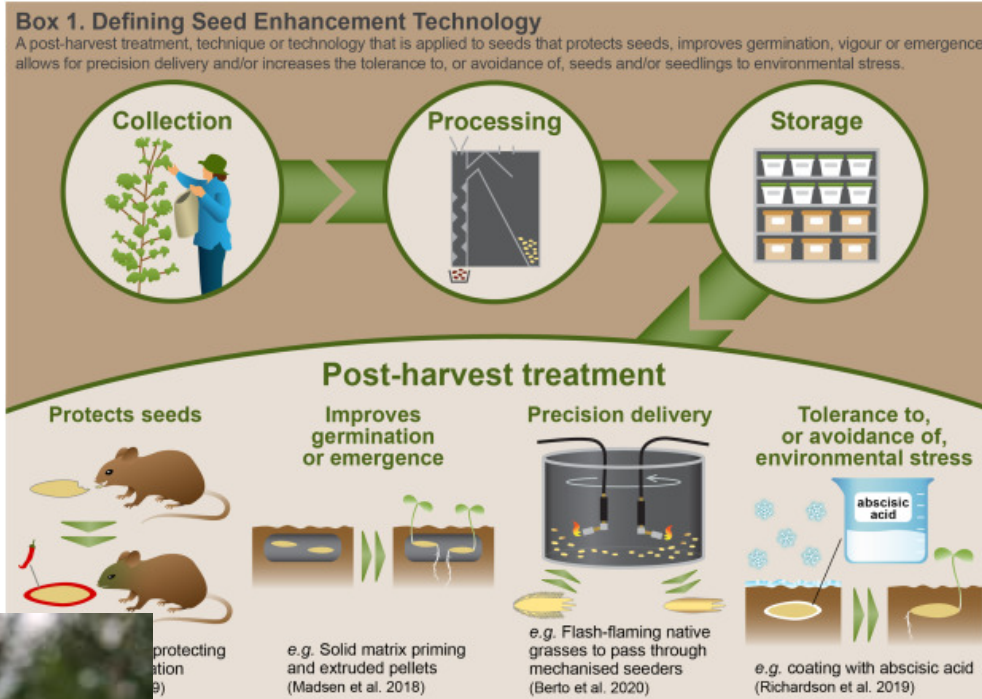


COLLABORATIVE



SEED ENHANCEMENT TECHNOLOGY

E.G., SEED PRIMING, COATING



MATT MADSEN, BYU

HOW DO I SEED?



With innovative technologies that alleviate barriers to recruitment success

SEED BALLS

E.G., SEED PELLETS



ELISE GORNISH
UNIVERSITY OF ARIZONA

The latest and greatest rangeland restoration is...

CLIMATE-ADAPTIVE



TRAIT-BASED



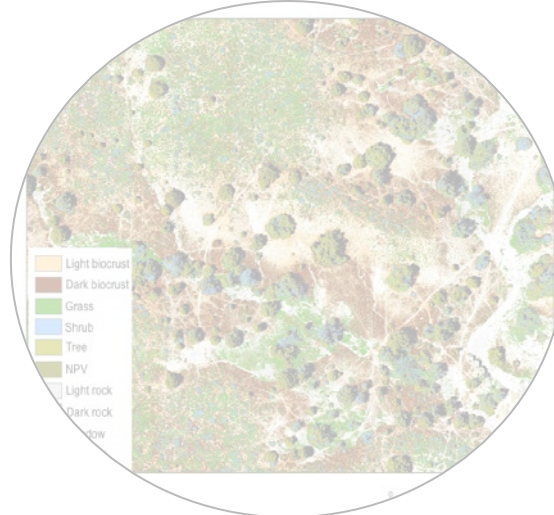
INNOVATIVE



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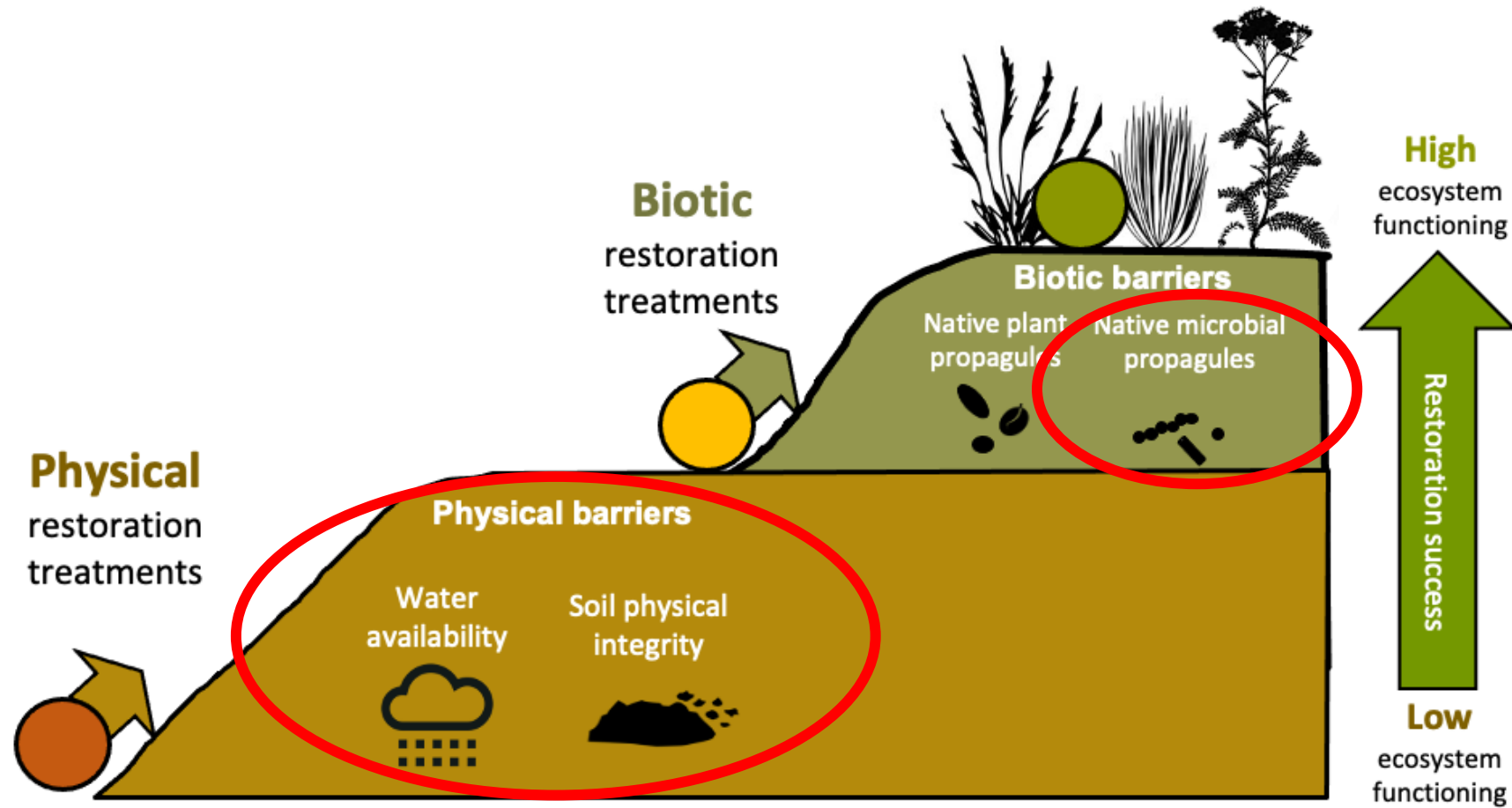


TECH-SAVVY



COLLABORATIVE





WHAT DO I SEED?



Soil microbes?

Seeds + microbes?

WHEN DO I SEED?



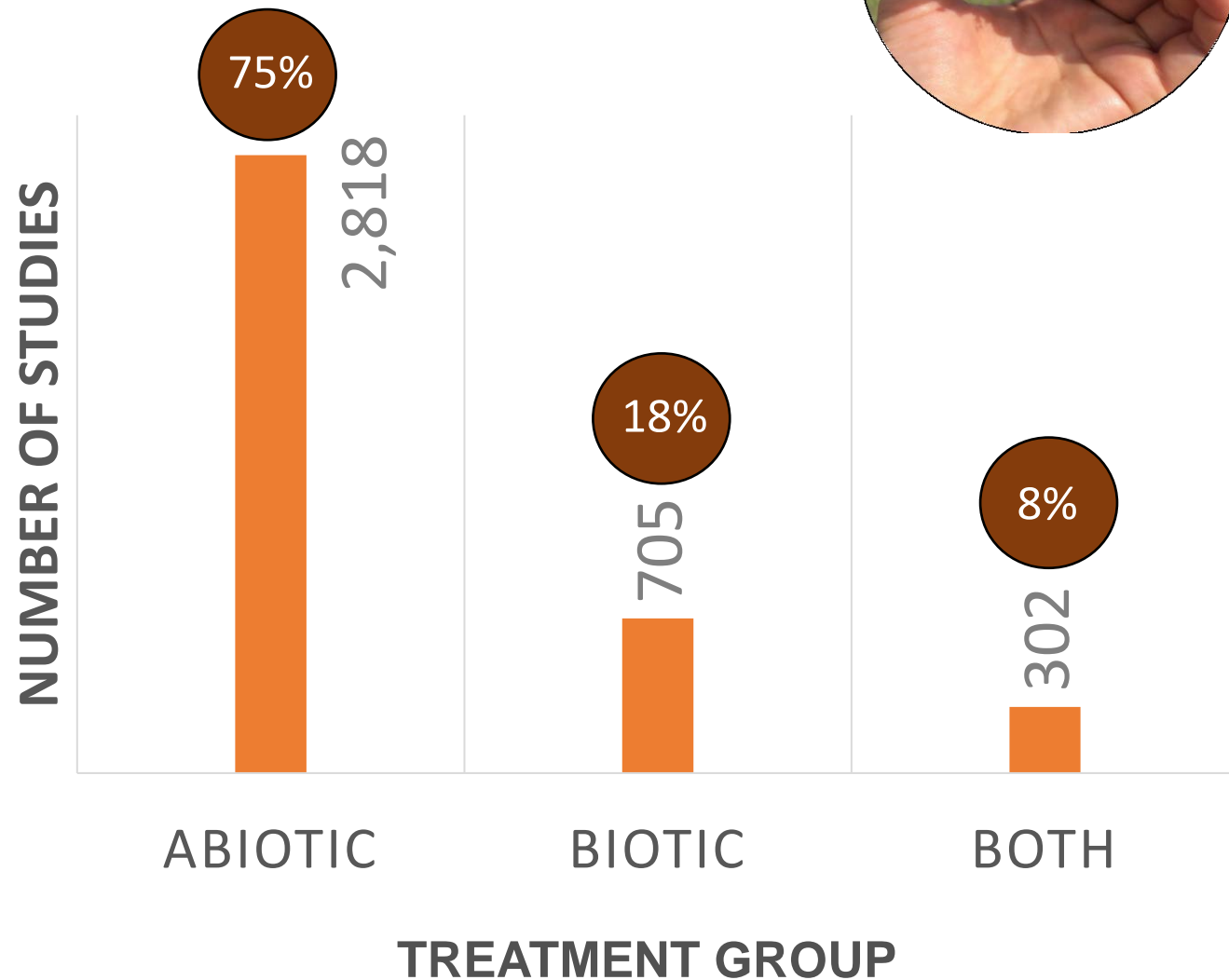
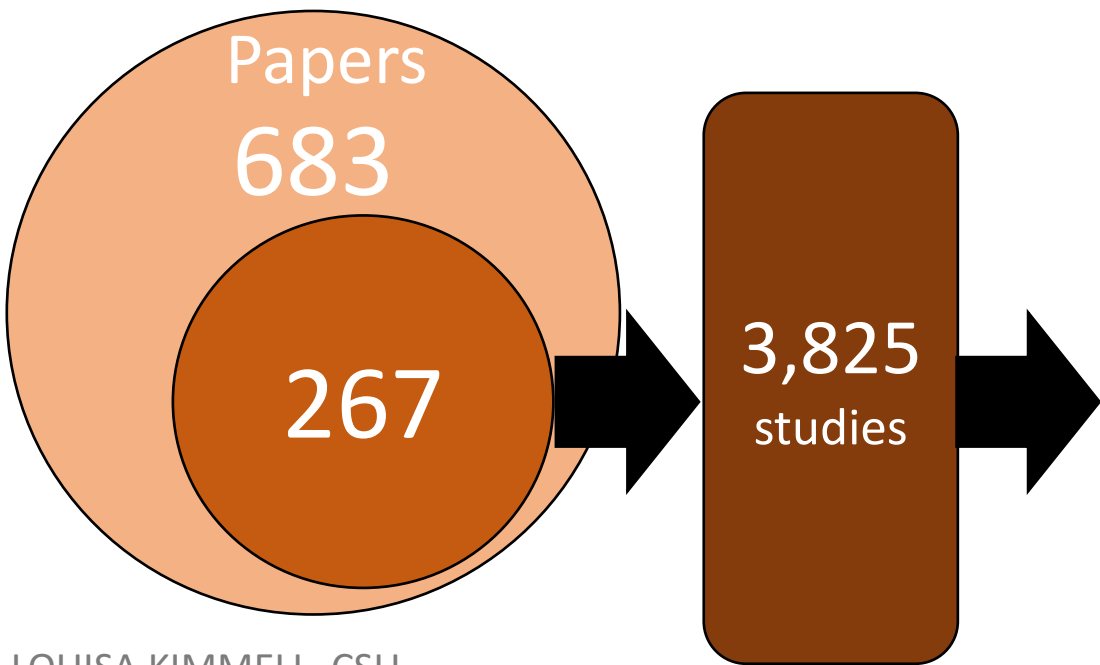
HOW DO I SEED?



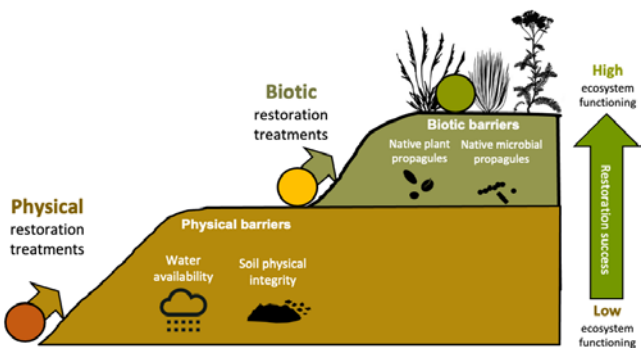
After or in tandem with other necessary treatments

Dryland soil restoration meta-analysis

SOIL-CONSCIOUS



LOUISA KIMMELL, CSU



OPERATIONAL MANUAL FOR
BIOCRUST RESTORATION IN DRYLANDS



Akasha Faist, Colin Tucker, Sasha C. Reed, Anita Antoninka, Matt Bowker,
Nichole Barger, Kara Dohrenwend, Natalie Day, Sue Bellagamba,
Jayne Belnap, Michael Duniway, Stephen Fick, Ana Giraldo-Silva,
Corey Nelson, Julie Bethany, Sergio Velasco-Ayuso, Ferran Garcia-Pichel

AKASHA FAIST, NMSU

NICHOLE BARGER, CU BOULDER

The latest and greatest rangeland restoration is...

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TRAIT-BASED



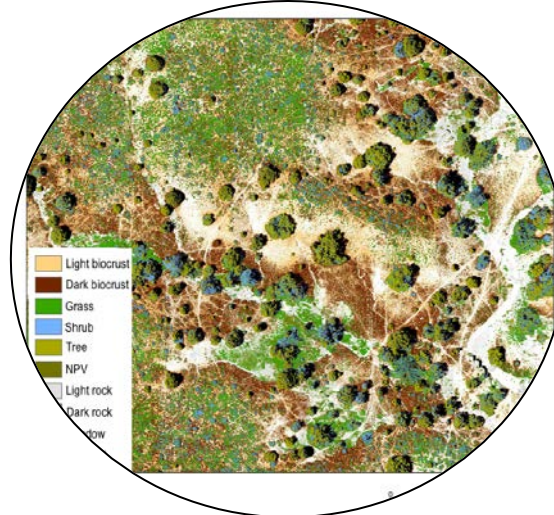
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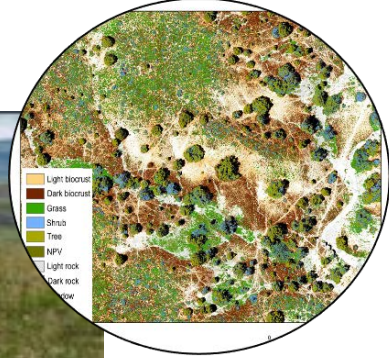


TECH-SAVVY



COLLABORATIVE





Land Treatment Exploration Tool

Learning from the past to improve future restoration and rehabilitation actions

An adaptive management and decision support tool for land treatment exploration and planning.

The tool is available at <https://www.usgs.gov/centers/fresc/science/land-treatment-exploration-tool>.



JOHN BRADFORD, USGS

WHAT DO I SEED?



Species with traits that match projected conditions

WHEN DO I SEED?



When the conditions are right!

The latest and greatest rangeland restoration is...

CLIMATE-ADAPTIVE



TRAIT-BASED



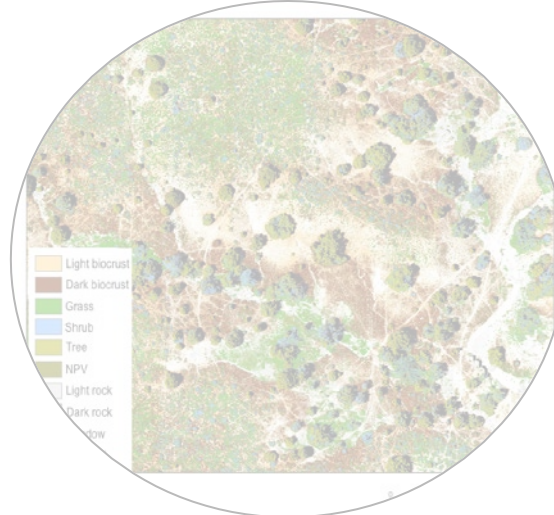
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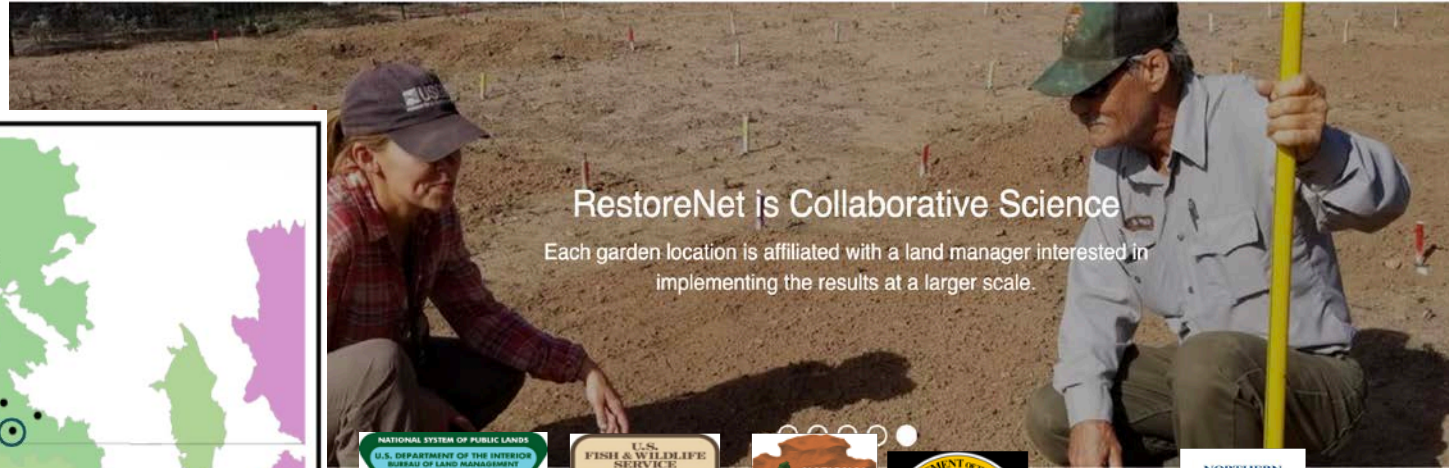
COLLABORATIVE





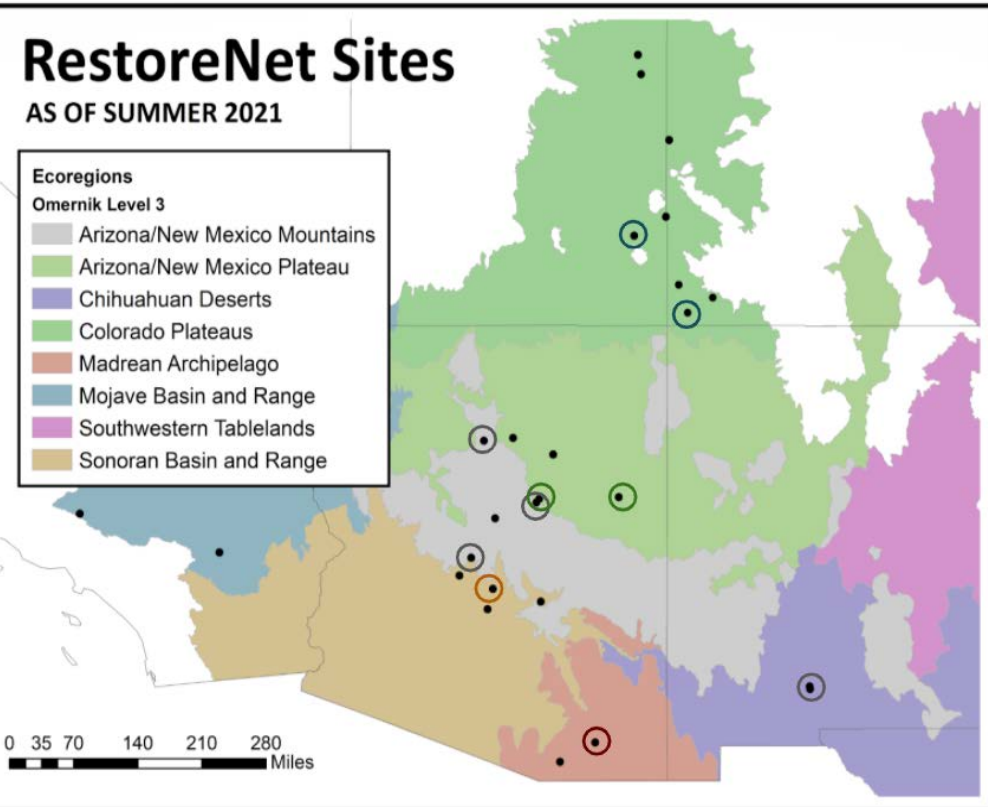
Southwest Biological Science Center

RestoreNet: Distributed Field Trial Network for Dryland Restoration



RestoreNet is Collaborative Science

Each garden location is affiliated with a land manager interested in implementing the results at a larger scale.



SETH MUNSON, USGS



RestoreNet Sites

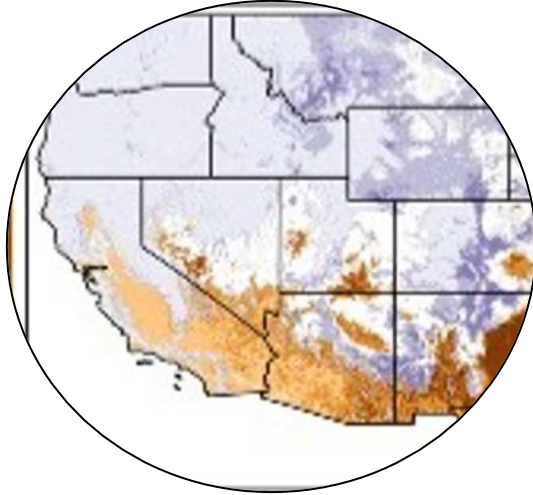
AS OF SUMMER 2021

- Ecoregions**
Omernik Level 3
- Arizona/New Mexico Mountains
 - Arizona/New Mexico Plateau
 - Chihuahuan Deserts
 - Colorado Plateaus
 - Madrean Archipelago
 - Mojave Basin and Range
 - Southwestern Tablelands
 - Sonoran Basin and Range



The latest and greatest rangeland restoration is...

CLIMATE-ADAPTIVE



TRAIT-BASED



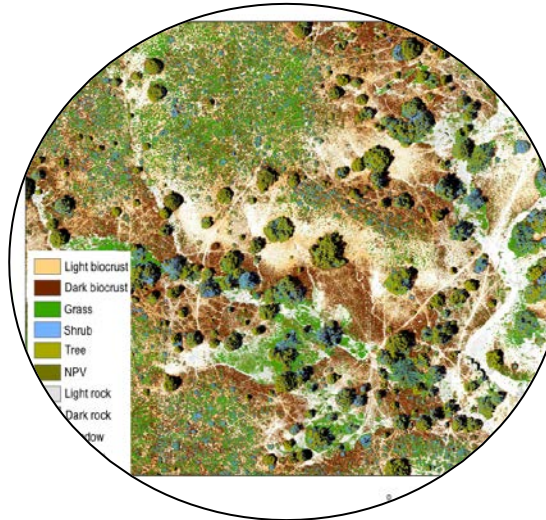
INNOVATIVE



SOIL-CONSCIOUS



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COLLABORATIVE



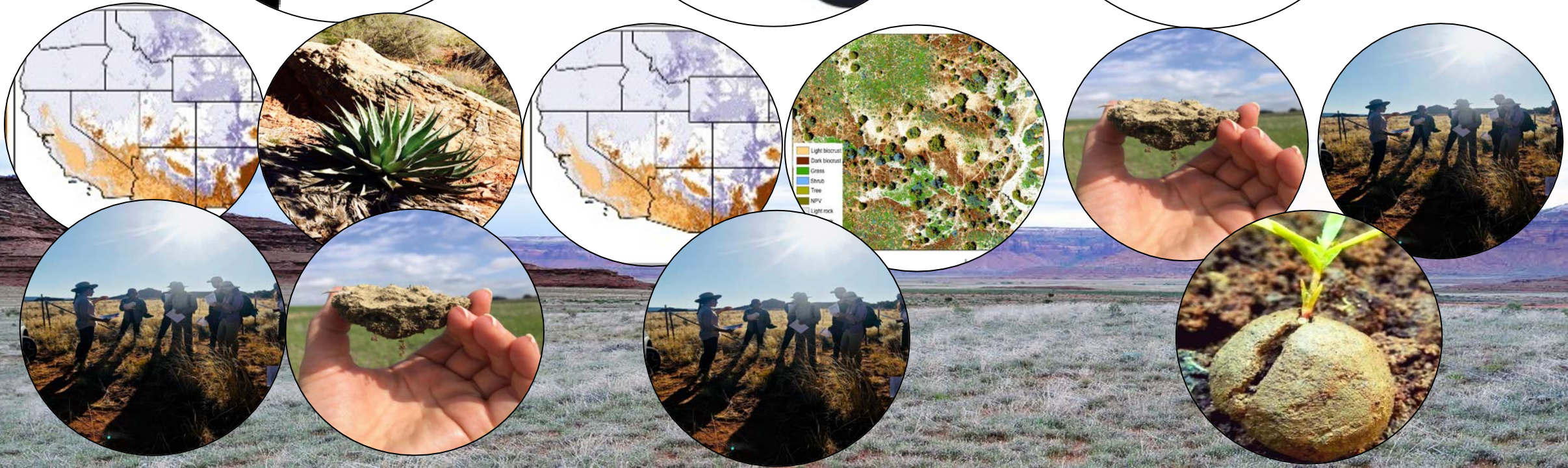
WHAT DO I SEED?



WHEN DO I SEED?



HOW DO I SEED?



Rangeland restoration

What we know

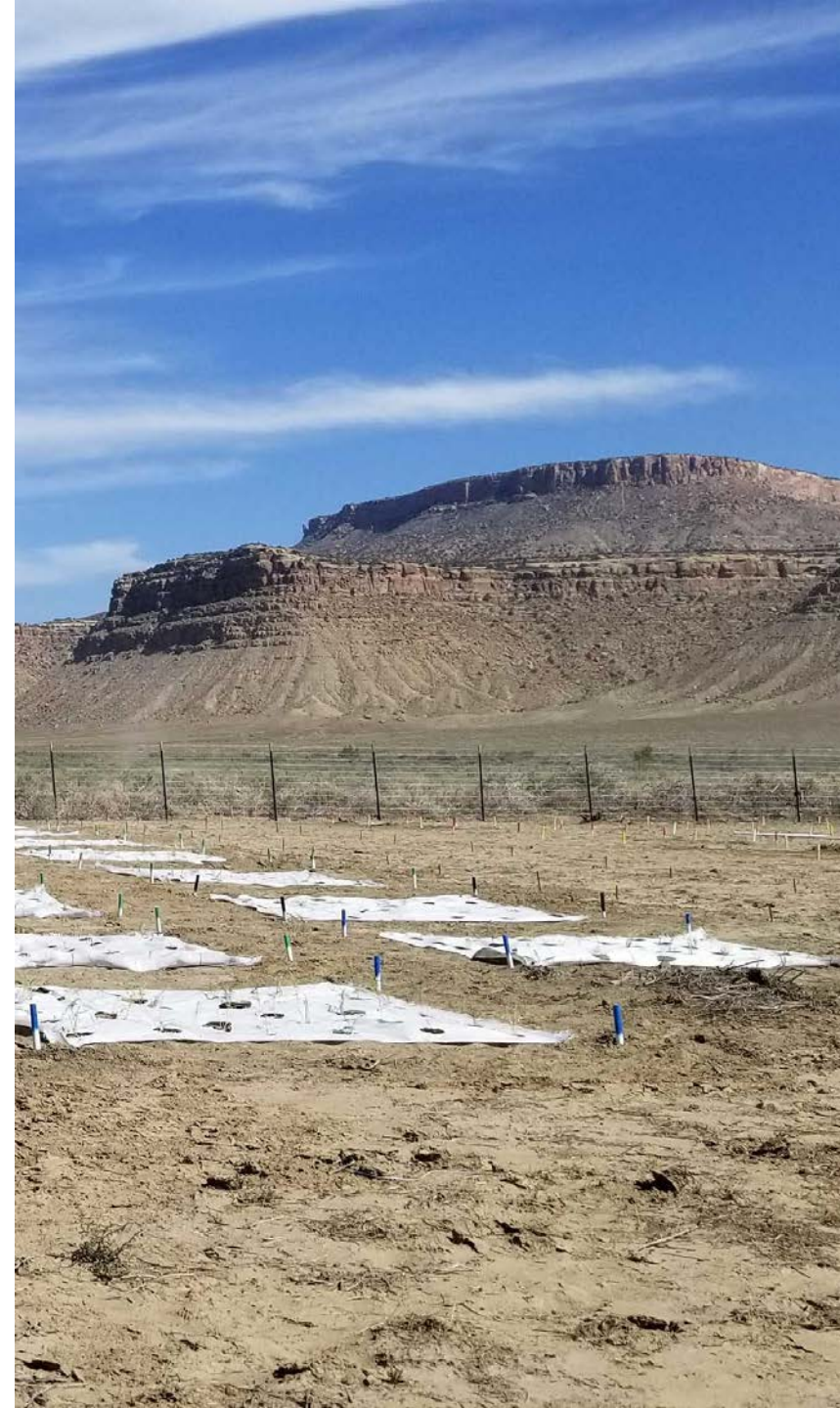
The latest & greatest

What we don't need to do again

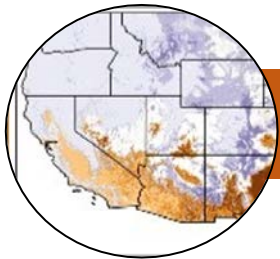
Poll 3:

What is one thing you think we should stop doing in rangeland restoration?

(1 word)



What we don't need to do again...



Ignoring change



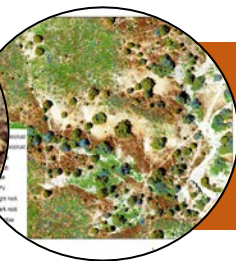
Focusing only on plants



**Ignoring other barriers to restoration success
(or focusing on the wrong ones)**



**Not learning
from the past**

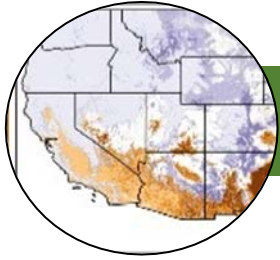


**Not embracing new (to us)
ideas**



**Leaving people and
perspectives out**





Adapt to change



Focus on the whole ecosystem



**Learning from
the past**



**Collaborating and sharing
knowledge**



Embracing new (to us) ideas

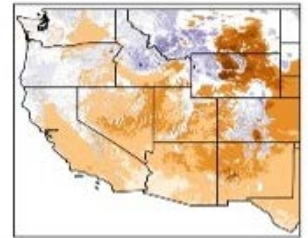


Rangeland restoration (recap)

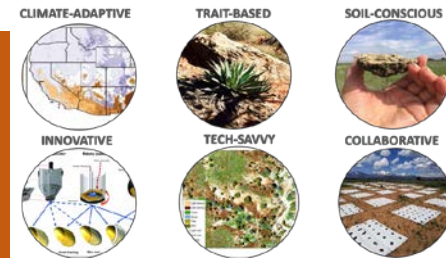
Challenges



What we know



The latest & greatest



What we don't need to do again



Questions?



Carrie Havrilla, Colorado State University

email: Caroline.Havrilla@ColoState.edu |



@Carrie_Havrilla