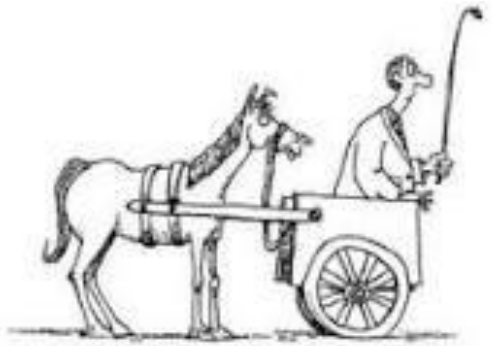
Great Basin LCC Webinar Series

Using weed-suppressive bacteria to control invasive annual grasses: *An interagency perspective on an emerging but yet untested tool*

Matt Germino, US Geological Survey

Introduction: *Emergence of an uncertain tool that may or may not be useful in controlling exotic annual grasses in rangelands*

- Exotic annual grasses are impacting the west; reinforcing feedbacks occuring
- Weed-suppressive bacteria - WSB - is on the market and being used
- Our interagency group is aiming to coordinate knowledge and efforts of this emerging and untested technology
- Goal is to determine if WSB works, and if so: where, when and why or why not?
- Focus science, and prepare the management community for proper application



- Dealing with risk in light of uncertainty

USGS science for a changing world

Basic elements of a viable control tool for exotic plants

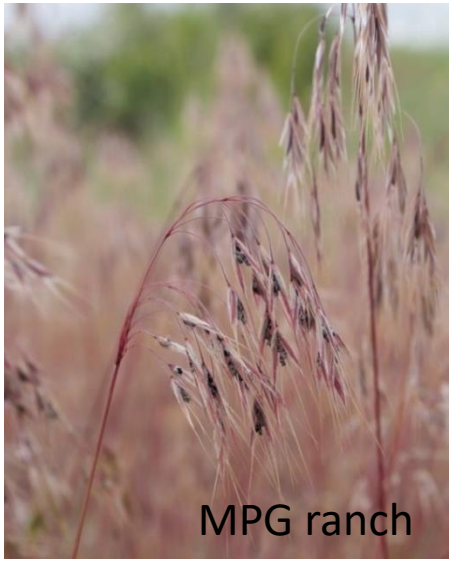
- Affects target species with minimal impact to non-target species of any taxa
- Cost effective – the area needing treatment is vast.
- Able to integrate with existing treatment delivery systems (spray from aircraft, tractor implements, etc).

Big "hopes" for WSB

- Seemingly natural(ish) control measure that is more acceptable to society
- Low density of bacteria applied, hope that it grows by year 2 and then fades by year 5
- Provides a temporal bridge between the short-term action of herbicides and long-term benefits of bunchgrass recovery and competition against exotic annuals.
- Use in marginally invaded areas – if selective enough, WSB might be a rare tool able to be applied where cheatgrass is being to invade, releasing native competitors and saving the site.

Background/native microbial context of affected ecosystems

- Really need to be understood, but hard to.
- Pathogen effects not well known in semiarid areas
- Microbes, esp bacteria, scarcer in semiarid rangeland soils
- These soils are inhospitable to surface bacteria
- Susan Meyer et al. have learned much about pathogenic fungi



SPEAKERS

Dave Pyke, US Geological Survey, Corvallis OR
The big picture of exotic annual control

Richard Lee, Bureau of Land Management, Denver CO
Status of WSB strains, and BLM efforts to coordinate demonstrations, west-wide

Mike Gregg, US Fish & Wildlife Service, Burbank WA
WSB biology, and FWS efforts to spur coordination

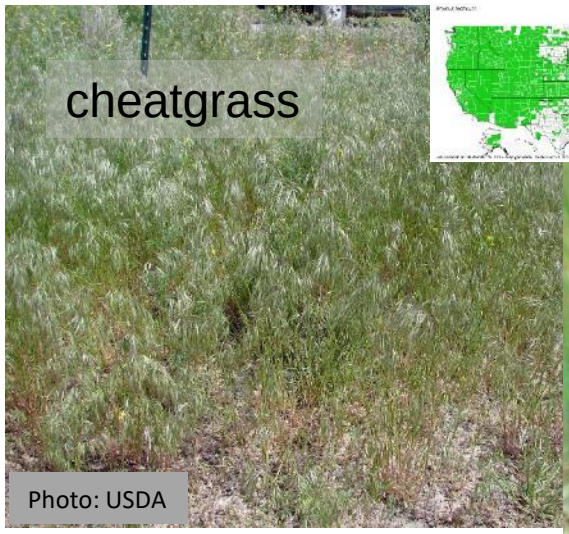
Jane Mangold, Montana State University, Bozeman MT
WSB and exotic annuals in northern range and crop regions, and a regional experiment

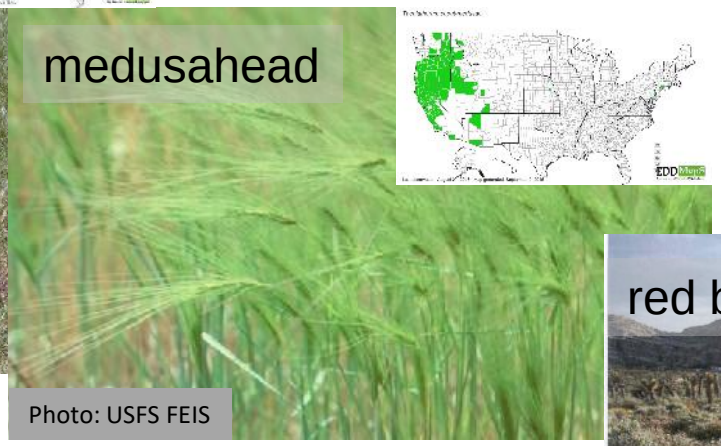
Brynne Lazarus, US Geological Survey, Boise ID
Learning from management trials and scientific studies

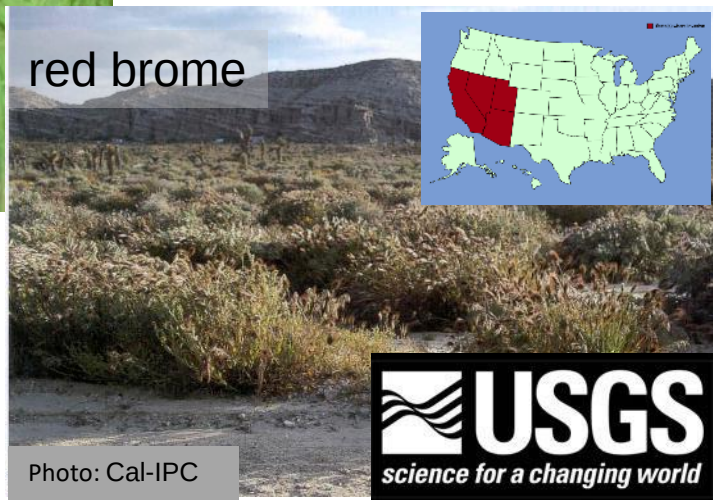
David Pyke, US Geological Survey

The big picture of exotic annual control: setting the context for weed-suppressive bacteria

- Invaded from Eurasia
- Late 1800
- Seed contaminants







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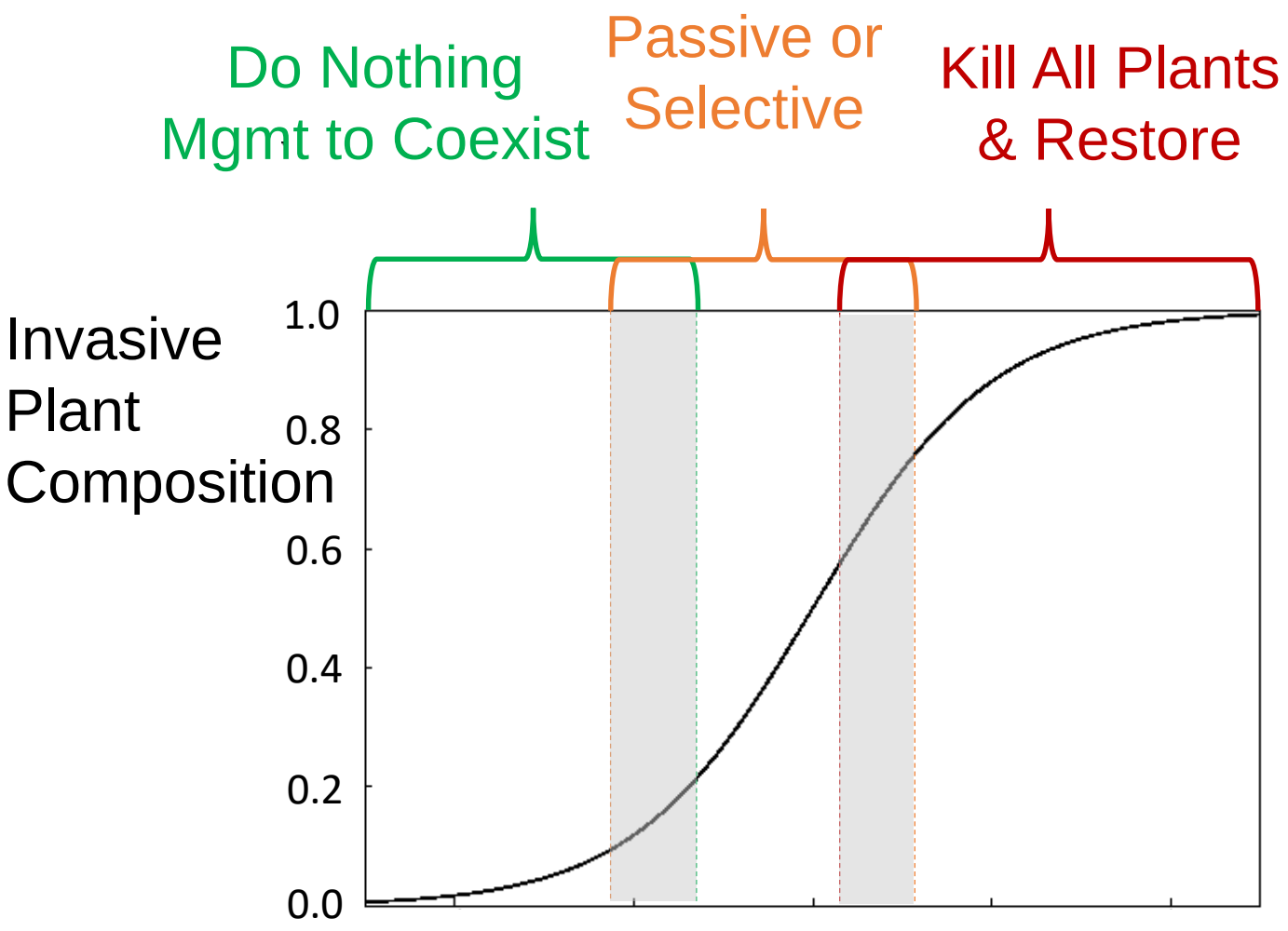
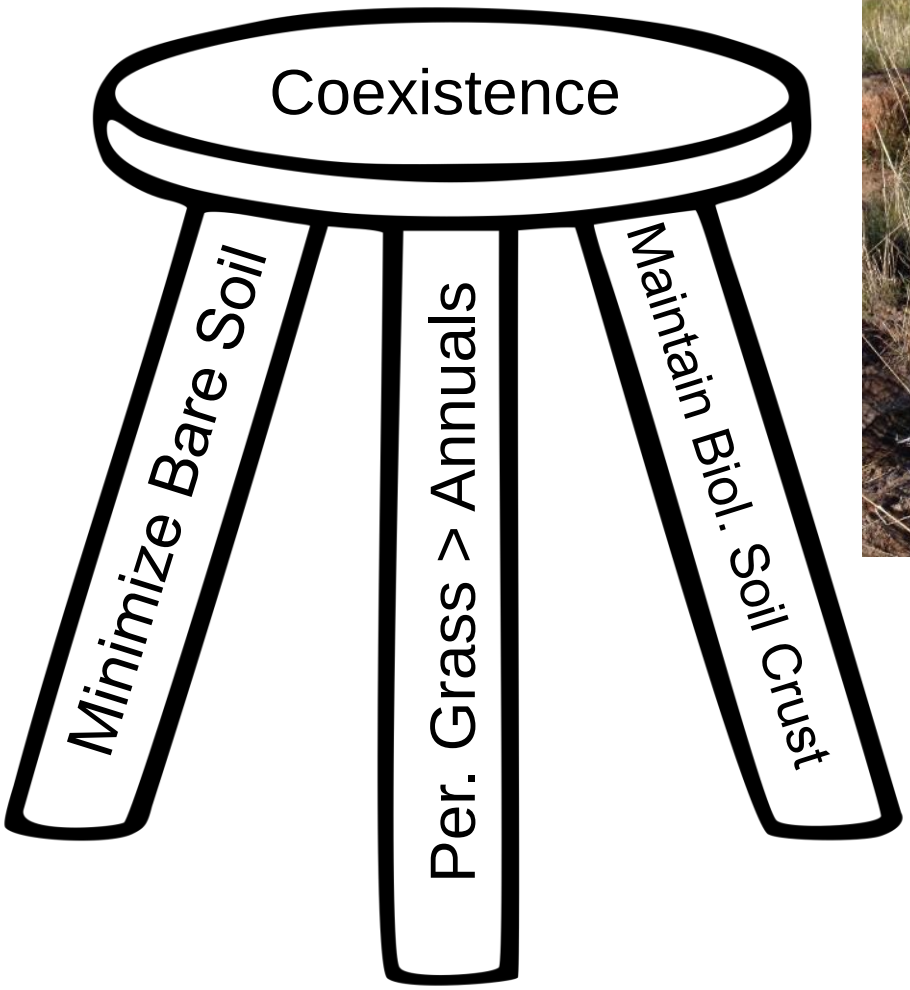
Control Options



Do Nothing – Management for Coexistence



- Cover
  - Perennial Grasses
  - Annual Invasives
  - Biol. Soil Crusts
  - Bare Soil
- Gaps among perennials

Kill All Plants & Restoration

- Perennials minor
- Annual Invasive dominates
- Use Broad-Spectrum herbicide
- Glyphosate
  - Round-up™ or Rodeo™
- Glyphosate with Imazapic
  - Journey™

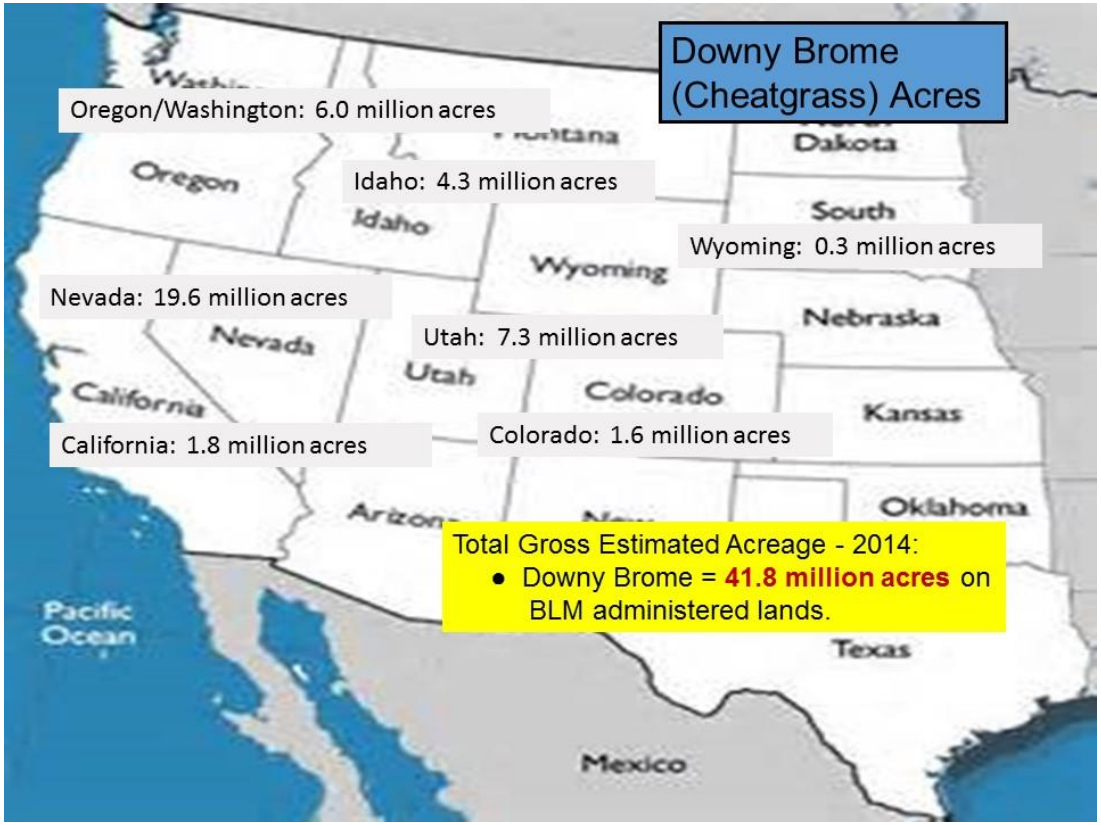
Passive or Selective

- Goal – Reduce Invasive Annual & Increase Perennials
- Targeted Grazing
  - Proposed, but limited testing
- Selective Herbicides (e.g. Imazapic – Plateau™)
  - Selective for annuals at lower rates
  - Residual effect for multiple years
  - May impact perennials too

Richard Lee, Bureau of Land Management

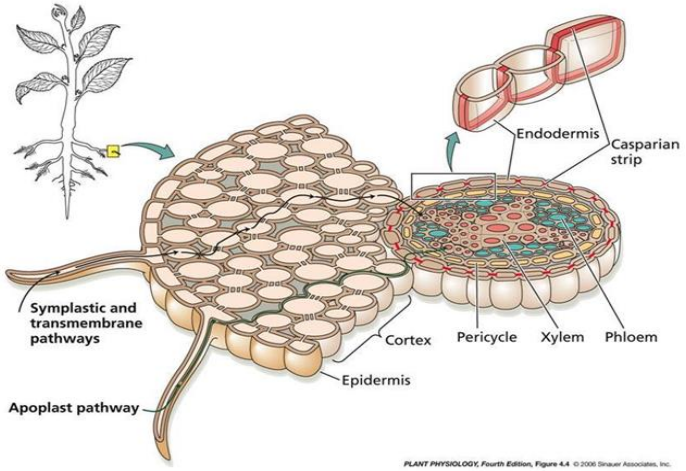
Integrated Pest Management Specialist

History and Status of the Different Strains of *Pseudomonas fluorescens* and a Summary of the BLM's Demonstration Project



Pseudomonas fluorescens strains

- 1989, Dr. Ann Kennedy discovered and isolated the first strain (D7).
  - Activity on downy brome (cheatgrass), medusahead rye, jointed goatgrass, and to a lesser degree Japanese brome.
- Registration package submitted to EPA in October 2013.
- EPA granted registration of the D7 strain on August 29, 2014:
  - Verdesian Life Sciences holds the registration of D7®
  - "Suppression of Downy Brome (cheatgrass), Medusahead, Japanese Brome, and Jointed Goatgrass on Wheat, Triticale, Oats, and Rangeland"
- 2001, second strain, ACK55, discovered and isolated.
  - Activity on downy brome, medusahead rye, and jointed goatgrass.
  - Mechanism of activity associated with disruption of the root cell membrane, resulting in stunting of roots.
- September 2015, USDA-ARS submitted registration package, for ACK55, to EPA.



Pseudomonas fluorescens strains

- Spring of 2016, EPA notified ARS of the need for additional data in support of registration of the ACK55 strain.
- Required data should be available to EPA by the end of August.
- EPA review of data, and if no other issues, registration should be granted in the 1st quarter of 2018.
  - Well beyond the ideal time for application of the *Pseudomonas fluorescens* strains.
- Final strain of *Pseudomonas fluorescens*, MB906, is the active ingredient of the product MB906®, manufactured by BioWest Ag Solutions.
  - Has not gone through the EPA registration process, documenting the toxicity of the strain, and the behavior in the soil, aquatic, and other environmental situations.

Demonstration Areas

- Range - 2.5 to 50 acres.
- 8 Established in November – December 2015
- 7 Established in April 2016
- 2 Established in November – December 2016
- 1 Established in March 2017
- Eleven Field Offices
- Seven States

- Treatments Summary:
  - 13 treatments - broadcast application of D7® alone.
  - 2 treatments – broadcast application of D7® plus imazapic @ 0.047 and 0.078 lb. a.e., (3.0 and 5.0 fl. ozs. Plateau®, respectively.)
  - 1 treatment – broadcast application of D7®, following a an earlier broadcast application of imazapic @ 0.11 lb. a.e. (7.0 fl. ozs. Plateau®).
  - 2 treatments – seed coated with D7® and drilled.
  - 2 treatments – seed coated with D7® and broadcast.

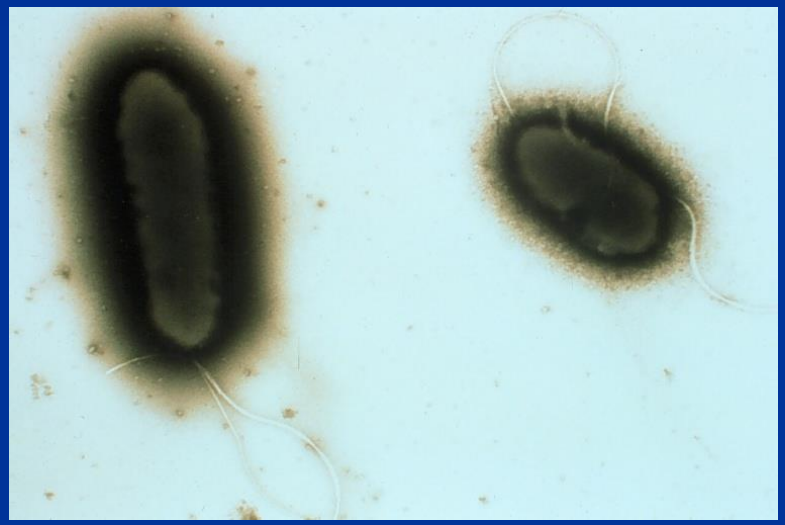
- Studies established during the fall/winter of 2015 and the early spring of 2016 have been evaluated according to the protocol provided, with the data undergoing analysis at the present time – and is not available at the present time.

- Immediate future of the three strains:
  - D7® - Verdesian Life Sciences has put the project on hold at the present time. The is no material available for sale to the public, State or Federal agencies.
  - ACK55 – With the registration process not expected to be completed until the first quarter of 2018, material will not be available until the fall of 2018.
  - MB906® - The latest word from BioWest Ag Solution, is that they are moving forward with the preparation of the necessary registration package for submission to EPA.

Mike Gregg, US Fish and Wildlife Service Biological aspects of WSB and outcomes of initial FWS-led coordination on WSB

Weed-Suppressive Bacteria

Pseudomonas fluorescens
(D7, ACK55)

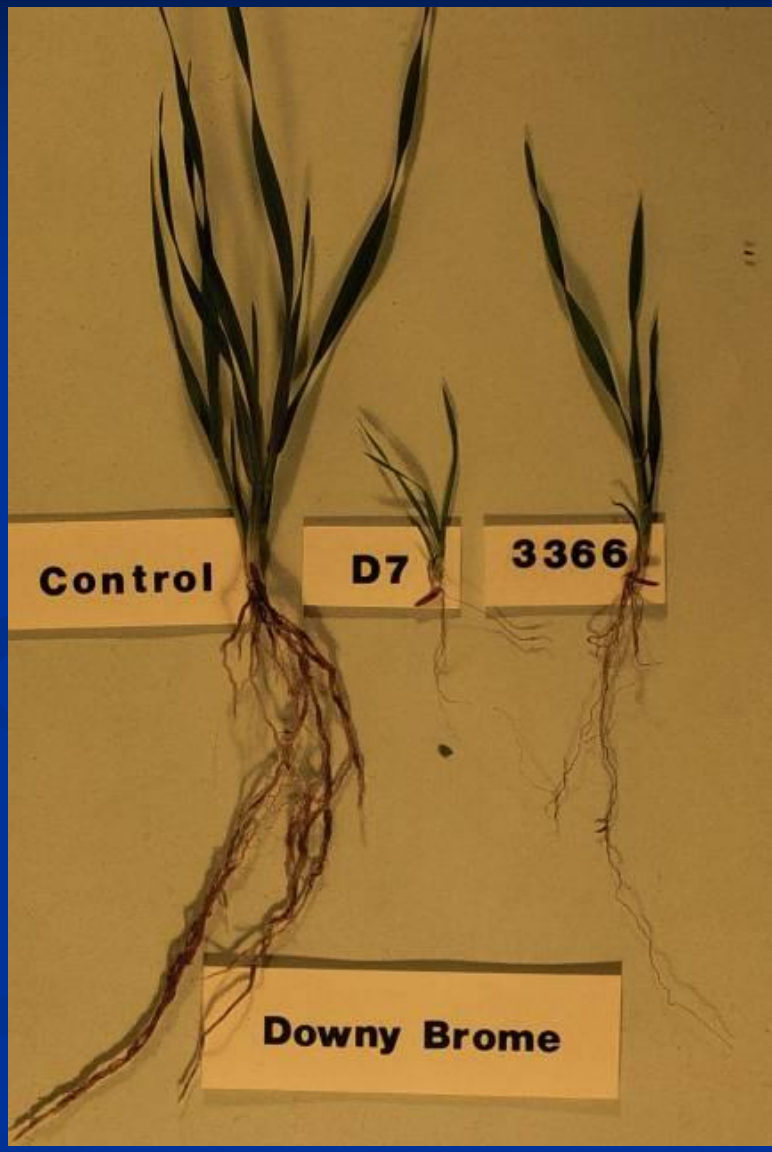


- **Native bacteria, colonize soil residue and roots**
- **Survive well at low temperatures**
- **Not competitive at warm temperatures**
- **Go dormant during hot, dry summer**
- **Do not suppress crops or native plants**
- **Produce and deliver weed-suppressive compounds to the weed root**

Photo and data slide credits to Ann Kennedy

Weed-Suppressive Compounds

- No visible lesions
- No signs of pathogenicity
- Inhibit root cell elongation
- Root stunting
- Interrupt tiller initiation
- Reduce seedling vigor, tiller and seed production, and seed bank
- Good match for biocontrol



Requirements for Success

- The bacterium must survive
  - Apply in fall (<50 F) with moisture
  - Must have soil contact
  - Applied as liquid or seed coat
- The bacterium must establish
  - Needs to over winter
- Soil Type is important
  - Heavy clay, high organic matter may bind compounds
- Desirable plants needed

USFWS Workshop
August 2015

Scale-up Trials Using Weed Suppressive Soil Bacteria in Rangeland Restoration – Design, Methods, and Implementation: An Experts' Workshop

Key Questions:

- Efficacy at Large Scales
- Non-Target Impacts
- Different Soils/Ecological Sites
- Delivery Systems (Seed Coat, Liquid, Pellet)
- Distance from Source Material

Jane Mangold, Montana State University

Example of a coordinated region-wide trial and context from the Northeast Range

MONTANA STATE UNIVERSITY

Photo: Todd Schlotfeldt, MSU

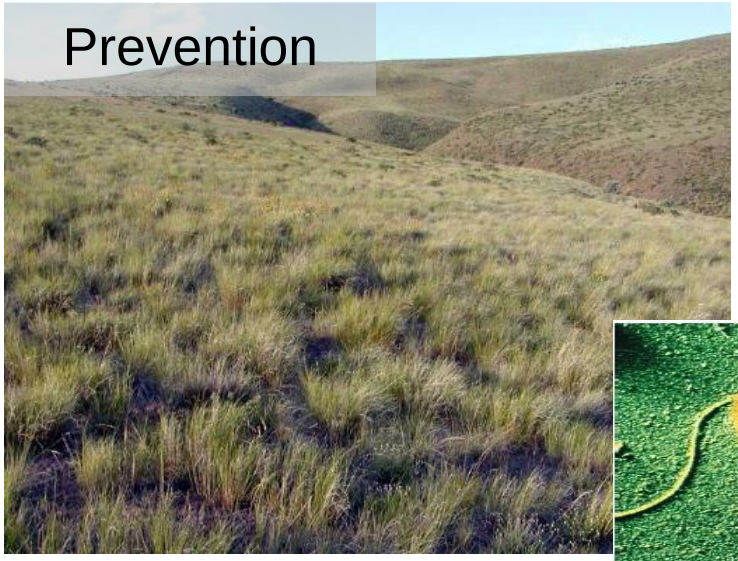

Photo: Stacy Davis, MSU

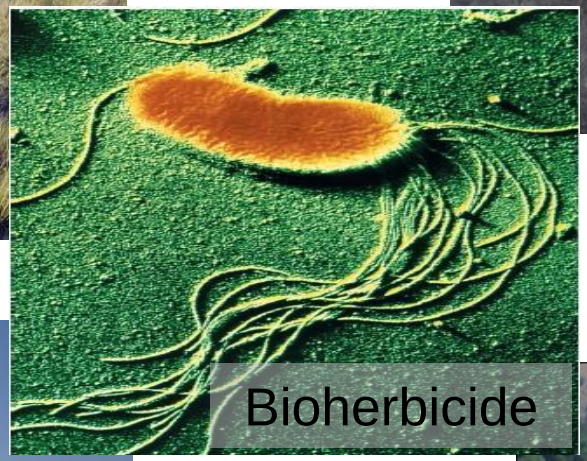

Photo: Jane Mangold, MSU

Photo: Stacy Davis, MSU


Photo: Elai Keren, MSU

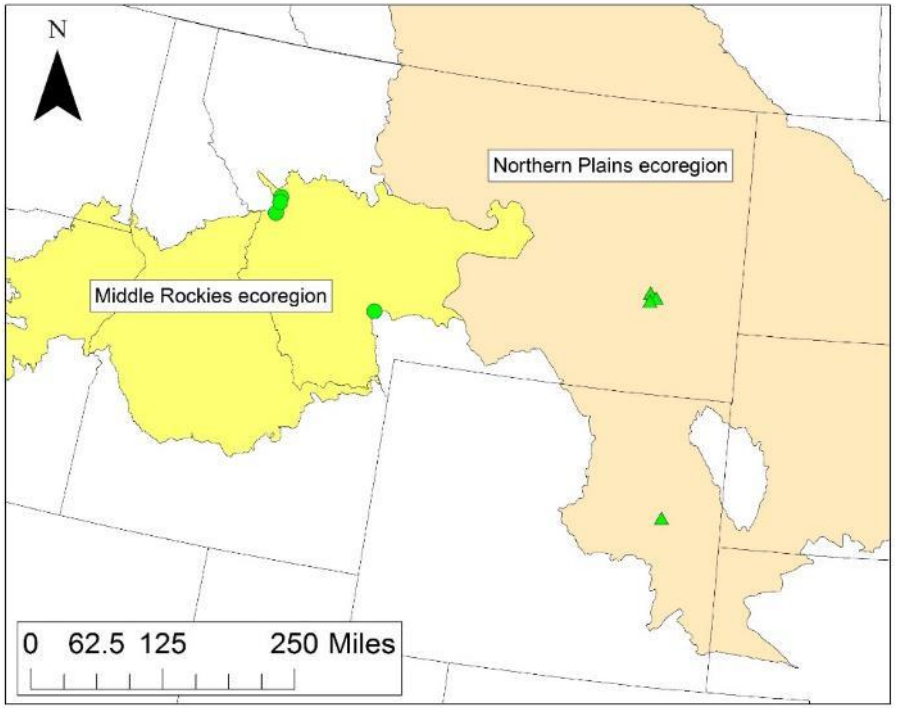
Management





Coordinated Distributed Experiment (2014-2019)

- Objective: Test effect of ACK55 on annual brome cover in MT and WY
- 8 sites
  - Miles City (3)—Kurt Reinhart, USDA-ARS, Miles City, MT (PROJECT COORDINATOR)
  - Missoula (2)—Morgan Valliant and Clancy Jandreau, City of Missoula
  - Lolo (1)—Philip Ramsey, MPG Ranch, Florence, MT
  - Norris (1)—Jane Mangold, MSU, Bozeman, MT
  - Bill, WY (1)—Kurt Reinhart/Dave Pellatz, Thunder Basin Grassland Prairie Ecosystem Assoc.



Methods

- 5m x 5m paired-plots, treated and non-treated
- 4-8 replications per site
- Treated with 0.1g freeze-dried ACK55 (Oct-Dec. 2014)
  - ~10 million ACK55 cells/m^2
- Sampling % cover annual bromes (2015-2019)
  - 1 m^2 frame divided into 100 cells (present/absent)

freeze-dried bacteria

Preliminary Interpretation

- Low effectiveness and low probability ACK55 will reduce cheatgrass or Japanese brome cover in Montana or Wyoming
- Stay tuned…monitoring plots through 2019 (5 years post-application)
- In most cases, it appears cover of annual bromes in treated plots is similar to cover of annual bromes in non-treated plots three years after applying ACK55. For more details, please contact Jane Mangold at jane.mangold@montana.edu.

Acknowledgements: Kurt Reinhart, Morgan Valliant, Clancy Jandreau, Philip Ramsey, Dave Pellatz, Anne Kennedy

Brynne Lazarus, **Matt Germino**
US Geological Survey

Early insights from collating/coordination and trials underway in the Central Range

Coordination project purpose:

Collate, compare, and contrast existing manager's trials and researcher's studies

- to understand what information is or will be available (and when)
- identify gaps in information for new studies
- bring the most efficiency to the collection of efforts underway

Connect researchers and managers working with WSB, exchange ideas and results

What makes a complete study/ what is needed to learn from a management trial?

USGS science for a changing world

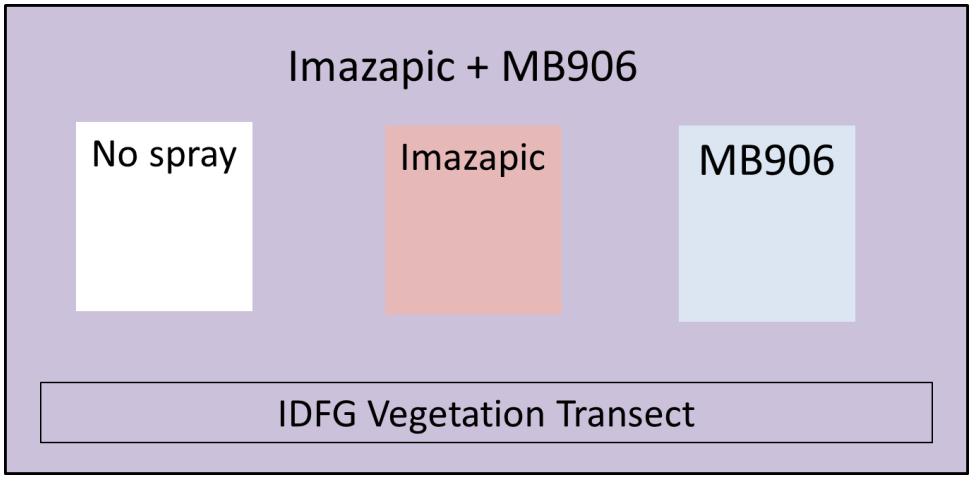
1) Controls 2) Replication 3) Monitoring

Controls = Comparable untreated areas within or directly outside treated areas

Must control for each co-treatment type (fire, herbicide, rangeland drill, etc)

Example: Controls folded into an Idaho Fish & Game application using tarps!

Tarps spread out to block spray

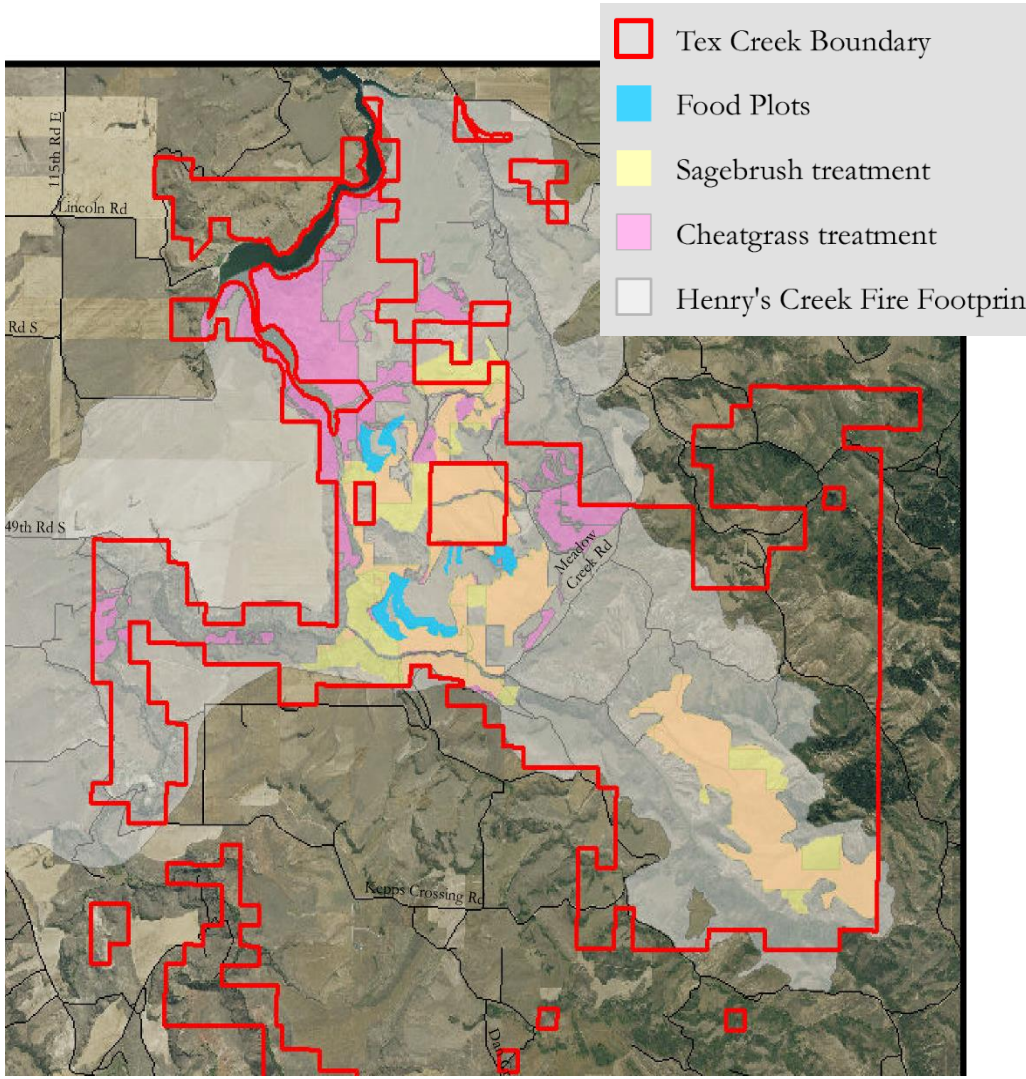


Control tarp configuration– repeated along 6 transects

Unsprayed plot the following spring

1) Controls **2) Replication** 3) Monitoring

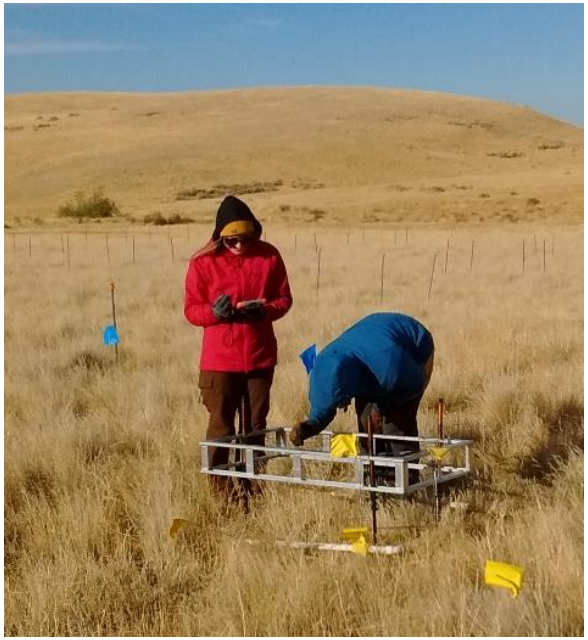
- Necessary to show **repeatability** and also to characterize **variability (+/-)**
- Important to replicate both **among** sites and **within** sites
- Example: MB906 application by IDFG at Tex Creek WMA -- 8 replicates for every treatment combination!

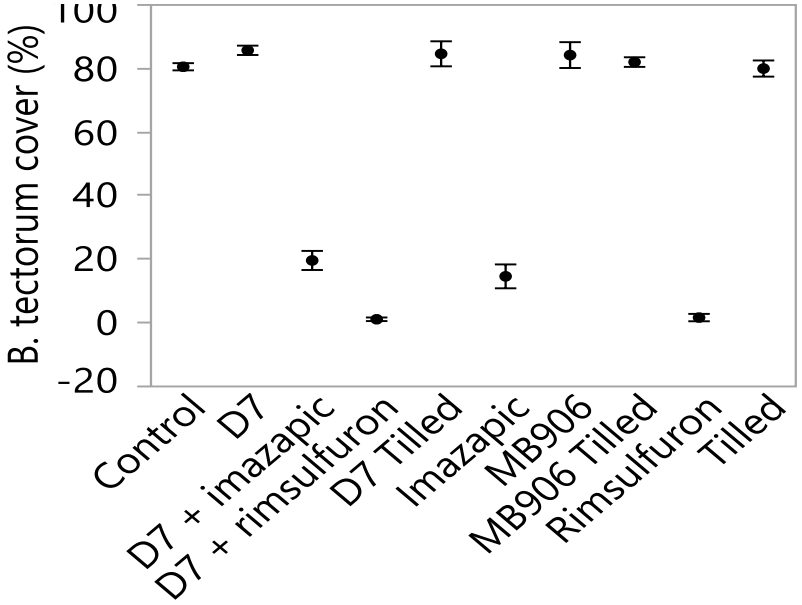


Ryan Walker, Logan Peterson, IDFG

1) Controls 2) Replication **3) Monitoring**

1) Needed to advance collective knowledge
2) Common measurements include
   1) Cover (proportion of area covered)
   2) Density (individuals/area)
3) Example: Idaho SG Action Team Bacteria Study replicated 3x/site across 3 sites in SW Idaho, many factors and controls





Monitoring Resources:
Sample point: http://www.samplepoint.org/
DIMA (Databse for Monitoring, Inventory, and Assessment): https://jornada.nmsu.edu/monit-assess/dima

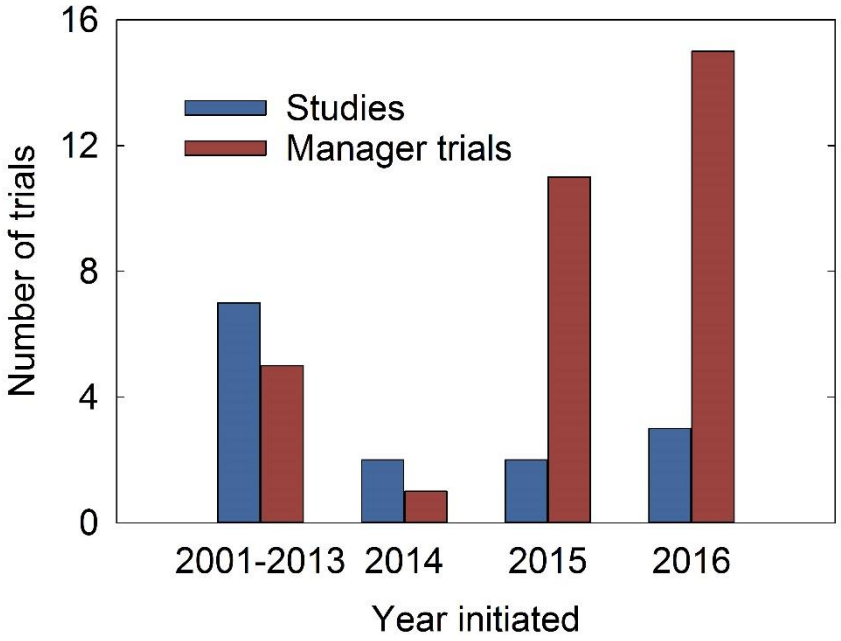
Unpublished prelim results, Lazarus & Germino

Findings from WSB coordination of 48 projects implemented to date:

34 manager trials, totaling **>30,000 acres**, 7 trials after wildfire

- Only **16** known to have controls for the specific WSB effect,
- **14** combined herbicide+WSB, ~½ of these cannot separate WSB effect
- **5** have replication of sites in a project – *but, collectively they make replication*
- **22** have quantitative monitoring
- ***few*** have all the study elements

14 scientific studies, <500 acres combined, plots ranging from 1 m^2 to 50 acres, 4 after fire



Peer-reviewed publications on WSB effects in rangeland ecosystems: **1** MS thesis (Reynecke 2012, Eastern WA University)

Take-home summary points, *all related to role of communication in our changing environment and people/management structure in the Great Basin*

- Situational awareness of an *uncertain*, rapidly changing, *potential* technology
- Coordinating work across the range – funding is limited, need for efficiency
- WSB is the issue now, but what will we face later? Coordination infrastructure is key!
- Address emerging threats/tools early: more proactively and less reactively.
- Managers actions on vegetation are “treatments”, lets learn from them, linking science and management.

QUESTIONS? COMMENTS?

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A recording of today's webinar and slides from the presentation will be available at **www.GreatBasinLCC.org**.

For more information on the Great Basin LCC webinar series contact:
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