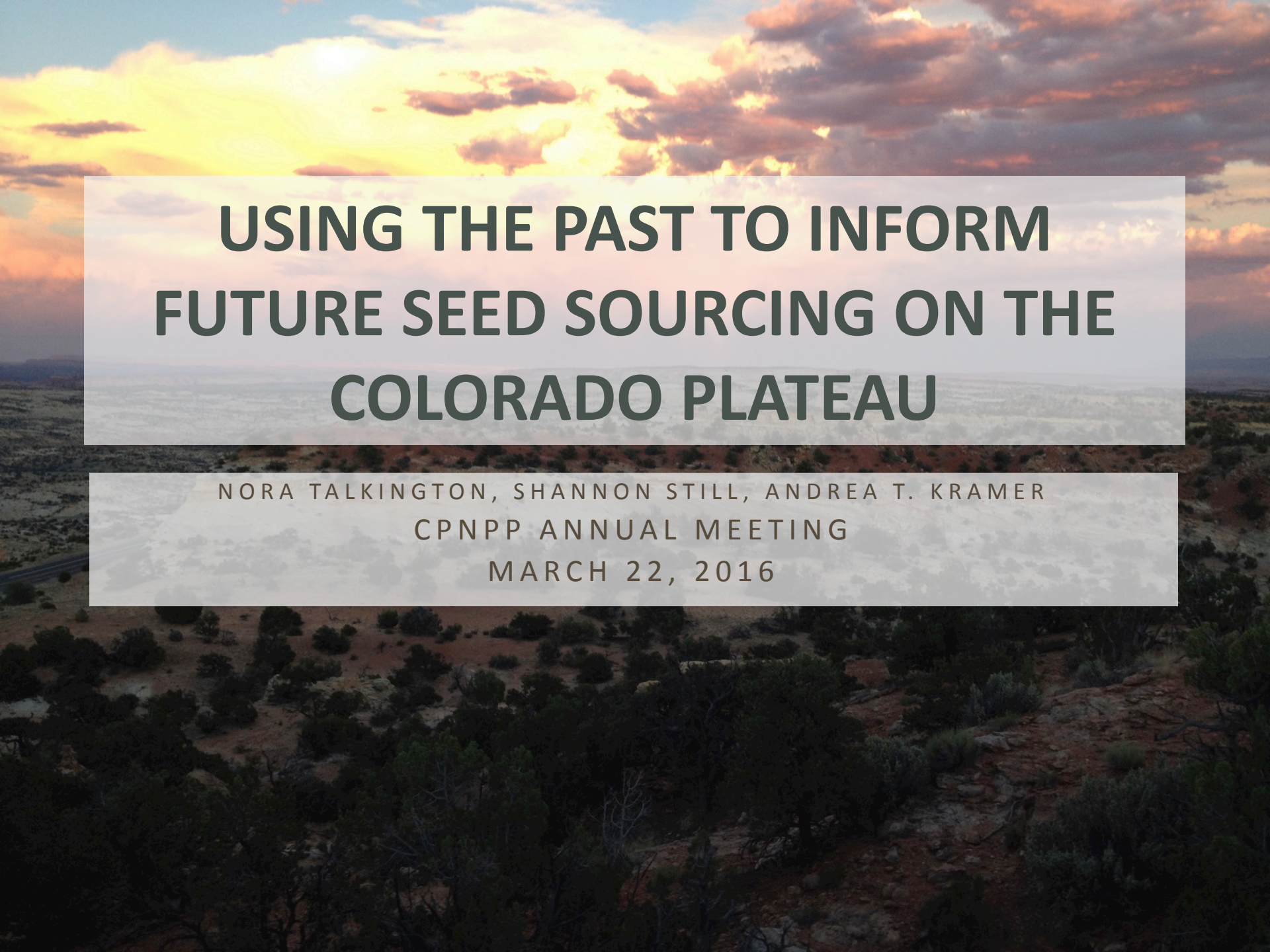


USING THE PAST TO INFORM FUTURE SEED SOURCING ON THE COLORADO PLATEAU

NORA TALKINGTON, SHANNON STILL, ANDREA T. KRAMER

CPNPP ANNUAL MEETING

MARCH 22, 2016

DRIVERS OF RESTORATION OUTCOMES

- Management
  - Composition, diversity, and source of plant species used
  - Propagule type used, timing and method of application
  - Invasive species control
  - Use of prescribed disturbances (e.g., fire, grazing)
- Site-specific and temporal factors
  - Land use history
  - Composition of surrounding landscape
  - Weather

Saari, C. and W. Glisson. 2012. Survey of Chicago region restoration seed source policies. Ecological Restoration **30**:162-165.

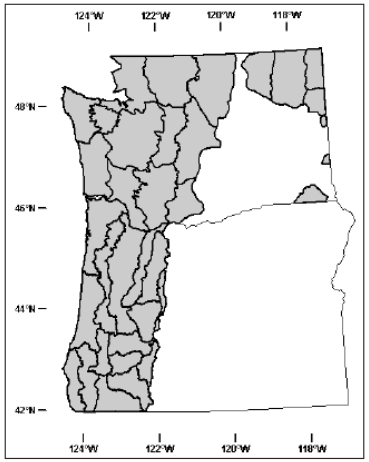
Knutson et al. 2014. Long-term effects of seeding after wildfire on vegetation in Great Basin shrubland ecosystems. Journal of Applied Ecology **51**:1414-1424.

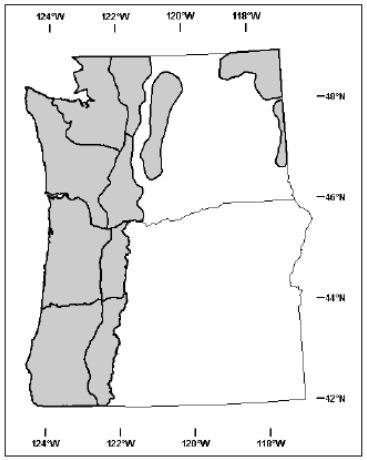
Grman et al. 2013. Confronting contingency in restoration: management and site history determine outcomes of assembling prairies, but site characteristics and landscape context have little effect. Journal of Applied Ecology **50**:1234-1243.

WE KNOW THAT SOURCE CAN MATTER

GOAL: establish genetically diverse populations that can germinate, grow, and reproduce at the site.

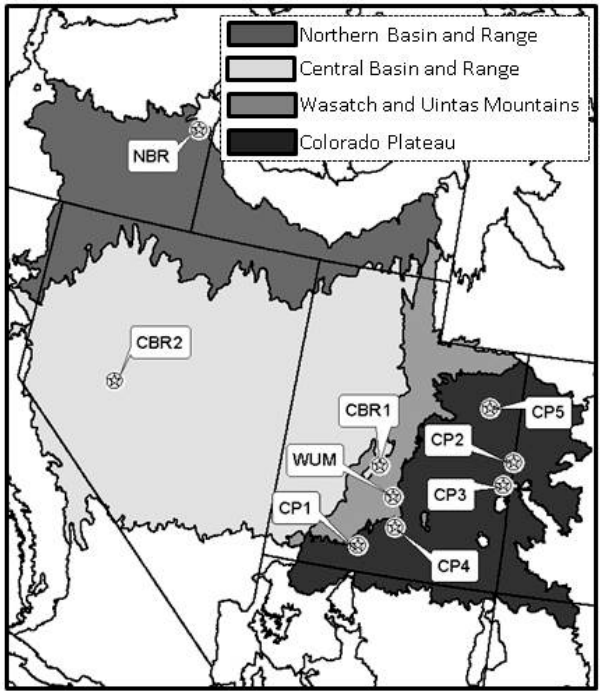
ONE APPROACH: Seed transfer zones that minimize the risk of maladaptation. Scales vary greatly by species.

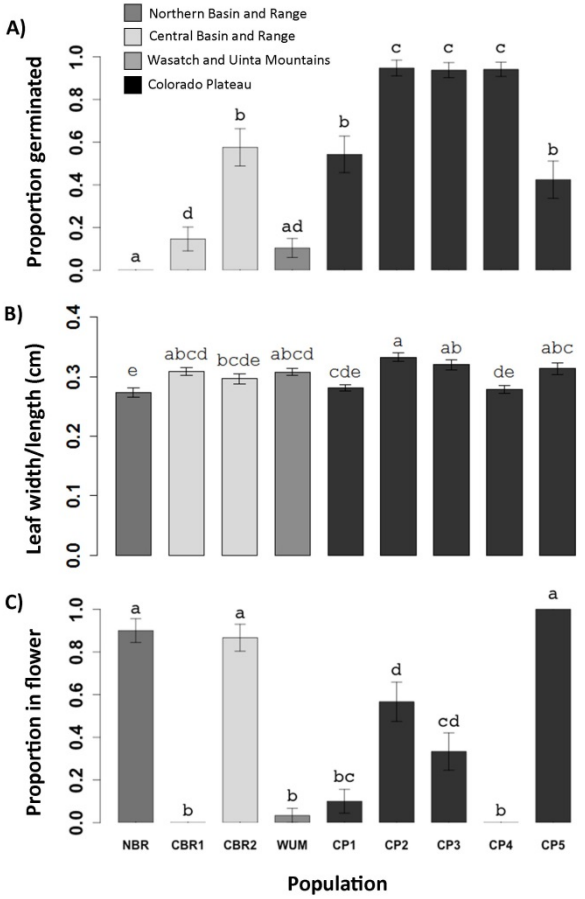




NOT JUST TREES AND GRASSES

- *Cleome lutea* in the western United States





Hintz, Eshleman, Foxx, Wood and Kramer. In review. Intraspecific variation for early life history traits in *Cleome lutea*. Western North American Naturalist.

HOW CAN WE DETERMINE COSTS & BENEFITS?

ONE OPTION: Use historical data from past restoration efforts

- **Goal:** Create a database that allows us to track performance of seeded species/sources used in historic restoration efforts across the Colorado Plateau.

- **Challenges:**
  - Monitoring data not detailed enough
  - Difficult to track down seed mix and monitoring records
  - Monitoring protocols not standardized

WHAT TYPES OF DATA DO WE HAVE?

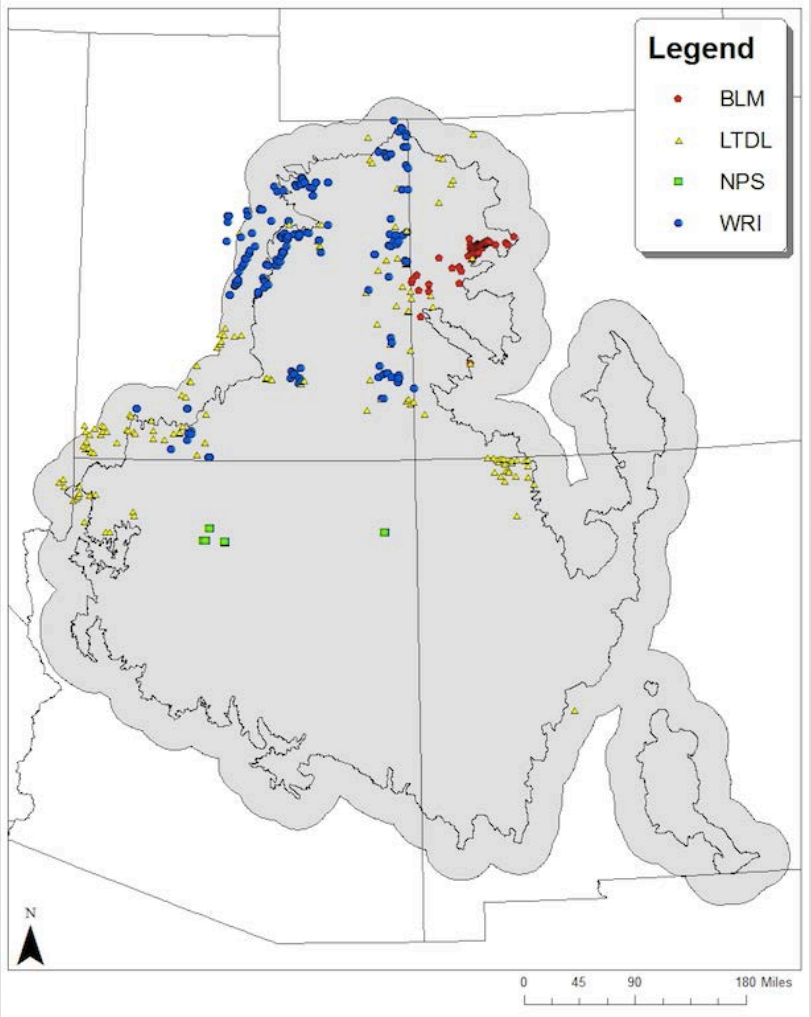
Approach: Site, seed mix, monitoring data from restoration efforts occurring across the CP

Types of Restorations:

Sources:

- **Databases:**
  - Utah's Watershed Restoration Initiative
  - USGS's Land Treatment Digital Library
  - BLM field offices
  - NPS restoration data: Grand Canyon, Capitol Reef, Canyon de Chelly

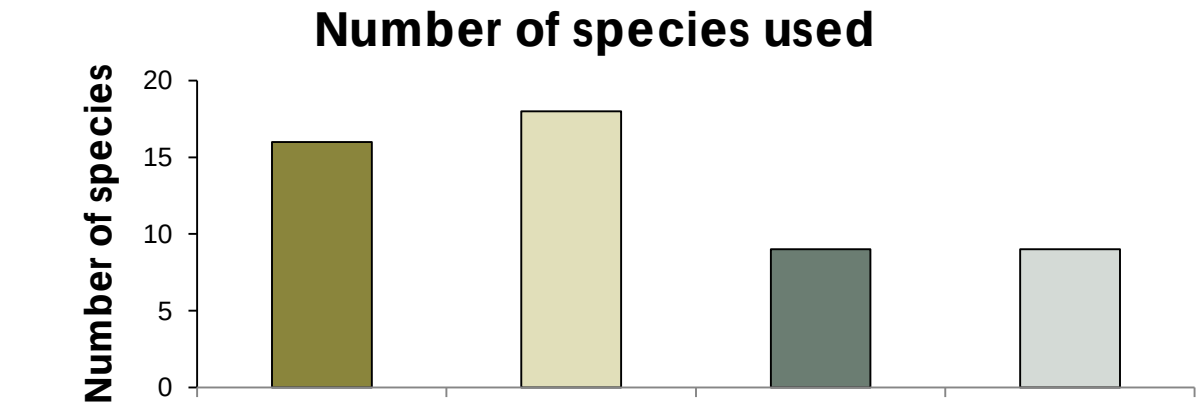
ALL SEEDED TREATMENTS BY SOURCE

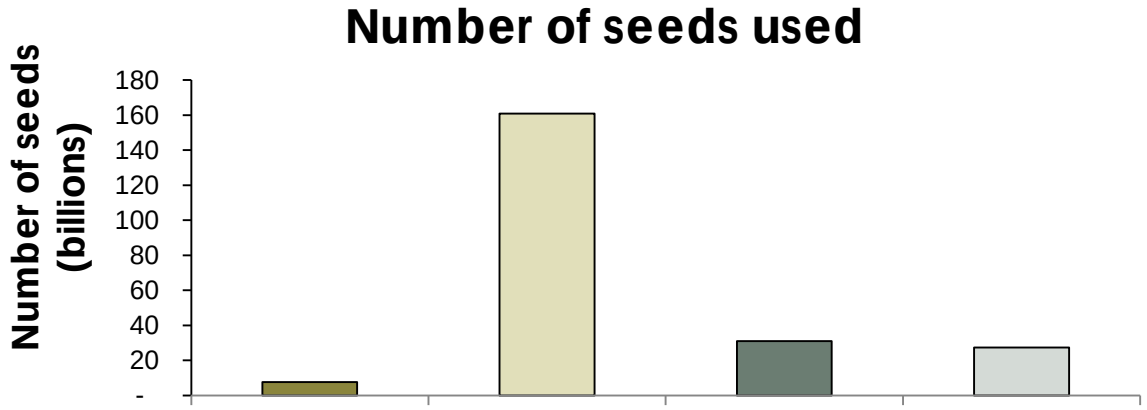


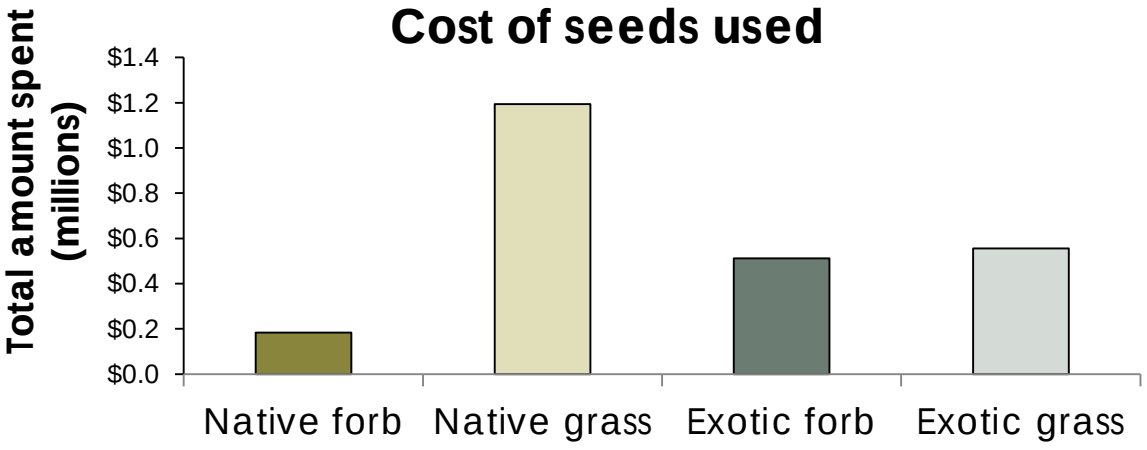
CASE STUDY: UTAH'S WRI DATA

Using a subset of available data that includes:

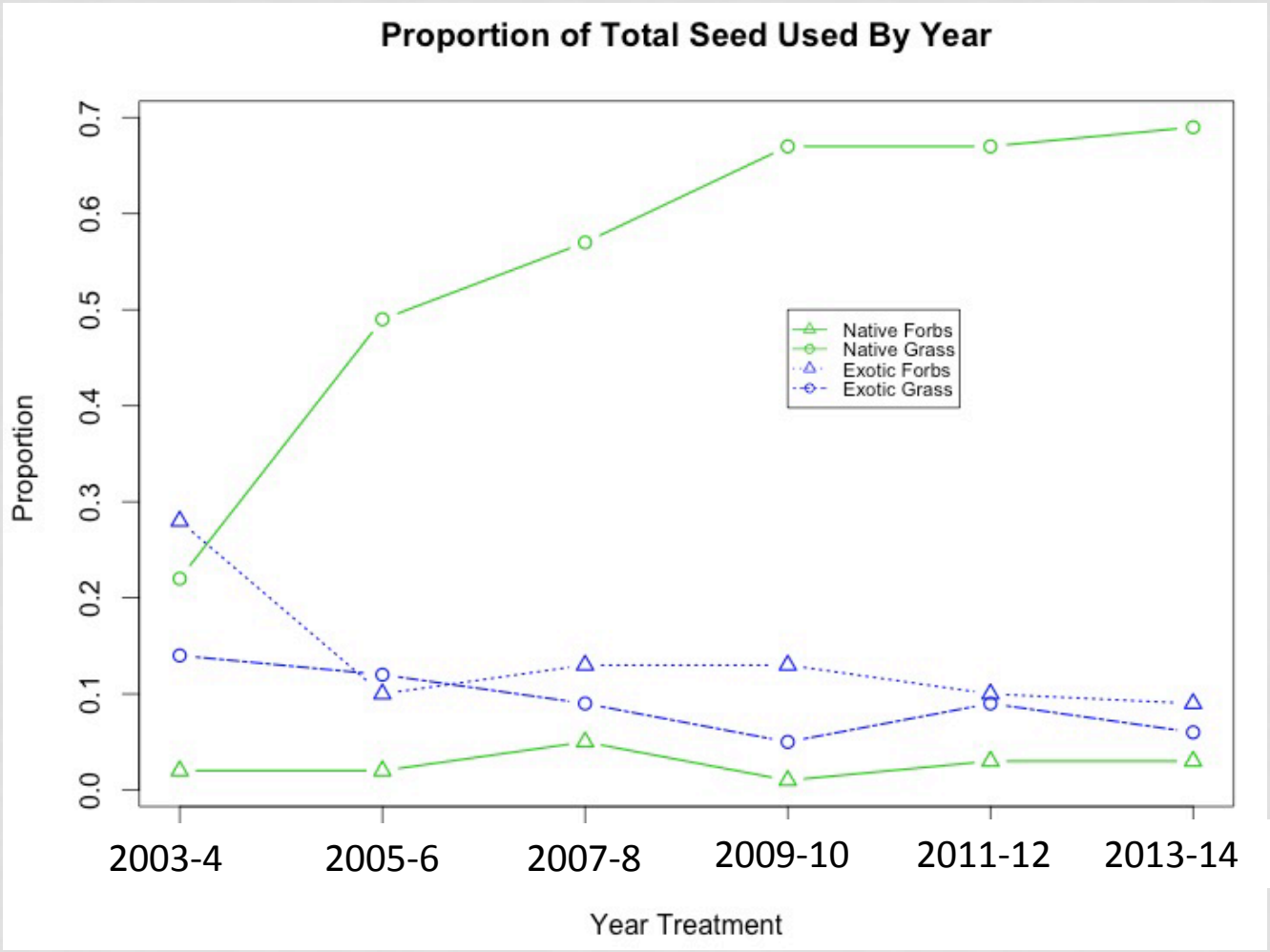
- 126 sites from UT within the Colorado Plateau (SITLA, Private, BLM, USFS)
- Restoration treatments applied 2003 – 2014
- Consistent pre- and post-monitoring protocols used
- 51 grass and forb species used (multiple sources, mostly non-local)


Number of species used
Number of species
20
15
10
5
0


Number of seeds used
Number of seeds (billions)
180
160
140
120
100
80
60
40
20
-


Cost of seeds used
Total amount spent (millions)
$1.4
$1.2
$1.0
$0.8
$0.6
$0.4
$0.2
$0.0
Native forb
Native grass
Exotic forb
Exotic grass

SEED USE OVER TIME



TOP SPECIES USED (BY NUMBER OF SEEDS)

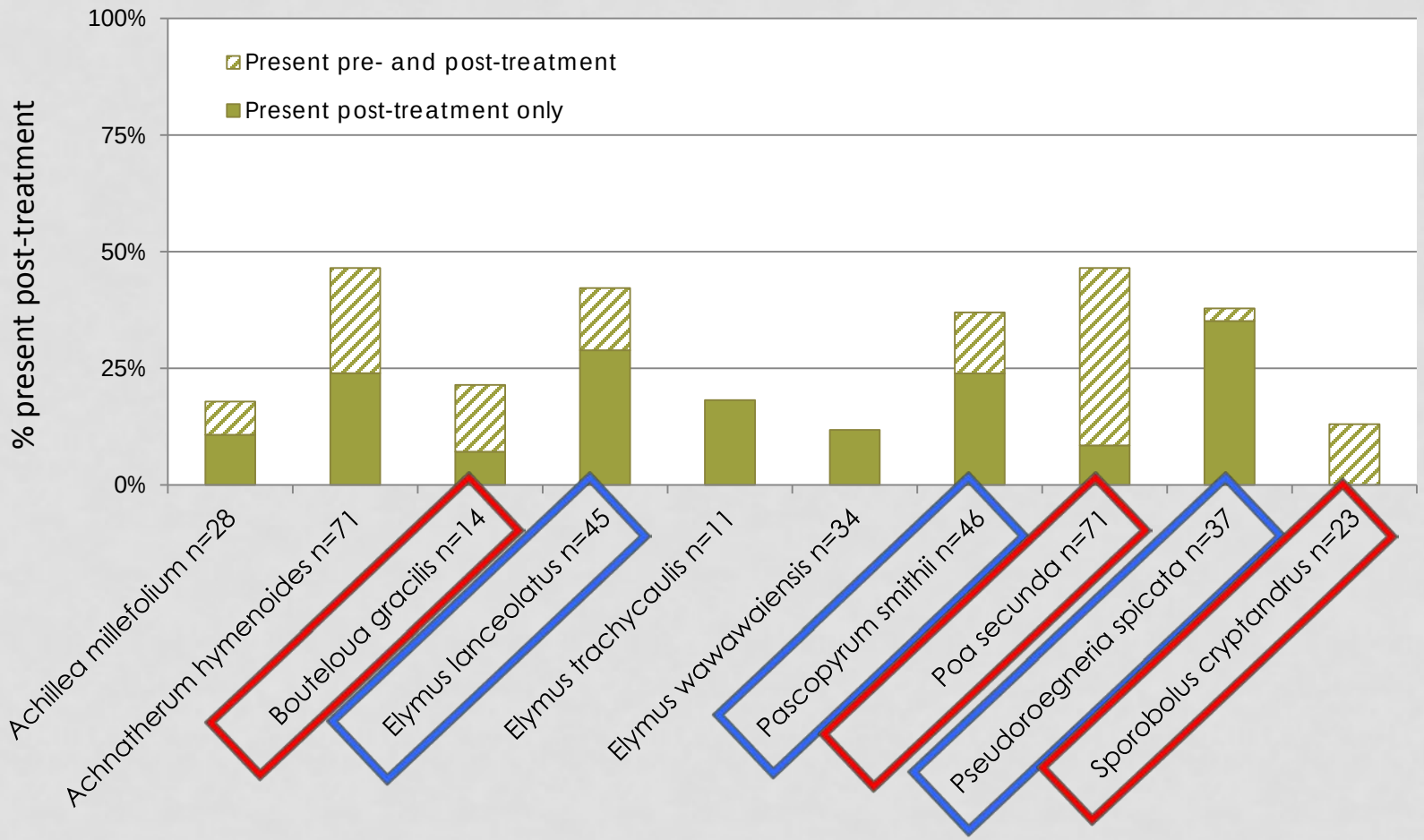
Rank	Genus	Species	PLS used (billions)	Lifeform	Status
1	*Sporobolus*	*cryptandrus*	108	Perennial Grass	Native
2	*Achnatherum*	*hymenoides*	79	Perennial Grass	Native
3	*Artemisia*	*tridentata*	55	Shrub	Native
4	*Poa*	*secunda*	20	Perennial Grass	Native
5	*Medicago*	*sativa*	12	Perennial Forb	Exotic
6	*Bassia*	*prostrata*	8	Perennial Forb	Exotic
7	*Psathyrostachys*	*juncea*	7.5	Perennial Grass	Exotic
8	*Achillea*	*millefolium*	5.9	Perennial Forb	Native
9	*Linum*	*perenne*	5.5	Perennial Forb	Exotic
10	*Agropyron*	*cristatum*	5.4	Perennial Grass	Exotic
11	*Dactylis*	*glomerata*	4.4	Perennial Grass	Exotic
12	*Pascopyrum*	*smithii*	4.2	Perennial Grass	Native
13	*Elymus*	*lanceolatus*	3.7	Perennial Grass	Native
14	*Sanguisorba*	*minor*	3.7	Perennial Forb	Exotic
15	*Elymus*	*wawawaiensis*	3.7	Perennial Grass	Native
16	*Bouteloua*	*gracilis*	3.3	Perennial Grass	Native
17	*Agropyron*	*fragile*	3.2	Perennial Grass	Exotic
18	*Thinopyrum*	*intermedium*	3.1	Perennial Grass	Exotic
19	*Agropyron*	*cristatum*	2.9	Perennial Grass	Exotic
20	*Pseudoroegneria*	*spicata*	2.3	Perennial Grass	Native

TOP 10 NATIVE GRASSES AND FORBS

https://en.wikipedia.org/wiki/Achillea_millefolium

Rank	Genus	Species	PLS used (billions)	Lifeform	Status
1	*Sporobolus*	*cryptandrus*	108	Perennial Grass	Native
2	*Achnatherum*	*hymenoides*	79	Perennial Grass	Native
3	*Poa*	*secunda*	20	Perennial Grass	Native
4	*Achillea*	*millefolium*	5.9	Perennial Forb	Native
5	*Pascopyrum*	*smithii*	4.2	Perennial Grass	Native
6	*Elymus*	*lanceolatus*	3.7	Perennial Grass	Native
7	*Elymus*	*wawawaiensis*	3.7	Perennial Grass	Native
8	*Bouteloua*	*gracilis*	3.3	Perennial Grass	Native
9	*Pseudoroegneria*	*spicata*	2.3	Perennial Grass	Native
10	*Elymus*	*trachycaulus*	1.5	Perennial Grass	Native

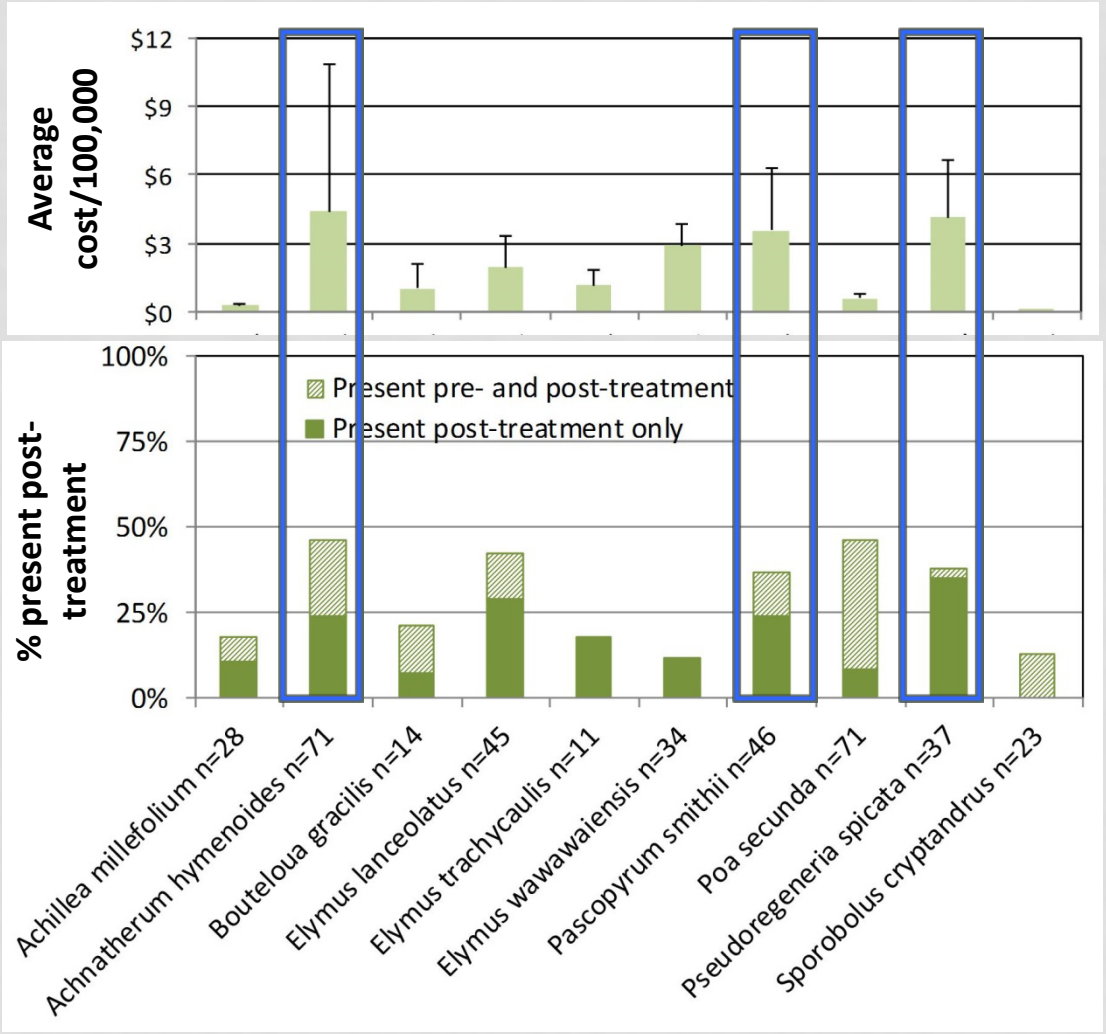
TOP 10 NATIVE SPECIES POST-TREATMENT PRESENCE



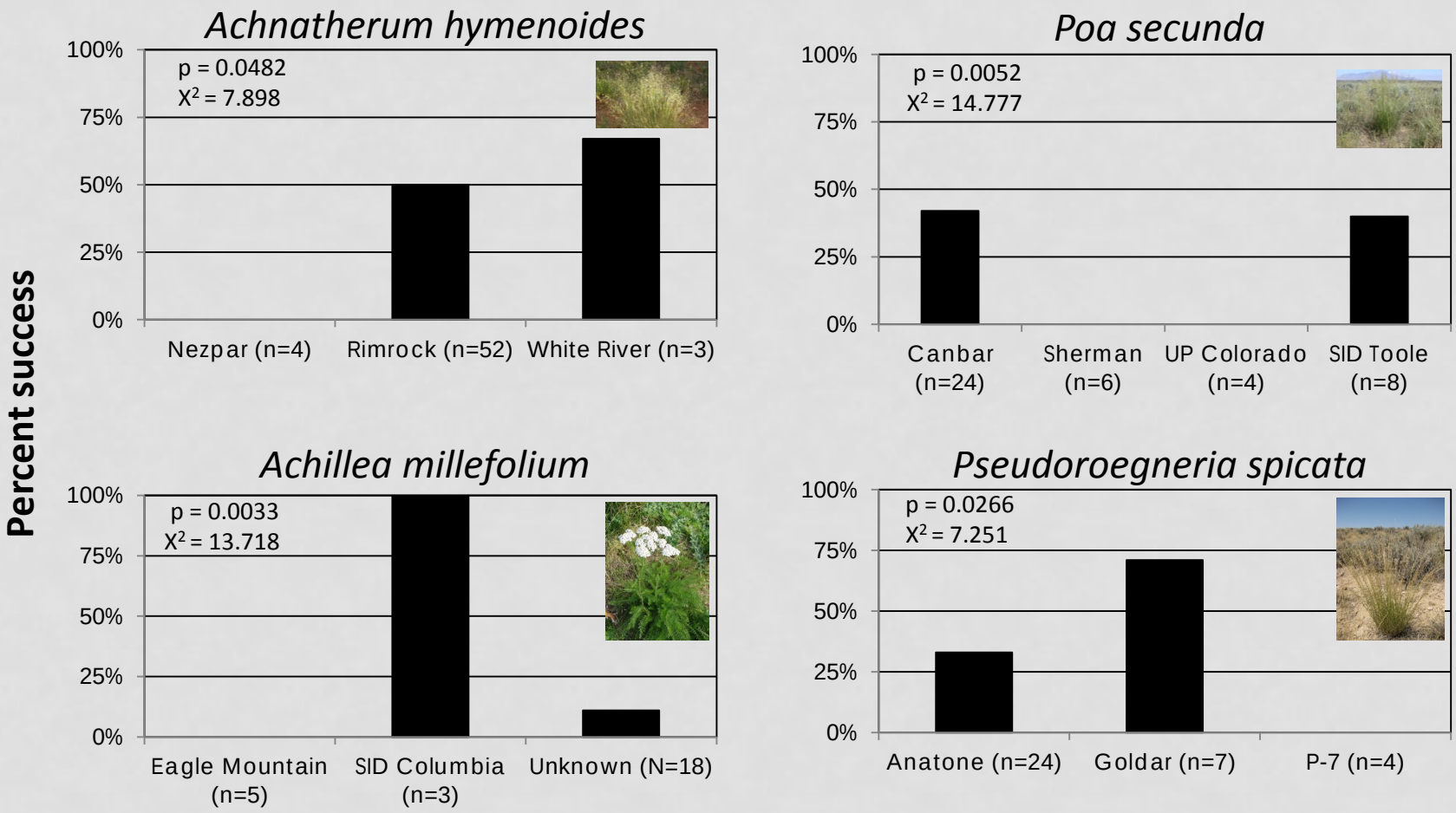
COST COMPARISON WITH SEEDING SUCCESS

Variation in success NOT explained by species, but significantly explained by cultivar

GLM (binomial logit)	DF	X^2	p
species	9	11.56	0.2391
cultivar(species)	14	37.167	0.0007



SEEDING SUCCESS BY CULTIVAR

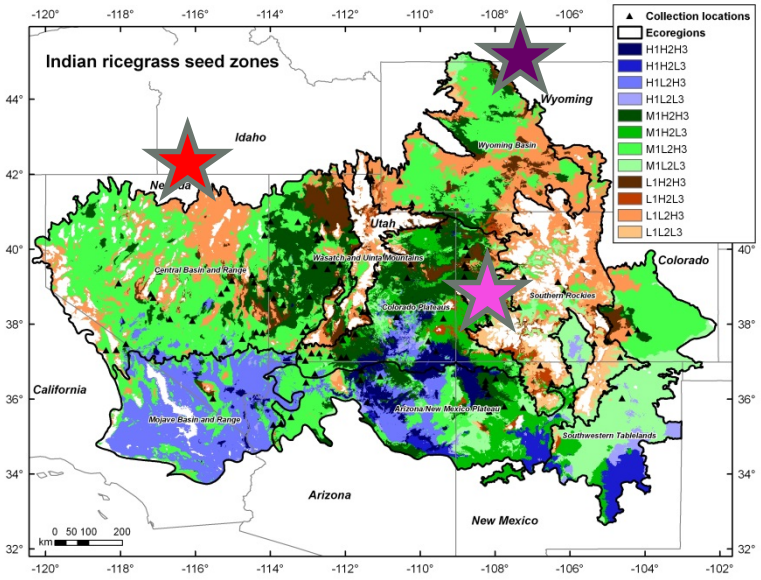


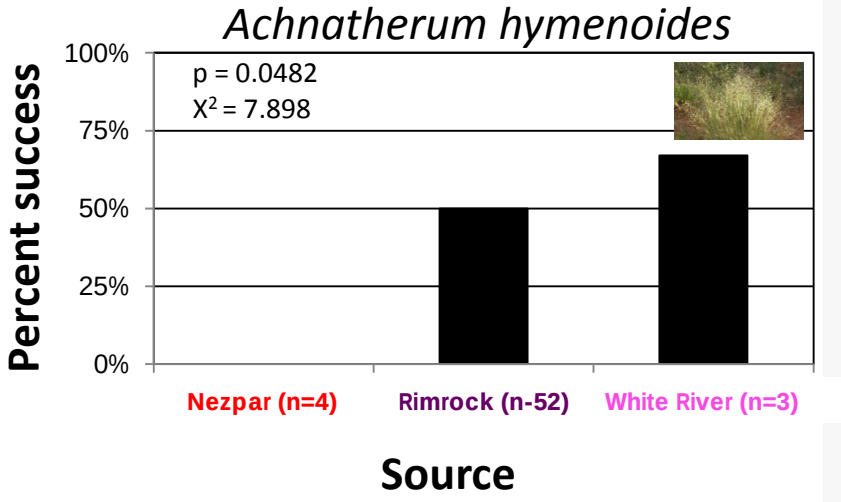
SEEDING SUCCESS BY CULTIVAR: INDIAN RICEGRASS

Achnatherum hymenoides

- **Nezpar:** Cultivar produced from seed collected in 1930 (White Bird, ID)
- **Rimrock:** Cultivar produced from seed collected in 1960 (Billings, MT)
- **White River:** Selected pre-variety released 2006 (Rangely, CO)

Source	Avg Price/lb
Rimrock	$3.71
Nezpar	$5.12
White River	$8.07

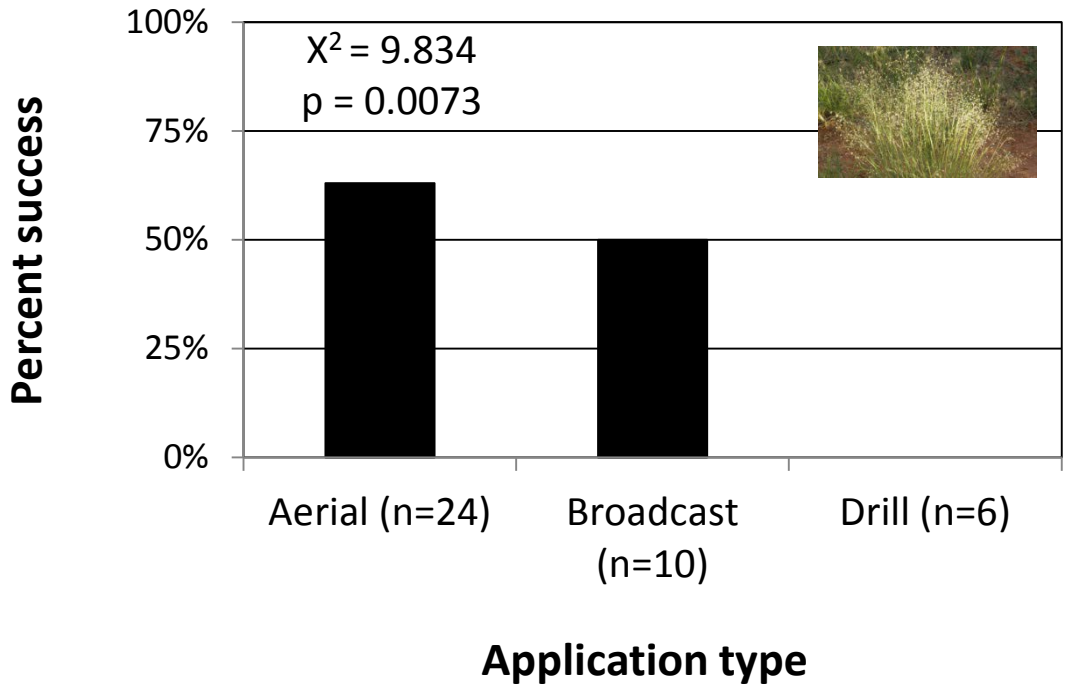




Johnson, R. C., et al. 2012. Genecology and seed zones for indian ricegrass collected in the southwestern United States. Rangeland Ecology & Management **65**:523-532.

OTHER IMPACTS ON SEEDING SUCCESS IN 'RIMROCK'

- Seeding success was NOT significantly explained by any climate factors
- Application type significantly explained seeding success, but not as expected (aerial was greater than drill)



CONCLUSIONS AND NEXT STEPS

- Interesting patterns beginning to show for the most commonly-used species
- More data is needed for a wider range of species and seed sources in similar habitat and situations (*working to expand this dataset across the Colorado Plateau*)
- Investigate specific site characteristics (soils, invasive species, climatic variables from year treatment occurred) that support/ inhibit establishment.
- Investigate effect of species mix, seeding rate, and source on species diversity of the restoration over short- and long-term.

THANK YOU!

- **Data assistance from:** Kevin Gunnell (WRI), Justin Welty (LTDL), Judy Perkins (BLM, Colorado River Valley), Gabe Bissonette (BLM, Moab), Ken Holsinger (BLM, UFO), Sandra Borthwick (NPS, Capitol Reef), Katie Sandbom (NPS, Grand Canyon), Mark Paschke (CSU), Lila Leatherman (UU).
- **BLM Field Offices:** Moab, Monticello, Grand Junction, Price, Tres Rios, White River, Uncompahgre, Colorado River Valley, Little Snake, San Luis Valley
- Support from Bureau of Land Management (Plant Conservation Program)

DATA FROM

- Data on restoration treatments and seed mixes from the Utah Watershed Restoration Initiative (WRI) and monitoring results from the Utah Division of Wildlife Resources Range Trend Project: https://wri.utah.gov
- Land Treatment Digital Library (LTDL): http://ltdl.wr.usgs.gov


QUESTIONS???

POTENTIAL CLIMATIC PREDICTORS OF SUCCESS

- For all species, only elevation significantly explains success (p=0.0151)
- Within species, patterns vary:

Species	Mean Annual Temp	Mean Diurnal Range	Temp Seasonality	Mean Temp Wet Qtr	Mean Annual Precip	Precip Seasonality	Precip Warmest Qtr	Elev
Achillea millefolium	0.0021 (-)	0.0407 (-)						0.0158 (+)
Achnatherum hymenoides						0.041 (+)		
Bouteloua gracilis								
Elymus lanceolatus	0.0013 (-)					0.0063 (-)	0.0063 (+)	0.0006 (+)
Elymus trachycaulus								
Elymus wawawaiensis				0.0021 (+)			0.0047 (+)	
Pascopyrum smithii	0.02 (-)							
Poa secunda		0.029 (+)				0.0115 (-)		
Pseudoroegneria spicata								
Sporobolus cryptandrus	0.0006 (+)					0.0045 (+)		