Climate, wildfire, and sagebrush-steppe ecosystems

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USGS science for a changing world

Great Basin LANDSCAPE CONSERVATION COOPERATIVE

Climate effects are central to:

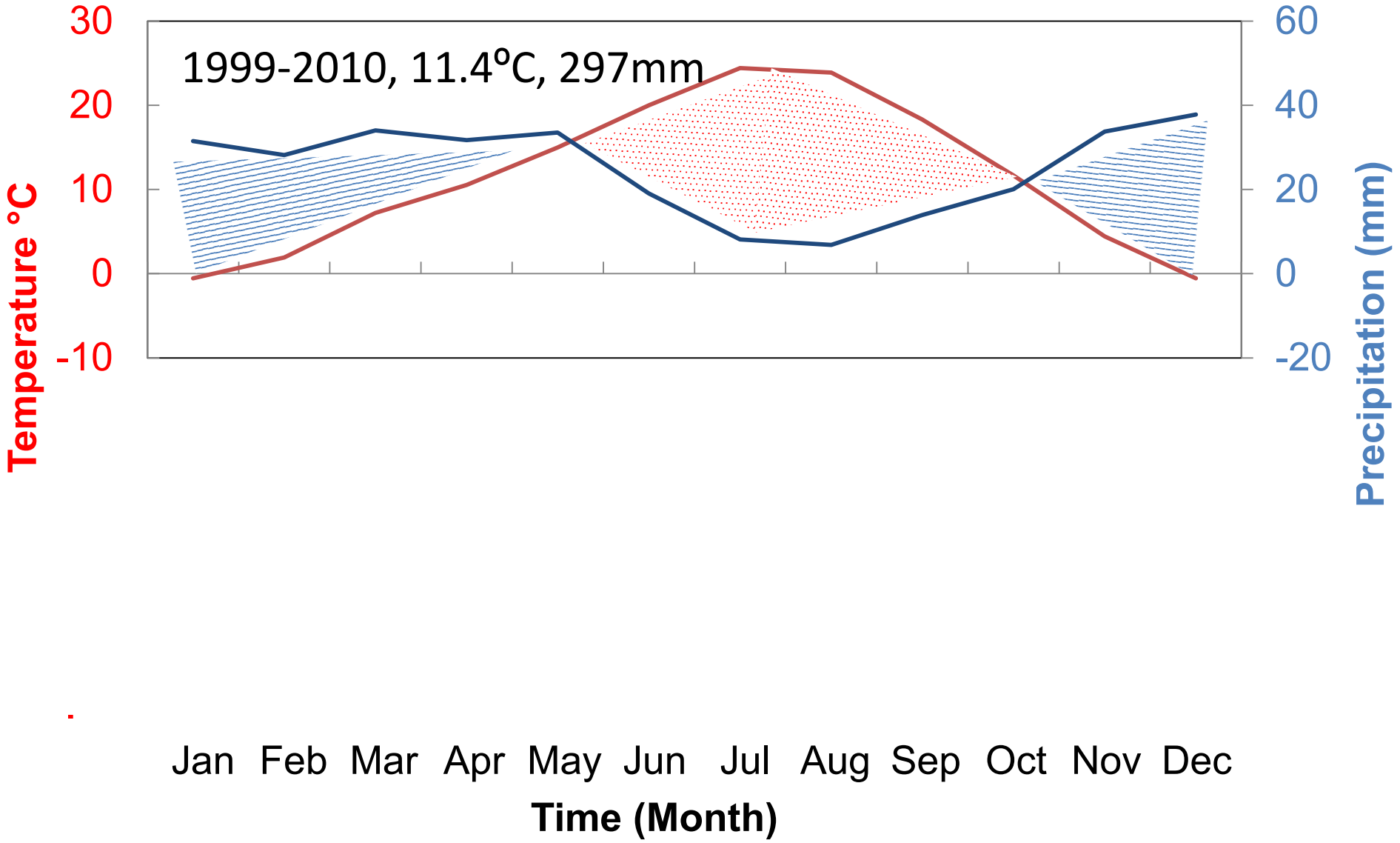
- Landscape **vulnerability** assessments (eg. Rapid Ecol Assessments)
- Landscape **prioritization** of conservation or development efforts
- **Rehabilitation** or **restoration** in sagebrush steppe

Outline:

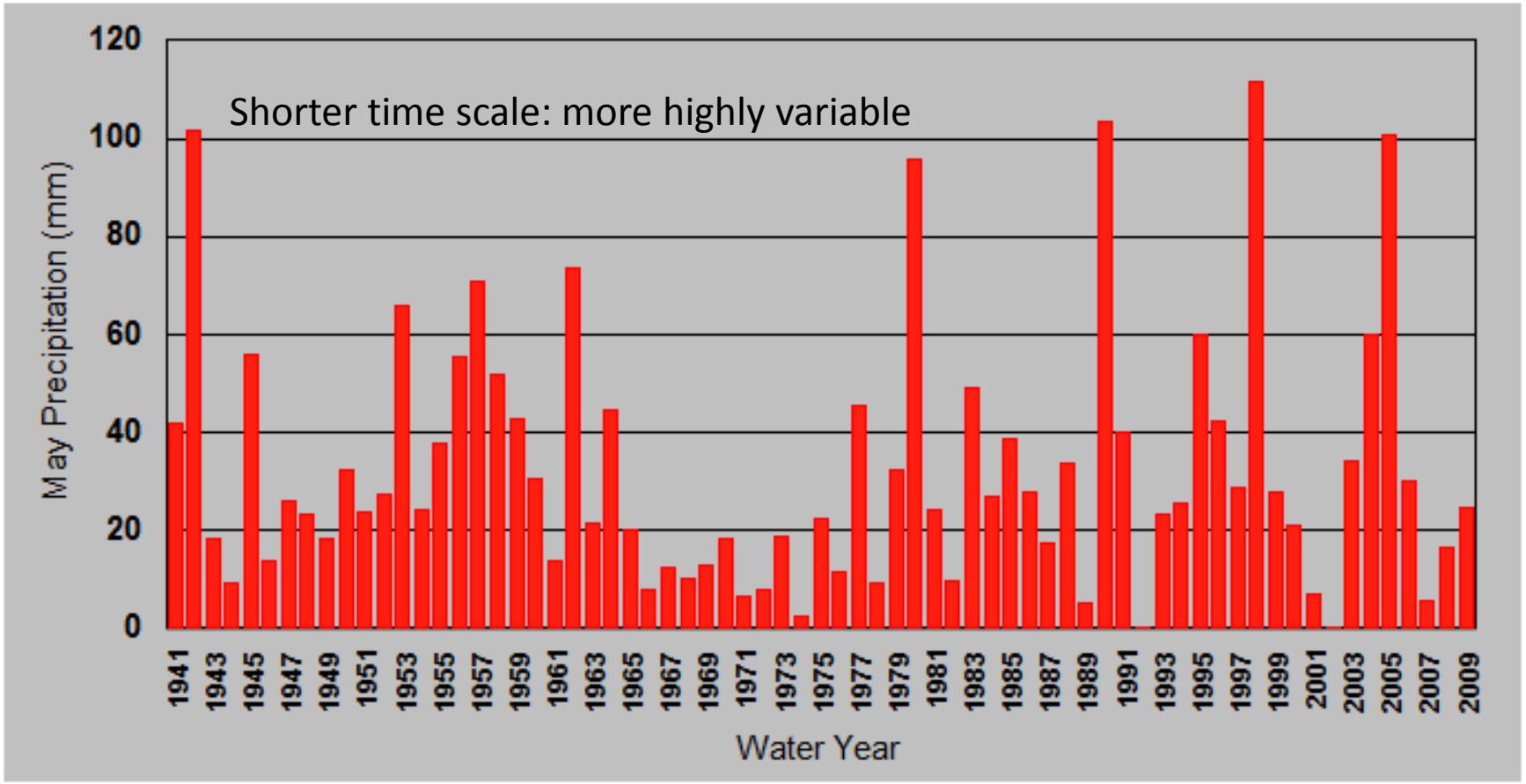
- Climate of the Great Basin (sagebrush steppe); trends
- Plant responses can tell us what constitutes climate “change”
- Feedbacks and landscape considerations

I. Climate of sagebrush steppe: *Cold desert!*

For Boise airport:



More arid = more variable precipitation from year-to-year!

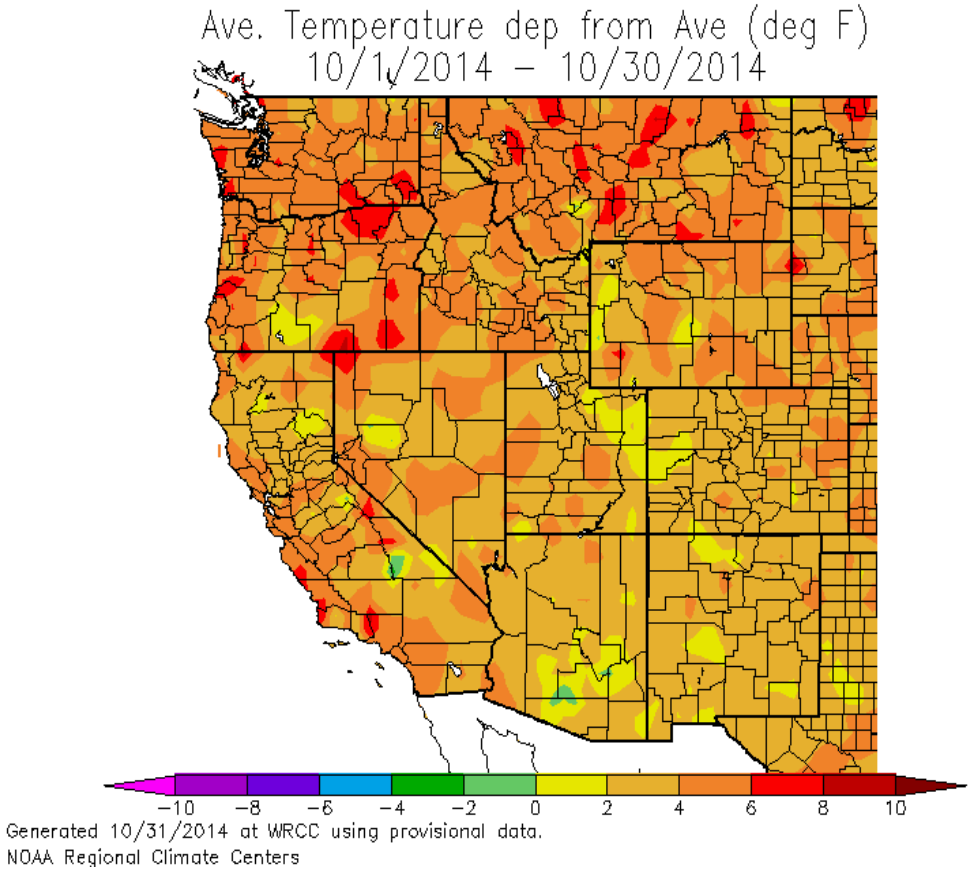


From S Hardegree.

Past Variability:

Trends for Boise 1940-2014 (NOAA, annual):

- **1.5ºC** greater <u>mean</u> temperature
- **1.85ºC** greater <u>minimum</u> temperature:
- Precipitation: no change



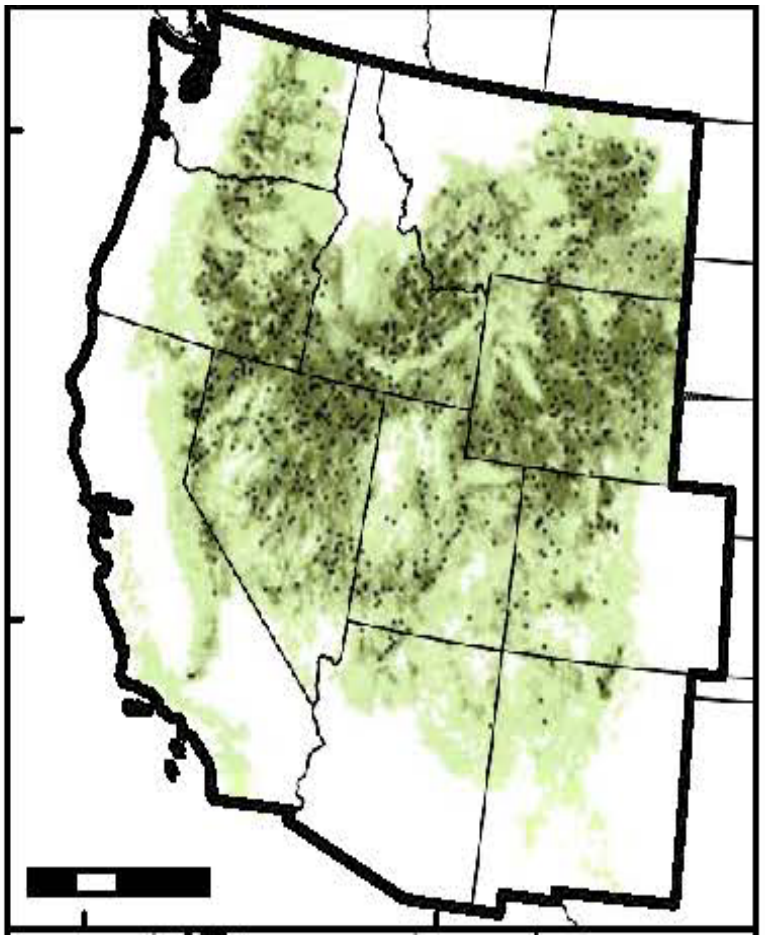
IPCC 2013 forecast for Great Basin:

Temperature more predictable than precipitation, winter weather more predictable than summer.

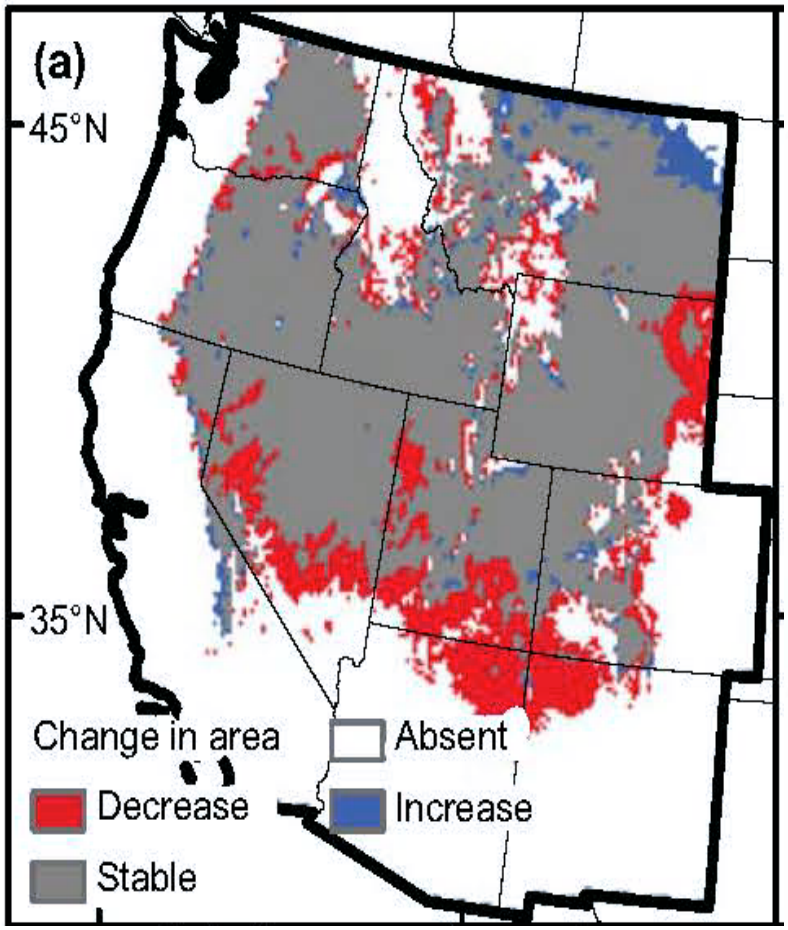
- Warming: up to 3°C by 2050
  More winter warming in N latitudes.
- Winter precipitation:
  Up to 10% more by 2050 for Northwest
- Soil moisture predicted to decline throughout.
- Implications for fire

Climate suitability for big sagebrush

CURRENT



2040-2069

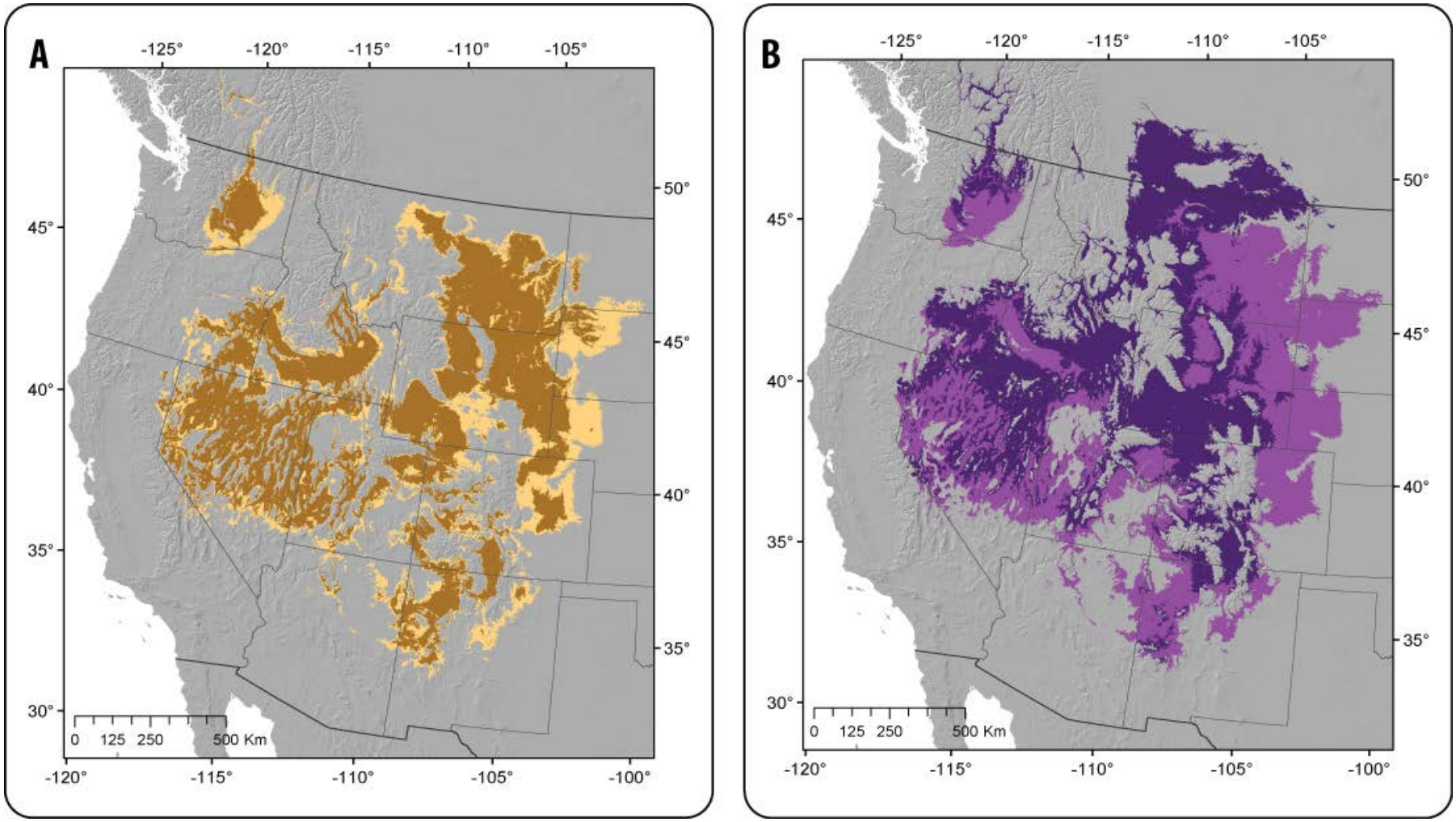


from Schlaepfer et al. 2012

Climate suitability for Wyoming Big Sagebrush,

(Lighter color = less suitable)

CURRENT **2050**

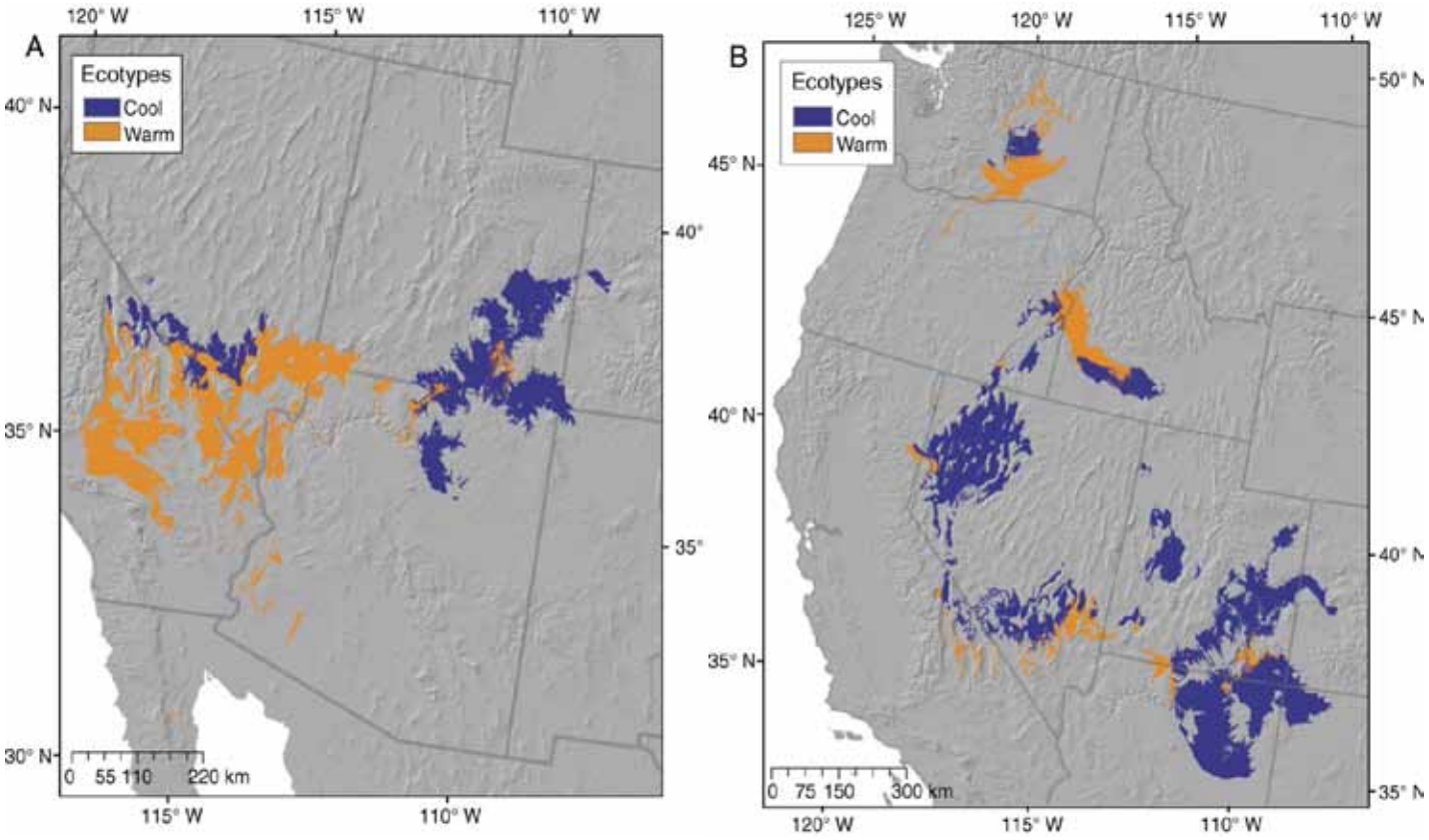


from Still and Richardson, 2014

Might native shrubs to replace sagebrush? Blackbrush?

Current

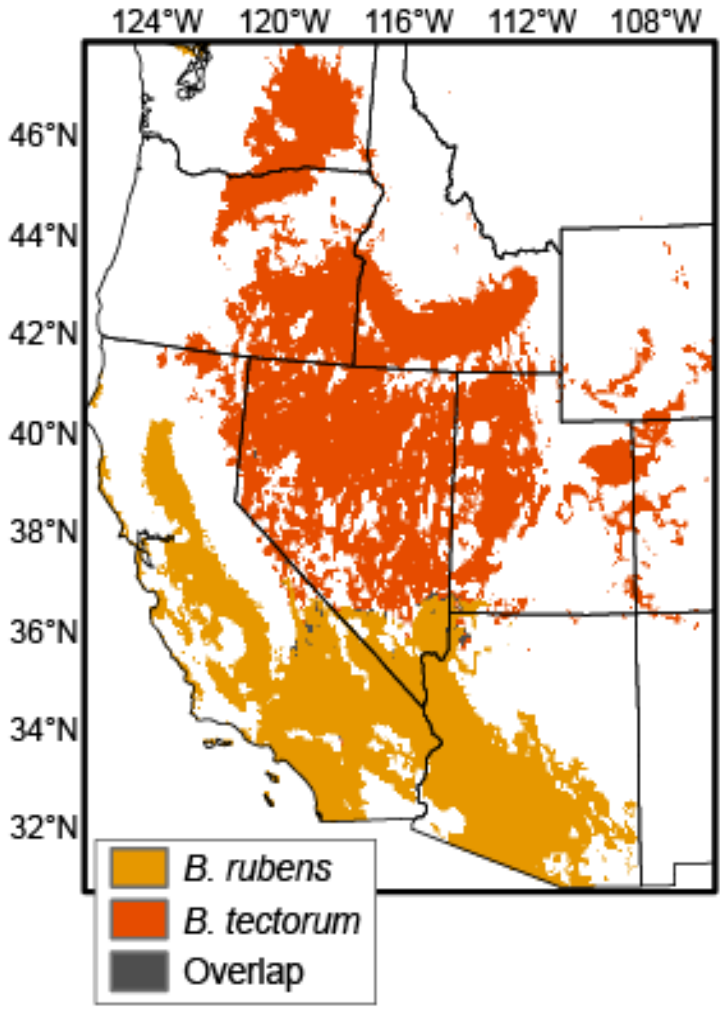
2060



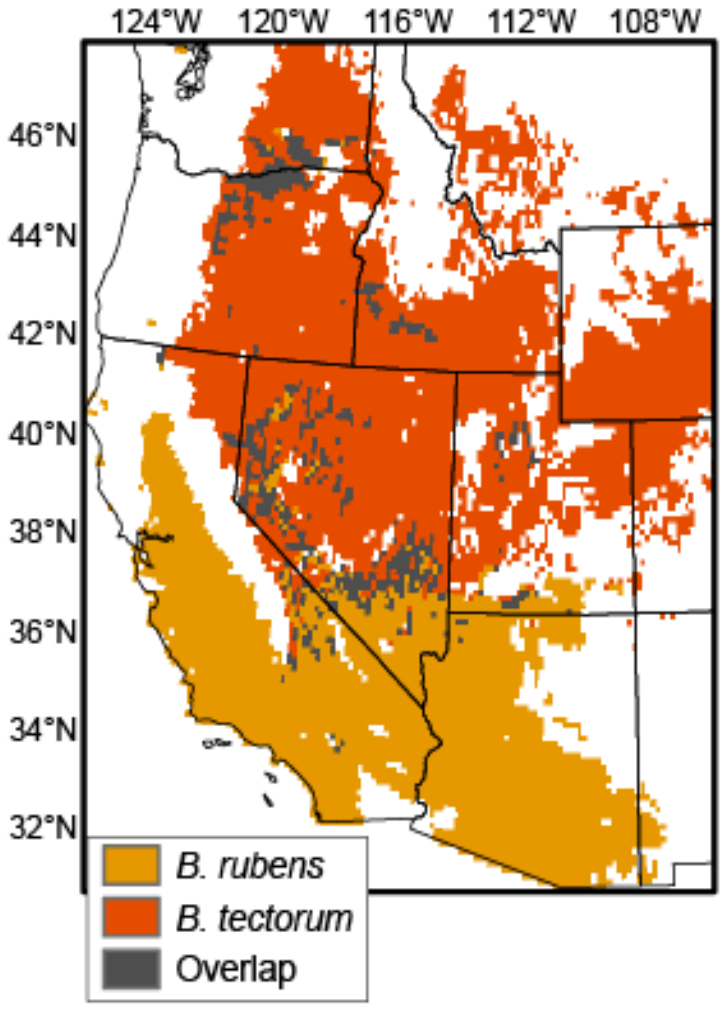
Richardson et al. 2014

Climate suitability for cheatgrass and red brome

CURRENT



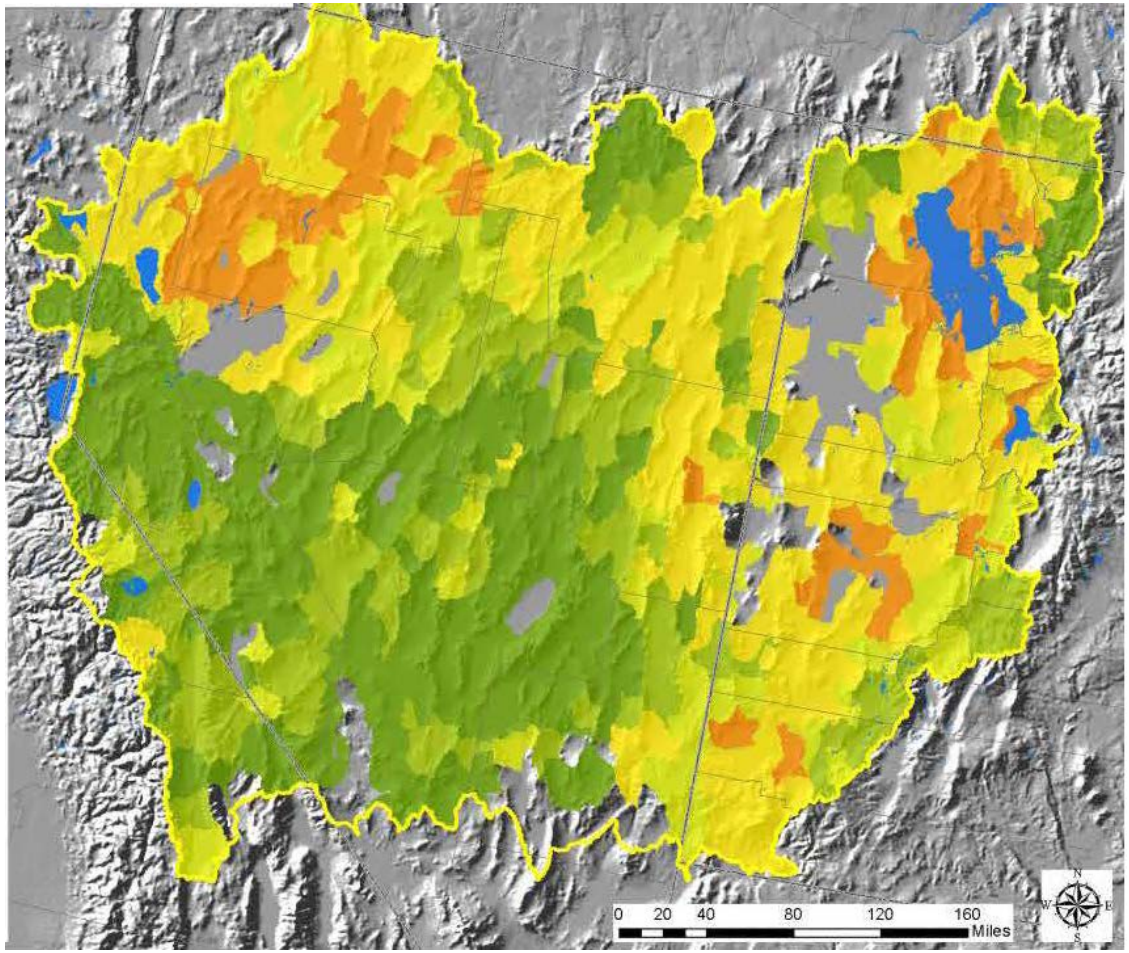
2040-2069



from Bradley et al. in revision

Fire regime departure forecast for 2060, in big sagebrush habitat

(warmer colors = more departure, more fire)



Crist/Comer et al. 2013, Central Basin & Range REA

feedback on climate

Feedback on climate-fire relationship:

Compared to sagebrush habitat, **cheatgrass:**

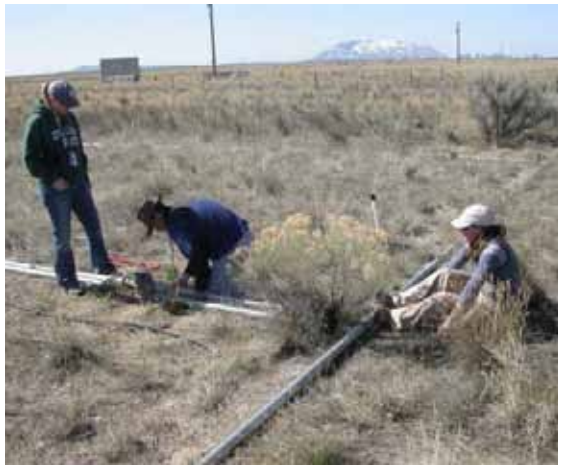
- Increases annual probability of burning from <1% to 1-2%
  (many cheatgrass sites known to burn every few years)
- Increases fire return interval from 97-313 year to 50-82 years
- Doubles probability of fire as a function of previous year's rain
- Also: 65% of fire starts on cheatgrass

For 650 km^2 of sagebrush steppe during 1980-2007

From Balch et al. 2013.

Experimental insight:

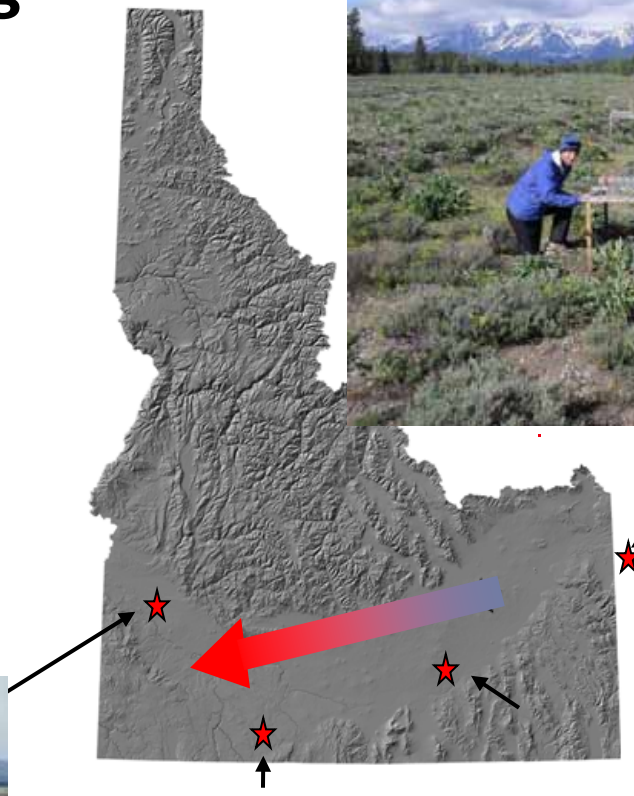
20 years of precipitation increase in winter or summer on INL Ecohydrology Experiment



Snake River Plain Warming Experiment:

Experimental warming effects vary along this gradient.

Grand Teton National Park

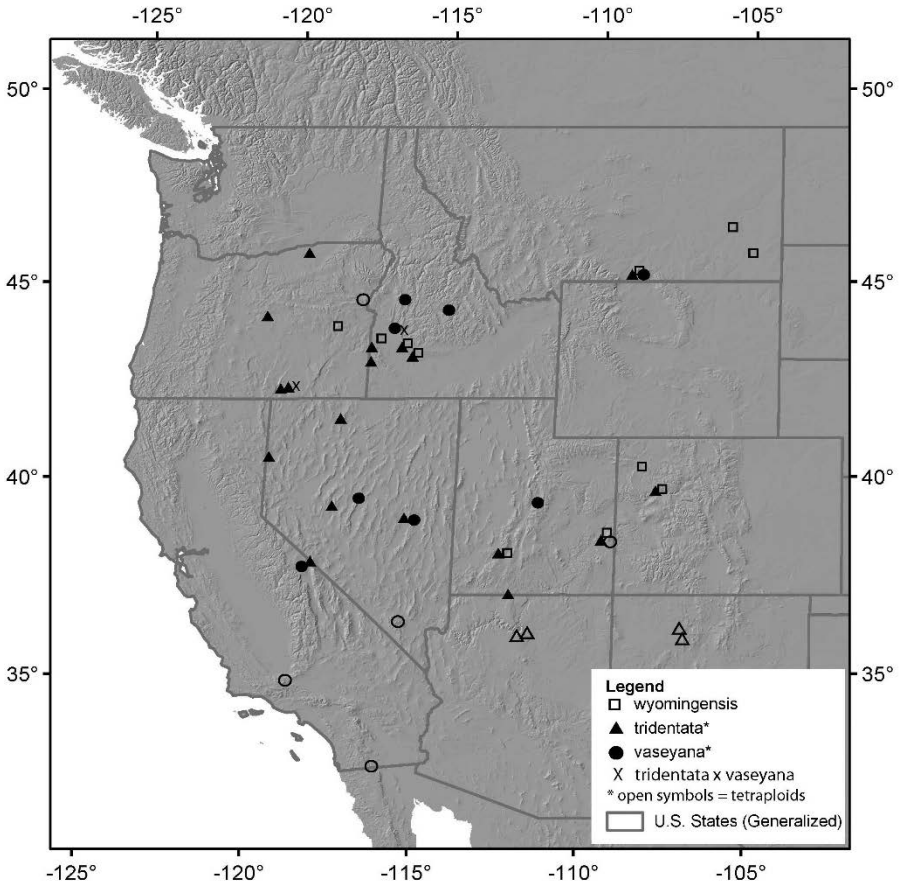


Twin Falls sagebrush

Raft River, burned now cheatgrass

Birds of Prey NCA, burned & unburned

Sagebrush common gardens reveal climate adaptation



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Common gardens of sagebrush seedlings after fire:

Climate adaptation via seed selection:

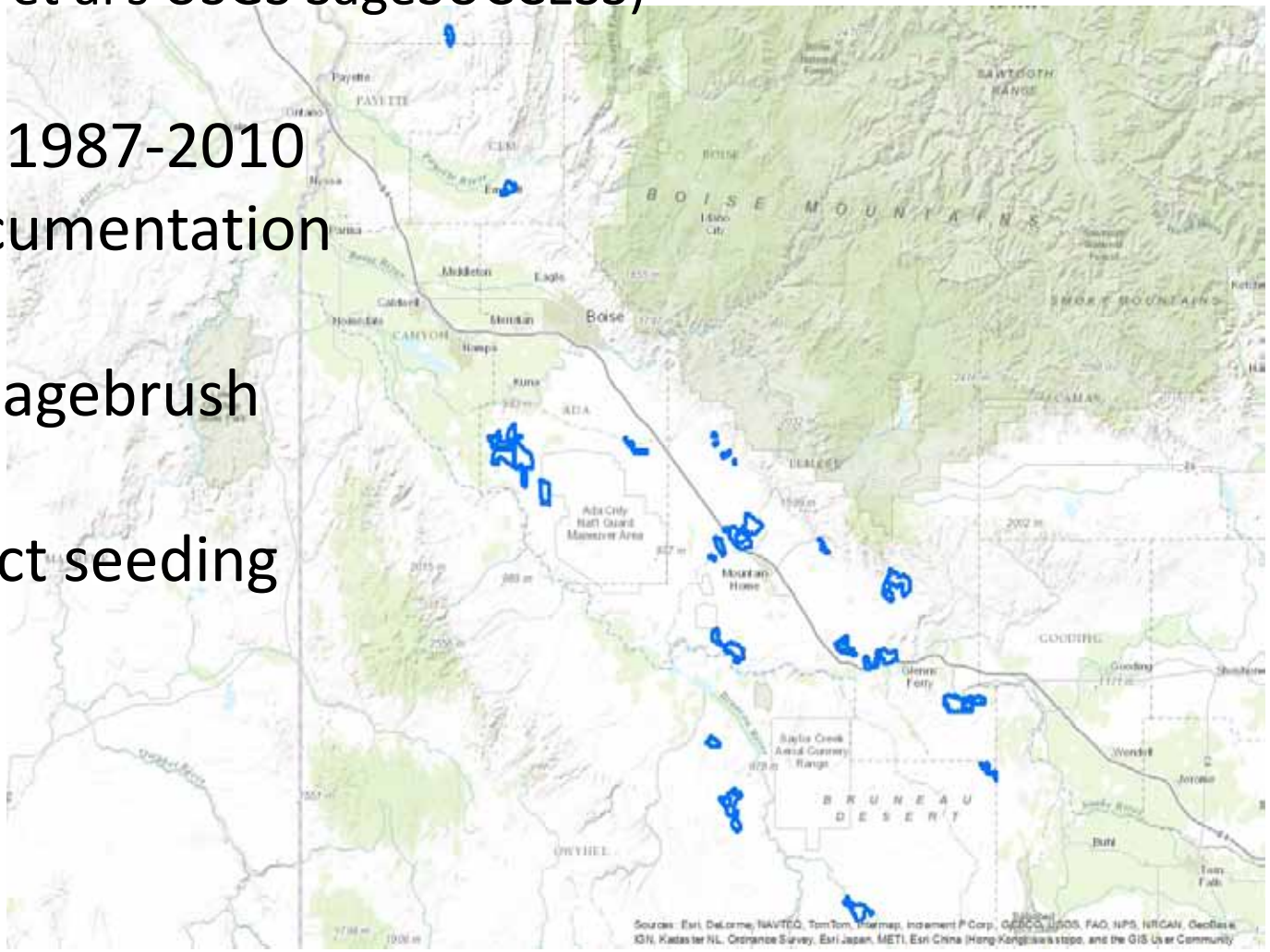
Boise "Pilot" Post-fire seeding/climate study

(follows Lysne&Pellant 2004,
followed by D Pilliod et al's USGS SageSUCCESS)

24 seedings from 1987-2010
had sufficient documentation

15 seedings had sagebrush

Many factors affect seeding
outcomes



Seeds were transported from areas that were/had:

- Distant (486 km away)
- Uphill (+751 m)
- Wetter (+5 mm annually)
- Less drought
- Cooler temperatures
- Different subspecies; hybrids

Photo credit: Elko Daily Free Press

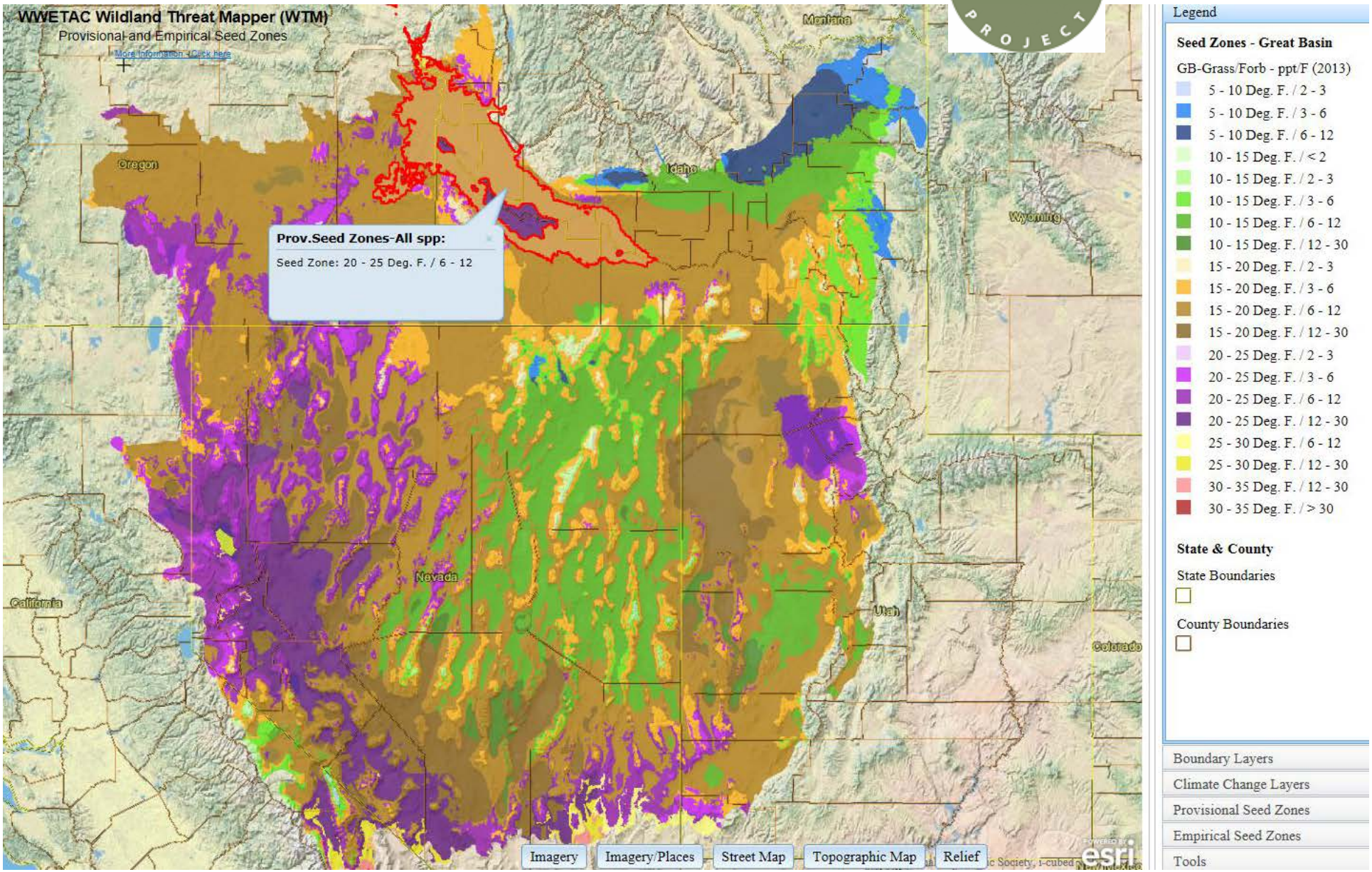
Climate of seed source relative to post-fire seeding site:

	+ sagebrush (success)	Had no sagebrush
mean annual temperature	<0.75°C lower	2°C lower
mean temperature of coldest month	**NO DIFFERENCE**	3°C lower
freezing degree days/yr	8 more	30 more
mean distance transferred	430 km	460 km

Also: more success with cooler and wetter weather following seeding

Assisted migration??

Seed zone use - provisional



Wind and fire

Wind erosion

Wind erosion: **scale-appropriate** information on climate **thresholds** needed to predict soil stability,

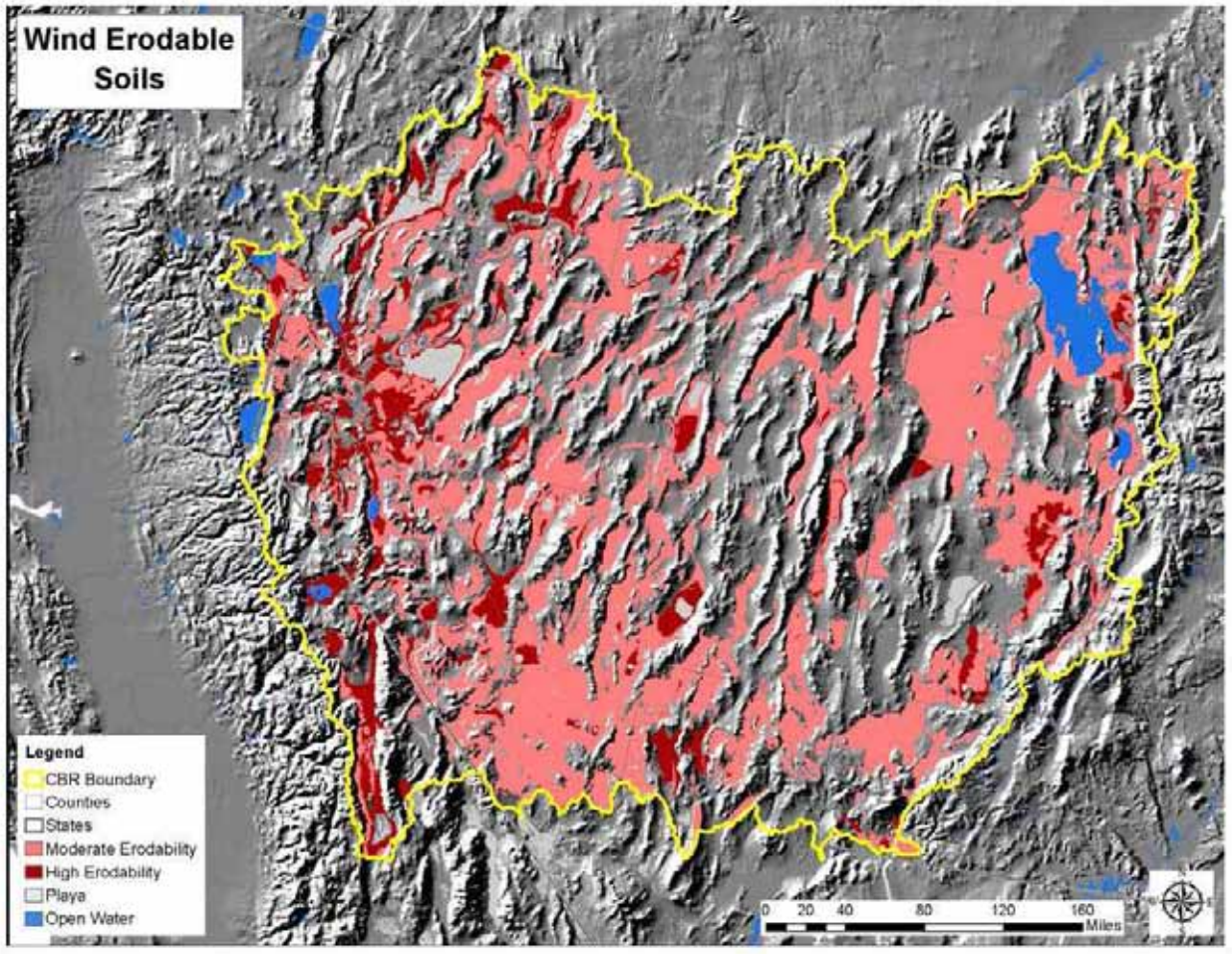


Figure 4-3. Modeled distribution of wind erodible soils in the Central Basin & Range ecoregion.

Crist/Comer et al. 2013 CBR REA

SUMMARY, relative to focus questions

*Where are the key **challenges to maintaining the diversity and productivity** of the Great Basin's sagebrush-steppe ecosystem?*

- **Less soil moisture with warming**, more variable climate extremes (eg. drought)
- **Expansion of invasive annuals**, contraction of sagebrush
- Potentially **worse fire conditions**, especially in NW
- **Large fire effects on soil stability and sagebrush**

What are some critical, near-term science needs to help us better understand rangeland fire in this ecosystem?

- Identification of **thresholds** related to fire and post-fire recovery
- **Monitoring /assessment** of climate, soil stability, and vegetation recovery
- Record keeping of treatments, **assessment of treatments**
- Addressing **appropriate seed sources**, including understanding of **climate adaptation**


The end
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