FIRE, WIND, and WATER :
Landscape change and its relationship to development

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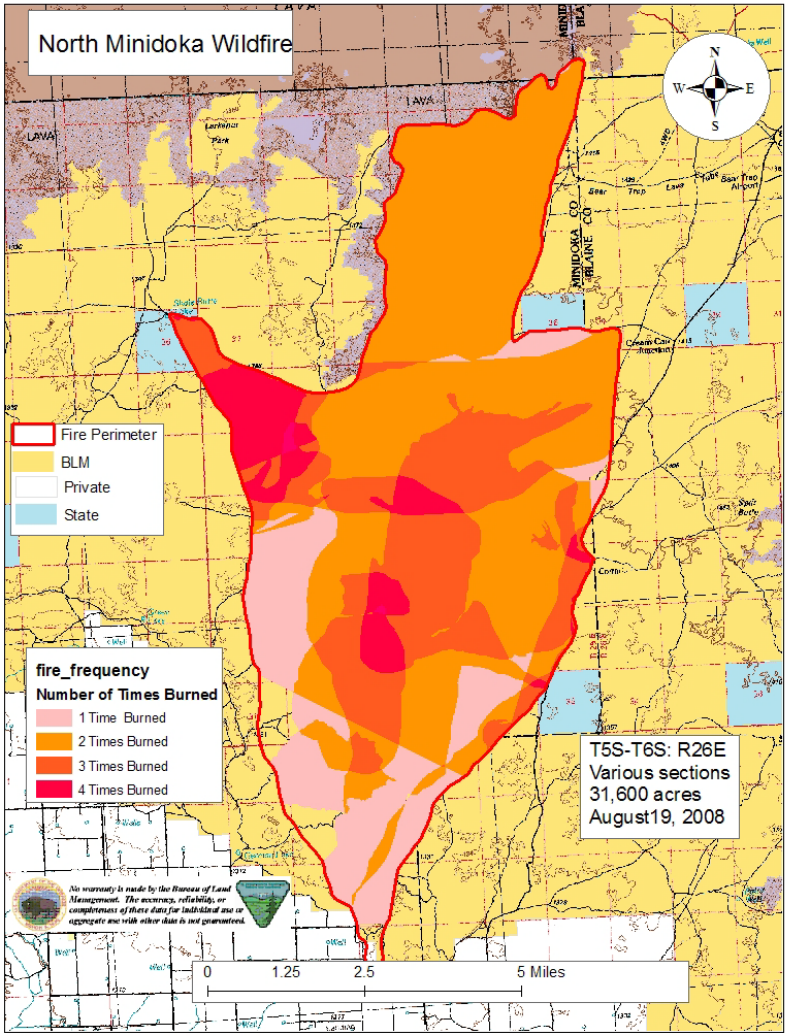
Semiarid rangelands:

1) primary locations for wind and energy development.
2) increasingly, landscape stability are concerns (vegetation, soils, C and H_2O cycles)
3) site ability to withstand disturbance is key to energy development prospects



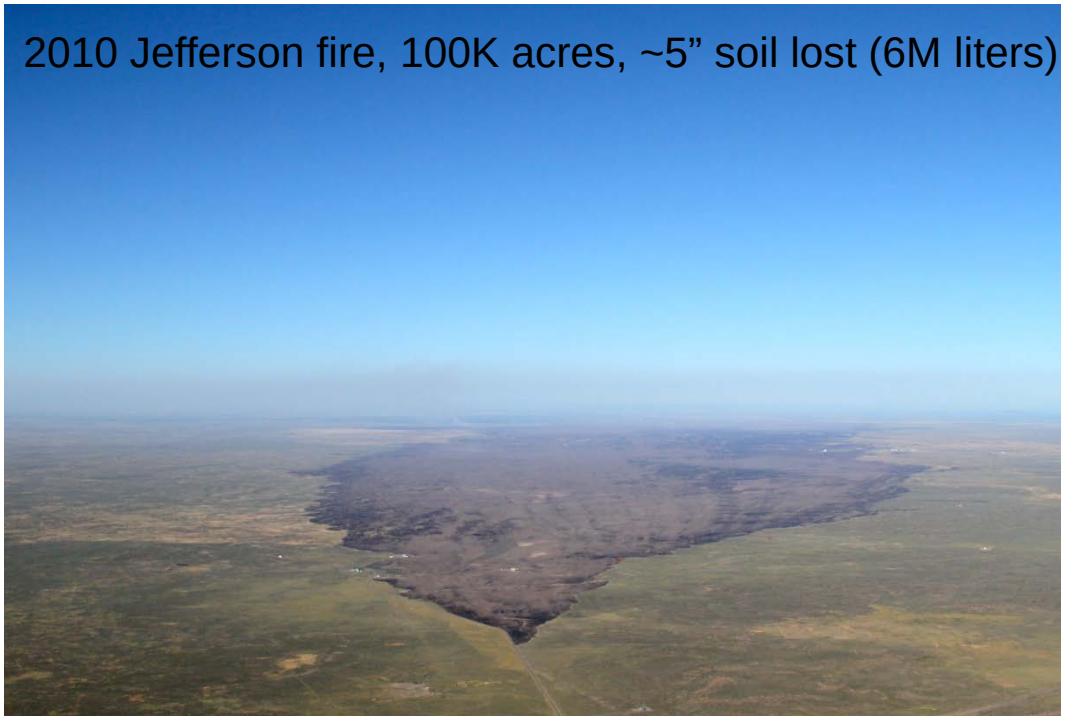
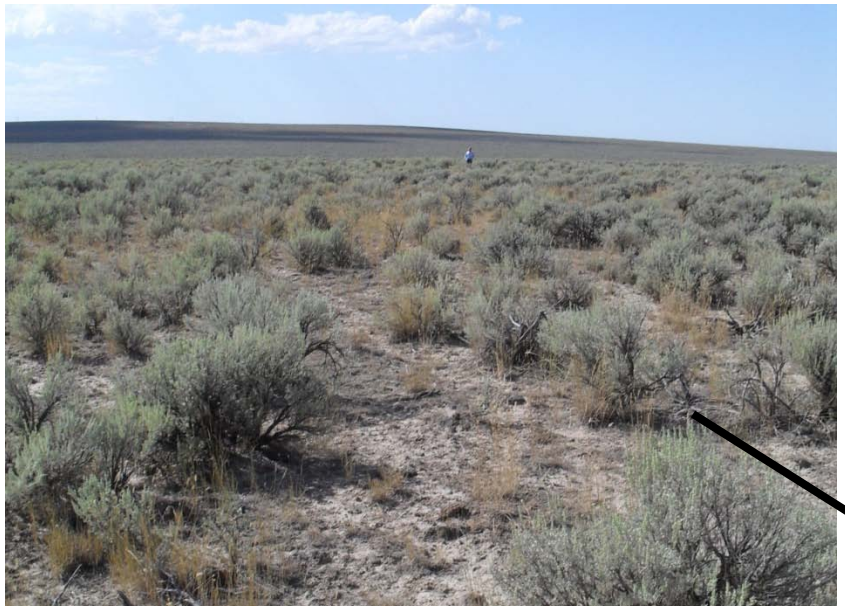
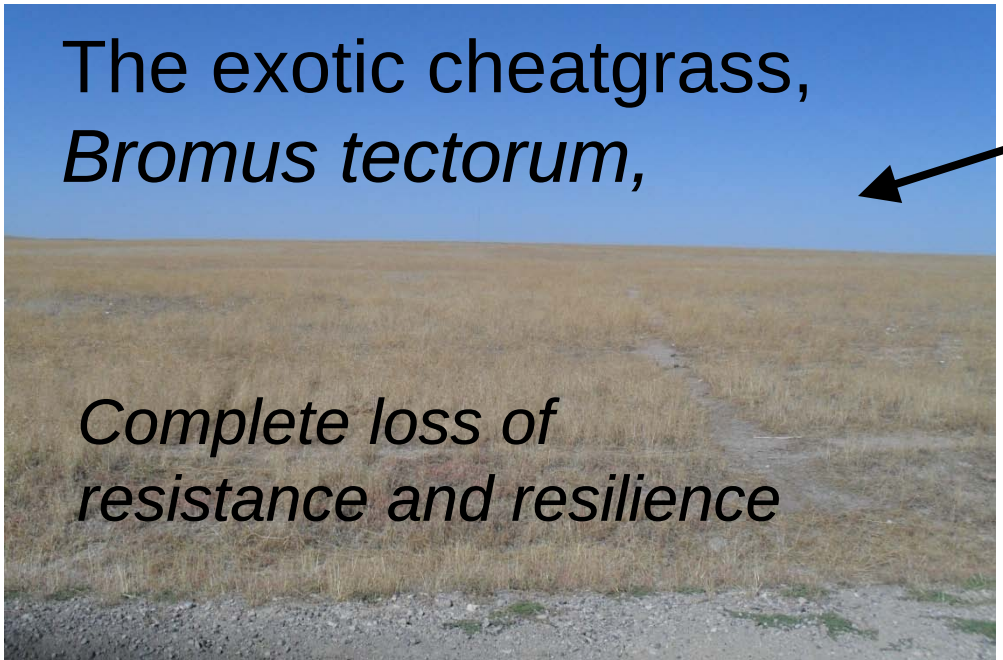


Photo credits: BLM and Stoller-Gonzales LLC

Feedbacks: the fire-cheatgrass cycle



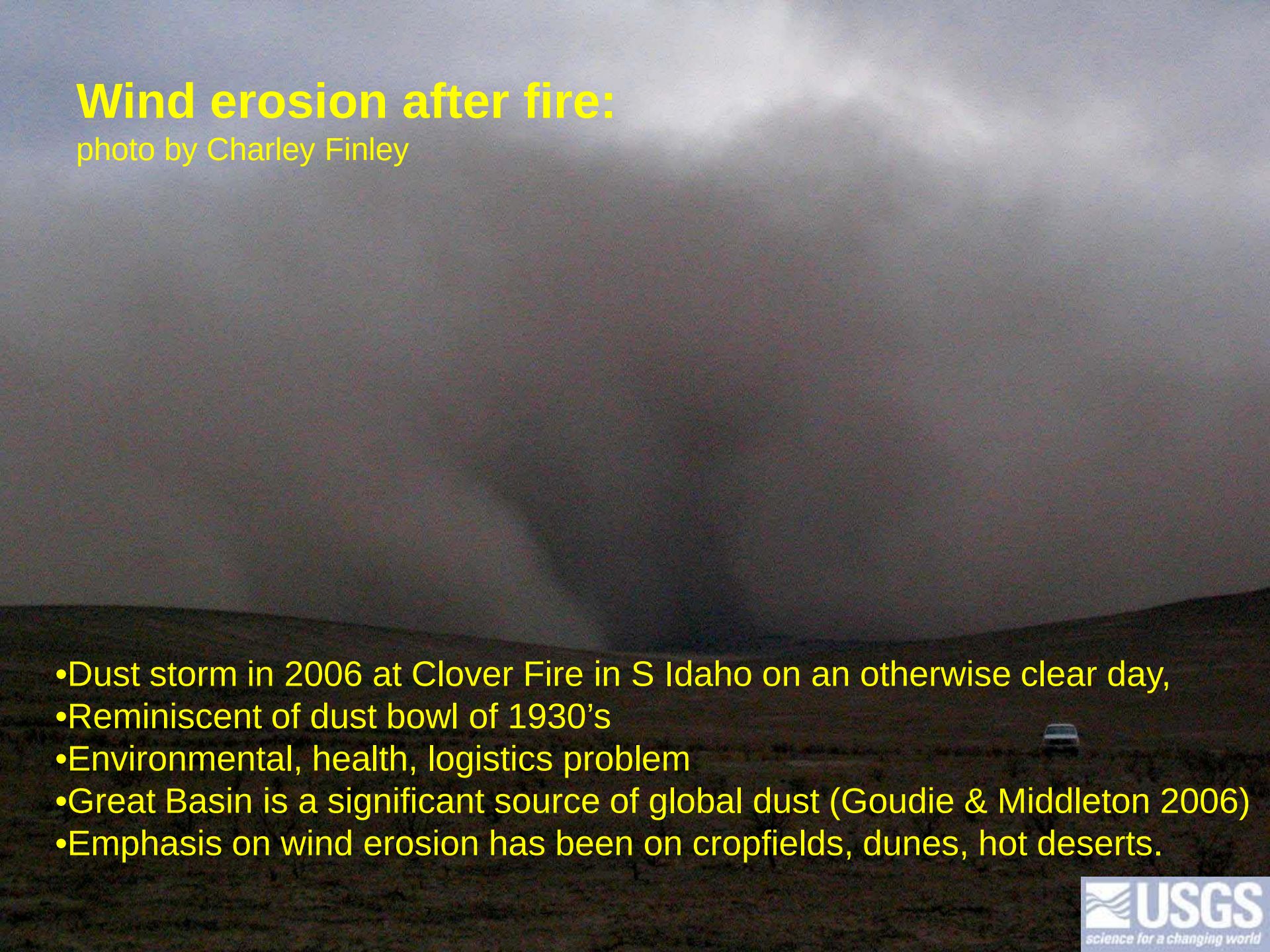


FIRES IN AND AROUND INL (image from www.geomac.gov)

2011: T-111 fire, 50K acres
2010: Jefferson fire, 110K ac
2010: Middle Butte fire, 15K ac
2008: Hwy 20 fire,1.5K ac
2007: Twin Buttes fire, Moonshiner Fire; 11K ac

Wind erosion after fire:

photo by Charley Finley



- Dust storm in 2006 at Clover Fire in S Idaho on an otherwise clear day,
- Reminiscent of dust bowl of 1930's
- Environmental, health, logistics problem
- Great Basin is a significant source of global dust (Goudie & Middleton 2006)
- Emphasis on wind erosion has been on cropfields, dunes, hot deserts.

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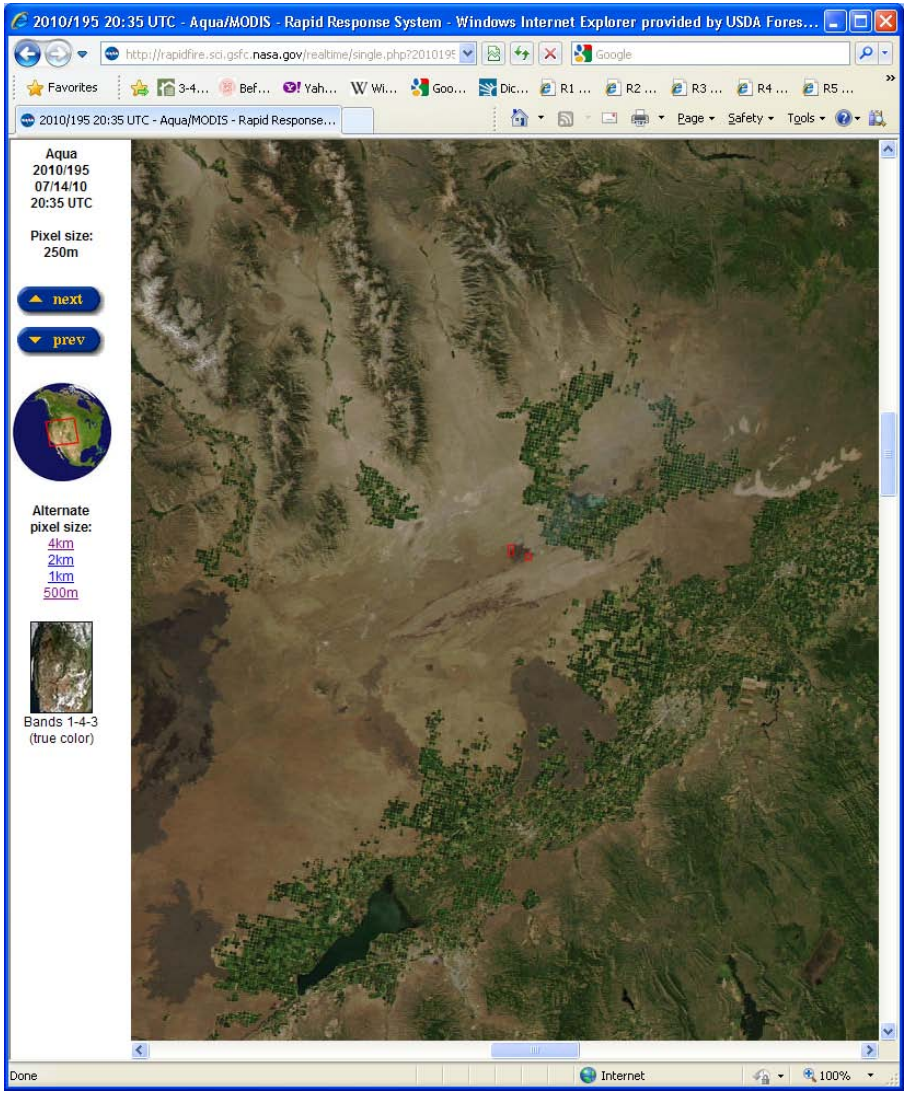
From the 2010 Jefferson Fire, near Idaho Falls

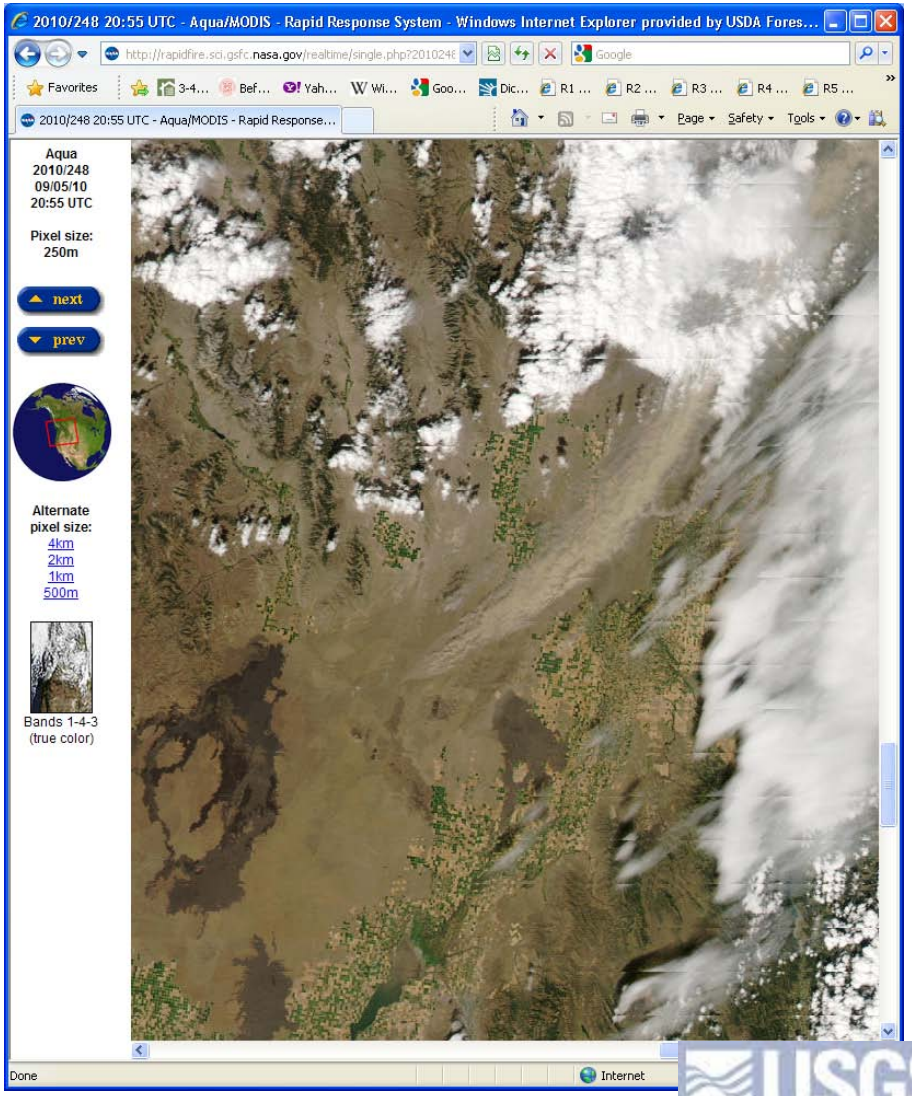
Our research questions for Post-fire wind erosion in the INL Great Basin:

1) When, where; predictable?
2) How extensive?
3) Causes and consequences?

Dust can be estimated from one of its constituent particles, PM10. MODIS or other satellite imagery are key.

From the 2010 Jefferson Fire, Idaho:





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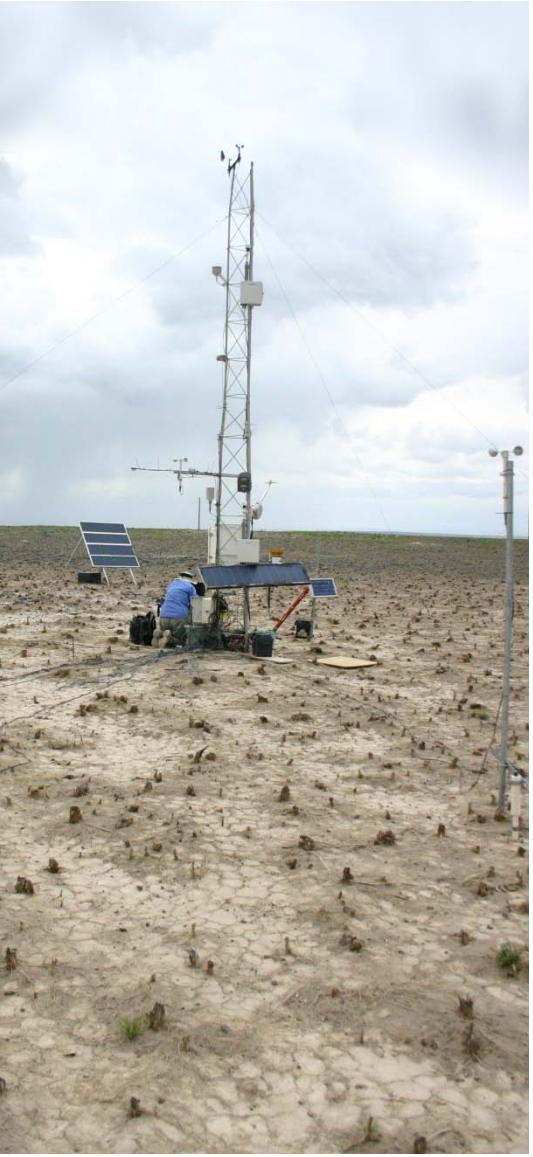
Wagenbrenner, Germino et al., in review



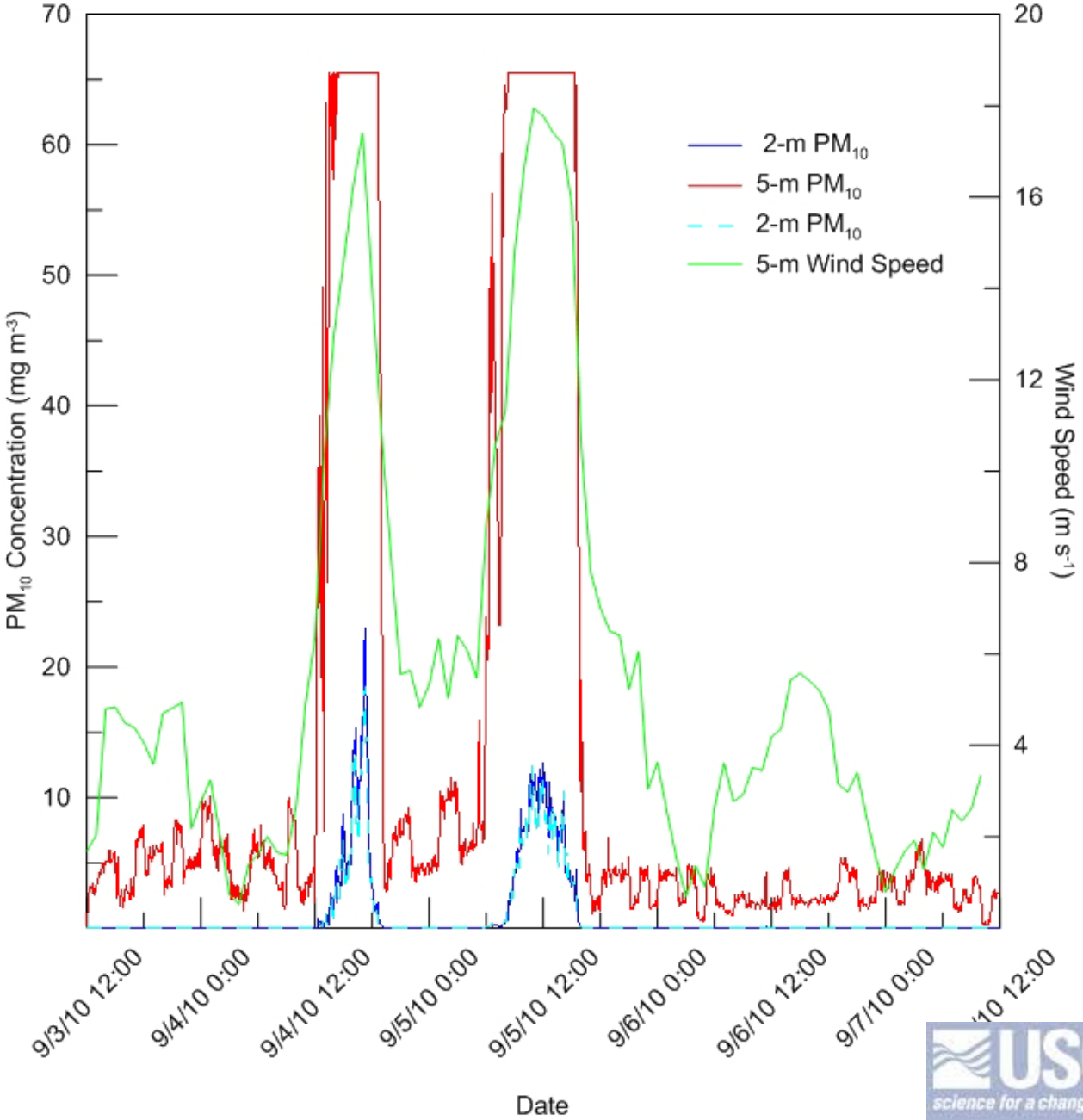


photo credit: Dennis Dimick

***Consequences* of aeolian transport**:

-Dust on snow, connectivity.

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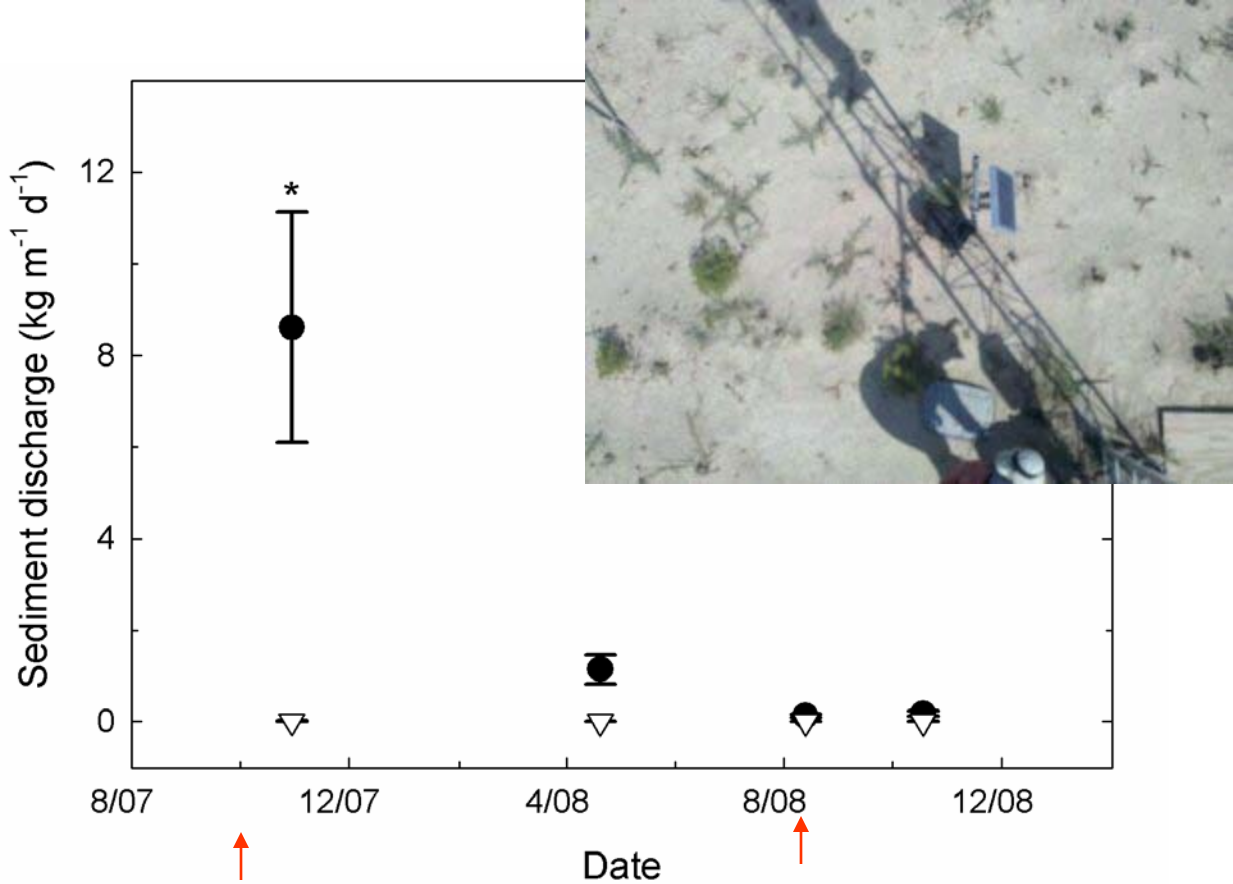
In photo: J Sankey, N Glenn



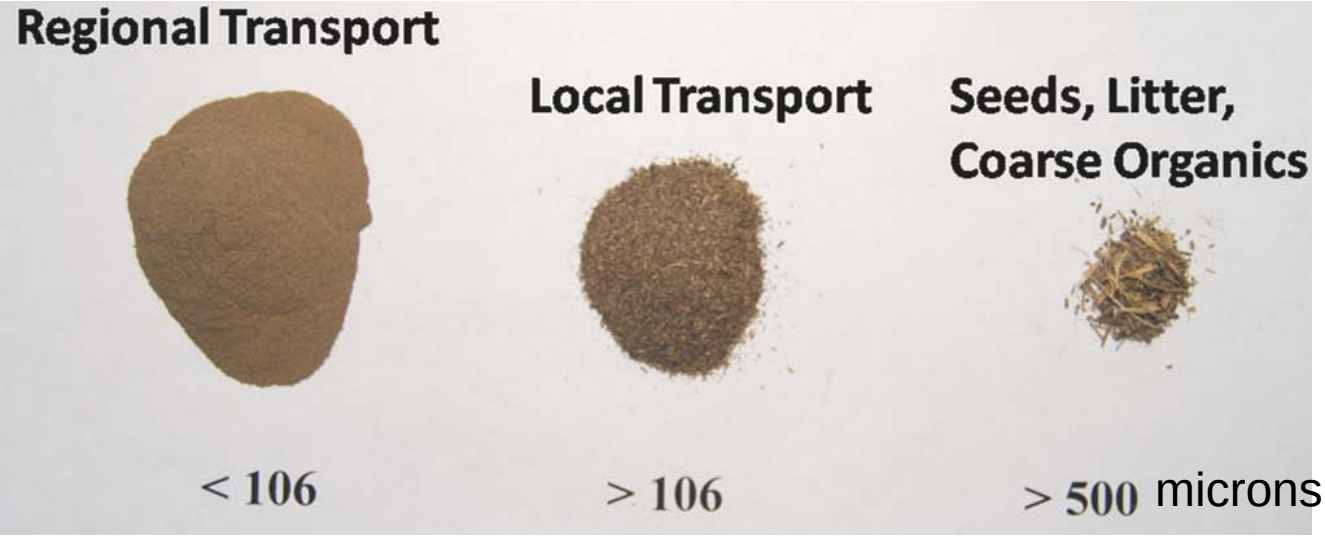
Time of Twin Buttes fire

Only about 10% vegetation cover by this time

Daily flux of sediment from 0 to 2 m height, estimated from integrating sediment mass from 5 collectors positioned on a tower, as: $\int_{height=0}^{2m} mass * area^{-1} * time^{-1}$

Sankey, Germino, Glenn 2009, in J Arid Environ; 2009b in Aeolian Research
Hasselquist, Germino 2011 et al. Biogeosciences

Post-fire wind erosion leads to large losses in soil organic material, nutrient loss, and altered site hydrology

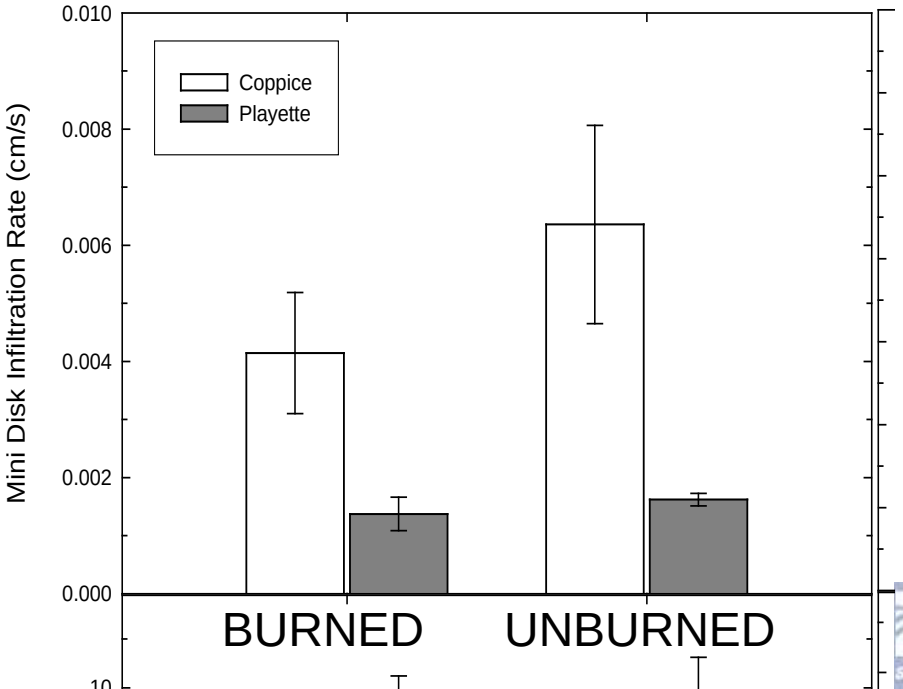


Transport of organic compounds and particles is important

Hasselquist et al. 2011, Biogeosciences
Sankey et al. 2012, Aeolian Research

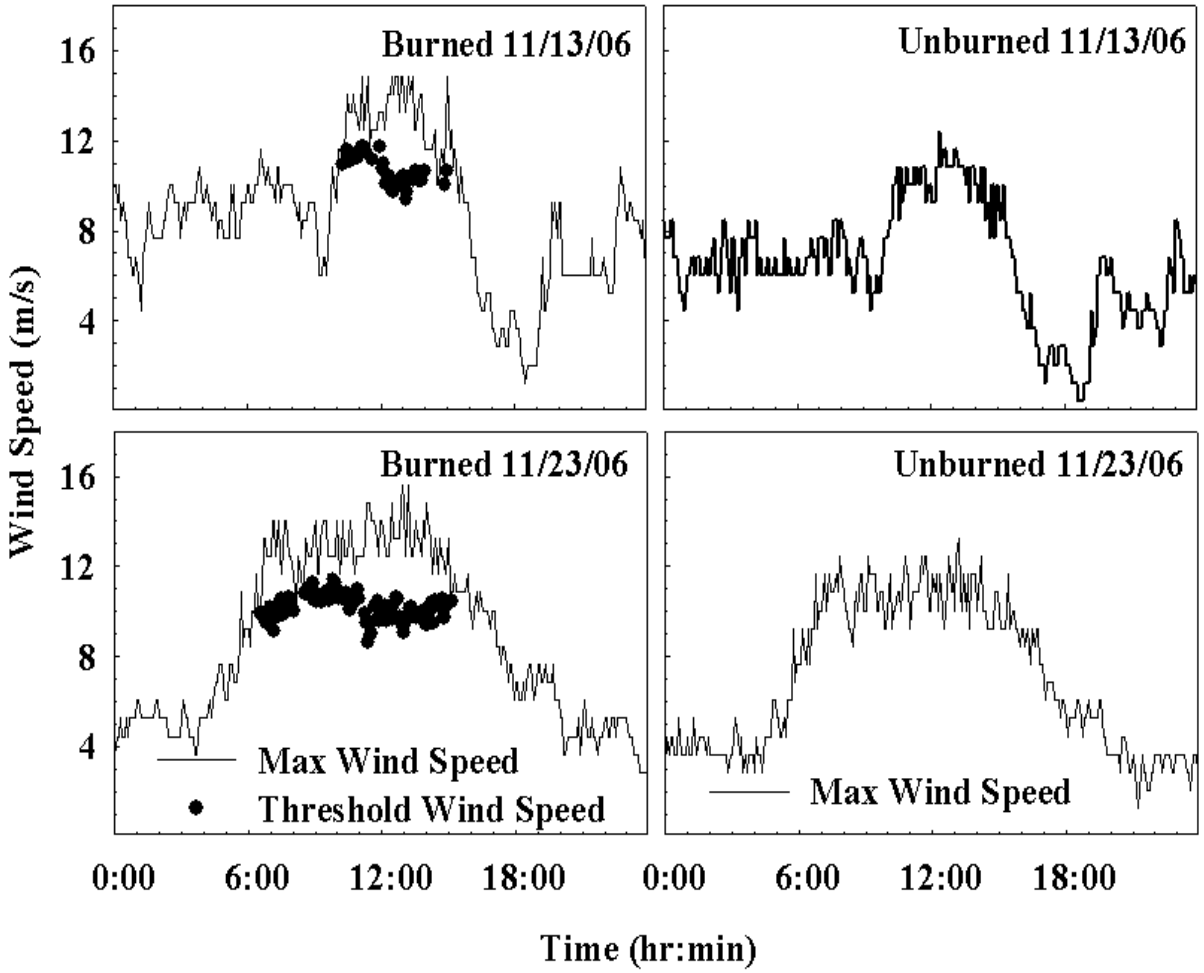
CONSEQUENCES: Site impacts of wind erosion?

From:
Hoover and Germino,
in Rangeland Ecol
Mgmt, 2012



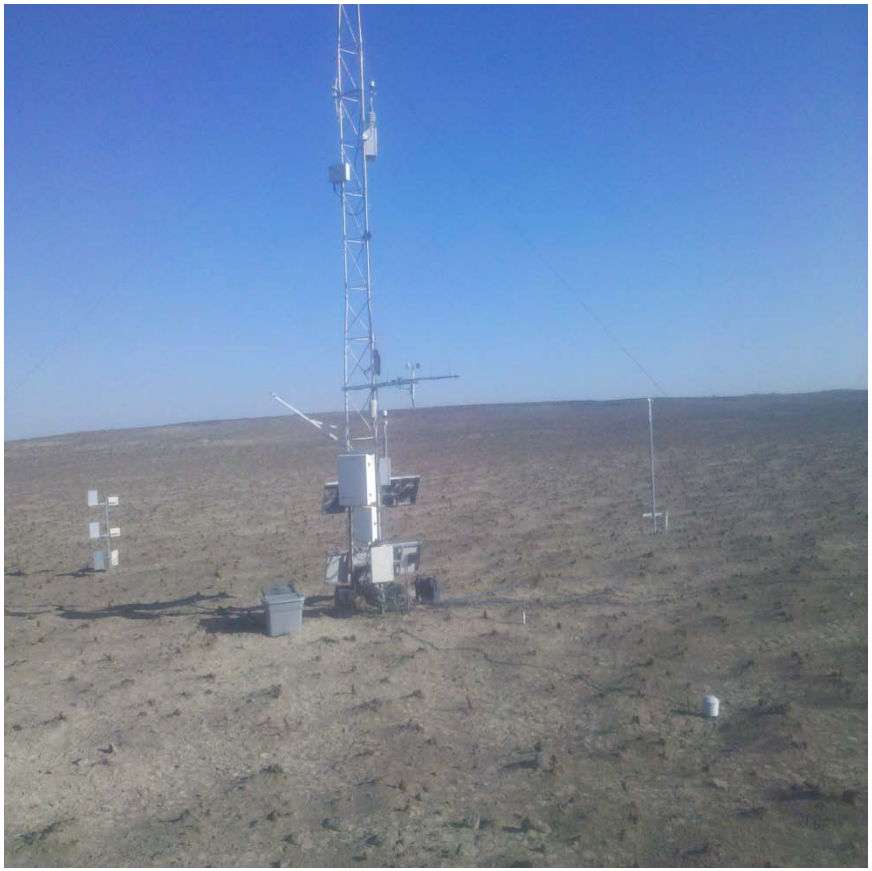
Erodibility: quantified through threshhold wind speeds:

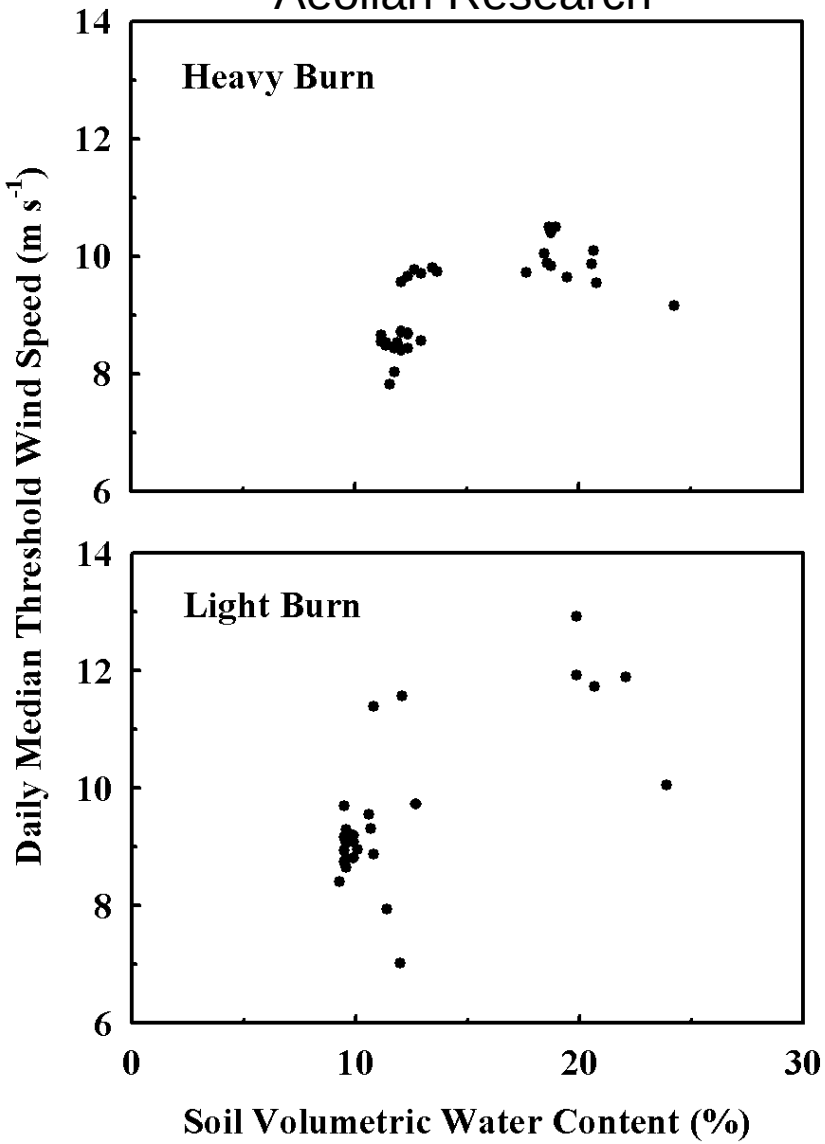
- quite variable in time
- Sankey, Germino, Glenn (2009, J Arid Env)
- From the ~300K acre Crystal Fire:



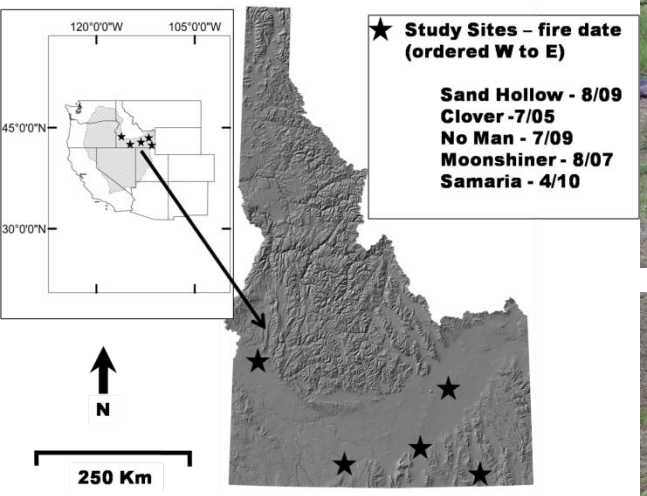
High **variability in erodibility** following fire:
Why: Surface moisture variability?

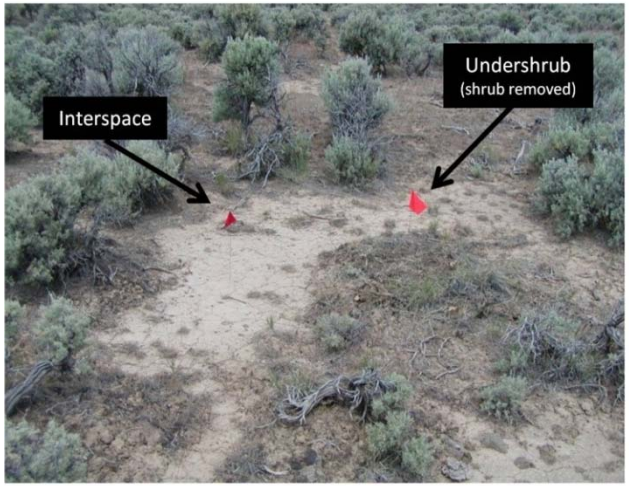
Sankey et al. 2009b, in Aeolian Research





Wind “tunnels” to help determine components of erosion: *vegetation condition before fire greatly affects erosion potential after fire*





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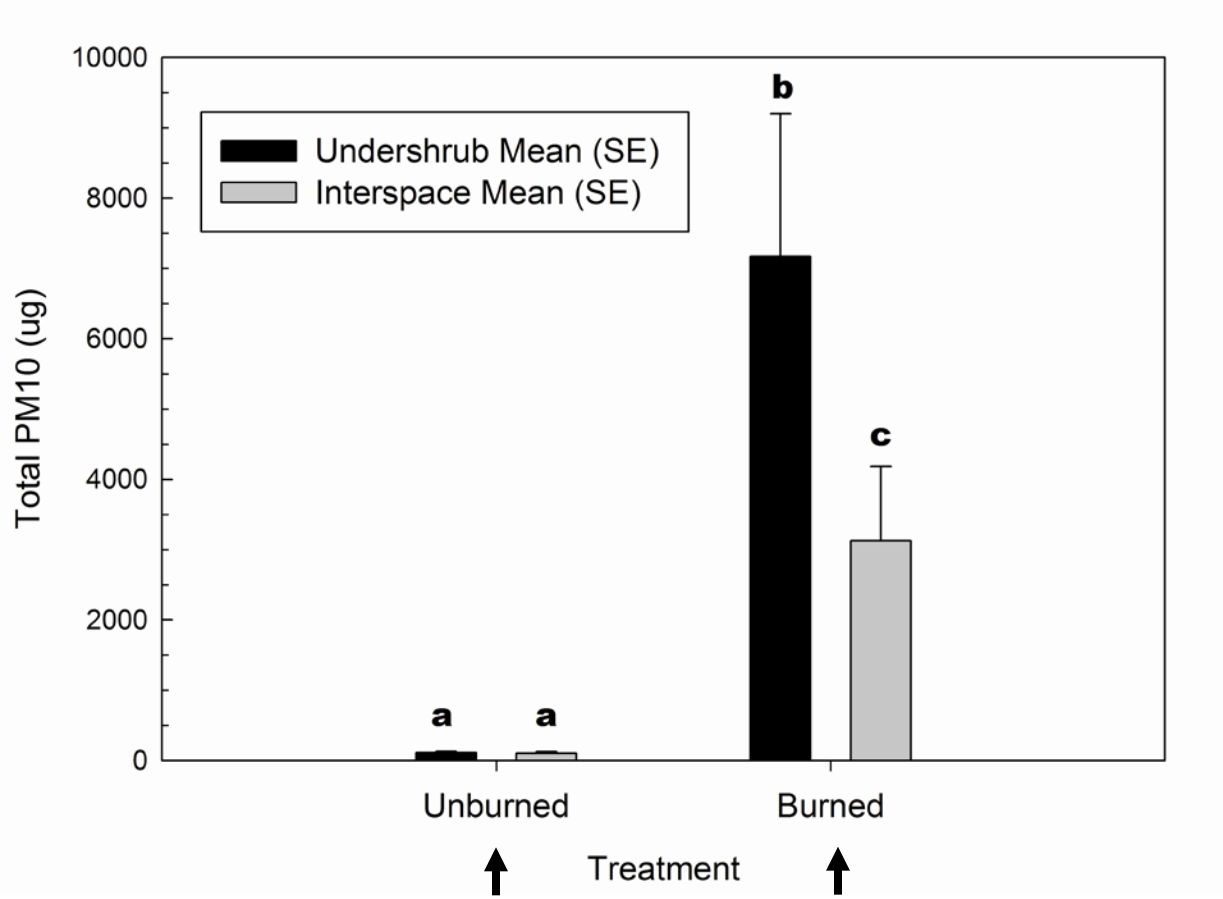
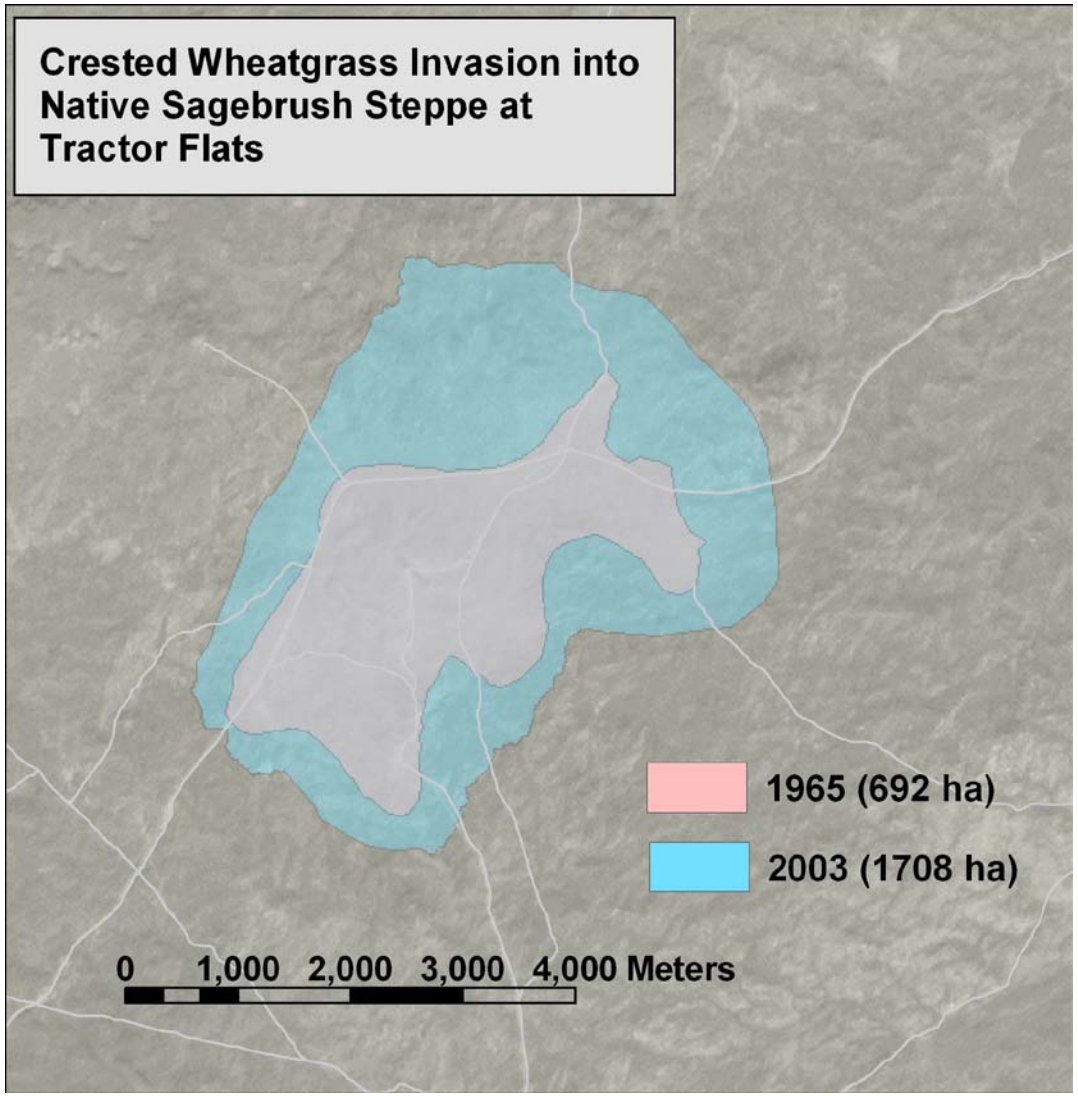


From: Sankey, Germino, Glenn,
2011 J Geophysical Research and 2011 Geomorphology

- Since mid-1900's, seeding practices have been common in semiarid rangelands of Western N America.
- Seeding in emergency post-fire rehabilitation plans is aimed at **soil stabilization** and pre-emption of native species.

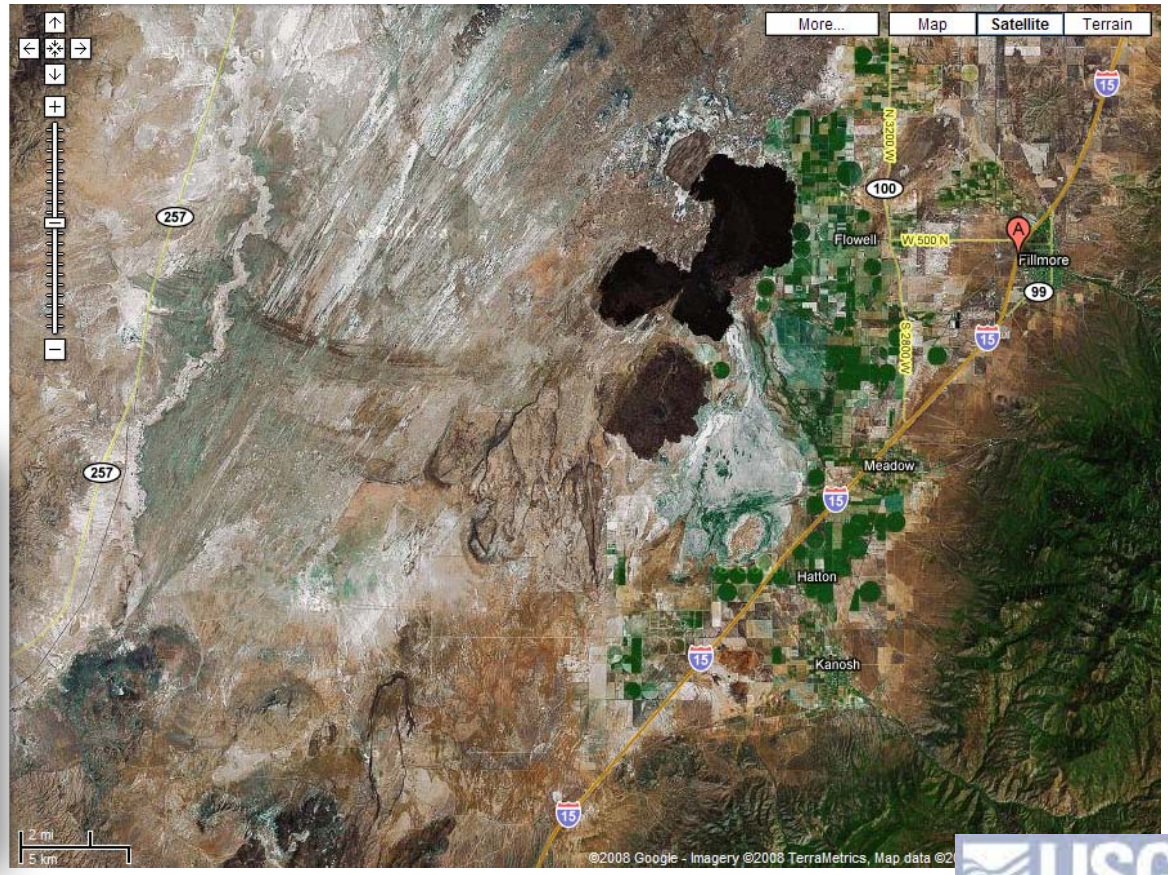
2003 report from US General Accounting Office notes the large cost and asks about efficiency of post-fire reseeding



At the Idaho National Lab
Sheedy, Blew et al 2010

Landscape **connectivity** is unambiguous in wind erosion events, and wind erosion processes are landscape cascades (like avalanches).

From Mark Miller, for Milford Flats UT:

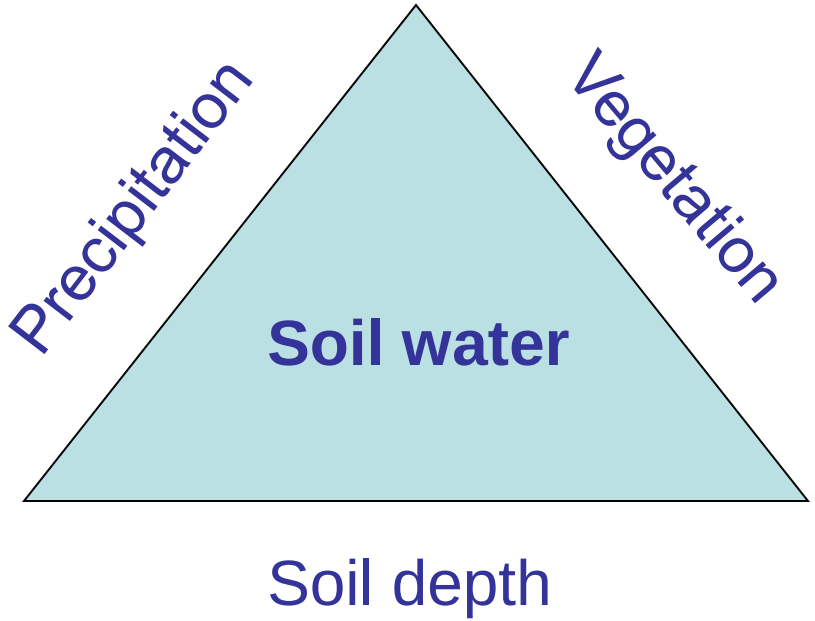


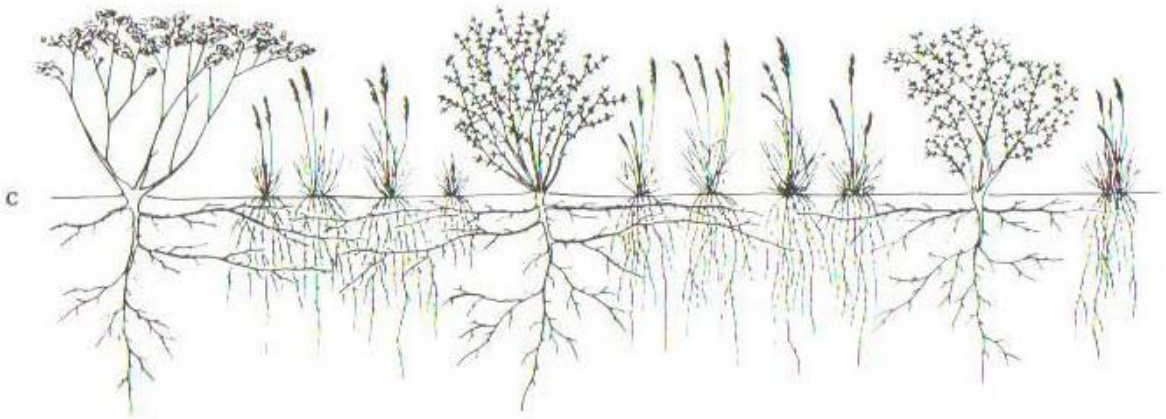
VEGETATION CHANGE:
Idaho National Lab (INL) Ecohydrology experiment:
1993 to present, was DOE “PCBE”, now USGS, NSF EPSCoR

INL Ecohydrology Experiment:

Begun by JA Anderson in 1993, sustained by Stoller Corp.

Direct manipulation of vegetation, precipitation, and soil depth; and thus soil-water storage capacity and use.





Walter 1985

Hypotheses:

1) Increased soil water storage capacity will increase native perennials compared to exotic grasses.
2) Native perennial communities will exhibit greater soil water use, resulting in less deep infiltration.

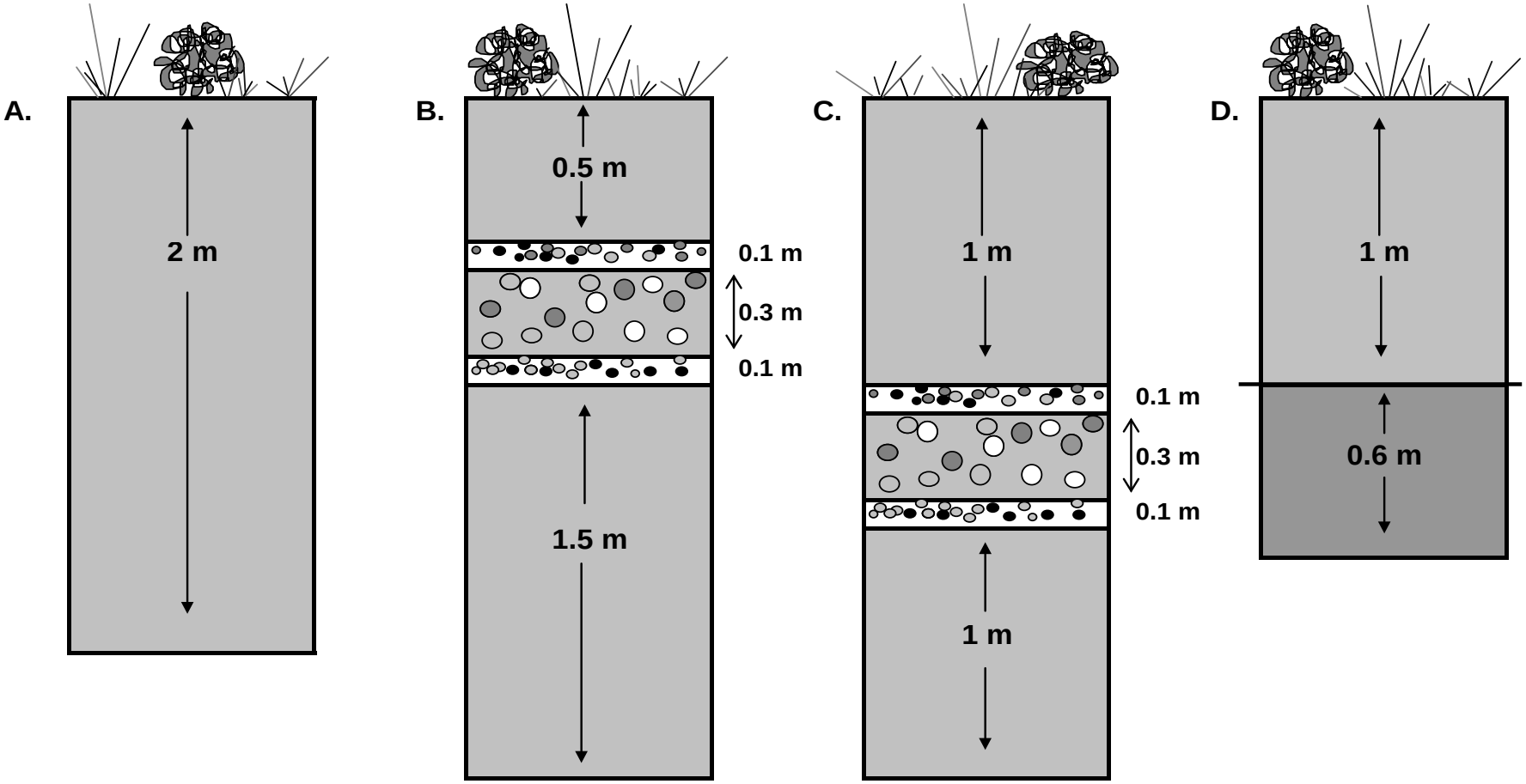
Aerial view:

N = 3 blocks of soil, ppt, veg treatments

72 8x8 m plots

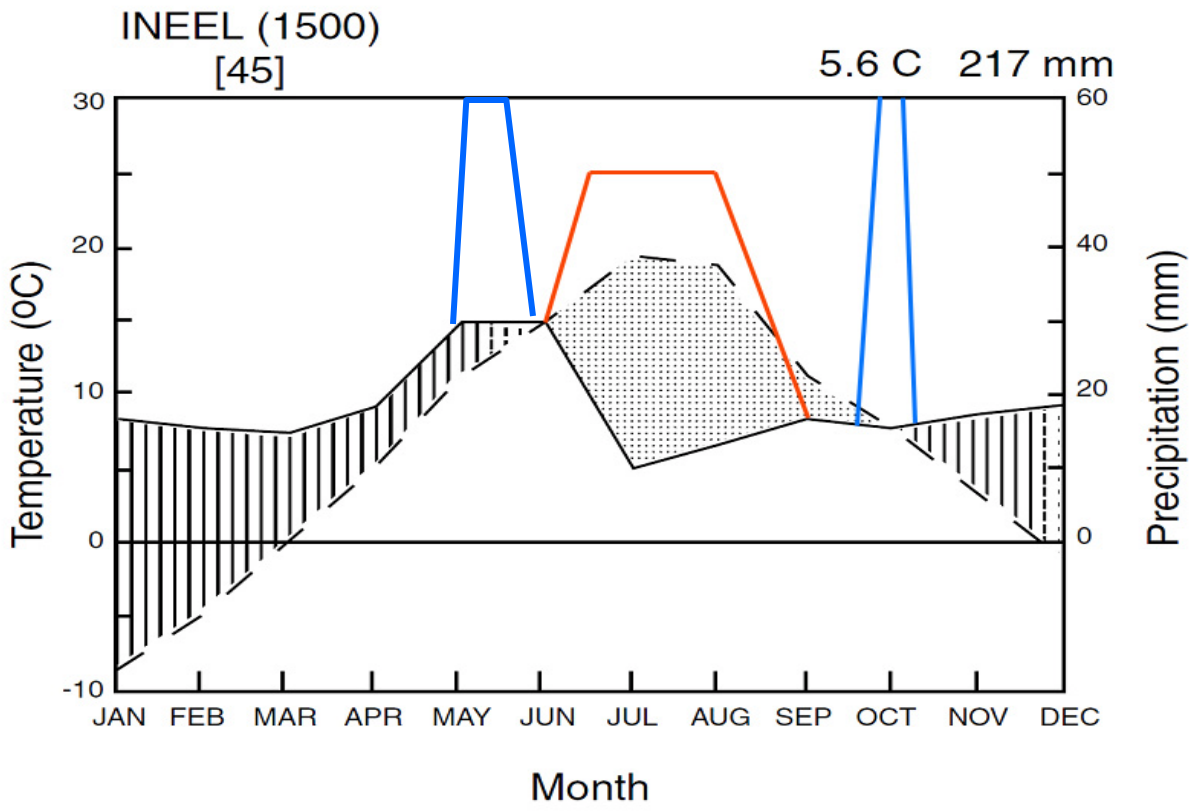
ANOVA, factorial

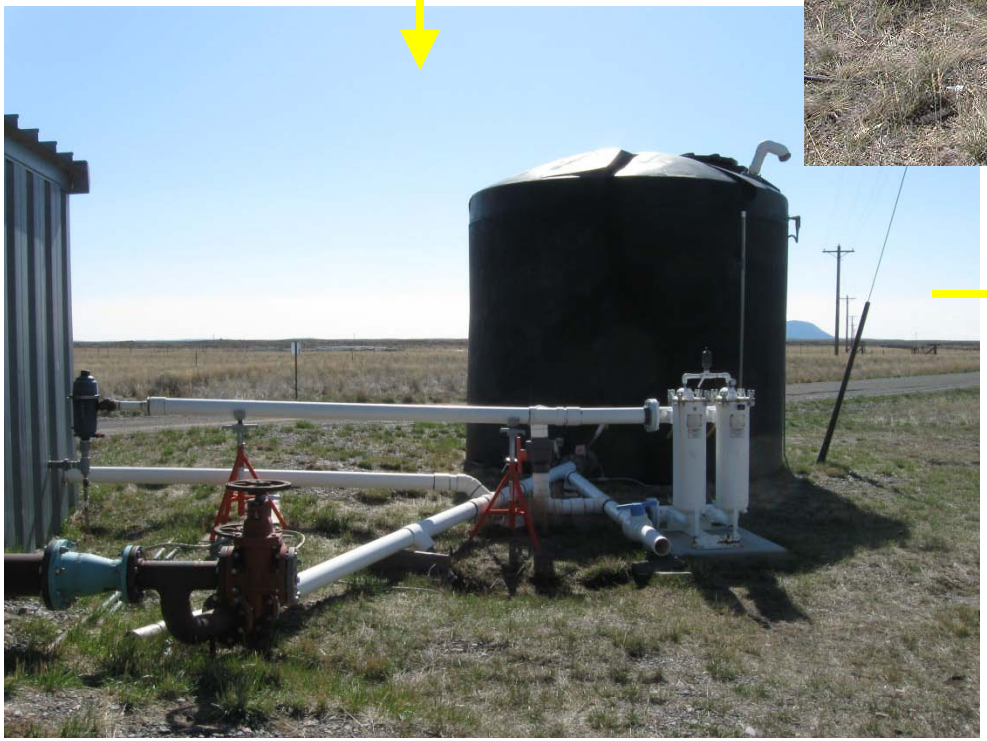
FACTOR 1: Soil profile construction type (following excavation; used local soils)



Soil Only Cap **Shallow Biobarrier Cap** **Deep Biobarrier Cap** **RCRA Cap**

FACTOR 2: Watering/irrigation treatment levels: doubling of annual PPT, in summer or in winter





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FACTOR 3: Vegetation treatment levels: Planted with native vegetation, or monoculture of CWG

- Transplanted from local sagebrush communities
  - Shrubs; *Artemisia tridentata ssp. tridentata, A. tridentata ssp. wyomingensis, Chrysothamnus viscidiflorus, Ericameria nauseosus,* and *Krascheninnikovia lanata*
  - Perennial Grasses; *Achnatherum hymenoides, Elymus elymoides, E. lanceolatus, Hesperostipa comata, & Leymus cinereus*
  - Growth forms alternated within planting rows
  - Spacing patterns based on plant density in local sagebrush communities
- Drill seeded
  - Perennial Forbs; *Linum perenne* (commercial), *Hedysarum boreale* (native/commercial)
  - Drill seeded into rows midway between transplant grid rows

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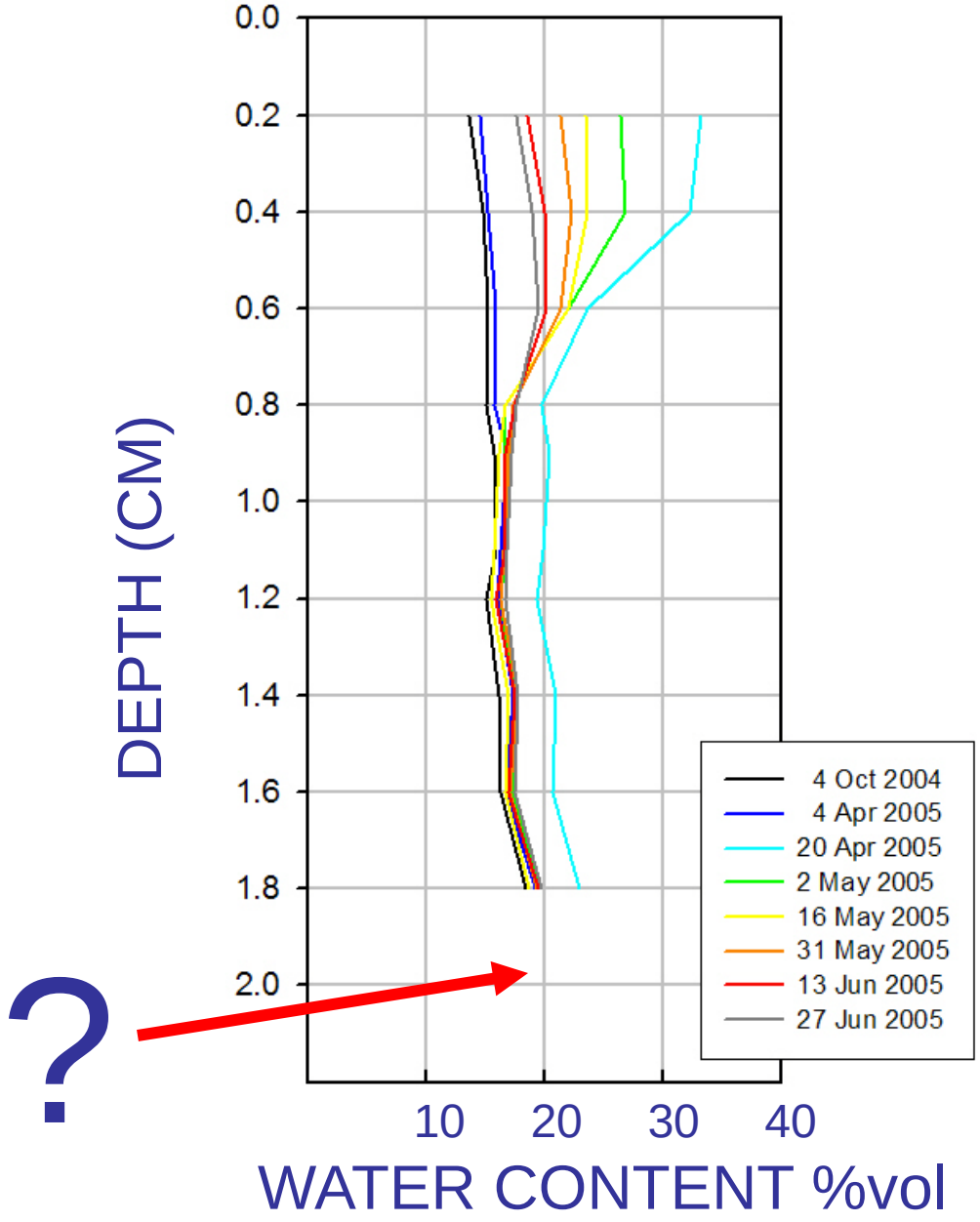
RESULTS;
Plant responses, plant effects:

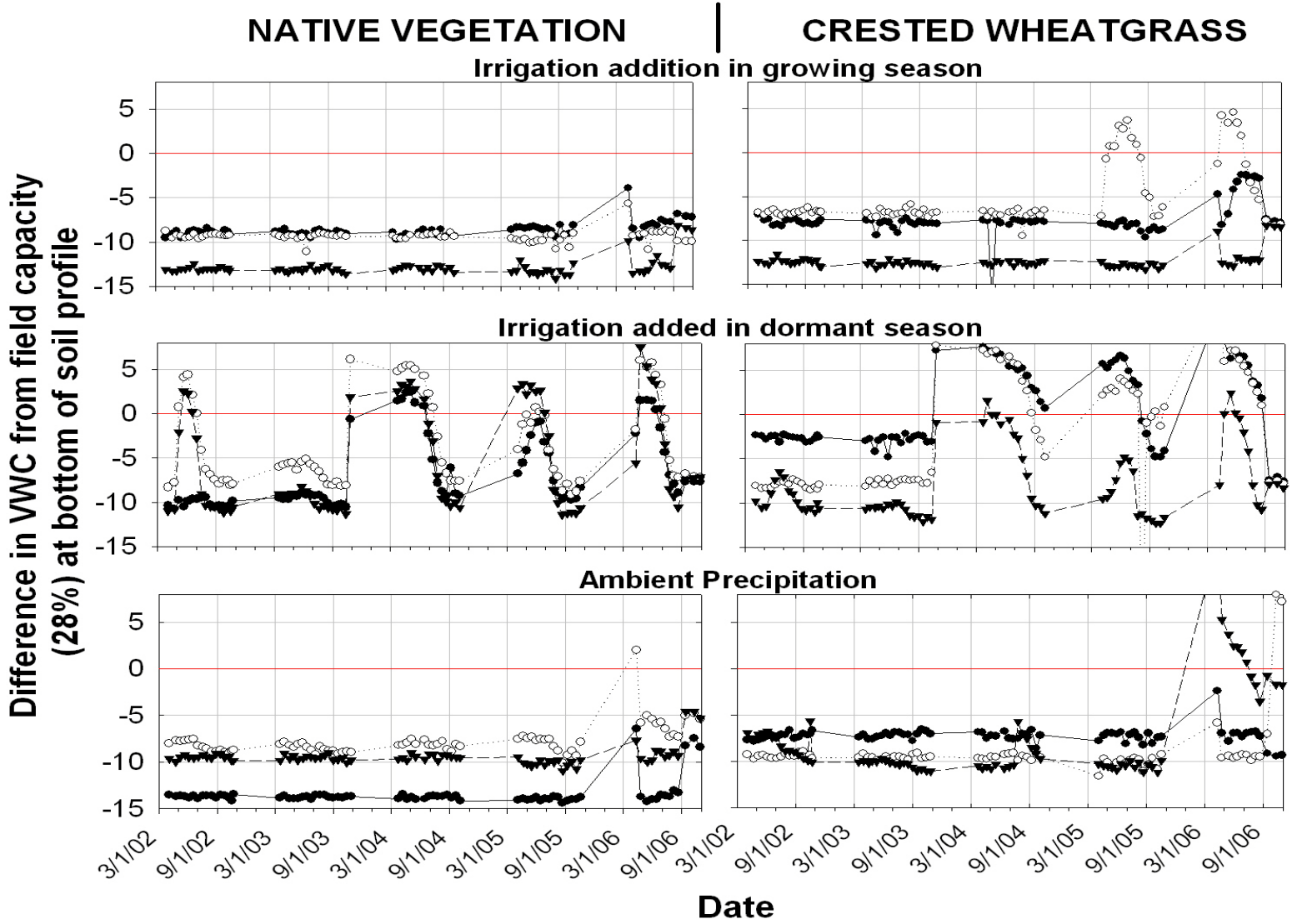
4-year mean hydr conductivities From USDA SPAW modeling on 2-m soil plots:

2.14 x 10^{-6} cm/s for CWG Plots
1.38 x 10^{-6} cm/s for Native Plots

Generally, hydraulic conductivities were in "good" range of >10^{-4} cm/s for only <1% of growing seasons

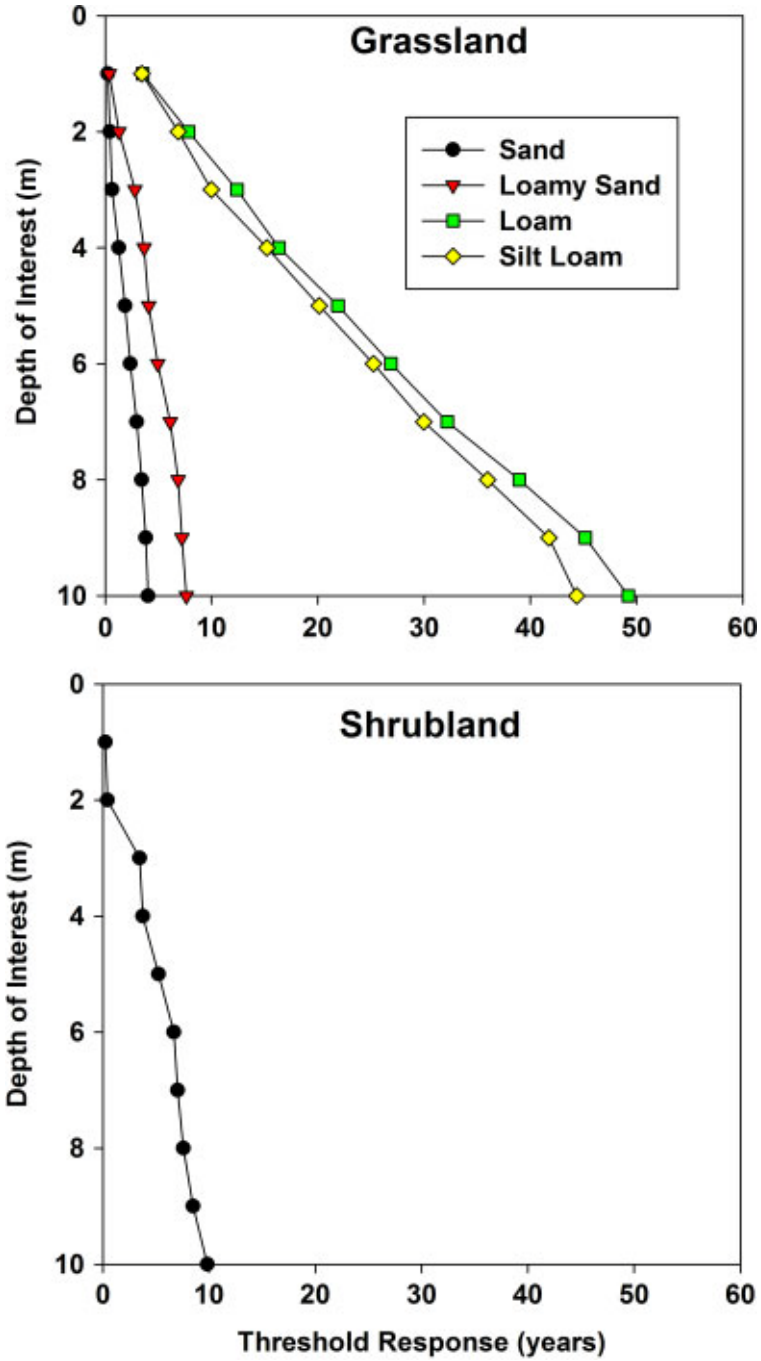


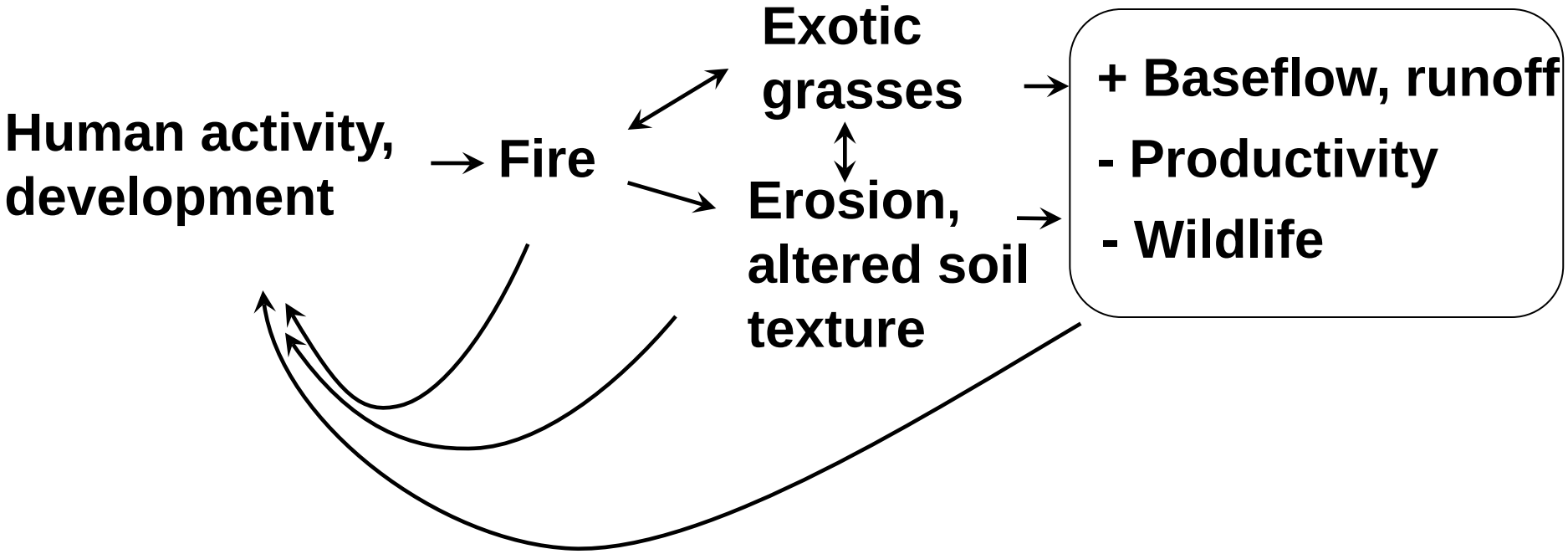
RESULTS; Plant responses, plant effects:
(for 2 m deep soils)



From simulation modeling on impacts of cheatgrass invasion, using Hydrus model.

From Wilcox, Germino et al. 2012 *In* “Ecohydrology”.




Human activity, development
Fire
Exotic grasses
Erosion, altered soil texture
+ Baseflow, runoff
- Productivity
- Wildlife

-Landscape stability is an increasing problem,
-It relates to water in the environment
-A landscape perspective will likely help

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The end