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Ecological and Societal Resistance to Prescribed Extreme Fire Inhibit Management Efforts to Restore Degraded Texas Rangelands: Can We Overcome These Constraints?

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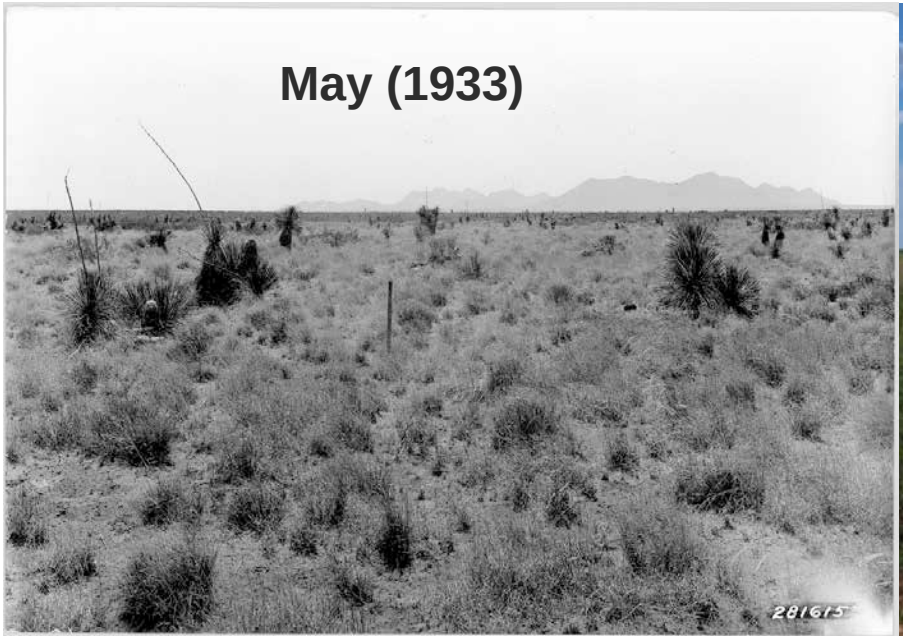
In recent history, woody plants have displaced grasses in many rangelands....



Why should we care?

- Rangeland ecosystems encompass nearly 50% of terrestrial land and account for >30% of global temperate NPP
- 2.4 billion people live in these habitats
- Tremendous amount of ecosystem goods and services derived from healthy, functional rangelands

The ability to suppress wildfires is an environmental service that is being lost in much of the Great Plains due to woody encroachment

Twidwell, Rogers, et al. 2013 Frontiers E&E

How do we restore a rangeland ecosystem once it has been degraded by woody and succulent plant encroachment?

Limitations of Fire – Maintenance vs. Restoration

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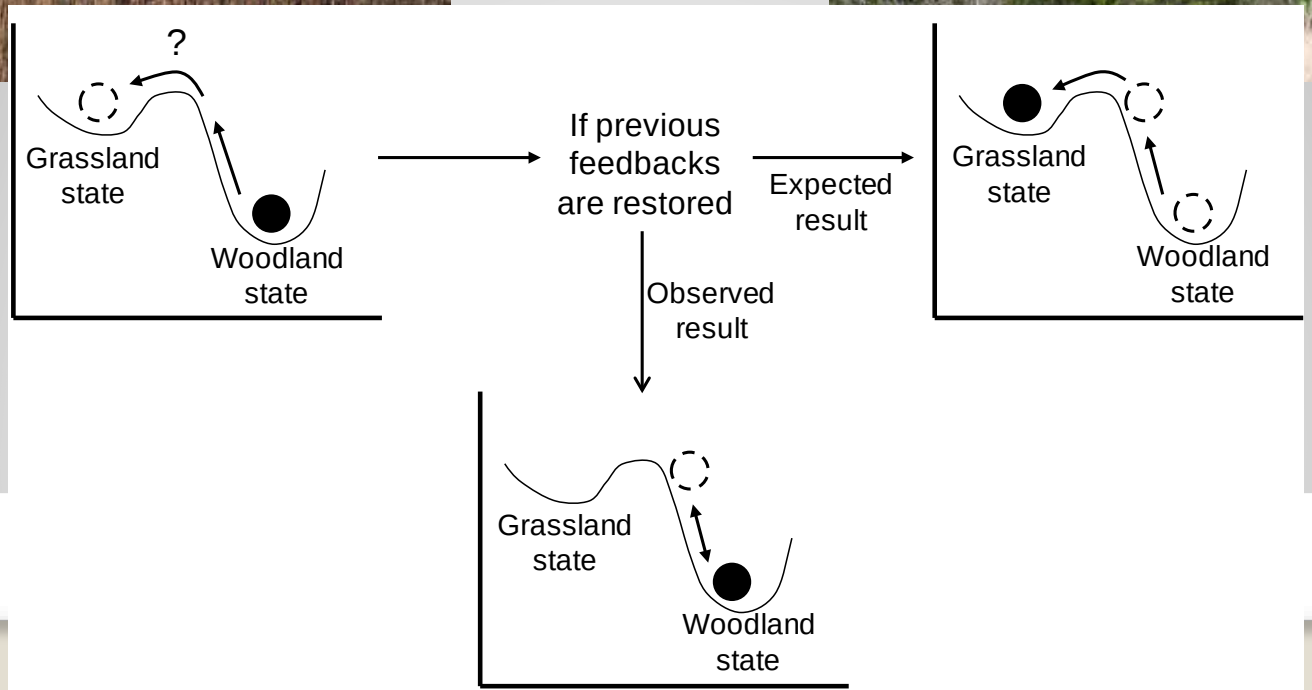


Can we use prescribed extreme fire to restore degraded rangelands?

- Most fires are conducted in dormant season and have been largely ineffective at reversing woody encroachment and overcoming biotic thresholds

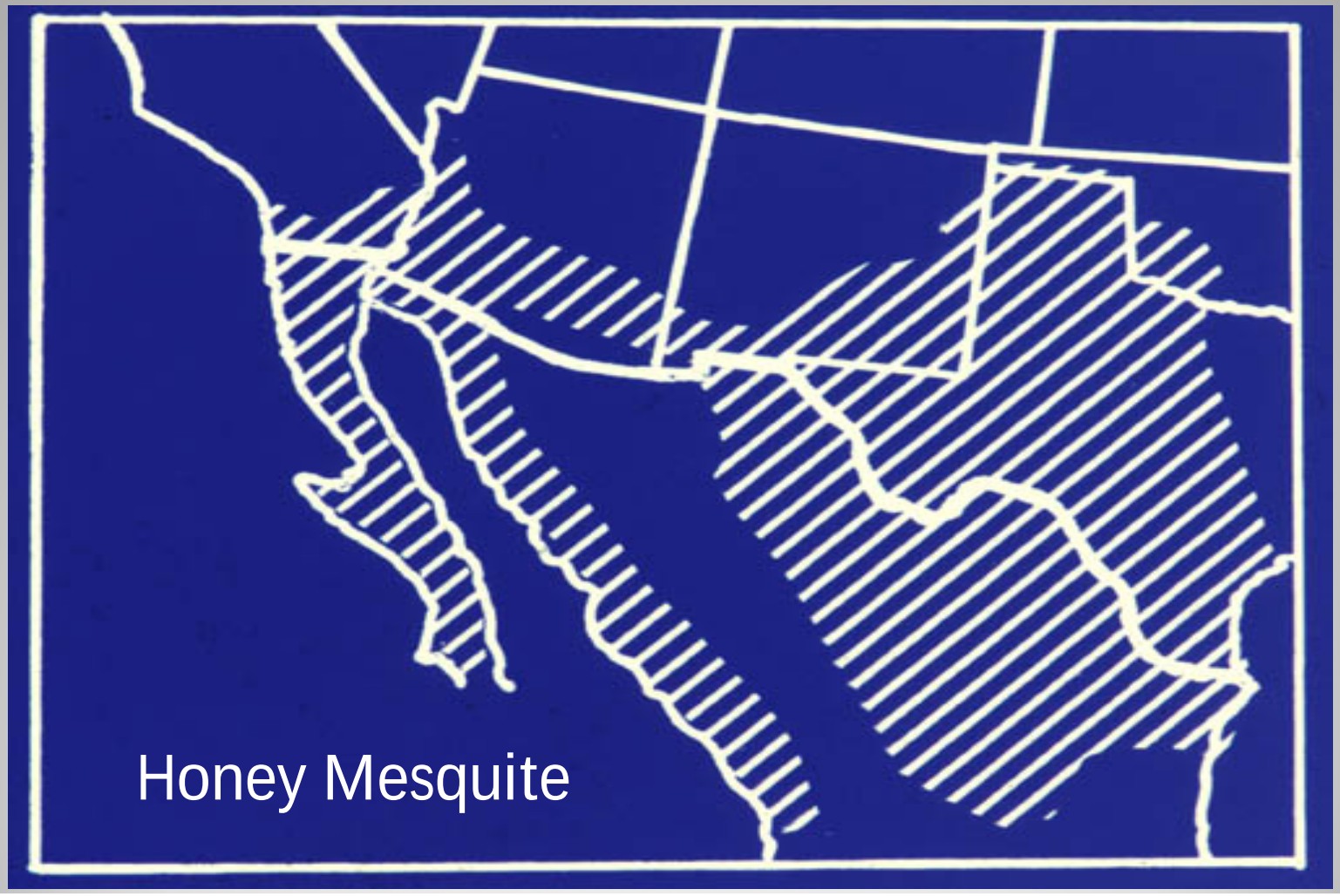
Additional bias against prescribed extreme fire as a restoration method

Untested assumptions that:

- the soil will become sterilized and/or hydrophobic
- erosion and nutrient leaching will intensify
- herbaceous productivity and diversity will decrease
- native grasses will be killed
- invasive grasses and forbs will thrive

There has been limited effectiveness in controlling resprouting woody plants with prescribed fire to date

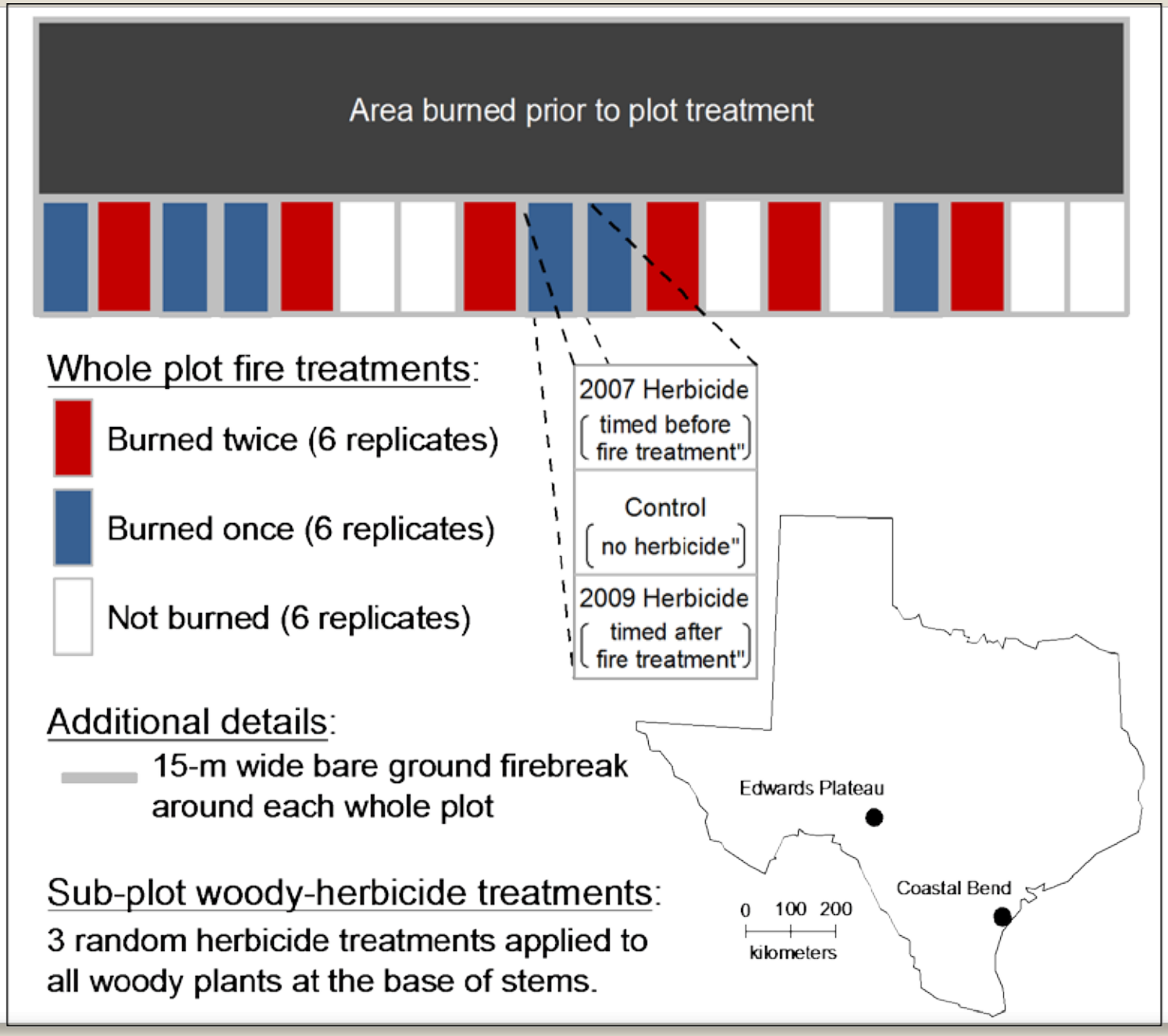
Geographic distribution of *Prosopis glandulosa*



Courtesy of OW VanAuken

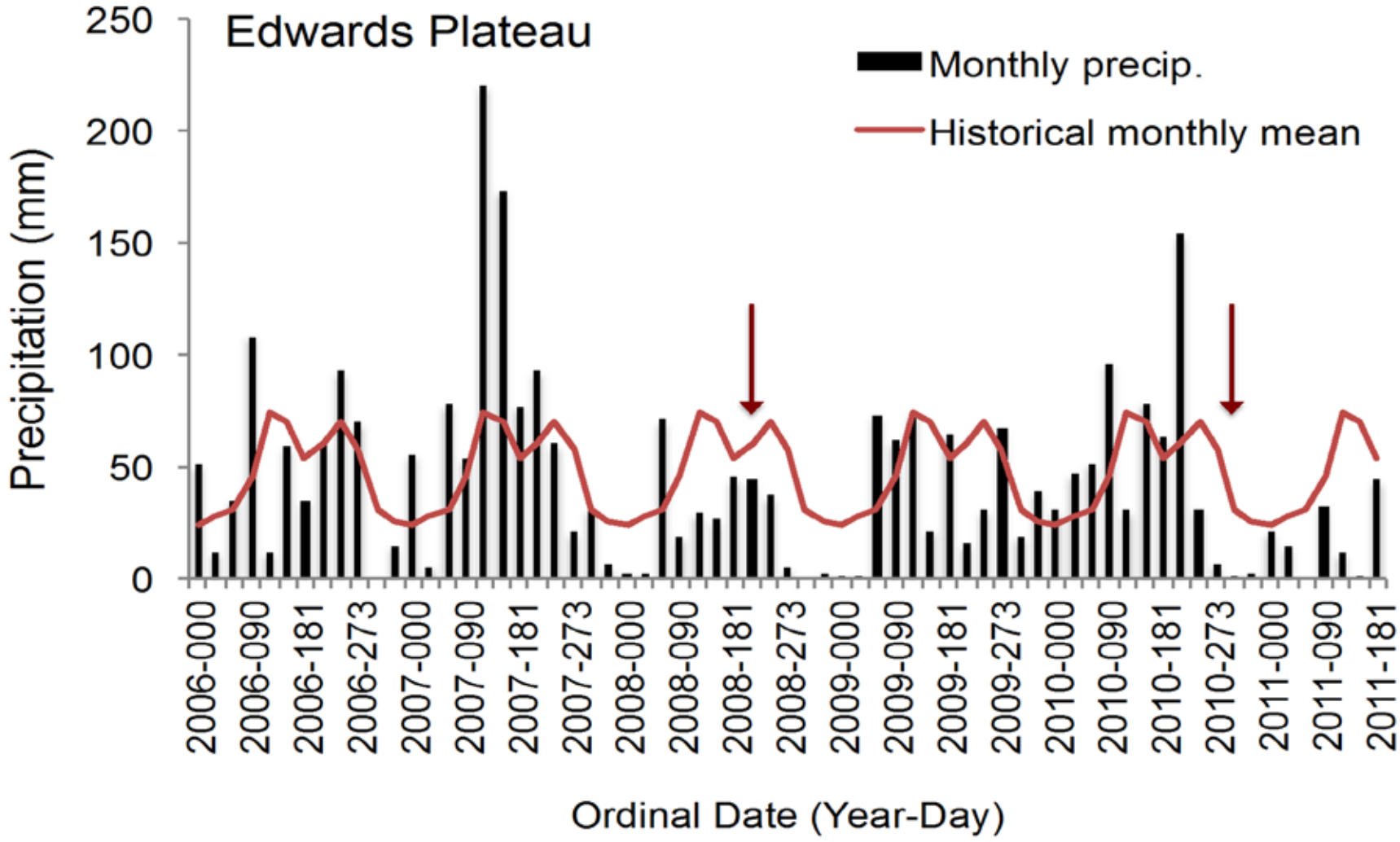
Rangeland Restoration Objectives

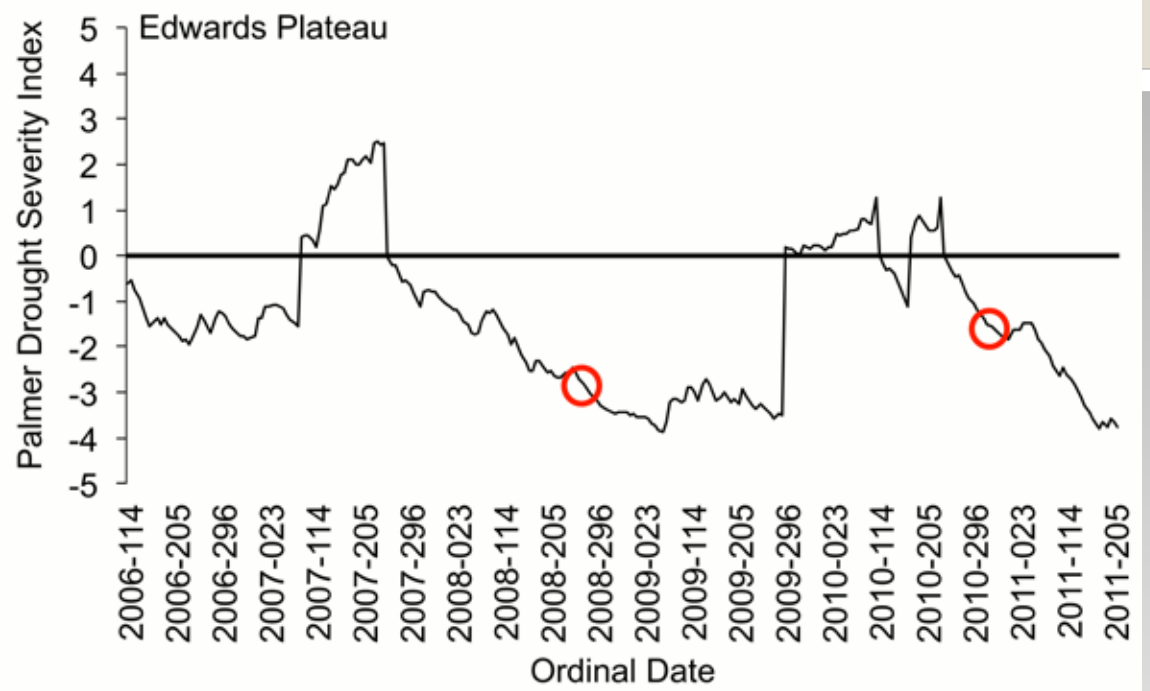
- Limited experimental data on extreme fire effects
  - Honey mesquite (*Prosopis grandulosa*) is the common link among sites
  - Examine all woody plant species
  - Monitor herbaceous vegetation responses and assess past bias against extreme fire
- Evaluate interactive effects of fire and herbicide with the aim of:
  - Increasing woody mortality with treatment interactions
  - Maximizing herbicide efficacy
  - Reducing total herbicide application

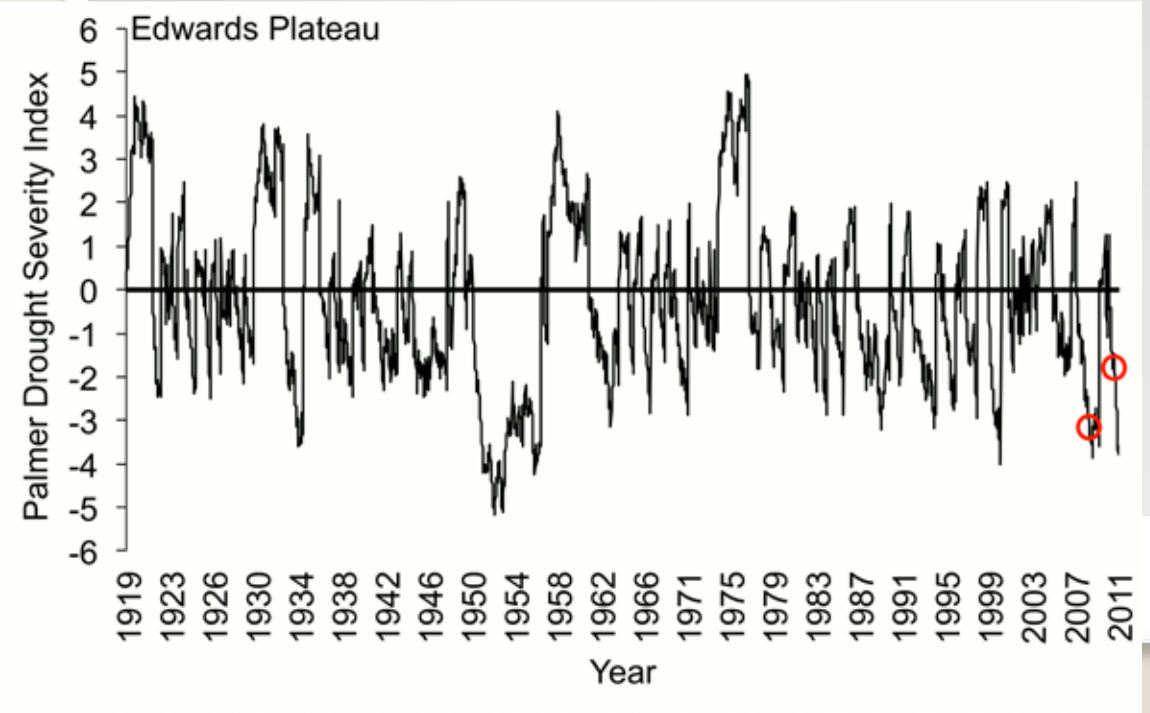


Adapted from Twidwell et al. 2012

The timing of fire treatments (arrows) was designed to occur during periods of low precipitation….







the cumulative effects of persistent drought were high,

and representative of other extreme drought conditions during the past century.

Weather conditions during fires

- avg air temp (°C / °F)
  - Sonora = 37.7 / 99.9
  - Welder = 36.4 / 97.5
- avg rel humidity (%)
  - Sonora = 23.6
  - Welder = 38.5
- avg wind speed (km/h)
  - Sonora = 4.4 (2.7 mi/hr)
  - Welder = 4.8 (3.0 mi/hr)

Fire Behavior

- Mean Flame Length
  - Sonora = 1.95 m
  - Welder = 1.61 m
- Maximum Flame Length
  - Sonora ~ 13 m
  - Welder = 6 m

- Mean Rate of Spread
  - Sonora = 0.133 m/s
  - Welder = 0.111 m/s

- Fire affected > 95% of vegetation in all plots

Fire temperatures at mature trees*

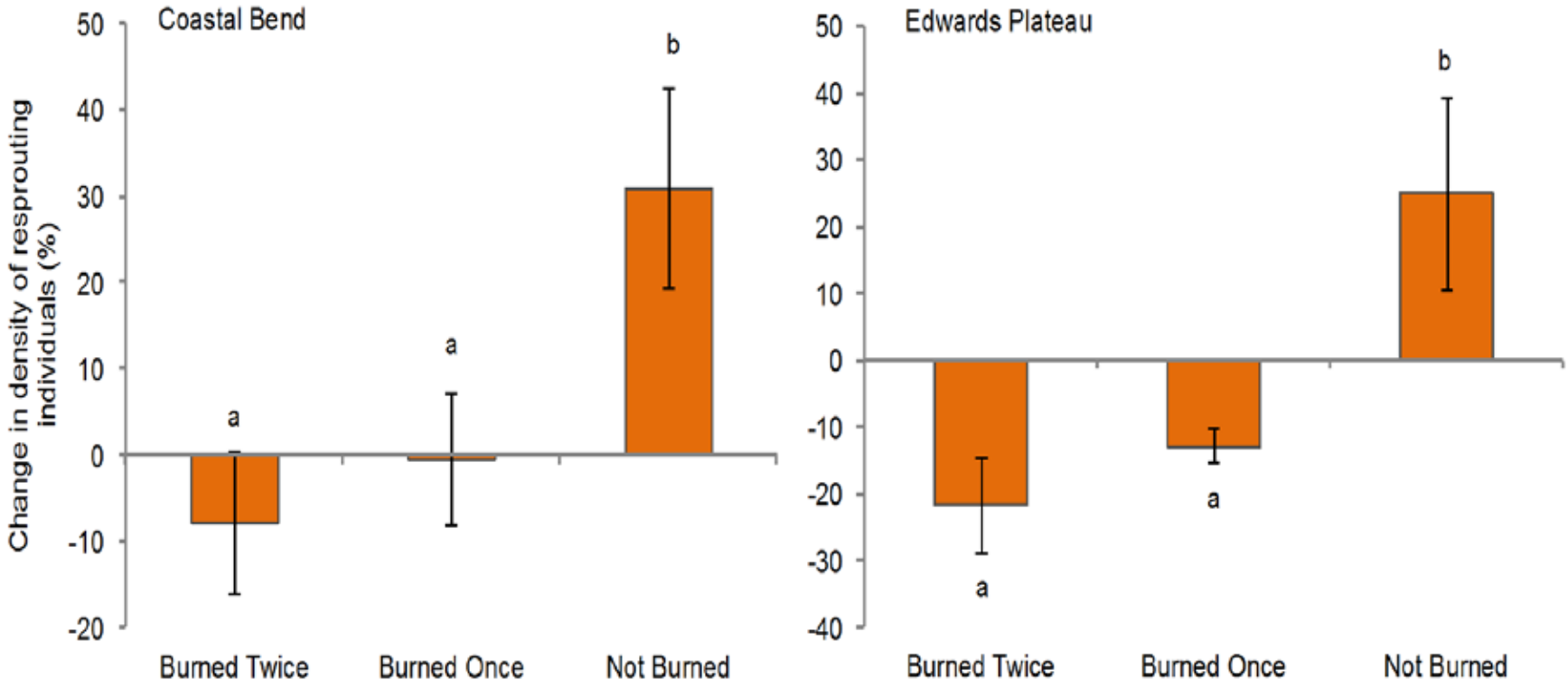
- Mean Temp (±sd) at 0 m
  - Sonora = 998 ± 263 °C
  - Welder = 936 ± 133 °C
- Mean Temp (±sd) at 1.5 m
  - Sonora = 419 ± 240 °C
  - Welder = 496 ± 248 °C

* Conservative estimates due to highest temperature reading = 1093 °C

Like good plant community ecologists.....

- Whole plot sampling (30 m x 20 m)
  - all woody individuals > 1.0 m tall = ~ 1600
    - Height, crown diameter, number of stems
- Sub-plot sampling
  - herbaceous cover, richness
  - herbaceous biomass
  - woody plant cover
  - bare ground cover
  - topography (slope, aspect)

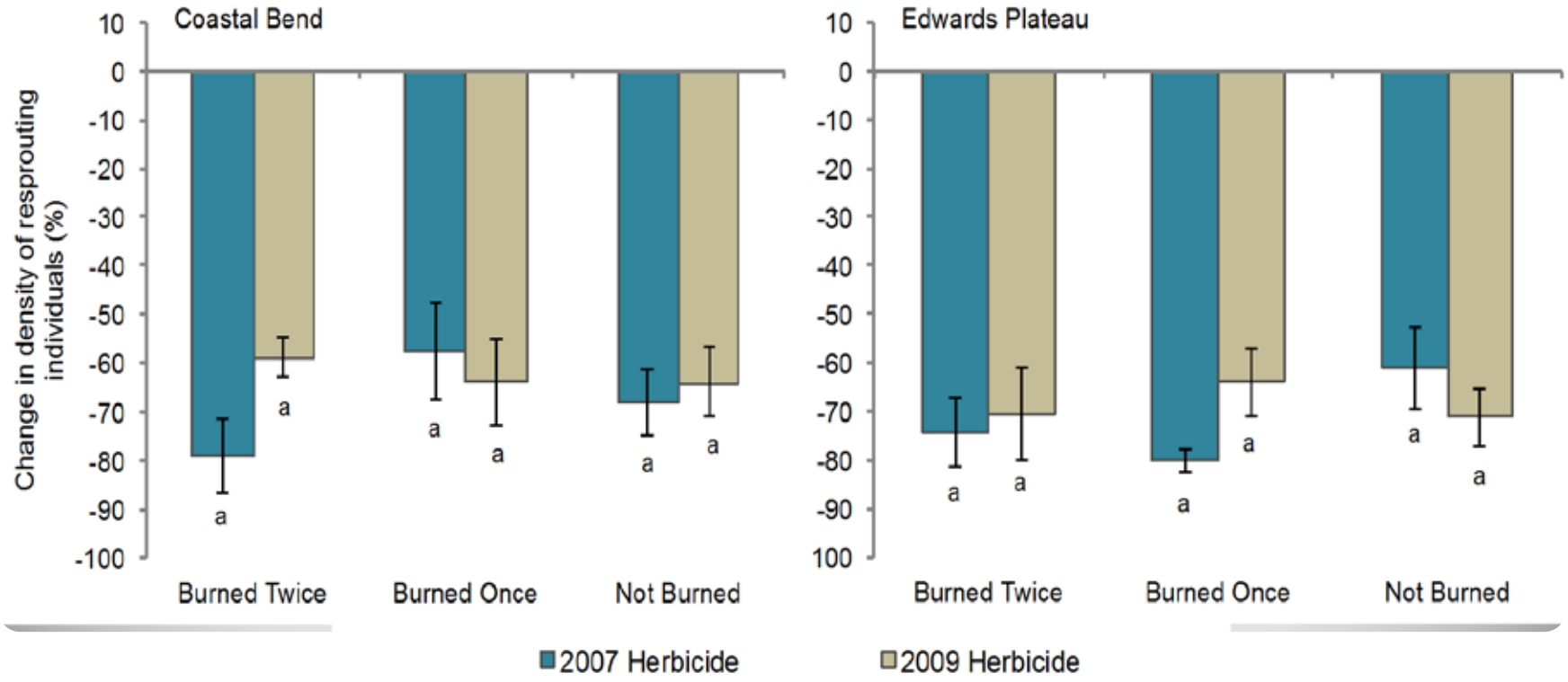
Shrub densities were significantly lower in extreme prescribed fire treatments relative to control



and woody plant mortality was 2-3 times higher in burned than unburned plots as of 2011

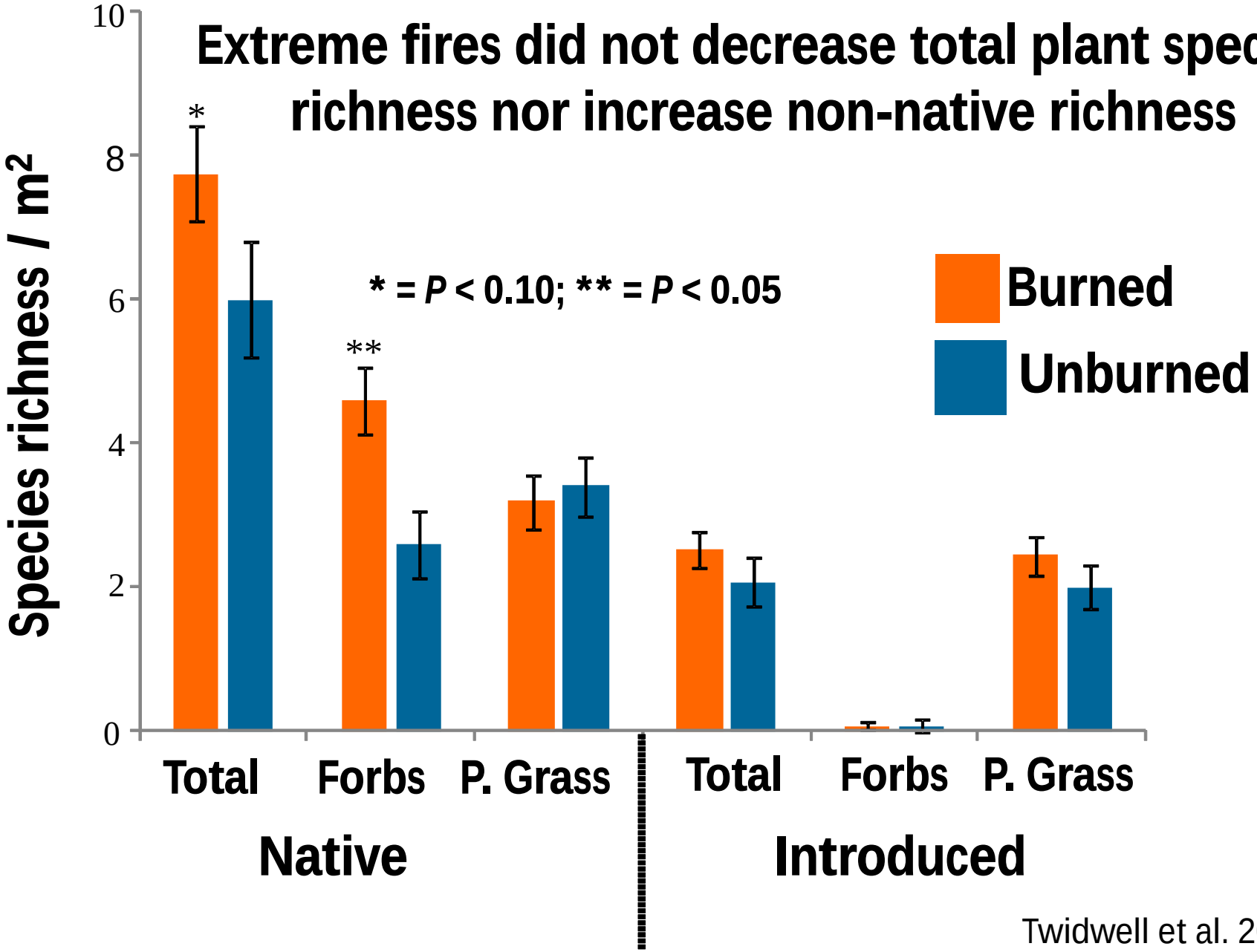
Twidwell et al. *in prep*

The combination of extreme prescribed fire and herbicide failed to significantly increase mortality levels beyond those observed in plots treated only with herbicide



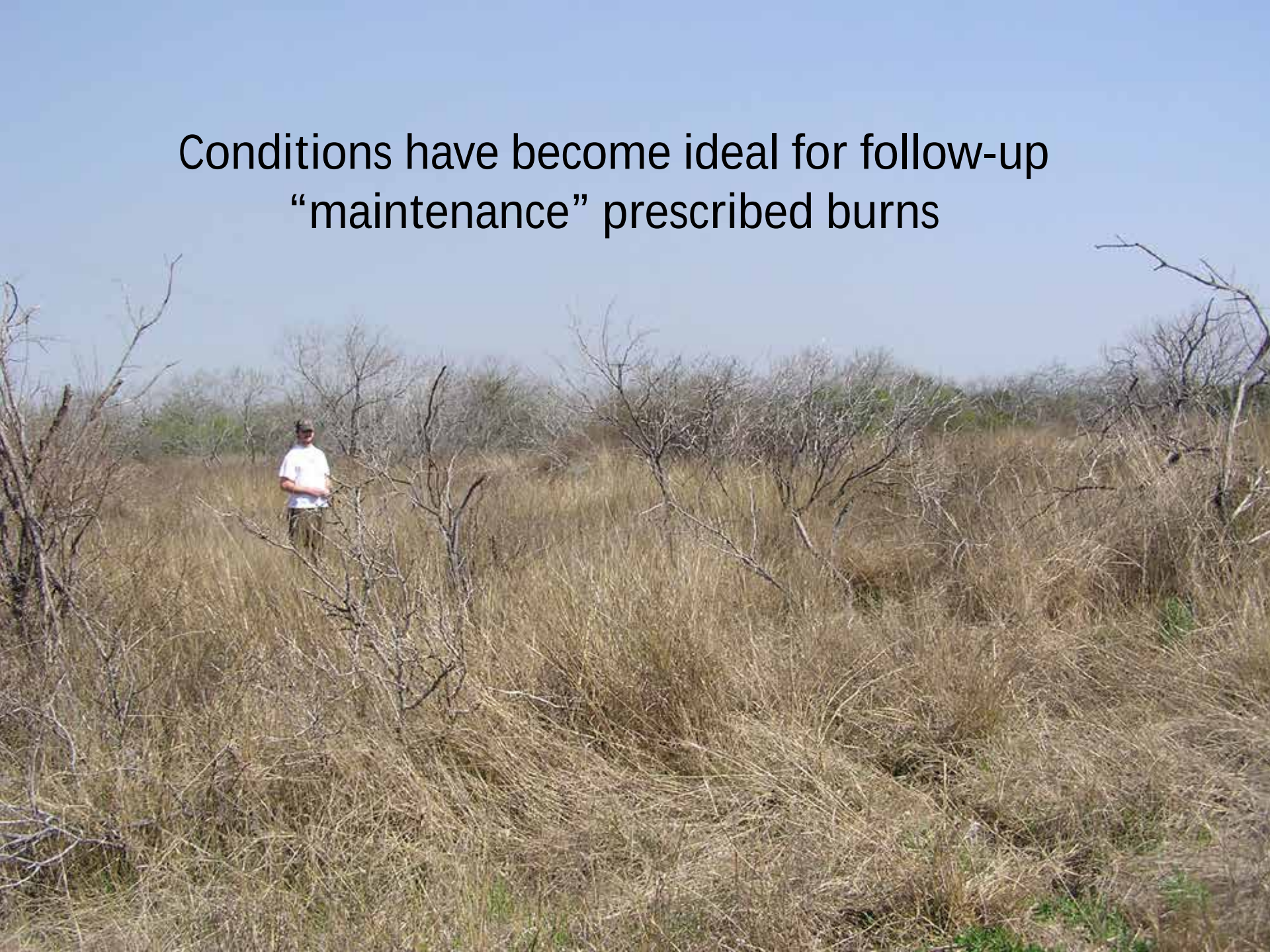
Twidwell et al. *in prep*

Extreme fires did not decrease total plant species richness nor increase non-native richness



Twidwell et al. 2012

Conditions have become ideal for follow-up "maintenance" prescribed burns



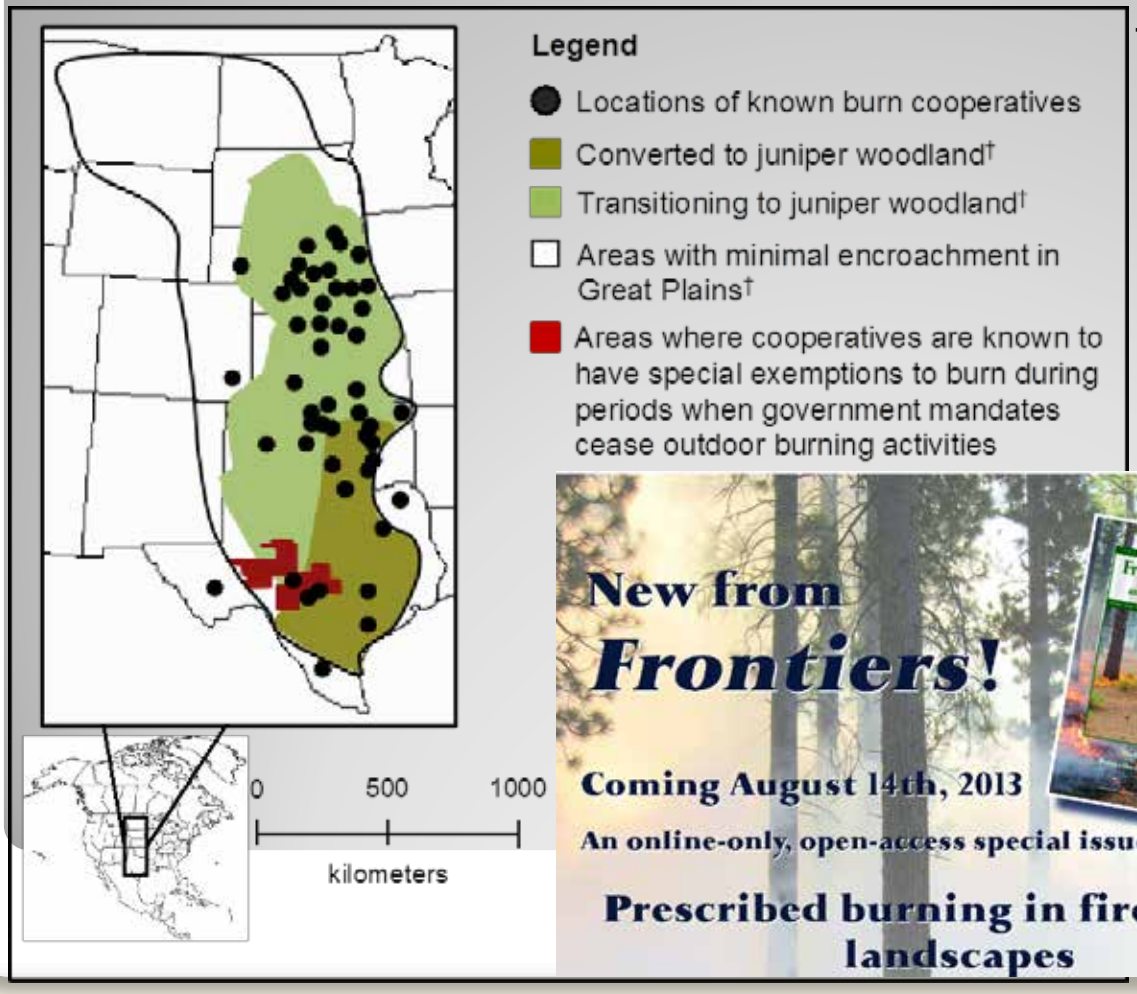
To date, our results suggest that the bias against prescribed extreme fires has not been justified

Extreme Fire Events in Texas Rangelands:

- Do not appear to “sterilize” the soil
- Do not decrease herbaceous plant diversity
- Do not increase the dominance and diversity of non-native grass species
- Are effective at controlling resprouting woody shrubs

Yet, with increasing fire intensities come increasing risks and in many instances societal constraints drive management applications

Burn cooperatives represent an unprecedented citizen-driven effort that has led to sociopolitical reforms and improves their ability to use fire for rangeland restoration and prevent further juniper encroachment into Great Plains grasslands



Twidwell, Rogers, et al. 2013