Wildfire severity and forest-conversion drive post-fire evapotranspiration in a southwestern pine-oak forest, Arizona, USA

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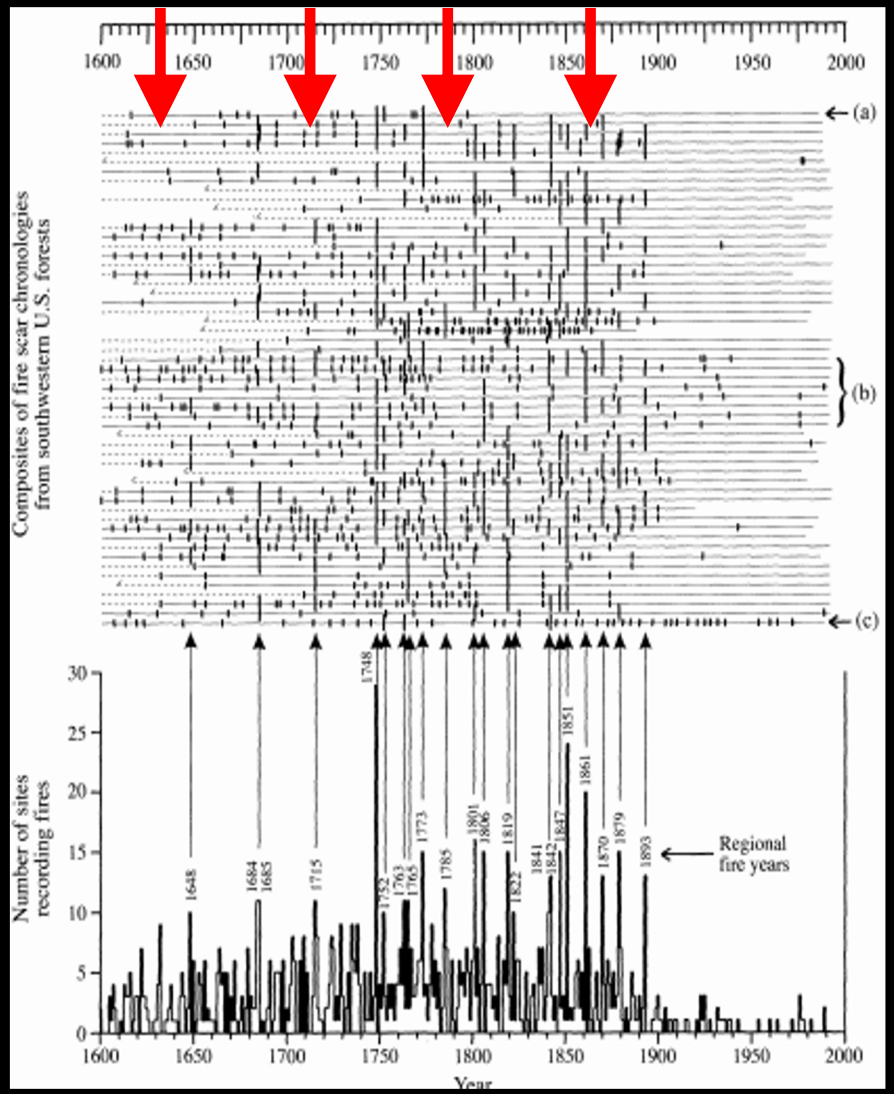
In Review in *Remote Sensing in Ecology and Conservation*

Southwest Frequent-fire Regime

- Lightning
- Low-severity, surface
- Every 5-15 yrs
- Synchronized regionally
- Maintained open canopy and diversity



Swetnam et al 1999

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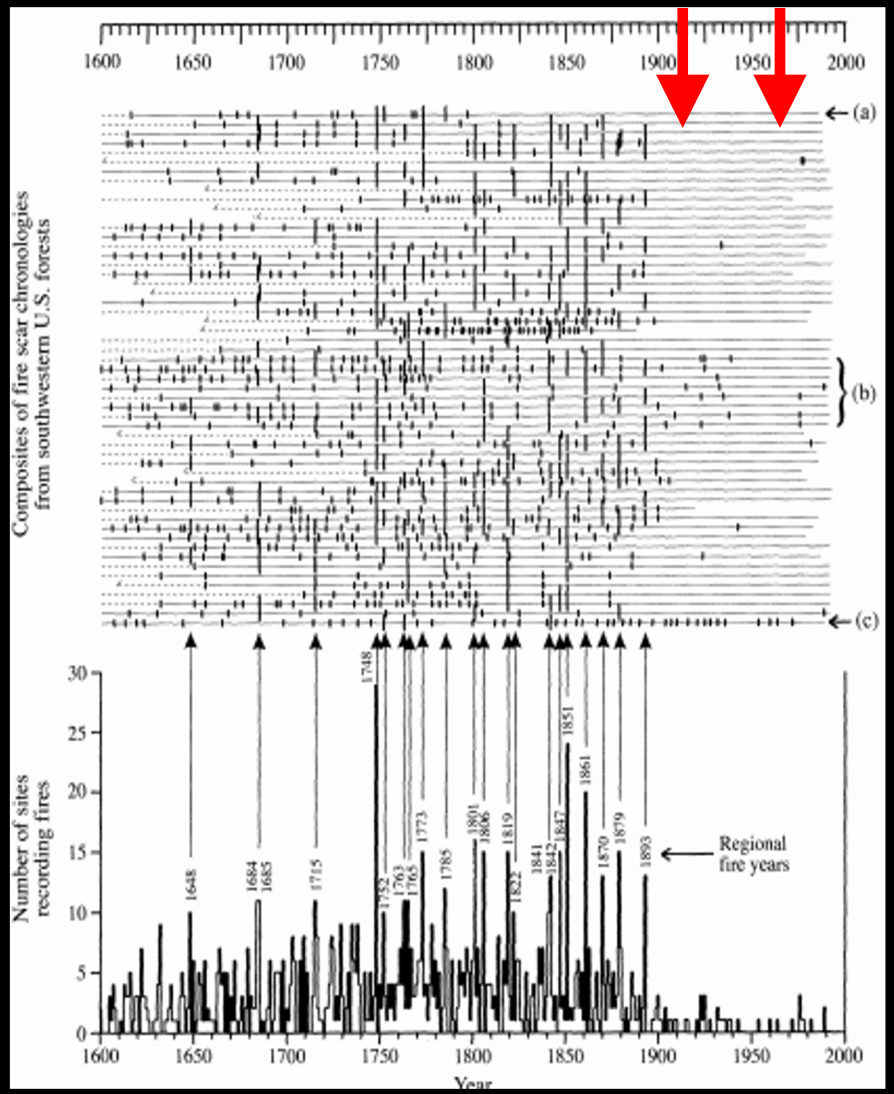
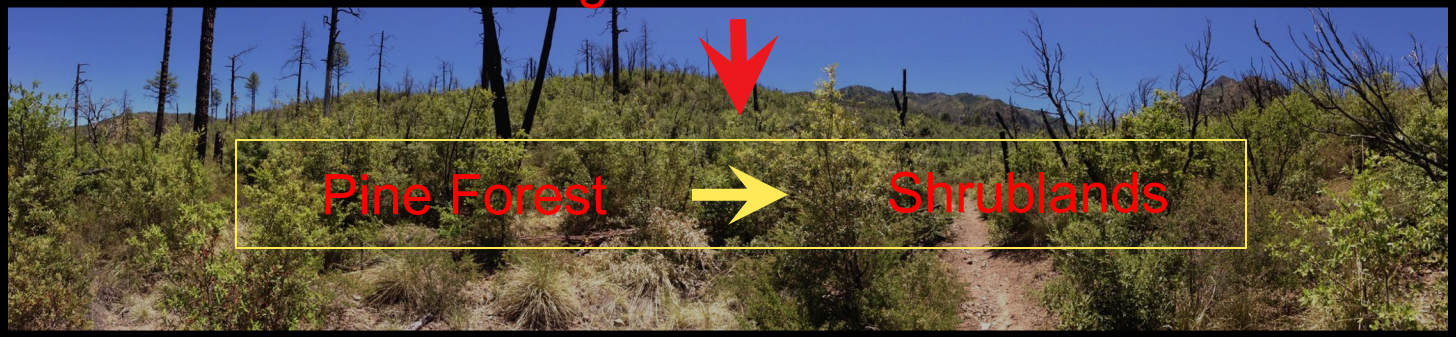


Swetnam et al 1999

Fire Exclusion → High Fuel Loads

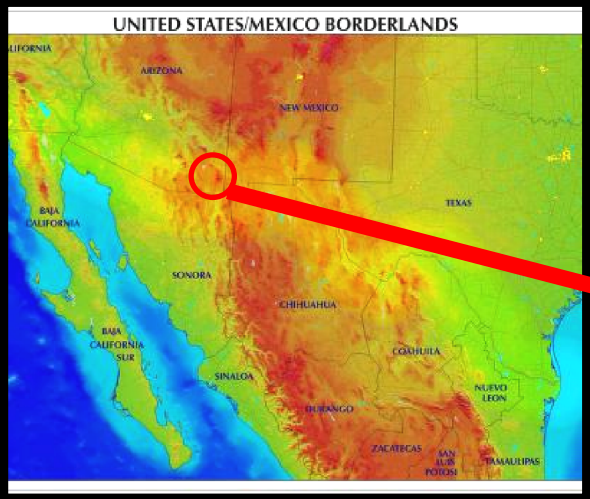
Climate Change → Increased Aridity

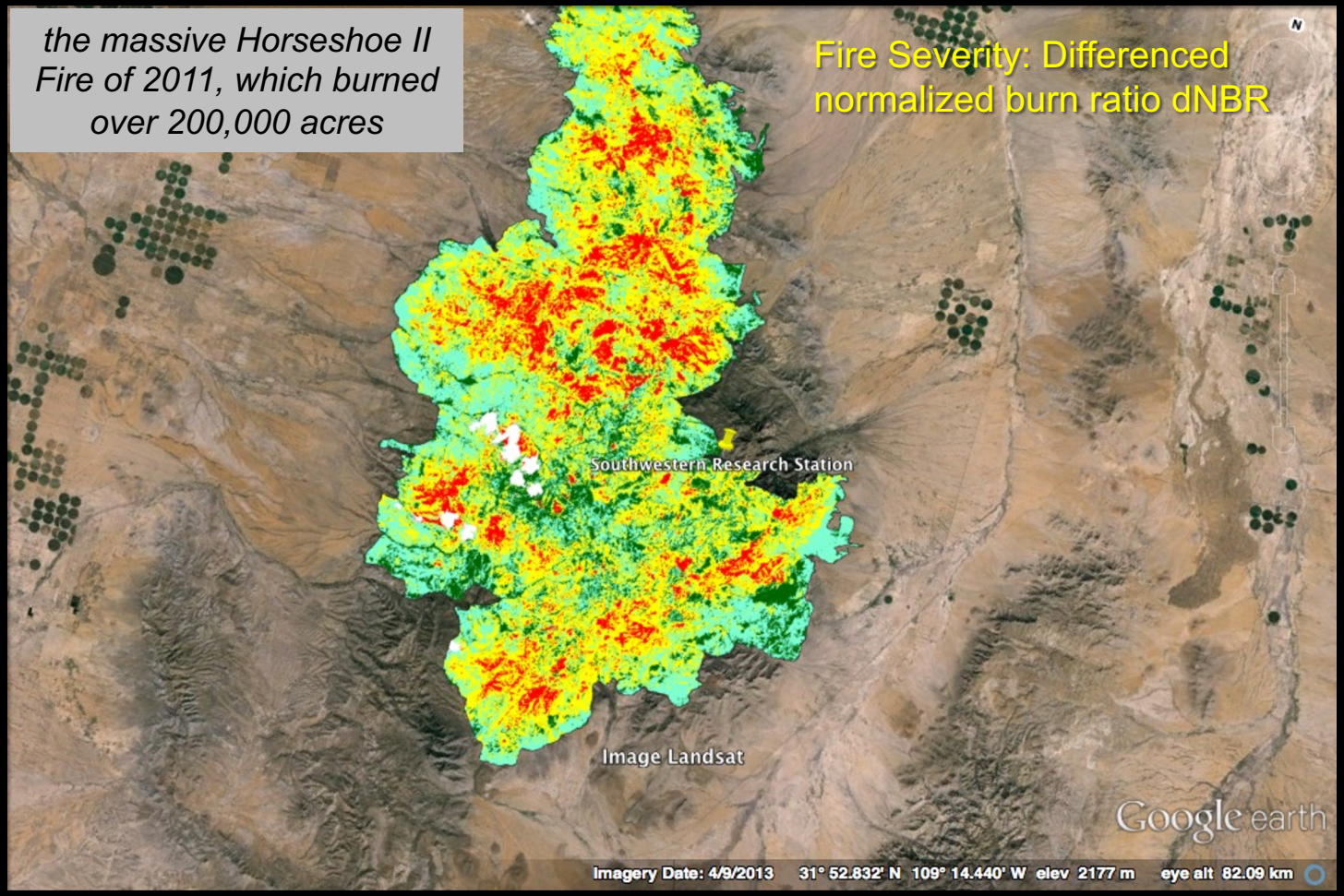
→ Large Crown Fires



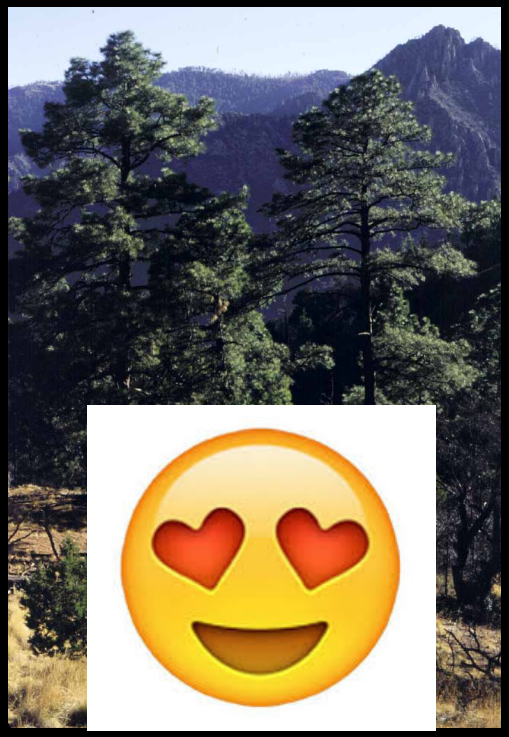
"…the fear that uncharacteristic fires may convert large areas of pine forest to other vegetation such as oak brush" (Wolfson & Thode 2014).

Sky Island Vegetation




the massive Horseshoe II Fire of 2011, which burned over 200,000 acres
Fire Severity: Differenced normalized burn ratio dNBR
Southwestern Research Station
Image Landsat
Google earth
Imagery Date: 4/9/2013 31° 52.832' N 109° 14.440' W elev 2177 m eye alt 82.09 km

Fire resistant
Post-fire seeder
Isohydric



Fire resilient
Vigorous post-fire sprouter
Strongly anisohydric

low → **high**

Competitive advantage in the high-severity wildfire landscape

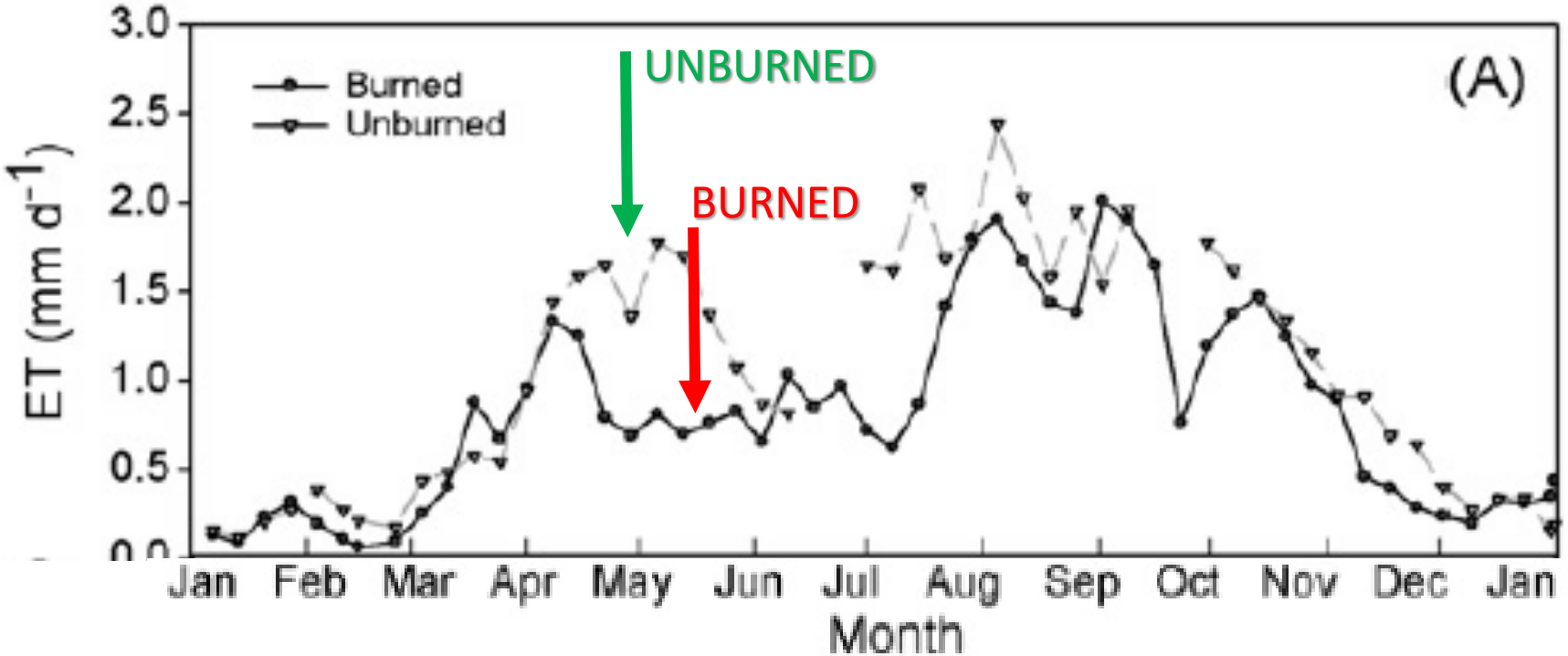
Poulos and Barton 2018, Poulos et al. 2020, Forest Ecology and Management

Research Questions

- How do fire severity and post-fire vegetation interact to influence ET in the wake of the 2011 Horseshoe Two Fire?

- How does this influence vary seasonally and diurnally?

Prior post-fire ET patterns in northern Arizona



Weekly evapotranspiration (ET) in a burned versus unburned stand calculated via eddy covariance at a northern Arizona wildfire site. Taken from Ha et al. (2015).

low-severity

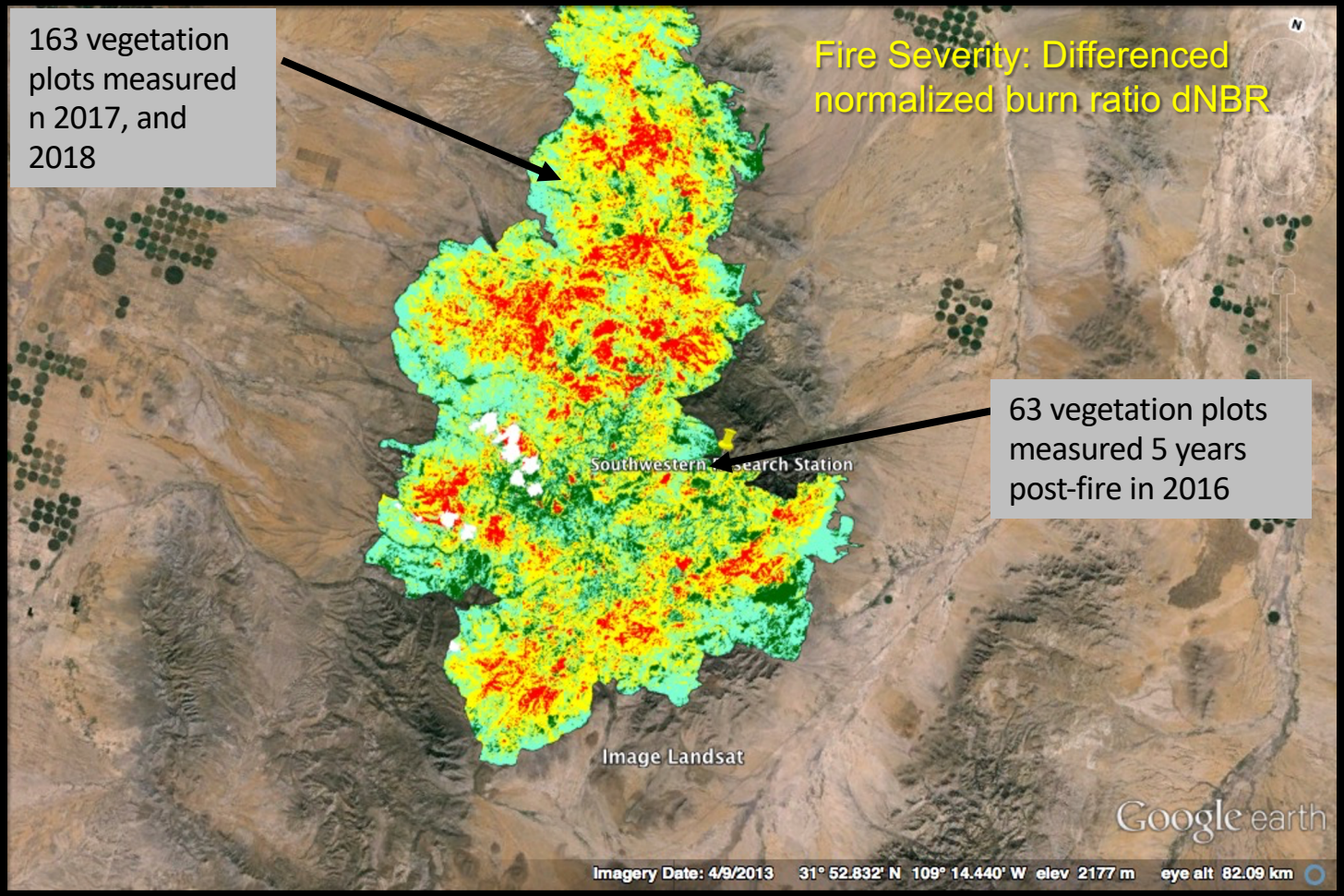
moderate-severity

high-severity

Hypotheses

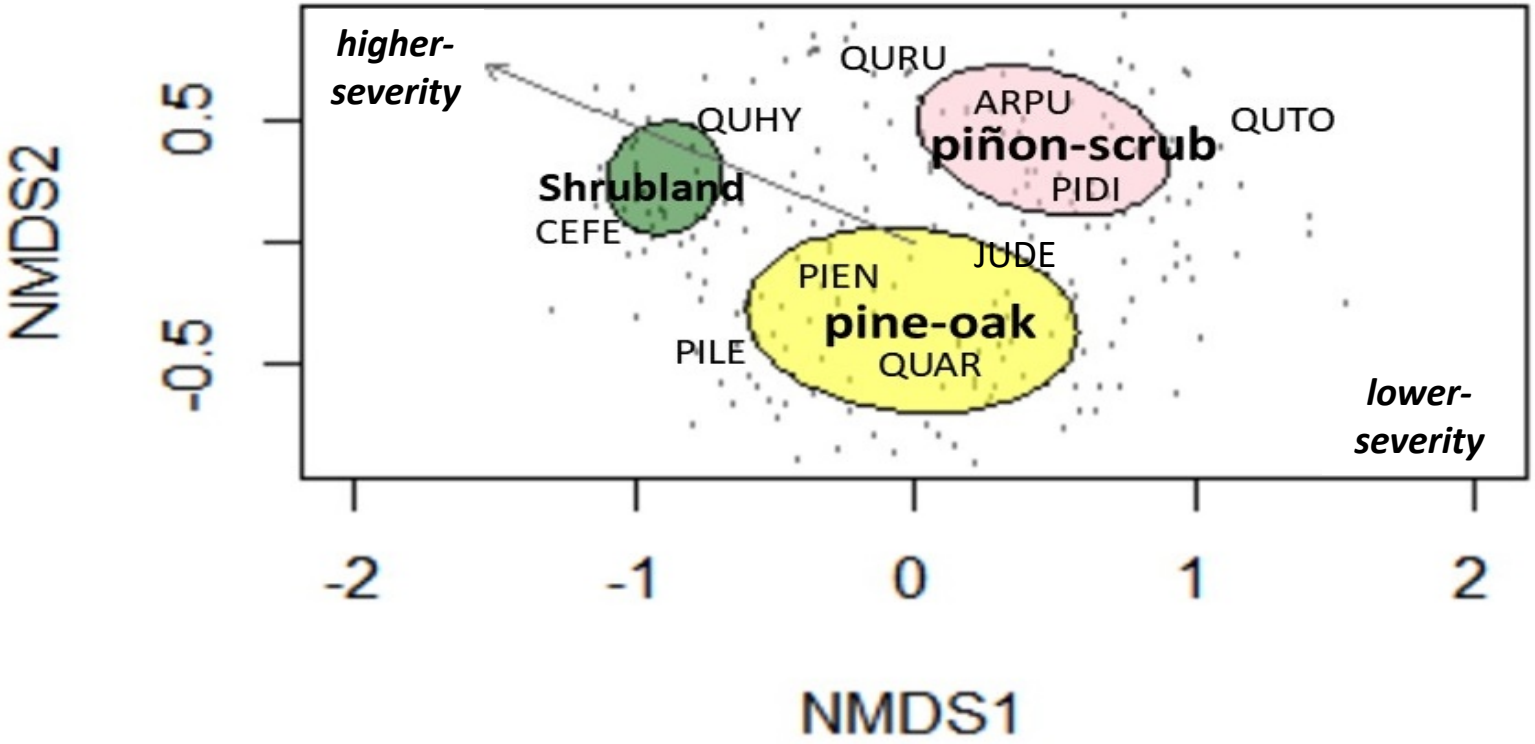
- Fire-severity and post-fire plant community composition will significantly influence spatio-temporal variation in ET

- Unlike other high-severity fire sites where ET can remain depressed for decades, post-fire shrublands at high fire severity sites will display high ET as a product of their high productivity and drought-tolerance in the post-fire landscape.


163 vegetation plots measured n 2017, and 2018
Fire Severity: Differenced normalized burn ratio dNBR
63 vegetation plots measured 5 years post-fire in 2016
Southwestern Research Station
Image Landsat
Google earth
Imagery Date: 4/9/2013 31° 52.832' N 109° 14.440' W elev 2177 m eye alt 82.09 km

Results

The post-fire plant community

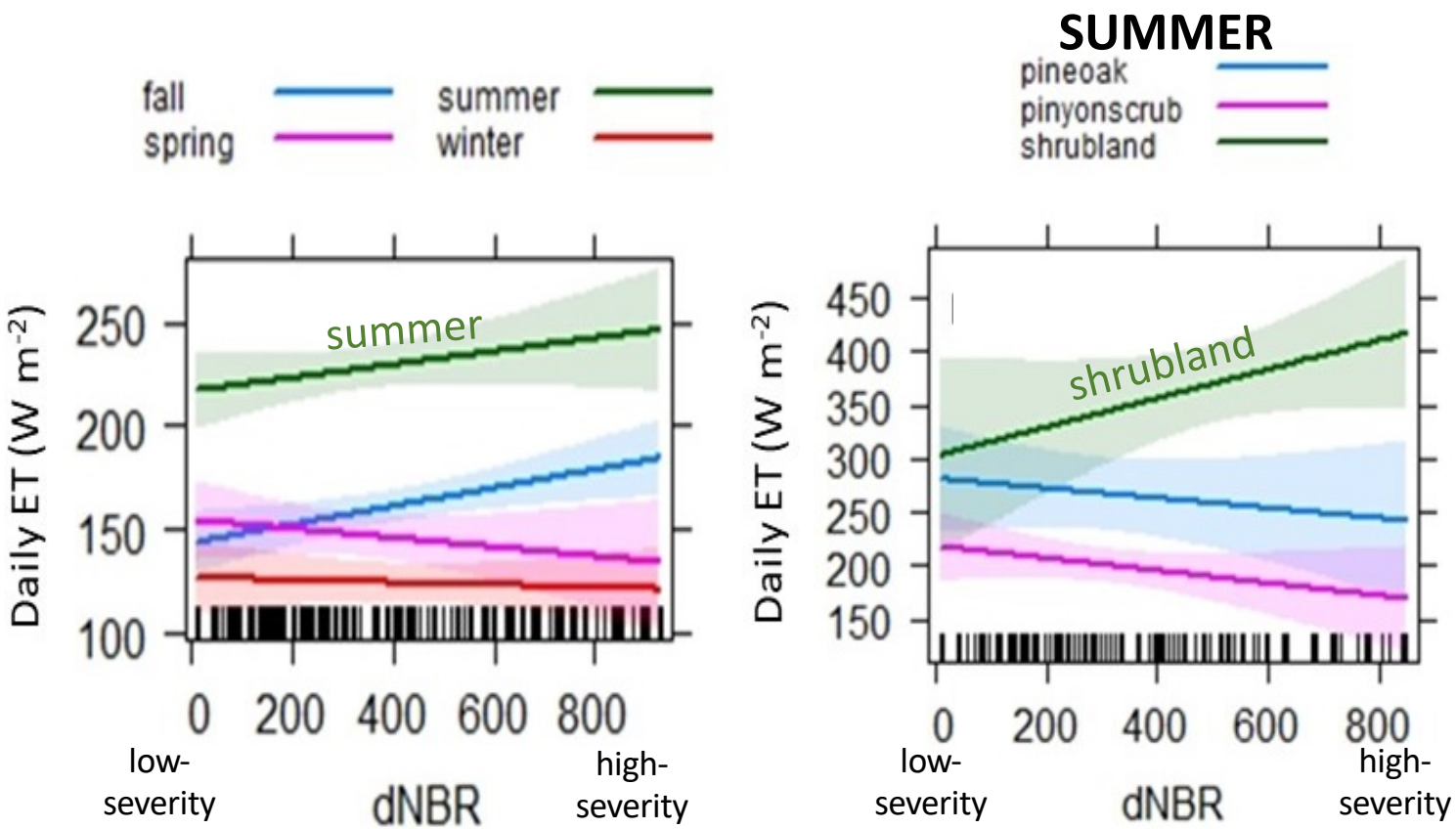


pine-oak forest

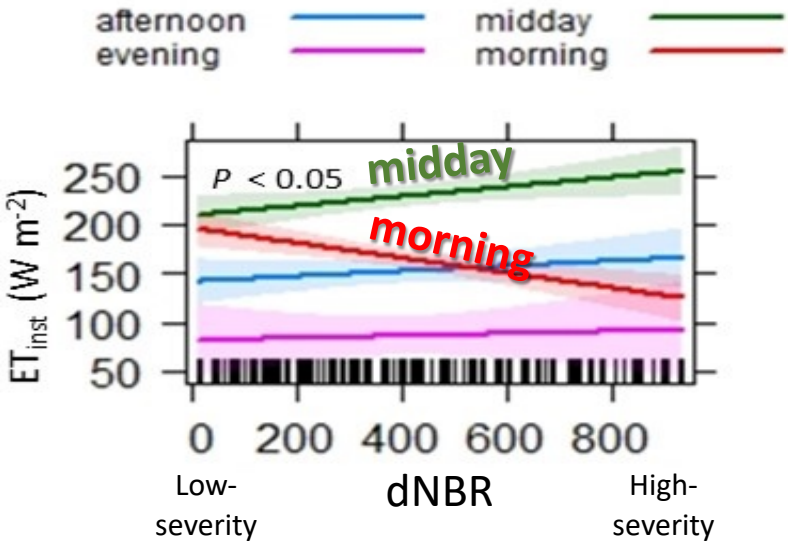
shrubland

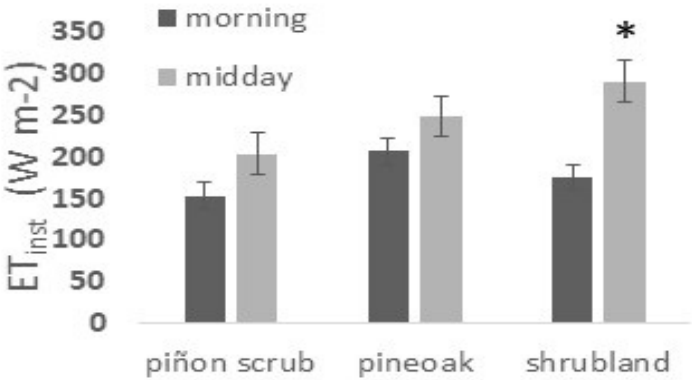
piñon scrub

Seasonal patterns in fire severity-ET relationships

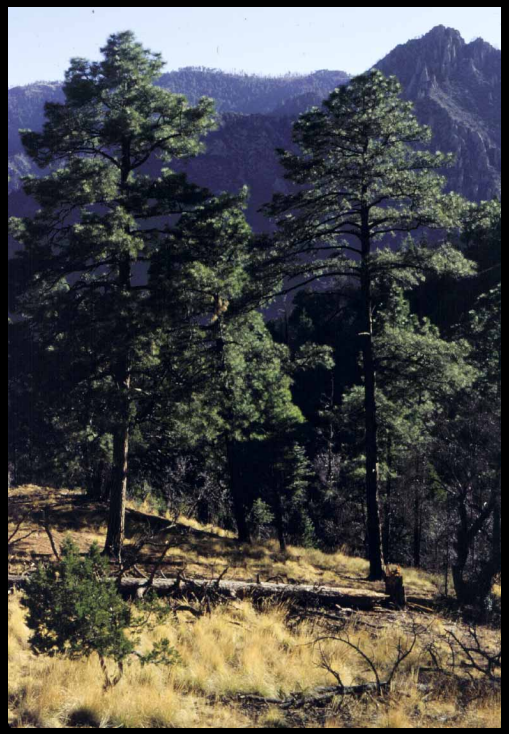


Diurnal patterns in fire severity-ET relationships





Post-fire seeder
Isohydric



Vigorous post-fire sprouter
Strongly anisohydric

low → high

Competitive advantage in the high-severity wildfire landscape

Conclusions

- Fire severity and post-fire plant community composition significantly influence spatio-temporal variation in ET.

- Vigorous post-fire shrublands at higher fire severity sites exhibit high ET, unlike the findings at other high-severity fire sites, where ET can remain depressed for decades.

- Fire severity had differential effects on post-fire ET over the course of the day. Species-level variation in plant water stress tolerance likely explains this pattern.

Next steps…FIELD WORK Spring 2021

Please keep ECOSTRESS in Orbit through 2022!

Thanks and chat me with questions?