Long Term Effects of Fuel Treatments in a Ponderosa Pine Forest Post-Fire

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Joint Fire Science Program

Rocky Mountain Research Station

Introduction

- Most historically dry ponderosa pine (*Pinus ponderosa*) forests are thought to have been fire resilient (Cooper 1960)
- Euro-American settlement:
  - Decrease ponderosa pine forest fire resistance
  - Increase in burn severity (Allen *et al.* 2002)
- Burn severity: amount of ecological change caused by fire (Morgan *et al.* 2001)
  - Commonly measured remotely

INTRODUCTION: Treatments

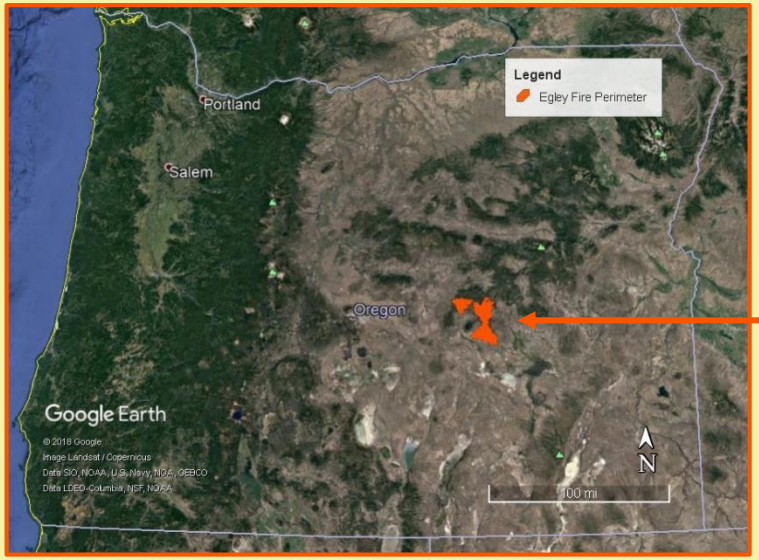
- Land managers implemented mechanical treatments
  (Fulé et al. 2012, Kaye et al. 2005)
  - Thinning
- Focus:
  - Increase in canopy base height
  - Break up horizontal canopy continuity (Agee and Skinner 2005)

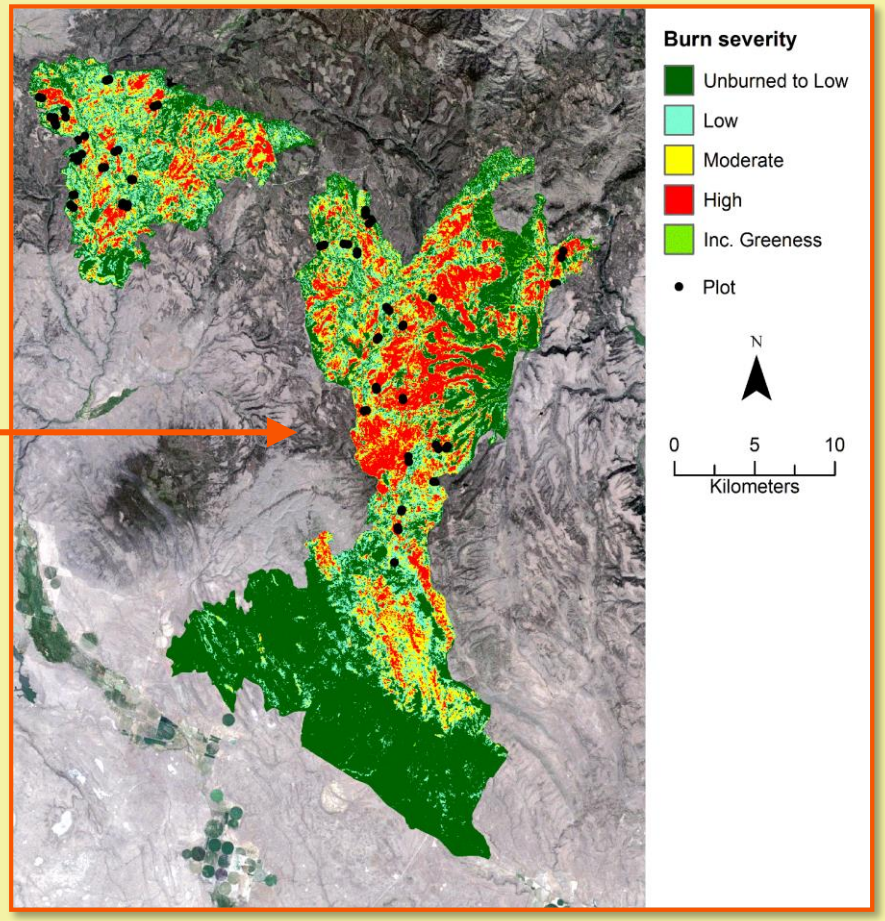
OBJECTIVES

1) Analyze remotely sensed burn severity gradient relationship to ground measurements 1 and 9 years after the Egley Fire Complex
2) Compare post-fire overstory and understory components between
    1) Treatment status
    2) Burn Severity
3) Evaluate the changes over time

METHODS: Study Area

- July 6th, 2007: Egley Fire Complex
- 70 paired plots (Harbert *et al.* 2007)
  - 35 treated (T) and 35 untreated (U)
- differenced Normalized Burn Ratio (dNBR)



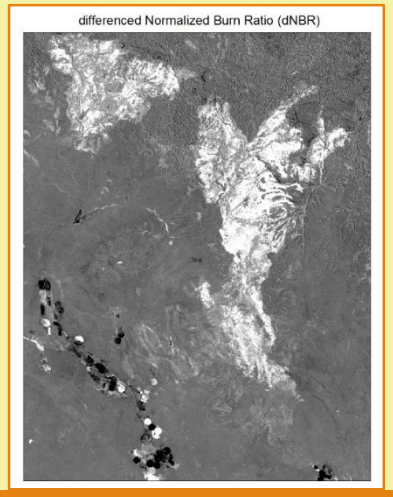


Monitoring Trends in Burn Severity (MTBS, www.mtbs.gov)

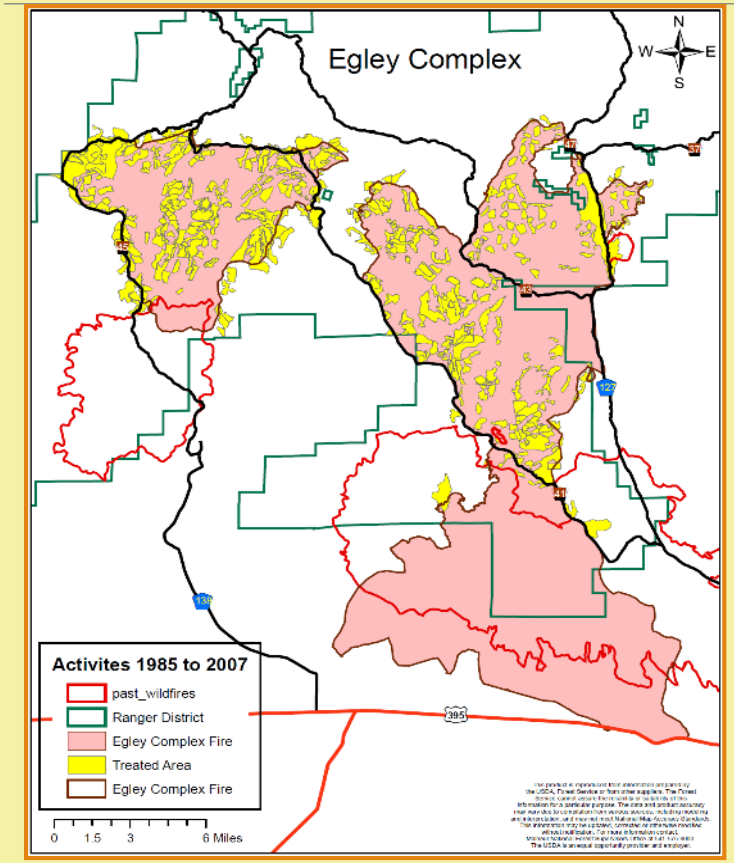
METHODS: Remote Sensing

Common way to measure burn severity:

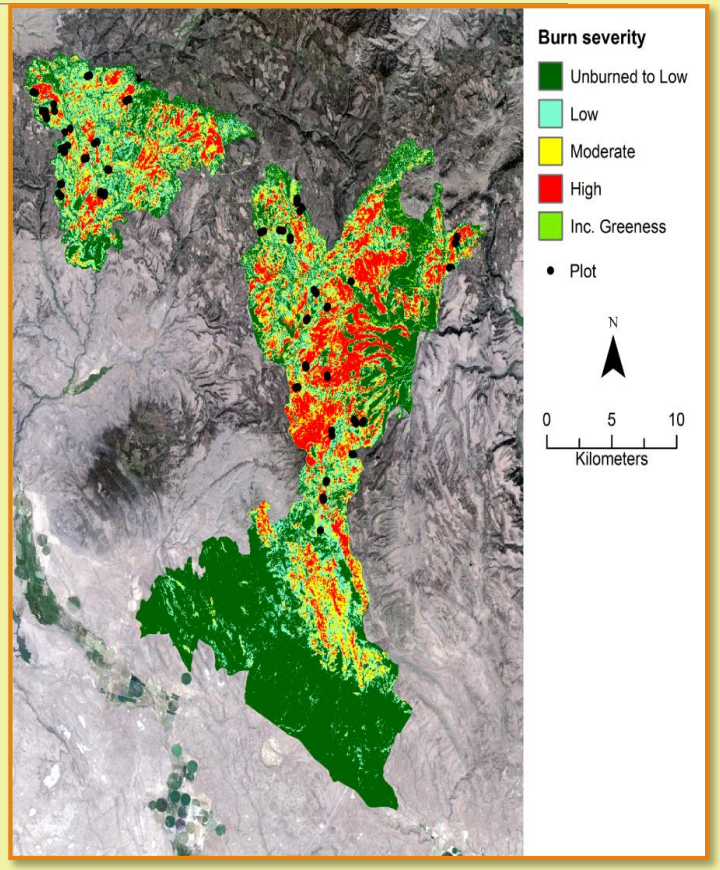
- Normalized Burn Ratio (NBR) = $\frac{RED - SWIR}{RED + SWIR}$
- differenced NBR (dNBR) = $NBR\ prefire - NBR\ postfire$
- LandTrendr: Landsat-based Detection of Trends in Disturbance and Recovery
  - Implemented from 1984 to 2016 (Gorelick et al. 2017; Kennedy et al. 2018).



METHODS: Treatments



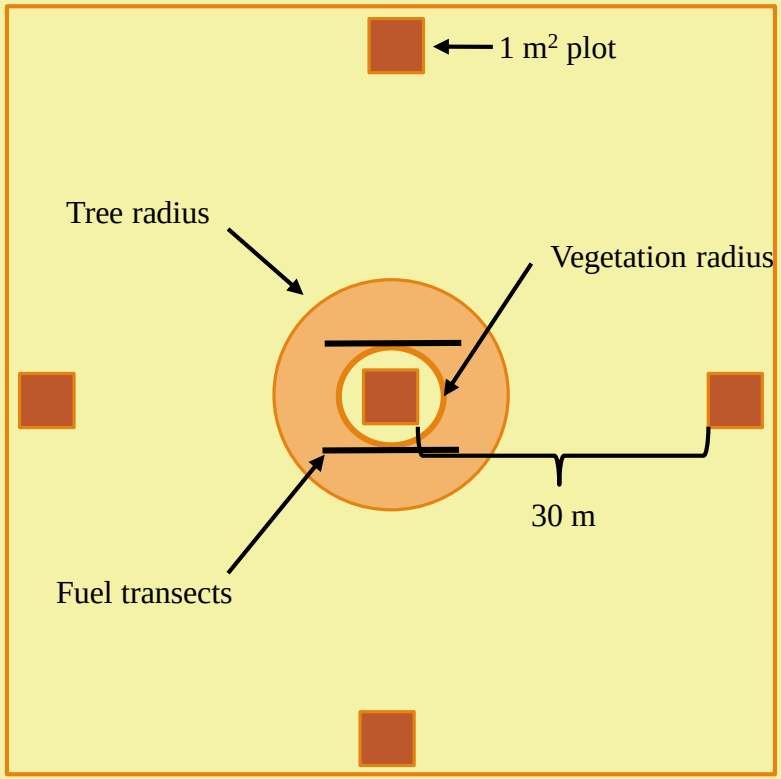
Harbert *et al.* (2007)



Monitoring Trends in Burn Severity
(MTBS, www.mtbs.gov)

METHODS: Field Procedures

- Measured in summers of 2008 and 2016
- Overstory
  - Tree density
  - Tree canopy cover
- Understory
  - Surface cover
  - Functional groups
  - Fuel loadings

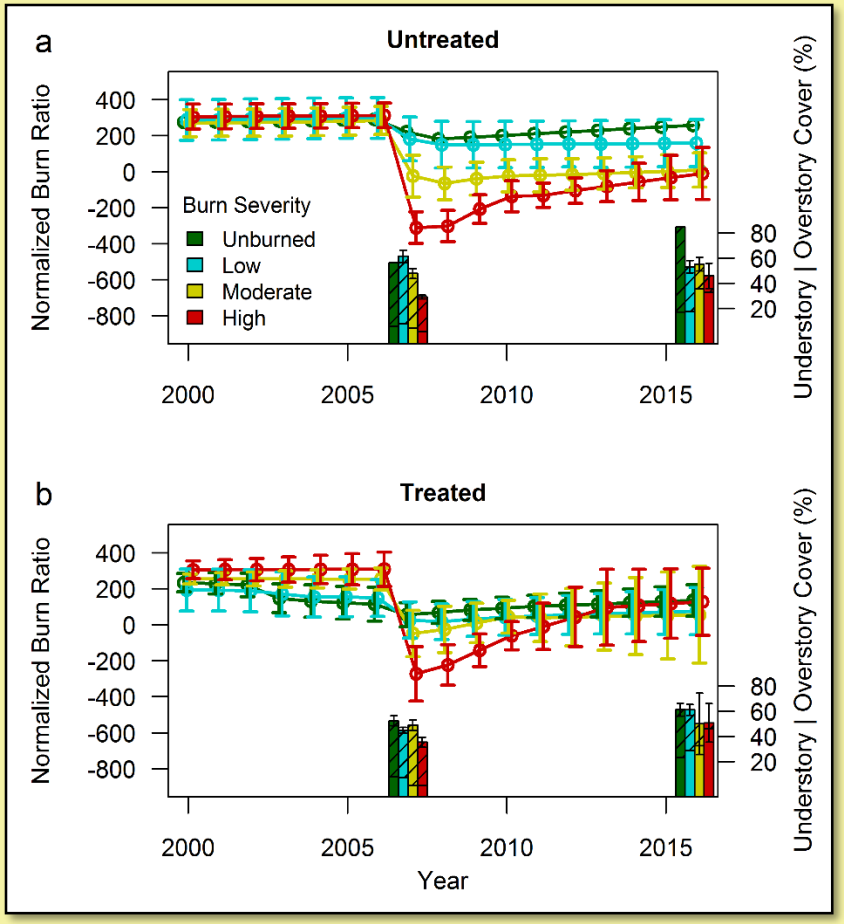


METHODS: Analysis

- Linear regressions: relationships between 2008 and 2016 NBR values and ground measurements:
  - Tree canopy, green, and char cover (%)
- Treatment status and burn severity were combined (TSEV) into 4 groups
- A Kruskal-Wallis test was used to test significance between TSEV groups
  - Dunn's test for significant ($\alpha = 0.05$) pairwise comparisons (R Core Team 2013)

TSEV	Number of Sites
T-low	30
T-high	5
U-low	11
U-high	24

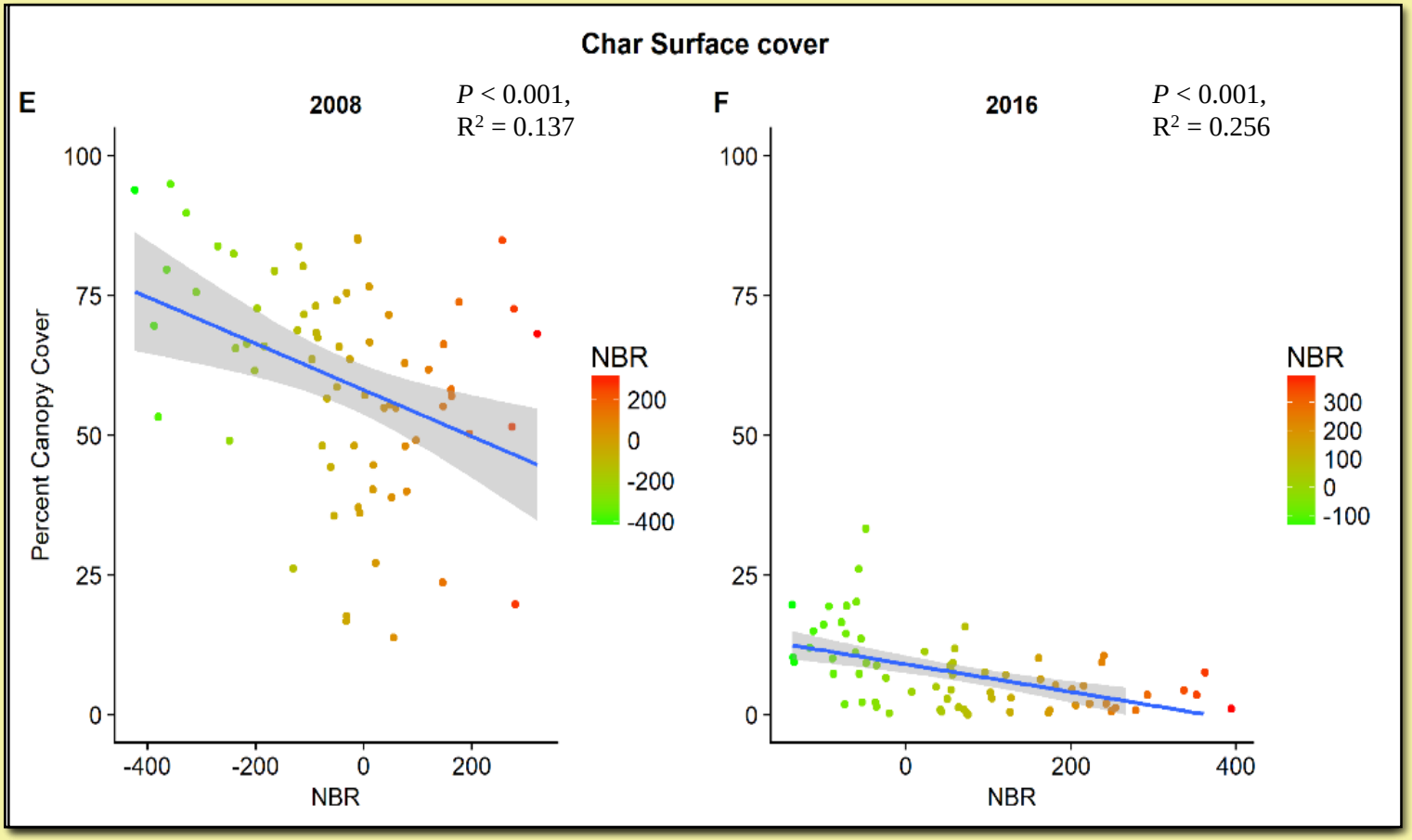
RESULTS & DISCUSSION: LandTrendr Time Series



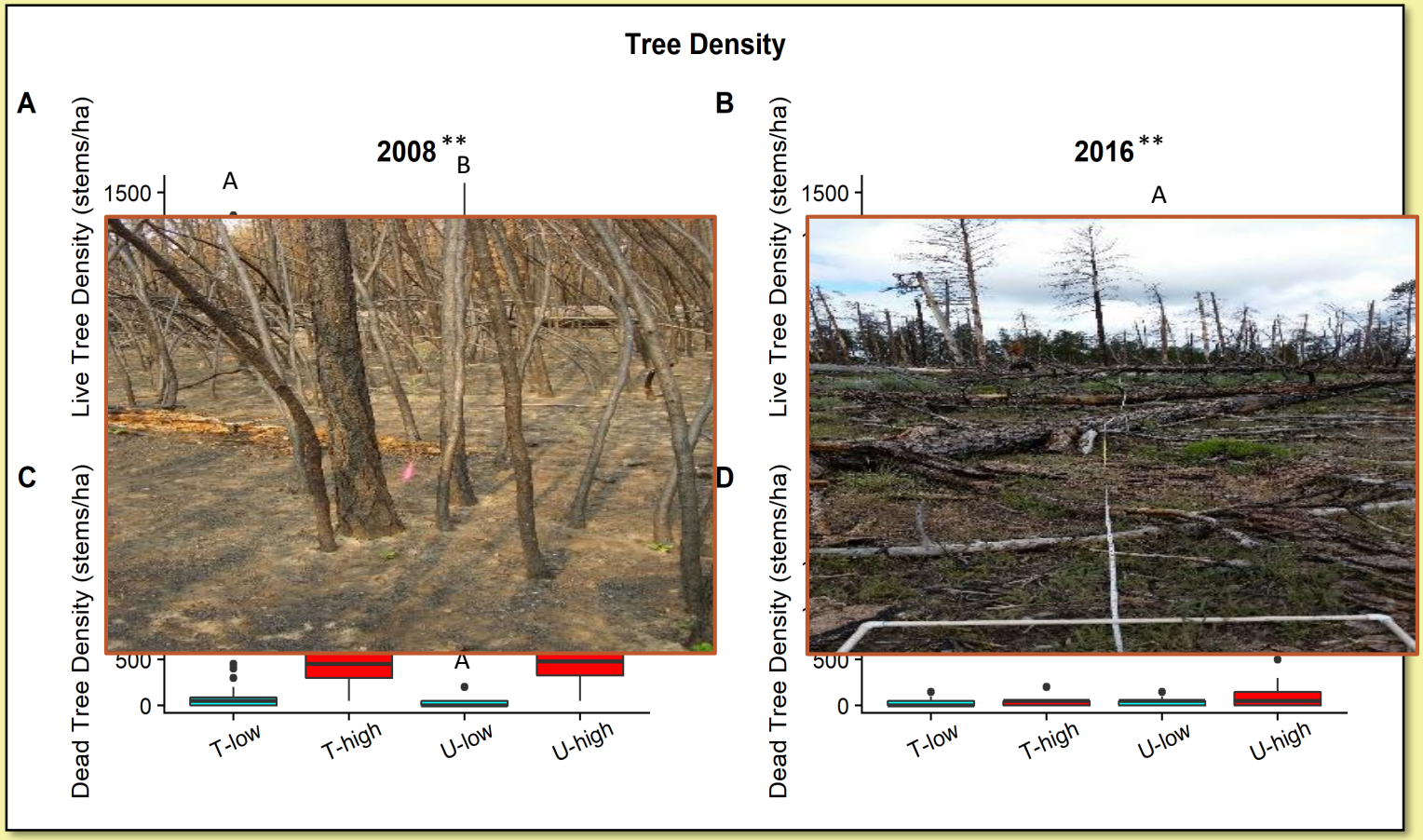
RESULTS & DISCUSSION: Treatments

	Untreated	Treated
2008		
2016		

RESULTS & DISCUSSION:
NBR vs Ground Measurements



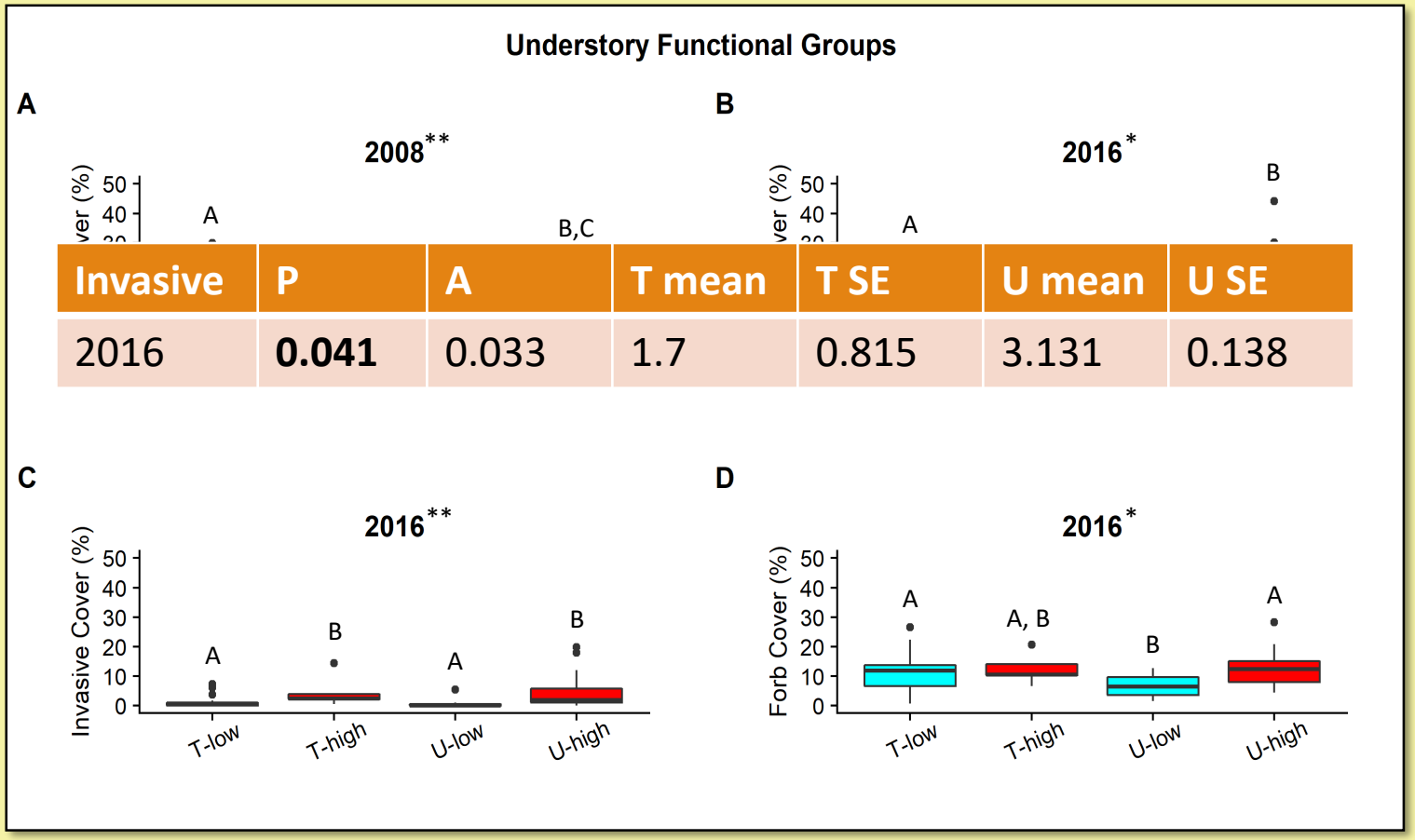
RESULTS & DISCUSSION: Tree Density



RESULTS & DISCUSSION: Functional Groups

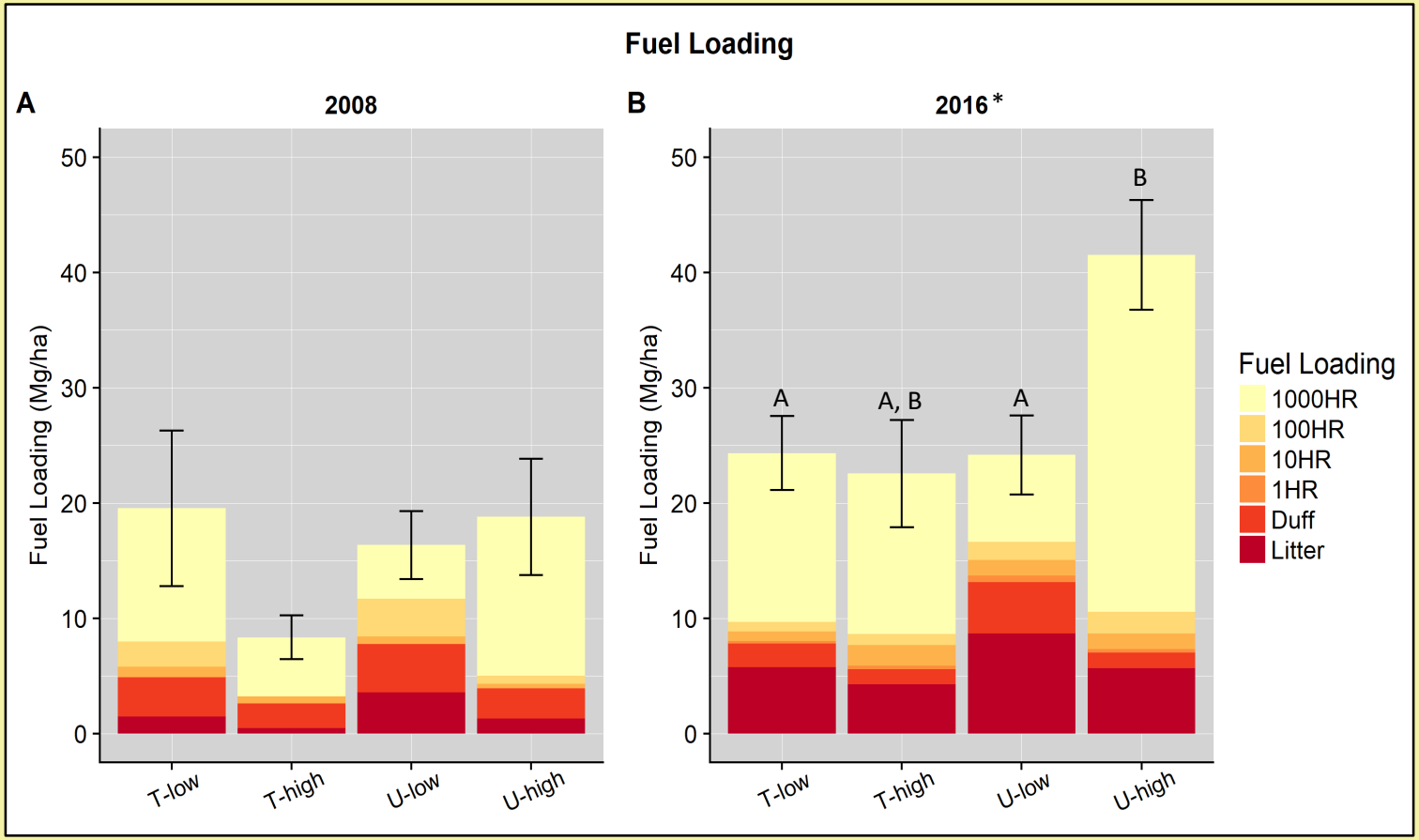
- Savage and Mast (2005)
- Our study: large patches of snowbrush ceanothus (*Ceanothus velutinus*)
  - No significant differences between TSEV in either year

RESULTS & DISCUSSION: Functional Groups



Invasive	P	A	T mean	T SE	U mean	U SE
2016	**0.041**	0.033	1.7	0.815	3.131	0.138

RESULTS & DISCUSSION: Fuel Loading



Management Implications

- Pre-fire fuel treatments were effective at reducing burn severity
- LandTrendr time series captured disturbance and post-fire vegetation recovery
- Burn severity affected tree canopy cover and tree density more than treatment
- Treatments passively affected percent invasive cover
- Lower total fuel loads can still be detected in pre-fire treated areas 9 years post-fire

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QUESTIONS

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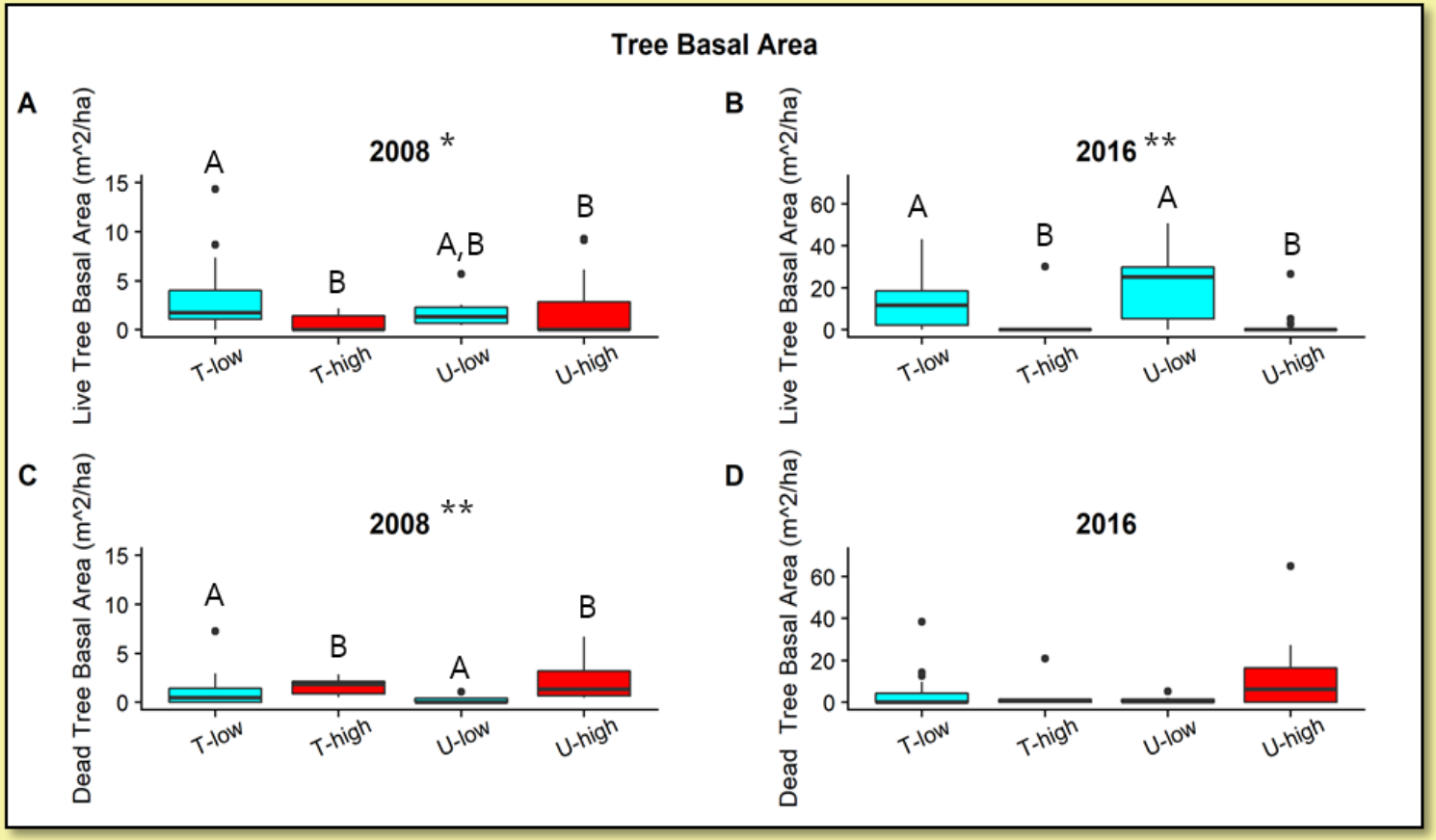
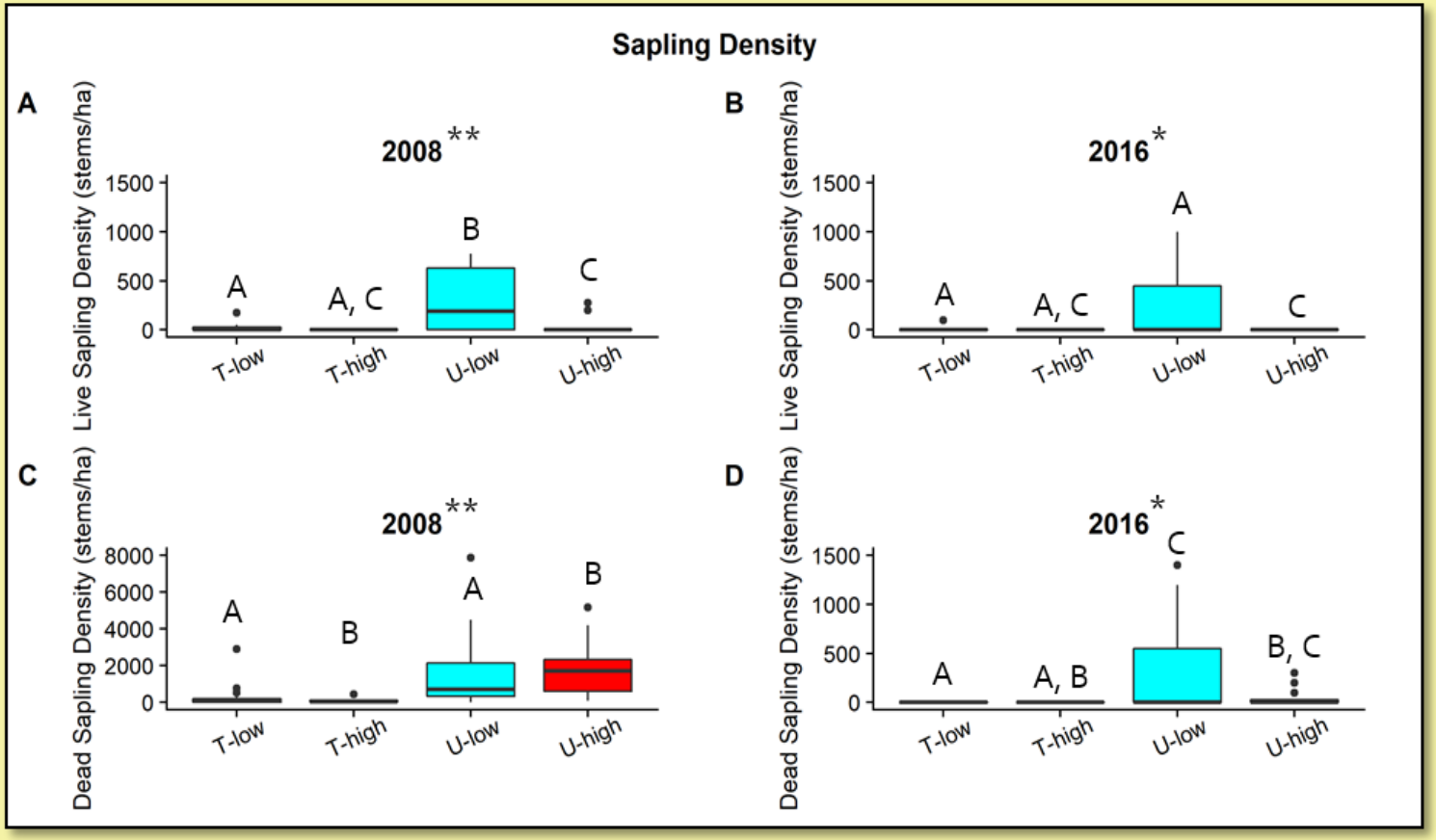
RESULTS: Tree Basal Area



RESULTS: Sapling Density



RESULTS: Surface Cover