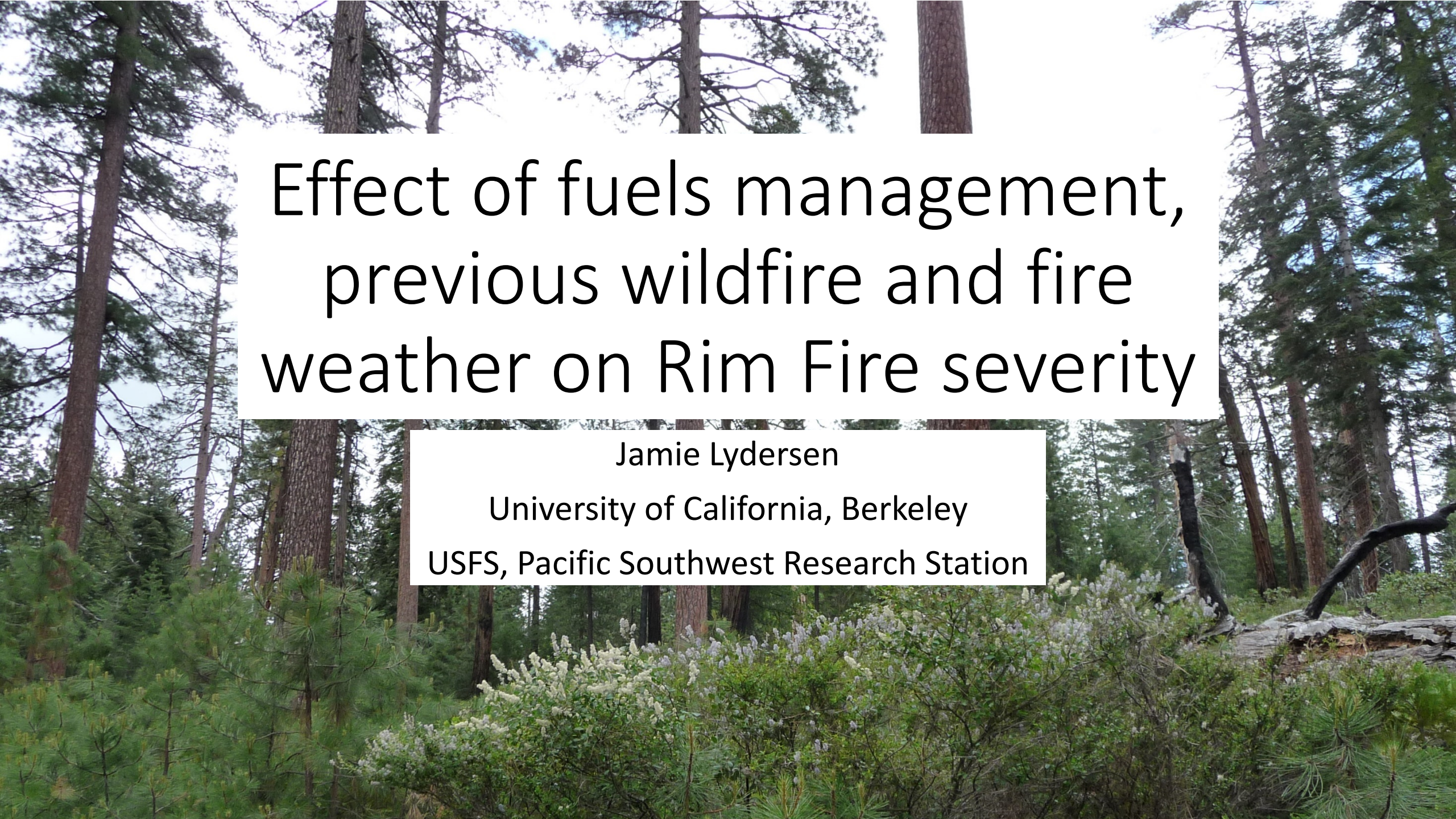

# Effect of fuels management, previous wildfire and fire weather on Rim Fire severity

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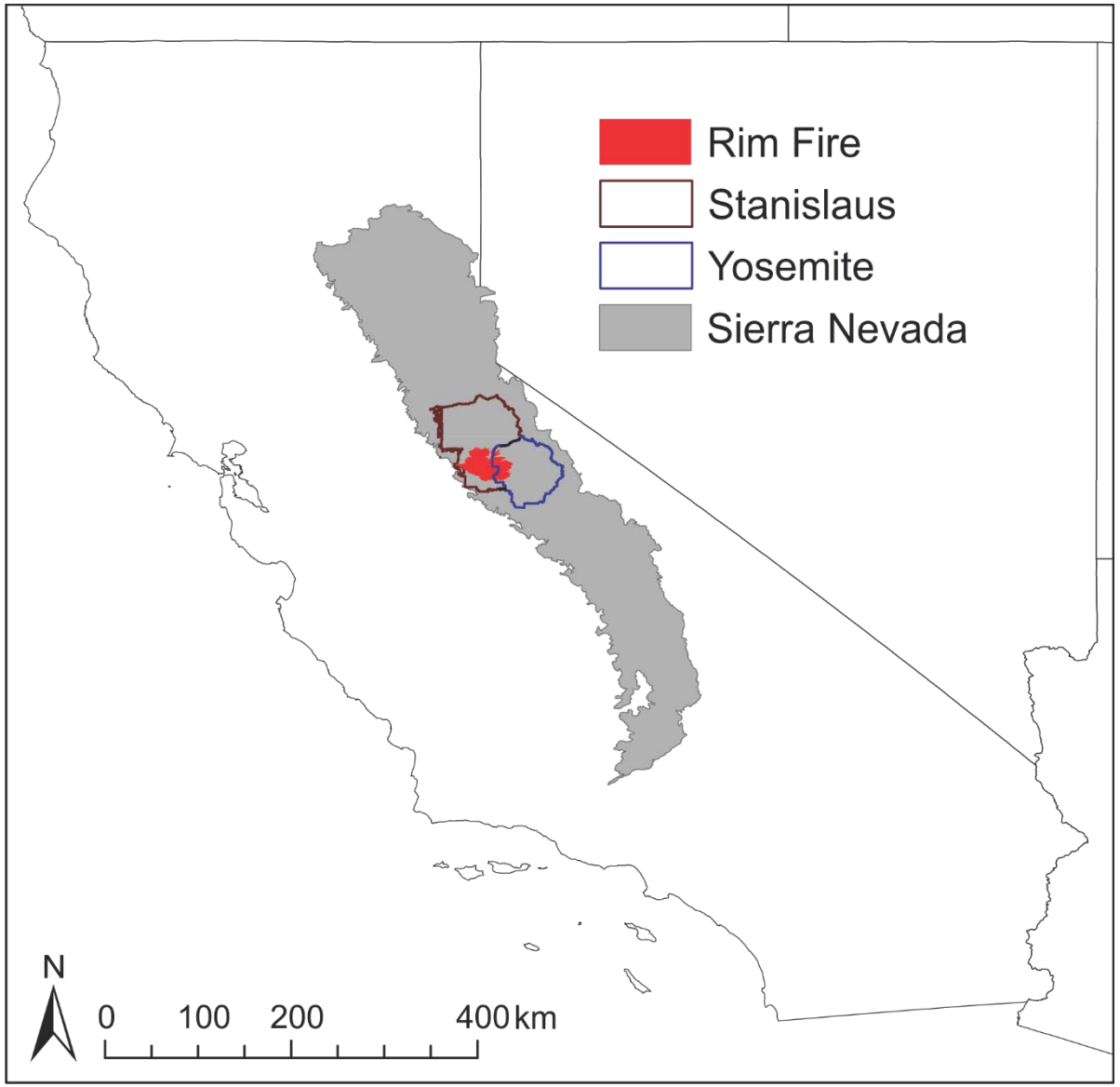
# Outline

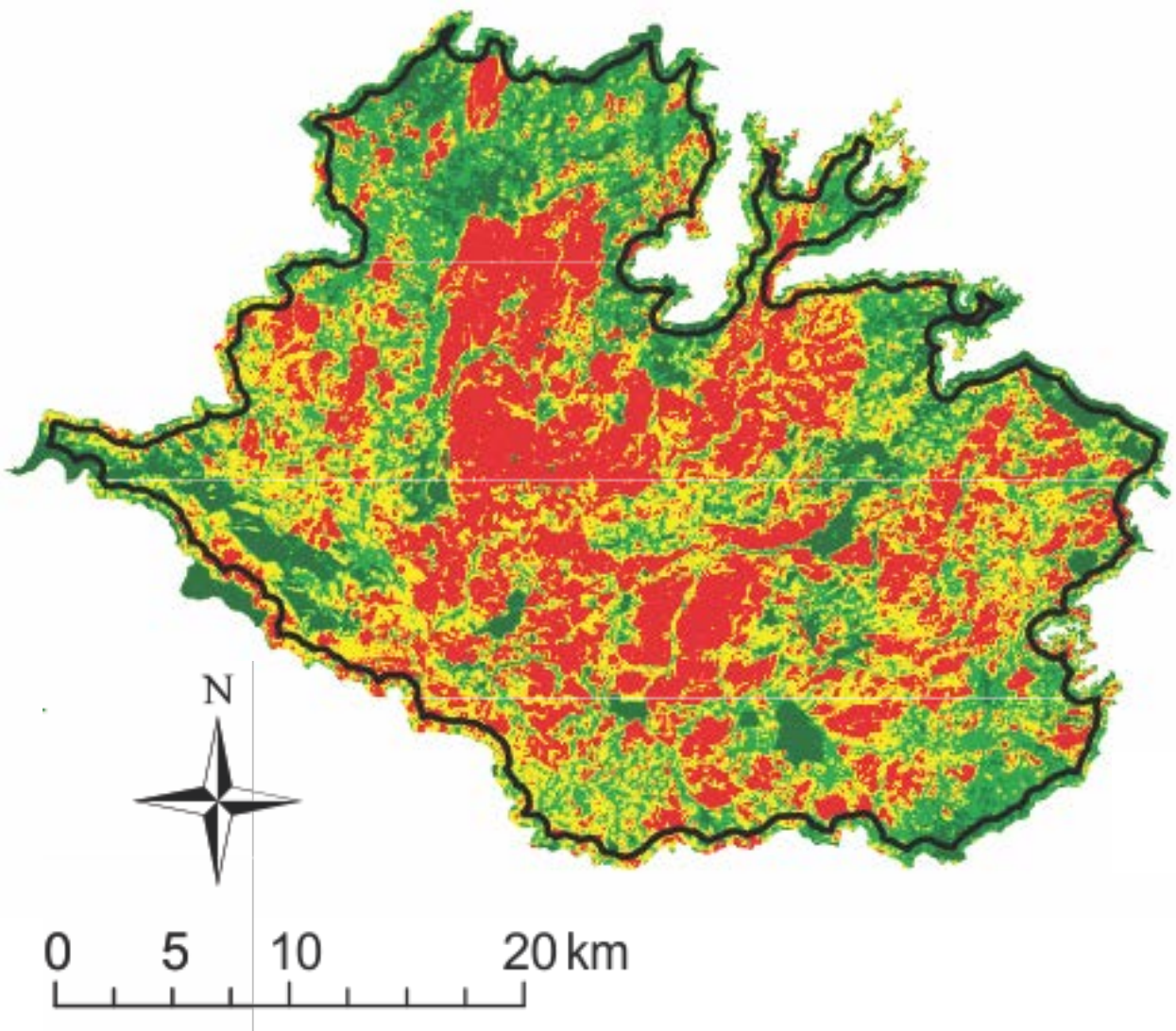
- Overview of Rim Fire
- Effects of fuels treatments
  - Census of all pixels across fire perimeter
  - Analysis of proportion high severity within sample landscapes
  - Analysis of severity as fire progresses into a treated area
- Summary

# Rim Fire location

- Fire size: 257,314 acres
- Elevation: 870-7900 ft
- Vegetation types:
  - Conifer 68.3%
  - Hardwood 16.3%
  - Shrubland 7.4%
  - Riparian 4.1%
  - Grassland 1.3%
  - Sparse/Barren 2.0%
  - Open Water 0.3%
  - Developed 0.3%



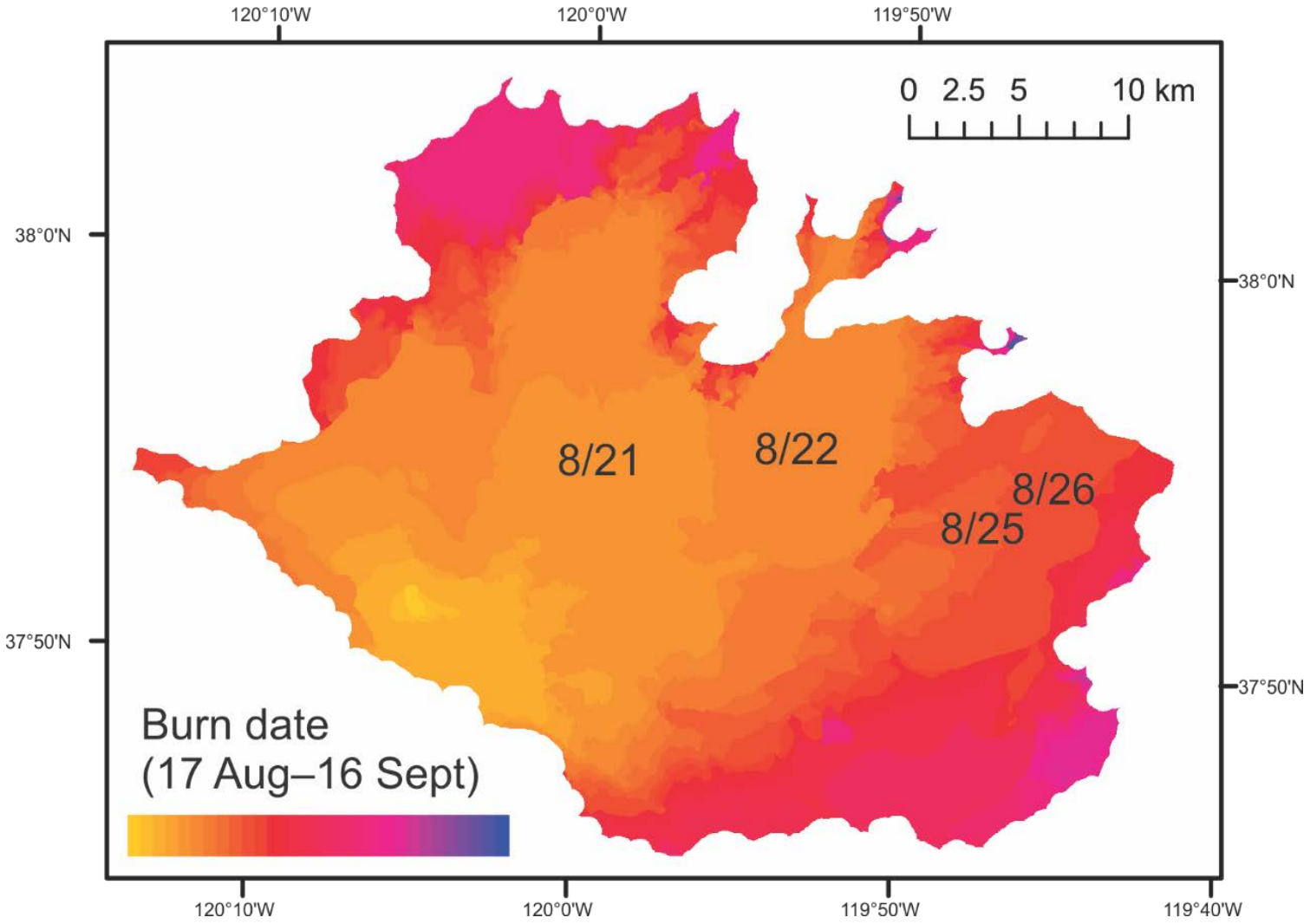
# Rim Fire Severity




| | Severity category | Ecological effect |
|---|---|---|
| | Unchanged 9% | No change to overstory trees; affects vegetation in understory only, includes unburned islands within the fire perimeter |
| | Low 25% | Little change in basal area; kills primarily smaller diameter trees and fire sensitive species |
| | Moderate 33% | Greater range in fire effects (26-75% change in basal area); often represents a transition from surface to crown fire |
| | High 33% | Most (>95%) of basal area is killed; associated with crown fire |

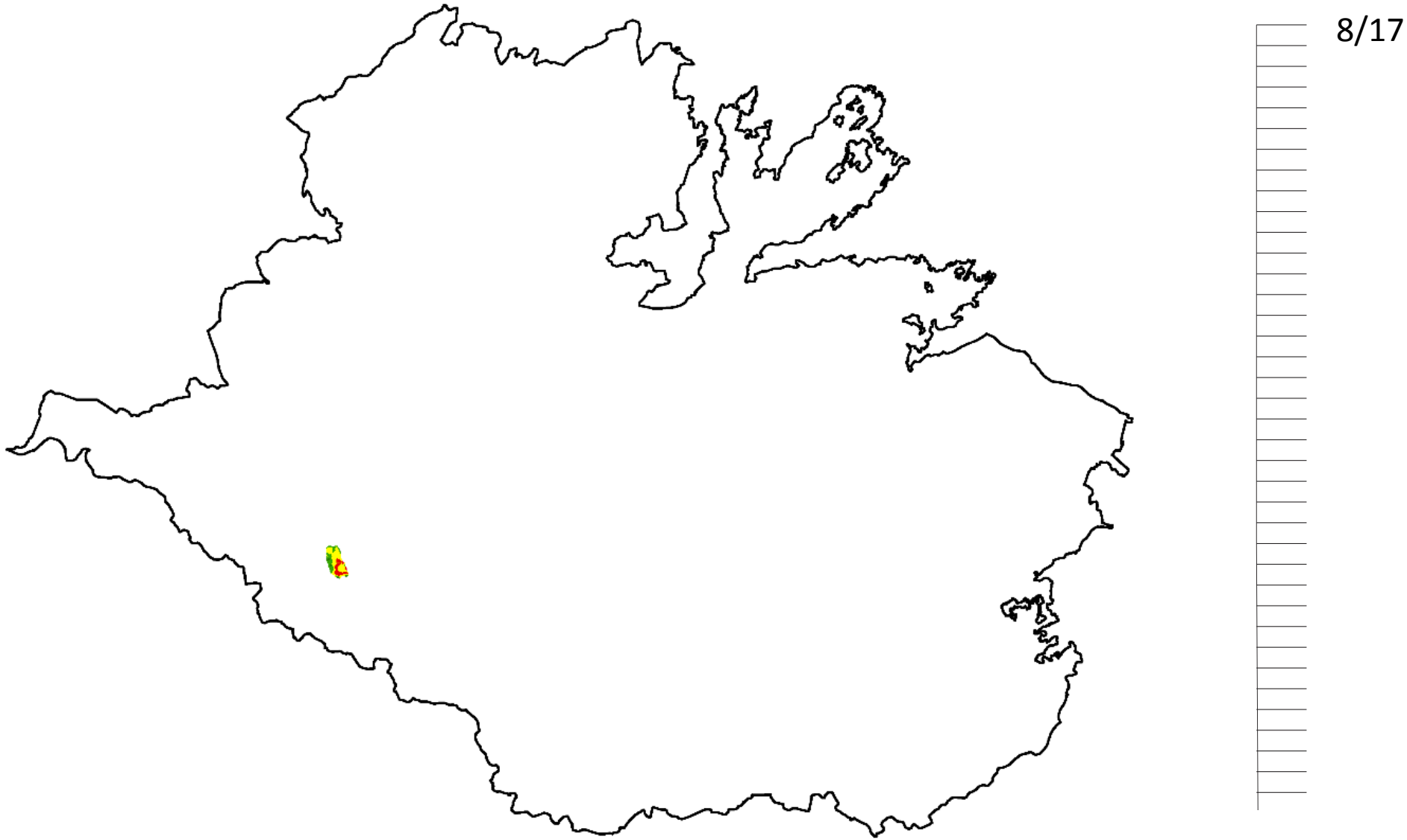
NRV for percent high severity: 5-10%
(Meyer 2015, Journal of Forestry 113: 49-56;
Safford and Stevens 2014, PSW-GTR-256)

# Rim Fire progression



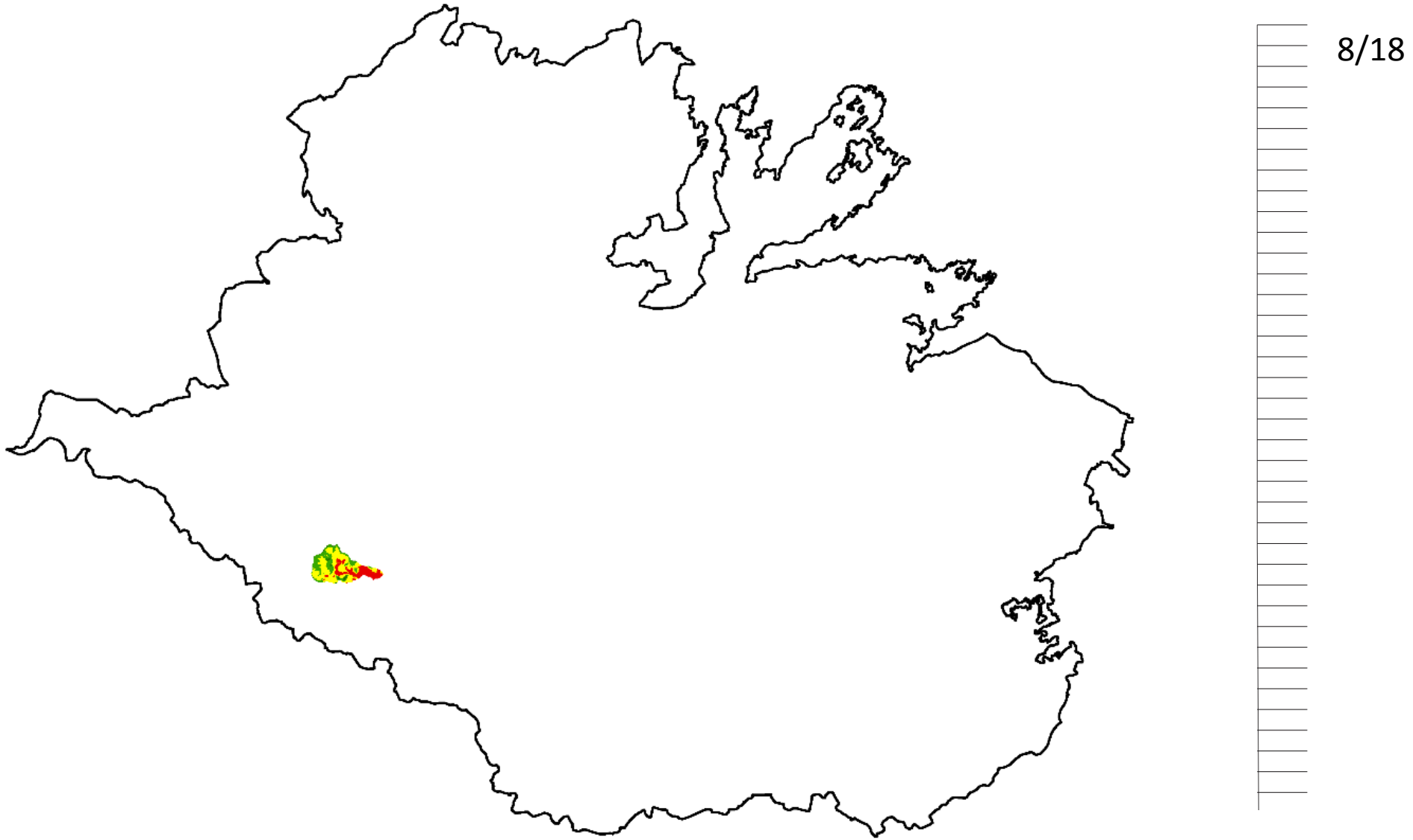

- Burned from 17 August – 23 October
- 47% of the area burned in the Rim Fire occurred during two large fire spread events (21–22 August and 25–26 August)

# Rim Fire progression



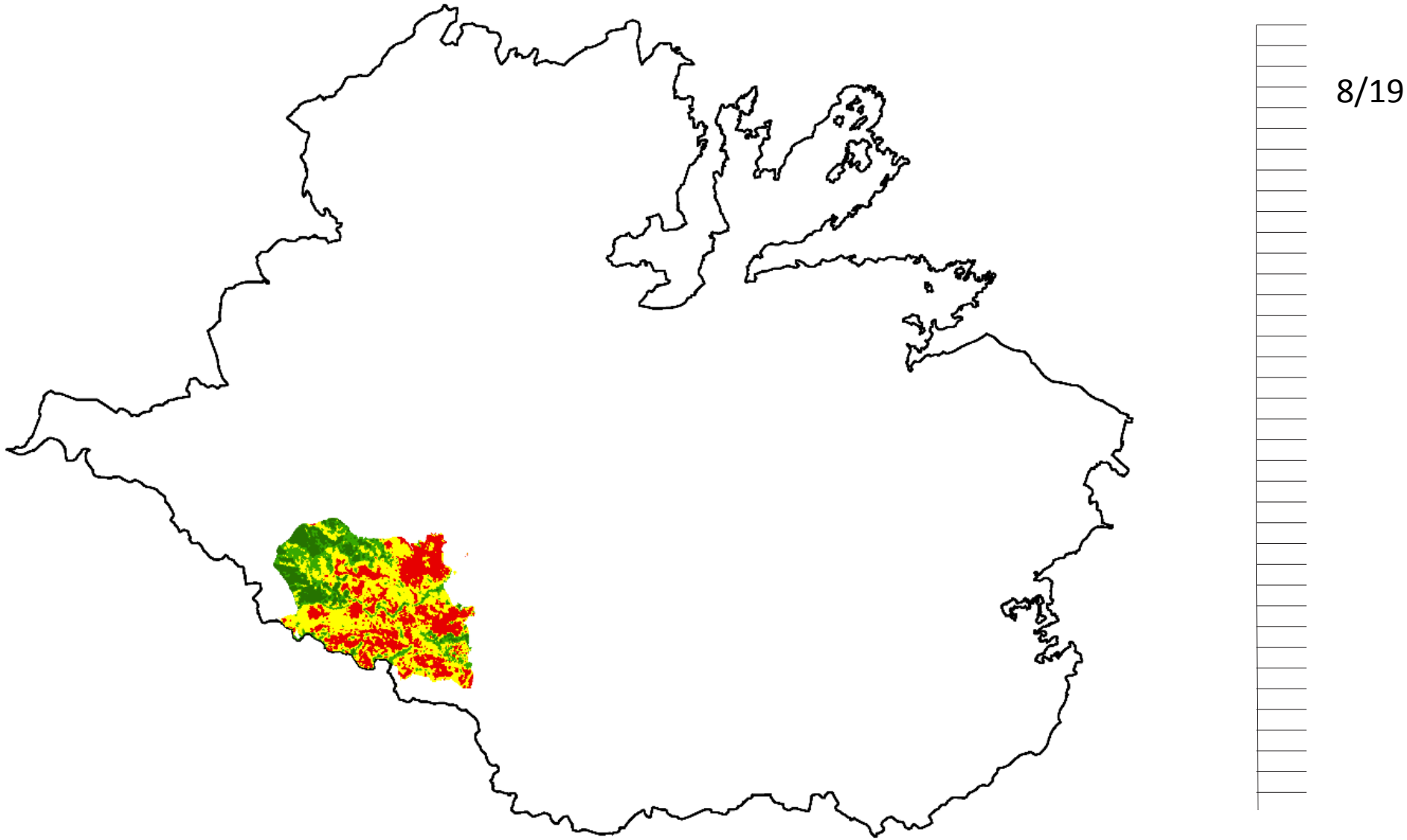
8/17

# Rim Fire progression



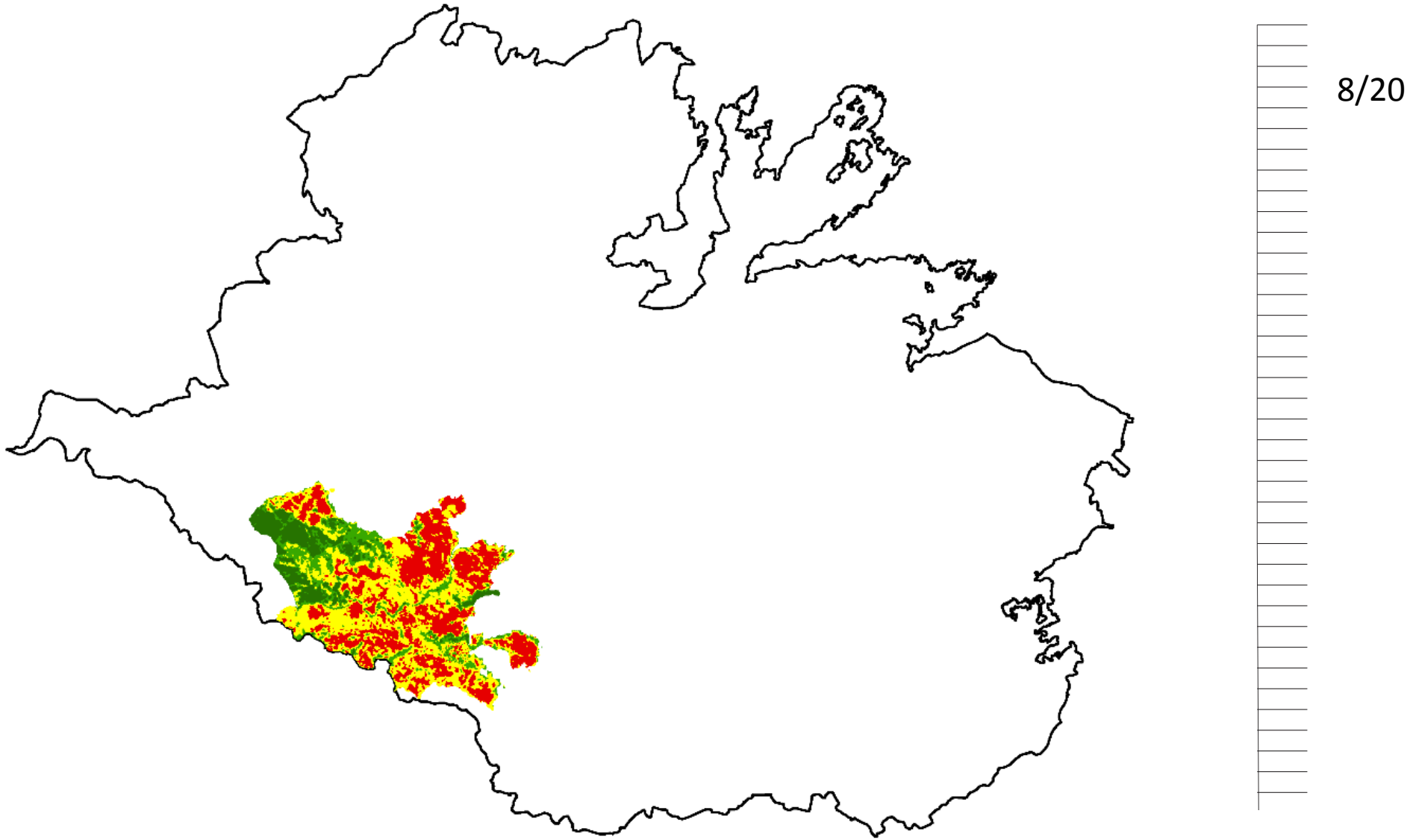
8/18

# Rim Fire progression



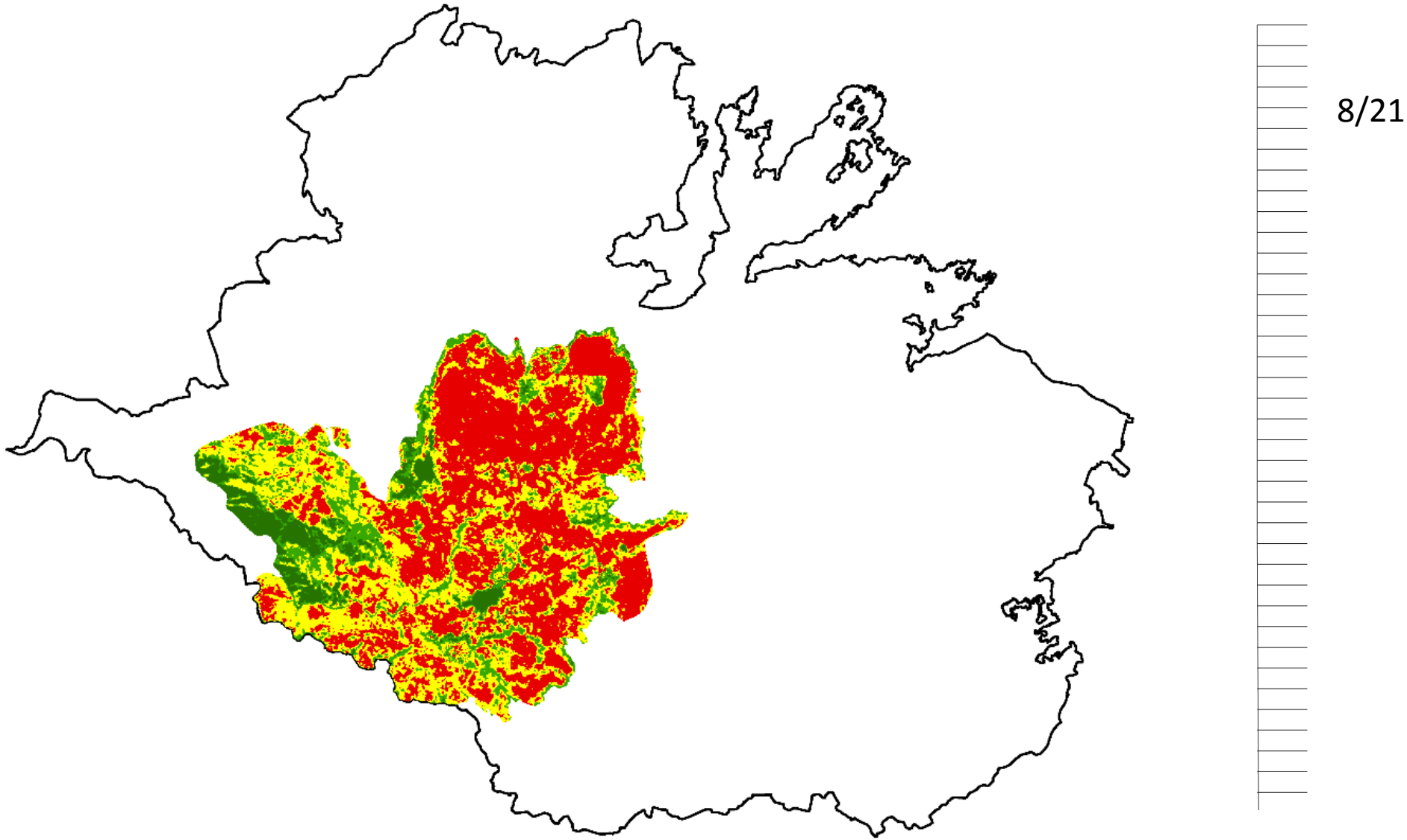
8/19

# Rim Fire progression



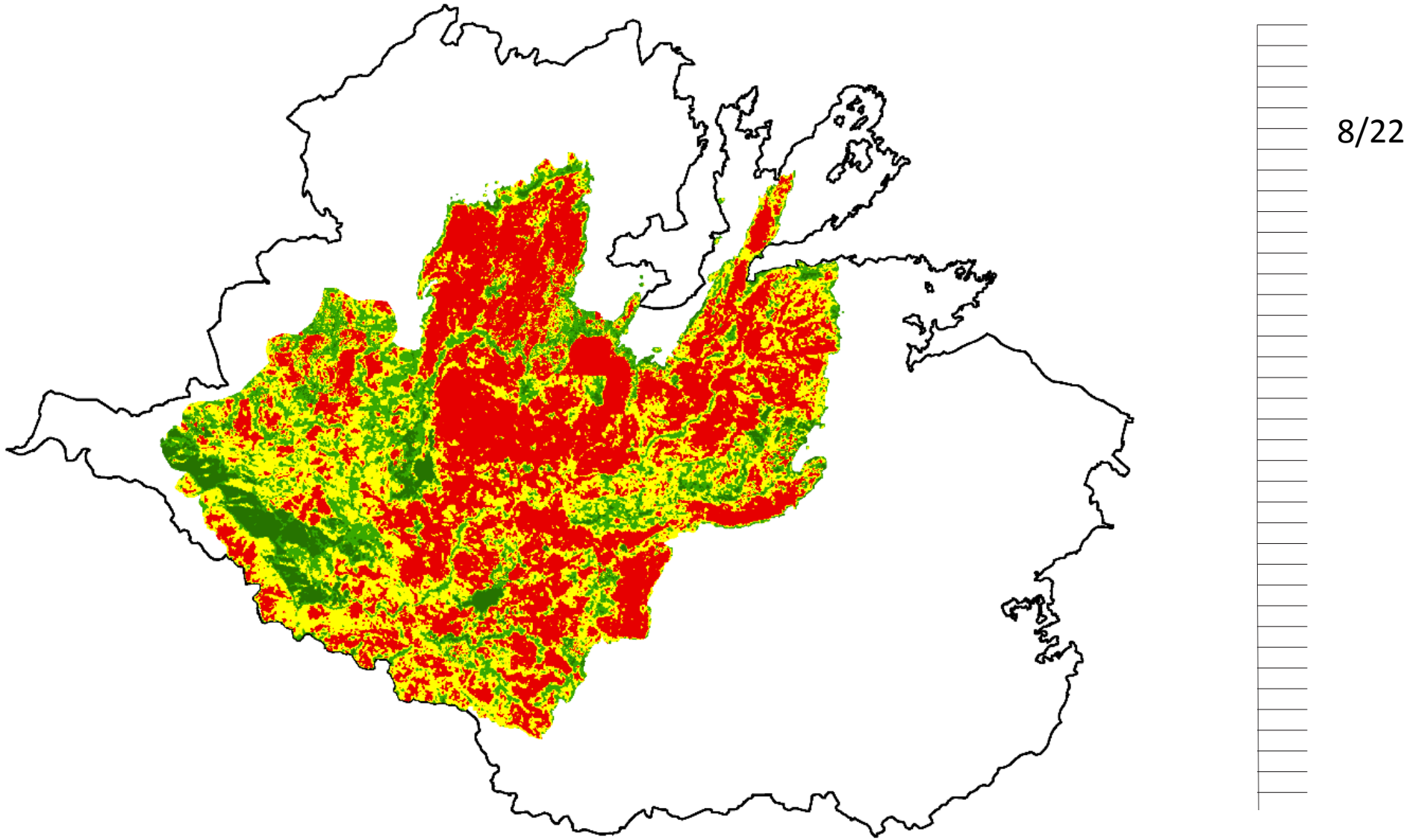
8/20

# Rim Fire progression



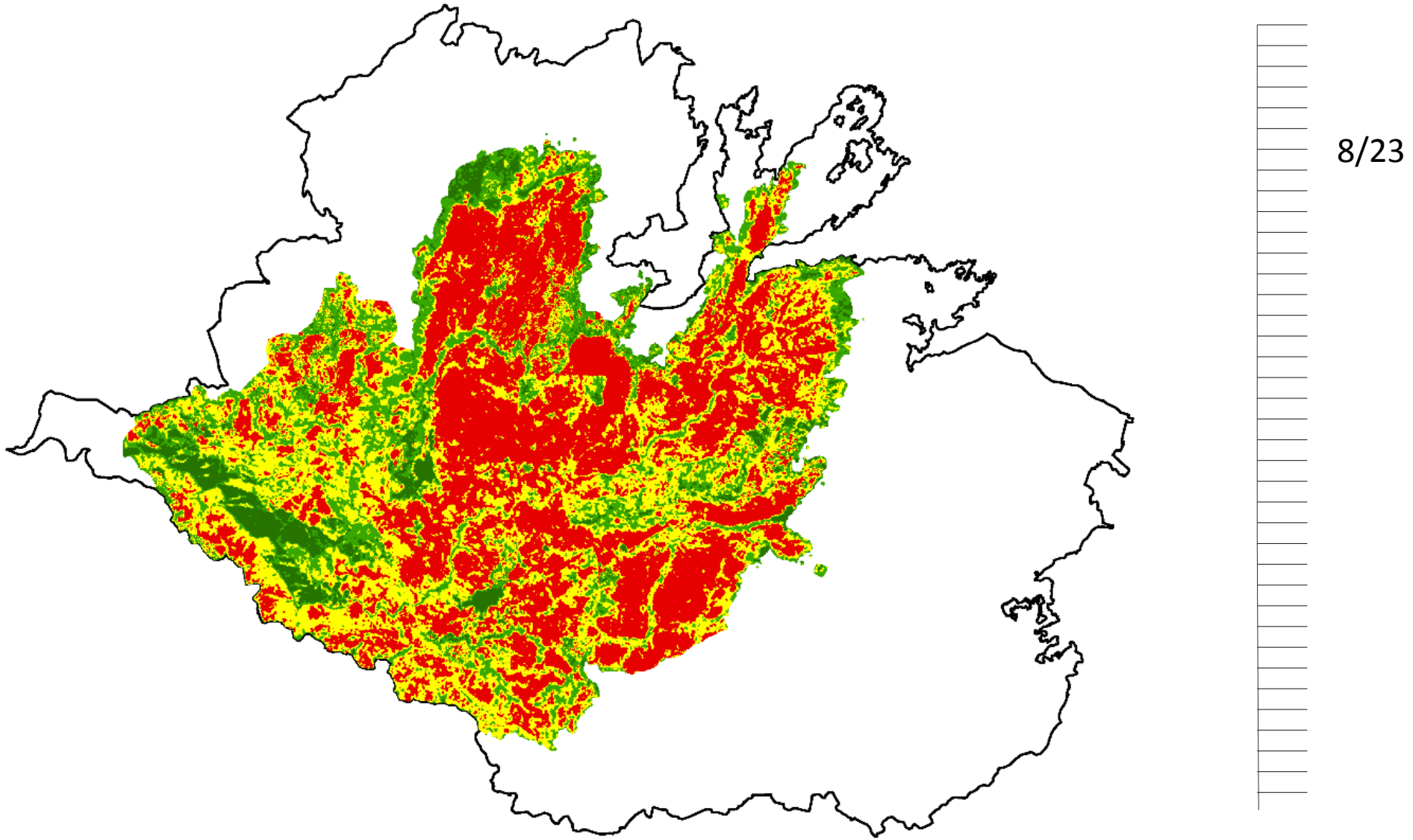
8/21

# Rim Fire progression



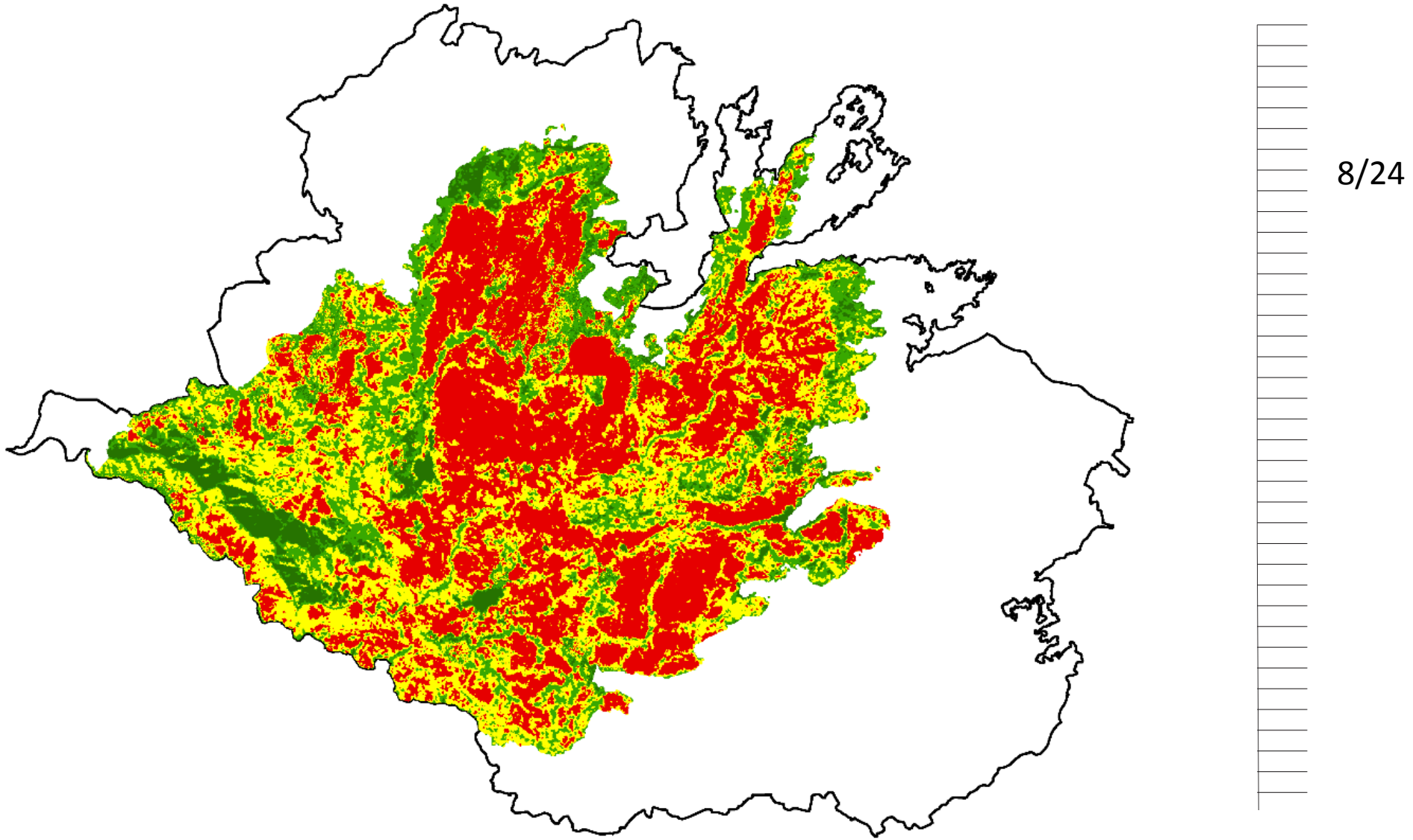
8/22

# Rim Fire progression



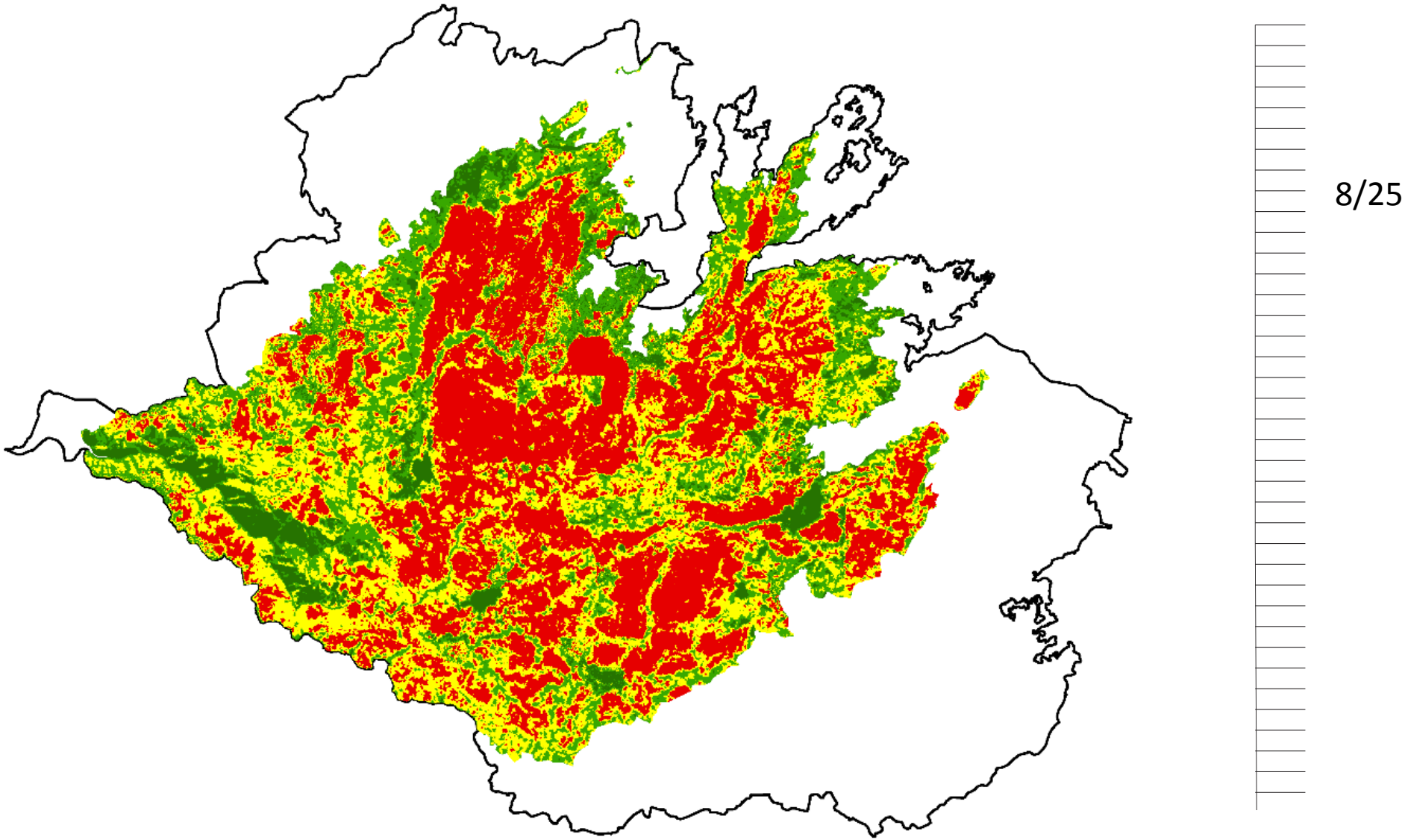
8/23

# Rim Fire progression



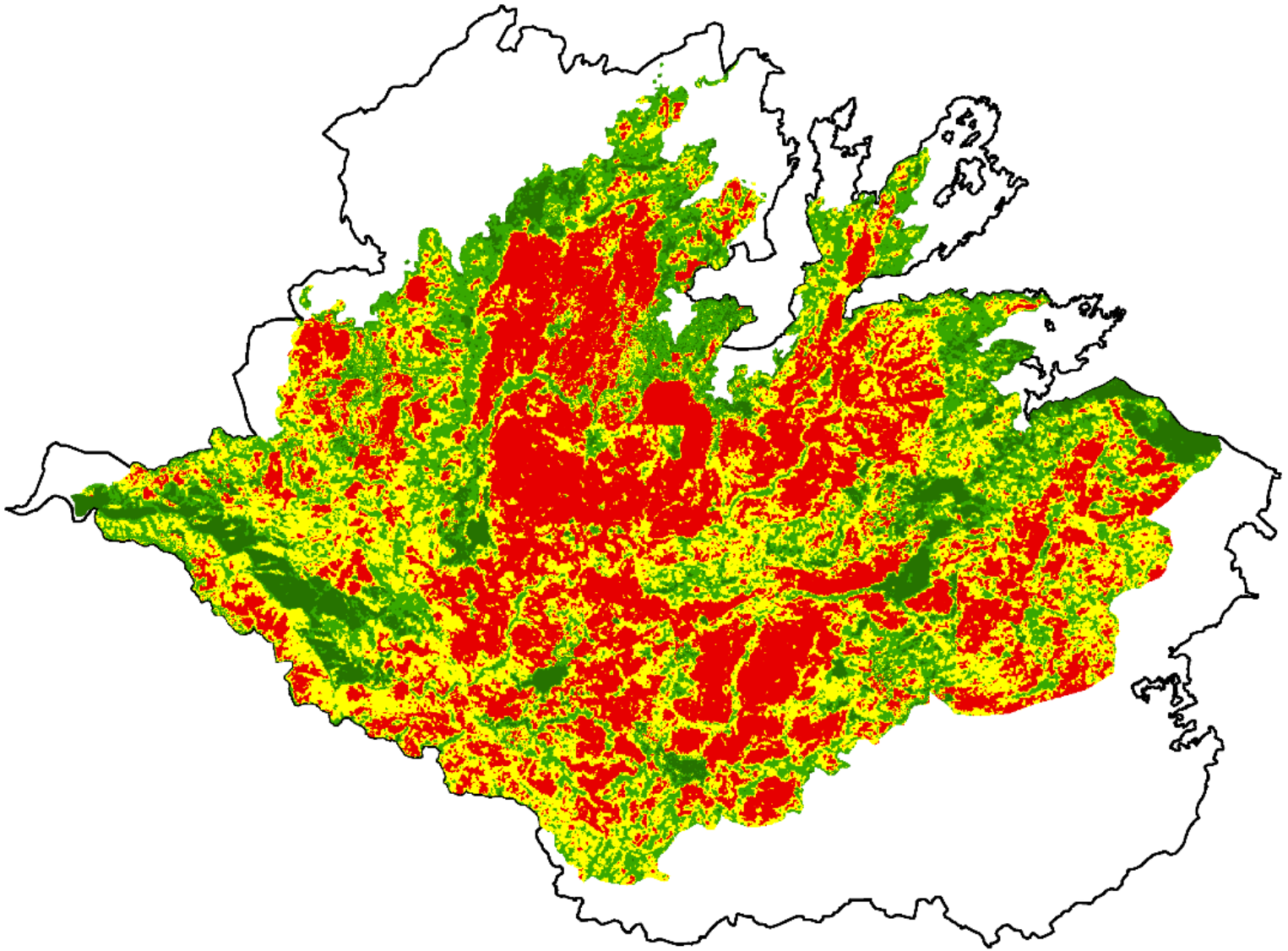
8/24

# Rim Fire progression



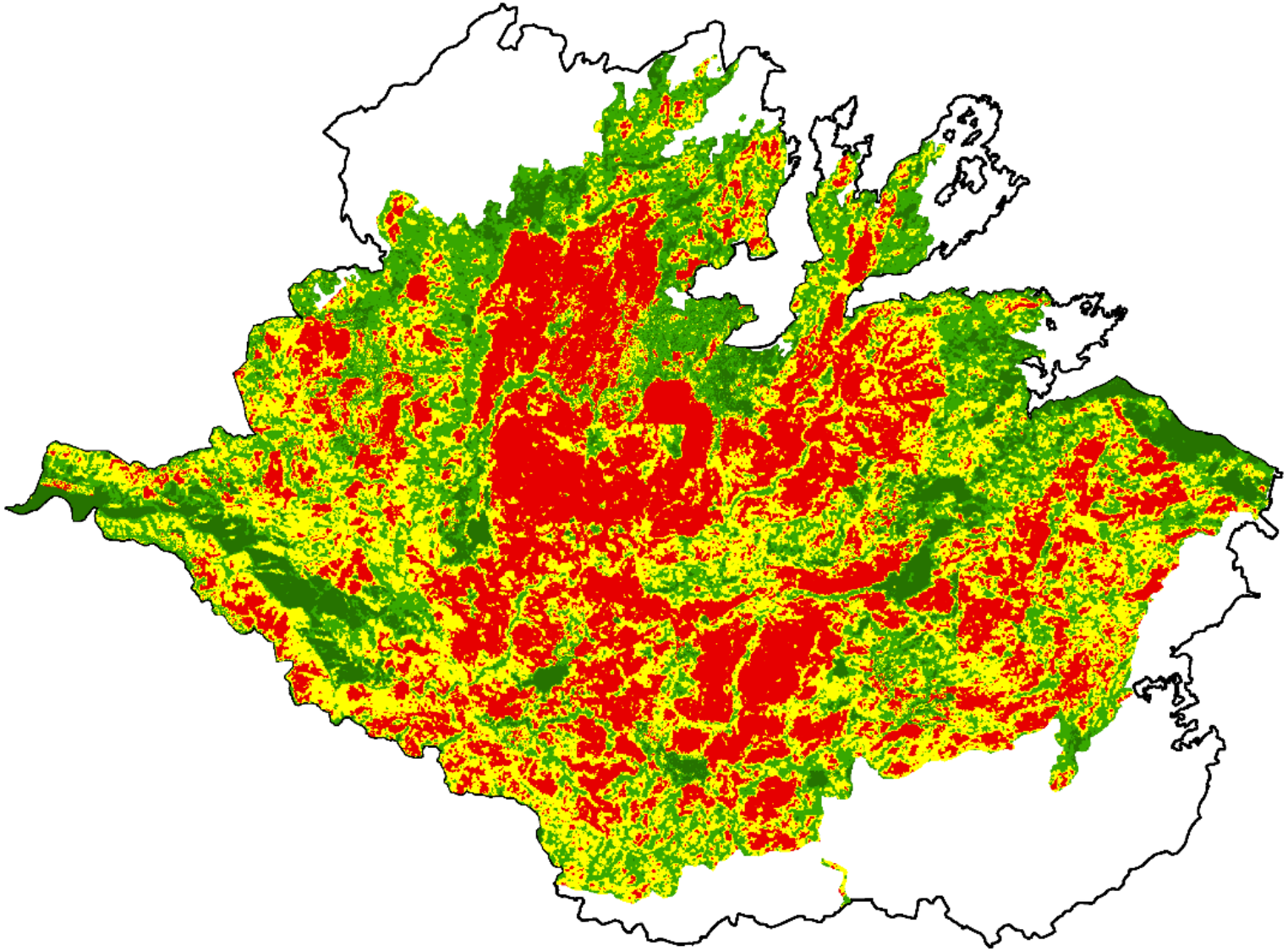
8/25

# Rim Fire progression



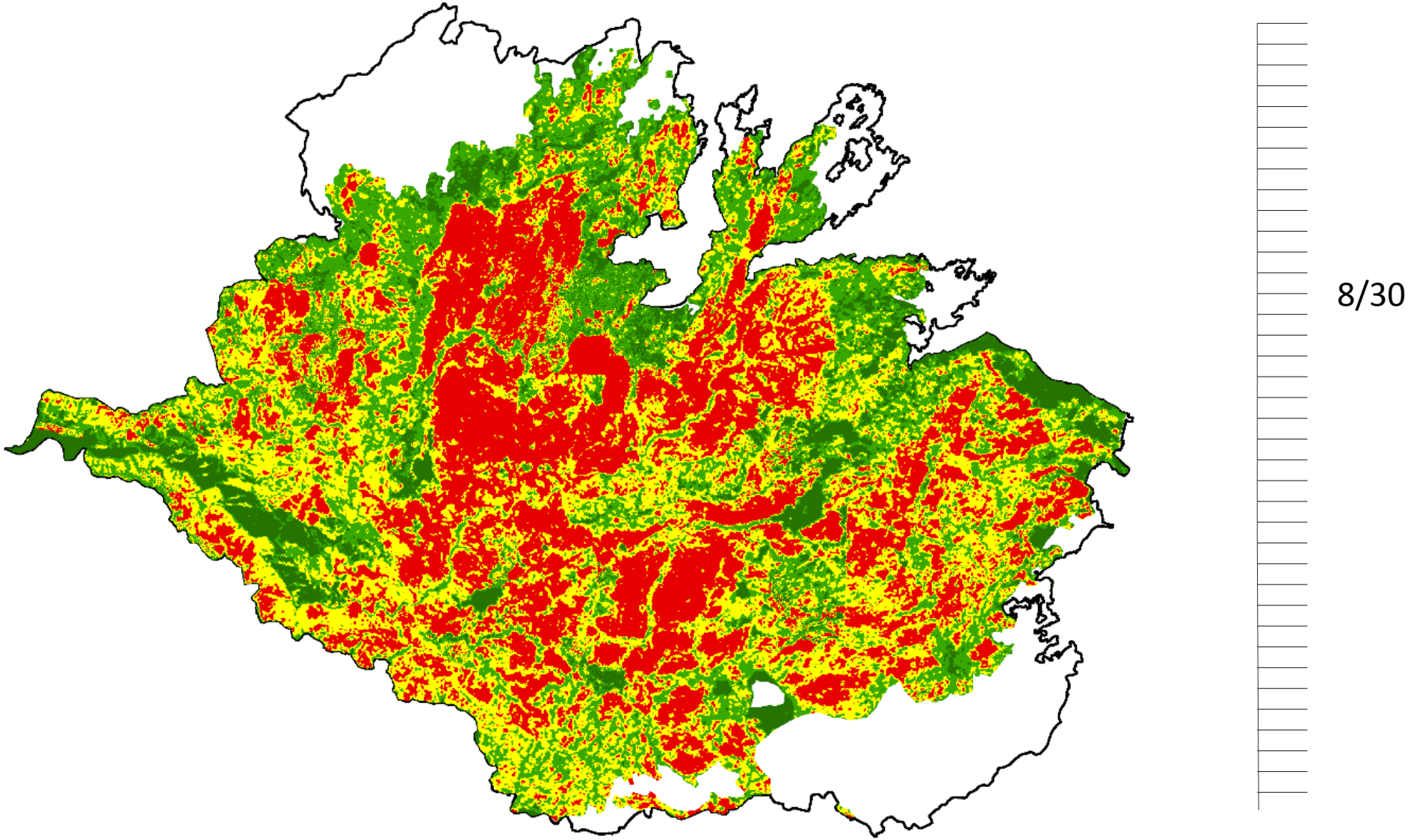
8/26

# Rim Fire progression



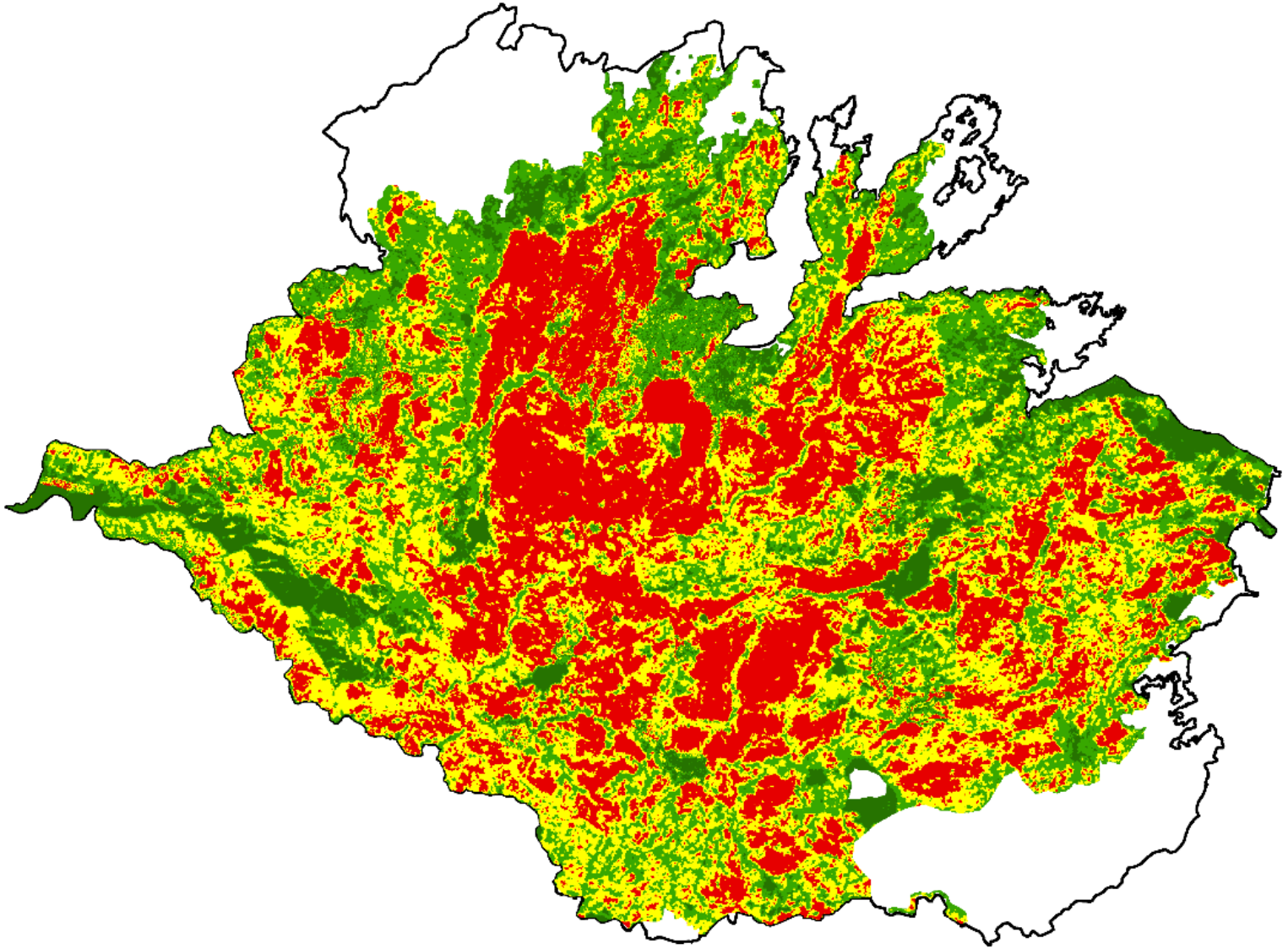
8/29

# Rim Fire progression



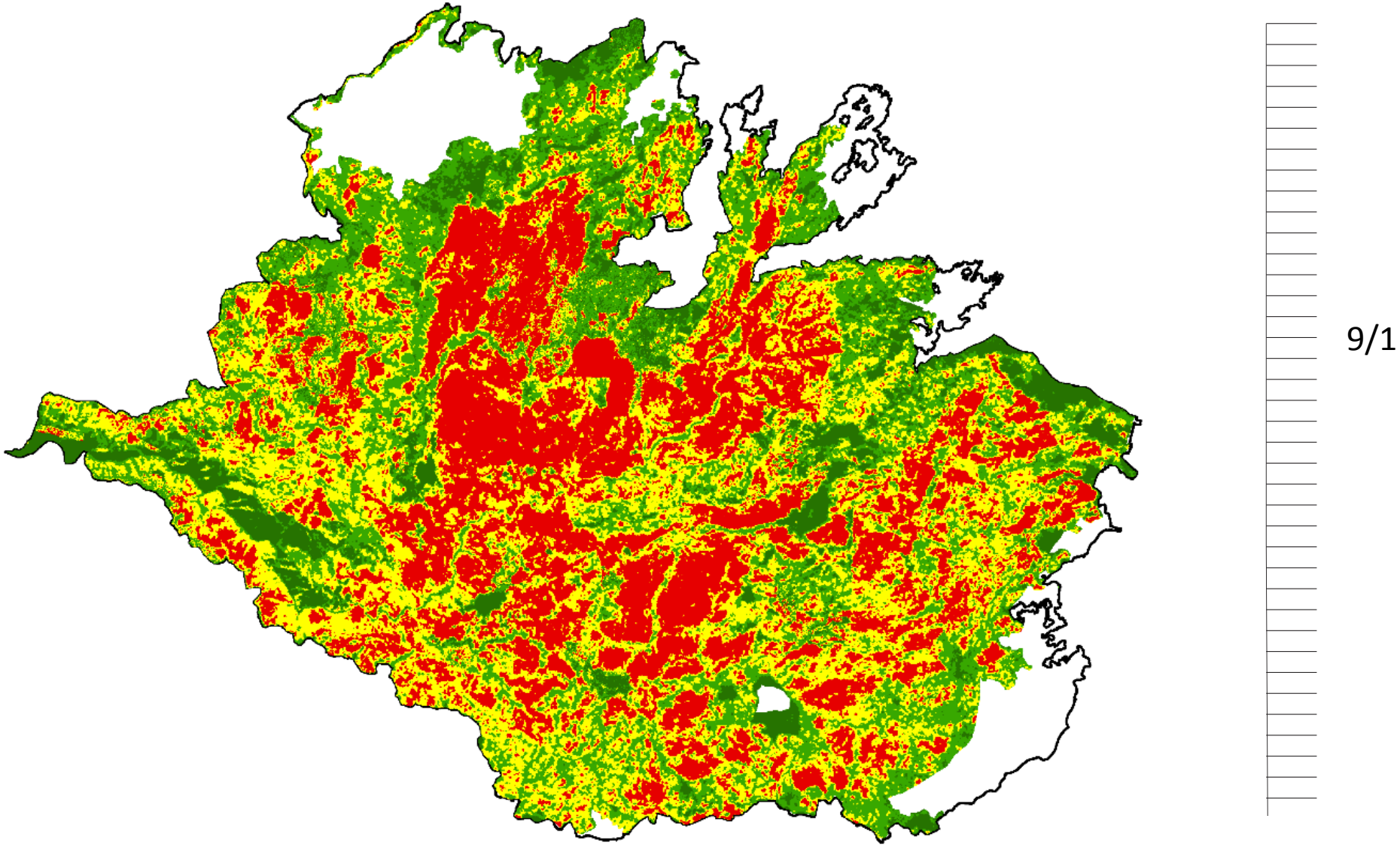
8/30

# Rim Fire progression



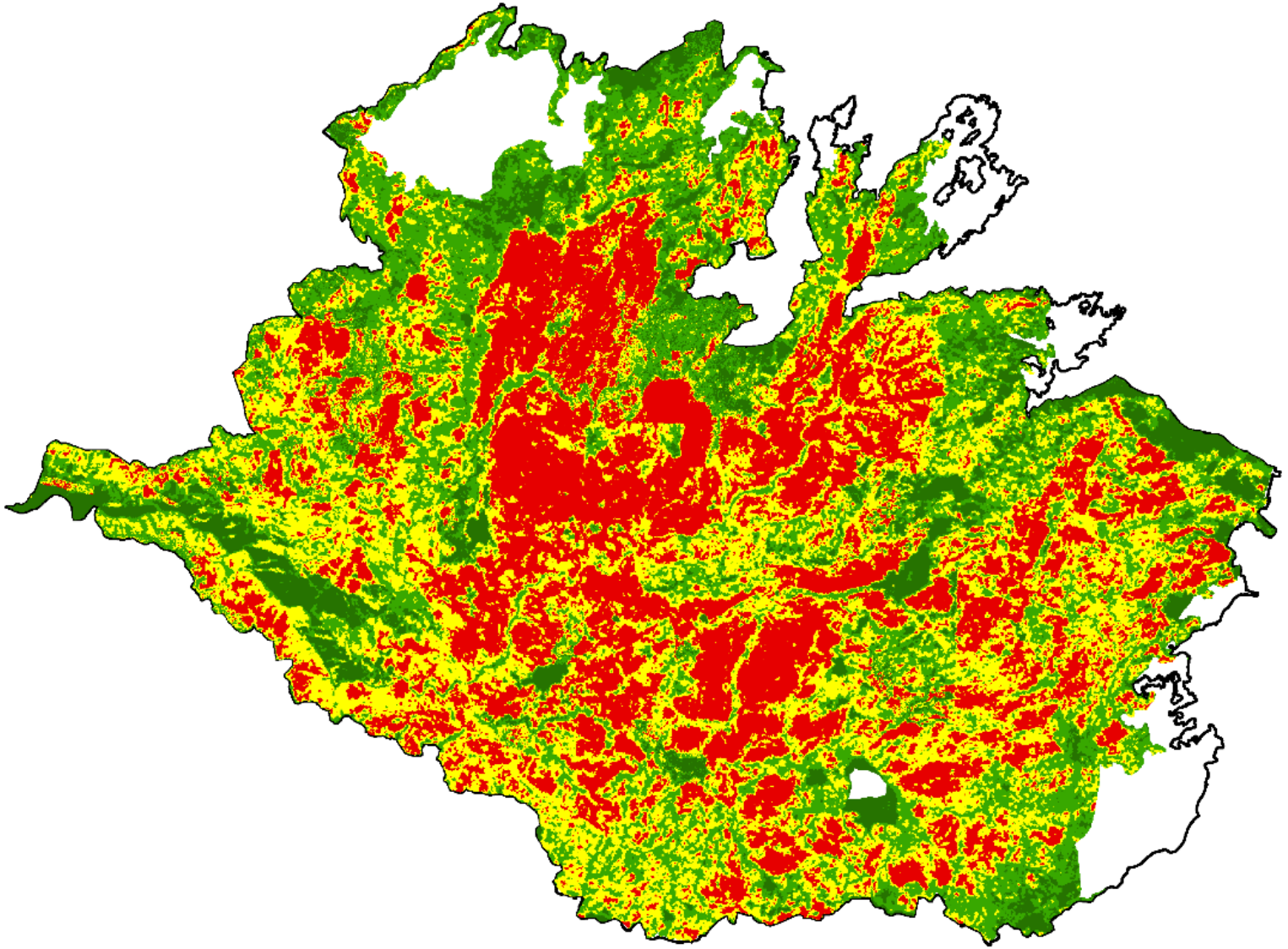
8/31

# Rim Fire progression



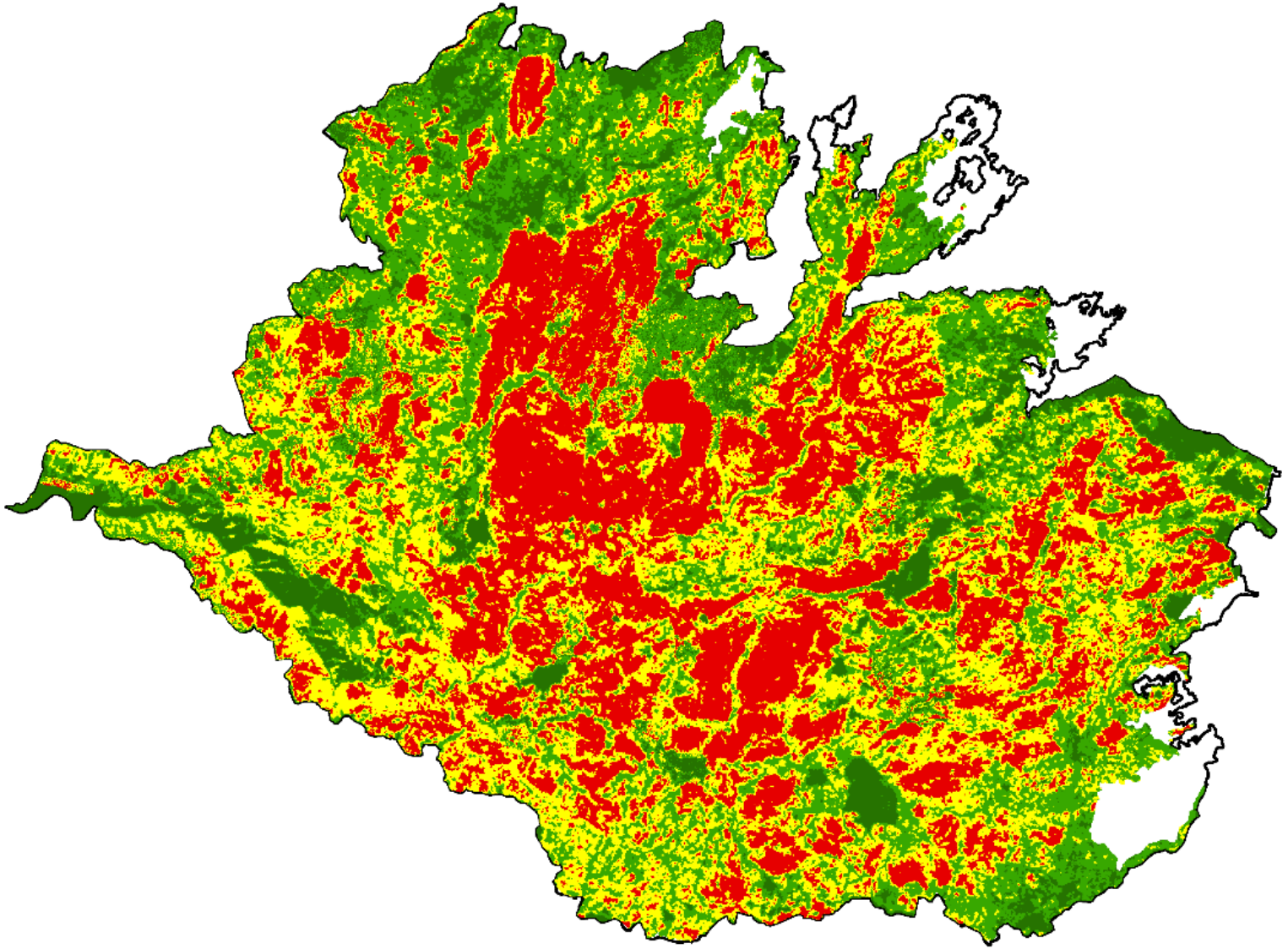
9/1

# Rim Fire progression



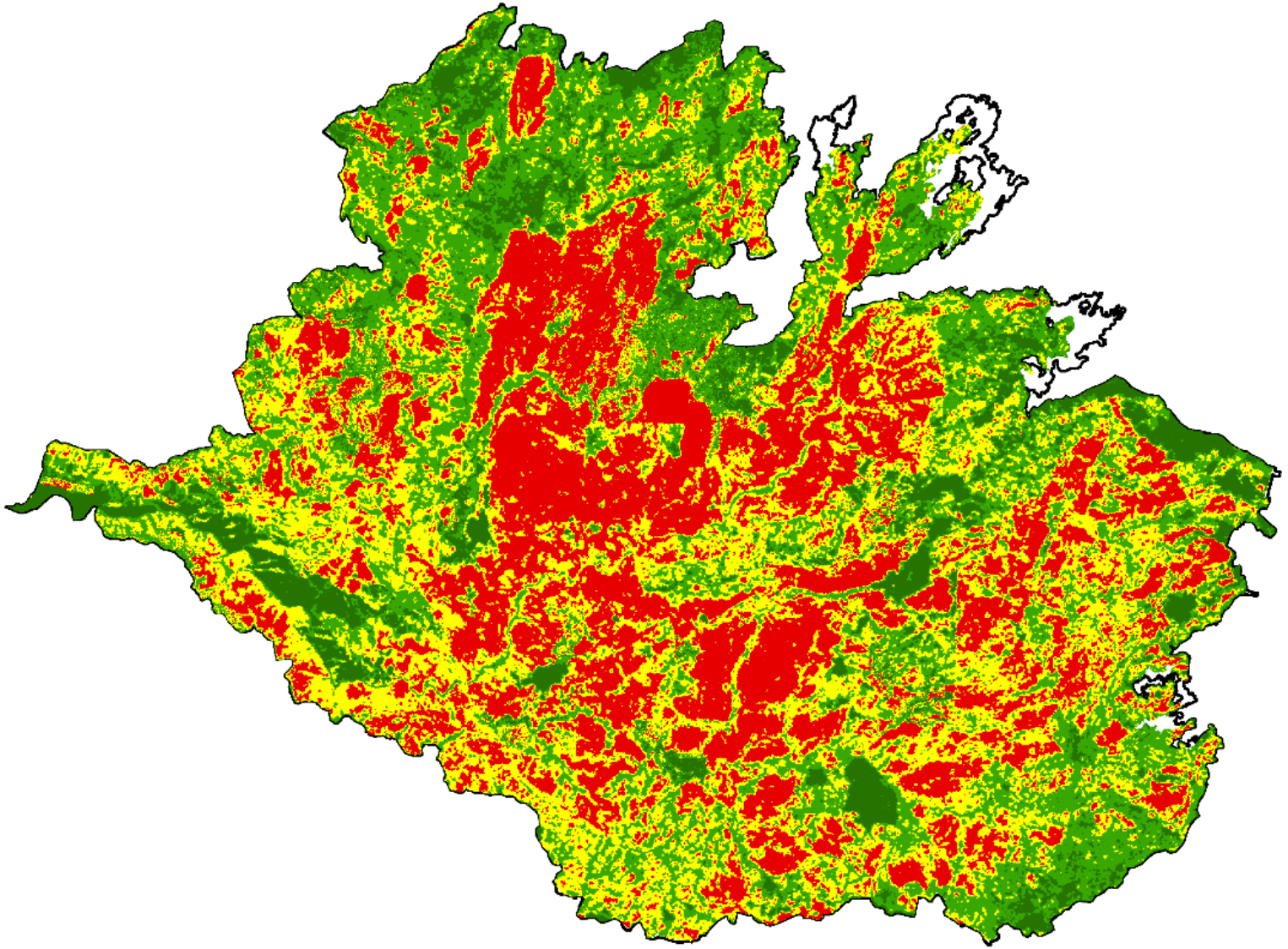
9/3

# Rim Fire progression



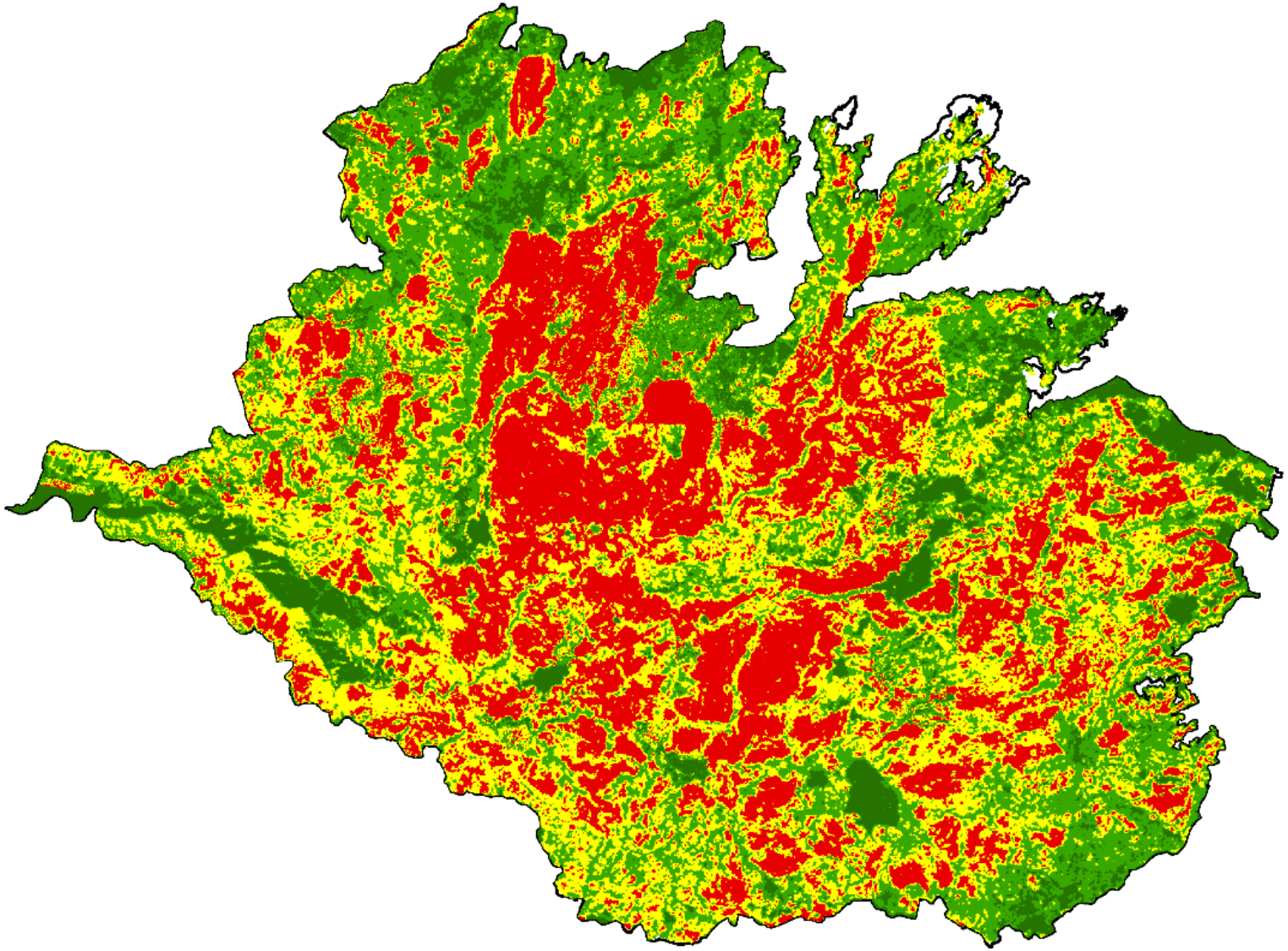
9/5

# Rim Fire progression



9/8

# Rim Fire progression



9/23

# Rim Fire publications

- Lydersen et al. 2014
  - Field data from 53 plots in areas previously burned at low-moderate severity
  - *Forest Ecology and Management 328:* 326-334.
- Lydersen et al. 2016
  - Field data from 175 plots collected the year of and one year post-Rim Fire
  - *Fire Ecology 12*(3): 99-116.
- Lydersen et al. 2017
  - GIS based analysis of the entire fire area
  - *Ecological applications* 27(7): 2013-2030.

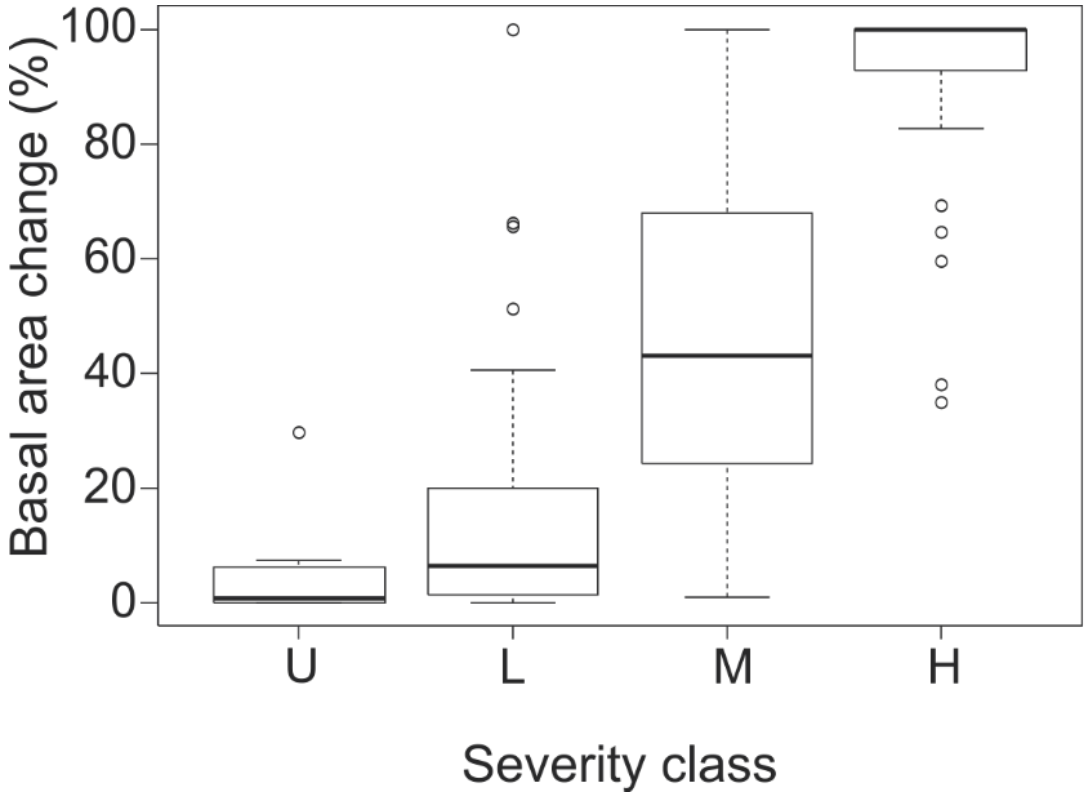
# Can fuels management influence the extent of high severity fire?

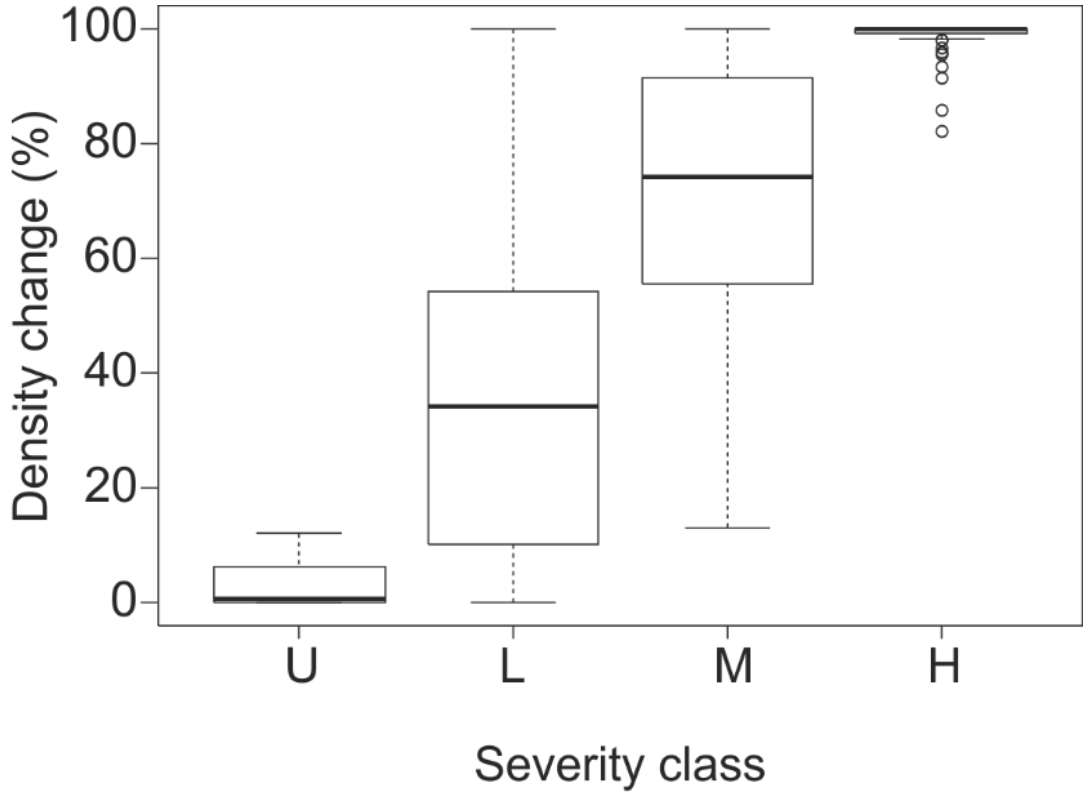
- Census of all pixels across fire perimeter
  - Effect of treatment type
- Analysis of proportion high severity within sample landscapes
  - How much of landscape needs to be treated?
  - What other factors are important?
- Analysis of severity as fire progresses into a treated area
  - Is fire severity reduced within treated areas?
  - At what distance within a treatment are effects apparent?

# Focus on high severity: Ecological relevance

- Large degree of ecological change
  - 94% ΔBA, 99% Δdensity
- 33% of fire area = 74,000 acres
  - NRV 5-10%
- Low natural conifer regeneration following wildfire
- Spatial configuration also important

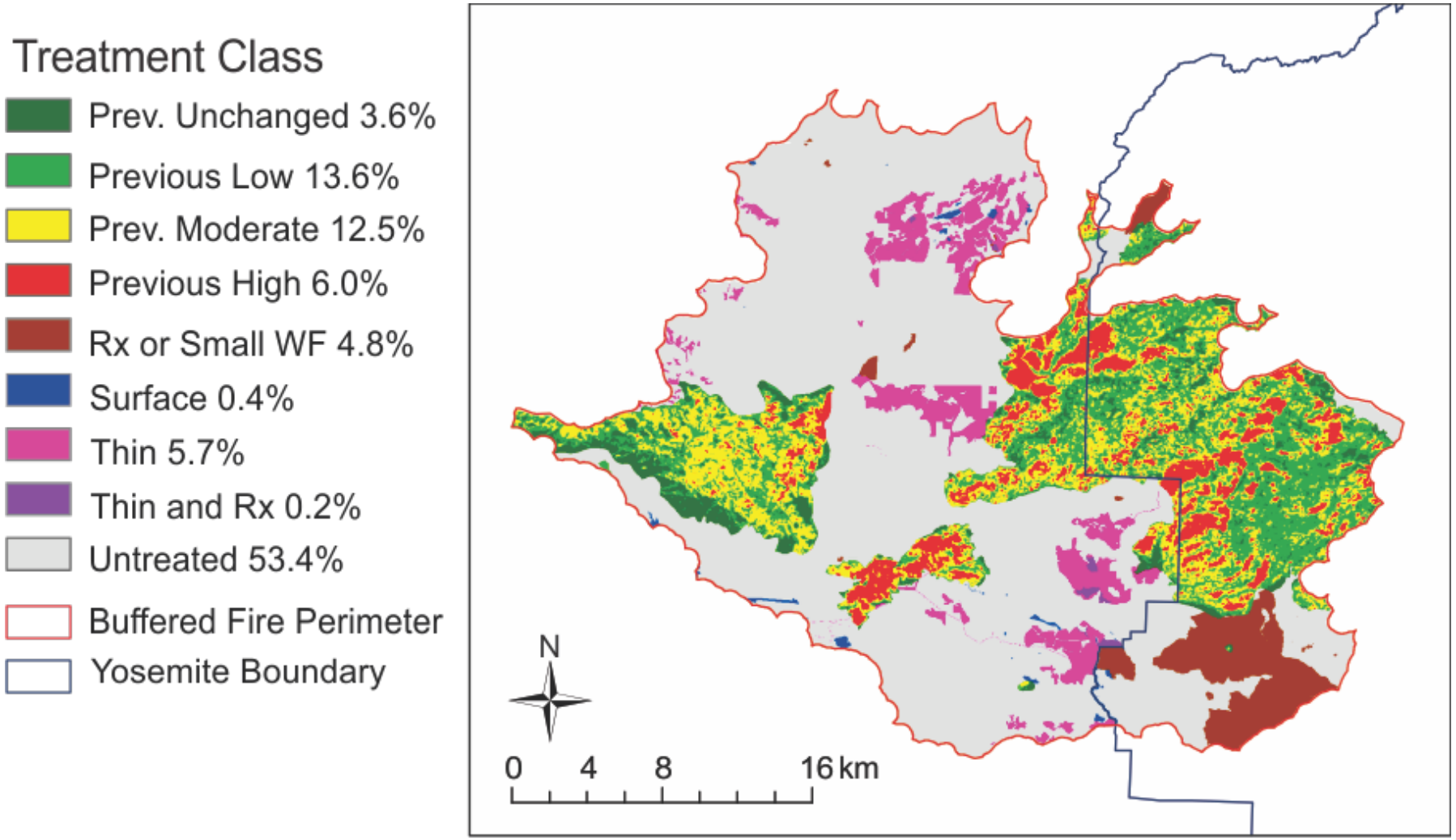
# Percent change in BA and density by fire severity class




Based on 175 plots measured pre- and post- Rim Fire on Stanislaus NF
Lydersen et al. 2016, Fire Ecology 12(3): 99-116

# Previous Fire Severity and Treatments




Treatment and fire history since 1995

# Census of Rim Fire severity

# Summary of treatment type census

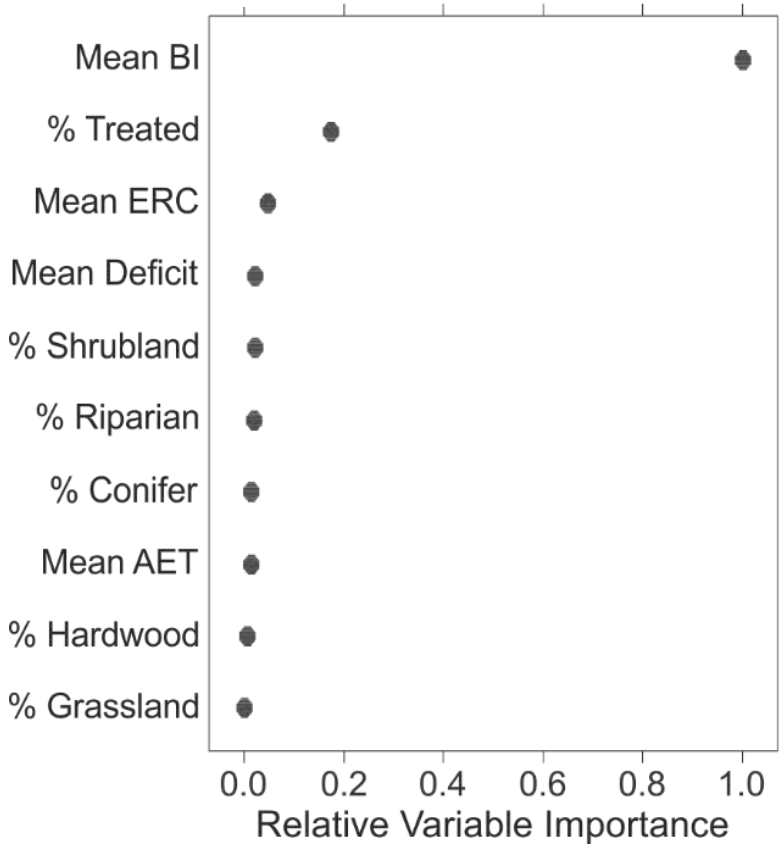
- Previous high severity had greatest proportion high severity
- Previously untreated/unburned also had greater proportion of high severity
- Rx burns, particularly Rx plus thinning had lowest proportion of high severity
- Mechanical thinning and surface fuels treatment had intermediate amount of high severity
- Some high severity observed in all treatment types

# What factors influence fire severity within sample landscapes?

- Sample windows across fire perimeter (GIS)
  - 3 scales: 500, 2500 and 5000 acres
- Proportion high severity in each sample
- Random forests to assess influence of
  - Proportion treated (including previous low-moderate severity wildfire)
  - Fire weather – BI and ERC
  - Water balance – AET and deficit
  - Vegetation – proportion among the most common types
    - 2012 LandFire existing veg

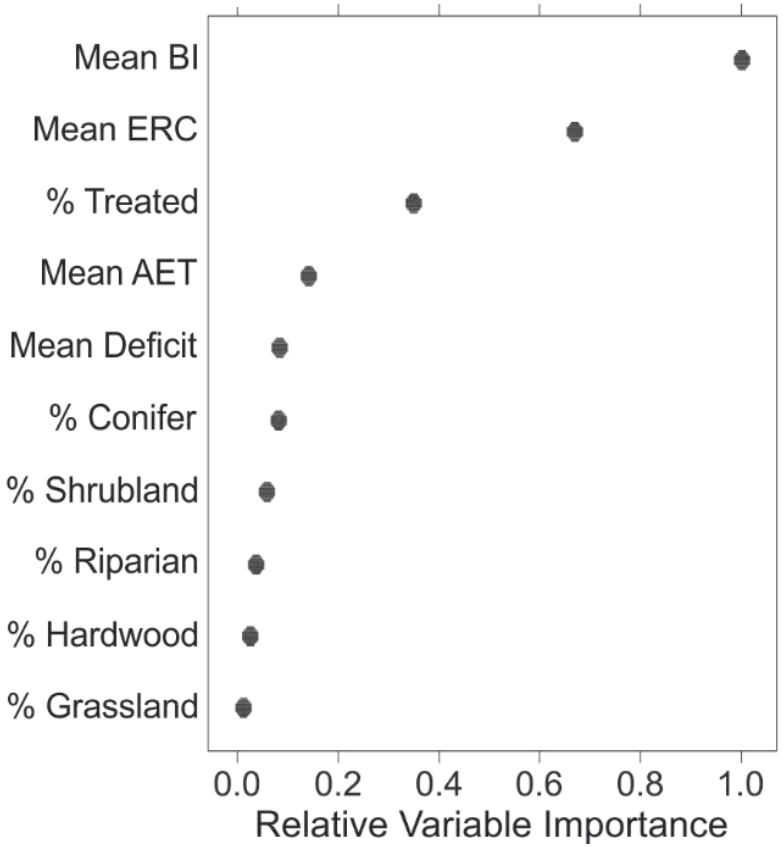
# Relative variable importance for % high severity

500 acres



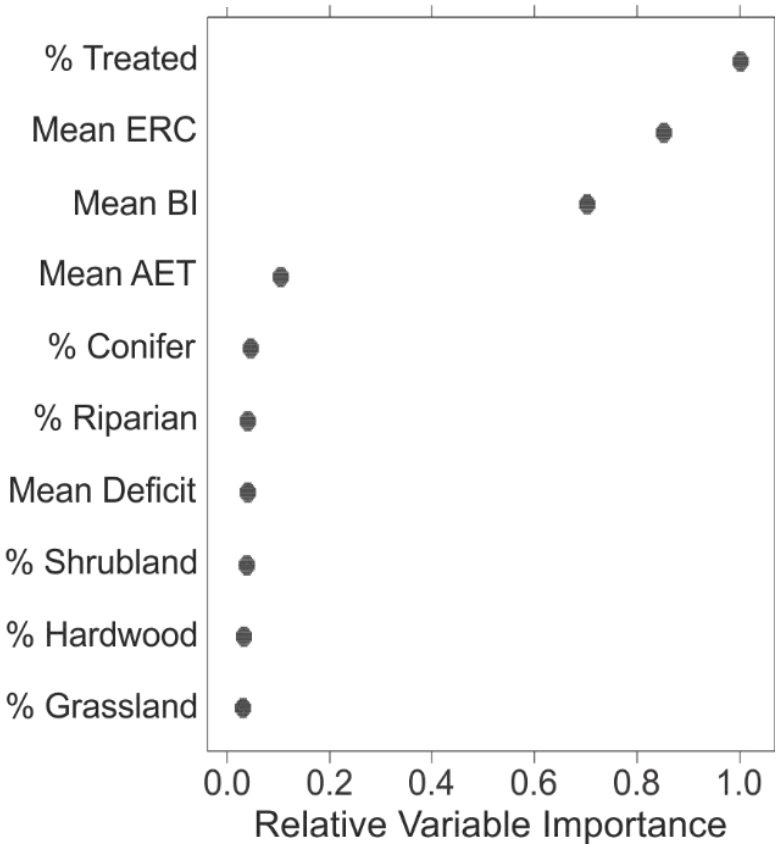

$R^2 = 0.46$

2500 acres




$R^2 = 0.31$

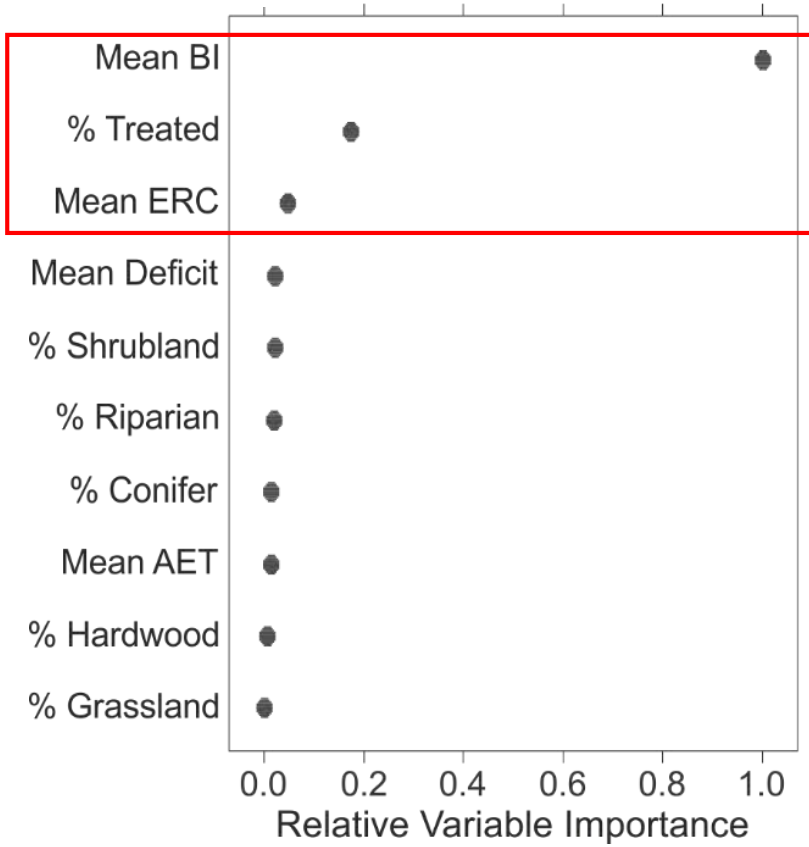
5000 acres




$R^2 = 0.34$

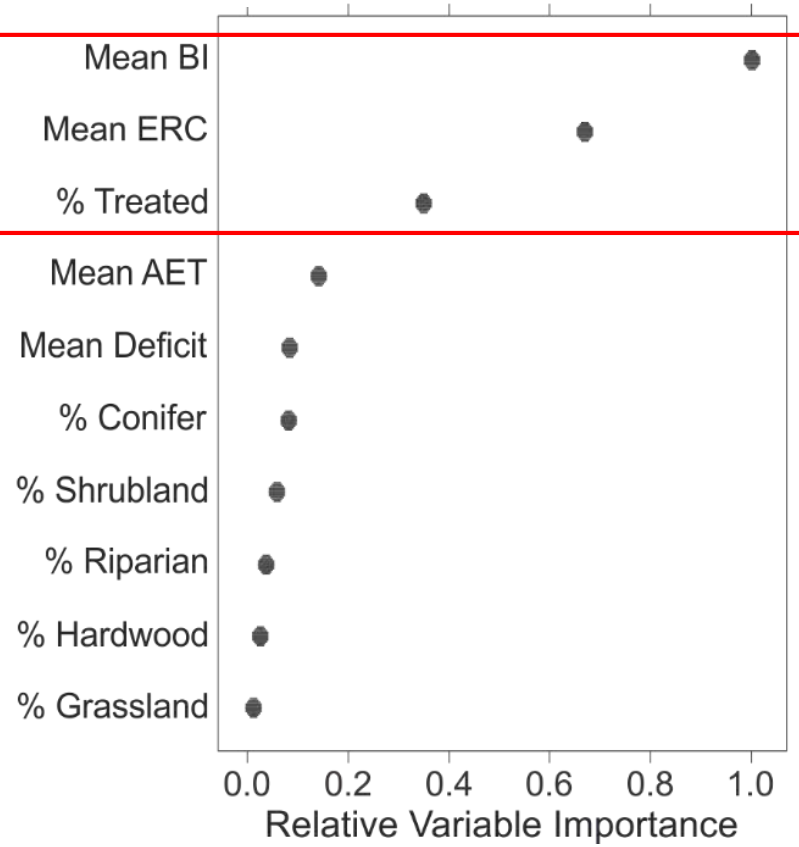
# Relative variable importance for % high severity

500 acres



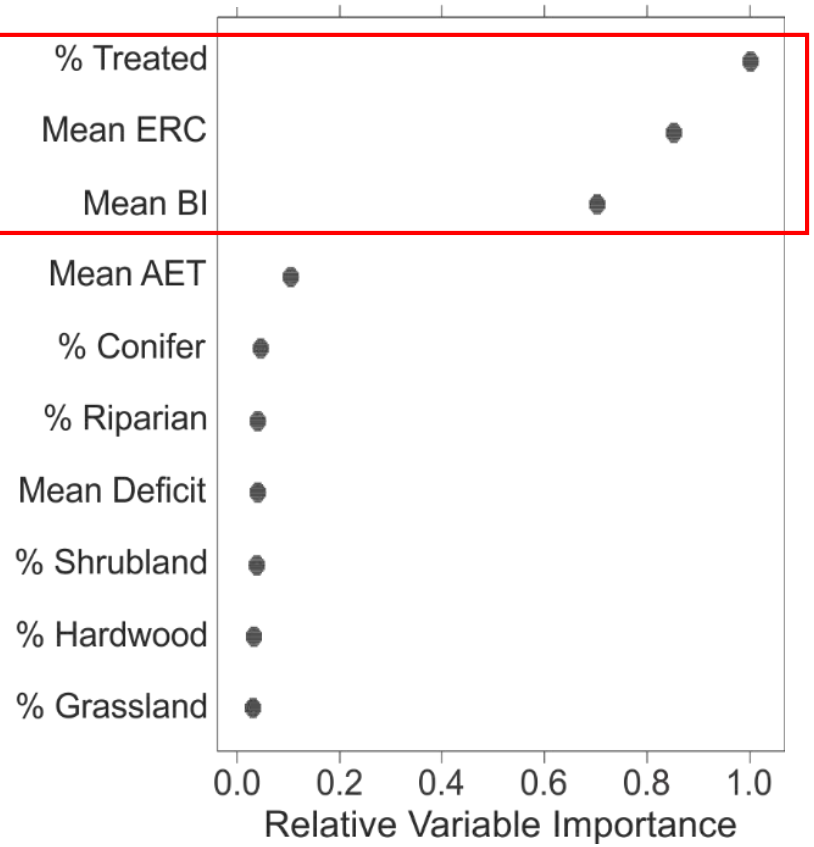

$R^2 = 0.46$

2500 acres




$R^2 = 0.31$

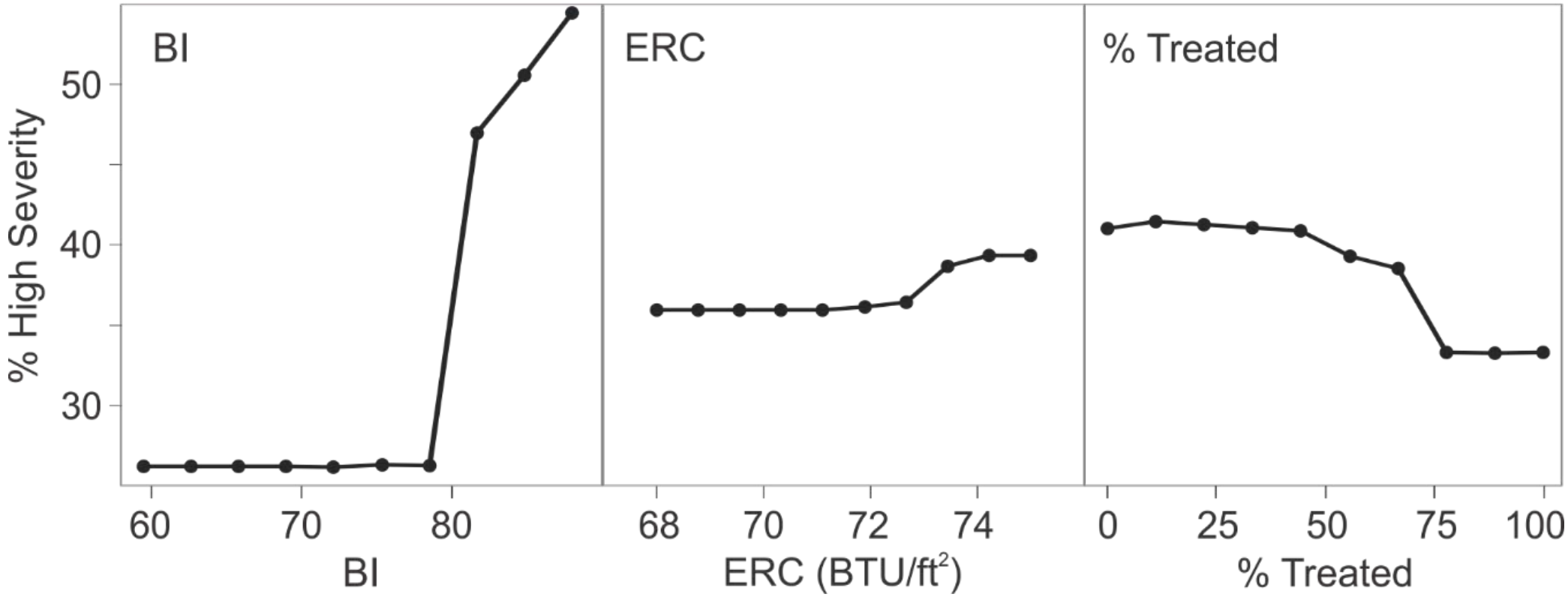
5000 acres




$R^2 = 0.34$

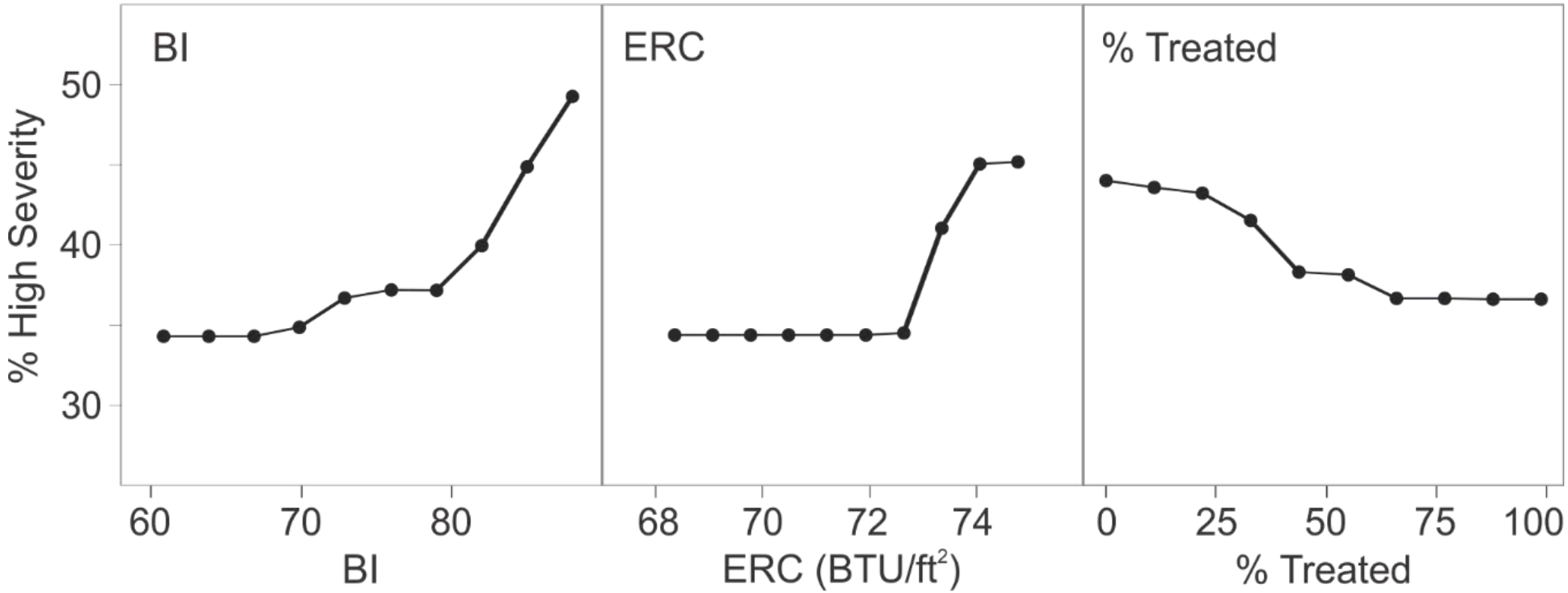
# Partial dependence – 500 acres

500 acres



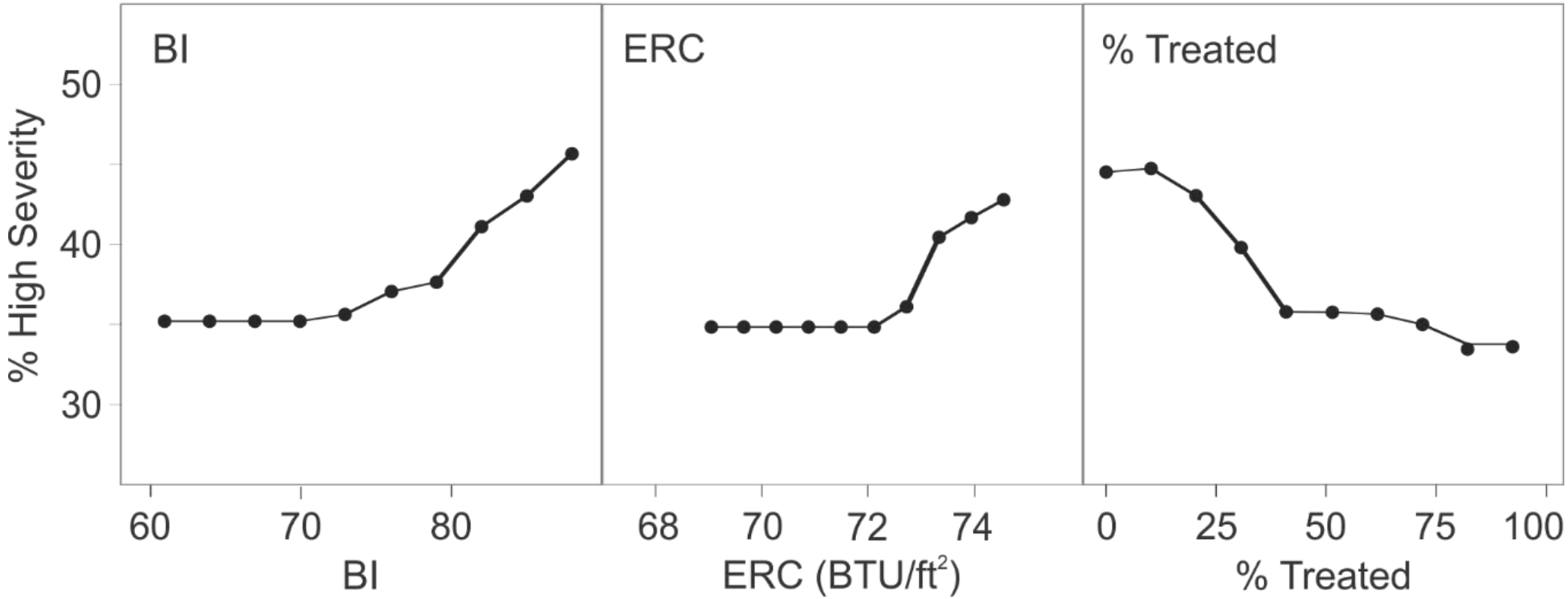
# Partial dependence – 2500 acres

2500 acres



# Partial dependence – 5000 acres

5000 acres



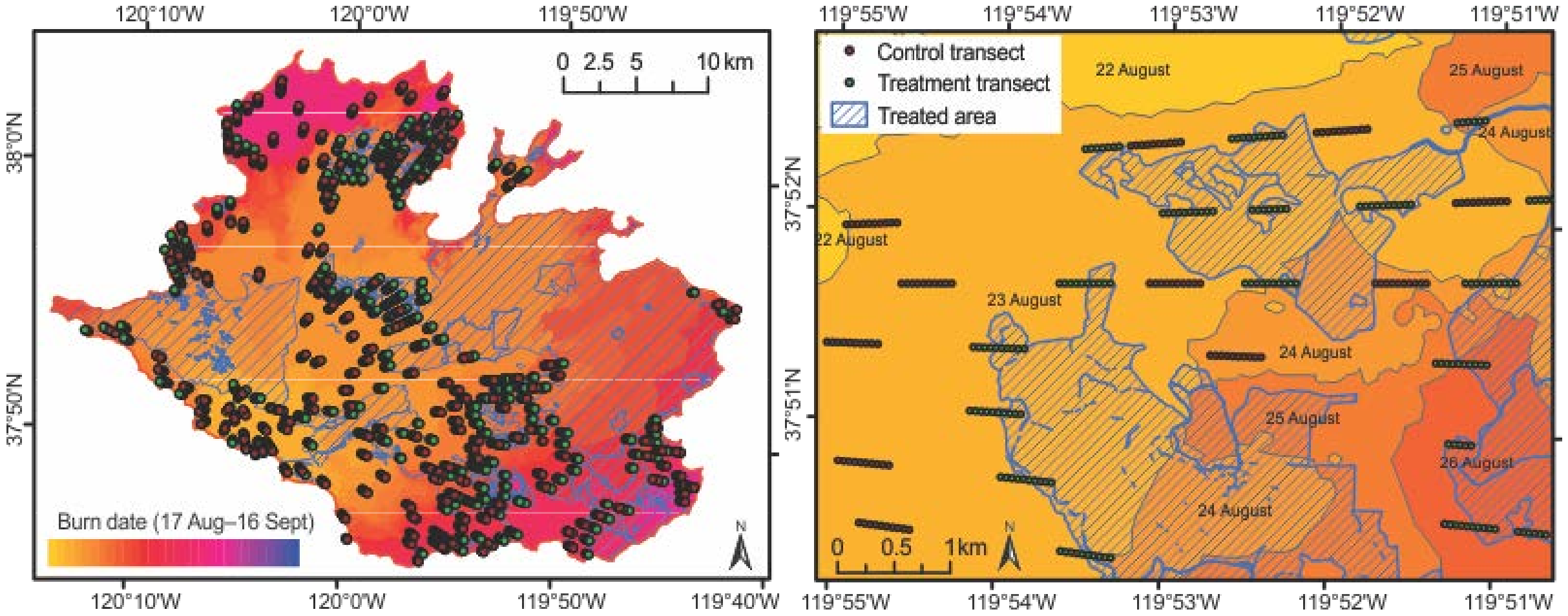
# Summary of landscape analysis

- BI, ERC and % treated most important at all scales
- BI had greatest influence at 2 smallest scales, % treated had greatest influence at largest scale
- At smaller scales a greater proportion treated was needed to influence fire severity
  - 50–75% treated for 500 acres
  - 25–60% for 2500 acres
  - 10–40% for 5000 acres

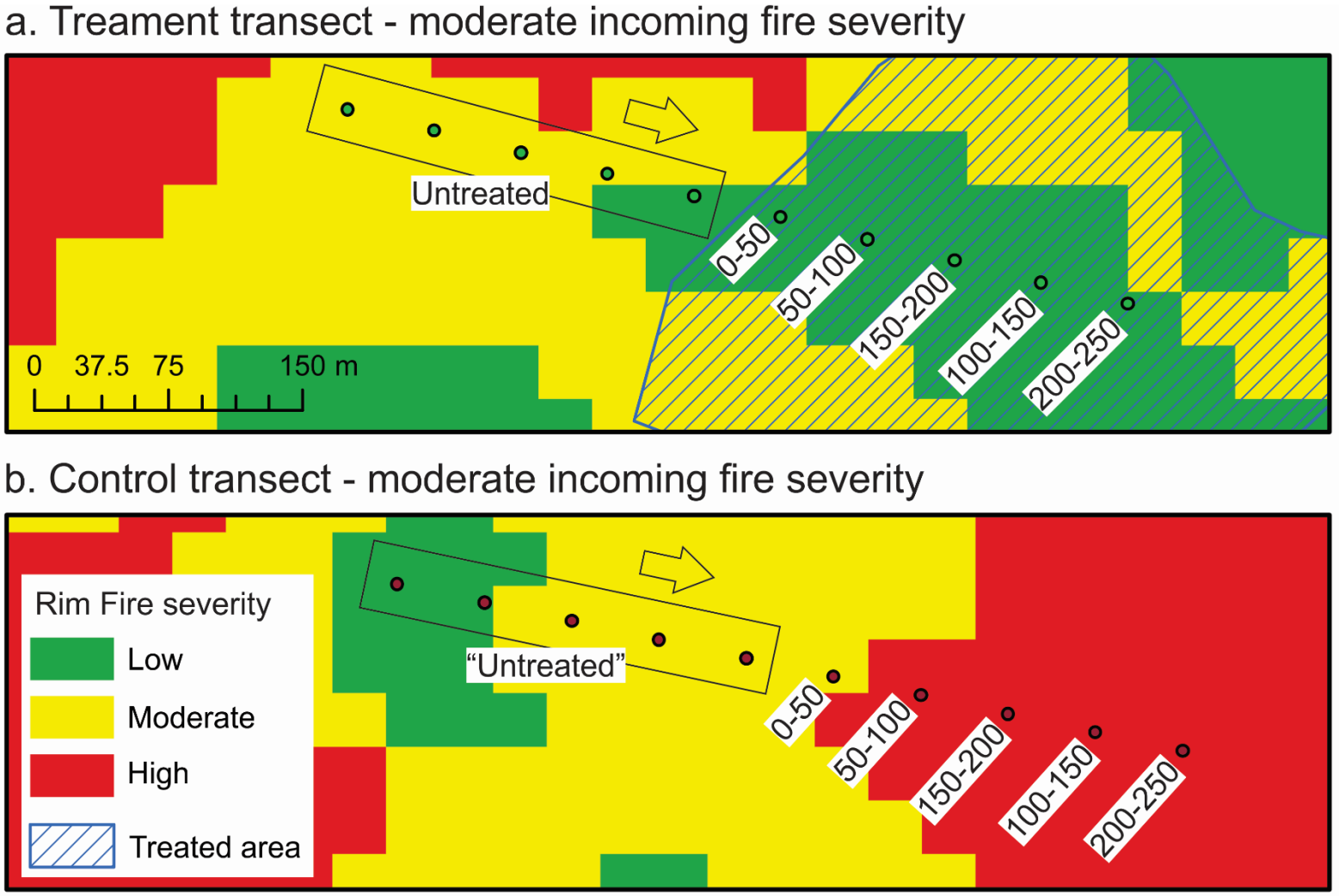
# How does fire severity change when a treated area is encountered?

- Generated GIS transects aligned in general direction of fire spread
- Compared fire severity outside treatment to inside at increasing distances from boundary (50 m interval)
  - Comparison of treated and control (untreated) transects
  - Included previous low to moderate severity fire as treated
  - Analyzed high, moderate and low Rim Fire severity separately

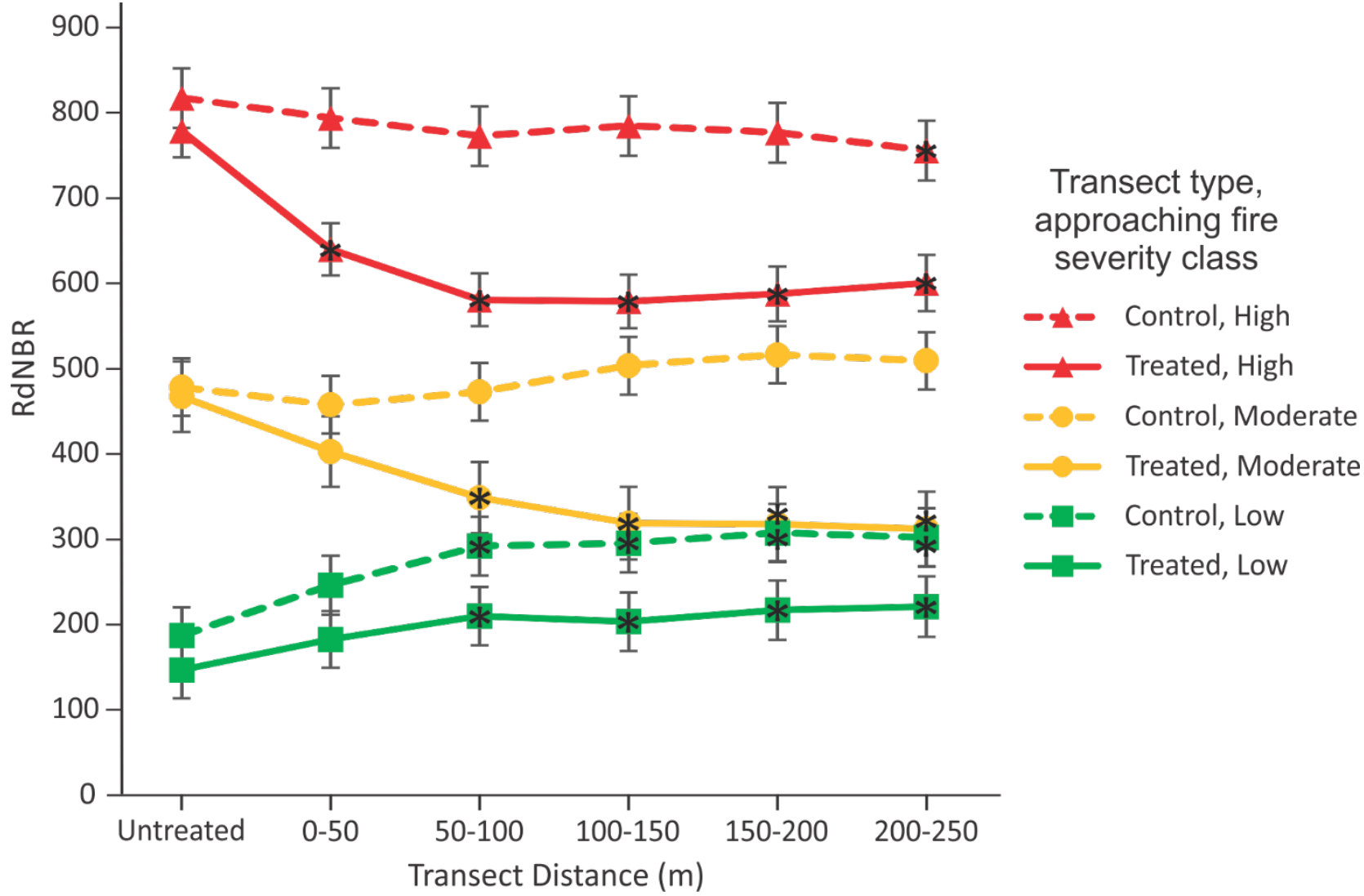
# Transects in general direction of fire spread



# Comparison of untreated and treated in general direction of fire spread



# Fire severity progression



# Summary of severity progression analysis

- High and moderate severity fire significantly reduced when burned into fuels treated area
  - High transitioned to moderate
  - Moderate transitioned to low-moderate
- Low severity stayed low, although increased slightly

# Conclusions

# Importance of fire weather

- BI and ERC reflect weather generally more conducive to burning
  - Lower fuel moisture
  - Greater expected flame lengths
- During 2 spread events fire was also burning under plume dominated conditions
  - Locally more extreme – high wind speeds near flaming front
  - Plume formation influenced by both weather and fuels
- Studies analyzing fire outside of plume-dominated fire days did not find significant effect of weather
  - Harris and Taylor 2015, Ecosystems 18: 1192-1208
  - Kane et al. 2015, Forest Ecology and Management  358: 62–79

# Fuels Treatments

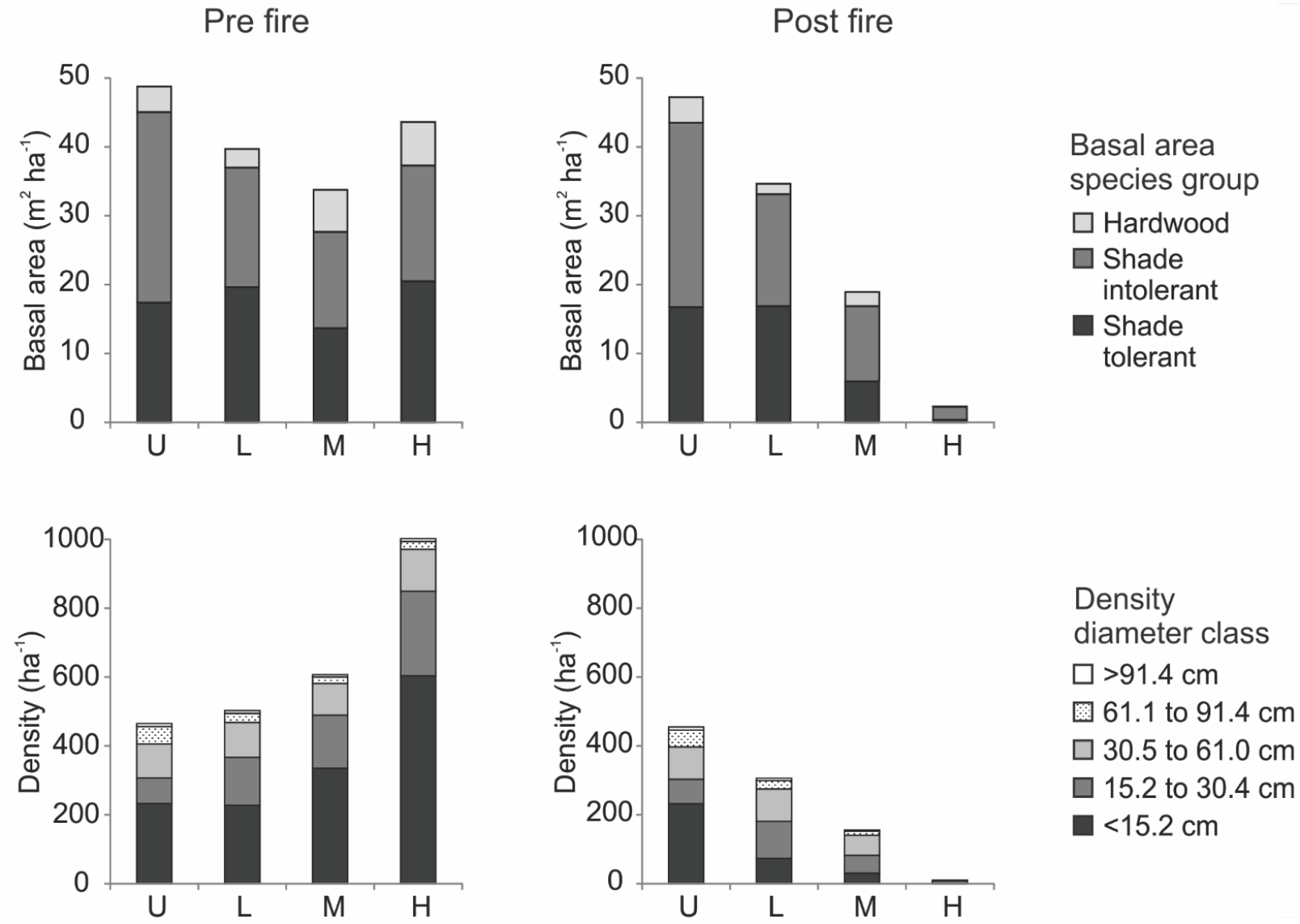
- Effectively lowered fire severity relative to untreated
  - Lower proportion high severity in sample landscapes
  - Reduced severity within first 50-100 m of treatment
- Prescribed fire appears most effective, especially combined with thinning
  - Pre-existing differences in forest structure?
  - Differences in topography?
- Previous high severity fire associated with high severity reburn
  - Permanent type conversion to non-forest
- Some high severity in all treatment types

# High severity within treated areas

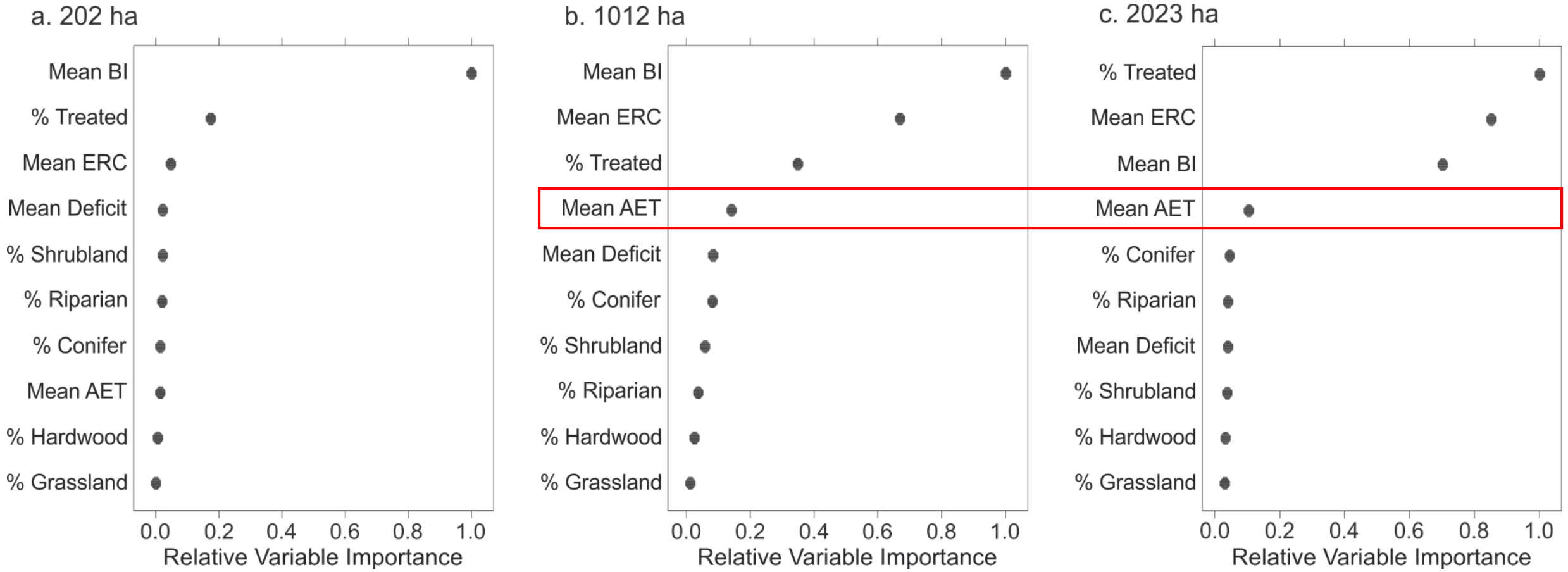
- Under high to extreme burning conditions fuels treatments reduce, but likely cannot completely eliminate high-severity fire effects
- Observed high-severity patches may be related to
  - Treatment boundaries if fire severity remained high for a distance prior to decreasing
  - Small spatial scale of treatments relative to  incoming fire behavior, (i.e., overwhelming a treatment)
  - Older treatments that may be less effective due to subsequent buildup of fuels
  - Local feedbacks between fire weather, topography, and fuels

# No effect of vegetation?

## Pre- and post-fire structure by severity class



# Productivity – marginal effect of AET




Kane et al. 2015 found positive relationship between AET and Rim Fire severity (Forest Ecology and Management 358: 62–79)

# Effect of scale

- Smaller landscapes needed larger proportion treated to see an effect
- Important to treat areas of high value
- If goal is to avoid any high severity in area of high value also important to treat the surrounding landscape

# Comparison to 2014 paper

- Lydersen et al. 2014
  - Plot data from areas with relatively restored fire regime
  - Plume dominated fire and higher BI associated with moderate-high severity
  - Time since fire >14 years associated with moderate-high severity
  - No comparison to baseline (i.e., unburned)
- Lydersen et al. 2017
  - Included entire core fire area
  - Areas with no previous fire or fuels treatment and previous high severity had greatest % high severity in Rim Fire
  - Higher BI and ERC associated with high severity fire
  - Fuels treatments and previous low-moderate severity reduced fire severity

# Additional questions

- Strategic placement of fuels treatments
- Reduced severity on the lee side of a treatment
- Effect of treatment age x type?

# Acknowledgements


- Coauthors from Lydersen et al. 2017
  - Brandon Collins (UC Berkeley)
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  - Van Kane (U Washington)
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