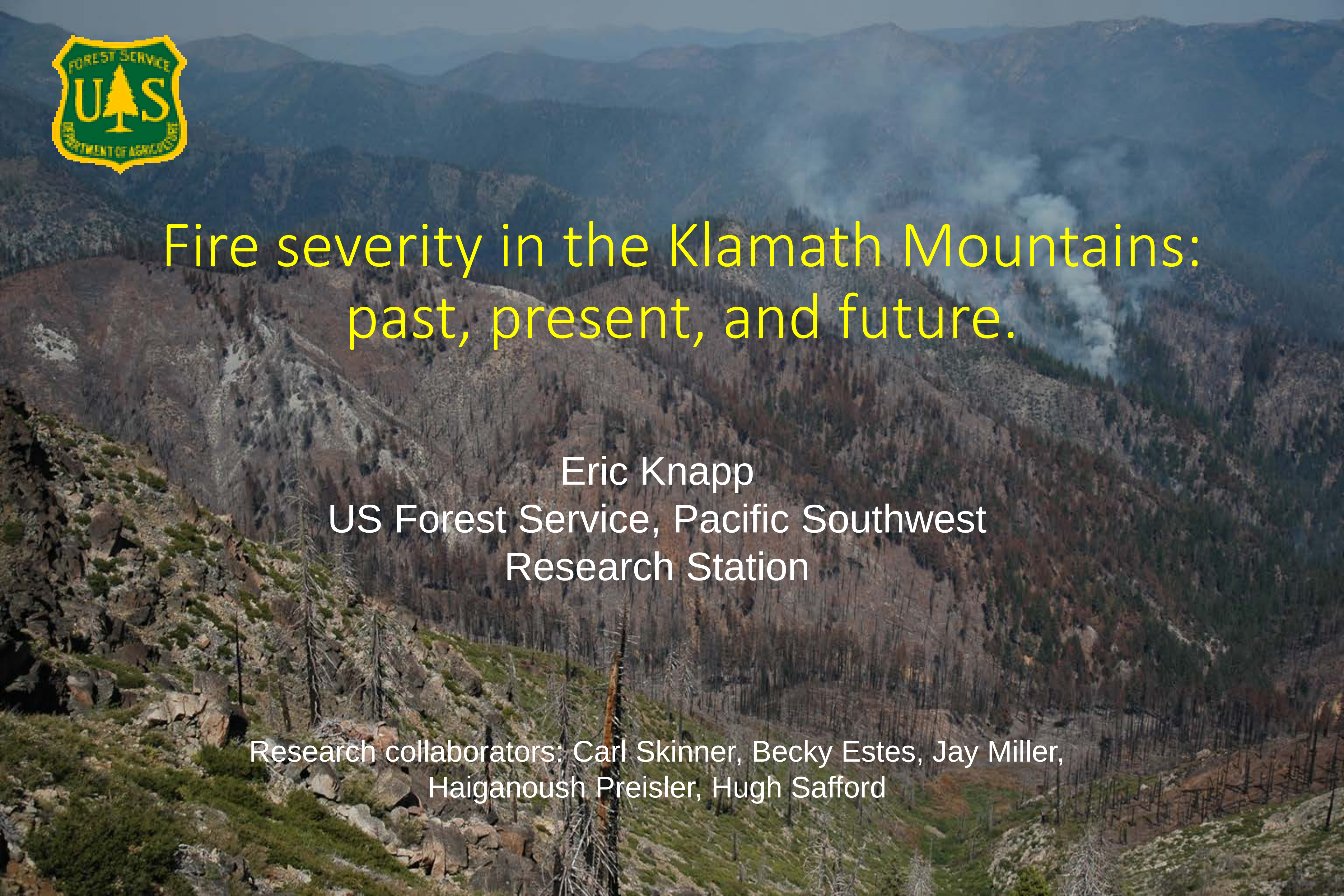


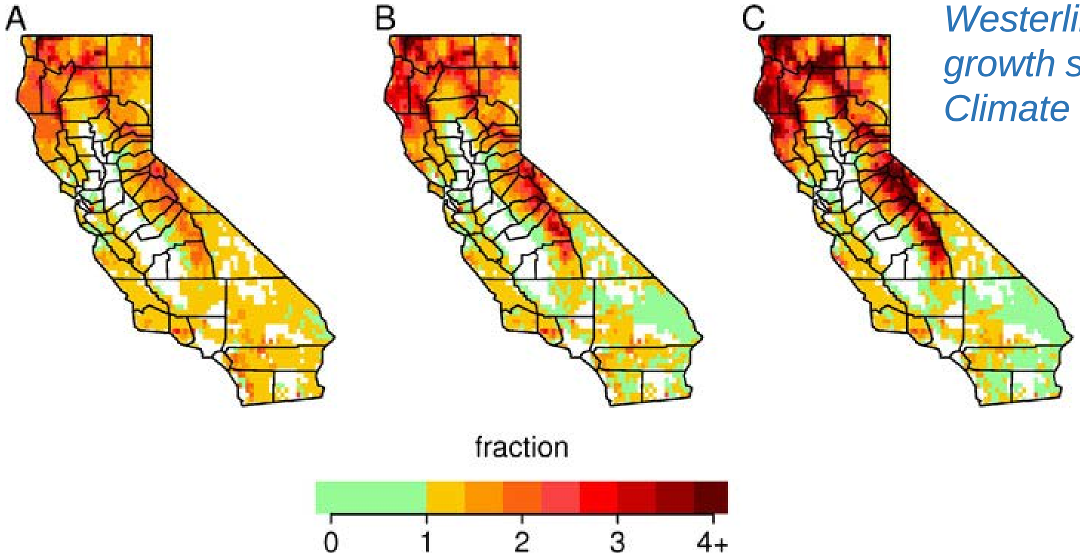
Fire severity in the Klamath Mountains: past, present, and future.

Eric Knapp
US Forest Service, Pacific Southwest Research Station

Research collaborators: Carl Skinner, Becky Estes, Jay Miller, Haiganoush Preisler, Hugh Safford

Fire activity versus fire severity

- Most models predict that as temperature warms and fire season lengthens the number of acres burned per year will increase

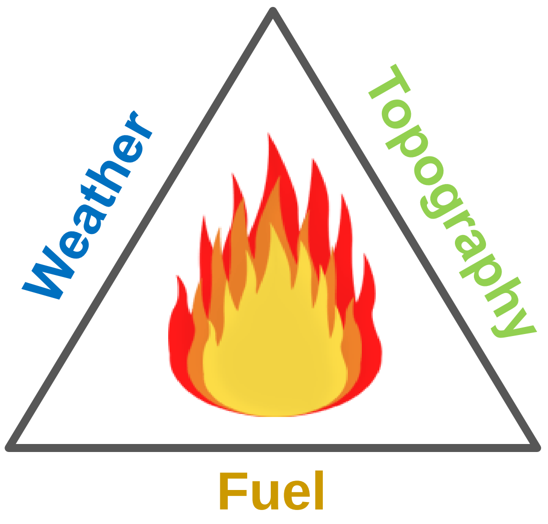


Westerling et al. 2011. Climate change and growth scenarios for California wildfire. Climate Change 109:S445–S463

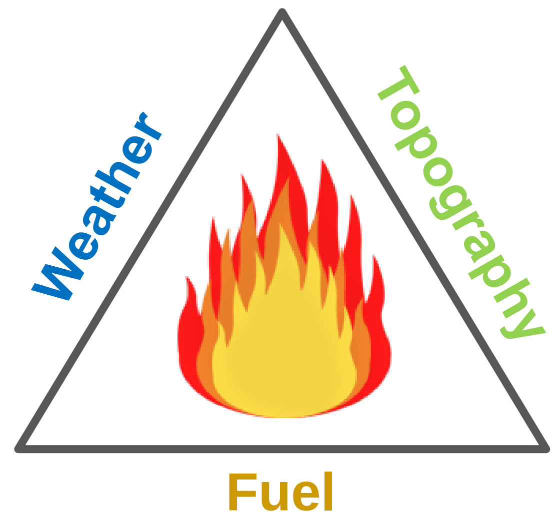
- Will more or less of that fire be “good” fire?

What determines fire severity?

- Fuel
  - Amount
  - Continuity
- Weather
  - Relative humidity
  - Air temperature
  - Wind
  - Temperature inversions
- Topography
  - Slope steepness
  - Slope position
  - Aspect



How might severity be influenced by climate change?

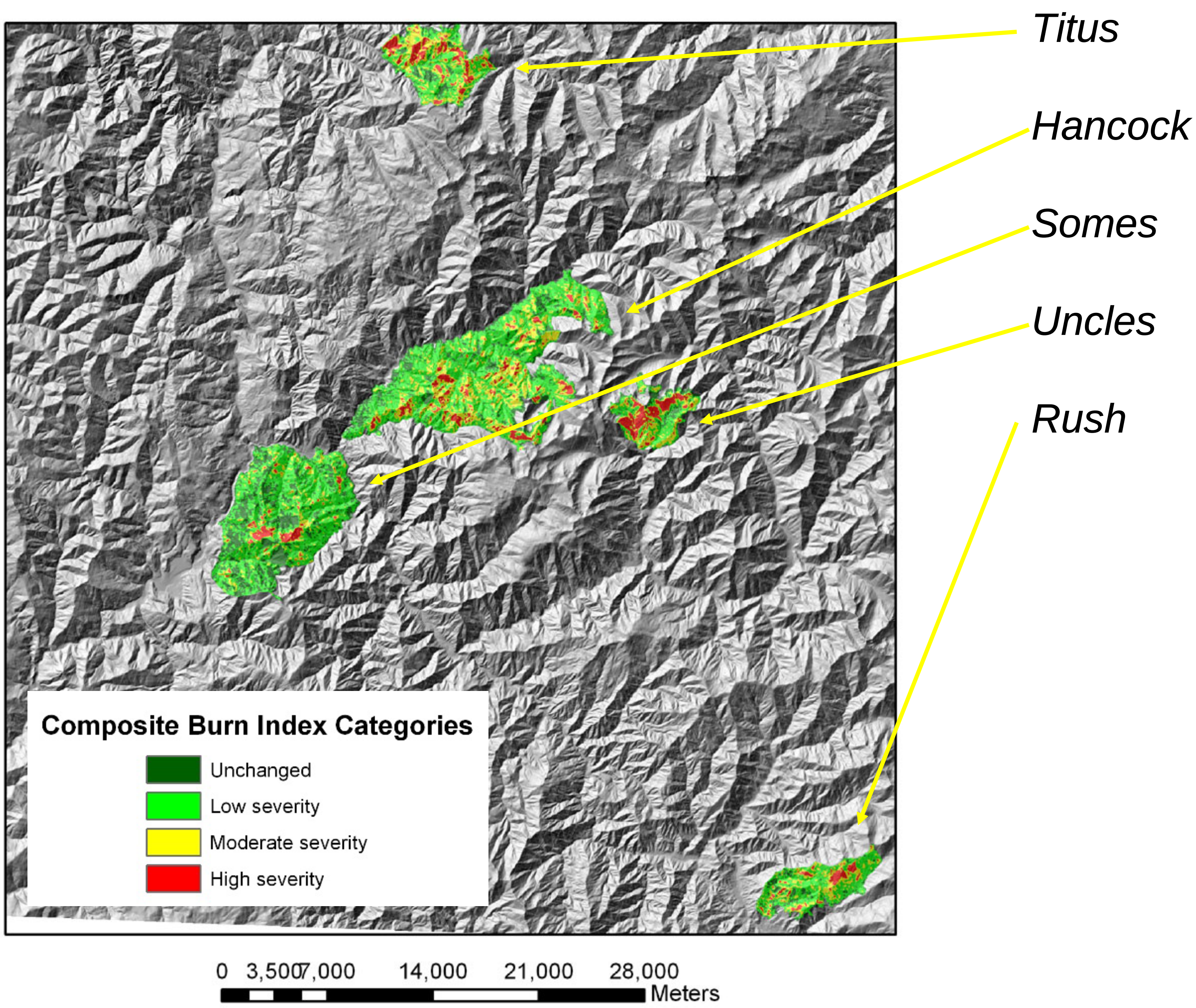


- Warmer temperature – direct effect
- Warmer temperature = reduced snow pack = longer fire season
  - Fuels dry earlier, large woody fuels dry more completely
- Precipitation – some models predict slightly higher amounts in NW California
  - Increasing drought stress = lower productivity = slower rate of fuel production
  - Shifts in species composition can alter fuels

Factors influencing fire severity in the Klamath Mountains

- 2006 fires
- Long term goal: Develop models to help predict outcomes under varying conditions, including those when fire might be used for resource benefit.

Estes BL, Knapp EE, Skinner CN, Miller JD, Preisler HK. 2017. Factors influencing fire severity under moderate burning conditions in the Klamath Mountains, northern California, USA. Ecosphere 8: Article e01794

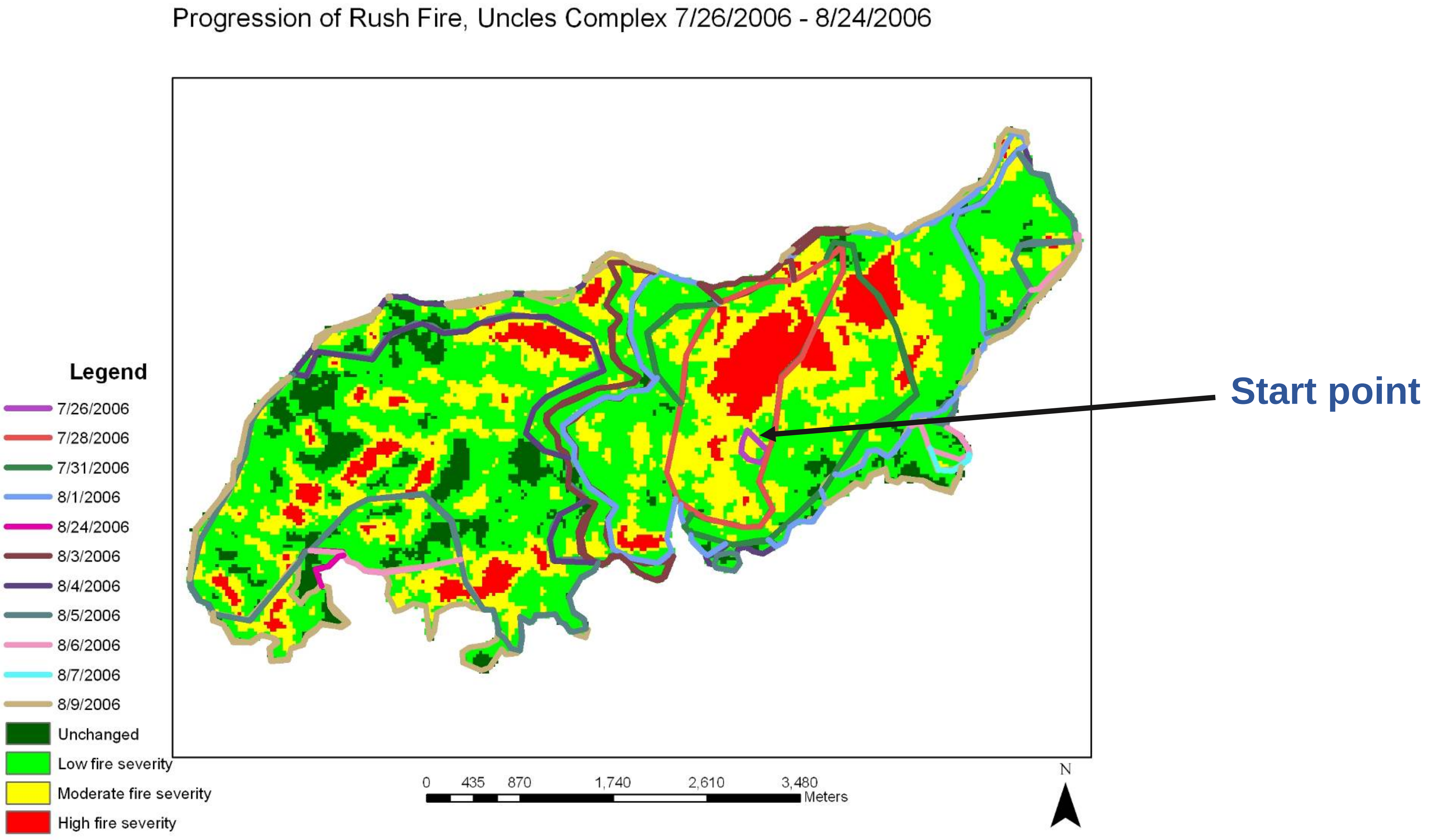


lighting fires
2006

Fire severity - 2006 fires

	Variables Analyzed
Topography	**Slope position (lower, mid, upper)**
	Slope steepness (%)
	Solar radiation
	Aspect
Fuels	**Vegetation type (conifer, mixed, hardwood, shrub, herbaceous)**
	Time since last fire
	Number of fires since 1911
Weather	**Inversion (above, below 4,250 ft)**
	Average temperature
	Average relative humidity

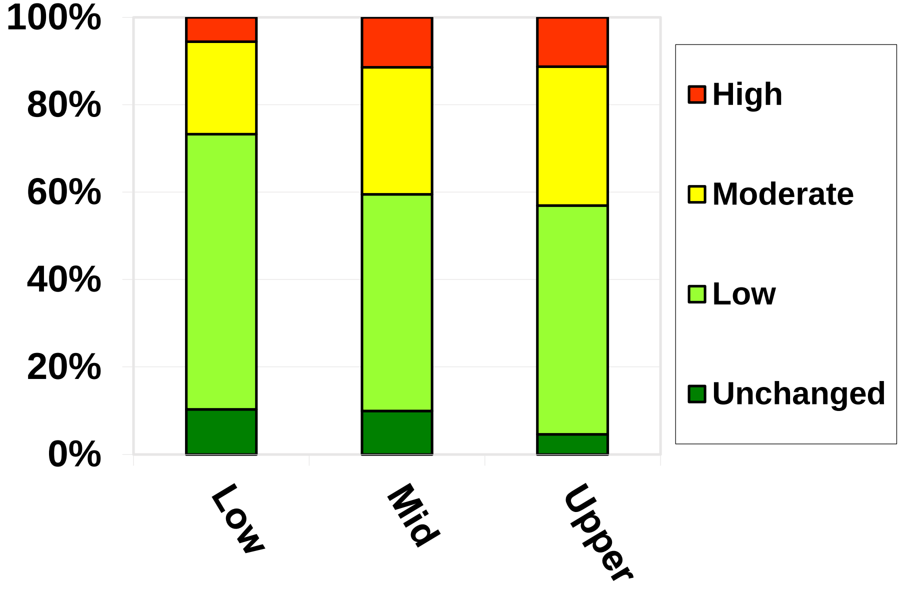
Rush Fire progression map – linking to weather variables

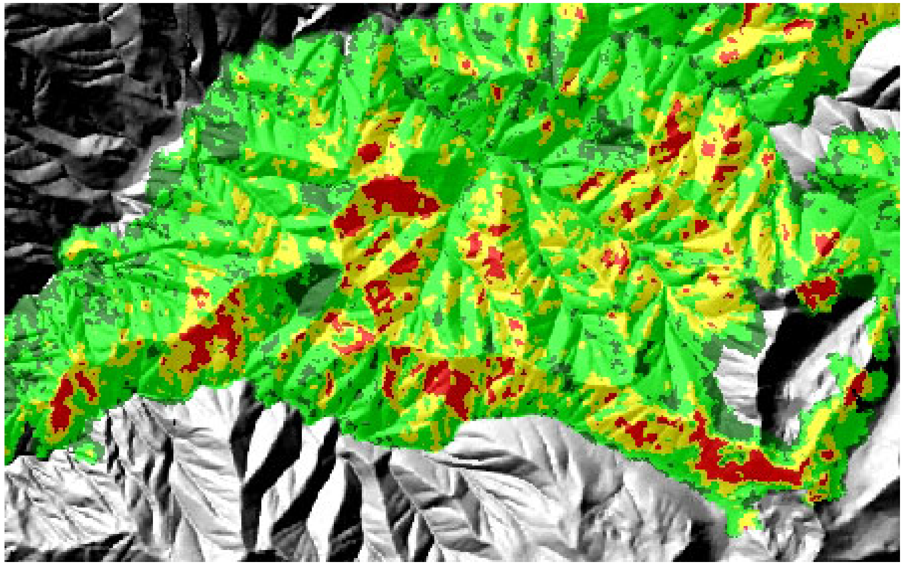


Fire severity - 2006 fires

	Variables Analyzed	*P*
Topography	**Slope position (lower, mid, upper)**	***
	Slope steepness (%)	
	Solar radiation	***
	Aspect	***
Fuels	**Vegetation type (conifer, mixed, hardwood, shrub, herb)**	***
	Time since last fire	***
	Number of fires since 1911	***
Weather	**Inversion (above, below 4,250 ft)**	***
	Average temperature	***
	Average relative humidity	***

Fire severity and slope position





Hancock Fire

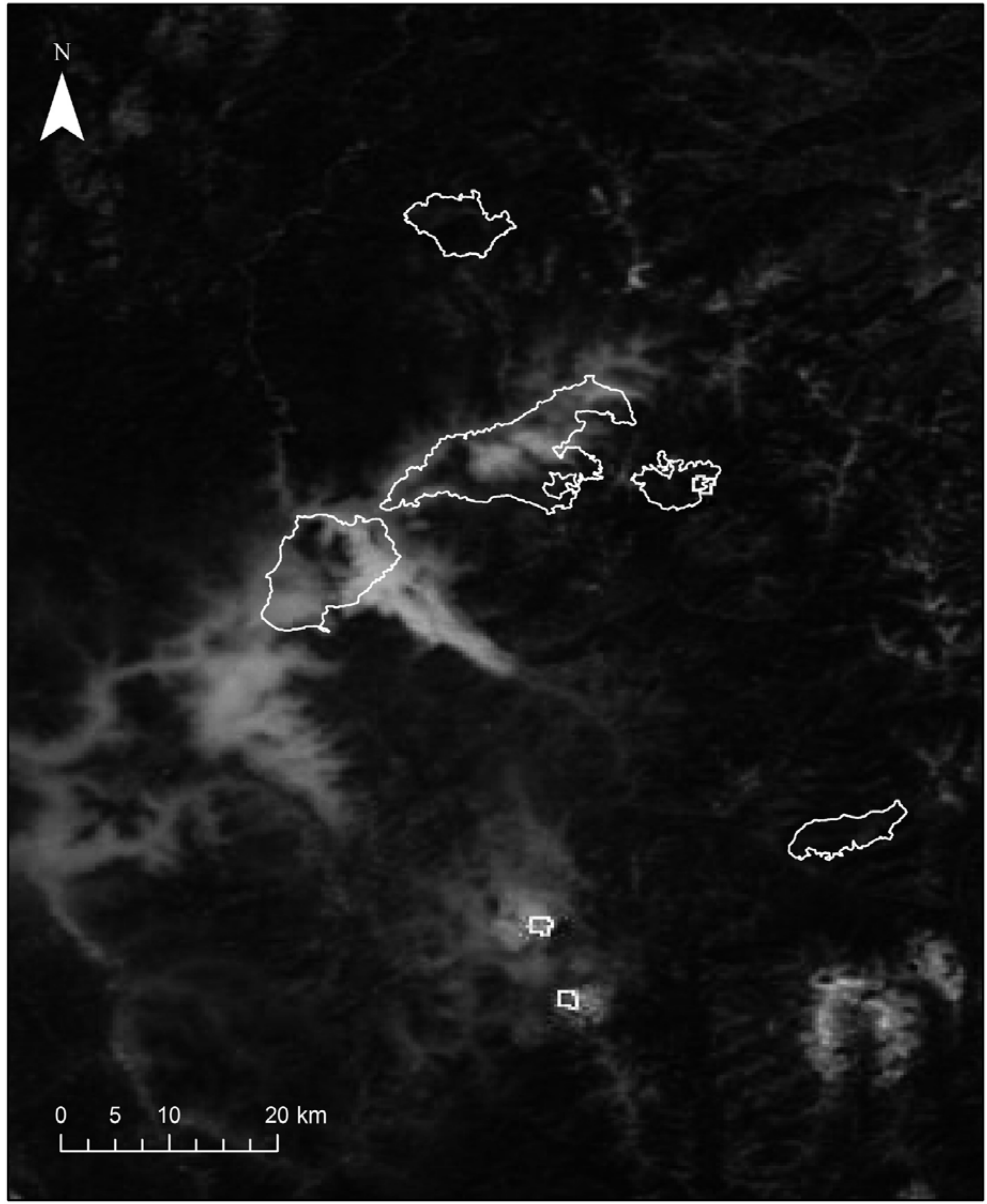
Reasons:

- fire type (backing/ heading)
- upper slope – more wind, moister microclimates in canyon bottoms
- vegetation type/ stature; taller trees in canyon bottoms

Fire severity and vegetation pattern

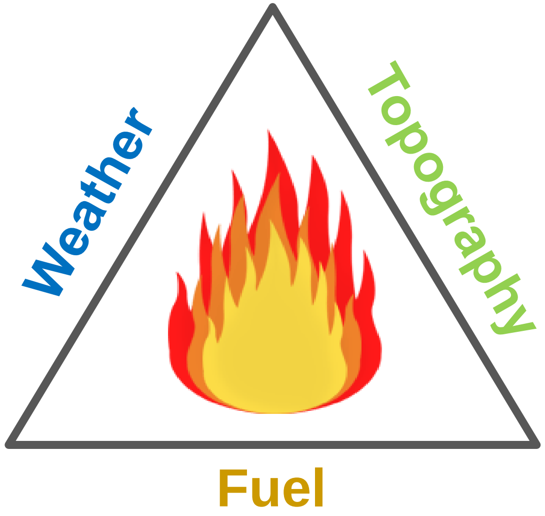
Smoke in the canyon bottoms.

MODIS image
August 18, 2006

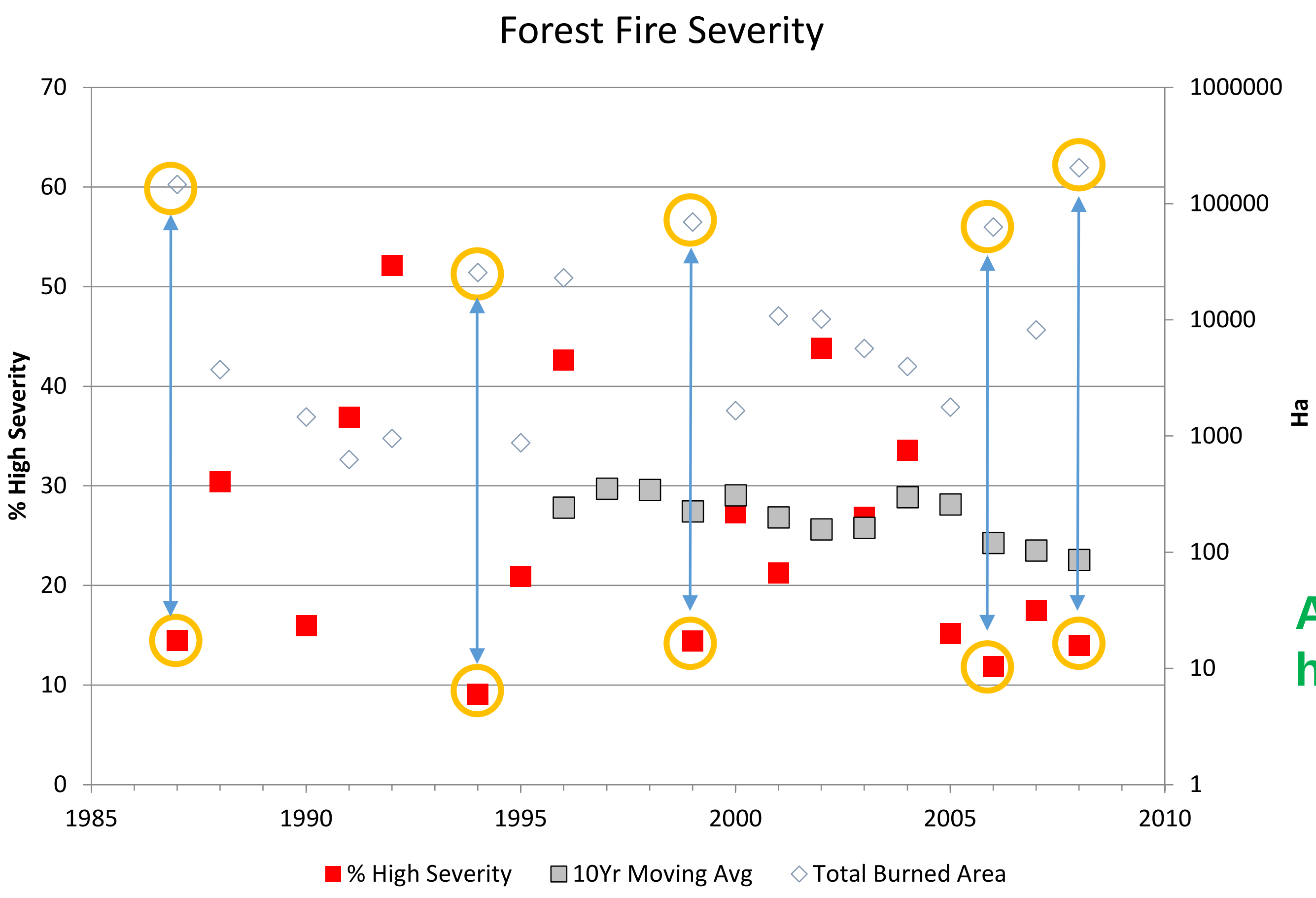


Conditions under which large high severity patches typically occur

- Upper slope positions and above inversion zone
- Excessive fuel loading and continuity combined with atmospheric instability (e.g. 2015 Whites Fire)
- Excessive fuel loading and continuity combined with wind (e.g. 1999 Megram Fire)
- Alignment of topography with wind (e.g. 2008 Panther Fire)



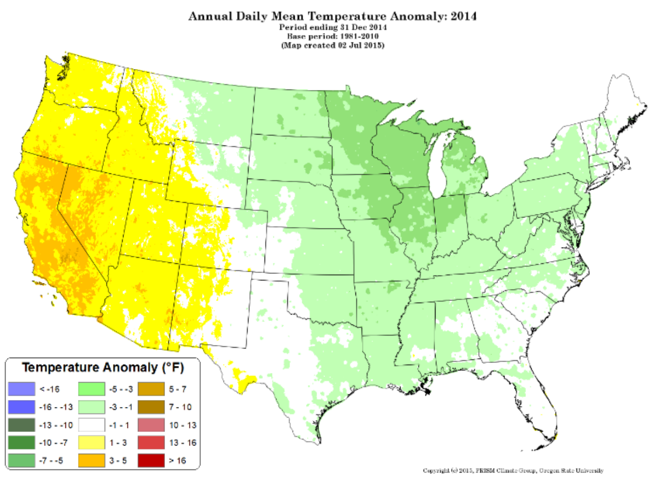
Trends in fire severity in the Klamath Mountains

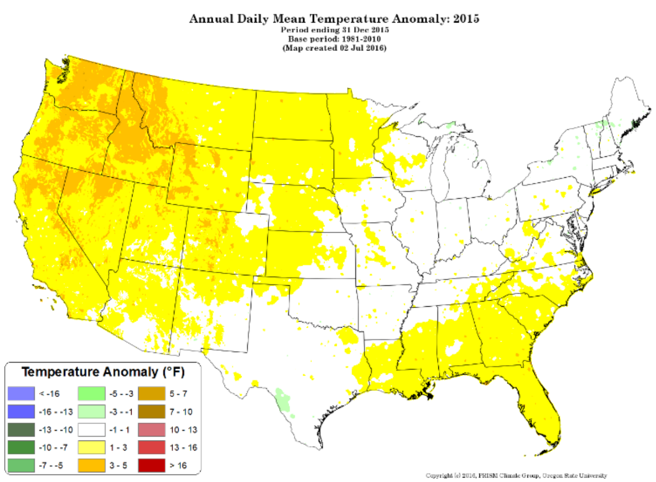


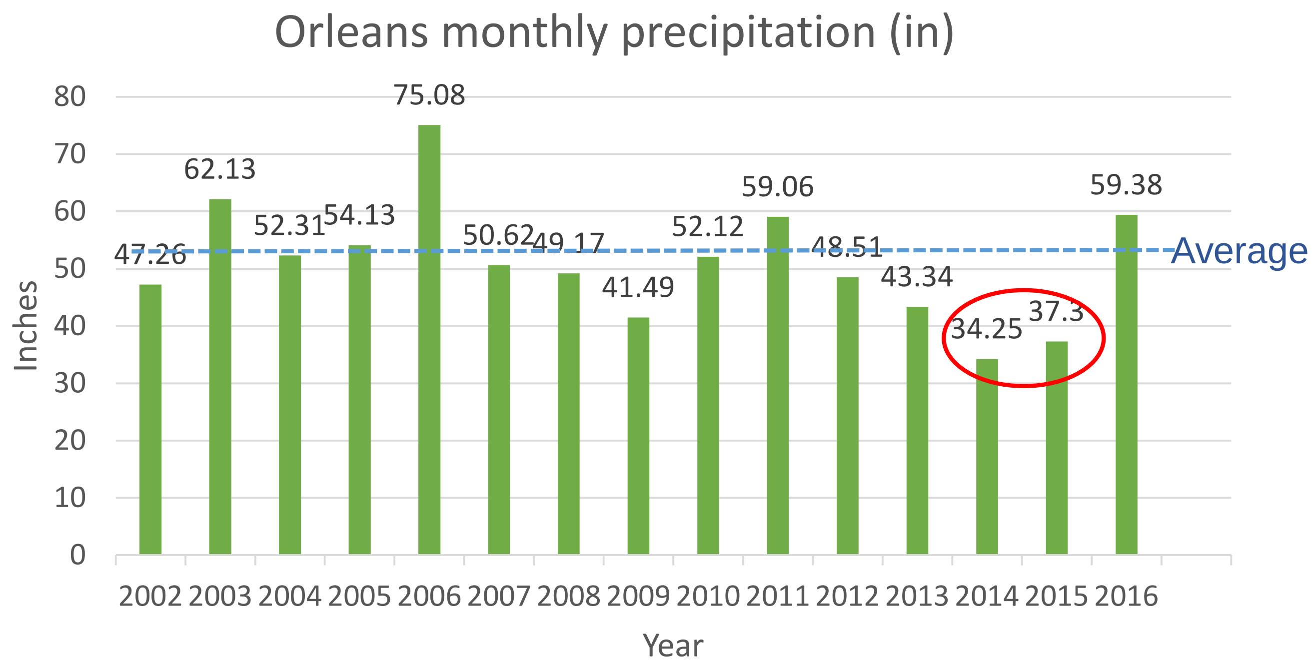
Average = 16% high severity

From Miller et al. 2012. Trends and causes of severity, size, and number of fires in northwestern California, USA. Ecological Applications 22: 184-203.

The 2014 and 2015 Klamath Mountains fires: a window into the future?





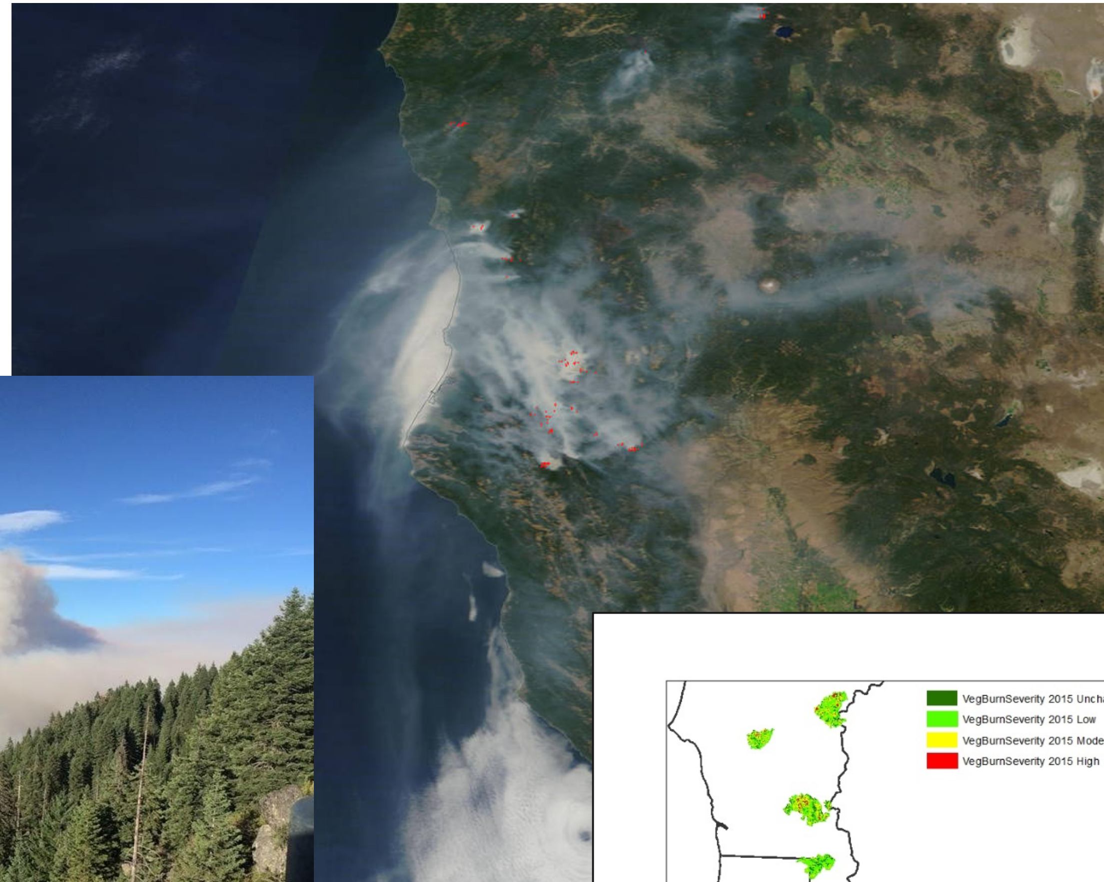


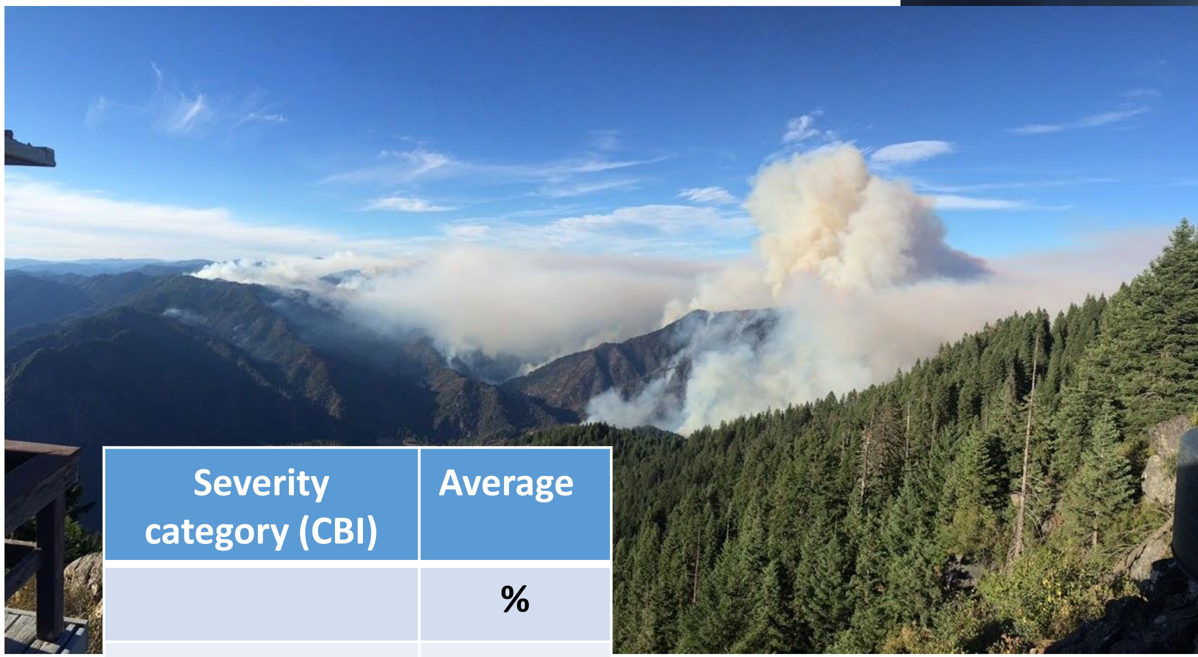
2014 fires

Severity category (CBI)	Beaver	Happy Camp	Whites	Average
	%			
Unchanged	2	6	8	**5.9**
Low	17	33	34	**30.3**
Moderate	35	34	27	**32.7**
High	45	27	31	**31.0**

Average (1987 to 2008) = 16%

2015 fires

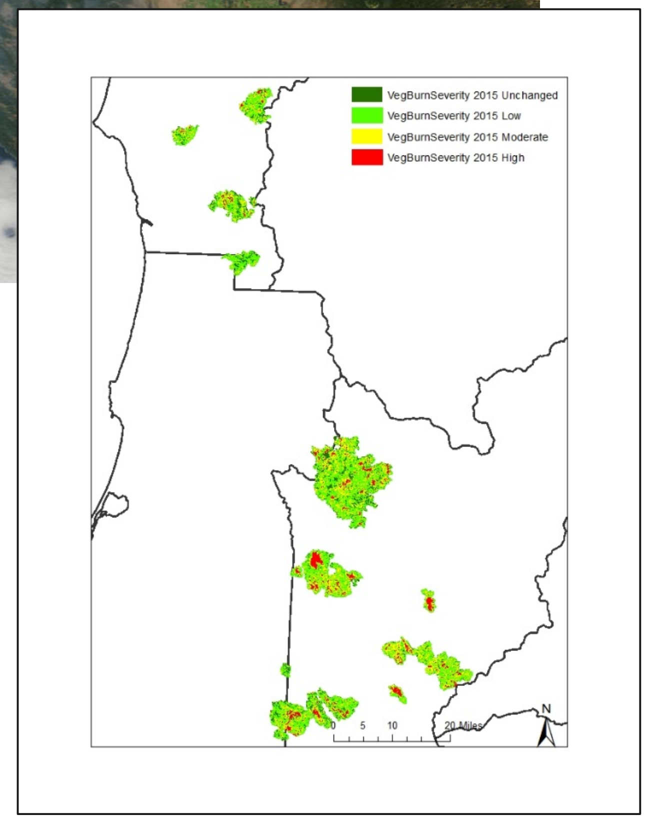




River Complex, August 30

Severity category (CBI)	Average
	%
Unchanged	**11.6**
Low	**42.9**
Moderate	**27.7**
High	**17.7**

Average (1987 to 2008) = 16%



Lessons from 2014 and 2015 fire seasons

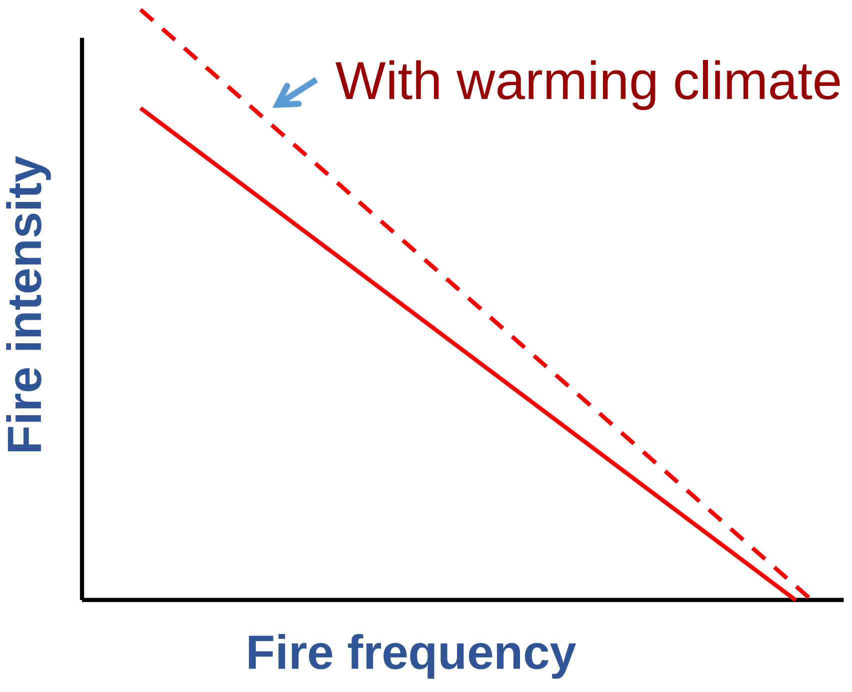
- Differences in severity controlled by many factors in addition to/other than anomalous warmth and drought
- 2014 – unstable atmosphere
- 2015 – greater stability, stronger inversions
- Strength of existing drivers of fire severity may to some extent buffer the Klamath Mountains against major climate-induced change

Climate change and early seral habitat resulting from high severity fire

- Succession from high severity back to forest in a warmer climate (Tepley et al. 2017)
  - Increased fire frequency: trees don't reach resistant size before next fire
  - Higher climatic water deficits – less regeneration
  - Possibility of early-seral habitat increasing over time even without change in the percentage of high severity

Can we influence the intensity at which future forest fires will burn, minimizing the negative effects and maximizing the positive effects?

- Fuel reduction, including more “good” fire will help buffer this landscape against burning at higher than desired severity, climate change or not
- With lower fuel loading, it matters less if fuels are drier



Summary

- Trends in future fire severity will likely depend on how we choose to manage fuels and on climate
- The strong controls on fire behavior and resulting severity in the Klamath Mountains:
  - buffer this landscape against major climate-induced change
  - provide some opportunities to shape fire effects

Acknowledgements

Klamath and Shasta-Trinity National Forests, Clint Isbell, Klamath NF fire personnel, Celeste Abbott – maps, photographers whose pictures I used

CALIFORNIA FIRE SCIENCE CONSORTIUM