BS of Another Kind:
Musings on Burn Severity Quantification

Based on Works from the Gang of Six:

Paper:

Fire Frequency, Area Burned, and Severity: a Quantitative Approach to Defining a Normal Fire Year.

James A Lutz, Carl H Key, Crystal A Kolden, Jonathan T Kane and Jan W van Wagtendonk
Fire Ecology Volume 7, Issue 2, 2011

Papers in review:

Modeling Composite Burn Severity in Continental, Regional and Local Analysis Using Continuous Distributions of dNBR and RdNBR.

CH Key and Nate C Benson

The significant role and proportion of unburned area within fire perimeters.

CA Kolden, JA Lutz, CH Key, JT Kane, and JW van Wagtendonk

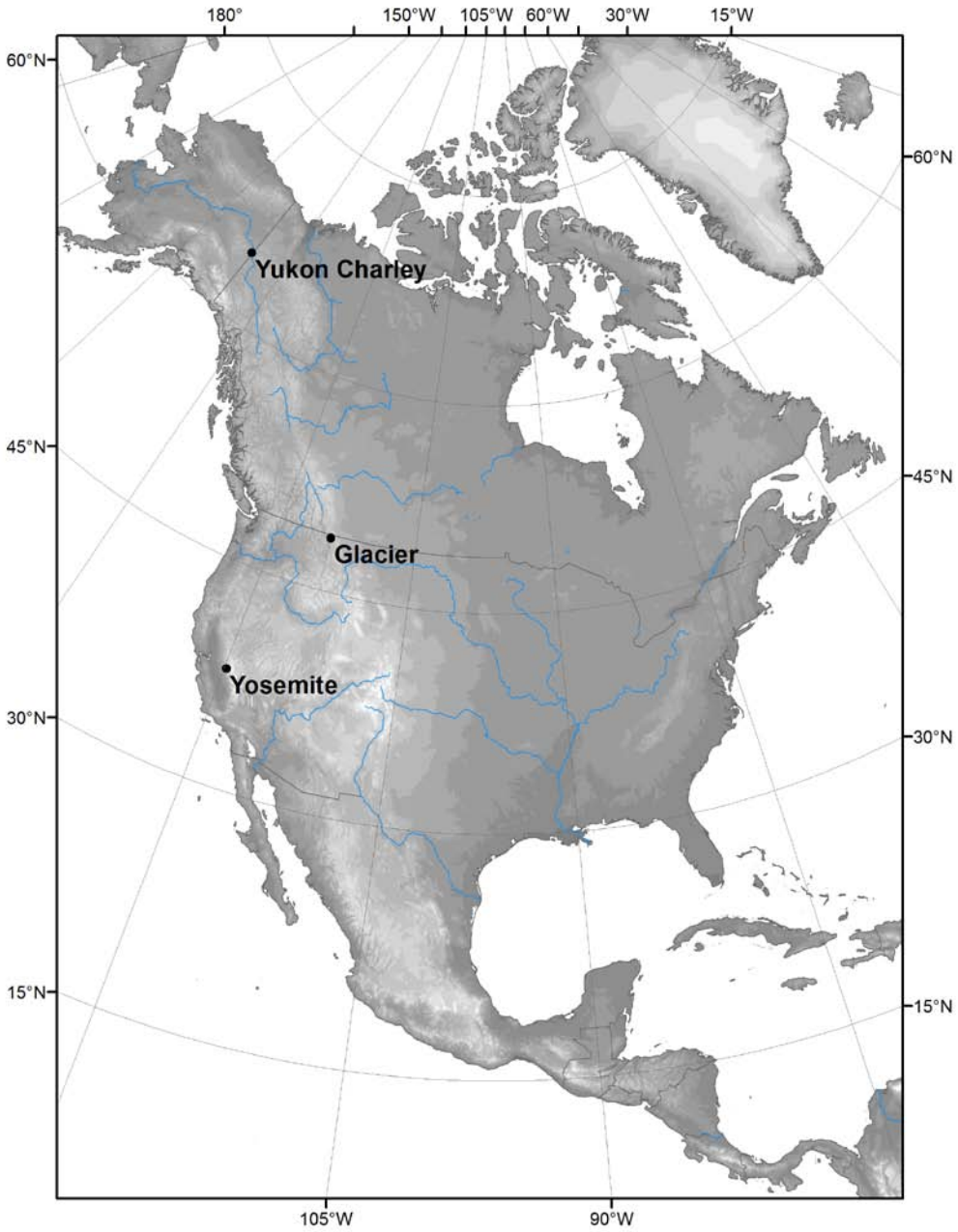
Completed data:

Climate Impacts on Burn Severity in Three Forest Ecoregions of the U.S.

CH Key, JA Lutz, CA Kolden and JW van Wagtendonk
USGS Global Change R&D Program.

Purpose

- Fire effects in North America
- How are fire effects quantified? (vs. described)
- Emphasis on ecological effect
- Statistical descriptions and models
- Relationships with ecological variability

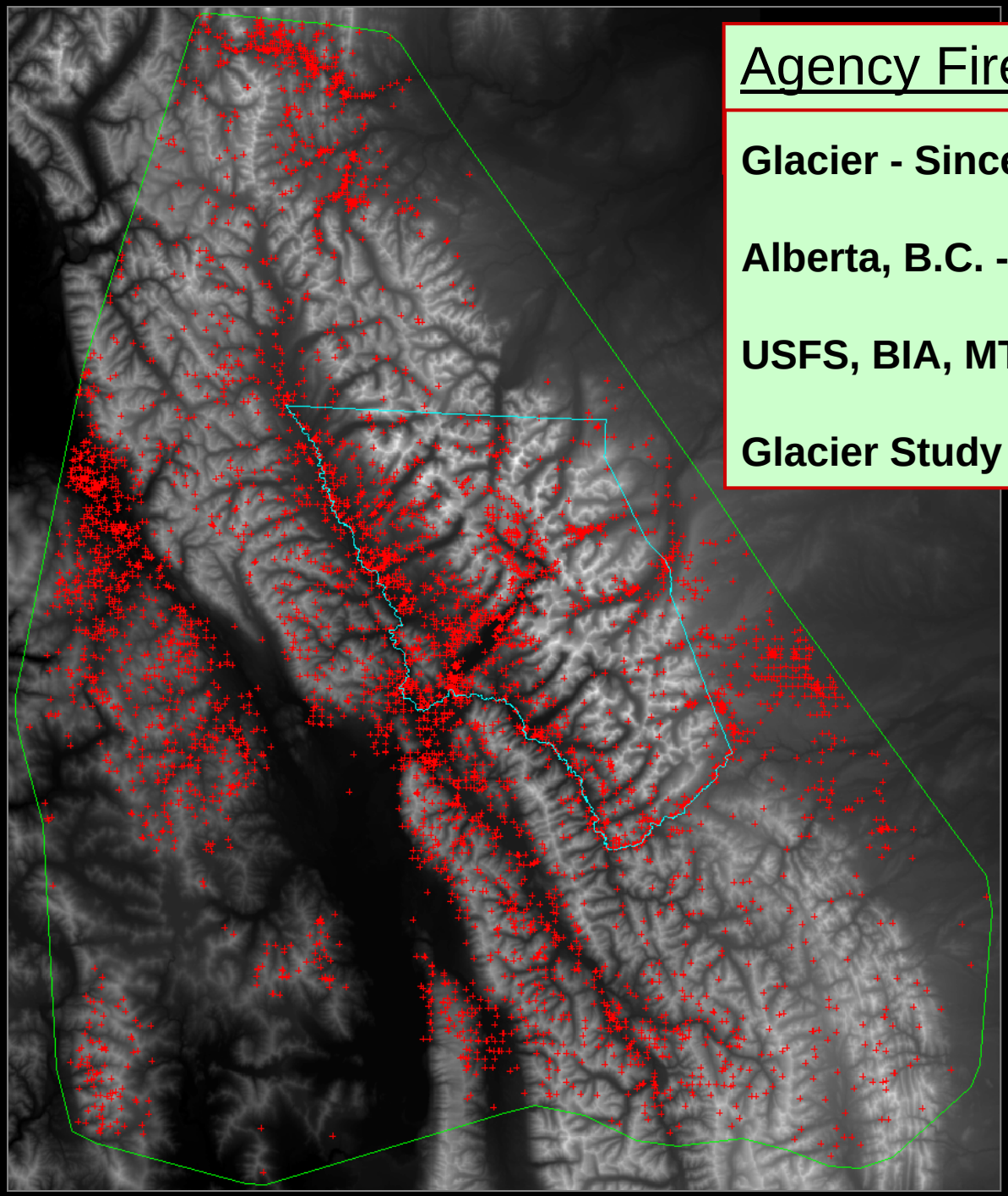


Three Core Regions

Yukon-Charlie, AK

Glacier, MT

Yosemite, CA



Agency Fire Occurrence

Glacier - Since 1910

Alberta, B.C. - Since 1950

USFS, BIA, MT - Since 1973

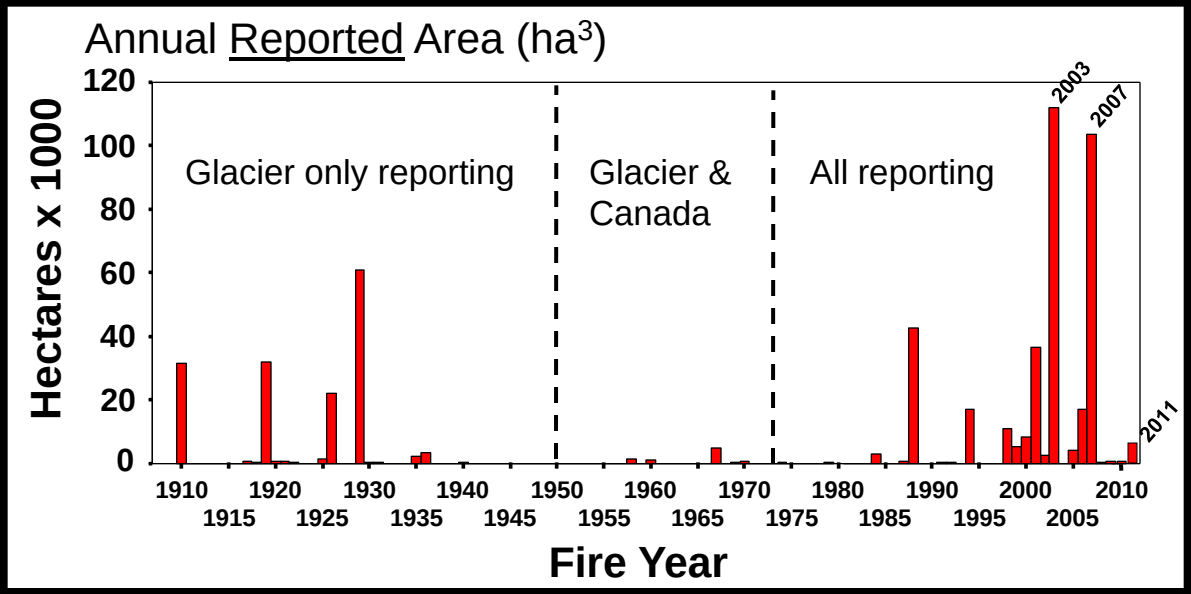
Glacier Study Area 29,850 km^2

5,682 Reported Fires

Total Fire Perimeter Area 535,049 ha

Only 1.5% of fires (85) are >= 405 ha (1000 ac); Account for 96% of total reported fire area.

All Reported Fires based on Incident Perimeters.

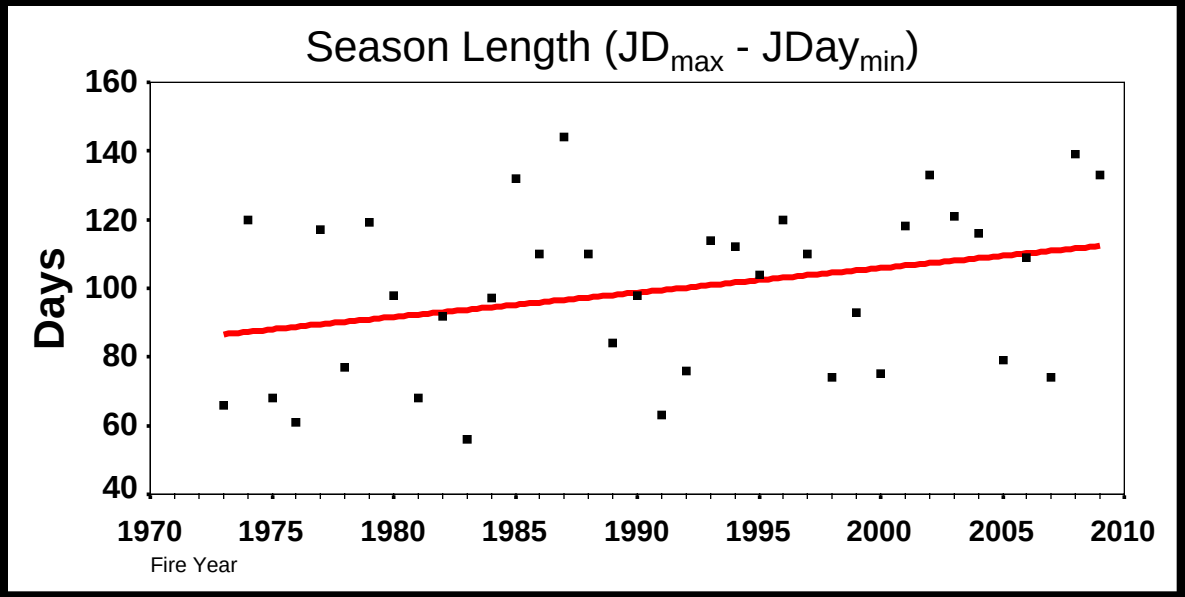


Typical Results

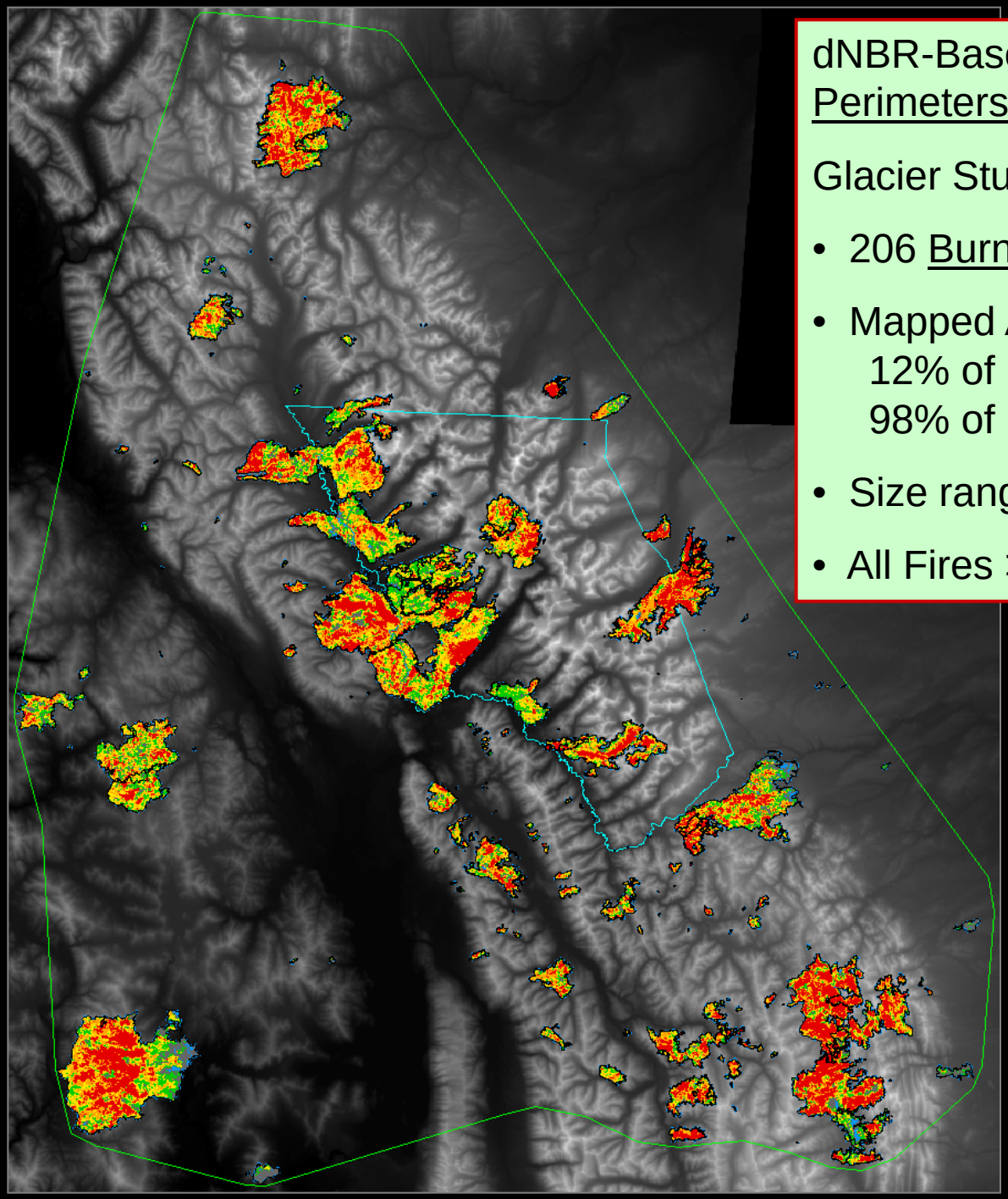
Fire Occurrence Data (FOD).

Reliable and Unreliable.

Days From First to Last Ignition. Lightning Fires 1973 - 2009 (N_Y >= 7).



r^2 0.099
Signif. 0.058



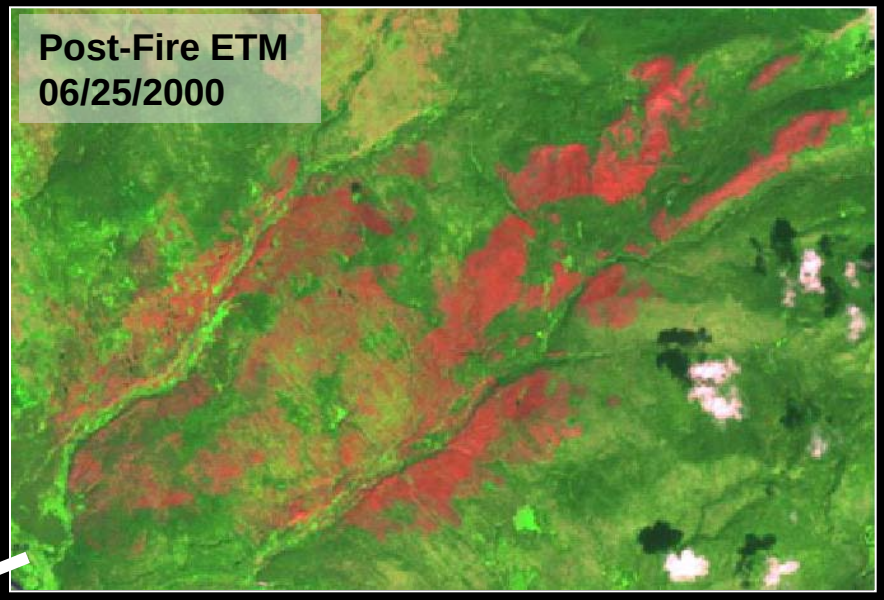
dNBR-Based Burn Severity and Perimeters 1984 – 2009....

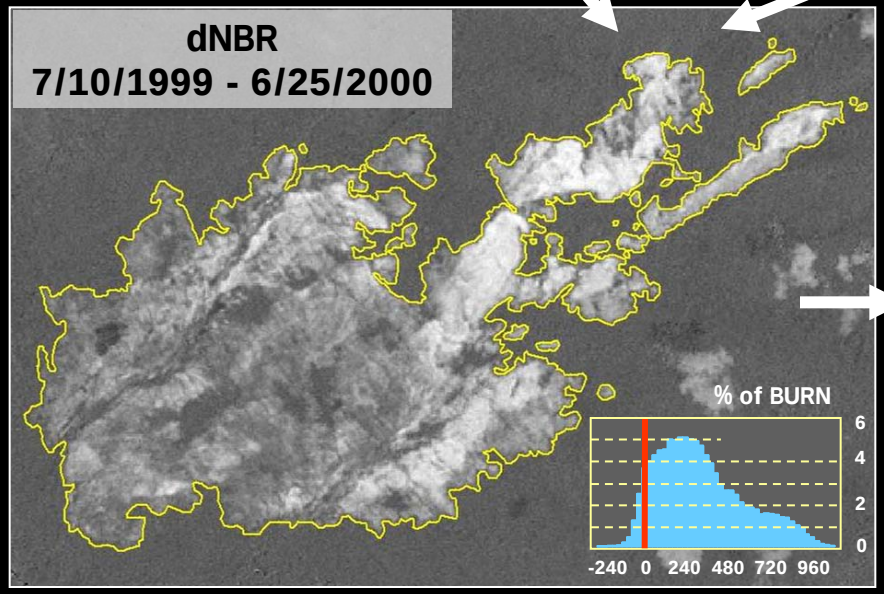
Glacier Study Area 29,850 km^2

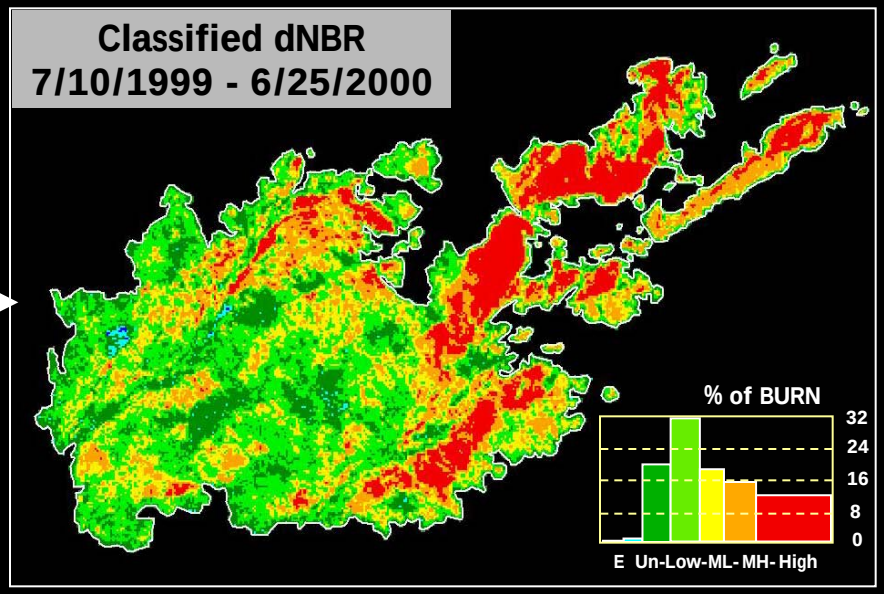
- 206 Burns Quantified
- Mapped Area 354,030 ha
  12% of Study Area
  98% of Reported Fire Area.
- Size range 1 – 40,190 ha
- All Fires >= 20 ha (N=151)

dNBR Conventional Approach

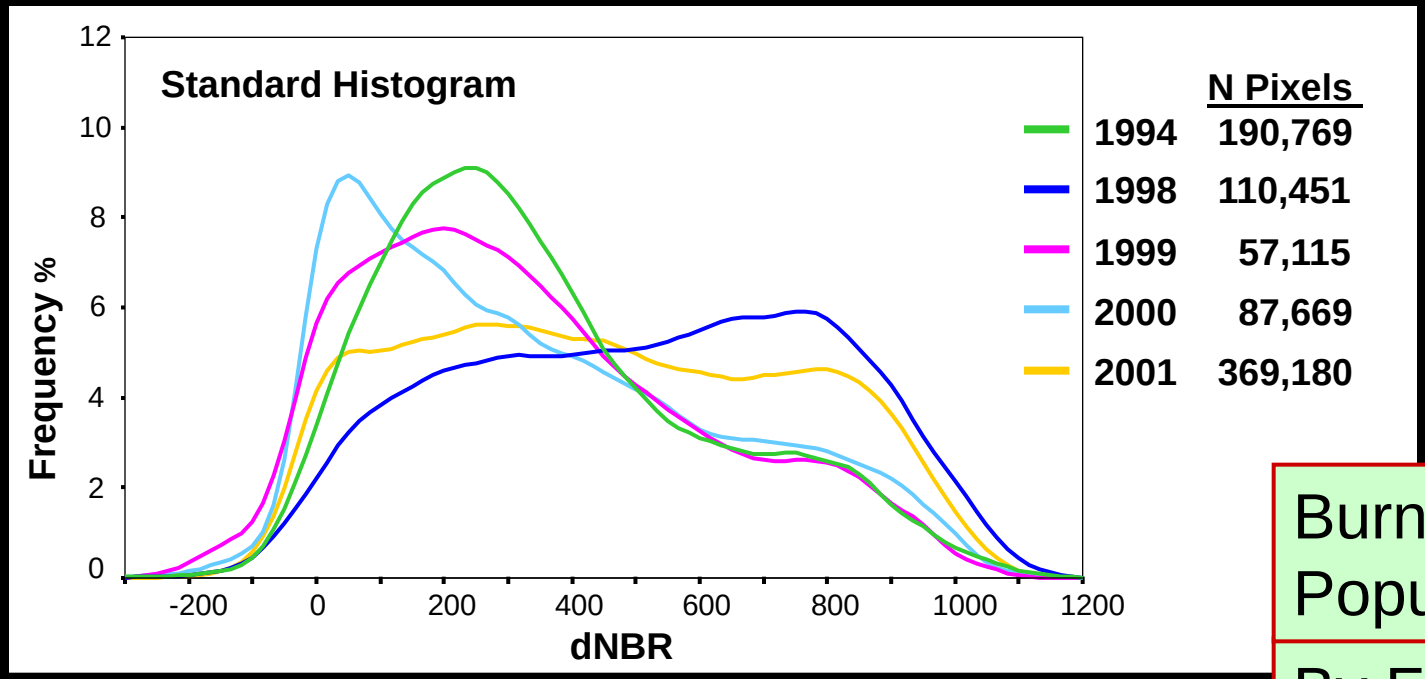
August 1999 Anaconda Burn 4,220 ha

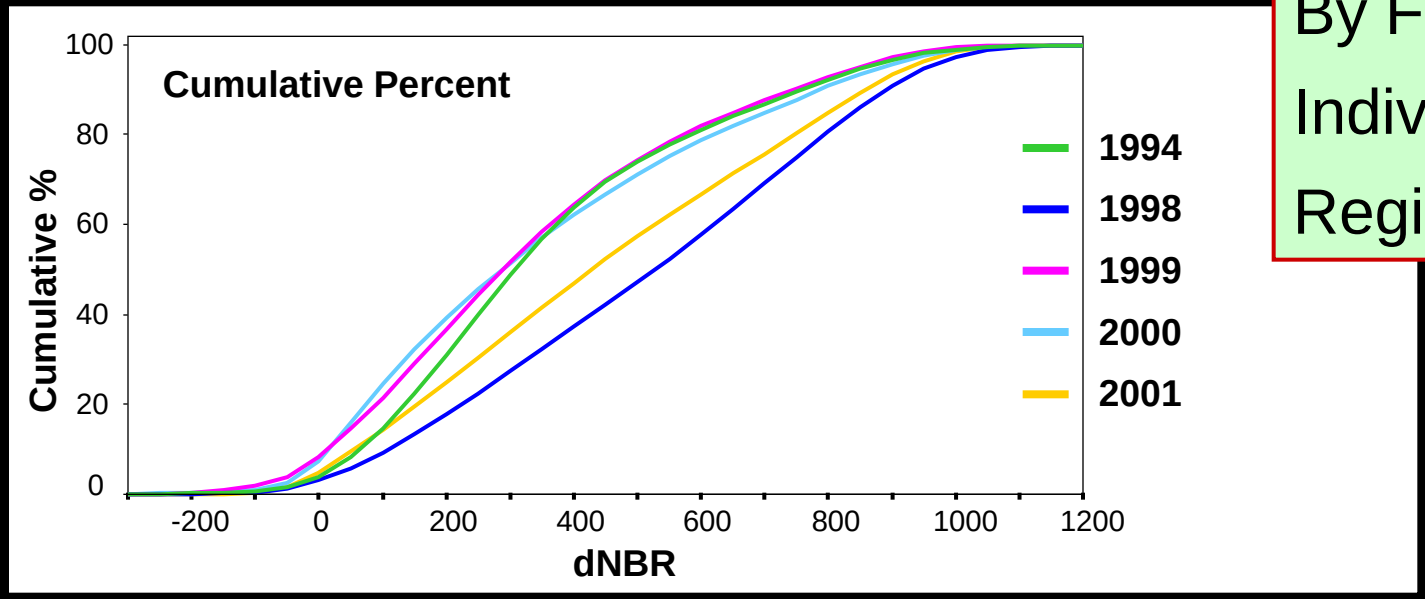






Characterization by continuous distributions





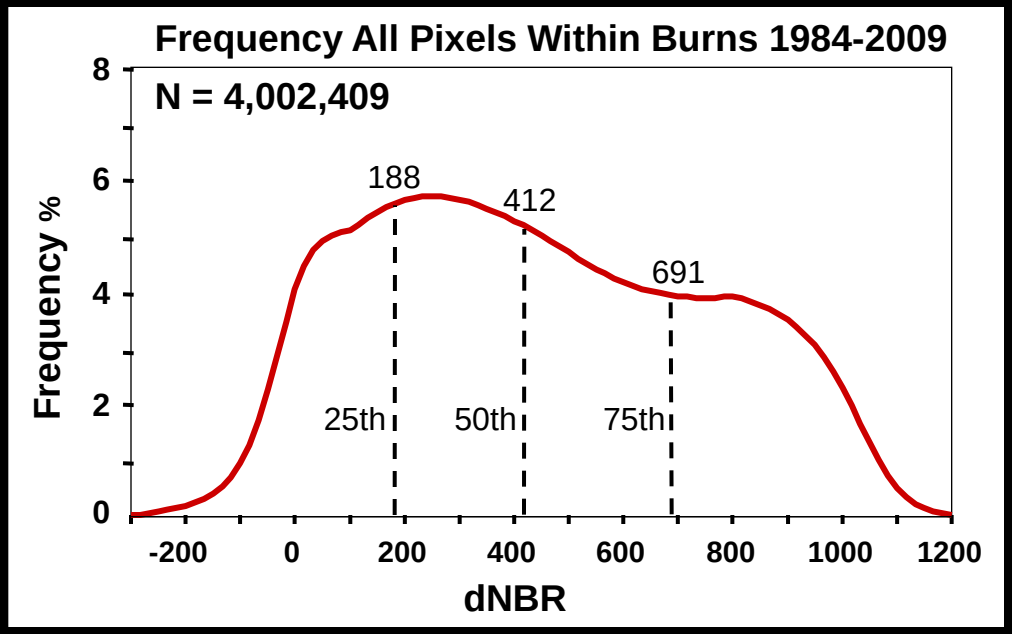
Burn-Area Pixel Populations…

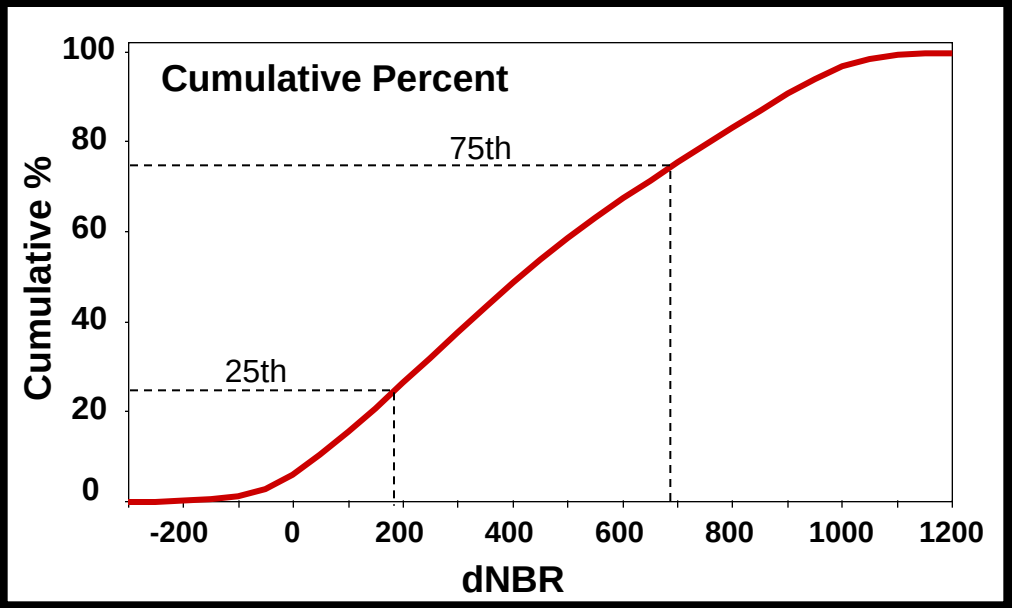
By Fire Years

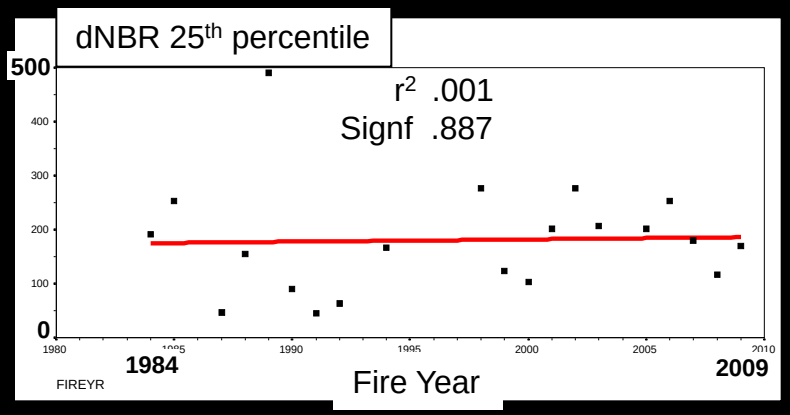
Individual Fires or

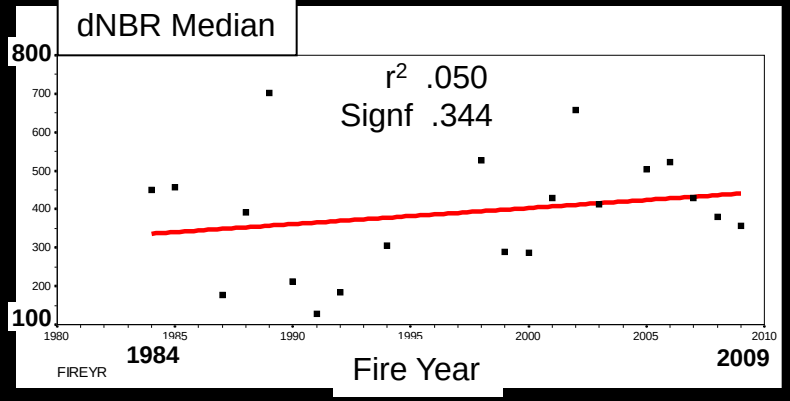
Regional Fires

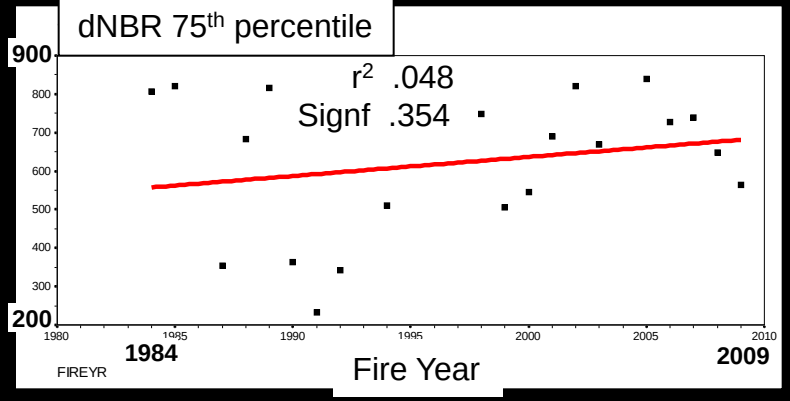
Normal Fire Year and Departures From Normal



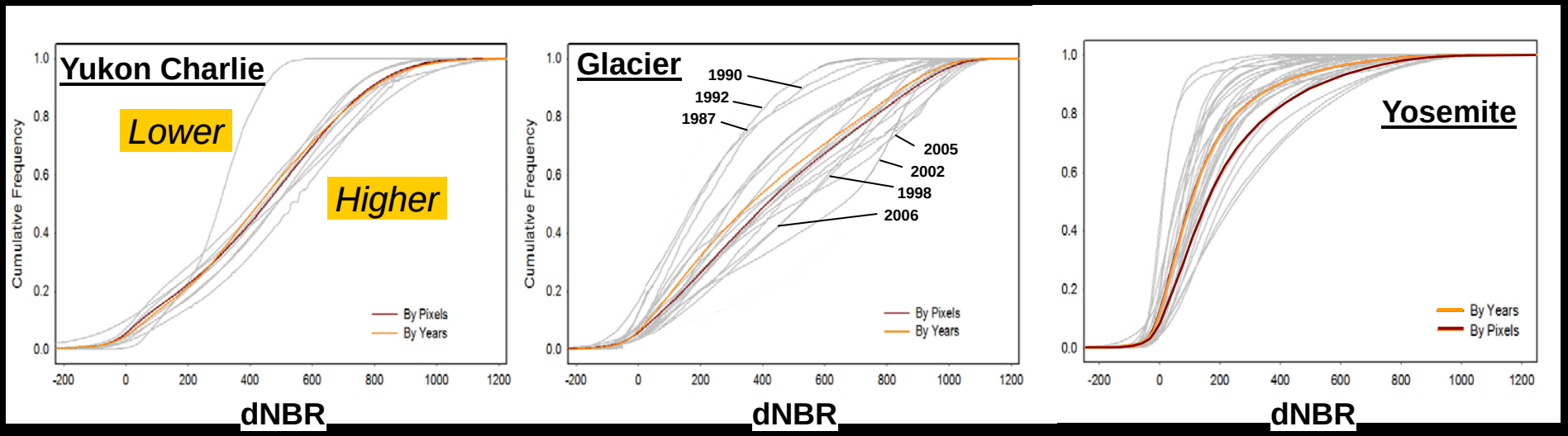








Cumulative Severity Distributions



- Each fire year
- *Normal A* - Average by years - small fire influence
- *Normal B* - All burned pixels

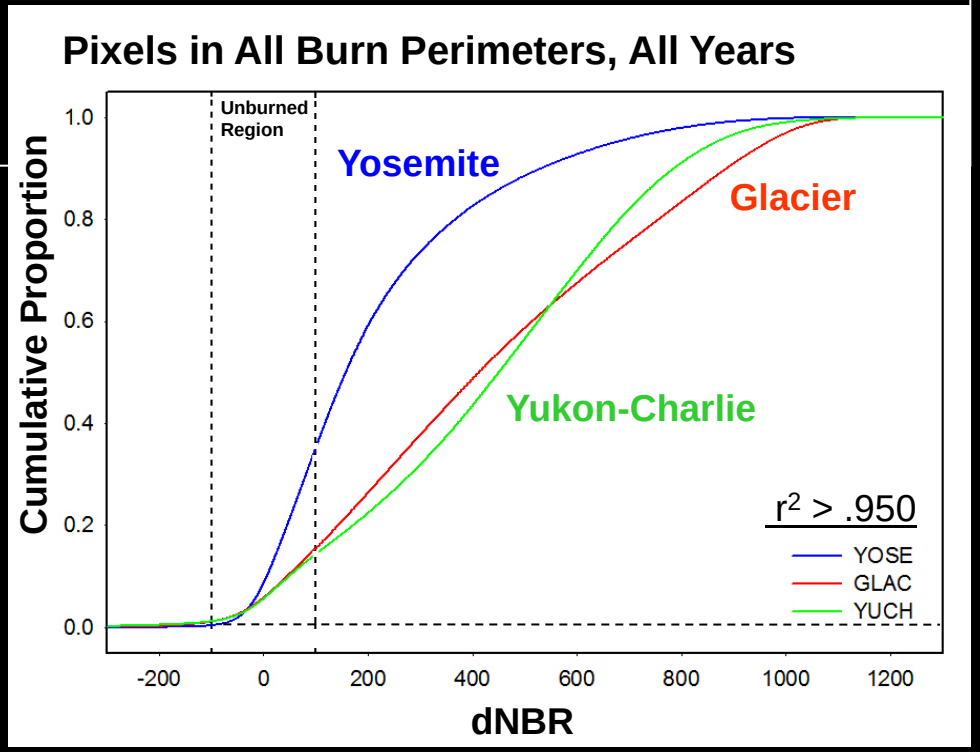
Weibull Distribution

- Weibull distribution good fit for dNBR distributions
- Burned/unburned – single ended
- Shape parameters

$x_0 \quad b \quad c$

$$y = 1 - e^{-\left(\frac{x - x_0 + b\ln 2^{\frac{1}{c}}}{b}\right)^c}$$

$$x > x_0 - b \times \ln(2)^{\frac{1}{c}}$$

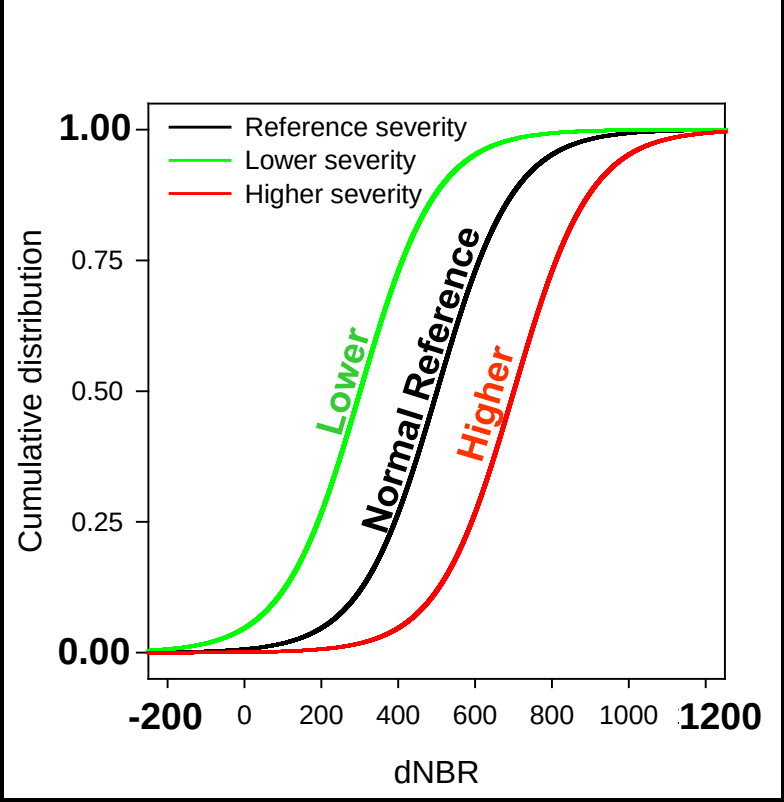


Considering Severity

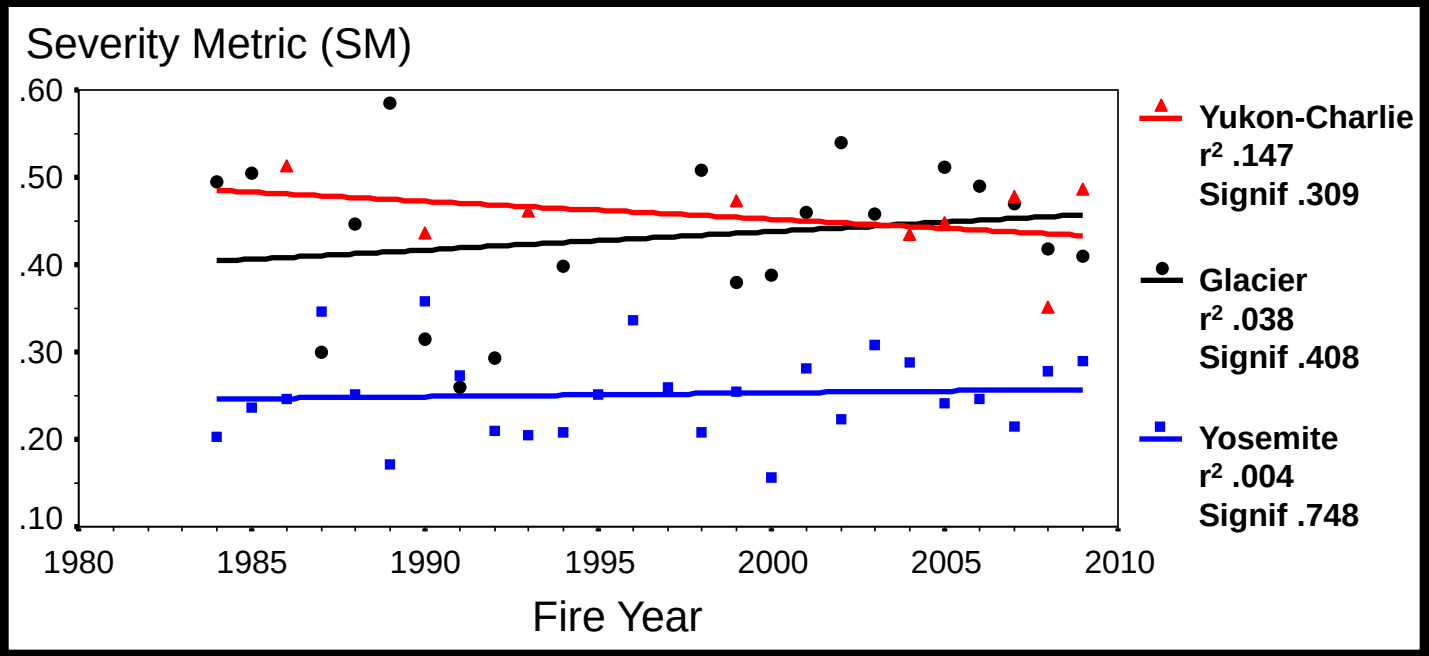
- Typical dNBR Range -200 to 1200
- Severity classification vs. Cumulative distribution
- Severity Metric (SM)

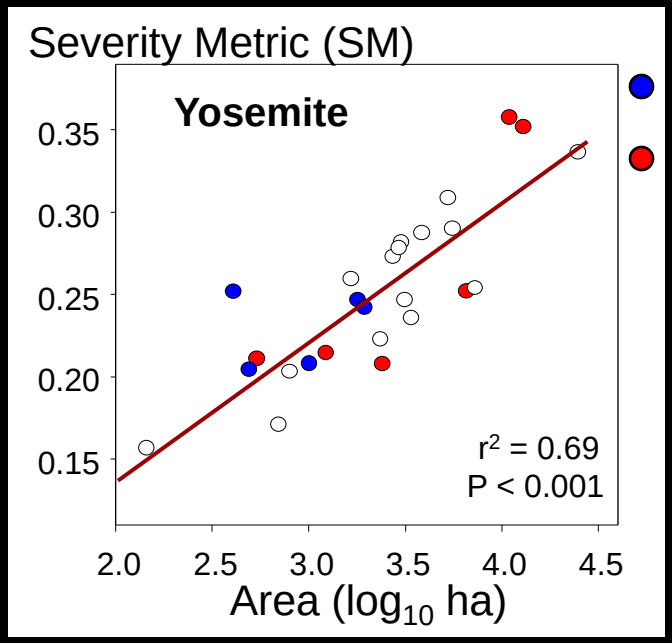
$$SM = 1 - \sum_{i=-200}^{1200} \frac{Proportion\ of\ pixels\ \leq i}{1401}$$

- SM for fires or fire years ...



Severity Trends – Severity Metric



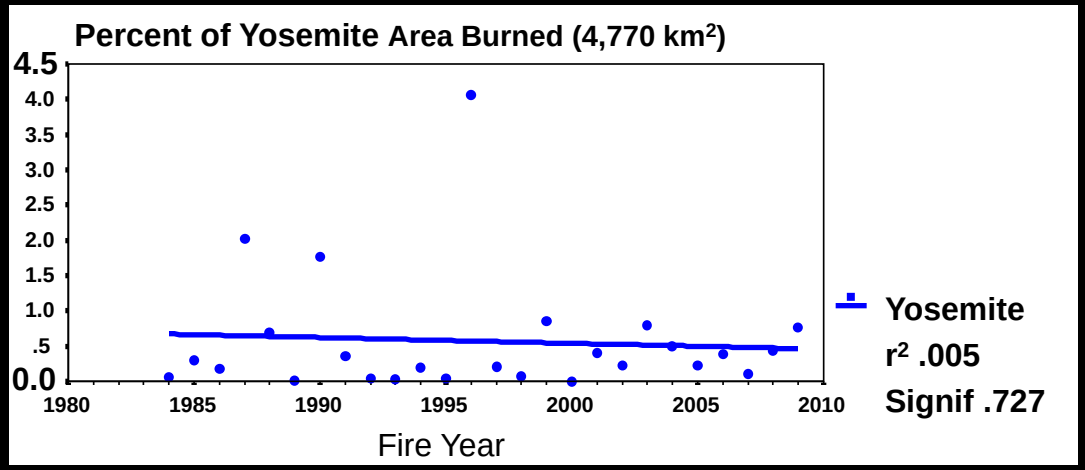


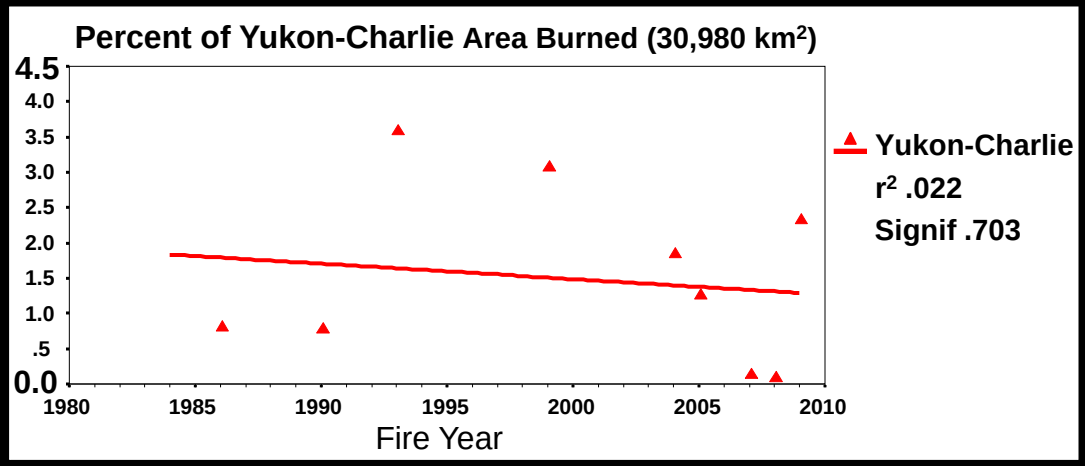
High Snow Pack Year

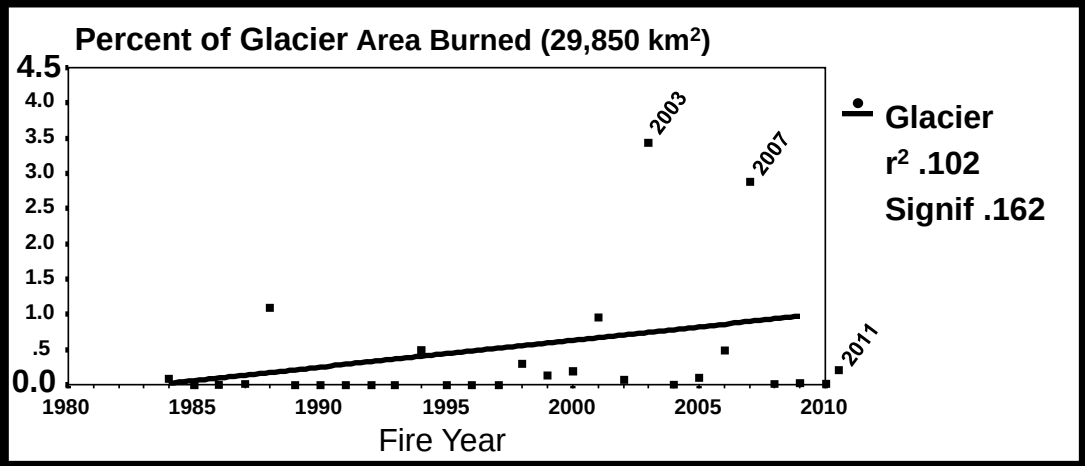
Low Snow Pack Year

Generally Weak (no) Correlations Across Years.

Considerably Stronger Correlations between Variables.

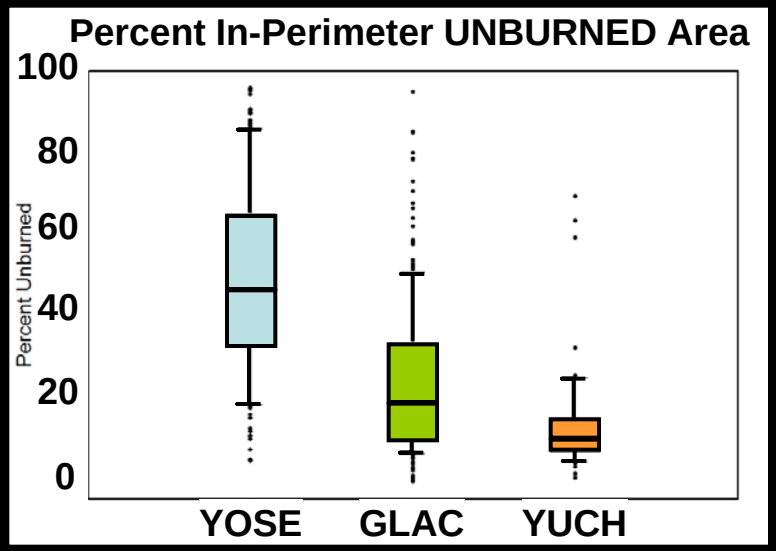




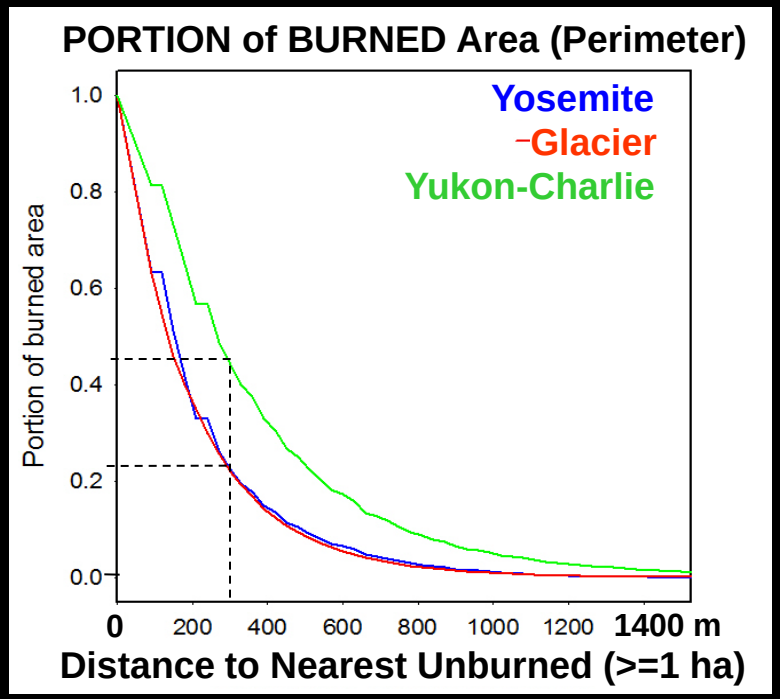


Actual Area Burned and Unburned w/in Fire Perimeter.

Normalized by Size Of Sample Area.

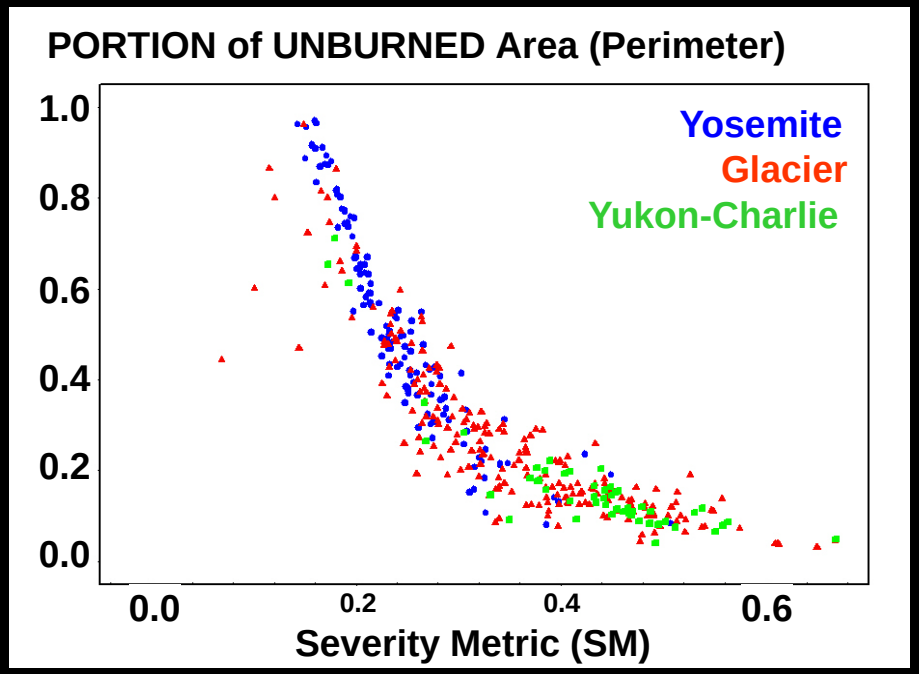


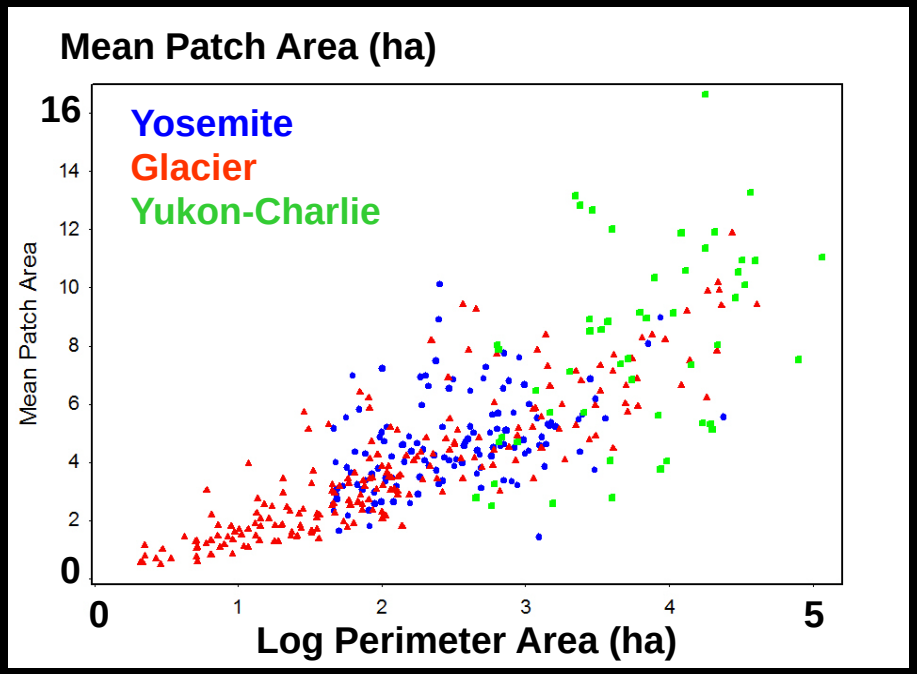
Burn heterogeneity...



Yukon-Charlie
45% of burn area
Is > 300 m from Unburned

Glacier and Yosemite
22% of burn area
Is > 300 m from Unburned





Contributions to Ecology

- Quantitative descriptions of fire/fire year
  - Ecological effect (dNBR),
  - as well as fire frequency and area burned
  - Post-fire landscape heterogeneity
- Cumulative severity distribution
- Consistent severity metric and models
- Objective statistical analysis