



5th International Fire Ecology and Management Congress

*Uniting Research, Education and Management*

December 3-7, 2012 Oregon Convention Center, Portland

Special Session  
Thursday—December 6, 2012

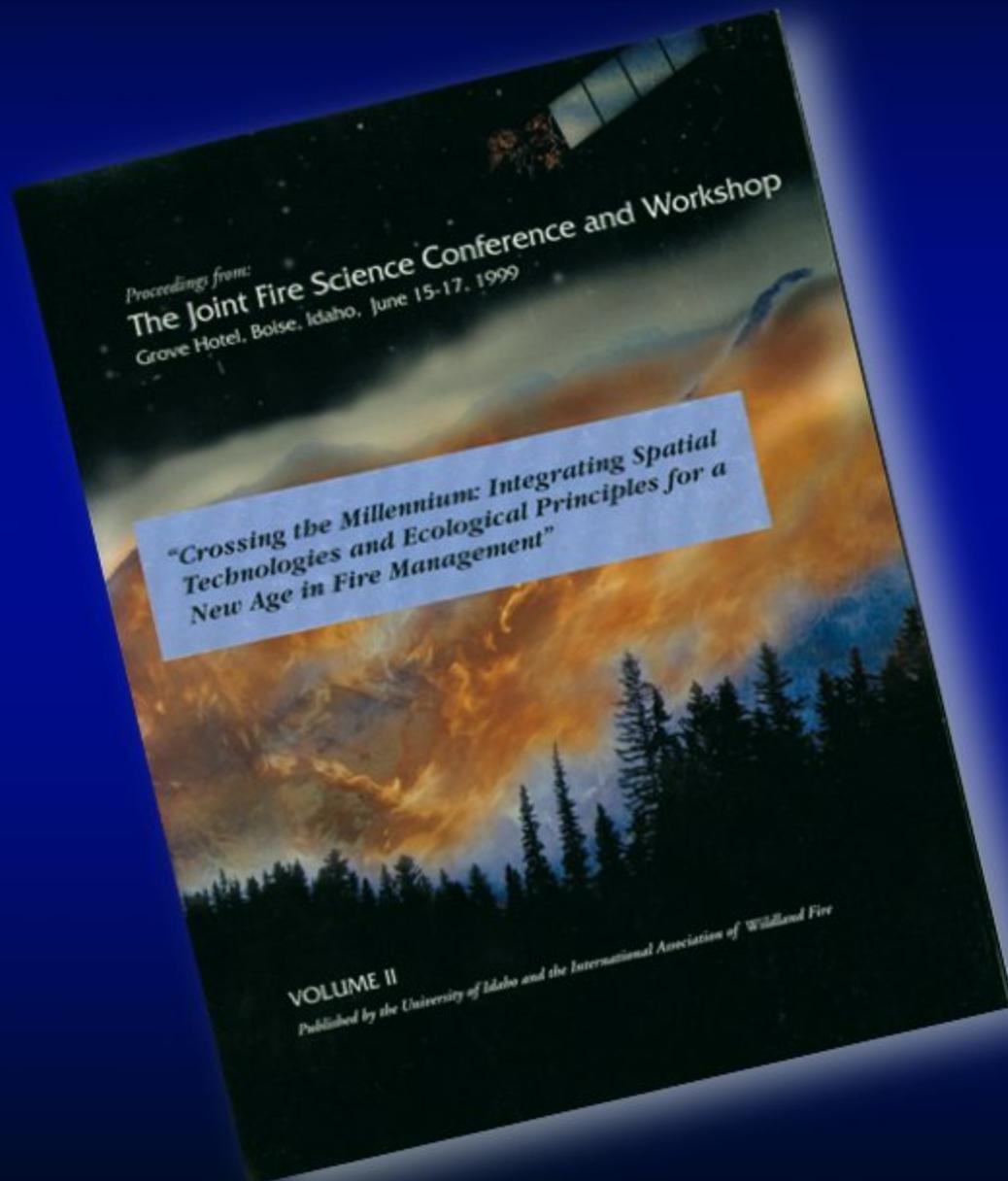
Looking back for a clear view  
of the future: 1999 to 2012

*“Life can only be understood backwards; but it must be lived forwards.”*

Søren Kierkegaard



# Crossing the Millennium: Integrating Spatial Technologies and Ecological Principles for a New Age in Fire Management



**Recommendation 6:**  
*More precise and consistent definitions and standards are needed for fire severity, hazard, and risk.*

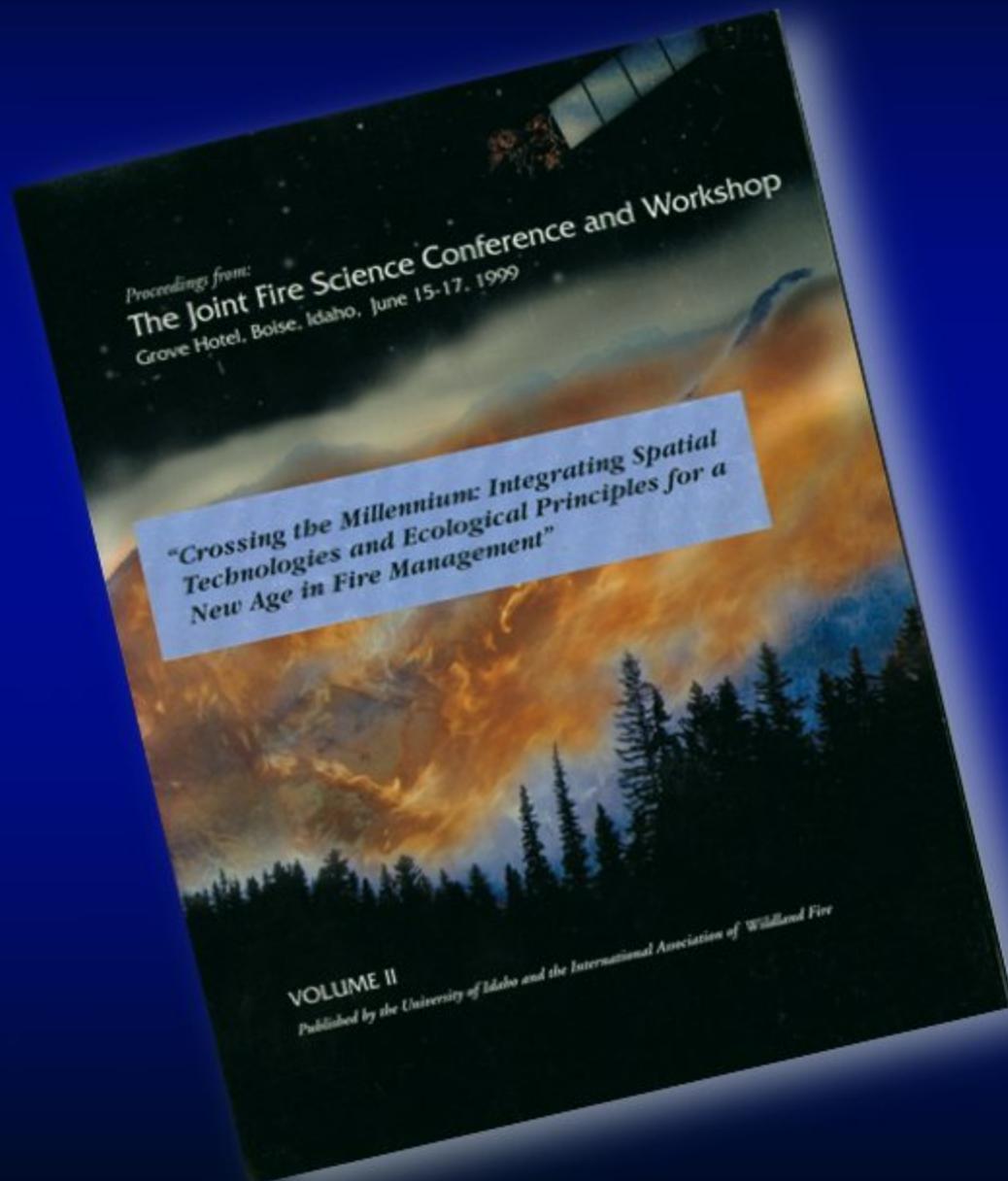
1. Hazard
2. Risk
3. Severity

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# Crossing the Millennium: Integrating Spatial Technologies and Ecological Principles for a New Age in Fire Management



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*More precise and consistent definitions and standards are needed for fire severity, hazard, and risk.*

1. Hazard
2. Risk
3. Severity

Jones FIRE With Contagion  
REPRINTED FROM THE JULY, 1968, MAGAZINE  
4229 / 4229

# NATIONAL GEOGRAPHIC

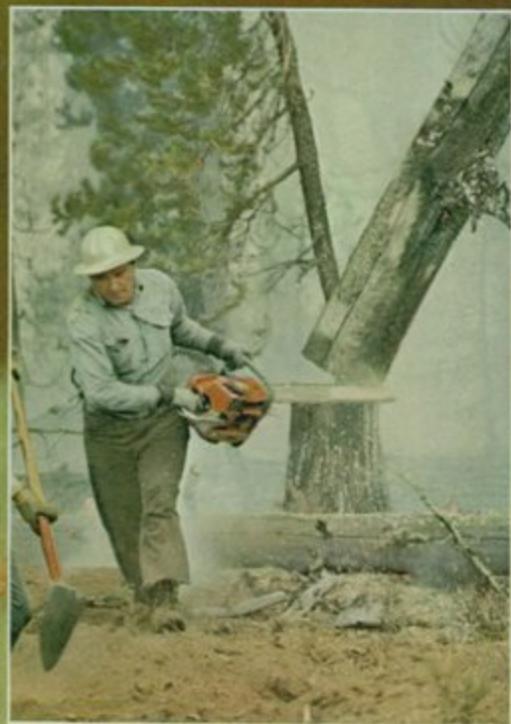
## *FOREST FIRE* *The Devil's Picnic*

By STUART E. JONES and JAY JOHNSTON  
National Geographic Staff



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National Geographic Magazine – July, 1968



ETCHINGS BY THE MUSEUM OF MODERN ART, NEW YORK

*WIND-WHIPPED FLAMES, roaring like a squadron of jets, ravage 100-foot trees on a mountaintop fire line in Willamette National Forest, Oregon. Firebrands the size of pie plates shoot hundreds of feet into the air. Courageous woodsman, chain-sawing a burning snag, joins in a valiant but futile effort to halt the holocaust.*

# *FOREST FIRE: The Devil's Picnic*

By **STUART E. JONES** and **JAY JOHNSTON**  
National Geographic Staff

# HAZARD



1909

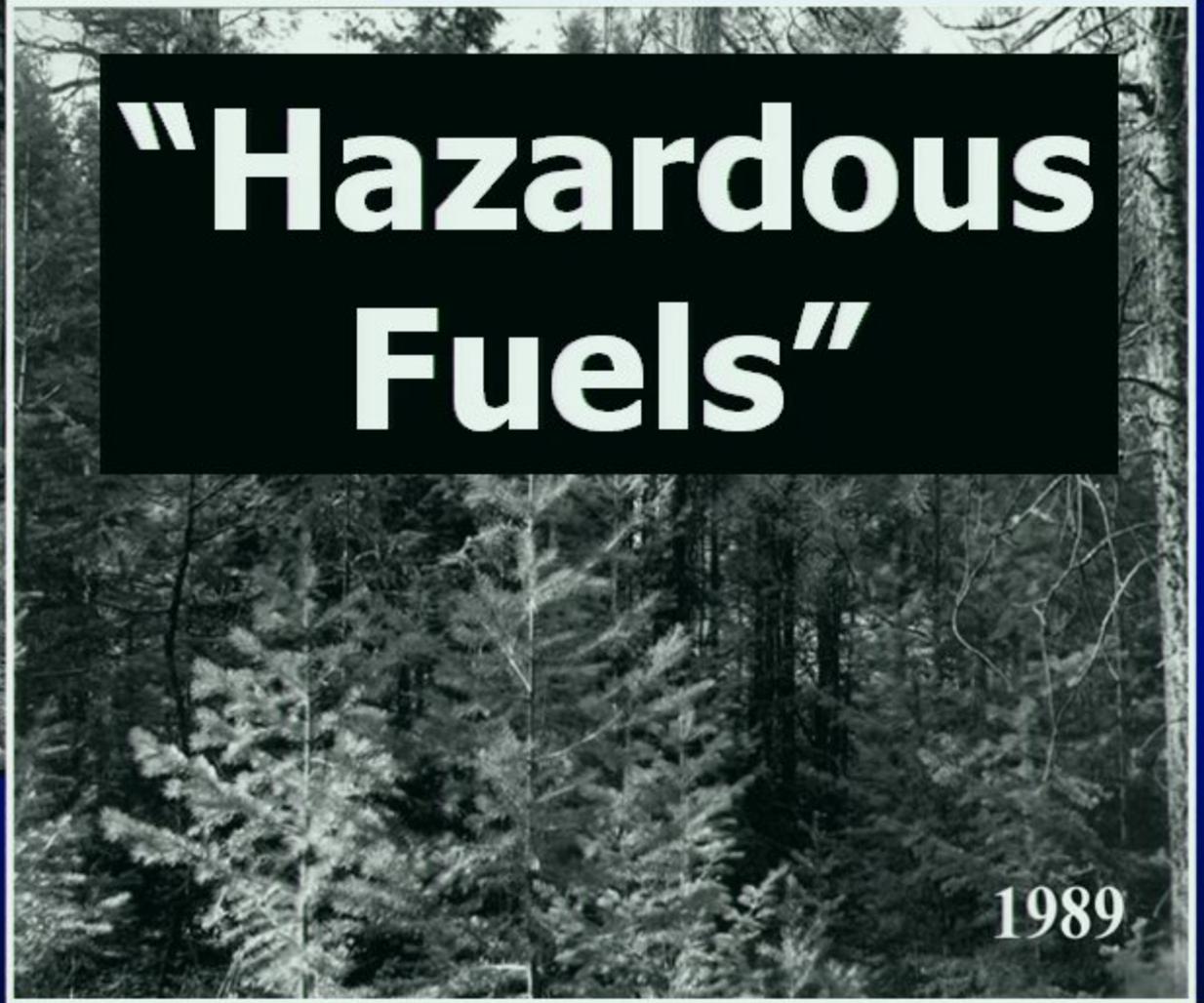
# HAZARD



# HAZARD



## "Hazardous Fuels"





# HAZARD

NWCG. Glossary of Wildland  
Fire Terminology.  
(2003 revisions)



# HAZARD

NWCG. Glossary of Wildland  
Fire Terminology.  
(2003 revisions)

A fuel complex, defined by volume, type, condition, arrangement, and location that determines the degree of ease of ignition and of resistance to control.

(classically defined; independent of weather)



1989

# HAZARD

In: Proceedings from the Joint Fire Science Conference and Workshop – 1999

*Crossing the Millennium: Integrating Spatial Technologies and Ecological Principles for a New Age in Fire Management*



# HAZARD

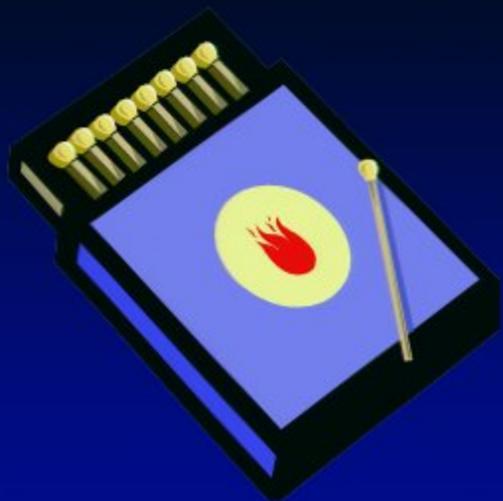
In: Proceedings from the Joint Fire Science Conference and Workshop – 1999

*Crossing the Millennium: Integrating Spatial Technologies and Ecological Principles for a New Age in Fire Management*

Bachman and Allgöwer – (on terminology) :

“...not only the precondition for a specific process...but it is the process itself.”

Therefore: *Wildfire is the Hazard.*



# FIRE RISK

NWCG —2003. Glossary of Wildland Fire Terminology.

SAF — 1998. The Dictionary of Forestry.

FAO —1986. [wildfire glossary].

CCFFM —1987. [wildfire glossary].



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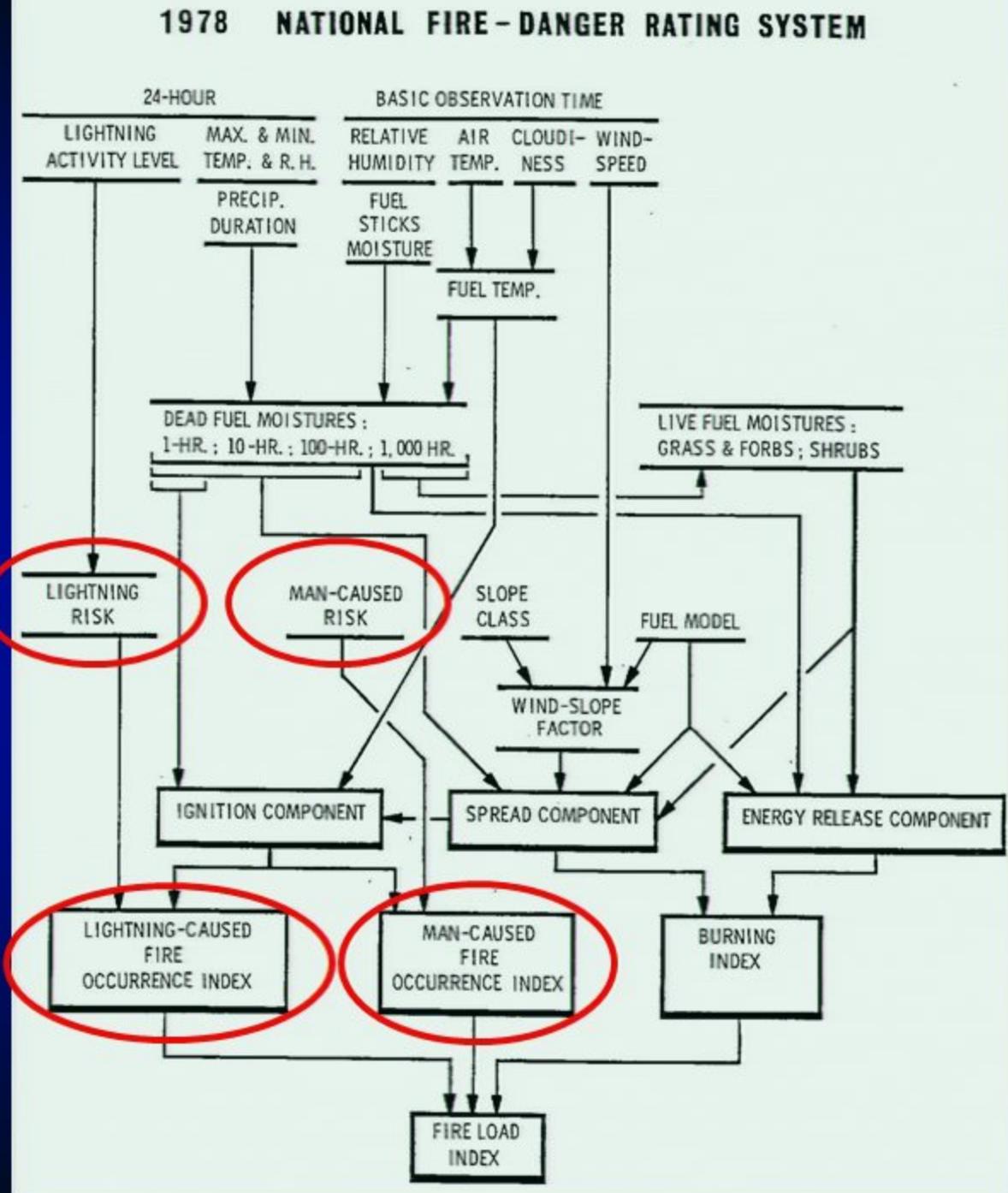
*The chance that a fire may start, as affected by the nature and incidence of causative agents.*

(classically defined only as probability)

# FIRE RISK

*The chance that a fire may start, as affected by the nature and incidence of causative agents.*

Simplistic ! ?



# Technical Risk

## Engineering Terminology

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$$\textit{risk} = \text{probability}^1 * \text{damage}^2$$

1 Probability of a fire outbreak

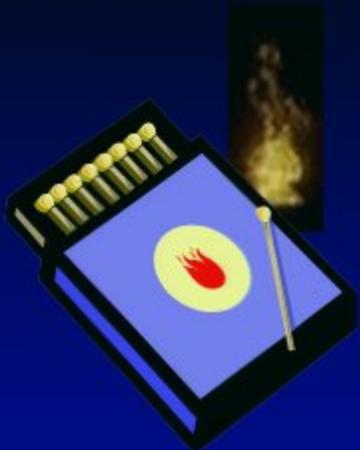
2 Damage caused by the fire



# FIRE RISK

\* In: Proceedings from the Joint Fire Science Conference and Workshop – 1999





# FIRE RISK

\* In: Proceedings from the Joint Fire Science Conference and Workshop – 1999



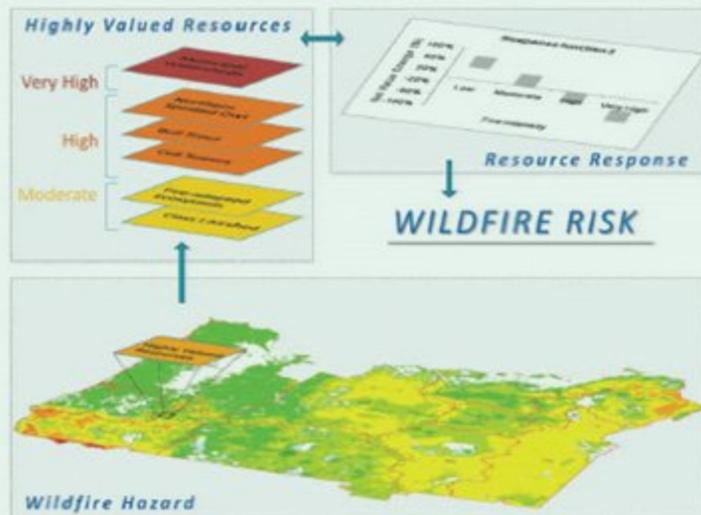
Wildfire Risk: The probability of a wildfire to occur at a specified location and **under given circumstances** and its expected outcome as defined by the **impacts on the affected objects**.

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\* Bachman and Allgöwer – (on terminology)



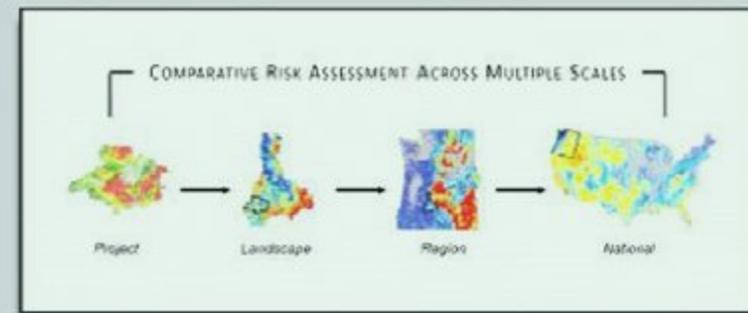
## Wildfire Risk and Hazard: Procedures for the First Approximation



Calkin et al. 2010 RMRS-GTR-235

## A Comparative Risk Assessment Framework for Wildland Fire Management:

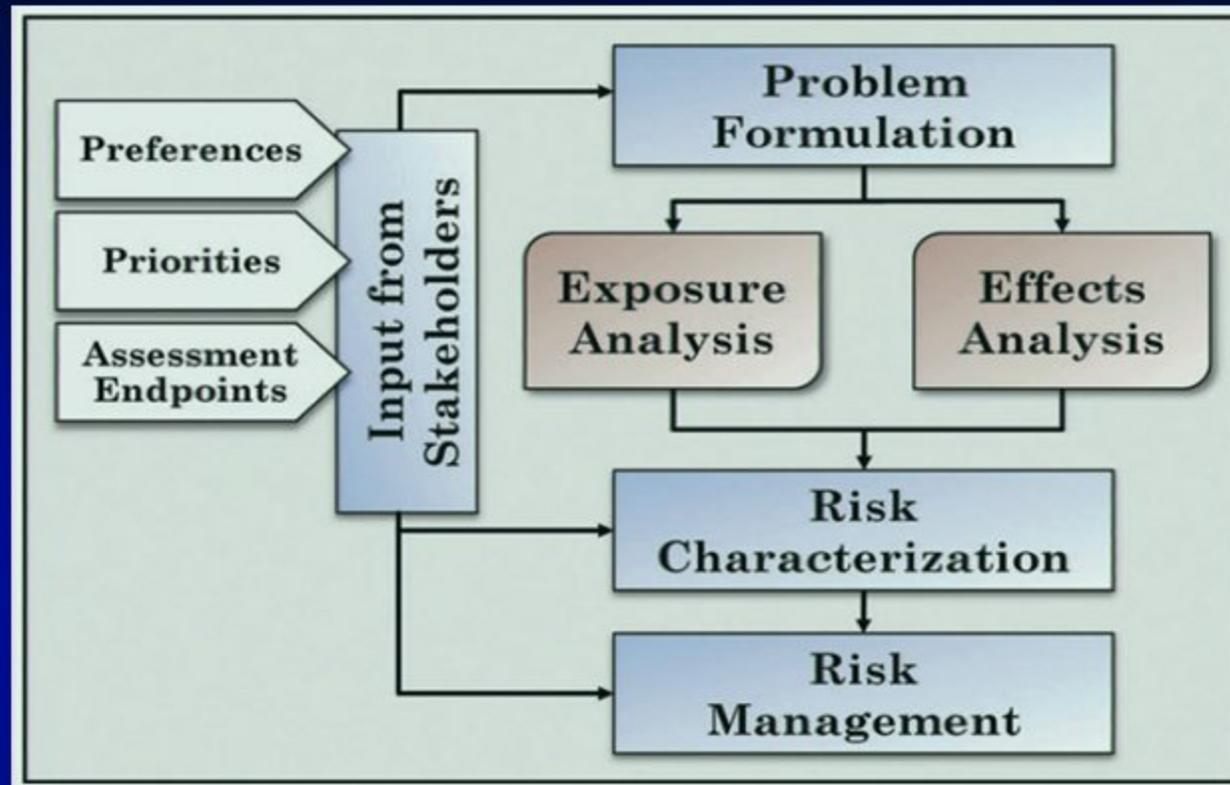
### The 2010 Cohesive Strategy Science Report



Calkin et al. 2011 RMRS-GTR-262

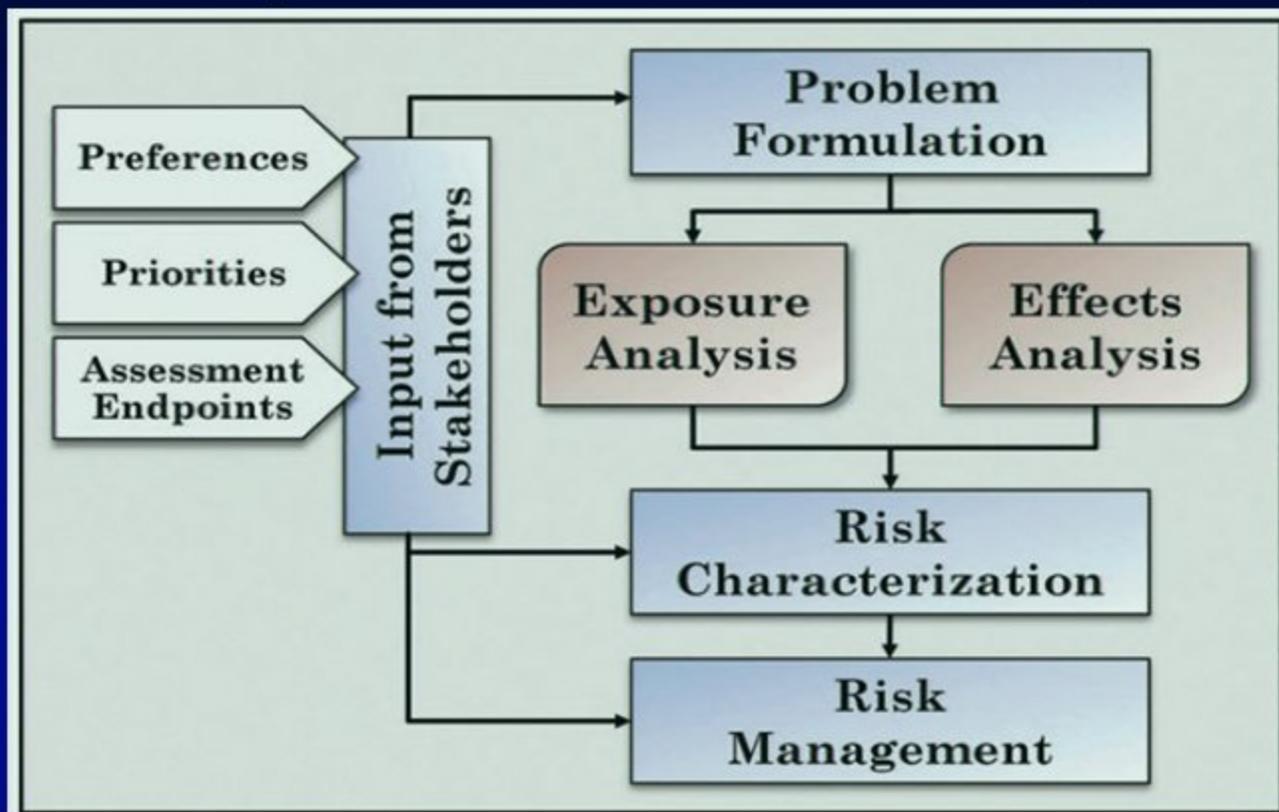
This Conference — Tuesday, 4 December  
Issues of wildfire risk assessment and management

# 2011 - - “Comparative Risk Analysis”



“Comparative risk assessment simply extends the [classic risk] analysis to include decision space available to managers and stakeholders to allow them to explore the tradeoffs between alternative courses of action.”

# “ Comparative Risk Analysis ”



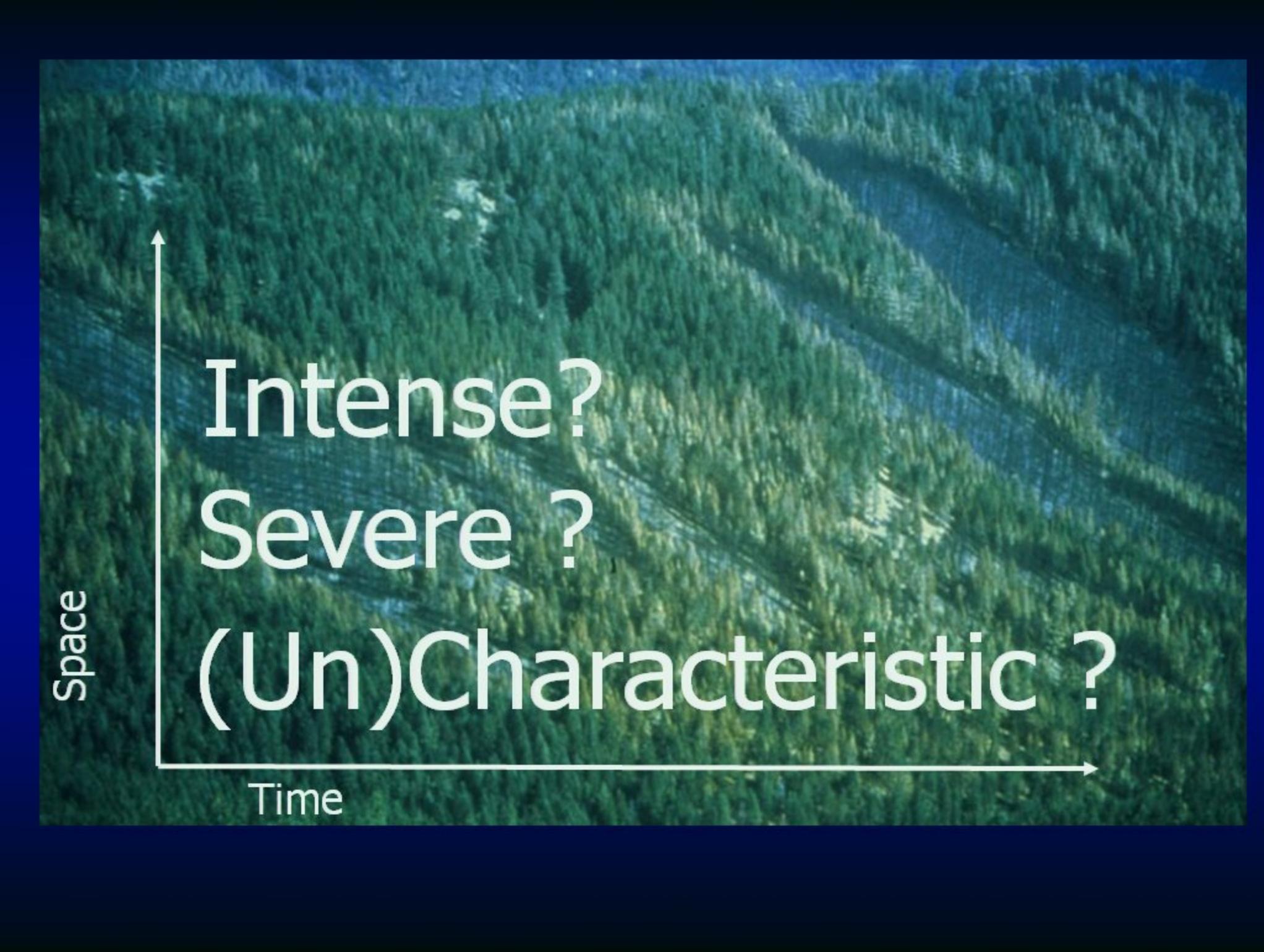
$$E(NVC_j) = \sum_i p(f_i) RF_j(f_i)$$

where

$E(NVC_j)$  = expected net value change to resource  $j$

$p(f_i)$  = probability of a fire at intensity level  $i$

$RF_j(f_i)$  = response function for resource  $j$  as a function of fire at intensity level  $i$

An aerial photograph of a dense green forest. A white coordinate system is overlaid on the image, consisting of a vertical y-axis and a horizontal x-axis, both ending in arrows. The y-axis is labeled 'Space' and the x-axis is labeled 'Time'. The text 'Intense?', 'Severe?', and '(Un)Characteristic?' is written in white, sans-serif font across the center of the image, positioned between the two axes.

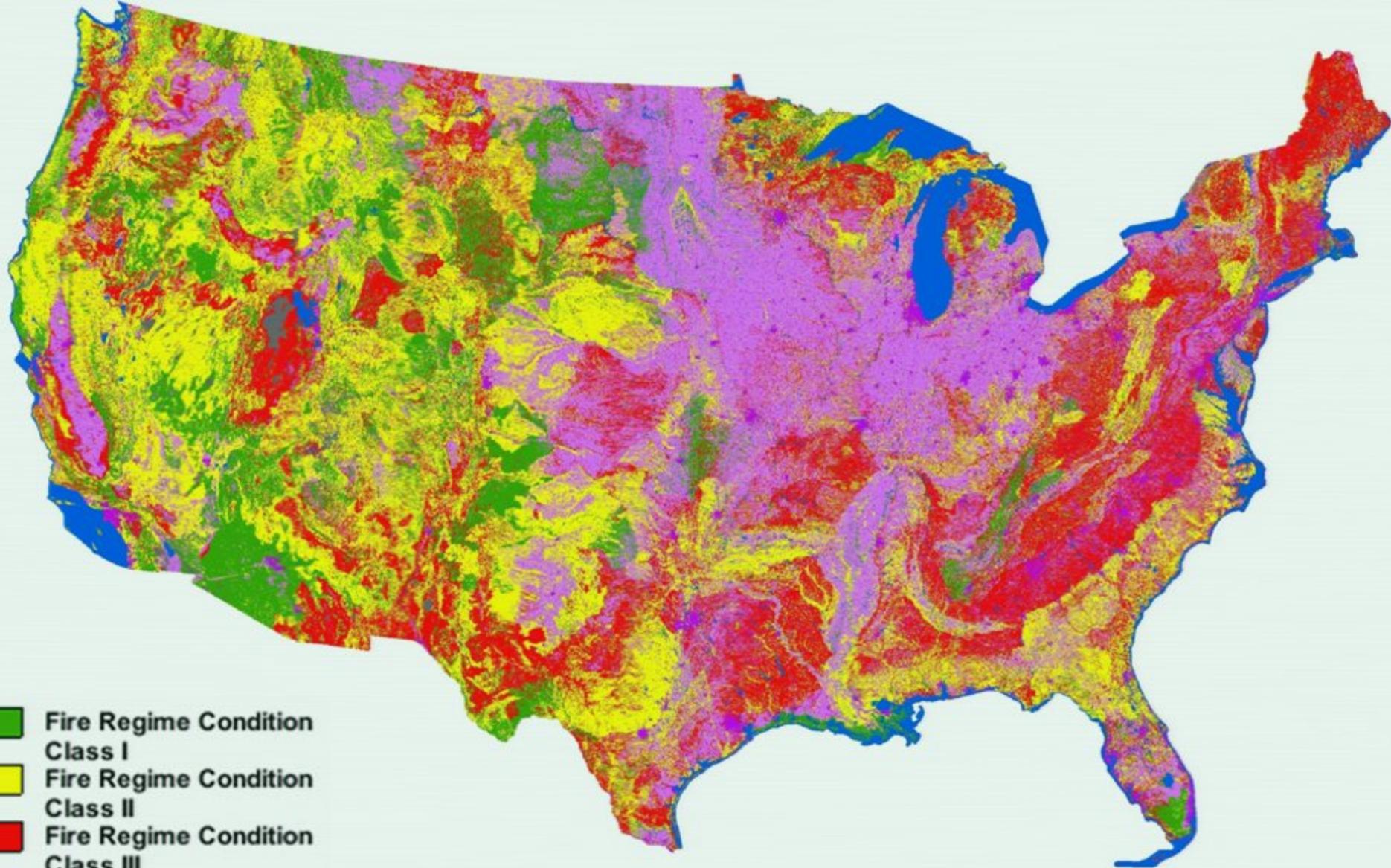
Space

Intense?

Severe ?

(Un)Characteristic ?

Time



-  Fire Regime Condition Class I
-  Fire Regime Condition Class II
-  Fire Regime Condition Class III
-  Water
-  Snow / Ice
-  Urban
-  Barren
-  Sparsely Vegetated
-  Agriculture
-  Out of range

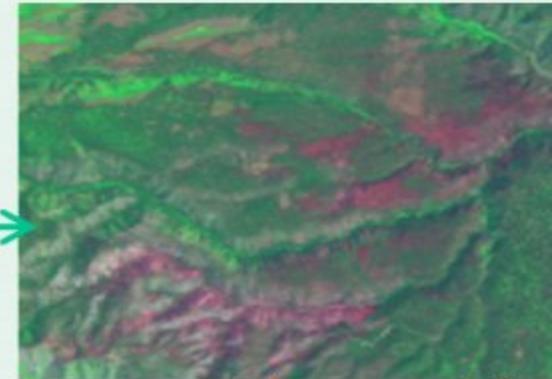
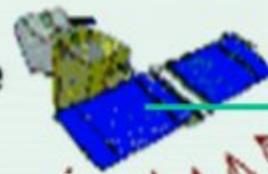
Fire Regime Condition Class  
from Landfire  
([www.landfire.gov](http://www.landfire.gov))

# Burn severity: ecological change

## Satellite-inferred burn severity:

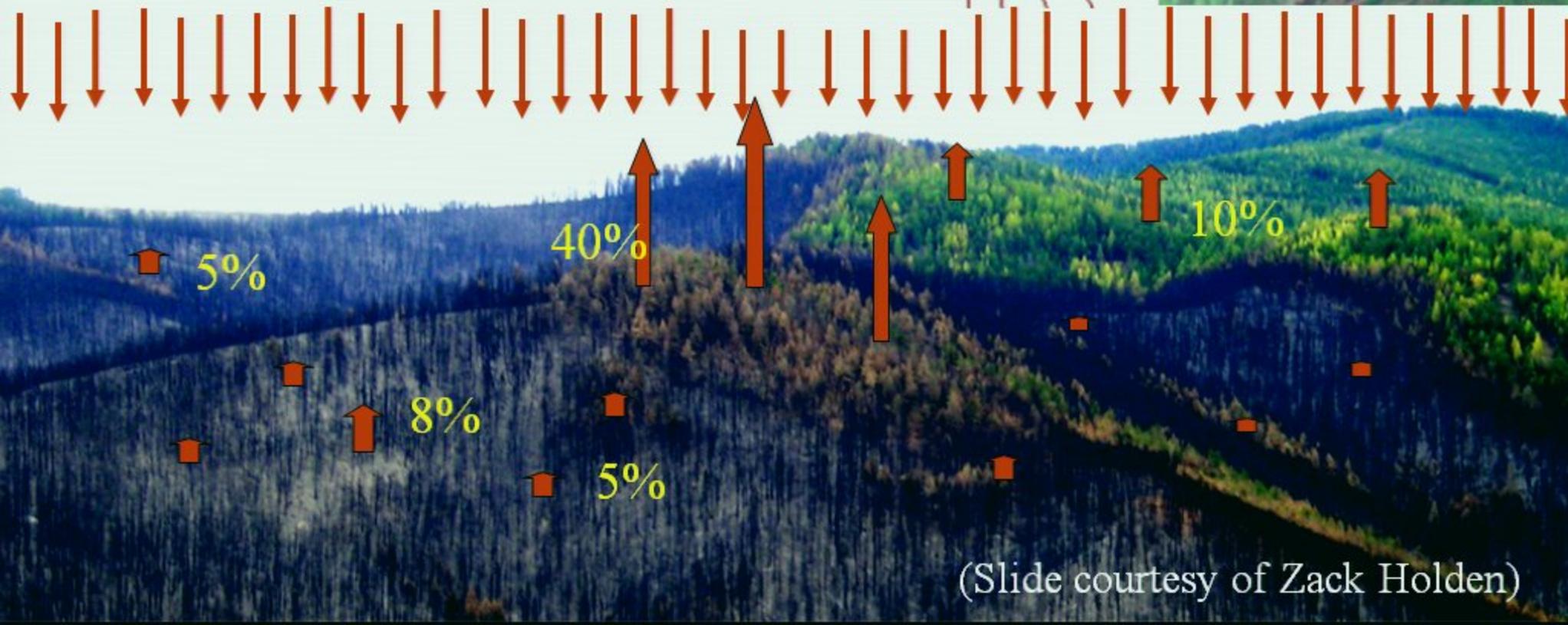
*Magnitude of change in 1 year post-fire relative to pre-fire conditions*

Satellite

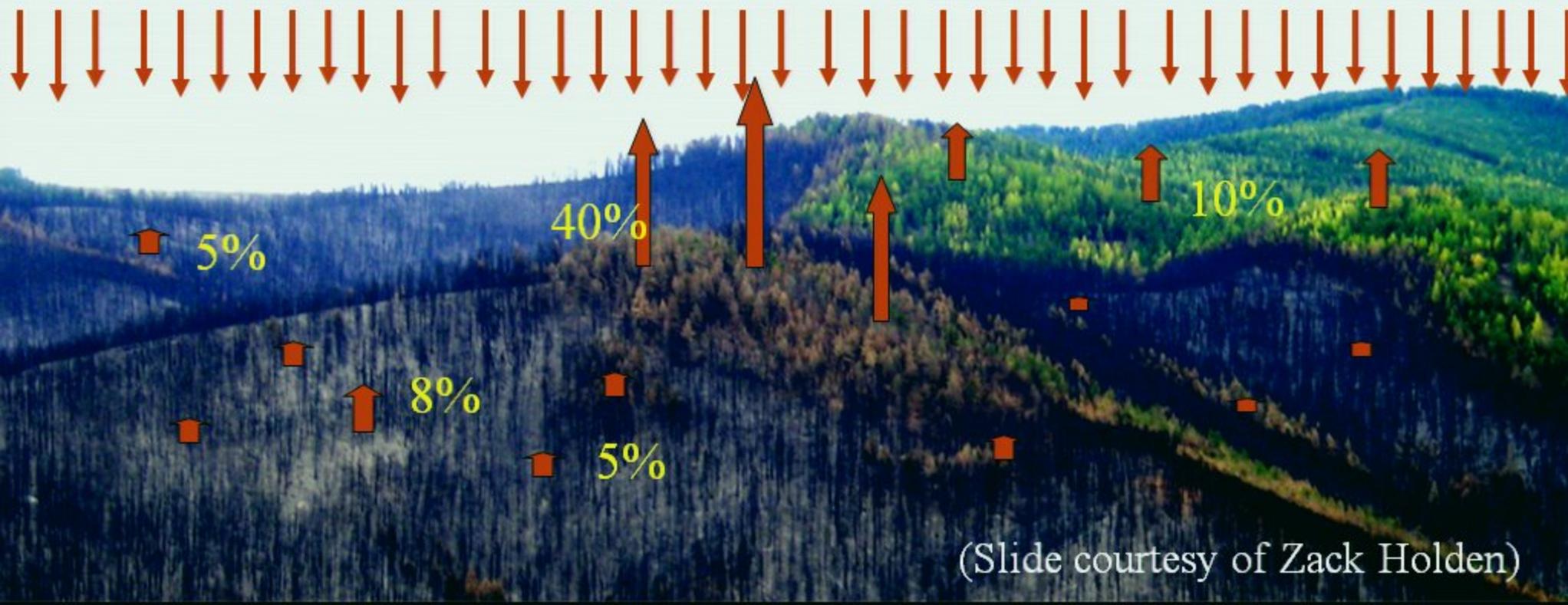
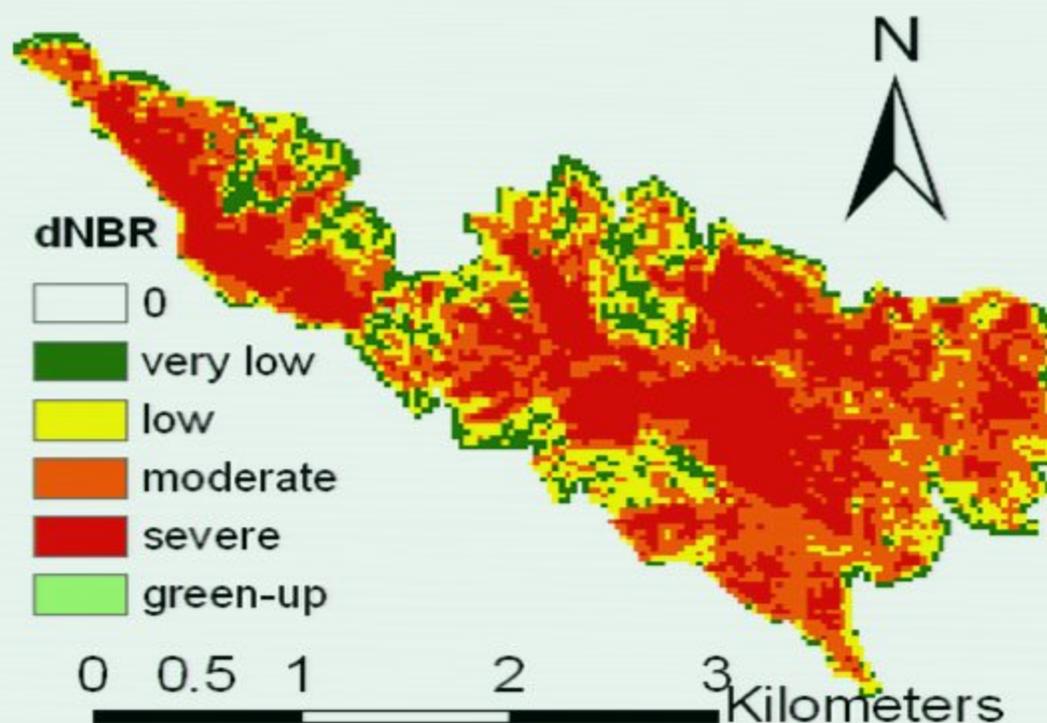
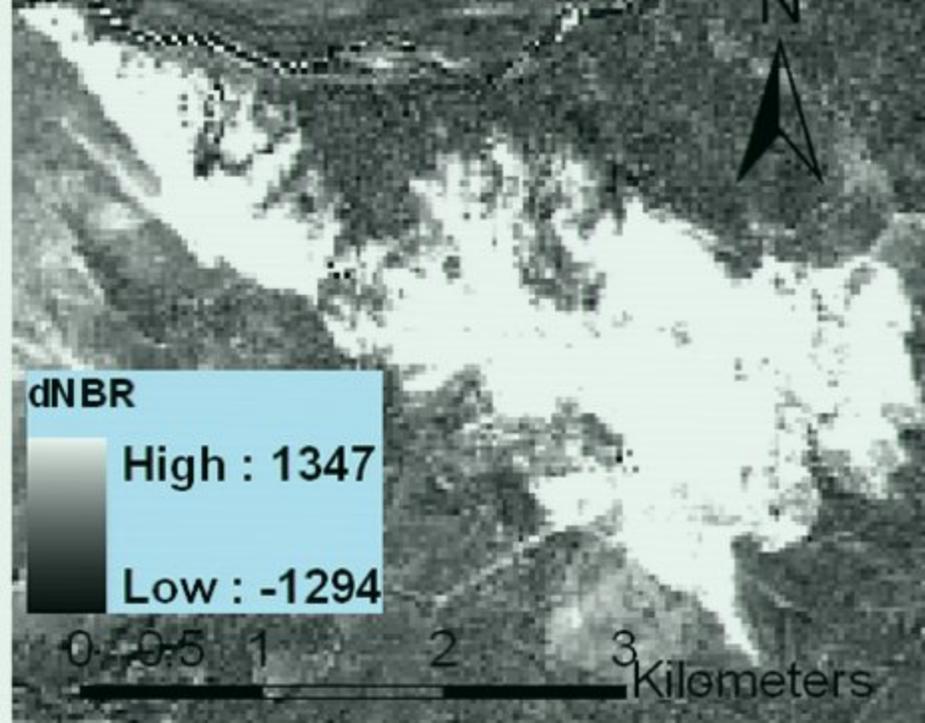


Reflectance

100%

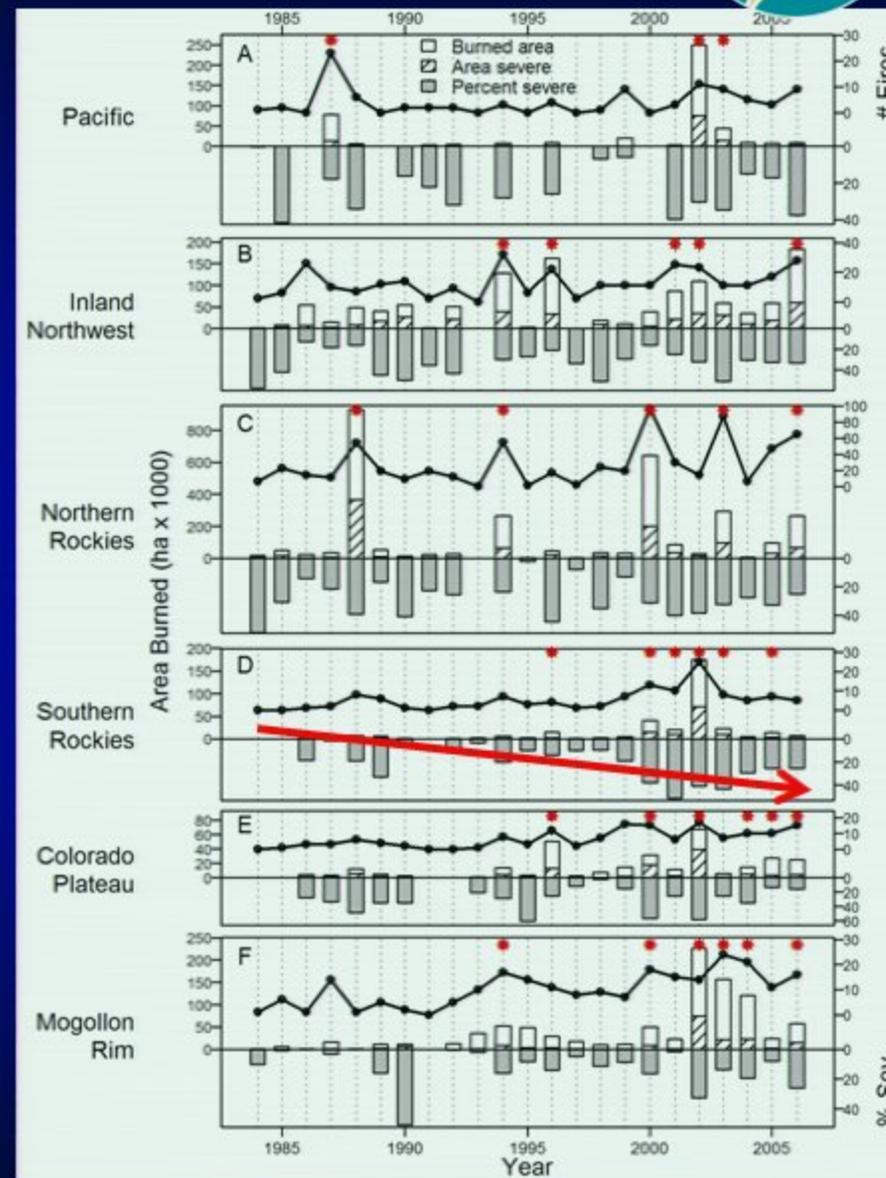
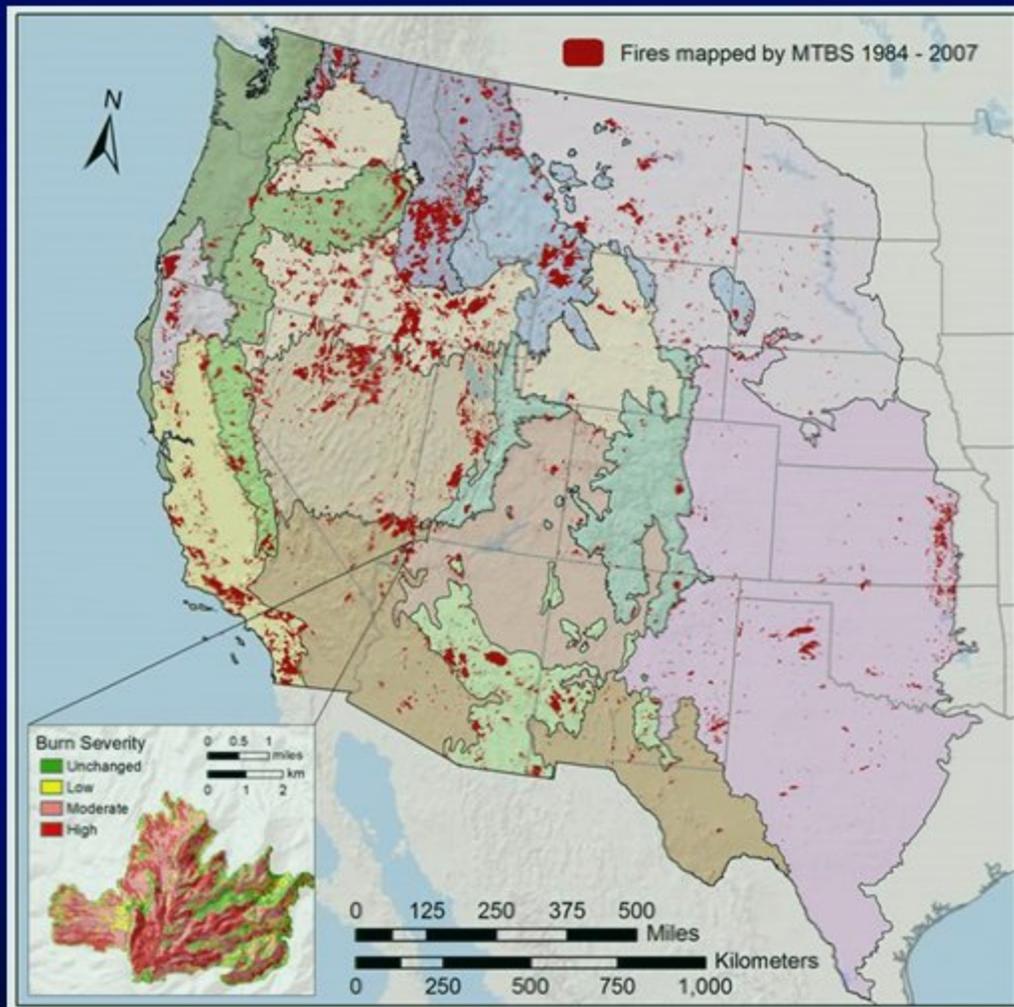


(Slide courtesy of Zack Holden)

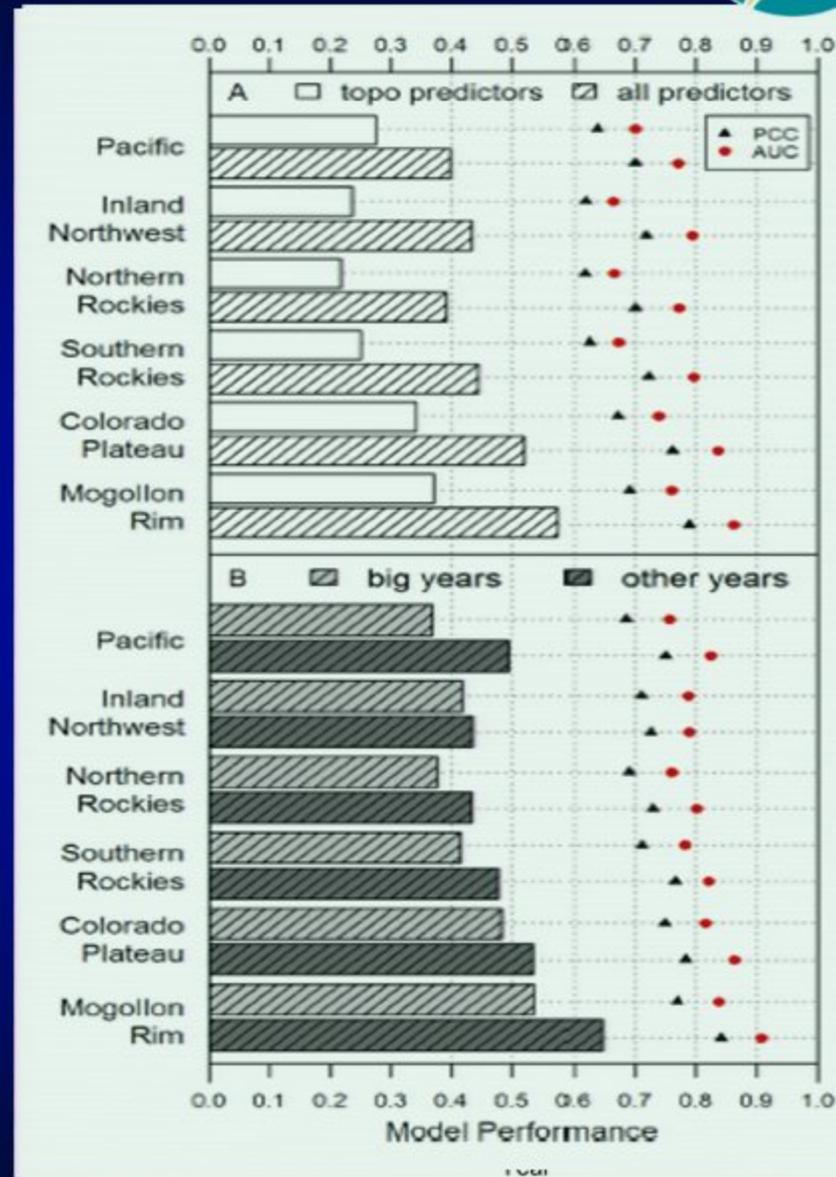
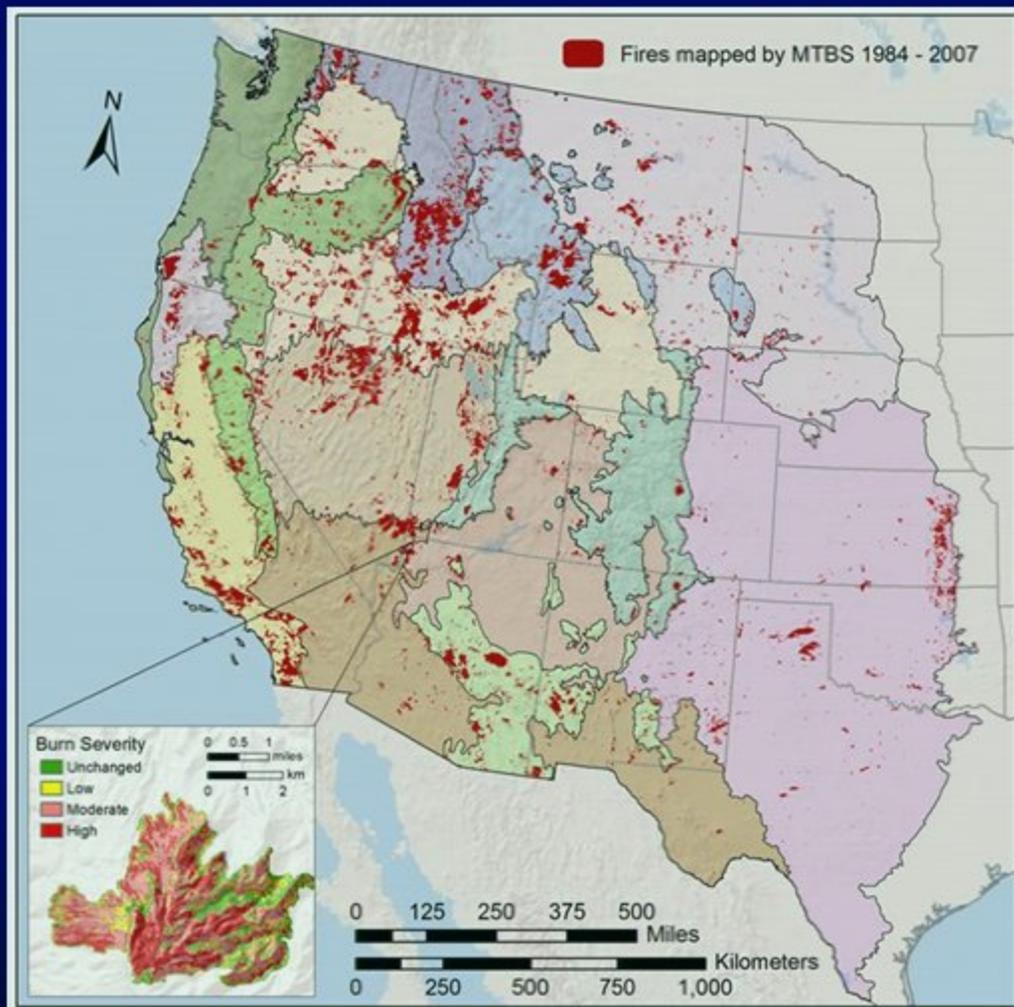


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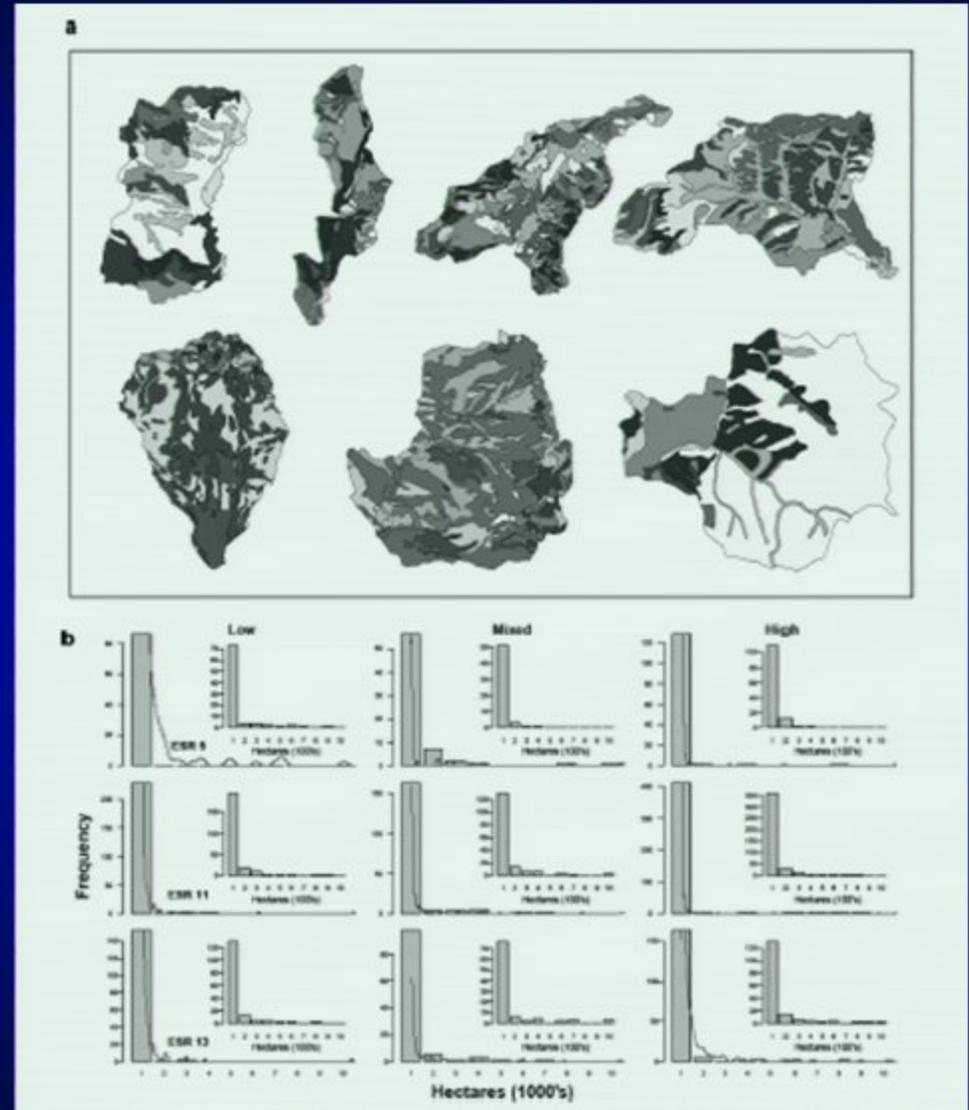
# Mapping probability of high severity fires



# Mapping probability of high severity fires



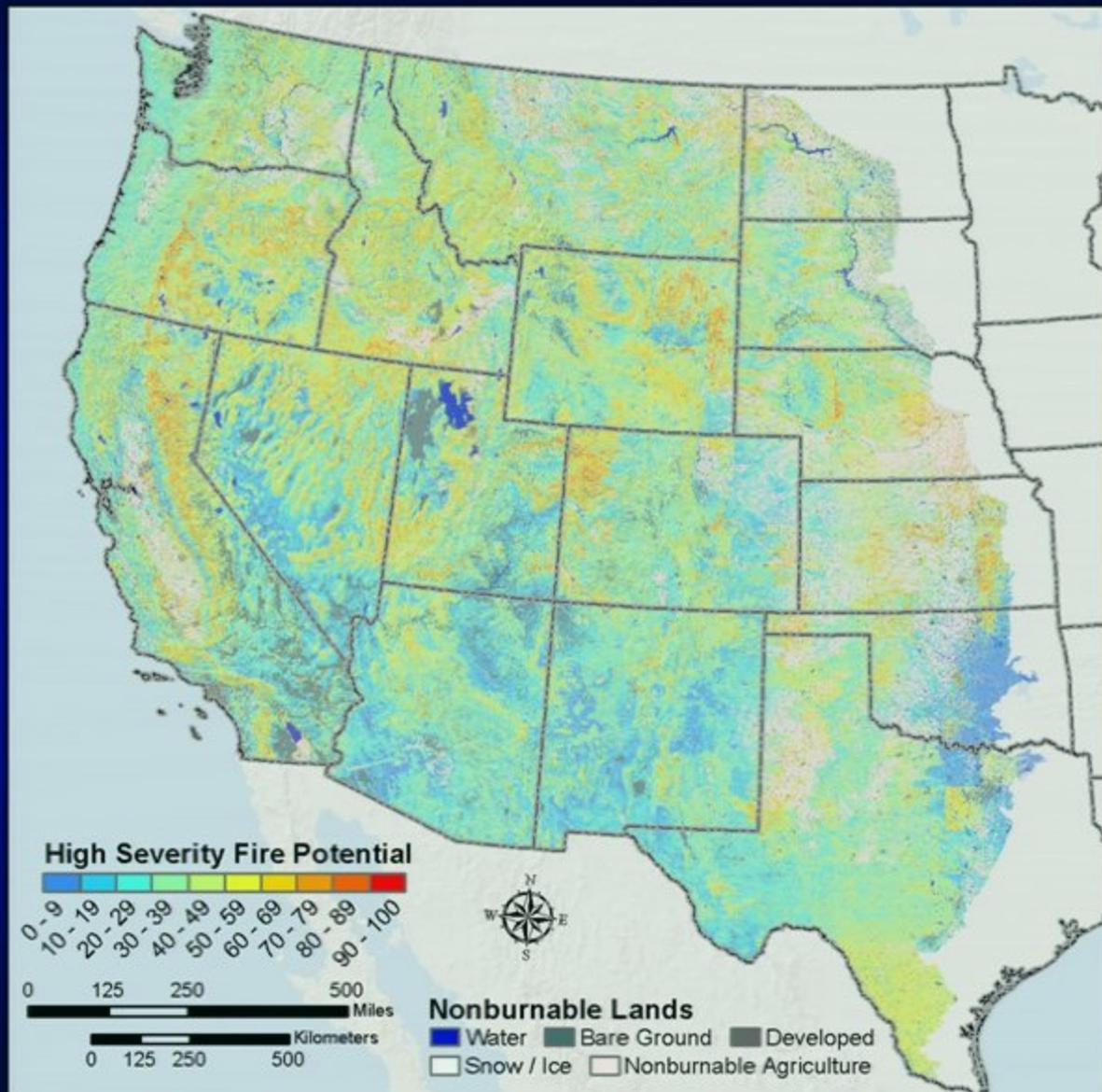
# Patch size distribution



Perry et al. 2012. The ecology of mixed severity fire regimes  
In Washington, Oregon, and Northern California.  
Forest Ecology and Management 262: 703–717

# Probability of severe fire

- 90<sup>th</sup> percentile, 30-m
- 2 million sample pixels
- 7,000 fires, 1984 to 2007
- Modeled and mapped separately for non-forest vs. forest and woodlands
- Topography, vegetation, & fuel moisture
- Cross-validated model accuracies 65% to 83%



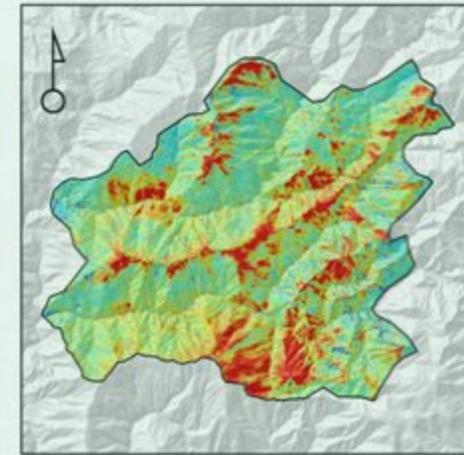
# Mixed severity fires

- Mixed fire effects, stand replacing to nonlethal
- Intermixed patches
- Many patches with 20-70% mortality (Agee 1990, 1993)
- Complex, poorly understood

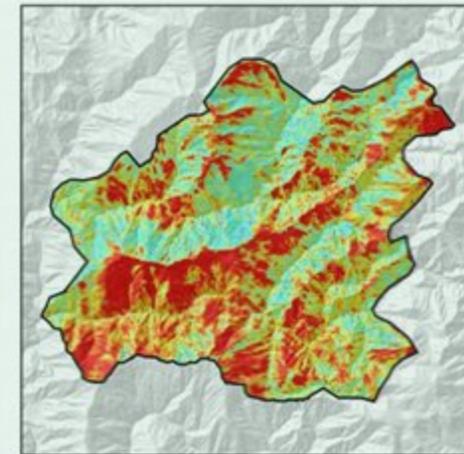


Mixed severity fire effects on Biscuit fire, Photo by T. Spies, from Halofsky et al. 2011, Ecosphere

Silver Fire Severity (1987)



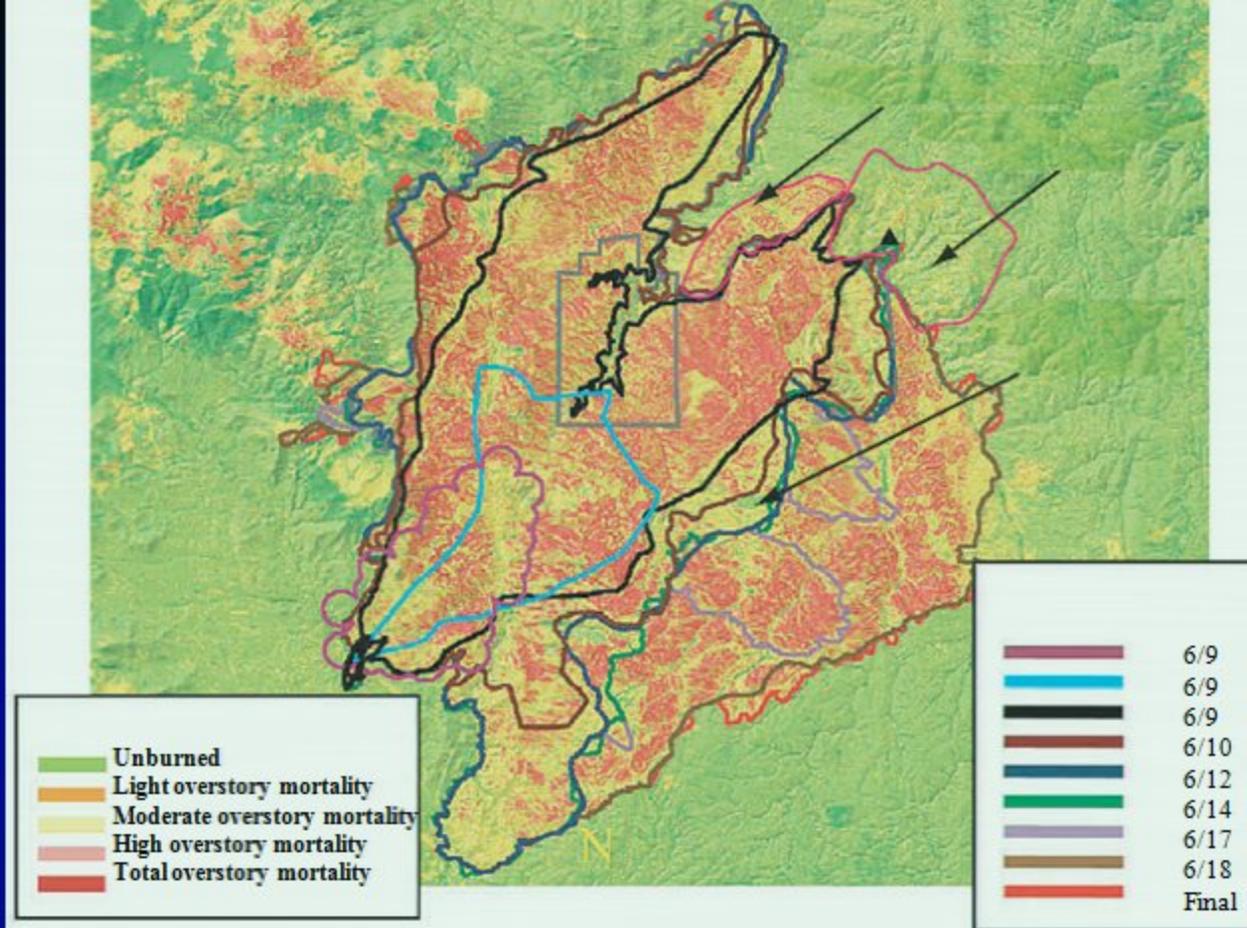
Biscuit Fire Severity (2002)



Both the Silver and Biscuit fire burned with mixed severity in the same area in Oregon. From Halofsky et al. 2011

# Implications, Interactions

- Variable over time and space
- Influence of land use, management, disturbances, climate, global change



Burn severity and fire extent in the 2002 Hayman fire. Most of the 138,110 ac burned in a few days (e.g. 9 June (black line) and 18 June (brown line)). Burn severity interpreted from classes interpreted from satellite imagery using dNBR. From Schoennagel et al. 2004 who modified it from Finney et al. 2003).

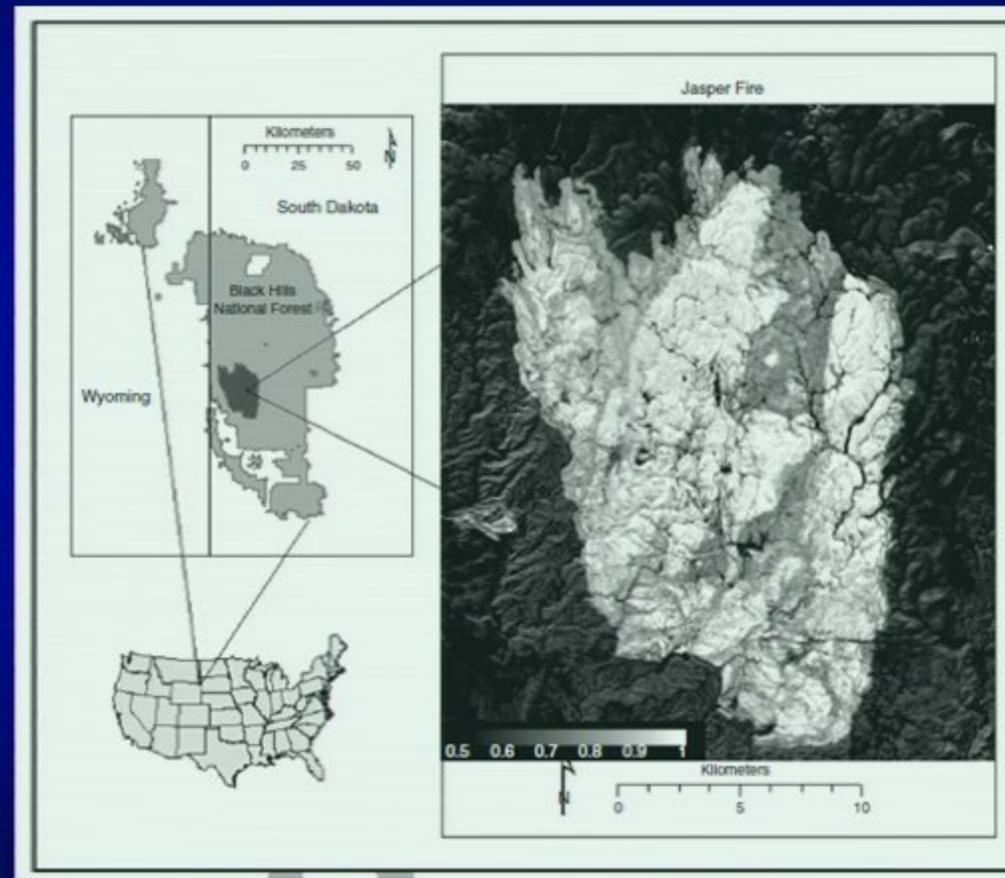
# Challenges & recommendations

- Causes and consequences
- Trends in burn severity
- Defining thresholds
- Continuous response
- Spatial variability



# Alternative metrics of severity: scalable, measurable in field & remotely, meaningful

- Percent char/green (Lentile et al. 2009)
- Suite of metrics
- Multiple dimensions of burn severity (Keane et al. 2011)
  - overstory mortality
  - soil heating
  - fuel consumption



# Challenges, recommendations

- Linking conditions before, during and after fires
- Models of flaming AND glowing combustion
- Depends on spatially coincident, quantitative, measures

