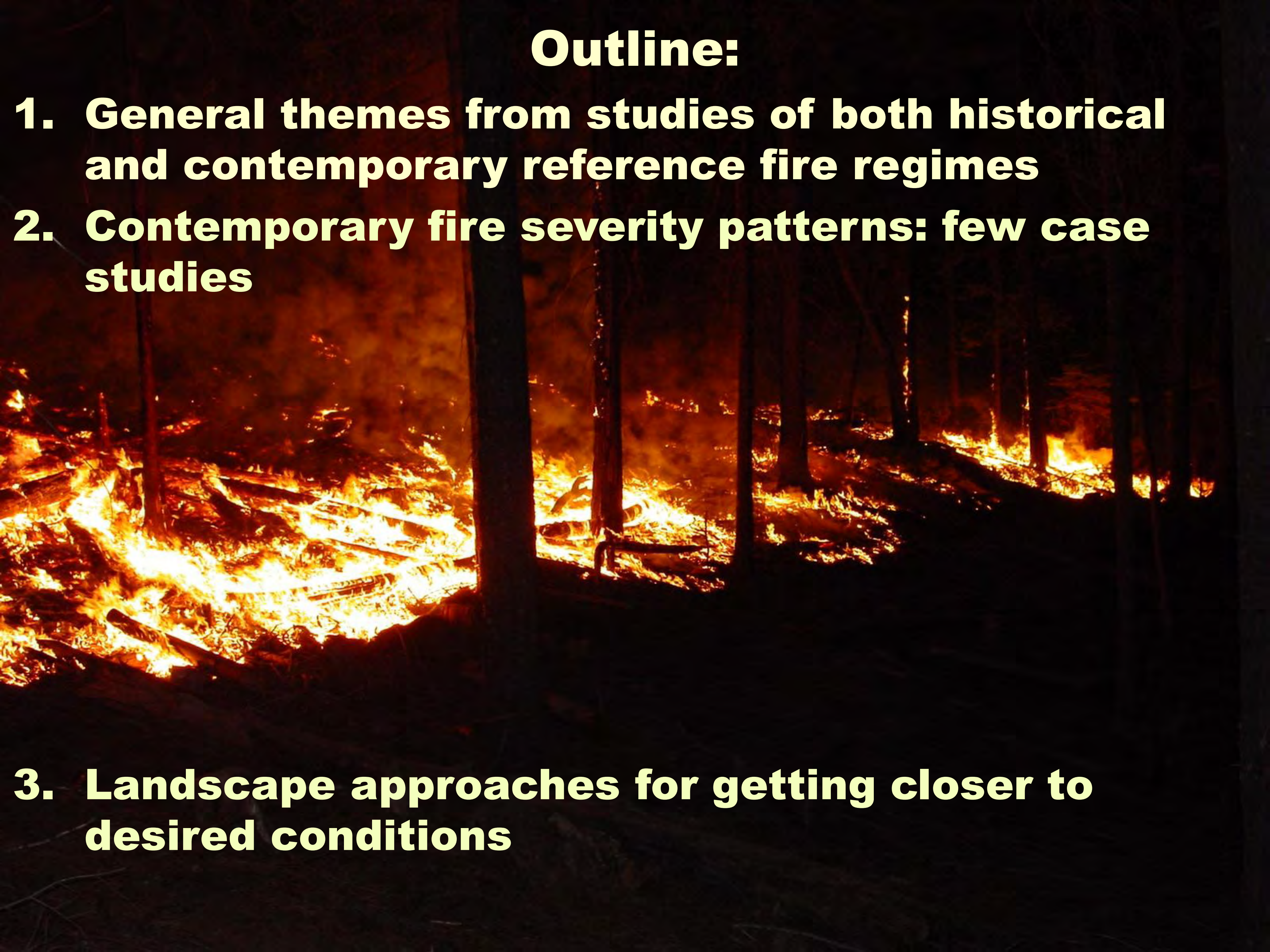
Managing forests and fire in landscapes historically associated with frequent fire

Brandon Collins, *USDA Forest Service, Pacific Southwest Research Station*



Outline:

1. General themes from studies of both historical and contemporary reference fire regimes
2. Contemporary fire severity patterns: few case studies
3. Landscape approaches for getting closer to desired conditions

1.1 Historical fire occurrence/effects cont'd

Mixed-conifer forests:

Show and Kotok (1924):

> "California pine forests* represent broken, patchy, understocked stands, worn down by the attrition of repeated light fires."

"Extensive crown fires…are almost unknown to the California pine region*."

"The virgin forest, subjected to repeated surface fires for centuries has been exposed to… cumulative risk."

*likely including mixed-conifer

1.1 Historical fire occurrence/effects cont'd

Landscape heterogeneity in mixed-conifer forests:

- open, patchy stands likely did not occur *ubiquitously*
- evidence of small proportions of stand-replacing fire (5-15%)

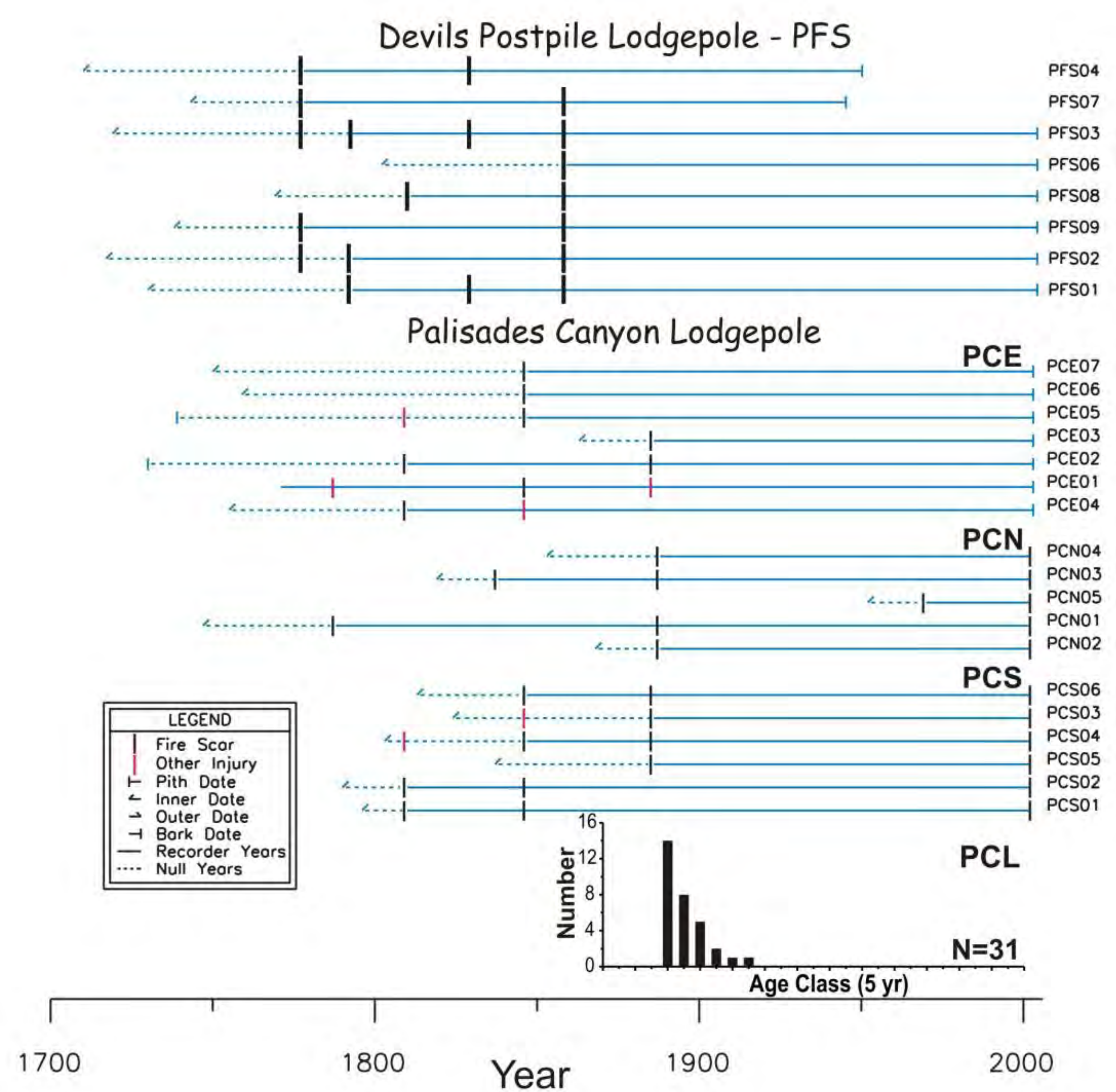
TOPOGRAPHY was likely a driver:

Show and Kotok (1924):

"…no large fires occur without a certain amount of heat-killing"

"This loss, it should be noted, represents the complete or nearly complete wiping out of small patches of the stand rather than a uniformly distributed loss over the entire area"

1.1 Historical fire occurrence/effects cont'd



Lodgepole pine-dominated areas:

- evidence of widespread fire approx. every 50 yrs
- regeneration pulses linked to fire dates
- small to moderate-sized stand-replacing patches

>> MIXED-SEVERITY

(work from Sequoia NP: A. Caprio, M. Keifer)

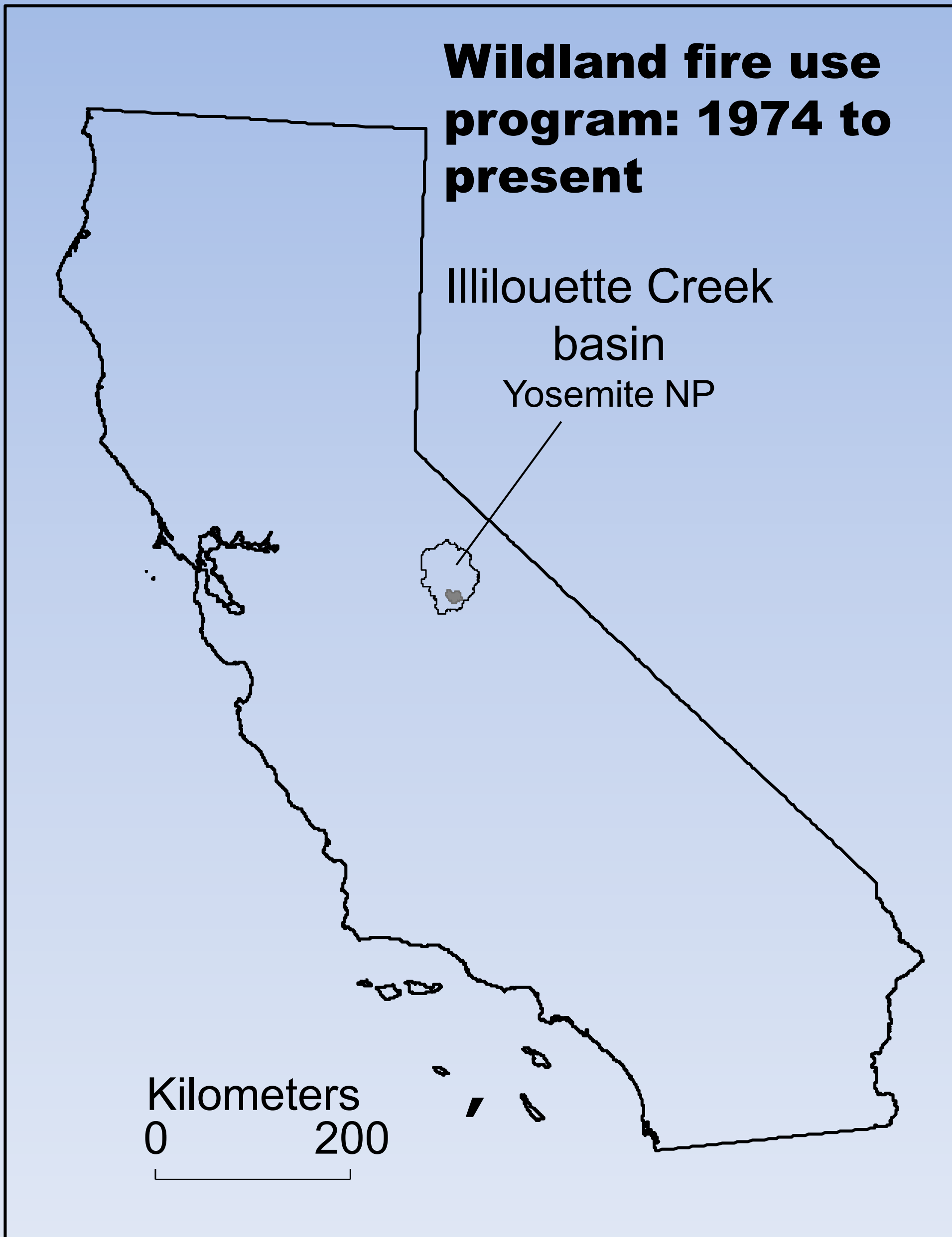
1.1 Historical fire occurrence/effects cont'd

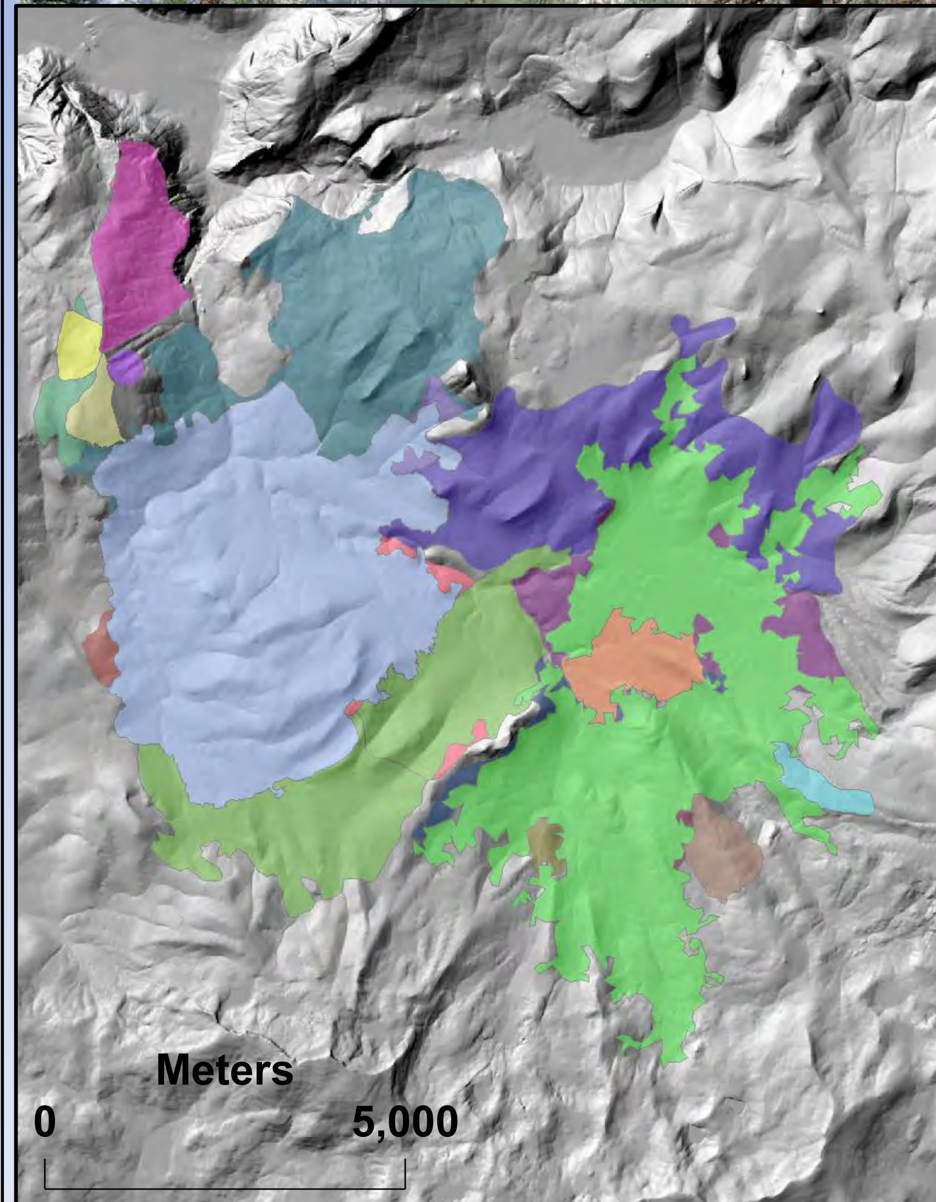
Red fir-dominated areas:

- fire return intervals tied to elevation
- regeneration pulses can be tied to fire events (in higher elev.)
- range of fire effects (more so relative to lodgepole pine)
- greater proportion of high severity in mixed stands

>> **MIXED-SEVERITY**

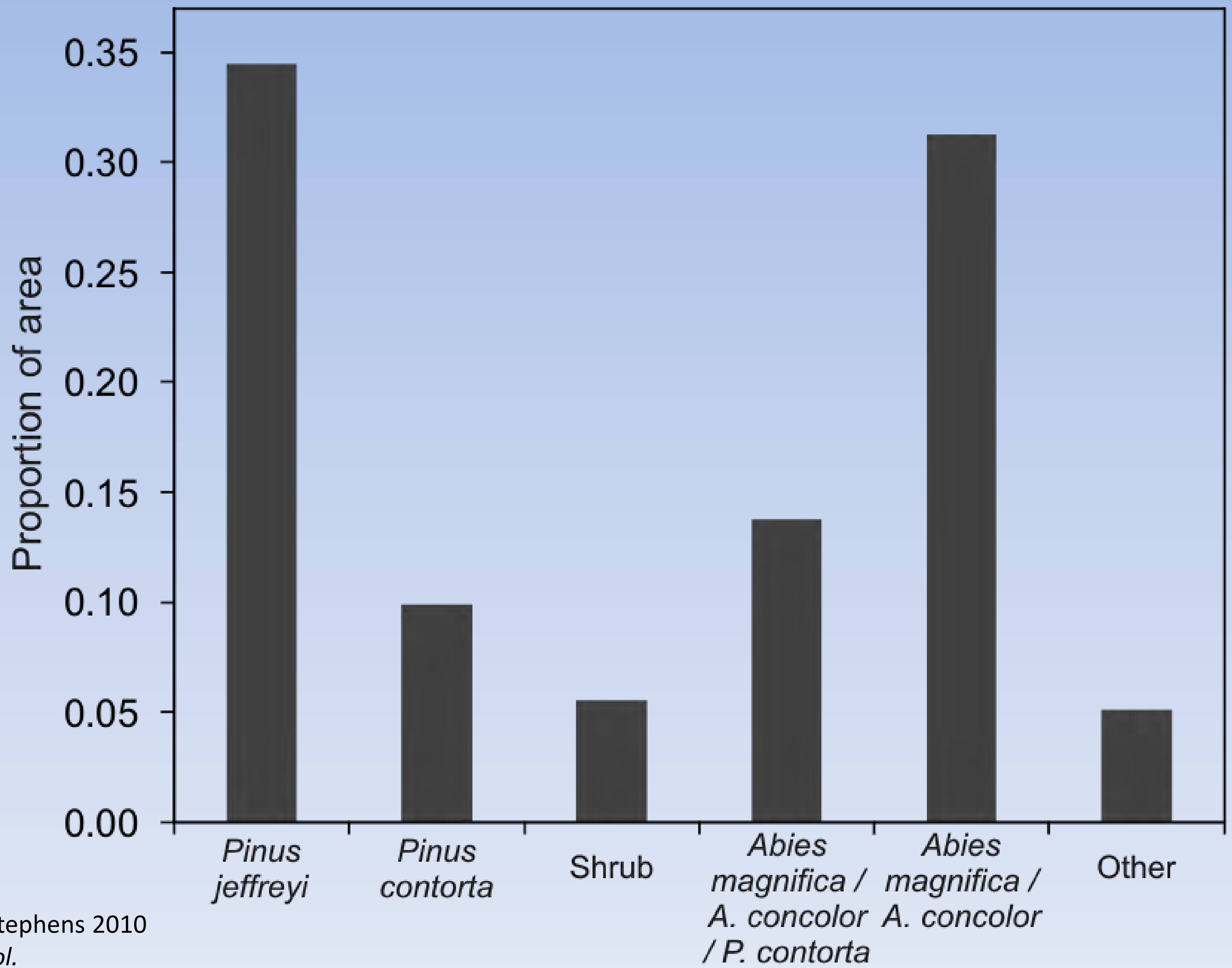
1.2 Contemporary reference fire regimes



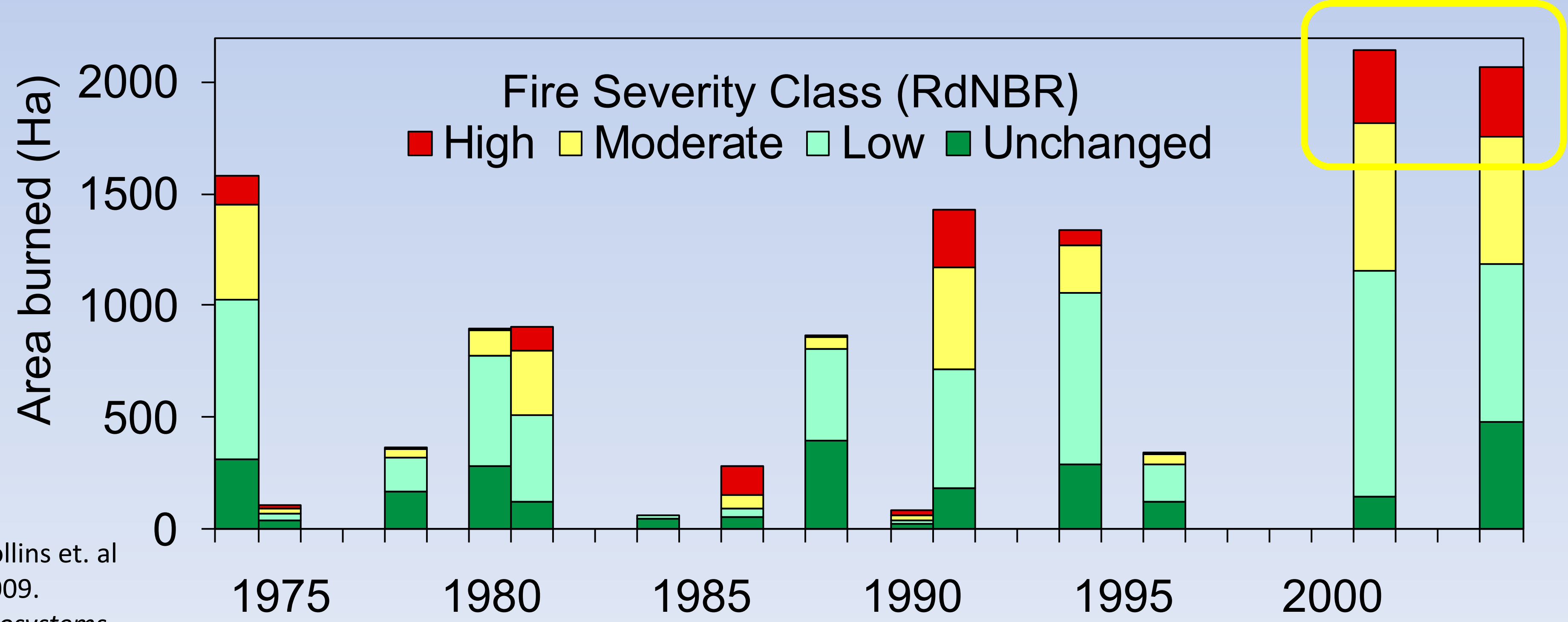


1.2 Contemporary reference fire regimes

Proportions of area by vegetation type – Illilouette basin

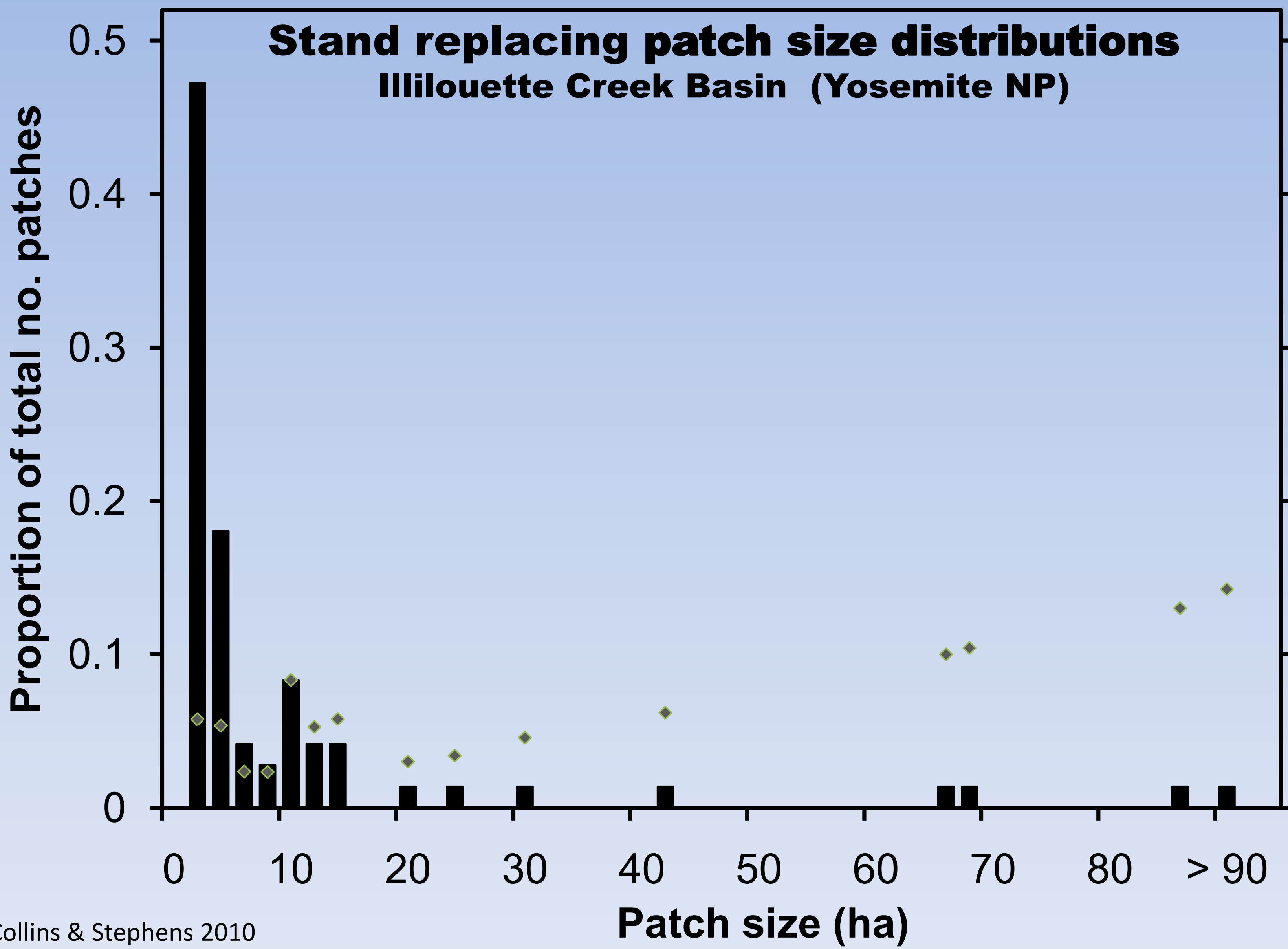


Collins & Stephens 2010
Landsc. Ecol.



Collins et. al 2009. *Ecosystems*

1.2 Contemporary reference fire regimes

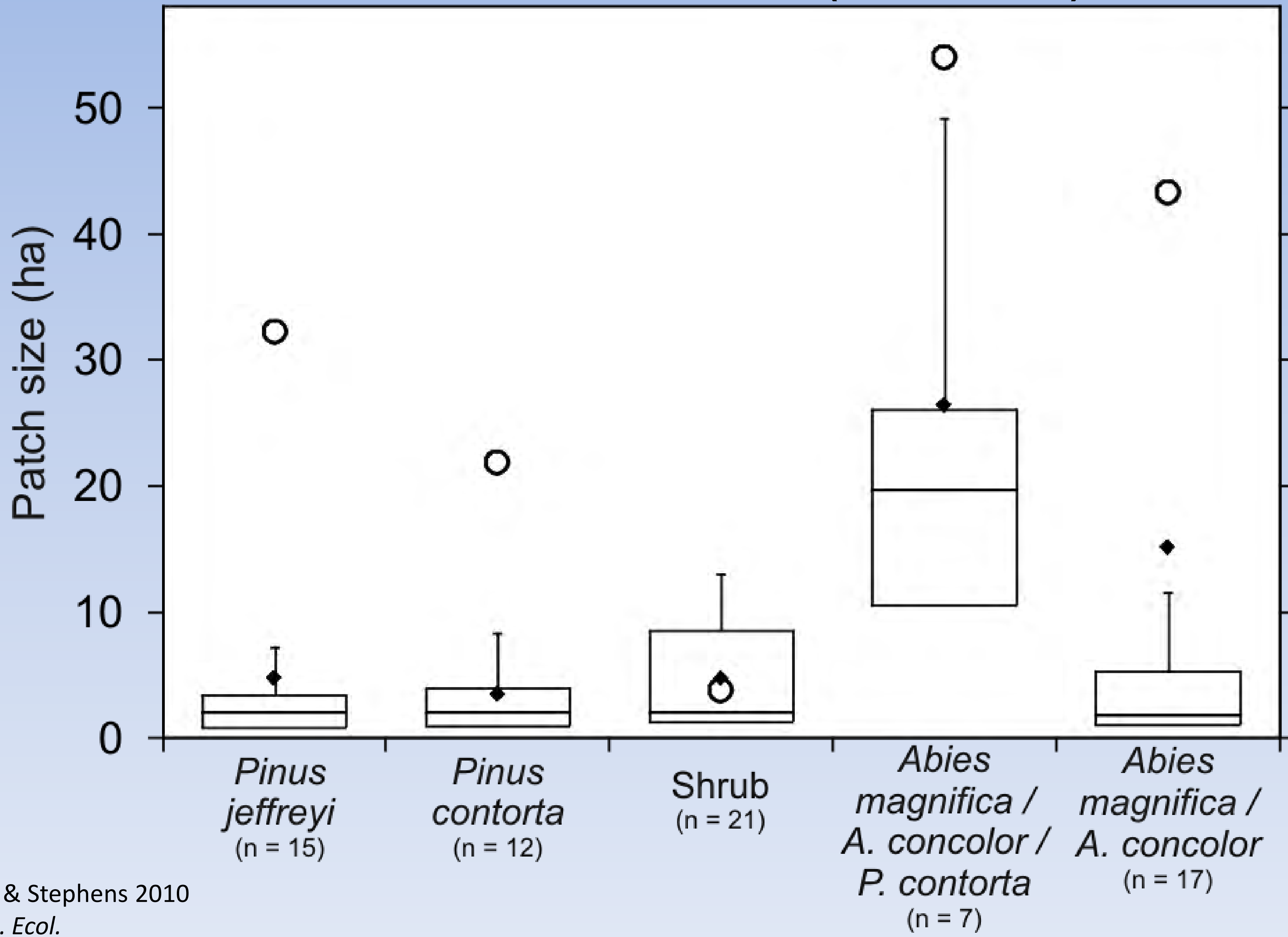


Collins & Stephens 2010
Landsc. Ecol.

1.2 Contemporary reference fire regimes

Stand-replacing/underlying vegetation (O) patch sizes

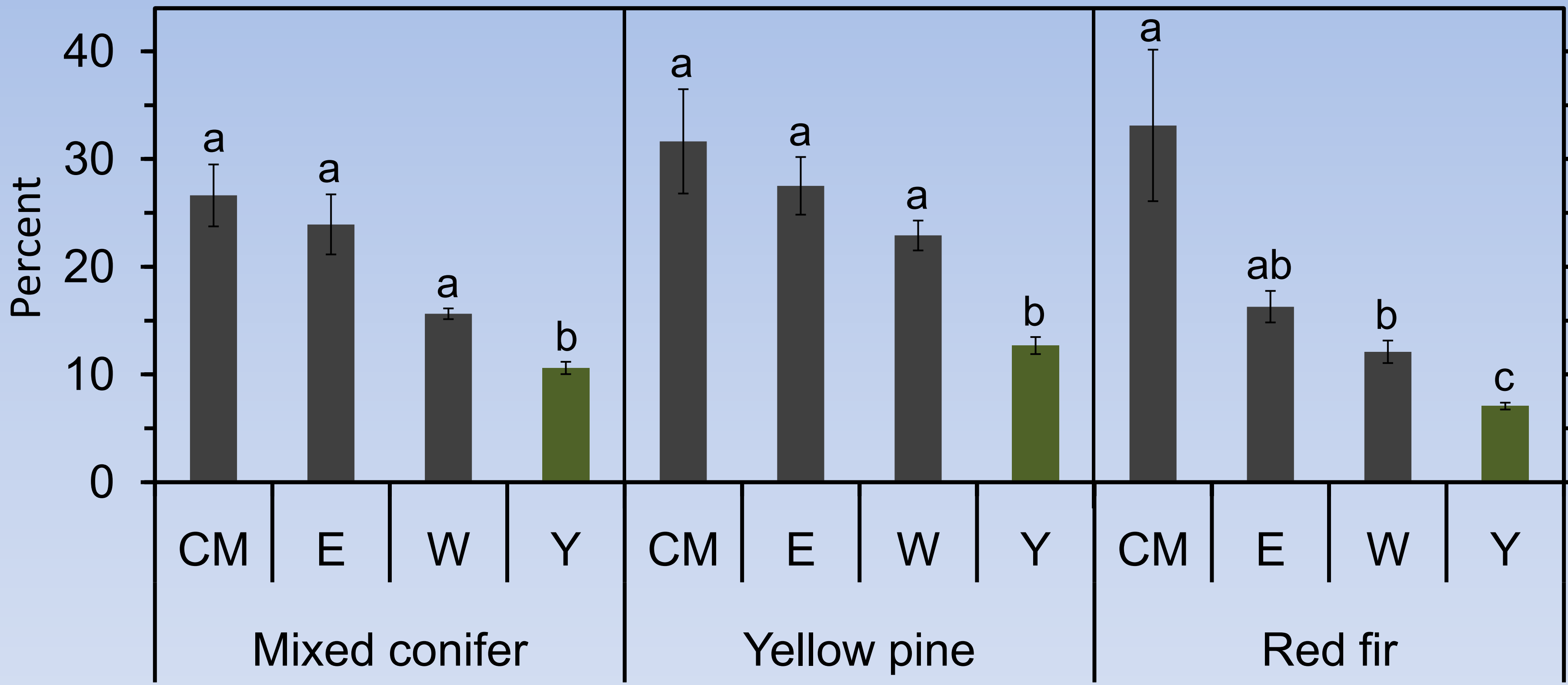
Illilouette Creek Basin (Yosemite NP)



Collins & Stephens 2010
Landsc. Ecol.

2. Contemporary fire severity patterns

Percent high severity for all fires >80 ha, 1984-2009 (by forest type and region)



Regions (CM, W, and E based on Bailey's ecoregions):

CM: Cascade-Modoc

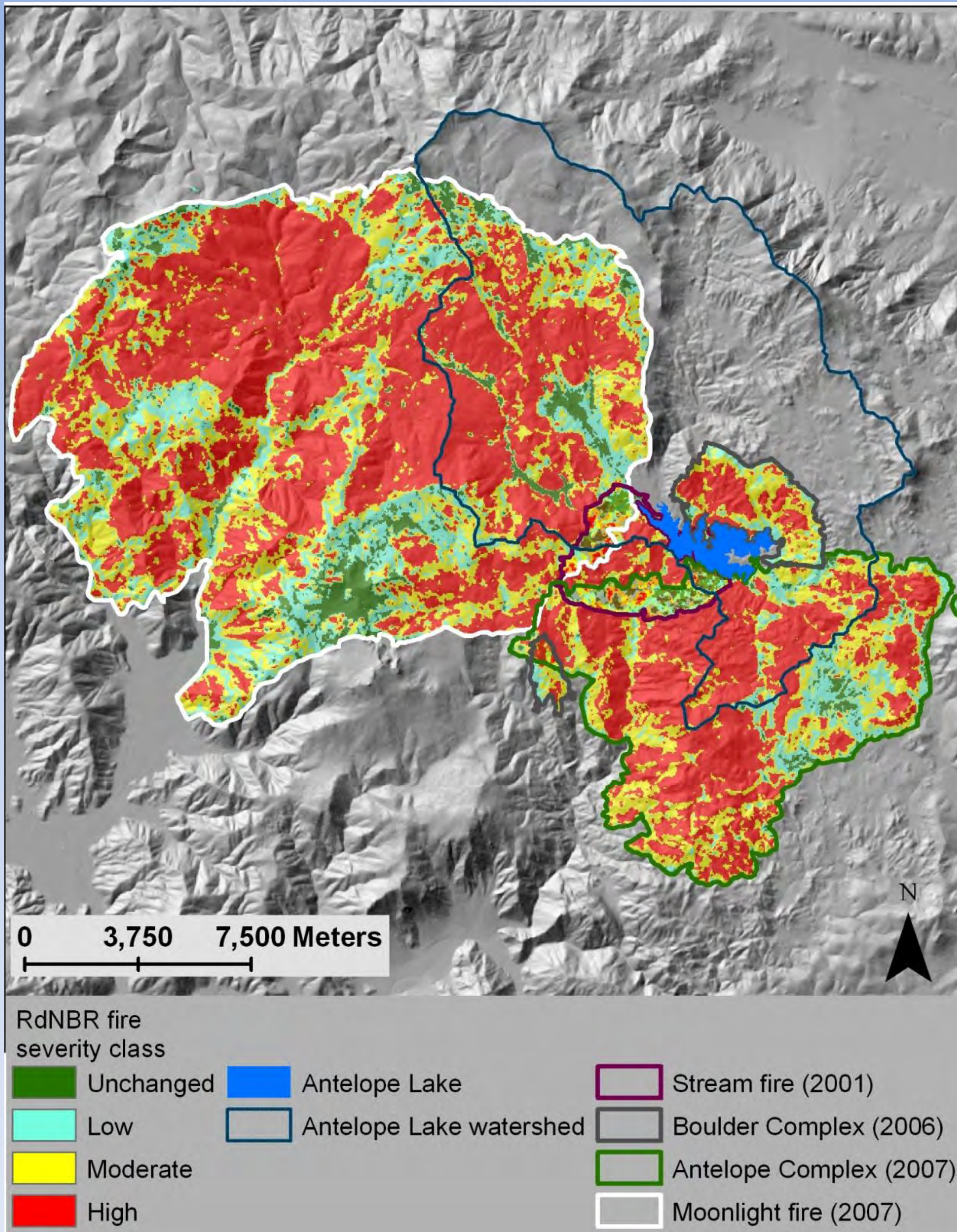
W: Westside Sierra Nevada

E: Eastside Sierra Nevada

Y: ***Yosemite***

Miller et al. 2012, *Ecosphere*


2007 Moonlight Fire
2006 Boulder Fire
2001 Stream Fire
0
200 Kilometers
ANTELOPE LAKE
A FACILITY OF THE
STATE WATER PROJECT
DEPARTMENT OF WATER RESOURCES
DEPARTMENT OF FISH AND GAME
DEPARTMENT OF PARKS AND RECREATION
PLUMAS NATIONAL FOREST

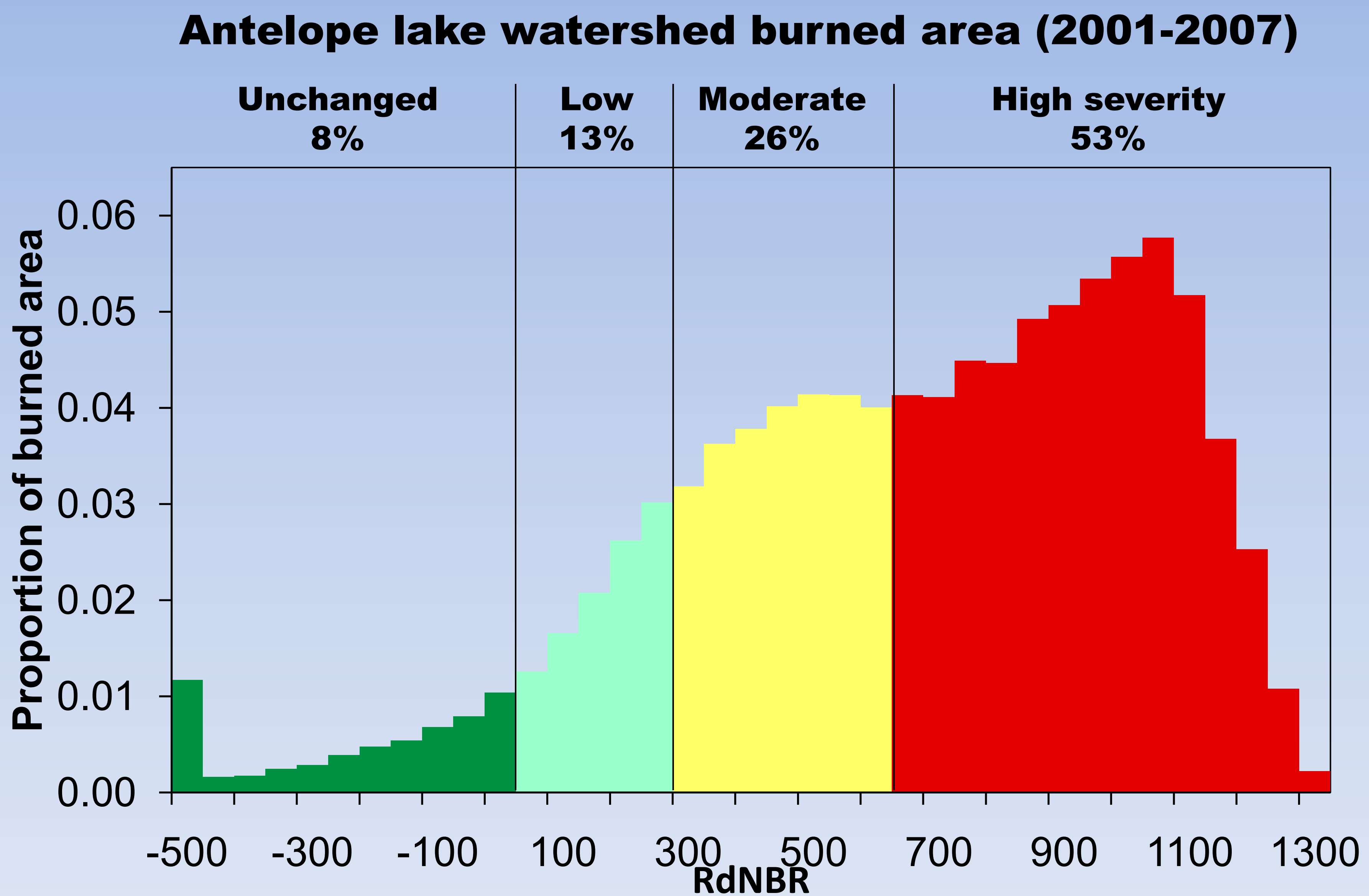


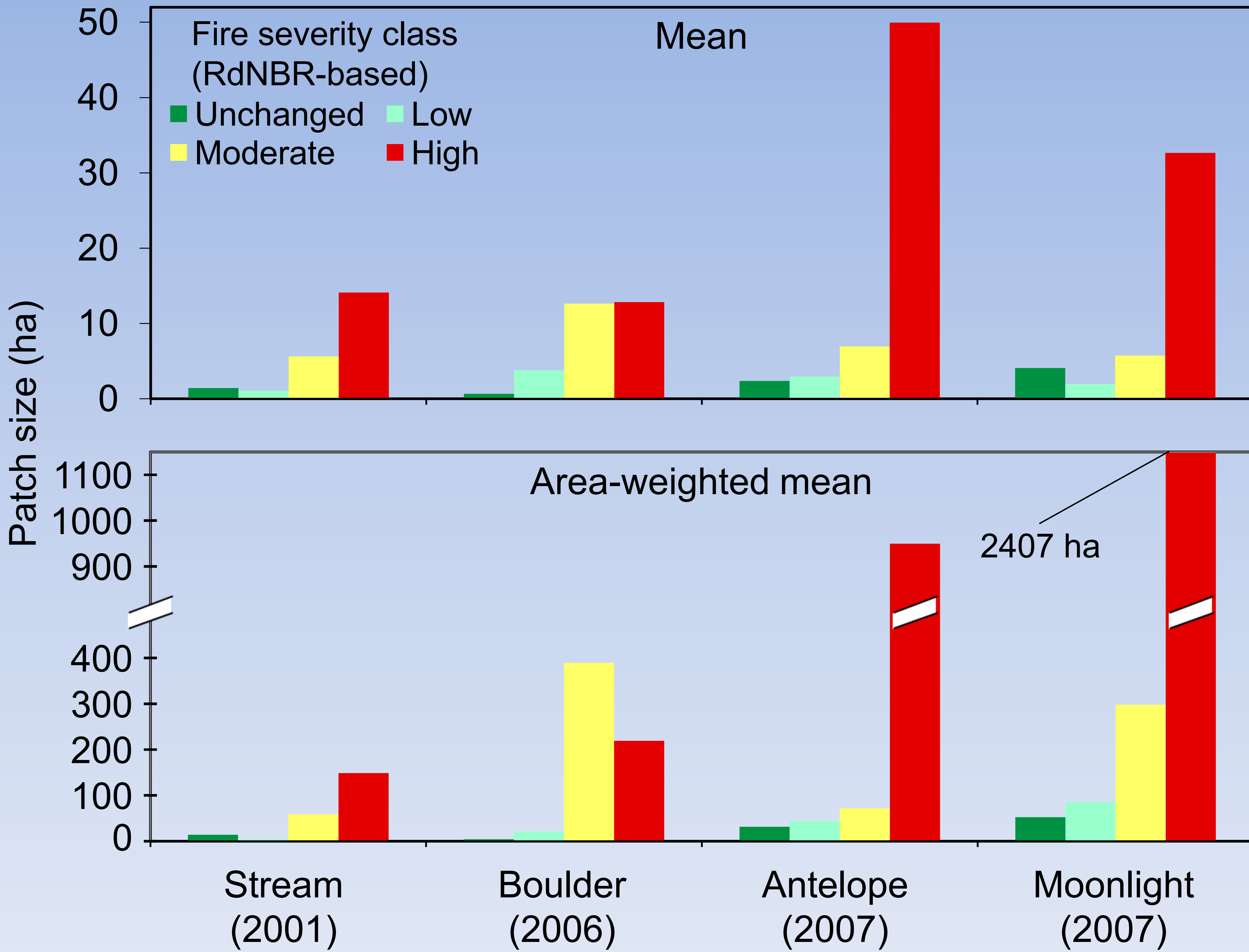
2. Contemporary fire severity patterns

Fire Name	Cause	Year	Final Size (ha)
Stream	lightning	2001	1472
Boulder Complex	lightning	2006	1388
Antelope Complex	lightning	2007	9389
Moonlight	accidental	2007	26,390

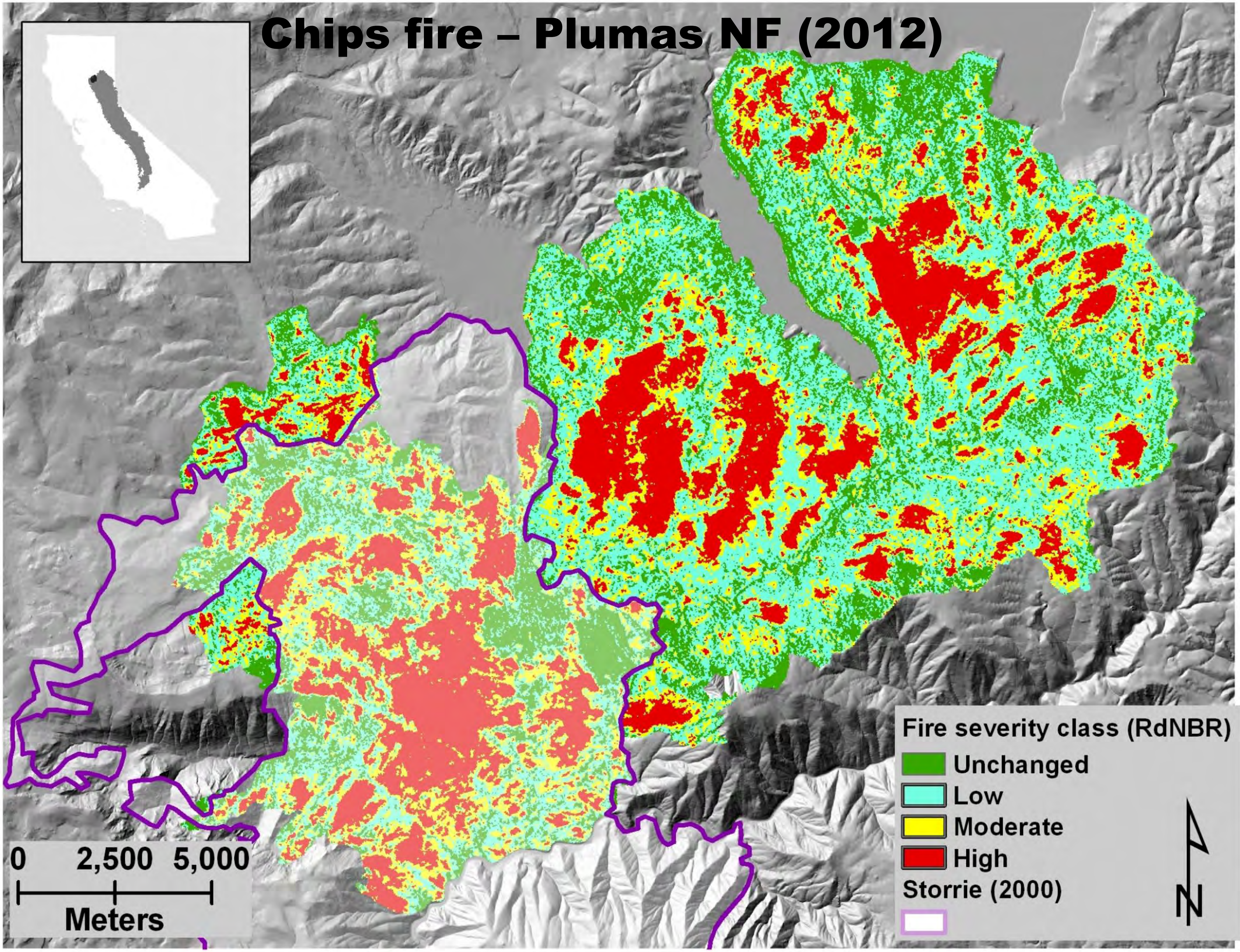
- Antelope Lake analysis watershed: 18,426 ha
- Proportion of watershed burned between 2001 and 2007: 56.4 %

2. Contemporary fire severity patterns

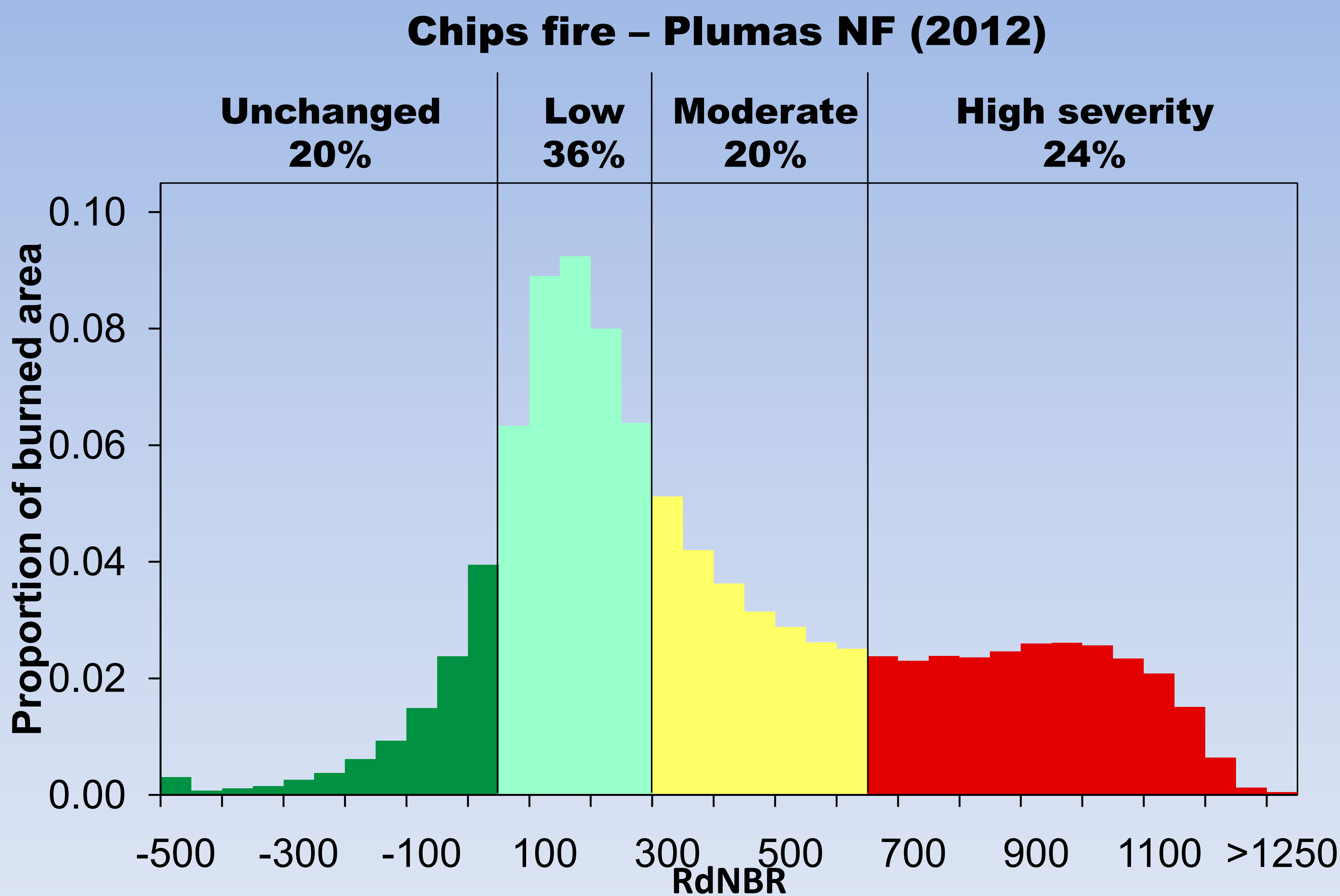


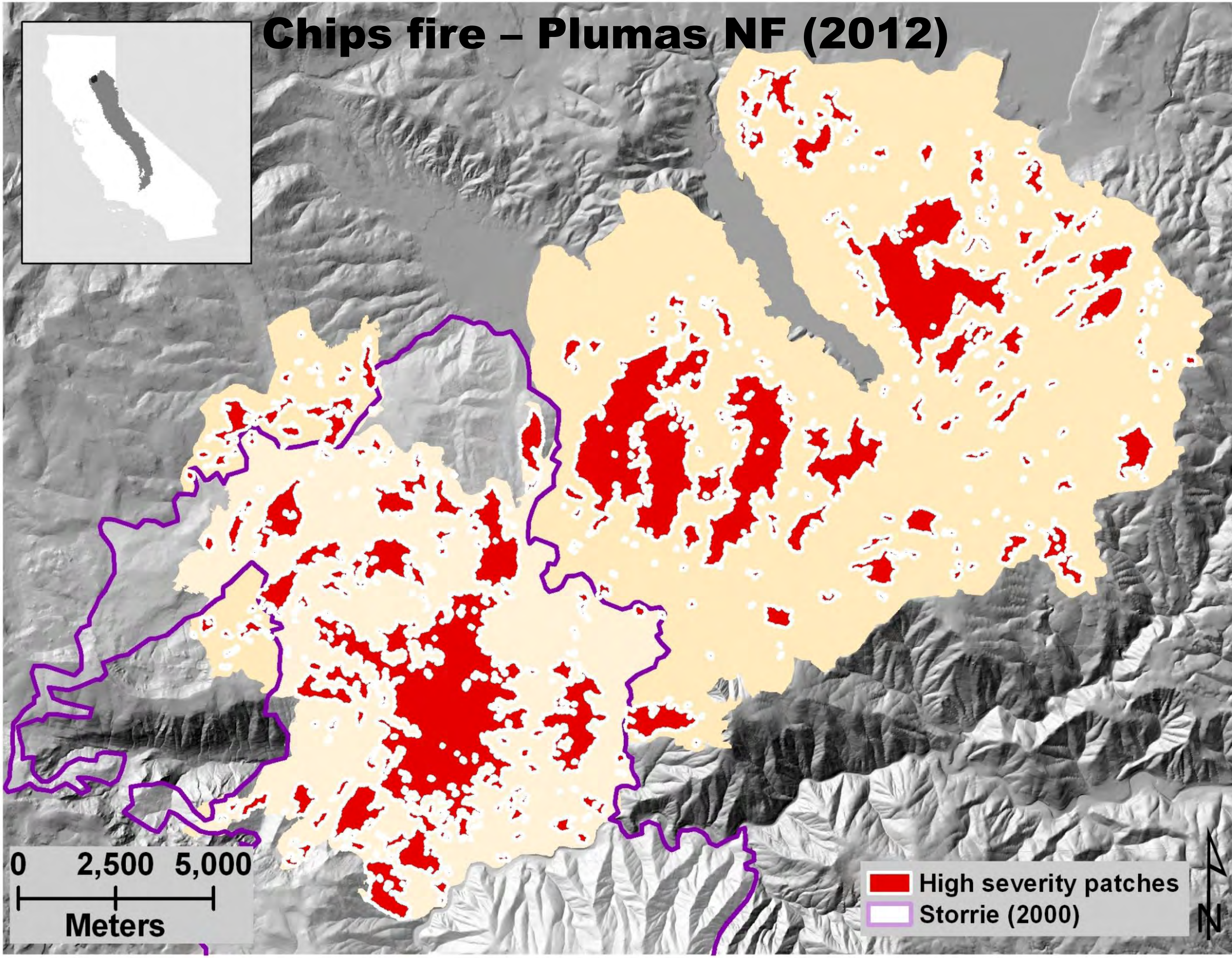


Fire severity class
(RdNBR-based)
Unchanged
Low
Moderate
High
Mean
Patch size (ha)
50
40
30
20
10
0
Area-weighted mean
1100
1000
900
400
300
200
100
0
2407 ha
Stream
(2001)
Boulder
(2006)
Antelope
(2007)
Moonlight
(2007)

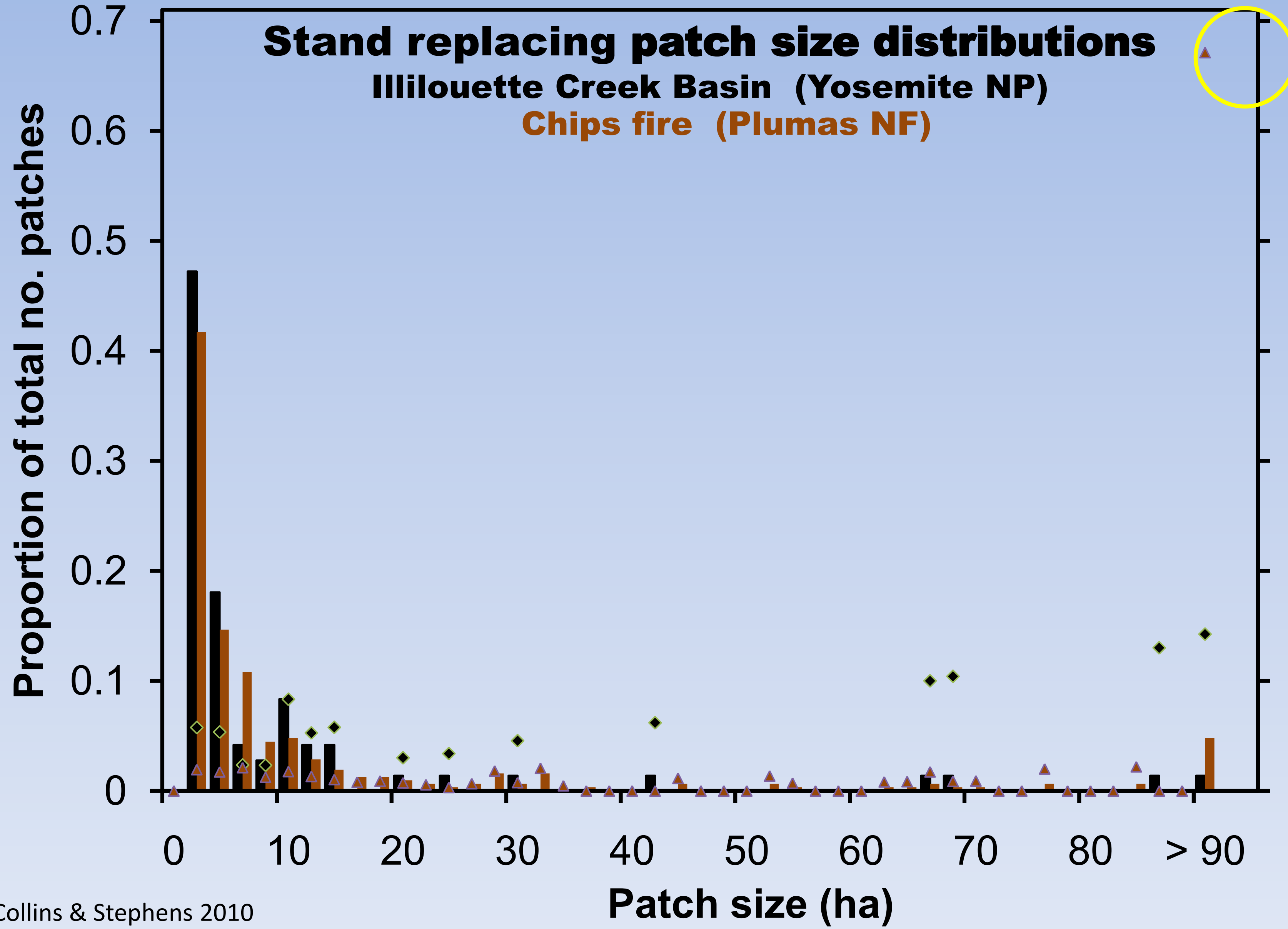

Chips fire – Plumas NF (2012)
Fire severity class (RdNBR)
Unchanged
Low
Moderate
High
Storrie (2000)
0
2,500
5,000
Meters

2. Contemporary fire severity patterns



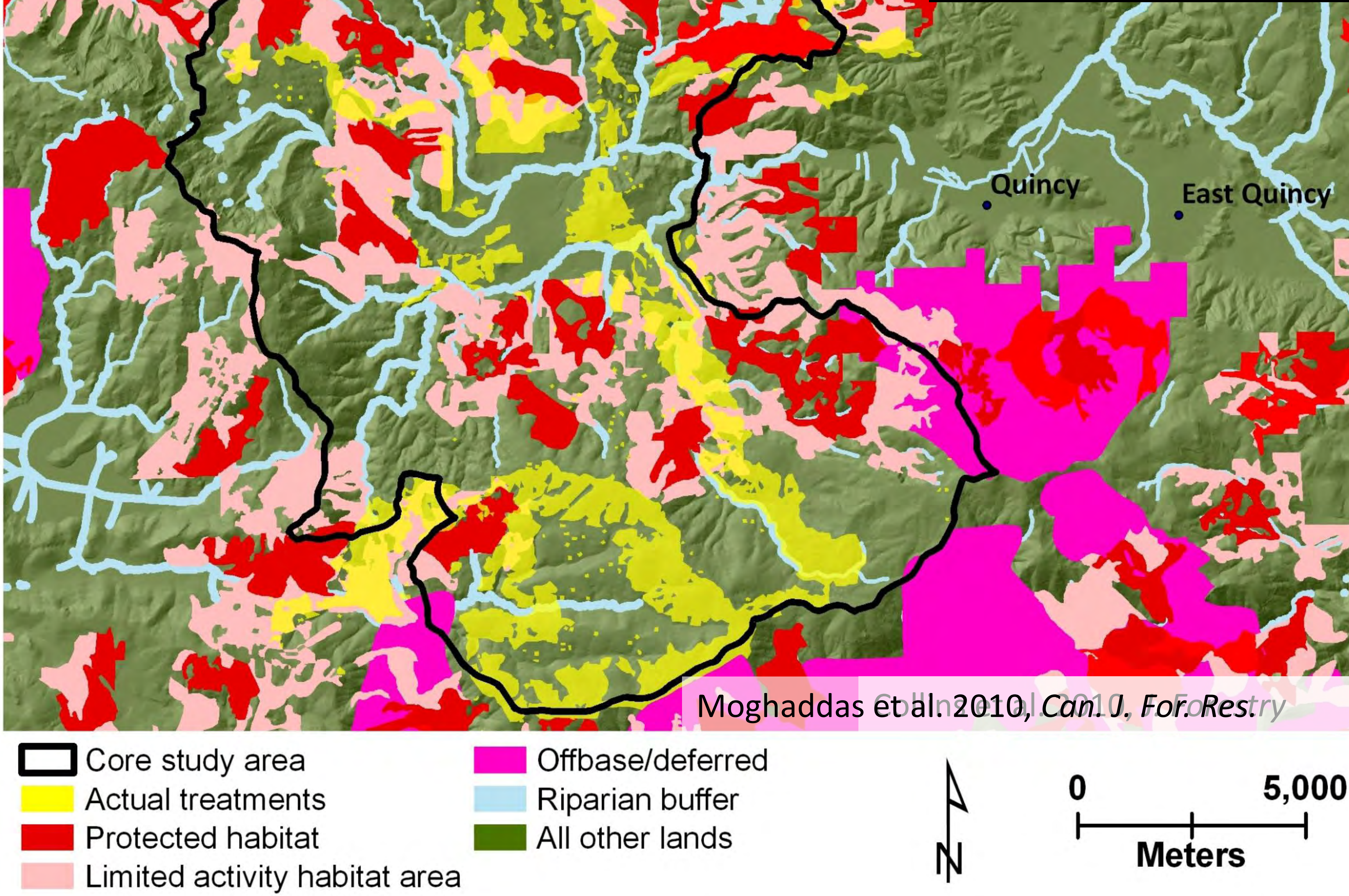

Chips fire – Plumas NF (2012)
0 2,500 5,000
Meters
High severity patches
Storrie (2000)
N

2. Contemporary fire severity patterns



Collins & Stephens 2010
Landsc. Ecol.

3. Landscape approaches



Moghaddas et al. 2010, *Can. J. For. Res.*

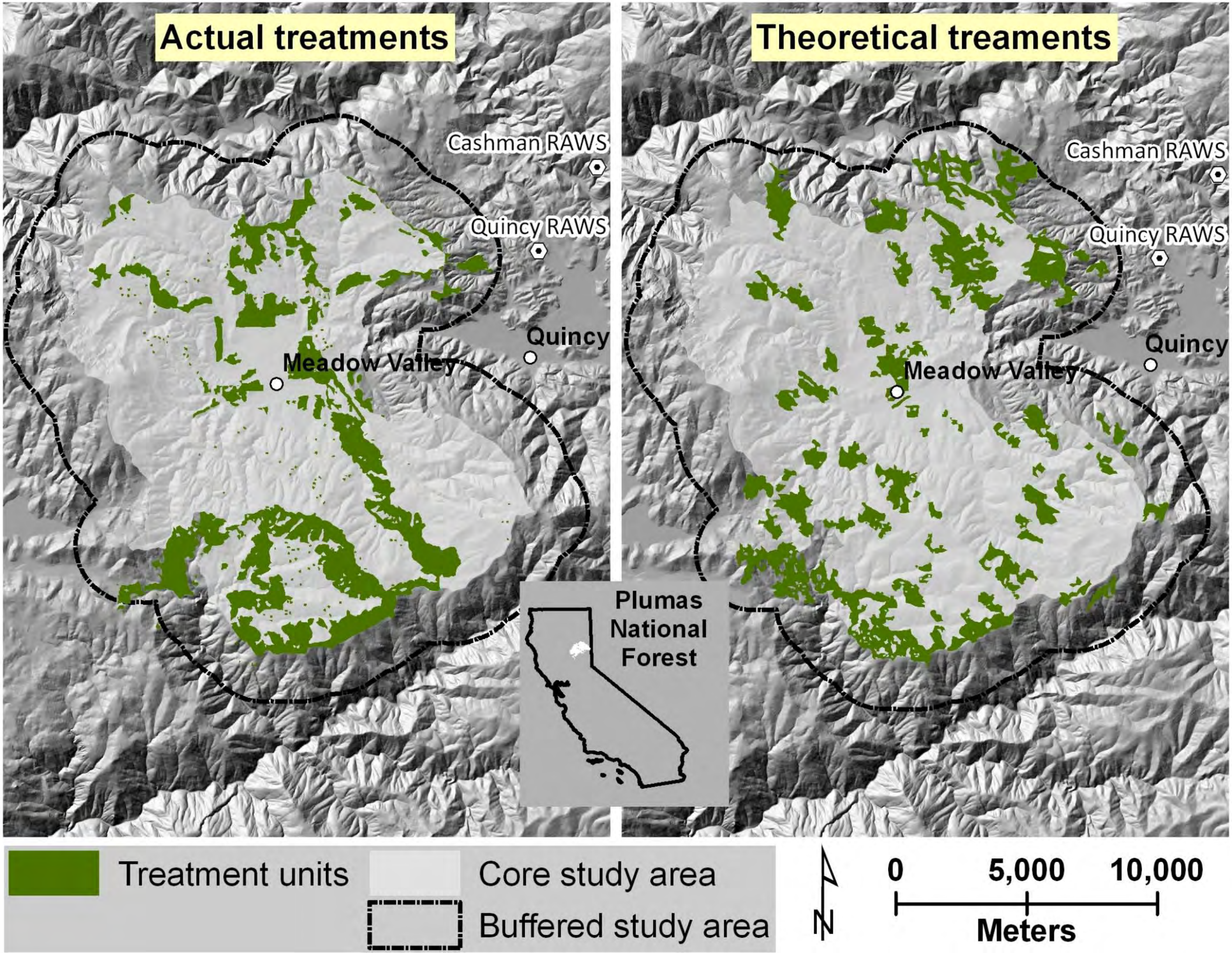
3. Landscape approaches

Theoretical design: Treatment Optimization Module

- **Generate ideal landscape incorporating operational constraints:**
  - Identify spatially (*based on* Finney et al 2007):
    1) all stands that are available for treatment
    2) post-treatment stand conditions in "treatable" stands

- **Fire modeling:**
  - FlamMap Minimum Travel Time algorithm
    - Identify major flow paths
  - Locate treatments to slow major flow paths

- **Translate spatial output:**
  - Identify "stands" based on vegetation map
  - Eliminate isolated "stands" <10 ha (25 ac)

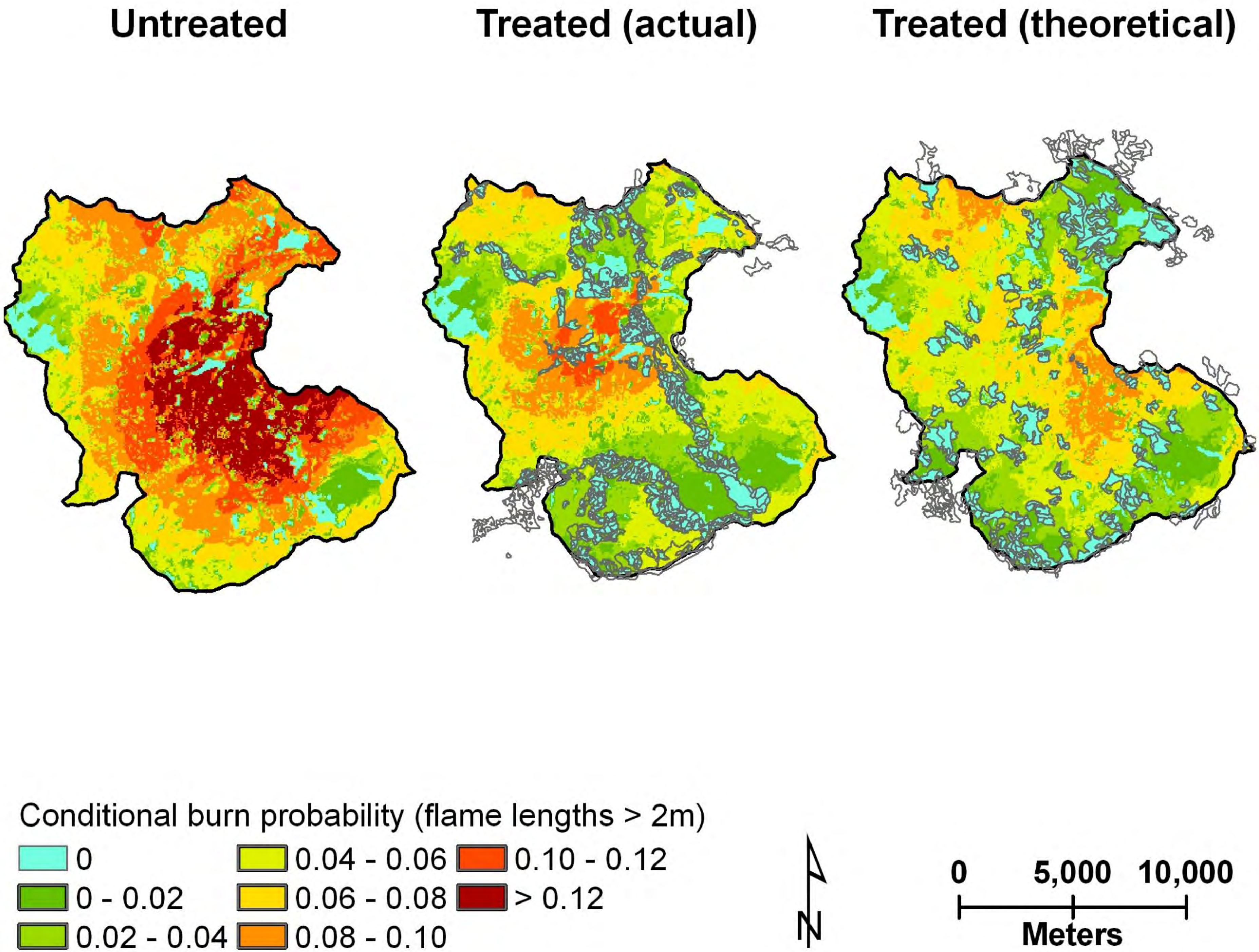

Actual treatments
Theoretical treaments
Cashman RAWS
Quincy RAWS
Quincy
Meadow Valley
Cashman RAWS
Quincy RAWS
Quincy
Meadow Valley
Plumas
National
Forest
Treatment units
Core study area
Buffered study area
N
0
5,000
10,000
Meters

3. Landscape approaches

Wildfire Simulations

- **Fire behavior modeling:**
  - Randig
    - uses Minimum Travel Time algorithm incorporated in FlamMap
    - generates burn probability based on simulated fires (n = 10,000)
- **Weather:**
  - "Problem fire" conditions (based on an actual event, or likely scenario) for fuel moistures and winds
- **Analysis:**
  - partition burn probability output based on critical flame length
  - Compare both treated conditions to the untreated landscape

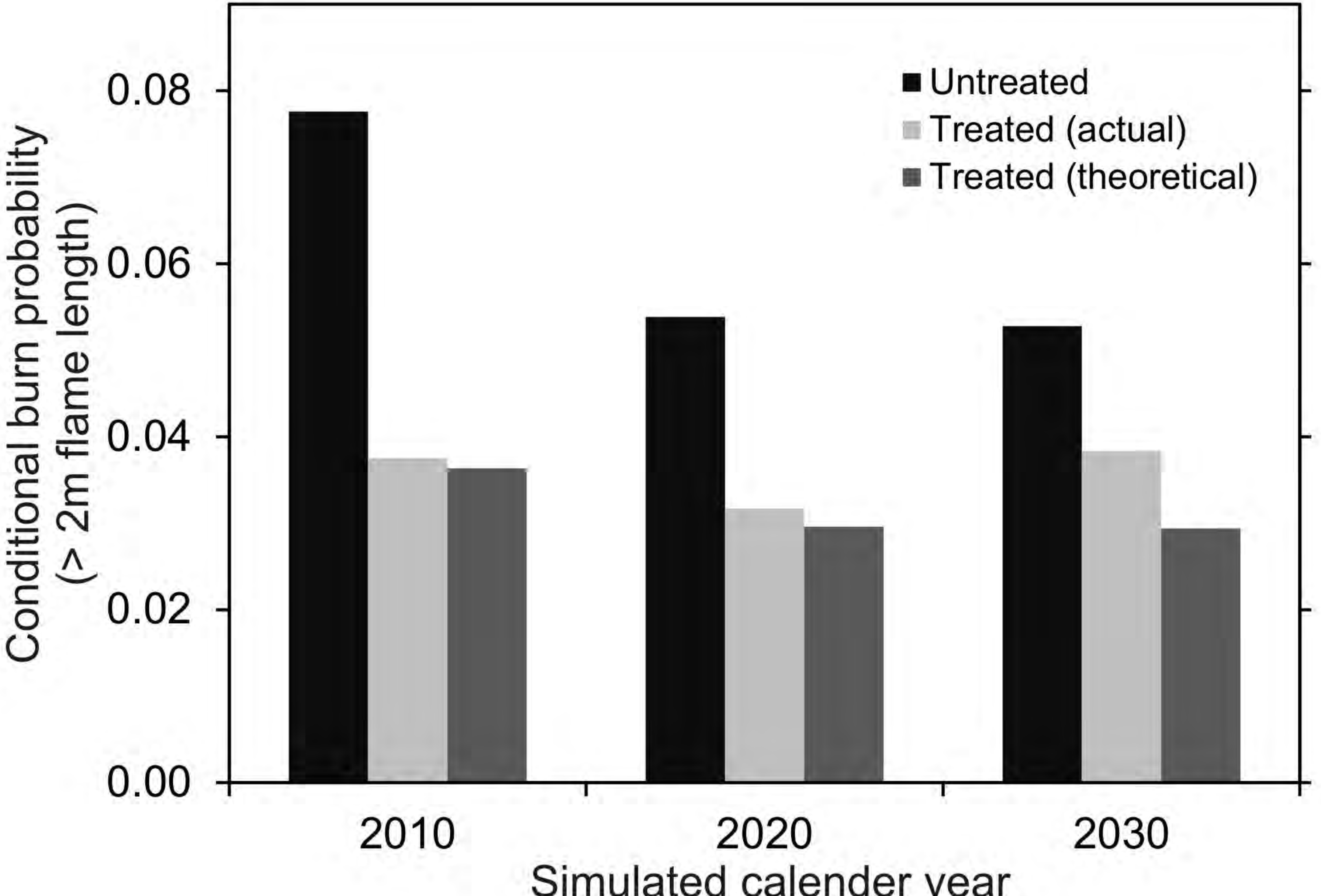
Collins et al. 2011, *For. Sci.*



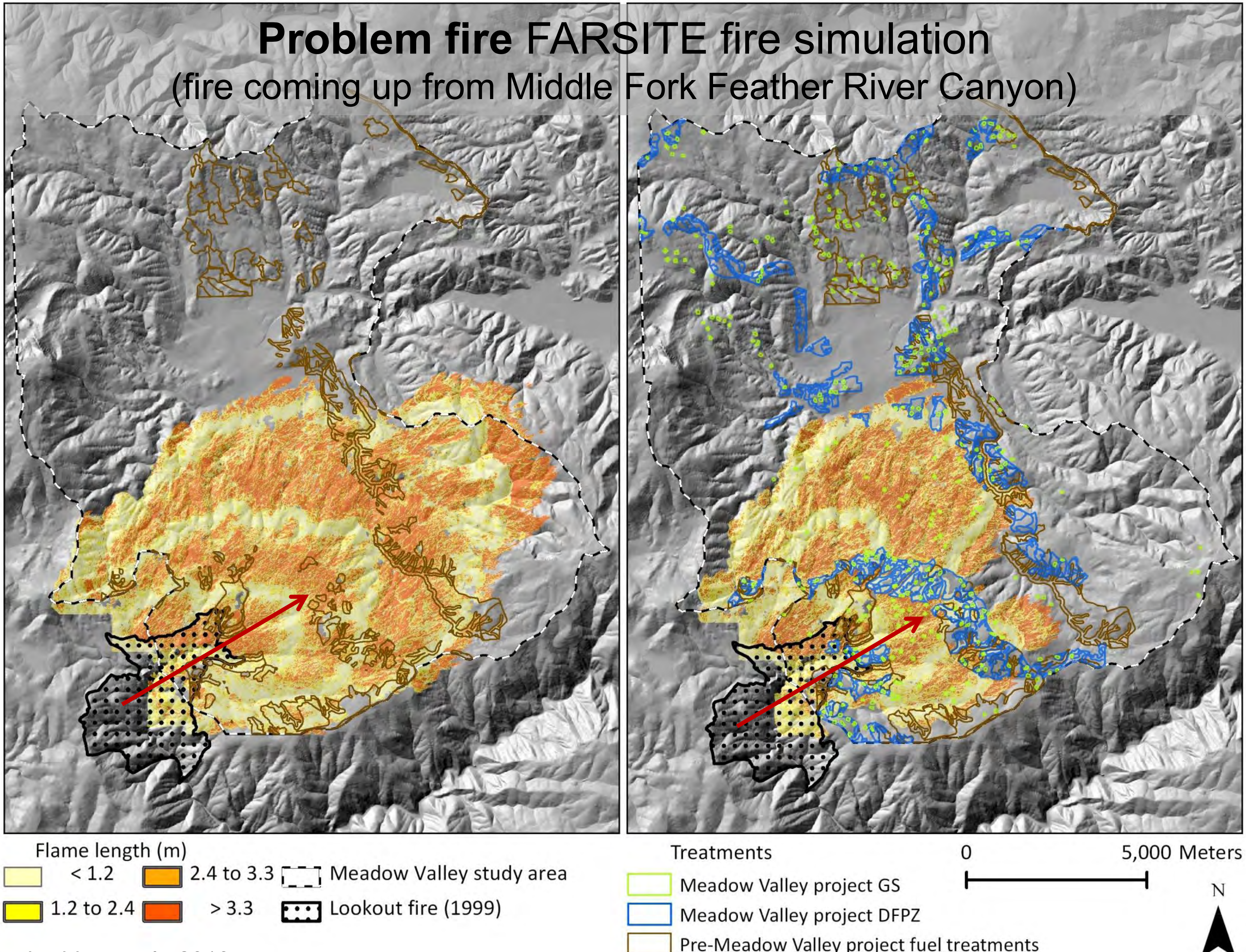
Untreated
Treated (actual)
Treated (theoretical)
Conditional burn probability (flame lengths > 2m)
0
0 - 0.02
0.02 - 0.04
0.04 - 0.06
0.06 - 0.08
0.08 - 0.10
0.10 - 0.12
> 0.12
N
0
5,000
10,000
Meters

3. Landscape approaches

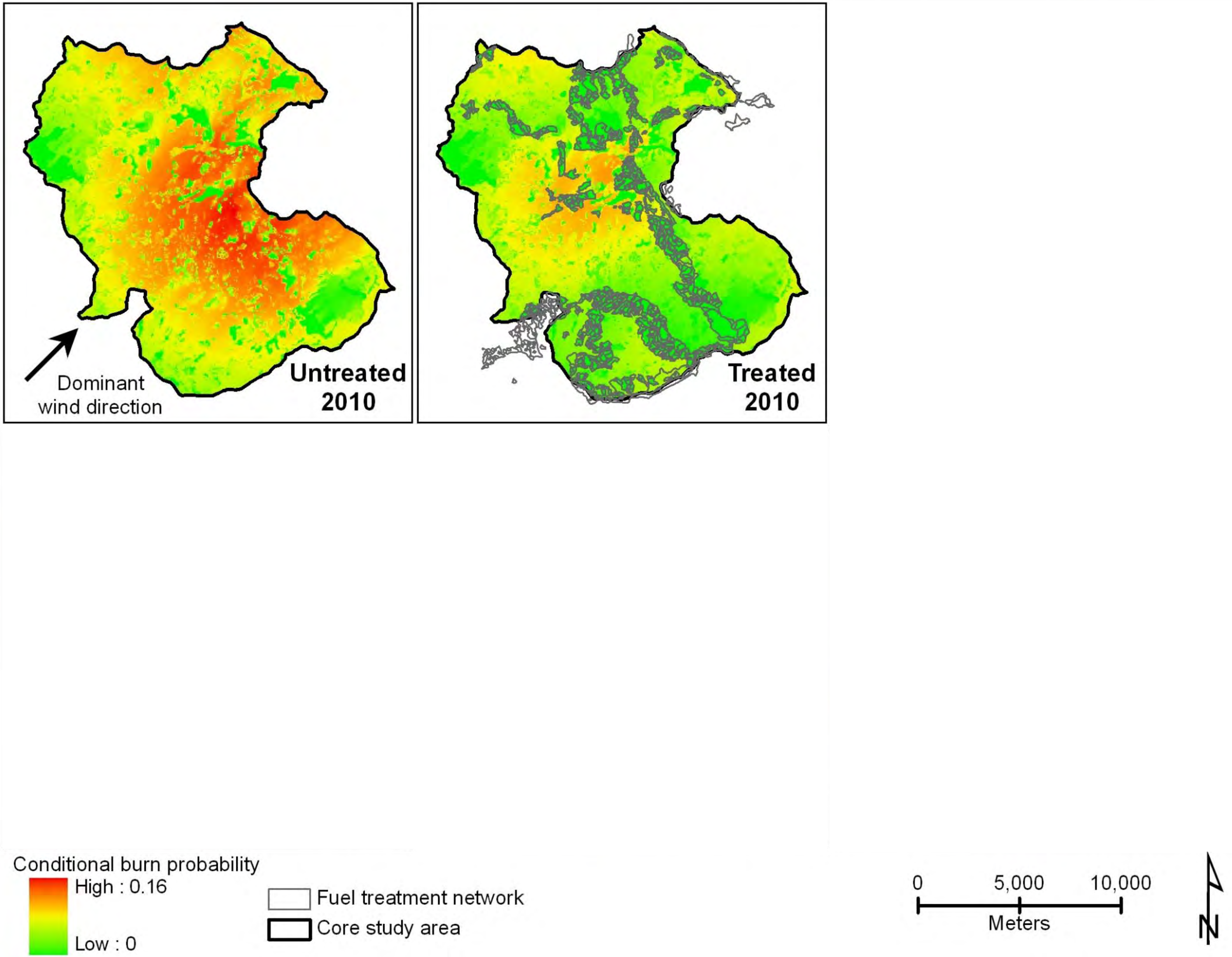
Meadow Valley fuel treatment effectiveness: 3 scenarios



Problem fire FARSITE fire simulation
(fire coming up from Middle Fork Feather River Canyon)



Moghaddas et al., 2010 *Can. J. For. Res.*



Dominant wind direction
Untreated 2010
Treated 2010
Conditional burn probability
High : 0.16
Low : 0
Fuel treatment network
Core study area
0
5,000
10,000
Meters
N

Summary and management implications:

- ***Fairly strong*** **indication that contemporary stand-replacing fire is outside historical range of variability**
  - ➢ **Most pronounced in mixed-conifer and yellow pine types**
  - ➢ **Not only proportions, <u>patch sizes</u> as well**
- **Good evidence that coordinated landscape treatments (e.g., SPLATS, DFPZs) can mitigate uncharacteristic fire behavior (and effects)**
  - ➢ **<u>Strategic</u> treatments across 20-25% of landscape seems optimal**
  - ➢ **Cannot continue to use treatments to STOP fire**
  - ➢ **Manage landscapes to incorporate fire**

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  - Storrie Fire Restoration

Alternate interpretations of historical and contemporary fire effects

Ecosystems (2012) 15: 832–847
DOI: 10.1007/s10021-012-9549-8

ECOSYSTEMS

Comparison of the *Higher*-Severity Fire Regime in Historical (A.D. 1800s) and Modern (A.D. 1984–2009) Montane Forests Across 624,156 ha of the Colorado Front Range

Mark A. Williams* and William L. Baker

Program in Ecology and Department of Geography, University of Wyoming, Dept. 3371, 1000 E. University Avenue, Laramie, Wyoming 82071, USA

Global Ecology and Biogeography, (Global Ecol. Biogeogr.) (2012) ••, ••–••

RESEARCH PAPER

Spatially extensive reconstructions show variable-severity fire and heterogeneous structure in historical western United States dry forests

Mark A. Williams and William L. Baker*

Based on General Land Office survey records they argue:

- greater high severity proportion and patch sizes historically
- contemporary high severity patterns not very different from historical

>> **MIXED-SEVERITY**

- large-scale fuel reduction efforts may be misguided

Alternate interpretations of historical and contemporary fire effects

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Figure 2. Historical size-class distribution of *higher*-severity fire patches. Historical (A.D. 1800s) fire patch size for the Colorado Front-Range landscape based on GLO survey data. Bin widths were 100 ha. Three fire patches larger than 3,000 ha were merged into the final class. Maximum patch size was 8331.3 ha. *Higher*-severity includes moderate- and high-severity.

Questionable methodology:

- moderate severity *combined* with high severity
- numerous adjustments /calibrations (e.g., buffering to ↑ patch sizes, age of burned patches)
- collectively, these blur the issue of greatest concern: STAND-REPLACING PATCH SIZES

>> BEWARE OF TERM MIXED-SEVERITY