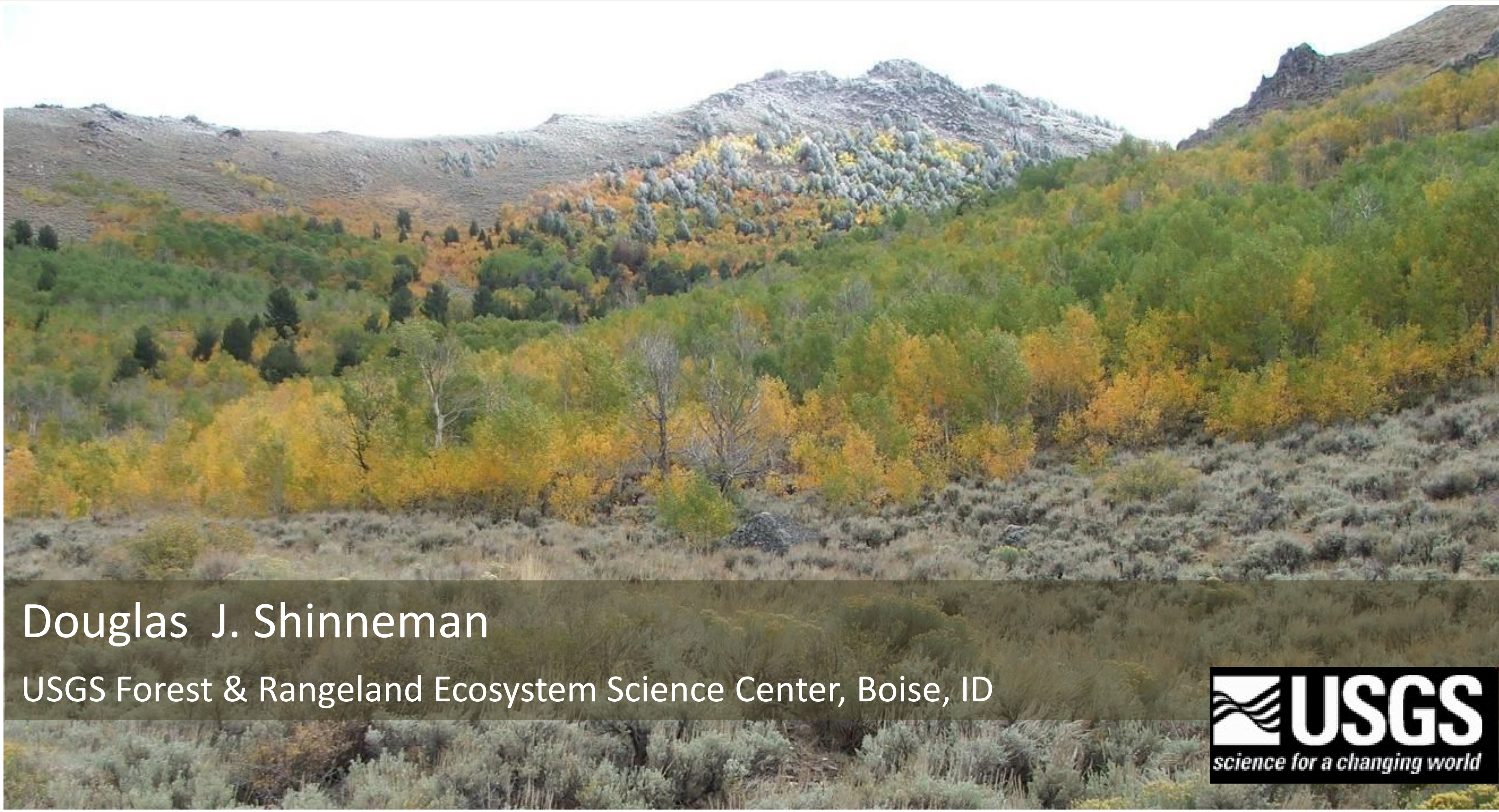
Fire Regimes of Quaking Aspen in the Mountain West



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USGS science for a changing world

Objectives

Shinneman, D.J., W.L. Baker, P.C. Rogers, and D. Kulakowski. 2013. Fire regimes of quaking aspen in the Mountain West. *Forest Ecology and Management* **299**:22-34.

1. Provide a brief overview of aspen fire ecology
2. Discuss methods to understand reconstruct *fire regimes*
3. Synthesize existing research literature that pertains to estimating aspen fire regimes in the Mountain West (U.S.)
4. Suggest a conceptual classification framework for aspen fire regimes in the Mountain West
5. Identify key knowledge gaps and research needs (incl. climate change)

Fire Regimes in Aspen – Background

- Fire regime dichotomy between *seral* (fire-dependent) vs. *stable* (fire-independent) aspen
  - too simple

- Should expect substantial variability of historical fire regimes in aspen communities across diverse biophysical & climatic gradients in North America

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Fire Ecology in Aspen - Behavior

- Lightning ignitions relatively rare in aspen stands
- Aspen not particularly flammable
  - Low fire spread
  - Low probability of burning
- Fire more likely in seral stands – increases with conifer-dominance
- Fire behavior influenced by: fuel loads, seasonality, biophysical settings, past disturbance, land use

Fire Ecology in Aspen – Fire Severity

- Mostly high-severity
  - Aspen-conifer more likely to crown; aspen easily top-killed
  - Surviving trees weakened and vulnerable to disturbance agents
- Some evidence for mixed-severity
- Limited evidence for low-severity fire regimes maintaining aspen
  - Fire scars rare or absent
  - High mortality rates from low-intensity surface fires

Fire Ecology in Aspen – Post-Fire Regeneration

- Early successional, shade-intolerant, fire-adapted, species
- Often prolific post-fire regeneration
  - Vegetative reproduction (resprouting)
  - Fire-exposed mineral soils
  - Up to >200,000 stems/ha reported

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Fire Ecology in Aspen – Post-Fire Successional Trends

- Seral stands
  - Early- to mid-successional
    - Even age stands gradually recolonized by conifer seedlings
  - Late successional
    - Conifer-dominated overstory Scattered old-aspen, patchy recruitment
- Persistent or stable
  - Self-sustaining stands
  - Even age stands typically develop multi-cohort age structure
  - Continuous or episodic recruitment
    - Canopy gaps
    - Broader-scale disturbance events (drought) or overstory cohort senescence

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Reconstructing Fire History in Aspen - Challenges

- Evidence of fire can be ephemeral
  - Short-lived trees
  - "Fading record problem" – e.g., Short-retention time for aspen snags, ambiguous charcoal record
  - "Burning record problem" – Evidence of previous fire events destroyed by subsequent stand-replacing events
- Need large enough landscape and long enough time scale

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Reconstructing Fire History in Aspen - Methods

- Dated fire scars
  - mostly conifers
- Stand-origins (ages)
  - Oldest trees => initiation after fire
  - Used to calculate fire rotation
- Stand tree age structures
  - Use tree age distributions to infer past population and disturbance dynamics
- Other: charcoal records, historical records, etc.

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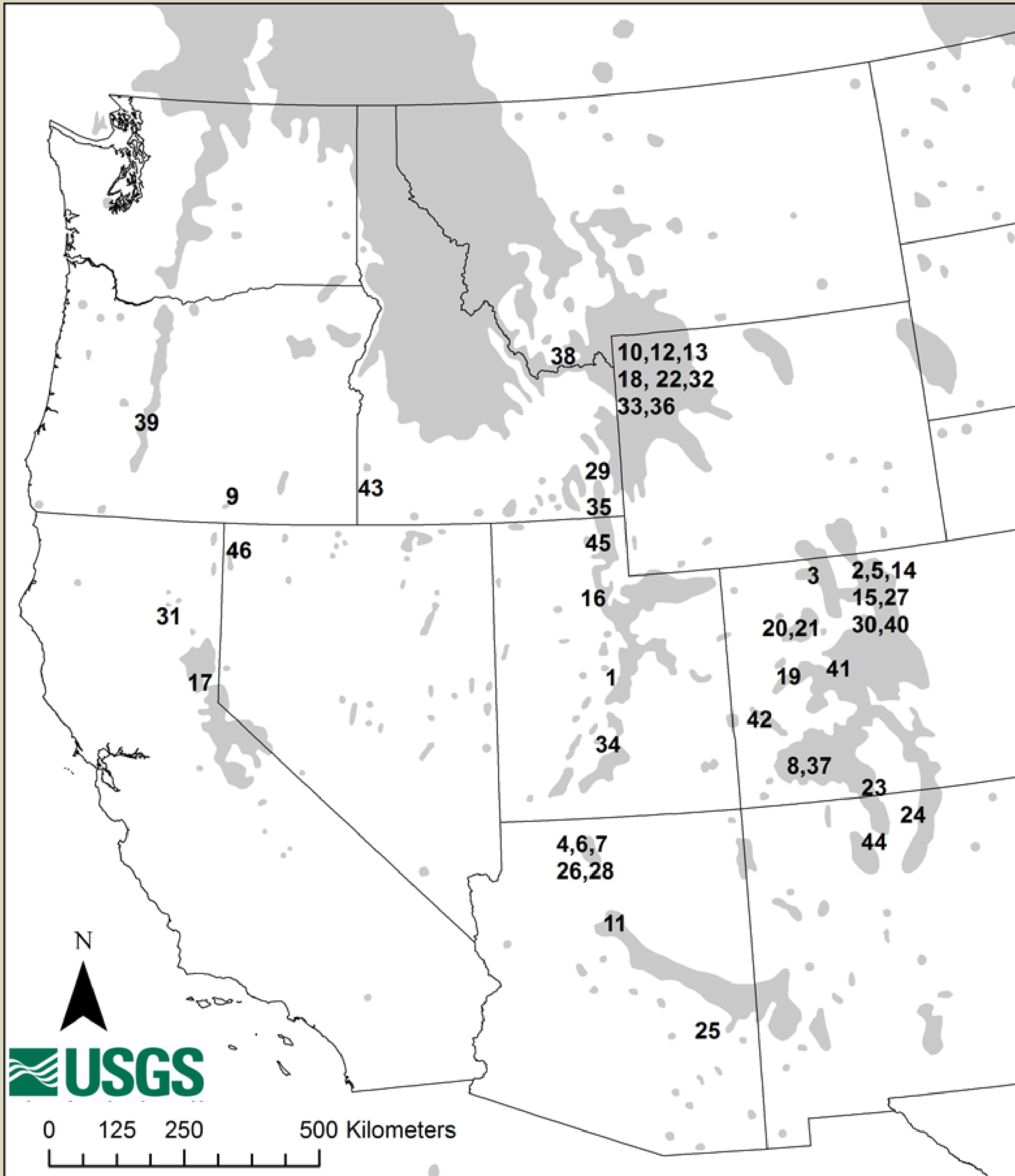


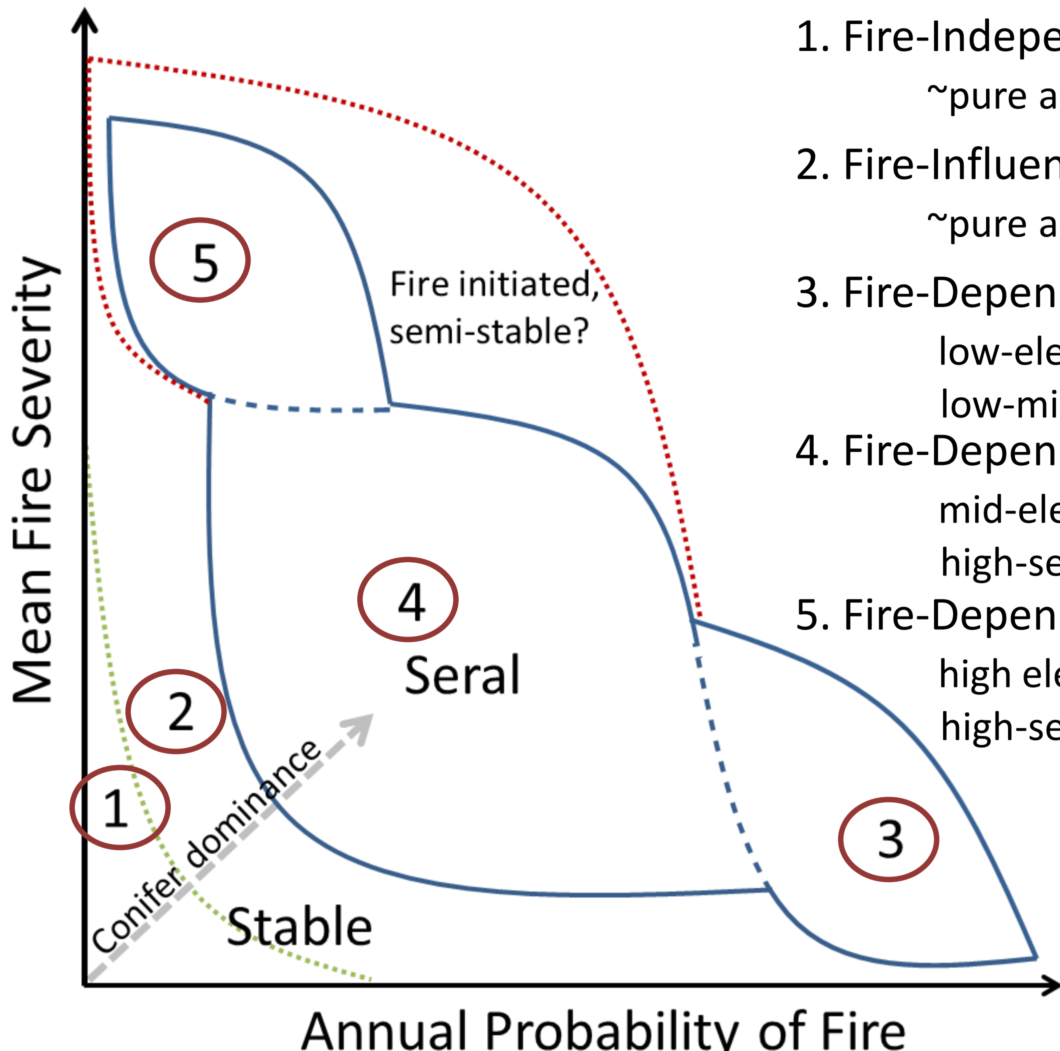
46 studies assessed

- 12 Fire history reconstruction studies – MFRI estimated
  - 10 used conifer scars
  - 2 used aspen scars
  - 1 used stand origin dates
- 34 used stand age or stand age structure
- 20 indicated some or all of stands sampled were stable without fire

Geography

- ✓ 39% So. Rockies
- ✓ 22% Middle Rockies
- ✓ 17% AZ/NM Mtns
- ✓ 13% Wasatch/Uinta Mtns

Aspen Fire Regime Classification – A Conceptual Framework



1. Fire-Independent Stable Aspen
   ~pure aspen, protected from fire
2. Fire-Influenced, Stable Aspen
   ~pure aspen, less-protected from fire
3. Fire-Dependent, Seral Conifer-Aspen Mix
   low-elevation, fire-adapted conifers, low-mixed severity fire
4. Fire-Dependent, Seral, Montane Aspen Conifer
   mid-elevation, mixed conifers, mixed- to high-severity fire
5. Fire-Dependent, Seral, Subalpine Aspen Conifer
   high elevation conifers, infrequent & high-severity fire

Aspen-Fire Research in the Sierra Nevada / South Cascades

- Few studies specifically addressed aspen fire regimes
  - Ko (2001), Lake Tahoe Basin
    - 3 stands catastrophic regeneration, 4 stands gap-phase, 13 continuous recruitment
    - ~4-5 stands where conifer recruitment out-paced aspen
    - Concluded some stands don’t need fire to persist
  - Pierce and Taylor (2010), Diamond Mtns
    - Mixed severity fire inferred from regeneration of aspen and fir
  - McCollough et al. (2013), Lassen NP
    - Half of stands persistent, half with conifer recruitment
  - Taylor (2008), Lassen NP

Aspen Types and Relative Fire Dependence in the Sierra Nevada

Stand type	Location	Fire dependence	Type
Riparian	Permanent/seasonal water course	Dependent	Seral
Meadow fringe	Dry meadow fringes	Dependent	Seral
Upland aspen/conifer	Located away from any surface moisture regimes	Dependent	Seral
Lithic	Lateral/terminal moraines, talus, rock	Independent	Stable
Upland pure	Variable site locations	Influenced/ Independent	Stable
Snow pocket	Topographic positions where snow accumulates	Influenced/ Independent	Stable
Krummholtz	Ridgelines	Independent	Stable

Shepperd et al. 2006;
Shinneman et al. 2013;
Estes 2013

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Knowledge Gaps & Research Needs

- Relatively few studies estimated fire rotation or landscape mean fire intervals
  - More fire histories are needed that use landscape-scale, replicated plot-samples of both fire scars and age structures

- New techniques are needed for more robust interpretations of stand age structures and estimates of fire regimes in aspen
  - Calibration of aspen fire scar rates using modern fires
  - Radiocarbon dating of annual growth rings
  - Analysis of stable isotope composition in tree rings
  - Determine how genotypic variation related to fire events
  - Determine influence of other disturbance agents (e.g., drought, disease, windthrow, insect outbreaks, browsing) on aspen fire regimes

- Paucity of research on aspen fire regimes in several ecoregions of the MW
  - Sierra Nevada / South Cascades, Great Basin, Northern Rockies, parts of Southwest

- Paucity of research on fire regimes of specific aspen types
  - Riparian aspen, snow pocket, etc.

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California Aspen - Research Needs

- Role of fire in HRV among different aspen types
- Spatial-temporal patterns between aspen and fire
- Variability in regeneration response after fire
  - both wildfire and controlled experiments
  - under different environmental and climatic conditions
- Vulnerability of aspen to climate change
  - Will more/less fire help/hurt aspen under a changing climate?

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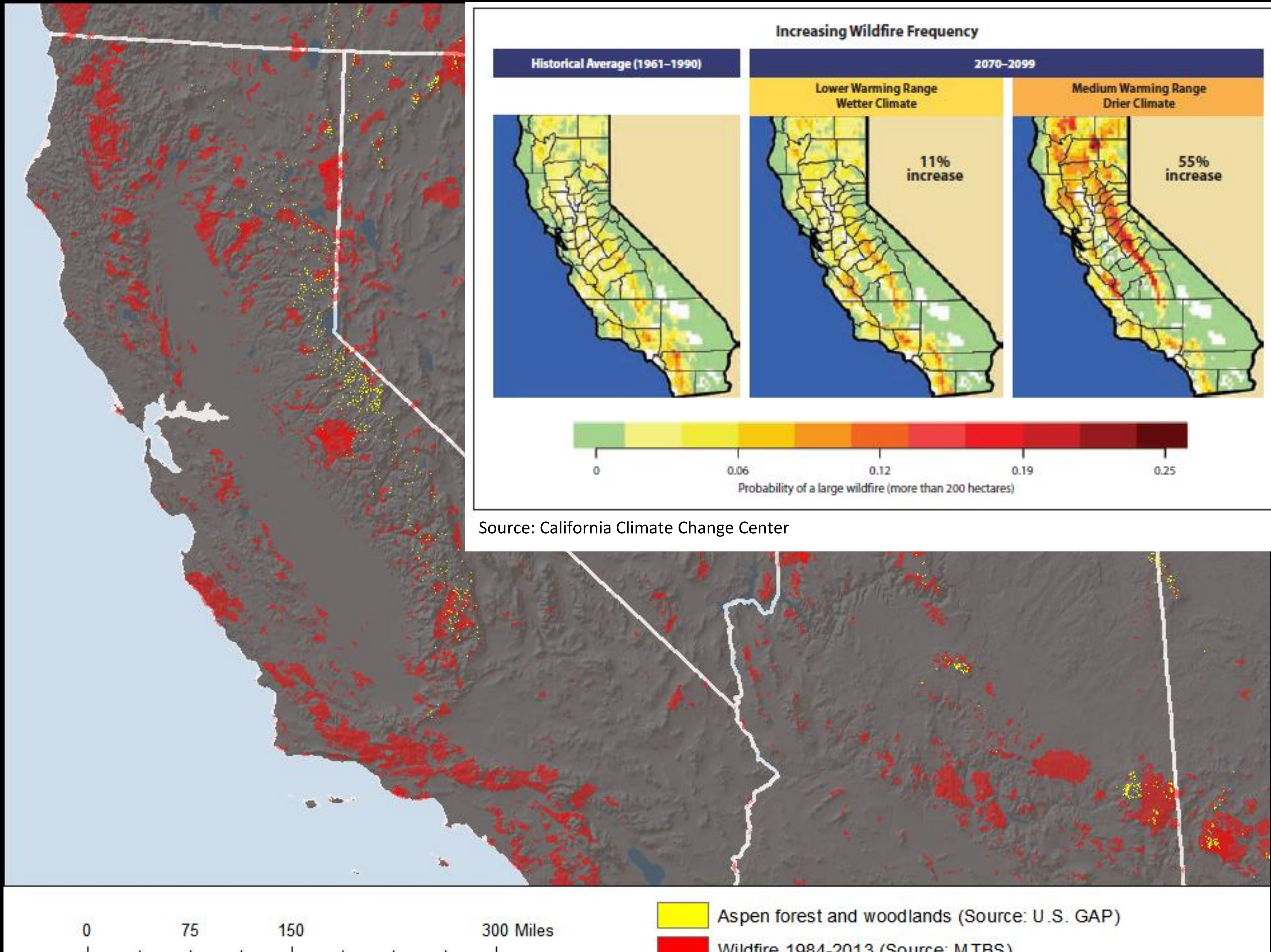
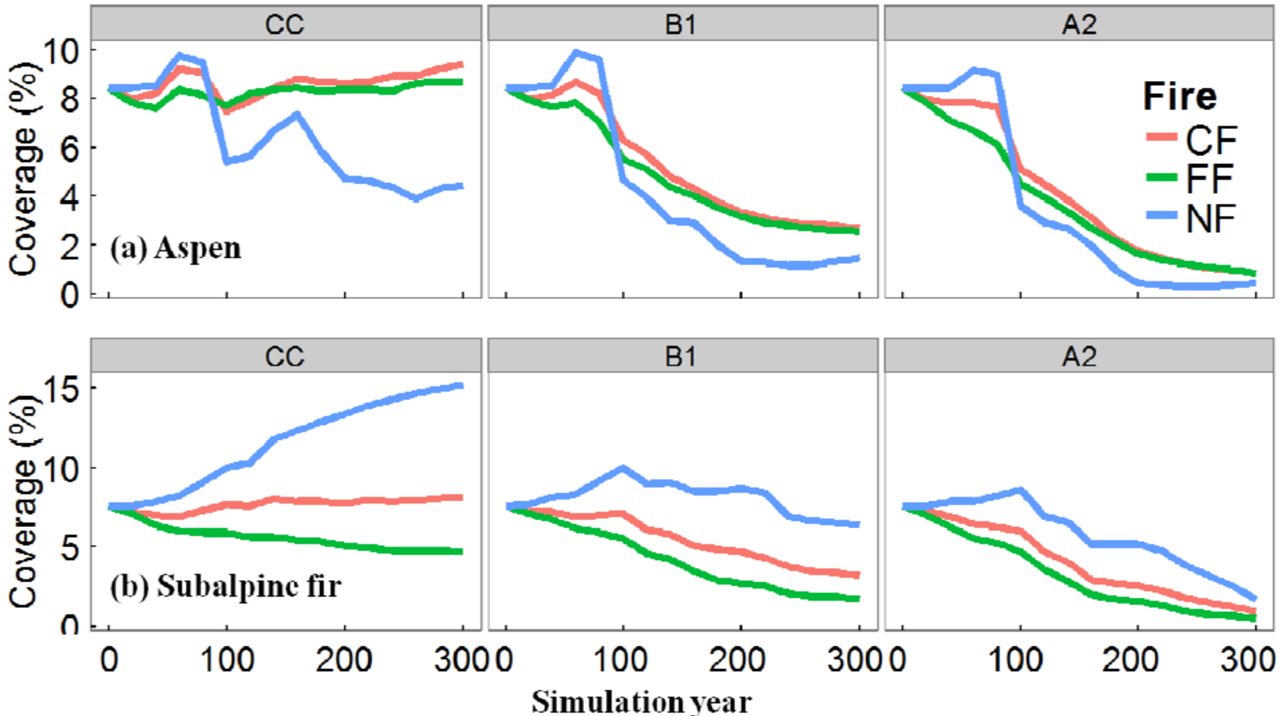

Increasing Wildfire Frequency
Historical Average (1961–1990)
2070–2099
Lower Warming Range
Wetter Climate
Medium Warming Range
Drier Climate
11% increase
55% increase
0
0.06
0.12
0.19
0.25
Probability of a large wildfire (more than 200 hectares)
Source: California Climate Change Center
0
75
150
300 Miles
Aspen forest and woodlands (Source: U.S. GAP)
Wildfire 1984-2013 (Source: MTBS)

Aspen, Climate Change and Fire - Jarbidge National Forest, Nevada



From: Yang, J., P. J. Weisberg, D. J. Shinneman, T. E. Dilts, S. L. Earnst, and R. M. Scheller. (in review). Fire modulates climate change response of aspen across topoclimatic gradients in a semi-arid montane landscape. *Landscape Ecology*.

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Aspen Fire Regimes - Conclusions

- Move beyond overly simplistic view of aspen fire regimes as fire dependent, or as a dichotomy of seral vs. stable aspen
- Recognize that biophysical gradients influence the relative dependency of aspen communities on fire and are correlated with the relative stability of aspen on the landscape
- Understand emerging trends in aspen within context of the HRV *and* likely changes under climate change (climate-vegetation-fire interactions)

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Thanks!
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