Regional trends in burn severity, tree regeneration, and reburns in the US Northern Rockies

Brian J. Harvey University of Washington October 2018 Northern Rockies Fire Science Network Fieldtrip

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Are severely burned patches in today's fires bigger than the fires of the past?



Are forests coming back after fire the way they used to?

Are re-burns becoming more common?

Overview

Regional trends for the N Rockies:

1) Burn severity



2) Post-fire tree regeneration

3) Reburns





Regional trends for the N Rockies:

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1988 Yellowstone Fires exhibited tremendous heterogeneity

where is track the output of station

Photo credit: M. Turner



MANIMUM PRACT

Stan man

12650

Edd proven in which

A loss marked



Photo credit: M. Turner

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1640

Key questions arising...

Is spatial heterogeneity of burn severity changing with increased fire activity?

where it that the water of the party



US Northern Rockies as an outdoor lab

668 forest fires in the US Northern Rockies ecoregion (1984-2010)

n = 668 landscapes!



Wealth of satellite and field data

1) Burn severity maps



2) Field validation plots



4) Classify burn severity and characterize heterogeneity for each fire landscape



For each fire: <u>Stand-replacing fire</u>

- Proportion
- AW mean patch size

3) Calibrated indices

- AW edge:area
- Total core area

Changes over time?

Fire perimeter

Less than stand-replacing fire

Stand-replacing fire

Core area

Metric (class)	Heterogeneous	Homogenous
Proportion (stand-replacing)		
Mean patch size (stand-replacing)		
Edge:area (stand-replacing)		
Core area (greater than 150 m from edge of stand-replacing patch)		

Is heterogeneity changing over time?



(Harvey et al., Landscape Ecology 2016)

Is heterogeneity changing over time?









(Harvey et al., Landscape Ecology 2016)

Minor changes...so far

Fire perimeter
Less than stand-replacing fire
Stand-replacing fire
Core area

Metric (class)	High heterogeneity	Low heterogeneity
Proportion (stand-replacing)		
Mean patch size (stand-replacing)		
Edge:area (stand-replacing)		
Core area (greater than 150 m from edge of stand-replacing patch)		

(Harvey et al., Landscape Ecology 2016)

Heterogeneity abounds...

> 90% of the forested area burned between 1984 and 2010 is within 150m of a seed source!!!



(Harvey et al., Landscape Ecology 2016)



2000 Moran Fire, Grand Teton National Park

But are we approaching a critical threshold?

For all fires between 1,000 and 1,500 ha





(Harvey et al., Landscape Ecology 2016)

Summary: Regional trends in burn severity patterns

- Large fires are still heterogeneous...
- ...but trends may be heading toward thresholds in the size and shape of stand-replacing fire patches



(Harvey et al., Landscape Ecology 2016)

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What happens when severe fires are followed by warm/dry conditions?



Approach: Regional field survey

11 fires occurring between 1994 and 2003

A)

B)



Post-fire tree establishment declines sharply with drought severity & burn patch size



Is this a glimpse into the future...?



Severe fire and dry conditions at the lower treeline leads to slow/no recruitment

Stand-replacing fire, <u>mesic</u> stand, <u>far from lower ecotone</u>



Stand-replacing fire, <u>dry</u> stand, <u>near lower ecotone</u>



(Donato et al., 2016 Ecosphere)

Regional trends across the N Rockies (and CO)



Stevens-Rumann et al. 2017, Ecol. Lett.

Post-fire recruitment shift?



Stevens-Rumann et al. 2017, Ecol. Lett.

Summary: Regional trends in post-fire tree regeneration

Effects of a warming climate on post-fire forests

- In subalpine/mid-montane forests, overall post-fire tree regeneration declined sharply with greater drought severity and distance to seed source
- At lower treeline, warm and dry areas nearest to ecotone with grassland may be converted to grassland

(Harvey et al. 2016 Glob. Ecol. Biogeog; Donato et al. Ecosphere; Stevens-Rumann et al. 2017, Ecol. Lett.)

Regional trends for the N Rockies:

1) Burn severity



2) Post-fire tree regeneration





Everything is a reburn, but context matters

Reburns as a "good" thing for forests



Ponderosa pine forest with an active frequent fire regime

Reburns as a "problem" for forests



Subalpine forest experiencing two stand-replacing fires in <30 years

How does burn severity in recent "reburns" interact with burn severity from past fires?

How do mosaics of multiple fires interact?



Fire effects on fuels occur at multiple scales

Spatial scale Among stands

Within stand



Expectations have been that there will be strong and persistent <u>negative</u> feedbacks among fires because one fire removes the fuels necessary for another.



1 year



Time since fire

Past fires limit the likelihood of reburning



BUT!!! Effects decay with: $\rightarrow \underline{time}$ since last fire $\rightarrow \underline{extreme}$ weather

Parks et al. 2018 Ecol. App.

Past fires limit the size / spread of subsequent fires



Parks et al. 2015 Ecol. App.

Past fires limit the size / spread of subsequent fires



Parks et al. 2015 Ecol. App.

Past fires limit severity of subsequent fires



What about landscape patterns of reburns?

Spatial scale Among stands

Within stand







Time since fire



Forested area in Yellowstone National Park

1988 Yellowstone Fires







The North Fork Fire in 1988

Total forested area burned

206,000 ha

Stand-replacing fire

Proportion of fire	54%
Mean patch size	<u>9,716 ha</u>
Patch complexity (edge:area)	98 m/ha
Core area (< 150 m from live tree)	<u>39,401 ha</u>
Core area mean patch size	<u>4,550 ha</u>



The Maple Fire in 2016

Re-burned 18,350 ha of the 1988 North Fork Fire









Stand-replacing fire was more heterogeneous in the 2016 Maple Fire (reburn)



Core area patch size







1988

2016

Additive SR 2x

But.. cumulative burn severity patterns are a different story



Core area patch size





Cumulative effects on landscape pattern of old/mature forest

1987



Cumulative effects on landscape pattern of old/mature forest





Cumulative effects on landscape pattern of old/mature forest

2017

Are we seeing what we think we are? (in reburns)

Stand-replacing fire (CBI ~ 3.0; RdNBR ~ 1200)



Stand-replacing reburn (CBI ~ 3.0; RdNBR ~ ???)



Summary: regional patterns of reburns

- Multiple fires are generally characterized by negative "links" between fire events...but effects are short-lived
- Going spatial gives important insight about cumulative patterns
- We need to calibrate remote sensing indices in reburns... stay tuned!

Summing it all up...

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Slow increases in standreplacing fire, but may be approaching thresholds in spatial patterns. Slower post-fire tree regeneration overall, possible regen failure near lower treelines. Negative feedbacks are important, but short-lived. Spatial patterns important.

Thanks!

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