Quantifying the characteristics and investigating the biogeoscientific and societal impacts of extreme wildland fires in the United States northern Rockies region: Group project highlights from IDS-NNX11AO24G

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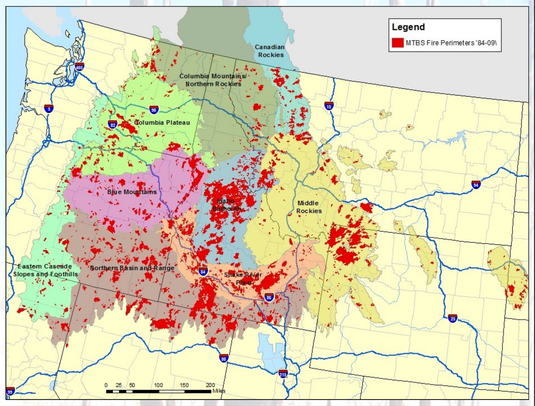
Project Overview. In recent years there is a perception that wildland fires have become more widespread with significant ecological, social, and economic impacts. Fewer than 5% of all fires account for the majority of area burned and the costs of fire suppression. The complex terrain in the northern Rockies offers steep environmental and social gradients to understand how and why landscapes change in response to extreme disturbances, as well as the social and environmental implications of those changes. The social gradient includes wildland interface community experience, while the environmental gradient covers aridlands, such as shrublands and grasslands, to mesic mixed conifer forests and subalpine ecosystems. Fires in these systems result in varying public and policy maker experiences and land management decisions in forested and rangeland ecosystems.

Project Objectives. This project has 3 principal objectives. Namely, to (1) Define and characterize extreme wildland fires, (2) Assess the near– and long-term trajectories (biophysical and social) following extreme fires, and (3) Evaluate how land managers have acted to mitigate the negative impacts of these extreme fires.



Project Area. Our study area encompasses wildland and WUI ecosystems in the northwestern United States. Middle-elevation forests have been identified as highly vulnerable to human-induced changes in fire size and severity (Westerling et al. 2006). This research advances our understanding of the resiliency of social and ecological systems in wildland and WUI landscapes and how these landscapes may be affected by future changes driven by climate, fire and land use.

PROGRESS: Objective 1

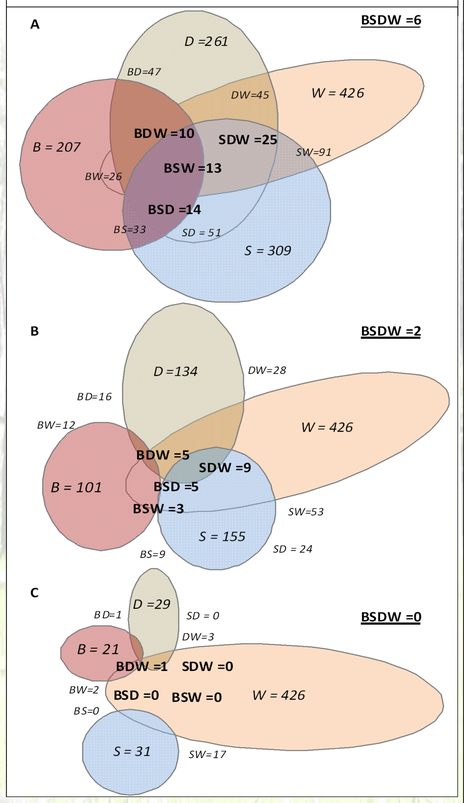
Social. Key social characteristics of extreme wildfires were identified by an expert panel of land managers, community leaders, and academic researchers with extensive field and/or research experience related to wildfires.

- Fire Characteristics: Recent, severe (state disaster of federal disaster declaration), extreme fire behavior, phase shifts in biophysical characteristics following the fire and the amount of time needed to return to pre-fire conditions.
- Community Characteristics: Aesthetic impacts, social disruption (evacuations), previous experience with wildfires, perception of control (fighting fire and public involvement), location of fire, preparedness or community and emergency responders, income dependency on forest resources.
- Impacts: Losses (economic, cultural, structures), loss of lives, infrastructure, costs (fire fighting and recovery/restoration, size of area burned, smoke impacts).

Geospatial. In Lannom et al. (in review), key geospatial metrics were investigated and potentially extreme fires were identified.

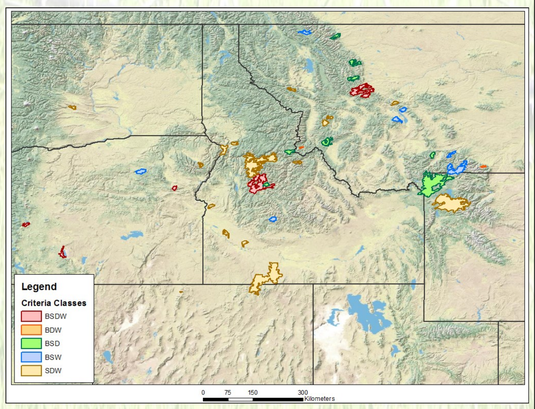
- 1988, 2000, 2007 were identified as widespread fire years.
- Metrics: Fire size, % mapped high burn severity, duration (extremely short or long), and intersection with WUI.
- 90th, 95th, and 99th percentiles were used as thresholds for size, severity, and duration. The 1st, 5th, and 10th percentiles were also used for duration. Fires that burned into or immediately adjacent to WUI were identified as having the most social impact. Fires that exceeded the percentile thresholds for 3 or more these metrics were identified as being potentially extreme.

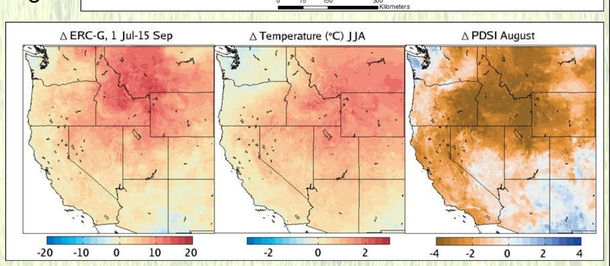
Number of fires meeting geospatial fire metric thresholds at the (a) 90th , (b) 95th , and © 99th percentile.s Duration (D) also included fires meeting the 10st, 5th, and 1st percentile).



Climate. In Lannom et al. (in review), interannual variability of biophysical metrics of extreme fires were compared to first order climate, integrated fire danger, and water balance metrics aggregated over the study area.

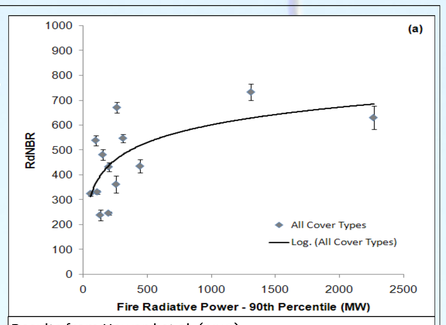
- Monthly mean temperature and the Palmer Drought Severity Index (PDSI) were calculated at the 4-km scale using data from PRISM; daily Energy Release Component (ERC, fuel model G), Duff Moisture Code (DMC) and reference potential evapotranspiration (PET) were calculated at the 4-km scale using data from Abatzoglou (2013).
- Area burned was strongly linked to concurrent drought and warm summer temperatures r=0.60 (p<0.01), for August PDSI and Jun-Jul temperature, respectively.
- Relationships were even stronger for area burned at high severity to 1 Jul-15 Sep ERC (r=0.91) and reference ET from 1 Jun-15 Sep (r=0.92).
- These results are in agreement with prior climate-fire studies in the region that show strong flammability-limited climatic controls on wildfire activity associated with drought concurrent to the fire season being of most importance.





Geospatial. Evaluating potential metrics of extreme. We compared MODIS Fire Radiative Power (MODIS FRP) products with Landsat-derived severity indices (dNBR, RdNBR) for sixteen fires across a vegetation structure continuum in the western United States.

- Across all fires, 69% of the variation in RdNBR was explained by the 90th percentile of MODIS FRP. It was determined that distributional MODIS FRP measures (median and 90th percentile FRP) derived from multiple MODIS overpasses of the actively burning fire event may be used to predict potential long-term negative ecological effects for individual fires.

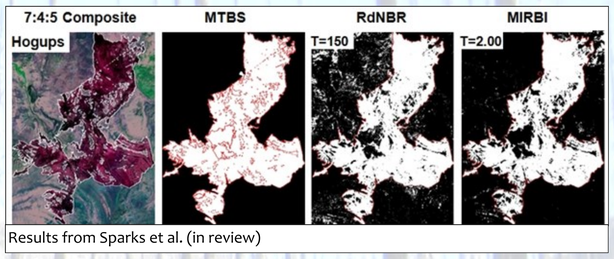


Results from Heward et al. (2013)

Geospatial. Preliminary assessment of MTBS burned area perimeters. We evaluated three rangeland fires that exhibited varying degrees of within-fire patch heterogeneity. We compared MTBS perimeters, RdNBR, and mid-infrared burn index (MIRBI) maps to hand digitized burned area maps using Landsat data.

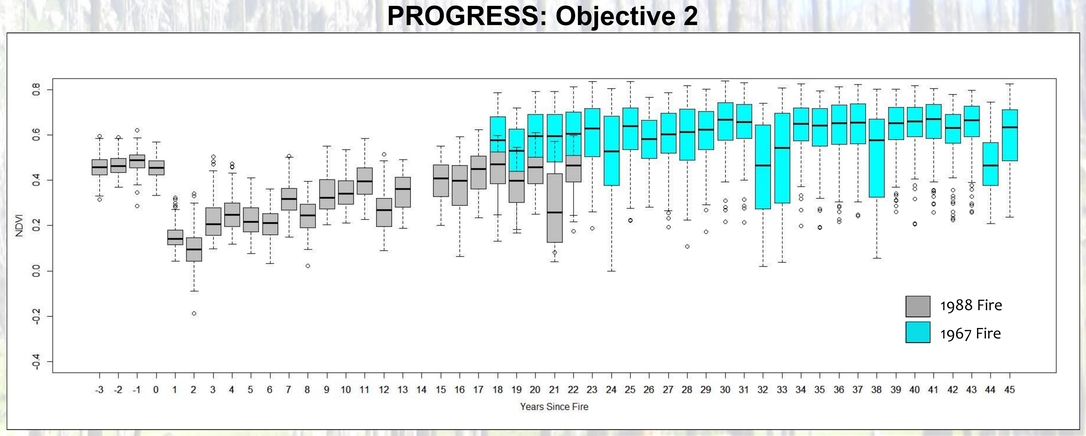
- MIRBI provided the most consistent accuracies (95.8-97.9%), with only small commission errors (2.1-7.4%).

	MTBS	RdNBR	RdNBR(P)	MIRBI	MIRBI(P)
Overall Accuracy	94.2	90.5	97.1	95.8	97.2
Commission Burned	15.5	22.8	4.7	7.4	1.7
Commission Unburned	0.4	2.7	2.1	2.9	3.3
Omission Burned	0.9	6.3	4.8	7.5	7.6
Omission Unburned	8.0	10.7	2.1	2.9	0.7
Total Area Burned (bias, %)	16.8	17.8	-0.3	-1.1	-6.1

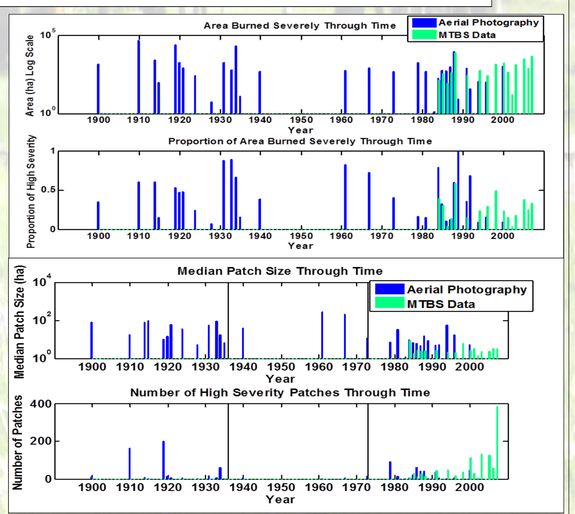


Results from Sparks et al. (in review)

PROGRESS: Objective 2



Geospatial. We are developing a 100+ year post-fire recovery chronosequences using Landsat data. Several examples of extreme fires, spaced out by 20 year intervals, from the past 100 years have been identified. Six fires have been selected, and two fires analyzed, to date. NDVI values show a post-fire recovery increase in NDVI values. The same methodology will be repeated with the remaining five fires and post-fire NDVI recovery plots will be stitched together to create a 100-year recovery chronosequence. Recent fires will also be included once LDCM data is available.



Case Study: Selway-Bitterroot Wilderness 1900 - 2007. We fused MTBS ('84-'07) and aerial photography data (1900-2000) and based on the compatibility of the two datasets, two time series of annual area burned severely and median patch size across the 1900-2007 time period were constructed.

Social. We are exploring how citizens' perceptions of extreme relate to biophysical and social impacts of wildfires. We will select 50 fires from 2011 and 2012, representing a spectrum of wildfires characterized from "insignificant' to 'extreme' in terms of biophysical characteristics.

- We are analyzing social data combined with measurable biophysical characteristics to assess the extent to which the magnitude of impact of fires on WUI resident's well-being is explained by measurable biophysical characteristics of the fire and subjective evaluations of the personal and community-level impacts of the fire.

Viewshed analysis of 2006 Columbia Complex fire in

PROJECT PUBLICATIONS

Brewer, N.W., Smith, A.M.S., Hatten, J.A., Higuera, P.E., Hudak, A.T., Ottmar, R.D. and Wade T. Tinkham, 2013, Fuel Moisture Influences on Fire-altered Carbon in Masticated Fuels: An Experimental Study, *Journal of Geophysical Research*, 118, 31–40 doi:10.1029/2012JG002079.

Heward H, Smith A.M.S., Roy, D.P., Tinkham, W.T., Hoffman, C.M., Morgan P. and Lannom, K.O. Is burn severity related to fire intensity? Observations from landscape scale remote sensing, *International Journal of Wildland Fire, In Press*.

Lannom, K.O, Tinkham, W.T., Newingham, B.A., Hall, T.E. Morgan P., Abatzoglou, J., Strand E.K., Paveglio, T.B., Anderson, J.W., Smith, A.M.S., Defining extreme wildland fires using geospatial data, *International Journal of Wildland Fire, in review.*

Sparks, A., Tinkham, W.T., Smith, A.M.S., Boschetti, L. Newingham B.A. and Lannom, K.O. Preliminary assessment of the Monitoring Trends in Burn Severity burned area accuracy for three shrub-steppe fires, *International Journal of Wildland Fire, in review.*