Boreal Fires: What is new and interesting?

2020 Alaska NSF EPSCoR All Hands Meeting, November 4, 2020

Tag team approach to make sure you hear from each researcher

Uma Bhatt
U Alaska BF Research Capacity

Long-term EPSCoR BF team

Personnel and Organization

Climate Variability
- Uma Bhatt (co-lead)
- Peter Bieniek
- Todd Brinkman (co-lead)
- Krista Heeringa

Ecology
- Matt Berman
- Jen Schmidt
- Joseph Little

Economics and Ecosystem Services
- UAA Terrestrial Faculty Hire

Fire Management Expertise
- Teresa Hollingsworth
- Robert Ziel
- Randi Jandt
- Alison York

Remote Sensing and Fuel Mapping
- Santosh Panda
- Martin Stuefer
- Chris Waigl (postdoc)
- Simon Zwieback

Uma Bhatt

Additional BF Capacity
- Students
  - Elizabeth Hinkle
  - Anushree Badola
  - Christopher Smith
  - Jonathan Christ
  - Cece Borries-Strigle
- Researchers
  - Erik Schoen
  - Sveta Yamin-Pasternak
  - Micah Hahn

Partners/Collaborators
- Heidi Strader
- Eric Stevens
- Jennifer Barnes
- Teresa Hollingsworth
- Lisa Saperstein
- Rana Gahway
  - fire management
Co-Production and Collaboration
Mutually Beneficial Examples

Wildlife Agencies & Hunters
*Immediate effects of wildfire on moose harvest success
-Moose harvest data 1983-2019 (Response variable)
-Wildfire, habitat, and access (Explanatory variables)

Tribal Organizations & Communities
*Rapid assessment tool to quantify fuels regeneration in wildfire breaks
-Compare drone-based image classification with ground measurements

Todd Brinkman
Chinook salmon declines have caused hardship in fishing communities throughout the boreal forest region of Alaska.

How does wildfire affect juvenile salmon growth?

- Warmer water temperature (+/-)
- Reduced water clarity (+/-)
- More invertebrate food (+)
- More distracting debris (-)

Opportunity: Two large fires during 2019 bisected a major, well-studied Chinook salmon habitat in the Chena River.

Goals: Compare water quality, food supply, and growth rates between fire-affected sites and reference sites (both small tributaries and mainstem salmon habitat).

Erik Schoen and Ben Meyer
Effects of wildfire on juvenile Chinook salmon: preliminary results

**Tributaries:** Burned sites had warmer water and greater debris loads than unburned sites. (Also reduced clarity and more food?)

**Mainstem:** Temperature slightly warmer and water clarity slightly reduced below the fire scar. (More food and debris?) **Juvenile salmon grew to a similar size above and below the fire.**

**Next steps:** Use drift foraging model to understand what factors limit growth rates and identify critical thresholds. Develop drone-based rapid-assessment tool (with TCC)

Erik Schoen and Ben Meyer
POST-WILDFIRE RESPONSE OF STREAM HABITAT AND AQUATIC MACROINVERTEBRATE ASSEMBLAGES IN THE BOREAL FOREST

BACKGROUND
• FIRE AFFECTS STREAMS HYDROLOGICALLY AND CHEMICALLY
• FIRE AFFECTS STREAM RESOURCE AVAILABILITY

RATIONALE
• ALTERED RESOURCE AVAILABILITY AFFECTS DOWNSTREAM CONSUMERS - E.G.: CHINOOK, ARCTIC GRAYLING
• NO DOCUMENTED EFFECTS IN INTERIOR AK

OBJECTIVES
• QUANTIFY MACROINVERTEBRATE ASSEMBLAGE AND DENSITY IN STREAMS WITH AND WITHOUT WILDFIRE
• ASSOCIATE DENSITY AND ASSEMBLAGE STRUCTURE WITH HABITAT CHARACTERISTICS.

Elizabeth Hinkle
METHODS

- 6 STREAMS, 2 TREATMENTS, 4 MONTHS (N=24)
- 24 HOUR DRIFT
- HABITAT CHARACTERISTICS (50 M SEGMENTS)
- WATER GRABS (N, C, P)

PRELIMINARY RESULTS

- LESS CANOPY COVER, LESS VEGETATION
- MORE ORGANIC MATTER
- HIGHER ABUNDANCE AND BIODIVERSITY MACROINVERTEBRATES
- IMPLICATIONS FOR FOOD AVAILABILITY
- HEALTH AND RESILIENCE OF SALMONIDS

Elizabeth Hinkle
2020 Harvest of Fire Morels in Alaska: A Synergy of Community Outreach and Local Knowledge Research

With the earliest reported harvest on May 16 (Swan Lake) and the latest on August 13 (Shovel Creek and Swan Lake), the collective experience of the foragers in the group shows that the duration of the 2020 morel harvesting season is the longest on record.

MORELS: MAKING MONEY, MEALS, MEMORIES.
Igor Pasternak, Sveta Yamin-Pasternak

Sites of last-year’s forest fires are often (not always) promising grounds for the hunting of morel mushrooms. Join us for this show-and-share on the where, when, and how. Free and open to the public, webcast via Zoom.

Wednesday, April 29
6PM Alaska time
Zoom Meeting ID: 967 1114 5718
Password: 184393.

Sveta Yamin-Pasternak

Forager Classification of Boreal Forest Burns

All Black Dry Burn
In this type of burn, forests are completely blackened, dusty, and dry, surrounded by mostly black trees. In these burns, it is not a primary fire, but it can produce new growth in areas where trees have not burned.

Mixed Black Burn
This is a dark burn that features sparse, young, and mixed forests. In the flat stretches of this burn, one often finds blackened trees, dust, and dry grass. In the age, one can see some spruce plants, including saplings and seedlings. In the presence of a burn, one can find areas with a higher percentage of spruce plants. The ground in this type of forest is not blackened, with patches that are densely covered by fallen spruce needles.

Mixed Partial Burn
Featuring birch, aspen, cottonwood, and white spruce, this type of burn tends to confound people because it contains some living trees and those that are partially burned. When facing an aerial view, one sees a lot of green foliage and may mistake it for an intact forest. The ground in this kind of forest is not blackened, with patches that are densely covered by fallen spruce needles - typically the most promising habitat for moths.

Sveta Yamin-Pasternak
Ecological effects of recent wildfires in the wildland urban interface

- **Goal**
  - To assess the ability of Sentinel-2 (remote sensed data) to detect burn severity
  - Assess new methods using drones and pictures
- **Methods**
  - Sampled 63 plots in the McKinley and 13 in the Montana Creek wildfires
  - Assessed on-the-ground burn severity (Composite burn index)
  - Vegetation and duff characteristics
- **Results**
  - CBI relates well to Sentinel-2 ($p < 0.001$; $R^2 = 0.67$)
  - Upward facing photos and drone photos show promise more so in moderate-lower severity areas
- **Conclusion**
  - Even in a WUI environment with active suppression remote sensed data works well to assess burn severity

Jen Schmidt
Social effects of recent wildfires in the wildland urban interface

● Goal
  ○ To better understand how recent wildfires in Alaska affect residents

● Methods
  ○ Built trust and a relationship with residents
    ■ Social media
    ■ Personal interactions
  ○ Interviewees and film production

● Results
  ○ McKinley wildfire video on lessons learned
  ○ Infographic about preparedness, evacuation, and recovery

● Conclusion
  ○ Local based knowledge in the WUI is valuable for increasing resilience and adaptation to wildfire
Surveys of Property Alaska Property Owners Affected by 2019 Wildfires
Matt Berman, Jen Schmidt, Joe Little, Yuqing Wang

McKinley Fire, Mat-Su Borough
- Caswell Fire Service Area property owners
- Survey posted, September 2020
- 120 responses, representing 129 homes/cabins (see below)

Shovel Creek Fire, Fairbanks NS Borough
- Murphy Dome area property owners
- Survey posted, October 2020 (ongoing)
McKinley Fire: Preparedness and Impacts

**Preparedness**

Prior to the fire, how high did you think the risk was to your property?

- 1% (0 no risk)
- 5% (1)
- 12% (2)
- 11% (3)
- 16% (4)
- 12% (5)
- 13% (6)
- 9% (7)
- 7% (8)
- 10% (9)
- 0% (high risk)

Sockeye Fire encouraged preparedness

- 27% Yes
- 73% No

**Impacts experienced**

- 44% Yes
- 56% No

**How were you affected?**

- Health-related problems: 3%
- Reduced social interactions: 25%
- Loss of food: 22%
- Loss of recreation opportunity: 28%
- Loss of subsistence opportunity: 11%
- Lost time/inconvenience: 63%
- Financial hardship/loss of work: 34%
- Increased stress: 78%
- Physically displaced: 45%
- Loss of personal items (clothing, vehicles, etc.): 9%
- Loss of home/property damage: 9%
Hyperspectral remote sensing of Boreal vegetation/wildfire fuel

Res. Question 1:

Acquisition & Processing

Fuel Map Test Sites

Scale Up: Fuel Map Boreal Domain

Field Survey of Vegetation

Sentinel (10m)

Airborne (1-2m)

Field (<1m)

BCEF: Bonanza Creek Experimental Forest

Kenai Refuge

Santosh Panda
Field Survey of Vegetation

Field Crew:
Christopher Smith
Anushree Badola
Robert Haan
Colleen Haan
Christine Waigl
Jennifer Schmidt
Santosh Panda

<table>
<thead>
<tr>
<th>Sites</th>
<th>Plots/Points</th>
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<tr>
<td>BCEF</td>
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<td>CPCRW</td>
<td>99</td>
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<tr>
<td>UAF</td>
<td>51</td>
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<td>Kenai Refuge</td>
<td>31</td>
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<td>Shovel Creek</td>
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<td>Nugget Creek</td>
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Field Survey of Burn Severity

Santosh Panda
LANDFIRE Existing Vegetation Type (EVT)

Dominant classes: 8

Accuracy: 32%

Vegetation classes from AVIRIS-NG

Dominant classes: 20

Accuracy: 80%

<table>
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<tr>
<th>LANDFIRE EVT (Landsat)</th>
<th>AVIRIS-NG Veg. Class</th>
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</thead>
<tbody>
<tr>
<td>Pixel size: 30 m</td>
<td>5 m</td>
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<tr>
<td>Dominant classes (% cover &gt; 1): 8</td>
<td>20</td>
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<tr>
<td>Top 3 dominant classes (% cover):</td>
<td>1. Closed Birch forest (16)</td>
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<tr>
<td></td>
<td>2. Open White Spruce forest (9)</td>
</tr>
<tr>
<td></td>
<td>3. Closed tall shrub (9)</td>
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</table>

Christopher Smith
OUTCOME:

Received over 60 geotagged photos from across Alaska.

Identified vegetation at GPS coordinates based on images.

Will continue to update page about fire research and encourage involvement in the project.
Simulating AVIRIS-NG hyperspectral image from Sentinel 2 multispectral image for vegetation mapping at species level

**UPDM Formula:**

\[ R = P_w C_w + P_s C_s + P_v C_v \]

Where,
- \( P \) = proportion of class
- \( C \) = normalised ground reflectance

**UPDM Matrix Form:**

\[
\begin{pmatrix}
R_1 \\
R_2 \\
\vdots \\
R_n
\end{pmatrix} =
\begin{pmatrix}
P_{1w} & P_{1s} & P_{1v} \\
P_{2w} & P_{2s} & P_{2v} \\
\vdots & \vdots & \vdots \\
P_{nw} & P_{ns} & P_{nv}
\end{pmatrix}
\begin{pmatrix}
C_w \\
C_s \\
C_v
\end{pmatrix}
\]

**Trois Form:**

\[
R = \sum_{i=1}^{n} P_i C_i
\]

Anushree Badola
Validation Results

Visual comparison

Sentinel 2  Simulated  AVIRIS-NG

Band Correlations

Bands Correlation

Classification

Random Forest Classification - Sentinel 2

Accuracy 89.1%

Random Forest Classification - Simulated Hyperspectral

Accuracy 92.4%

Random Forest Classification - AVIRIS-NG

Accuracy 98.2%

Anushree Badola
HySpex aerial hyperspectral data acquisition: Fuel type and condition as well as burned area characterization on demand with unprecedented spatial resolution

- 2019/2020, 77 boreal fires flightlines acquired and processed with HySpex camera at 1m GSD
- 55 - fuels: Bonanza Creek, Caribou-Poker Creeks (CPC); 15 - burn severity: Shovel Creek burn, McKinley burn; 7 - active fire opportunistic acquisition over Clear Creek Fire.
- Enables creation of spectral libraries of individual tree crowns of fuel species
- More on HySpex in Thursday 9:15 session

CPC site. Top: AVIRIS-NG 2018, bottom: HySpex 2019

HySpex acquisitions in the Fairbanks area 2020. Left: flightline locations; right: close-up of Shovel Creek burn scar with unburned fuels

Sample reflectance spectra from CPC field site - HySpex vs. AVIRIS-NG
Co-production of knowledge: Science tools to help manage fire risk, make operational decisions, and understand fire behavior.

- GIS data services ready-to-use in management tool
- Re-use & combine available datasets
- Generate new data responding to need
- Spin-off science questions!

Progression of the 2019 Swan Lake Fire

Snow cover 2020

Chris Waigl
Cardiorespiratory health impacts of wildfire smoke in Anchorage, Fairbanks, and Mat-Su

Study period: 2015-2019 | Presenter: Micah Hahn, UAA ICHS

**Exposure**
- Daily average PM$_{2.5}$
- Plume locations
- Wildfire days

**Outcomes**
- Daily emergency room visits
  - Respiratory
    - Asthma
    - Bronchitis
    - Pneumonia
    - COPD
  - Cardiovascular
    - Arrhythmia
    - Cerebrovascular
    - Heart failure
    - Ischemia
    - Myocardial infarction

Micah Hahn
Red lines show long-term (2008-2019) monthly average PM$_{2.5}$

13% increase in odds of asthma ED visits on day of increased wildfire smoke

Micah Hahn
2012-2019 PSA Scale Lightning Climatology

Goal
● Link currently operational BLM lightning data counts to meteorology to answer: ‘Is there predictability for lightning?’

Methods
● Analyze co-variability of lightning & meteorology at monthly/hourly timescales.

Summary of Climatology
● PSAs with the most lightning in June are further south and west
● PSAs with the most lightning in July are further north and east
● Interesting case: Seward Peninsula has seen more lightning in August than July in recent years

Jonathan Chriest
Lightning: Is There Predictability?

Goal
- Analyze patterns in weather conditions at individual lightning strokes on a PSA scale.

Methods
- Assign ERA5 (European Center) hourly reanalysis variables to individual lightning strokes.

Results
- Average 850mb temperature for lightning near Fairbanks: 10.9°C
- Average 500mb height for lightning near Fairbanks: 566 dam
- NE/NW mid level flow is most favorable for lightning near Fairbanks.

Jonathan Chriest
Goal
● Provide seasonal outlook of upcoming summer fire activity to fire managers in March

Methods
● Use three seasonal forecasts: NOAA CFSv2, ECMWF SEAS5, MF Sys. 6/7
● Calculate buildup index (BUI) for fire season by region
● Evaluate forecast skill with ROC score
### Results
- Skill varied by region, season, model, BUI tercile
  - Most skill in upper, lower tercile BUI forecasts
  - Overall, MF performed best

### Conclusions
- March seasonal forecasts show potential of providing summer fire outlook
- Continue working with fire managers to identify which forecast information is useful

**Forecast Skill for PSA AK01W**

<table>
<thead>
<tr>
<th>Model</th>
<th>Entire Season</th>
<th>Wind</th>
<th>Duff</th>
<th>Drought</th>
<th>Diurnal</th>
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Summary

Understand Boreal fires at a systems level
  ○ Climate drivers of Fire Weather/Lightning
  ○ State of fuels (type and moisture)
  ○ Impact on people
    ■ Costs
  ○ Health
  ○ Impact on ecosystems services
    ■ Food Security: Moose harvest, Fish, & Morels
    ■ Fuel treatments and their consequences
Acknowledgements

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- We thank our numerous partners who have contributed to this project. Partners include: Alaska Fire Service, National Park Service, Cook Inlet Region, Inc., Fairbanks North Star Borough, Alaska Division of Forestry, Colorado State University, Tanana Valley Chiefs Council...