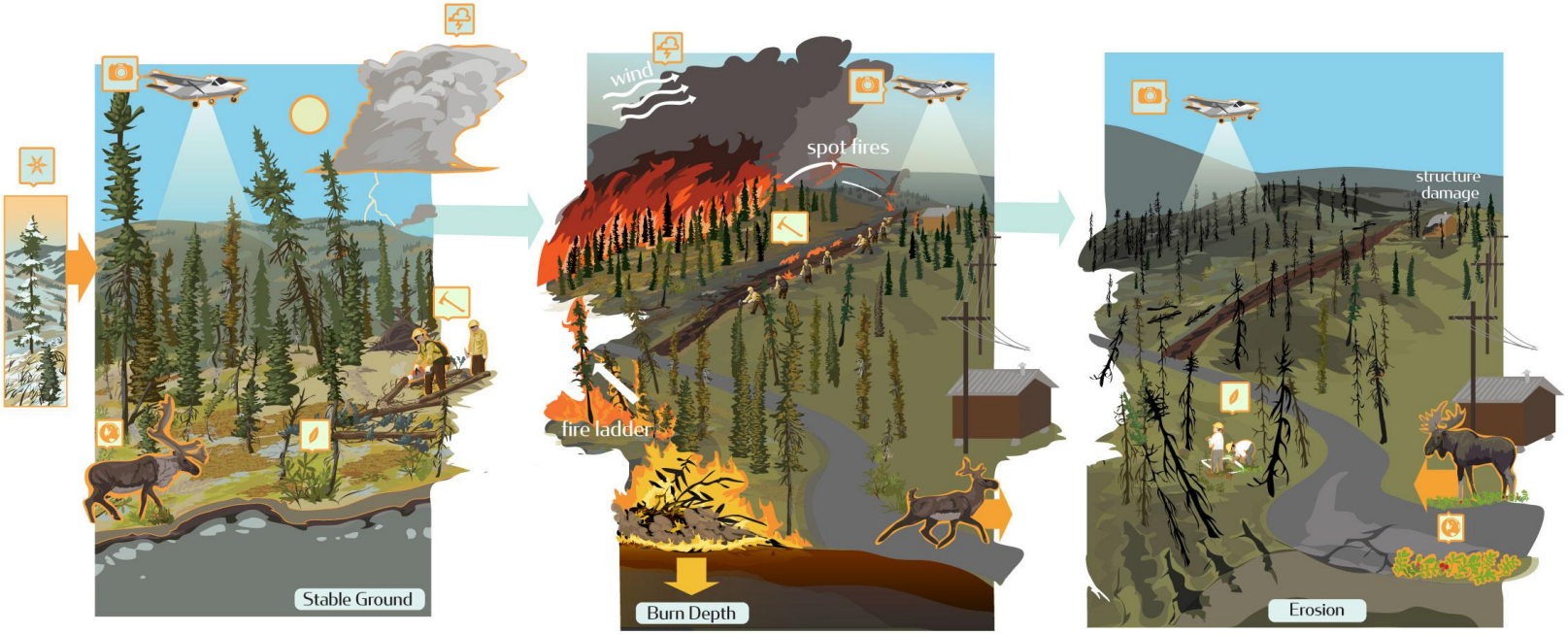
Boreal Fires: What is new and interesting?

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

Additional BF Capacity

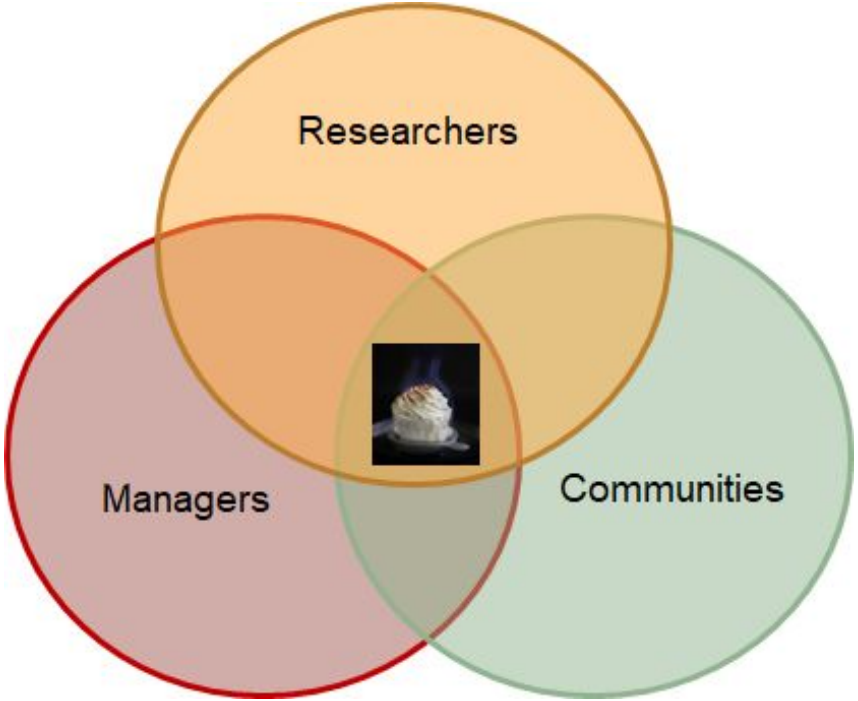
- Students
  Elizabeth Hinkle
  Anushree Badola
  Christopher Smith
  Jonathan Chriest
  Cece Borries-Strigle
- Researchers
  Erik Schoen
  Sveta Yamin-Pasternak
  Micah Hahn

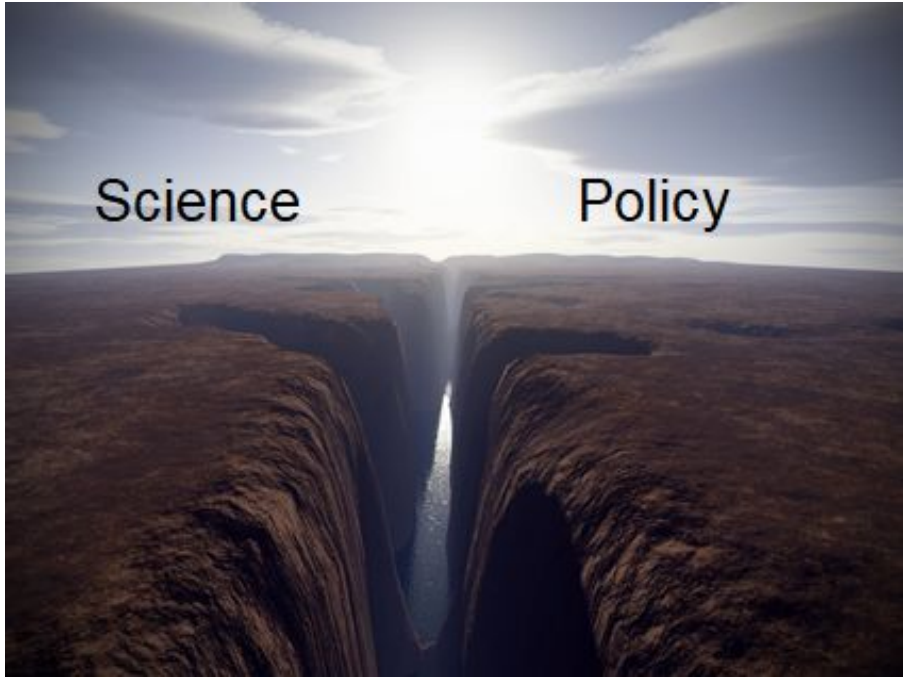
Partners/Collaborators

Heidi Strader
Eric Stevens
Jennifer Barnes
Teresa Hollingsworth
Lisa Saperstein
Rana Gahwagy
+ fire management

Uma Bhatt

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)

Todd Brinkman

Tribal Organizations & Communities

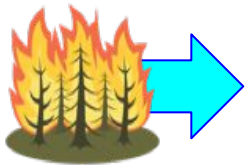
*Rapid assessment tool to quantify fuels regeneration in wildfire breaks

-Compare drone-based image classification with ground measurements

Effects of wildfire on juvenile Chinook salmon

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)

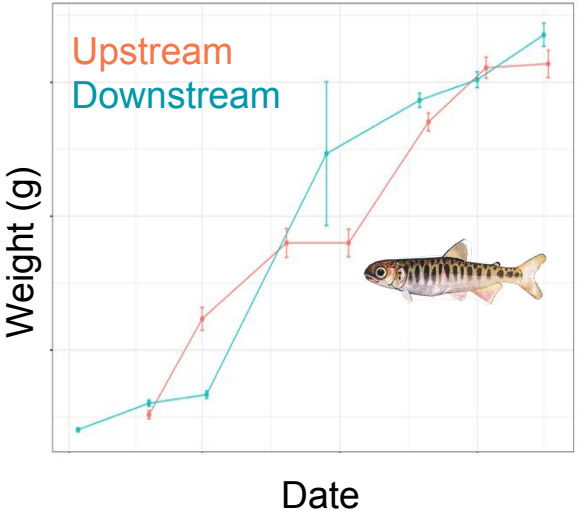
Erik Schoen and Ben Meyer

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.

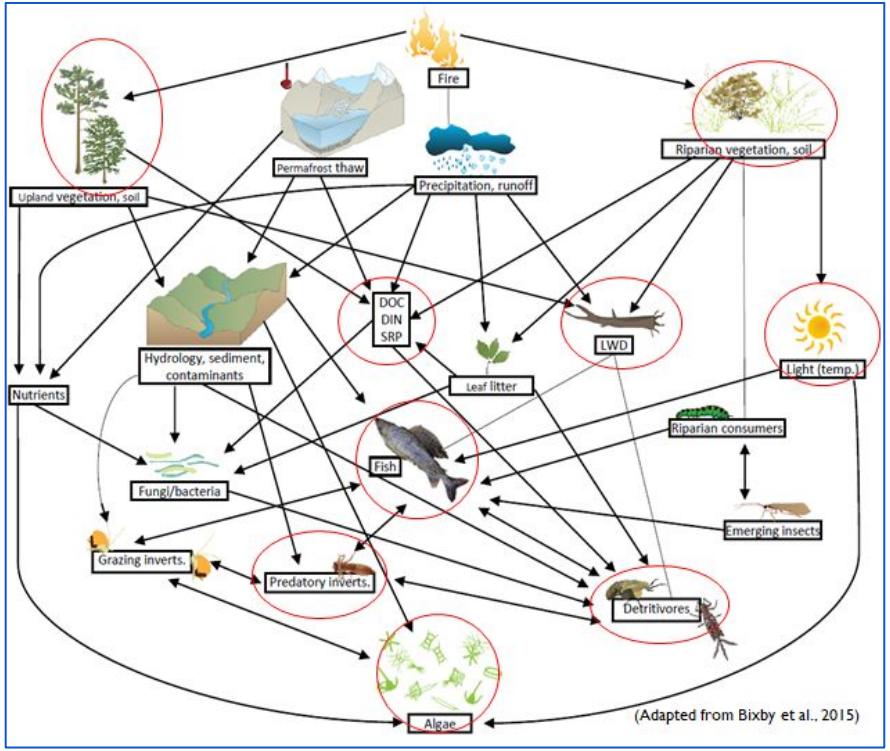


Photo: T. House

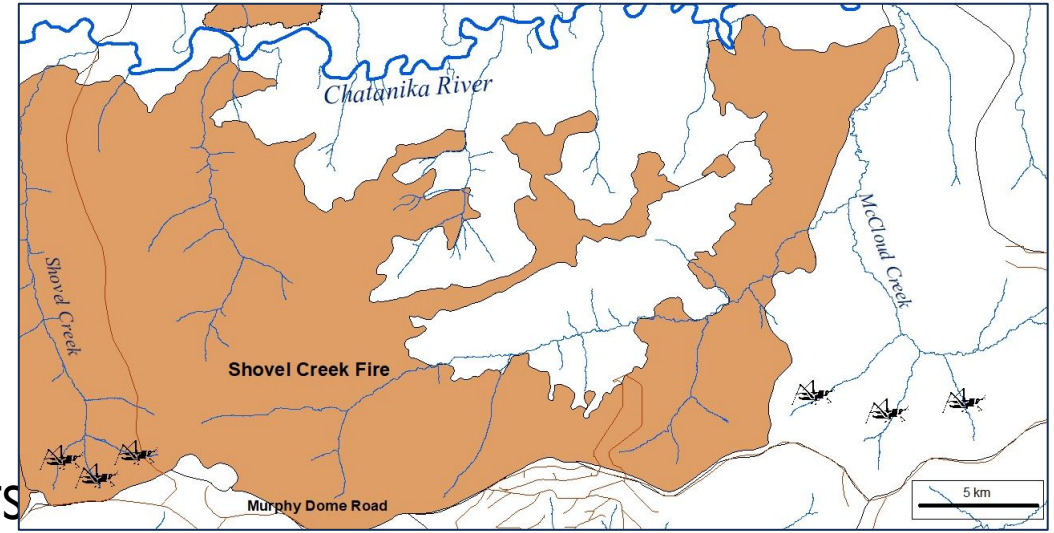
Photo: T. Cubbage

Elizabeth Hinkle

POST-WILDFIRE RESPONSE OF STREAM HABITAT AND AQUATIC MACROINVERTEBRATE ASSEMBLAGES IN THE BOREAL FOREST

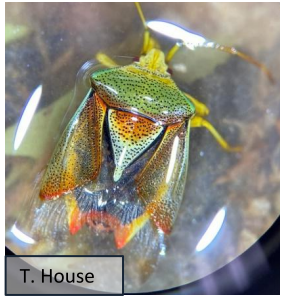
METHODS

- 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.

Alaska Morel Harvest 2020
Alaska Mushroom Madness

Public group · 2.7K members

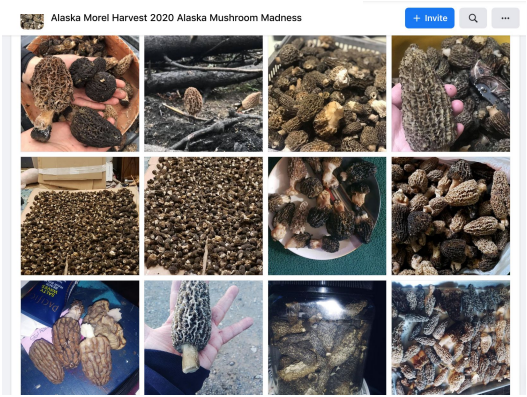
MORELS: MAKING MONEY, MEALS, MEMORIES.

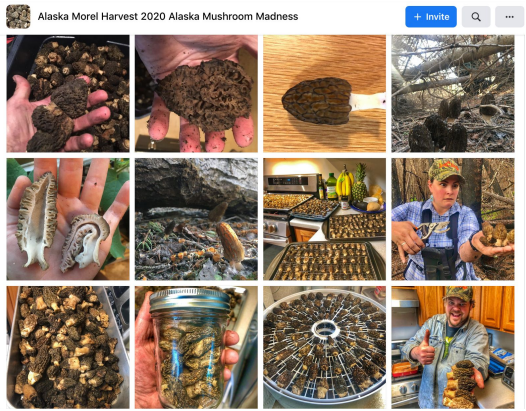
Igor Pasternak, Sveta Yamin-Pasternak

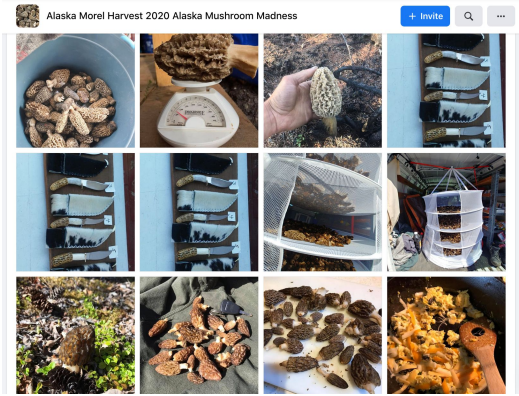
Sites of last-year's forest fires are often (not always) promising grounds for the hunting of morel mushrooms. Join us for this show-and-share on the where, when, and how.
Free and open to the public, webcast via Zoom.

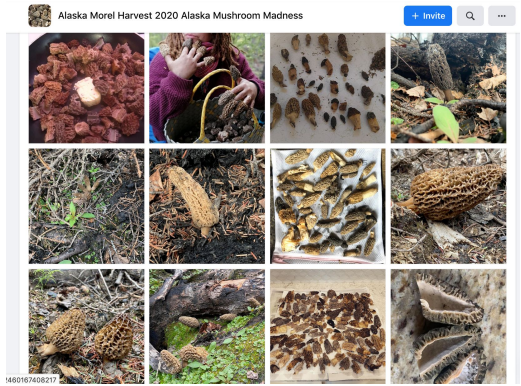
Wednesday, April 29
6PM Alaska time
Zoom Meeting ID: **967 1114 5718**
Password: **184393**.

zoom









Sveta Yamin-Pasternak

Fires and Harvests 1999/2000 - 2019/2020

Fort Greely 1999
(Donnelly Flats fire)
June 11th-17th

Tok area 2004 (701 fires)
June 15 -October 9

Chatanika 2004
-Started on June 13th

Nenana area 2006
(Parks Hwy Fire)
June 7th-June 25

Circle area 2009
(Bluff Creek fire)
July 12-August 12

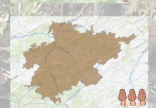
Livengood/Elliott Hwy area 2010
(Cascaden Ridge Fire)
May 26-June 3

Fort Wainwright and Chena Hot Springs road 2013
(Stuart Creek Fire)
June 19th-July 30th

North of Fairbanks off-Steese Mile 33 2015
(Aggie Creek)
June 21-July 20

Chena Hot Springs 2019
(Nugget Creek Fire)
June 21- August 18

Murphy Dome 2019
(Shovel Creek Fire)
June 21-July 31



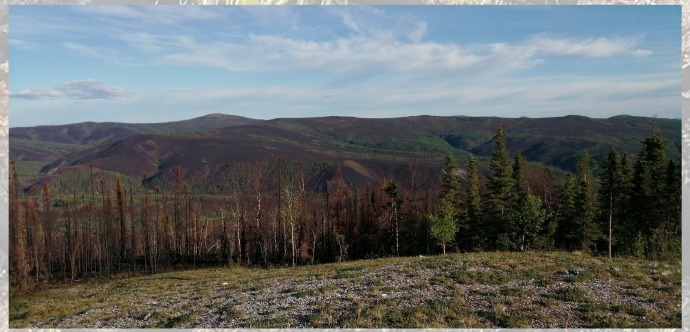
Livengood 2019
(Hess Creek Fire)
June 21-September 18

Skilak lake 2019
(Swan Lake Fire)
June 5 (first stage)
August 17-September 9
(second stage)

Forager Classification of Boreal Forest Burns

All Black Dry Burn
In this type of burnt forest one walk on soft, blackened, dusty-dry moss, surrounded by mostly thin black trunks. Overall, this is not a promising kind of burn, but it can produce morels in moss-free pockets near some, usually a bit larger, trees.

Mixed Black Burn
This is a dark black burn that features spruce, alder, and willow. In the flat stretches of this burn one walks on blackened moss, kicking up dust and picking up lots of soot. In the slopes, one sees more vascular plants, including top-killed fireweed seedlings. In this type of a burn morels are also typically found in the pockets/pits between the partially exposed exposed roots of the trees. With a lower tree density than in the All Black Dry Burn, the Mixed Black Burn is a more desirable morel habitat, offering larger pockets/pits of exposed soil.

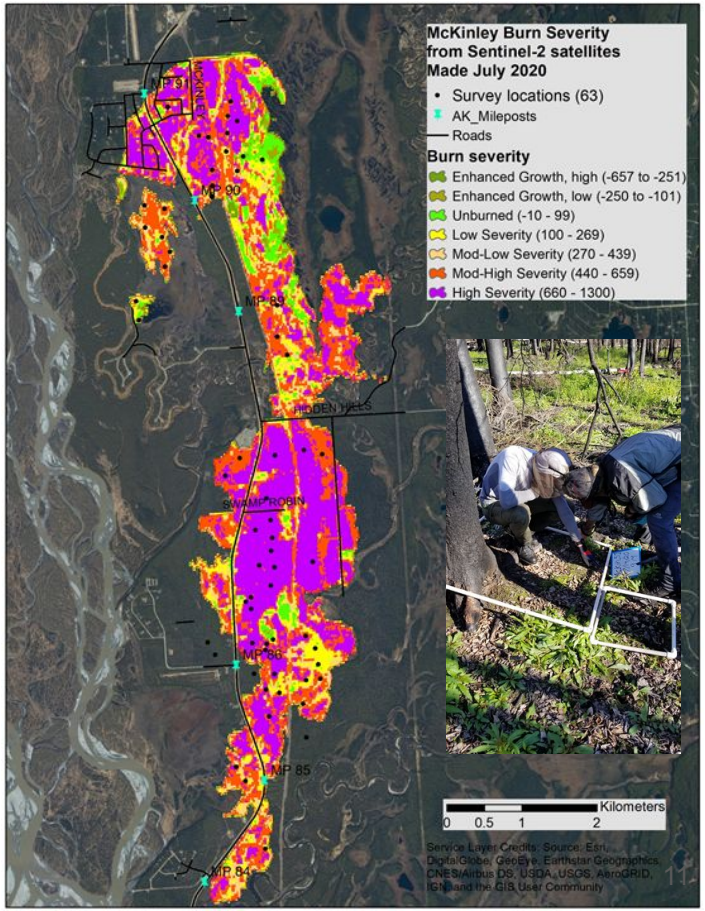


Mixed Partial Burn
Featuring birch, aspen, cottonwood, large white spruce, this type of a burn tends to confuse people because it contains some living trees and those that are partially burned. When facing an aerial view one sees a lot of green foliage and may mistake it for an intact forest. The ground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

Sveta Yamin-Pasternak

Ecological effects of recent wildfires in the wildland urban interface

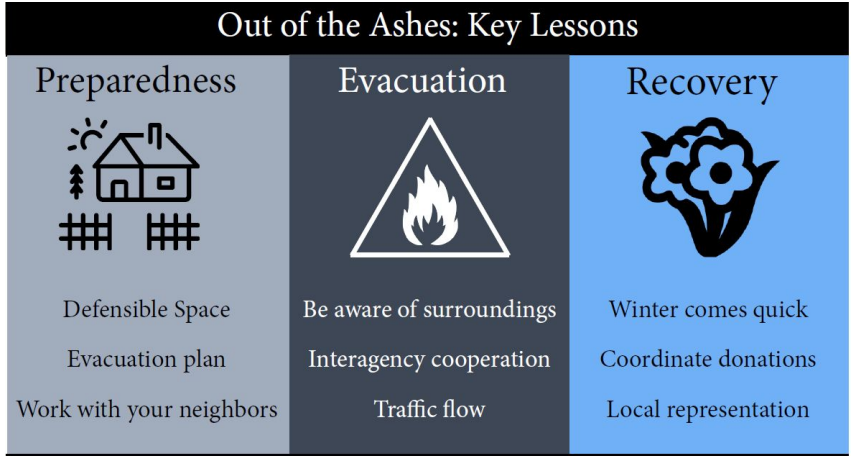
- Goal
  - To assess the ability of Sentinel-2 (remote sensed data) to detect burn severity
  - Assess new methods using drones and pictures
- Methods
  - Sampled 63 plots in the McKinley and 13 in the Montana Creek wildfires
  - Assessed on-the-ground burn severity (Composite burn index)
  - Vegetation and duff characteristics
- Results
  - CBI relates well to Sentinel-2 ($p < 0.001$; $R2 = 0.67$)
  - 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, evaculation, and recovery
- Conclusion
  - Local based knowledge in the WUI is valuable for increasing resilience and adaptation to wildfire



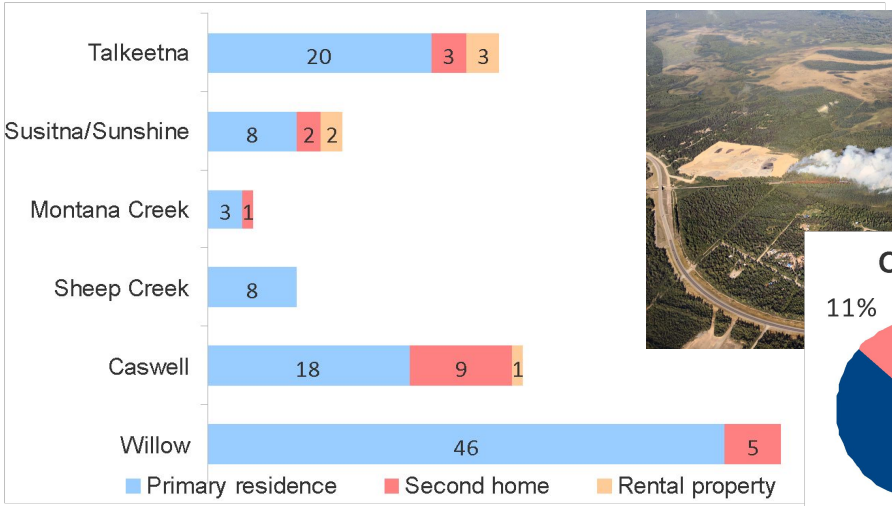
Jen Schmidt

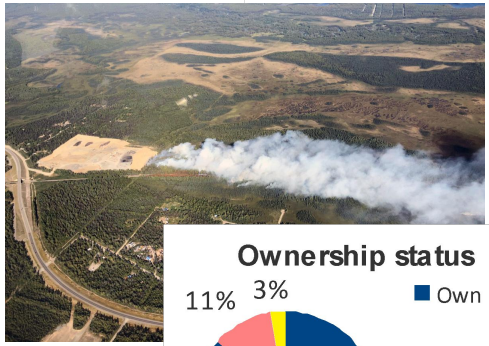
Surveys of Property Alaska Property Owners Affected by 2019 Wildfires

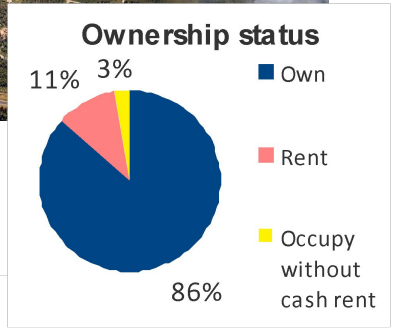
Matt Berman, Jen Schmidt, Joe Little, Yuqing Wang

McKinley Fire, Mat-Su Borough

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







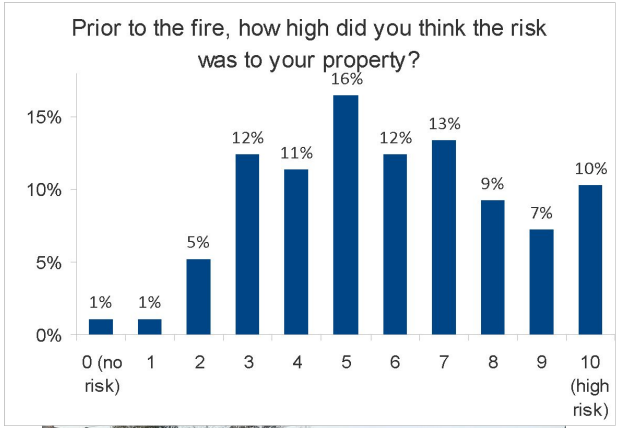
Matt Berman

Shovel Creek Fire, Fairbanks NS Borough

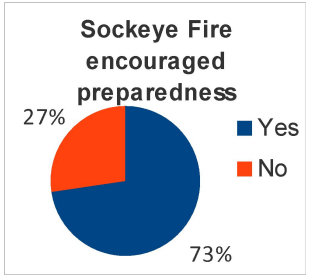
- Murphy Dome area property owners
- Survey posted, October 2020 (ongoing)

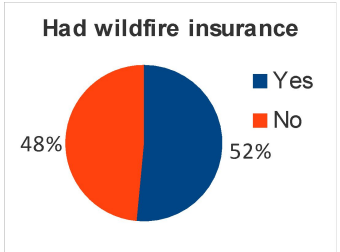
McKinley Fire: Preparedness and Impacts

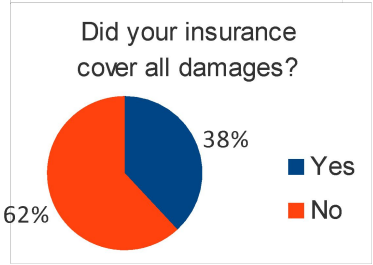
Preparedness



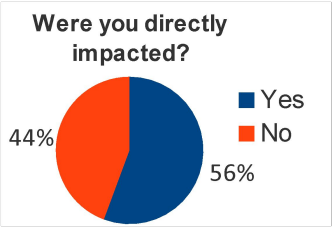
Matt Berman

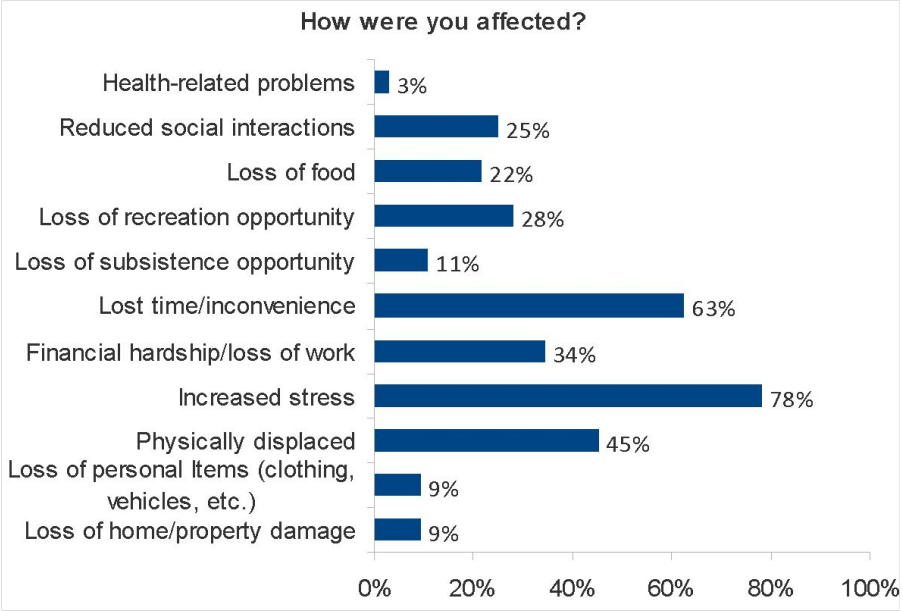






Impacts experienced





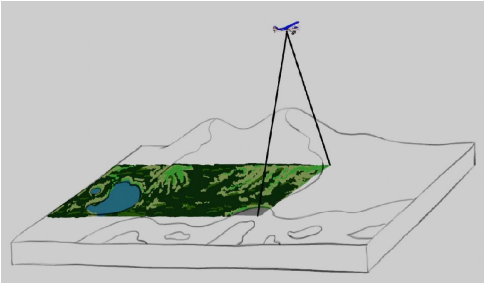
Hyperspectral remote sensing of Boreal vegetation/wildfire fuel

Res. Question 1:

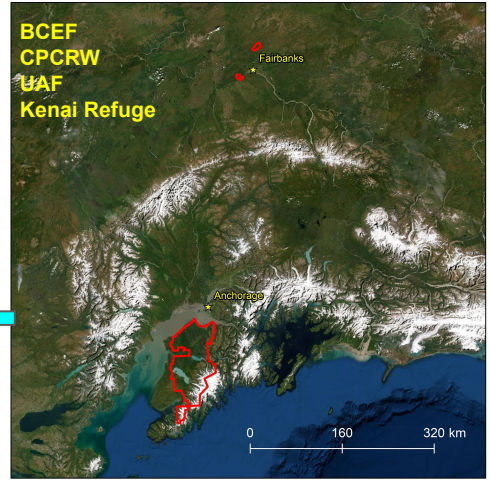
Acquisition & Processing

Fuel Map Test Sites

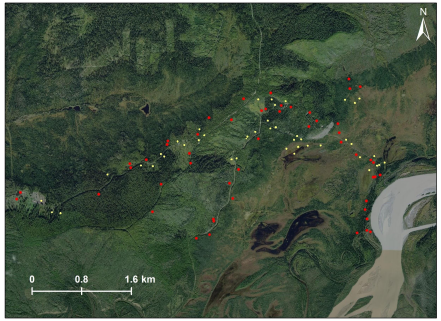
Scale Up: Fuel Map Boreal Domain

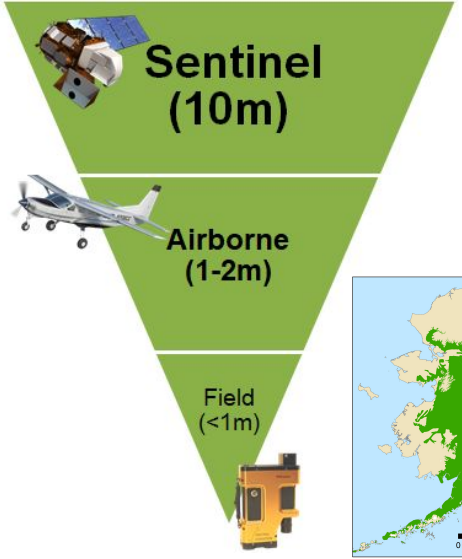


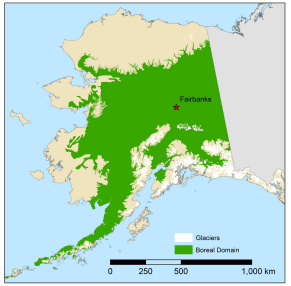
Field Survey of Vegetation



BCEF: Bonanza Creek Experimental Forest



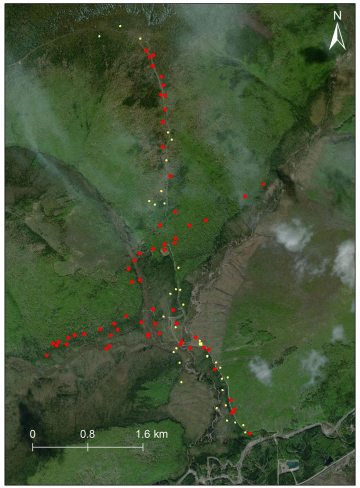




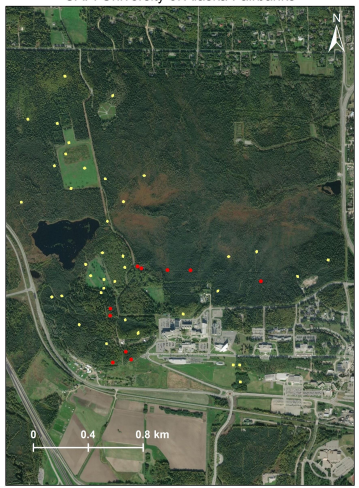
Santosh Panda

Field Survey of Vegetation

CPCRW: Caribou-Poker Creeks Research Watershed



UAF: University of Alaska Fairbanks



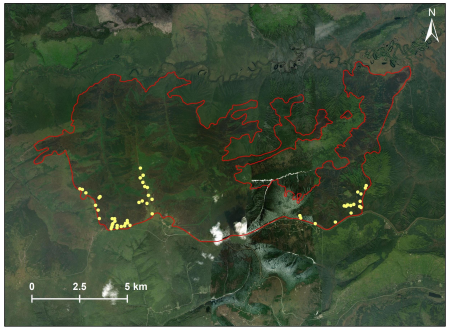
Sites	Plots/ Points
BCEF	101
CPCRW	99
UAF	51
Kenai Refuge	31
Shovel Creek	52
Nugget Creek	28

Field Crew:

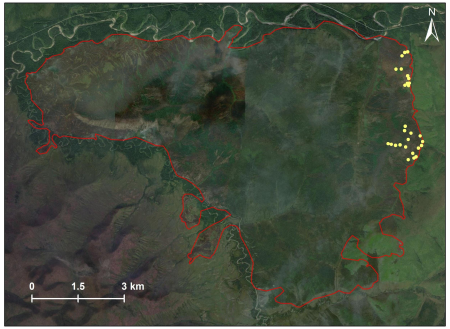
Christopher Smith
Anushree Badola
Robert Haan
Colleen Haan
Christine Waigl
Jennifer Schmidt
Santosh Panda

Field Survey of Burn Severity

SC: Shovel Creek Burn Scar

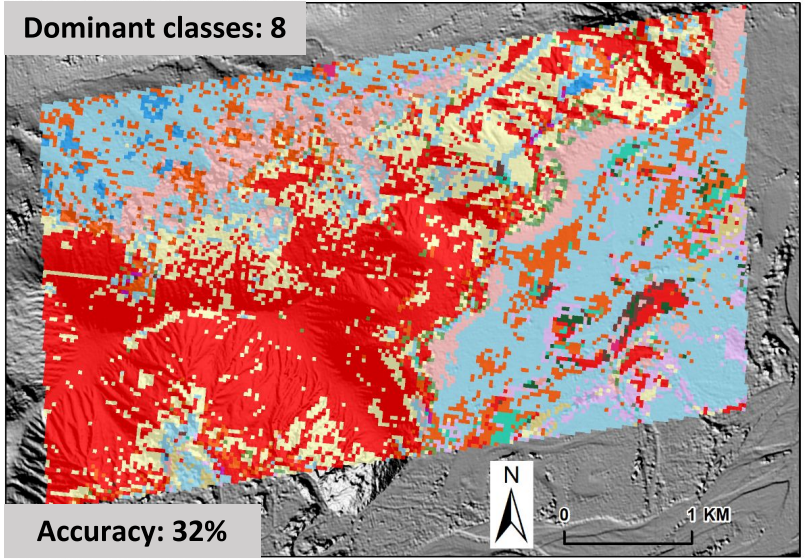


NC: Nugget Creek Burn Scar

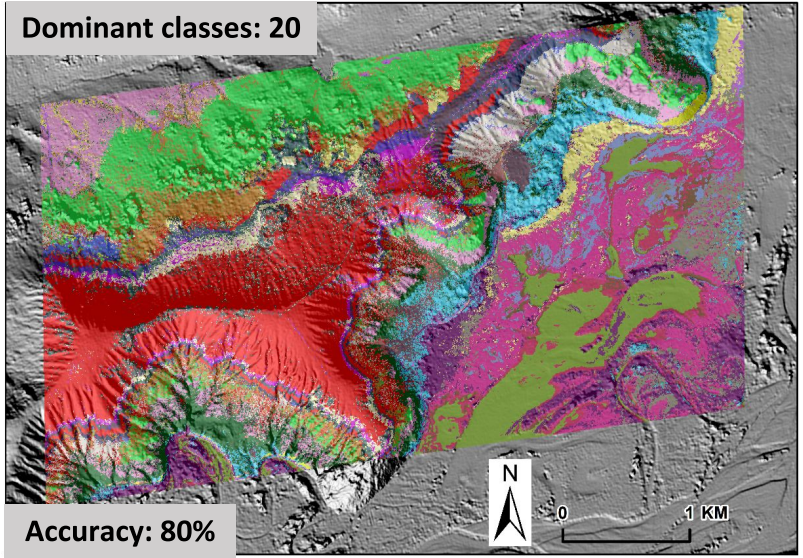


Santosh Panda

LANDFIRE Existing Vegetation Type (EVT)



Vegetation classes from AVIRIS-NG



LANDFIRE EVT (Landsat)	AVIRIS-NG Veg. Class
Pixel size: 30 m	5 m
Dominant classes (% cover > 1): 8	20
Top 3 dominant classes (% cover): 1. Birch-Aspen forest (33) 2. Black spruce forest (26) 3. Birch-Willow shrubland (15)	1. Closed Birch forest (16) 2. Open White Spruce forest (9) 3. Closed tall shrub (9)

Closed Paper Birch Forest

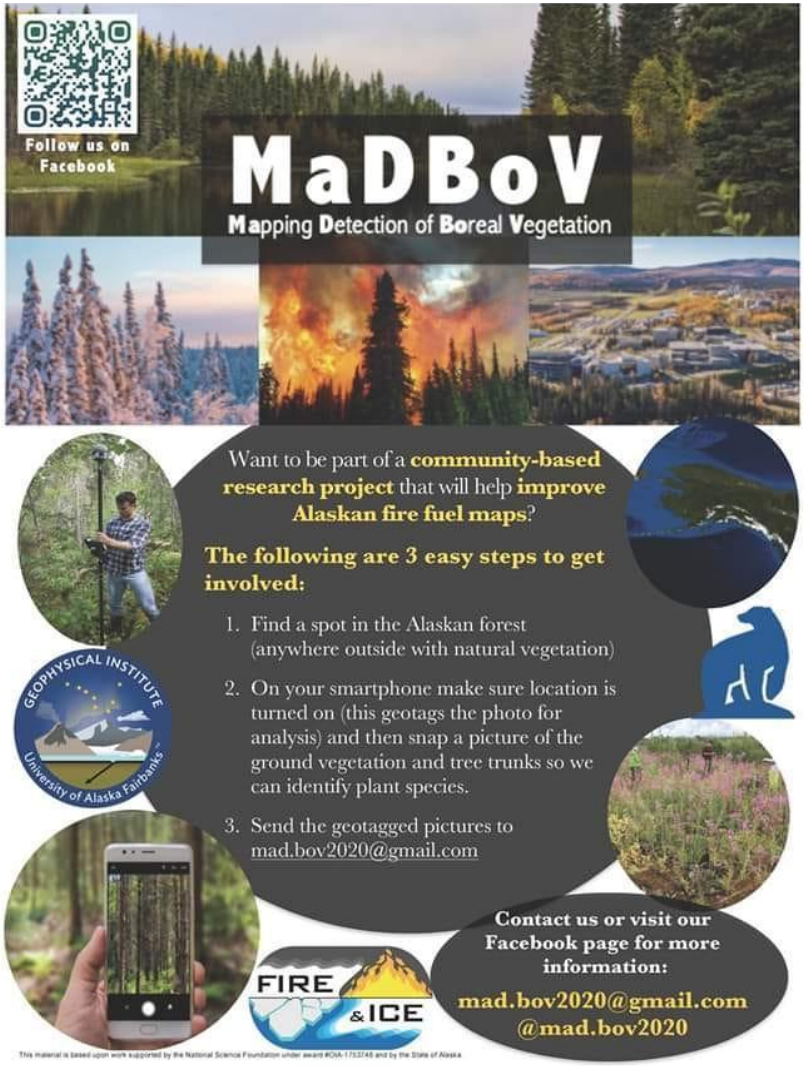
Open White Spruce

Closed Tall Alder

Closed White Spruce Forest

Wet Sedge Meadow

Closed Tall Shrub Birch/Willow Shrub



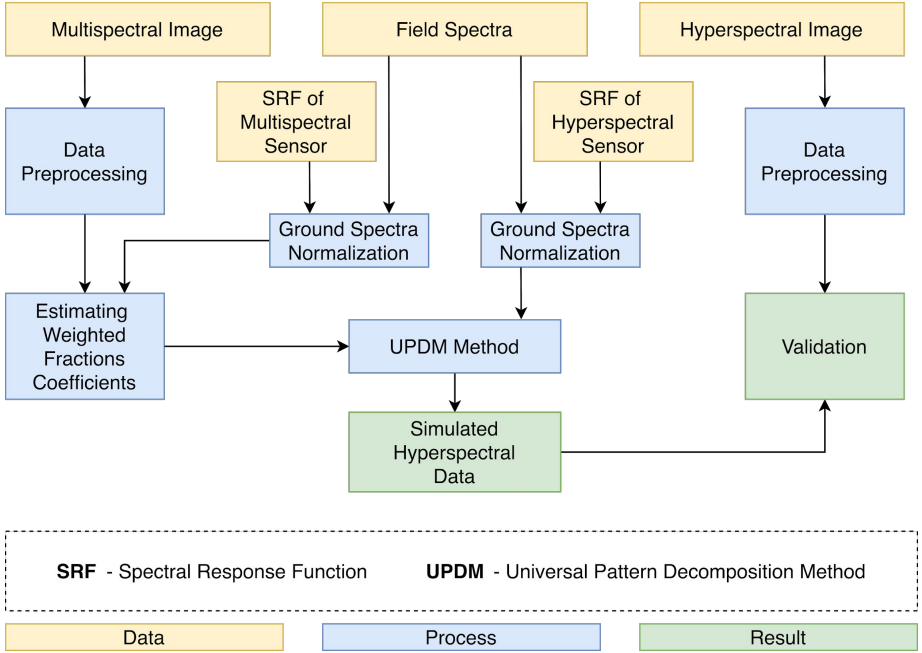
OUTCOME:

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

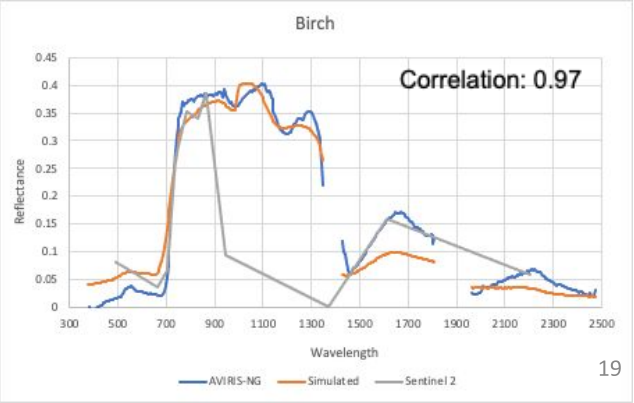
Simulating AVIRIS-NG hyperspectral image from Sentinel 2 multispectral image for vegetation mapping at species level



Sentinel 2

Simulated

AVIRIS-NG



UPDM Formula:

$$R = P_w C_w + P_s C_s + P_v C_v$$

UPDM Matrix Form:

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

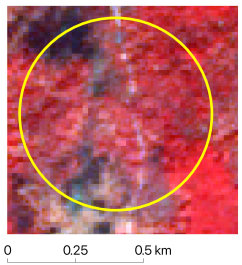
Where,
w = water
s = soil
v = vegetation
n = band number

R = total pixel reflectance
C = proportion of class
P = normalised ground reflectance

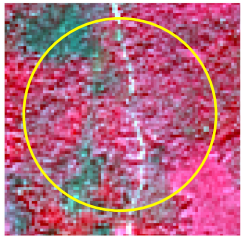
Anushree Badola

Validation Results

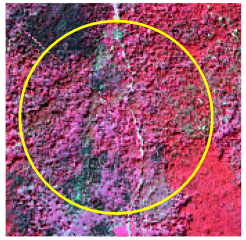
Visual comparison



Sentinel 2

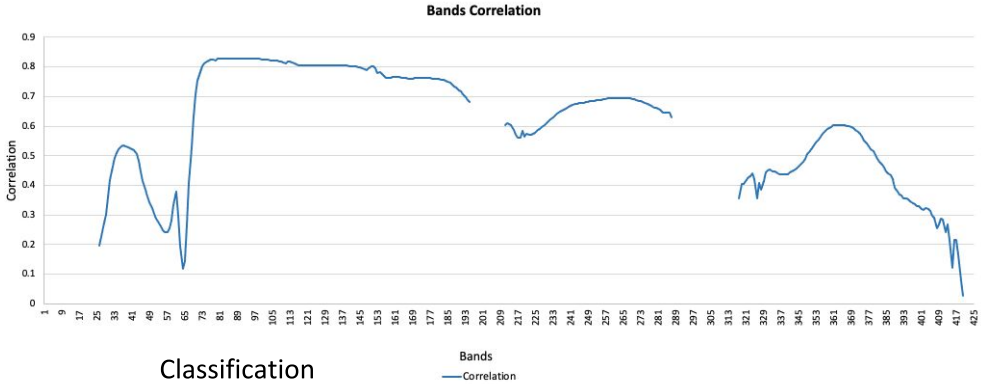


Simulated

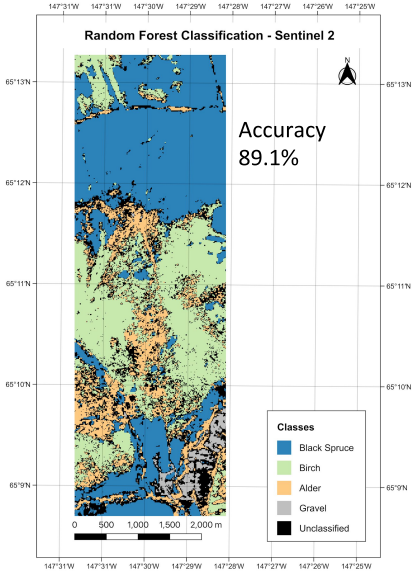


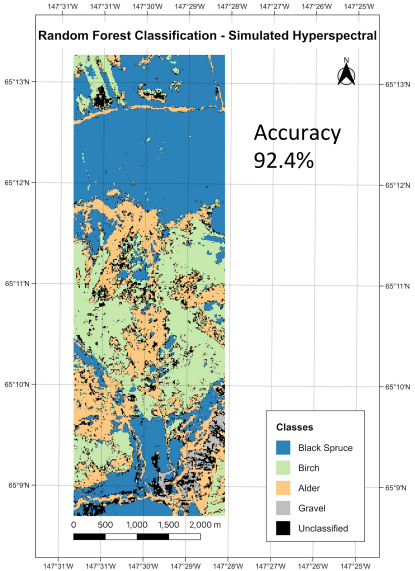
AVIRIS-NG

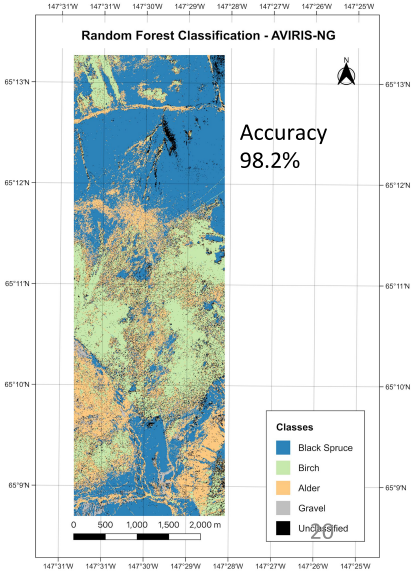
Band Correlations



Classification

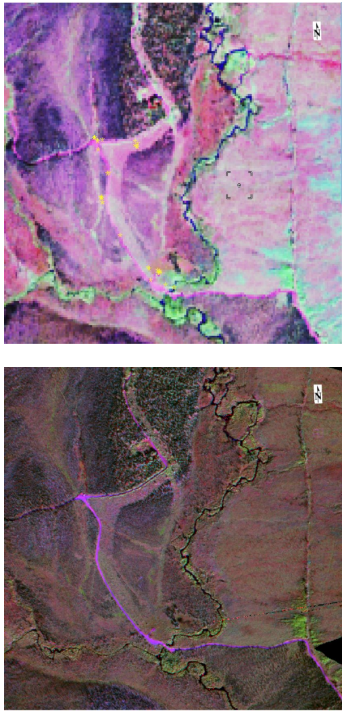






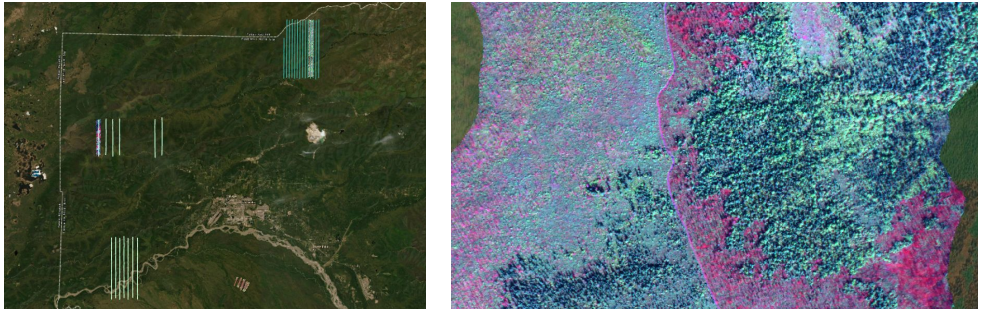
Anushree Badola

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

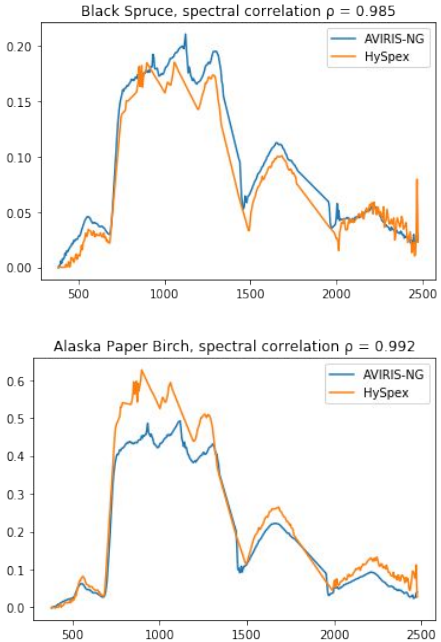


CPC site. Top: AVIRIS-NG 2018, bottom: HySpex 2019

- 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



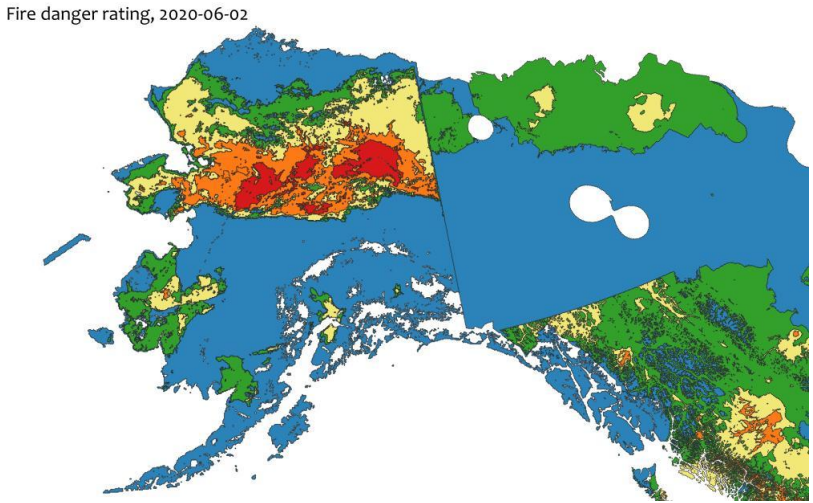
HySpex acquisitions in the Fairbanks area 2020. Left: flightline locations; right: close-up of Shovel Creek burn scar with unburned fuels



Sample reflectance spectra from CPC field site - HySpex vs. AVIRIS-NG

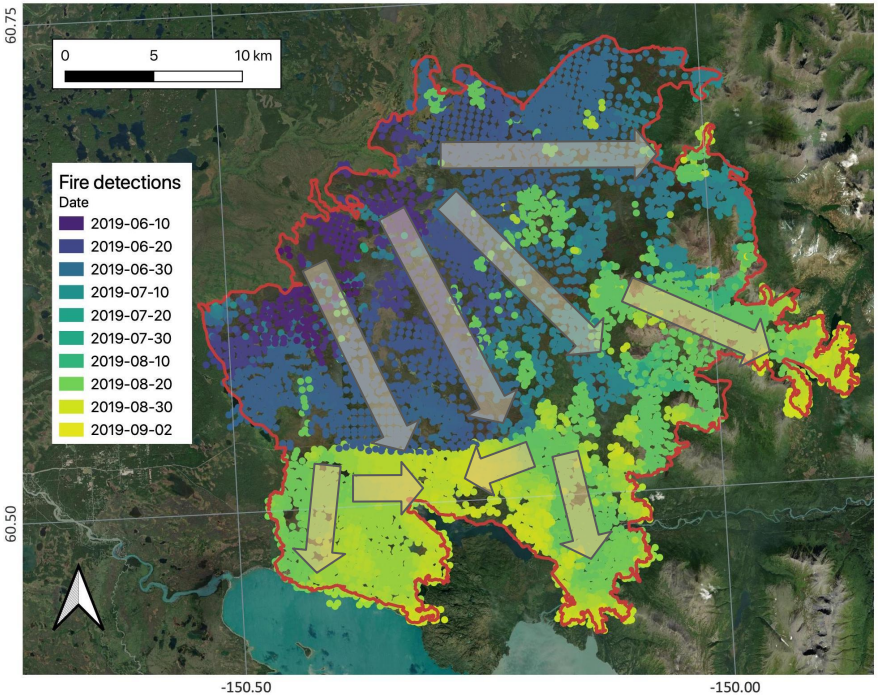
Chris Waigl

Co-production of knowledge: Science tools to help manage fire risk, make operational decisions, and understand fire behavior



Chris Waigl

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



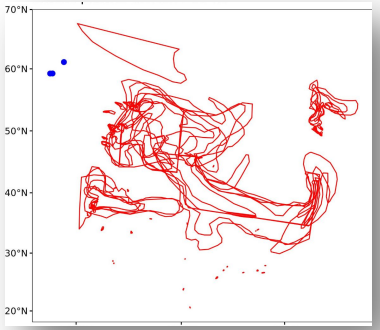
Progression of the 2019 Swan Lake Fire

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

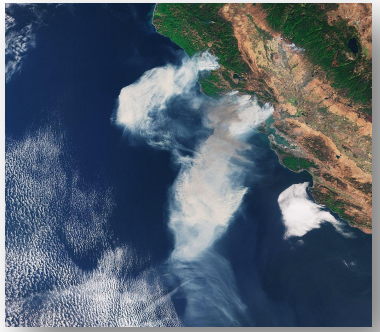
Study period: 2015-2019 | **Presenter:** Micah Hahn, UAA ICHS

Exposure

Daily average $PM_{2.5}$



Plume locations



Wildfire days

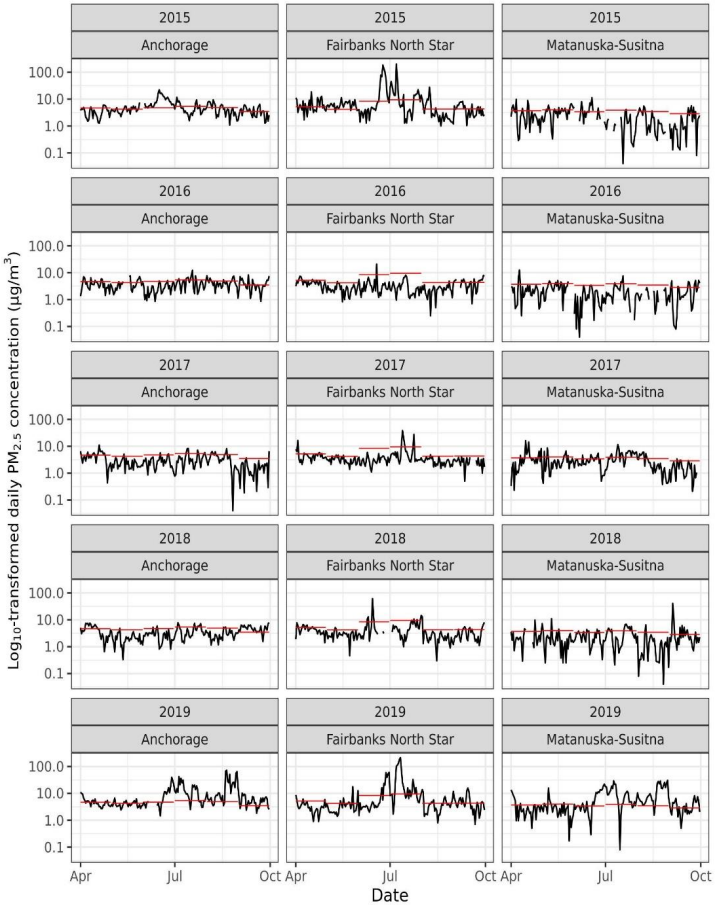
Outcomes

Daily emergency room visits

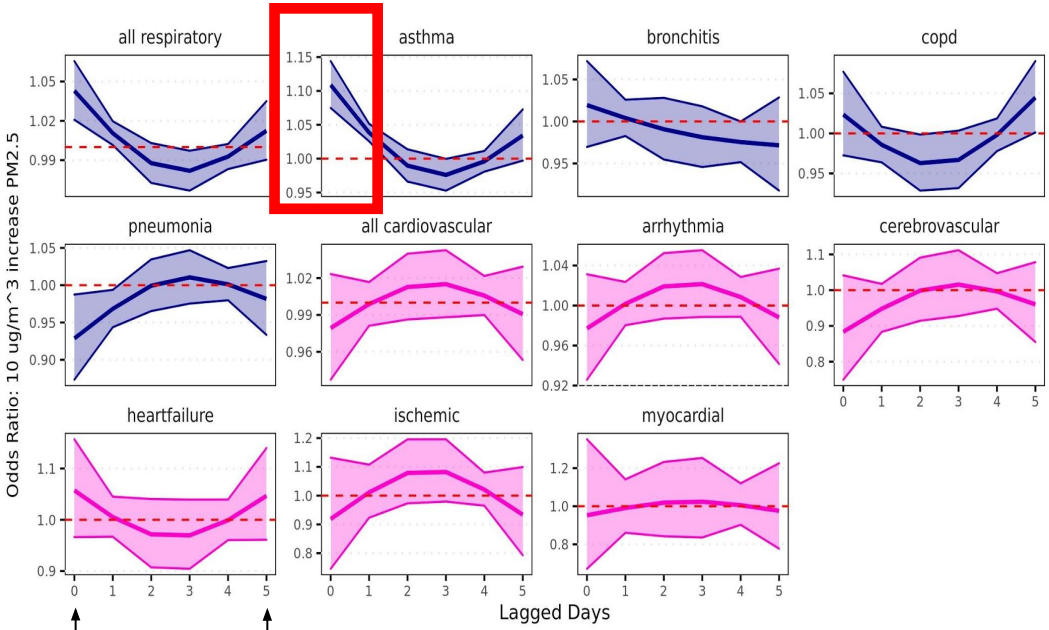
Respiratory
- Asthma
- Bronchitis
- Pneumonia
- COPD

Cardiovascular
- Arrhythmia
- Cerebrovascular
- Heart failure
- Ischemia
- Myocardial infarction

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



Same-day exposure

Exposure 5 days earlier

Cardiorespiratory

Respiratory

Cardiovascular

Micah Hahn

2012-2019 PSA Scale Lightning Climatology

Goal

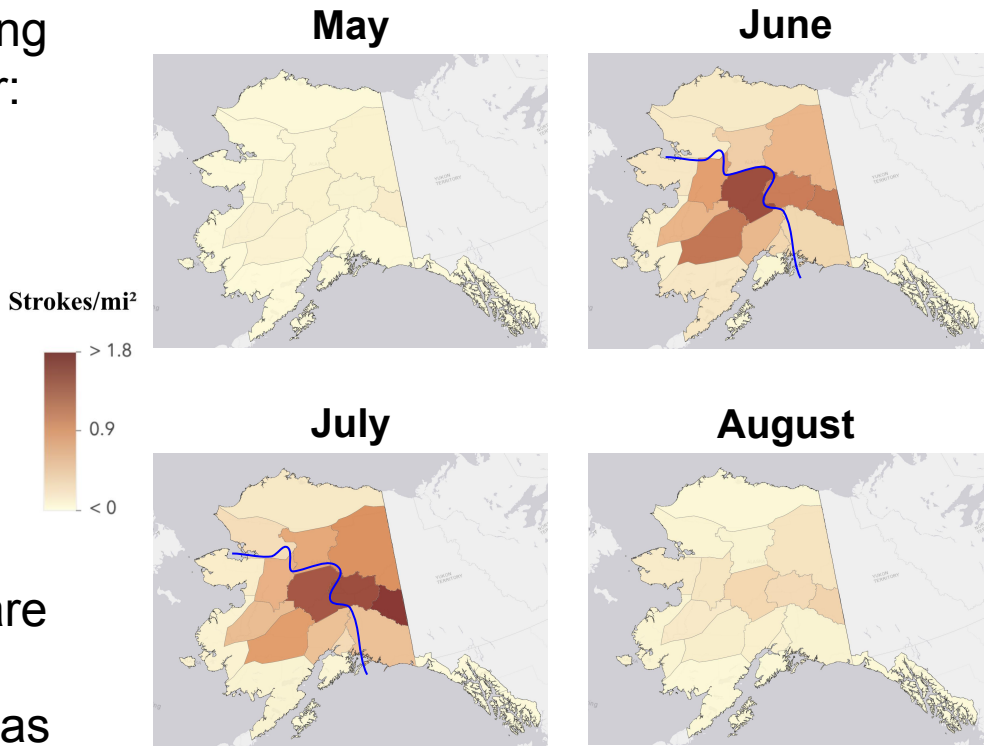
- Link currently operational BLM lightning data counts to meteorology to answer: ‘Is there predictability for lightning?’

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

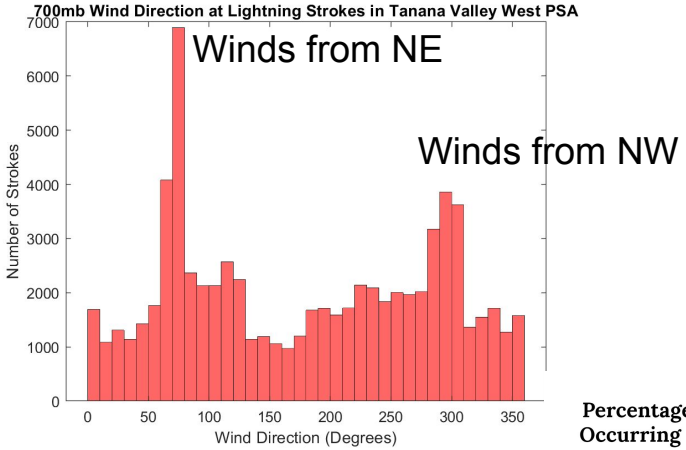
- Analyze patterns in weather conditions at individual lightning strokes on a PSA scale.

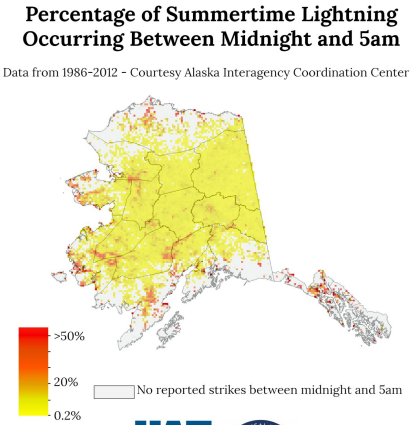
Methods

- 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

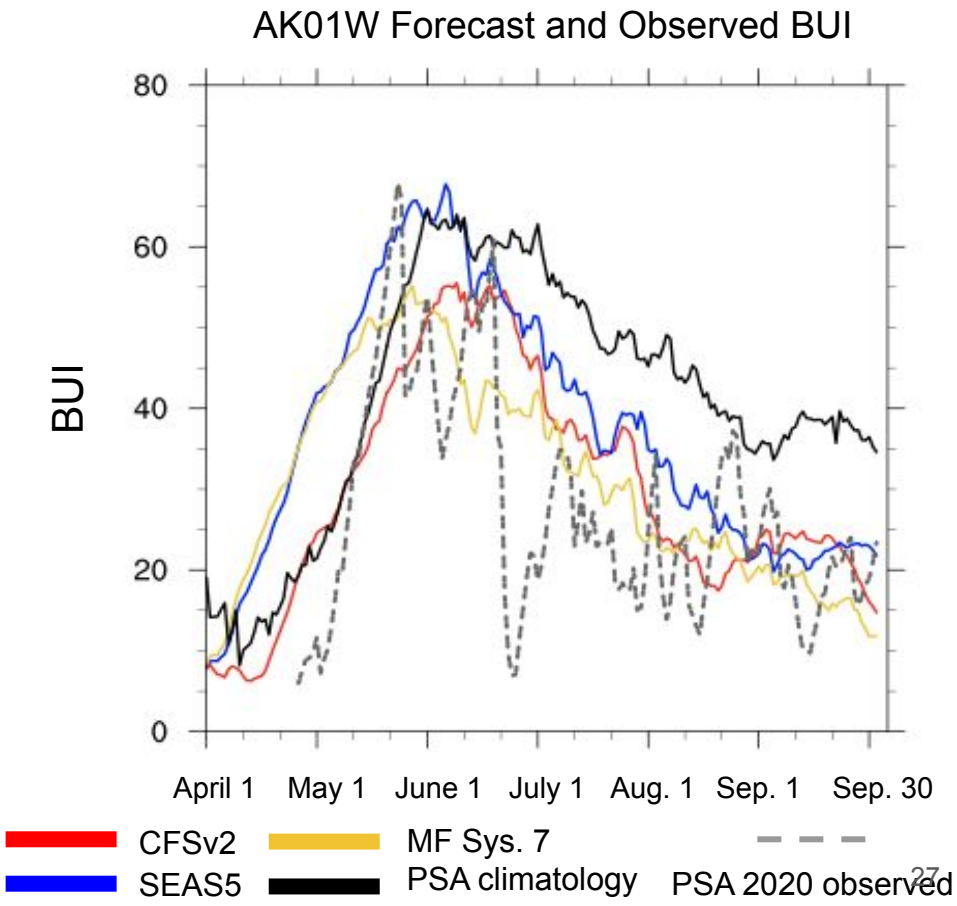
Producing Seasonal Fire Outlooks

<u>Goal</u>

- Provide seasonal outlook of upcoming summer fire activity to fire managers in March

<u>Methods</u>

- 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



Cece Borries-Strigle

Producing Seasonal Fire Outlooks

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

	Entire Season	Wind	Duff	Drought	Diurnal
Model	**Upper tercile**				
NOAA CFSv2	0.55	0.63	0.44	0.55	0.52
ECMWF SEAS5	0.49	0.51	0.56	0.48	0.49
MF Sys. 6	0.46	0.50	0.54	0.47	0.52
	Middle tercile				
NOAA CFSv2	0.44	0.50	0.29	0.41	0.35
ECMWF SEAS5	0.37	0.39	0.42	0.34	0.32
MF Sys. 6	0.45	0.36	0.50	0.36	0.40
	Lower tercile				
NOAA CFSv2	0.47	0.63	0.42	0.56	0.46
ECMWF SEAS5	0.46	0.50	0.37	0.58	0.51
MF Sys. 6	0.26	0.50	0.44	0.53	0.50

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

- This material is also based upon work supported by the National Science Foundation under award #OIA-1753748 and by the State of Alaska.
- We thank our numerous partners in the Alaska Fire Service and the National Park Service, who have contributed to this project.