# Soil Water Repellency Responses to Burn Severity in the Pacific Northwest

Jalene Weatherholt

Northwest Forest Soils Council Meeting 2020

March 4, 2020

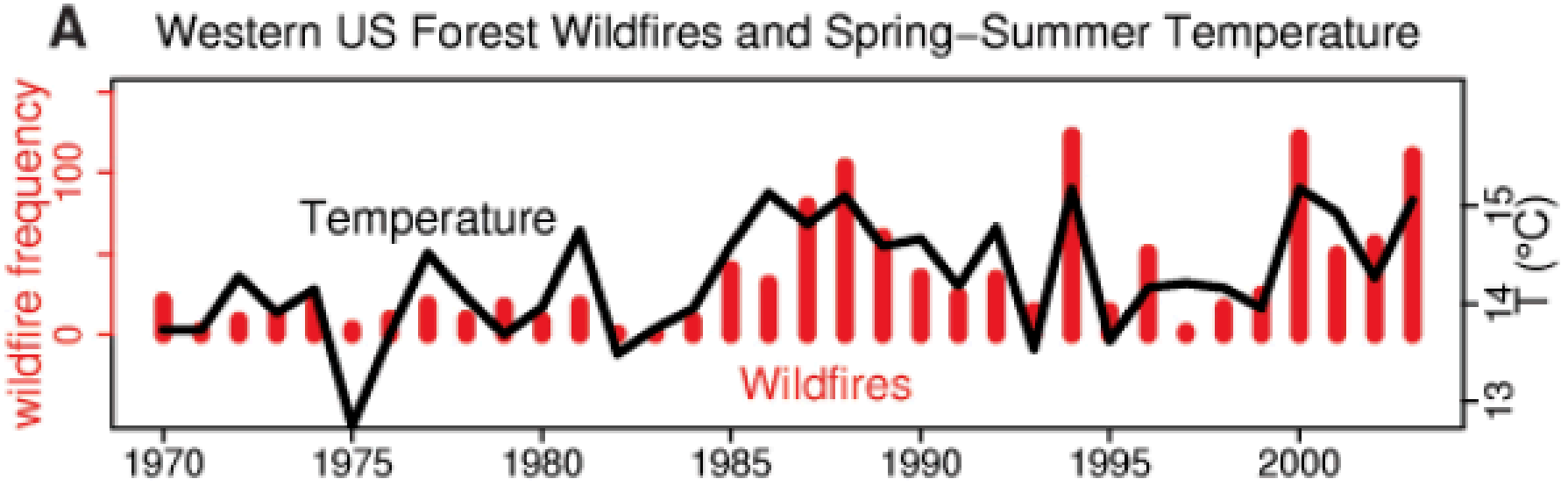
UNIVERSITY of WASHINGTON

**School of Forest Resources**

- Bachelors University of Washington 2018
- First Year Masters Student in the Johnson Soil Lab
- Post-Fire Field Seasons
  - Eastern Washington
  - Pacific Northwest
- Wildfire Fuels Management Hand Crew
  - Summit Crew 3 Stanislaus NF

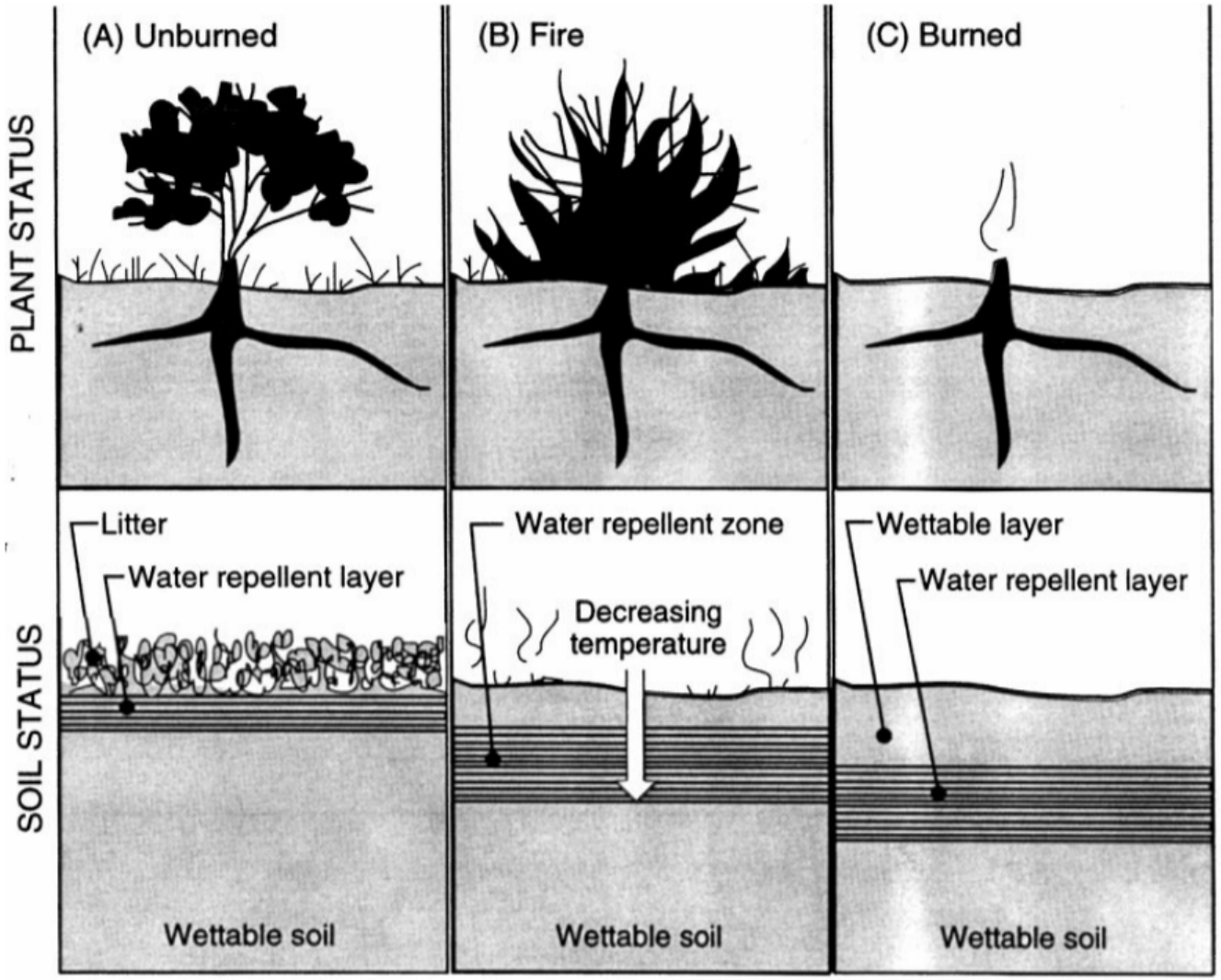



# Increased temperatures impact wildfire frequency and future risk.




(Westerling et al., 2006)

# Fire disturbance moves organic, volatile compounds below the surface and down into the mineral soil to form soil water repellency.

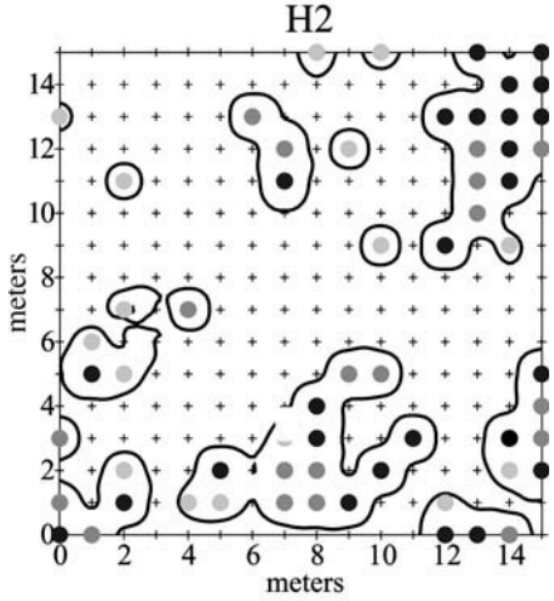


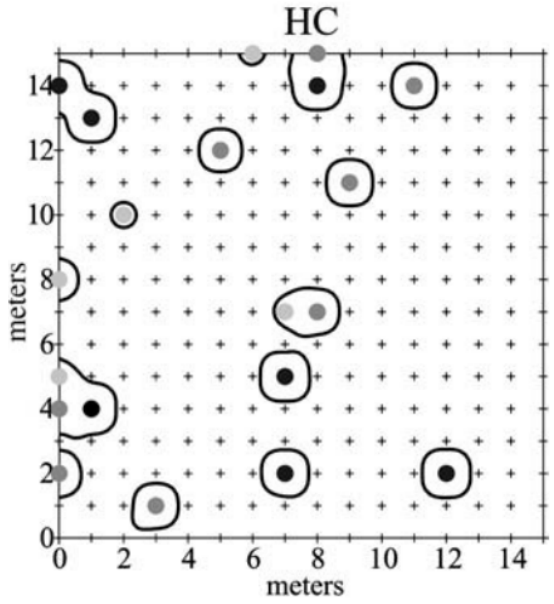

(Debano, 2000)

# Management Implications

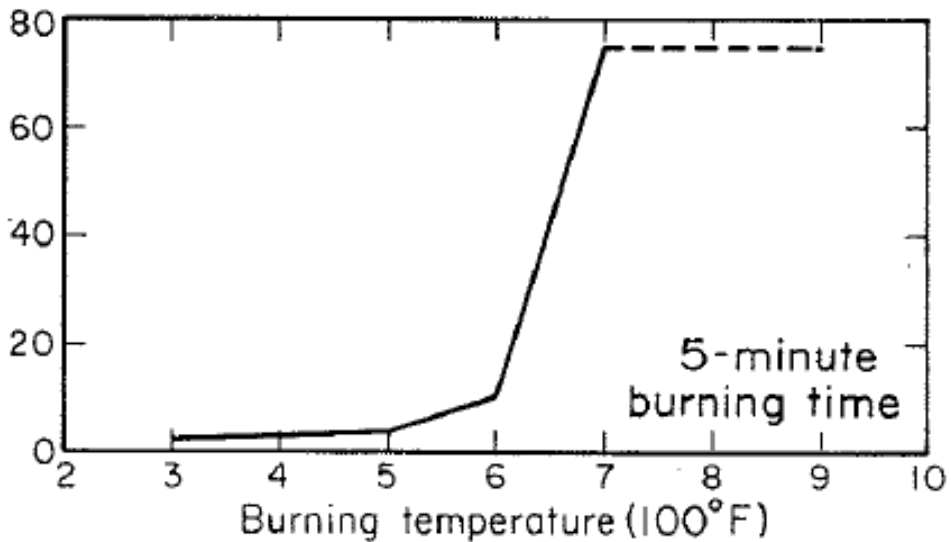
Photo: (Esposito et al., 2017)

# Soil water repellency is an extremely variable process within a small geographic area.



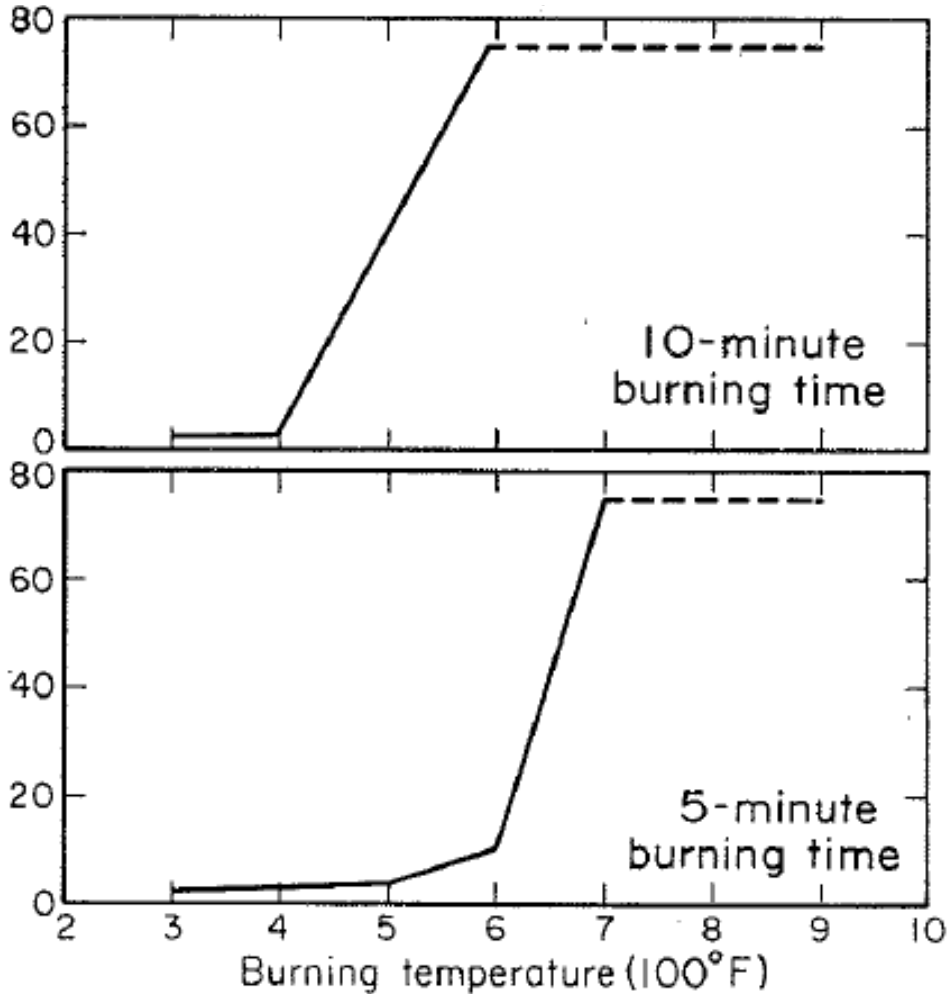




(Woods et al., 2006)

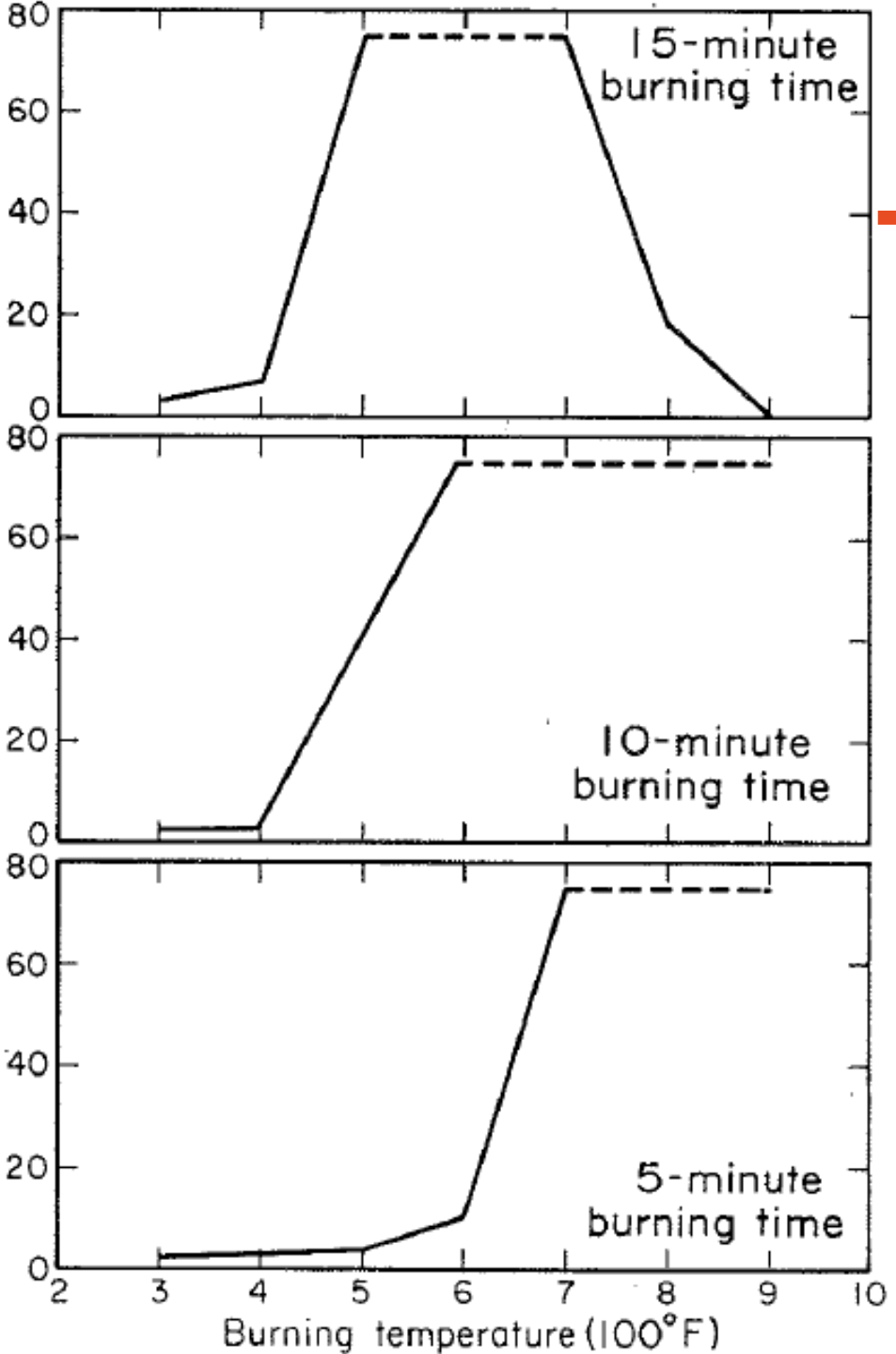



(Debano and Krammes, 1966)

Hydrophobicity created at lower temperatures with a longer burning time




(Debano and Krammes, 1966)




Increased burn duration and temperature can also remove soil water repellency

Hydrophobicity created at lower temperatures with a longer burning time

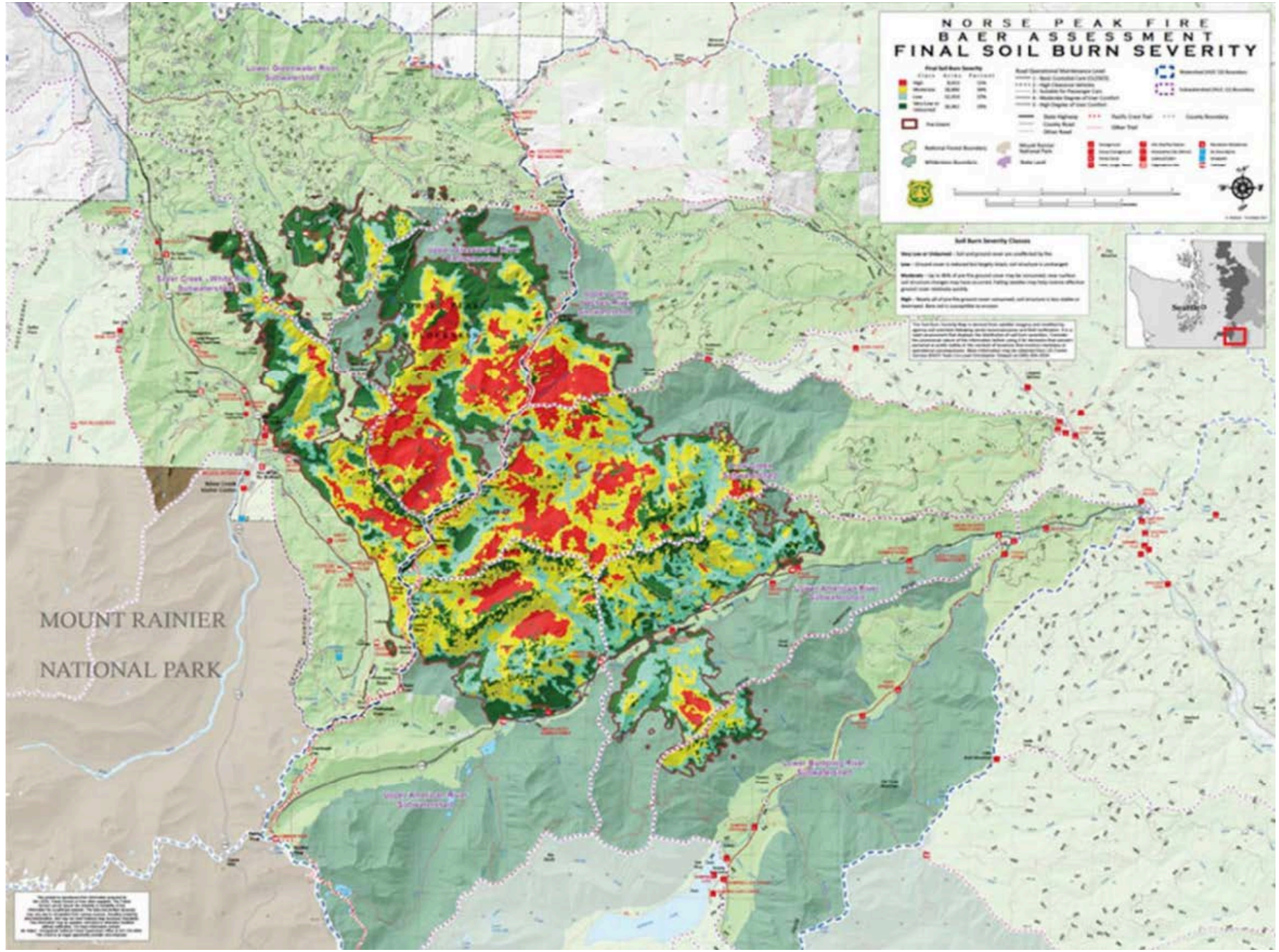
(Debano and Krammes, 1966)

Photos: (Parson et al., 2010)

Soil Burn Severity

Canopy Burn Severity

**Soil Water Repellency (SWR)**

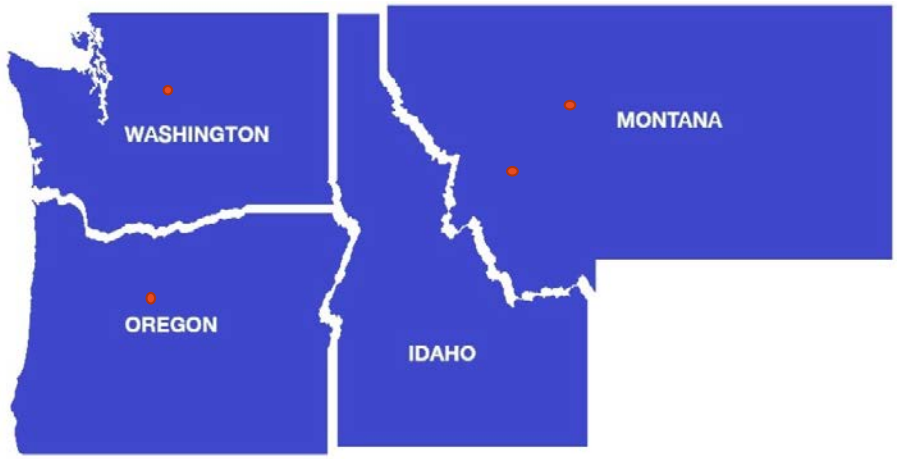

NORSE PEAK FIRE
BAER ASSESSMENT
FINAL SOIL BURN SEVERITY
MOUNT RAINIER
NATIONAL PARK

(USDA, 2017)

Objective:

Do soil and canopy burn severity measurements effectively predict a probability of SWR occurrence in the Pacific Northwest?

| Fire | National Forest (State) | Size (Acres) |
|---|---|---|
| Liberty | Flathead (MT) | 28,689 |
| Lolo Peak | Lolo (MT) | 59,902 |
| Milli | Deschutes (OR) | 24,079 |
| Norse Peak | Okanogan/Wenatchee (WA) | 55,909 |

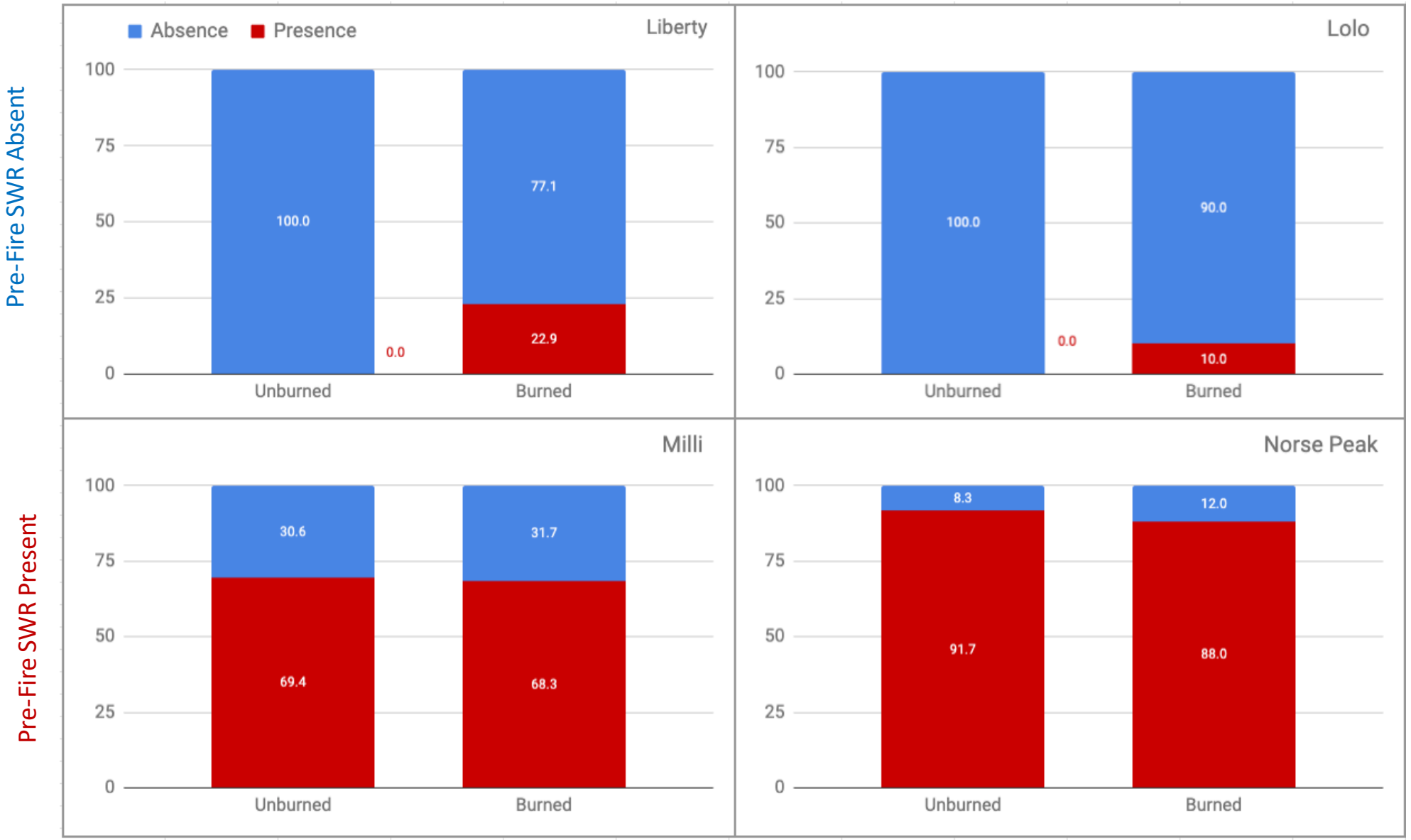



17-CS-11130400-010 grant from the **US Forest Service Geospatial Technology and Applications Center**


Plot Canopy Burn Severity
Soil Conditions + WDPT
Soil Conditions

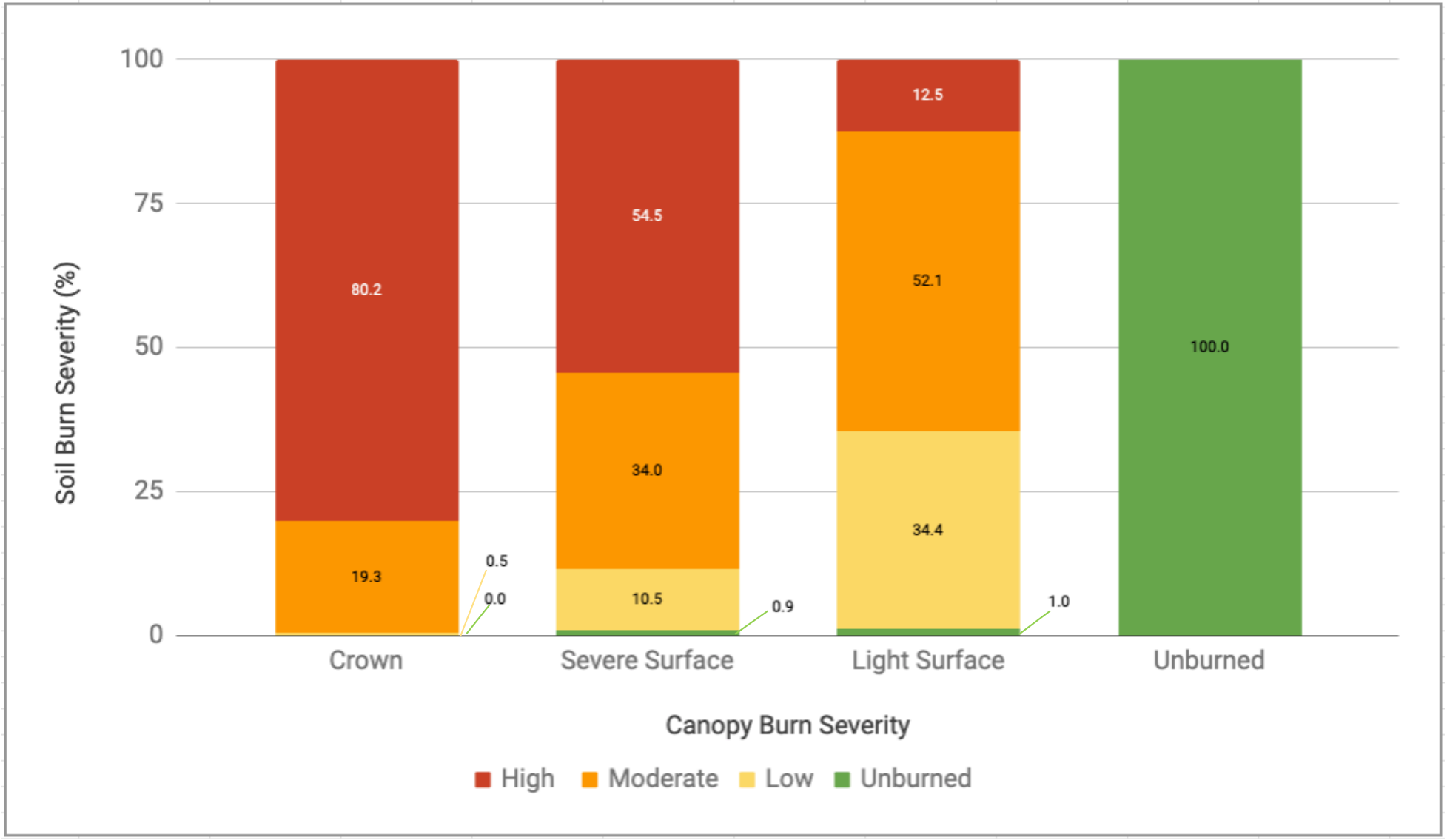
# Did fire disturbance impact SWR heterogeneity?

# Unburned regions of each fire presented variable contrast to post-fire conditions.

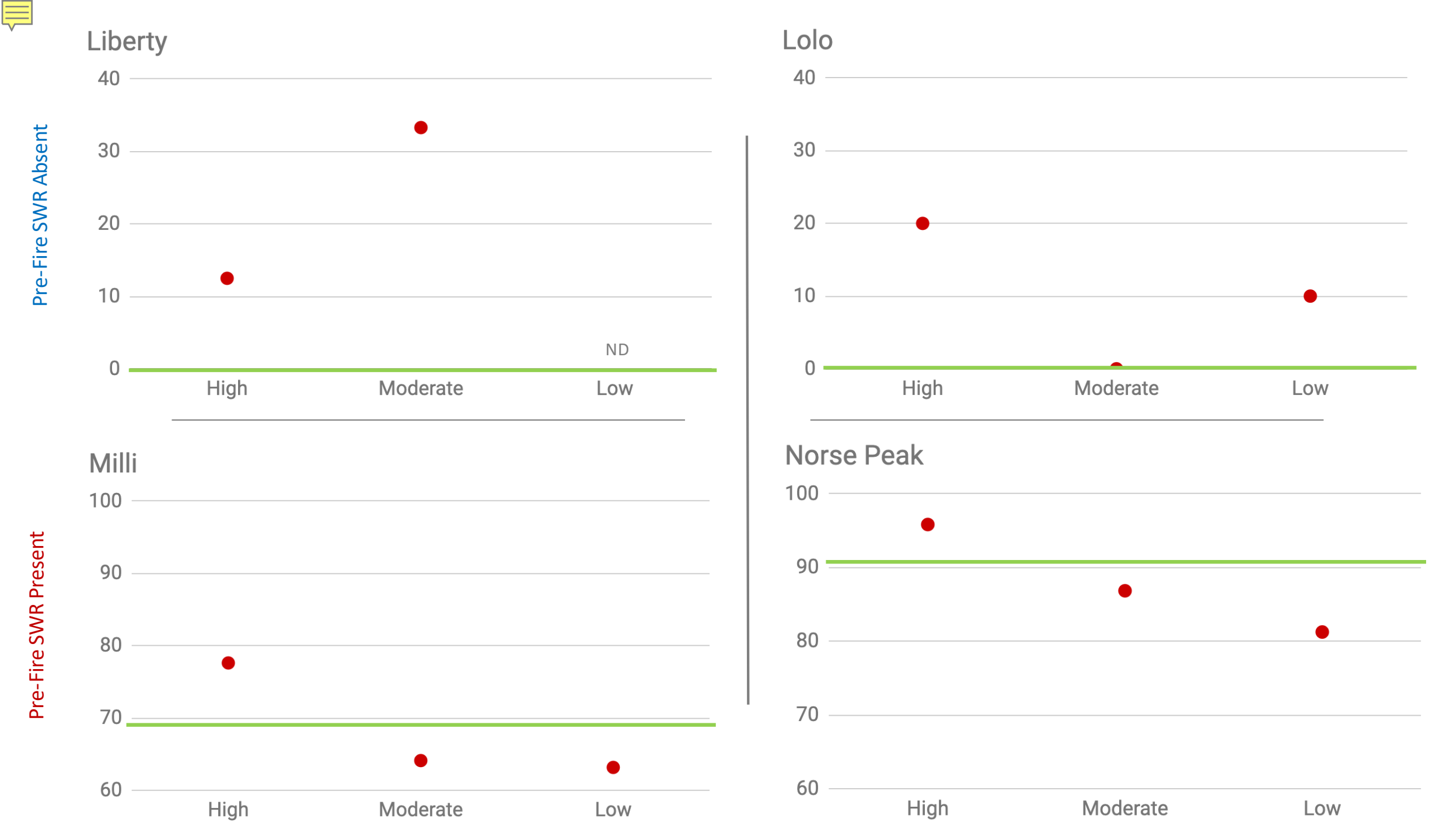


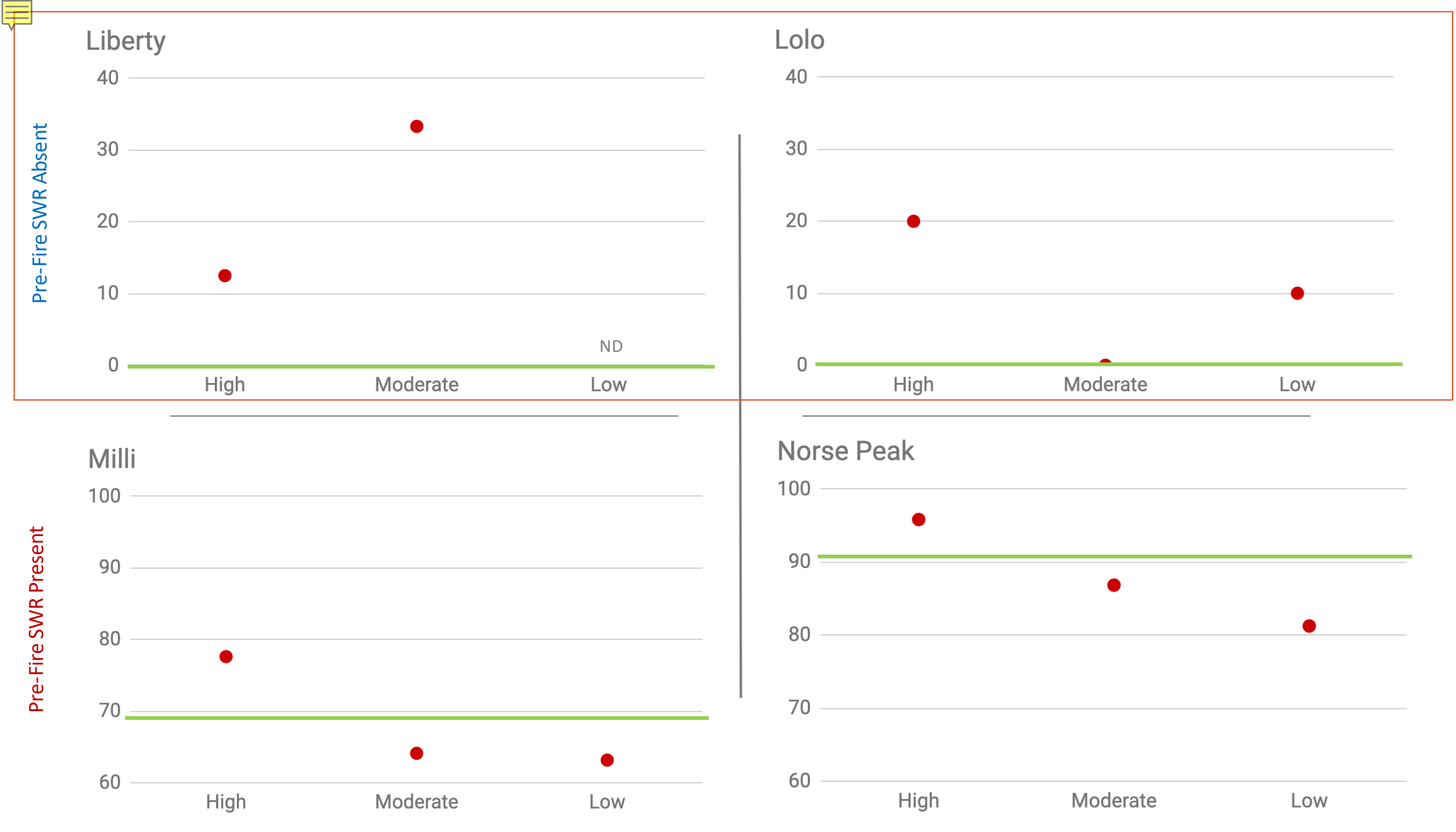
# Are canopy soil burn severity and soil burn severity related?

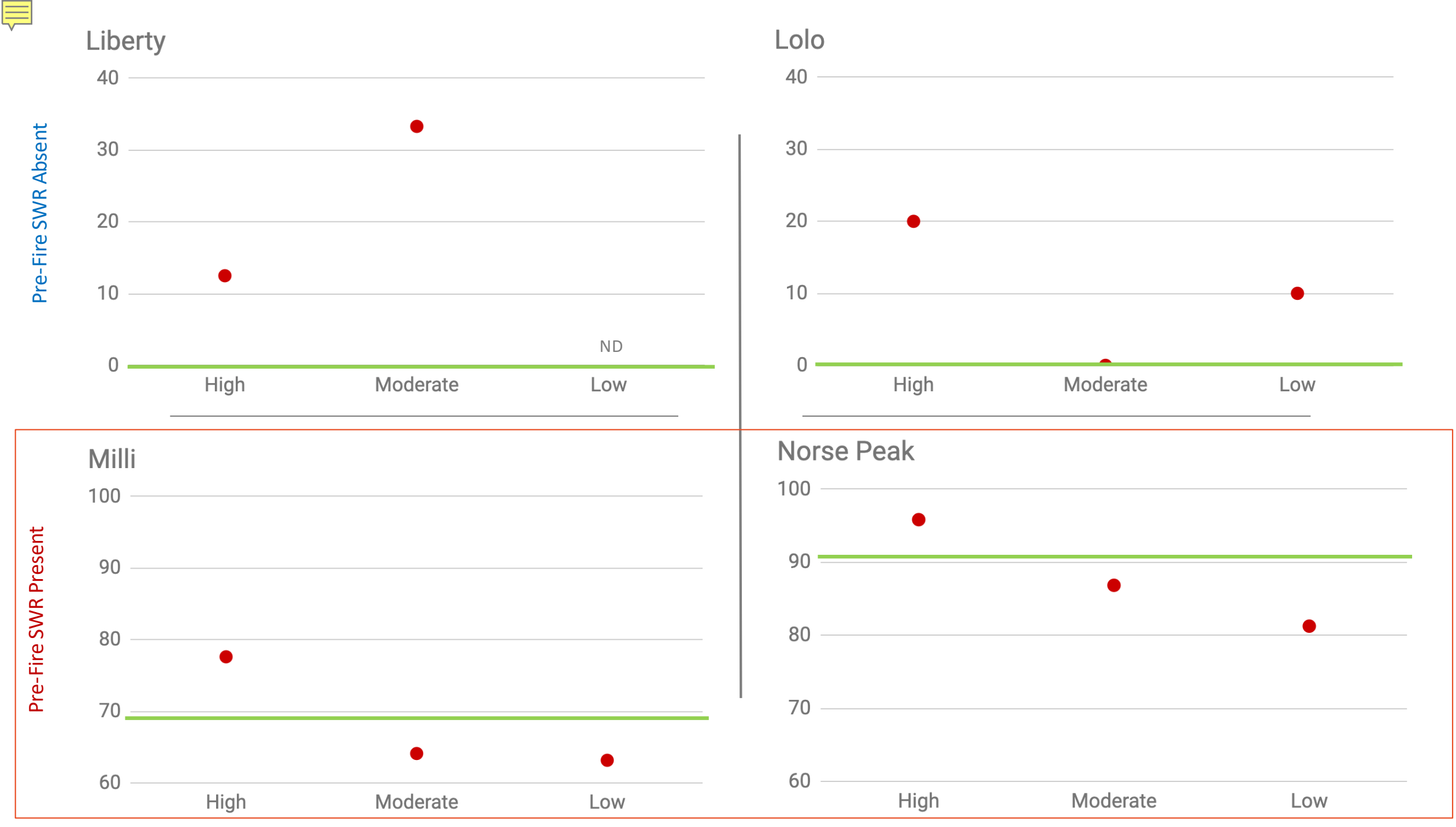
# Soil burn severity within categories of canopy burn severity were highly variable with a trend of increasing soil burn with increasing canopy burn.



What is the relationship between soil burn severity and SWR?


Liberty
40
30
20
10
0
ND
High
Moderate
Low
Lolo
40
30
20
10
0
High
Moderate
Low
Pre-Fire SWR Absent
Milli
100
90
80
70
60
High
Moderate
Low
Norse Peak
100
90
80
70
60
High
Moderate
Low
Pre-Fire SWR Present

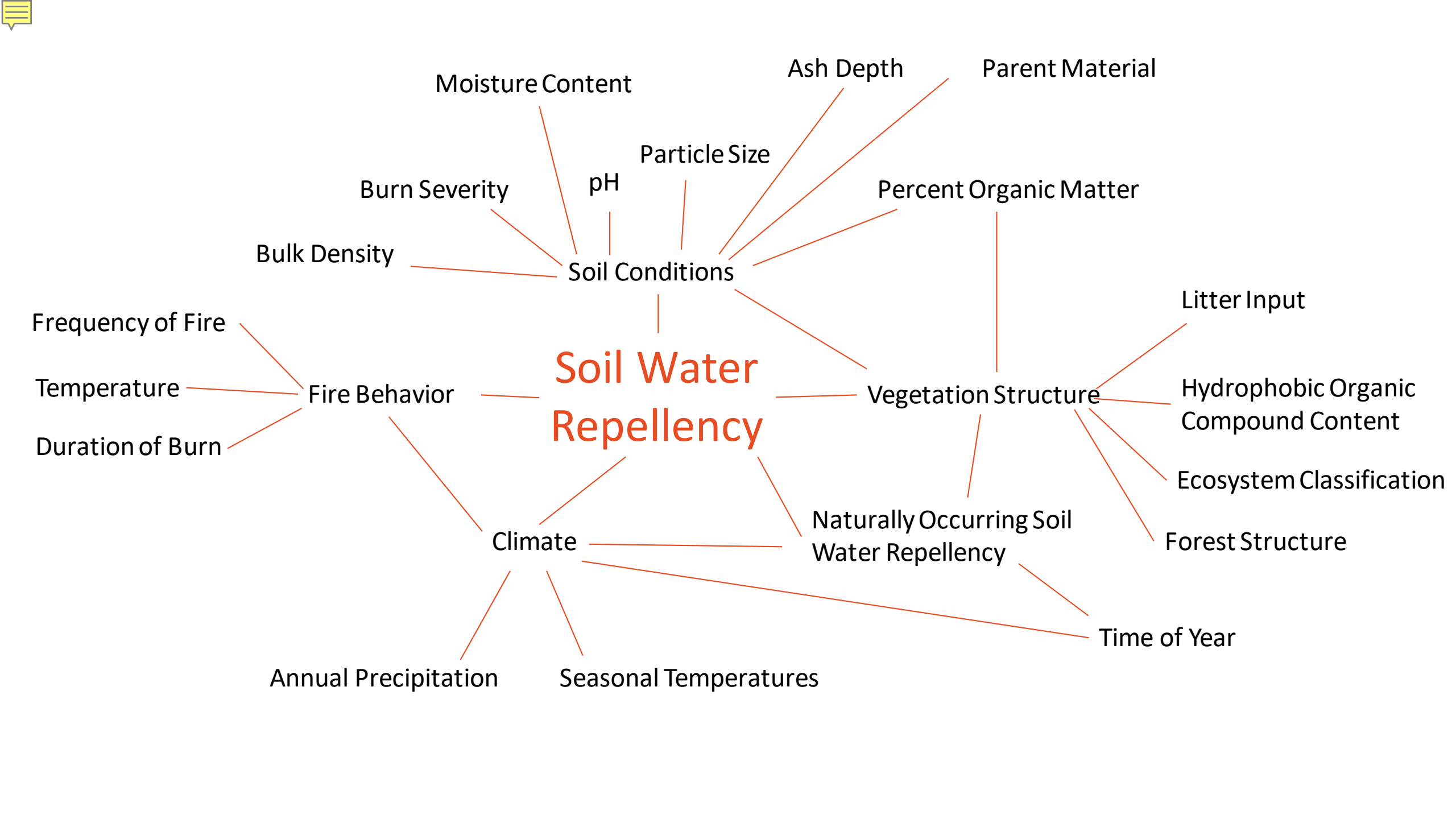

Liberty
40
30
20
10
0
ND
High
Moderate
Low
Lolo
40
30
20
10
0
High
Moderate
Low
Pre-Fire SWR Absent
Milli
100
90
80
70
60
High
Moderate
Low
Norse Peak
100
90
80
70
60
High
Moderate
Low
Pre-Fire SWR Present


Liberty
40
30
20
10
0
ND
High
Moderate
Low
Lolo
40
30
20
10
0
High
Moderate
Low
Pre-Fire SWR Absent
Pre-Fire SWR Present
Milli
100
90
80
70
60
High
Moderate
Low
Norse Peak
100
90
80
70
60
High
Moderate
Low


Soil Burn Severity
Soil Water Repellency
?

Objective:

Can environmental and climatic characteristics derived from publicly-available data sources predict SWR characteristics in a fire-affected soil in the PNW?


Soil Water Repellency
Soil Conditions
Moisture Content
Ash Depth
Parent Material
Particle Size
Burn Severity
pH
Percent Organic Matter
Bulk Density
Frequency of Fire
Temperature
Duration of Burn
Fire Behavior
Litter Input
Vegetation Structure
Hydrophobic Organic Compound Content
Ecosystem Classification
Forest Structure
Naturally Occurring Soil Water Repellency
Climate
Time of Year
Annual Precipitation
Seasonal Temperatures

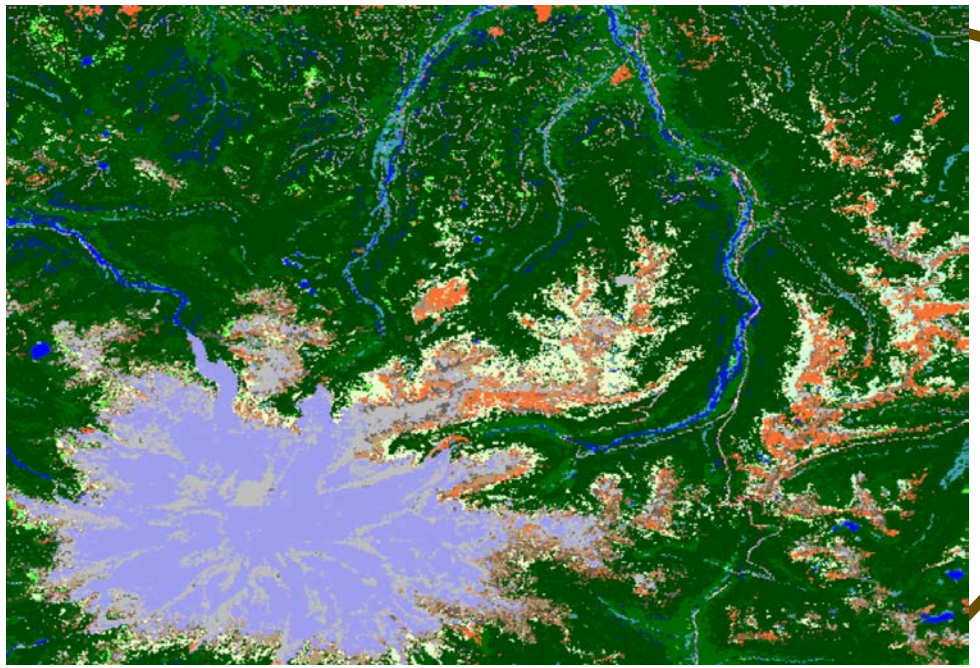
Soil Burn Severity

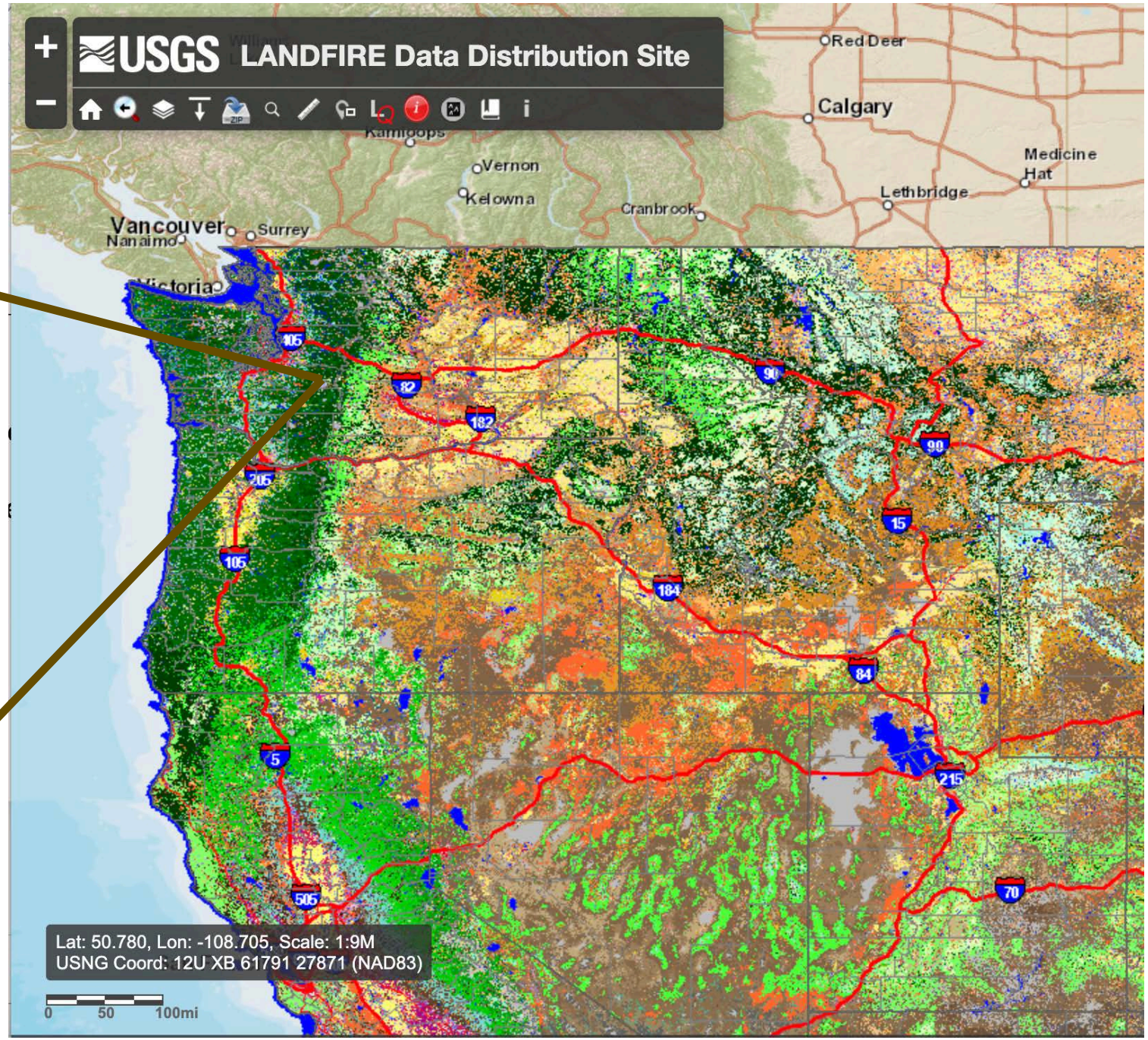
Canopy Burn Severity

**Vegetation Classification-** ***NDVI, Landfire***

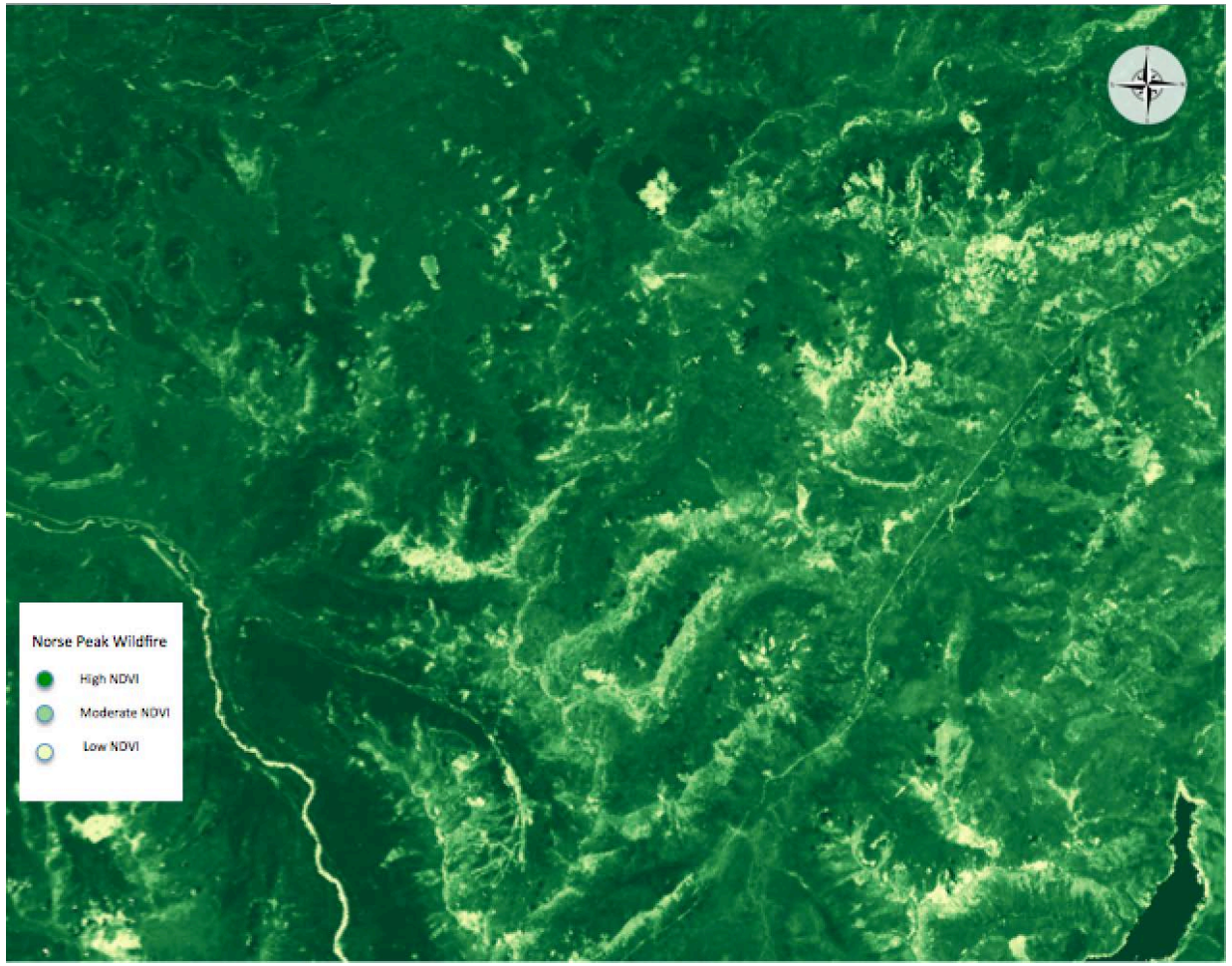
**Soil Classification-** ***SSURGO***

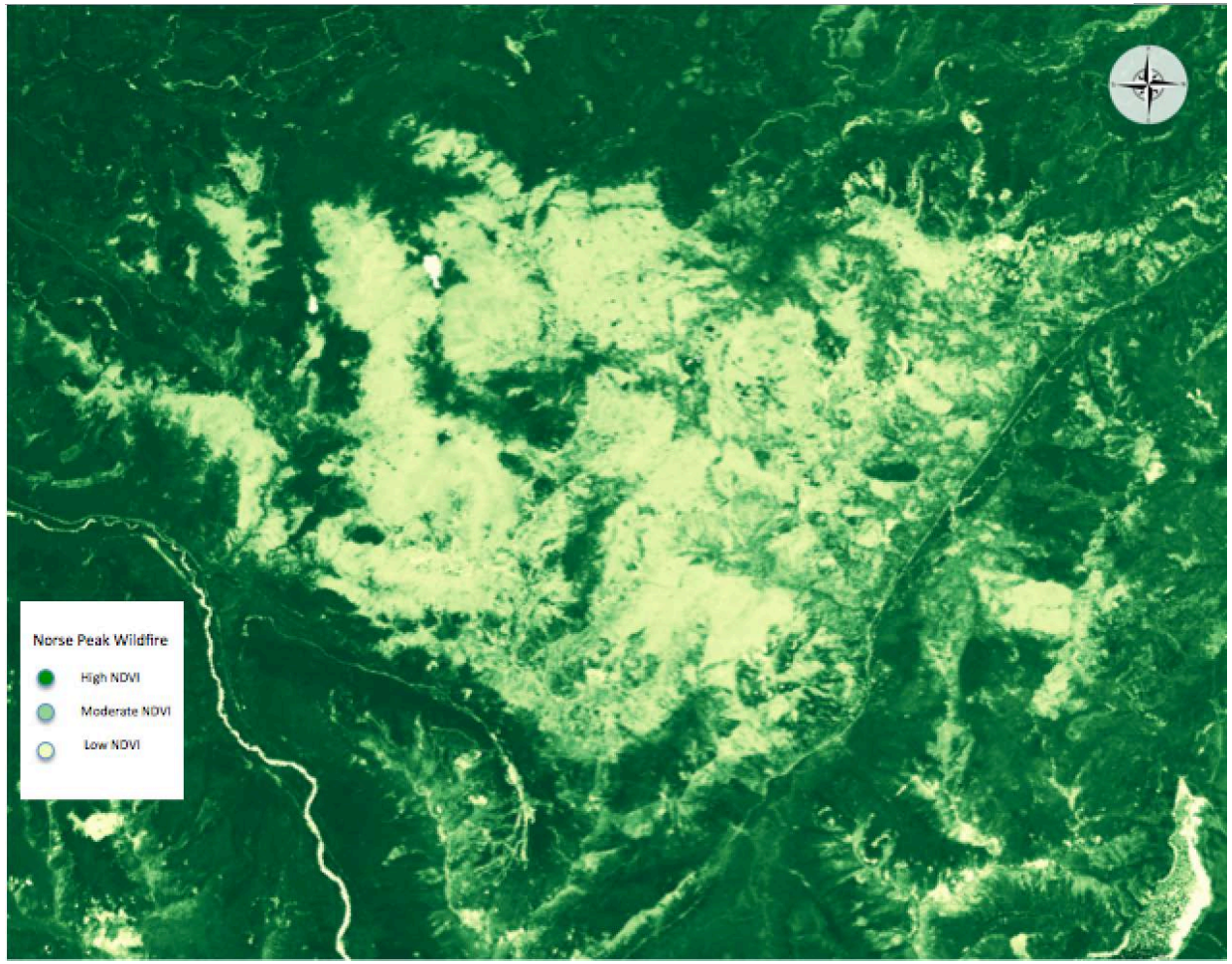
**Annual Precipitation and Temperature-** ***PRISM Climate Group***




USGS LANDFIRE Data Distribution Site
Red Deer
Calgary
Medicine Hat
Lethbridge
Kamloops
Vernon
Kelowna
Cranbrook
Vancouver
Nanaimo
Surrey
Victoria
Lat: 50.780, Lon: -108.705, Scale: 1:9M
USNG Coord: 12U XB 61791 27871 (NAD83)
0 50 100mi

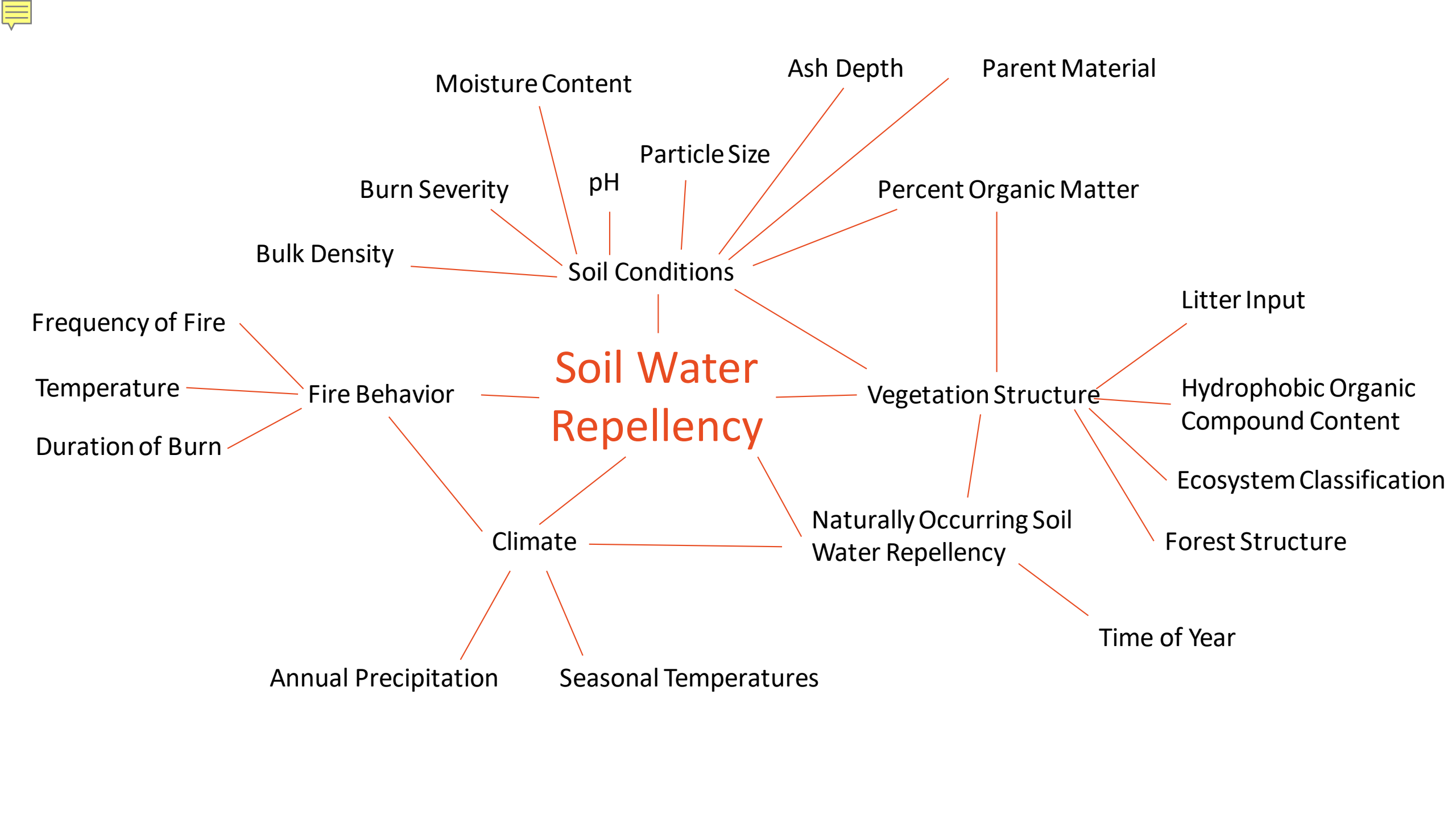
# Normalized Difference Vegetation Index (NDVI)

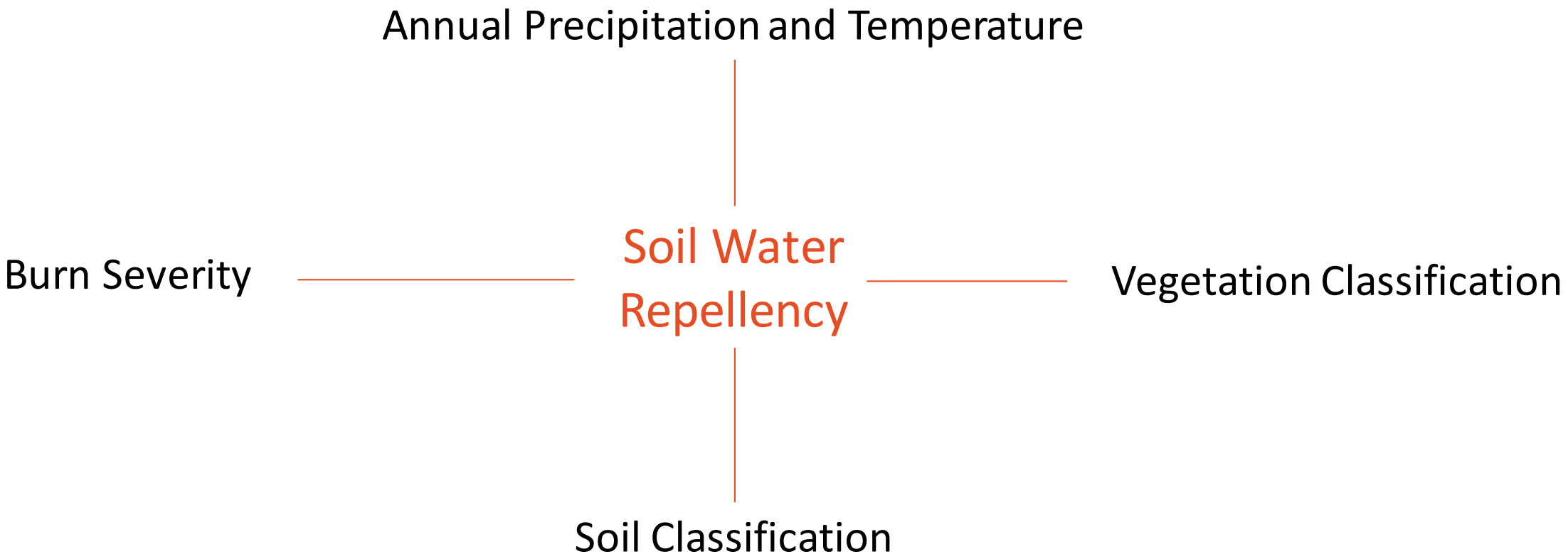



Pinochle Creek
Wrong Creek
Mule Creek
Pigeon Creek
Skookum Cr
Buck Creek
SSURGO Data
Web Soil Survey

- Historical temperature and precipitation regimes
- Monthly and annual temperature and precipitation


Soil Water Repellency
Soil Conditions
Moisture Content
Ash Depth
Parent Material
Particle Size
Burn Severity
pH
Percent Organic Matter
Bulk Density
Frequency of Fire
Temperature
Duration of Burn
Fire Behavior
Vegetation Structure
Litter Input
Hydrophobic Organic Compound Content
Ecosystem Classification
Forest Structure
Climate
Naturally Occurring Soil Water Repellency
Time of Year
Annual Precipitation
Seasonal Temperatures


Annual Precipitation and Temperature
Burn Severity
Soil Water Repellency
Vegetation Classification
Soil Classification

# Continued Work

| | |
|---|---|
| Define | Further define the parameters of each variable selected |
| Connect | Connect variable data to soil water repellency measurements |
| Discover | Discover any statistically relevant connections between variables and soil water repellency |

# Application and Future Work

- Supplement BAER products
- Predictive power
- Inform erosion management
- Salvage logging and Replanting decisions
- Conversion of soil polygon to raster data
  - 30 m grid sized

# Thank You!

jweath19@uw.edu

Research Gate:

LinkedIn: Jalene Weatherholt

Johnson Lab Website:

https://sites.google.com/uw.edu/johnsonsoilslab/home