Influence of Seismic Lines on Fire Potential- A Case Study in the Boreal Plains

Tori Green-Harrison[1], Lelia Weiland[1], Scott Ketcheson[1,2]

[1]University of Calgary, Faculty of Arts- Geography, Calgary, AB; [2]Athabasca University, Faculty of Science and Technology, Athabasca, AB

Background Information

- Wildfires are the largest natural disturbance in the Boreal Plains ecozone where forest organic soils and thick deposits of peat are common.
  - Fire behavior is influenced by three primary factors: fuel (compactness, continuity, fuel moisture, temperature), weather (windspeed, RH, temperature) and topography.
- Seismic lines are linear features created by the oil and gas industry to delineate subsurface resource deposits.
  - Clearing of vegetation and access of heavy equipment results in disturbances to the natural environment.

The creation of seismic lines changes several factors that influence fire behavior. These changes are poorly understood and quantified, particularly regarding fire fuel and local weather.
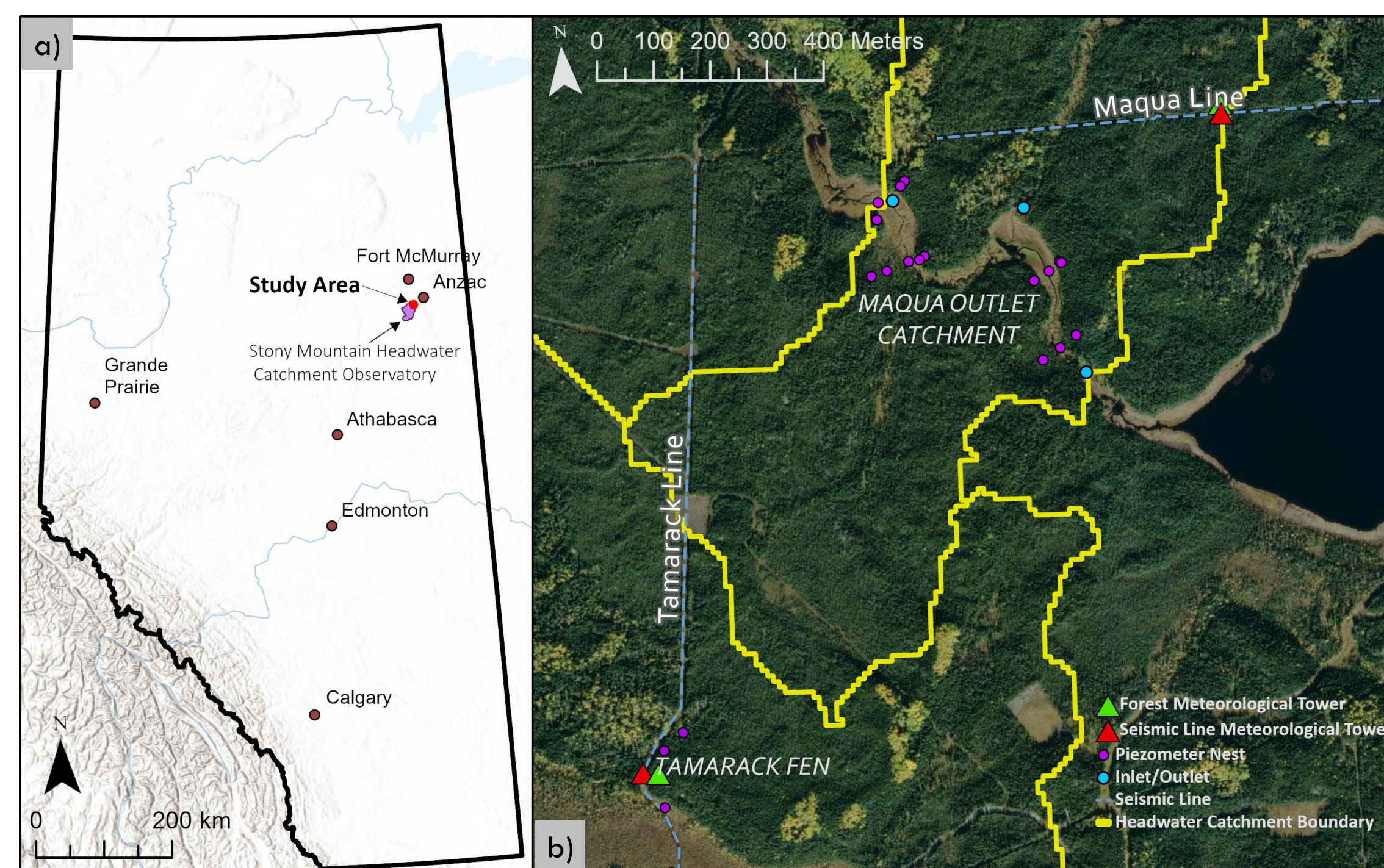

Figure 1: a) *Study location in northern Alberta.* **b)** *Detail map of study areas showing the location of tower sites within Stony Mountain Headwater Catchment Observatory.*

Objectives

1. **Investigate changes to organic soil properties, vegetation, and moisture regimes between seismic lines and adjacent natural areas.**
   - Compare properties and quantities of fuel
   - Evaluate differences in weather parameters
   - Assess soil moisture changes throughout the fire season, April to October.
2. **Determine the influence of several key variables on wildfire risk associated with seismic lines**
   - Assess the impact of line orientation on key factors influencing fire behavior
   - Assess the impact of restoration efforts on fire behavior.

Methods

- Continuous monitoring of local environmental factors at paired stations on the line and in the adjacent natural area.
- Repeated soil moisture surveys to assess and compare spatial variation in soil moisture.
- Sampling of organic soils to determine bulk density, quantity of fuels and hydrophysical properties.

Figure 2: *Meteorological monitoring station.*

Figure 3: a/b) *Paired natural (a) and seismic line (b) study sites. Vegetation in the natural area is dominated by P. mariana, and small amounts of shrub cover. Ground surface is dominated by Feather mosses and some patches of Sphagnum moss species. Large, woody vegetation on the line is absent, with increased amounts of small herbaceous shrubs. Ground surface is dominated by Sphagnum mosses. Canopy openness is increased on the line compared to the natural area.*
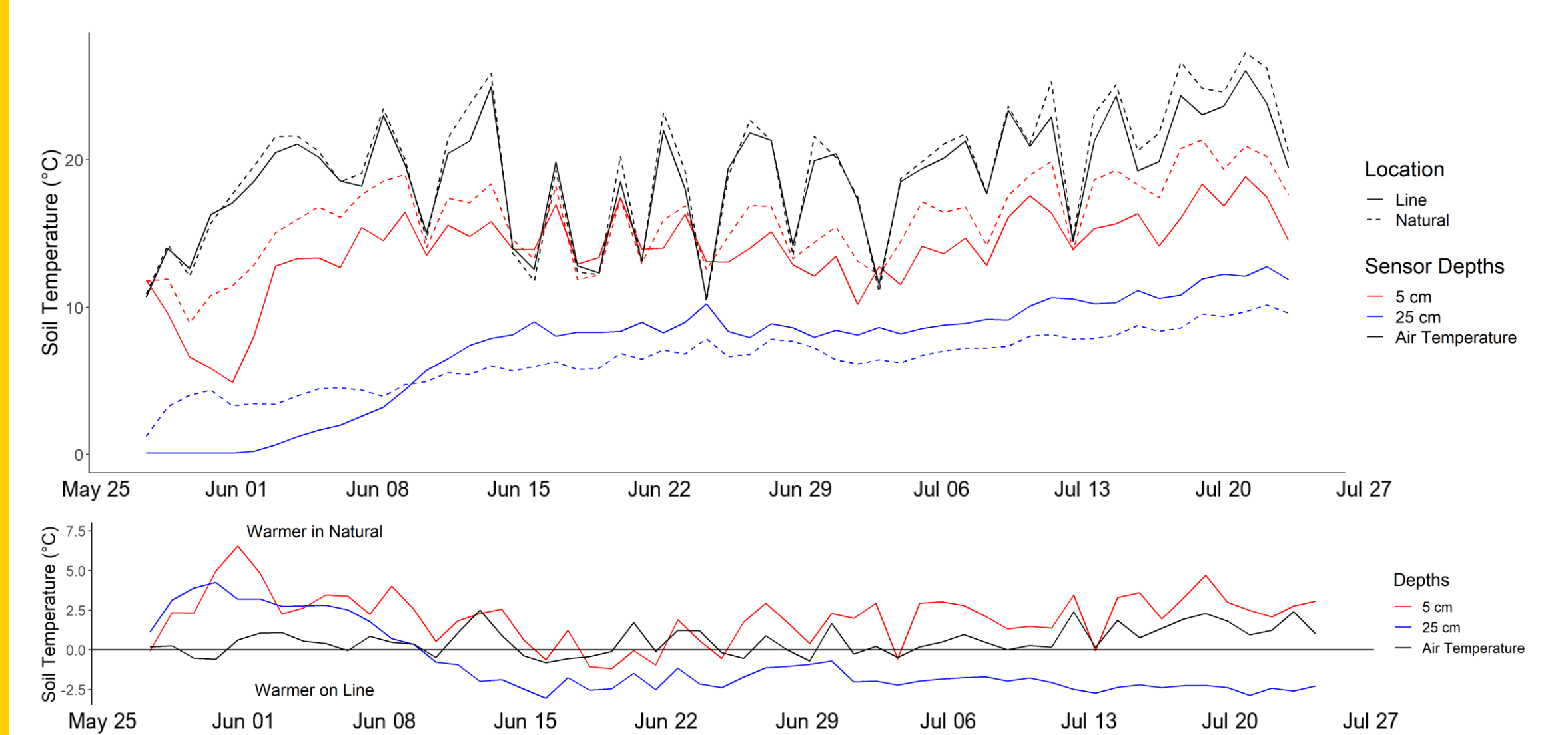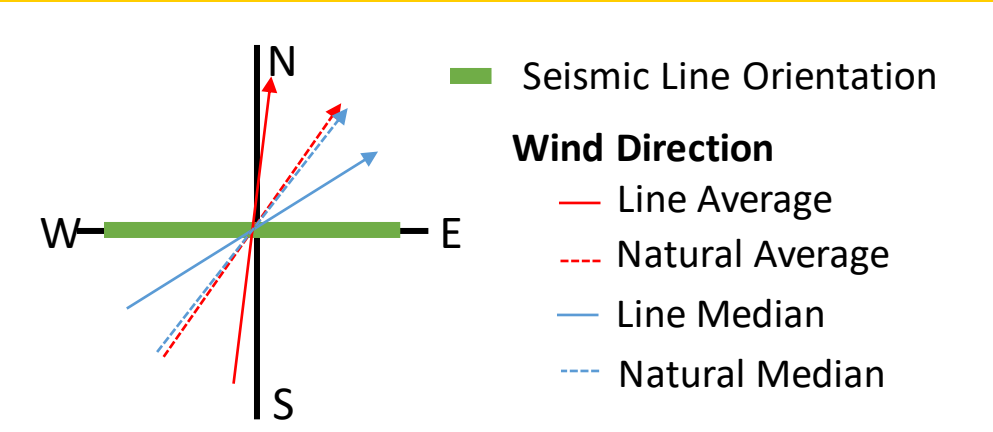

Figure 4: *Soil temperature comparison on seismic line and natural area showing 12 pm measurements (top) and the 12 pm difference between the seismic line and adjacent natural area (bottom).*

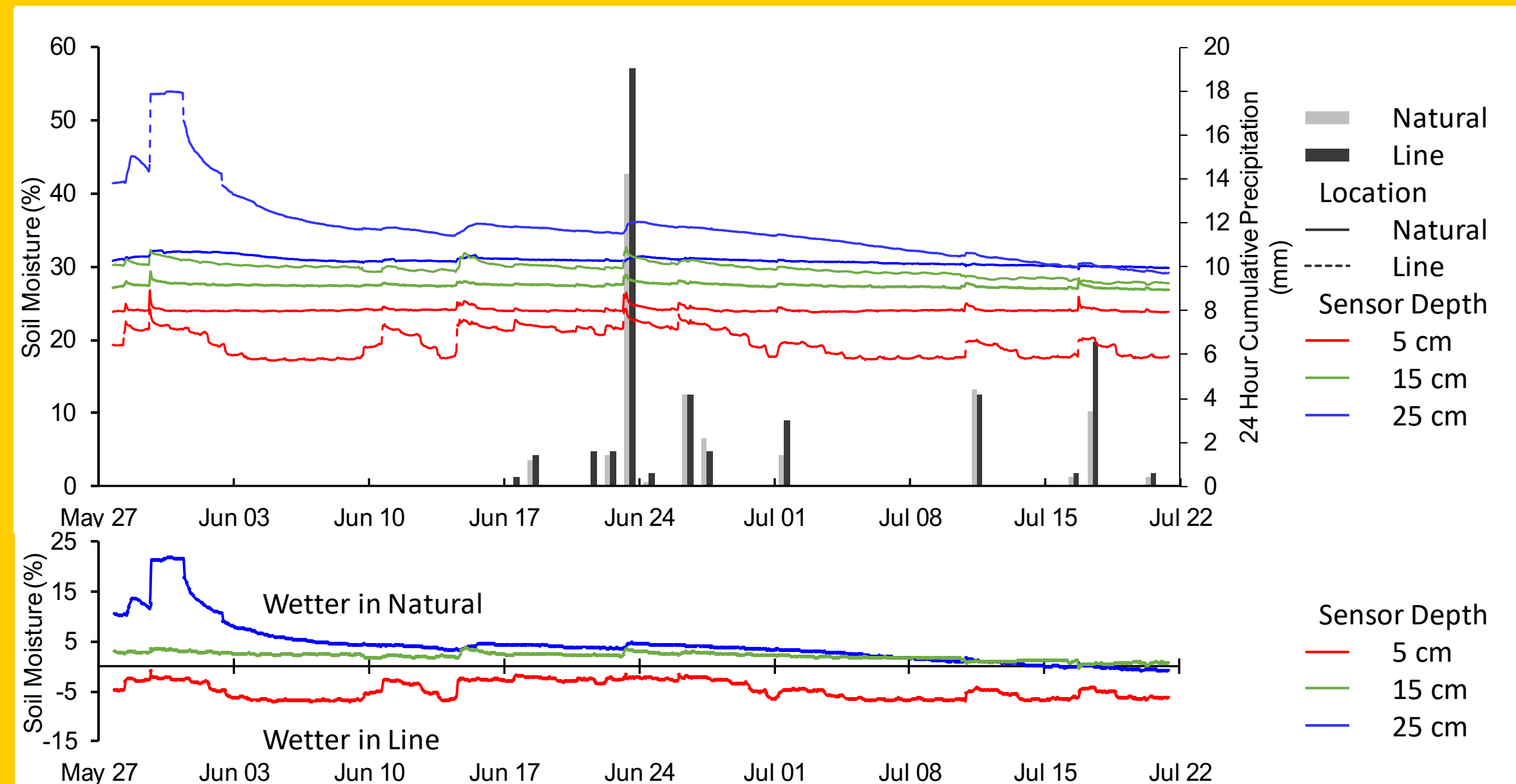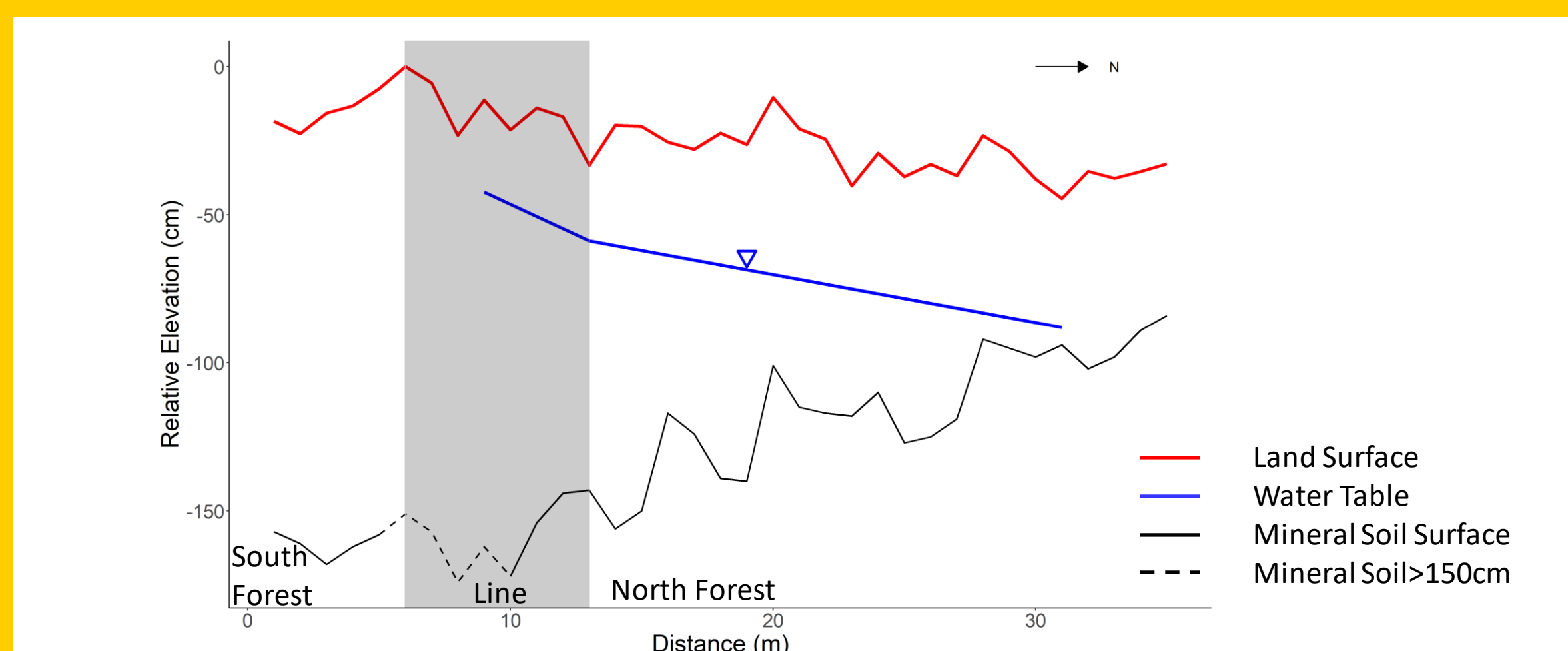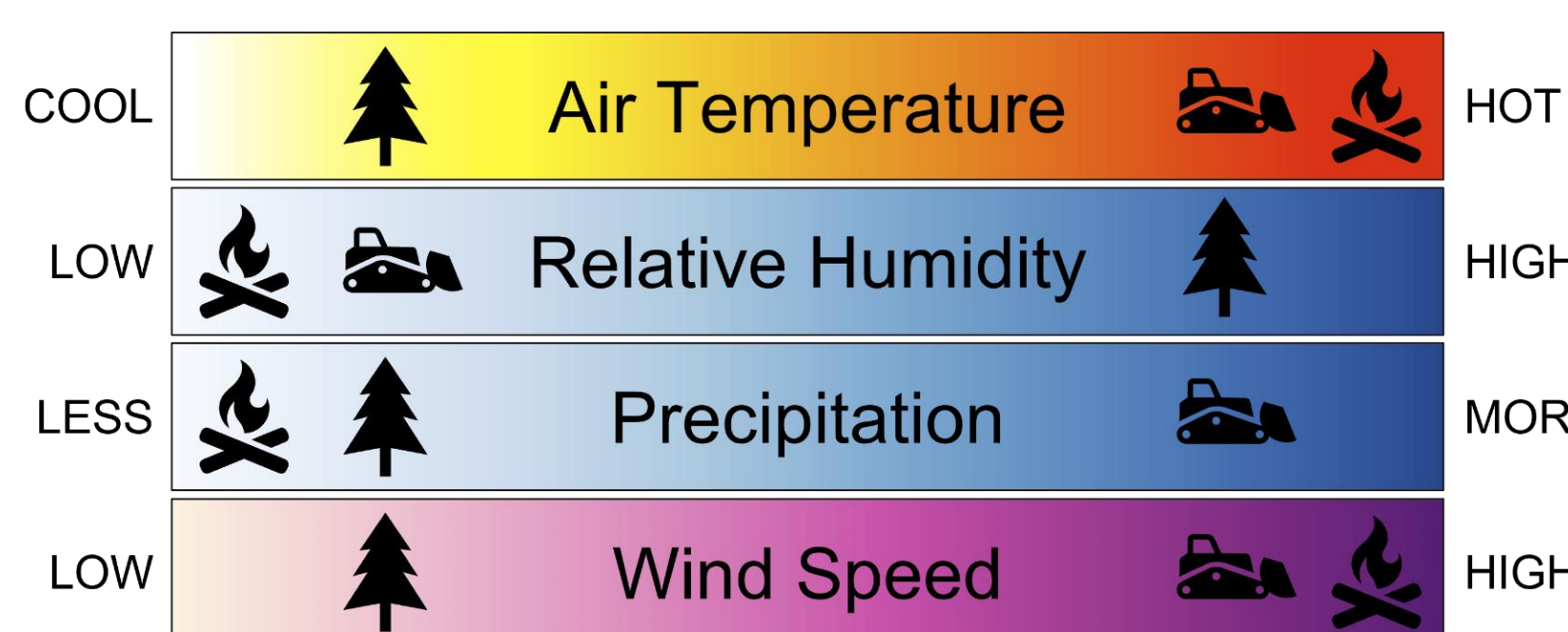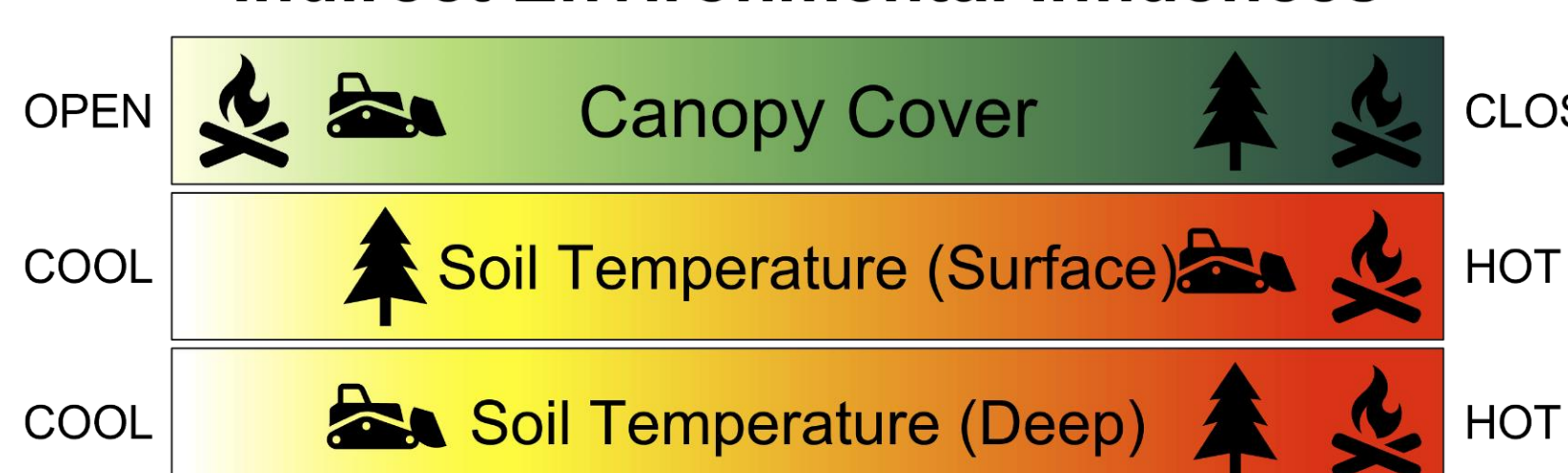| Windspeed Summary Statistics (m/s)		
Measurement	**Natural Area**	**Seismic Line**
30-min Average	0.08	0.49
Max 30-min Average	0.67	2.67
Max Gust	3.34	9.02

Figure 5: *Hourly soil moisture and 24-hr cumulative precipitation measurements at meteorological stations (top) and the difference between values in the natural area and on the line (bottom).*

Figure 6: *Vertical profile of a transect from South to North across the seismic line and into the natural area.*

Direct Environmental Influences

- Air Temperature — COOL / HOT
- Relative Humidity — LOW / HIGH
- Precipitation — LESS / MORE
- Wind Speed — LOW / HIGH

Indirect Environmental Influences

- Canopy Cover — OPEN / CLOSED
- Soil Temperature (Surface) — COOL / HOT
- Soil Temperature (Deep) — COOL / HOT

Fuel Characteristics

- Fuel Continuity — PATCHY / CONTINUOUS
- Quantity Fine Fuels — LESS / MORE
- Quantity Coarse Fuels — LESS / MORE
- Fuel Density — LOW / HIGH
- Soil Moisture (Surface) — DRY / WET
- Soil Moisture (Deep) — DRY / WET

(Legend: Increased Fire Potential; Natural Area; Seismic Line)
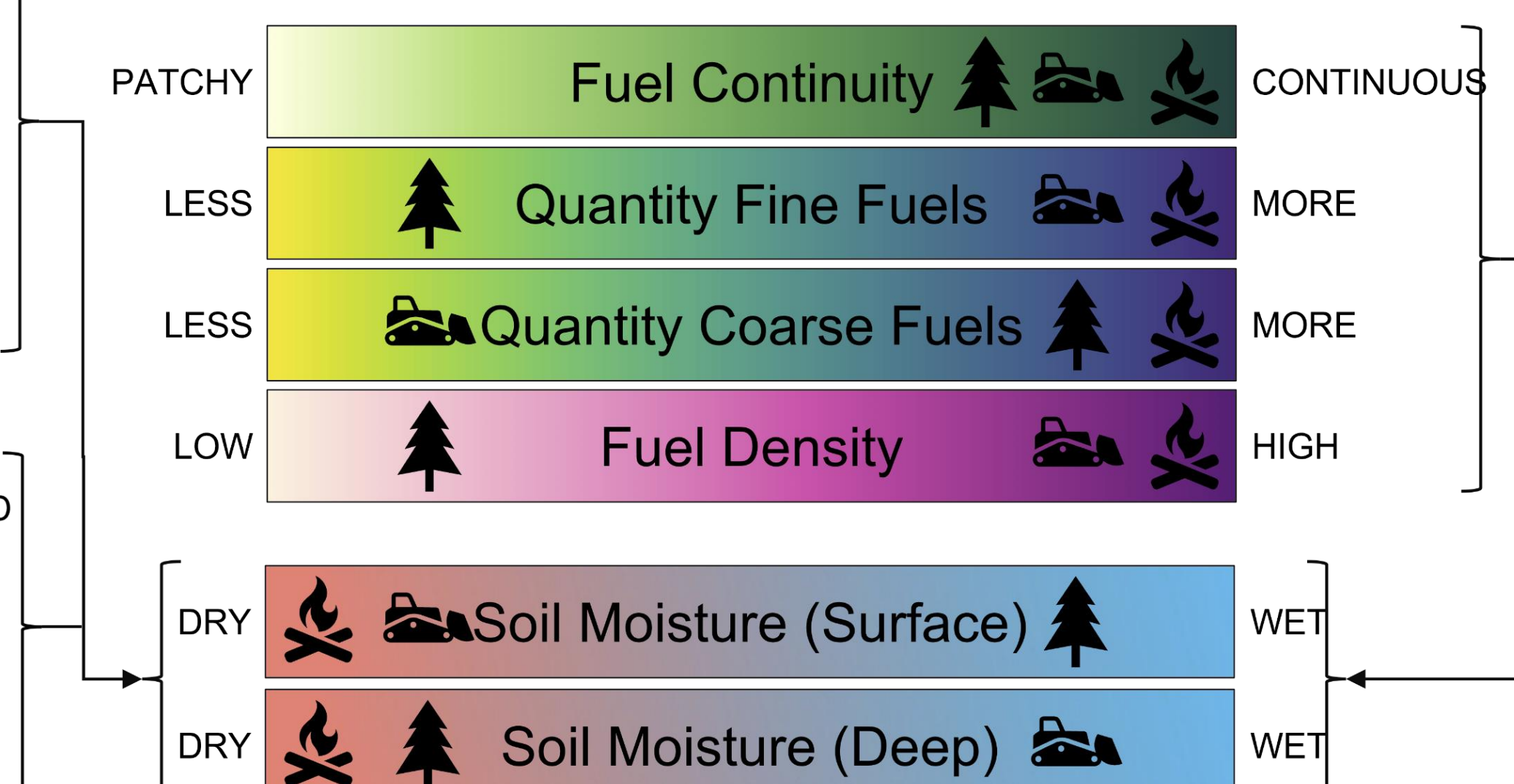
Figure 7: *Schematic summary of factors influencing fire potential and whether they are greater on the seismic line or in the natural area. Representation of risk are not quantitively scaled.*

Summary

- Seismic lines, which are prolific in northern Alberta, influence all aspects of fire potential when considering environmental, fuel characteristics and fuel moisture variables.
- Different factors influence fire potential on and off the line.
- **Based on this sample size, we are limited in our capacity to make conclusions on the impact of seismic lines on fire potential overall; however, our preliminary analyses indicates that seismic lines change important fuel characteristics (coarse fuel presence, organic soil bulk density) and environmental variables (wind speed, soil moisture and temperature), which are likely to influence overall fire potential.**

Further Research

- Apply quantitative analysis (FWI or other) to determine where fire potential is higher and if it is consistent throughout fire season.
- Expand study area to seismic line with different orientation.
- Expand study to seismic line with treatment to aid regeneration.

Presenter in Attendance:
Tori Green-Harrison
tlgreenh@ucalgary.ca