Water Meets Seismic Lines: It's Complicated

Lelia Tuffner

Athabasca University

Scott Ketcheson, Maria Strack, Greg McDermid

Boreal Ecosystem Recovery & Assessment

Applied Geospatial Research Group

Athabasca University

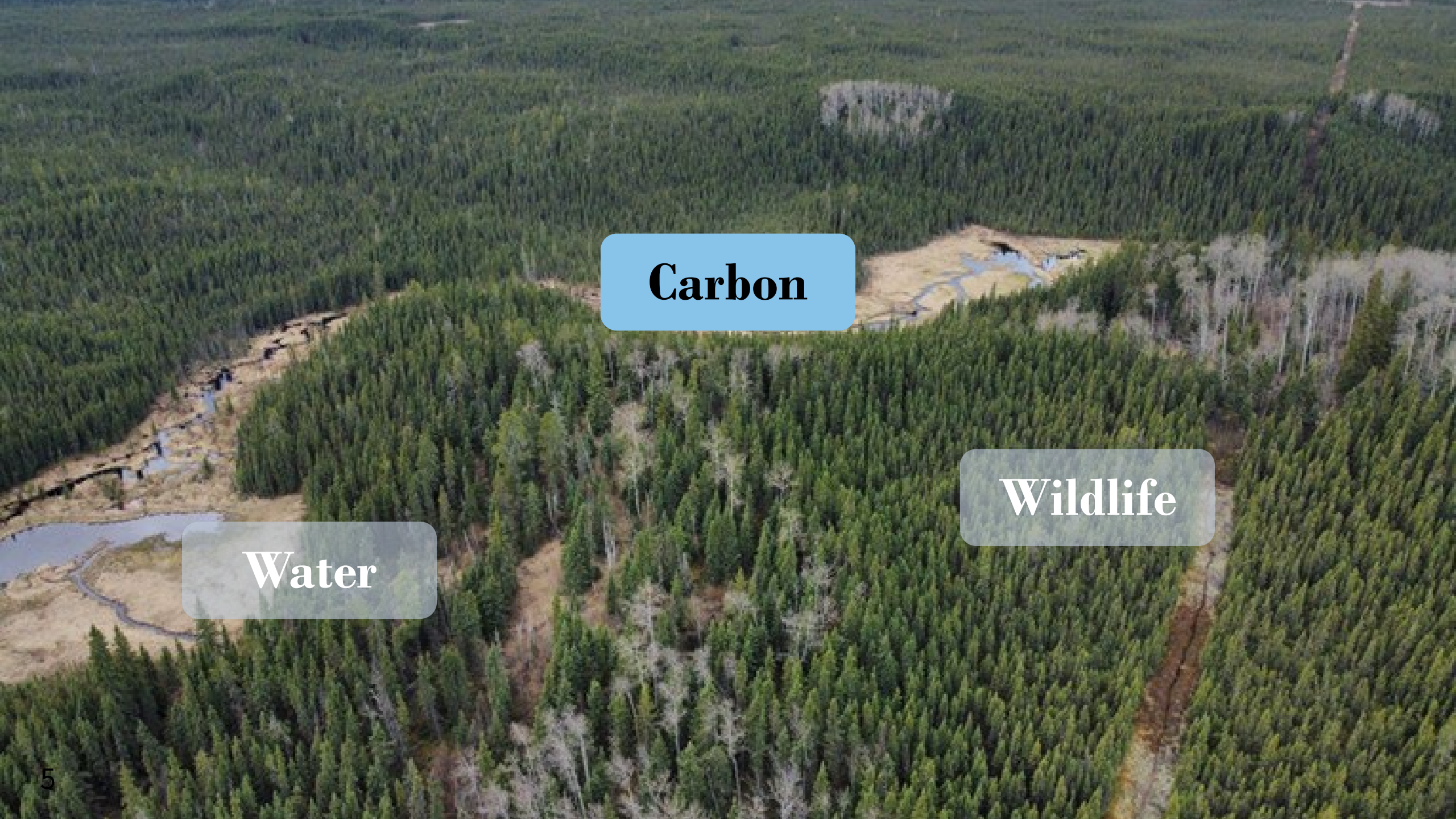
University of Calgary

AU Hydrology

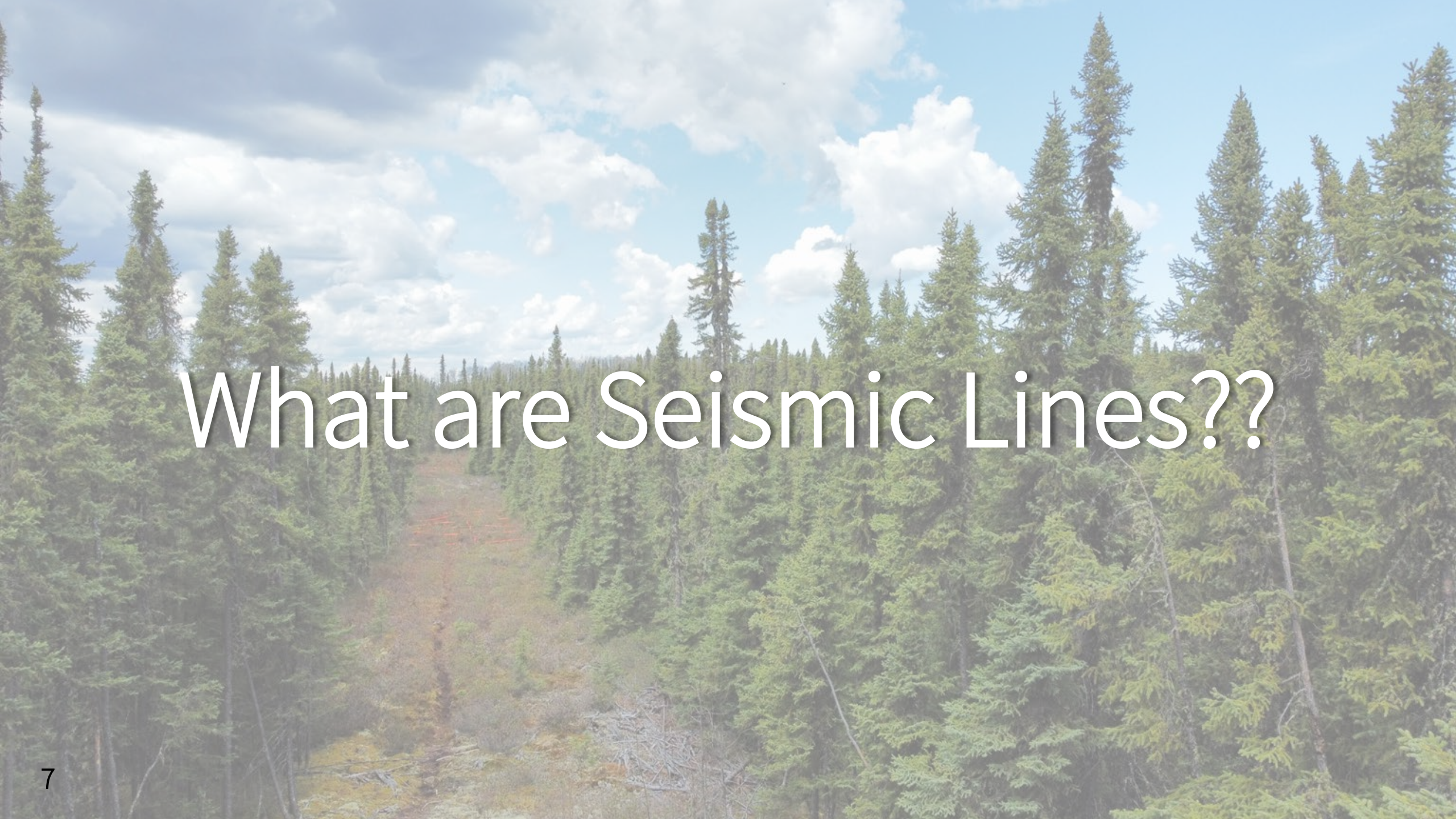

Carbon
Wildlife
Water


Carbon
Wildlife
Water


Carbon
Wildlife
Water

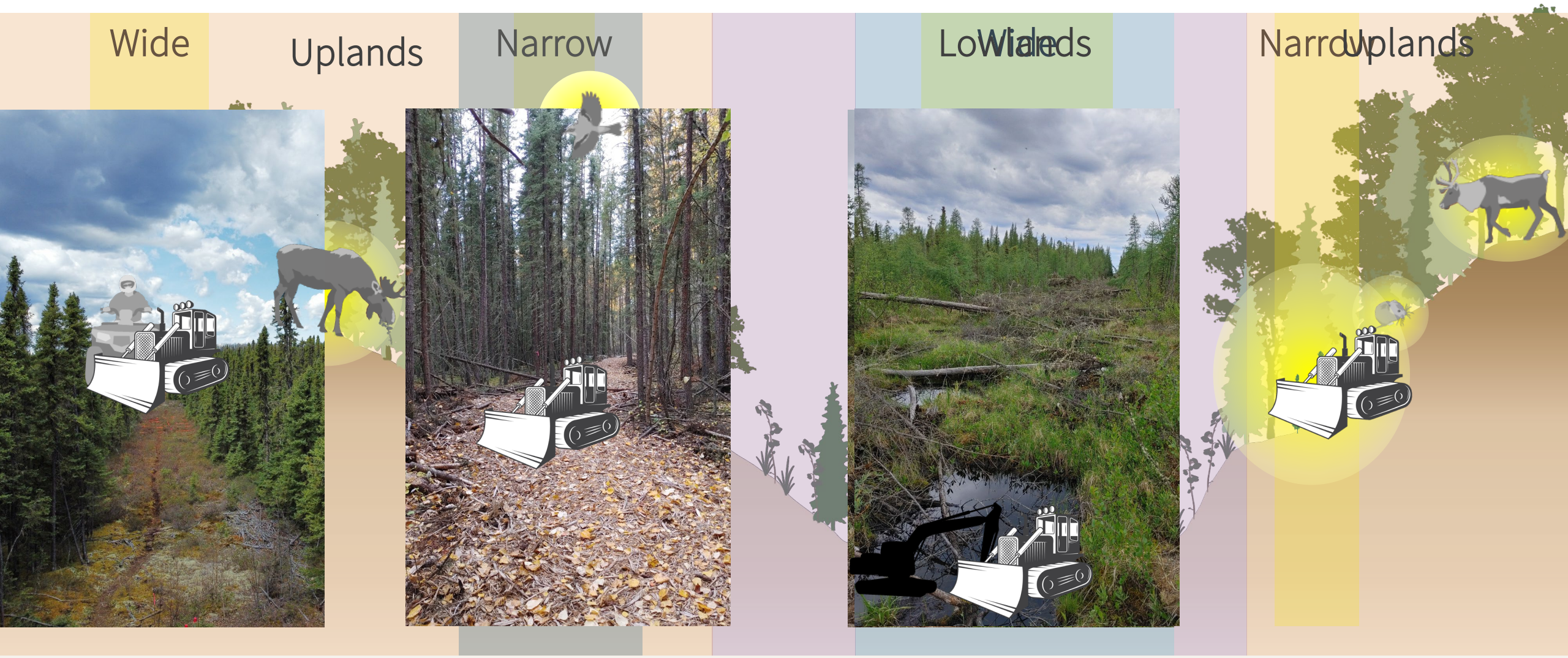

Carbon
Wildlife
Water


Well Site
Seismic Line
Pipeline
Well Pad
Seismic Line
Harvest Area
Road
Well Site
Road
Seismic Line
Seismic Line
Well Site
Well Pad
Pipeline
Ft. McMurray
Lac La Biche
Edmonton
Calgary

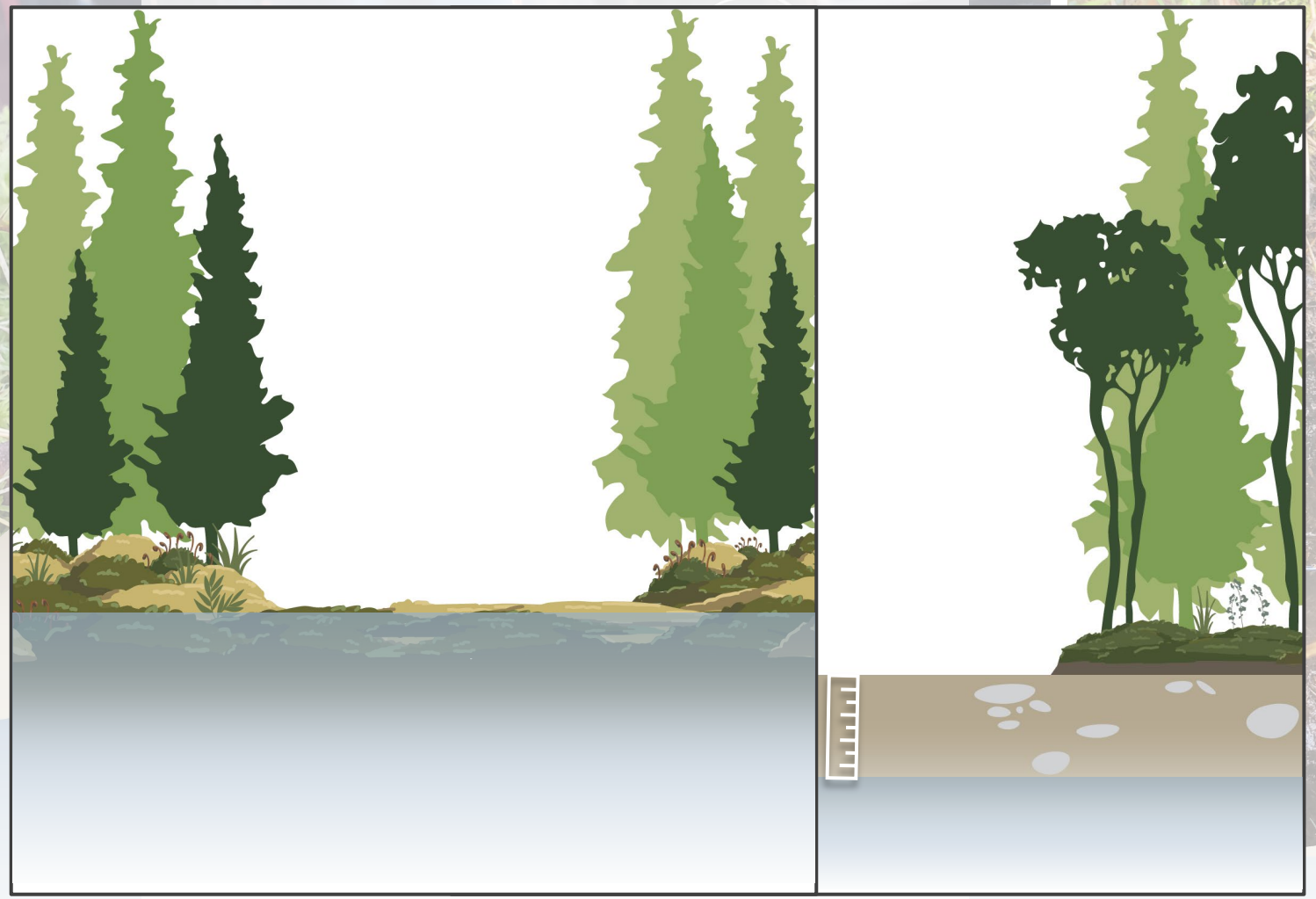


What are Seismic Lines??

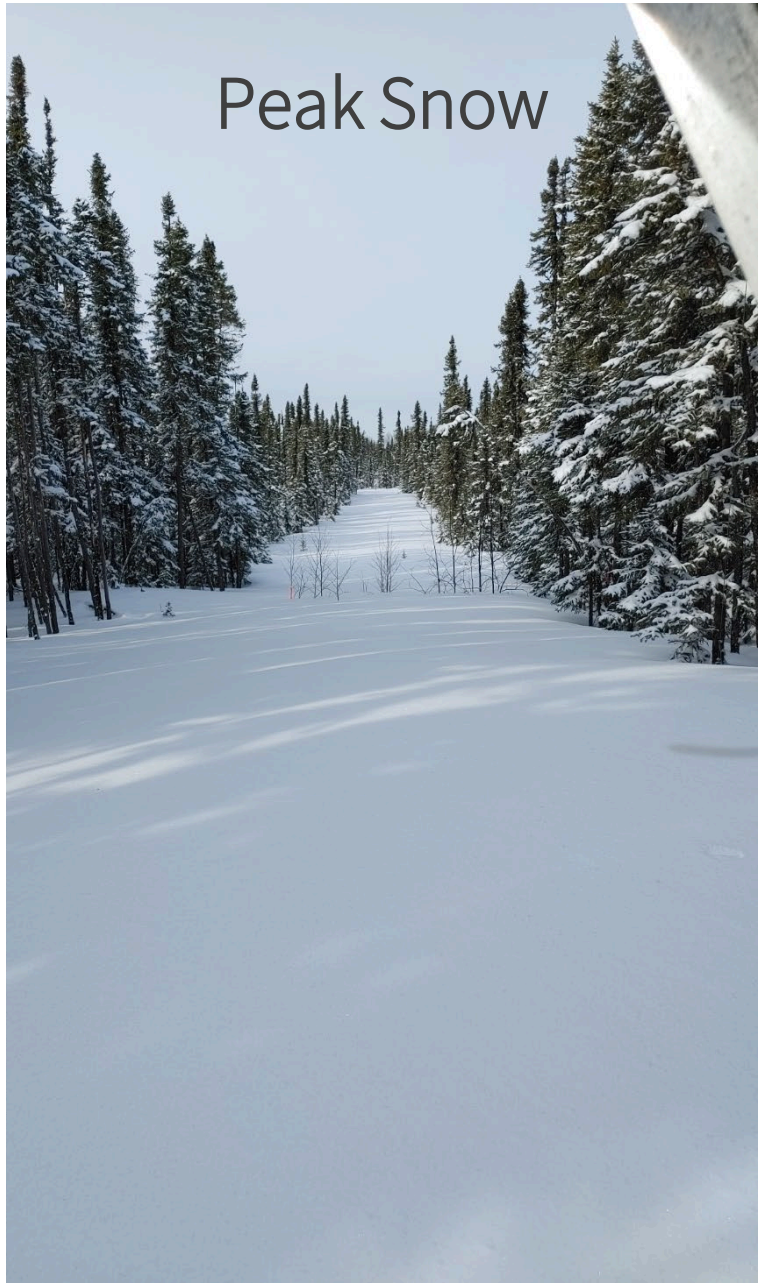
BOREAL
ECOSYSTEM
RECOVERY &
ASSESSMENT



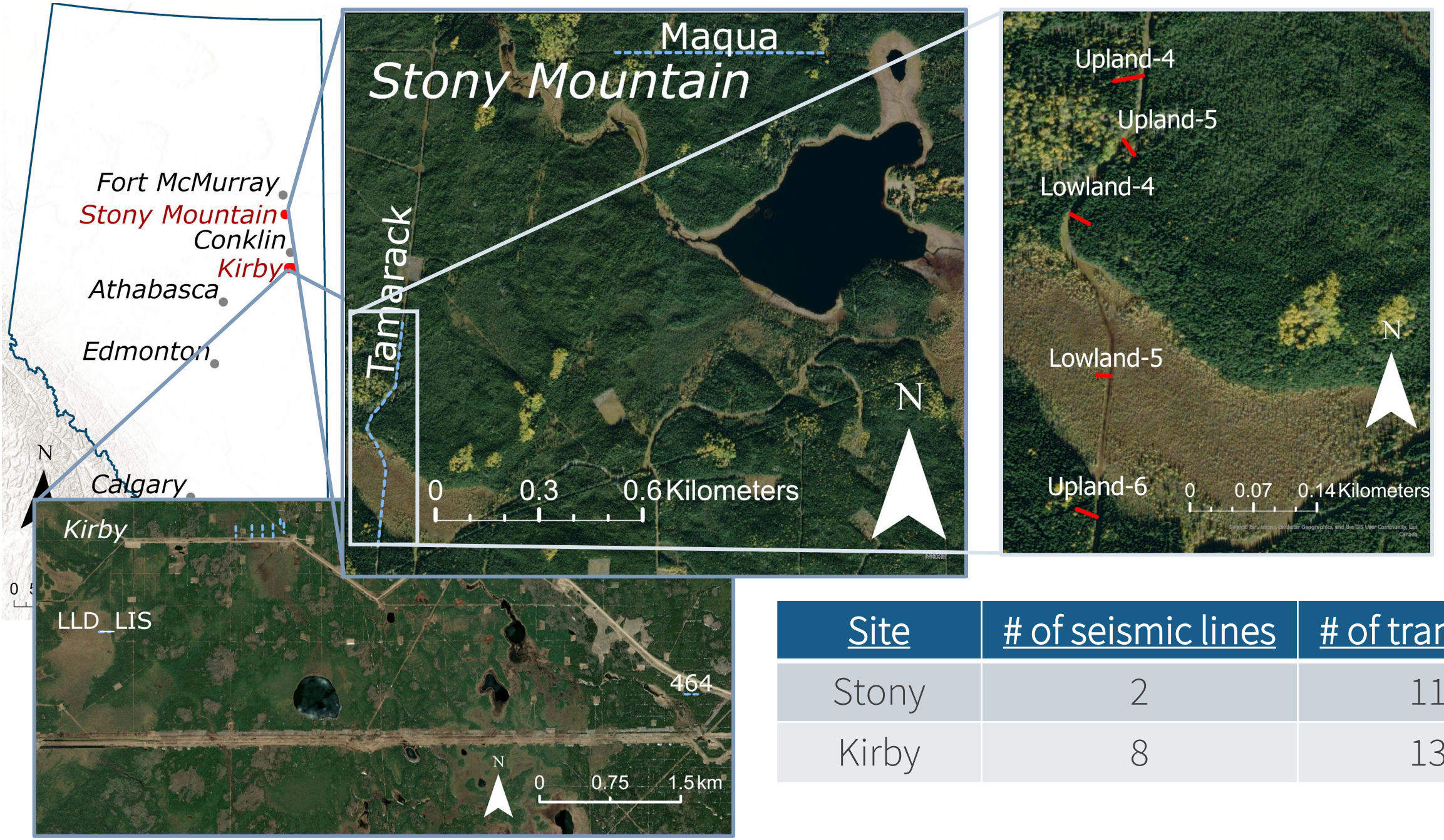
Select graphics by freepik



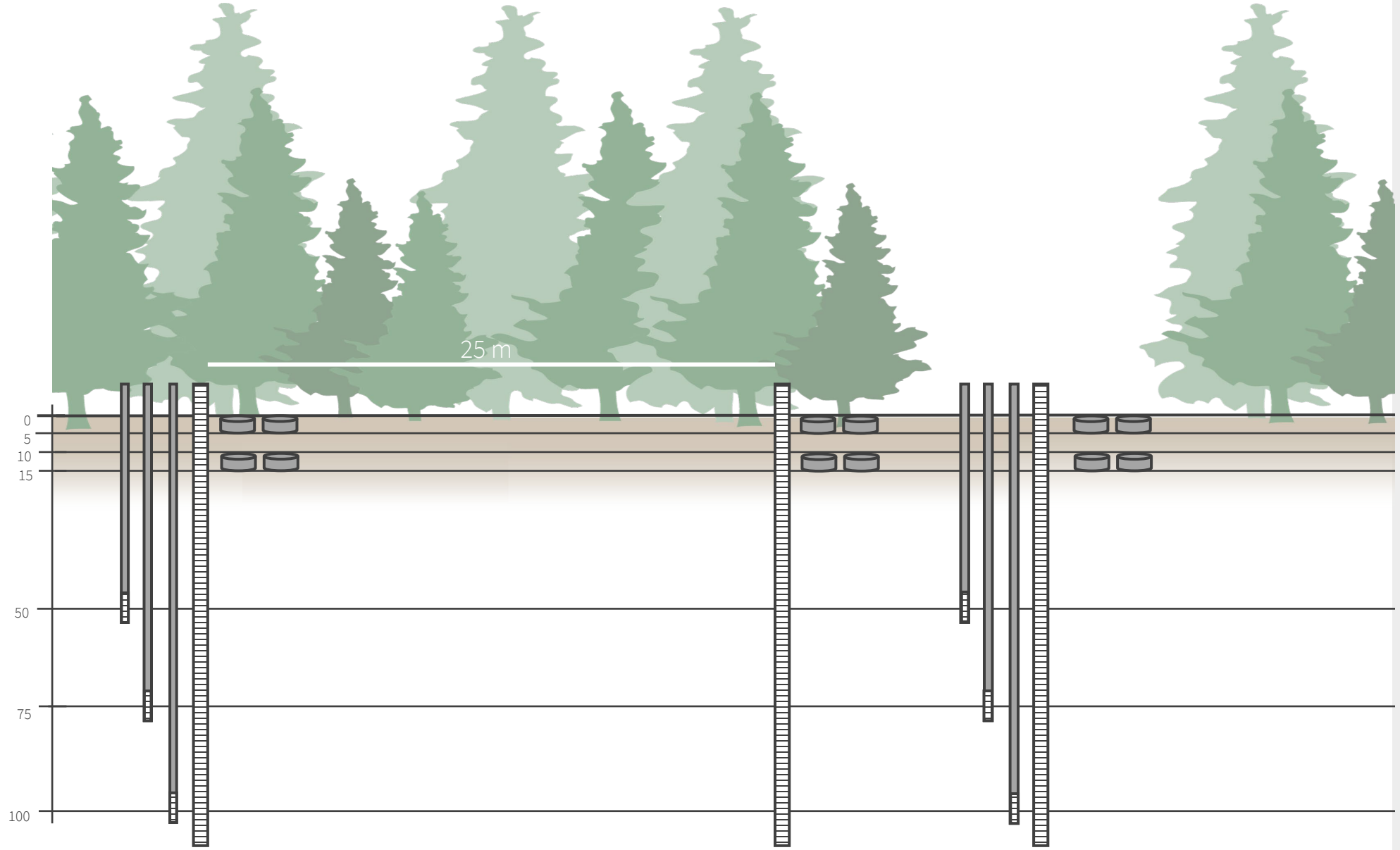

Summer


Peak Snow

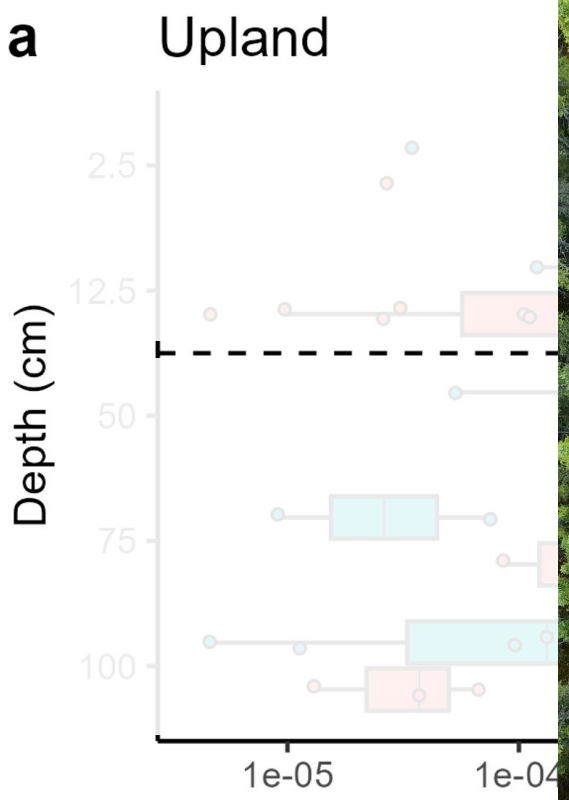

Snow Melt



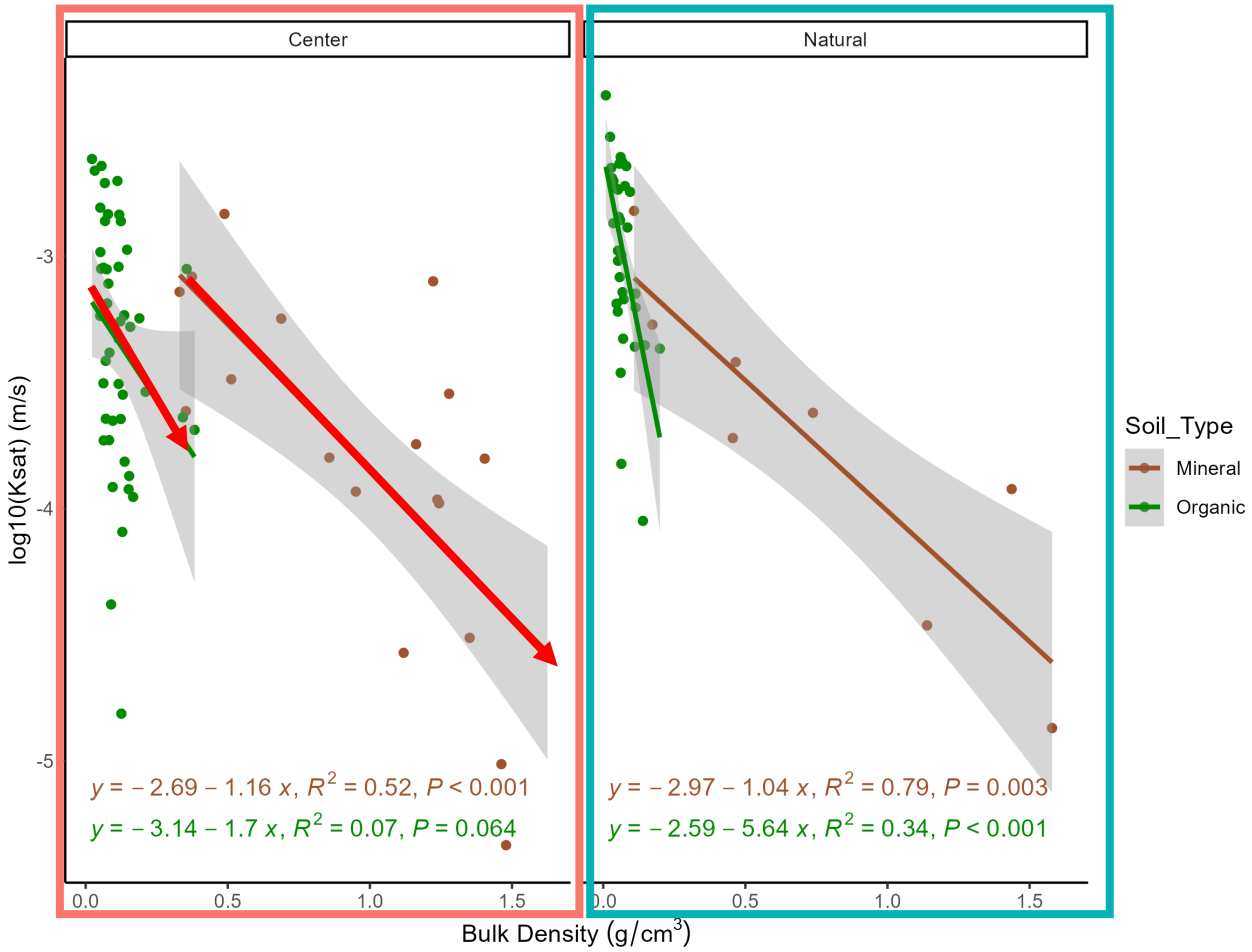
Site	# of seismic lines	# of transects
Stony	2	11
Kirby	8	13



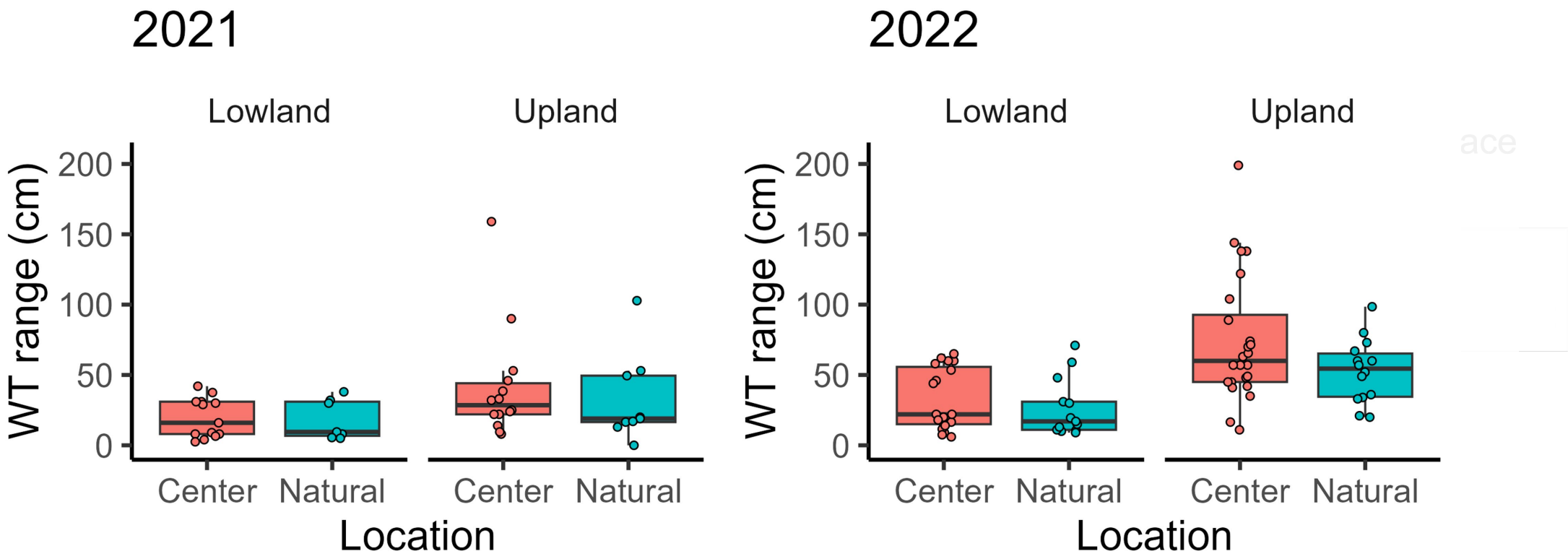
Soil samples at
3 wells
each well
3 piezometers
Surface: 0-5 cm
50, **75** and **100**
Rooting zone:
cm
10-15 cm



ydraulic
ivity
d on
ines



Saturated hydraulic conductivity decreases as bulk density increases

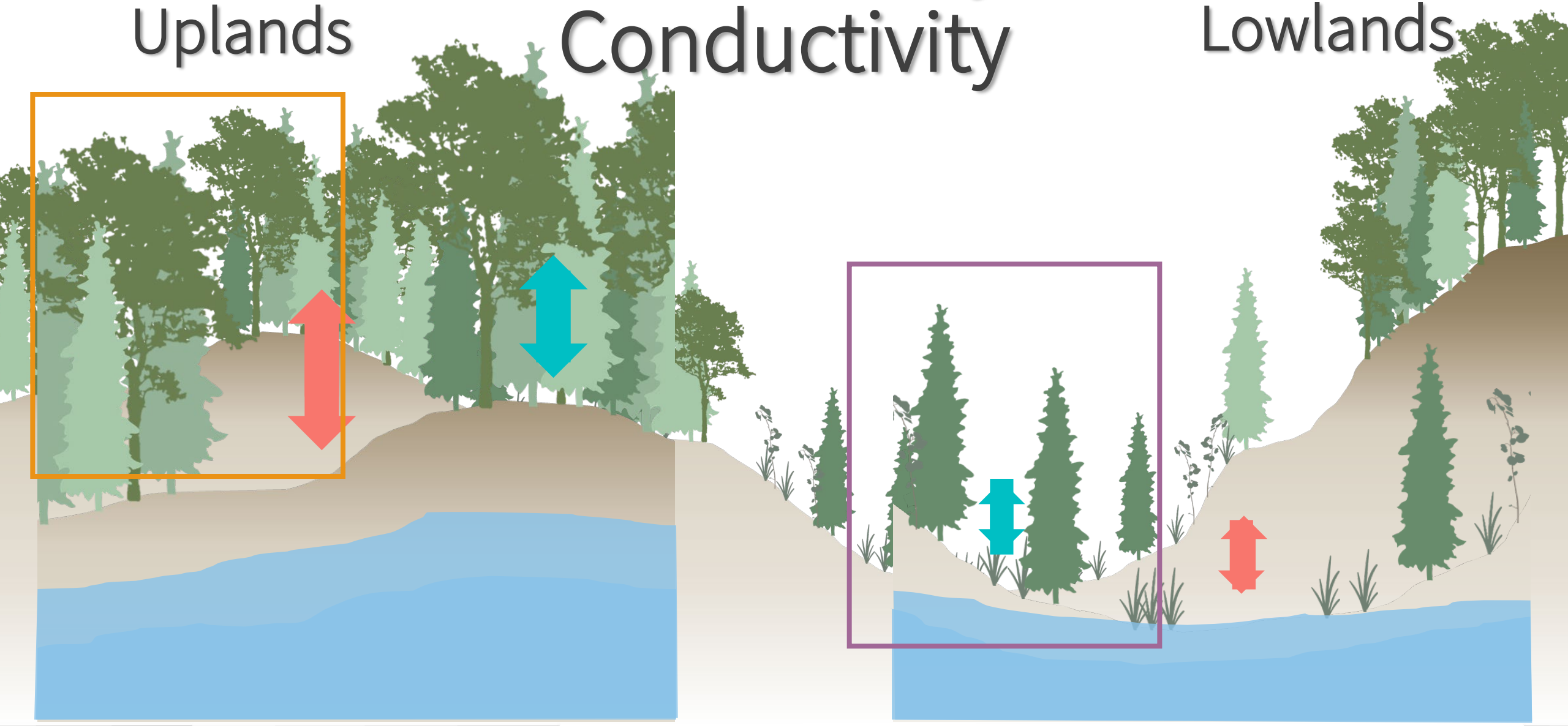


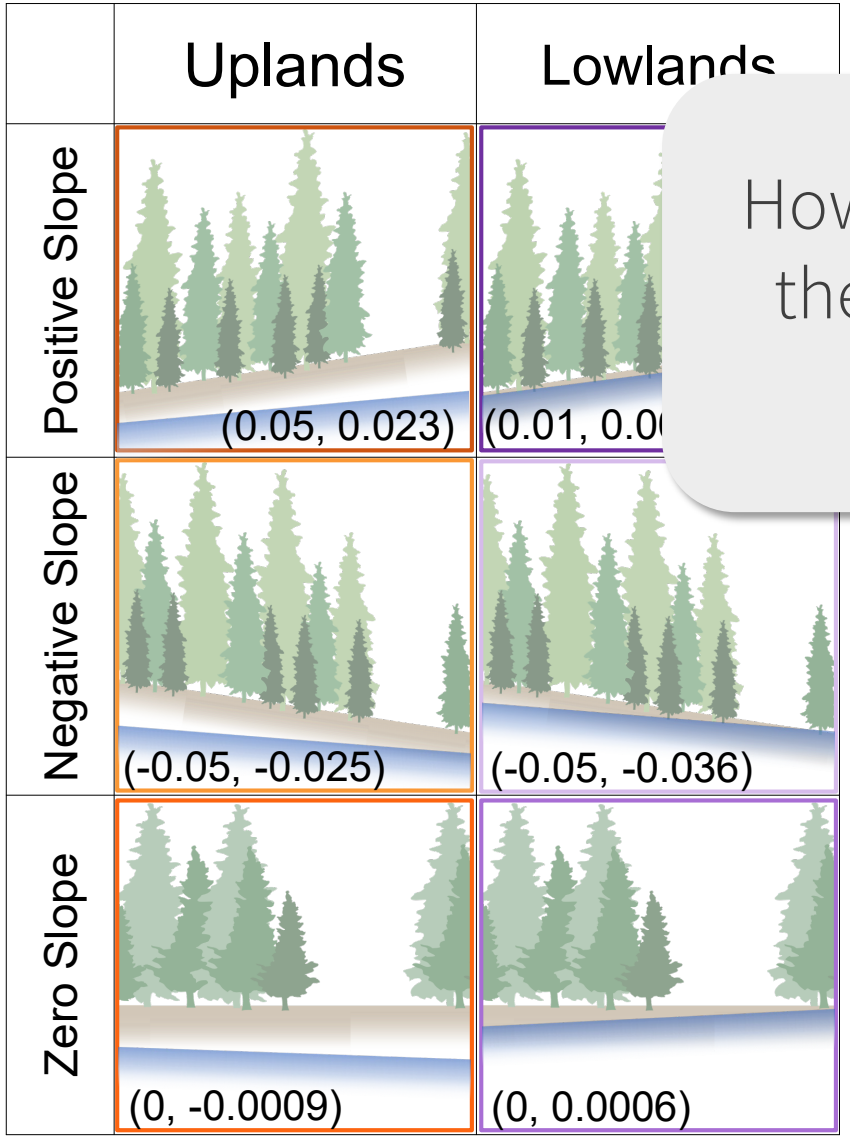
Water table variation (range) increased on seismic lines

Saturated Hydraulic Conductivity

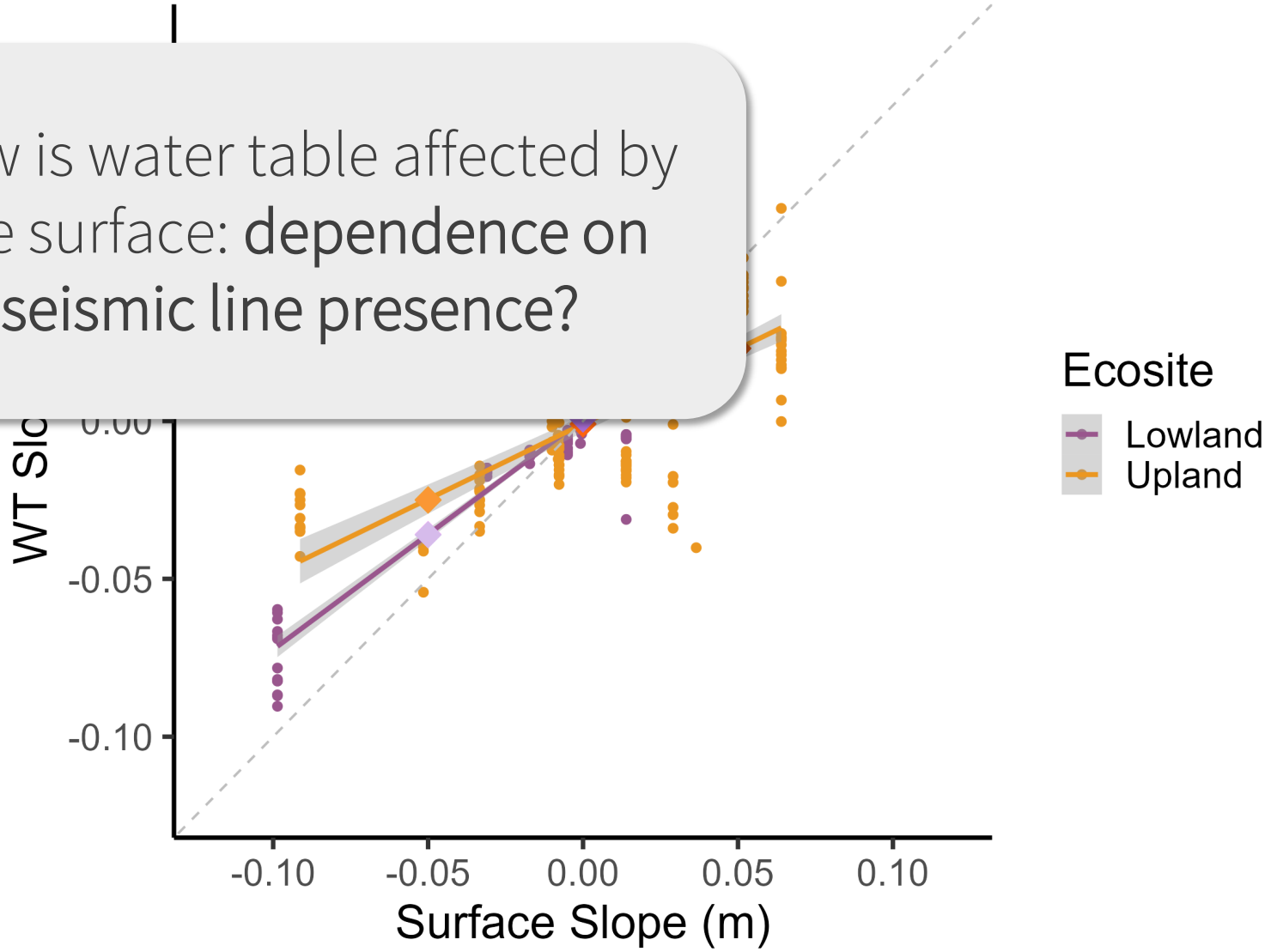
Uplands

Lowlands





How is water table affected by the surface: **dependence on seismic line presence?**



Surface topography matters more for water table configuration than seismic line presence

March 2022

Depth on line, natural

Weight measured at key locations

Snow Depth | Snow Density | SWE

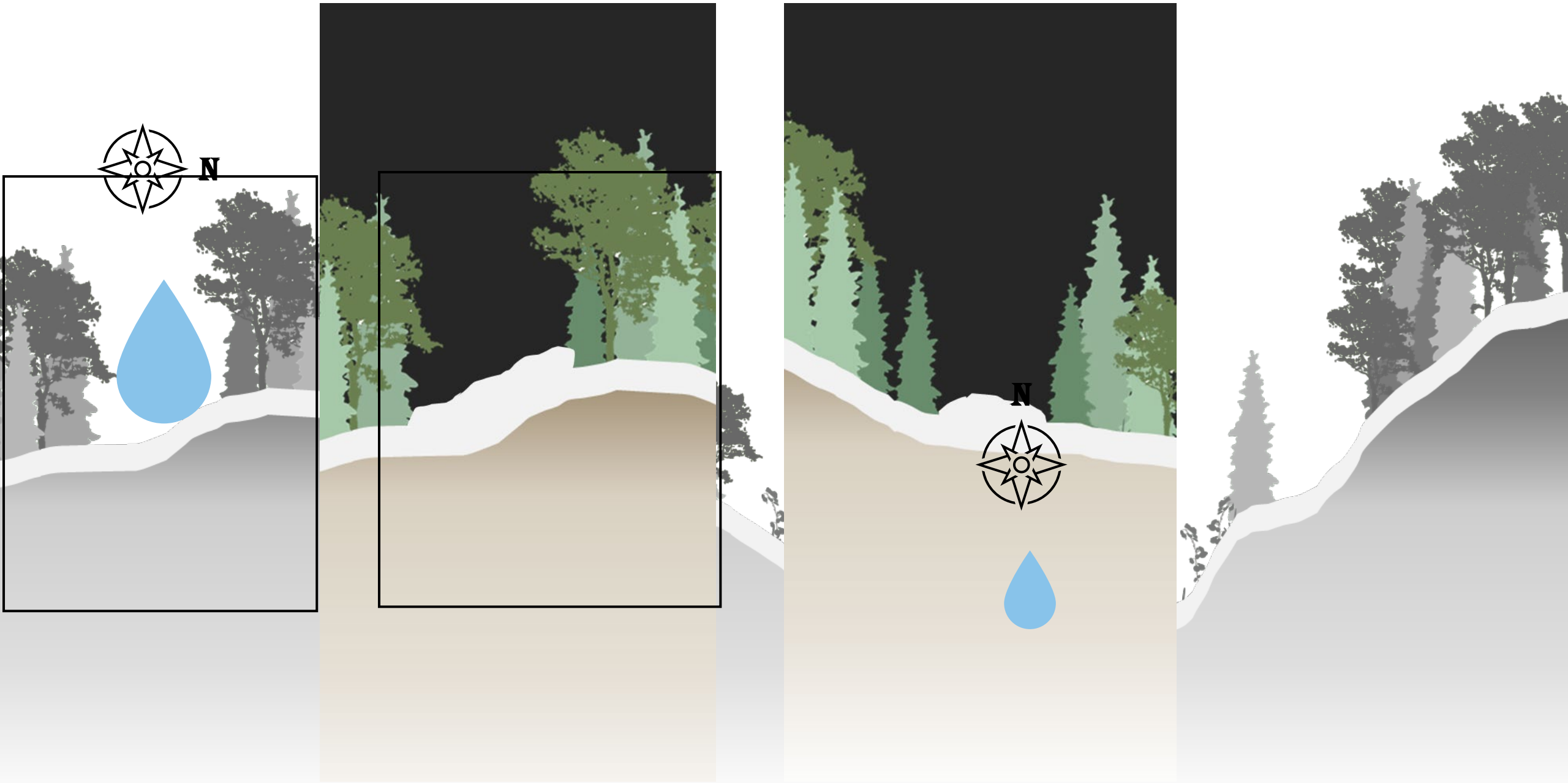
$$Difference = Seismic\ line\ - Natural$$

Ecosite

Line Width

Orientation

Snow water equivalent higher on seismic lines


N
N


N


N

It’s Complicated

Key Takeaways

- Soil properties and water table position are altered on seismic lines
- Meso-topography matters more for water table position than seismic line presence
- Seismic lines alter snow accumulation

Special thanks goes to Jennifer Attema, Tori Green-Harrison, Hannah Ponsonby, Jasper Koch, Colette Shellian, Maverick Fong, Xue Yan Chan, Nataša Popovič, Samantha Jang, Austin Zabel, Jennifer Fliesser, Brian Newton and Maryam Bayatvarkeshi

Lelia Tuffner
lweiland@athabascau.ca
Lelia Tuffner
auhydrology.com
beraproject.org
Athabasca University
Hydrology Research Group

Questions?

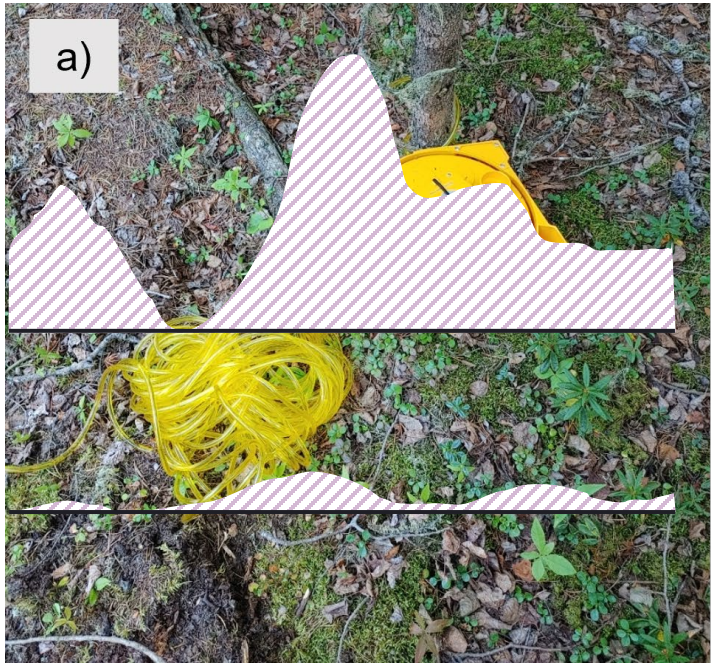
Key Points

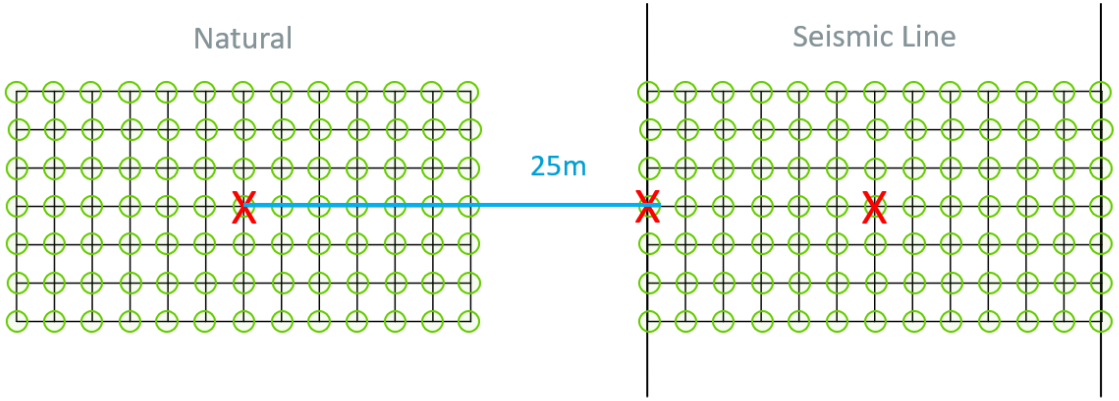
Soil and snow properties impacted by line presence

Local topographic context is important

1

Soils





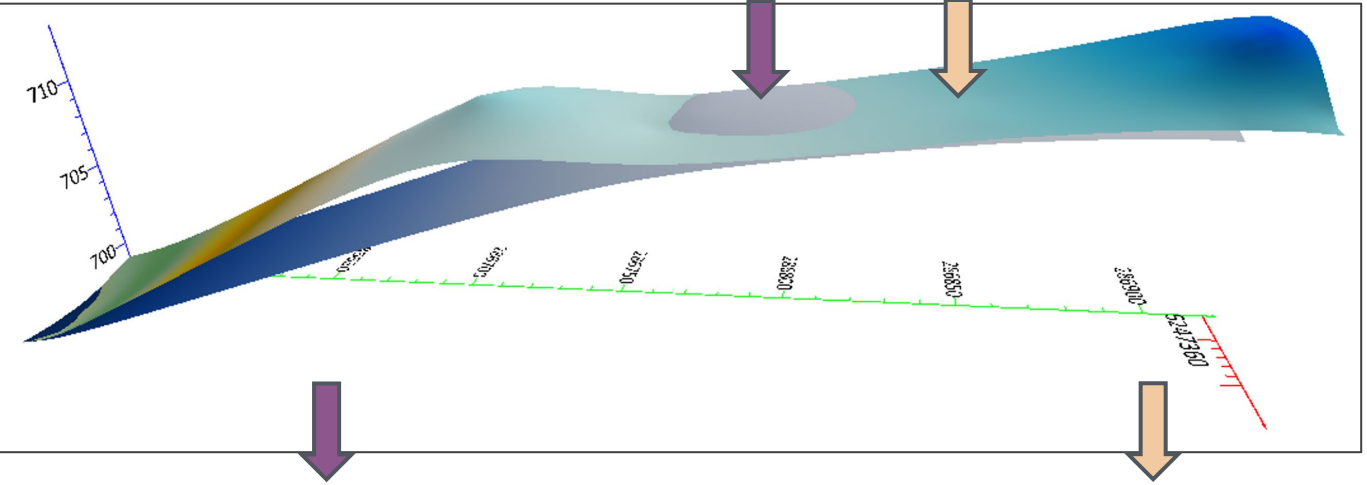
Altimeter measures relative elevation changes

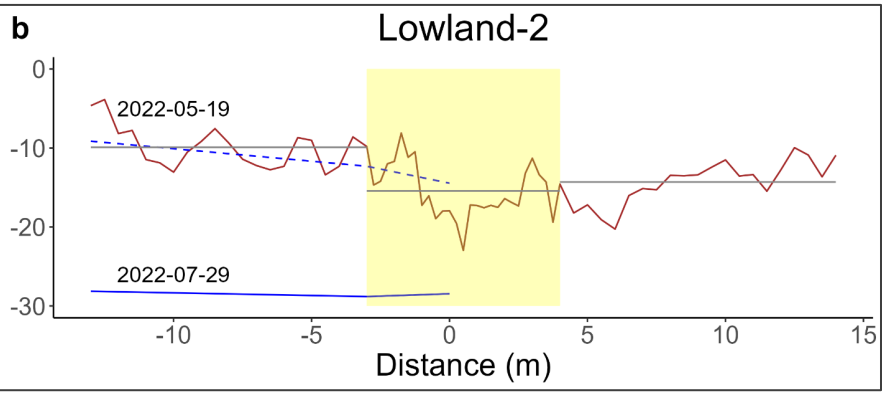
Every 50 cm in a grid (7x3 m)

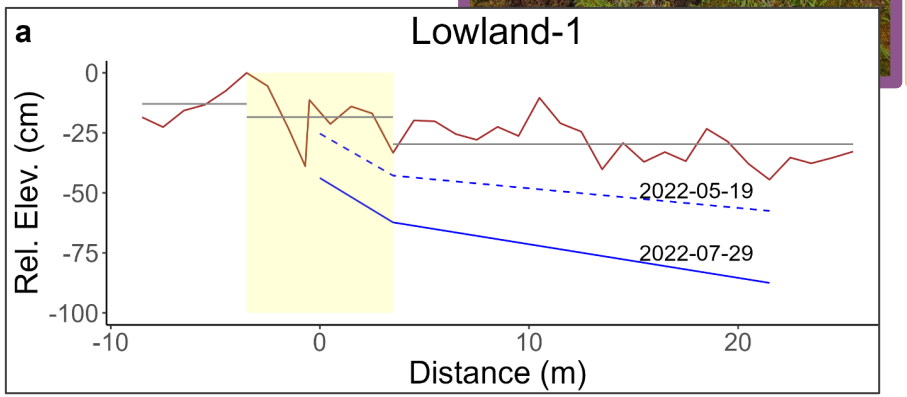
Along a transect

2

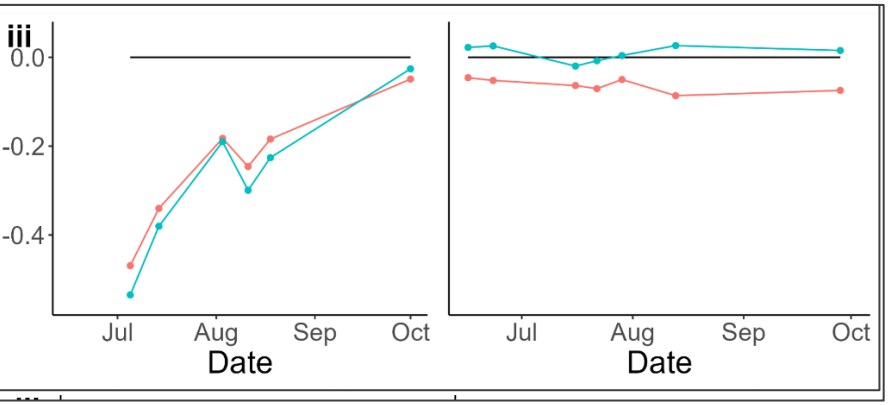
Hydrology

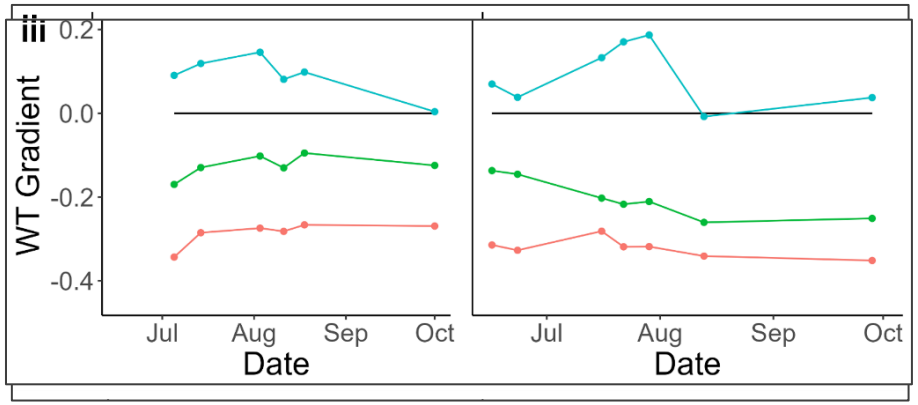


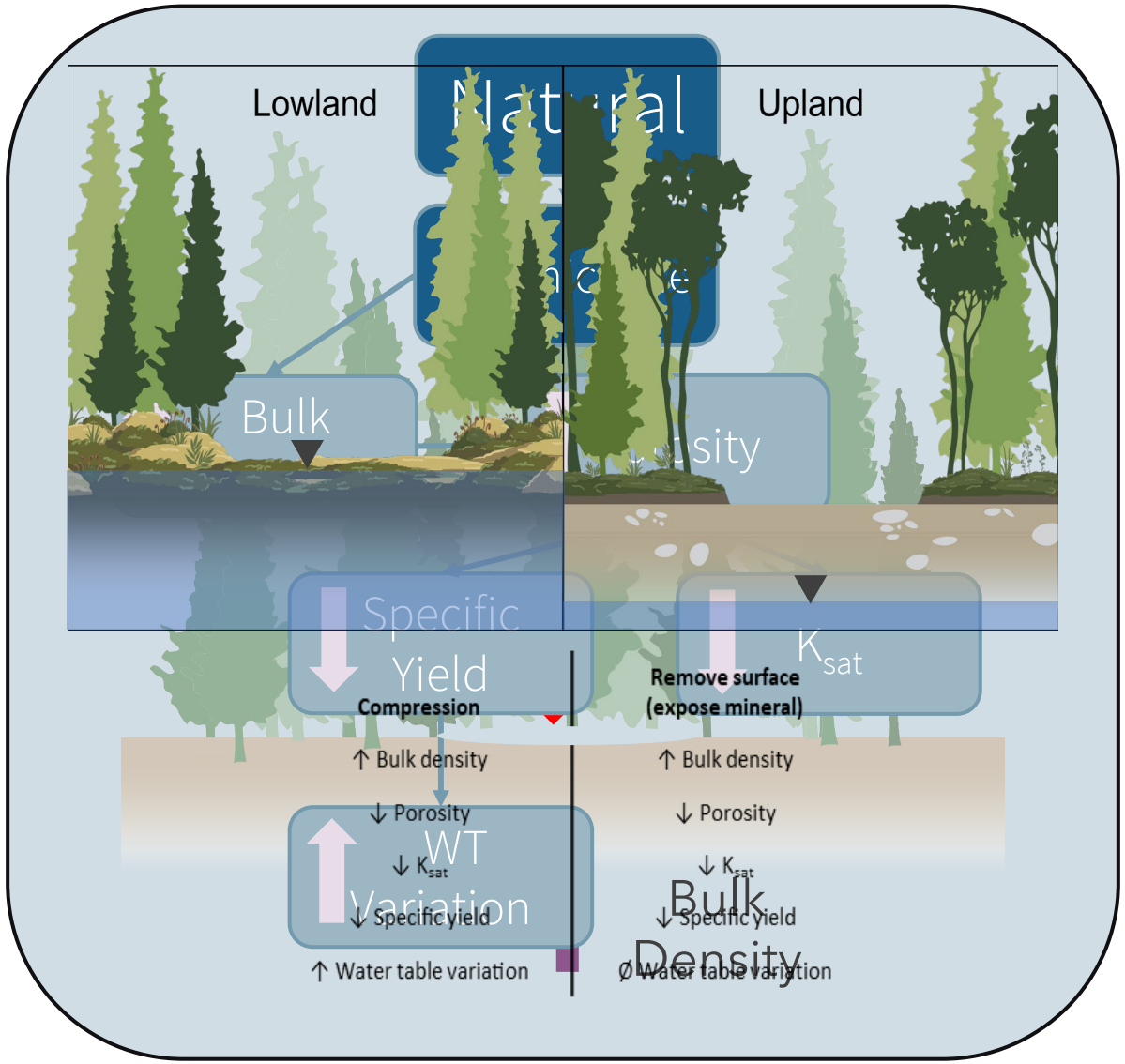


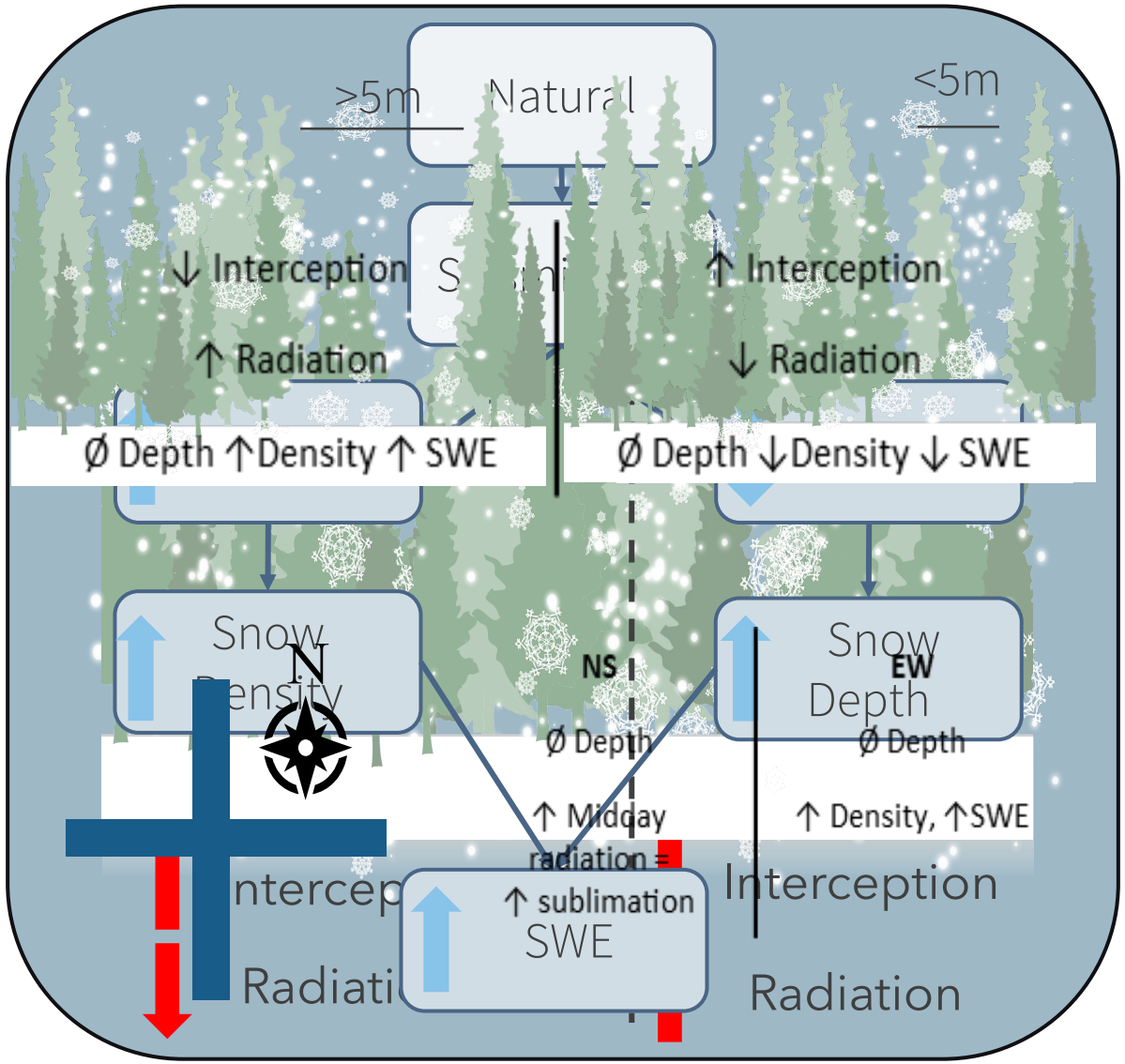


WT trends inconsistent
Same ecosite type – varying effects



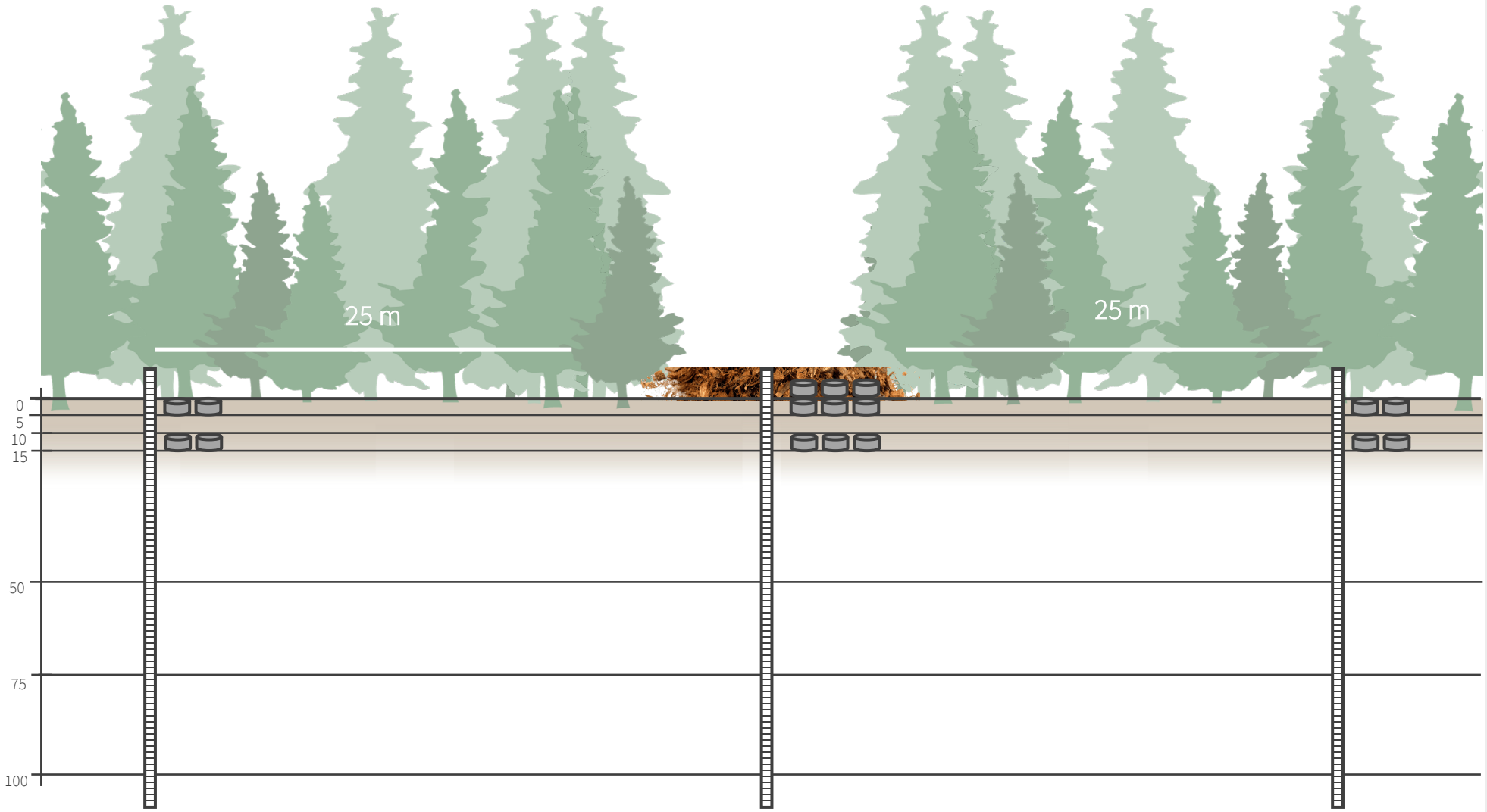



Lowland
Natural
Upland
Bulk
Specific
Yield
Compression
↑ Bulk density
↓ Porosity
↓ K_{sat}
↓ Specific yield
↑ Water table variation
WT
Variation
K_{sat}
Remove surface
(expose mineral)
↑ Bulk density
↓ Porosity
↓ K_{sat}
↓ Specific yield
Bulk
Density


≥5m
Natural
<5m
↓ Interception
↑ Radiation
↑ Interception
↓ Radiation
Ø Depth ↑Density ↑ SWE
Ø Depth ↓Density ↓ SWE
Snow Density
N
NS
EW
Snow Depth
Ø Depth
Ø Depth
↑ Midday radiation =
↑ Density, ↑SWE
↑ sublimation
SWE
Interception
Radiation
Radiation

1 Soils

2 Hydrology



Low Impact

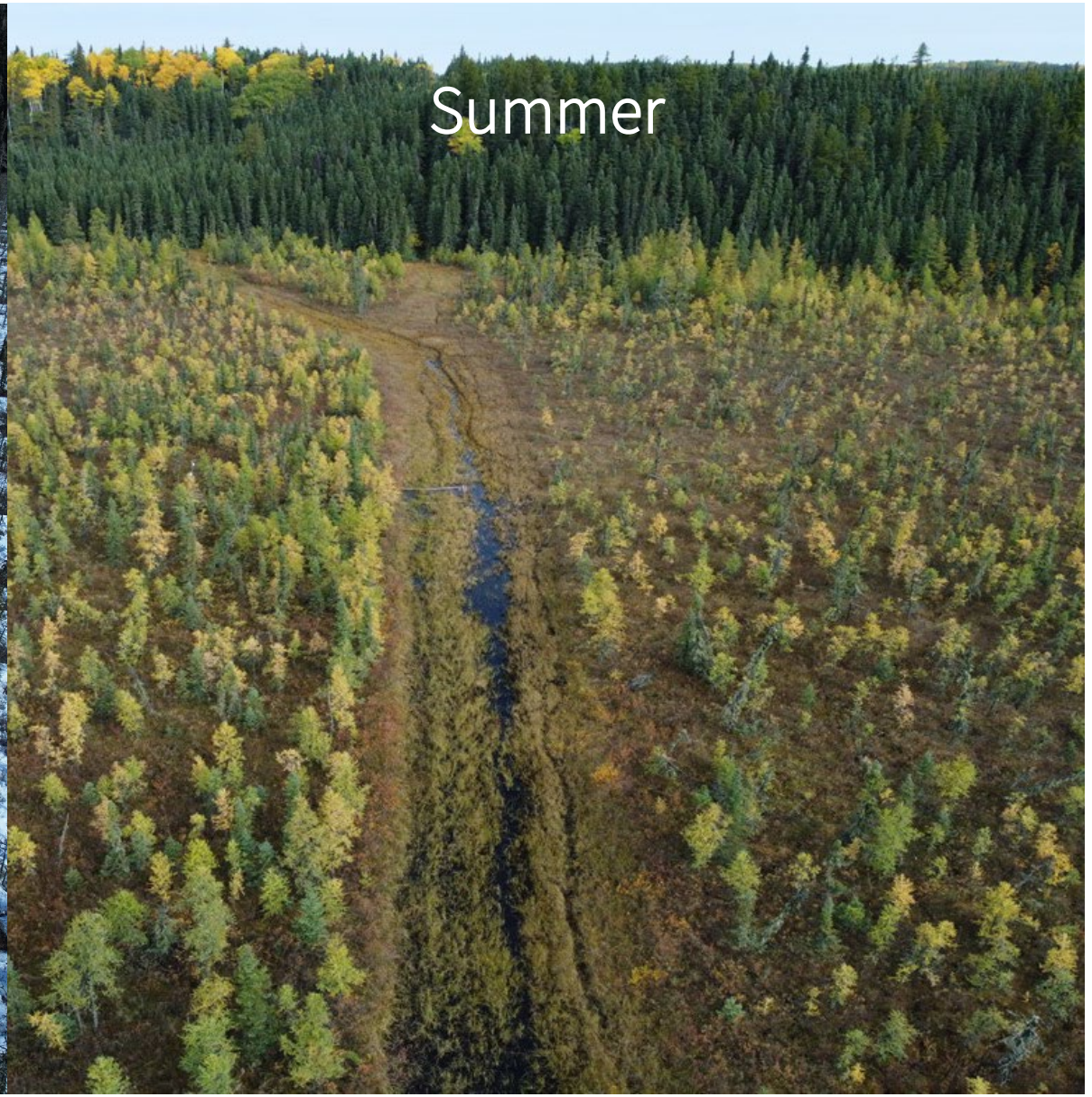
3 wells

Soil Samples at each well

Triplicate at center (Mulch, 0-5 & 10-15)

Duplicate in natural (0-5 & 10-15)


Winter


Summer

Management Implications

Where to avoid seismic lines?

- Wetlands
- EW oriented

How to restore seismic lines?

- Consider local topography
- Passive restoration

Future Studies

Hydrologic processes affected by seismic lines

- Runoff spring freshet

Relate hydrologic properties to seedling growth potential

Produce remote sensing tools to increase sample size and spatial scale