



# Permafrost Science Workshop

## Permafrost Modelling in the Mackenzie Valley

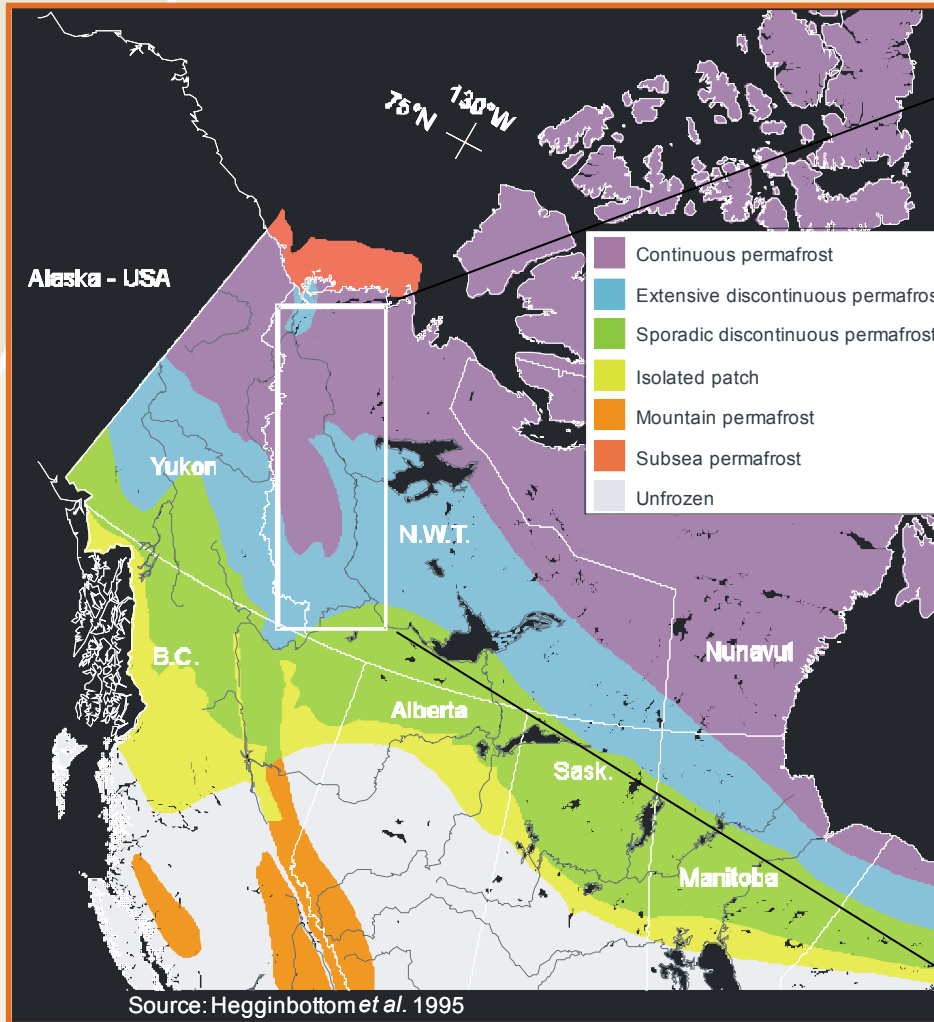
*Presenter:* Caroline Duchesne

*Contributors:* M. Ednie, F. Wright,  
M. Côté, D. Riseborough

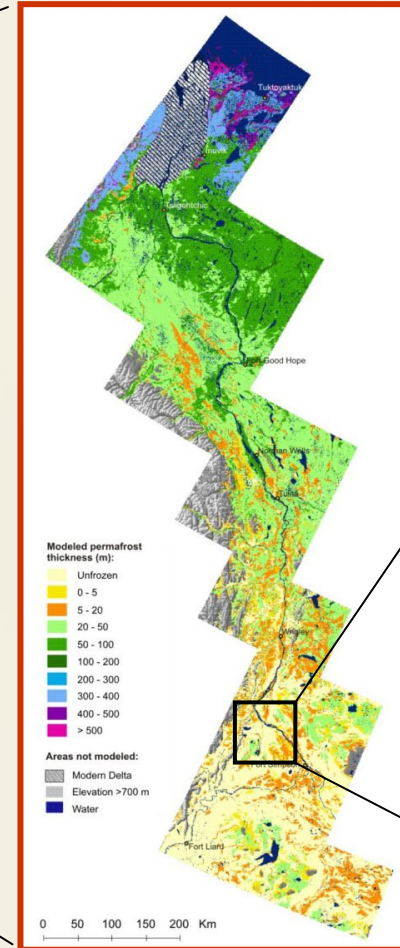
**Workshop on State of the Science at ESS**



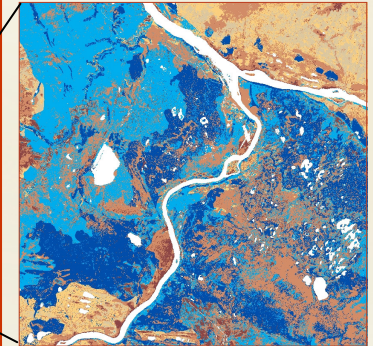
# Purpose: Permafrost distribution at different scales



Policy: 1 km model



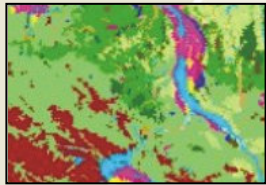
Planning: 30 m model





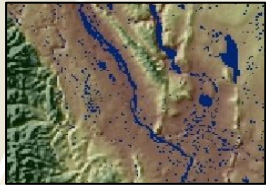
# Method: T-ONE finite element model

## Surficial materials



Bulk density  
Mineralogy  
Texture  
Derived Kf and Kt  
Heat capacity

## Topography - DEM



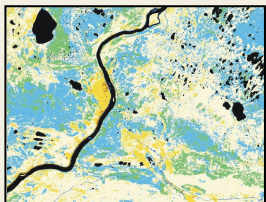
Slope and aspect:  
Derived potential  
insolation index

## Vegetation cover



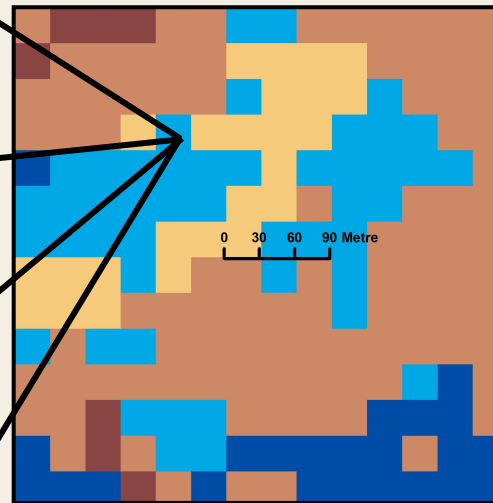
Soil moisture level  
Thawing N-Factor  
Freezing N-factor  
*(snow cover implicit  
in freezing N-factor)*

## Climate

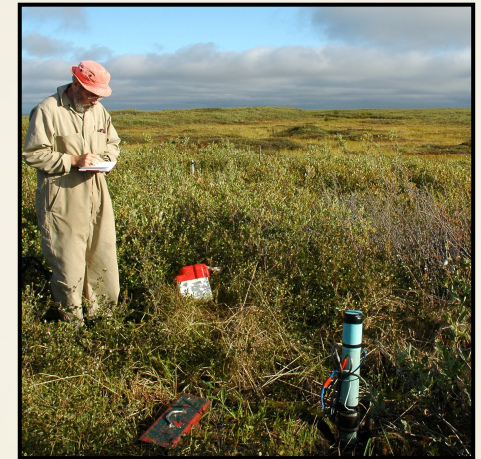


Mean Annual Air  
Temperature  
Amplitude

## Unique condition grid

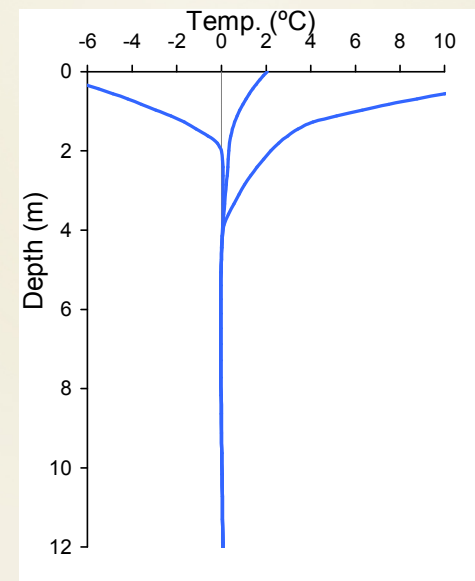
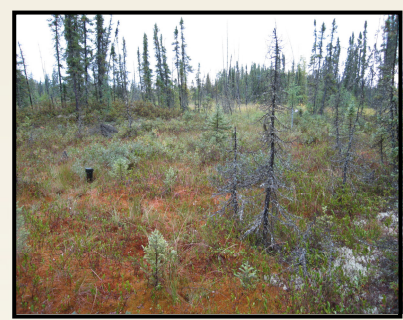
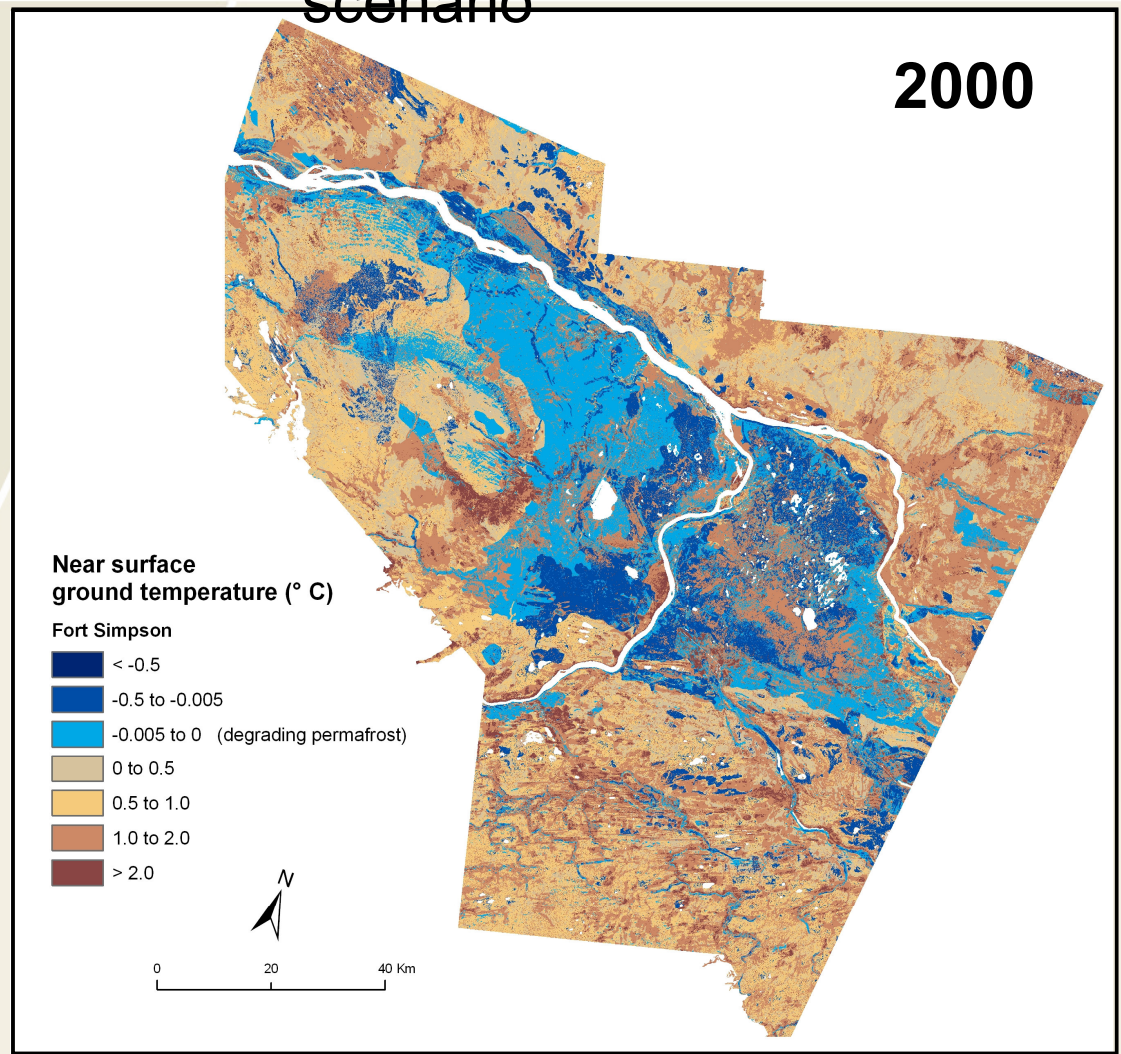


## Calibration / Validation





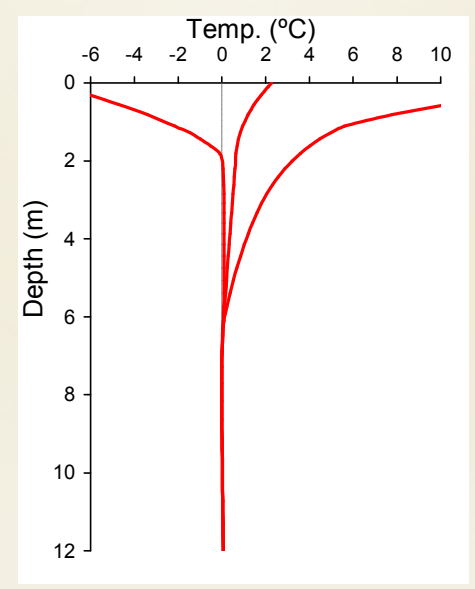
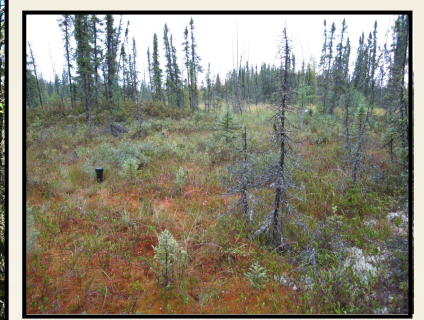
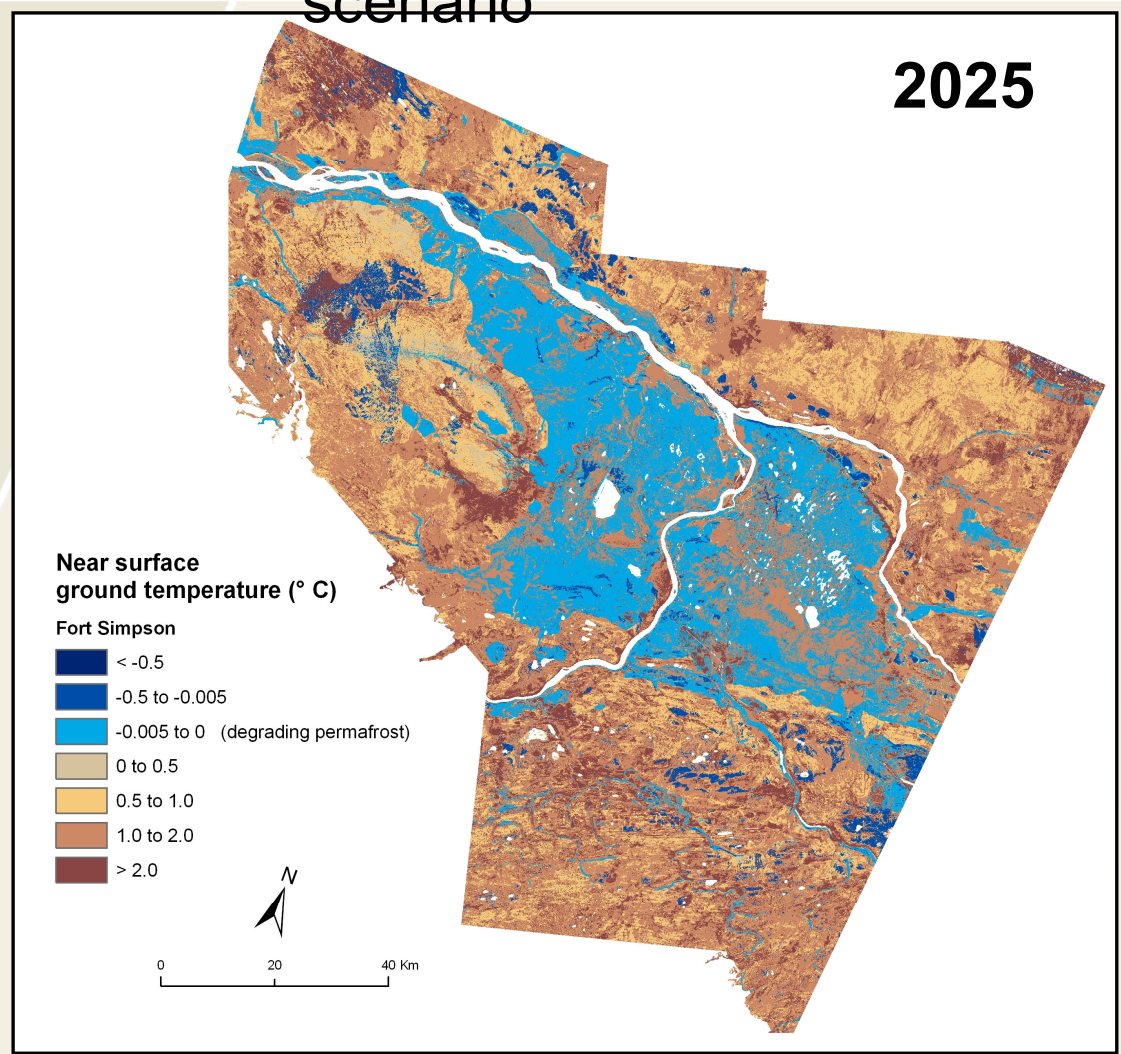
# Application: Modeled permafrost distribution and climate warming scenario





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2025



Natural Resources Canada

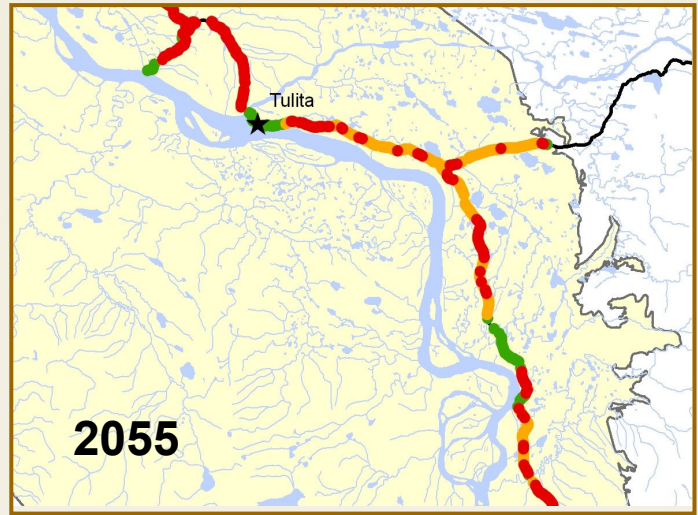
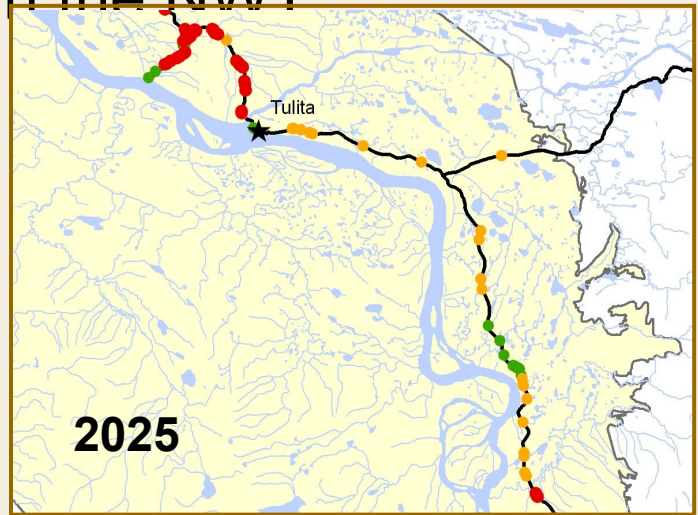
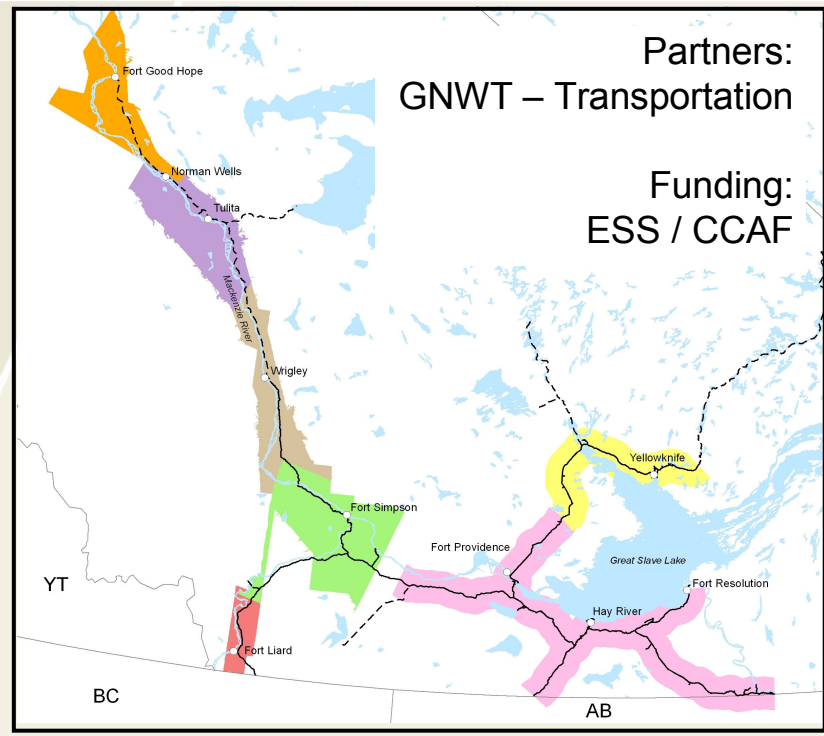
Ressources naturelles Canada





# Activities: Permafrost modeling and road

## study in the NWT



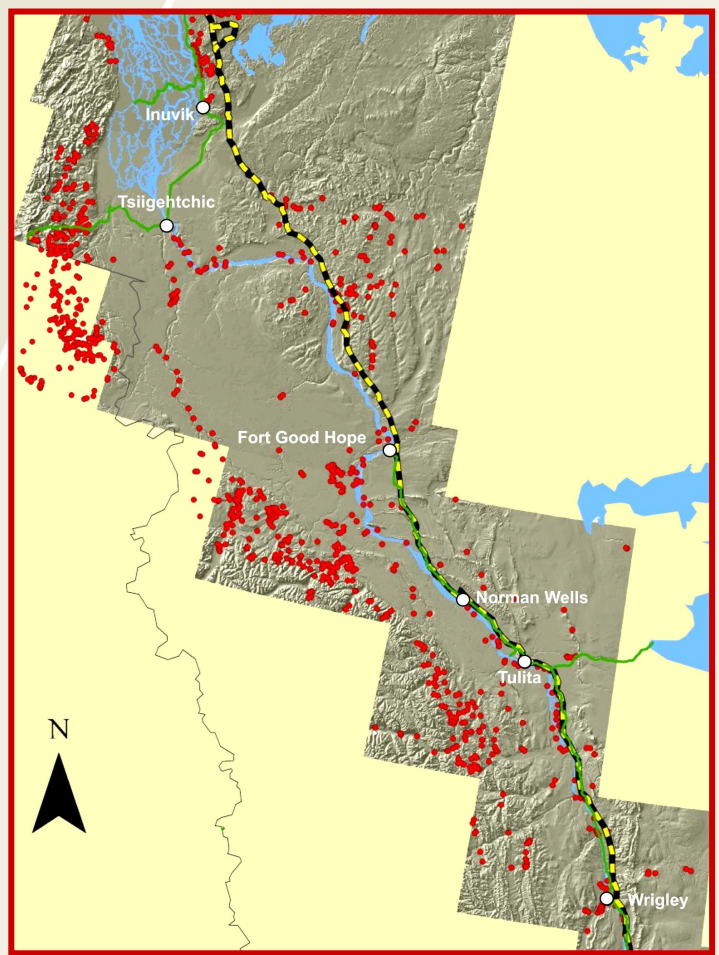
**Predicted change in thaw depth:**

- > 1 m coarse sediment
- 1 to 2 m fine/organic sediment
- > 2 m fine/organic sediment



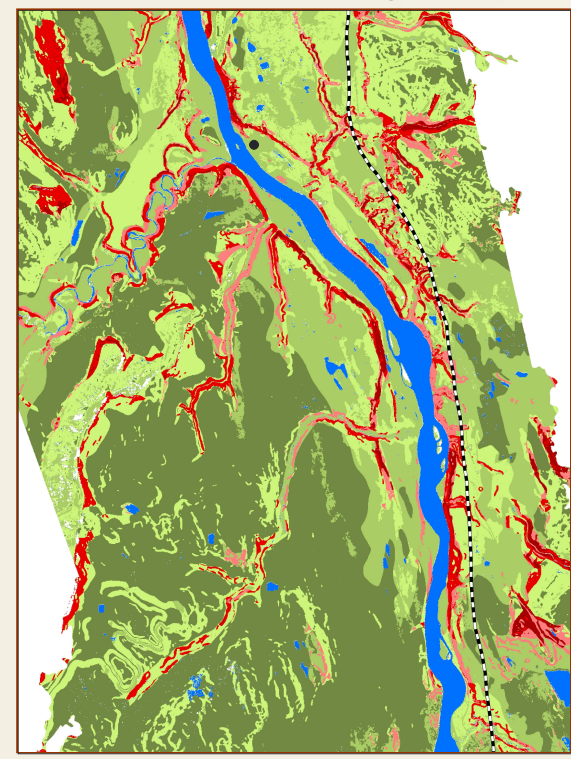
# Activities: Geo-statistical Analysis (Weight-of-Evidence)

## Landslide Occurrences



## Funding: PERD-pipeline

## Predictive Landslide Susceptibility



**Landslide type:**  
*Retrogressive thaw flow*

- Less susceptible
- Most susceptible

Proposed pipeline ROW

Pipeline ROW



## Scientific Gaps: Data and Processes

- Up to date forest fire distribution
- Vegetation classification for tundra region (Delta)
- Ground disturbance distribution (landslide, subsidence)
- Snow cover at various scale
- Location and persistence of air temperature inversion
- Soil moisture and ground ice information (small scale)
- Surface organic layer: thickness and thermal properties







## Publications

Duchesne, C., J.F. Wright, and M. Ednie (2008) High-Resolution Numerical Modeling of Climate Change Impacts to Permafrost in the Vicinities of Inuvik, Norman Wells, and Fort Simpson, NT, Canada. *9th International Conference on Permafrost*, Fairbanks, Alaska, June 29-July 3, 2008.

Ednie, M., J.F. Wright, and C. Duchesne (2008) Establishing Initial Conditions for Transient Ground Thermal Modeling in the Mackenzie Valley: A Paleo-Climatic Reconstruction Approach. *9th International Conference on Permafrost*, Fairbanks, Alaska, June 29-July 3, 2008.

Wright, J.F., Duchesne, C. and M.M. Côté. 2003. Regional-scale permafrost mapping using the TTOP ground temperature model, in *Proceeding of the 8th International Conference on Permafrost*, Zurich, Switzerland, 21 - 25 July 2003.

