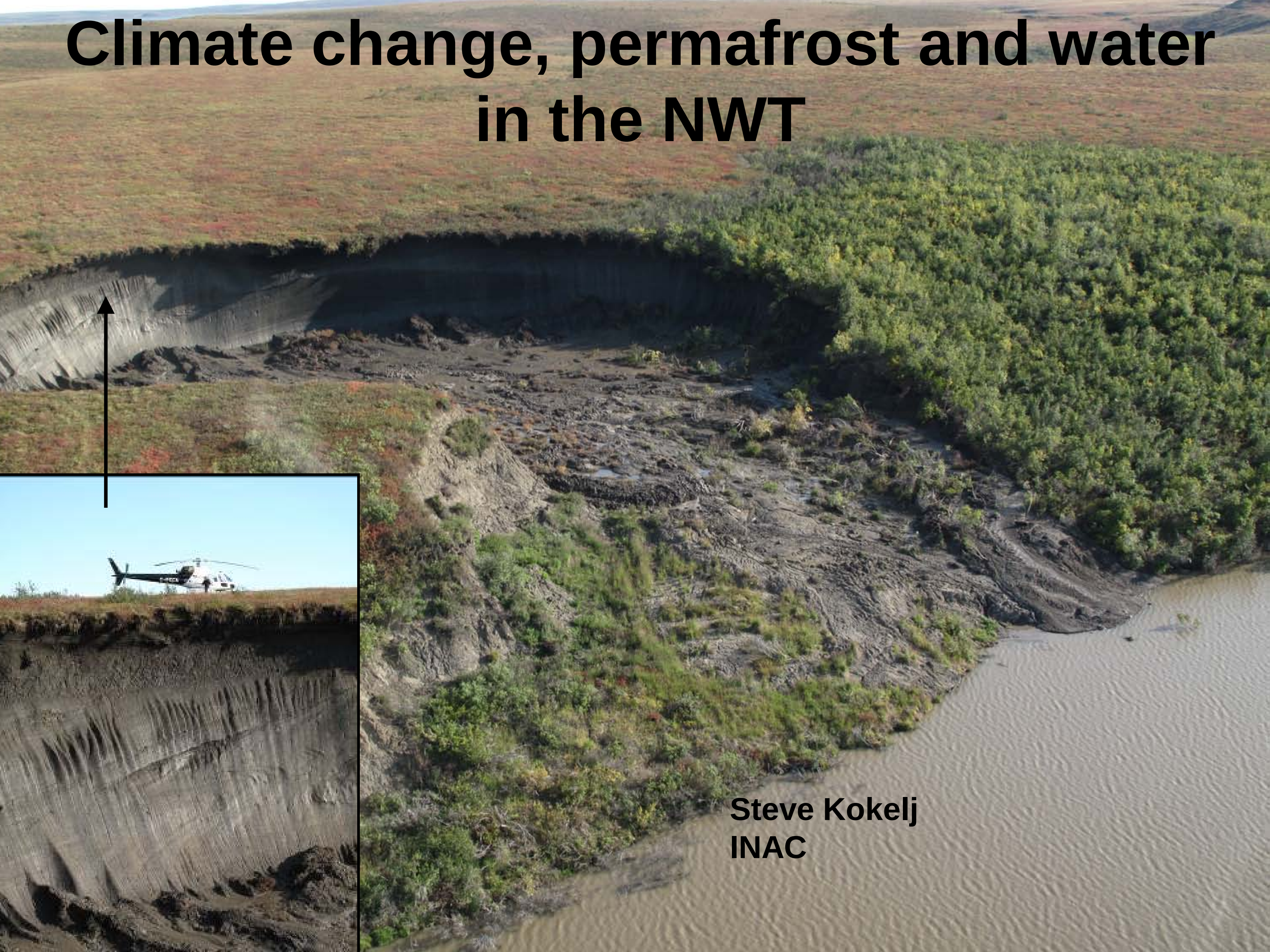

Climate change, permafrost and water
in the NWT
Steve Kokelj
INAC



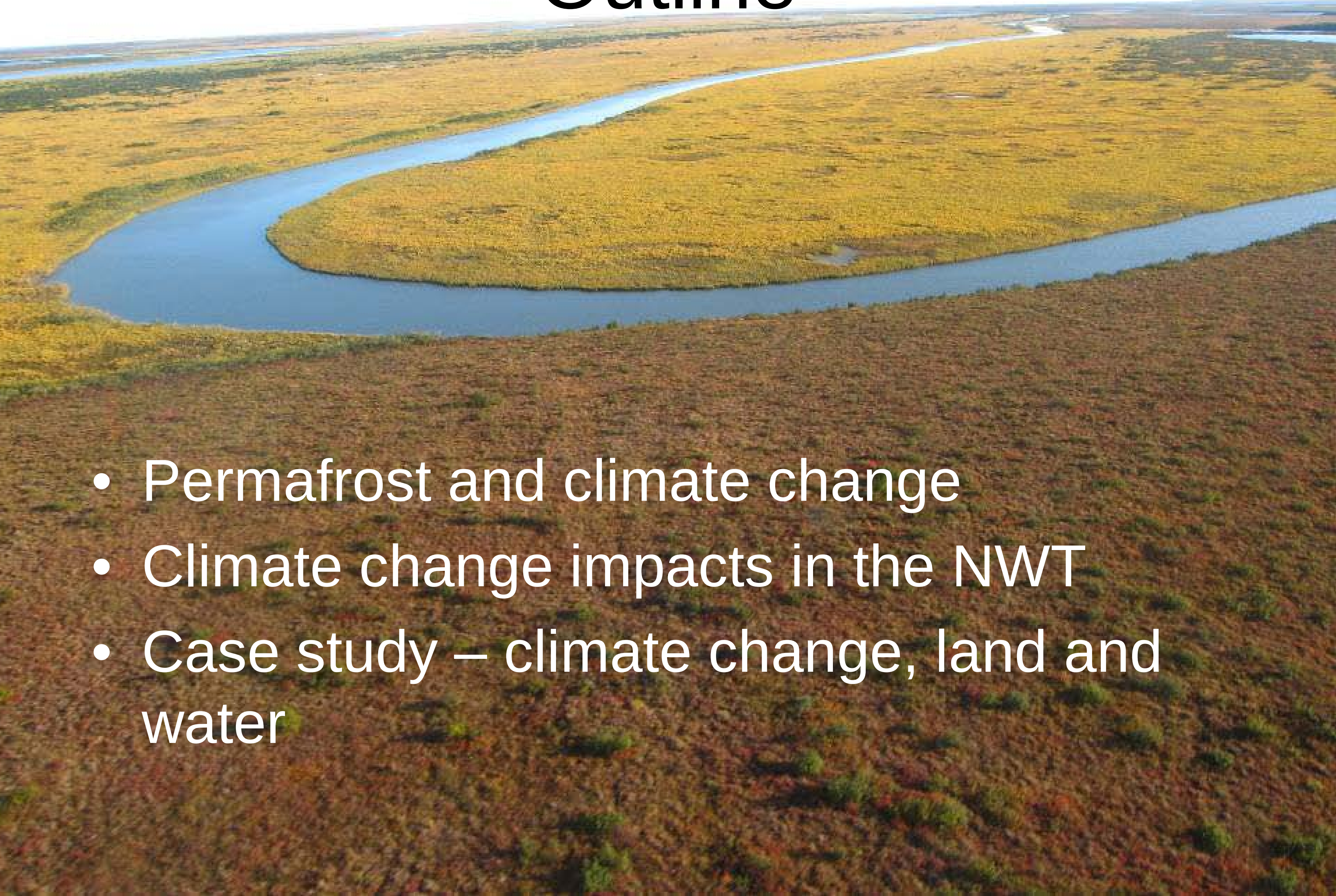
Steve Kokelj



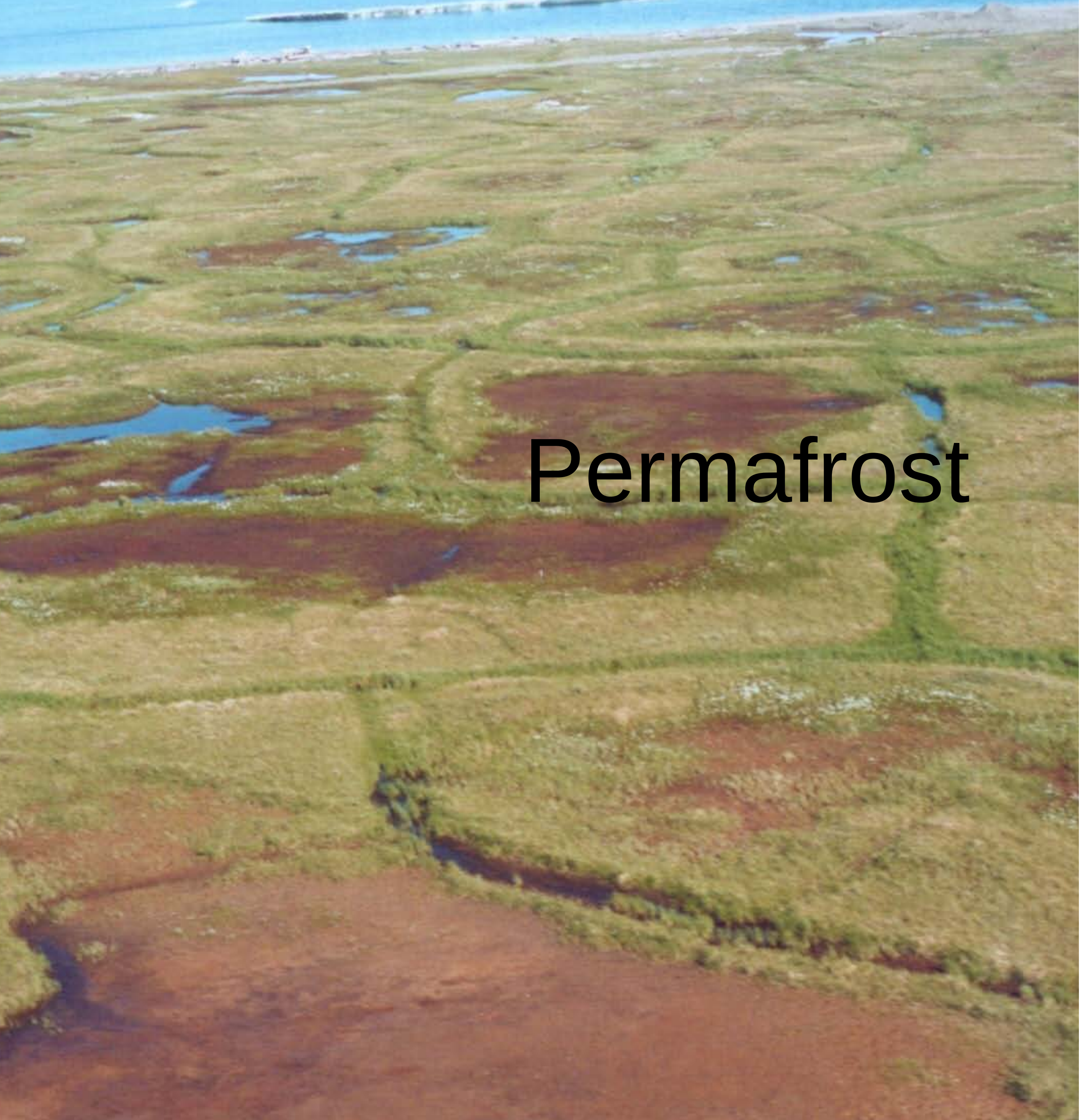
Indian and Northern
Affairs Canada

Carleton
UNIVERSITY

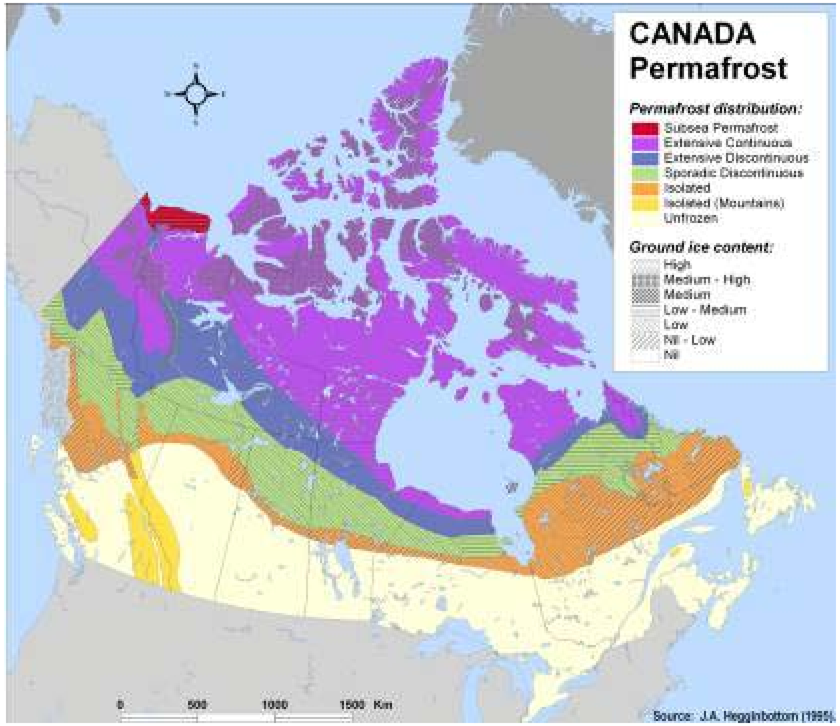
Outline



- Permafrost and climate change
- Climate change impacts in the NWT
- Case study – climate change, land and water

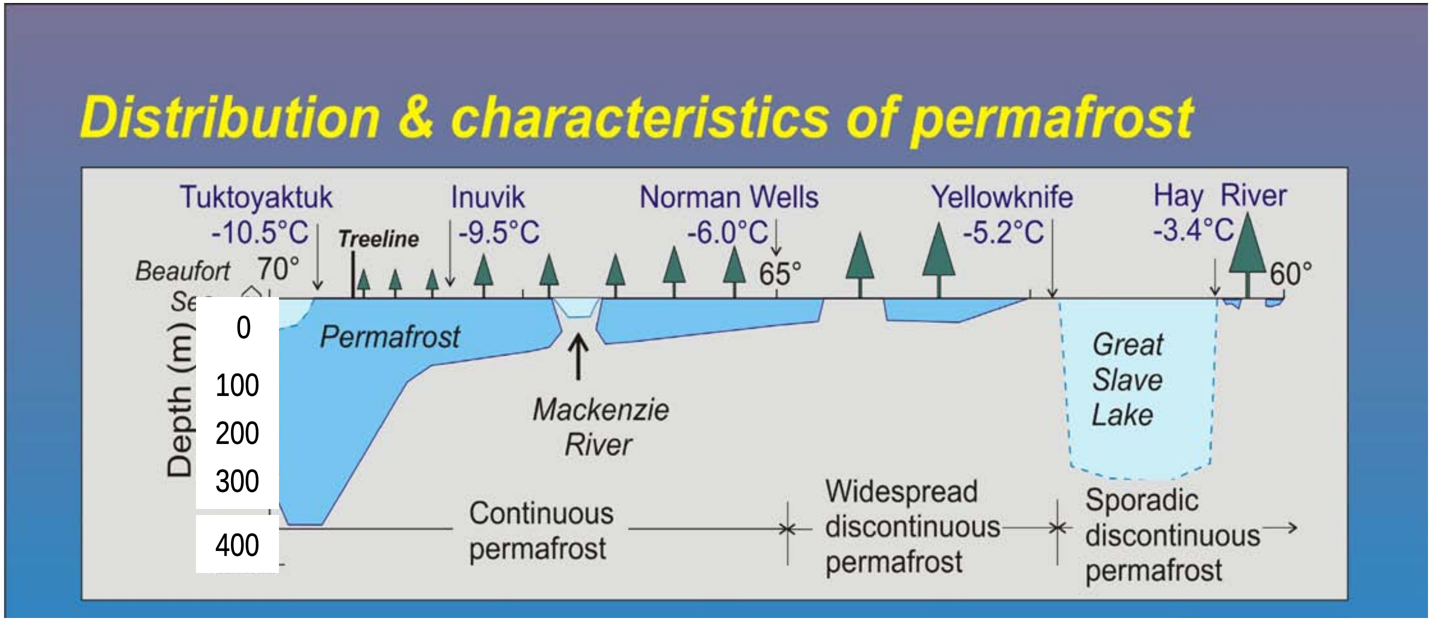

Permafrost

Permafrost is a defining feature of high latitudes

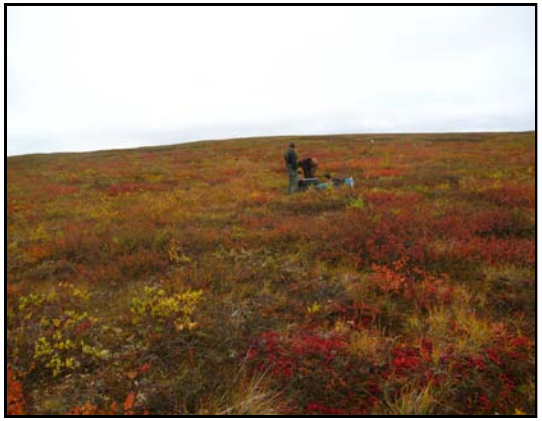


ACIA

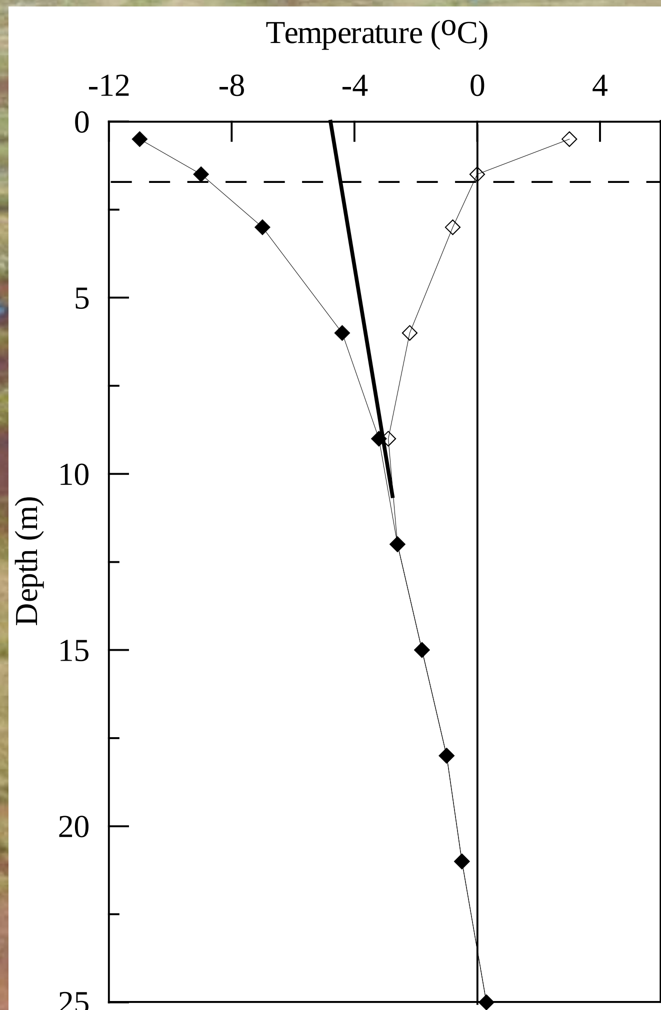
Permafrost thickness



S. Wolfe

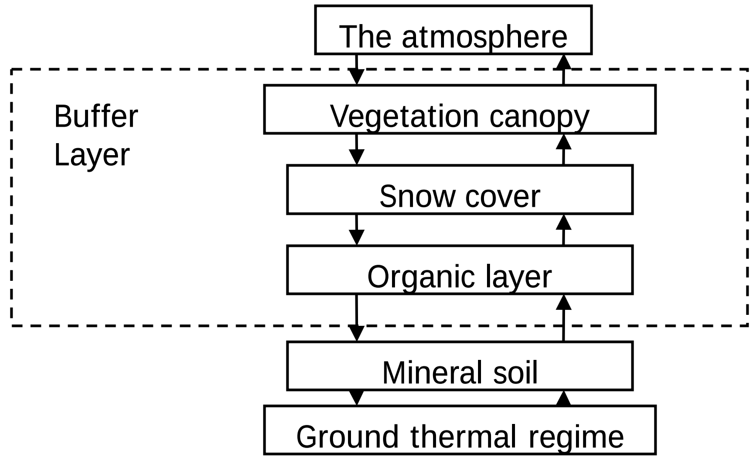


Ground temperature

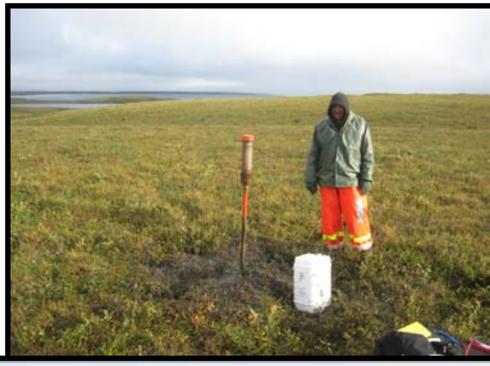


Tundra, Tuktoyaktuk

Buffer layer

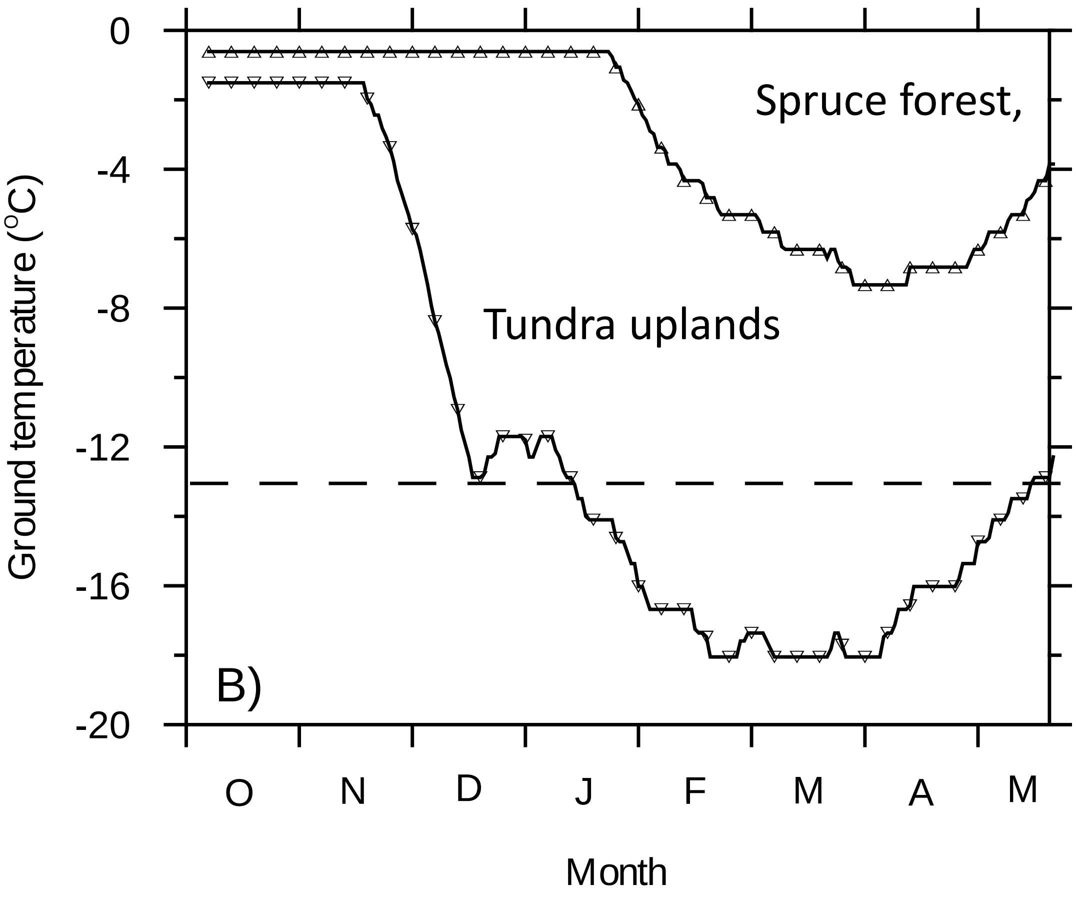


(Based on Luthin and Guymon, 1974)



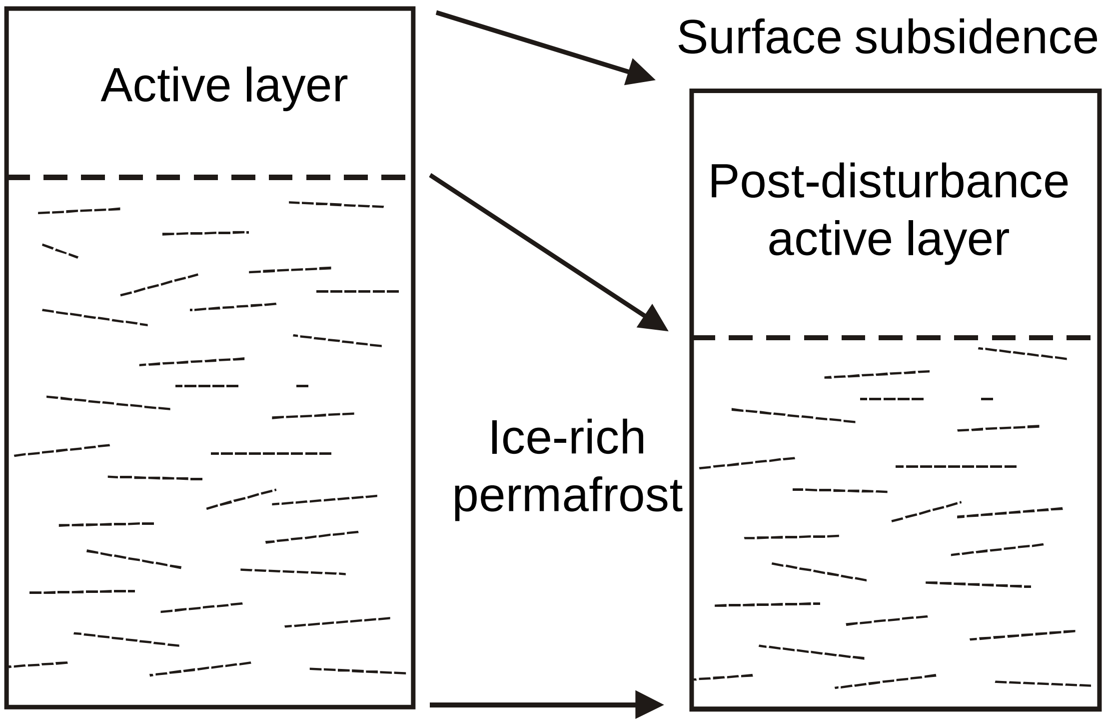
Subarctic boreal forest, Inuvik

Influence of vegetation and snow

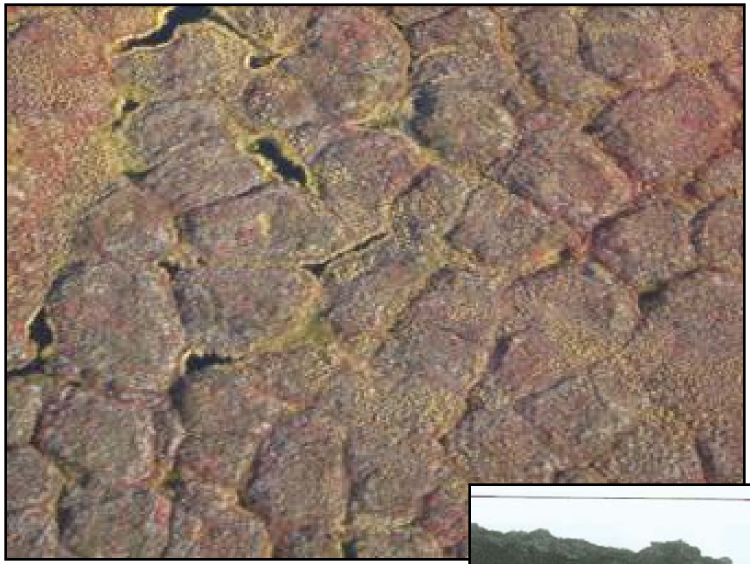


Ground ice

Active layer

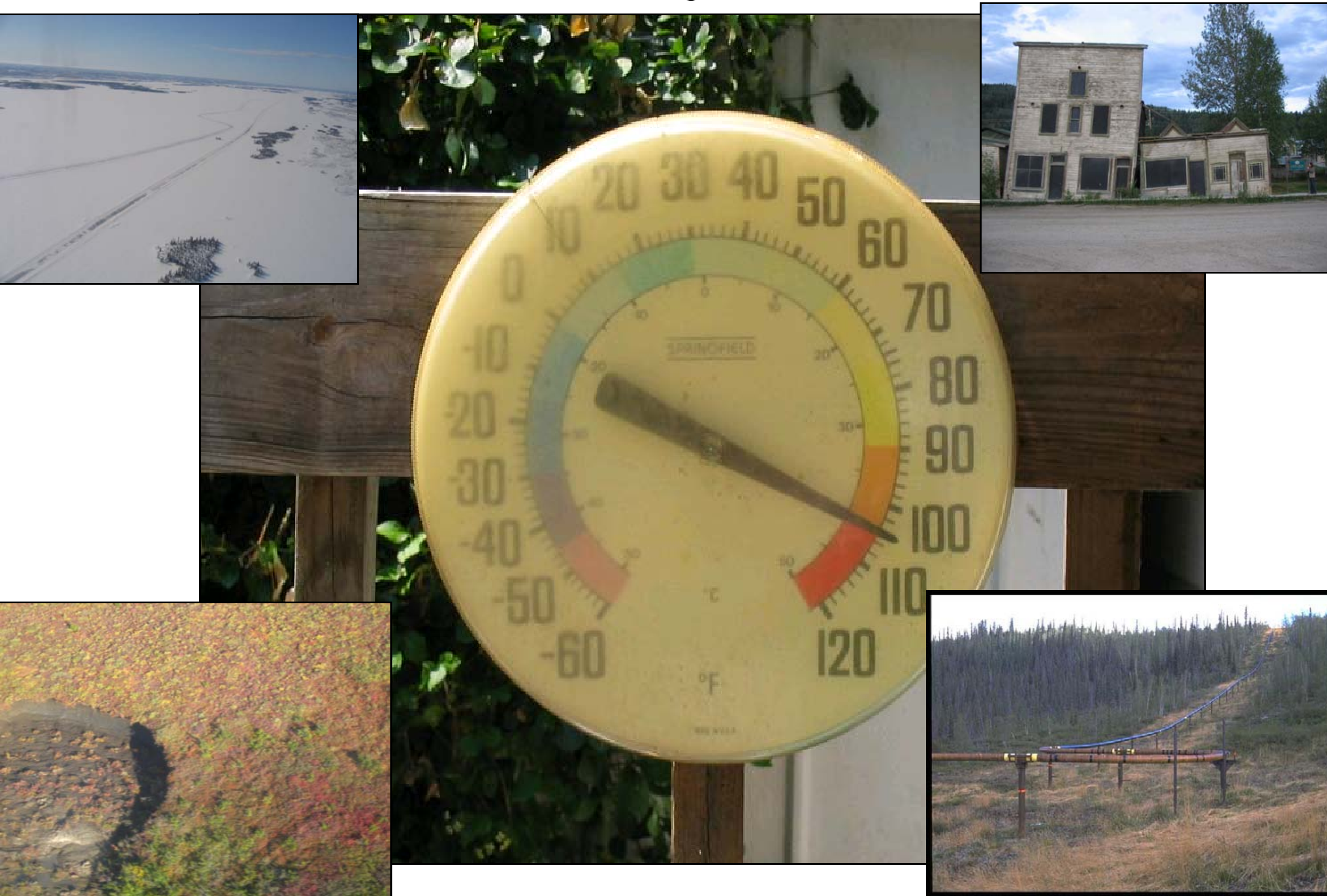


Permafrost gives rise to a unique landscape

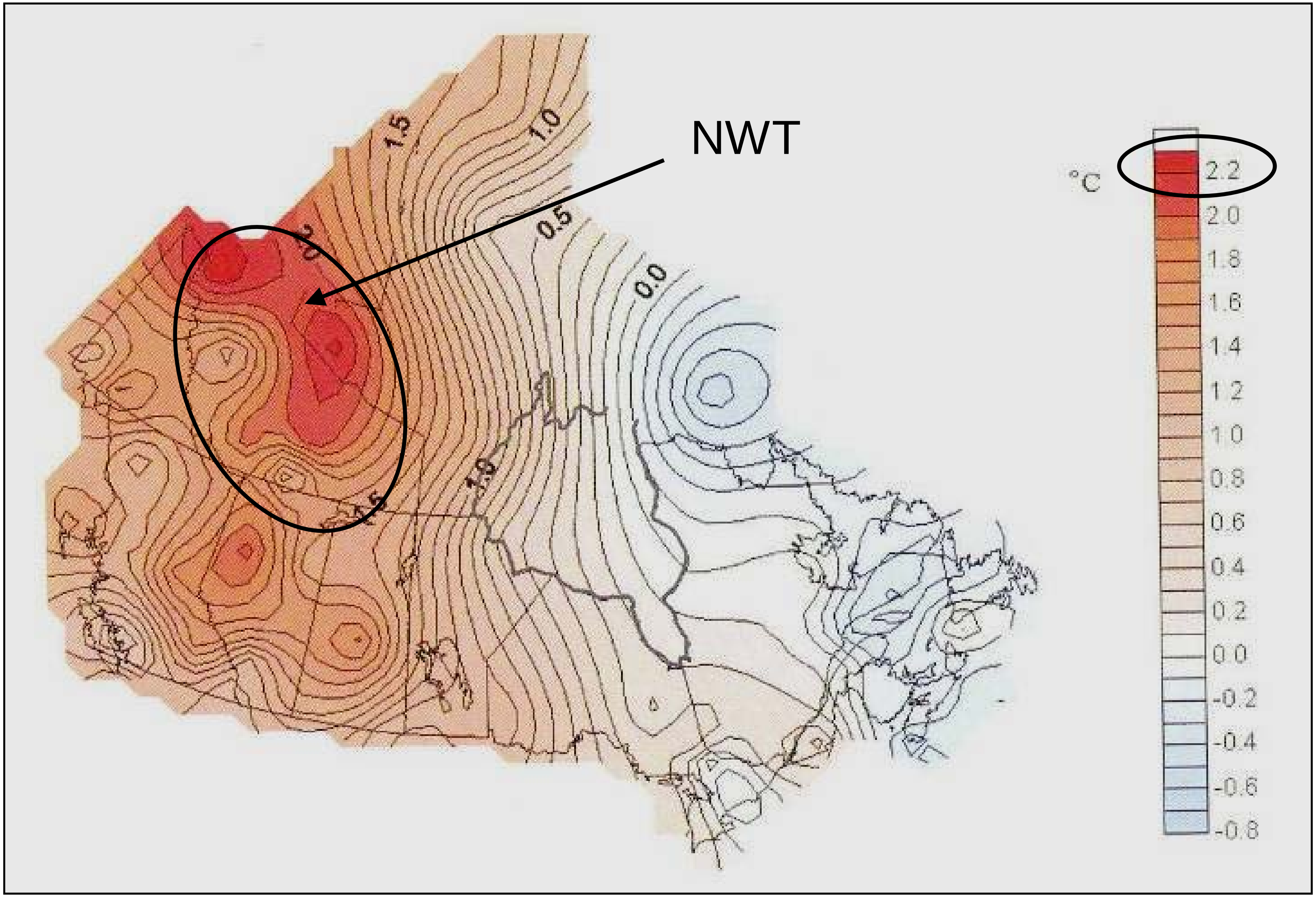


Impacts of thawing permafrost on aquatic systems are not well understood

Climate warming and the NWT

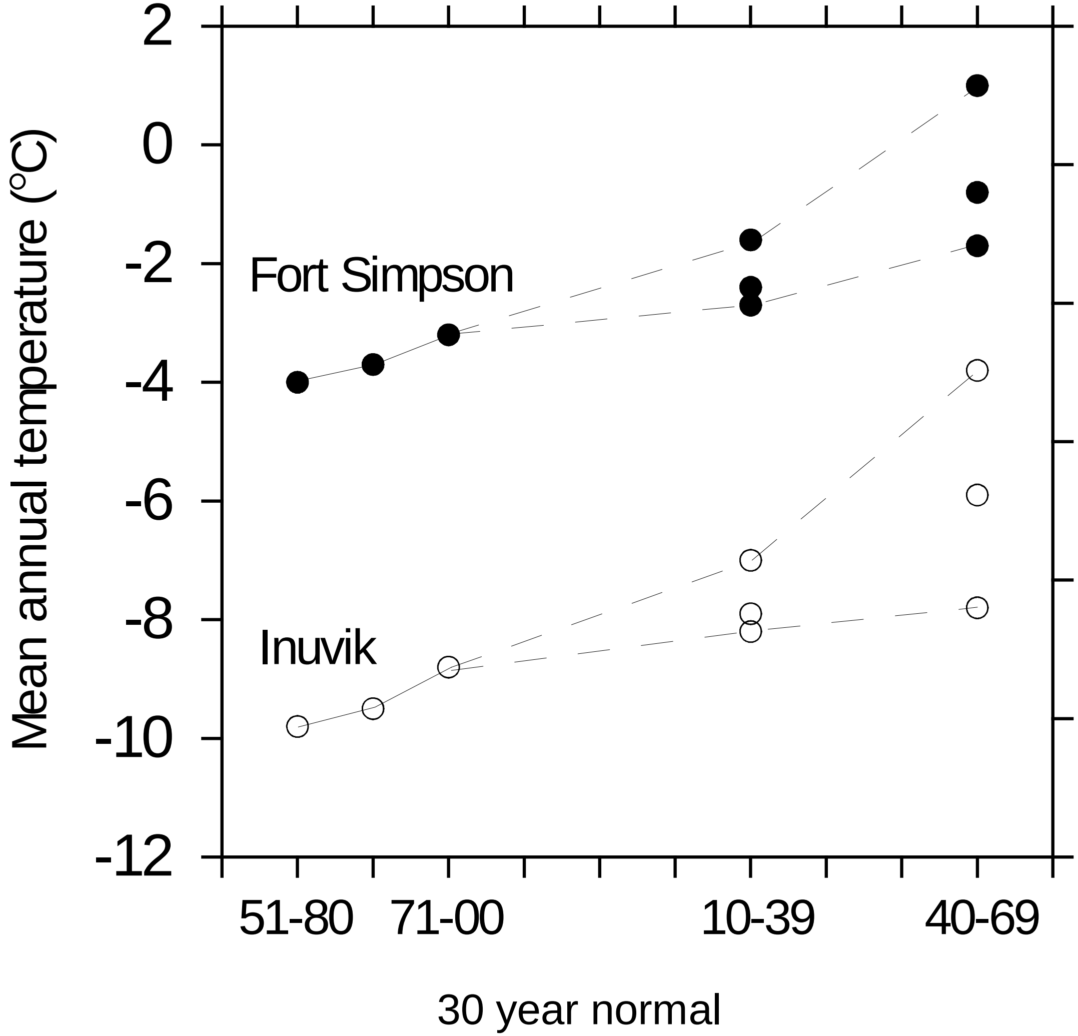


Observed changes in mean annual air temperature – 1948 to 2000



(Meteorological Service of Canada, Environment Canada – from Gunn et al. 2004)

Trends in the air temperature, Mackenzie Valley



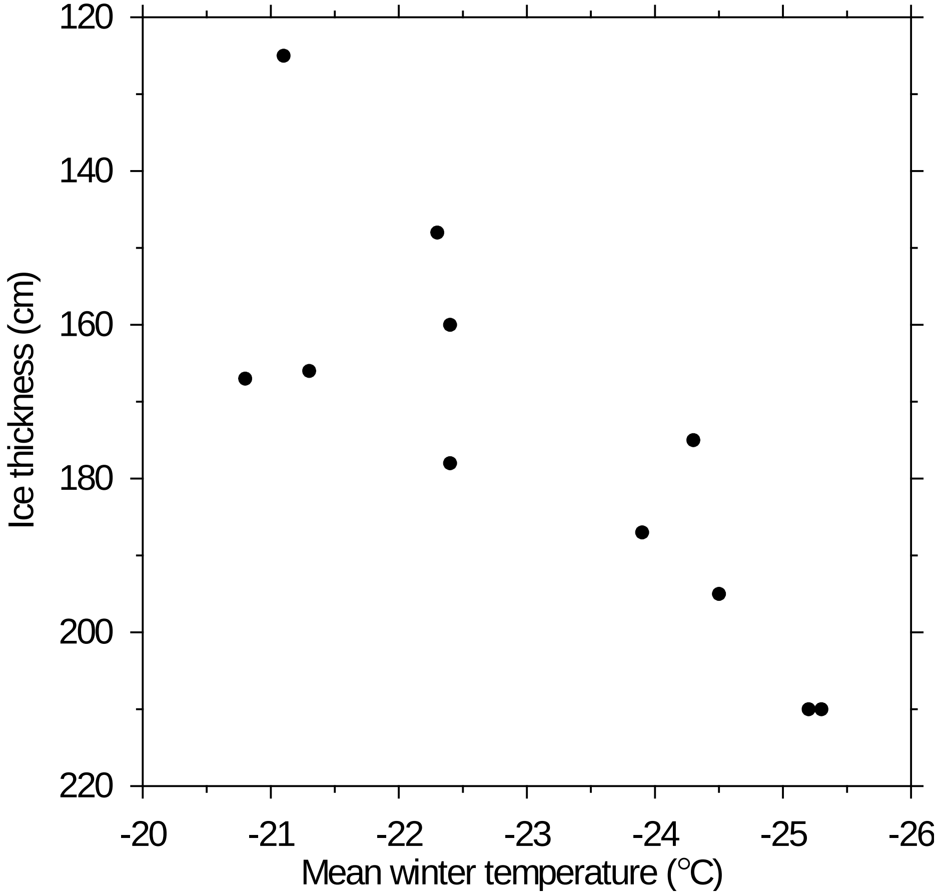
Burn et al., 2004


- Winter warming
- More rain and snow?

Impact on the winter operating season

Climate warming

Results - ice thickness



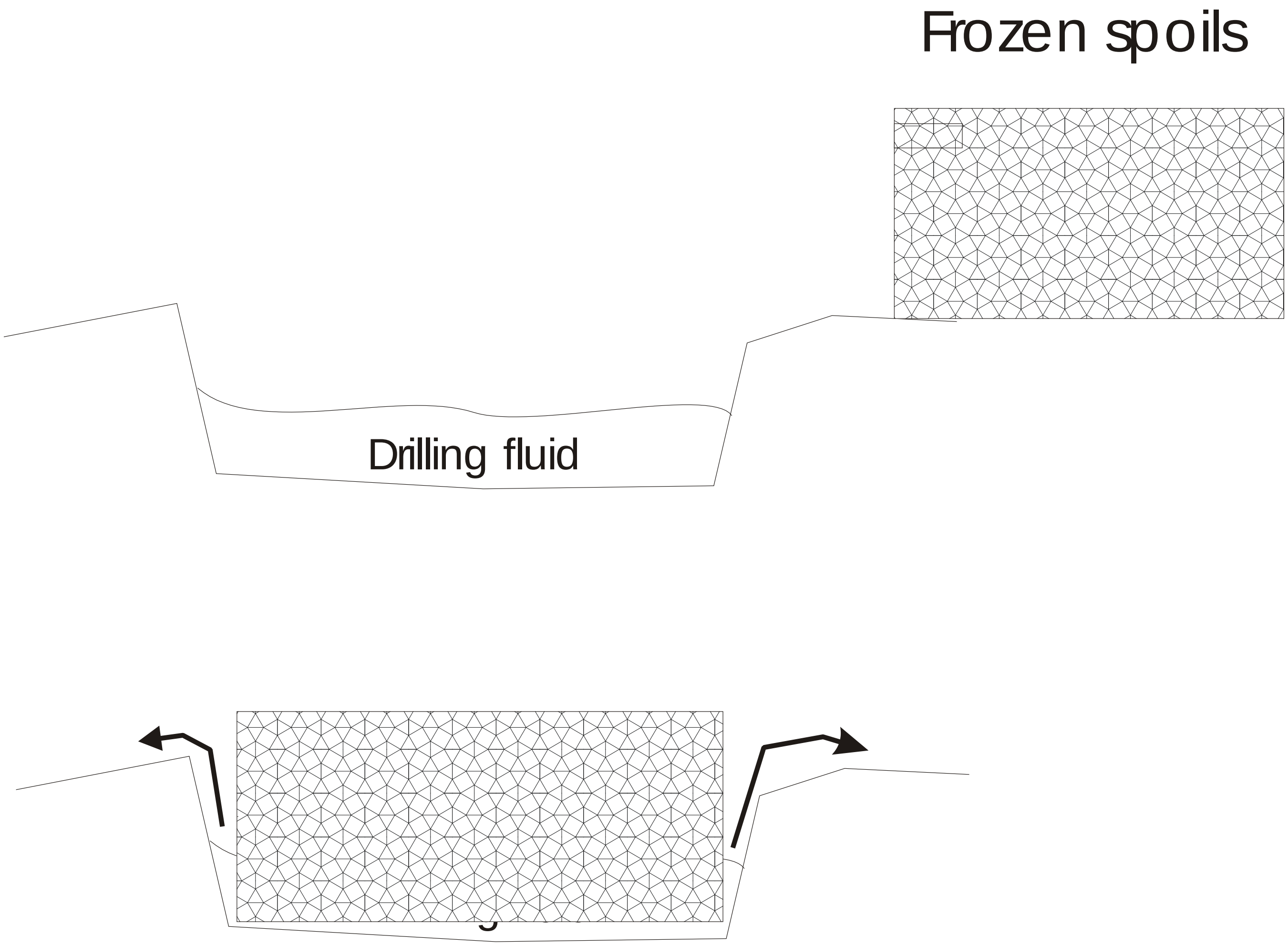
Todd Lake, 1992 - 2004

C.R. Burn

April 1 to 15, mean temperatures (1970-1979 and 1996-2005)

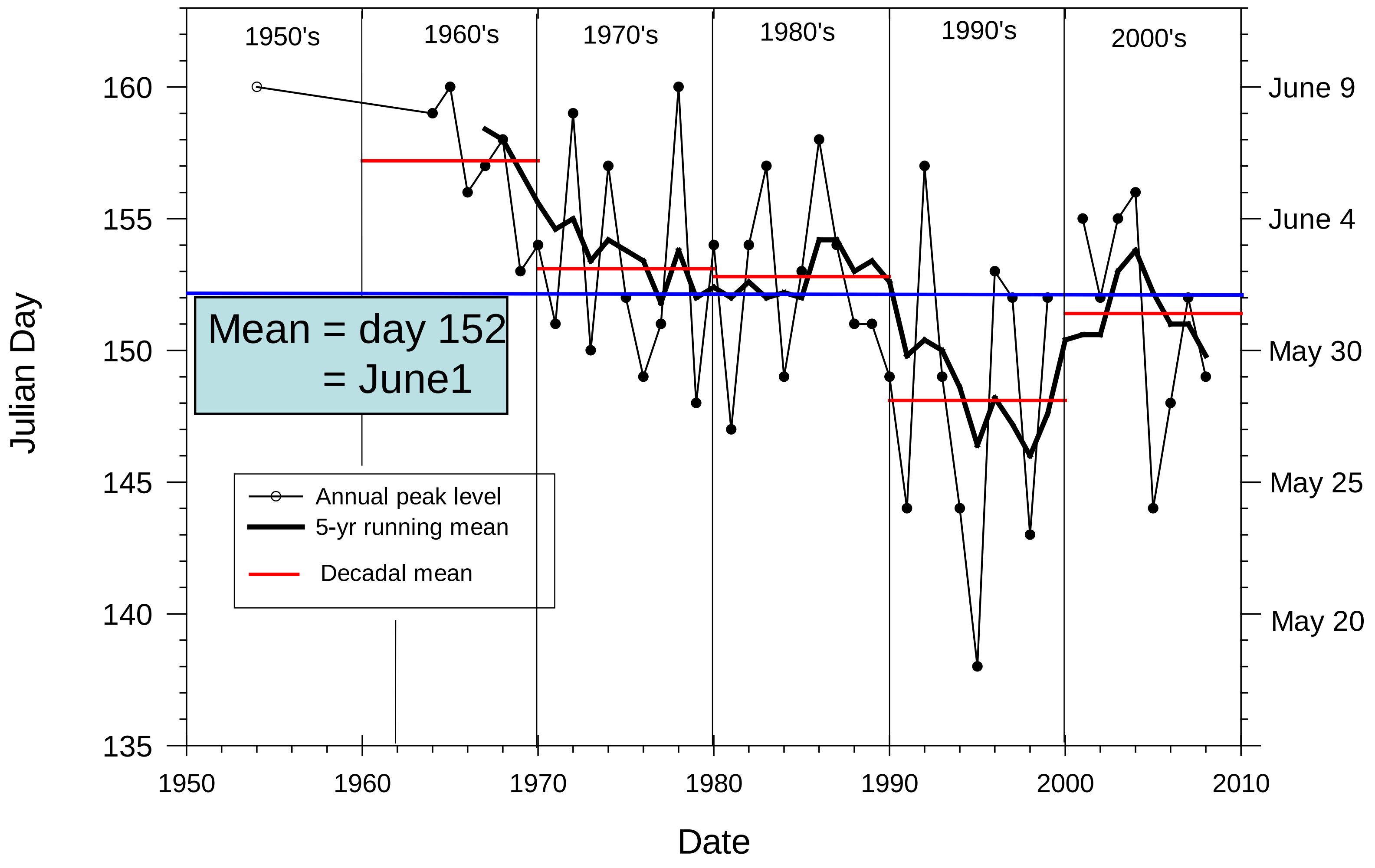
	1970-1979	1996-2005
Mean (N=10)	-18.3	-14.2
Warmest year	-11.1	**-2.7**
Coldest year	-24.4	-18.7

Backfilling a sump containing unfrozen fluids

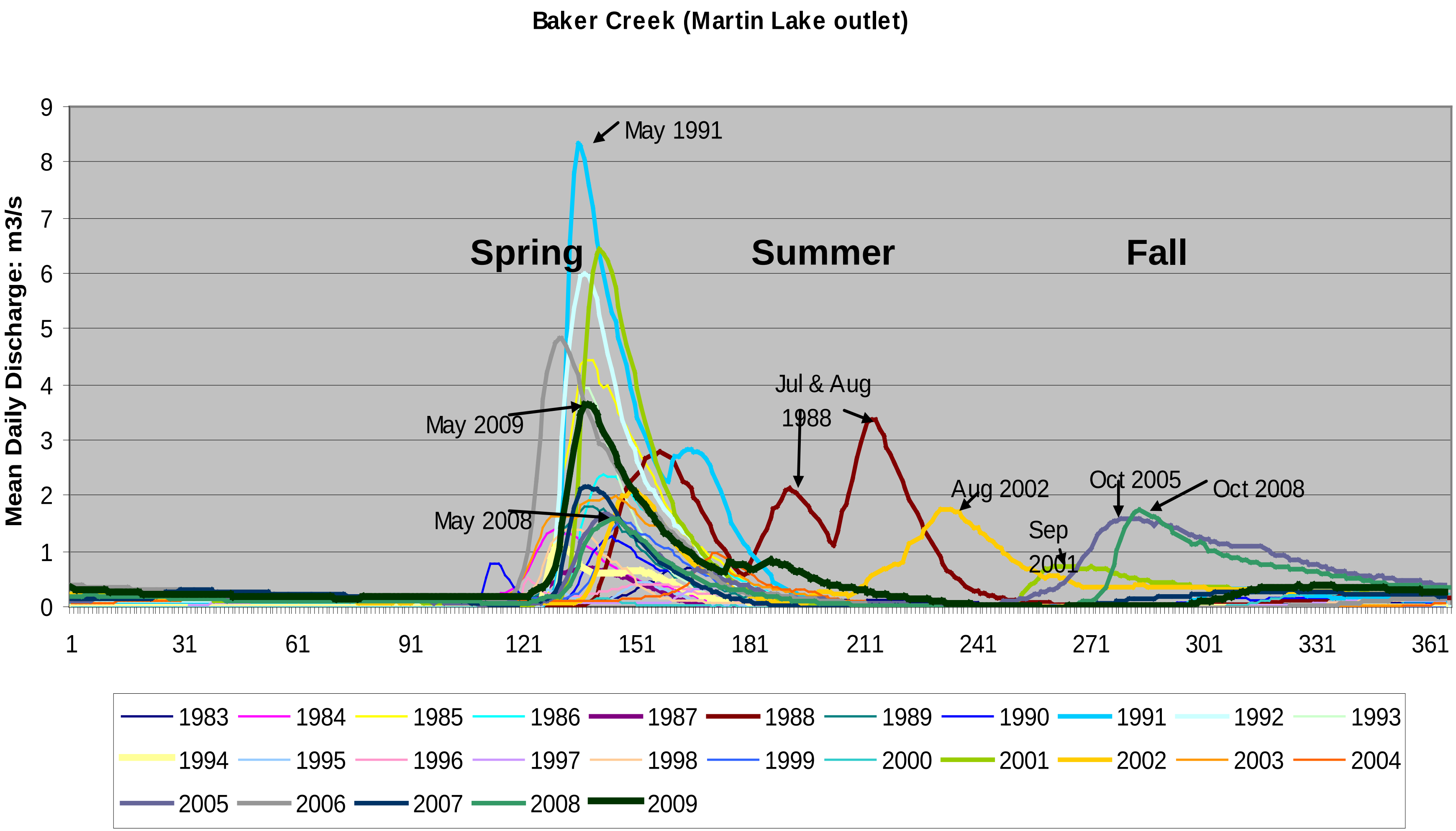


Climate change impacts

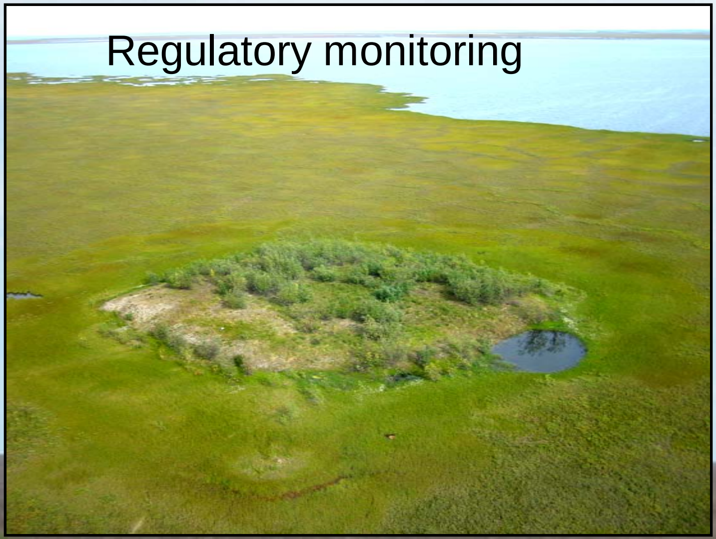
Breakup of rivers

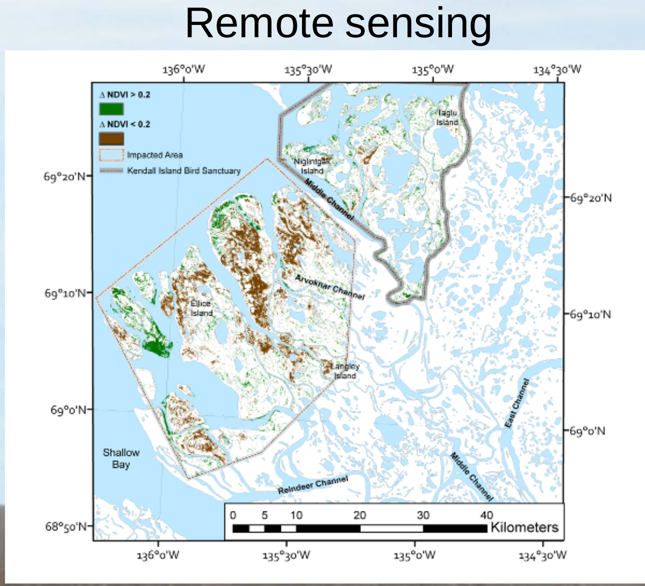


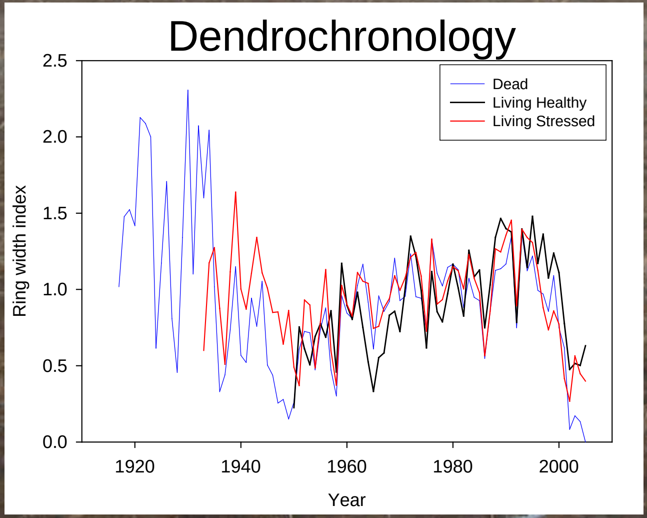
Changing stream flow



Storm surges and ecological change





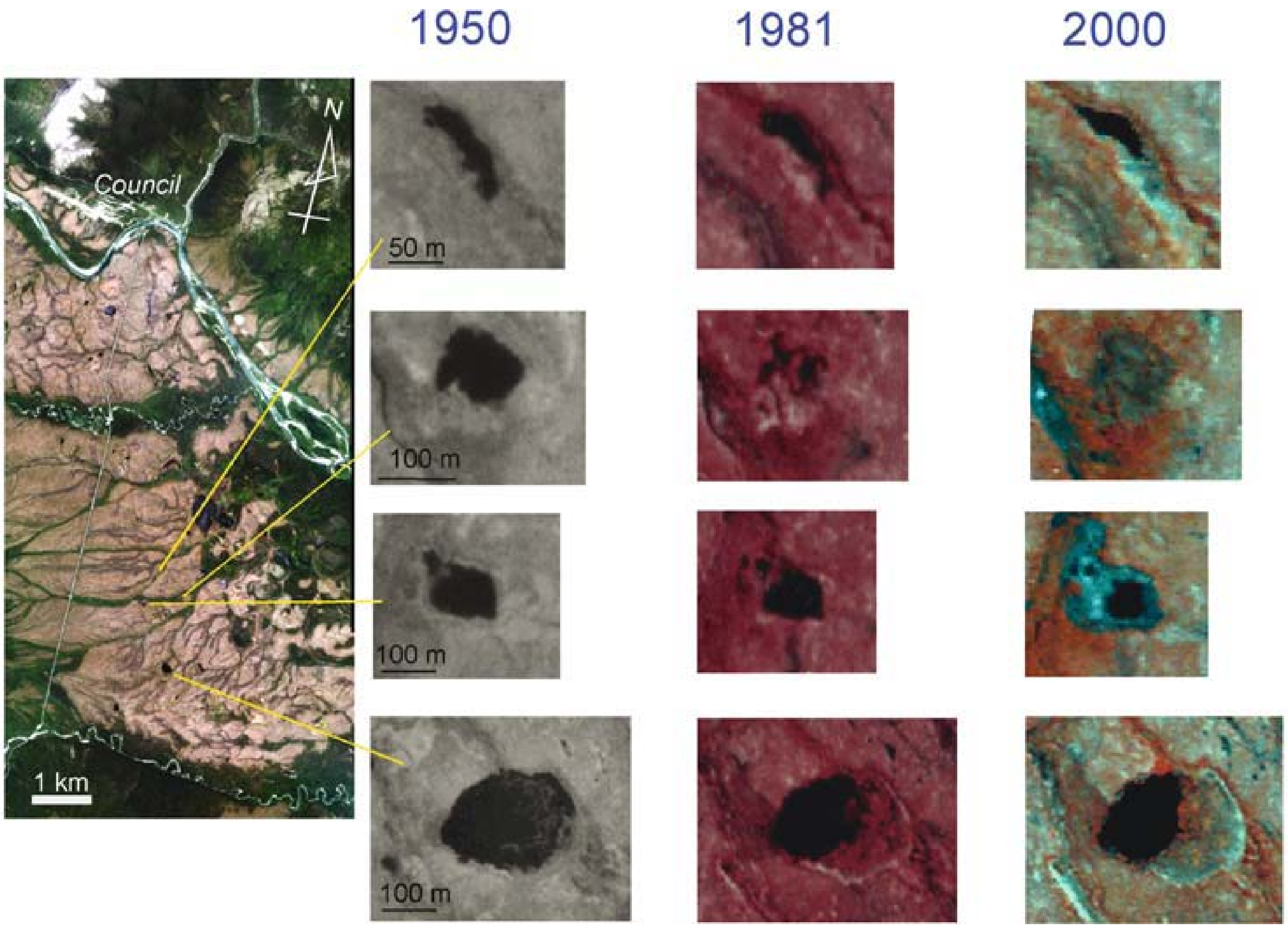


Hydrometric

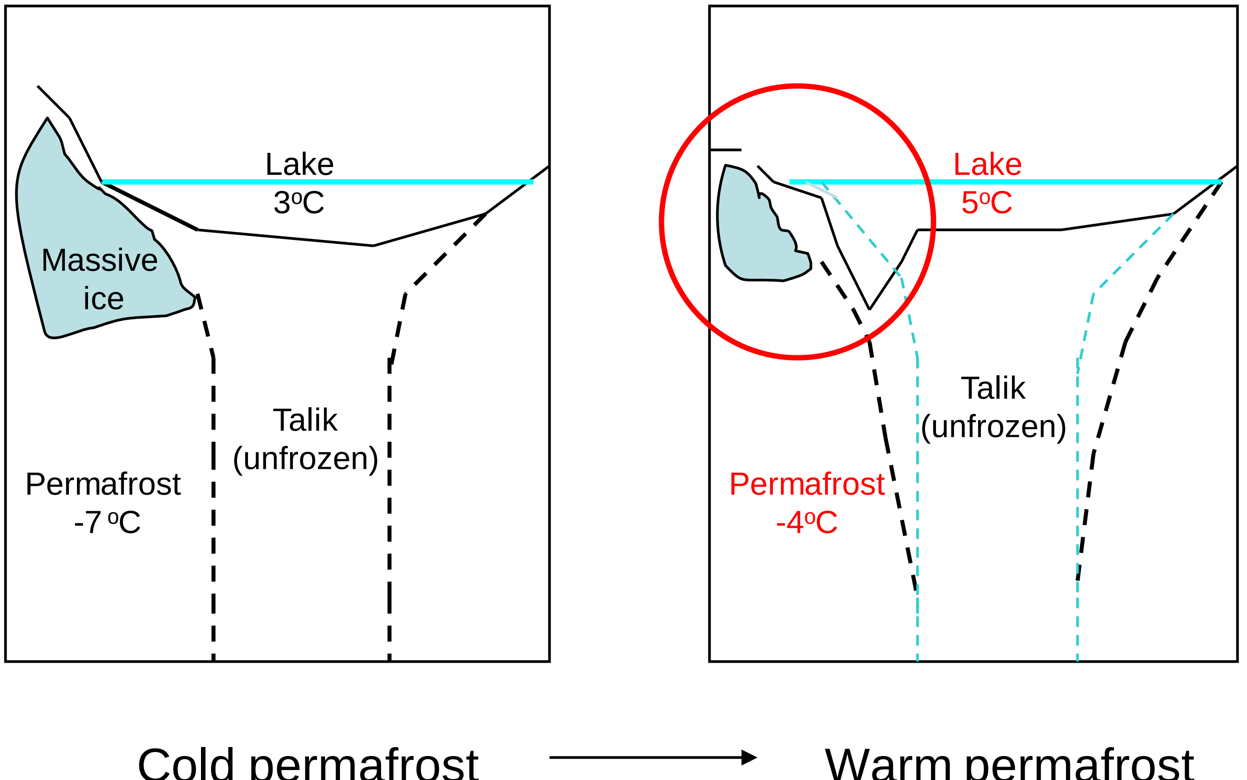
Vegetation

Shrinking ponds

(Yoshikawa and Hinzman, 2003).

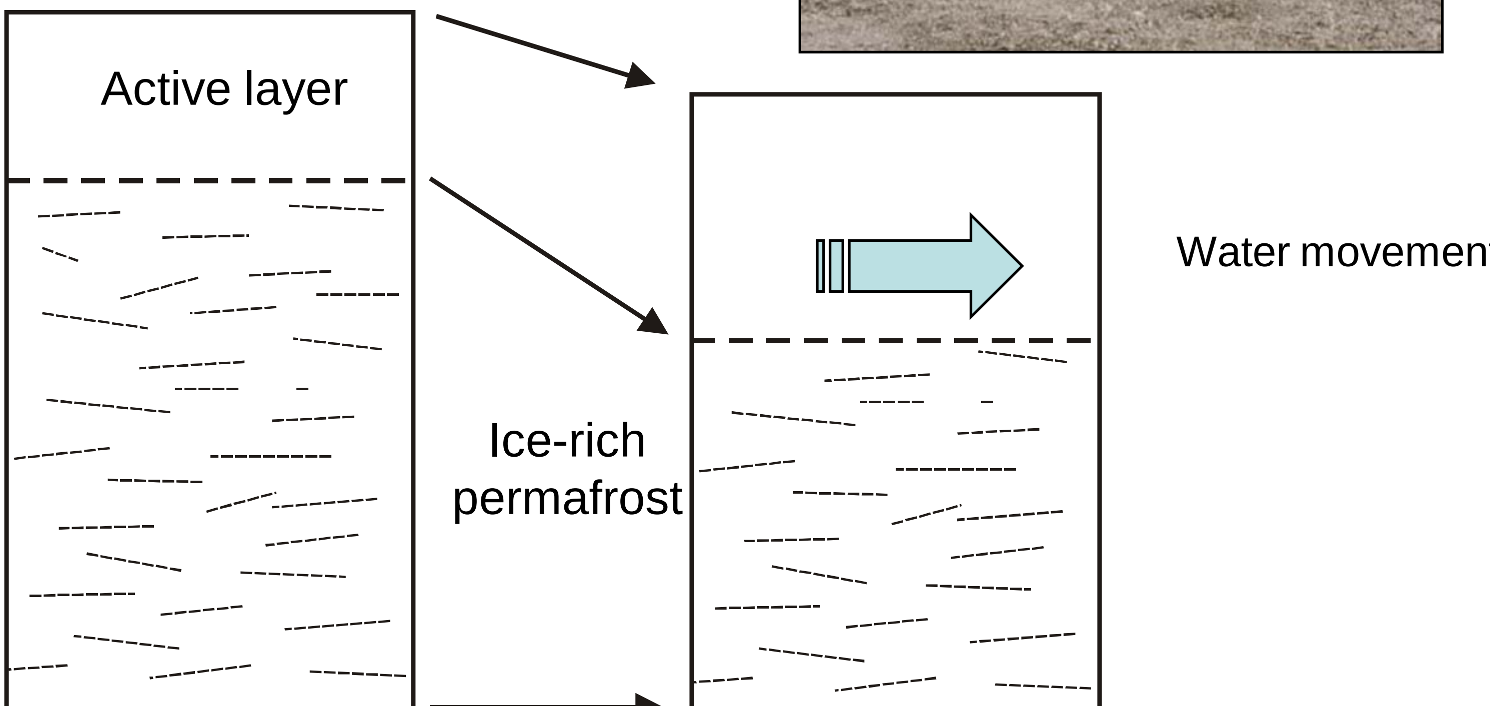


Talik adjustment due to warming

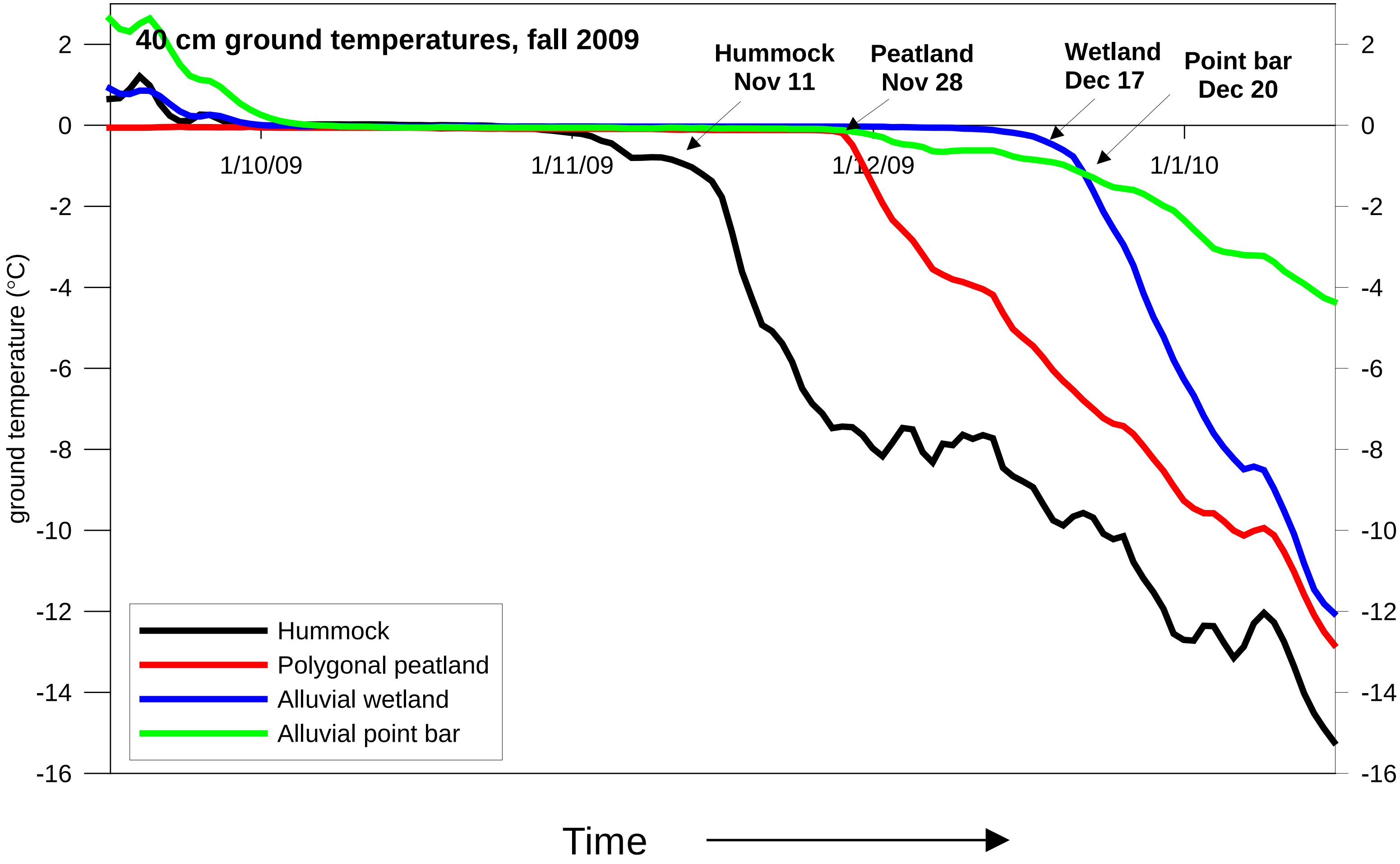


Natural and infrastructure related stability

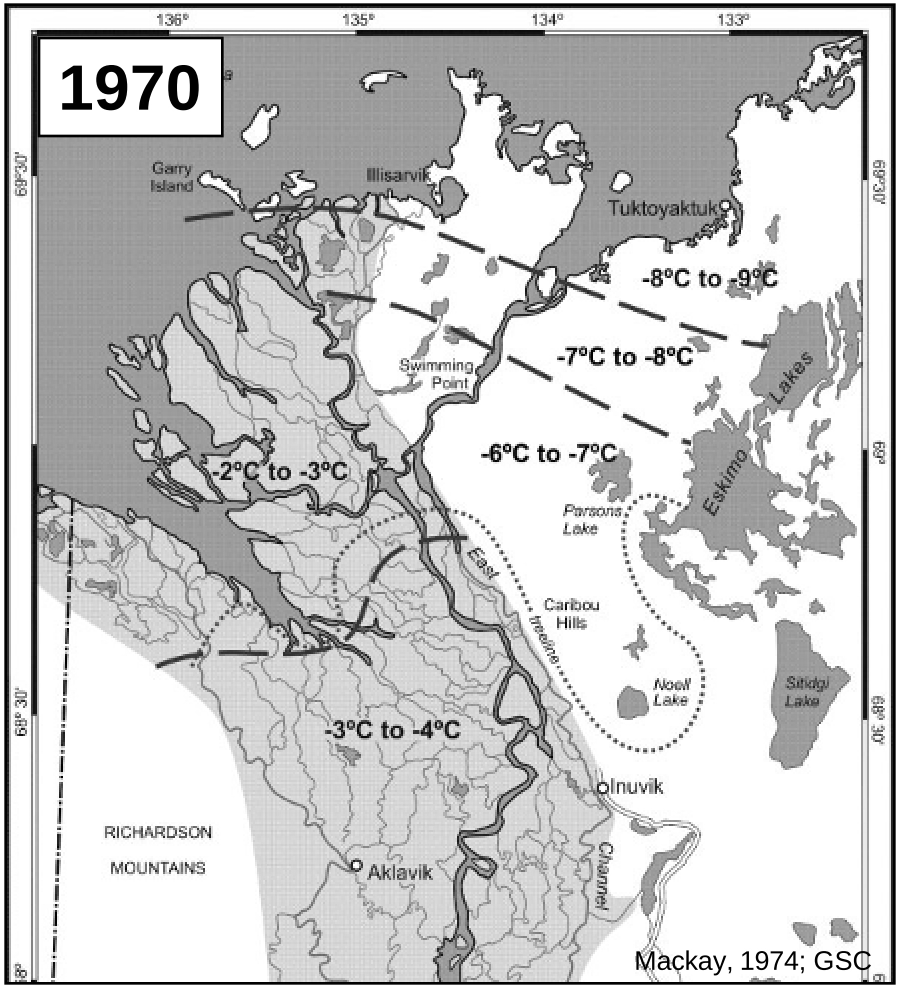
Active layer deepening

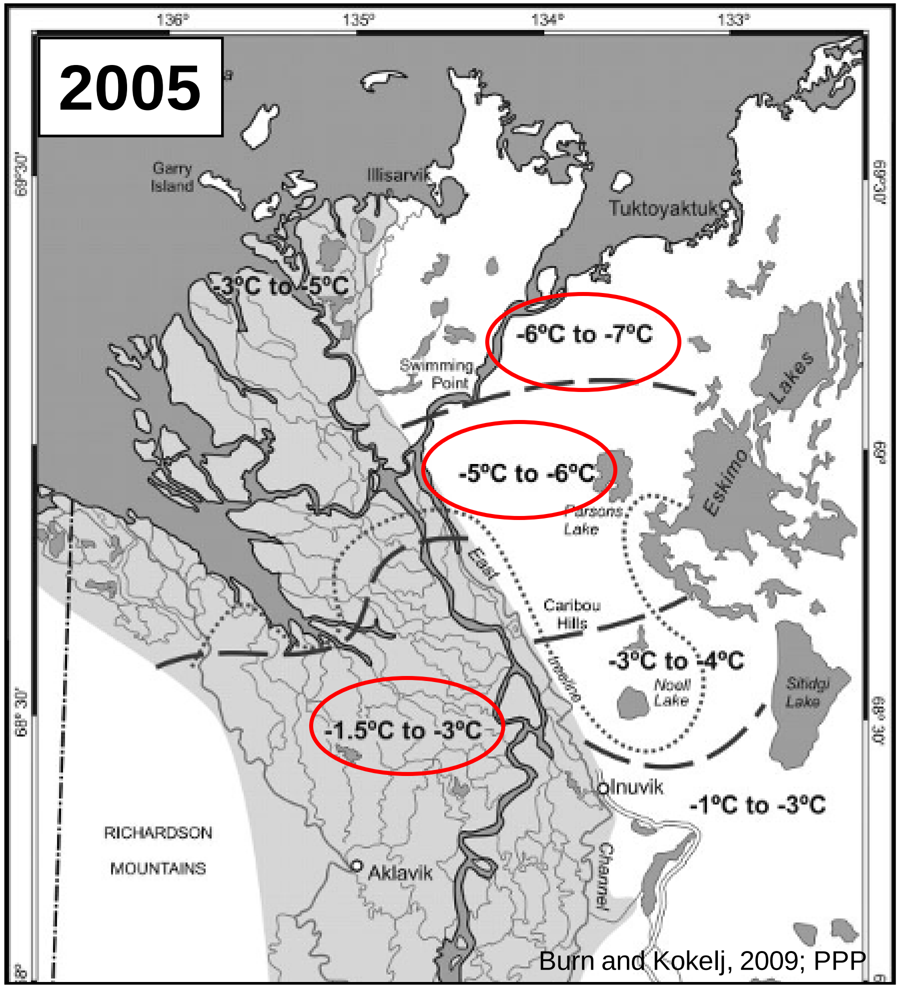


Active-layer freezeback



Climate warming and permafrost

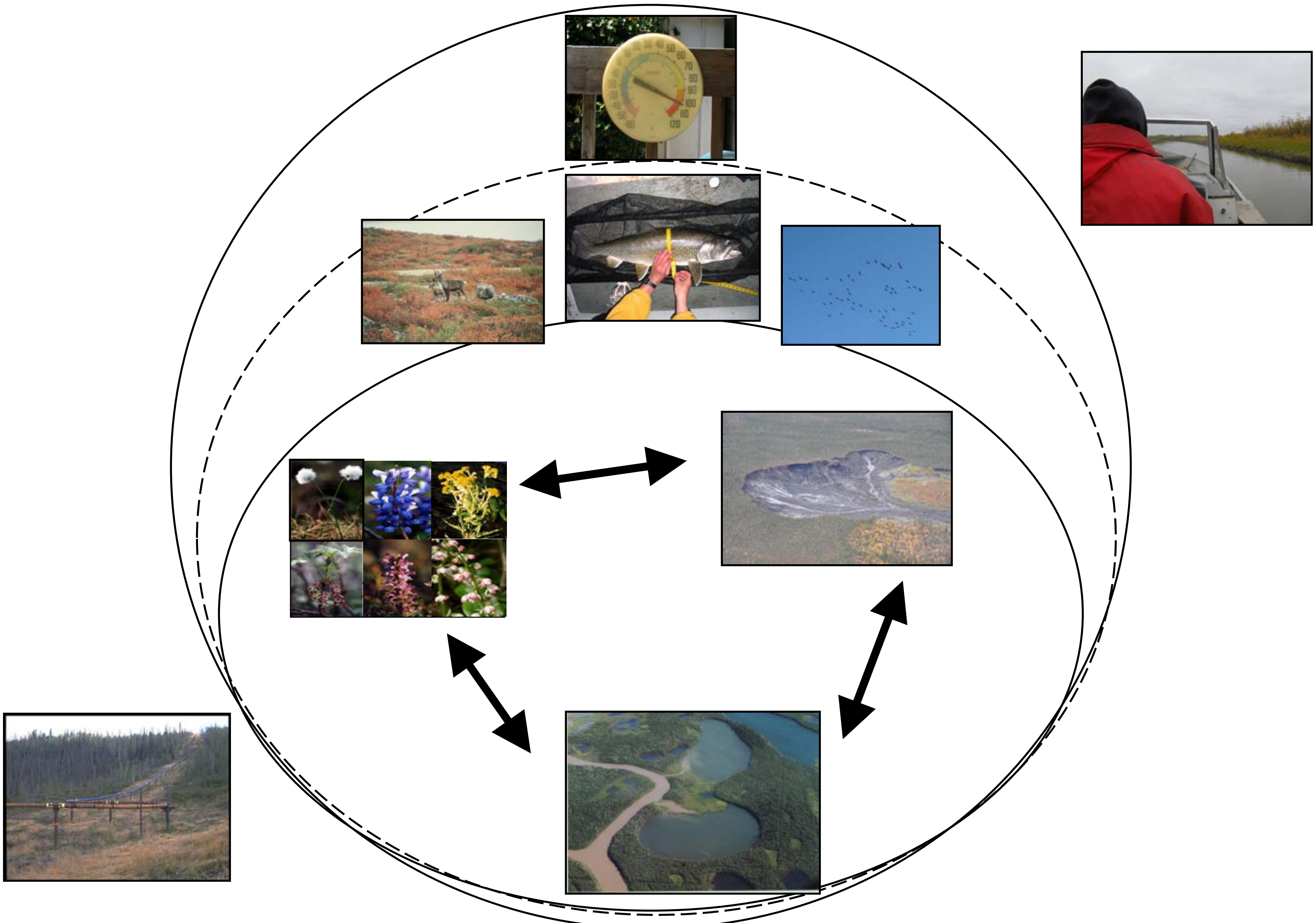




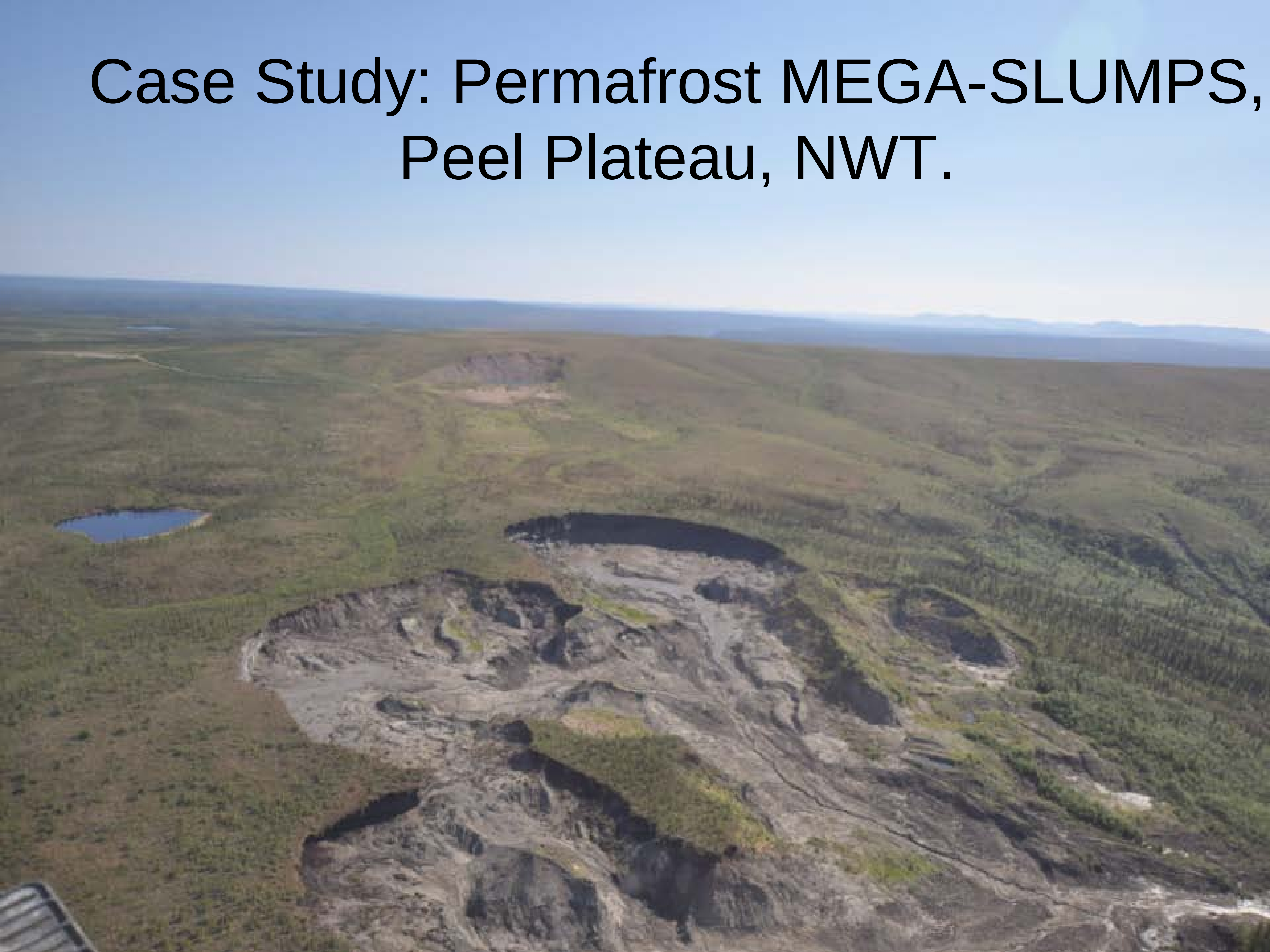
Impacts of thawing permafrost on aquatic systems are not well understood

Anticipating impacts and adapting

How are things connected?



Case Study: Permafrost MEGA-SLUMPS, Peel Plateau, NWT.



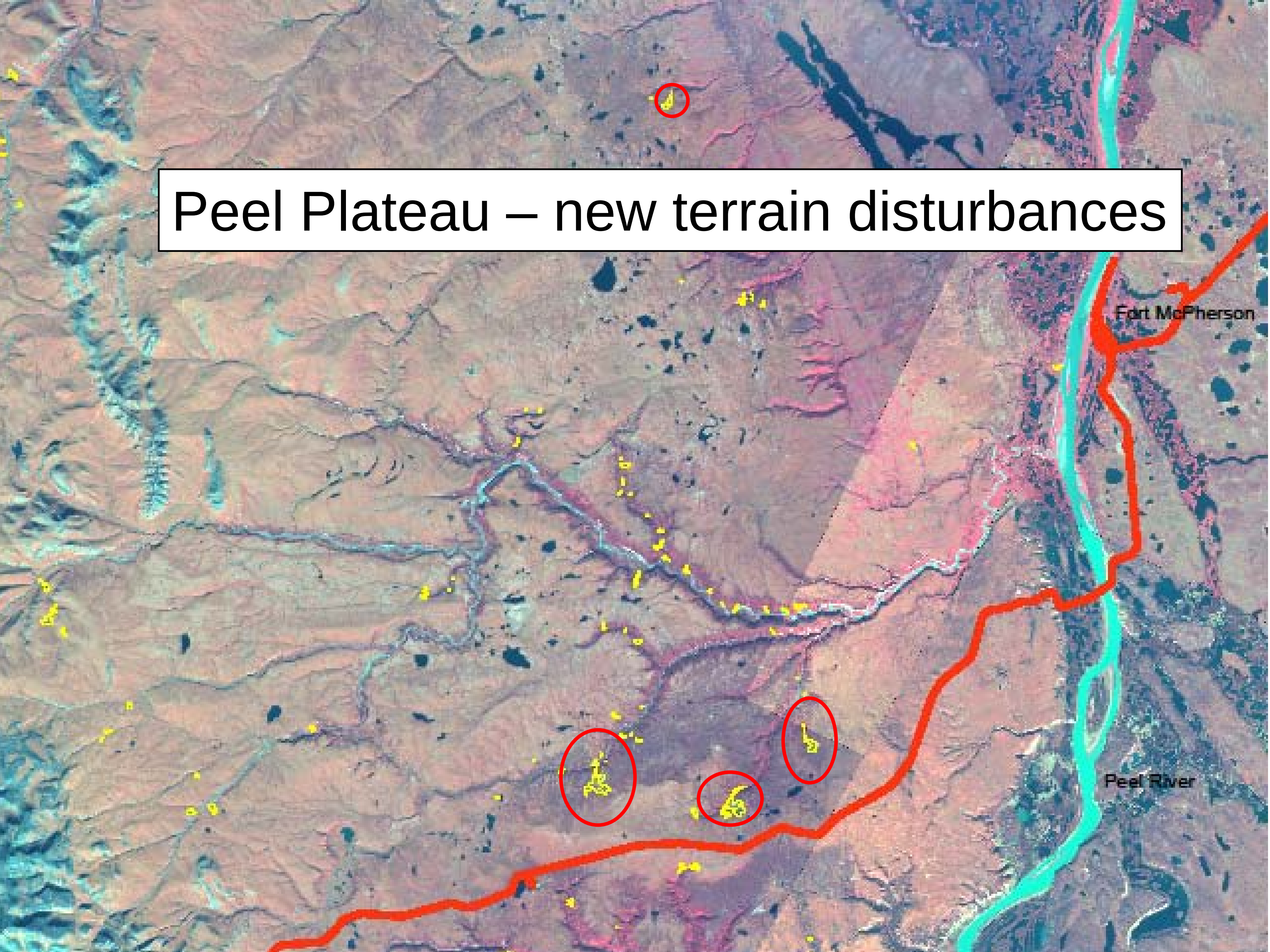
Cumulative Impact Monitoring and Research

An ‘Ice-Cored’ Landscape

Landscape change on the Peel Plateau

- What are the changes on the landscape?
- What is driving the changes?
- What are the fluvial impacts?

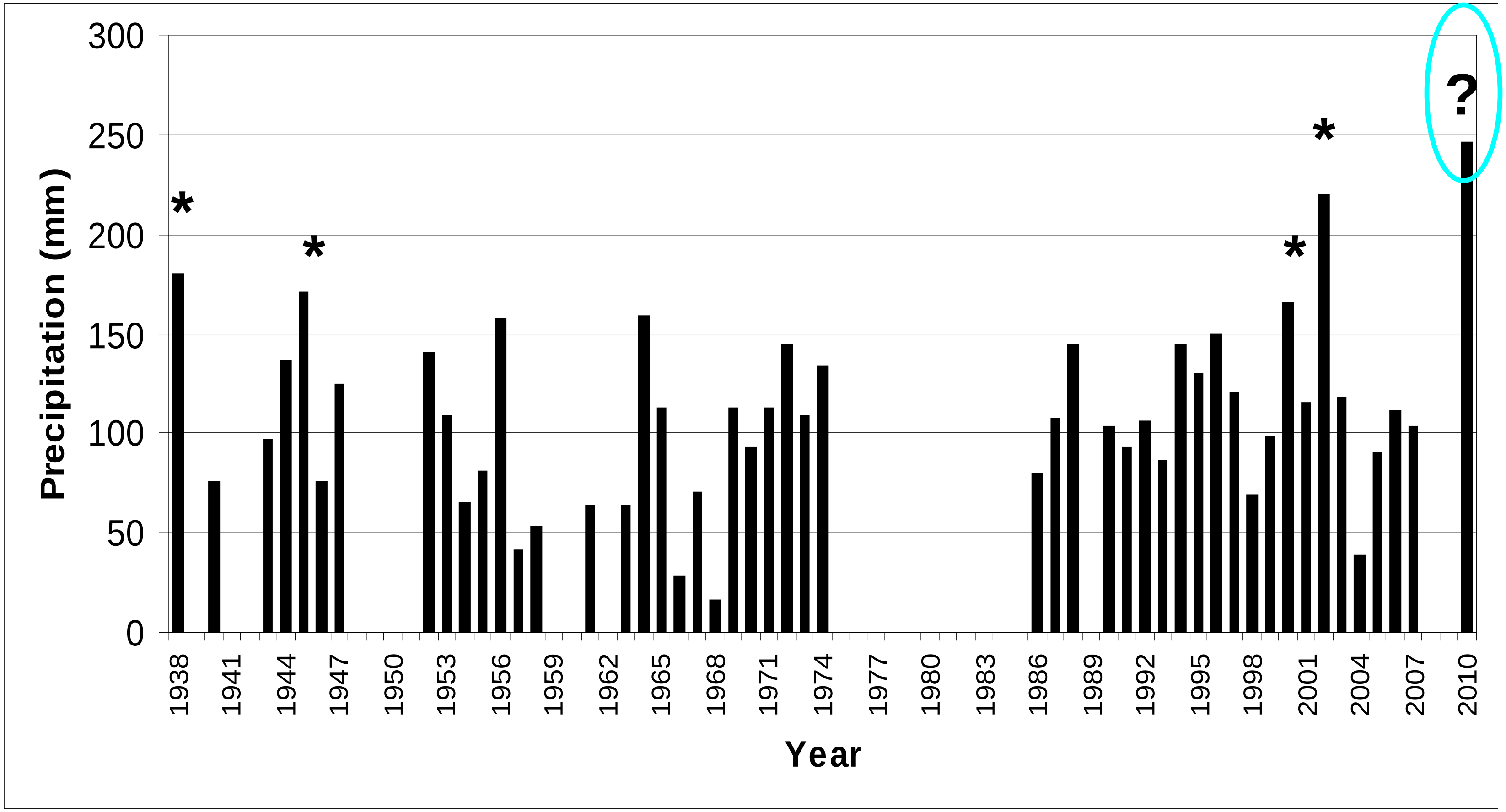
Peel Plateau – new terrain disturbances



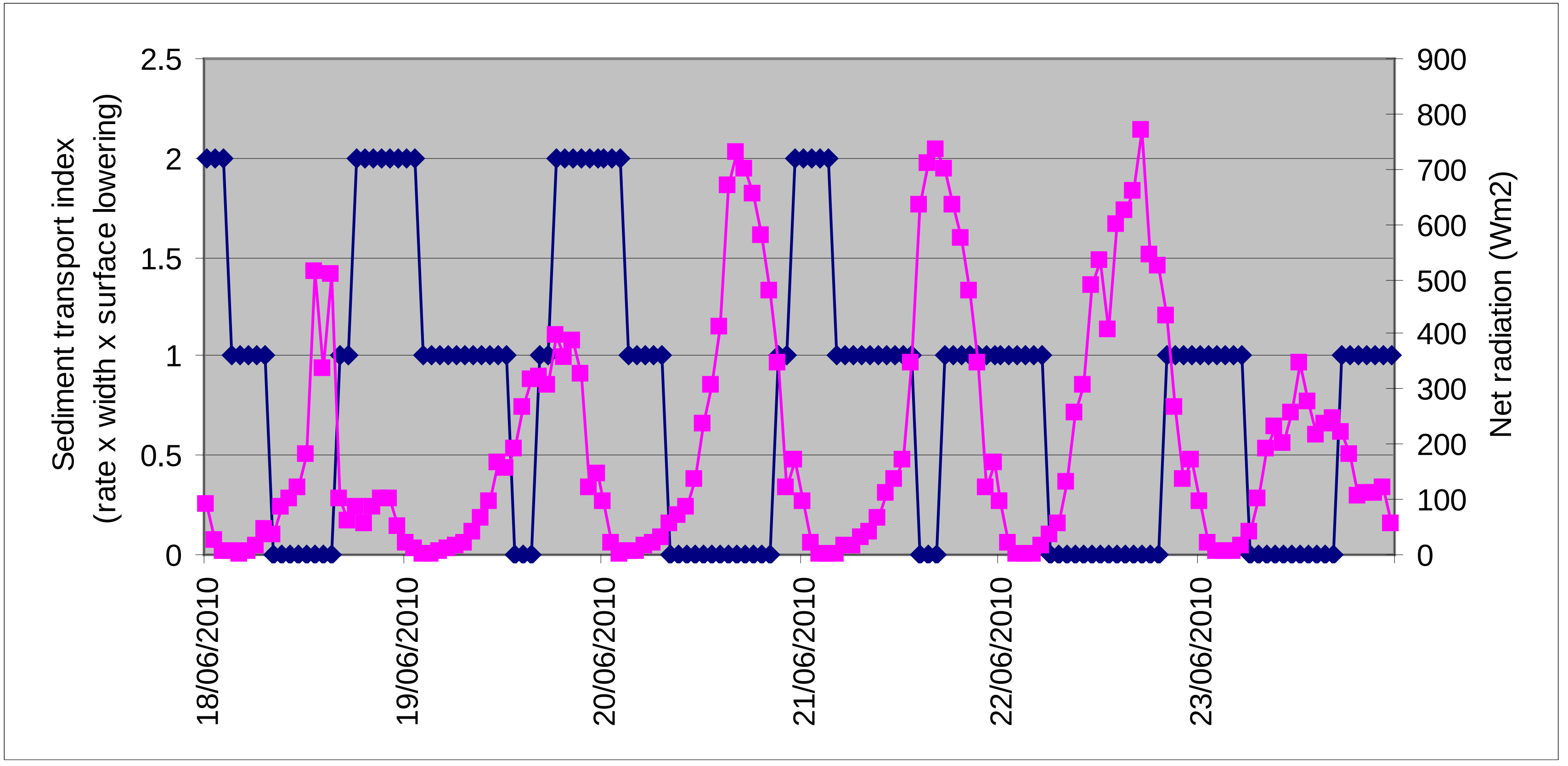

Infilling of stream valleys
Mega slump
Debris dam lake
1 km

Largest disturbances known

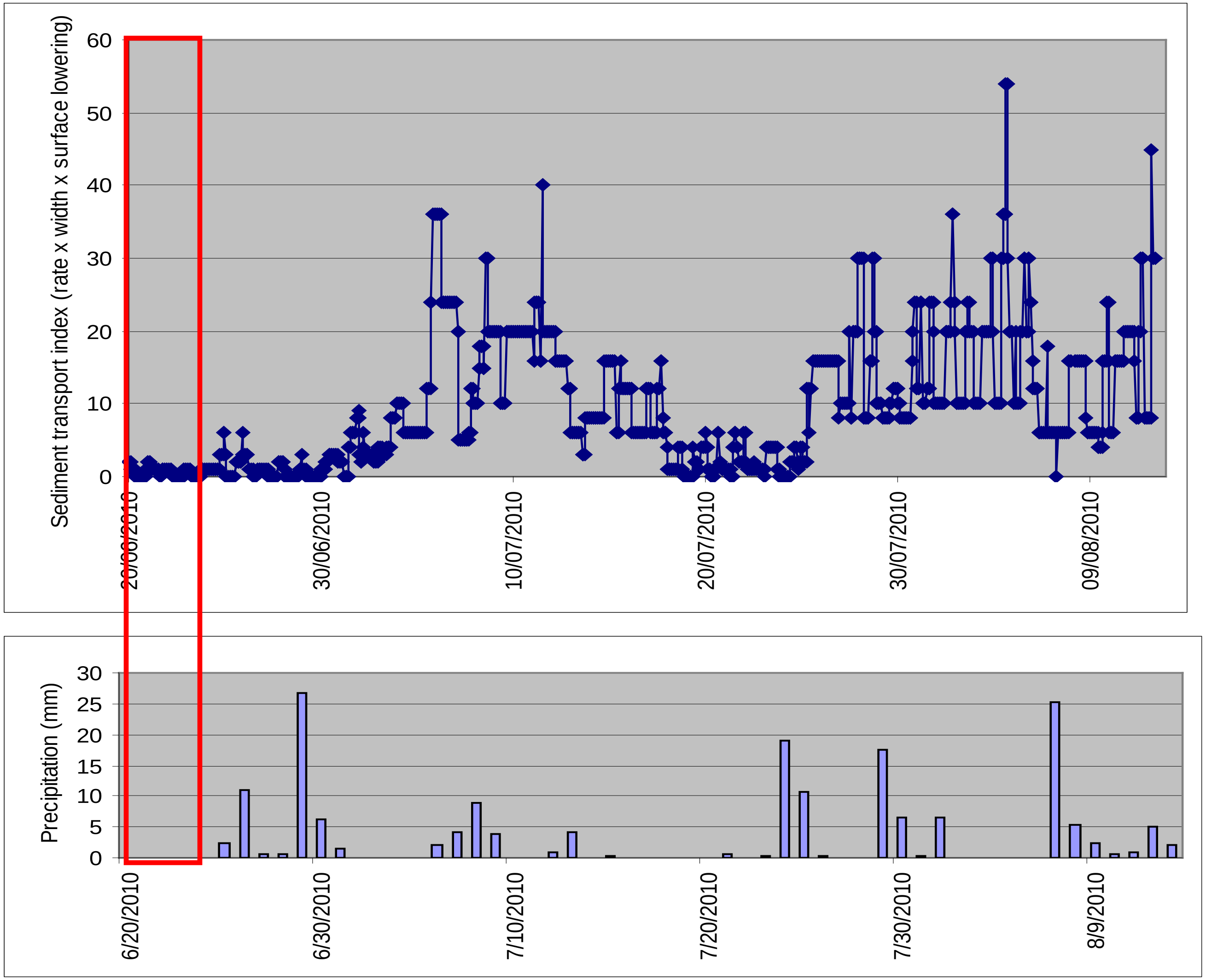
Fort McPherson summer precipitation (mm)



Debris flow activity, hot and dry period, summer 2010

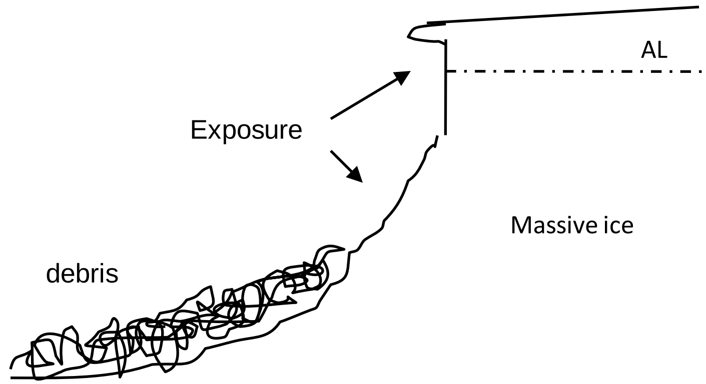


Debris flow activity and precipitation, summer 2010

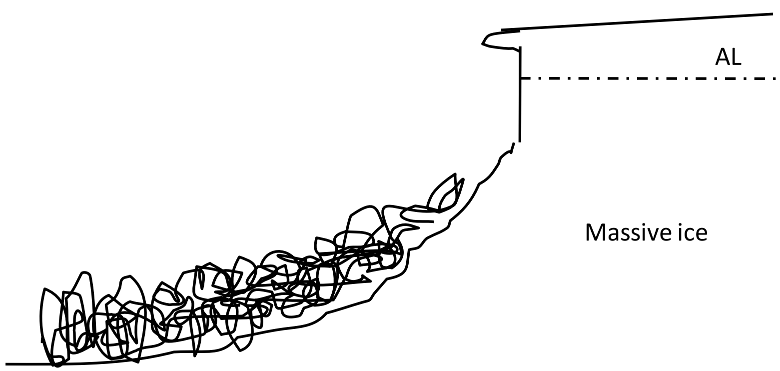


Why are **mega-slumps** developing?

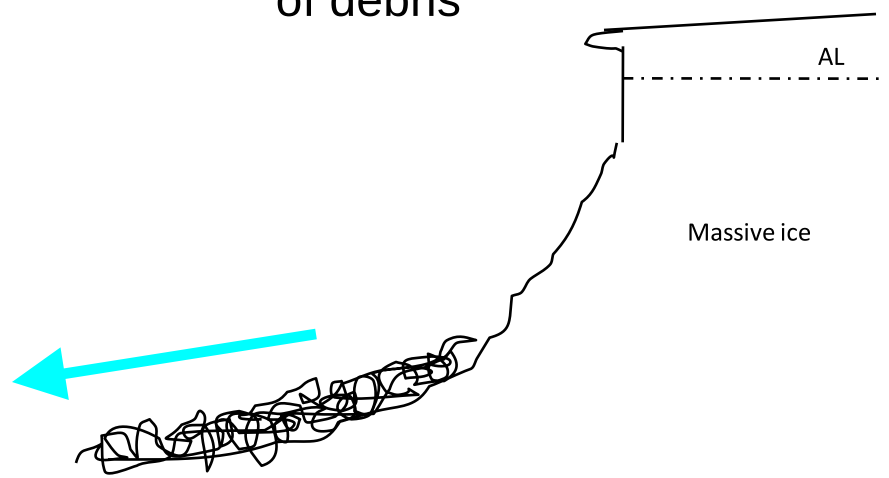
1. Slump headwall and toe



2. Accumulation of debris

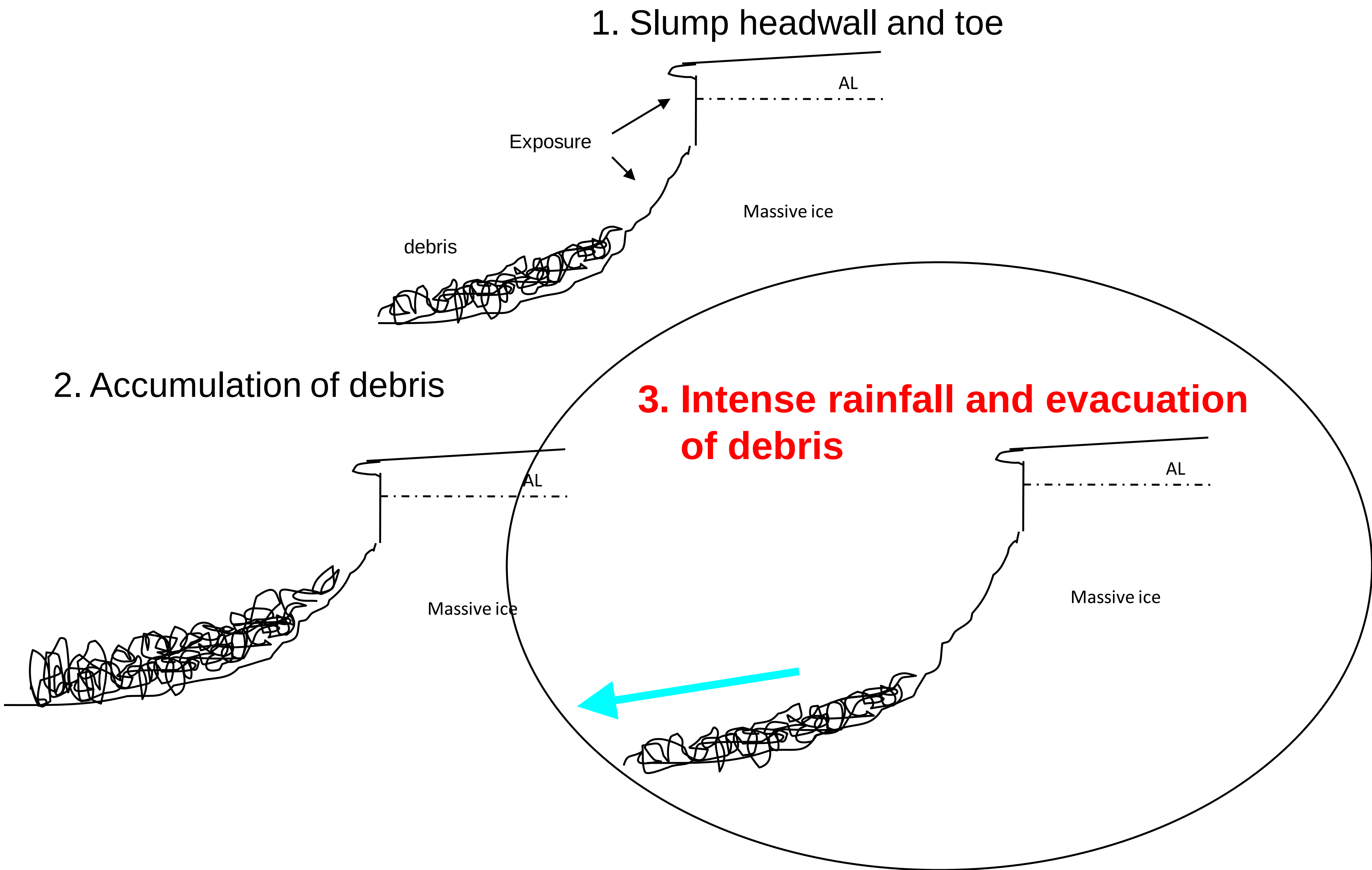


3. Intense rainfall and evacuation of debris



Infilling and stabilization

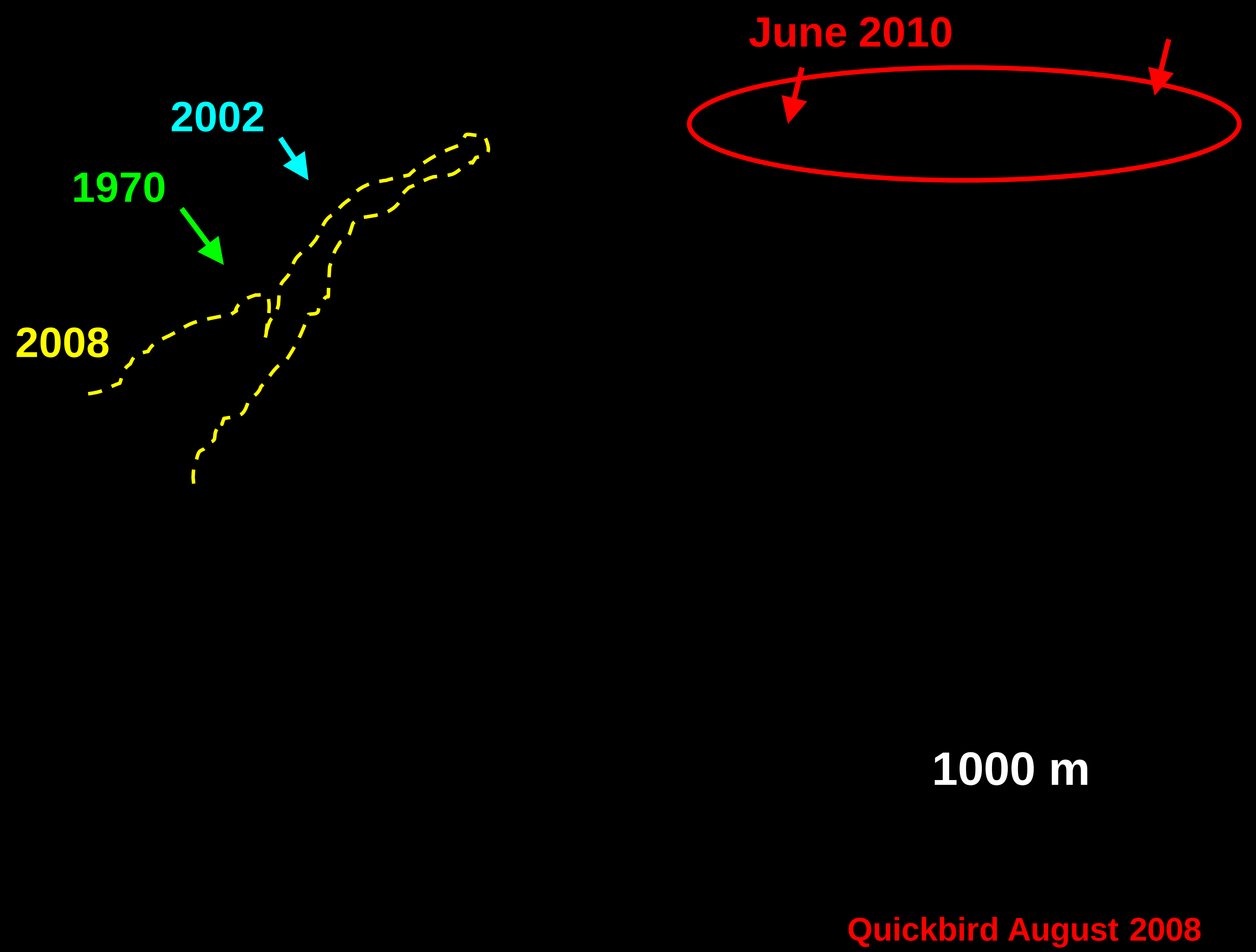
Why are **mega-slumps** developing?



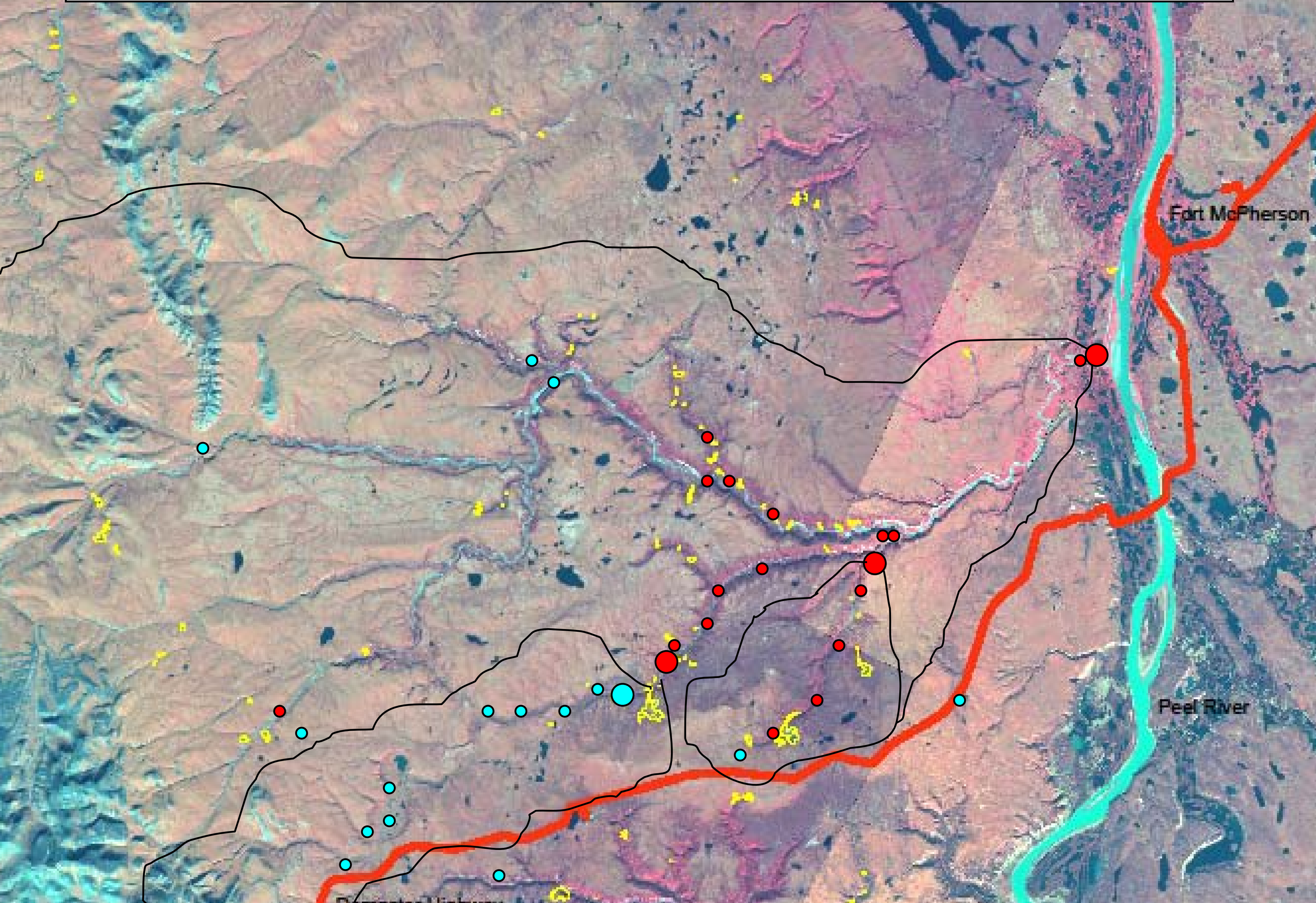

2010-06-09 13:00:00 T
24°C
BIG TURK SLUMP 2A
RECONYX


2010-08-11 18:00:00 T
19°C
BIG TURK SLUMP 2A
RECONYX

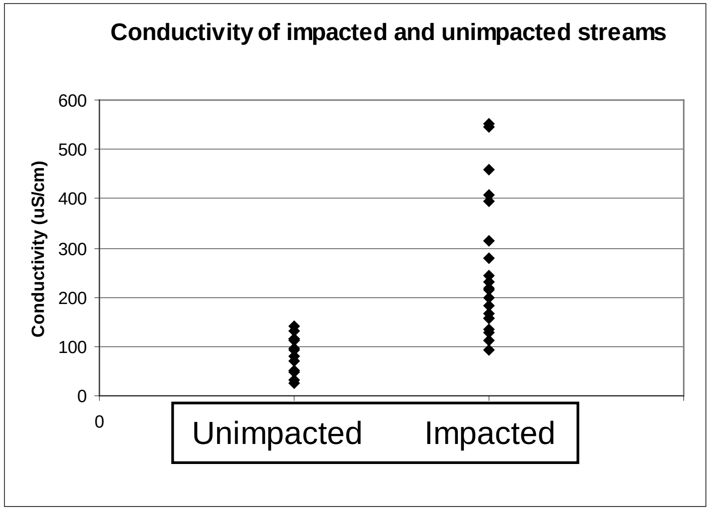
Growth of debris flow



Study catchments and water quality stations

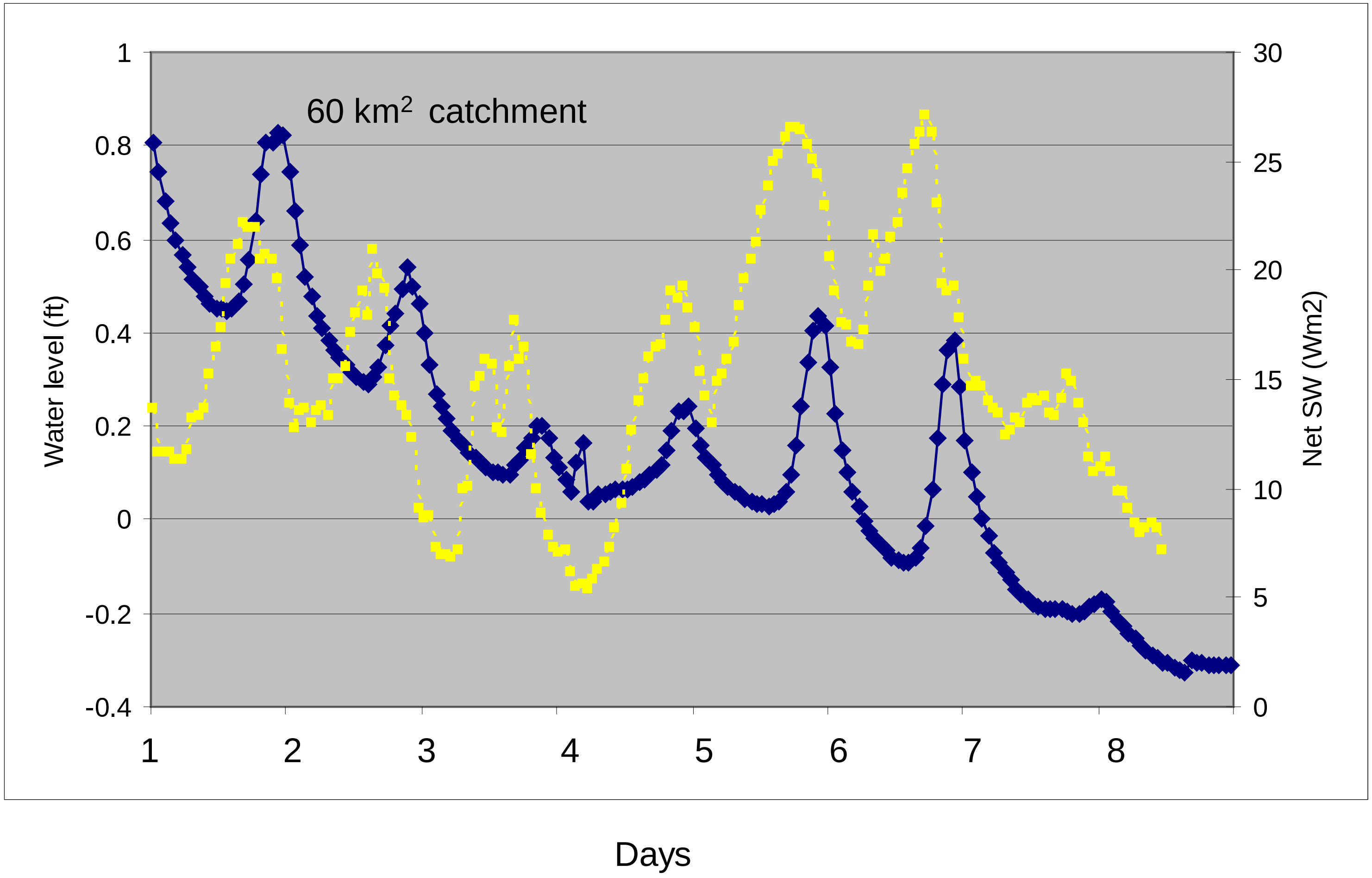


Profound aquatic effects

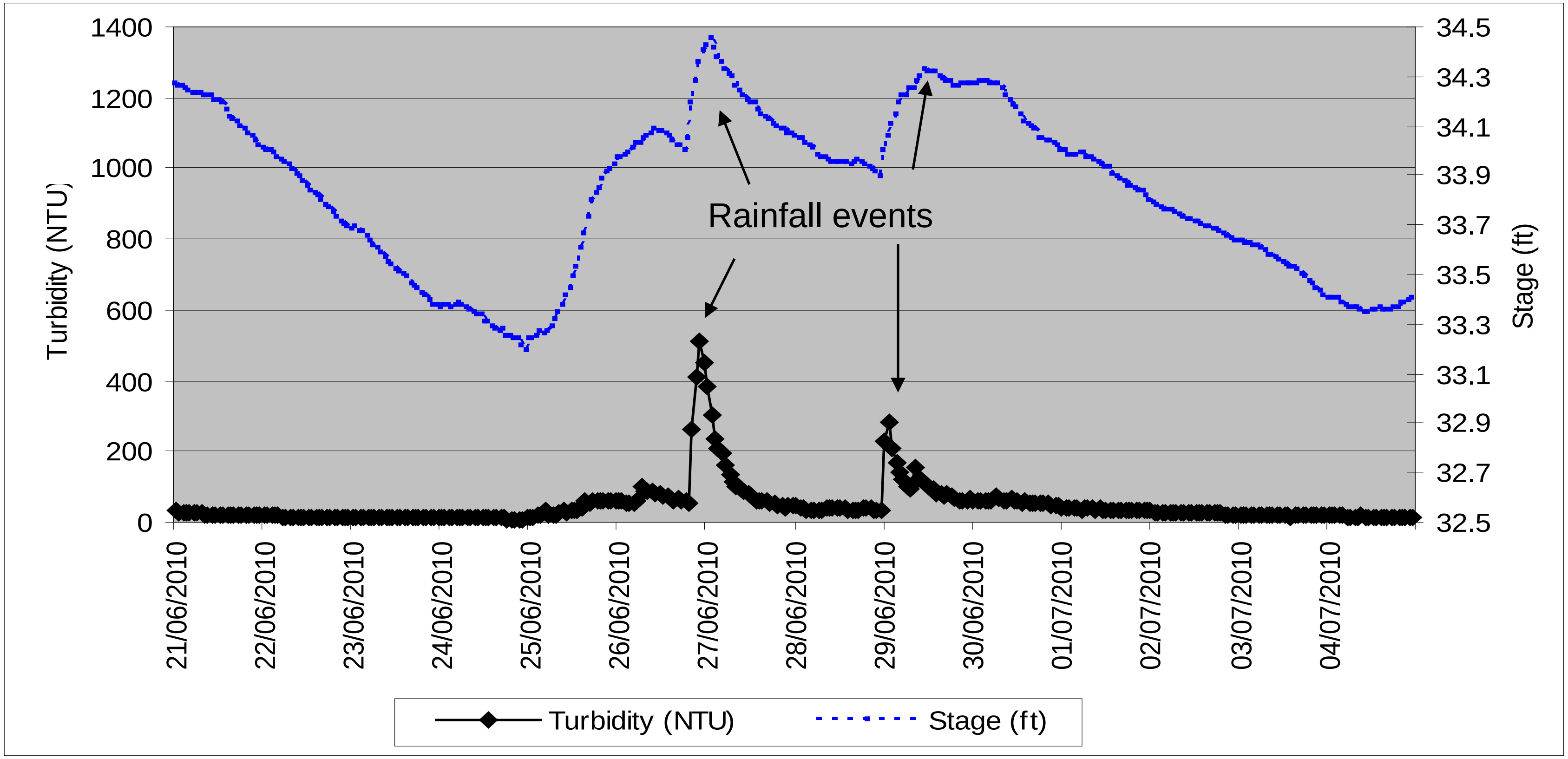


	Unimpacted	Impacted
TSS (mg/L)	< 10	280 to 12800
SO_4	< 20	45 to 569

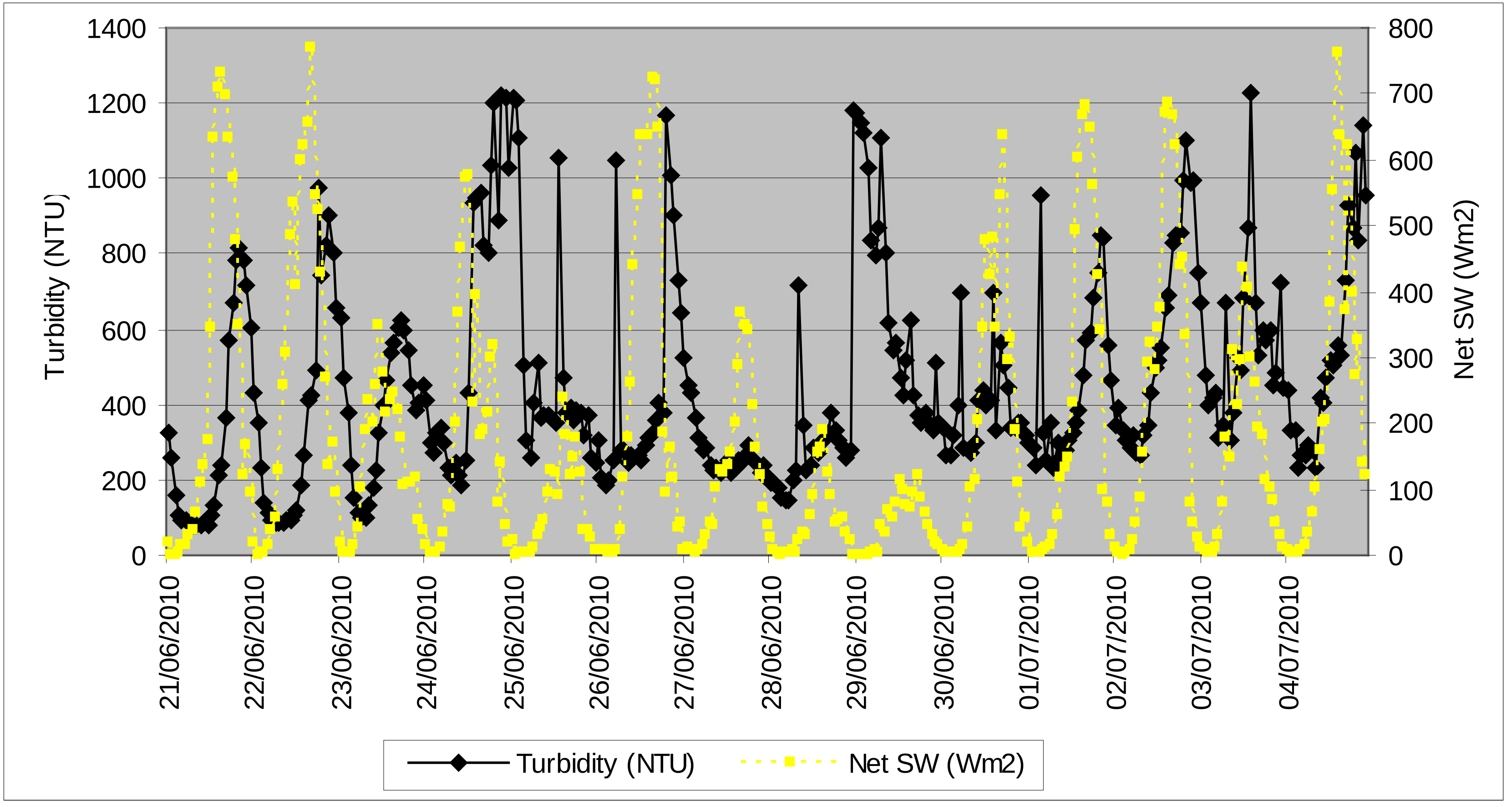
Impacted stream water level and net SW radiation (Wm^2)



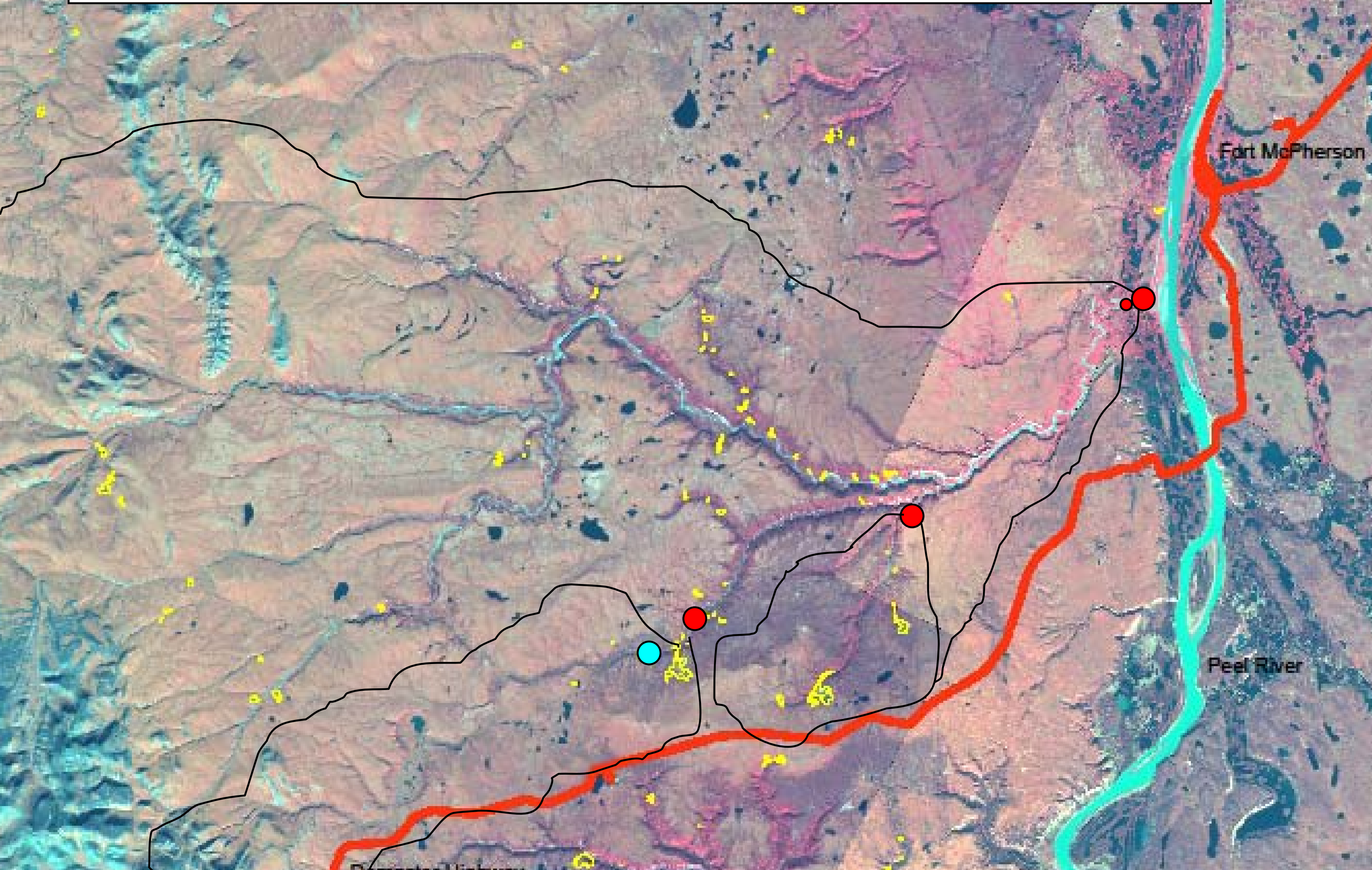
Water level and turbidity – undisturbed stream



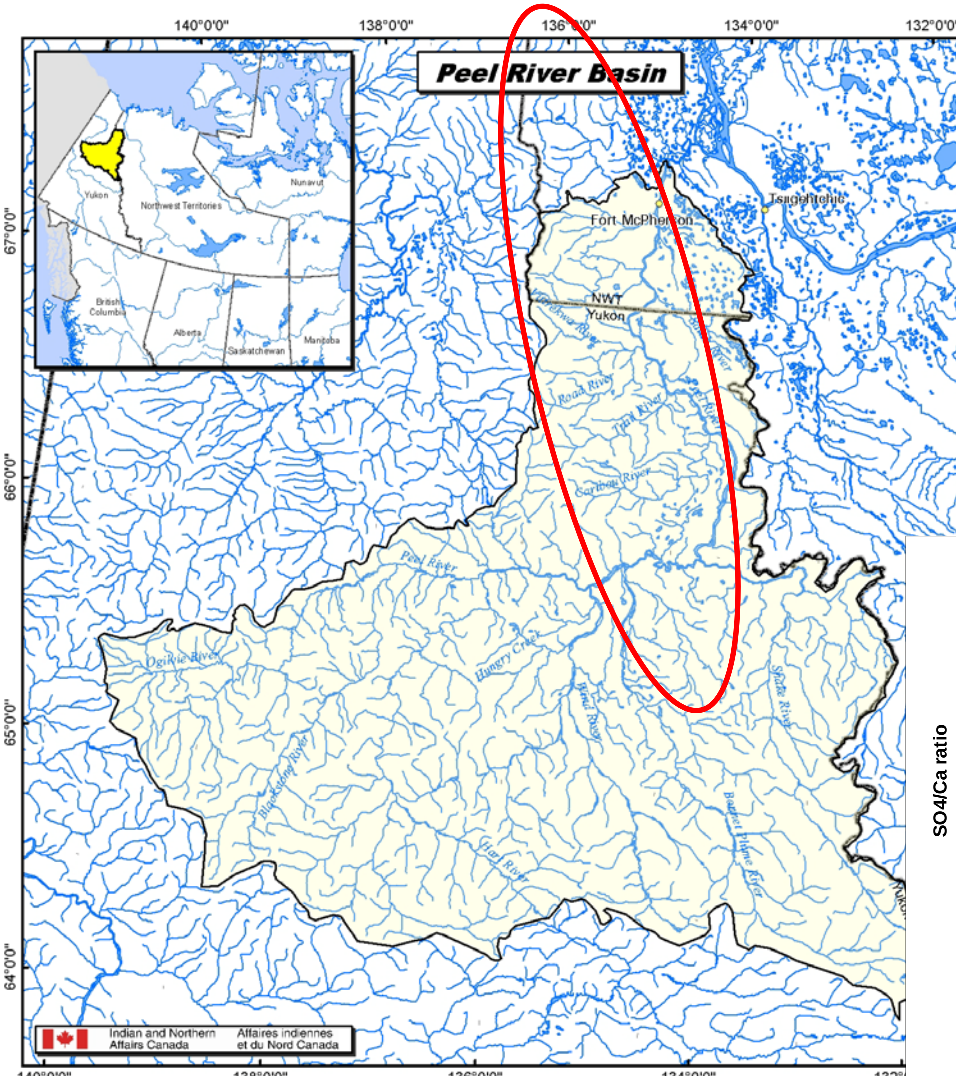
Turbidity and net radiation – downstream of slump

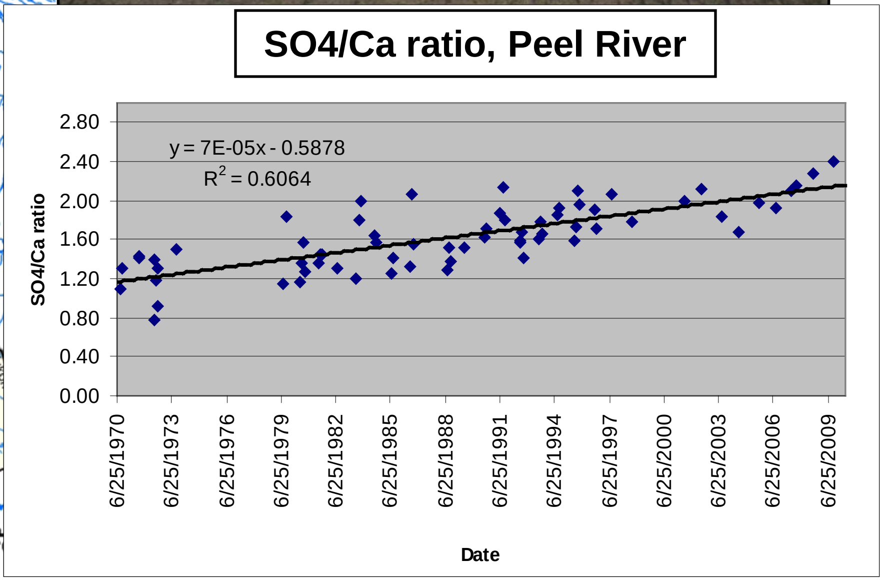


Impacts observed where less than 1% of catchment is affected



Changing environmental conditions, Peel River



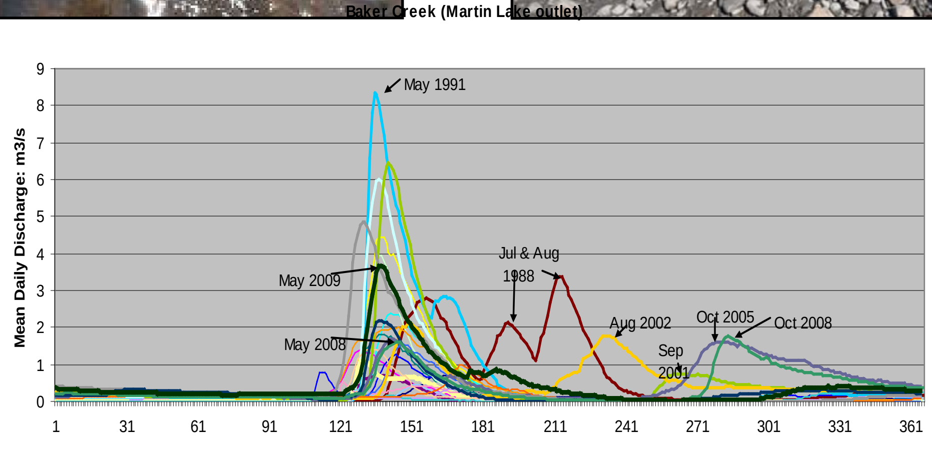


Conclusions

- **Various landscapes will respond differently to climate change**
- **In order to adapt, changes need to be understood**

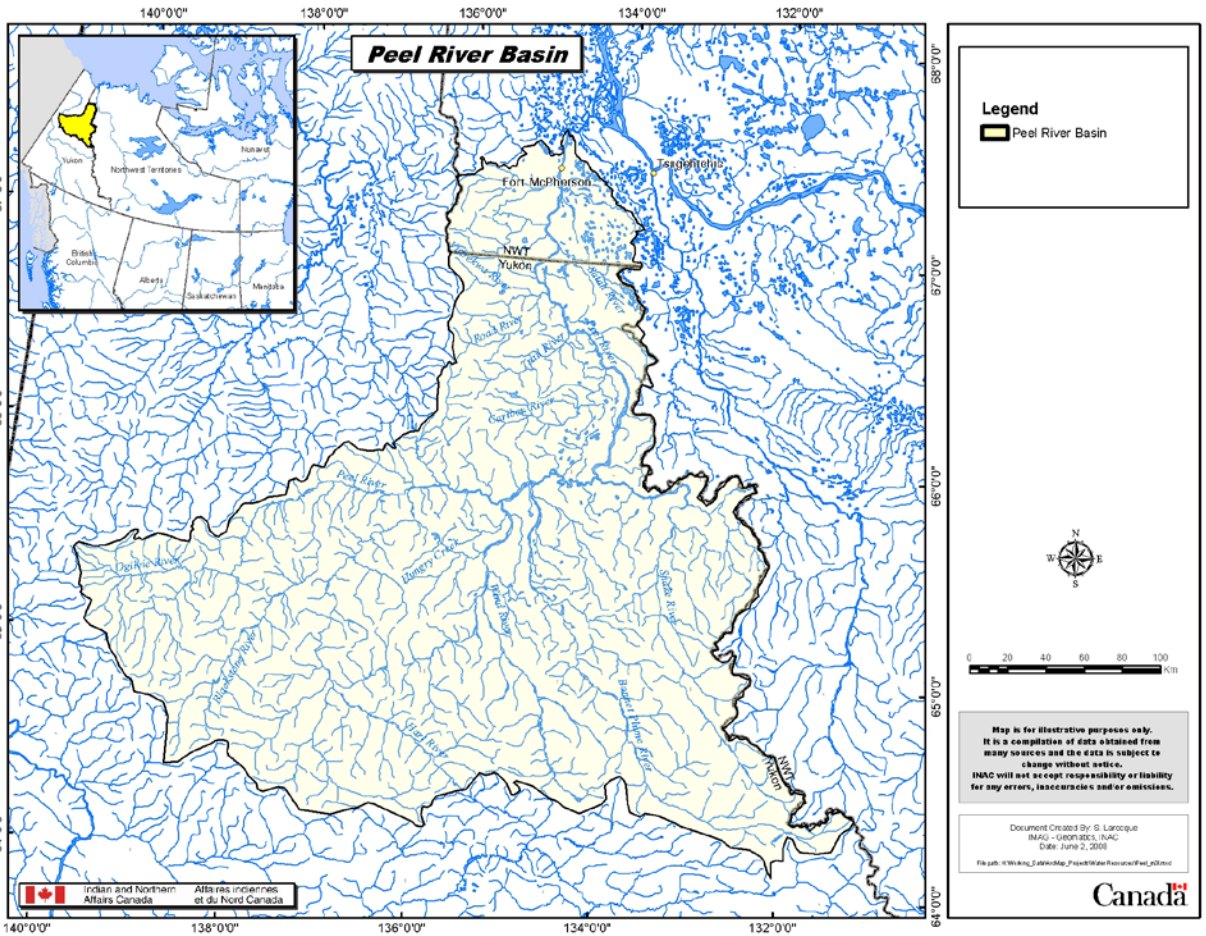
Conclusions

- **Thawing permafrost is causing aquatic environments to change**



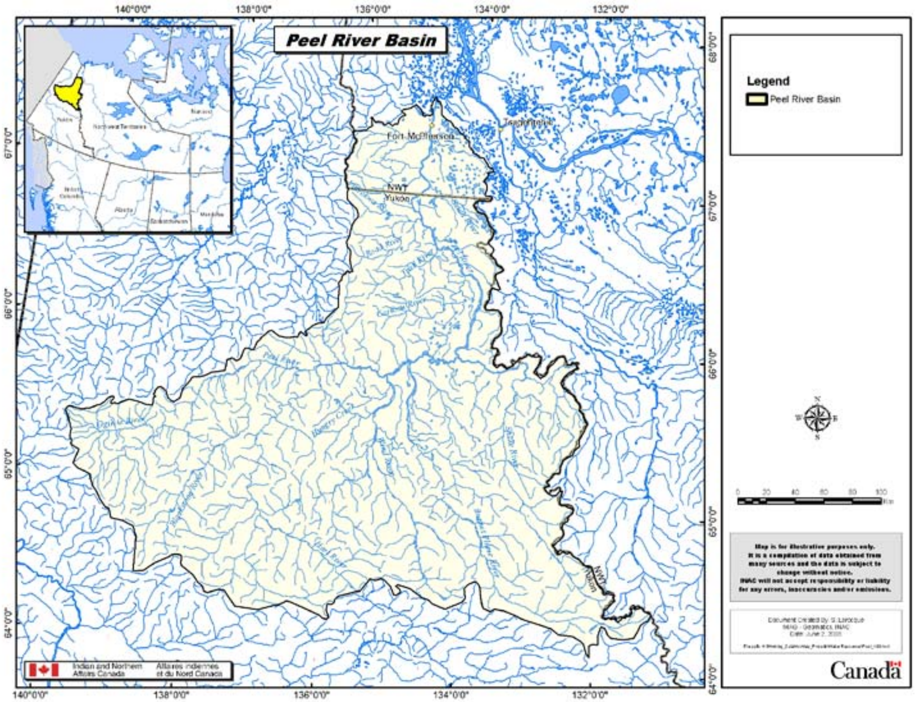
Conclusions

- **Impacts are detectable at the large basin scale**



Conclusions

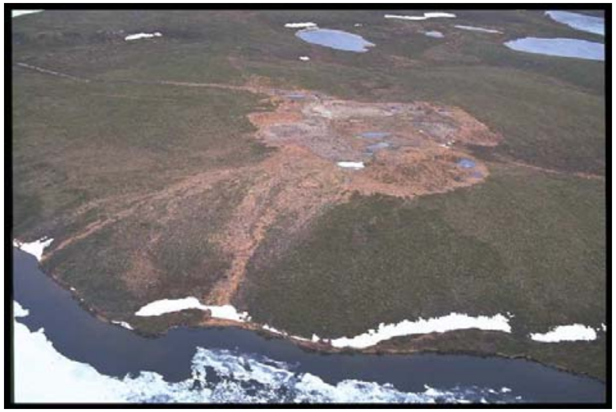
- **Understanding drivers of change is the knowledge base upon which cumulative impacts can be assessed and tracked**



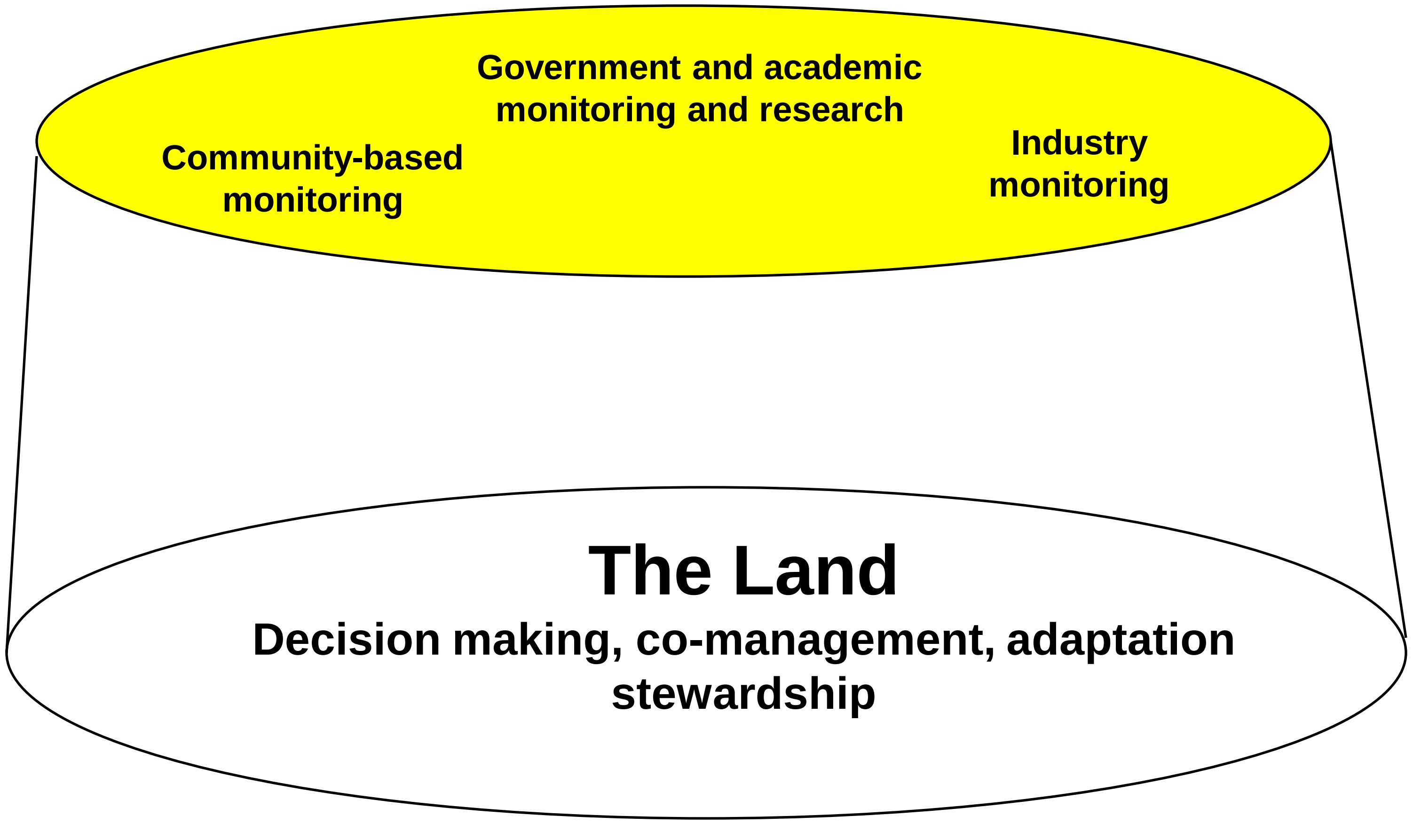
Variability – Processes – Cumulative impacts - Mitigation

Climate change, permafrost and the North

- Integral part of northern environment
- Impacted by climate change
- Key consideration in all development
- Need best available information
- Northern capacity in science
  - Ability to lead or direct research is limited
  - Understanding and applying results
  - Combine information from multiple sources



Northern based integrated monitoring system




Thank you