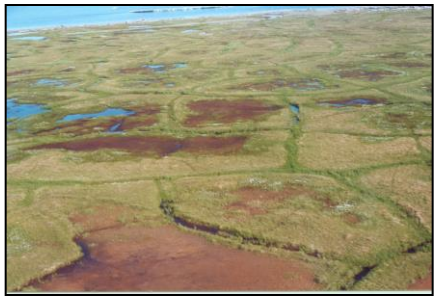
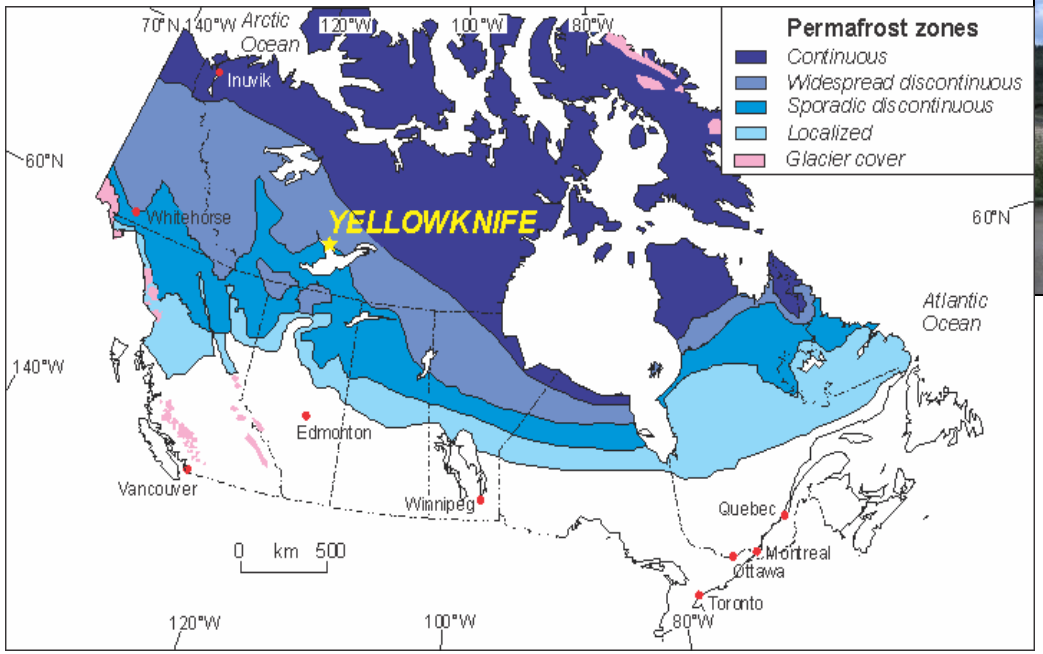
Permafrost, climate change and infrastructure

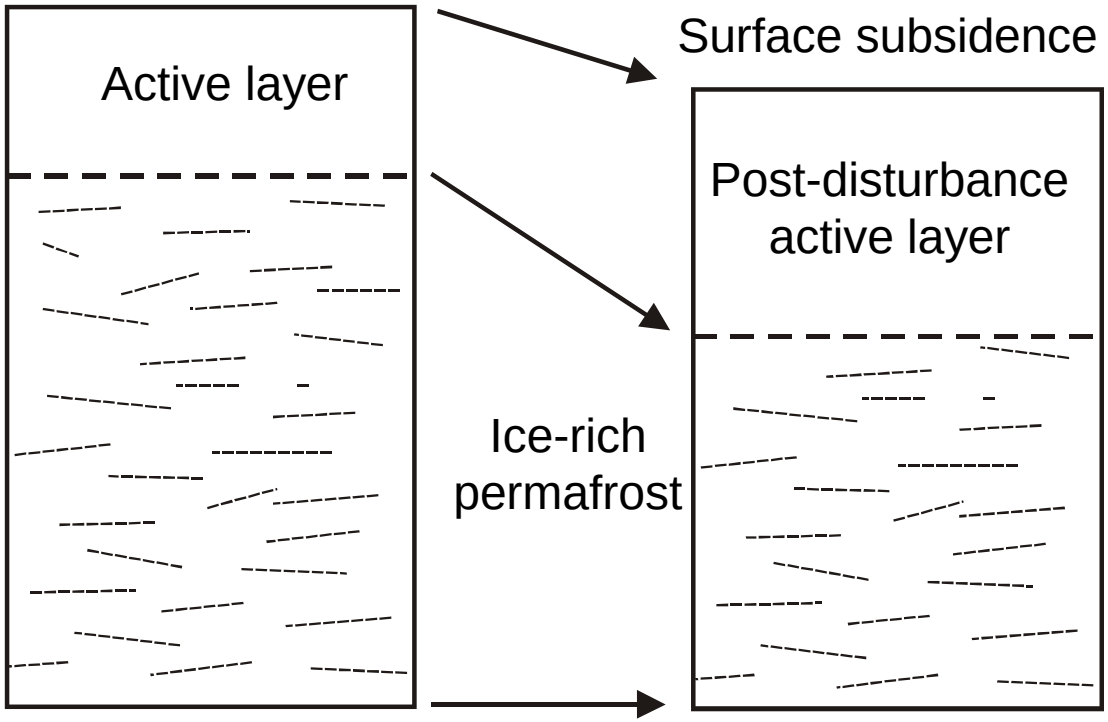
Steve Kokelj, NWT Geoscience Office, GNWT

Permafrost is a defining feature of high latitudes



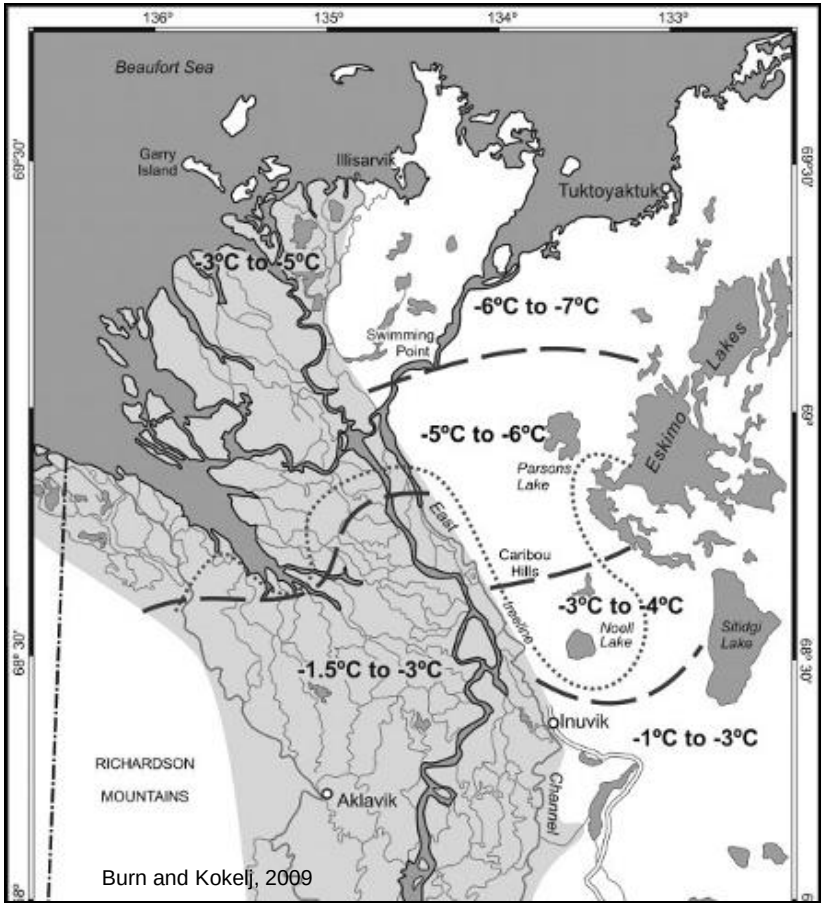


Active layer

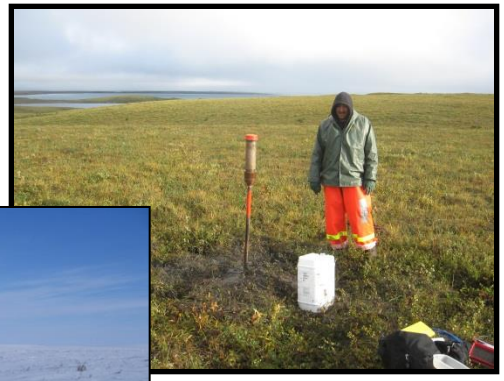


Active layer is the surface layer of soils that thaws and refreezes annually. If the active layer deepens and ice-rich ground thaws the ground surface will subside.

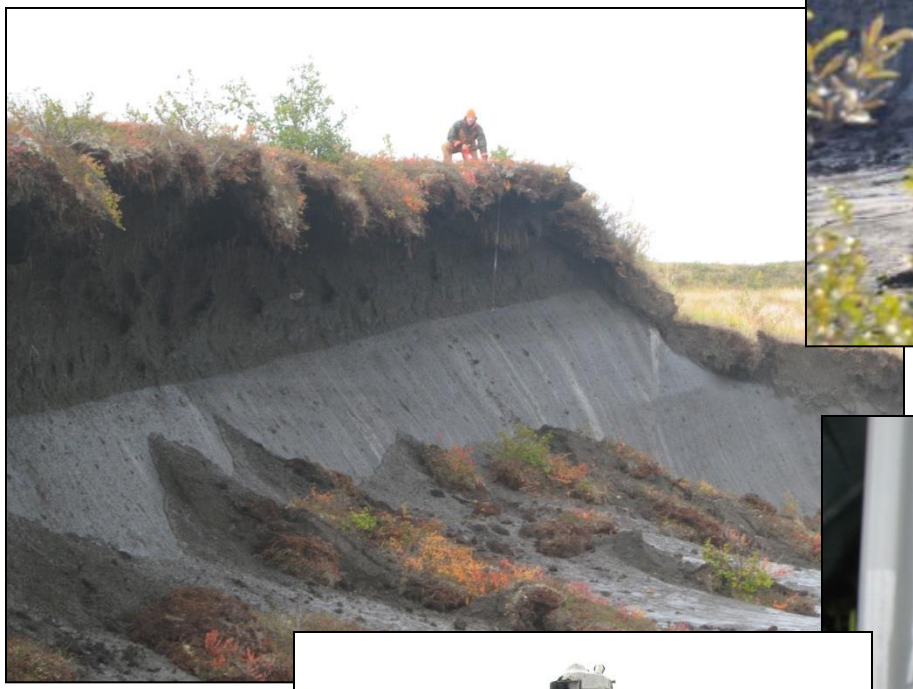
Ground temperatures – Mackenzie Delta

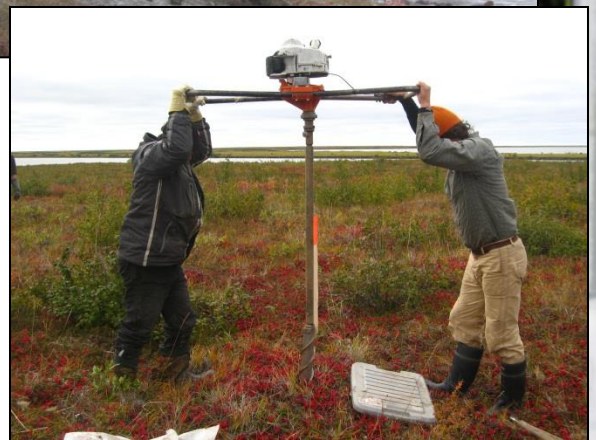


Burn and Kokelj, 2009

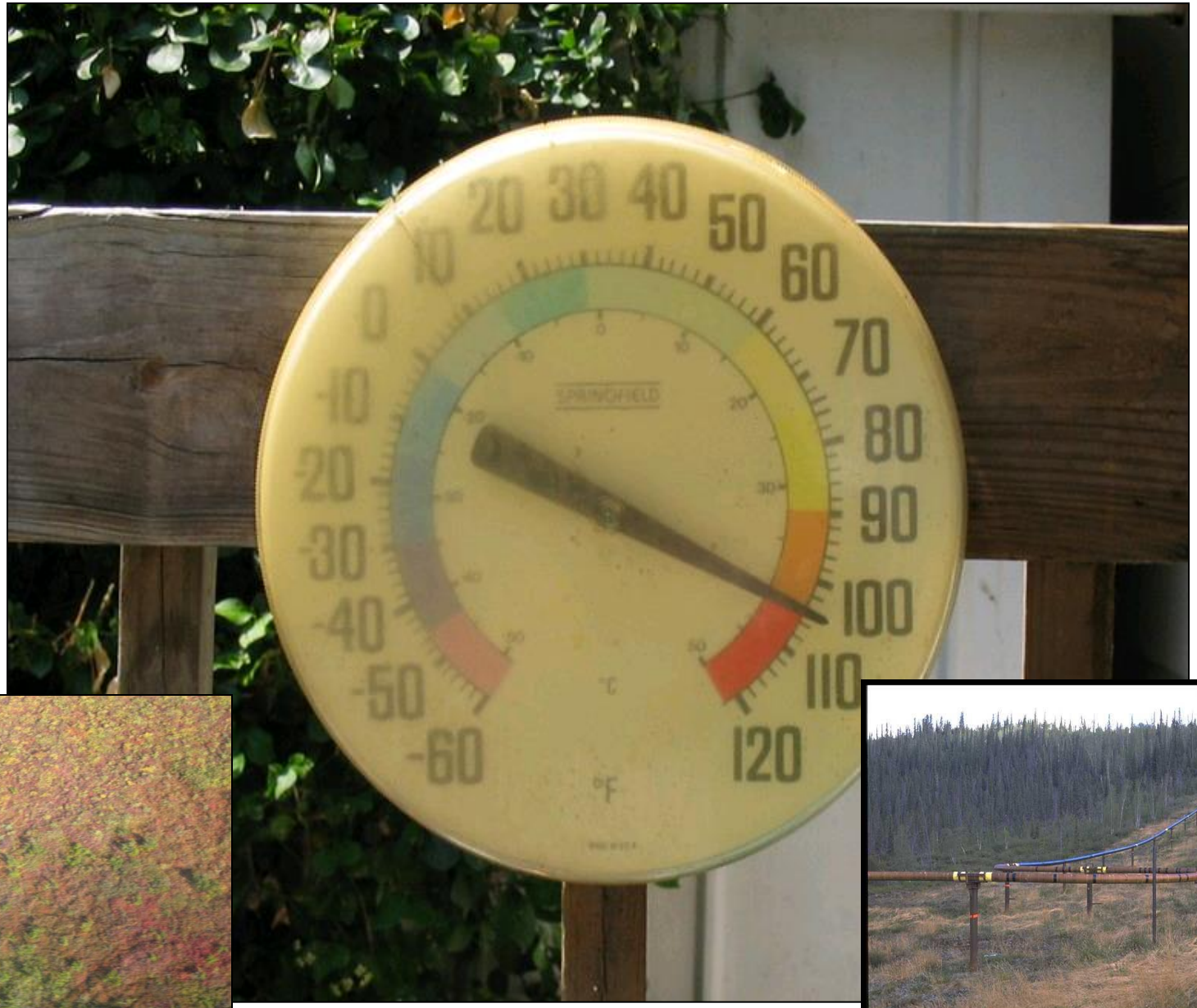


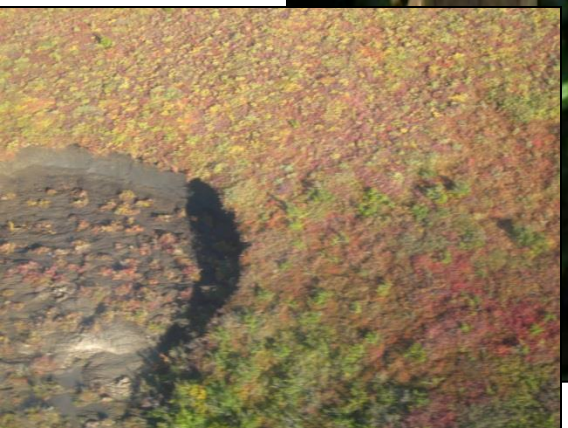
Ground ice



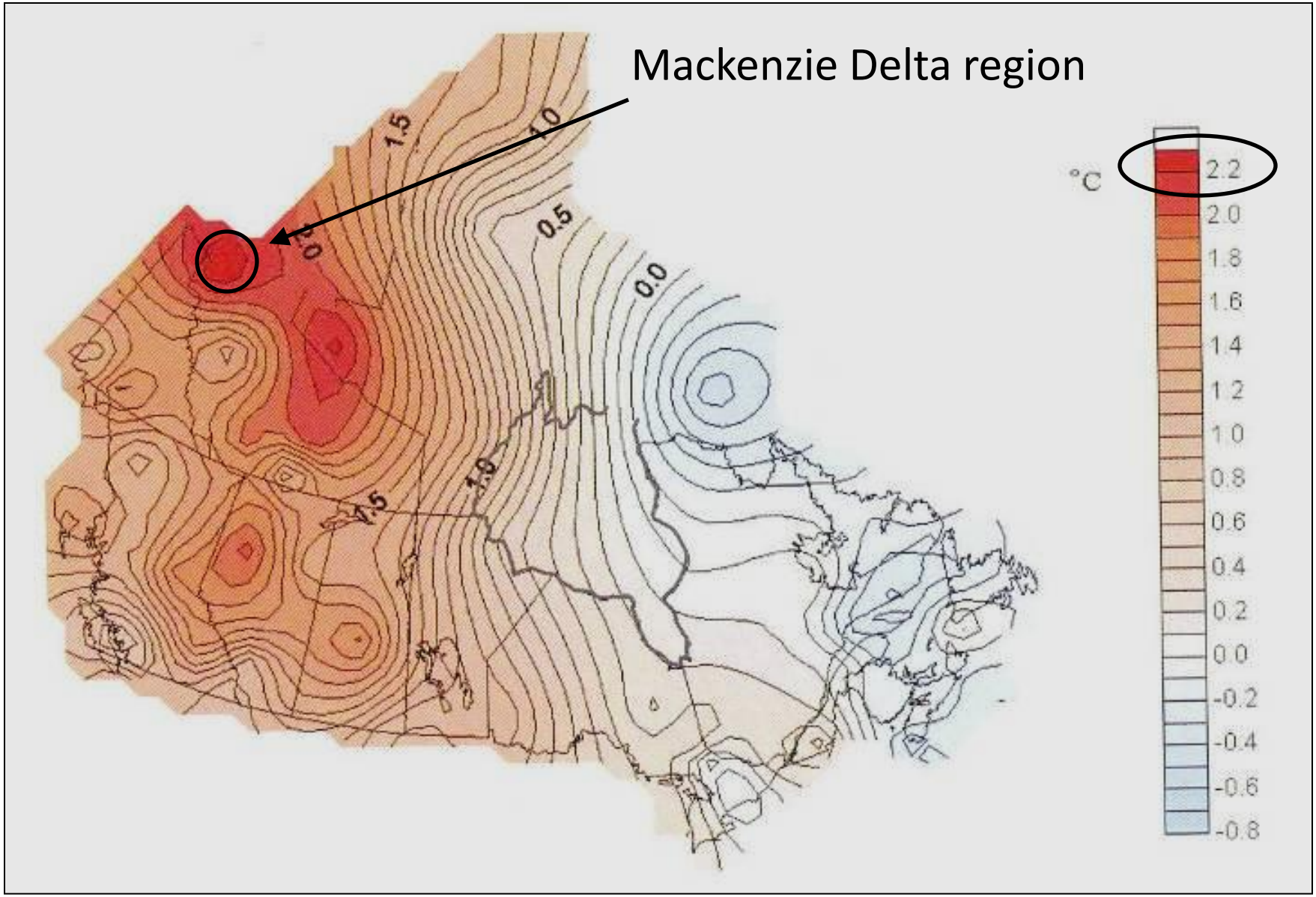


Climate warming and permafrost

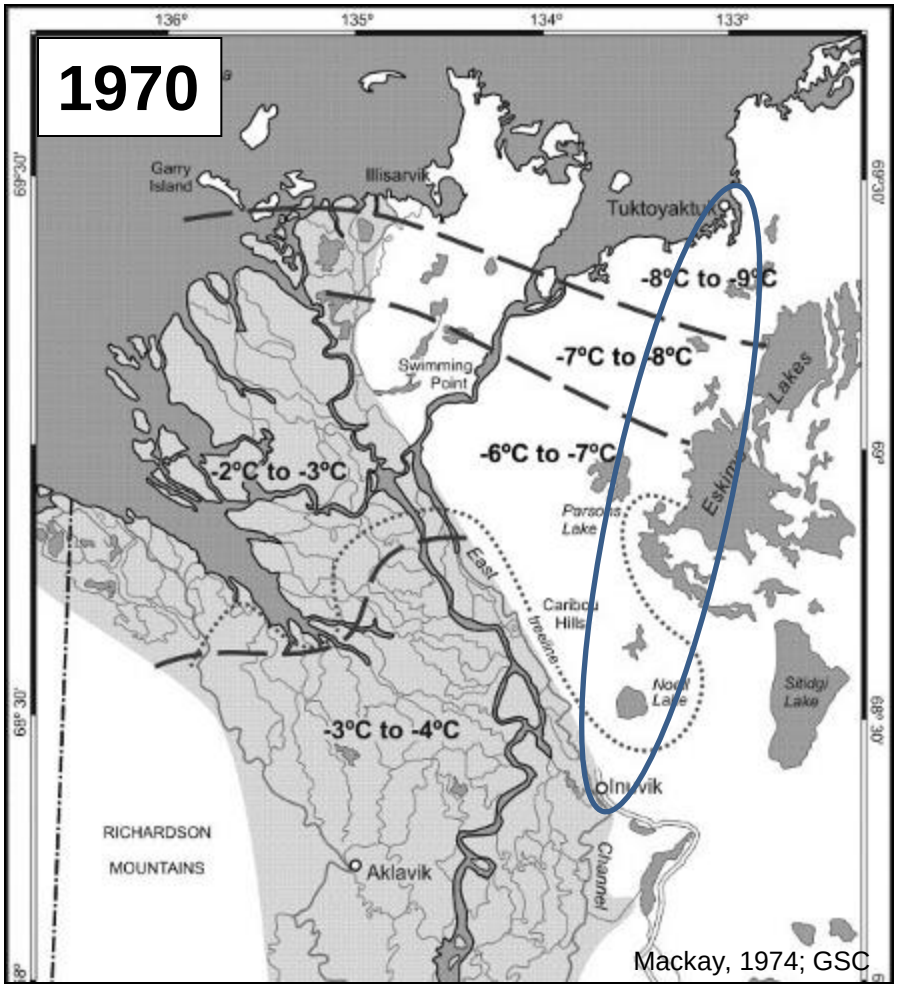




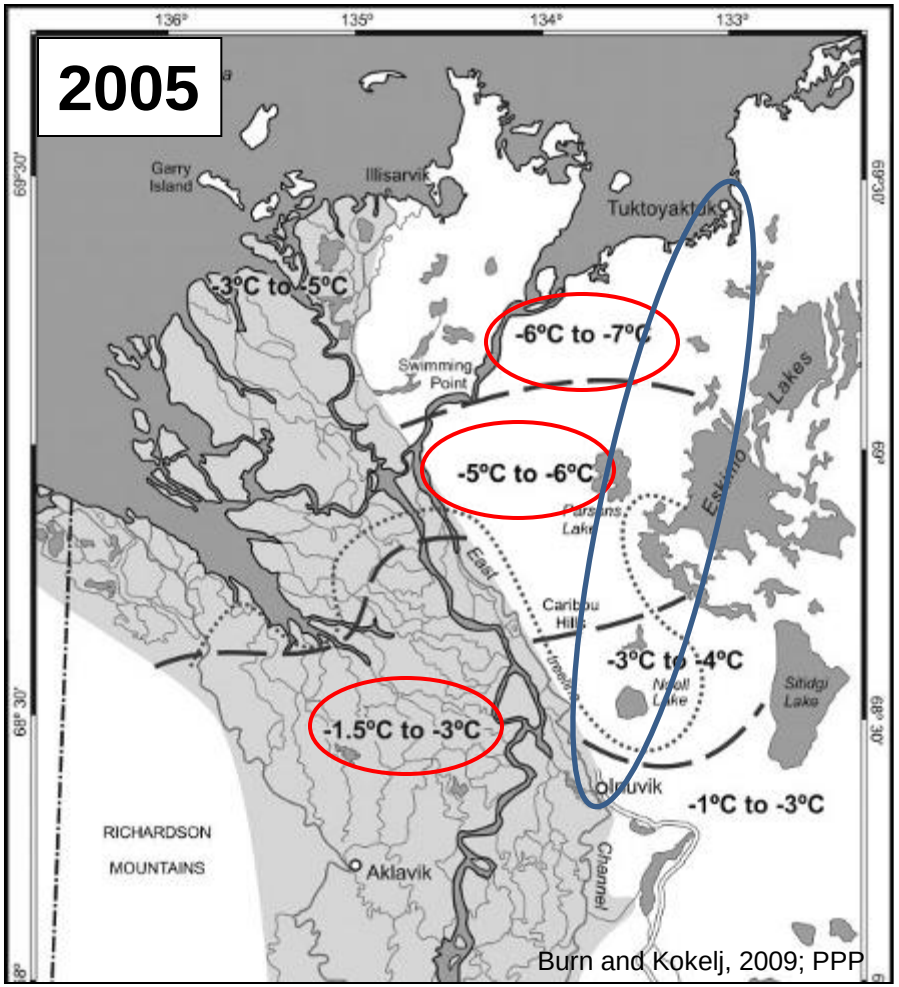
Observed changes in mean annual air temperature – 1948 to 2000



Climate warming and permafrost

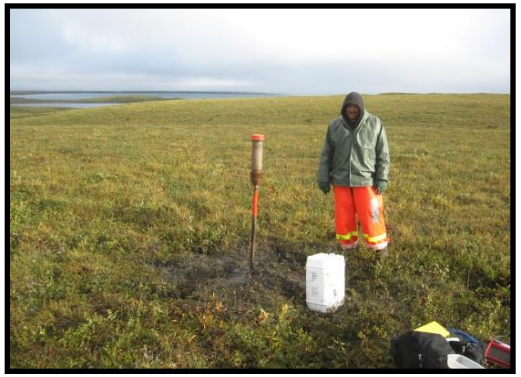


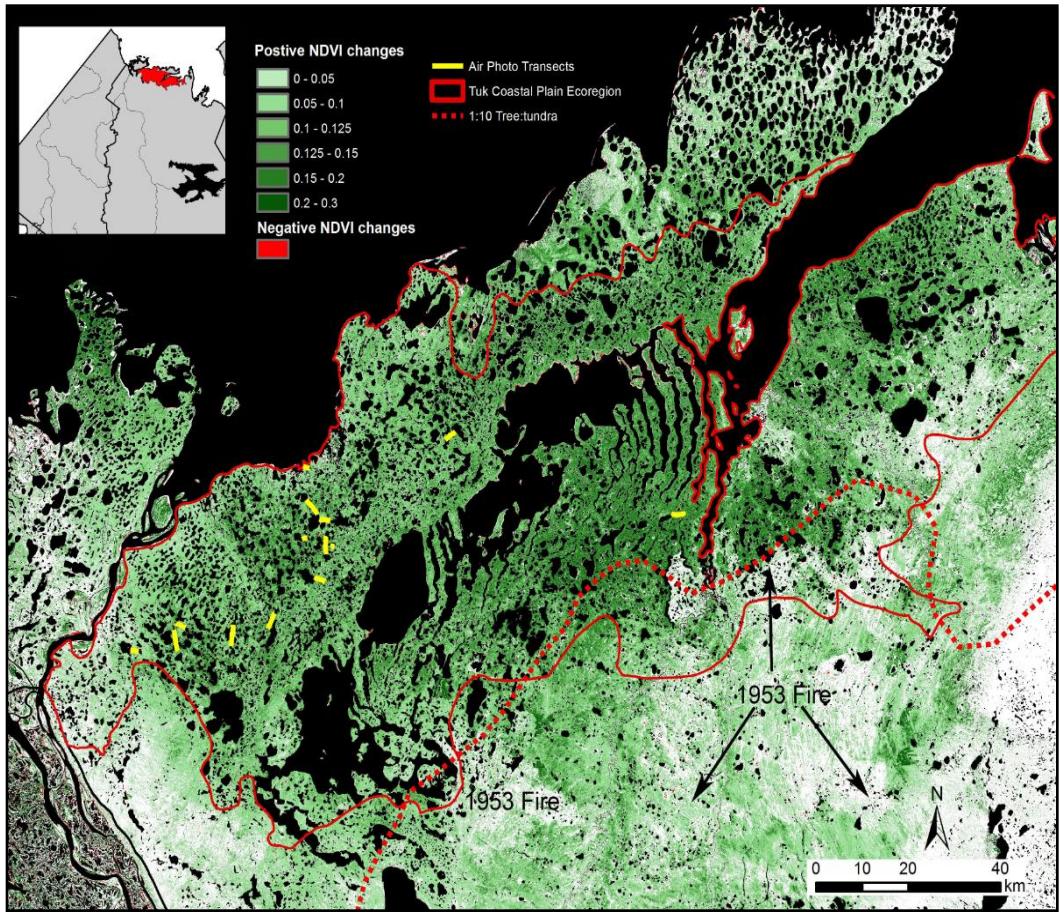
Mackay, 1974; GSC



Burn and Kokelj, 2009; PPP

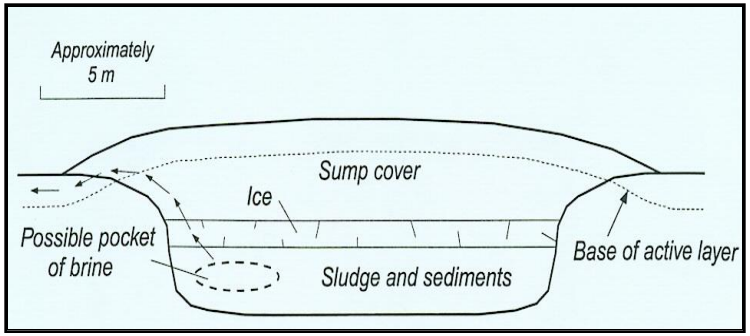
Climate warming and vegetation - Tundra greening

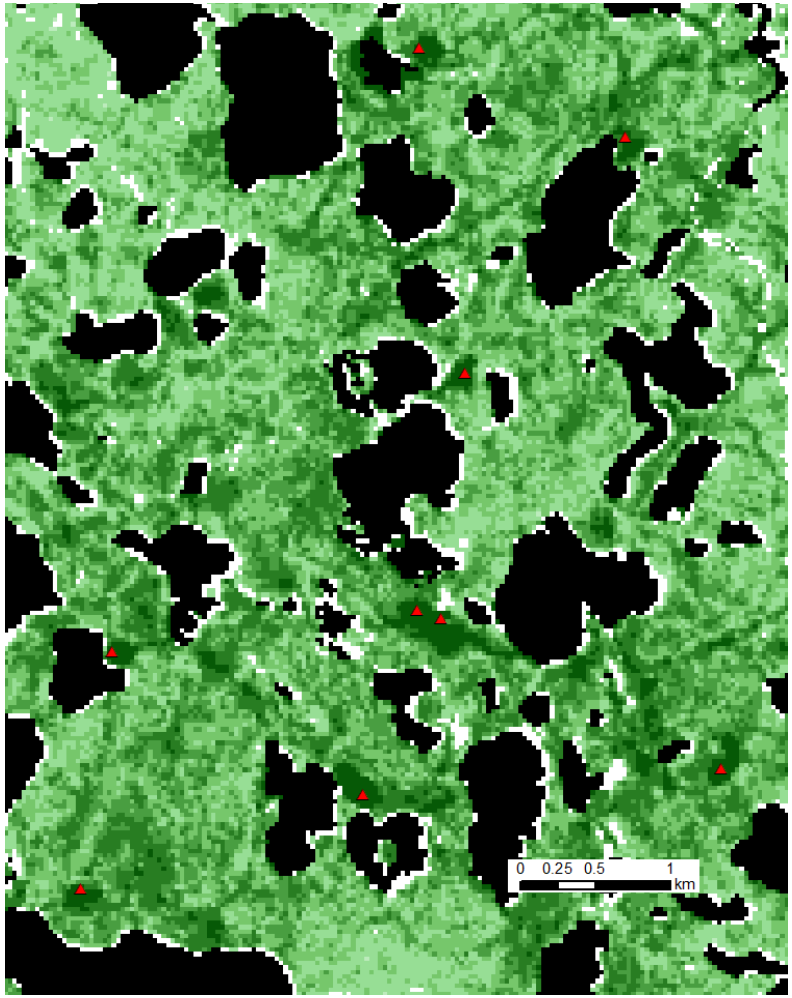




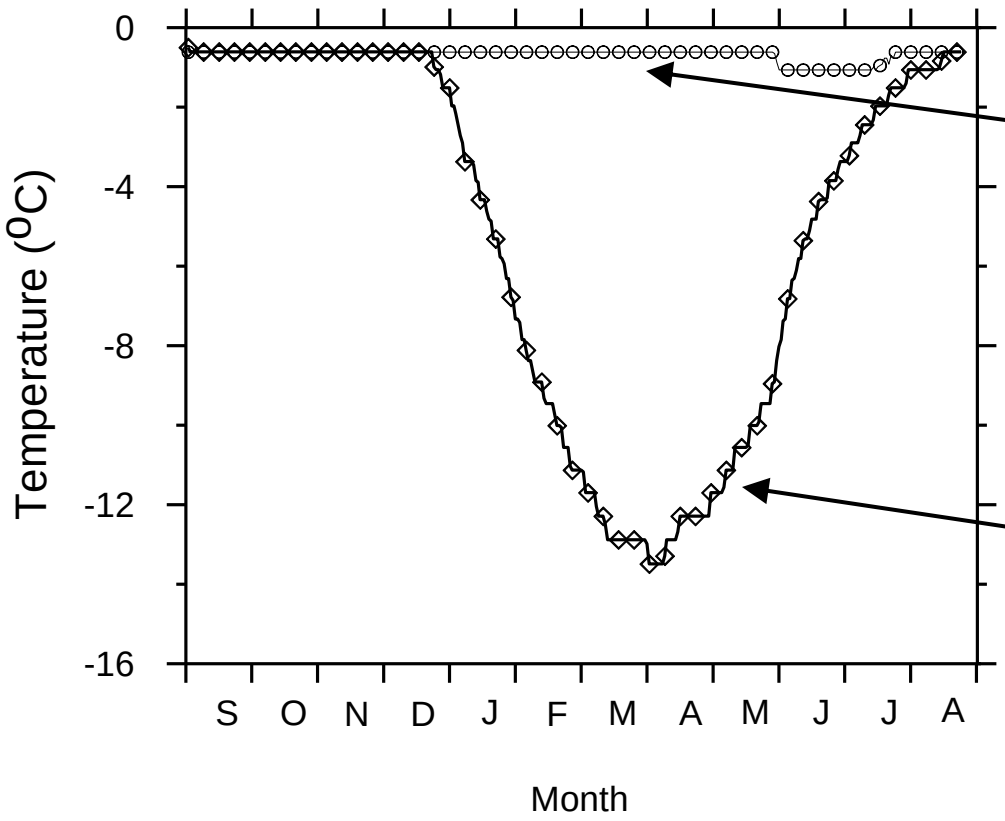
Fraser et al., in prep

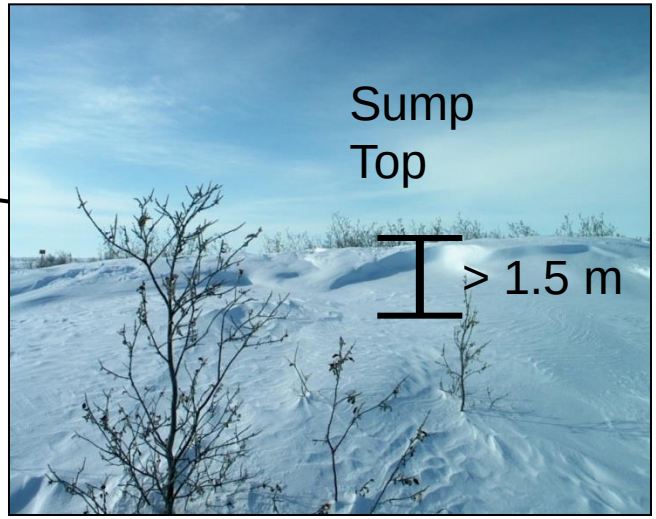
Greening at historical drilling leases

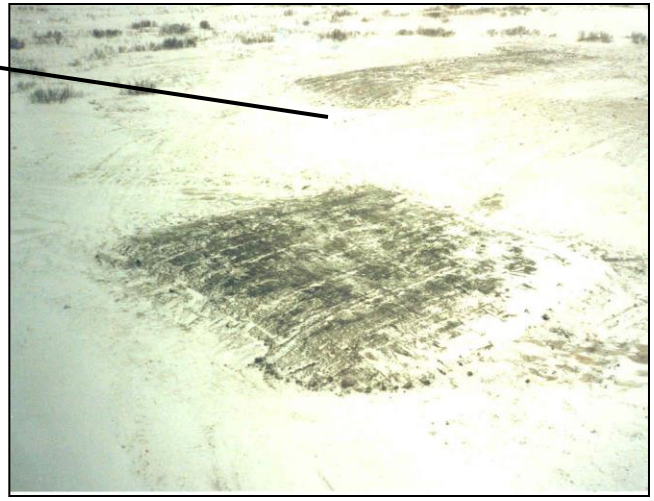




Permafrost temperatures in drilling waste sumps

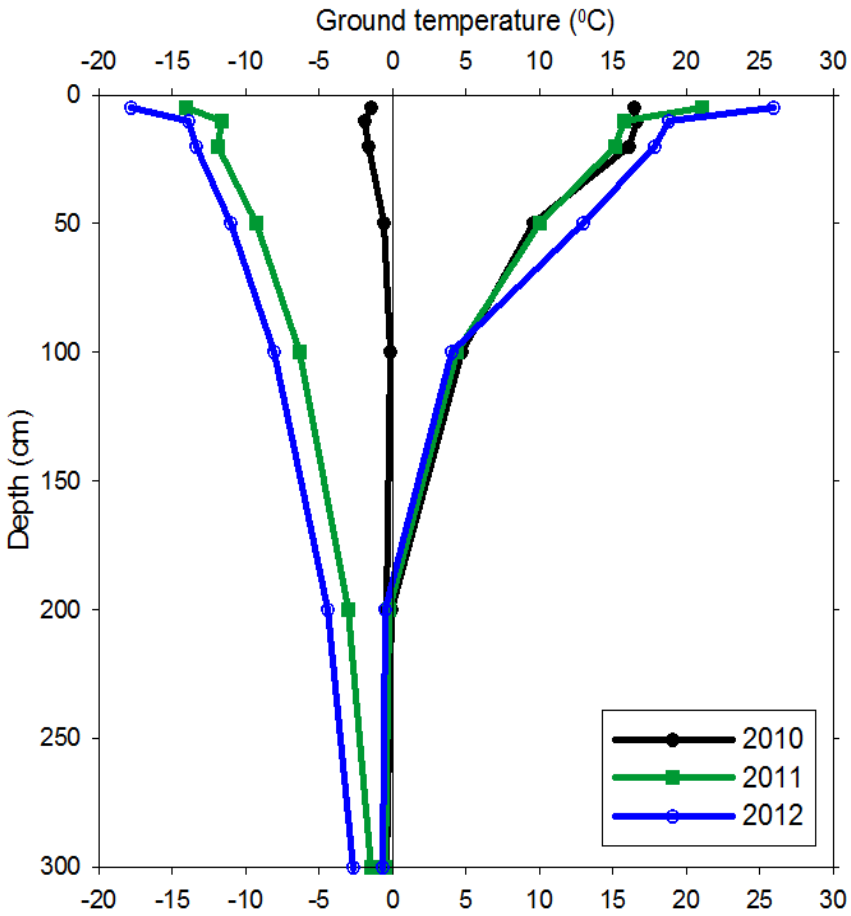




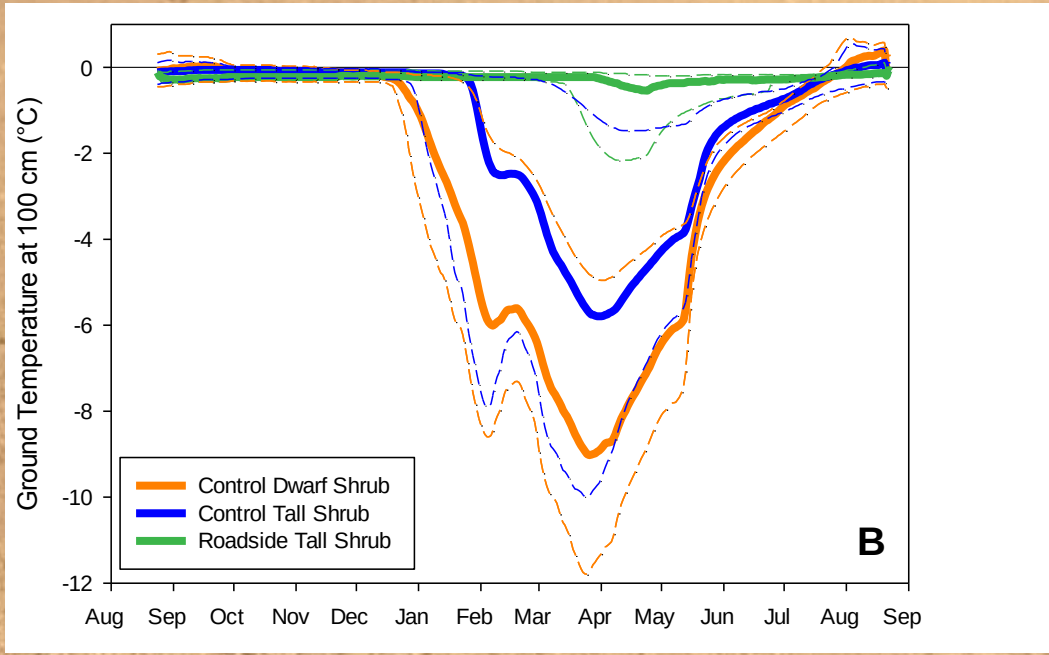


Stability – shrub growth - thawing

Remove shrubs and cool the permafrost



Dempster Hwy
↑ air temperatures + ↑shrub + ↑snow = rapidly warming permafrost



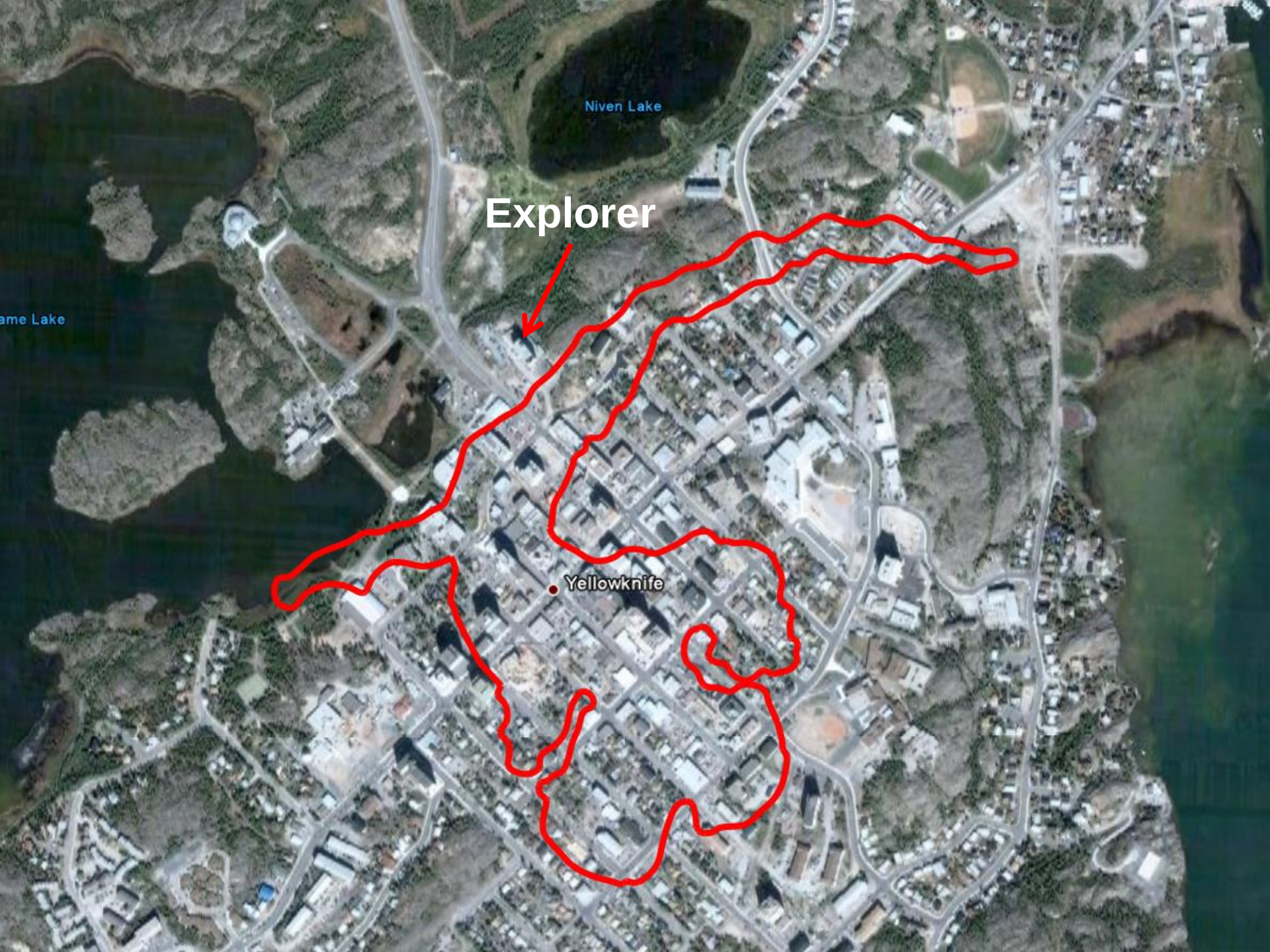
“The hills are getting really messy”

Robert Alexie, Fort McPherson

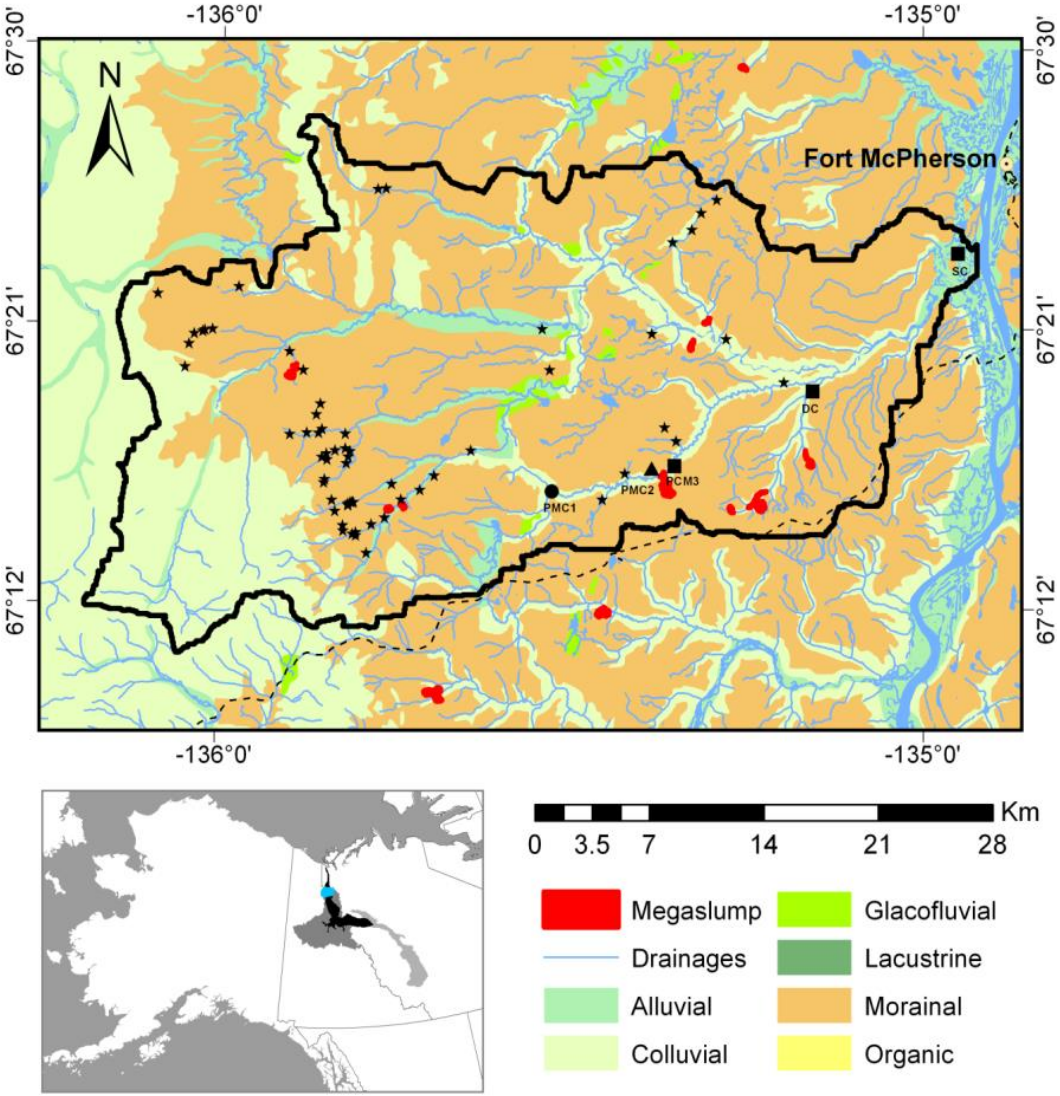
Immense thaw slumps in northwestern NWT

Massive ice in permafrost – buried glacier ice?

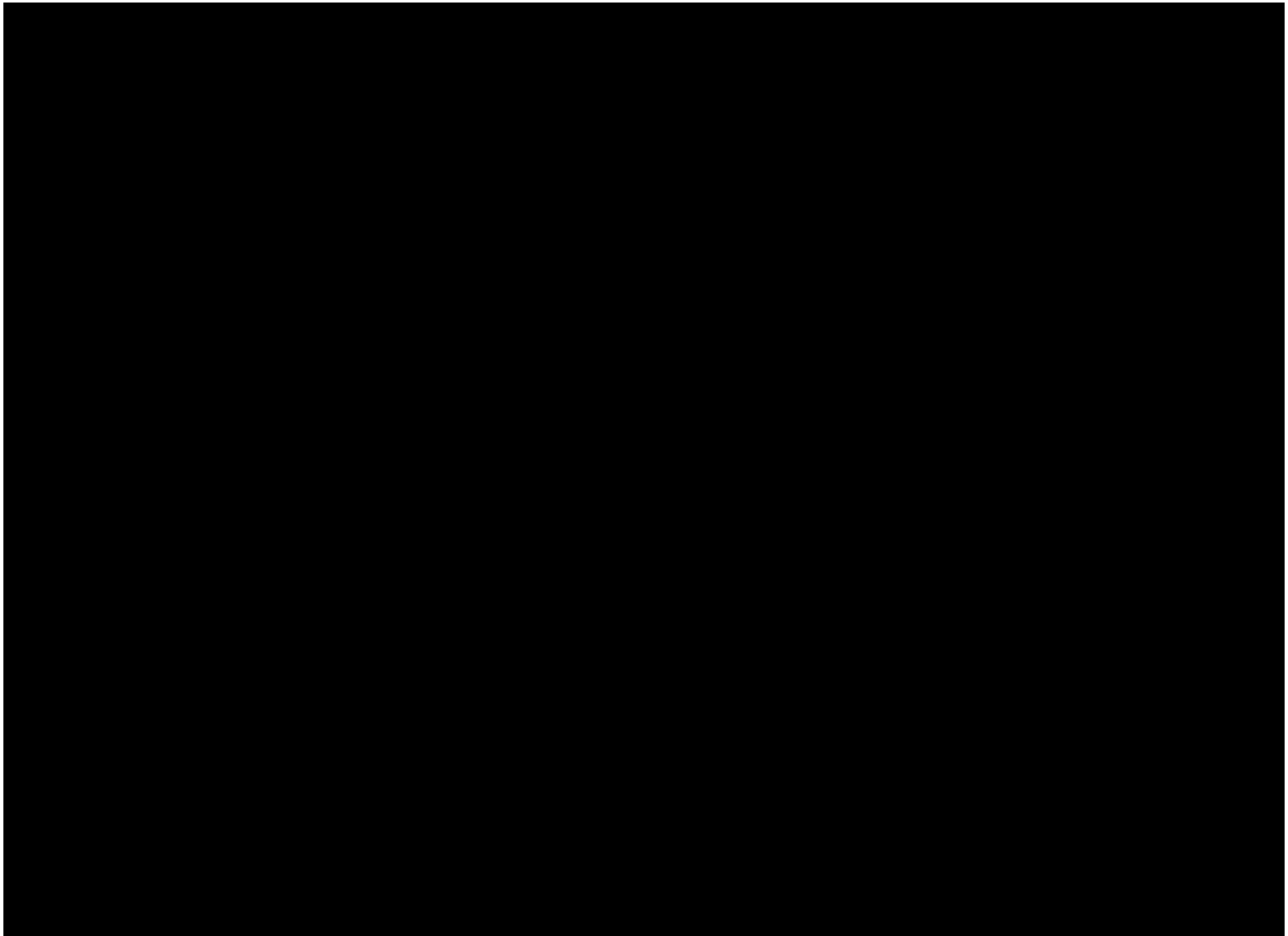
Debris flow infills stream valleys


Niven Lake
Explorer
ame Lake
Yellowknife

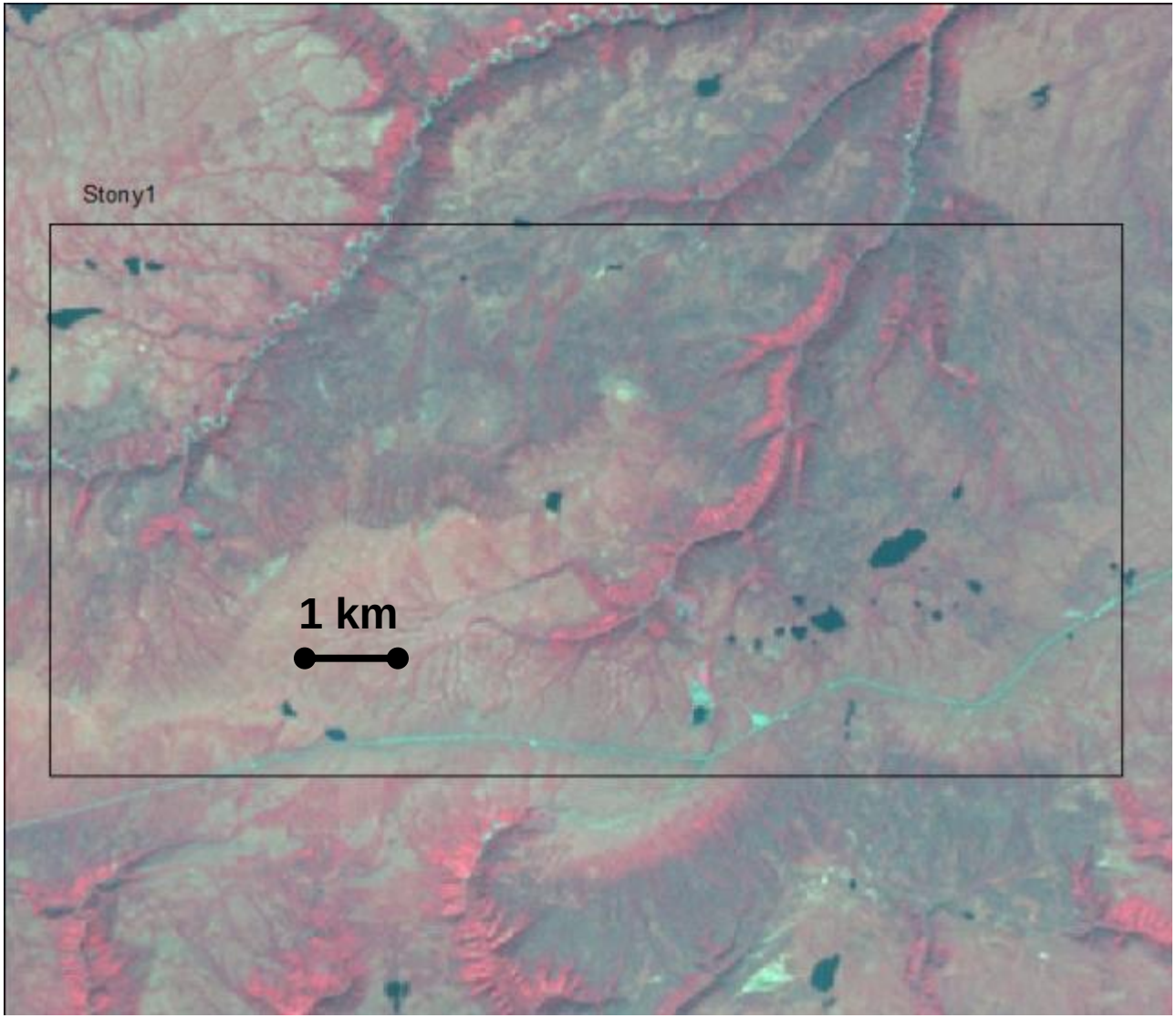
Peel Plateau



Slump video

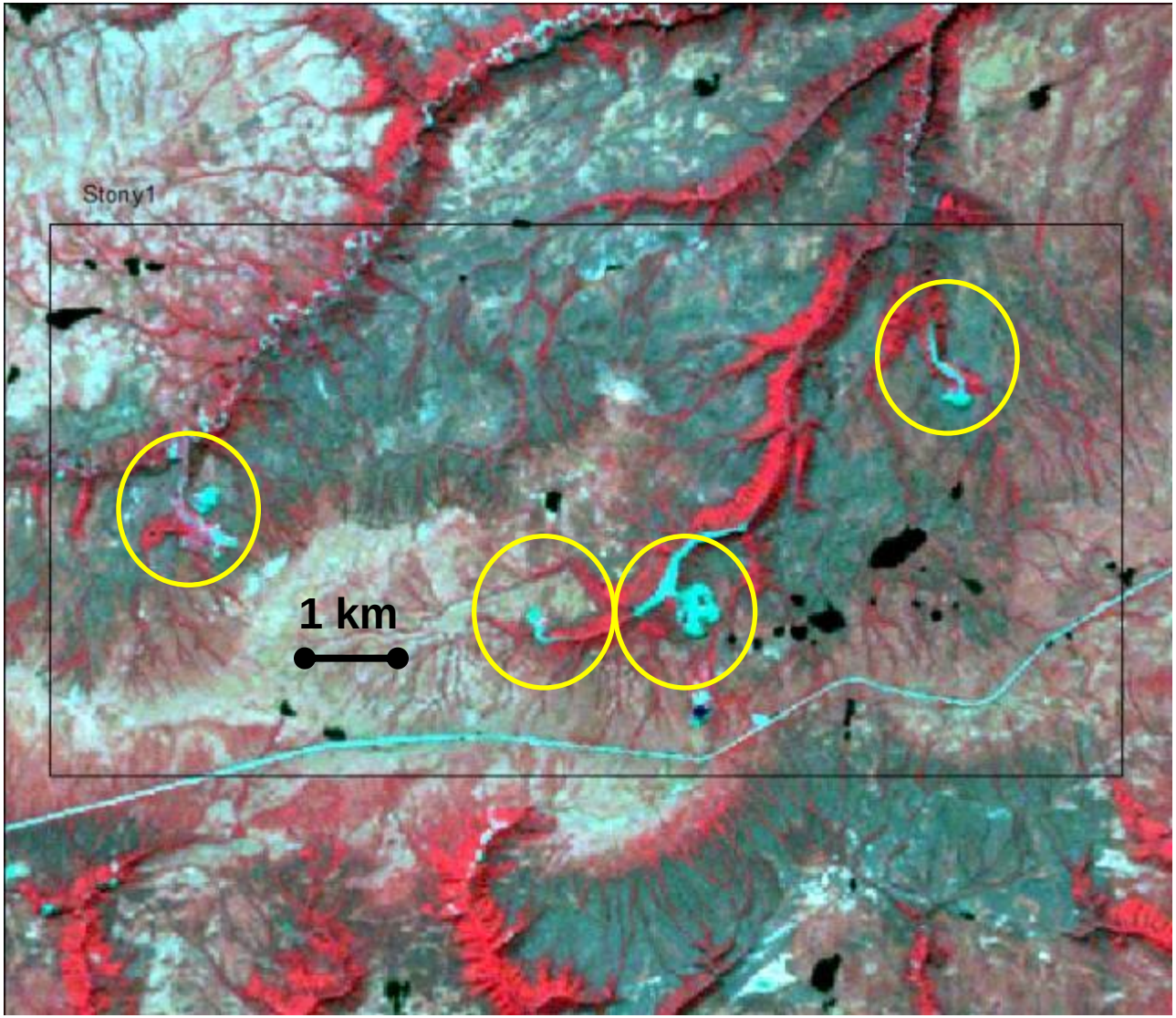


Peel Plateau 1985



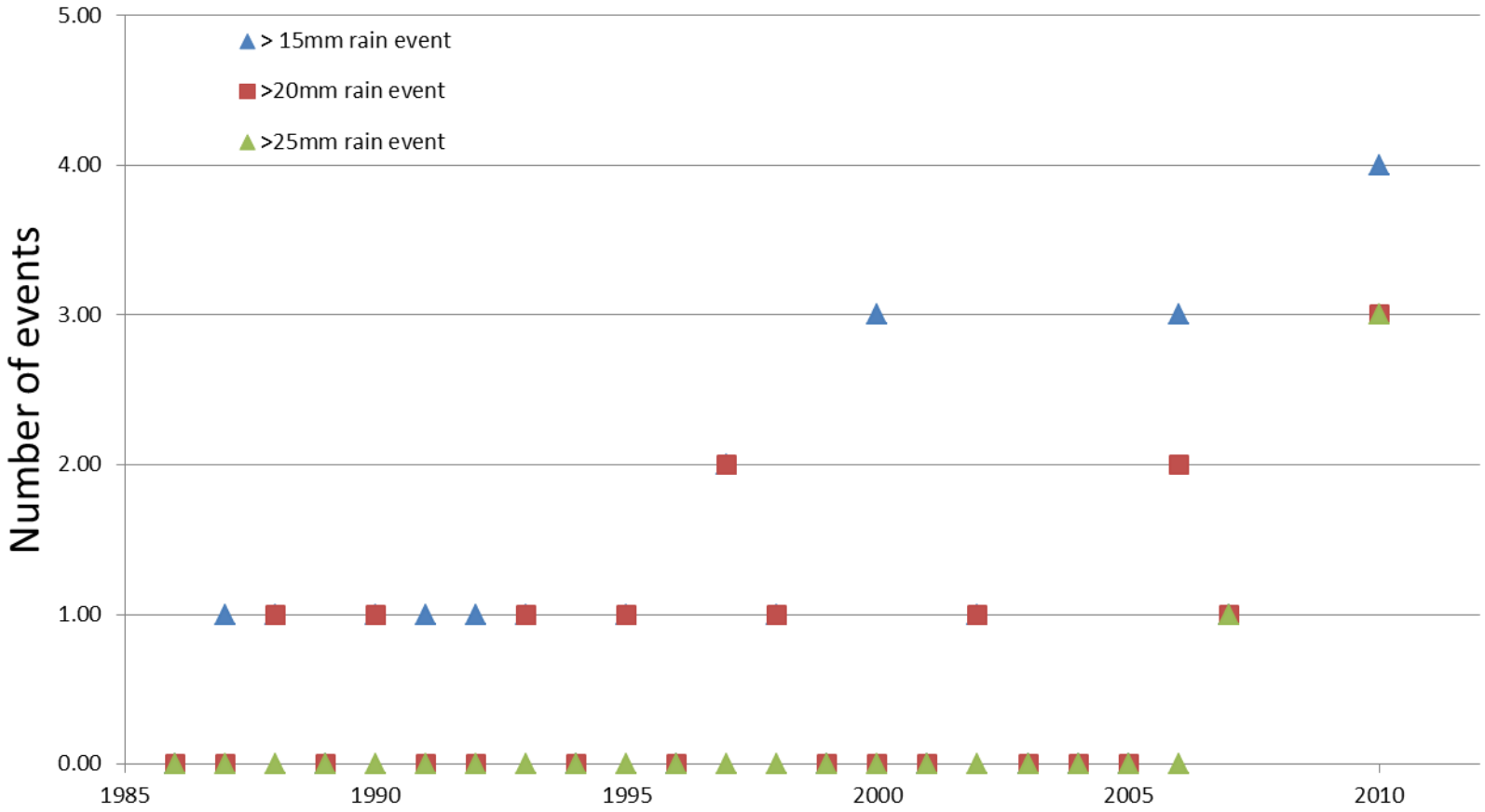
Stony 1_1985

Peel Plateau 2011

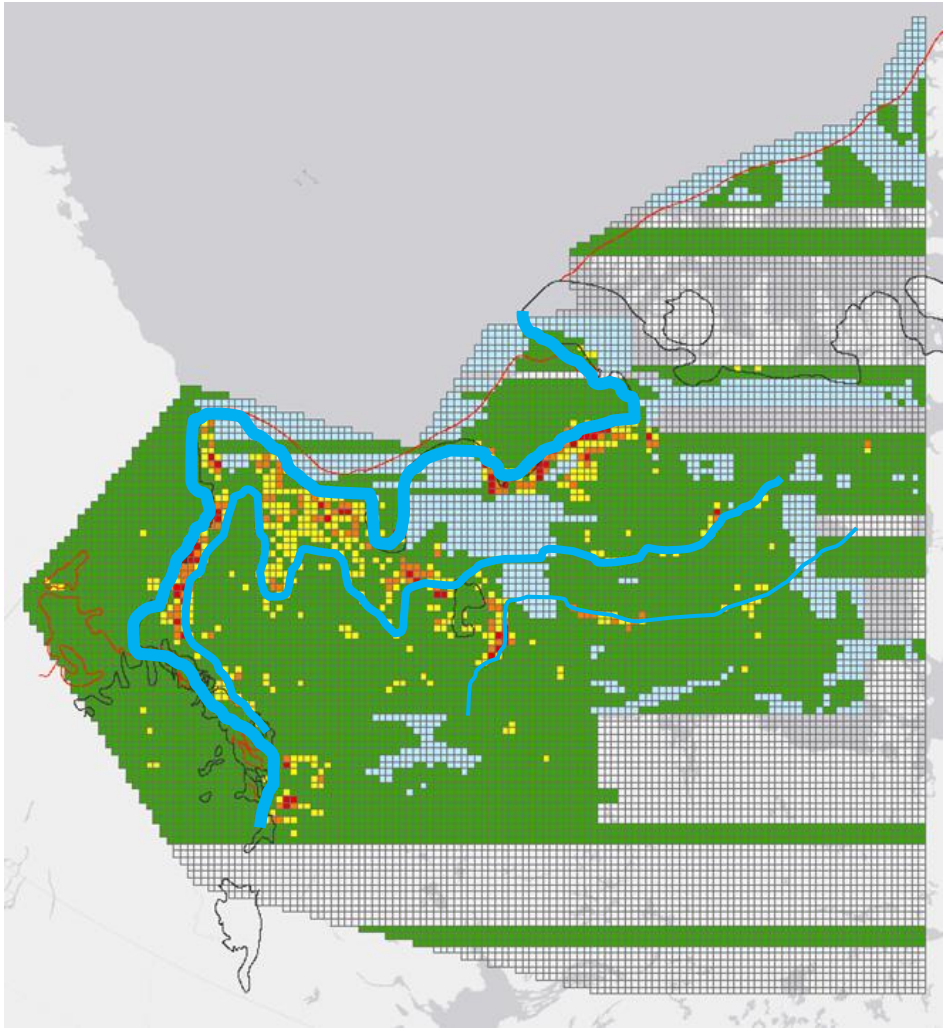


Stony 1_2011

More extreme rainfall events

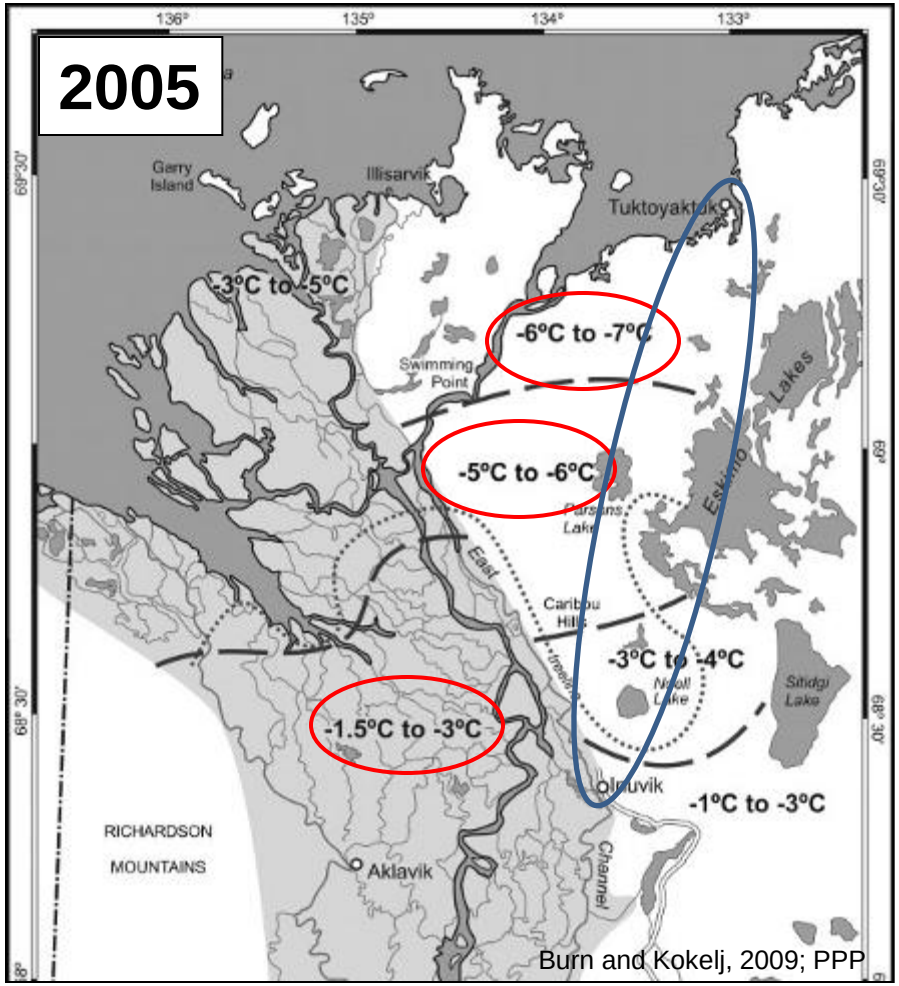


Distribution of ice-cored terrain



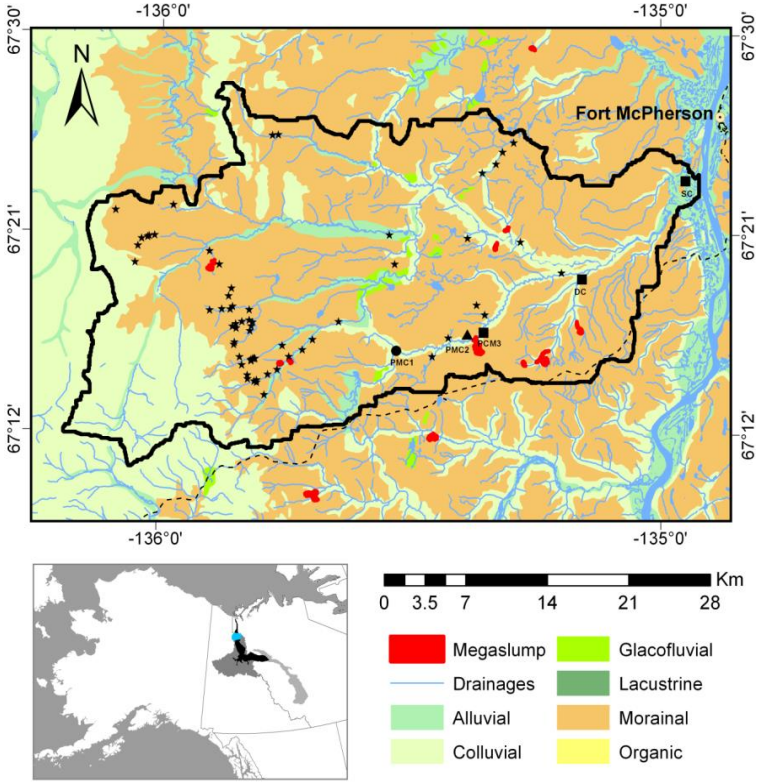
Conclusions

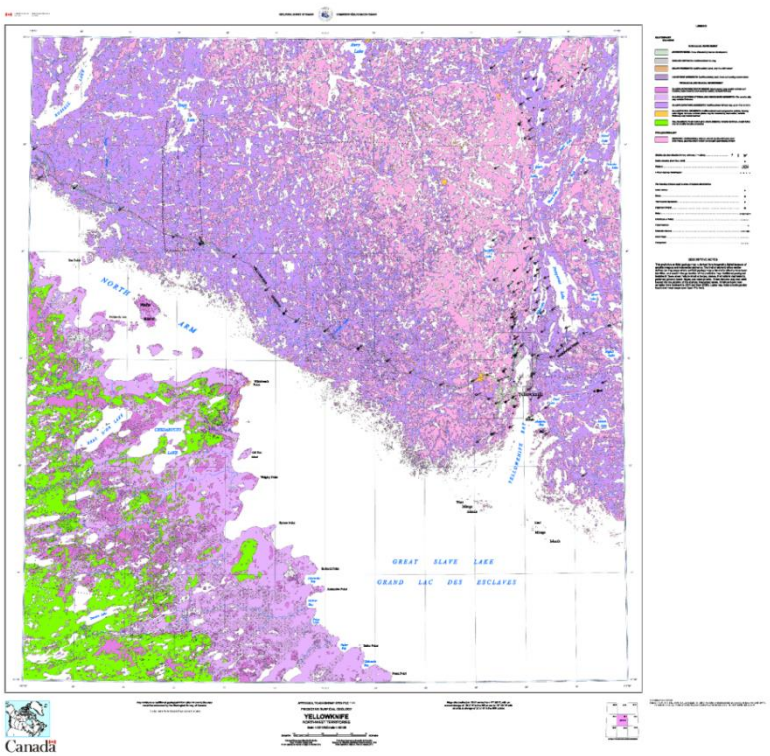
- Permafrost conditions are changing in response to climate warming



Conclusions

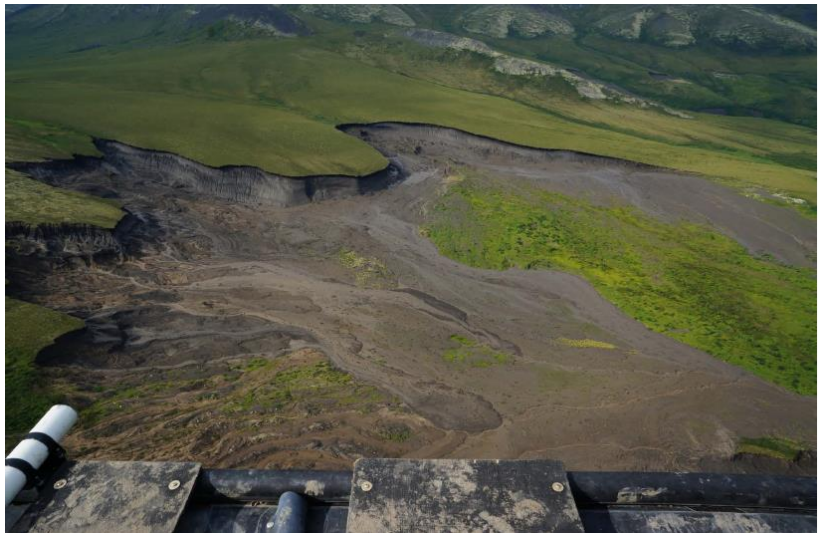
- Knowledge of the permafrost environment and the response to climate change will inform infrastructure planning and mitigation measures

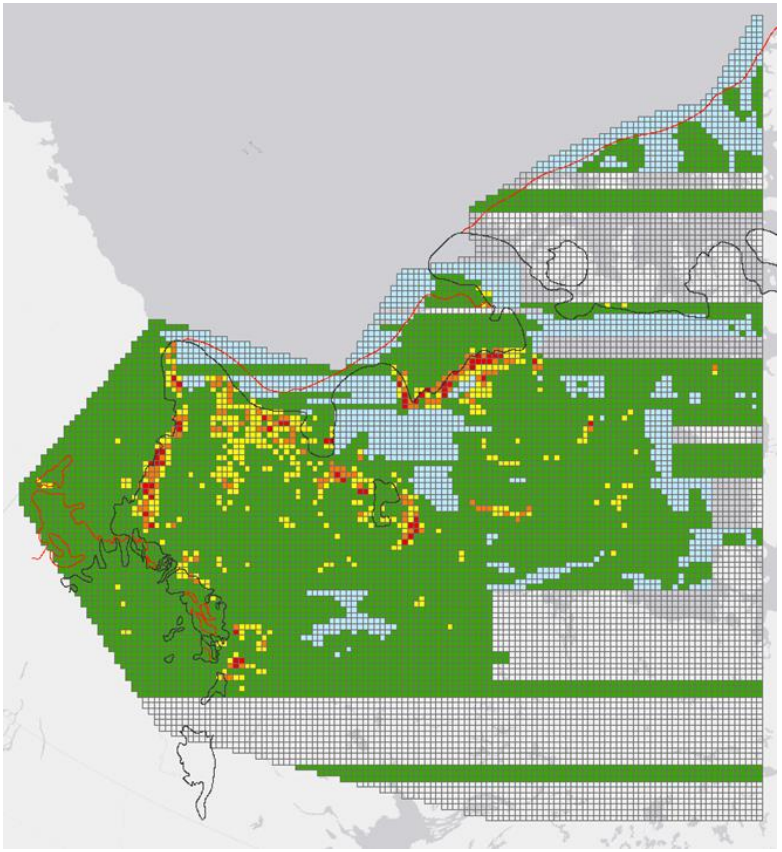




Conclusions

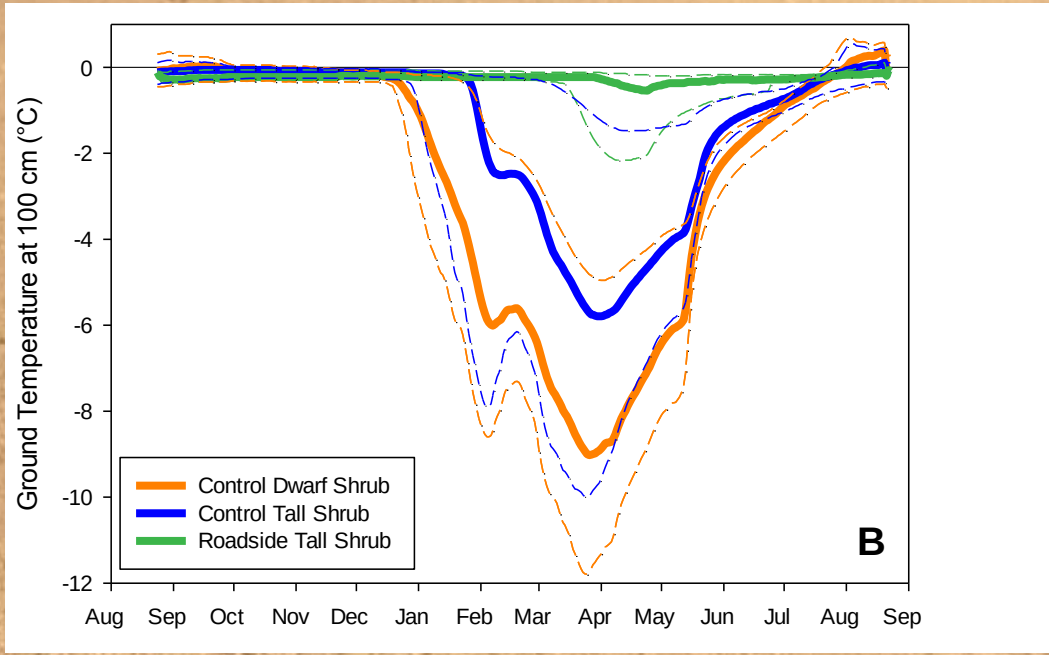
- Expect some surprises, consequence of a poor knowledge base will be bigger and more costly surprises





Conclusions

- Knowledge sharing and multidisciplinary approaches will lead to advances in knowledge and adaptation



Conclusions

- Resilience – build in flexibility and develop multiple options to deal with uncertainty