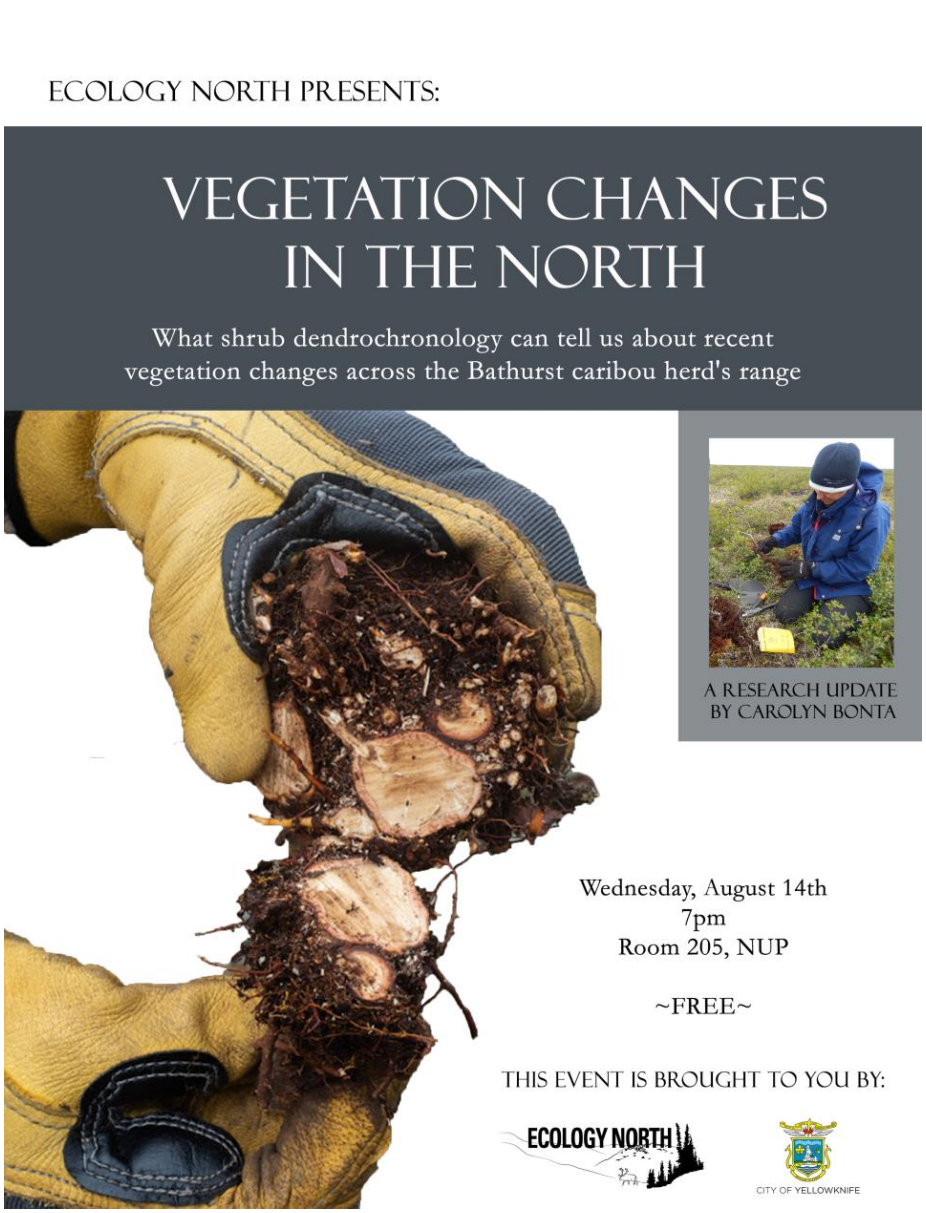


Carolyn Bonta is a Geography graduate student at Queen's University in Kingston. She has just returned from two months of fieldwork at the treeline-tundra transition zone.

What shrub dendrochronology can tell us about recent vegetation changes across the Bathurst caribou herd's range

Dendrochronology, the study of annual growth rings of woody vegetation, offers a means to decipher past growing conditions. With the pressure to understand the effects of climate on vegetation beyond the treeline, dendrochronology using shrubs is a rapidly-emerging and exciting new area of study. Here, I demonstrate how this technique can offer insights into a changing landscape that is critical to one of Canada's most rapidly-declining barren-ground caribou herds.

Vegetation Changes in the North

What shrub dendrochronology can tell us about Bathurst caribou range condition

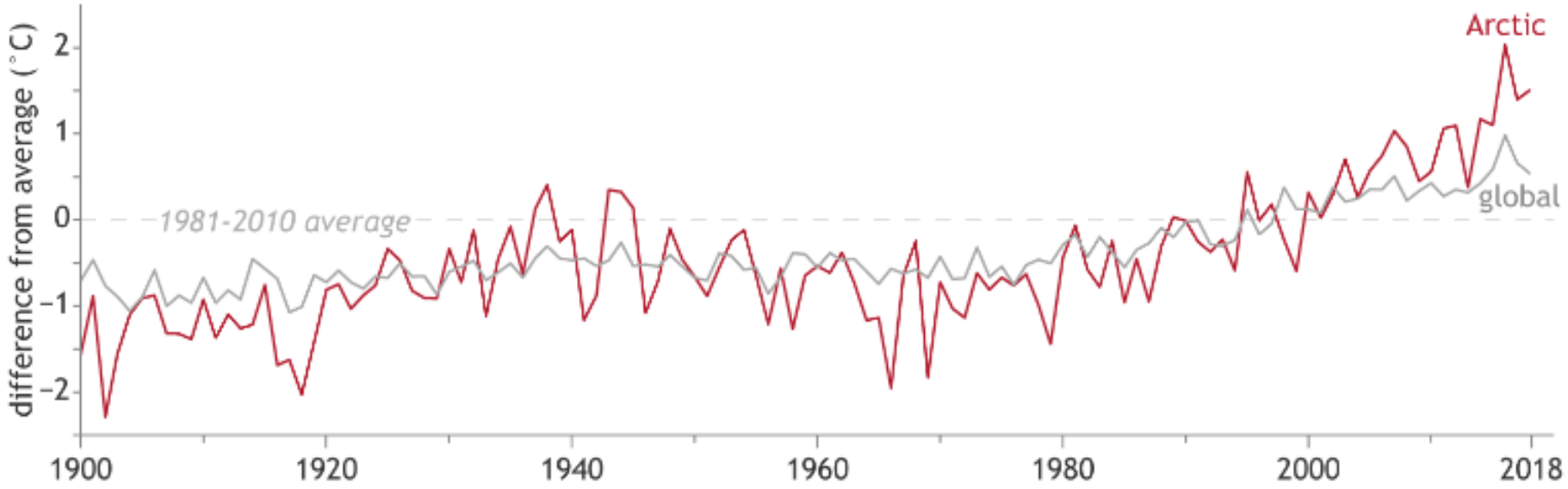
Carolyn Bonta

Science for the People
Ecology North – 14 August 2019

joelkoop.com

A Warming Arctic Climate

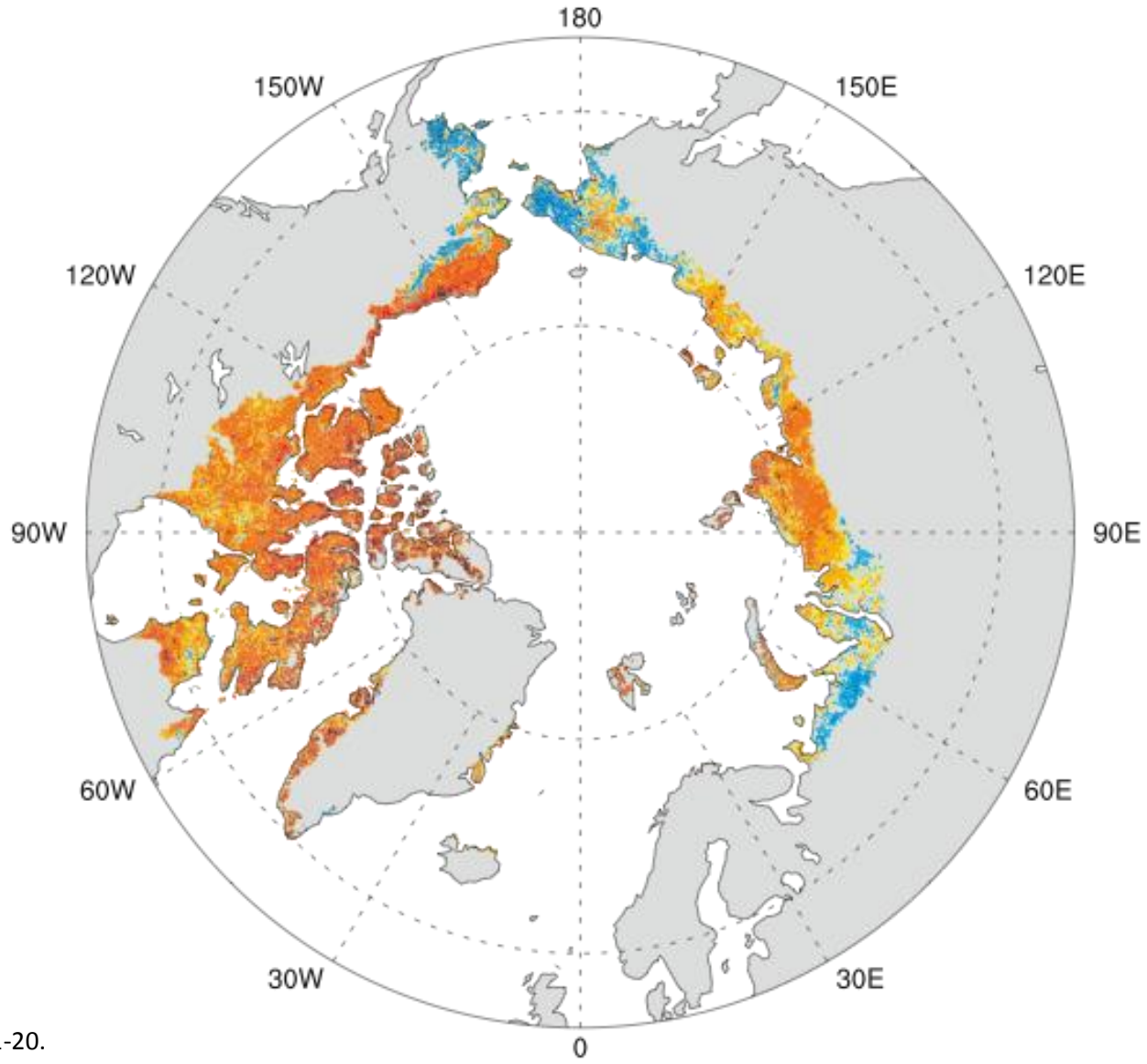
- Arctic temperatures increasing at *twice* the rate of the global average!
- Multi-year stretch of record / near-record warmth unlike any other period on record.



Source: NOAA Climate.gov, adapted from the 2018 Arctic Report Card. https://www.climate.gov/news-features/featured-images/2018-arctic-report-card-multi-year-stretch-record-and-near-record

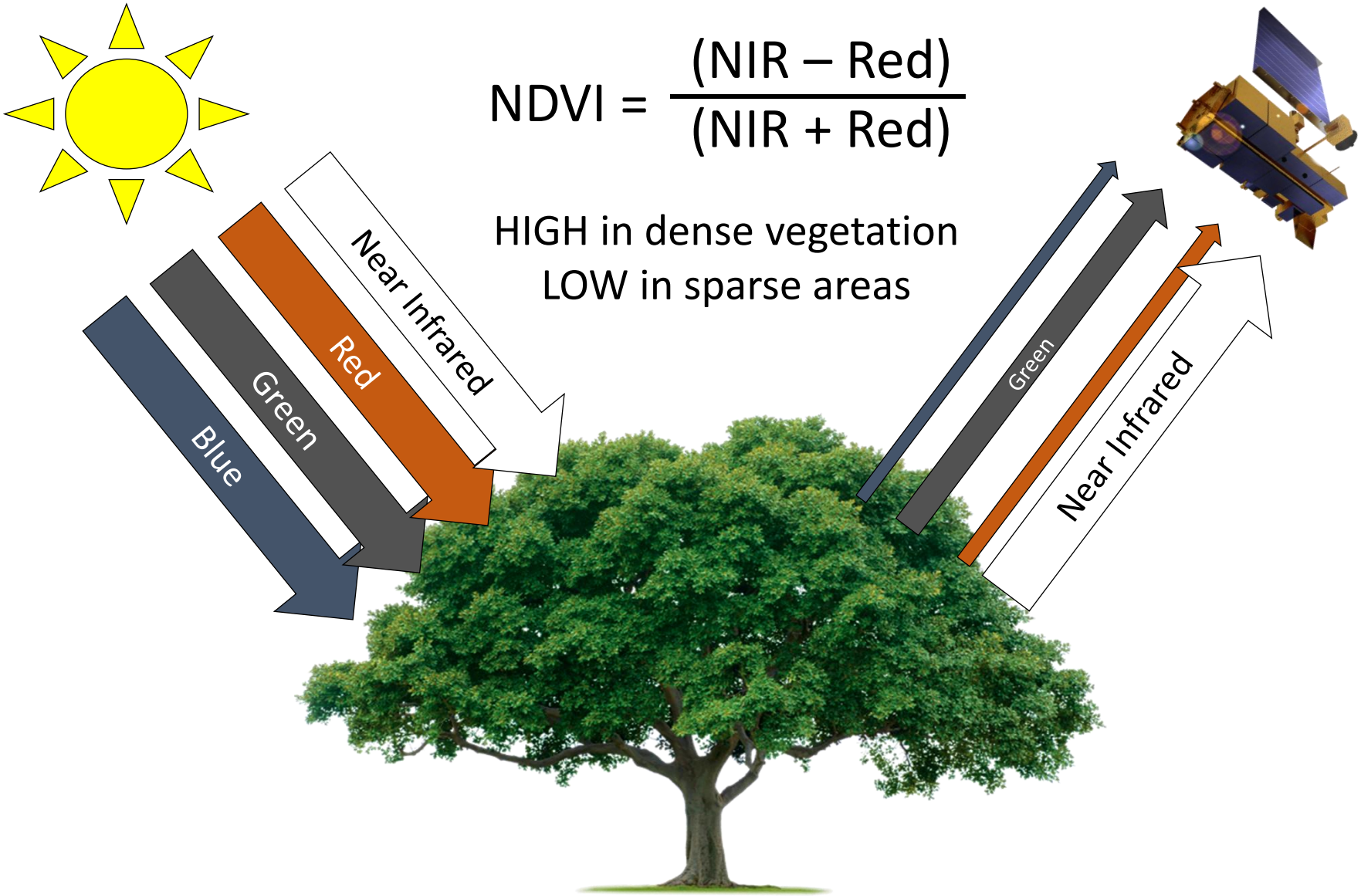
Changing Arctic Vegetation Patterns

Maximum NDVI
Percent change
1982-2008



Source: Bhatt et. al. (2010) Earth Interactions, 14:1-20.

Vegetation Productivity



Remotely-sensed Productivity

Source: *NASA's Goddard Space Flight Center/Cindy Starr, www.nasa.gov/feature/goddard/2016/nasa-studies-details-of-a-greening-arctic*

On-the-Ground Productivity

Sources: Tremblay et al. (2012) Environmental Research Letters, 7: 035501.

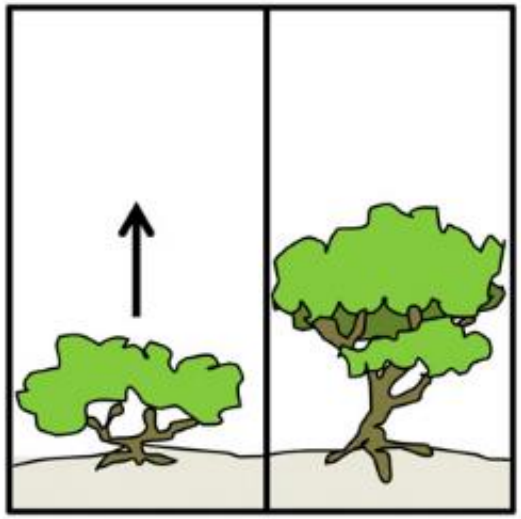
Fraser et al. (2011) Environmental Research Letters, 6: 045502

Shrub Expansion

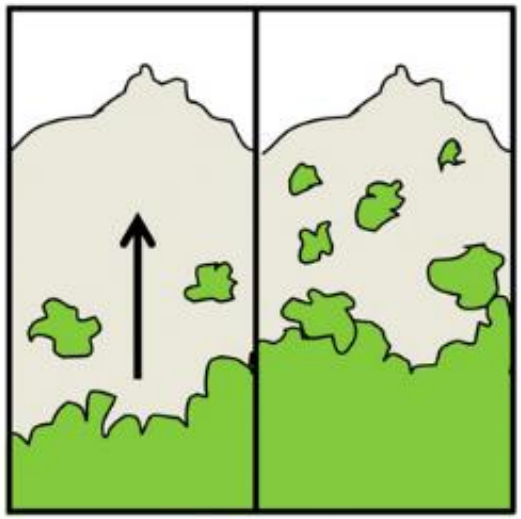
"Arctic Greening" = shrubs!

- Change in size: Larger individuals
- Change in number: Colonizing new areas
- Change in size and number: Increasing density ("infilling")

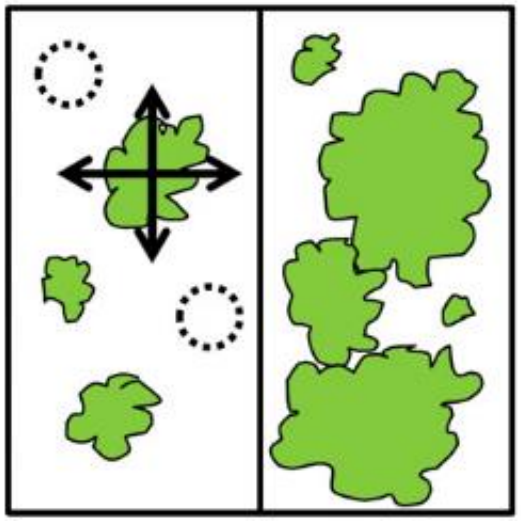
LARGER SHRUBS



COLONIZATION



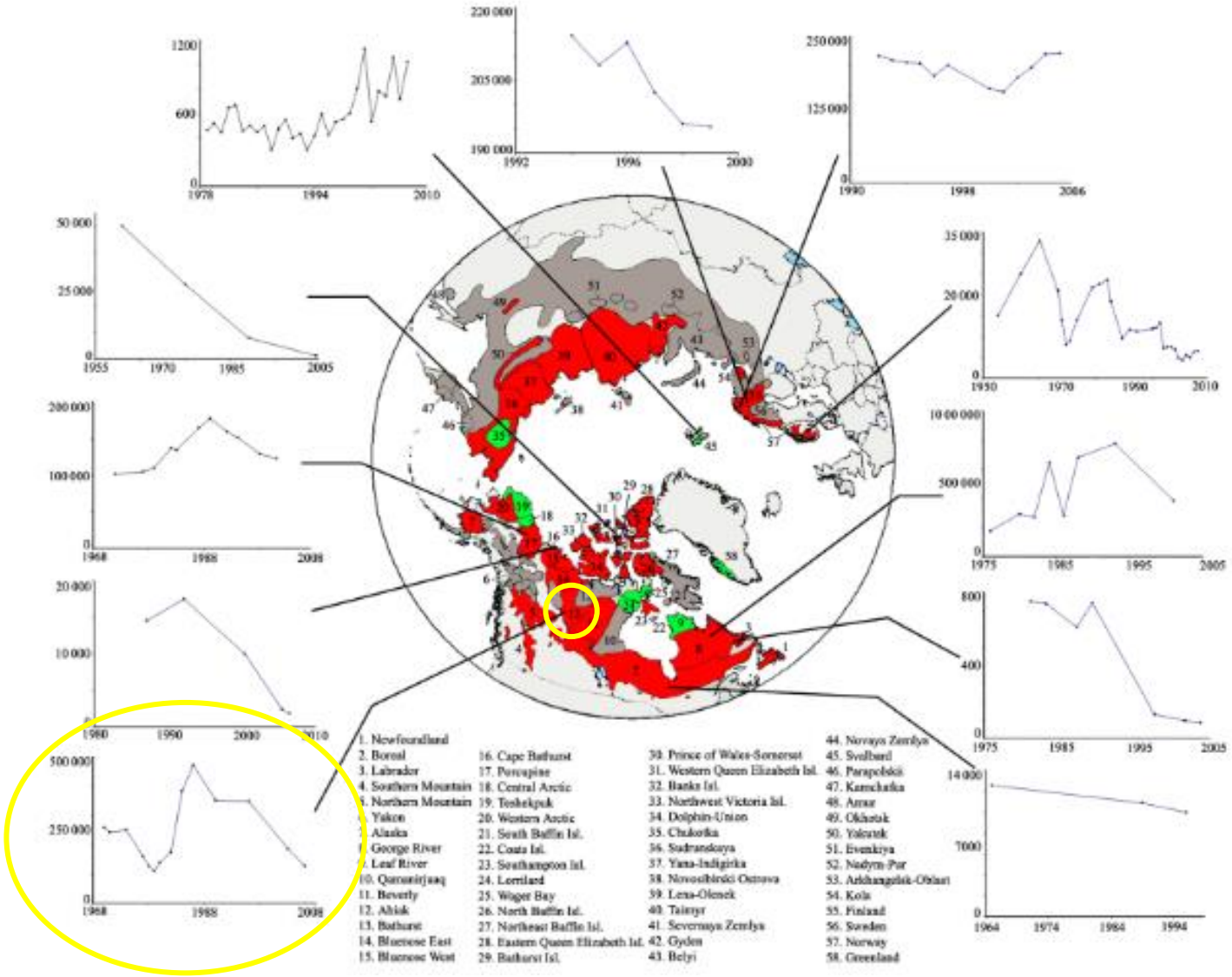
INFILLING



Source: Myers-Smith et. al. (2011) Environmental Research Letters, 6: 45509.

Barren-Ground Caribou

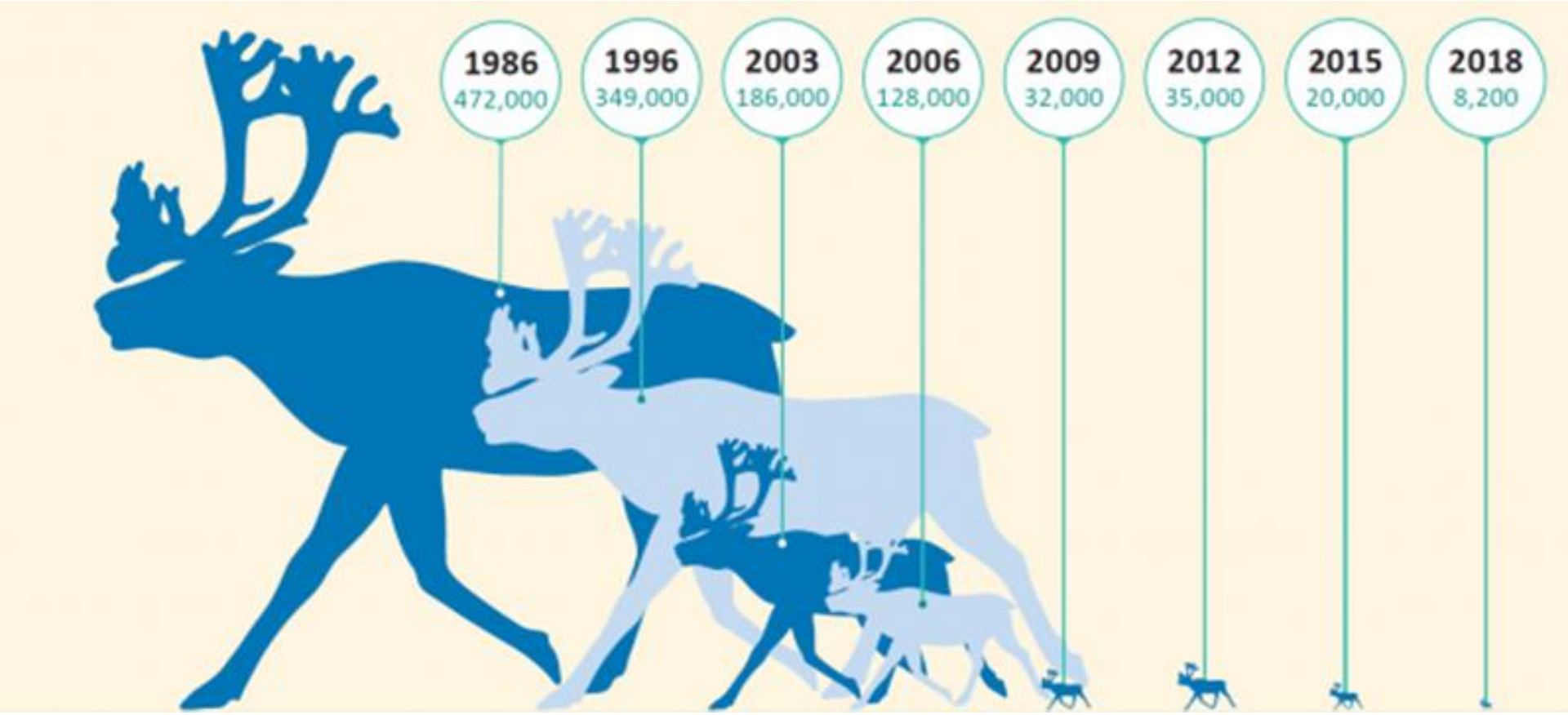
Global Caribou Declines



Source: Vors and Boyce (2009) Global Change Biology, 14: 2626.

Bathurst Caribou Herd

- One of the most steeply-declining herds in Canada: 99% decline since 1986



Source: Government of the Northwest Territories, www.enr.gov.nt.ca/en/services/barren-ground-caribou/bathurst-herd

Research Hypothesis

Increased vegetation productivity on the Bathurst caribou range is the result of a change in the structure, composition, and/or growth of shrubs in response to climate change.

Research Questions

Plant level:

Influence of climate on tree and shrub growth.

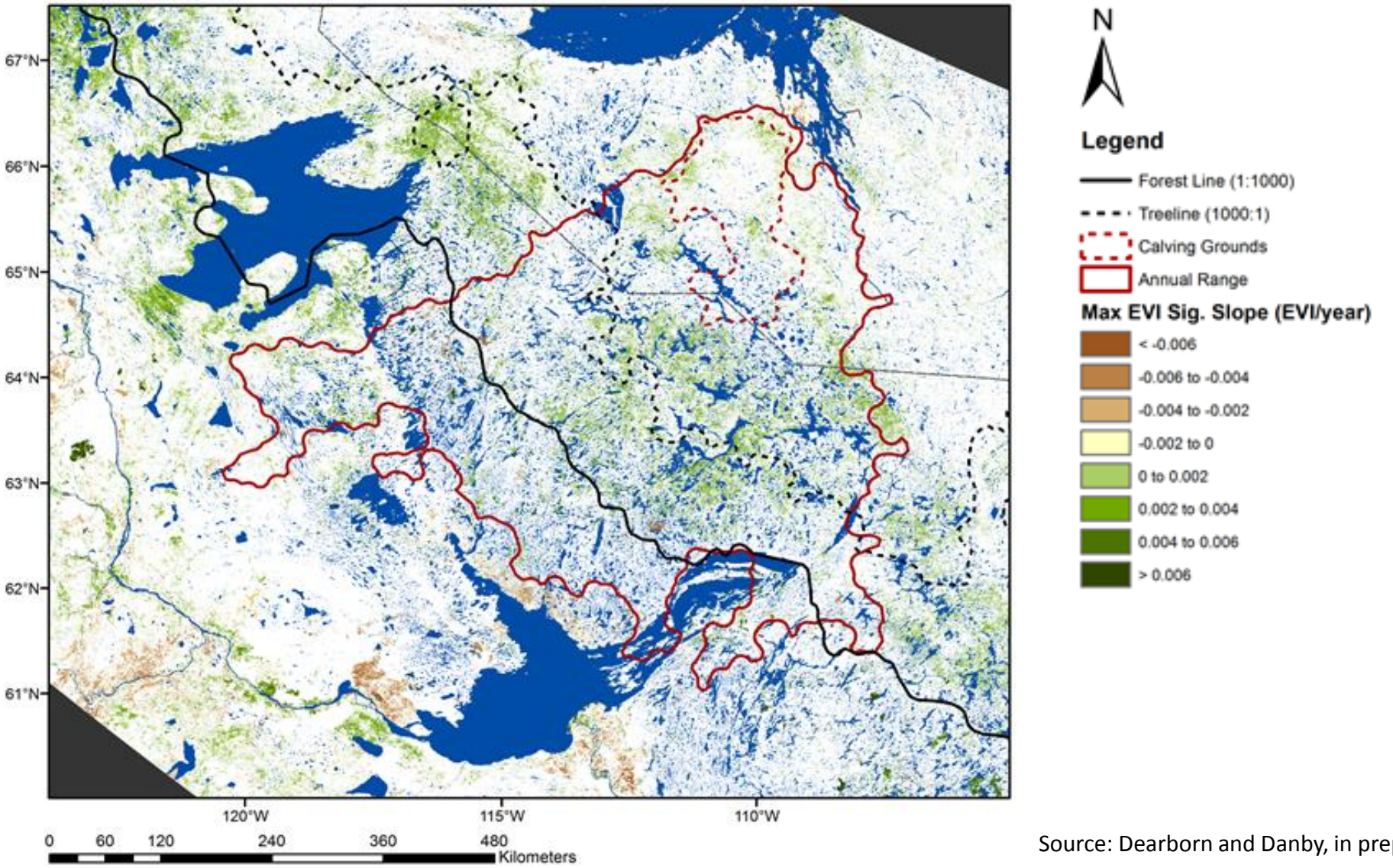
Population level:

Abundance and distribution of erect deciduous shrubs.

Community level:

Susceptibility to greening of different types of vegetation, particularly those which are caribou forage.

Study Area: Bathurst Herd Range

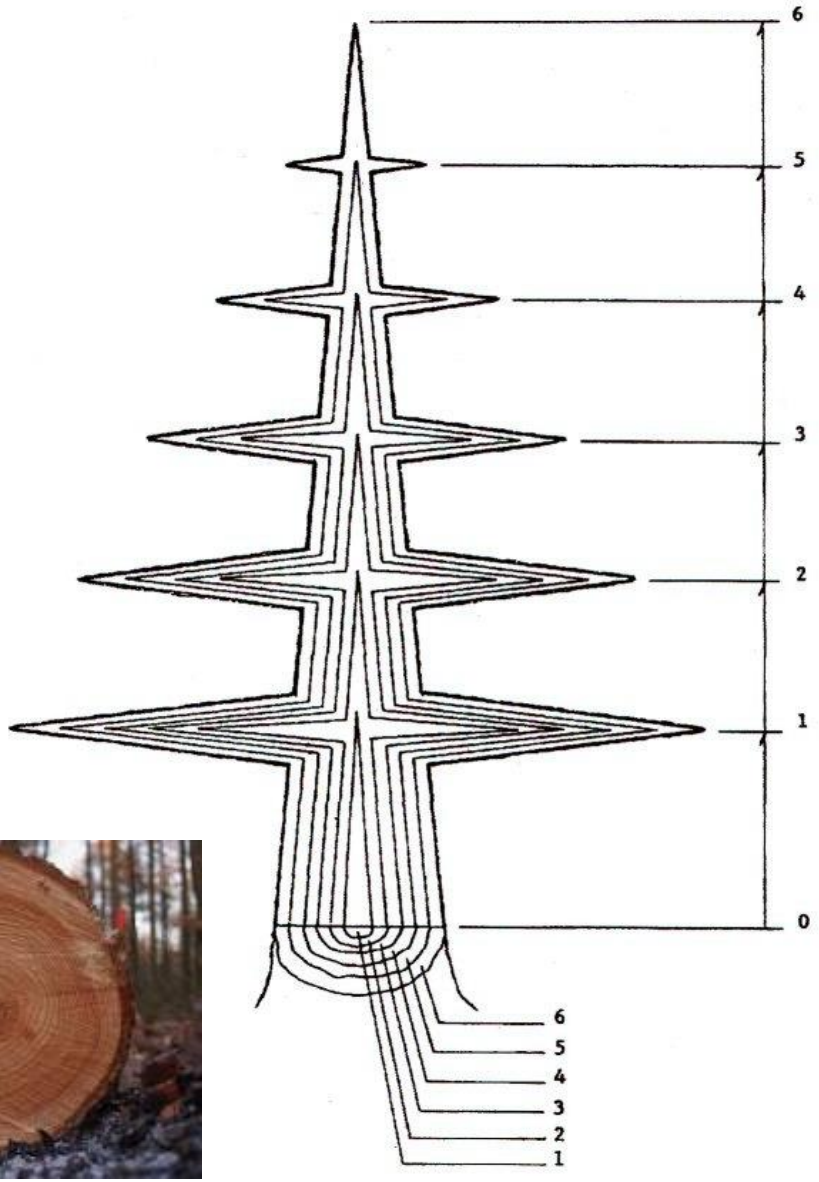


Source: Dearborn and Danby, in prep.

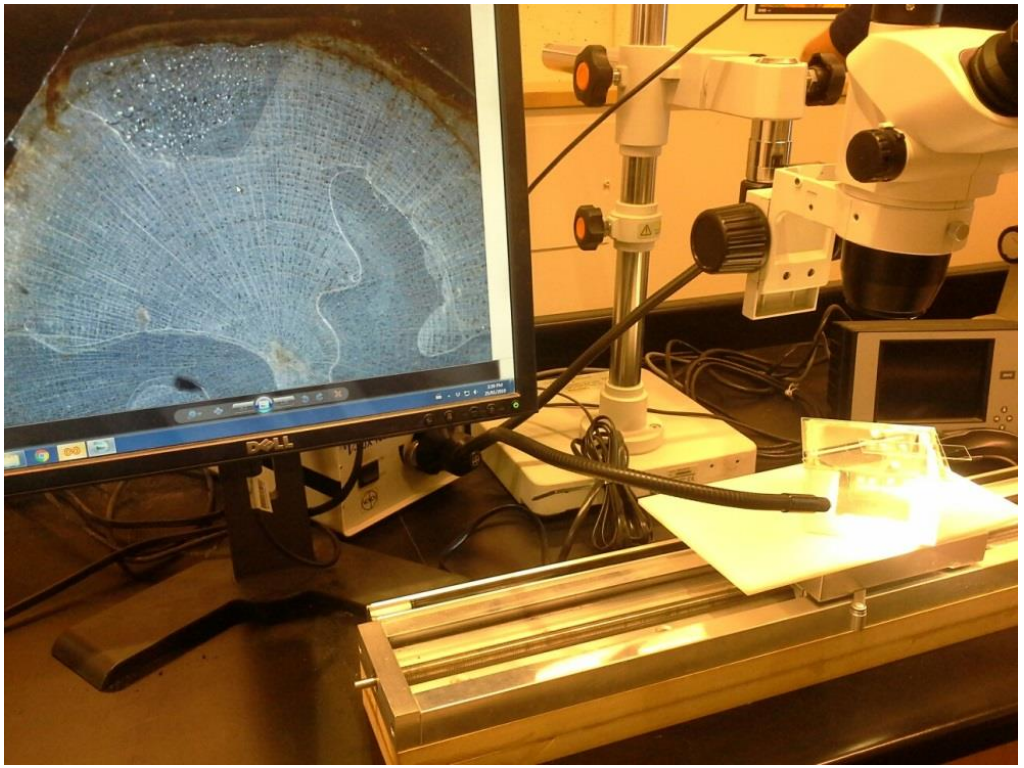
At the plant level…

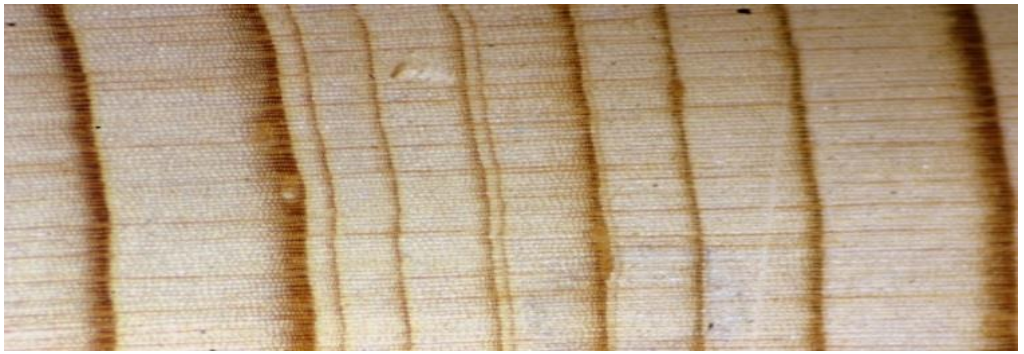
1. **What climatic variables influence the growth of trees and erect deciduous shrubs on the Bathurst range, and has their growth rate changed over the past 30-40 years?**
   - Target oldest trees and shrubs to build chronologies and determine growing conditions.
   - Relate growing conditions to past climate.
   - Identify the variables that most influence vegetation productivity.

Tree Growth



Tree Dendrochronology

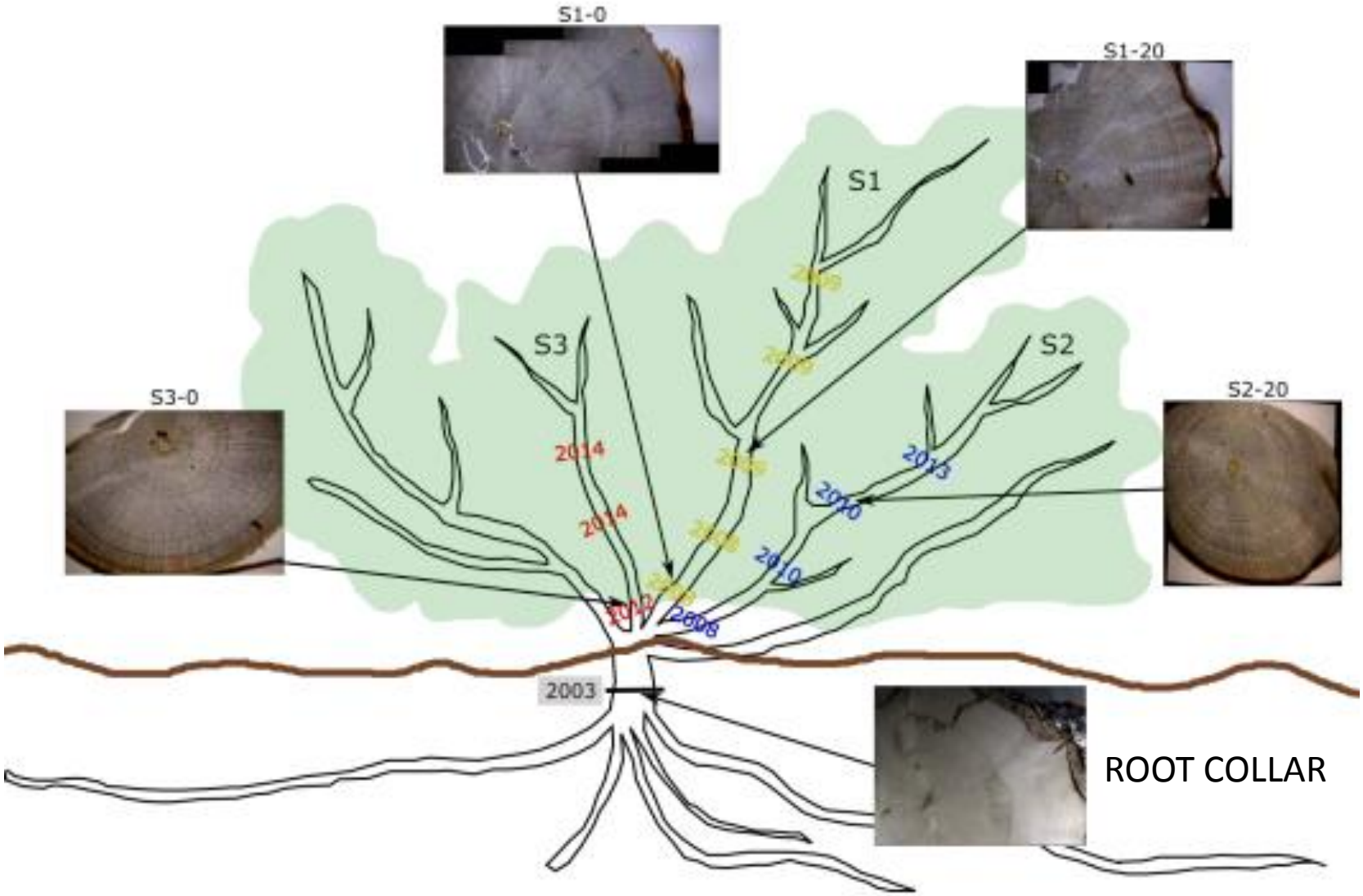




Beyond the Treeline

Shrub Dendrochronology

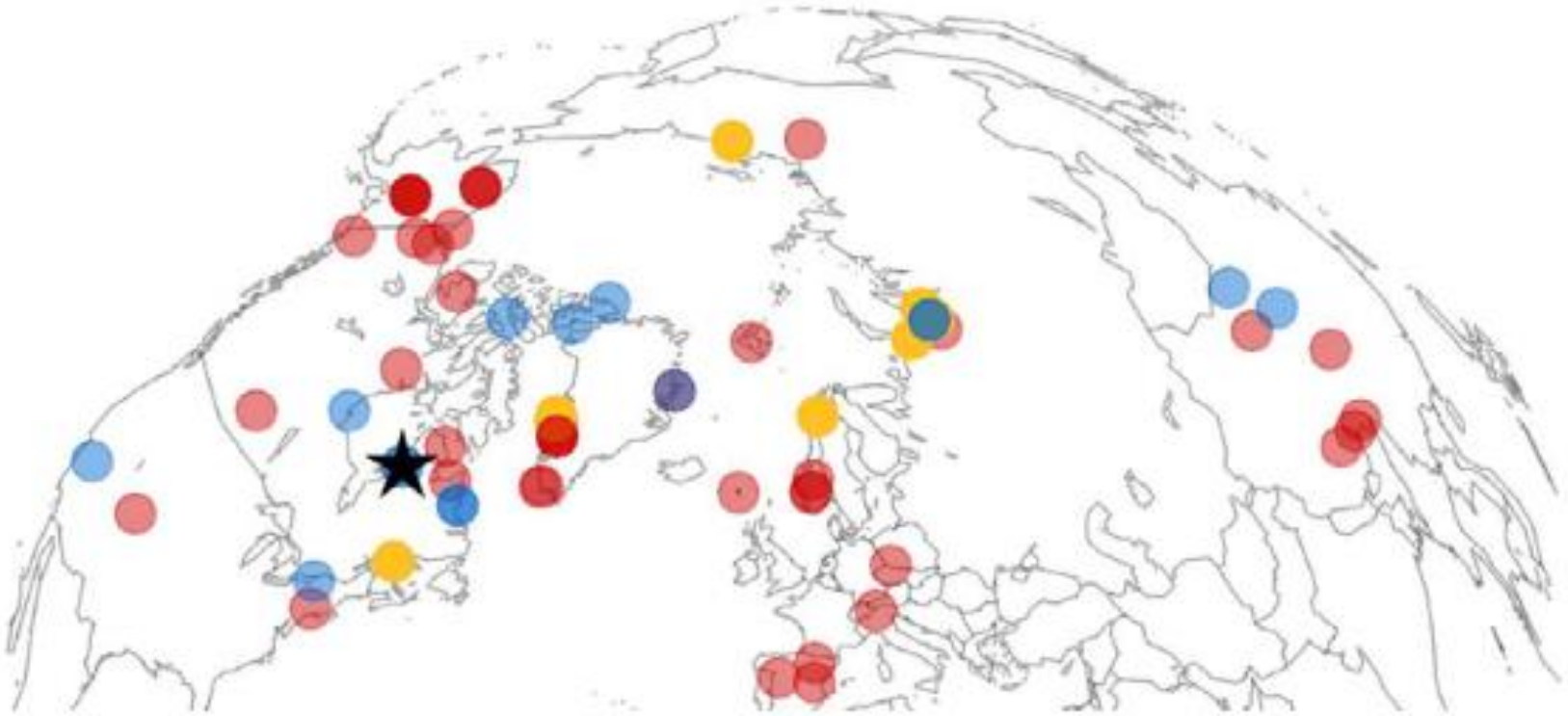
Shrub Growth



“The Perfect Shrub”

All Other Shrubs

Root Collars or Stems?



Global Change Biology (2017) **23**, 3281–3291, doi: 10.1111/gcb.13631

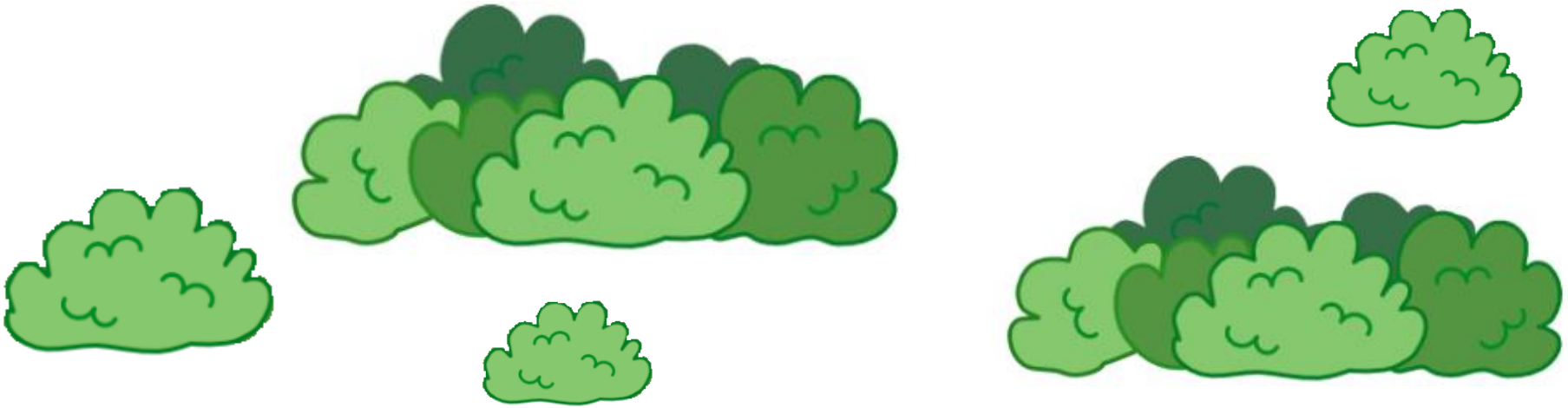
Different parts, different stories: climate sensitivity of growth is stronger in root collars vs. stems in tundra shrubs

PASCALE ROPARS[1,2], SANDRA ANGERS-BLONDIN[2,3], MARIANNE GAGNON[2,4], ISLA H. MYERS-SMITH[3], ESTHER LÉVESQUE[2,5] and STÉPHANE BOUDREAU[2,4]

At the population level…

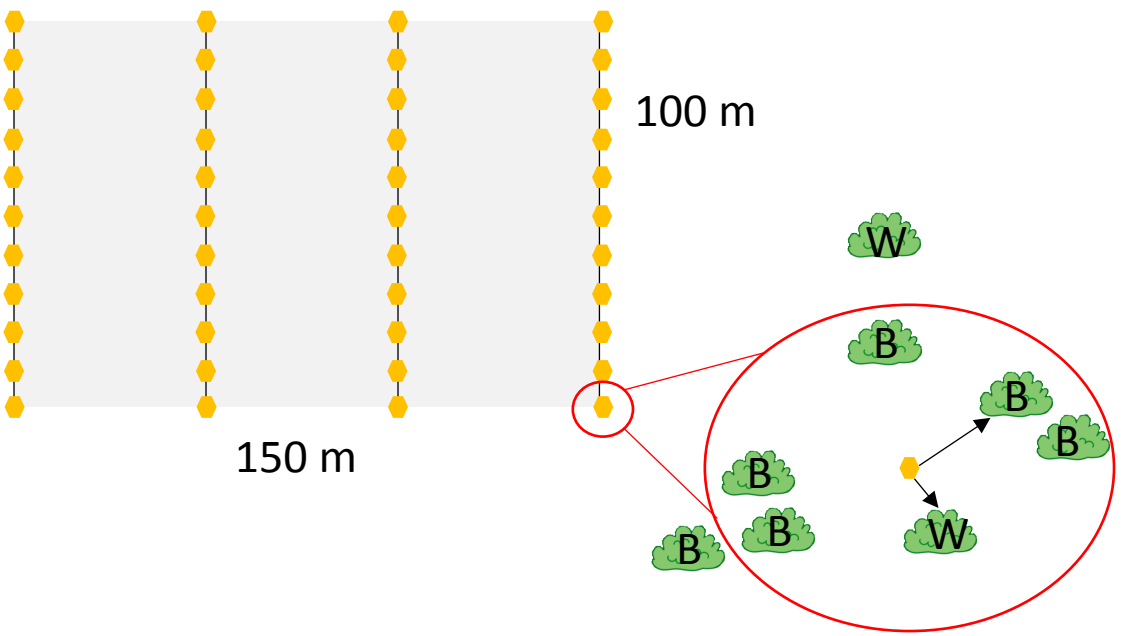
1. What climatic variables influence the growth of trees and erect deciduous shrubs on the Bathurst range, and has their growth rate changed over the past 30-40 years?

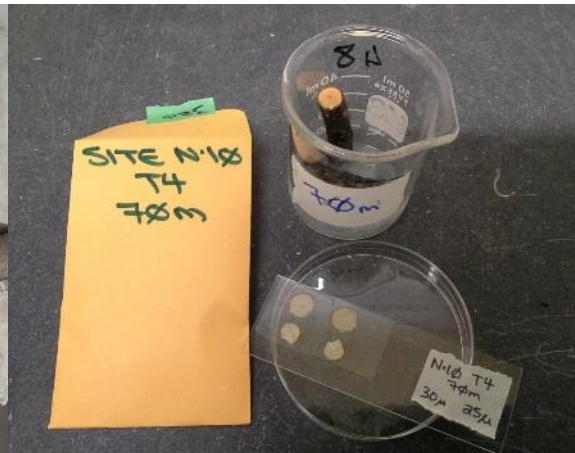
2. **Has the abundance and distribution of erect deciduous shrubs changed during the period of the Bathurst herd's most recent decline?**
   - Sample shrub stems to determine year of stem establishment and growth rate.
   - Estimate abundance and age distribution of shrubs on the landscape.



Greening vs. No Change

Sampling Shrub Stems

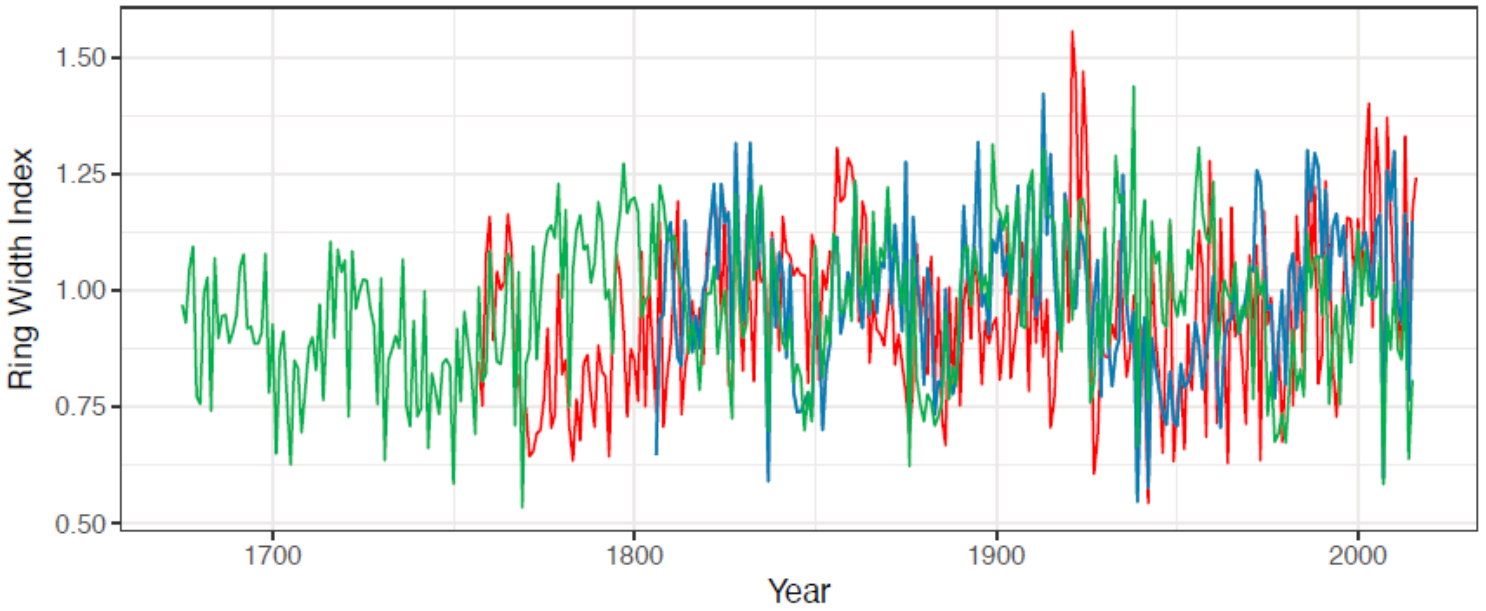




Sampling Root Collars

Next Steps…

Plant level:

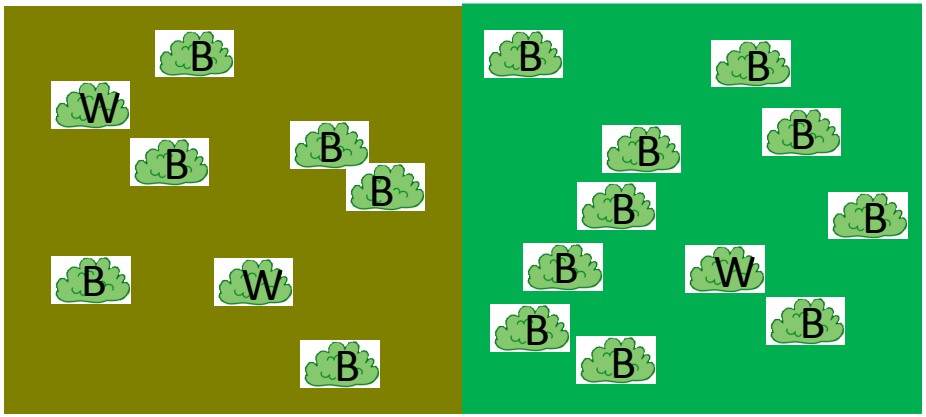


Site

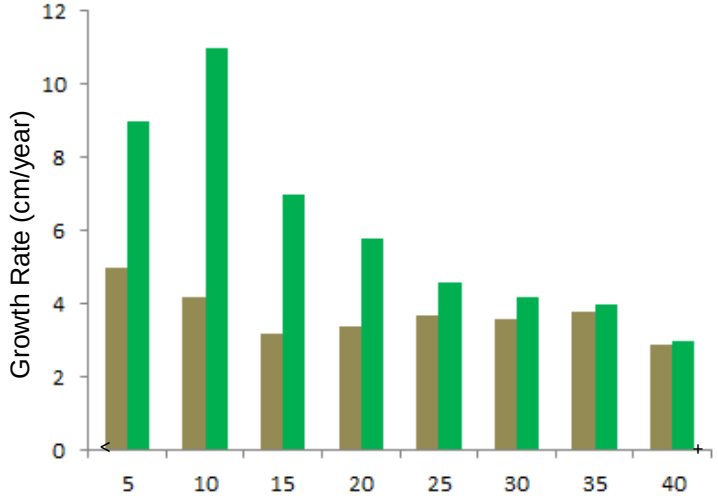
- Lutsel K'e – White Spruce
- Snare Lake – Black Spruce
- Snare Lake – White Spruce

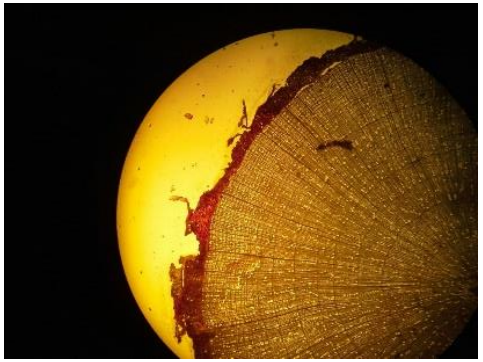
Next Steps…

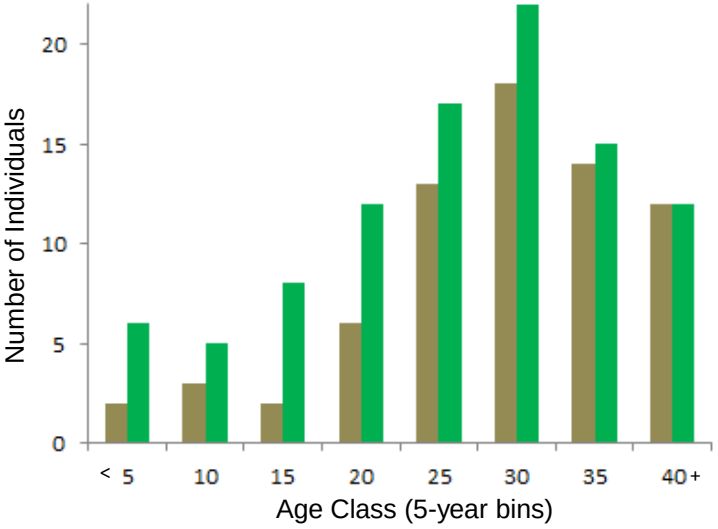
Population level:



?







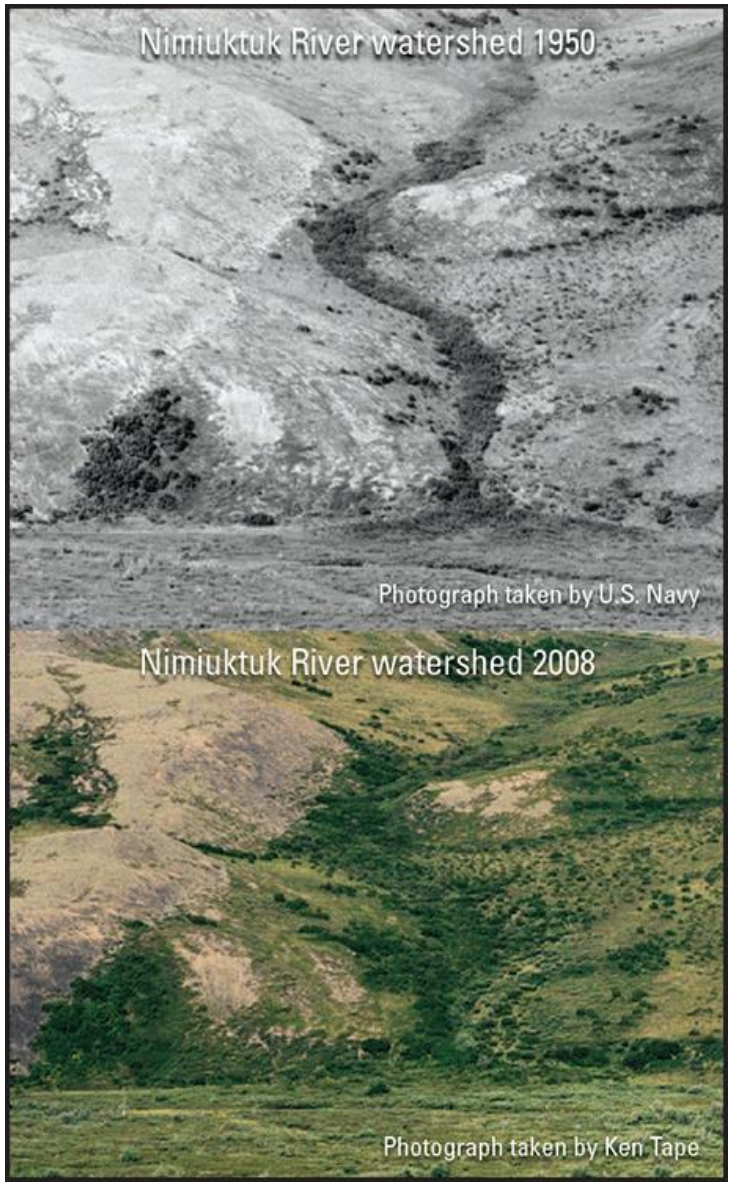
Changing Plant Communities

Shrub expansion is affecting vegetation composition

⬇ Preferred forage: Lichen and cottongrass

⬆ Less-preferred forage: Toxic dwarf birch dominating over palatable willow

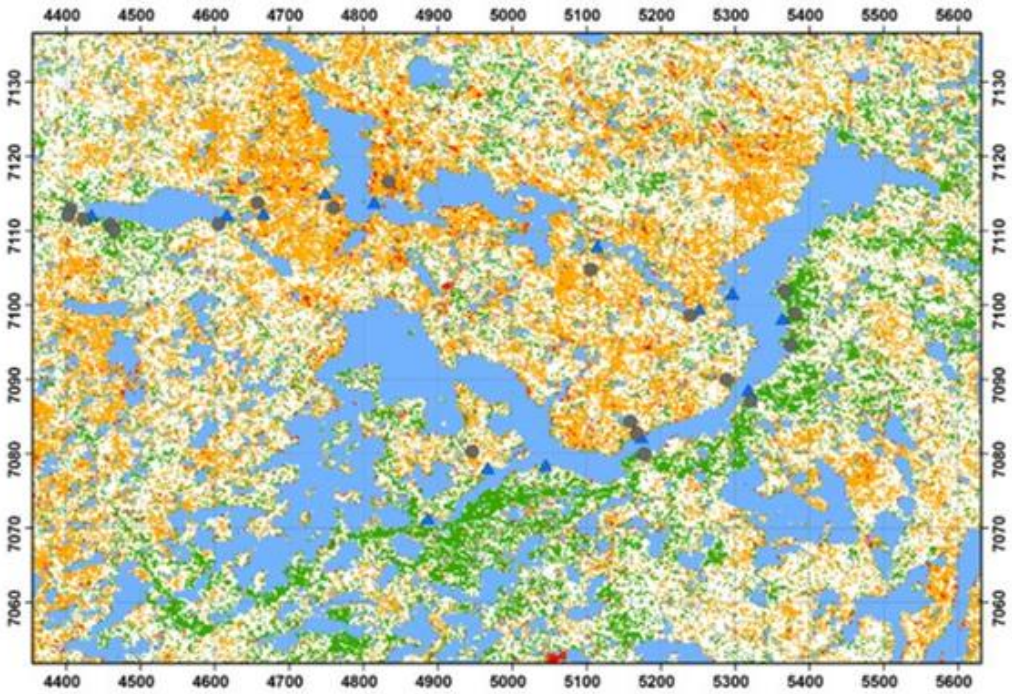
Historic & Archival Information



Supplemental documentation of landscape change:

- ✓ Aerial images, photographs
- ✓ Archival references to landscape vegetation

Future Fieldwork?



2018: Jolly Lake, Courageous Lake, MacKay Lake

2019: Daring Lake (TERS), Yamba Lake

2020: Bathurst caribou calving grounds… Boreal forest…
Area with opportunity for repeat photography…

Project website: http://rangechange.ca

Carolyn Bonta: 18cb12@queensu.ca