Environment and Climate Change Canada / Environnement et Changement climatique Canada

Characterizing Arctic Vegetation and Ecosystems With Remote Sensing:

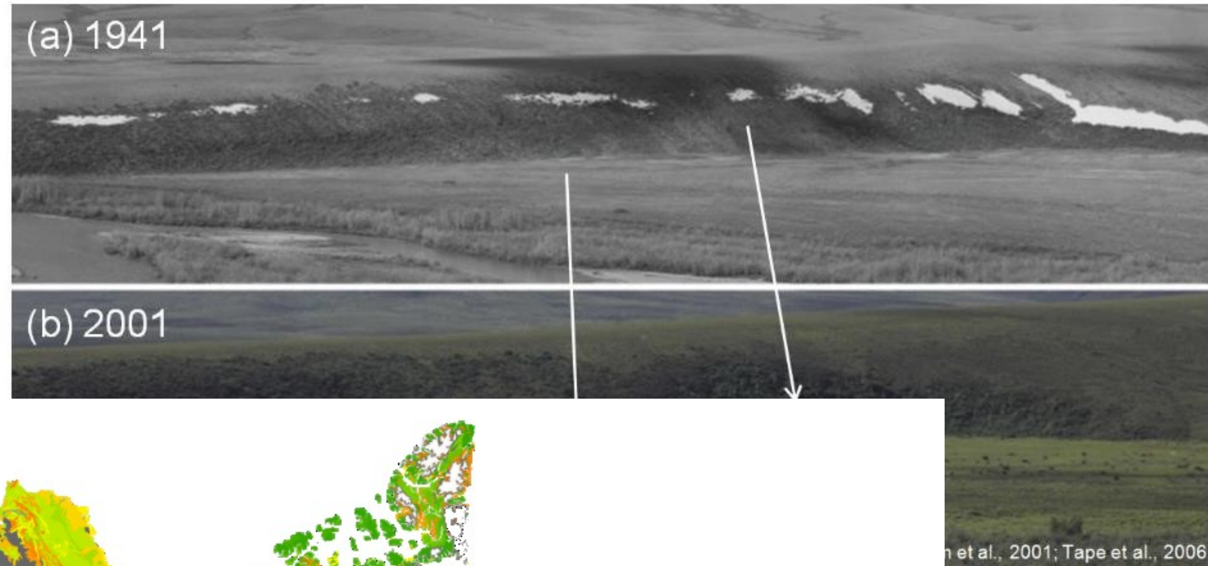
Projects and Partners

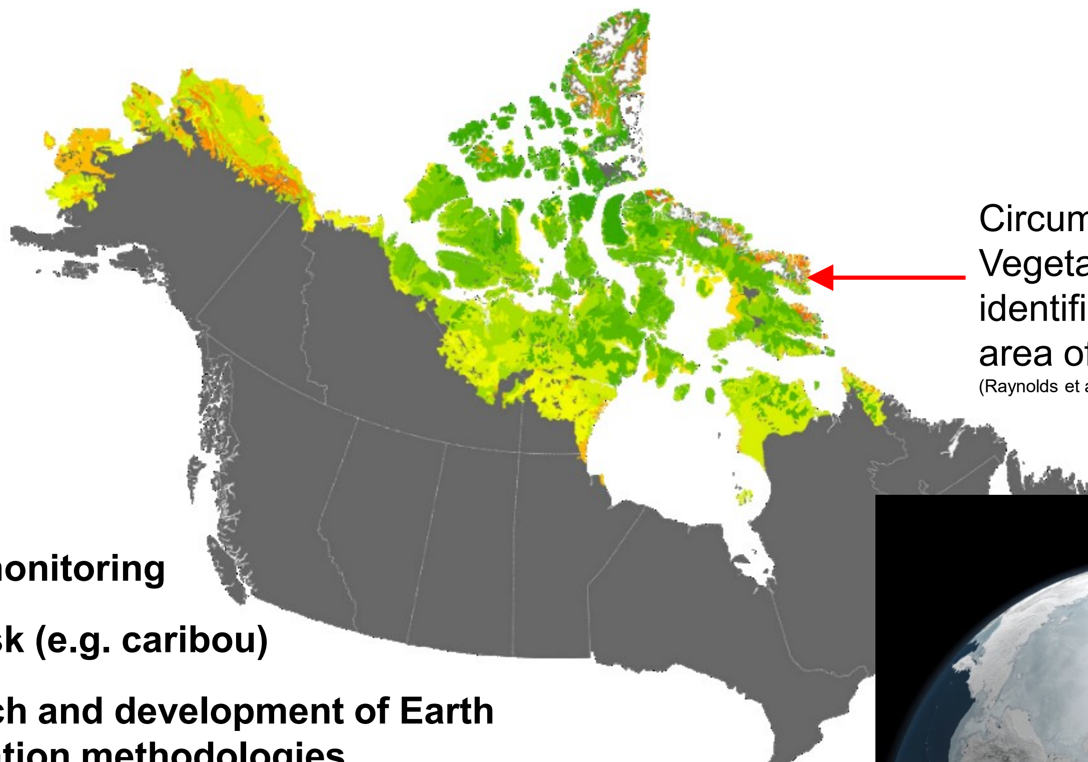
BLAIR KENNEDY
LANDSCAPE SCIENCE AND TECHNOLOGY,
ENVIRONMENT AND CLIMATE CHANGE CANADA

Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi NPP satellite

Monitoring a changing Arctic: Why is it important?

- Temp have increased ~2 °C since 1950's
- Changes to sea ice extent, permafrost, hydrology, vegetation
- Greening of ecosystems,expansion of shrubs/trees
- Vegetation identifie ***valued ecosysten component***
- Arctic ecosystems represent a signific portion of Canadiar landmass – ***climat feedback mechan***





Circumpolar Arctic Vegetation Map (CAVM) identifies a total ecosystem area of ~1.4 million km^2
(Raynolds et al., 2019)

Sea ice decline

<u>ECCC Mandate:</u>

- **Ecosystem monitoring**
- **Species at risk (e.g. caribou)**
    - **Research and development of Earth observation methodologies**

Current Arctic-Based Projects:

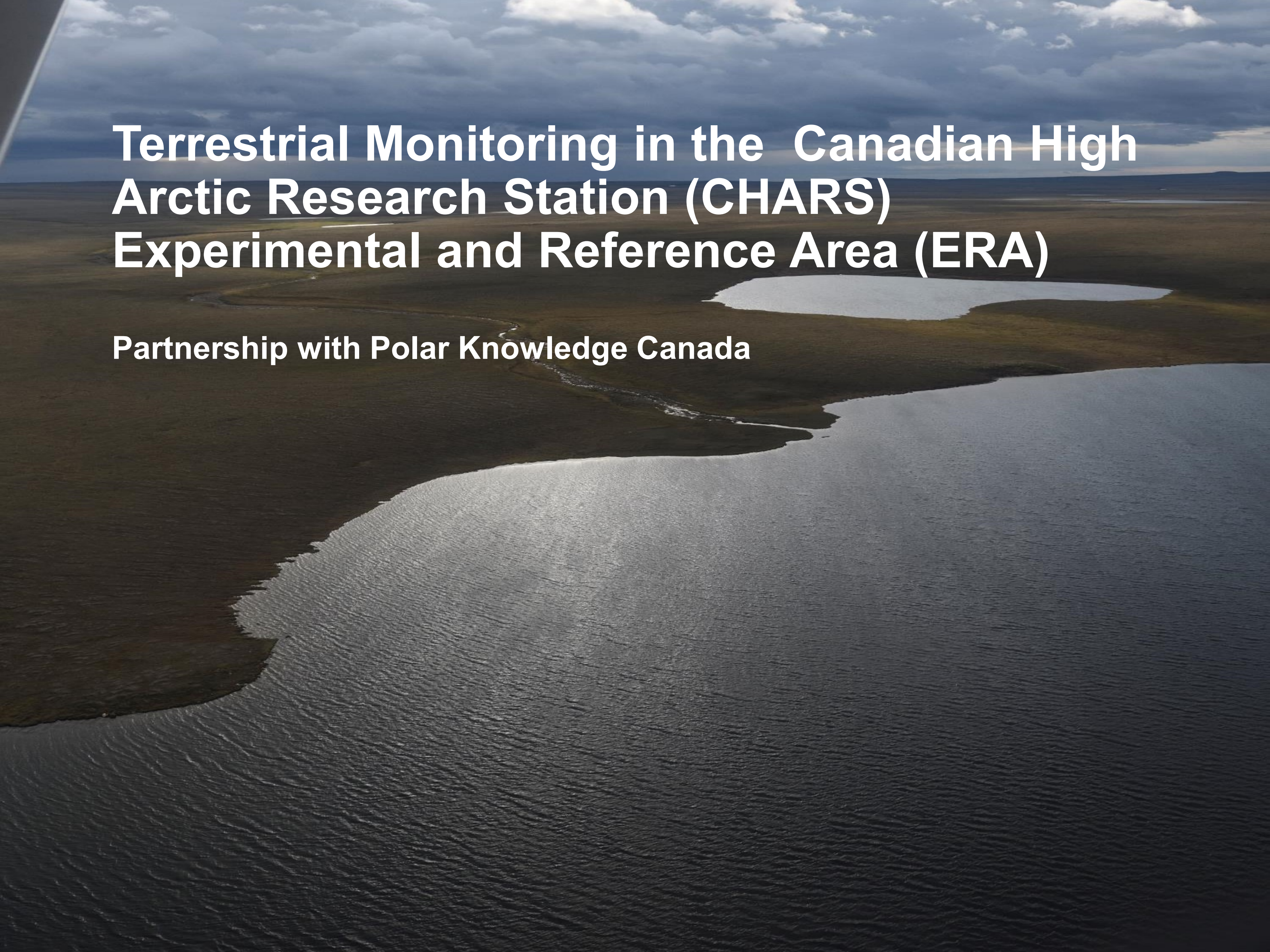
1. **Terrestrial Monitoring in the Canadian High Arctic Research Station (CHARS) Experimental and Reference Area (ERA)**

2. **Nío Nę P’ęnę: Trails of the Mountain Caribou – Mapping Ecological Changes and Caribou Habitat**

3. **Comparison of Machine Learning Algorithms for Predicting Lichen Fractions in Northern Canada and Alaska**

Terrestrial Monitoring in the Canadian High Arctic Research Station (CHARS) Experimental and Reference Area (ERA)

Partnership with Polar Knowledge Canada

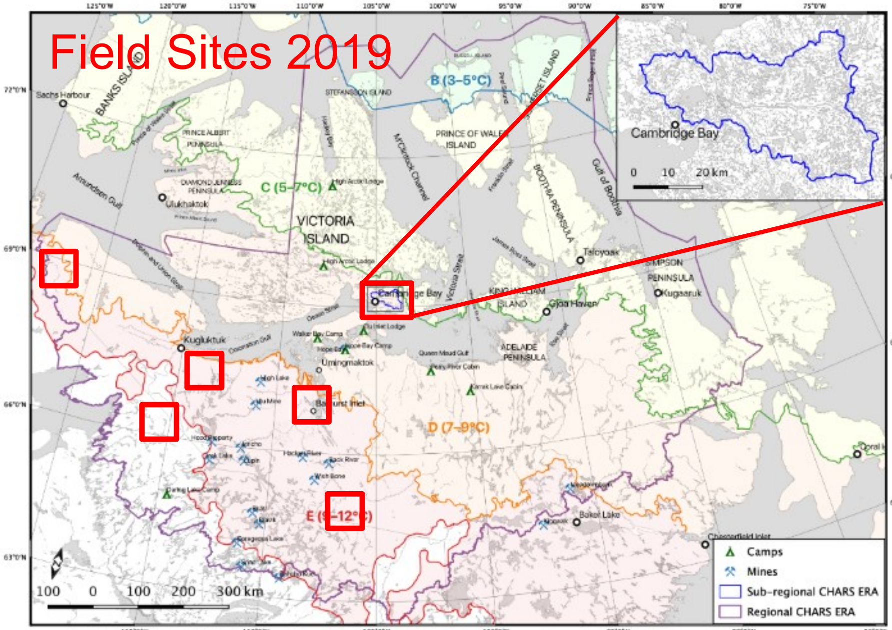


CHARS Regional ERA – Extent and Issues

Objectives of the CHARS ERA project:

Support Polar Knowledge Canada with remote sensing expertise

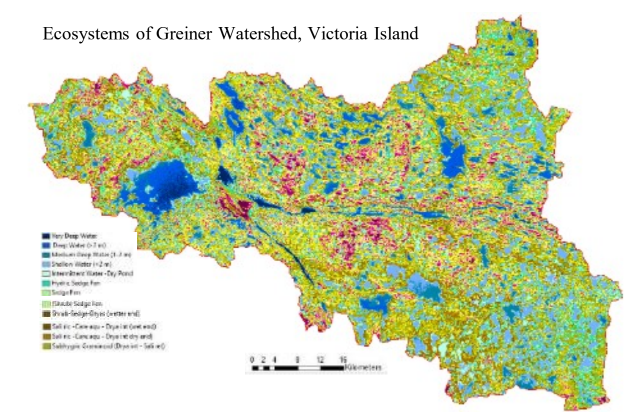
- Develop a medium-resolution (Landsat-based) maps for targeted areas of high greening/change
- Conduct ground studies to characterize ecosystems where changes occurring
- Conduct high-resolution ecosystem classification and mapping for the areas of change
- **Data cube**



McLennan (2019)

Field

UAV – High Res Optical



Ponomarenko (2019)

Characterization of Plant Traits

Leaf chlorophyll content:

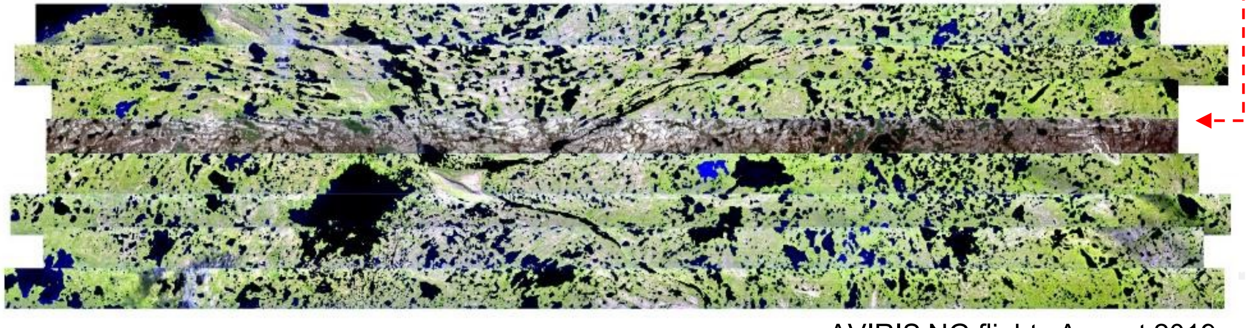
- Responsible for photosynthesis (i.e. stored chemical energy)
- An indicator of plant physiological conditions (i.e. disturbance and stress)

Leaf area index:

- Linked to atmosphere-vegetation exchange processes (e.g. photosynthesis, evapotranspiration, carbon flux)
- Provides an understanding of dynamic changes to ecosystems (e.g. phenology)
- Provides a means of scaling leaf measurements to the canopy scale

Hyperspectral Remote Sensing:

- Linking leaf and canopy measurements to the remote sensing scale
- Field spectroscopy and Airborne Visible-Infrared Imaging Spectrometer - Next Generation (AVIRIS NG)



AVIRIS NG flights August 2019

Nío Nę P’ęnę: Trails of the Mountain Caribou

Partnership with Sahtú Dene and Sahtú Renewable Resource board

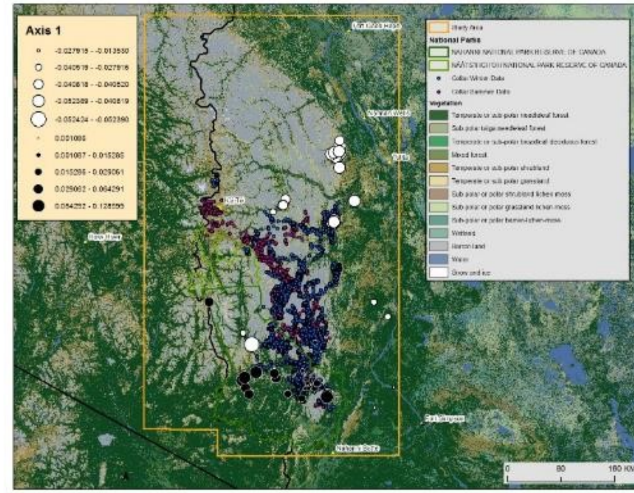
Níο Nę P'ęnę́: Trails of the Mountain Caribou

How can healthy relationship between Indigenous people and caribou be maintained in the context of ecological change in the Níο Nę P'ęnę area?

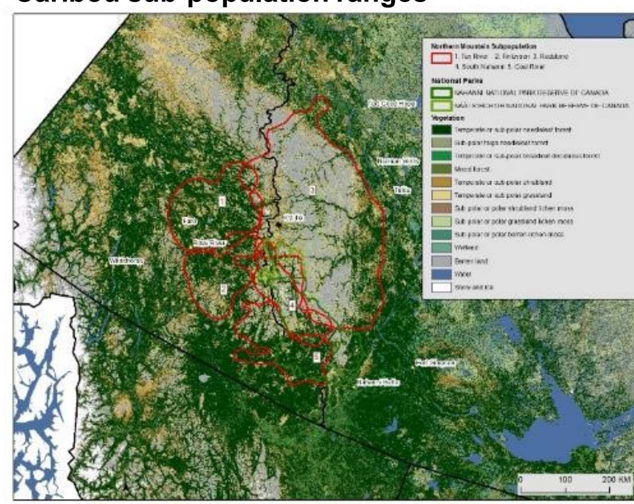
Objectives:

- Compile traditional and scientific knowledge about landscape change and caribou population ecology (genetics)
- Train Guardians to monitor their lands – Engage with communities and youth
- Investigate the relationship between caribou movement, population and landscape change using remote sensing

Caribou collar data



Caribou sub-population ranges

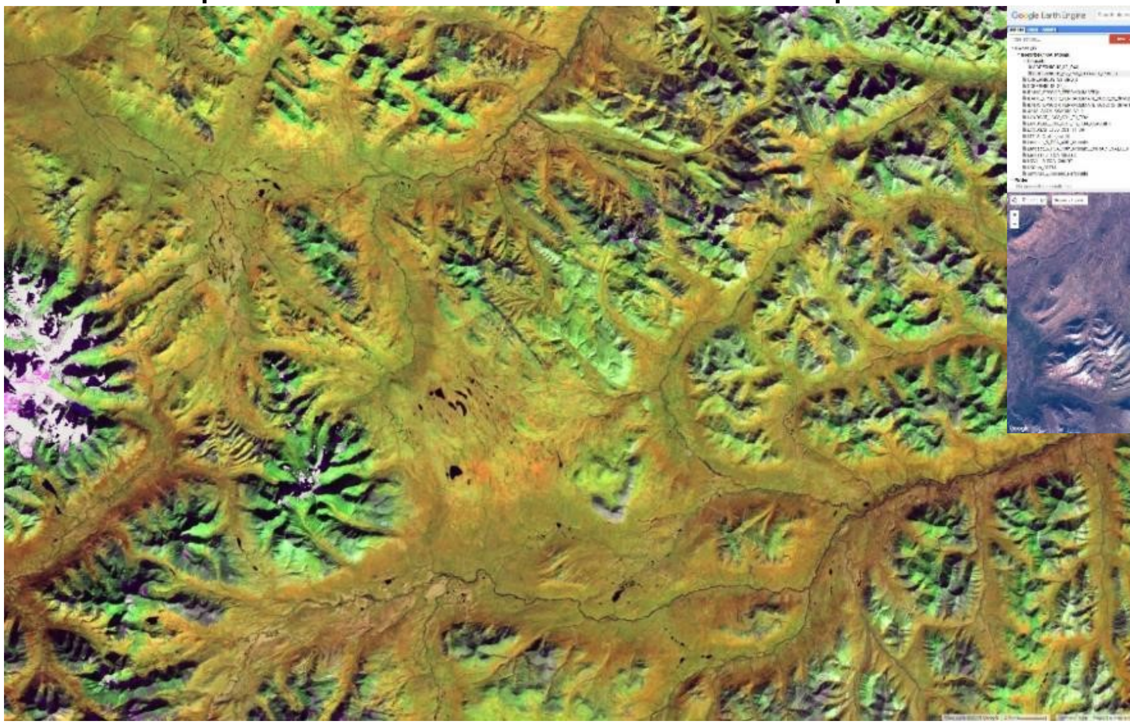


Identify landscape change mechanism

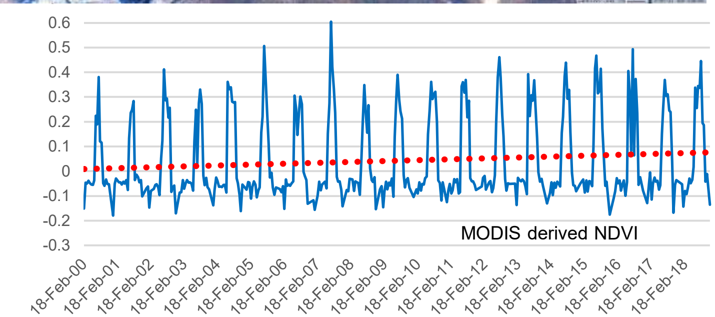
Guardian Training – technological transfer

Monitoring Vegetation in the Mackenzie Mountains

Landsat 5 composites for 1985 and 2010 – NIR SWIR RED composites



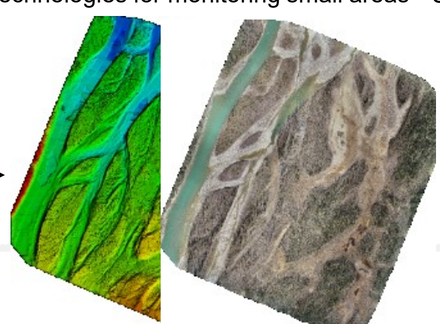
Google Earth Engine: Remote sensing for the people?



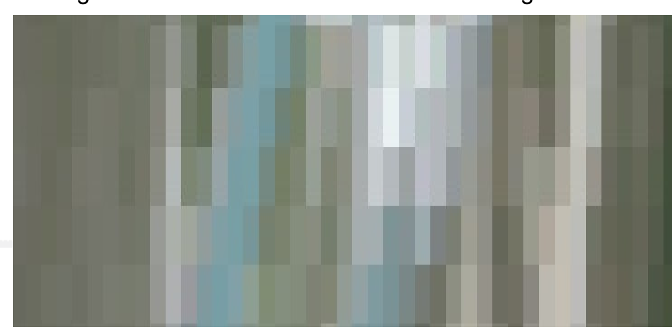
Data collection: From the field to the remote sensing scale – tools and techniques for monitoring

Field techniques: documenting change

Technologies for monitoring small areas - UAVs



Scaling field and UAV data to the remote sensing scale



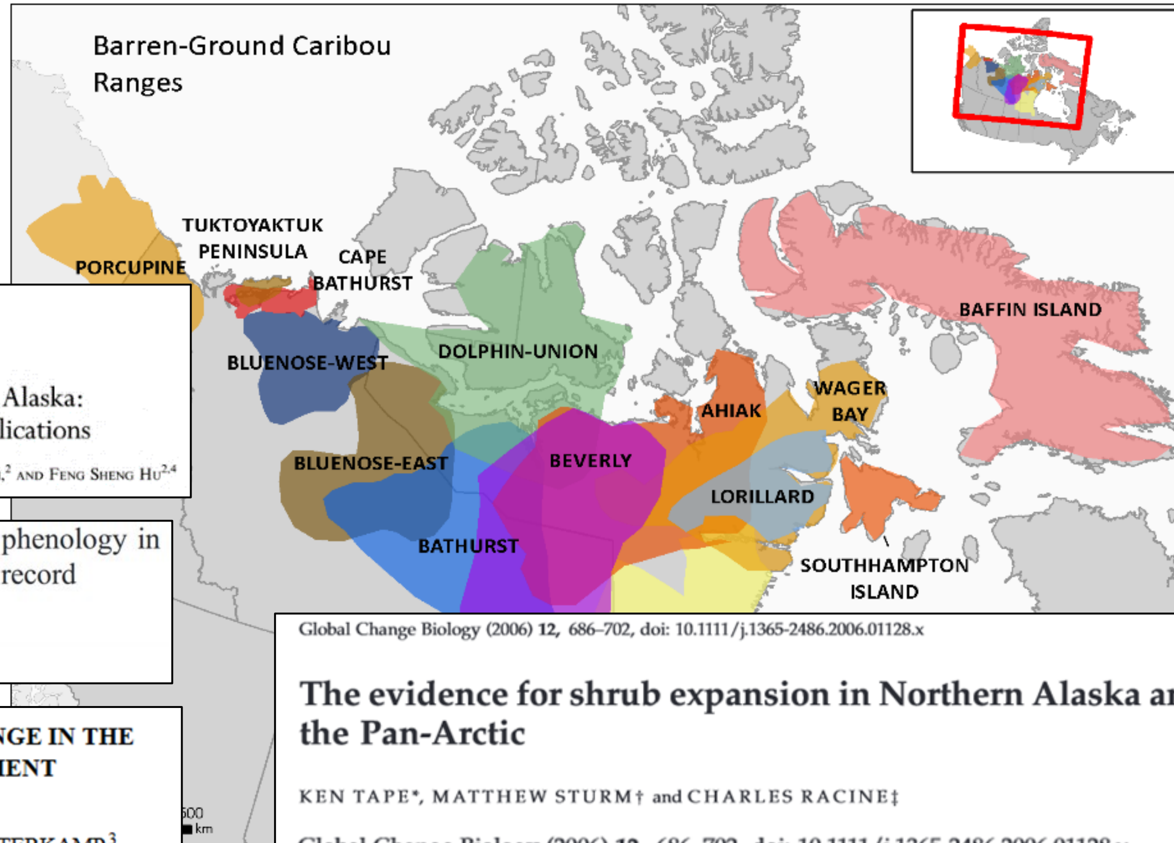
Comparison of Machine Learning Algorithms for Predicting Lichen Fractions in Northern Canada and Alaska

Caribou and changing Arctic ecosystems

Increased plant growth in the northern high latitudes from 1981 to 1991

R. B. Myneni*, C. D. Keeling†, C. J. Tucker‡, G. Asrar§ & R. R. Nemani‖

NATURE | VOL 386 | 17 APRIL 1997



Ecological Applications, 21(8), 2011, pp. 3211–3226
© 2011 by the Ecological Society of America

Variability of tundra fire regimes in Arctic Alaska: millennial-scale patterns and ecological implications

Philip E. Higuera,[1,5] Melissa L. Chipman,[2] Jennifer L. Barnes,[3] Michael A. Urban,[2] and Feng Sheng Hu[2,4]

Analysis of climate change impacts on lake ice phenology in Canada using the historical satellite data record

Rasim Latifovic *, Darren Pouliot

Remote Sensing of Environment 106 (2007) 492 – 507

Global Change Biology (2006) 12, 686–702, doi: 10.1111/j.1365-2486.2006.01128.x

The evidence for shrub expansion in Northern Alaska and the Pan-Arctic

KEN TAPE*, MATTHEW STURM† and CHARLES RACINE‡

Global Change Biology (2006) 12, 686–702, doi: 10.1111/j.1365-2486.2006.01128.x

OBSERVATIONAL EVIDENCE OF RECENT CHANGE IN THE NORTHERN HIGH-LATITUDE ENVIRONMENT

M. C. SERREZE[1], J. E. WALSH[2], F. S. CHAPIN III[3], T. OSTERKAMP[3], M. DYURGEROV[4], V. ROMANOVSKY[3], W. C. OECHEL[5], J. MORISON[6], T. ZHANG[1] and R. G. BARRY[1]

Climatic Change **46:** 159–207, 2000.

Detection of rain-on-snow (ROS) events and ice layer formation using passive microwave radiometry: A context for Peary caribou habitat in the Canadian Arctic

A. Langlois [a, b], C.-A. Johnson [c], B. Montpetit [a], A. Royer [a, b], E.A. Blukacz-Richards [d], E. Neave [c], C. Dolant [a, b], A. Roy [a, b], G. Arhonditsis [e], D.-K. Kim [e], S. Kaluskar [e], L. Brucker [f]

Remote Sensing of Environment
Volume 189, February 2017, Pages 84-95

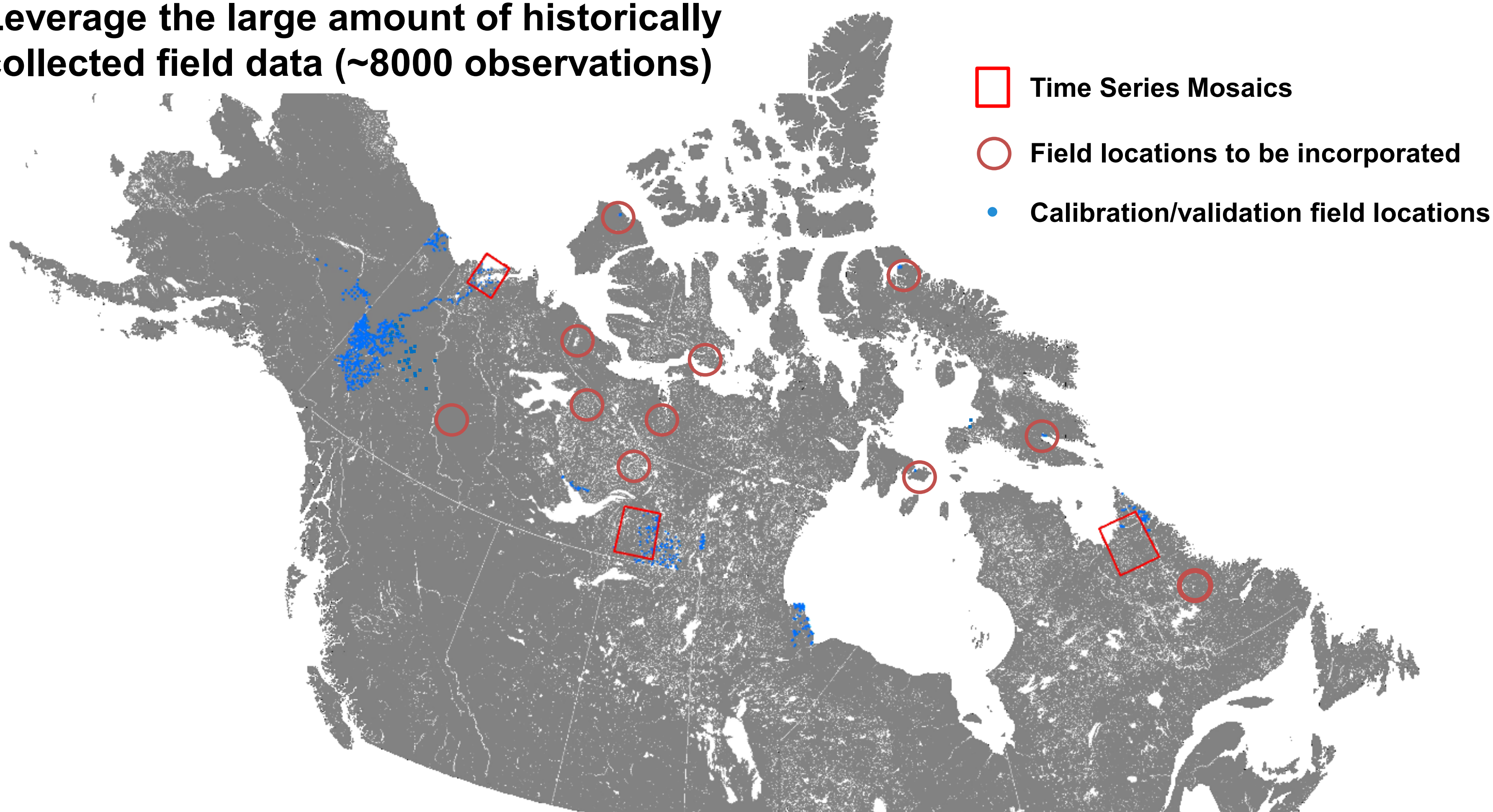
The sign, magnitude and potential drivers of change in surface water extent in Canadian tundra

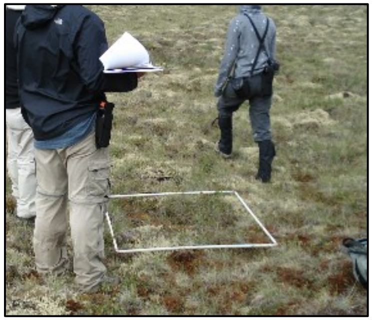
Mark L Carroll[1,2,3,4] and Tatiana V Loboda[3]

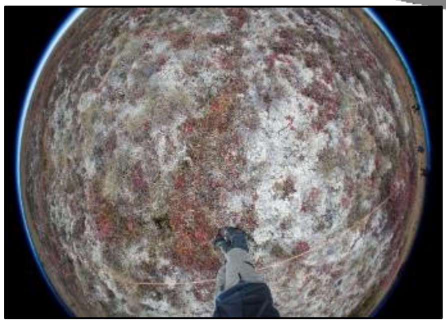
Environ. Res. Lett. **13** (2018) 045009

Arctic land surface characterization database

Leverage the large amount of historically collected field data (~8000 observations)

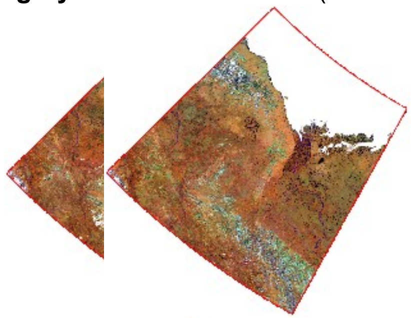






Mapping Lichen Cover with Deep Learning

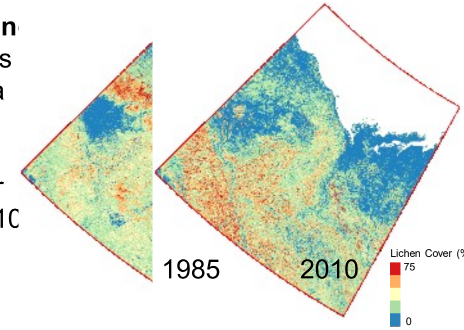
Imagery: Landsat 5 TM TOA (1985 - 2010)



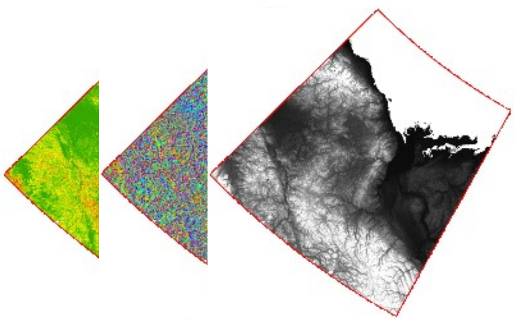
Lichen data:

Deep Neural Networks Modellin
- EO derived predictor variables
- X-Canada lichen training data

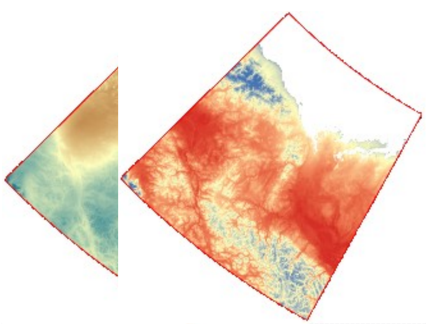
Results:
- Lichen prediction products for various years (e.g. 1985 - 201C
- Elevation important predictor
- Correlation = ~0.70



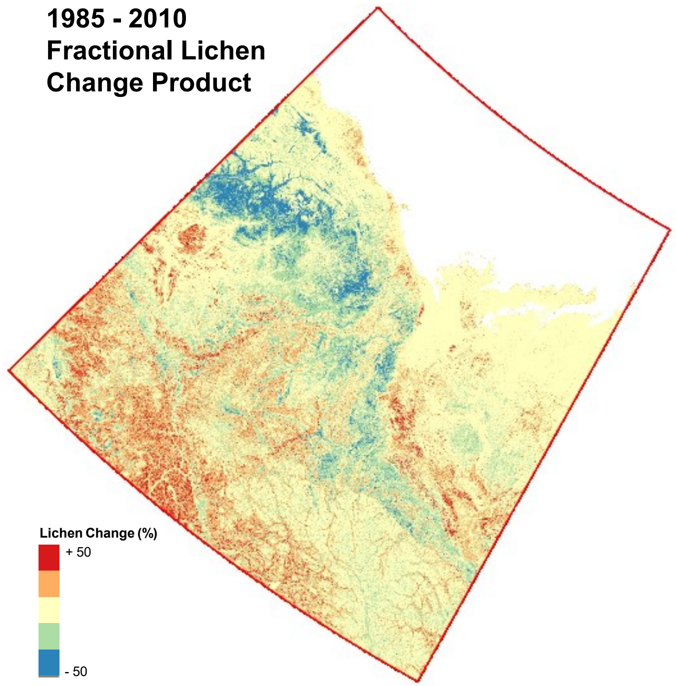
Geophysical: Slope, Aspect, Elevation



Climate: Precipitation, Temperature



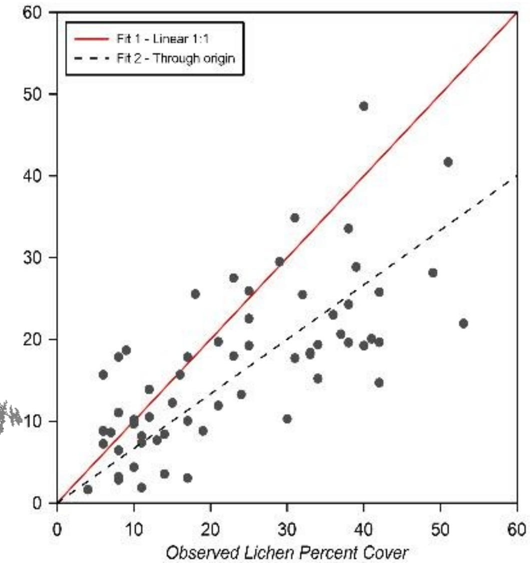
1985 - 2010 Fractional Lichen Change Product

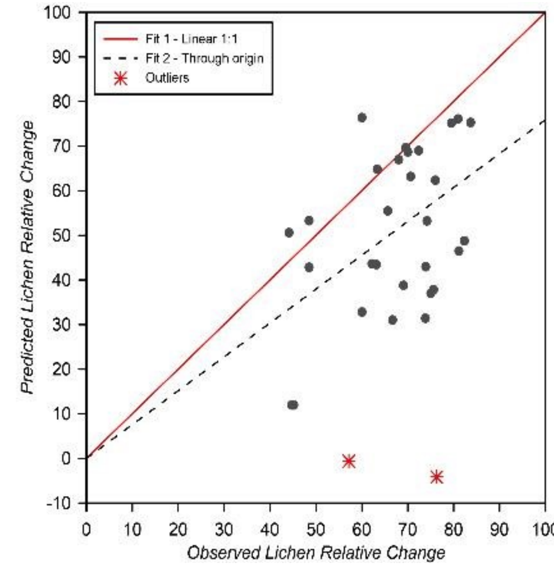


Identification of lichen change drivers:

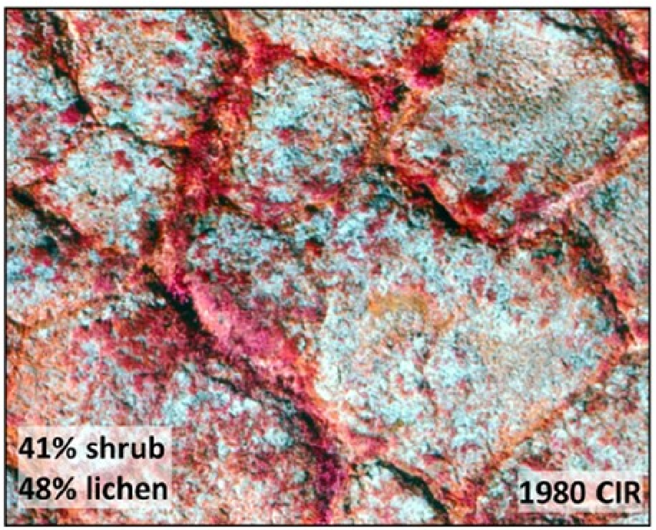
Lichen change in the Western Arctic

Western Arctic: Tuktoyaktuk Peninsula





Aerial Photographs showing lichens

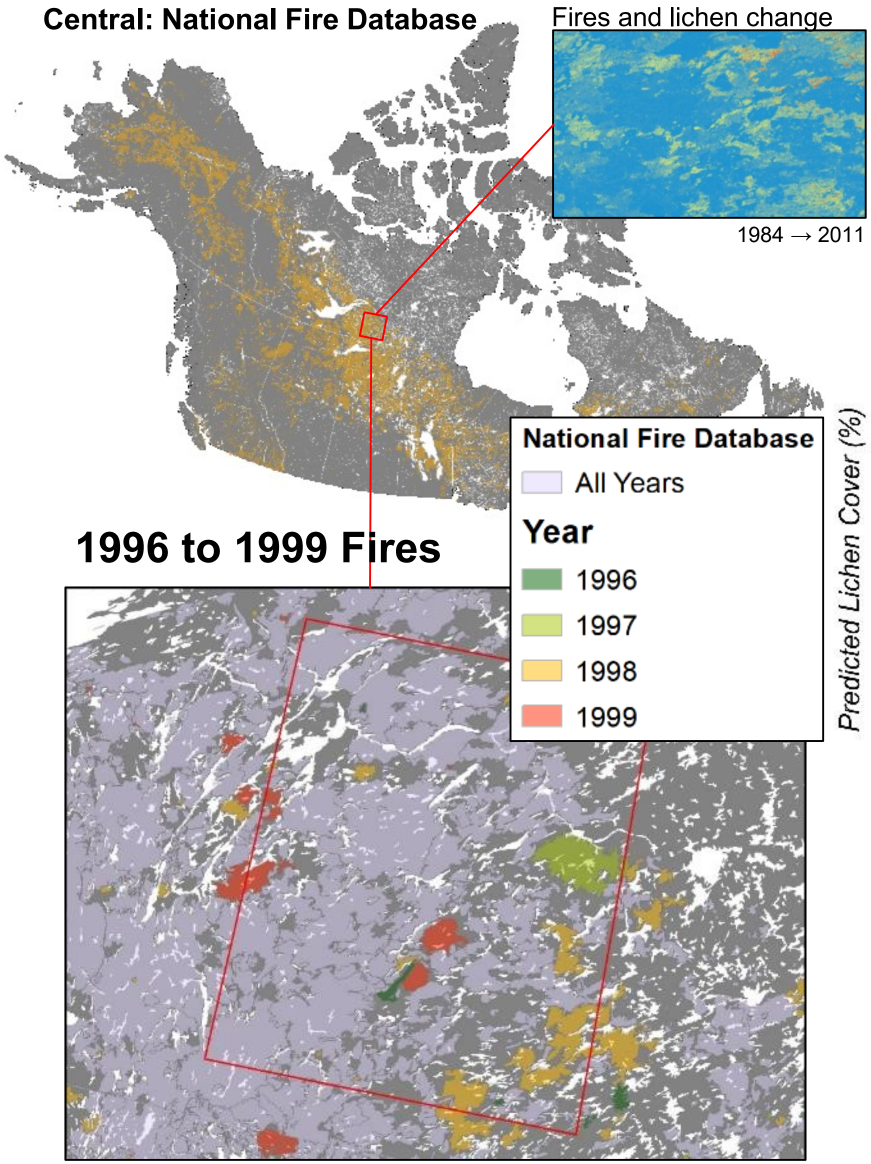


Warming-Induced Shrub Expansion and Lichen Decline in the Western Canadian Arctic

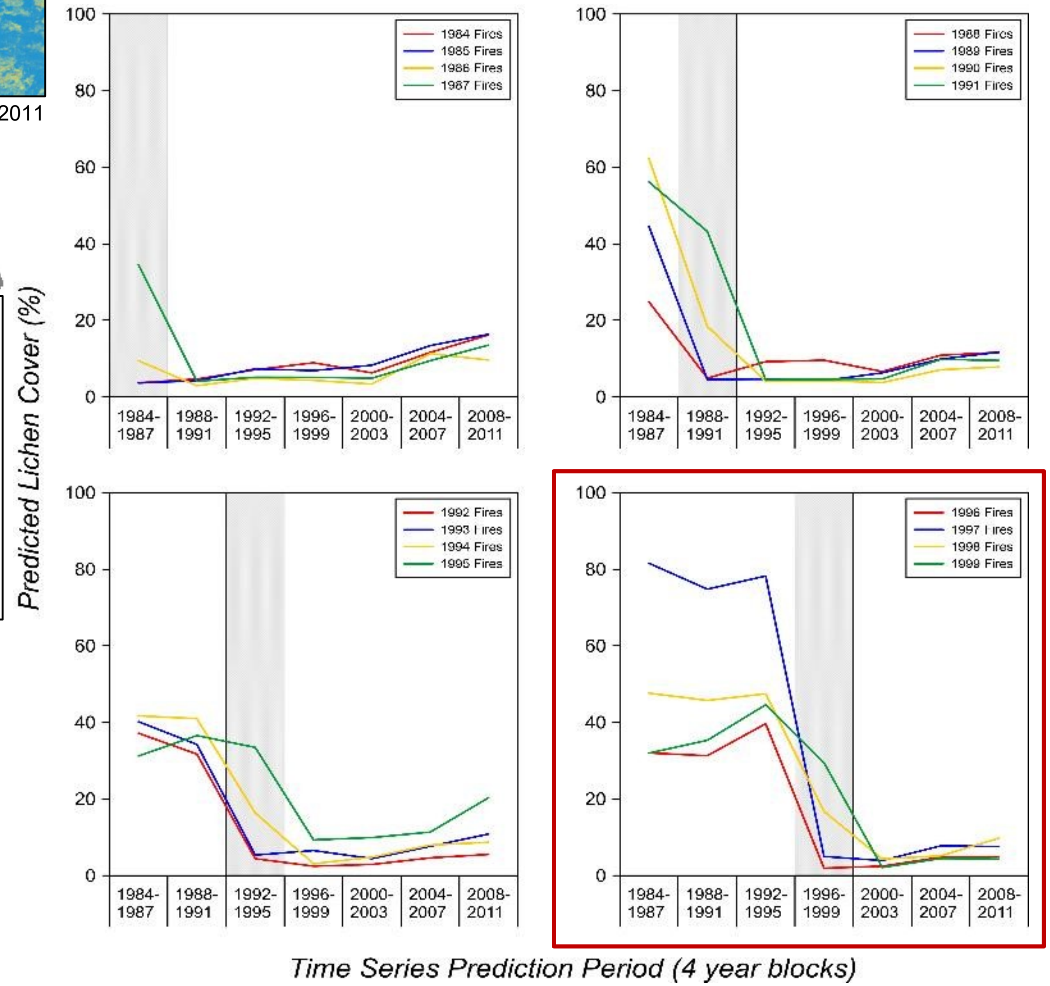
Robert H. Fraser,[1]* Trevor C. Lantz,[2] Ian Olthof,[1] Steven V. Kokelj,[3] and Richard A. Sims[4]

Fire history and lichen reestablishment

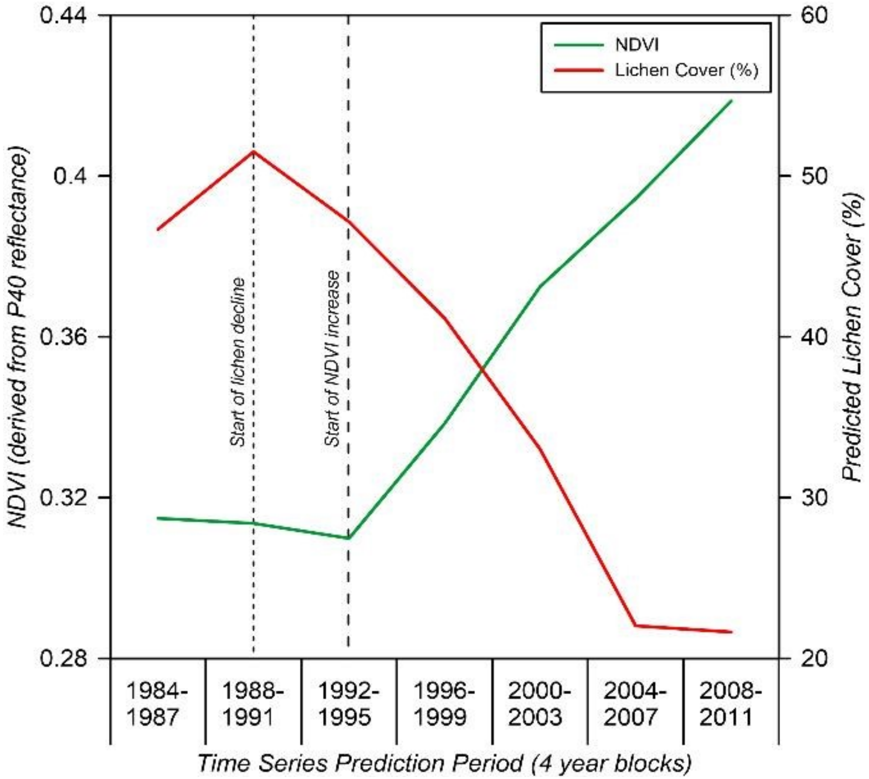
Central: National Fire Database

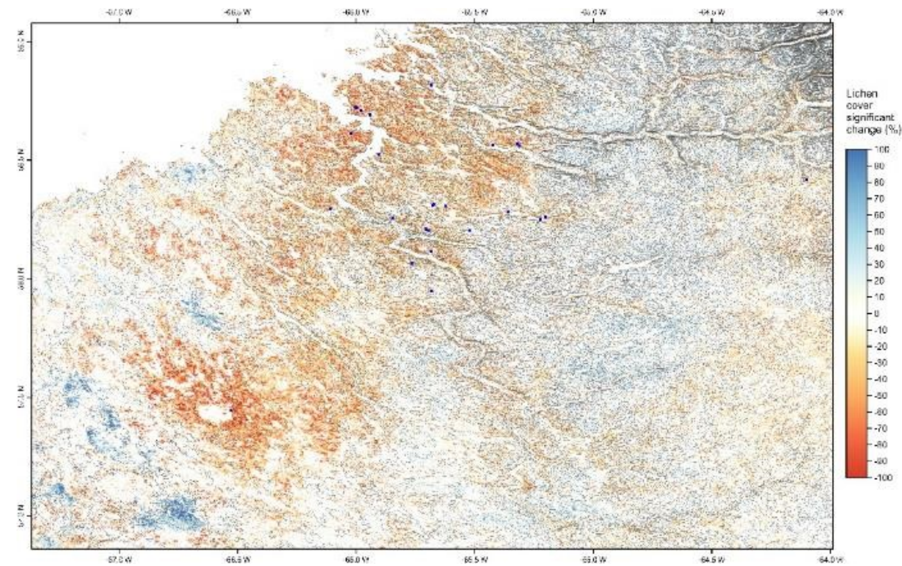


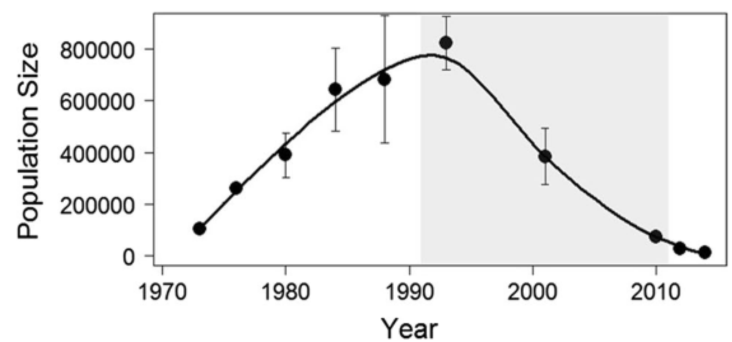
Modeled lichen percent cover for selected fire zones across the time series



Potential effect of caribou foraging accelerating climate change related shrub expansion







IOP PUBLISHING ENVIRONMENTAL RESEARCH
Environ. Res. Lett. 7 (2012) 035501 (11pp) doi:10.1088/1748-9326/7/3

Recent expansion of erect shrubs in the Low Arctic: evidence from Eastern Nunavik

Benoît Tremblay[1], Esther Lévesque[1] and Stéphane Boudreau[2]

Fig. 2 A loess smoothing spline fitted to aerial survey estimates of Rivière-George caribou (*Rangifer tarandus*) herd population size (black data points) to produce annual population size estimates. Error bars represent confidence intervals (α = 0.10) associated with the aerial survey data. The grey shaded area represents the 1991–2011 study period

Thank you for your interest.

Please contact me for information on these projects.

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