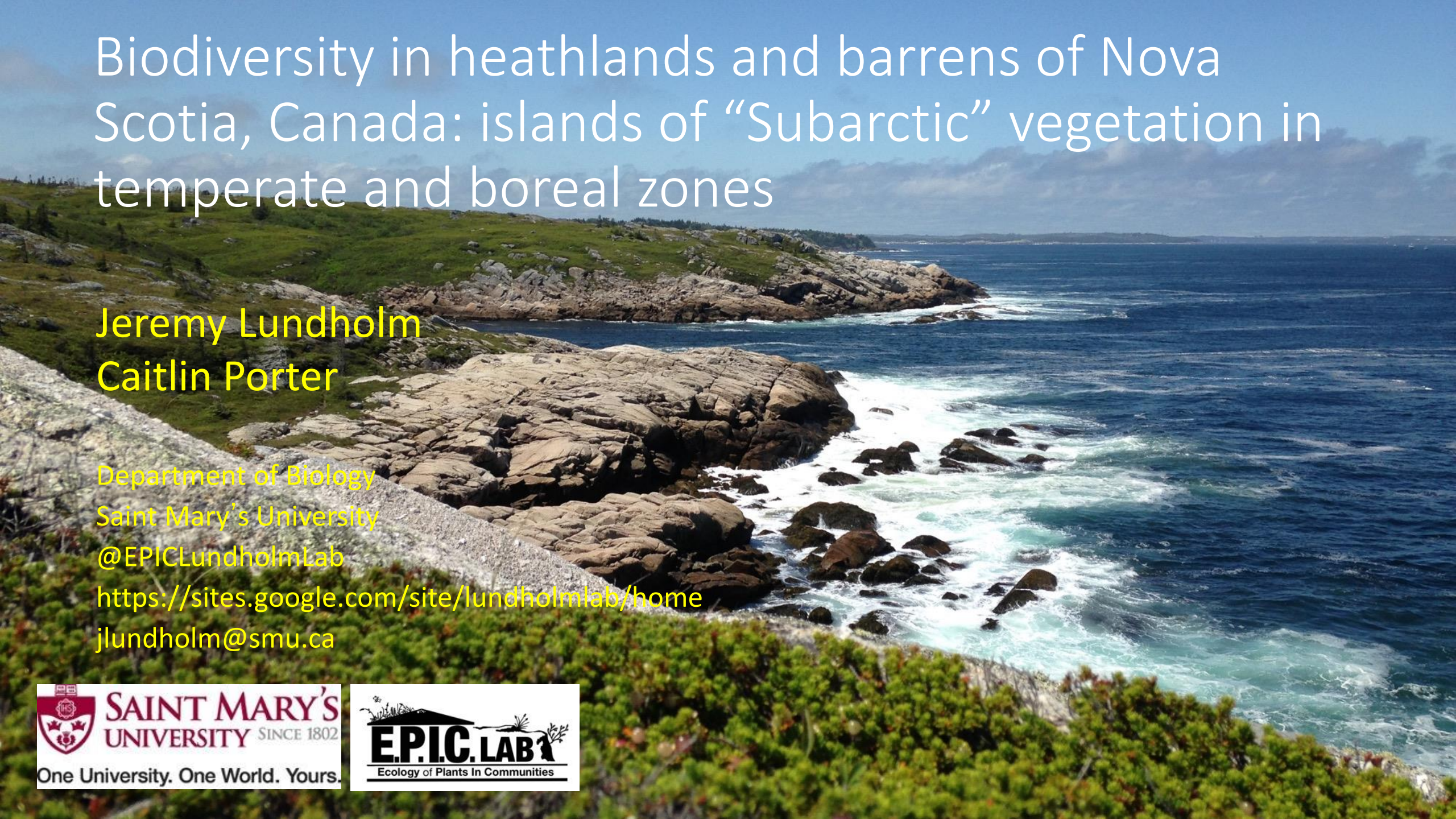
Biodiversity in heathlands and barrens of Nova Scotia, Canada: islands of “Subarctic” vegetation in temperate and boreal zones



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E.P.I.C. LAB
Ecology of Plants In Communities

Thank You

Sean Basquill, Emily Walker, Erica Oberndorfer, Mike Buckland-Nicks, Maddie Clarke, Jane Burchill

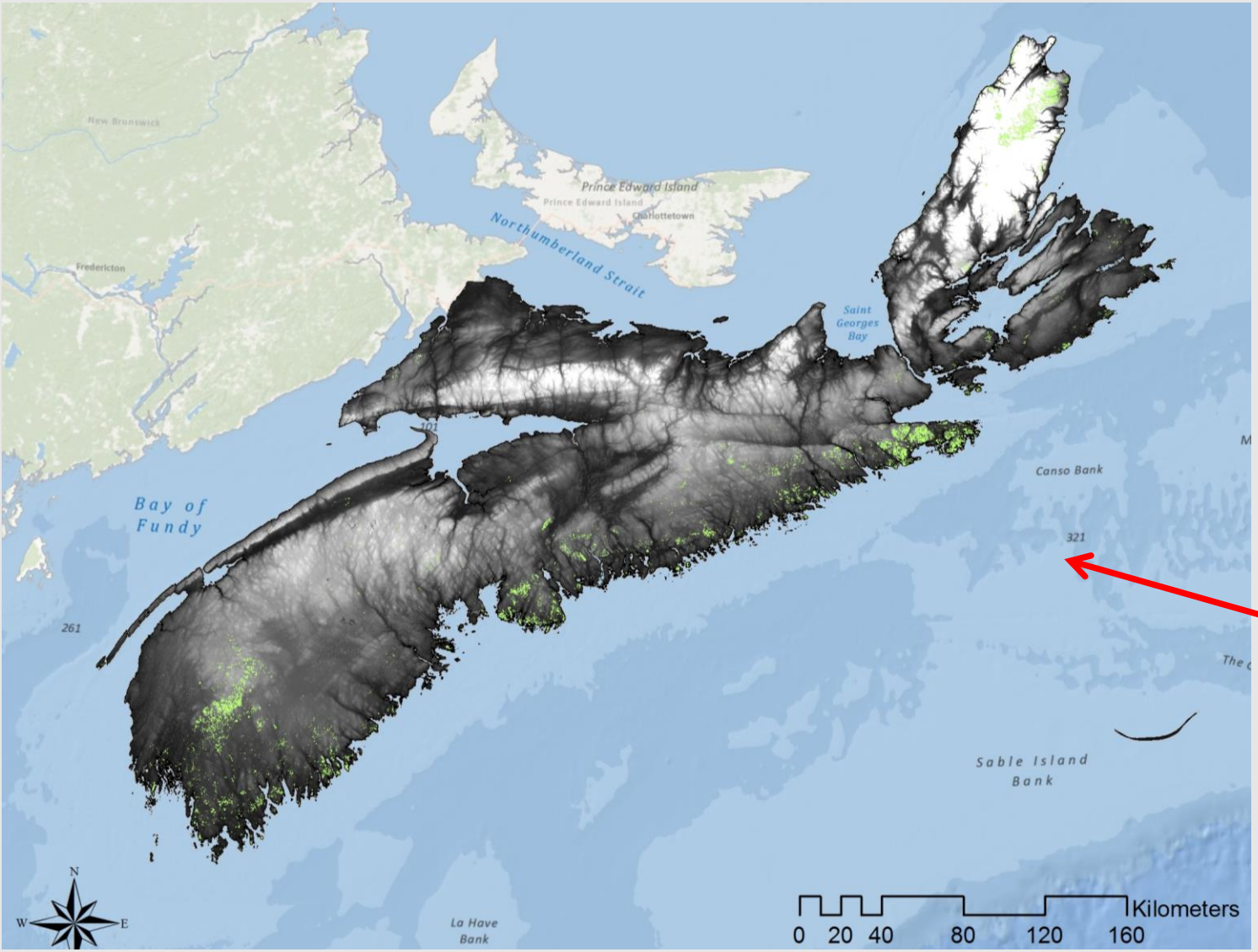
NOVA SCOTIA
Department of Natural Resources

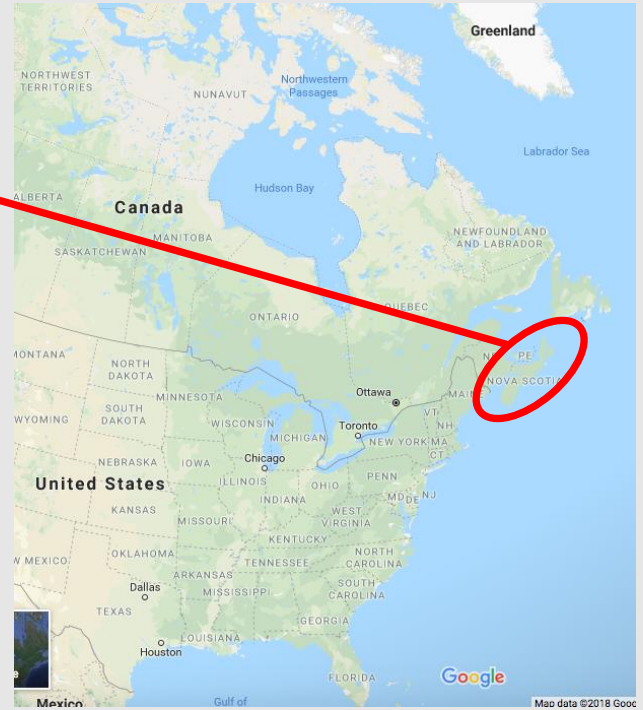
Environment and Climate Change Canada
Environnement et Changement climatique Canada

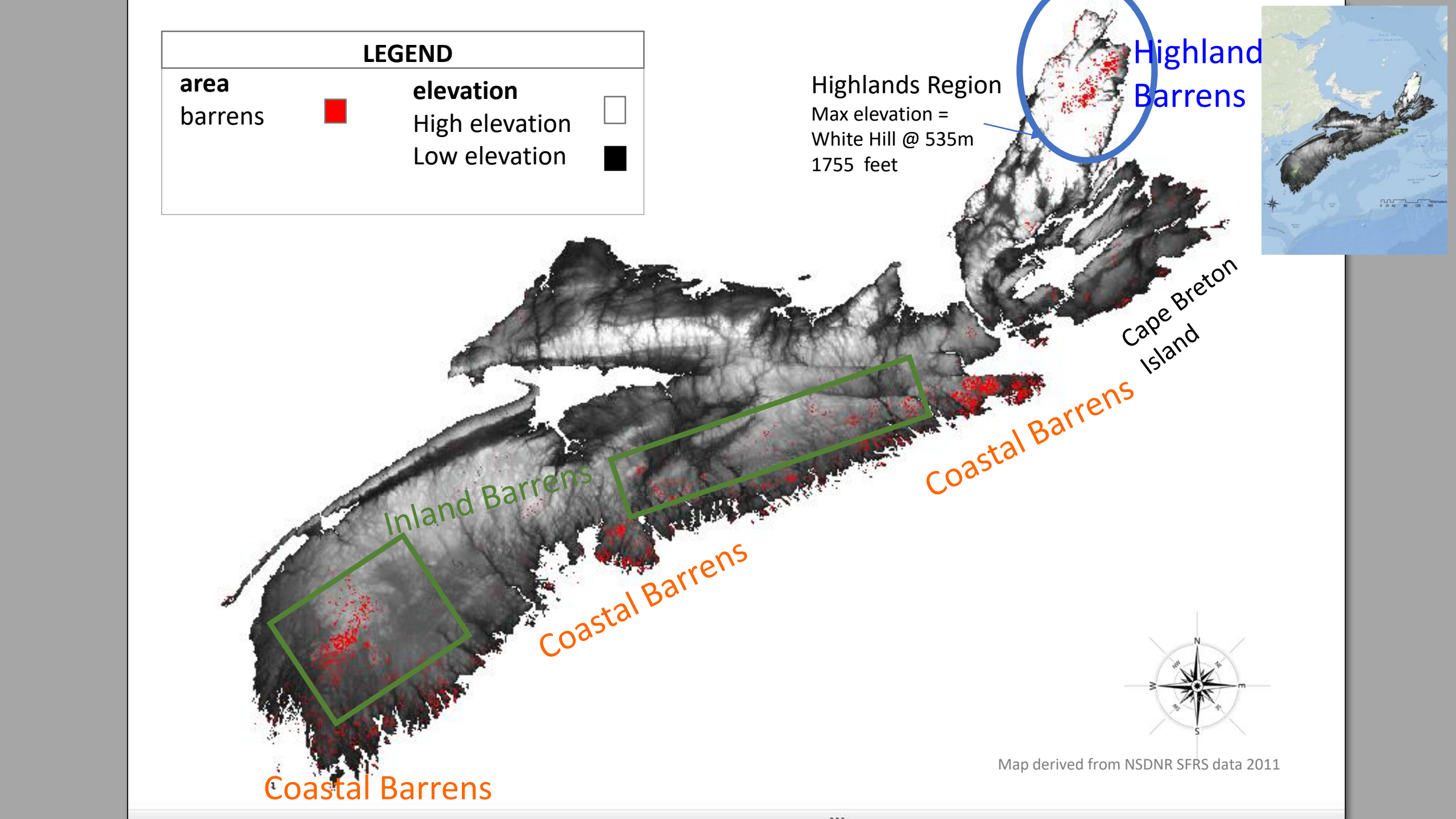
NSERC CRSNG

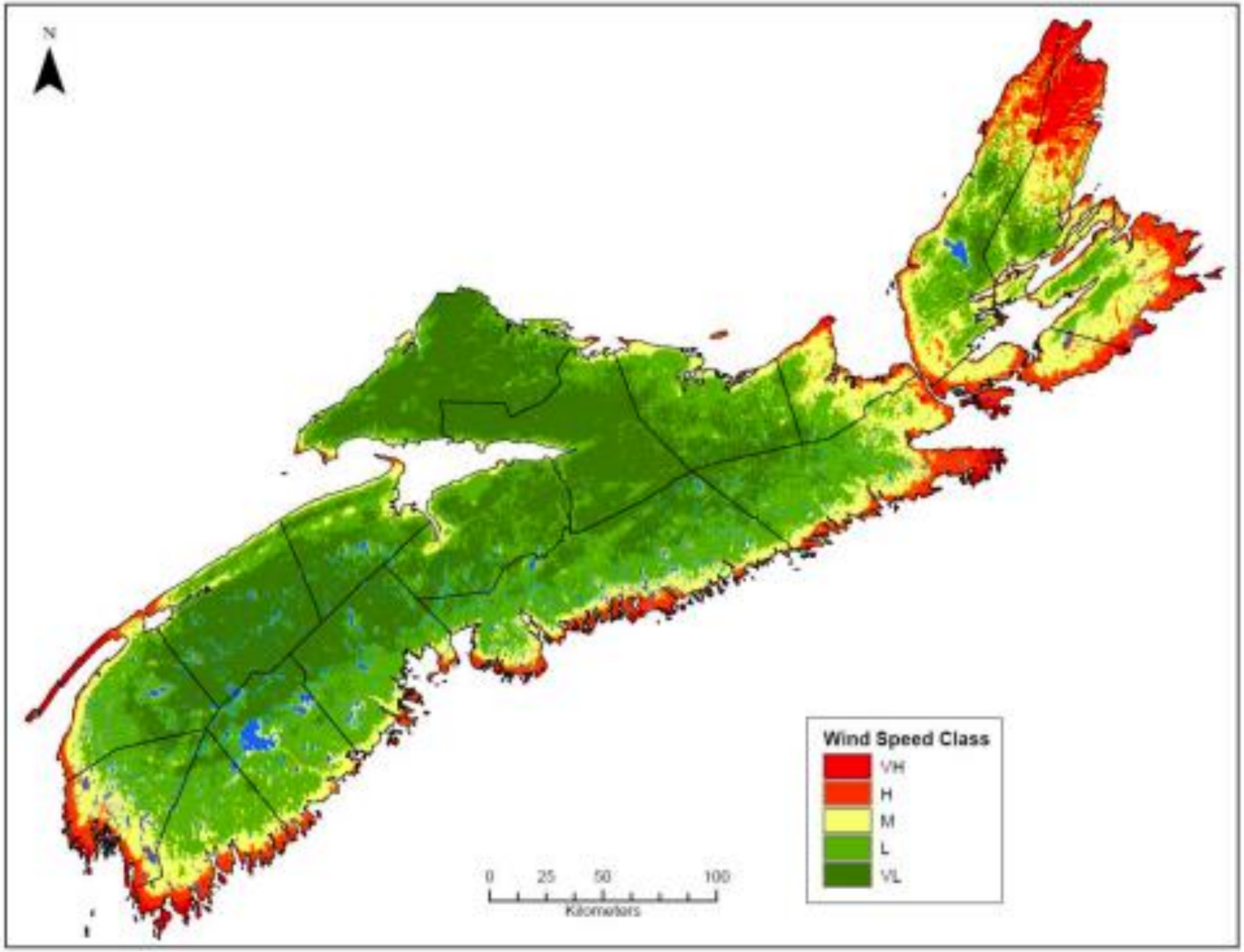
Geography of Nova Scotia Barrens

- NS = mostly mixed forest, wetlands. some Boreal forest in Cape Breton
- < 3% area of NS = barrens

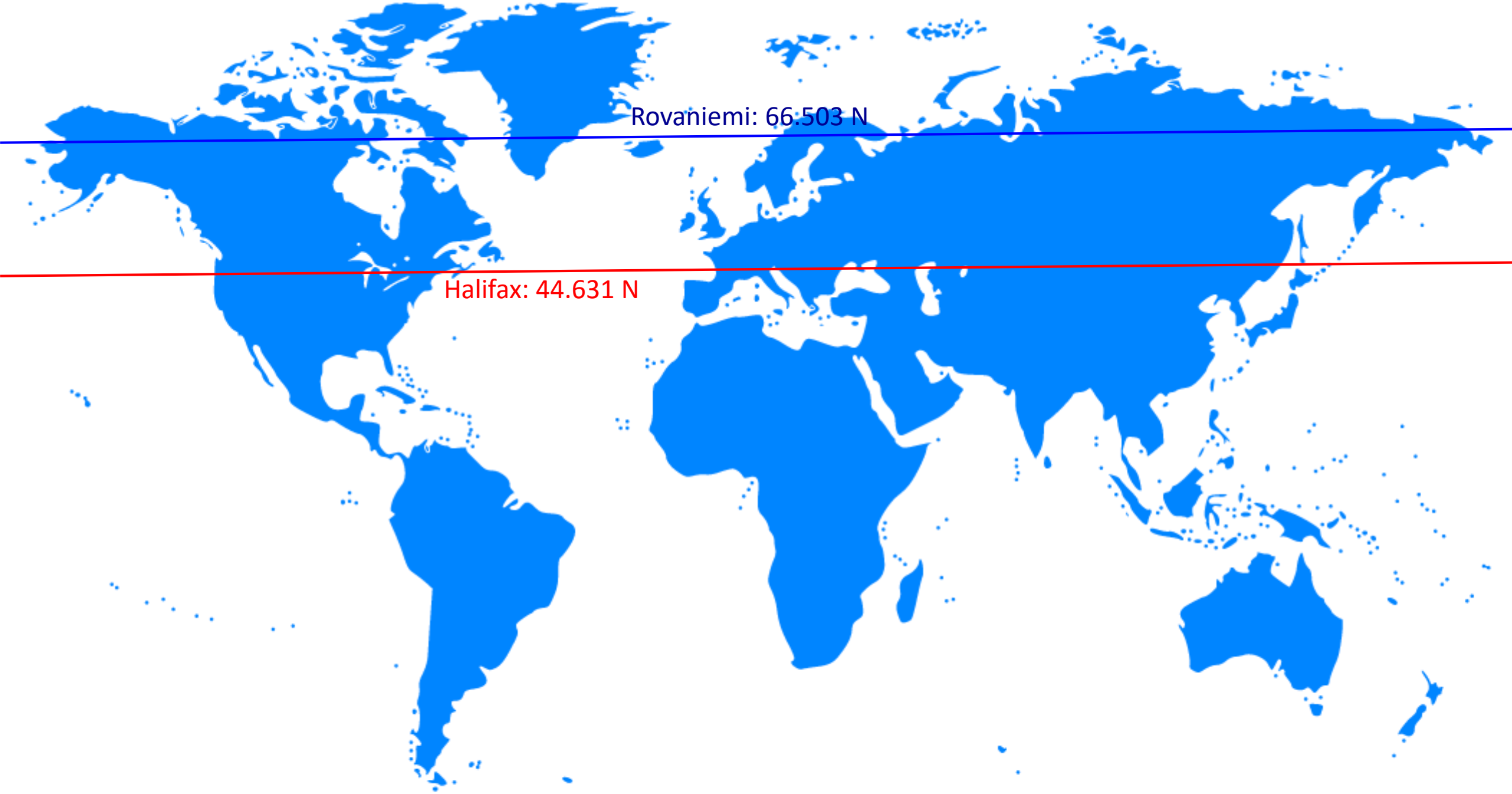





LEGEND
area
barrens
elevation
High elevation
Low elevation
Highlands Region
Max elevation =
White Hill @ 535m
1755 feet
Highland Barrens
Cape Breton Island
Coastal Barrens
Inland Barrens
Coastal Barrens
Coastal Barrens
Map derived from NSDNR SFRS data 2011



Relative Wind Exposure. Model by Nova Scotia Department of Natural Resources (NS DNR) (2017)


Rovaniemi: 66.503 N
Halifax: 44.631 N

Highland barrens

Wind exposed

Les Suêtes; can be > 200km/hr

Volatile weather

Coastal influence (fog, salt spray)

Short growing season

Winter: frost heaving, snow

Arctic-alpine plant species

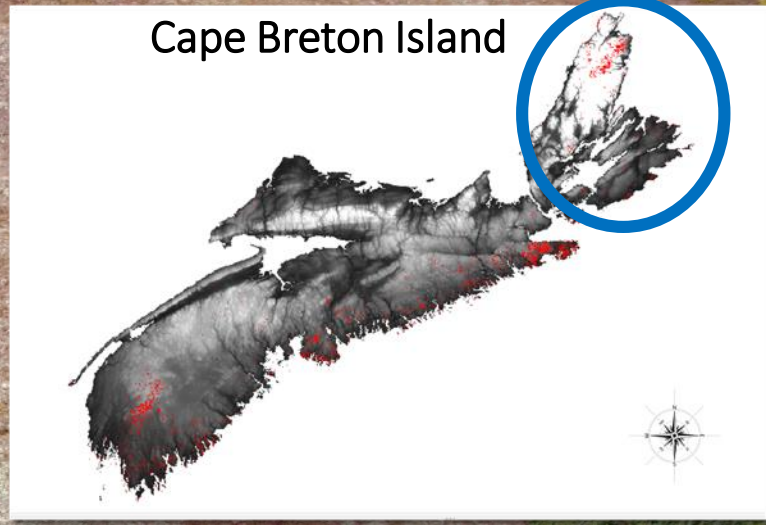


Photo by Sean Basquill

Coastal Barrens

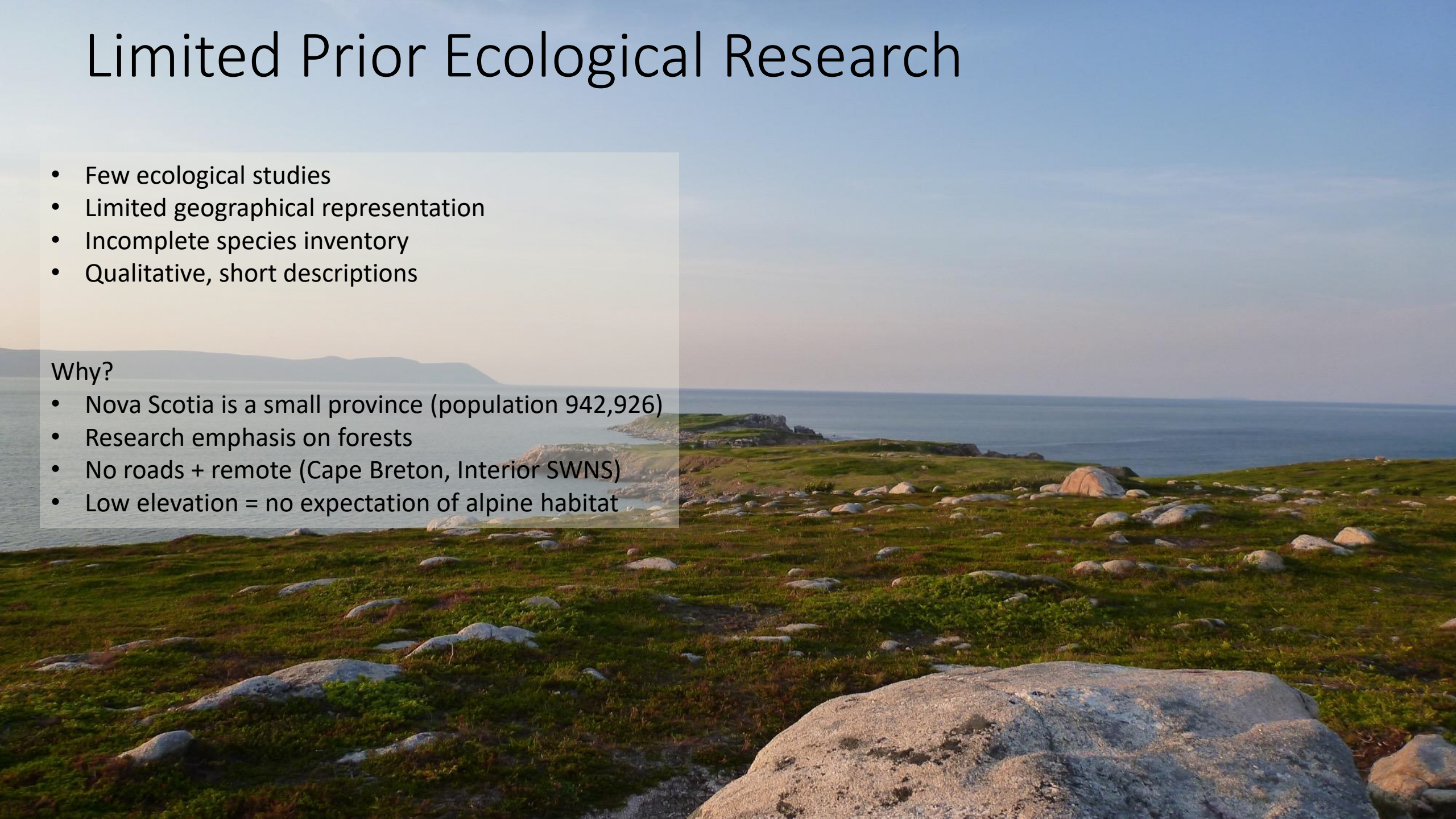
- Wind exposed
- Volatile weather
- At sea level
- Coastal influence (fog, salt spray)
- Winter: variable snow cover; frost action; ice at coast
- Arctic-alpine species

Limited Prior Ecological Research

- Few ecological studies
- Limited geographical representation
- Incomplete species inventory
- Qualitative, short descriptions

Why?

- Nova Scotia is a small province (population 942,926)
- Research emphasis on forests
- No roads + remote (Cape Breton, Interior SWNS)
- Low elevation = no expectation of alpine habitat



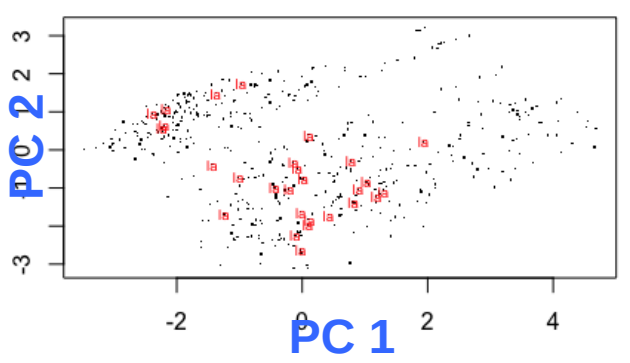
Plant Species Diversity on Barrens

Oberndorfer & Lundholm 2009
1m x 1m plots: 2 - 28 species per plot

Why so many species in some areas and so few in others?
Richer plots: deeper soil, more soil moisture
Spatial heterogeneity not related to diversity at $1m^2$ scale
Soil depth, moisture, sodium content drove vegetation composition

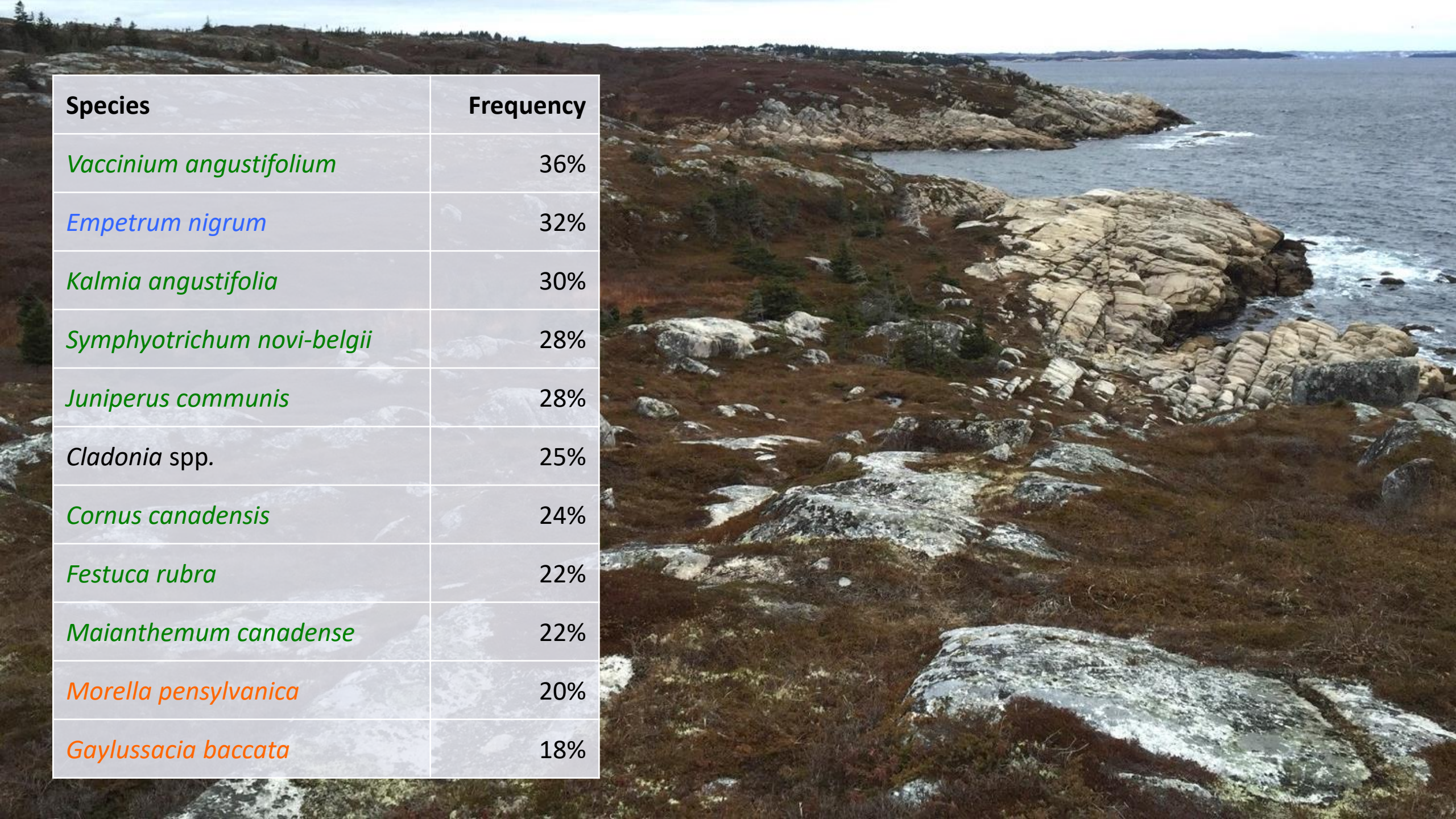
Study Design

- 20 sites
- Randomly selected 1500m section of coastline
- Transects every 300m
- Quadrats every 100m on a transect + rocky coastal zone
- 1m^2 square quadrat
- n= 482
- Species composition, richness



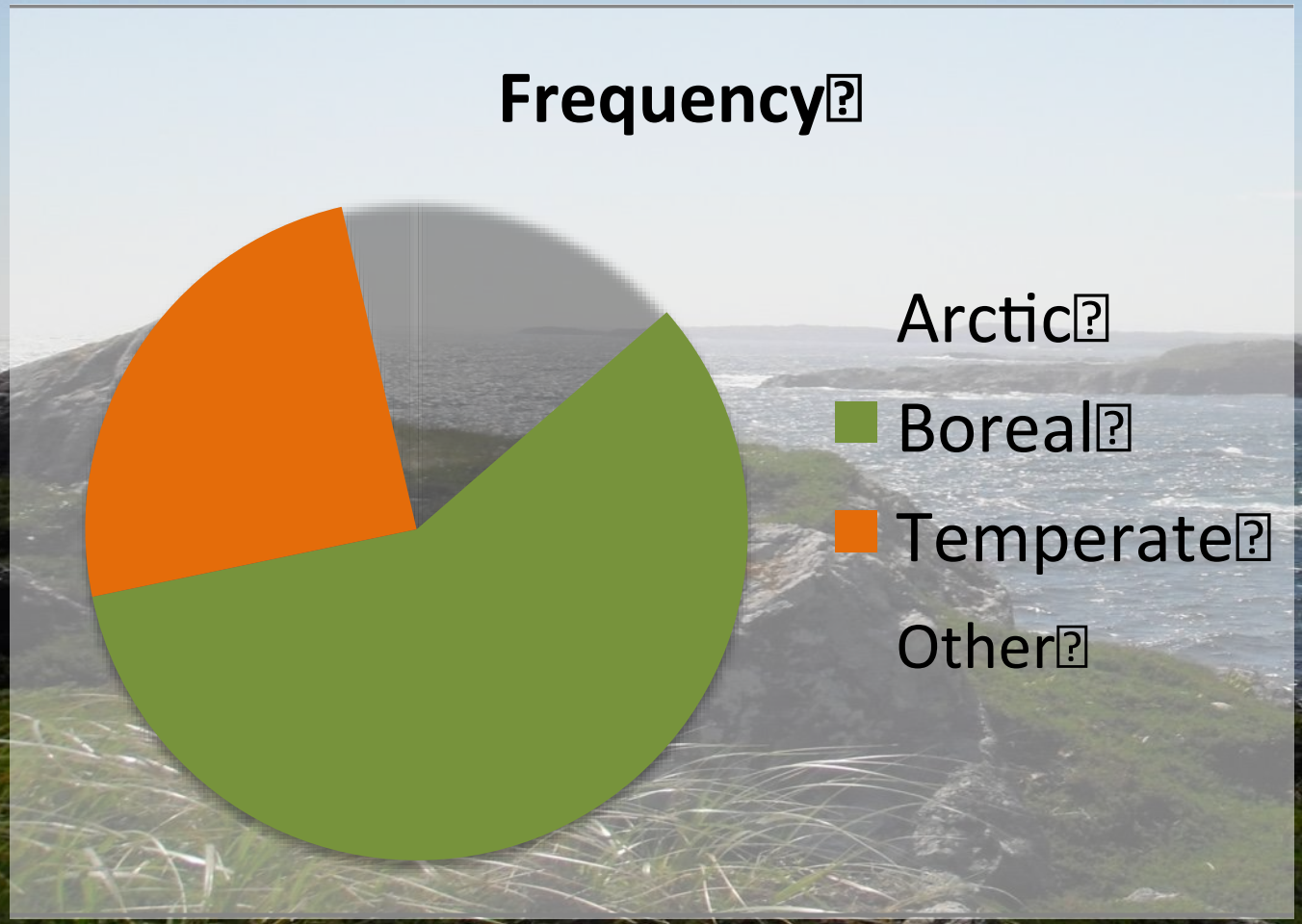
Predictor Variables:

- Site size
- Site average northing
- PCA on plot data to reduce # variables and focus on main gradients
  Mean, Standard deviation (spatial heterogeneity)



Species	Frequency
Vaccinium angustifolium	36%
Empetrum nigrum	32%
Kalmia angustifolia	30%
Symphyotrichum novi-belgii	28%
Juniperus communis	28%
Cladonia spp.	25%
Cornus canadensis	24%
Festuca rubra	22%
Maianthemum canadense	22%
Morella pensylvanica	20%
Gaylussacia baccata	18%

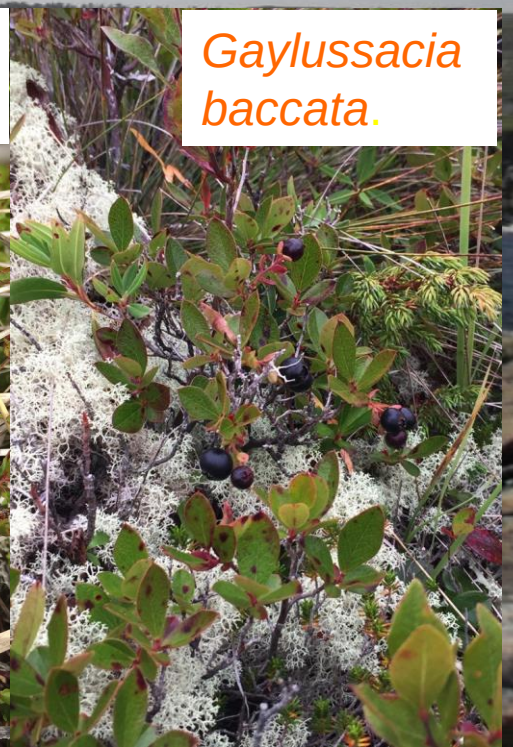
Coastal Barrens Vegetation: Biogeographic Affinities



Gaultheria procumbens

Juniperus communis
Empetrum nigrum

Vaccinium angustifolium



Gaylussacia baccata.

Vegetation Classification

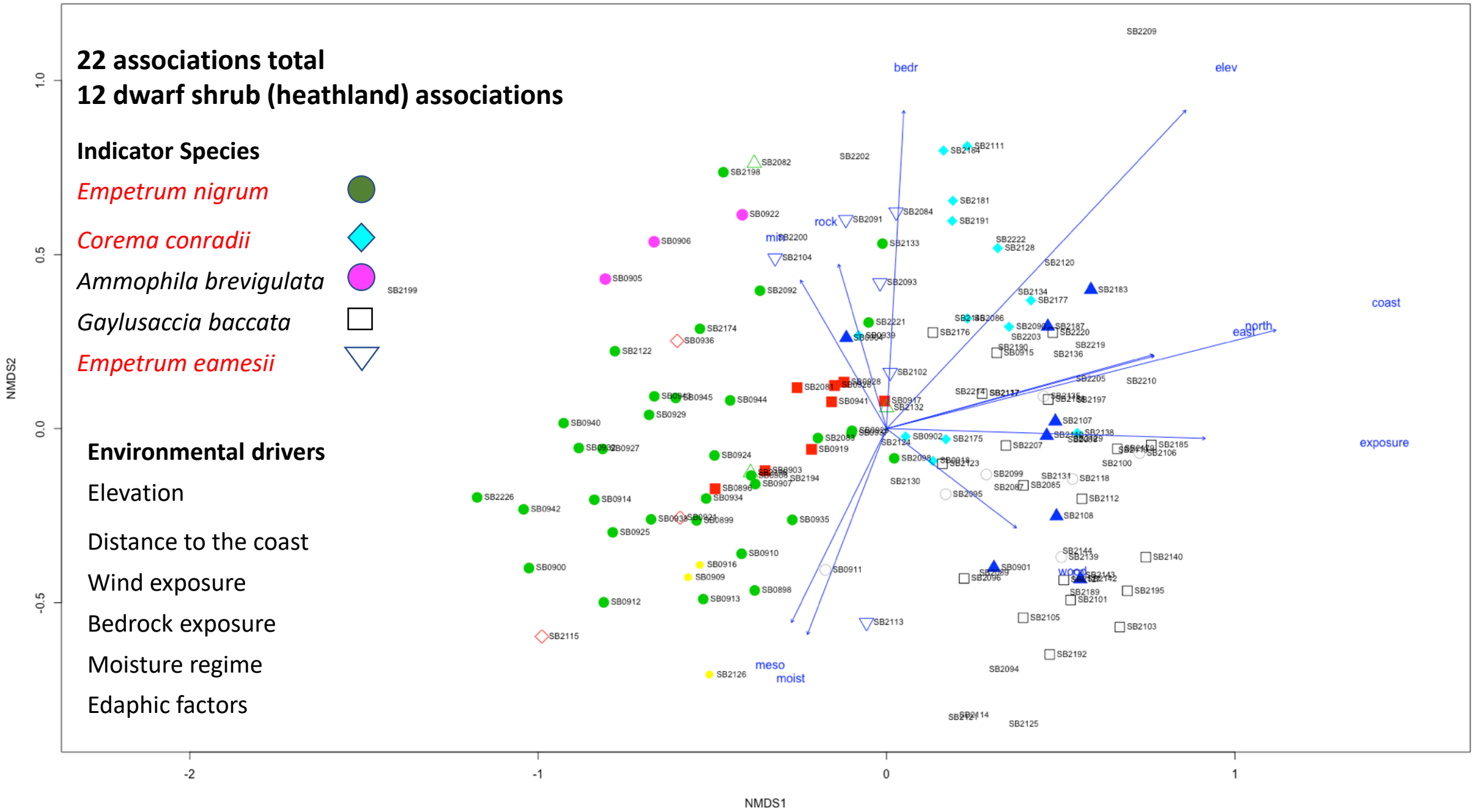
a) Describe and classify natural heathland communities across Nova Scotia's barrens

b) Identify and describe those environmental factors that explain variation in the species composition, diversity, and distribution of these communities

Photos by: Eugene Quigley

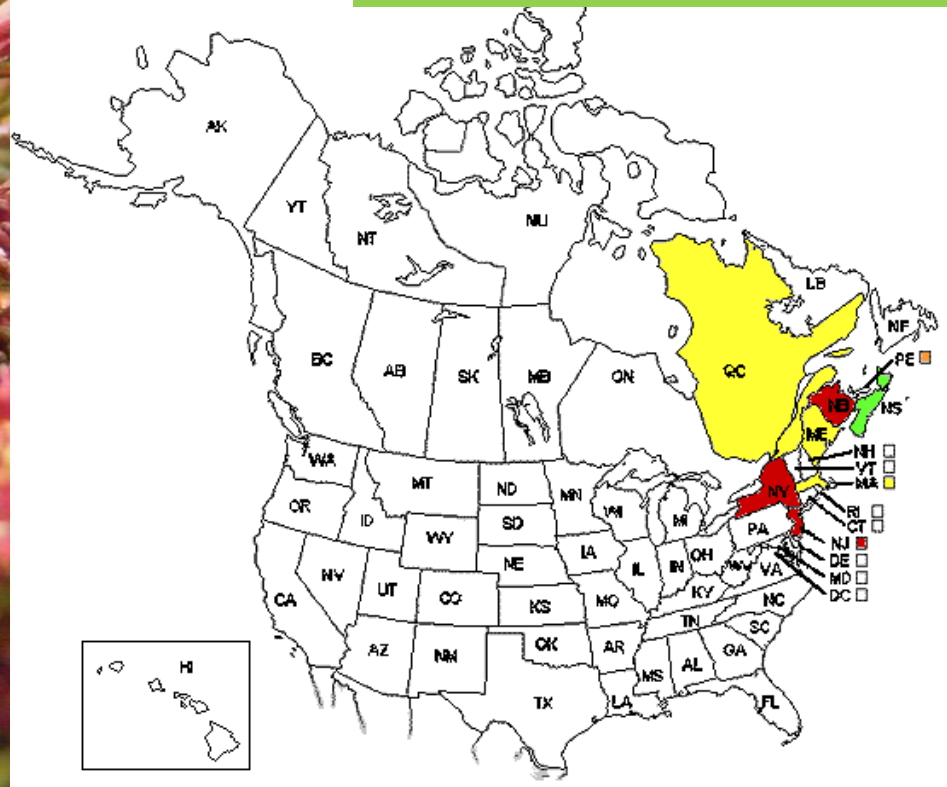
Photo by: Terry Power

NMDS of axes 1,2. + Fitted environmental variables + Wards Cluster Analyses



Broom Crowberry (*Corema conradii*), an endemic of the Northeast

Nova Scotia: S5 (common)



http://explorer.natureserve.org/

gobotany.newenglandwild.org

Empetrum nigrum – Empetrum eamesii – Vaccinium uliginosum highland dwarf heath

Environment:
Provincially rare, found in Cape Breton
Above the treeline
Crests of prominent hills (>400m)
Exposed rock,
Wind exposed
Shallow, nutrient-poor, acidic humus

Other key species:
Vaccinium boreale
Racomitrium lanuginosum
Cladonia spp; (*boryi, stygia, uncialis, wainioi..)*
Cetraria spp. (esp. *islandica*)
Ochrolechia frigida

Photo by Emily Walker

Provincially rare alpine species, e.g. Diapensia (*Diapensia lapponica)*

Black Crowberry (*Empetrum nigrum*) mesic coastal dwarf heath

Folisol (humus);
nutrient poor, acidic. +
Veneer of sandy glacial till
Shallow over bedrock (~ 30cm)

Other key species: *Juniperus communis, Juniperus horizontalis, Empetrum eamesii, Vaccinium angustifolium, Sibbaldiopsis tridentata, Calamagrostis pickerengii, Maianthemum canadense, Cornus canadense, Cladonia* spp. *(terrae-novae, boryi, rangiferina, oricola etc)* & others! mean spp. richness = 23 (5x5m)

Environment:
coastal exposures (peninsulas, islands, headlands)
salt spray, wind

Black Huckleberry Shrubland (*Gaylusaccia baccata)*

Threats

Vehicle and Hiking Trail Damage to and Heathlands

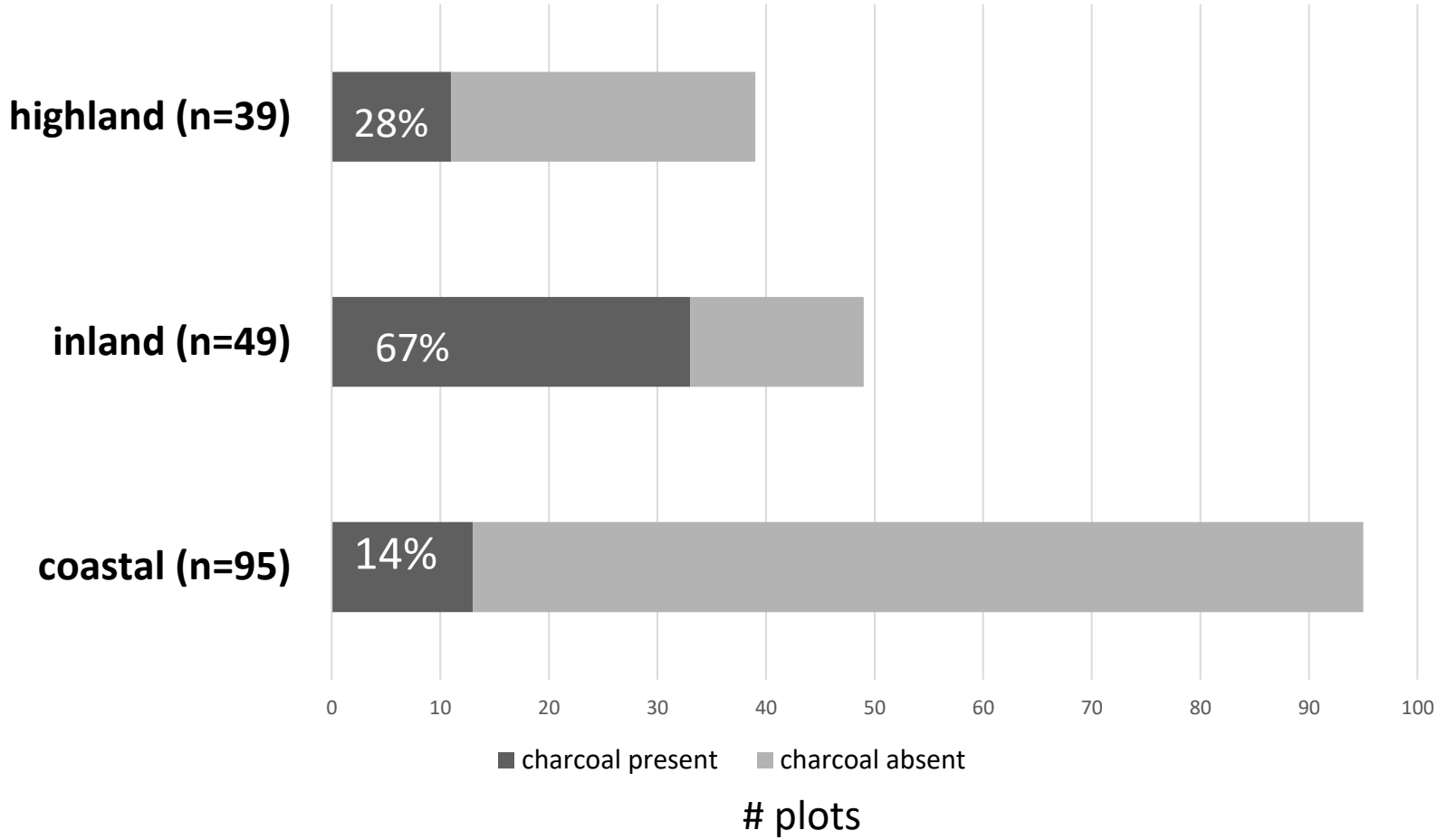
Climate Change Impacts

- Rising sea levels: coastal squeeze/erosion
- Drought
- Shifts in species composition?

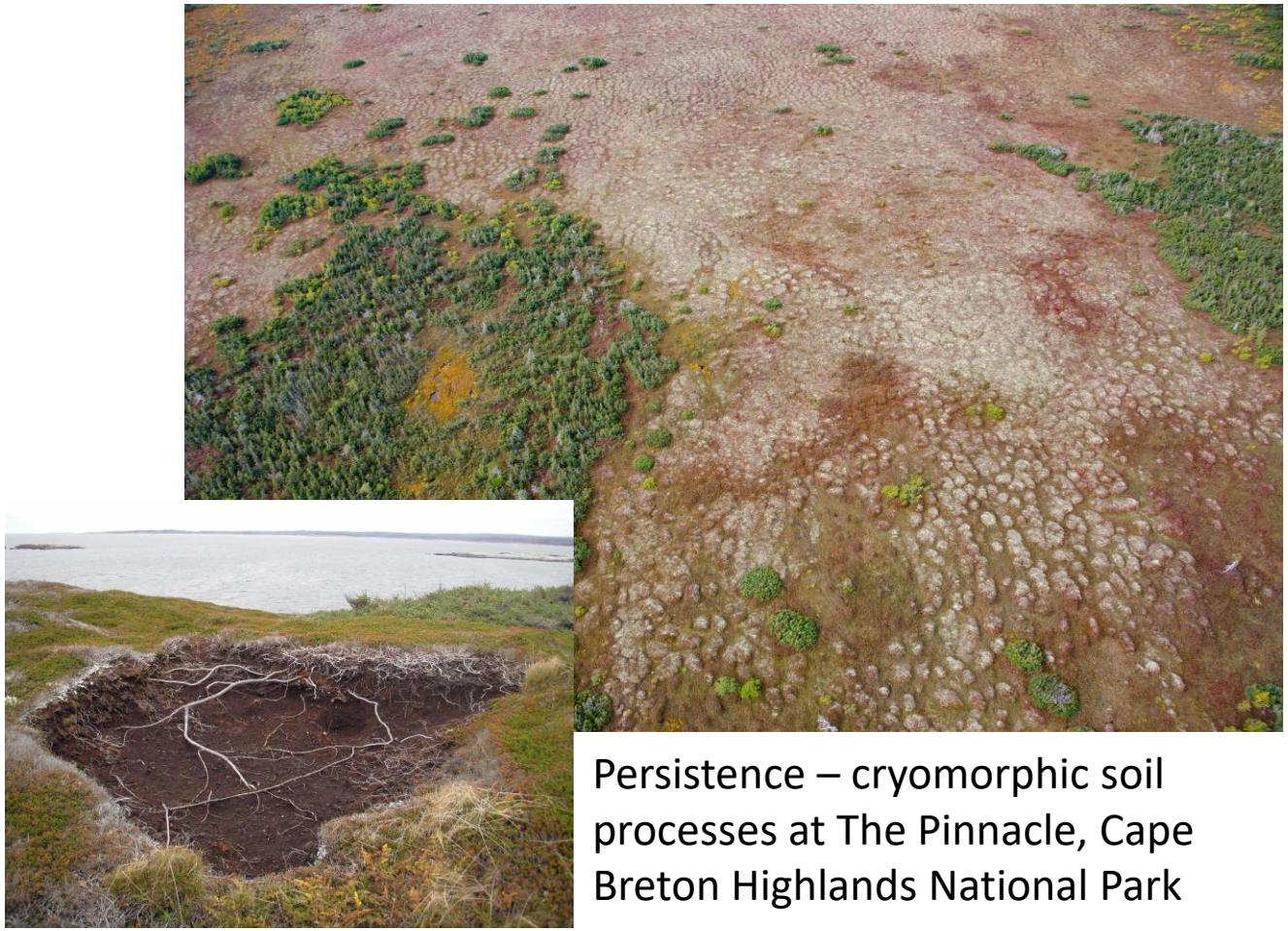
Prevalence of historic fire on Nova Scotia's barrens

Evidence of fire:
charcoal in soil pits

Presence of charcoal in 31% of soil pits;
NS heathlands classification project (n=183 plots)



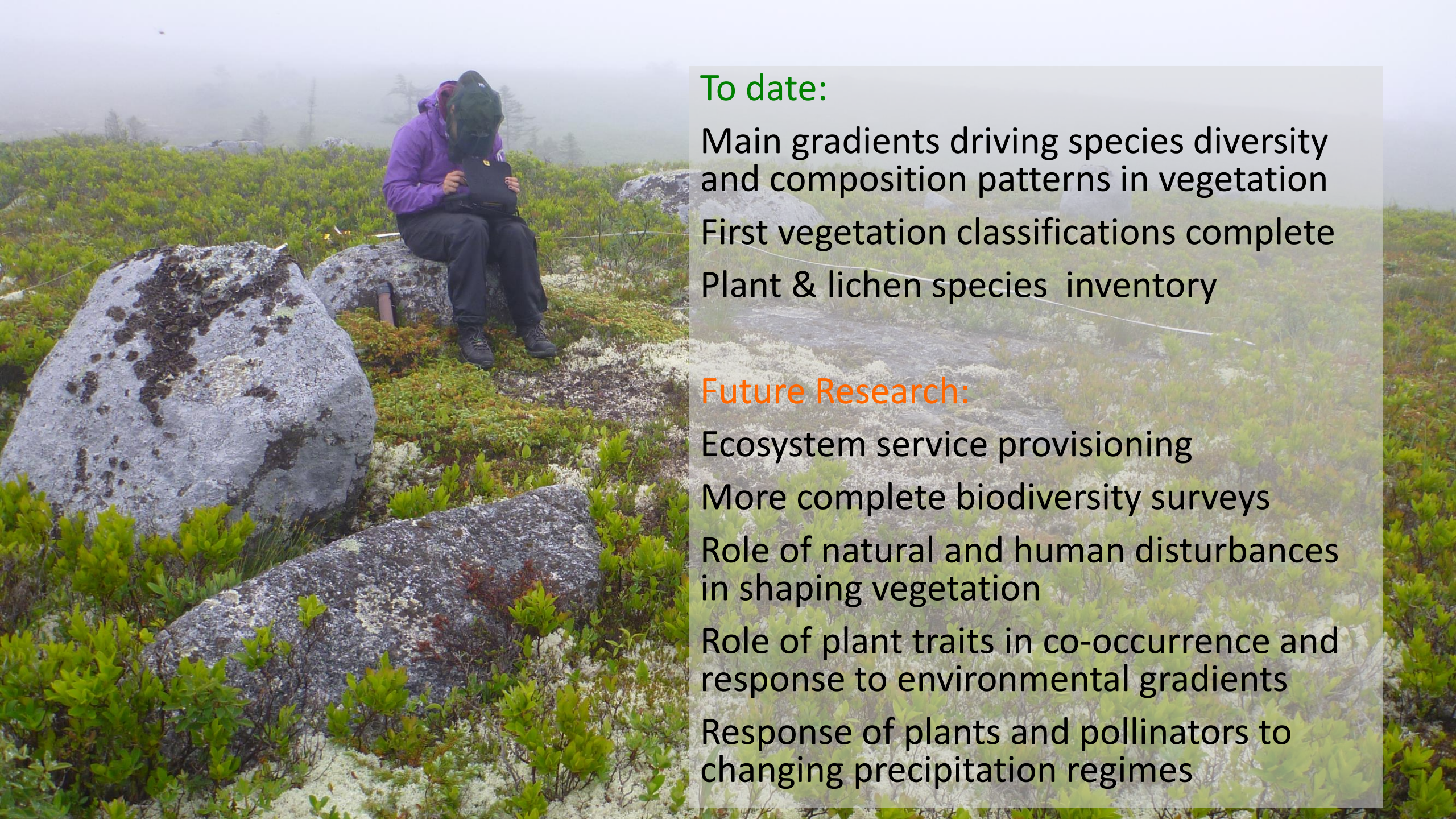
“Persistent” vs “Dynamic” barrens



Persistence – cryomorphic soil processes at The Pinnacle, Cape Breton Highlands National Park

Afforestation – tree regeneration, interior Southwest Nova Scotia


Afforestation on a coastal barren, Chebucto Peninsula
UAV Photo by: Michael Buckland-Nicks



To date:

Main gradients driving species diversity and composition patterns in vegetation

First vegetation classifications complete

Plant & lichen species inventory

Future Research:

Ecosystem service provisioning

More complete biodiversity surveys

Role of natural and human disturbances in shaping vegetation

Role of plant traits in co-occurrence and response to environmental gradients

Response of plants and pollinators to changing precipitation regimes

Alpine Bilberry (*Vaccinium uliginosum),*
Cape Breton Highlands National Park

Questions? Kysymyksiä?

Predictors of Site-Level Species Richness

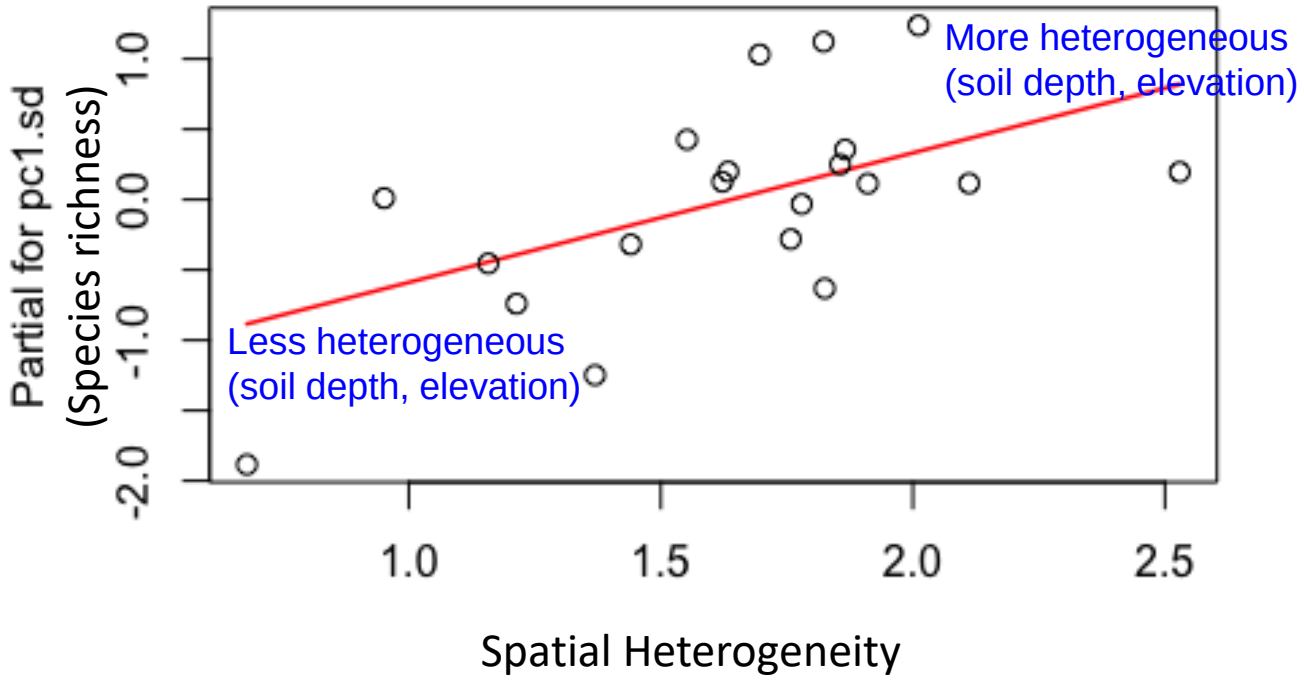
Native species

- Site area, soil depth, distance from coast: mean & spatial variability

Rare native species

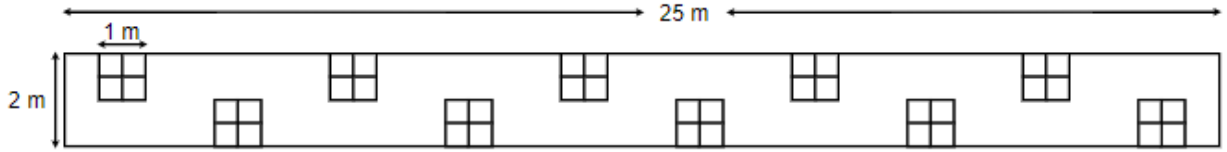
- Site average northing, spatial variability (elevation, slope, soil depth, aspect)

- Sites with pronounced topographic variability recommended for protection



Species richness vs. Spatial Heterogeneity

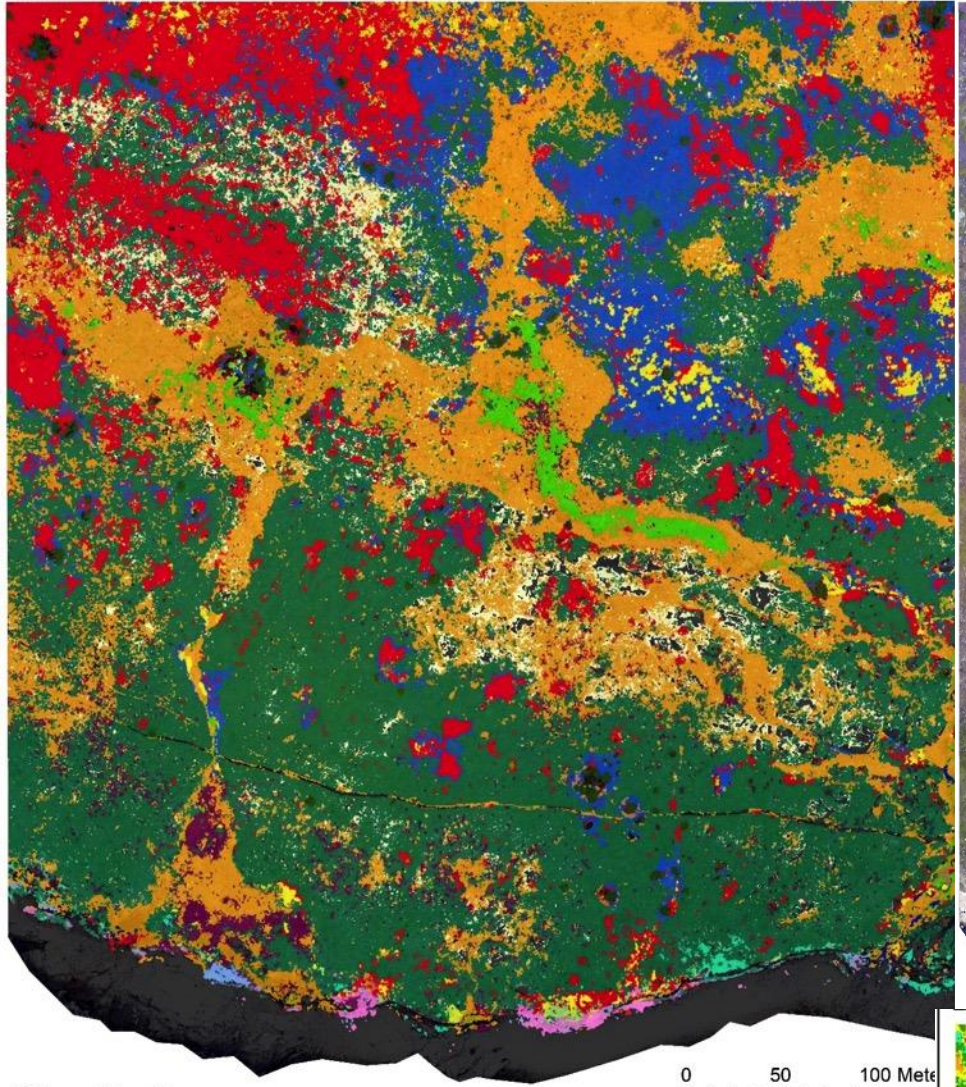
How large an area is required?

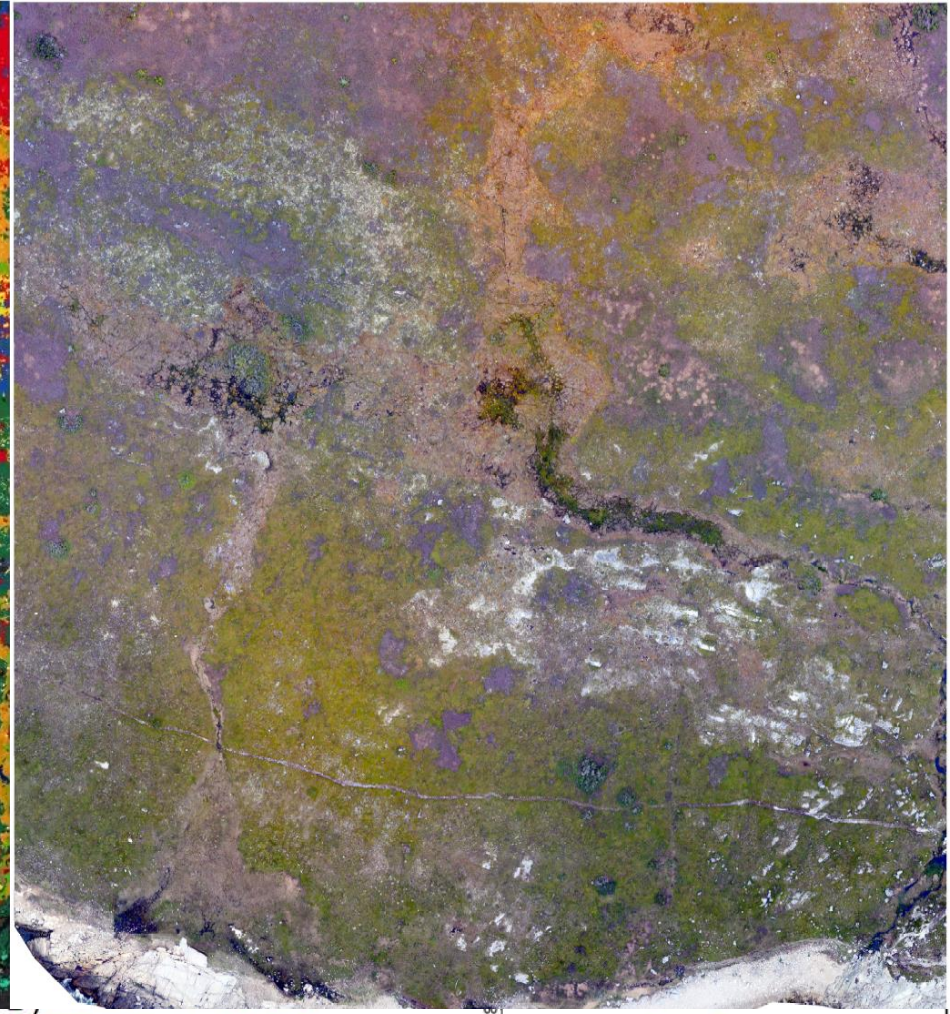


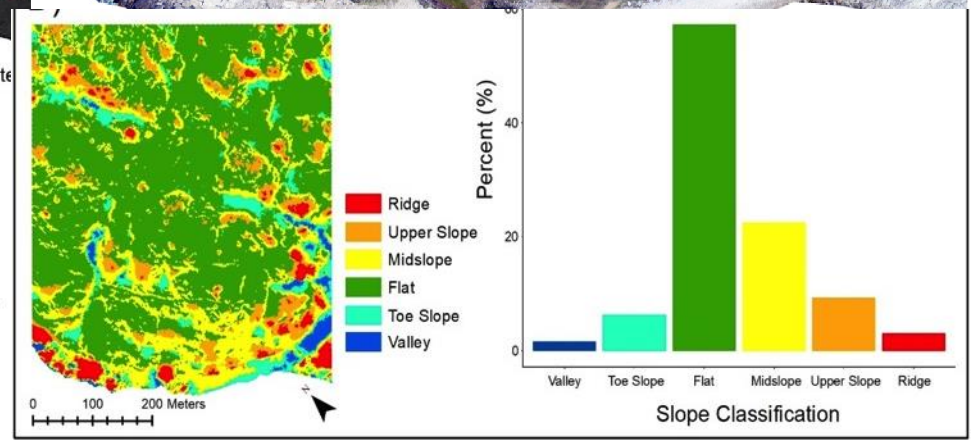
Environmental Factors Spatial variability	**Subplot** $0.5m^2$			**Plot** $1m^2$			**Transect** $50m^2$		
	Conf int lower	Coef.	Conf int upper	Conf int lower	Coef	Conf int upper	Conf int lower	Coef.	Conf int upper
Substrate depth (SD)	-0.01	-0.002	0.002	-0.01	0.05	0.18	-0.58	0.07	0.09
Substrate moisture (SD)	N/A	N/A	N/A	-0.10	-0.01	0.04	1.33	**0.63**	0.19
Topographic elevation (SD)	-0.01	-0.001	0.003	0.04	**0.10**	0.17	-0.68	0.09	0.10
Percent cover variables (H')	0.02	**0.02**	0.03	0.07	**0.16**	0.24	-1.07	0.04	0.63

?

Topography, distance from coast drive spatial patterns of vegetation

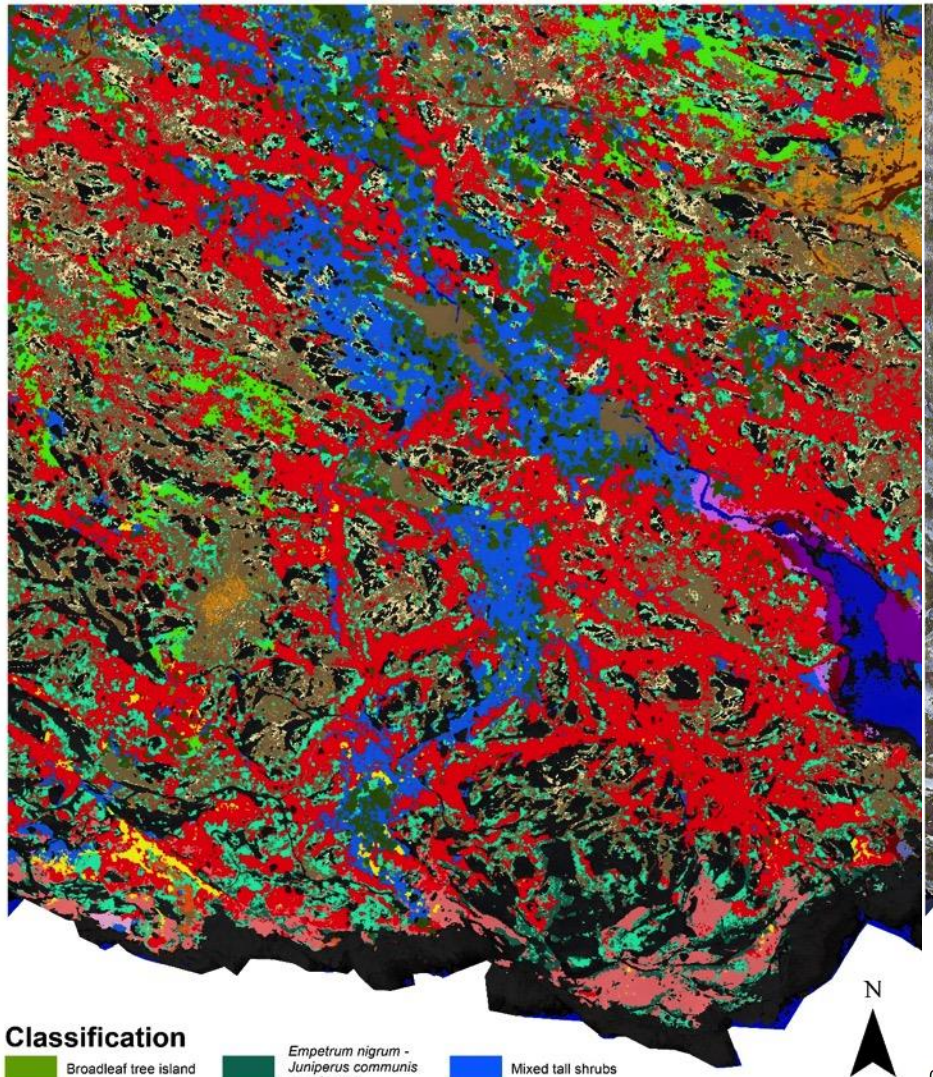


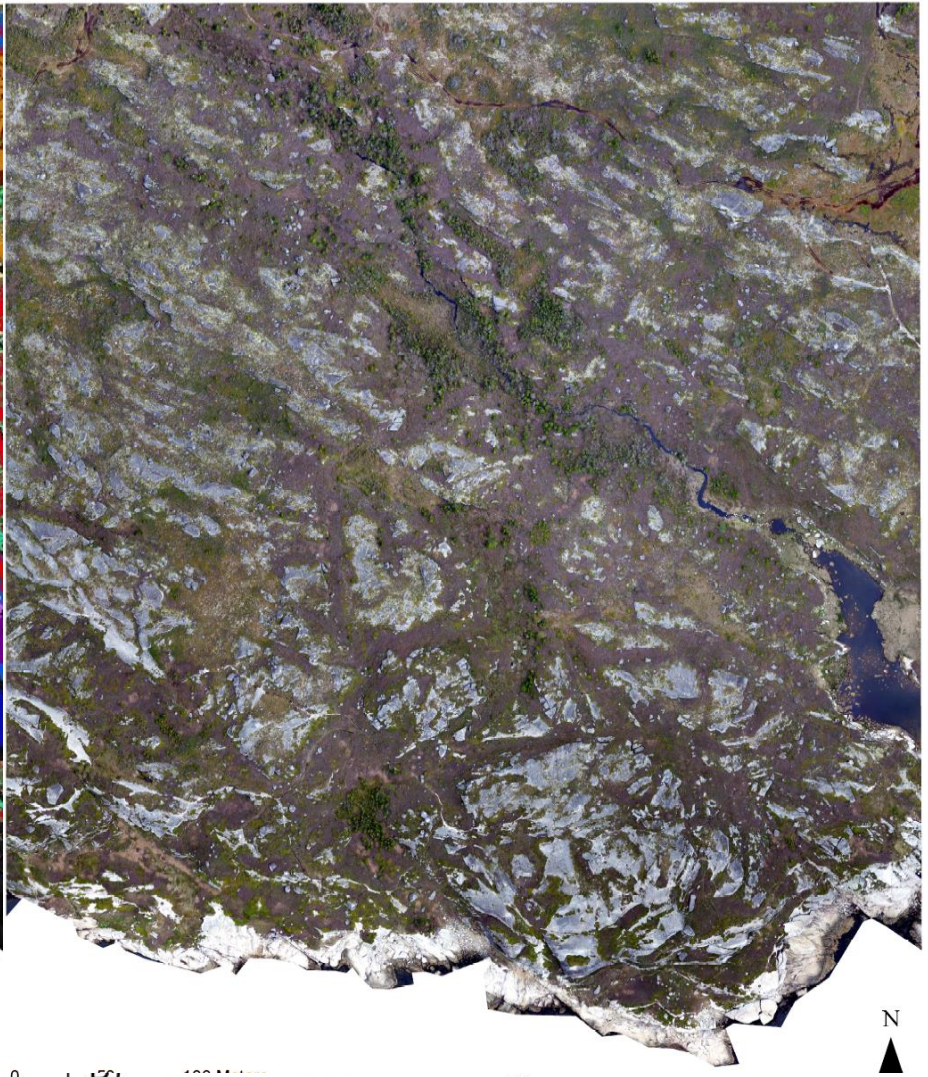


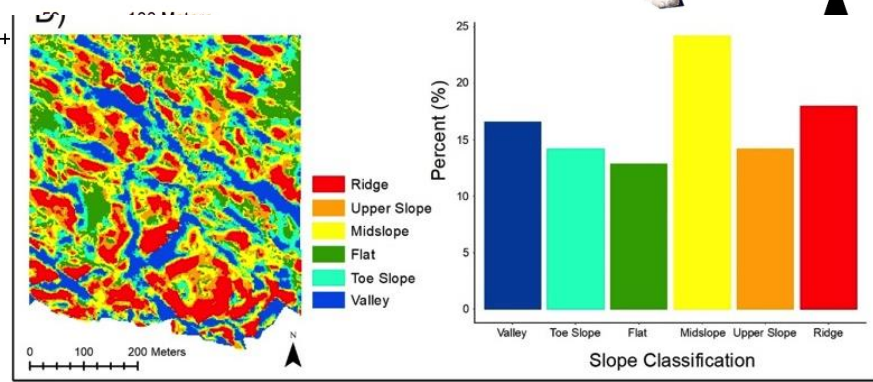


Images: Buckland-Nicks 2018

Distribution and topography of exposed bedrock contributes to vegetation diversity







Images: Buckland-Nicks 2018

Berry harvesting

Abundance and diversity of edible berries on the barrens.

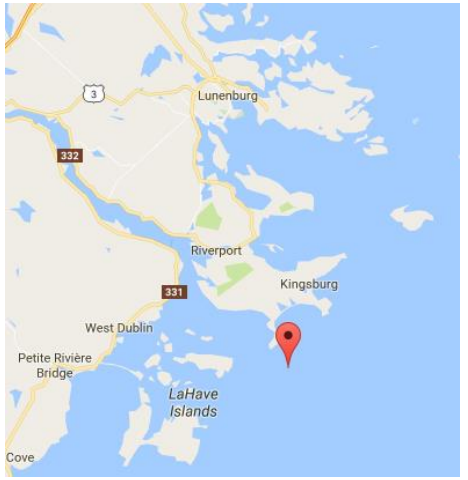
Best known examples:

- Wild blueberry *(Vaccinium angustifolium)*
- Cranberry (*Vaccinium macrocarpon*)

Blackberries (called Black Crowberries in NS) (*Empetrum nigrum)* harvested by Erica

Katie's 2016 harvest of Huckleberry (*Gaylusaccia baccata, bigelovania),* and Juniper *(Juniperus communis)*

European activities on barrens (traditional & contemporary)



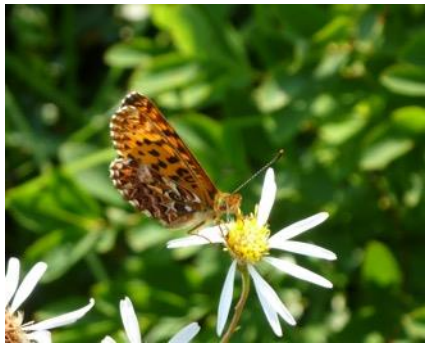
- Farming homesteads & sheep pasturing

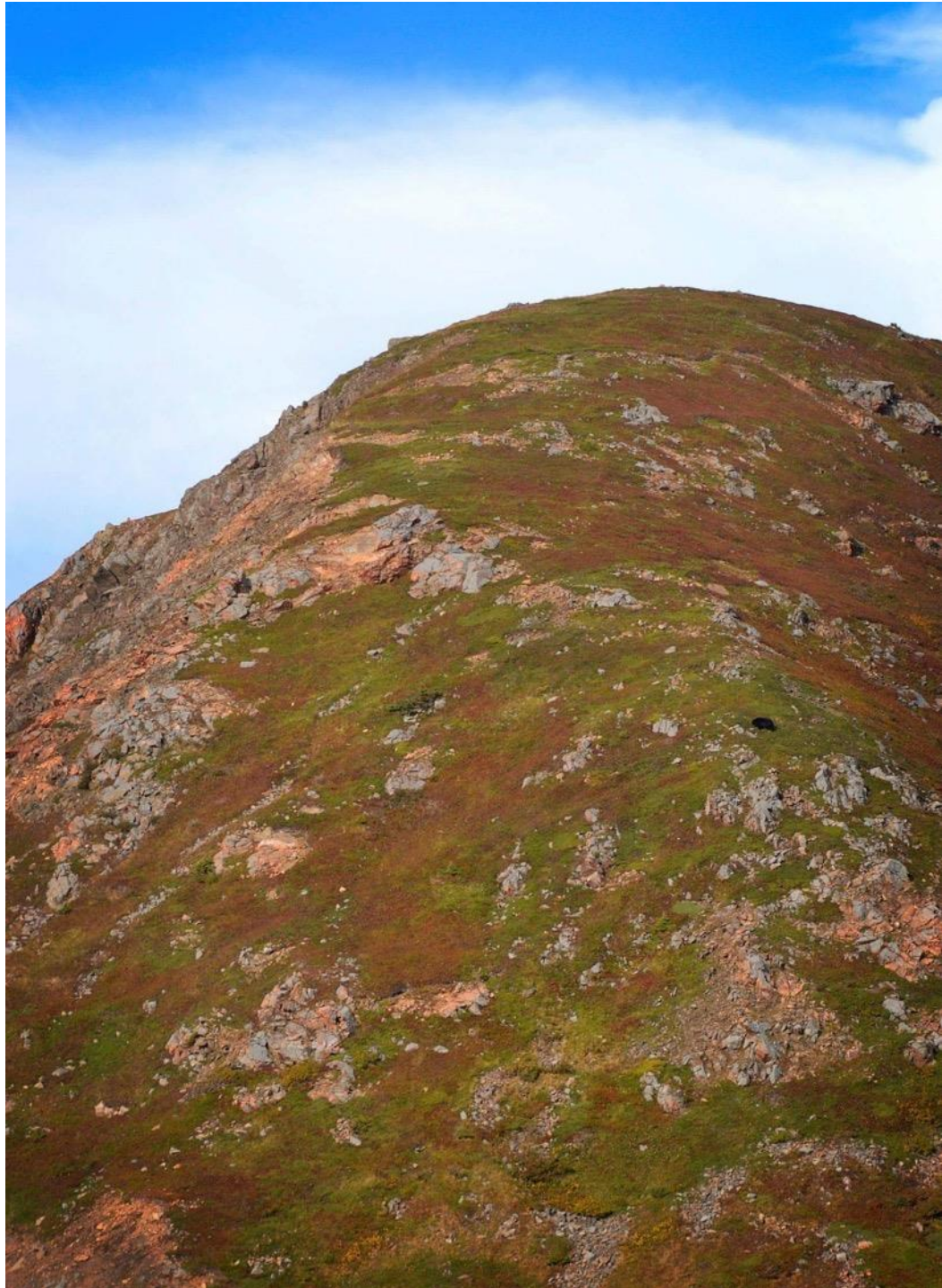
New lambs on West Ironbound Island (1977)

Bringing sheep to West Ironbound (2013)

Photo credits: West Ironbound Facebook group, West Ironbound Sheep facebook group

Ecological & cultural value





Photos: Whimbrel (Andreas Trepte), Arctic Fritillary (me), Black Bear (Jeff Clemments), Peggys Cove (NS Tourism)