

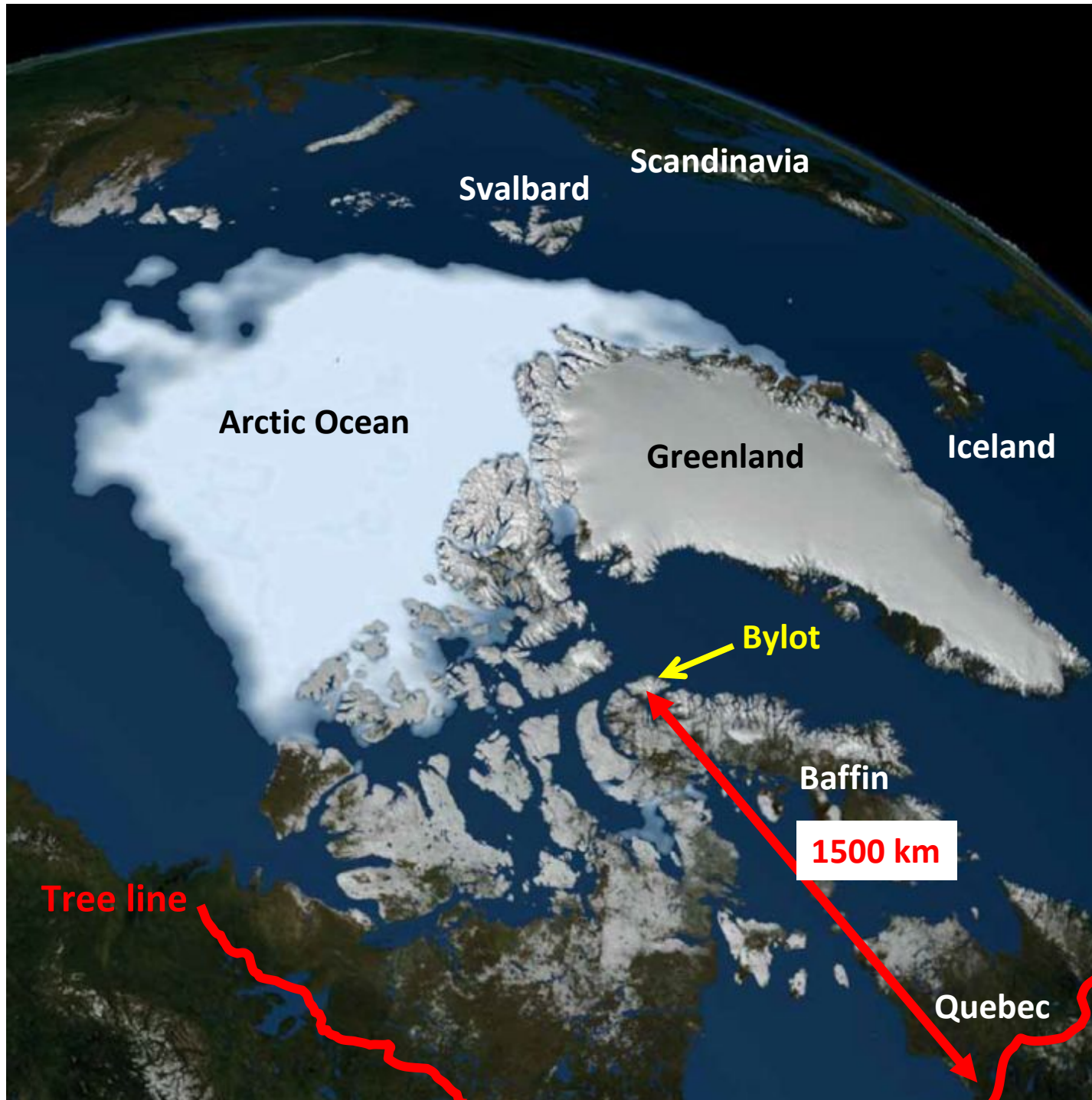
Long-term monitoring of the Bylot Island tundra ecosystem: what did we learn?

Dominique Berteaux and Gilles Gauthier



1. Background and monitoring history
2. Examples of recent findings
3. Answers to the 5 questions





Svalbard

Scandinavia

Arctic Ocean

Greenland

Iceland

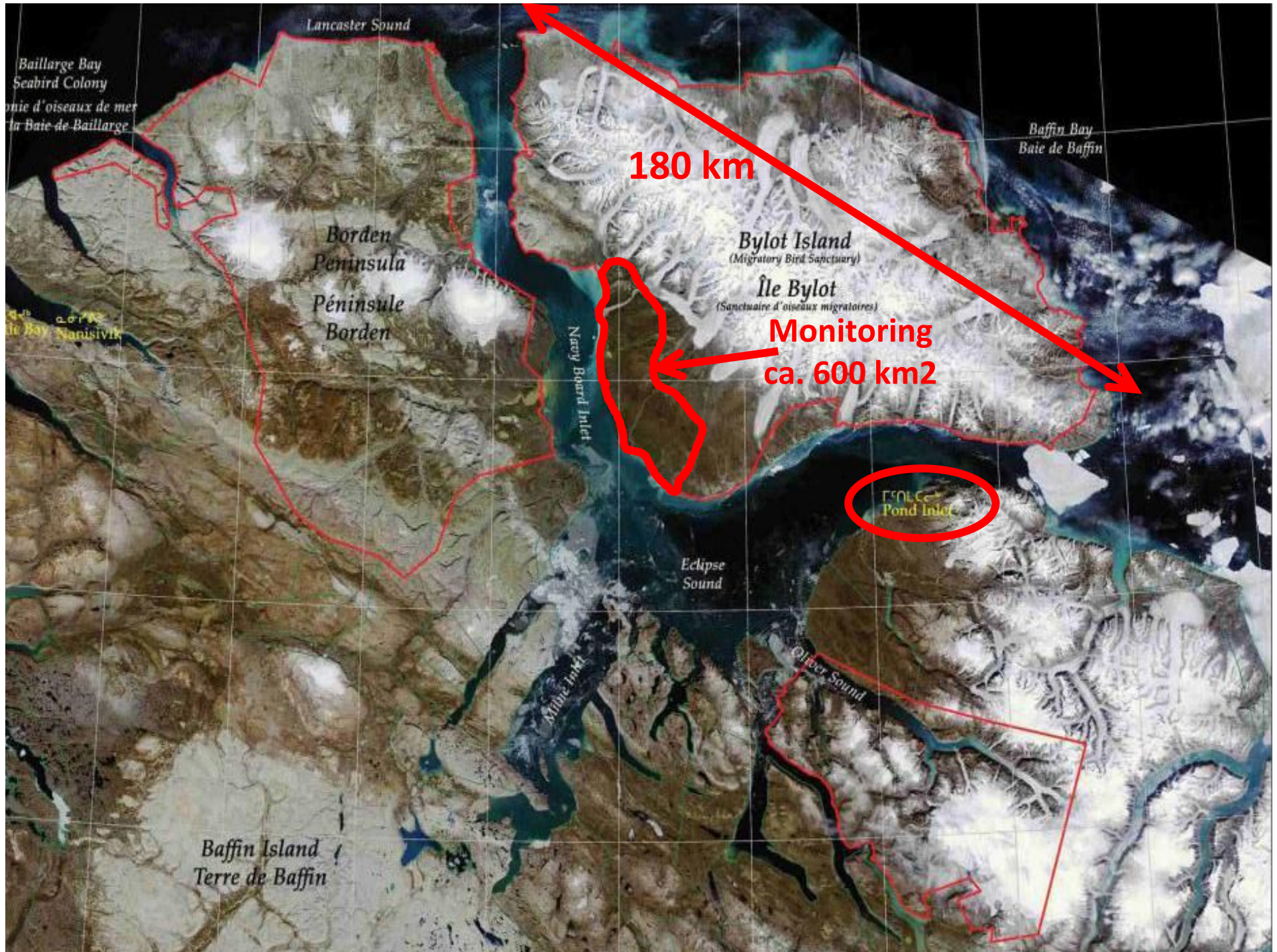
Bylot

Baffin

1500 km

Tree line

Quebec





Mountains/glaciers

Study area

Sea (usually ice-covered)



Mountains/glaciers

Study area

Study area

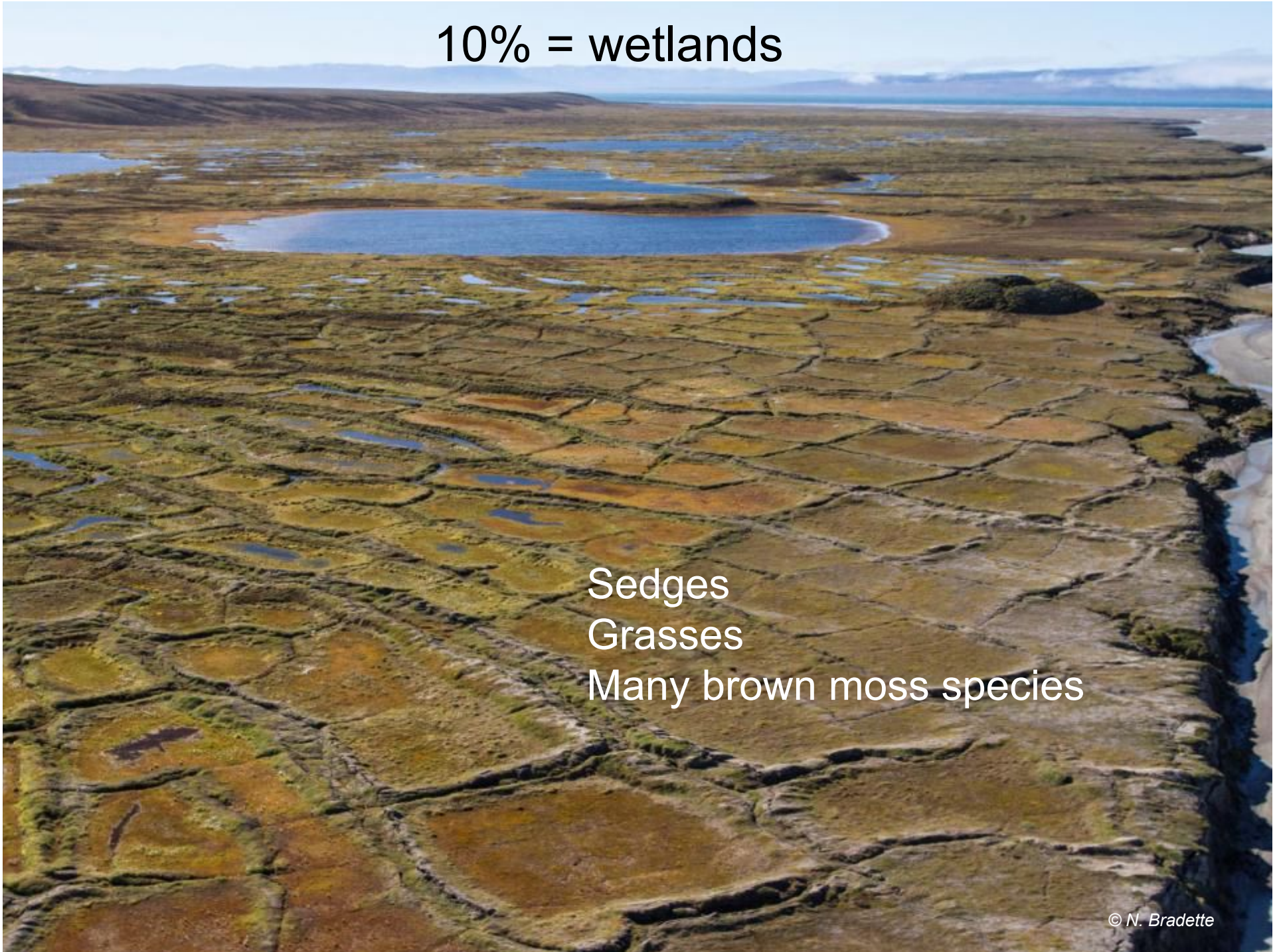
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10% = wetlands



10% = wetlands

Sedges
Grasses
Many brown moss species

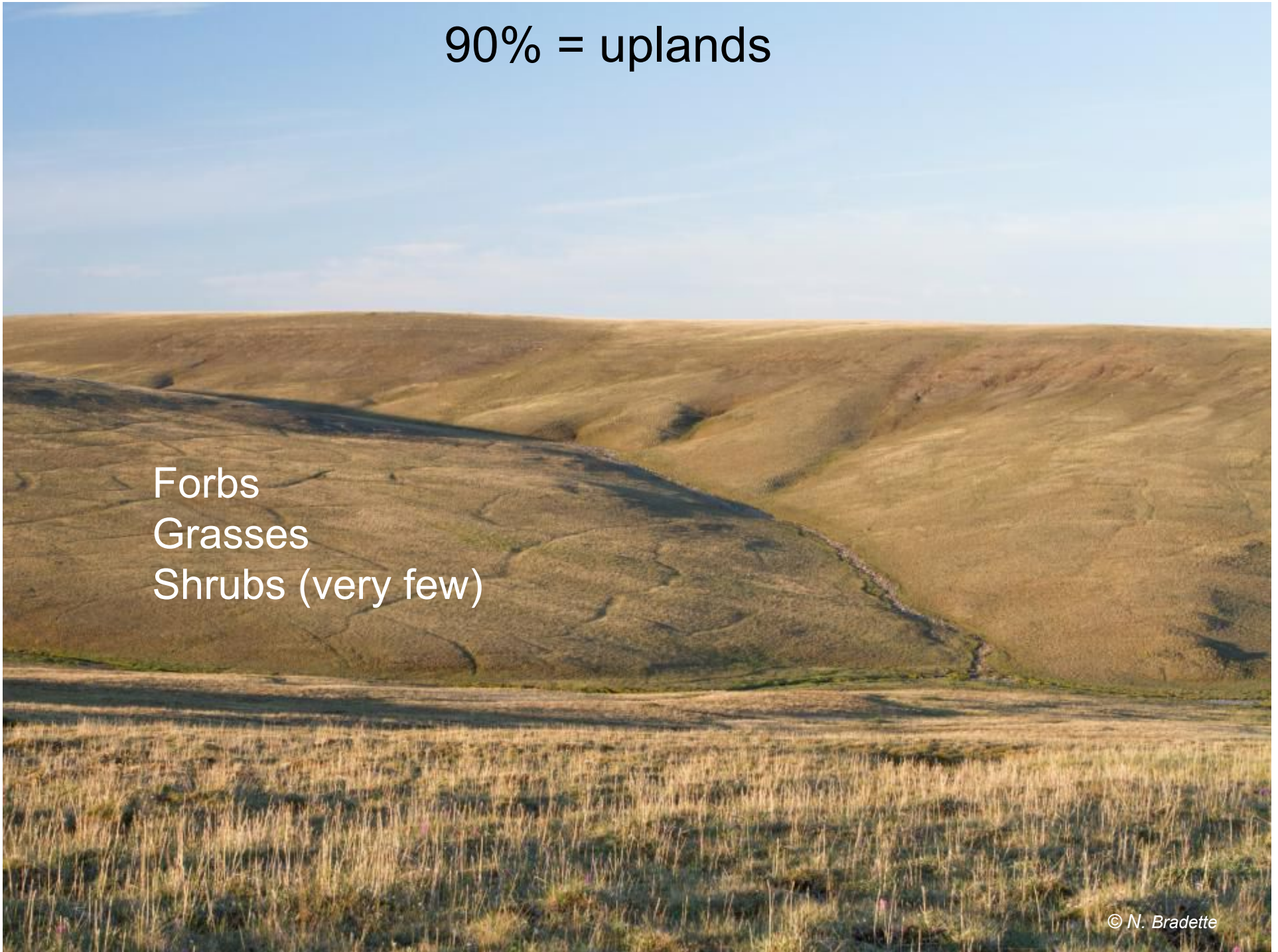


90% = uplands



90% = uplands

Forbs
Grasses
Shrubs (very few)





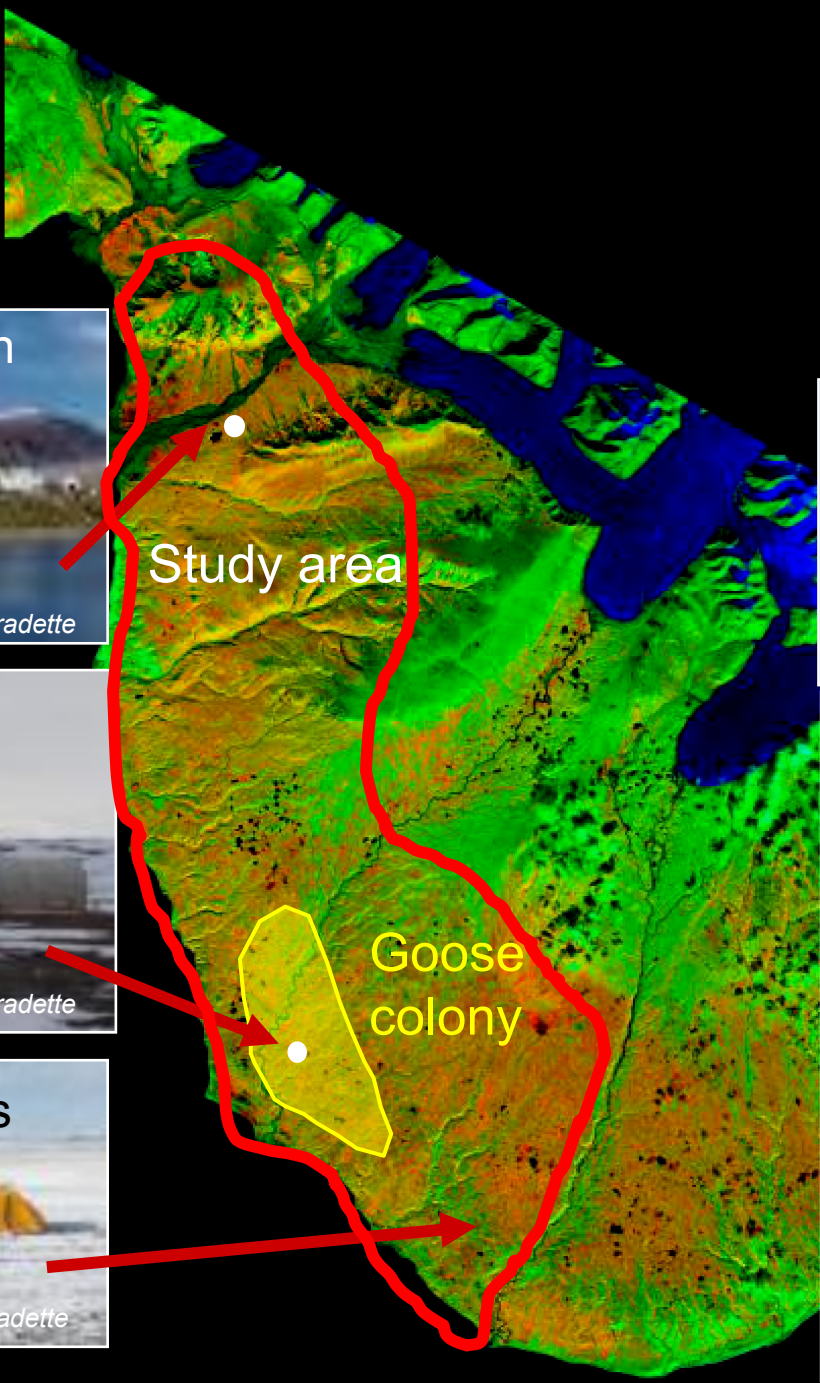
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Average Temp (C)

Annual	-15
February	-34
July	+6



Research station



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Summer camp



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Short-term camps



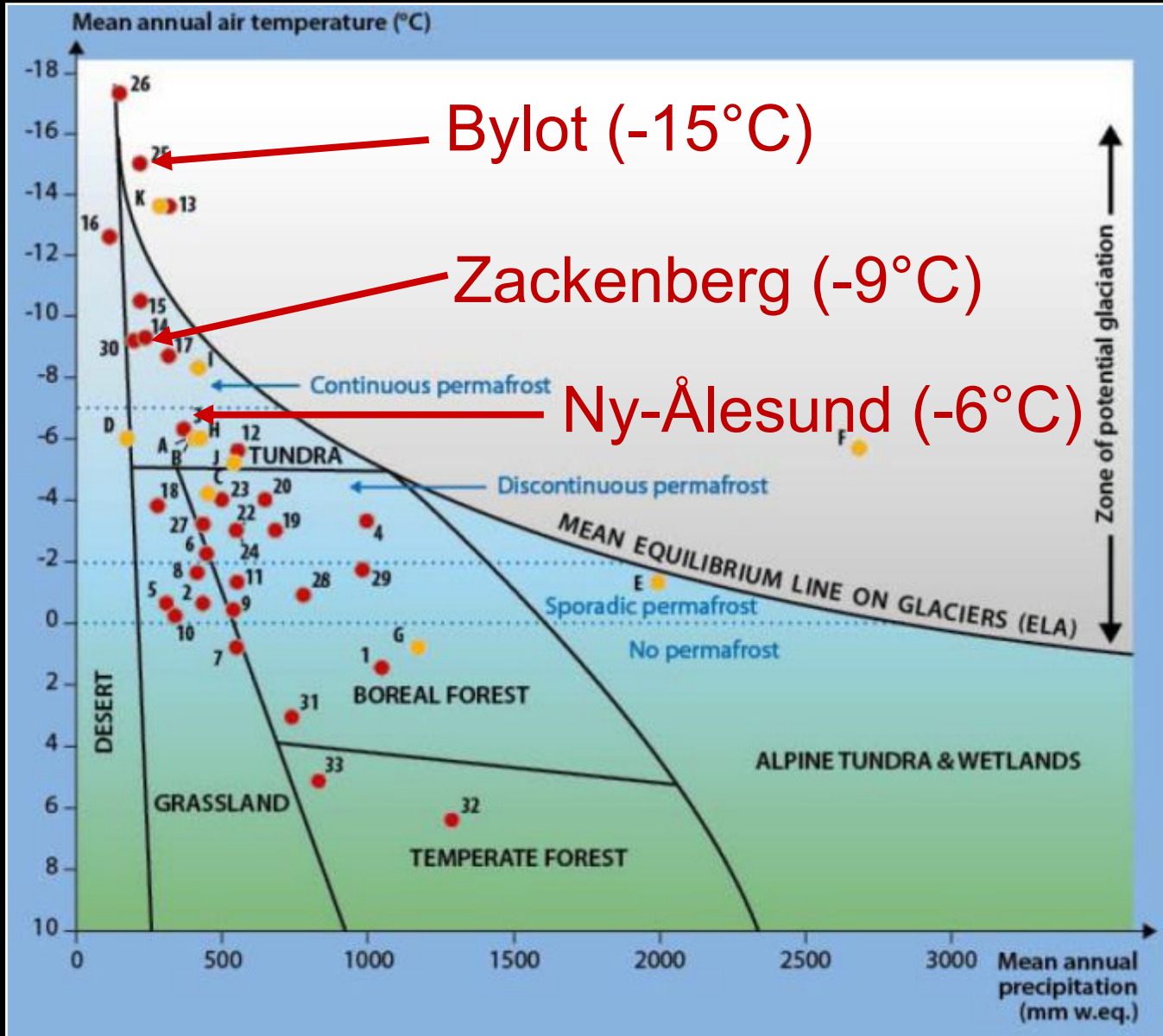
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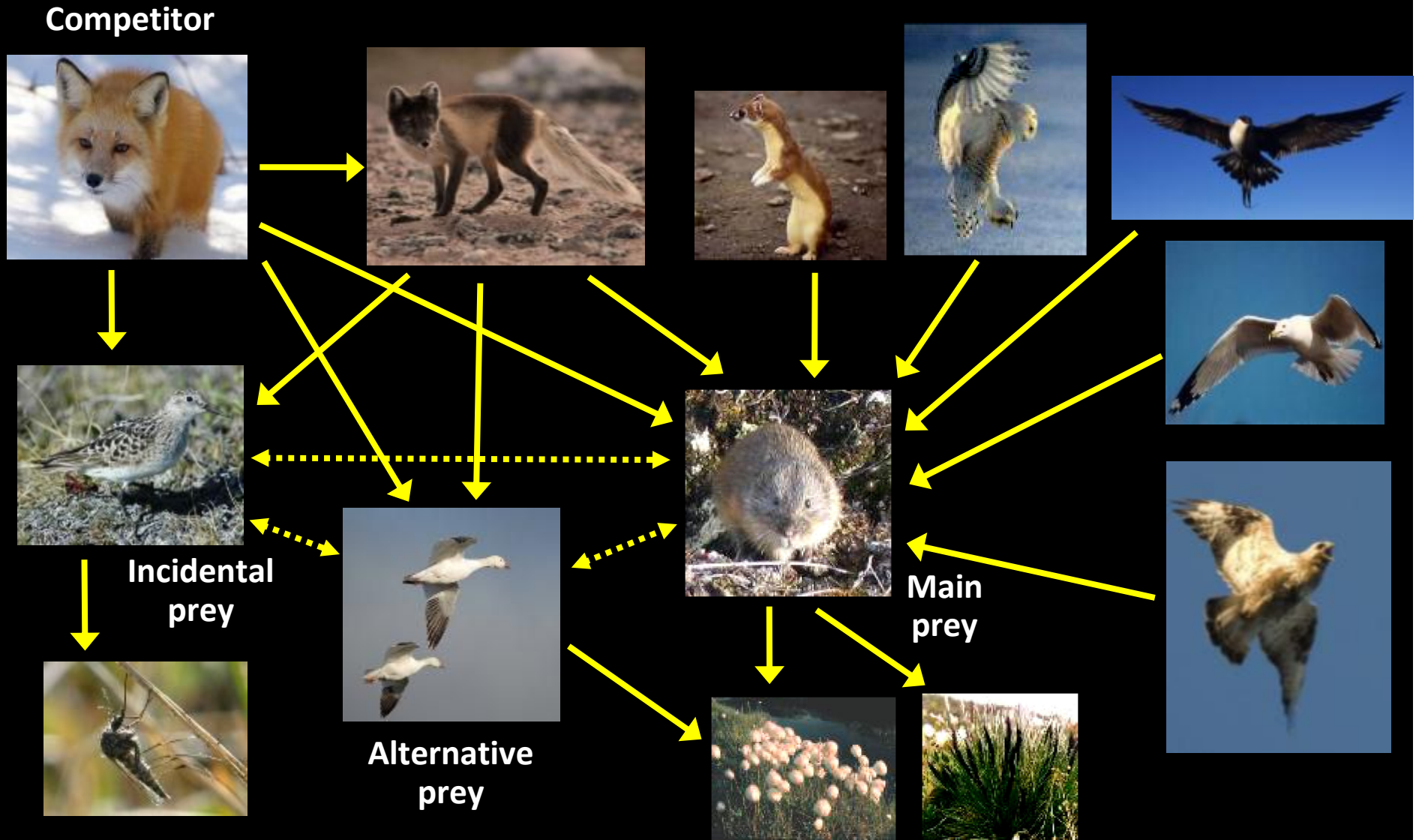


Average Temp (C)

Annual	-15
February	-34
July	+6

INTERACT stations

The tundra food web on Bylot

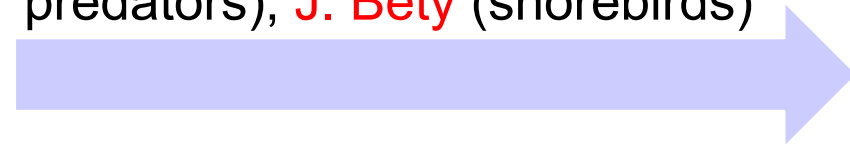


G. Gauthier started to study geese and plant-herbivore interactions

Other components added (lemmings, arctic foxes, snowy owls), but always in relation to geese



Other researchers came in, e.g., **D. Berteaux** (mammalian predators), **J. Bêty** (shorebirds)



First funding aimed at ecosystem monitoring = start of EBM. Coordinator for protocols and a common database.

Northern Ecosystem Initiative (Env. Canada)

ArcticNet

IPY-ArcticWOLVES

No specific funding for EBM

No monitoring mandate from Gov. – Monitoring driven by research interests

1990

1995

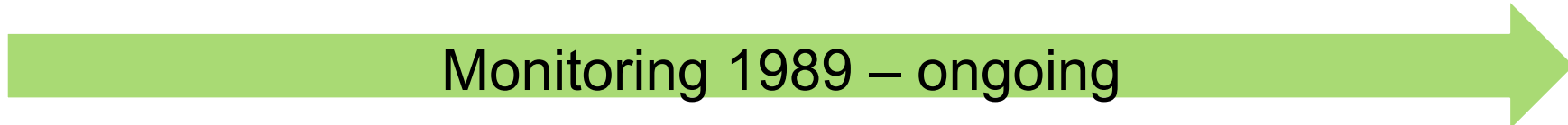
2000

2005

2010

2015

Monitoring 1989 – ongoing



Methods = observations + experiments



Variable	Period / Length
Phenology	
Graminoids – date ¹ of peak nitrogen concentration	1991-2010 / 20 years
Snow geese – peak arrival date ¹	1996-2012 / 17 years
Snow geese – median laying date ¹	1989-2012 / 23 years
Lapland longspur – median laying date ¹	2000-2012 / 12 years
Snowy owl – median laying date ¹	1993-2010 / 18 years
Abundance	
Graminoids – primary production (g m ⁻²)	1990-2012 / 23 years
Brown lemming – summer density (nb ha ⁻¹) ²	1993-2012 / 20 years
Brown lemming – summer density (3-yr running mean, nb ha ⁻¹) ²	1993-2012 / 20 years
Snow geese – nest density (nb ha ⁻¹)	1993-2012 / 20 years
Long-tailed jaeger – nest density (nb ha ⁻¹)	2004-2012 / 8 years
Snowy owl – nest density (nb km ⁻²) ⁴	1993-2010 / 18 years
Productivity	
Snow geese – clutch size	1989-2012 / 24 years
Snow geese – nesting success ³	1989-2012 / 24 years
Snow geese – young-adult ratio near fledging	1990-2012 / 23 years
Lapland longspur – clutch size	1995-2012 / 18 years
Lapland longspur – nesting success	1995-2012 / 18 years
Lapland longspur – hatching success	1995-2012 / 18 years
Snowy owl – clutch size	1993-2010 / 18 years
Arctic fox – proportion of natal dens	1995-2012 / 16 years
Other attributes	
Graminoids – peak nitrogen concentration (%)	1991-2010 / 20 years
Goose – grazing impact (% biomass removed)	1990-2012 / 23 years
Arctic fox – isotopic signature (d ¹⁵ N, ‰)	2003-2011 / 9 years

Modified from Gauthier et al. (2013) 



Gauthier
Vertebrate
ecologist
(birds)



Berteaux
Vertebrate
ecologist
(mammals)



Bêty
Vertebrate
ecologist
(birds)



Lévesque
Plant
ecologist



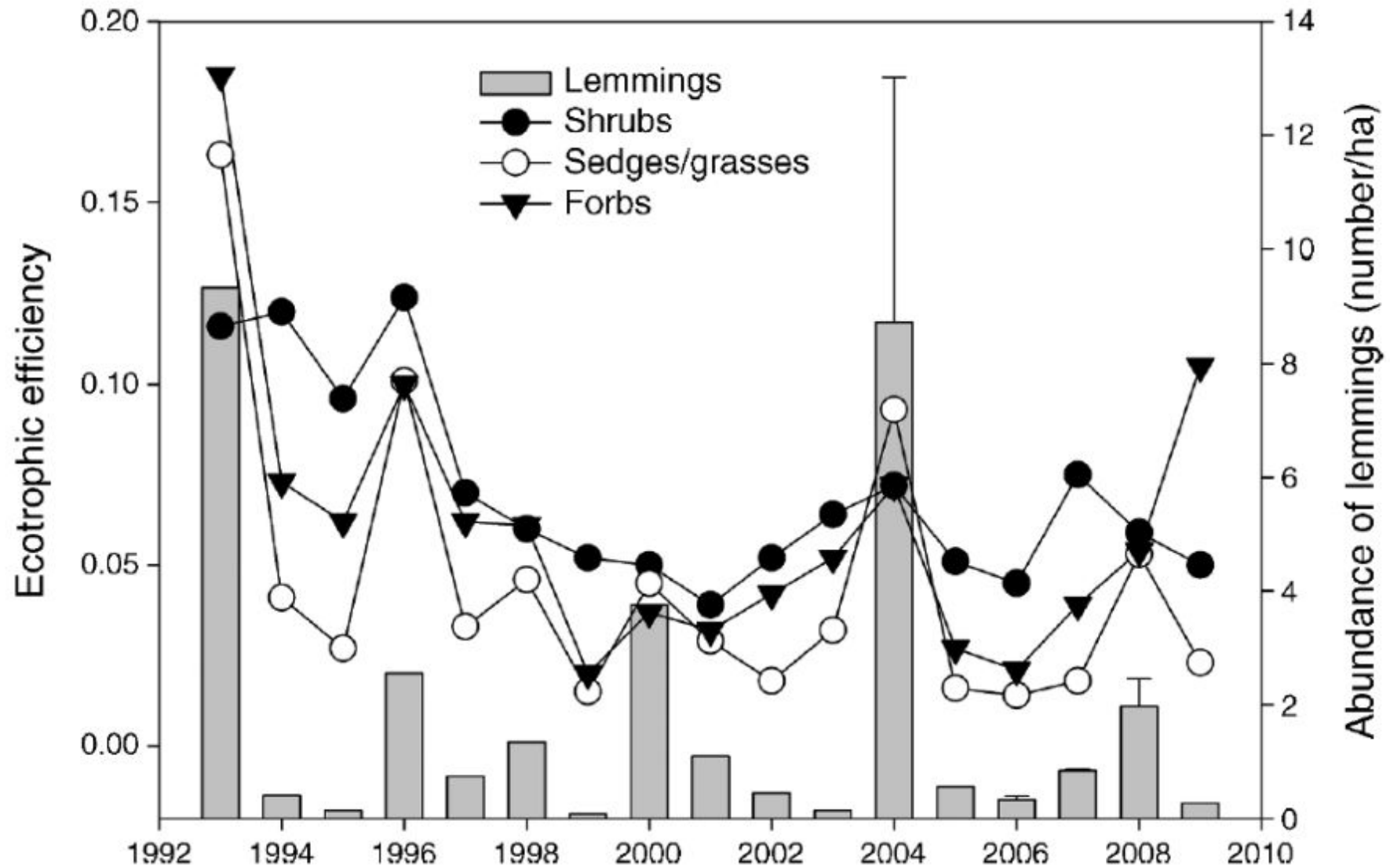
Fortier
Permafrost
specialist

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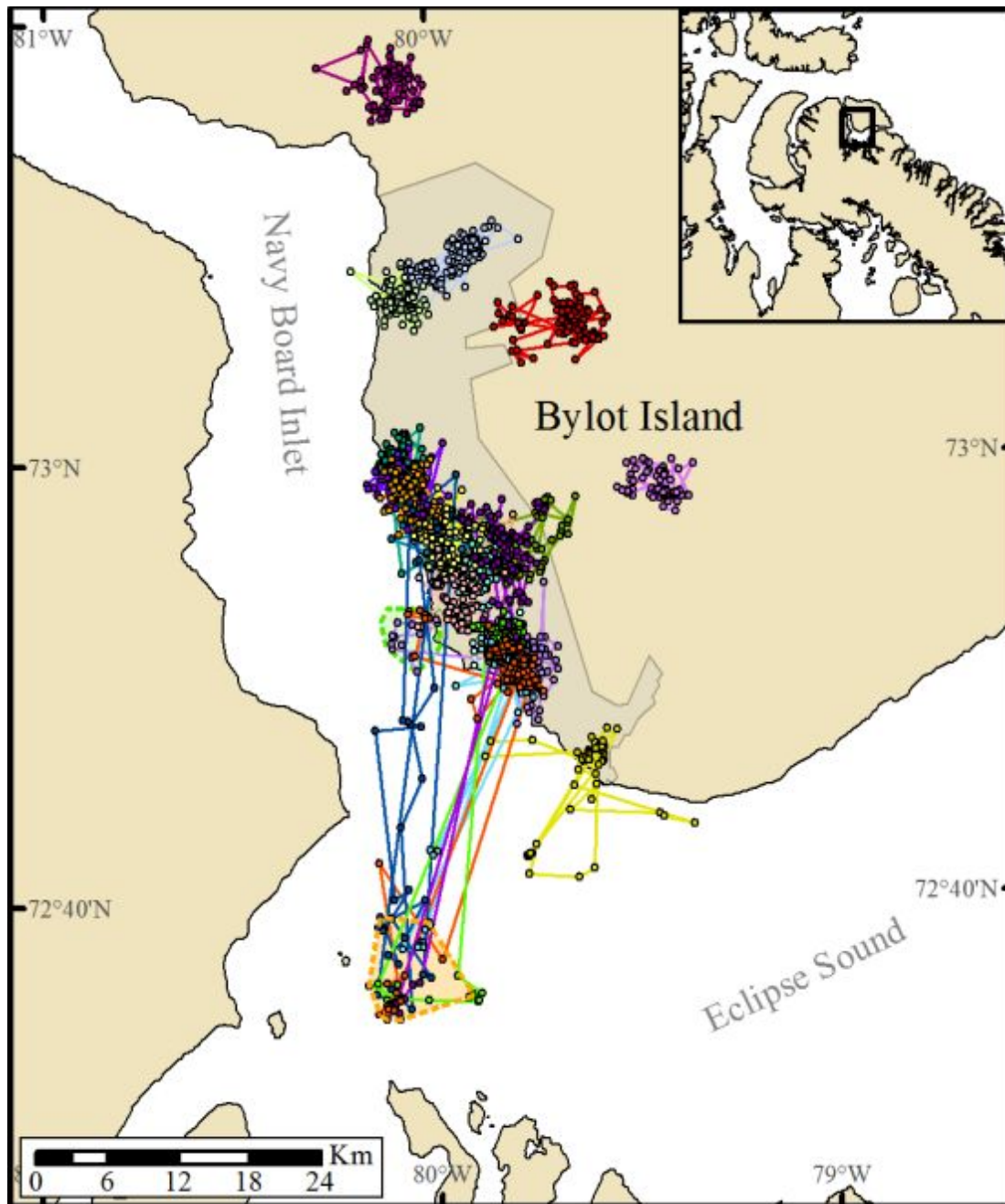
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- Top-down interactions are important : 10% of the annual primary production consumed by herbivores, but 20–100% of the annual herbivore production consumed by predators.



Source : Legagneux et al. Ecology 2012. 93(7)



- The system works as a meta-ecosystem: mostly because of migration and vagrancy of organisms

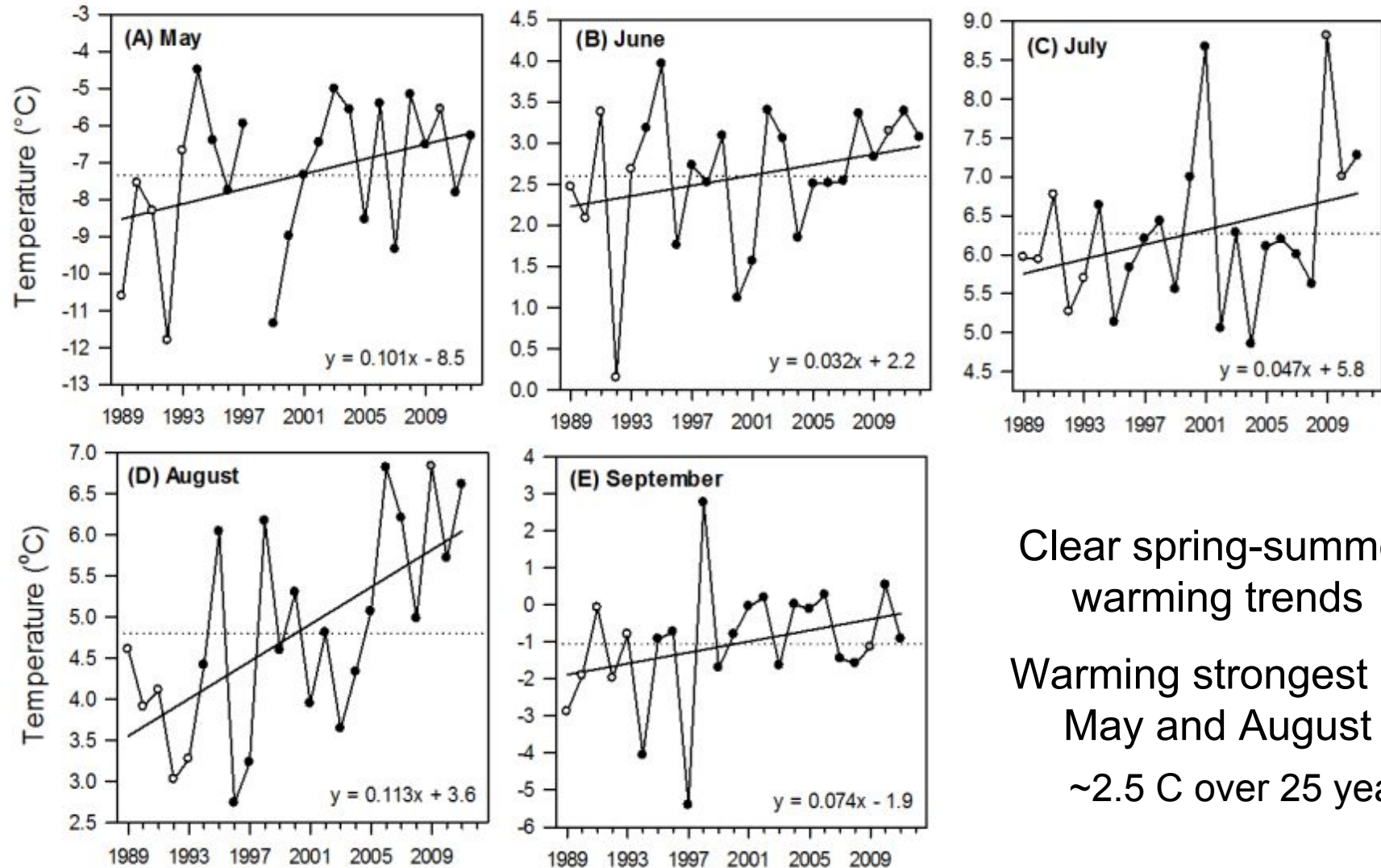


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Source : Lai et al. Submitted

- Responses to climate change differ across trophic levels

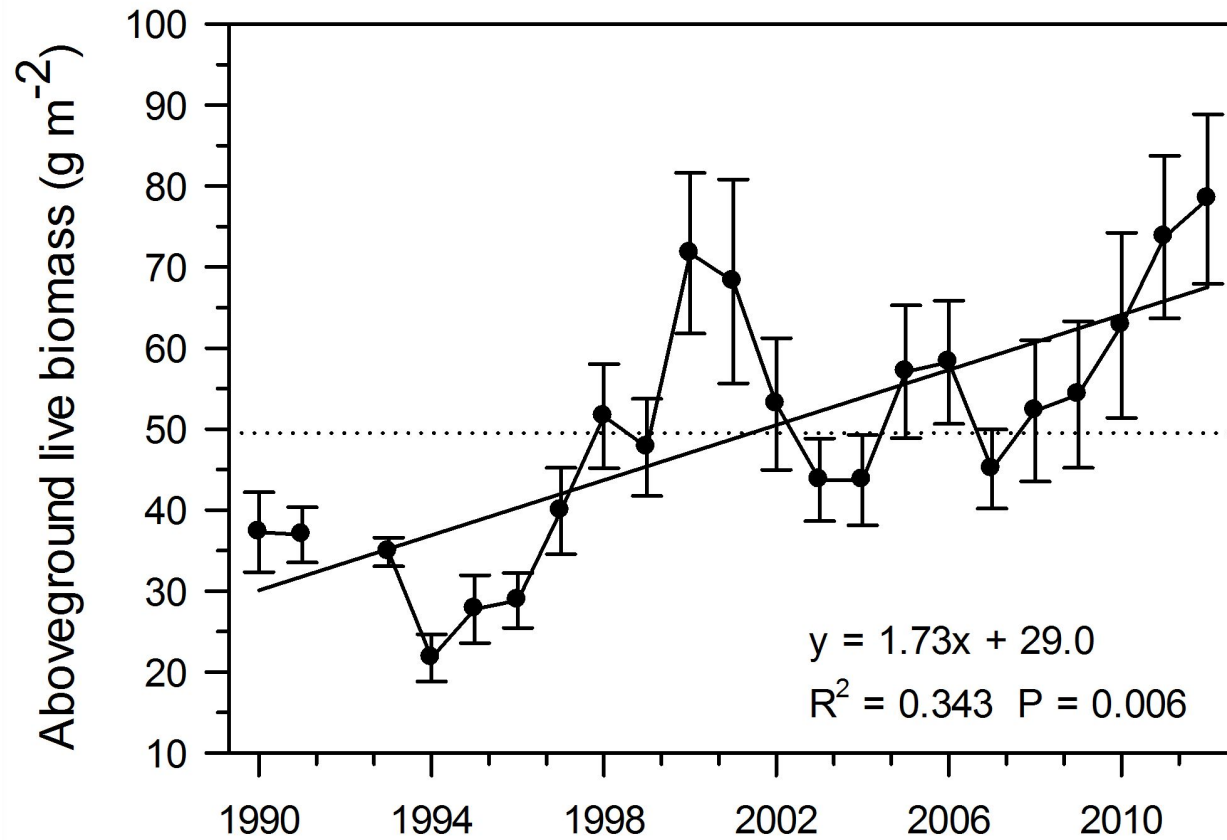
Spring-summer temperature is increasing



Clear spring-summer
warming trends

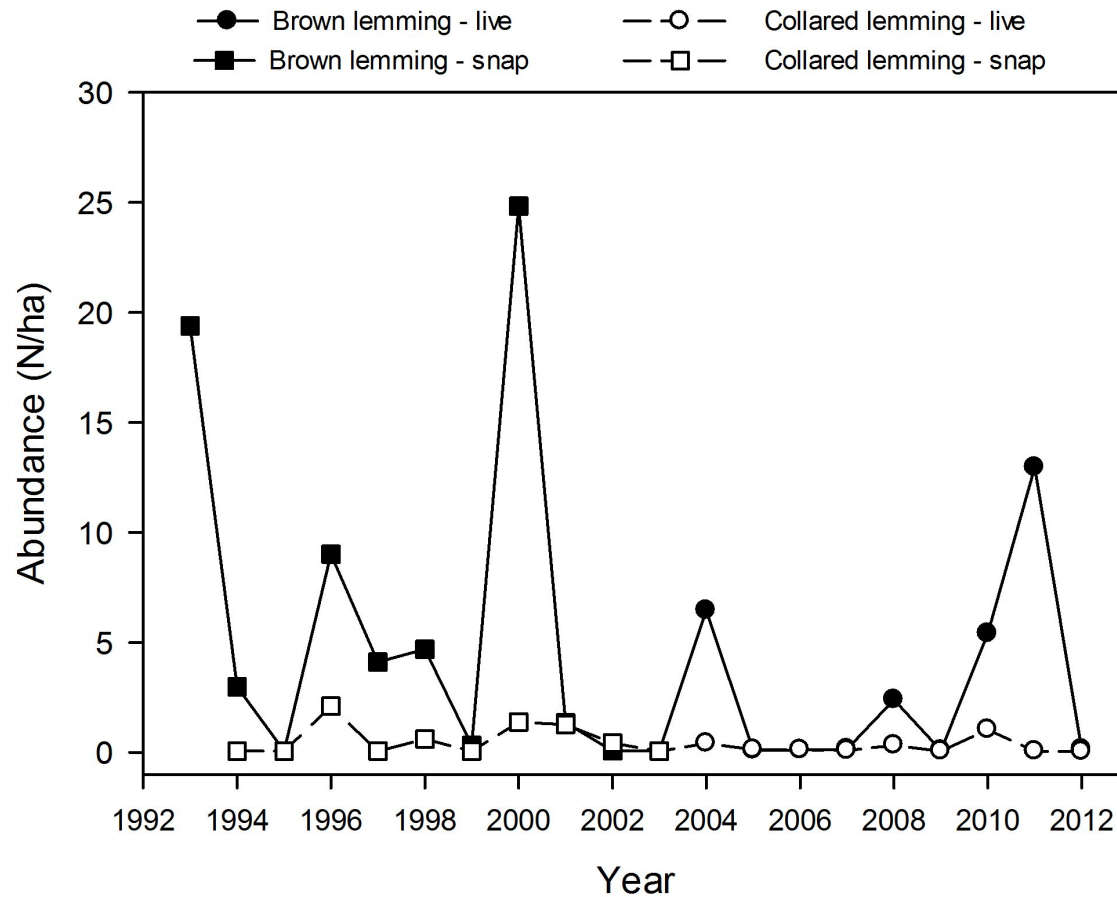
Warming strongest in
May and August
~2.5 C over 25 years

Graminoid production has increased



- Above-ground live biomass of graminoids in August increased **123%** in wetlands over a 23-year period

No major change in lemming populations



- Brown: regular, 3-4 year cycles of high amplitude (2014 was a high peak)

- Few changes in the phenology, abundance or productivity of tundra wildlife species at Bylot despite strong warming.
 - Time series are too short (but some are up to 24 years)
 - Strong inertia in this system
 - Changes have not yet exceeded the phenotypic plasticity of species
 - Constraints prevent adjustments in some species (e.g. in migrants)
 - Some changes can only occur above a certain threshold (i.e. non-linear)

- What is the best interpretation?
 - Bad news? The system is not able to adapt to climate change
 - Good news? The system is able to resist to climate change

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What defines EBM and what are optional approaches?

Monitoring of most major(?) ecosystem structures and processes.

What is the EBM approach adopted in the ongoing programs?

Goal = scientific understanding. No initial grand plan. Built from the bottom. No major mandate and no secure funding attached to the Bylot EBM.

Are adaptivity and management options included in ongoing programs and eventually how?

No, except slightly for geese.

What are the key insights gained so far from ongoing programs and approaches?

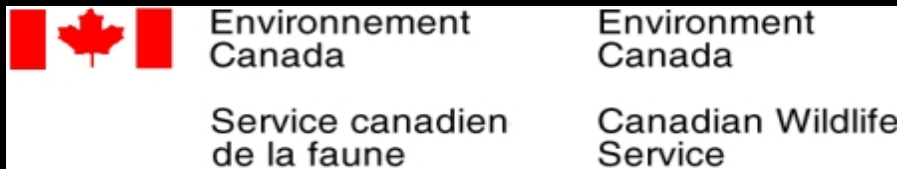
Science: previous slides. Other: Science and organization of EBM are both complex.

To what extent do the ongoing programs reflect site-specific idiosyncrasy versus biome scale generality.

Generalities: role of the meta-ecosystem (migrations, vagrancy), snow and phenology as key processes, pressure for change due to climate warming.

Idiosyncrasies: biogeographic history (strong effect on species composition), climatic characteristics (large variability within the biome).

Acknowledgements



>140 researchers, students & collaborators



Current ecological studies started as a collaboration between Université Laval (CEN) and the Canadian Wildlife Service

