

A photograph of a grassy field with a wire mesh fence in the foreground and a mountain in the background. The fence is made of a fine, light-colored mesh supported by dark blue poles. In the background, there is a large, dark, rocky mountain under a blue sky with scattered white clouds. The field is covered in green grass and some small white flowers.

Herbivory Research Conducted near Toolik Field Station: A Brief Review

Laura Gough, Towson University

Amanda Koltz, University of Texas Austin

Jennie McLaren, University of Texas El Paso

Rebecca Rowe, University of New Hampshire

Acknowledgments: Gus Shaver



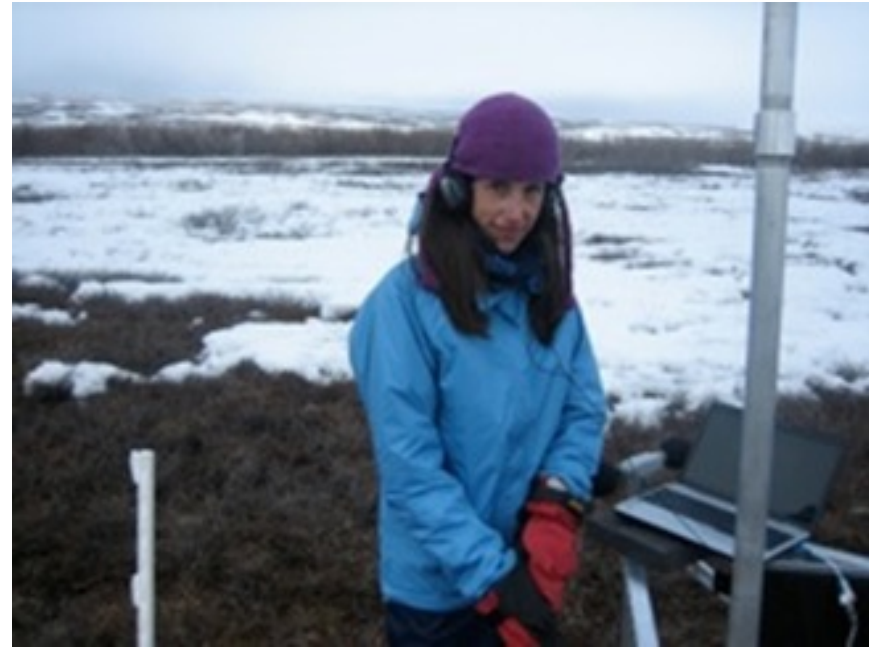
Setting up Donie's removal experiment, 1997

Acknowledgments: Jim Laundre



Acknowledgments

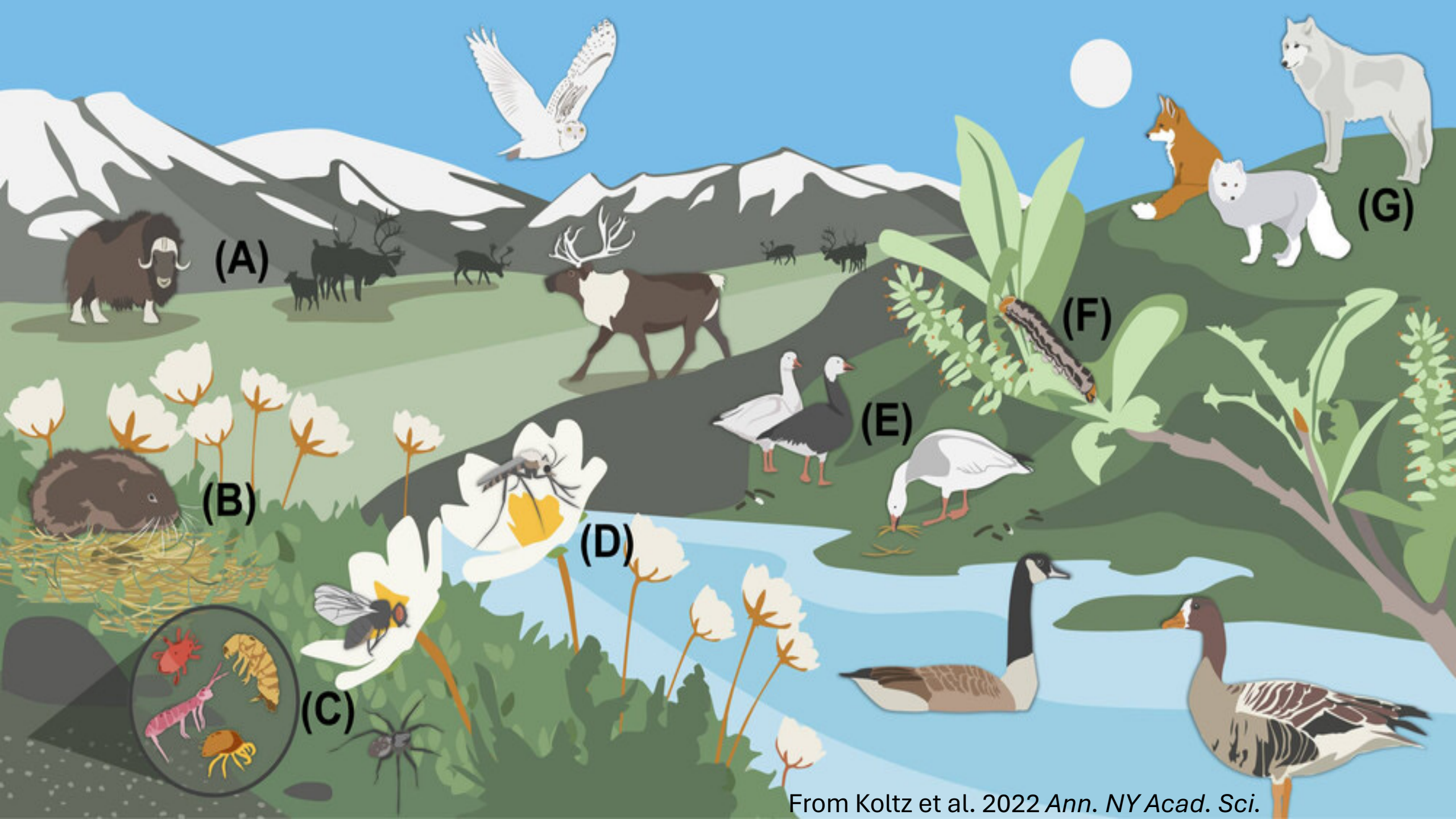
- Gus Shaver
- Jim Laundre
- Team Vole
 - Natalie Boelman
 - Kevin Griffin, Ed Rastetter, Austin Roy, Liz Min, Matt Suchocki, Nicole Williamson, Jess Steketee, Mary Kate Lisi, Andrew Uccello, Lyndsey Marquez
- Multiple grants from NSF to support ARC LTER, Team Vole, and related projects











(A)

(B)

(C)

(D)

(E)

(F)

(G)

THE HERBIVORY NETWORK

Studying herbivory in arctic and alpine ecosystems

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ABOUT US

The Herbivory Network is a collaborative research initiative that investigates the role of herbivory in Arctic and alpine ecosystems.

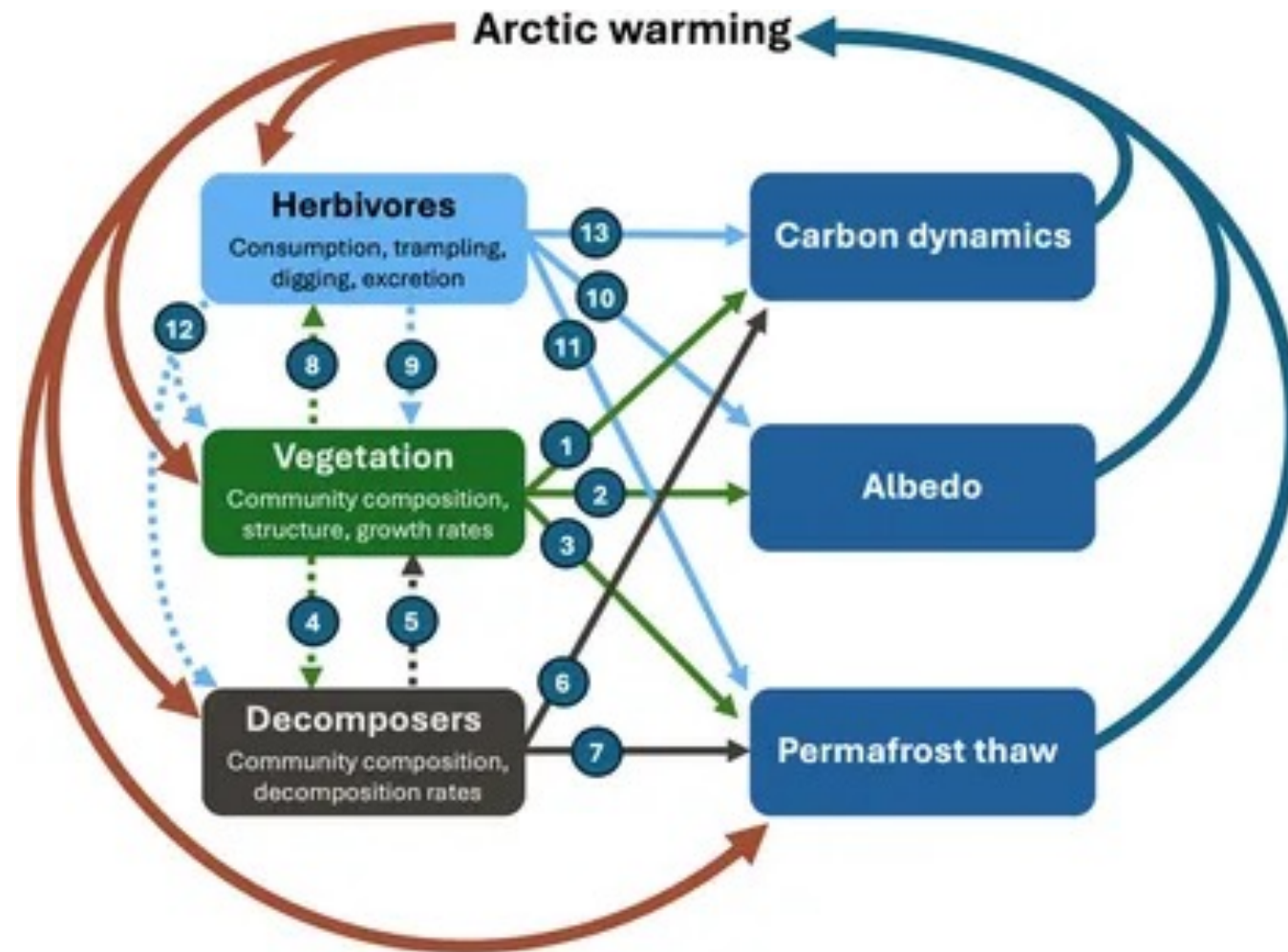
The HN was established in 2014, as the first global initiative to start coordinated research on this topic. The goal of HN is to foster collaborations within and across disciplines, to facilitate multi-site comparisons, and to assist in understanding the complexity and variability of responses of tundra ecosystems to herbivory.

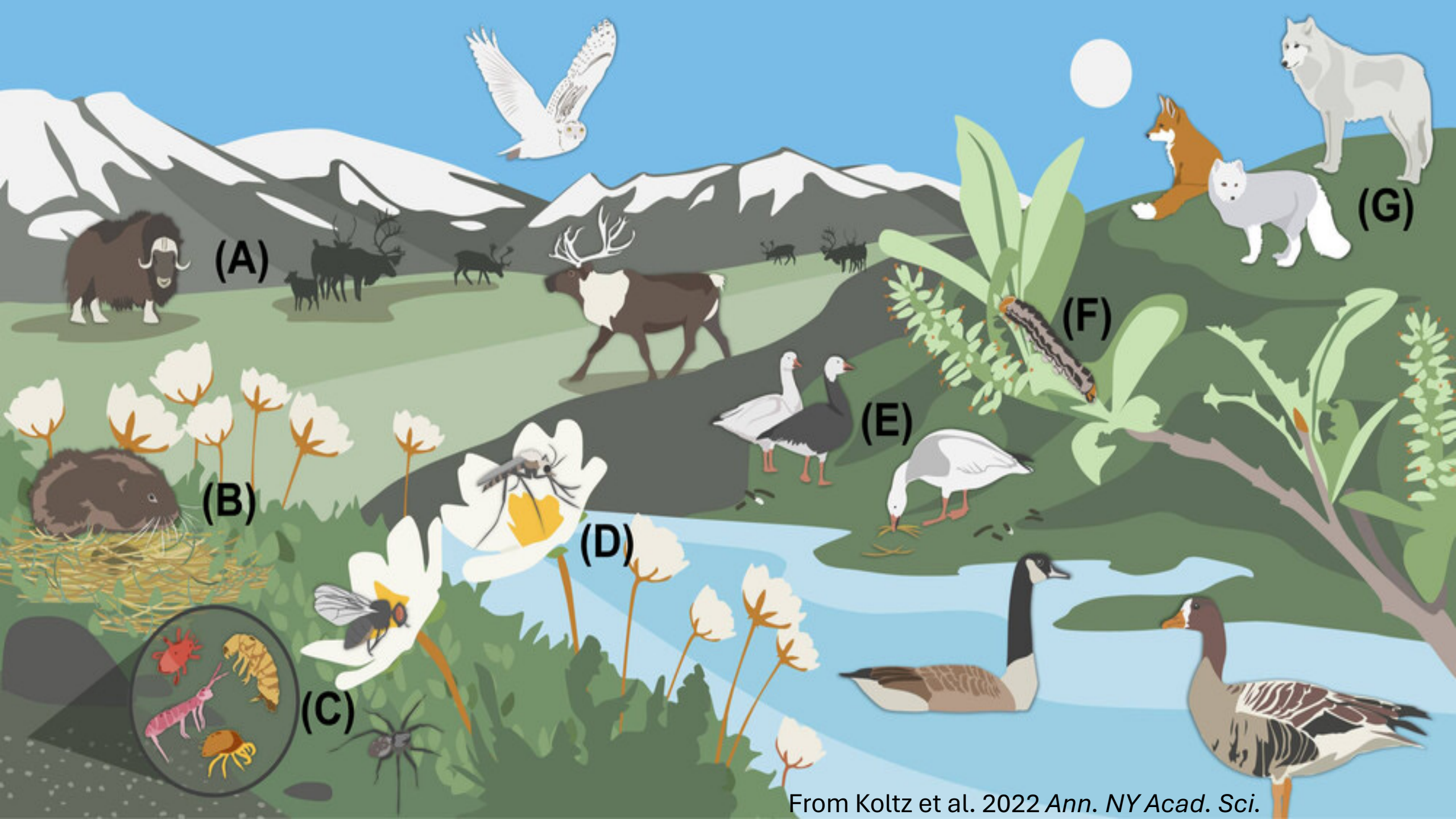
Here you can learn more about:

- [the story behind the Herbivory Network](#)
- [our current members](#)

<https://herbivory.lbhi.is/>

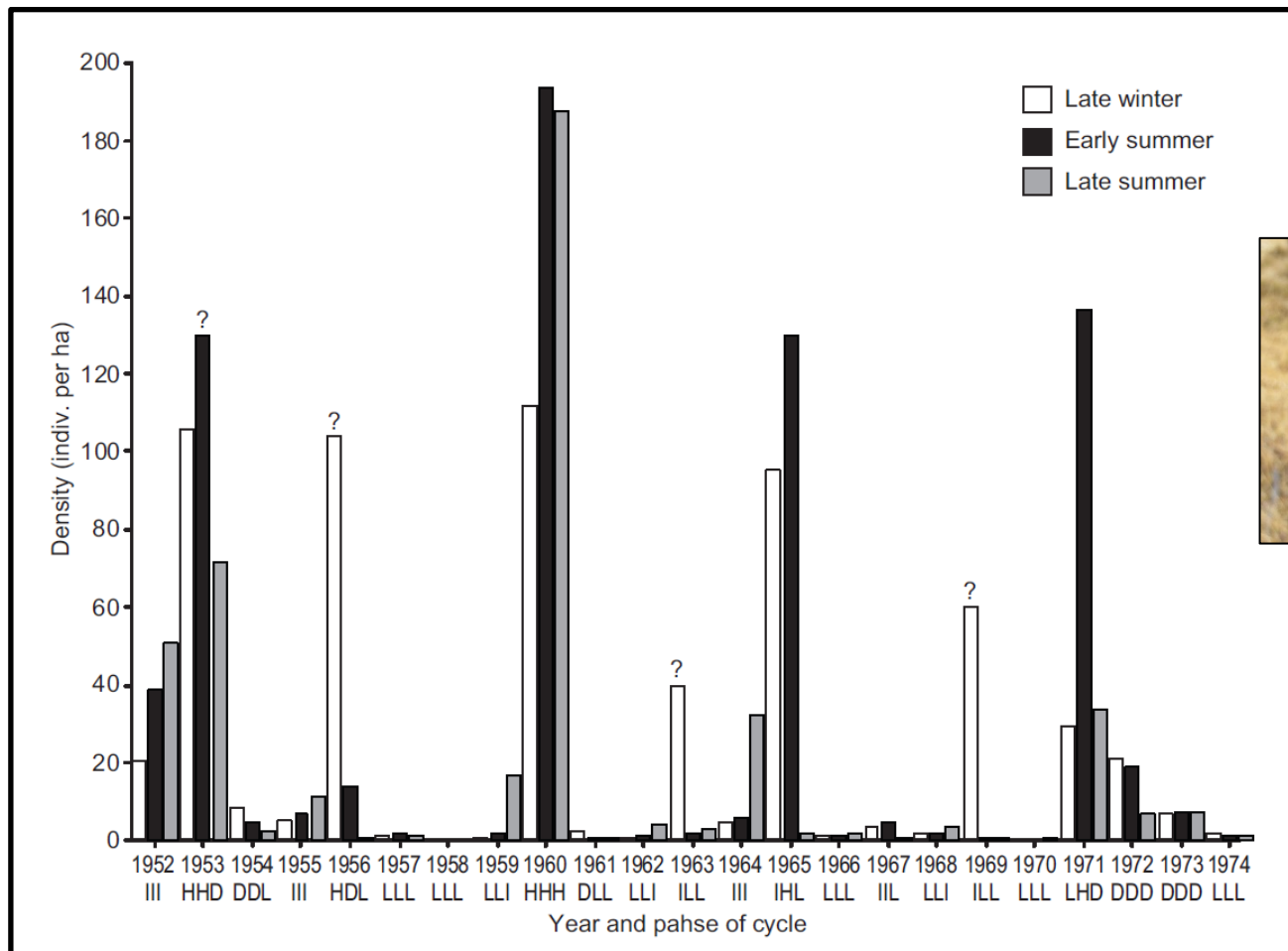
Biotic Feedback Loops in the Arctic





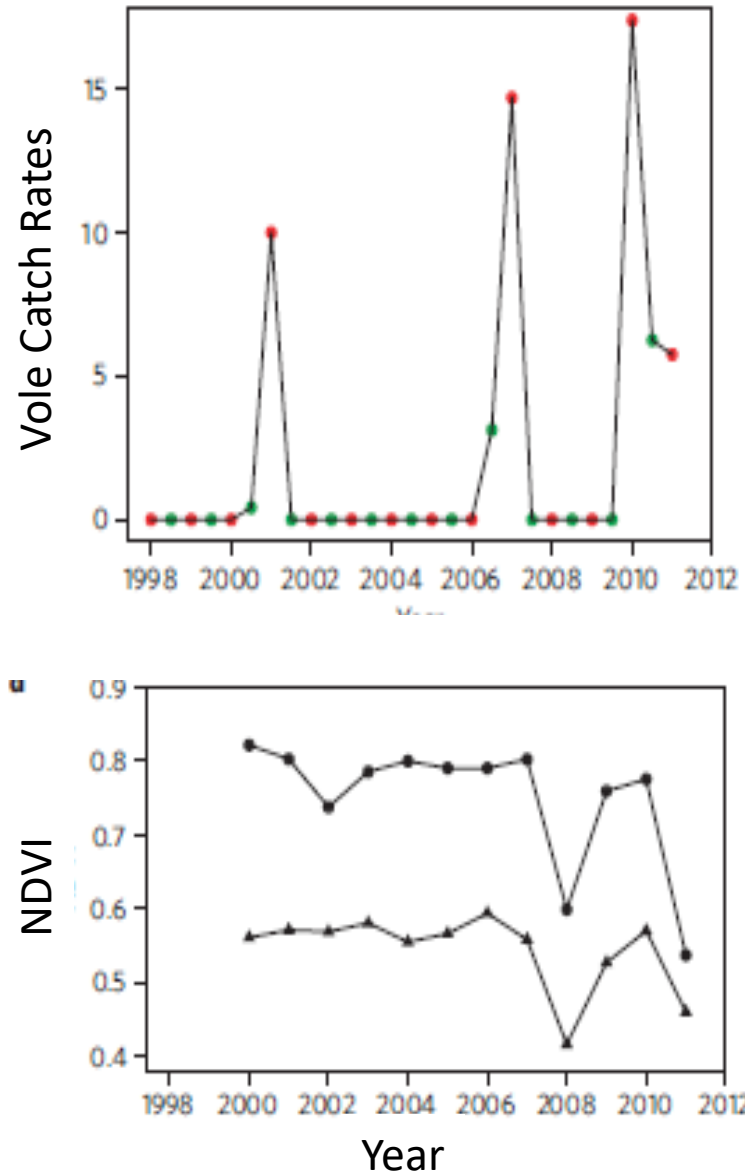


Rodent Population Cycles

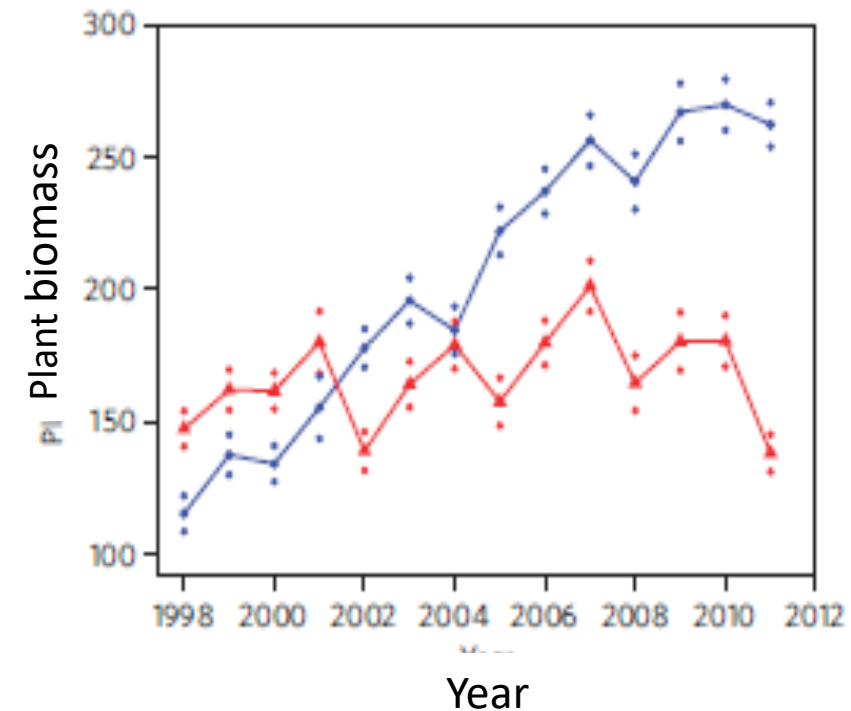


Historic 3-5 year lemming population
cycle near Utqiagvik, AK

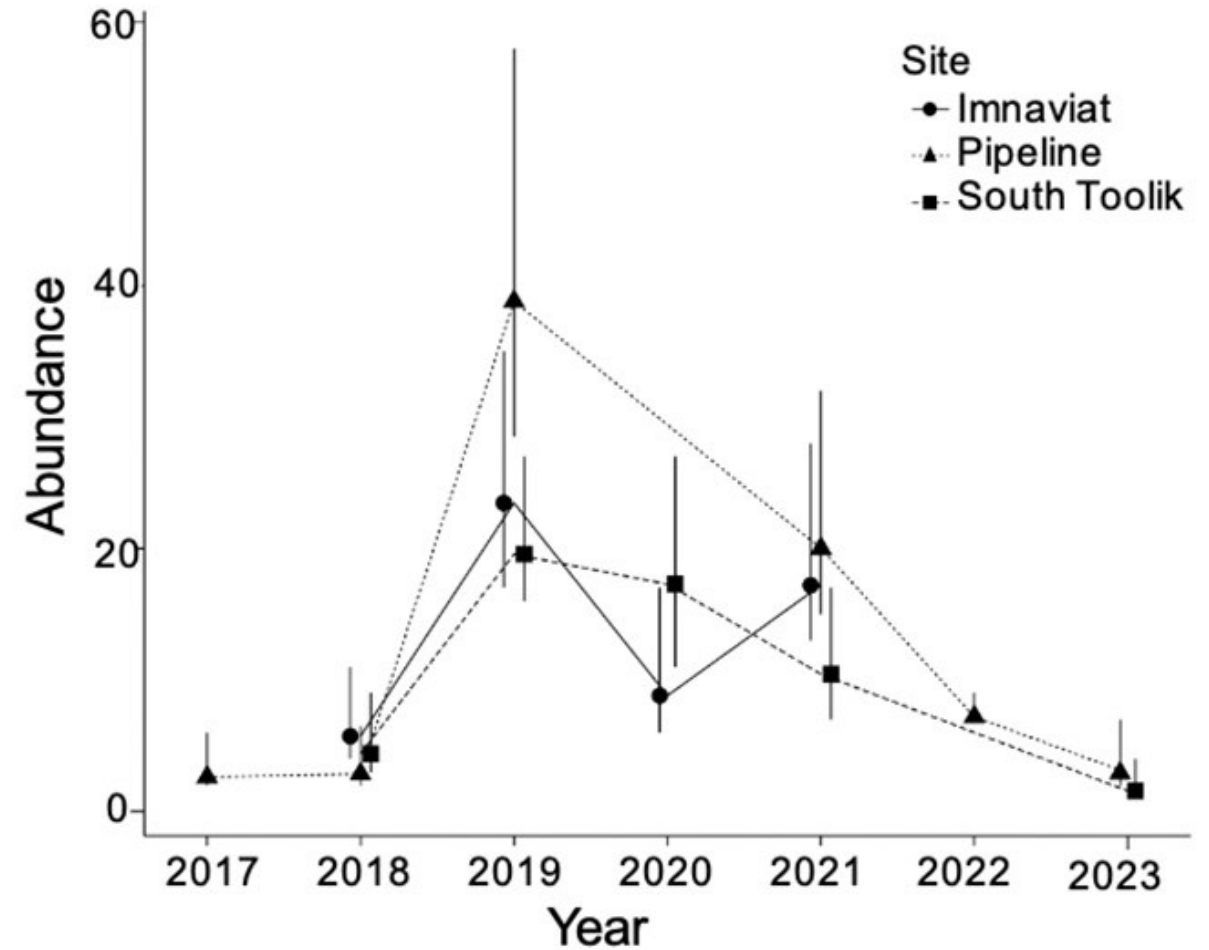
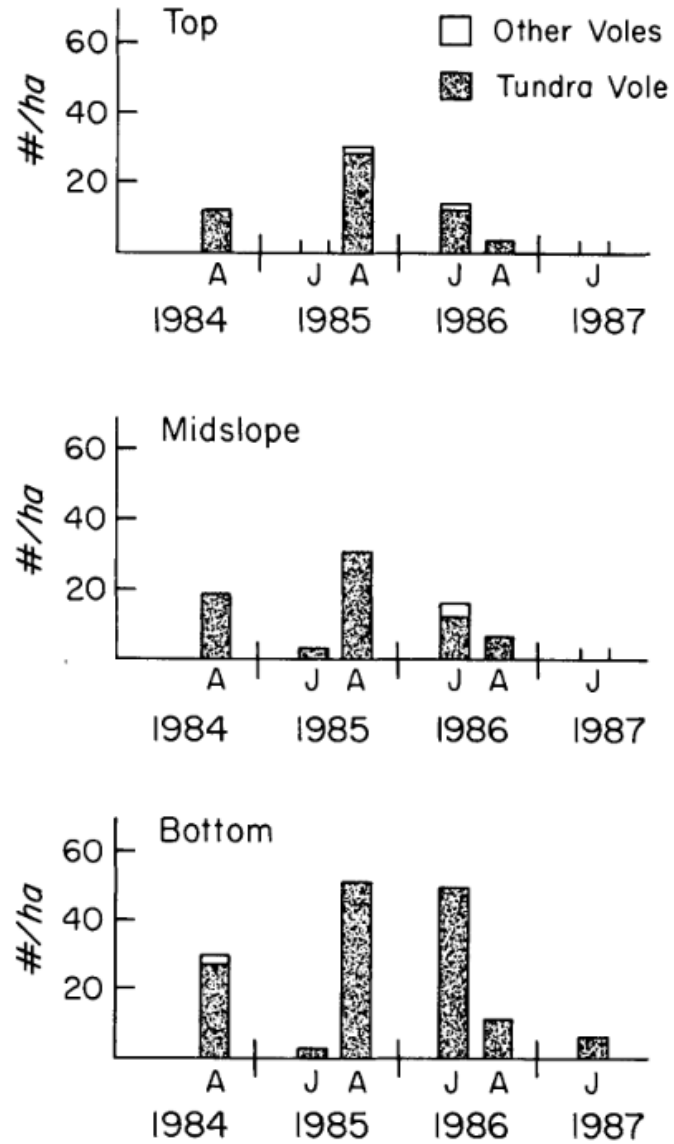
Evidence that Rodents Affect Carbon Cycling



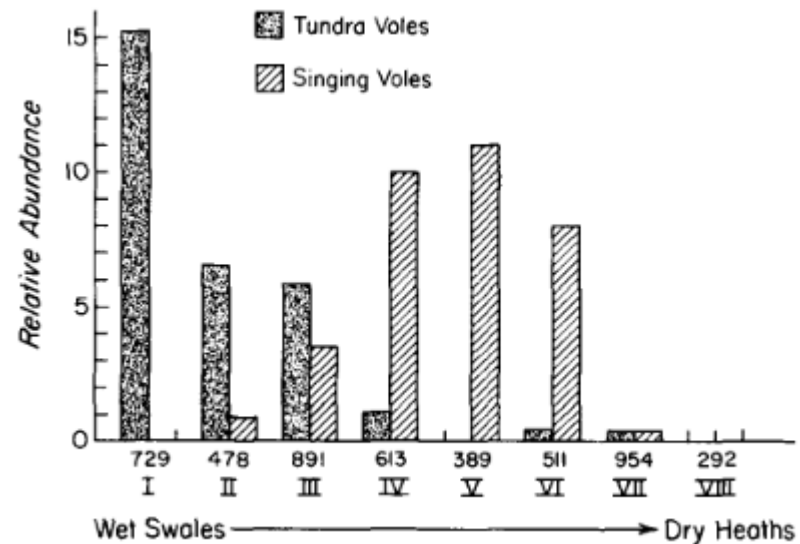
Abisko Region of Northern Sweden



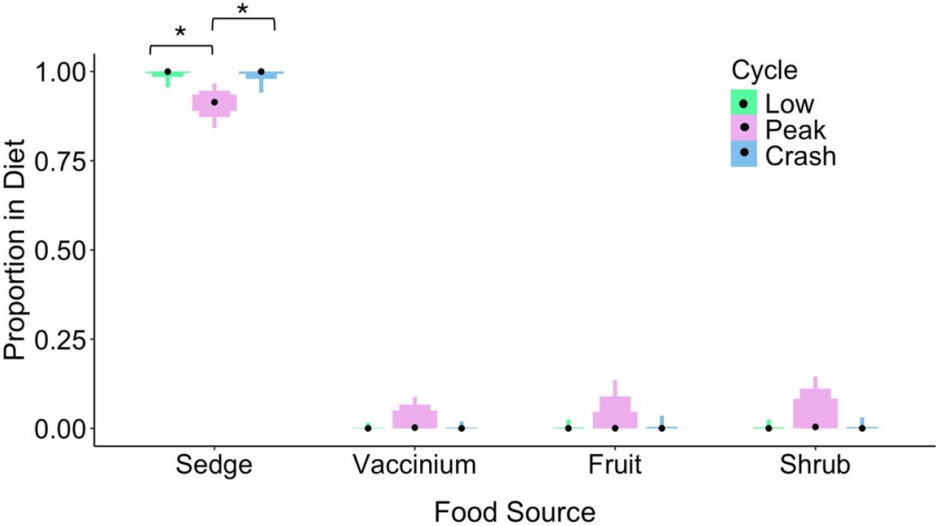
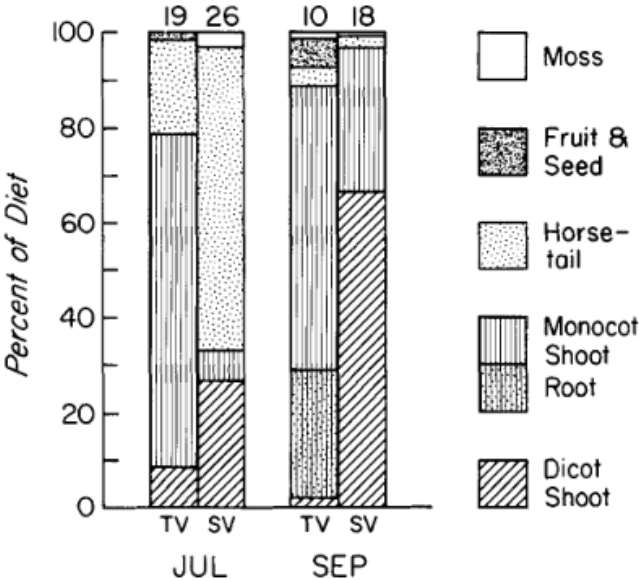
Vole Density near Toolik Field Station



Vole Habitat Preference and Diet



Batzli and Henttonen 1990 *Arc. Alp. Res.*



Lisi et al. 2025 *Arc. Ant. Alp. Res.*

Simulated Herbivory with Nutrient Addition

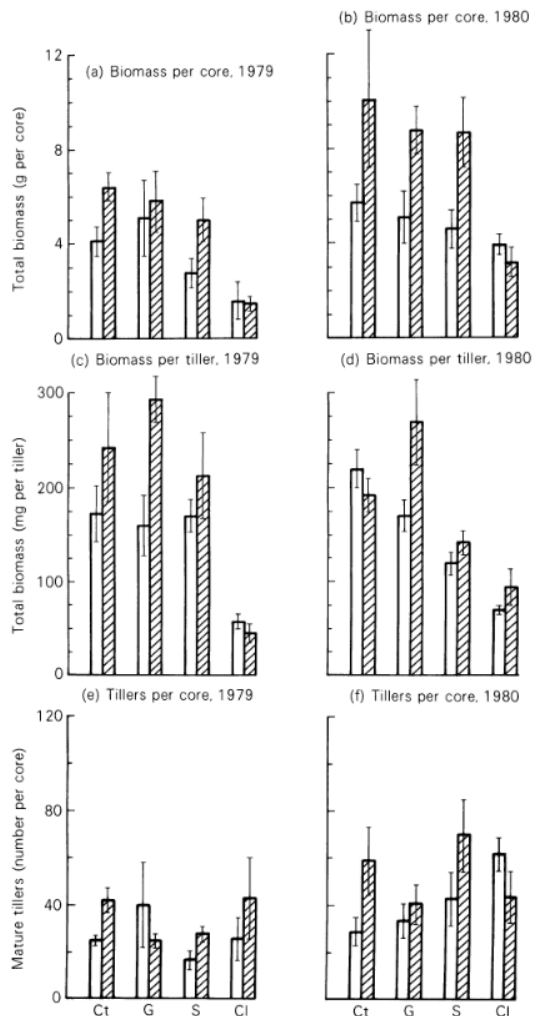
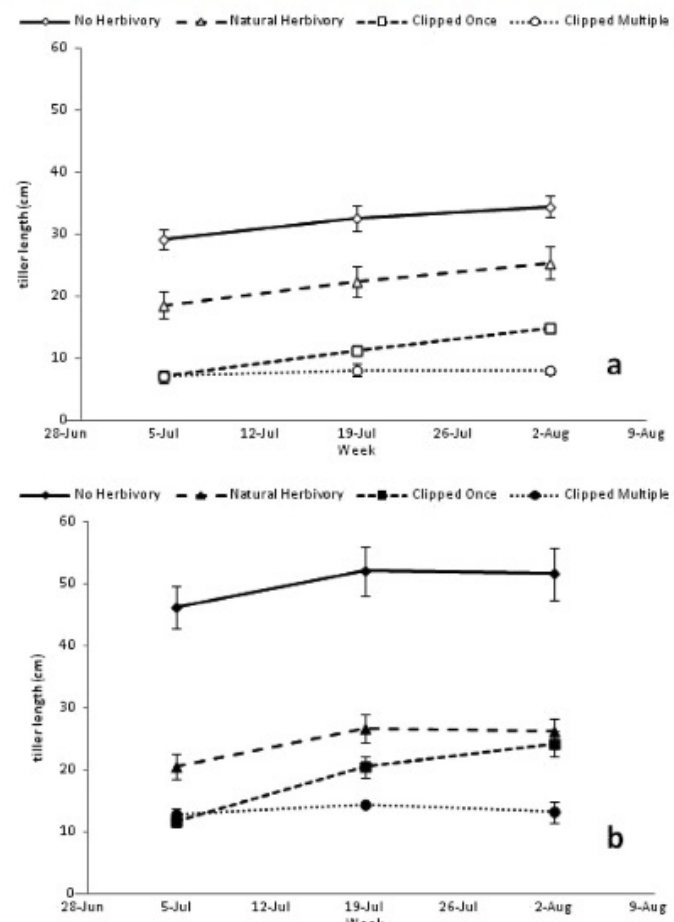


FIG. 6. Treatment effects on (a, b) total biomass per core, (c, d) total biomass per mature tiller, and (e, f) number of mature tillers per core in *Eriophorum vaginatum* at the peak-season harvests (27 July–1 August 1979 and 24 July–1 August 1980) at Toolik Lake, Alaska. Unfilled bars indicate unfertilized treatments; hatched bars indicate fertilized treatments. Symbols: Ct, control and fertilizer only; G, glasshouse; S, shade; Cl, clipped. The range bars are ± 1 S.E.

Shaver et al. 1986 *J. Ecol.*

Fig. 2. Mean *Eriophorum vaginatum* tiller size ($n = 4$, error bars ± 1 SE) in (a) control and (b) fertilized plots following biomass removal by experimental clipping and natural herbivory. Clipping occurred 15 June 2004 for “clipped once” and additionally on 29 June and 13 July 2004 for “clipped multiple”. See text for description of treatments.



Johnson and Gough 2013 *Botany*

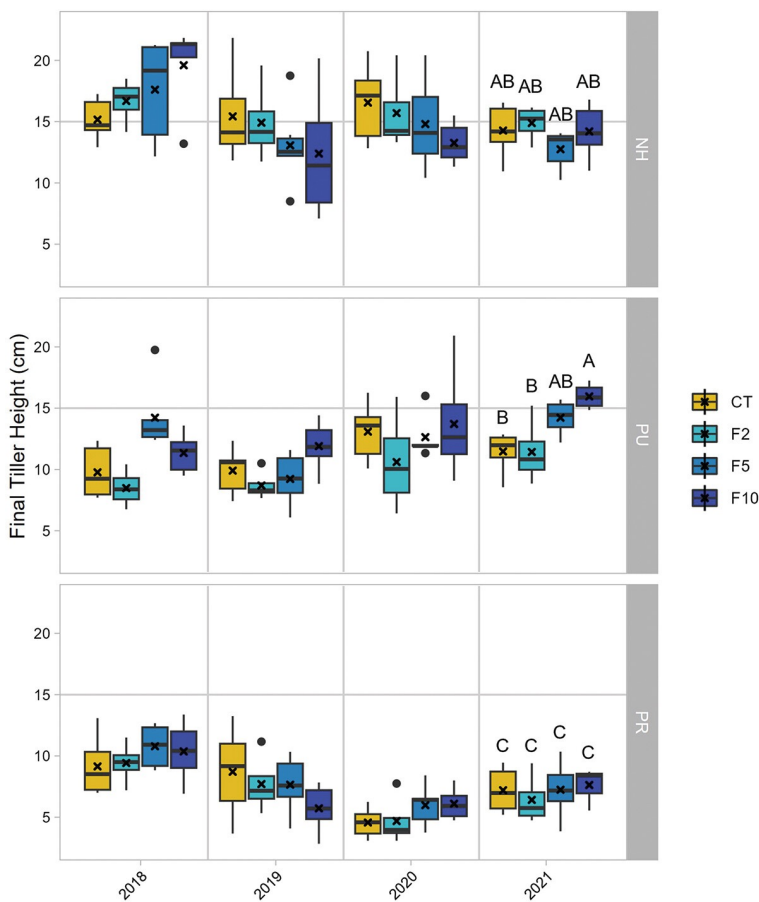


Figure 5. Final tiller heights ($n=3$ except $n=2$ in F2) among simulated herbivory and fertilization treatments for four growing seasons (2018–2021); NH=no herbivory; PU=pulse; PR=press

Williamson et al. 2024 *Arc. Alp. Ant. Res.*

OIKOS 71: 193

MINI- REVIEW

Vertebrate
influence

R. L. Jefferies



tree levels) and

PLUCKIN

G

Gus Shaver and Laura Gough
(2012)



Mat Williams and Ed Rastetter (1997)

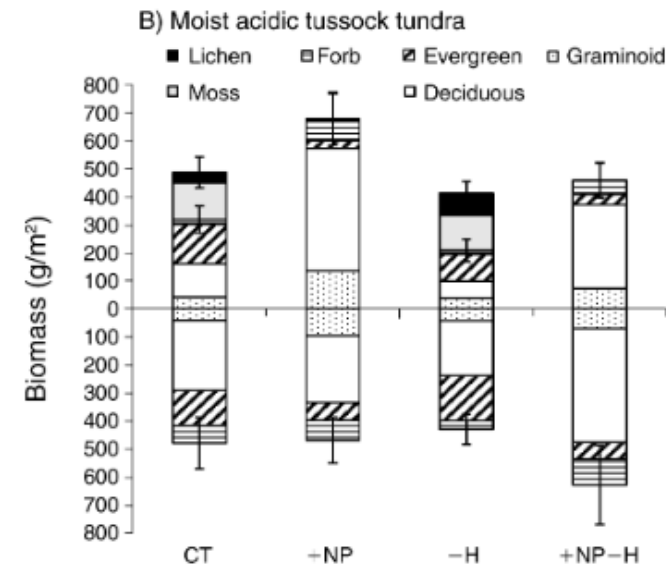
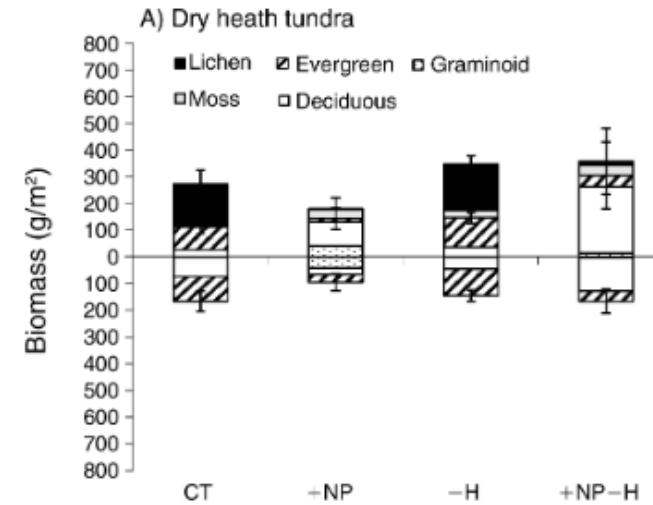
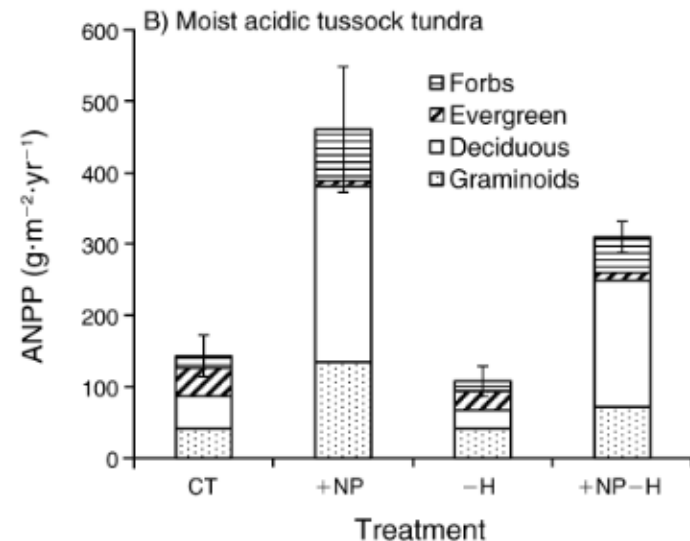
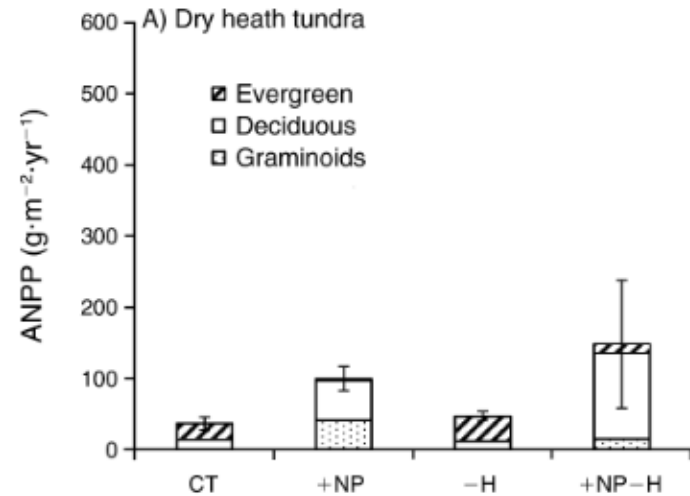


Anne Giblin
(1997)



Sarah Hobbie and Laura Gough (2000)

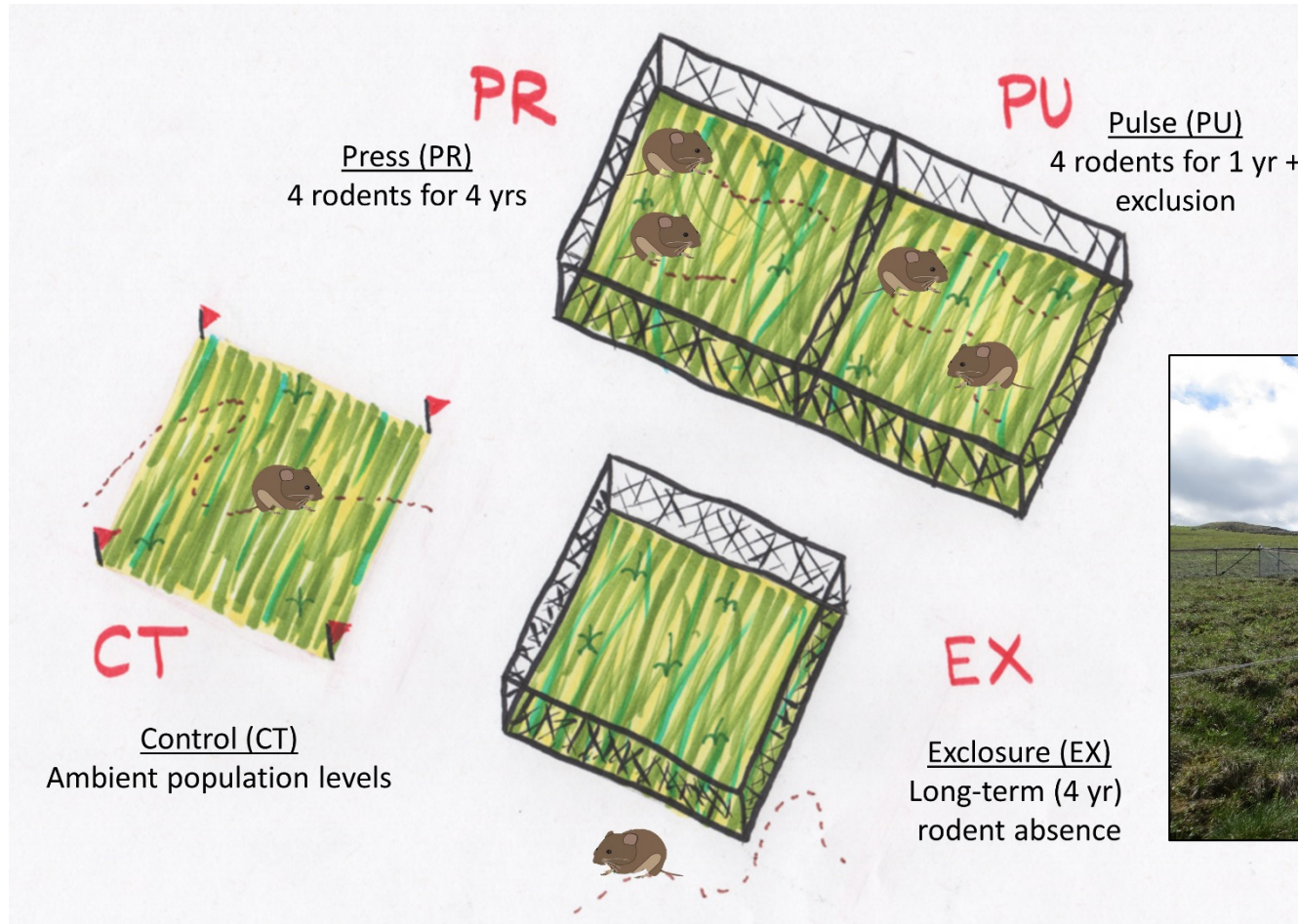
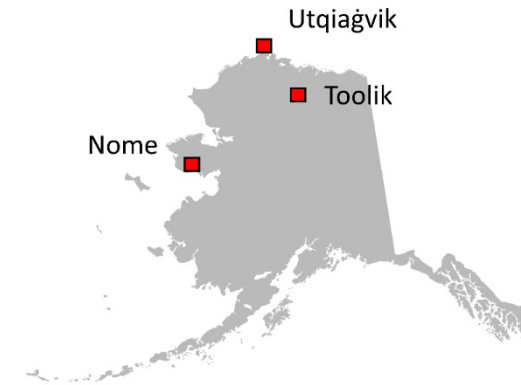
Herbivore Exclosure with Nutrient Addition



CT = control
 +NP = added N and P
 -H = exclosure
 +NP-H = added N and P
 inside exclosure

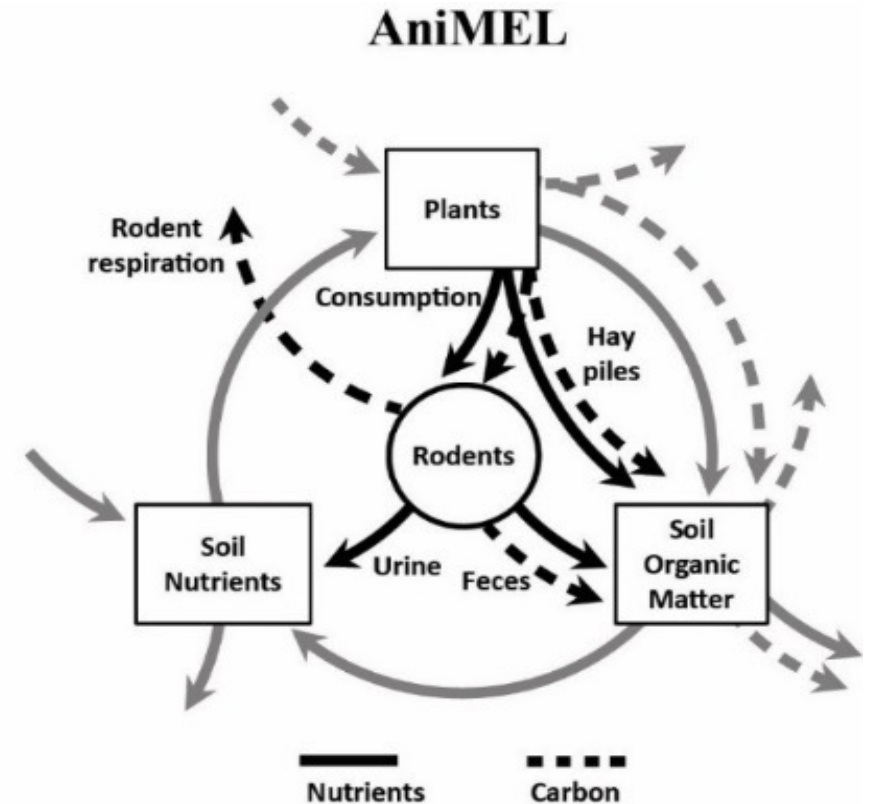
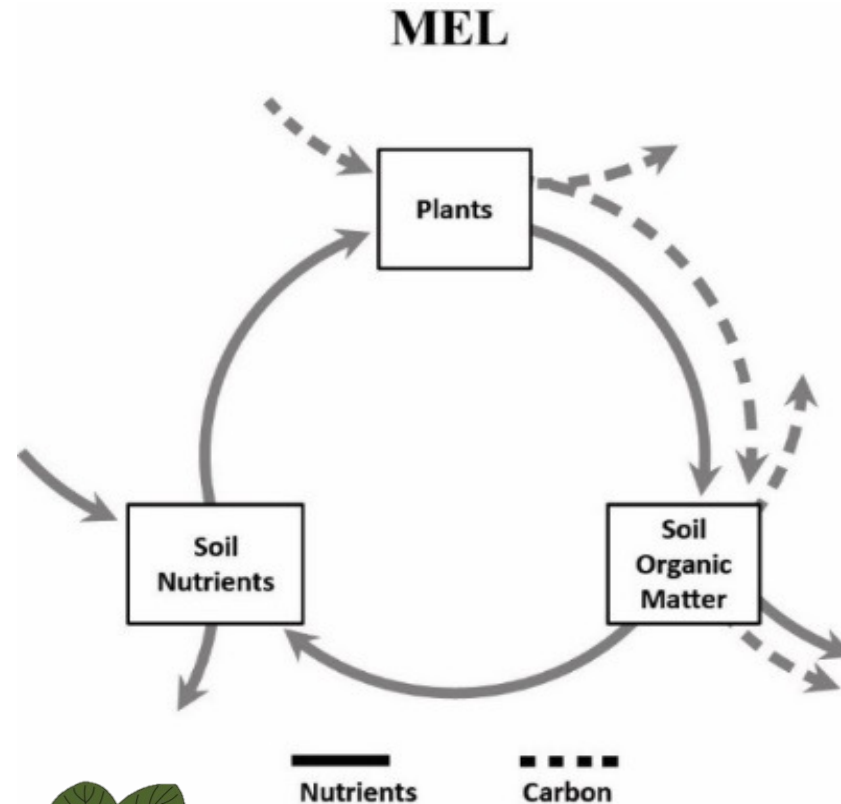
Team Vole: Changing Rodent Density

Exclosures AND Enclosures across multiple ecosystems



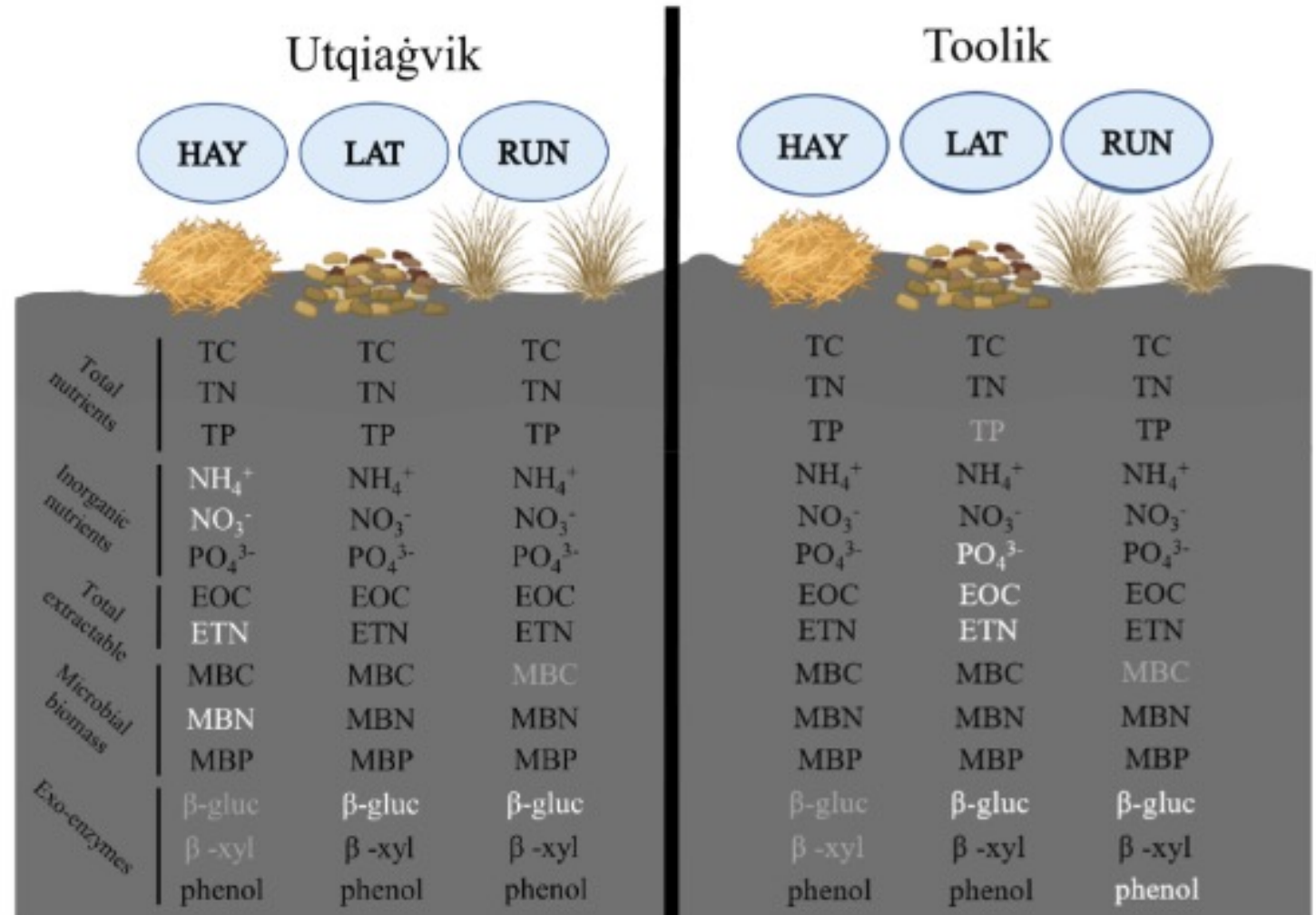
“Animating” the Carbon Cycle

Quantify and model impacts of rodents on carbon & nutrient cycling

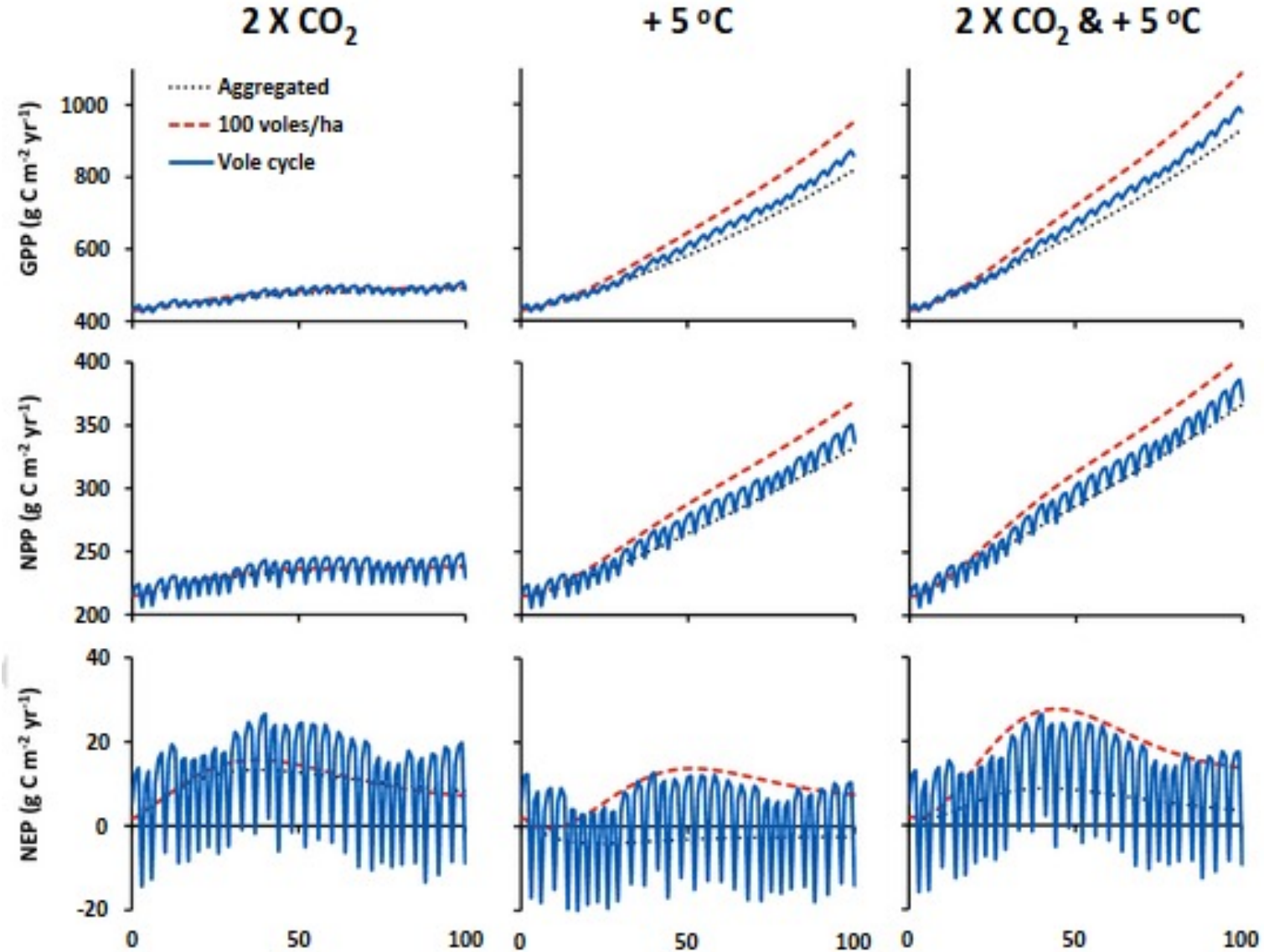


Project future climate & vegetation

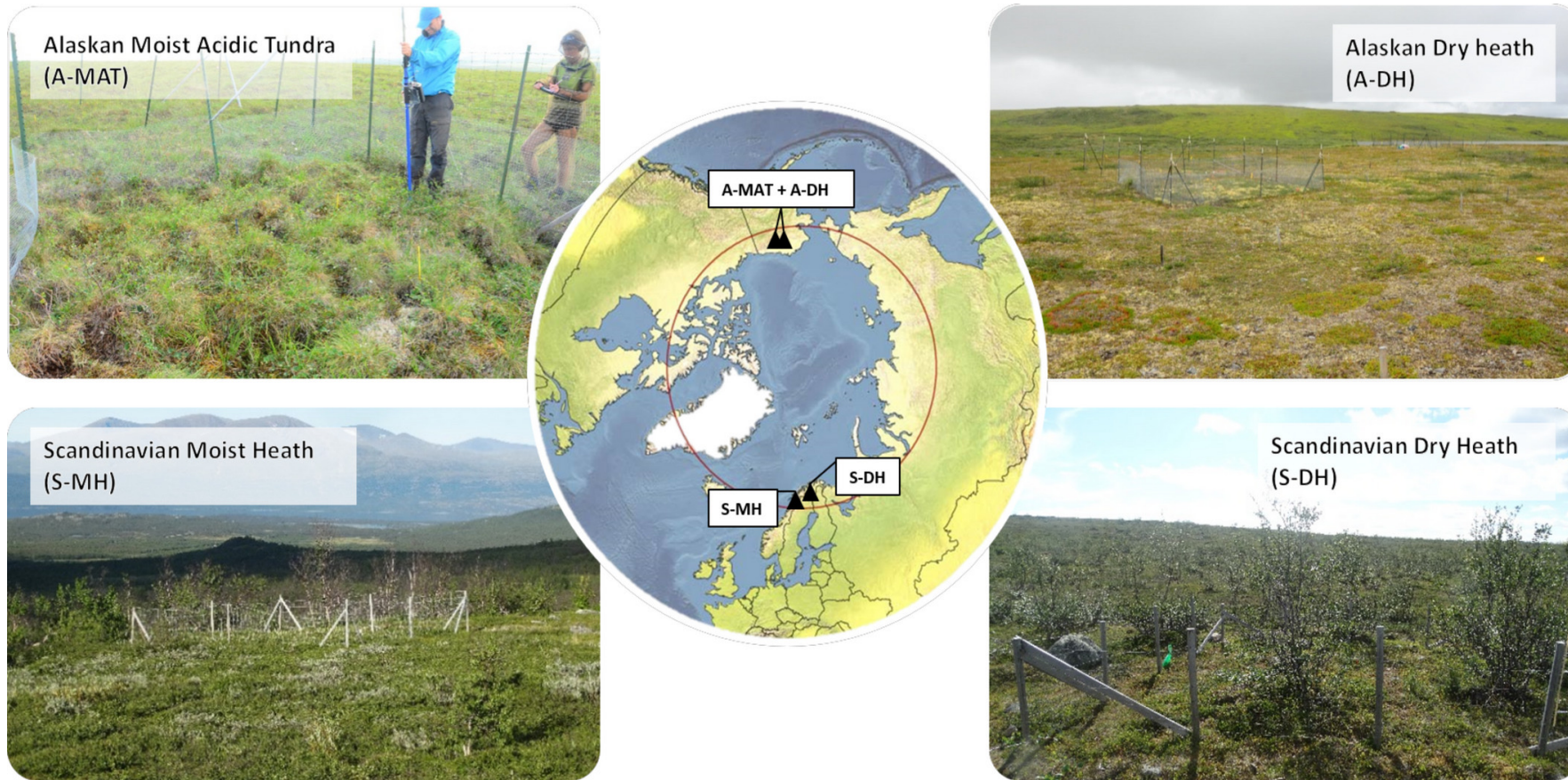
Non-consumptive Effects of Voles (and Lemmings)



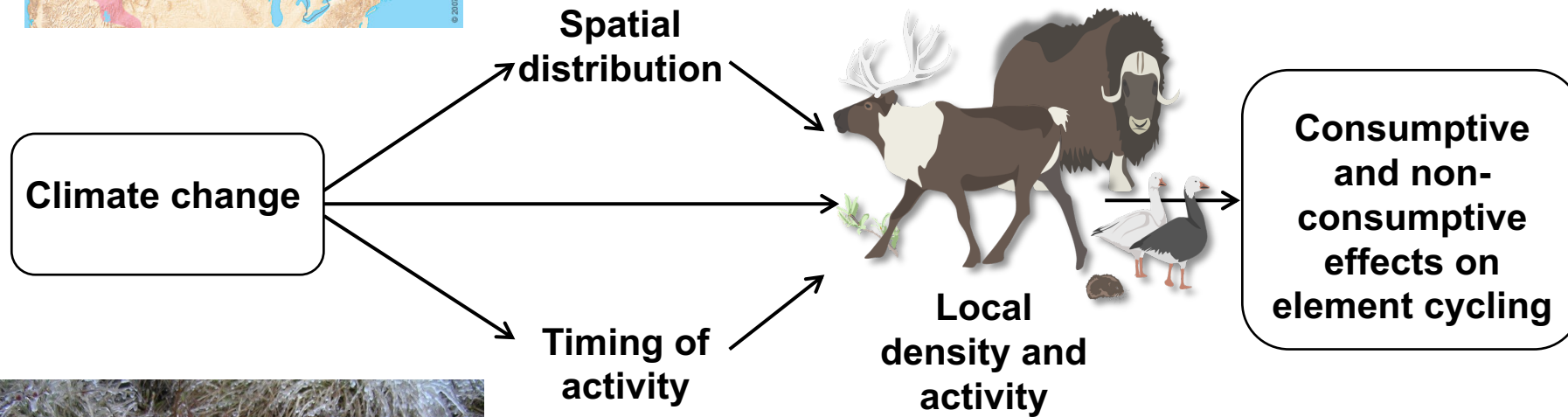
AniMEL – Adding Animals to the Equation



Cross-Site Studies: Large Mammals

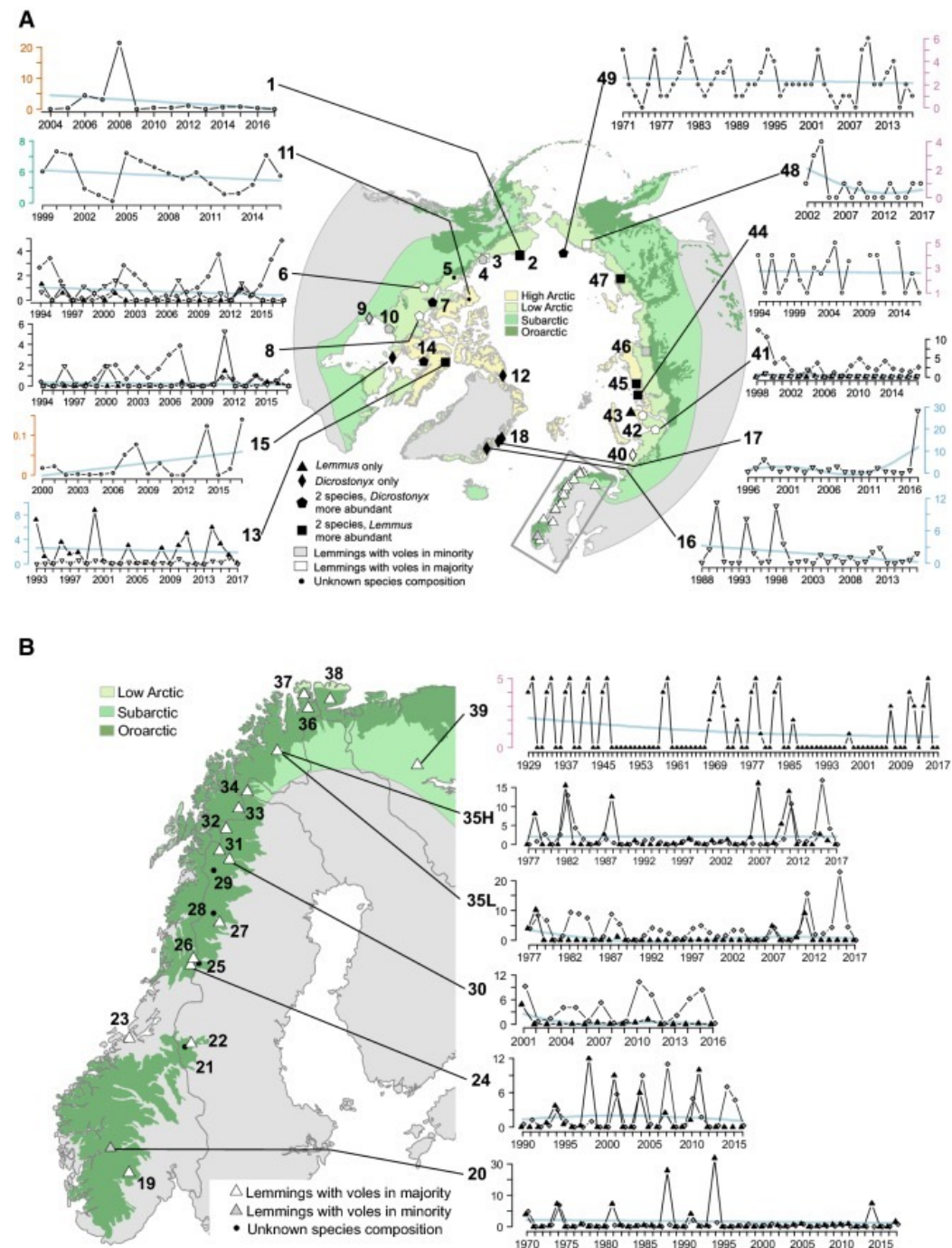


Arctic Animals & Climate Change



Mysteries

- Will boom-bust cycles continue?
- How are predators involved?
- Are parasites/disease involved?



Thank you!

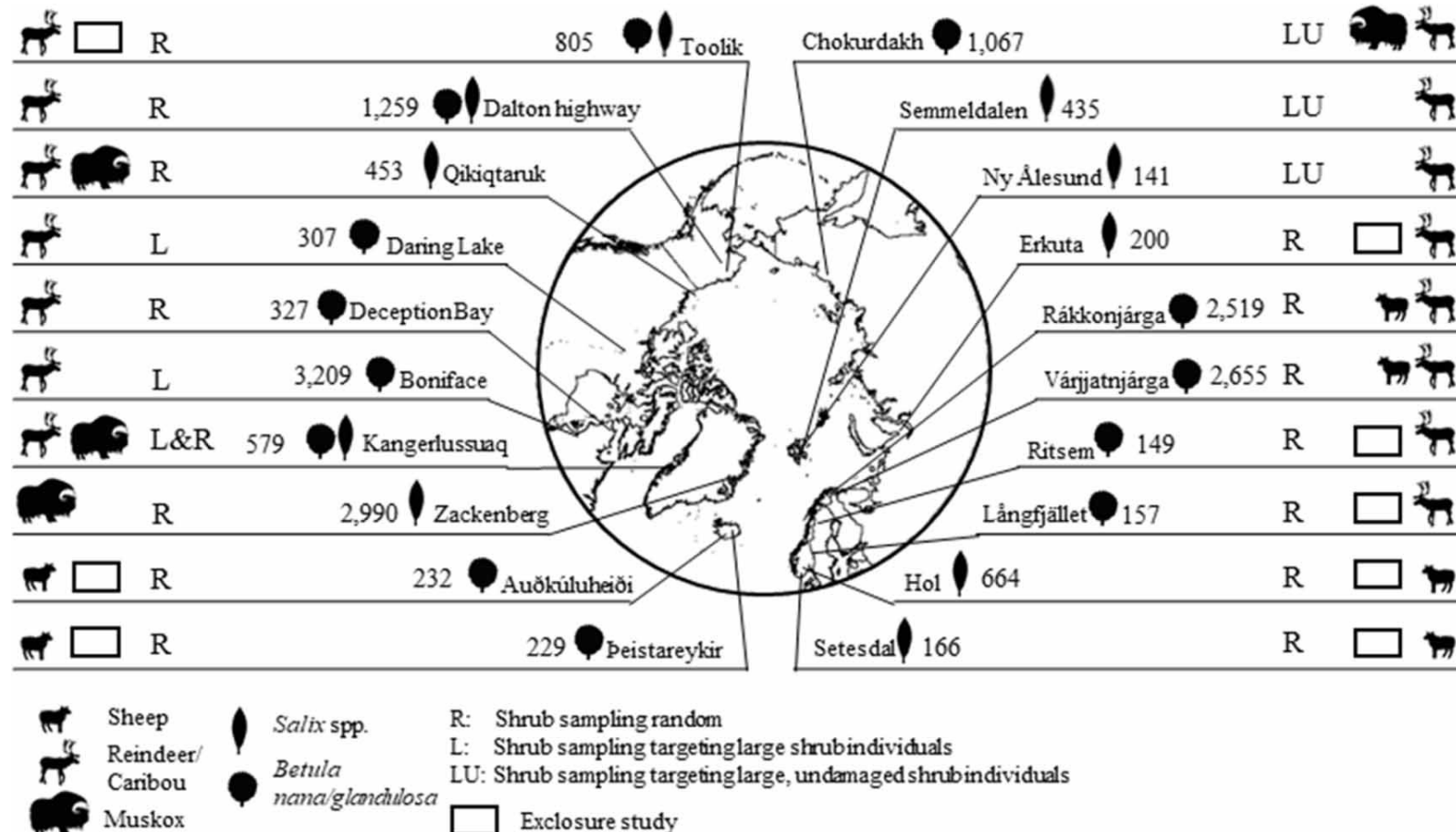






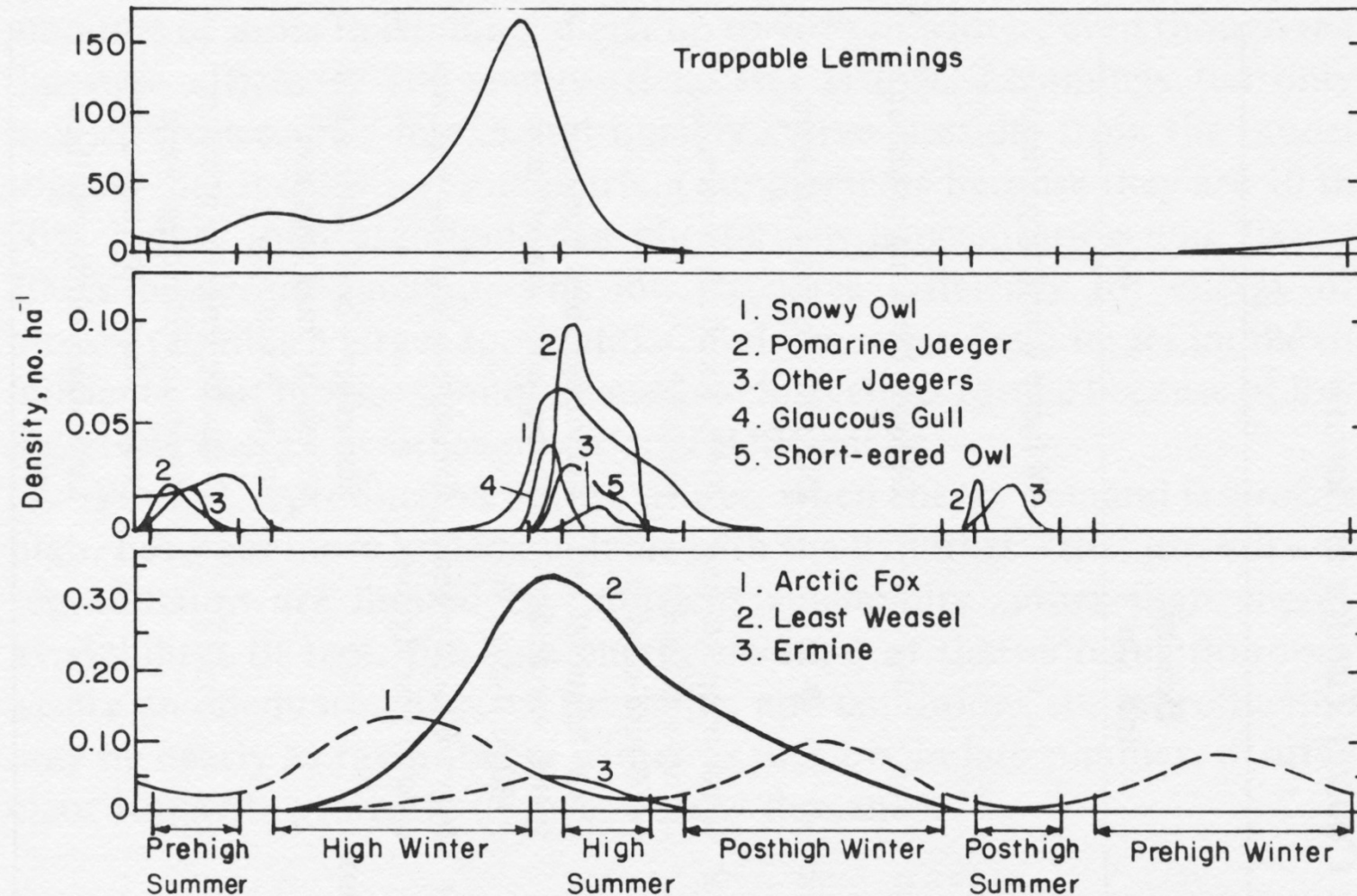


Cross-Site Studies: Large Mammals





Top-Down Pressures on Lemmings



Small rodent population cycles and plants – after 70 years, where do we go?

Inherent plant cycles (A)

Higher quality of diet due to inherent cycles of plant reproduction/quality

Cyclic variation in plant quality (A_i)

Rodent food plants have cyclic variation in flower, seed and berry production OR nutritional quality.

High plant quality (A_{ii})

The cyclically available food sources have higher quality than other food items.

Increased diet quality (A_{iii})

At increasing densities, rodent_i ingest a higher quality diet than at low densities.

Increased reproduction (A_{iv})

Increased diet quality leads to increased rodent_i reproduction.

Increased population growth (A_v)

Increased reproduction affects rodent_p growth rate positively.

Rodent cycles follow plant cycles (A_{vi})

Rodent_p density follows food plants with a timelag.

Interaction cycles (B, C, D)

Reduced plant quantity (BD_i)

Rodent_p feeding reduces the quantity of their preferred food plants.

No change in diet (BC_{ii})

Rodent_i diet composition does not vary with population density.

Reduced diet quantity (B_{iii})

At high population densities, rodent_i ingest quantitatively less food than at low densities.

Reduced health due to lower ingestion (B_{iv})

Lower consumption rate of food affects rodent_i health negatively.

Reduced population growth (BCD_v)

Lower rodent_i health affects rodent_p growth rate negatively.

Plant availability follows rodent density (BD_{vi})

Quantitative availability of plant foods follows rodent_p densities with a timelag.

Reduced plant quality (C_i)

Rodent_p feeding reduces the quality of their preferred food plants.

Change in diet (D_{ii})

Rodent_i diet composition varies with population density.

Reduced diet quality (CD_{iii})

At high population densities, rodent_i ingest lower quality food than at low densities.

Reduced health due to lower diet quality (CD_{iv})

Lower diet quality affects rodent_i health negatively.

Plant quality follows rodent density (C_{vi})

Plant quality follows rodent_p densities with a timelag (C_{vi}).

Food quantity (B)

Reduced quantity of food per individual due to overgrazing at high population densities

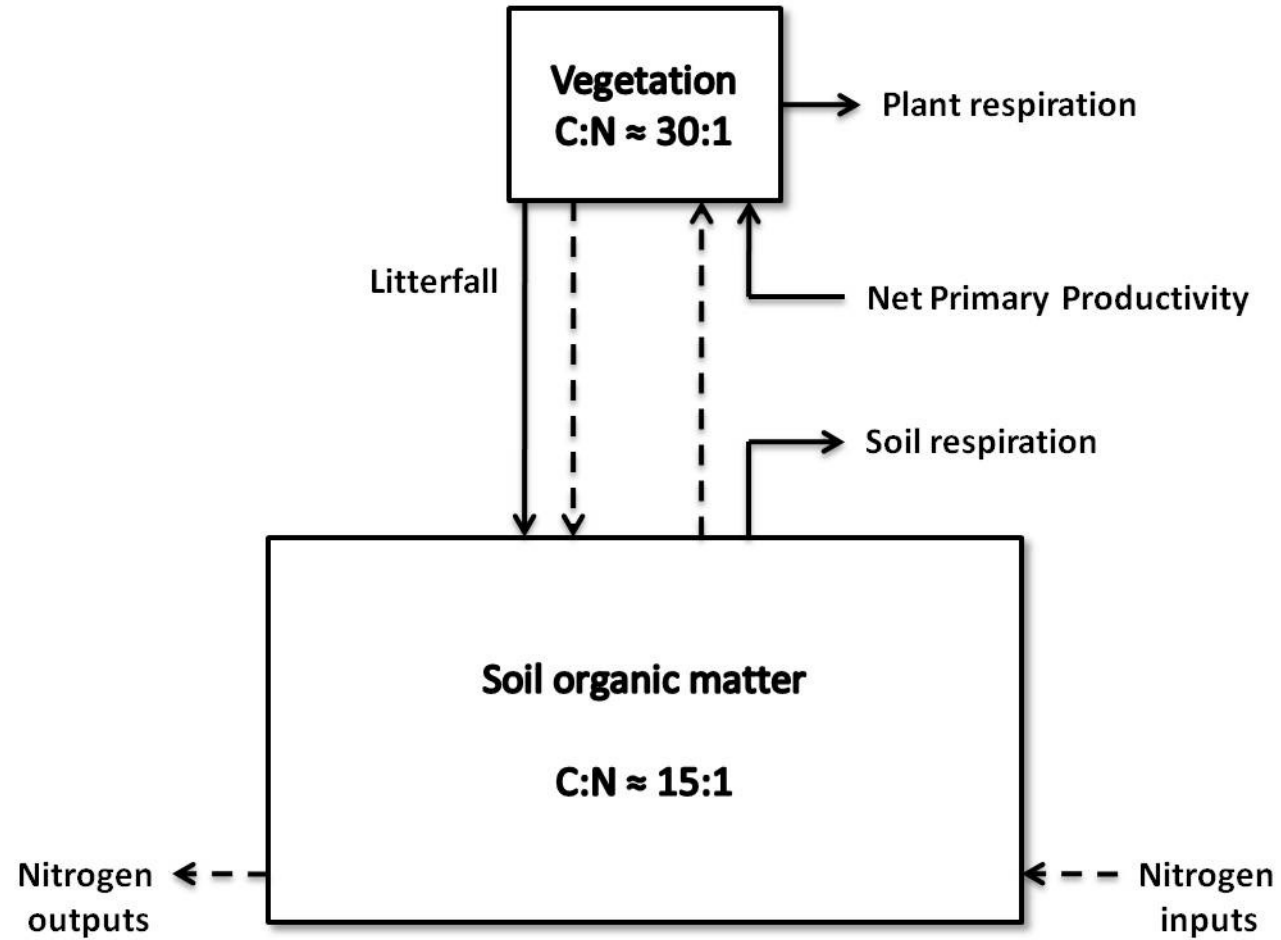
Quality of preferred foods (C)

Reduced quality of diet due to decreased quality of preferred food(s)

Food quality due to dietary changes (D)

Reduced quality of diet due to additional food items OR fewer food items

Simple Arctic Model



Adapted from Shaver et al. 1992 *BioScience*

Animals Can Affect Carbon Cycling

