Using a common protocol to measure invertebrate herbivory: responses to warming across tundra sites

BARRIO, I.C., **HIK, D.S**, PRÉVEY, J., ALATALO, J., BOULANGER-LAPOINTE, N., BUENO, C.G., MÖRSDORF, M., MYERS-SMITH, I., RAVOLAINEN, V.T., **JÓNSDÓTTIR, I.S.**.

HERBIVORY NETWORK

STUDYING HERBIVORY IN ARCTIC AND ALPINE ECOSYSTEMS

ITEX International Tundra Experiment

Polar Science 10 (2016) 297–302

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Herbivory Network: An international, collaborative effort to study herbivory in Arctic and alpine ecosystems

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Polar Biology
https://doi.org/10.1007/s00300-019-02568-3

ORIGINAL PAPER

Check for updates

Hiding in the background: community-level patterns in invertebrate herbivory across the tundra biome

Sarah I. Rheubottom[1] · Isabel C. Barrio[2,3] · Mikhail V. Kozlov[4] · Juha M. Alatalo[5,6] · Tommi Andersson[7] · Ashley L. Asmus[8,9] · Capucine Baubin[10] · Francis Q. Brearley[11] · Dagmar D. Egelkraut[12,13] · Dorothee Ehrich[10] · Gilles Gauthier[14] · Ingibjörg Svala Jónsdóttir[3,15] · Sophia Konieczka[16] · Esther Lévesque[17] · Johan Olofsson[18] · Janet S. Prevéy[19,20] · Guillaume Slevan-Tremblay[14] · Aleksandr Sokolov[21,22] · Natalia Sokolova[21,22] · Svetlana Sokovnina[23] · James D. M. Speed[24] · Otso Suominen[7] · Vitali Zverev[4] · David S. Hik[1,25]

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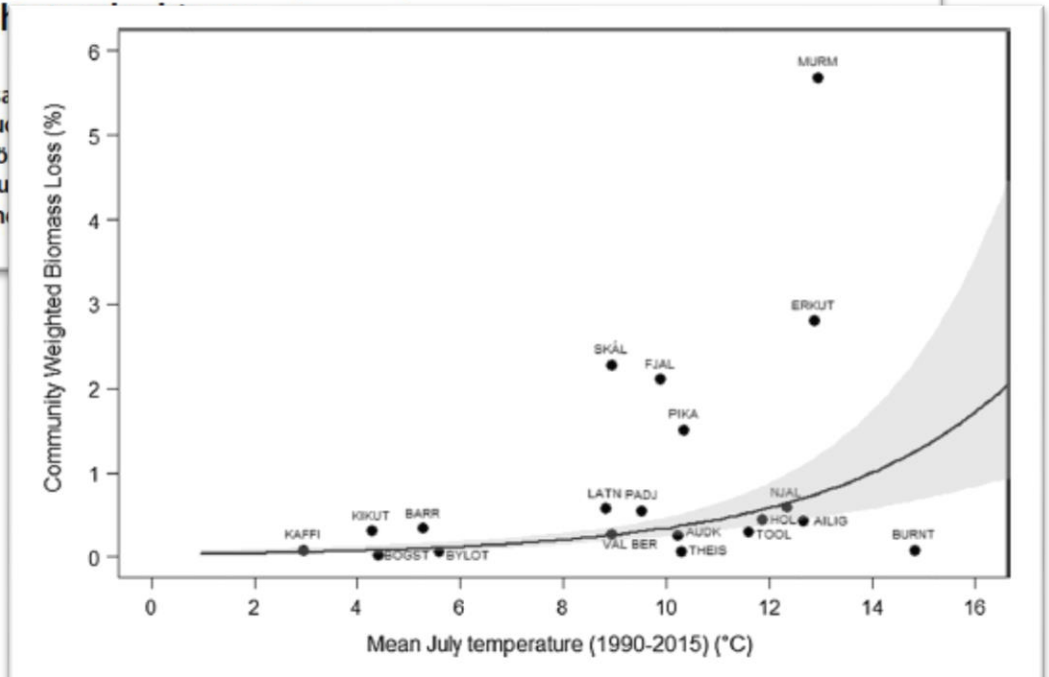

- ✓ Invertebrate herbivory prevalent at low intensity
- ✓ Plant biomass consumed average: 0.94%, range: 0.02-5.69%
- ✓ Mid-summer temperature influences the intensity

Reubottom et al. 2019

HERBIVORY NETWORK

STUDYING HERBIVORY IN ARCTIC AND ALPINE ECOSYSTEMS

ITEX herbivory protocol – updated version 2016

Changes since last version

A summary of the main changes since the previous version (and why) are listed here. For more details read corresponding section.

- Pellet counts for large/medium sized herbivores: we suggest conducting four 25 m transects spread across the ITEX site (instead of one 100 m transect) to assess use of the area by large/medium sized herbivores. A larger number of shorter transects captures better the spatial variability, provides an idea of the heterogeneity of use across the area, and 25 m are enough to detect >90% of herbivore species present. See "Transects for pellet counts" in section 2.
- Pellet counts for small mammals: counting droppings of small mammals in plots placed systematically along a transect is no longer recommended; we suggest instead to count all small mammal pellets present in the ITEX monitoring plots. More efficient estimates of small mammal use of the area would involve sampling specific habitats and/or more time-consuming methods that are beyond the relative estimates proposed in this protocol. See section 3.
- Estimating observer bias: variation within and between observers can be a potential source of variation. As an internal control procedure at each site we suggest where feasible that some estimate of repeatability be conducted for each set of measurements (e.g. repeating the same point-intercept or transects independently by different observers, or by the same observer). This would allow a quantification of observer bias and error. See 'Quality control' section.

Background and rationale

Herbivory is a main driver of tundra plant communities [1,2], and recent studies have shown that herbivores can modulate the responses of tundra plants to warming [3-8]. The International Tundra Experiment (ITEX; http://www.geog.ubc.ca/itex/) provides an experimental setting to test this idea across a large number of tundra sites.

This protocol is designed specifically for the ITEX experimental set up. The goal of this protocol is to provide guidelines for assessment of herbivory occurrence and intensity within ITEX plots (OTCs vs controls) and among study sites (controls at different sites). This information will allow a quantitative evaluation of herbivory, to address the following questions:

- ✓ If herbivory is similarly prevalent across tundra sites (by comparing control plots at different sites)
- ✓ If herbivory by vertebrates and invertebrates has a similar impact across tundra sites
- ✓ If herbivory occurs at different intensities within OTCs and in controls

While the measurements proposed in this protocol will undoubtedly benefit the ongoing studies at each site, the data obtained would be also extremely valuable for collaborative research, e.g. comparisons across sites.

Because herbivores (both vertebrates and invertebrates) can affect plant communities directly, through plant biomass consumption, and indirectly, through trampling and nutrient deposition via faeces and urine[9], it is relevant to quantify both, the signs of herbivory and the signs of herbivore presence.

http://herbivory.lbhi.is

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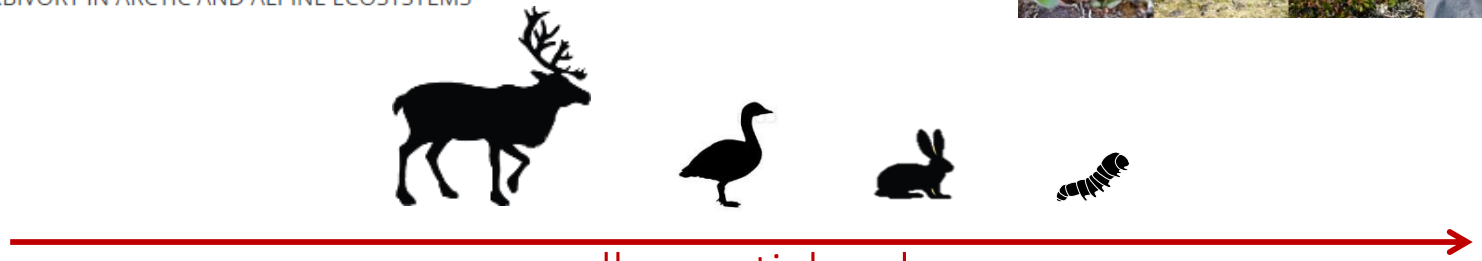

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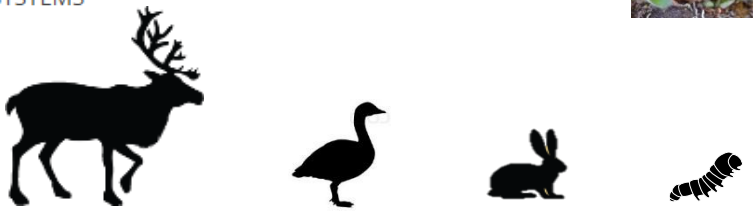
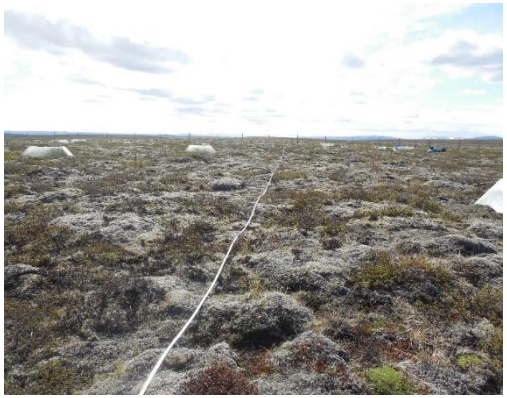


smaller spatial scale

1. Overall characteristics of the herbivore community

Overall description of the site, and relevant management practices that may affect herbivore populations

2. Site-level assessment



Local estimates of (vertebrate) herbivore presence and abundance in the area

3. Plot-level assessment

Fine-scale measures of herbivory and herbivore activity that can be related to plant measurements

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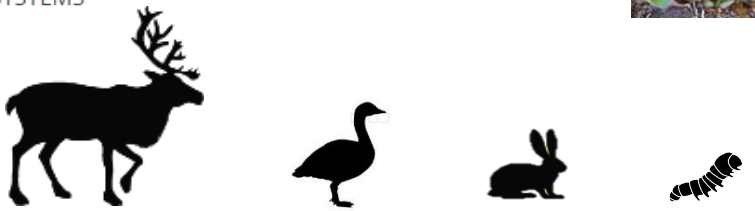

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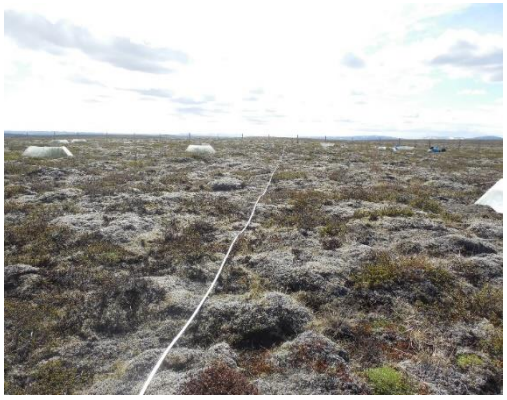

Local estimates of (vertebrate) herbivore presence and abundance in the area

Transects: pellet counts.
Assess changes **within sites** (over time)

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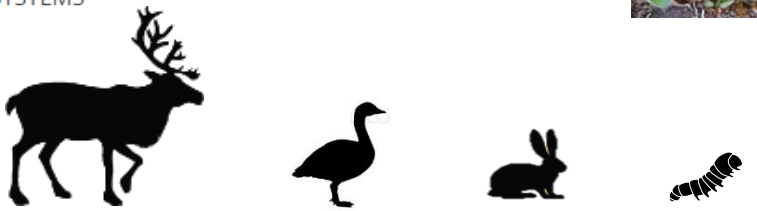

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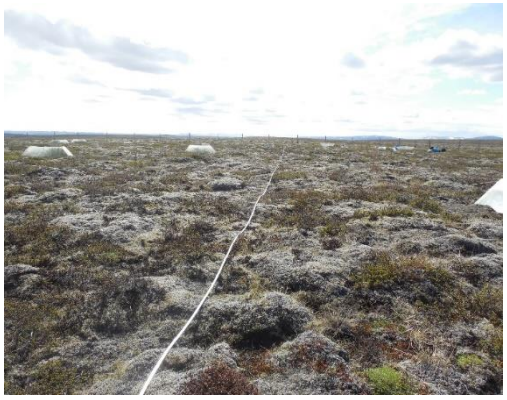

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Fine-scale measures of herbivory and herbivore activity that can be related to plant measurements

Modified point-intercept method for estimates of leaf damage. Comparisons between plots with/without warming, and **between sites**

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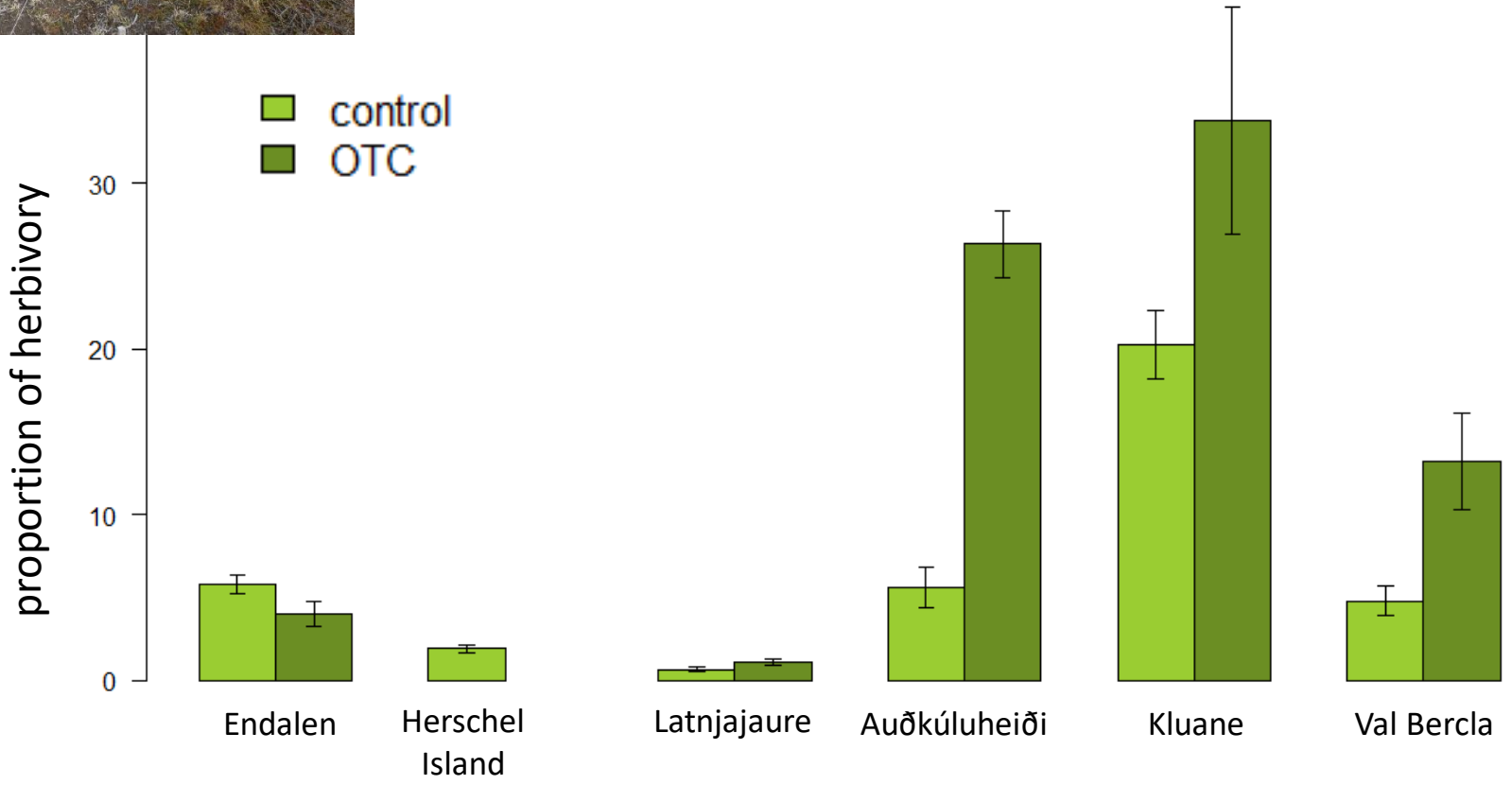
Plot-level assessment

- Reflects mostly the activity of **invertebrate herbivores** (>97% of observed leaf damage)
- Overall, the frequency of invertebrate herbivory in control plots was low (range 1-12%) and varied across sites (LM; SITE, F=7.1, p<0.001)

Contributing sites

Plot-level assessment

- At most sites, **increased herbivory within warmed plots** – except at a High Arctic site (GLM; SITE*TTM, $p<0.001$)



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In sum…

- ☑ The ITEX protocol seems to work well to detect overall differences in herbivory/herbivore activity by invertebrates (plot-level assessment)
- ☑ Invertebrate herbivory generally low (<7%) and variable across sites
- ☑ More invertebrate herbivory in **warmed plots,** but some local deviations from this pattern

Field assistance

Ueli Schmid, Lisa Leibold at Val Bercla; Thecla Munanie Mutia and Ágústa Helgadóttir at Endalen; Edwin Liebig and Ágústa Helgadóttir at Auðkulúheiði; Haydn Thomas and Jennifer Lowe (Team Shrub) at Herschel Island

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