Stomping in silence: the overlooked role of ungulate trampling in shaping tundra ecosystems

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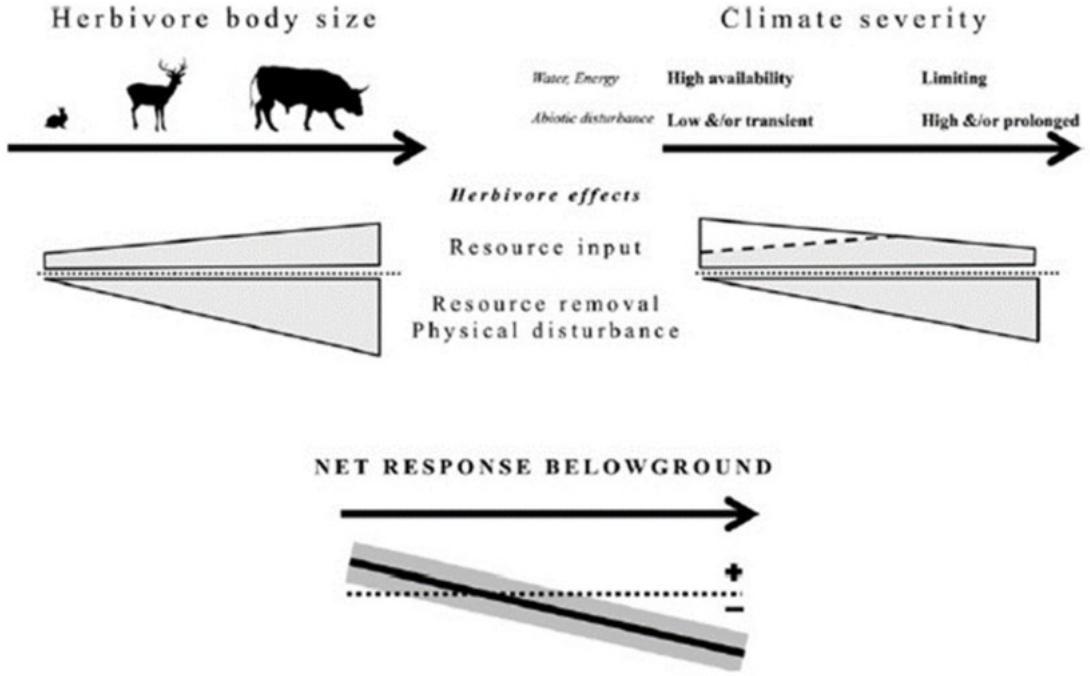
Session EBM6: Large herbivores as agents of ecosystem based management in the circumpolar Arctic

The larger the herbivore, the harsher the environment, the stronger the role of physical disturbance in affecting soil



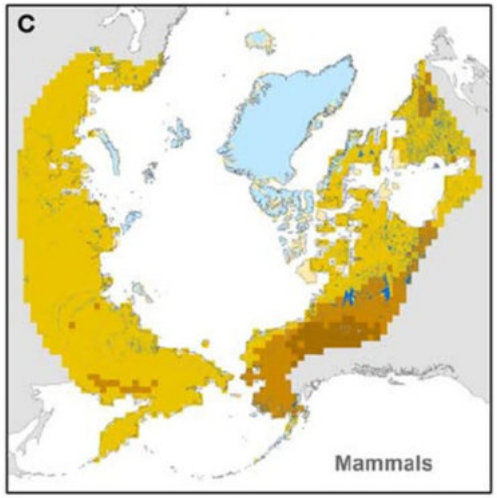
PRIMARY RESEARCH ARTICLE

WILEY Global Change Biology

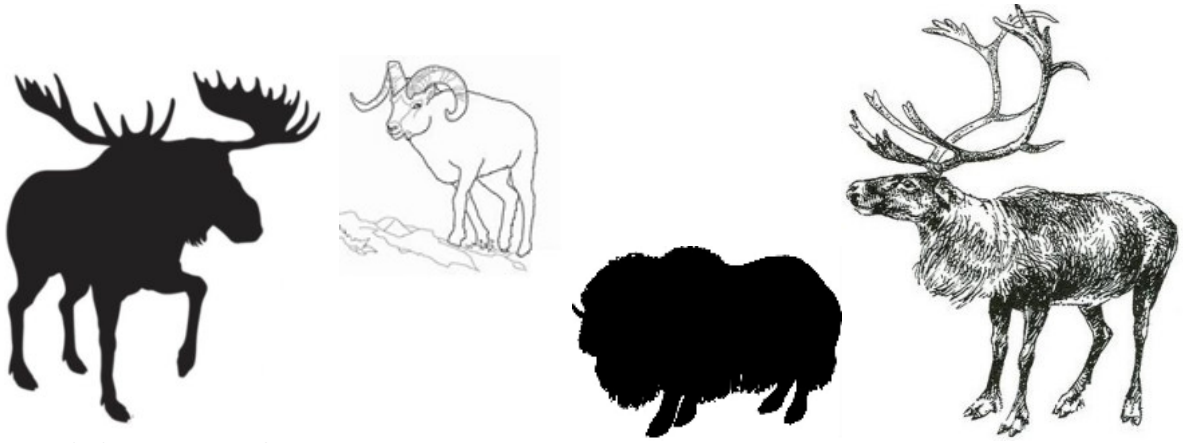
Responses of belowground communities to large aboveground herbivores: Meta-analysis reveals biome-dependent patterns and critical research gaps

Walter S. Andriuzzi[1] | Diana H. Wall[1,2]

Glob Change Biol. 2017;23:3857–3868.



Biotic interactions mediate patterns of herbivore diversity in the Arctic
Barrio et al. (2016) Global Ecology and Biogeography 25: 1108-1118

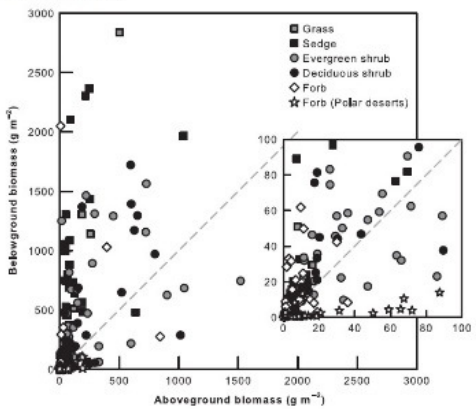


TUNDRA

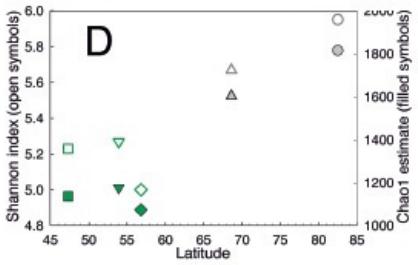
i. Large herbivores
ii. Harsh climate
iii. Biomass, biodiversity belowground
iv. Vast soil carbon stores

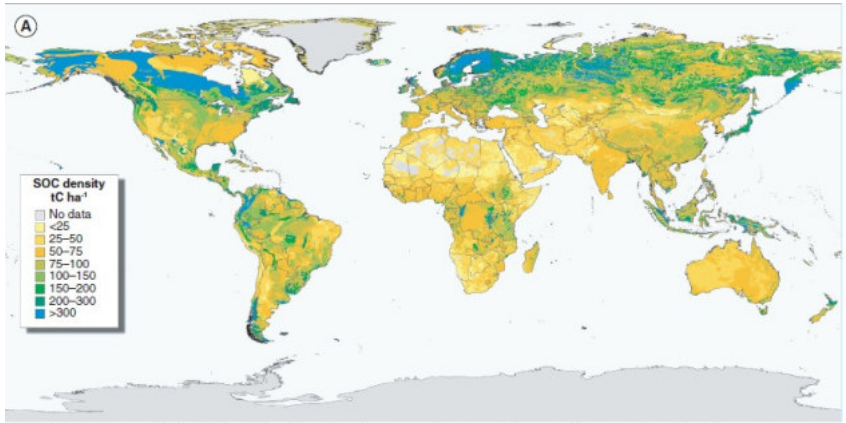
→Role of physical disturbances important !

The unseen iceberg: plant roots in arctic tundra
Iversen et al.
New Phytologist (2015) 205: 34–58
doi: 10.1111/nph.13003



Unexpectedly High Bacterial Diversity in Arctic Tundra Relative to Boreal Forest Soils, Revealed by Serial Analysis of Ribosomal Sequence Tags
Neufeld & Mohn (2005) Applied & Environmental Microbiology 71: 5710-5718





Scharlemann et al. (2014) Global soil carbon: understanding and managing the largest terrestrial carbon pool. Carbon Management 5(1) 81-91

Effects of trampling on vegetation known but effects on soil largely unknown in tundra

1.1) Trampling directly damages vegetation, decreases plant biomass (Starr et al. 2018 Agriculture, Ecosystems & Environment, 255, 12–19; Heggenes et al. 2017 Ecology & Evolution, 7, 6423–6431)

1.2) Trampling a strong driver for longer-term vegetation community shift (Egelkraut 2018 thesis)
- longer-term vegetation shift parallels with many changes in soil

2.1) More compacted soils under areas grazed by ungulates
- “indirect evidence” (Stark et al. 2002 *Oikos,* 97, 69-78)

2.2) Trampling decreases soil faunal and fungal biomass and alters soil food web (Sørensen et al. 2009 *Ecosystems*, 12, 830–842)

International networks and expert knowledge a way to disentangle the role of arctic ungulate trampling

How do herbivores affect soils in the Arctic?

Soil Working Group workshop in Reykjavik 16.9.2016

Led by Maria Tuomi, Guillermo Bueno and co-organized by Maria Väisänen and Francis Brearley

Participants (in alphabetical order):

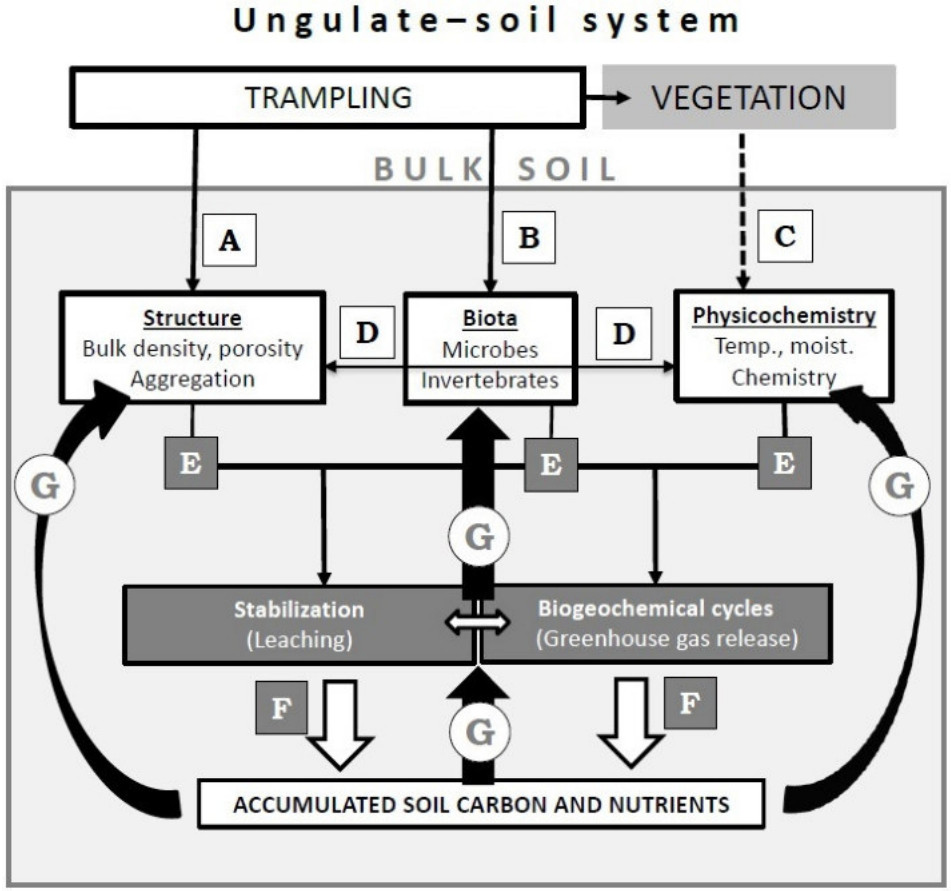
Isabell Eischeid
Hannu Fritze
Anders Kolstad
Petr Macek
Matteo Petit Bon
Sari Stark
Ingibjörg Svala Jónsdóttir (Inga Svala)
Jóhann Thórsson
Henni Ylänne

Bruce Forbes
Isabel Barrio
James Speed

Participants' Herbivory soil Research

HERBIVORY NETWORK
STUDYING HERBIVORY IN ARCTIC AND ALPINE ECOSYSTEMS

Trampling could impact soil through many pathways



Soil properties

A **B** Compression and cutting action directly impact on soil structure. Soil microorganisms, such as fungal hyphae and bacteria, may break down and lyse due to compression and cutting. Invertebrates may also lyse and relocate into deeper soil horizons to escape cutting.

C Compression and cutting induced vegetation damages (indirect effect: dashed line), such as shifts in the cover of vegetation, litter and root exudation, affect soil temperature, moisture, and chemistry

D Structure, biota and physicochemistry interact.

Soil processes

E Changes in structure, biota and physicochemistry cascade down to soil processes that are intertwined.

Soil pools

F Changes in processes cascade down to accumulated soil pools.

G Changes in pools and processes feedback to the preceding levels.

THANK YOU!