Physical properties of snow guide the movements of lemmings under the snowpack

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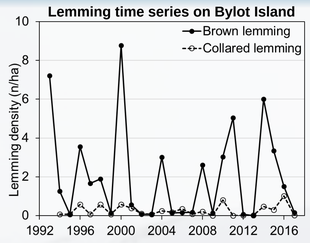
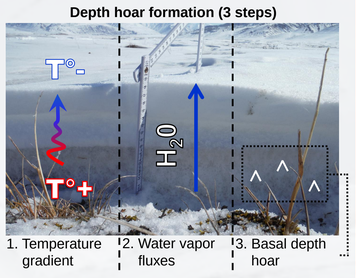
Introduction

Lemmings are key species in tundra ecosystems
- Cyclic population fluctuations
- Winter breeding plays a significant role in their population fluctuations



Lemmings and snow
- Snow provides a protection against cold and predators
- Lemmings dig networks of burrows in the snowpack to reach food under the snow
- Lemmings build nest under the snow to reproduce

Snow in the High Arctic
- Depth hoar in the basal layers is soft and loosely bounded :
  - ⇨ Provides ideal conditions for lemmings to dig burrows
- However, melt-freeze events produce hard basal snow layers



Objectives

1. Determine whether lemmings prefer to dig in a specific snow layer.
2. In presence of a hard basal melt-freeze crust, determine if lemmings select snow layers where physical properties are optimal for digging.

Methods

Study area
- Bylot Island, Nunavut

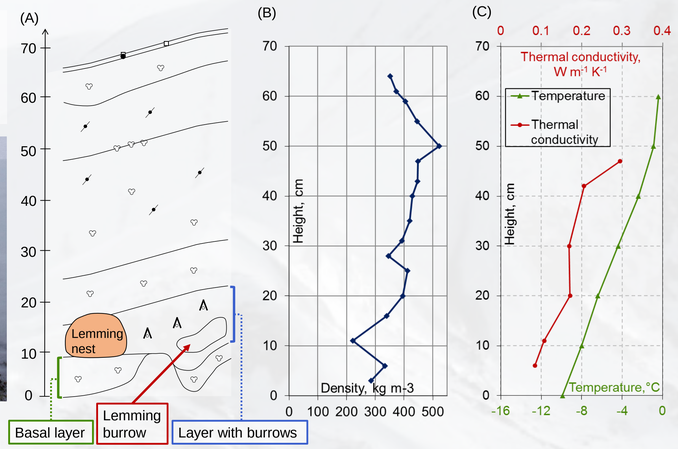
Measure of lemming burrows
- Snow pits (n = 11) were dug where there were signs of arctic fox attacks on lemmings
- Characterization of lemming burrows (n = 35)

Measures of snow physical properties in different layers
- Density
- Thermal conductivity (proxy for snow hardness)

Results

During the 2016-2017 winter, the basal layer was often a hard melt-freeze crust, difficult to dig for lemmings: (A) stratigraphy, (B) density profile and (C) thermal conductivity and temperature profile of the snow

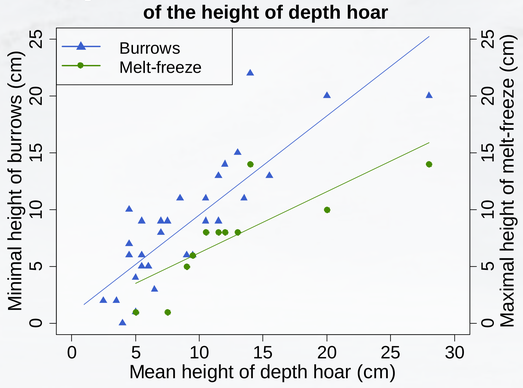
Legend for snow stratigraphy (A):
- Faceting rounded crystals
- Faceted crystals
- Melt-freeze polycrystals
- Wind crust
- Λ Indurated depth hoar from melt freeze

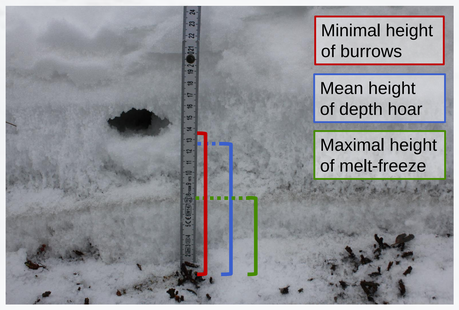


1. Lemmings prefer to dig in depth hoar

- Strong positive relationship between minimal height of burrows and mean height of depth hoar ($R^2 = 0.69$, $p < 0.0001$, n = 35)
- Positive relation between maximal height of melt-freeze layer and mean height of depth hoar ($R^2 = 0.61$, $p = 0.002$, n = 12)

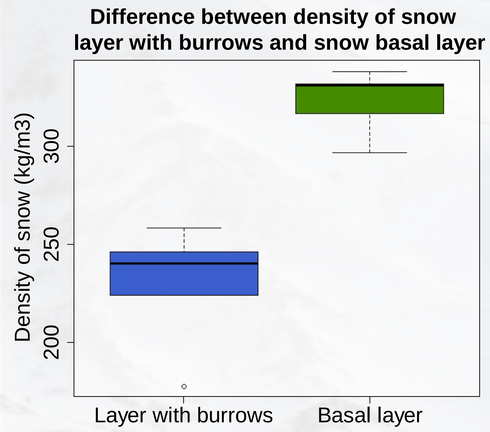
Height of burrows & melt-freeze as a function of the height of depth hoar

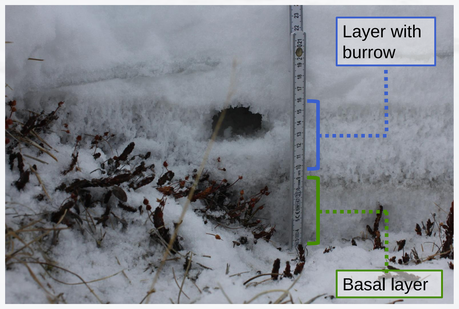




2. Lemmings prefer to dig in a snow layer less dense than the hard basal snow layer

Snow density of layer with burrows vs basal layer:
$t(5) = -5.89$, $p < 0.001$





No difference in thermal conductivity between layers with burrows and basal layers:
$t(5) = -1.26$, $p = 0.245$

Conclusion

- Lemmings prefer to dig in low density snow layers (i.e.depth hoar) when moving, even if it is not at the ground level where food is available
  - ⇨ Strategy for minimizing energy expenditure
  - ⇨ 2016-17: melt-freeze event that created a hard basal snow layer
- Snow physical properties play a key role on lemming movements under the snowpack
- Next step: Determine whether snow physical properties could affect lemmings capacity for winter breeding and thereby modulate their population fluctuations

Lemming nest use for reproduction

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