The fluctuating world of a tundra predator guild in winter

Bottom-up constraints can overrule top-down species interactions in winter
The threat of a warmer climate over northern latitudes

Switch from **bottom-up** to **top-down** regulation\(^1\)

Expansion of **boreal** species\(^2\)

A threat to **native tundra** species\(^3\)

\[\Rightarrow \text{Top-down effects (predation + competition) would become a significant structuring force}\]

\(^1\)Legagneux et al 2014; \(^2\)Elmhagen et al 2015; \(^3\)Angerbjörn et al 2013
A highly dynamic ecosystem

Seasonality should not be ignored\(^1\)

Winter severity

Effect of the rodent cycle\(^2\)

Pulsed resources

⇒ Do top-down interactions still prevail over bottom-up effects
  - in winter?
  - when resources are low?

\(^1\)Ims & Fuglei 2005; \(^2\)Krebs 2011
Fennoscandian mountain tundra community in winter

- Arctic fox
- Red fox
Fennoscandian mountain tundra community in winter

Largest predators detected were wolverine, red fox and arctic fox
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Rodent abundance as a treatment

Post-peak

Pre-peak

Low
Fennoscandian mountain tundra community in winter

Largest predators detected were wolverine, red fox and arctic fox

Main bottom-up factors
- altitude
- aspect
- PP

Rodent abundance as a treatment
- Post-peak
- Pre-peak
- Low
Methods:


Wildlife Triangle Scheme\(^1\) (12km triangle transects by snowmobile)

\(^1\)Lindén et al. 1996
Results: Analysis of the spatial patterns

Non-metric dimensional scaling (NMDS) ordination
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Non-metric dimensional scaling (NMDS) ordination
Results: Species interactions modelling

When rodent resource is low

- No top-down effect observed
- Bottom-up effect from westness
- Surprising positive relationship between arctic fox and red fox
Results: Species interactions modelling

When rodent resource is high

- Bottom-up effect on red fox (westness and ptarmigan)
- Top-down effect of arctic fox on ptarmigan
- Altitudinal segregation between fox sp
Can bottom-up constraints overrule top-down interactions?

**Top-down effects** were weak and fewer than expected

**Bottom-up effects** appear dominant in winter

Red fox was **limited bottom-up**, rather than exerting a top-down effect

**Variable pattern** for arctic fox and wolverine

⇒ **cold-specialists: ecological strategy founded in flexibility?**
Take-home message

Seasonality and pulsed resources affects the structuring rules

Winter conditions + low food = dominant bottom-up control

The interplay between summer and winter appears to determine the changing rate of northern ecosystems

There is a need to include the winter perspective in community ecology
Research

The fluctuating world of a tundra predator guild: bottom-up constraints overrule top-down species interactions in winter

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Global warming is predicted to change ecosystem functioning and structure in Arctic ecosystems by strengthening top-down species interactions, i.e. predation pressure on small herbivores and interference between predators. Yet, previous research is biased towards the summer season. Due to greater abiotic constraints, Arctic ecosystem characteristics might be more pronounced in winter. Here we test the hypothesis that top-down species interactions prevail over bottom-up effects in Scandinavian mountain tundra (Northern Sweden) where effects of climate warming have been observed and top-down interactions are expected to strengthen. But
Thank you for your attention!

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Fundings:
Community effect of rodents in winter

- **Wolverine**
  - Low winter
  - Pre-peak winter
  - Post-peak winter

- **Arctic fox**
  - Low winter
  - Pre-peak winter
  - Post-peak winter

- **Red fox**
  - Low winter
  - Pre-peak winter
  - Post-peak winter

- **Ptarmigan**
  - Low winter
  - Pre-peak winter
  - Post-peak winter