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Biome-wide patterns and drivers of Arctic herbivores functional and phylogenetic diversity

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HERBIVORY NETWORK

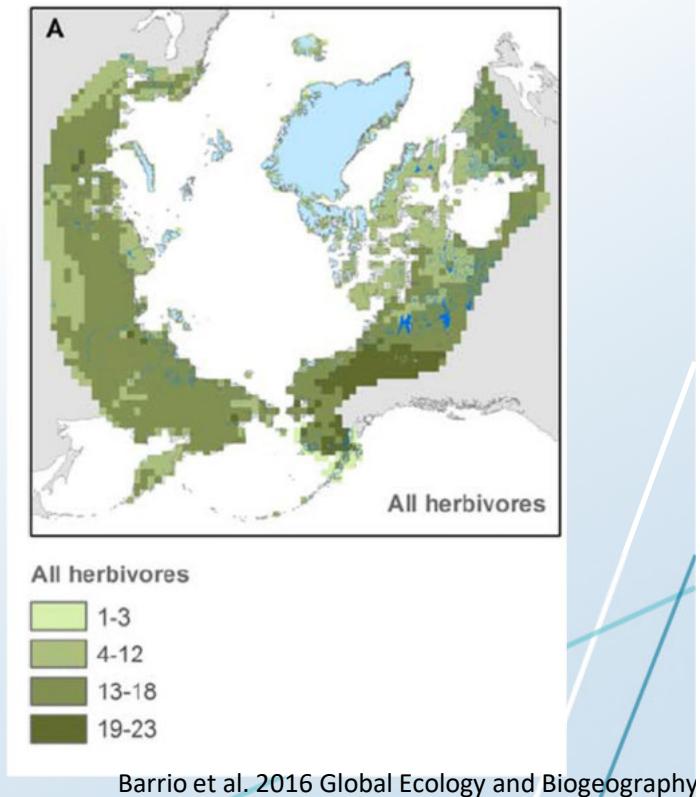
STUDYING HERBIVORY IN ARCTIC AND ALPINE ECOSYSTEMS





Vertebrate herbivores across the Arctic tundra biome

- Arctic vertebrate herbivore assemblages
 - Species richness varies with vegetation productivity and predator diversity

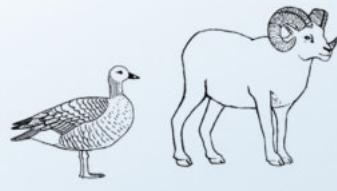
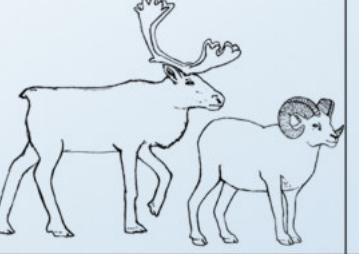
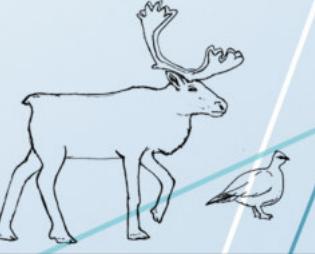




Phylogenetic and functional diversity

- Functional diversity
 - Links to ecosystem functioning
- Phylogenetic diversity
 - Evolutionary history
- Functional divergence
 - Ratio of functional and phylogenetic diversity
 - Assembly mechanisms

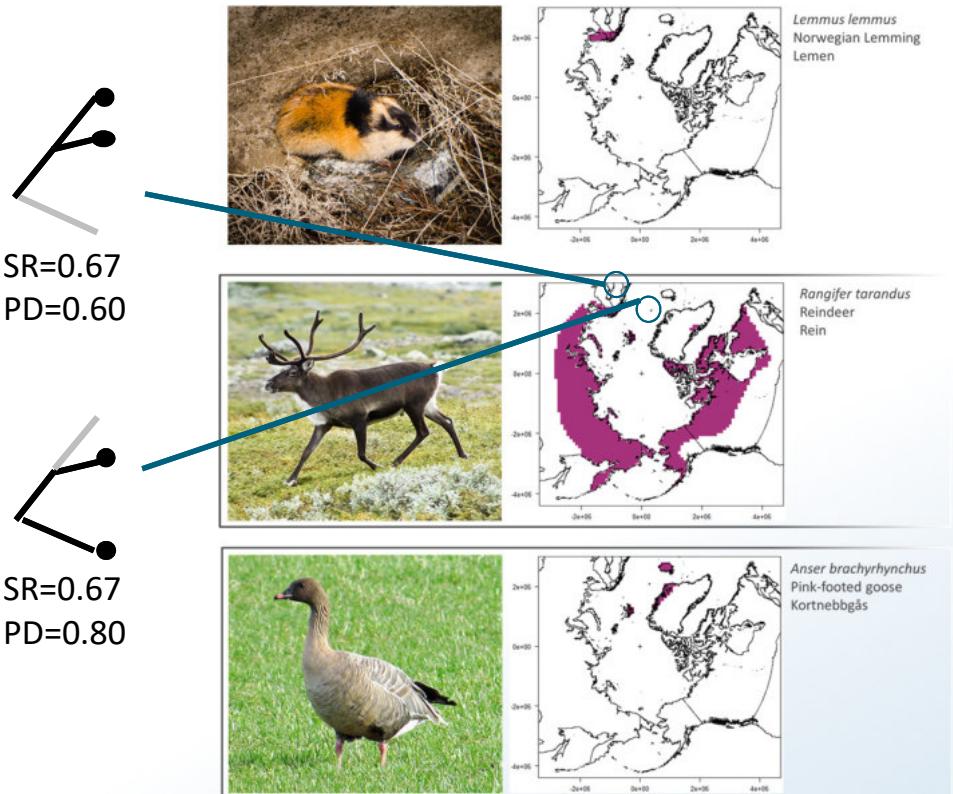
$$\text{Functional divergence} = \frac{\text{Functional diversity}}{\text{Phylogenetic diversity}}$$

		Phylogenetic diversity	
		Low	High
Functional diversity	High	High functional divergence 	
	Low		

Rationale

- Assess patterns and drivers of functional and phylogenetic diversity of arctic herbivores
 - Species poor guild but phylogenetically and functionally diverse
- Hypothesised drivers of functional and phylogenetic diversity:
 - Geographic factors affect phylogenetic diversity
 - Abiotic and biotic factors drive functional diversity
 - Functional divergence predicted to increase with increased vegetation productivity due to niche divergence in complex vegetation

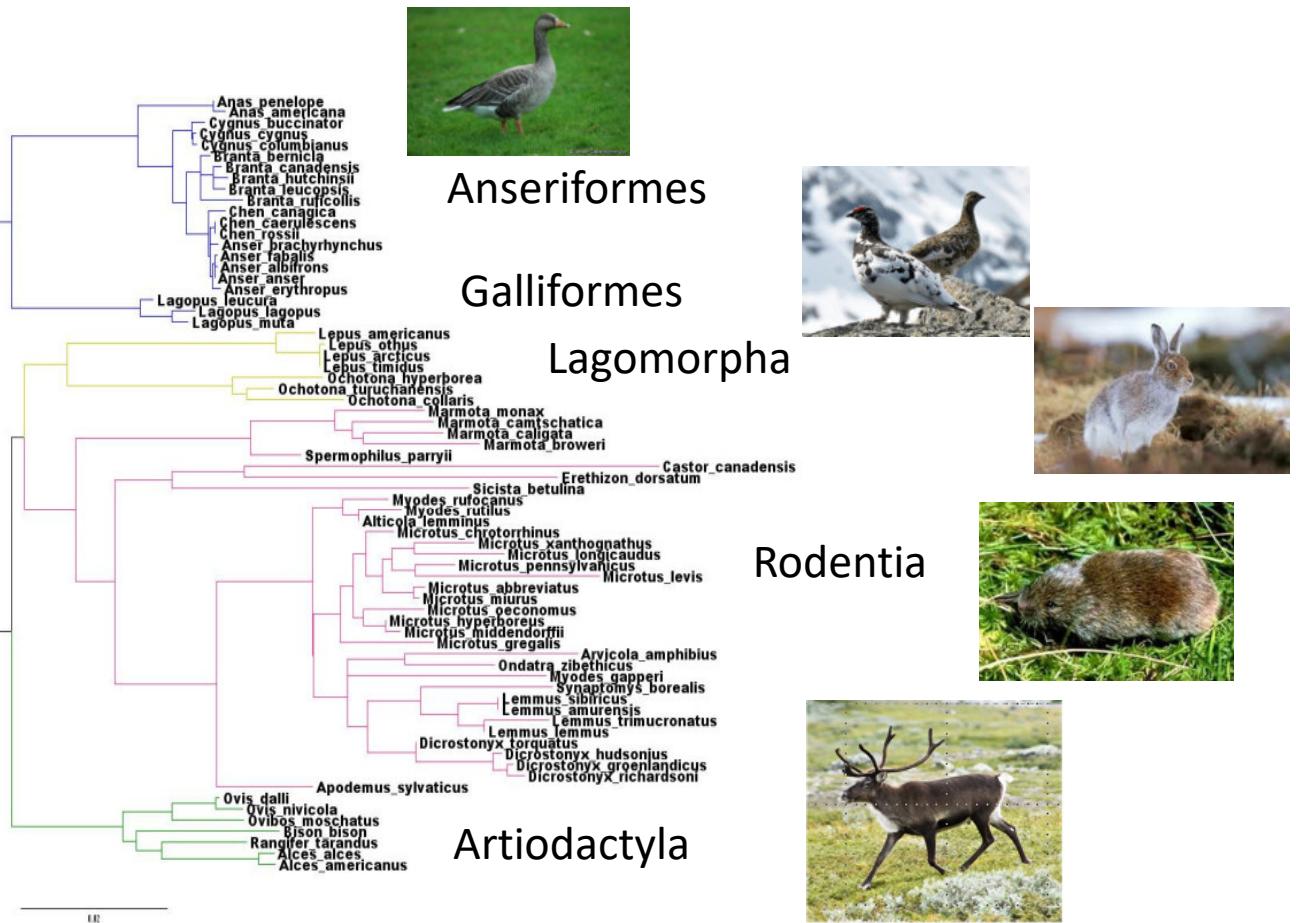
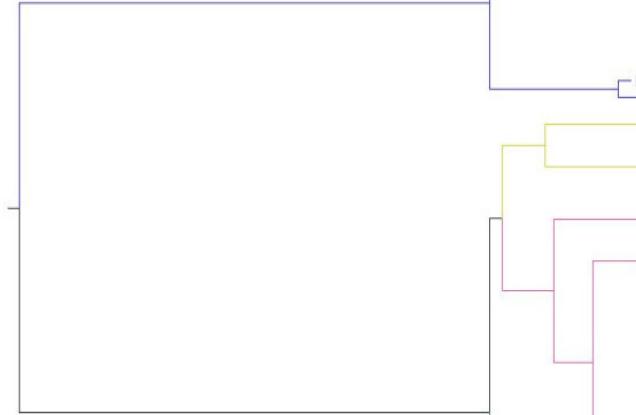
Methods



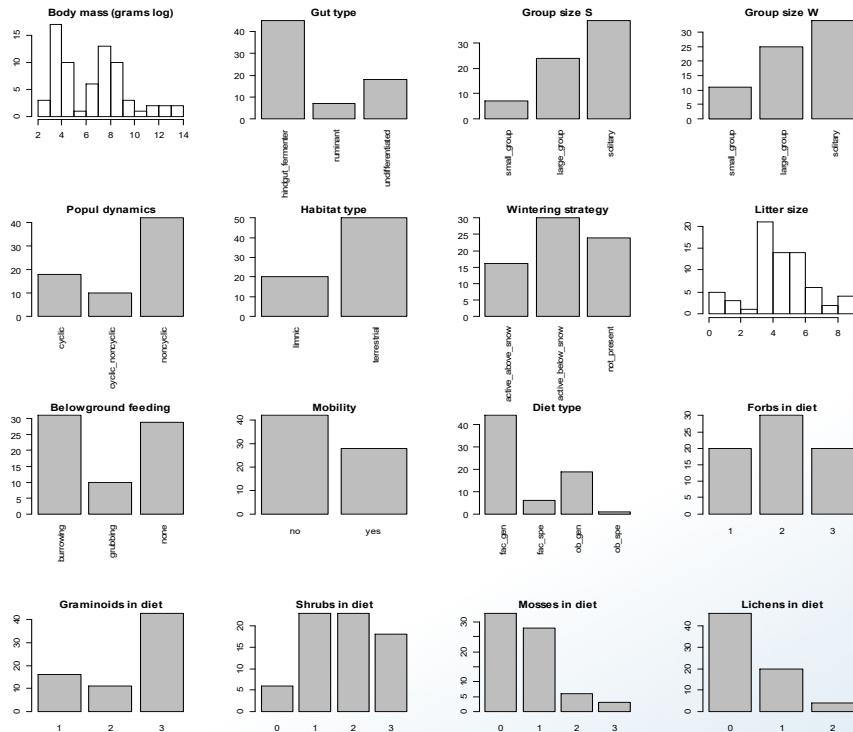
70 species distributed in Arctic tundra biome
CAFF area including sub-Arctic
Mammalian and avian herbivores (all vertebrates)
Range maps from IUCN and Birdlife International
100km grid cells

- Species richness
 - Proportion of total species pool in each grid cell
- Phylogenetic diversity
 - Proportion of total phylogeny branch lengths present per grid cell (Faith 1992)
- Functional diversity
 - Proportion of total functional classification branch lengths present per grid cell
- Functional divergence
 - Functional diversity/Phylogenetic diversity

Phylogeny



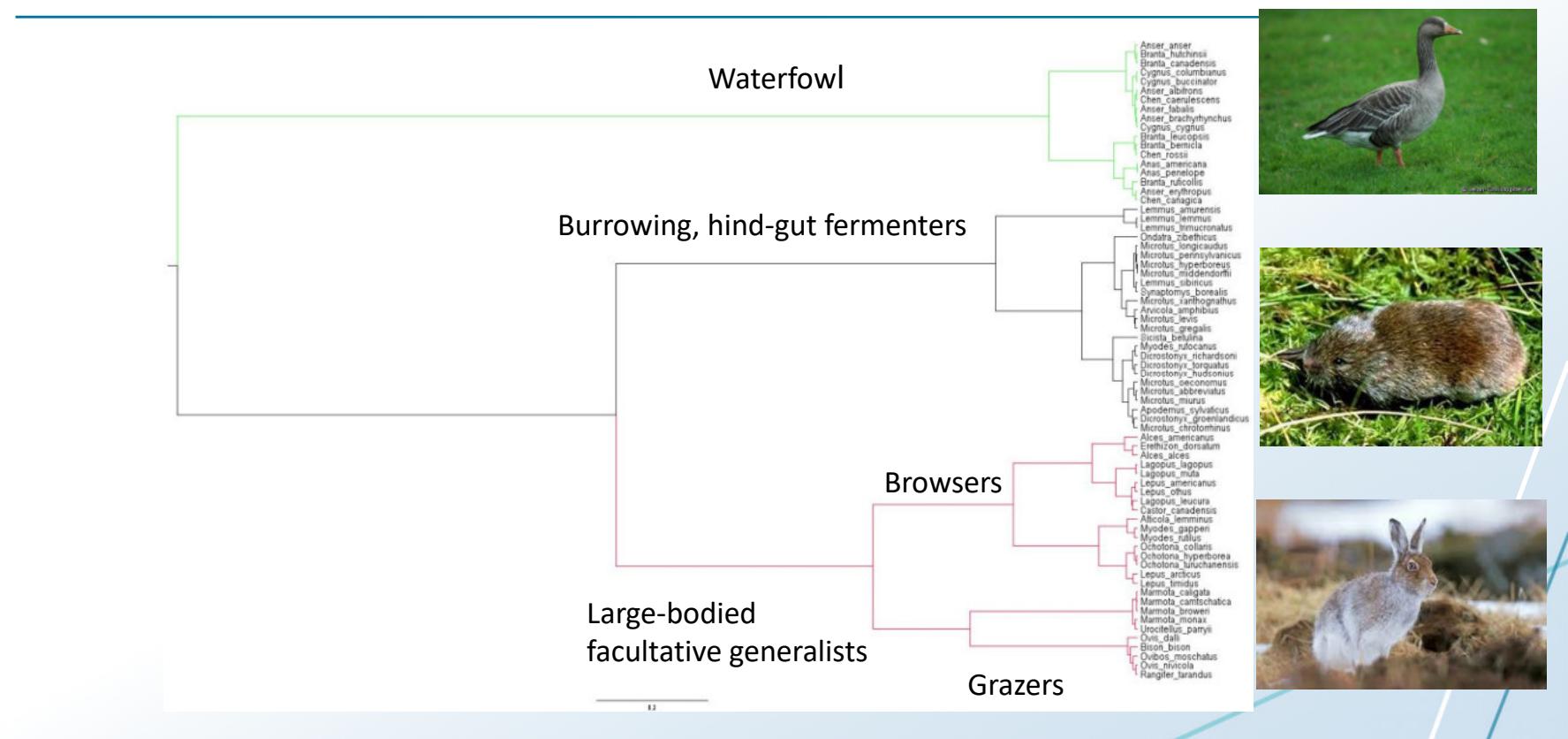
Functional Traits

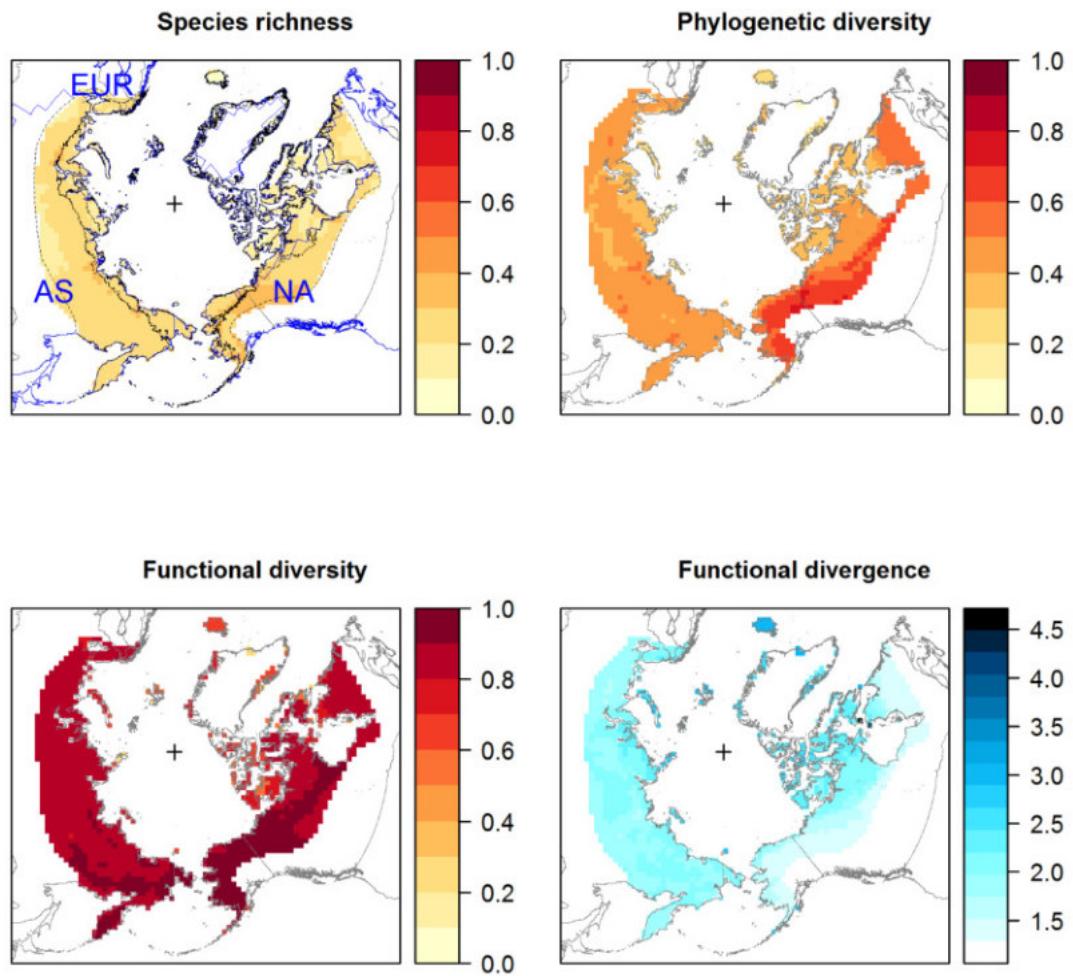


- Forbs, graminoids, lichens, bryophytes, shrubs in diet
- Diet type
 - facultative/obligate generalist/specialist
- Digestive system
 - hindgut fermenter, ruminant, undifferentiated
- Belowground feeding
 - grubbing, burrowing, none
- Body mass (g)
- Mobility
- Group size in summer and winter
- Population dynamics
 - cyclic, partial, non-cyclic
- Litter/clutch size
- Wintering strategy
 - Above snow, below snow, outside Arctic
- Habitat
 - Terrestrial, limnic

Functional classification

Hierarchical clustering based on factorial analysis of mixed data on trait database



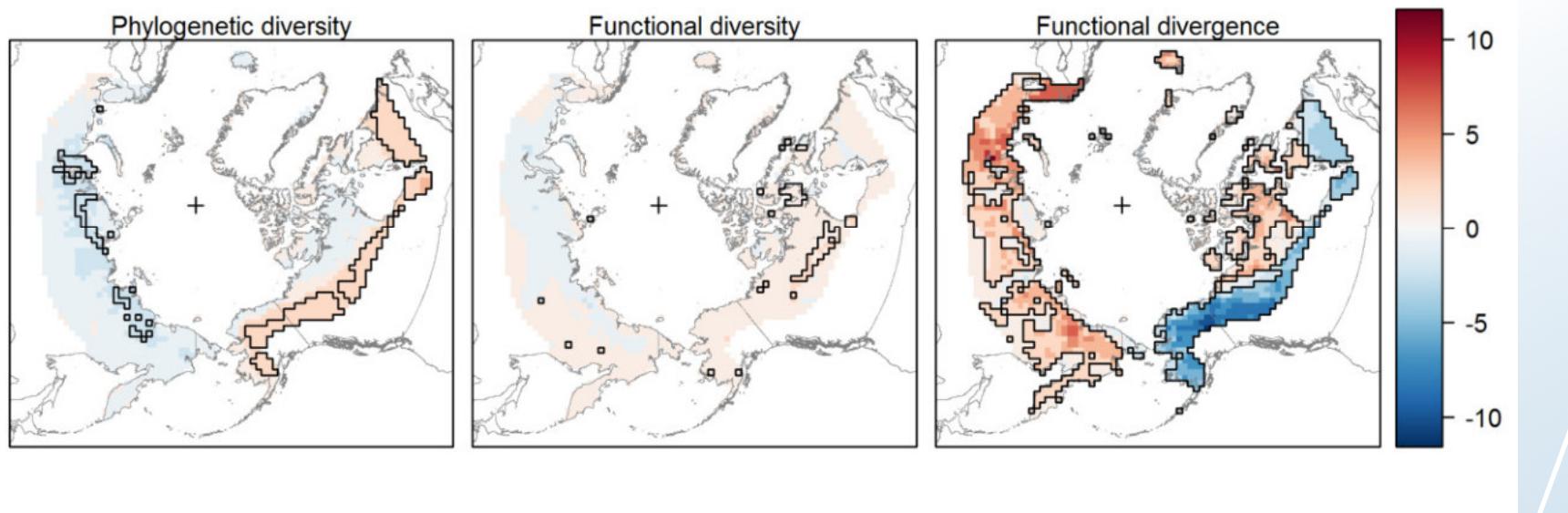


$$\text{Functional divergence} = \frac{\text{Functional diversity}}{\text{Phylogenetic diversity}}$$

- Species richness, phylogenetic diversity and functional diversity all greatest in western North American Arctic
- Functional diversity more evenly spread than phylogenetic diversity
- Species richness less evenly spread
- Functional divergence highest in regions with low species richness

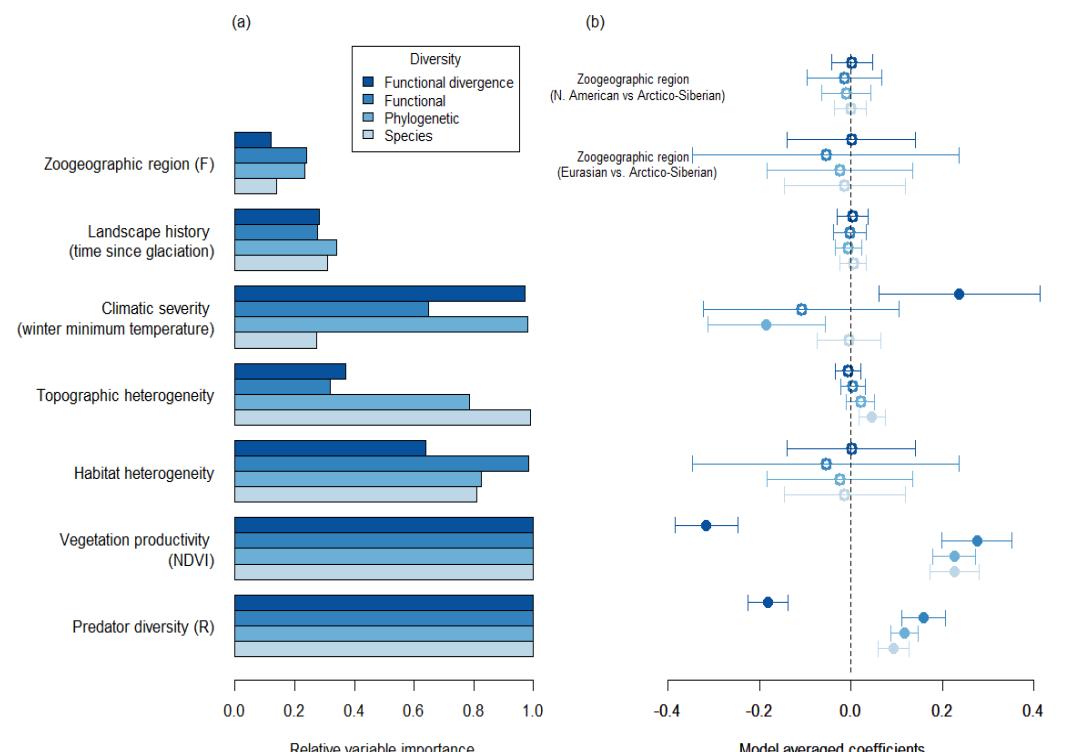
Standardised effect sizes

$$\text{Functional divergence} = \frac{\text{Functional diversity}}{\text{Phylogenetic diversity}}$$



- Phylogenetic diversity is higher than expected in sub-Nearctic but lower than expected in Palaearctic.
- Functional diversity is higher than expected in parts of Nearctic (Nunavut)
- Low and Sub-Nearctic show low functional divergence
- Palaearctic and high Nearctic show high functional divergence

Drivers of diversity patterns



- Biotic interactions important across diversity dimensions
- Increased PD and FD with productivity and predation
- Decreased functional divergence with productivity and predation
- Milder winters increase phylogenetic diversity but decrease functional divergence
- Geographic variables unimportant

Conclusions

- Trophic interactions and climate drive diversity of vertebrate herbivore communities
- Increased temperature, vegetation productivity, or predator diversity will cause decrease of functional divergence of herbivore assemblages with **implications in the changing Arctic**
 - Selection for species with similar impacts on tundra ecosystem

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