# Seabird colonies as biodiversity hotspots for terrestrial invertebrates – a case of beta diversity

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## Introduction

In the Arctic, areas within and close to seabird colonies are often regarded as biodiversity hotspots, being characterized by exceptionally rich vegetation communities linked with the high nutrient subsidies transported by seabirds from the marine environment to the land (Zwolicki et al. 2016).

These areas may support atypically high population densities for several invertebrate species, and specific invertebrate assemblages of which springtails, mites, and tardigrades often represent the most abundant and diverse groups (Zawierucha et al. 2016, Zmudczyńska-Skarbek et al. 2015).

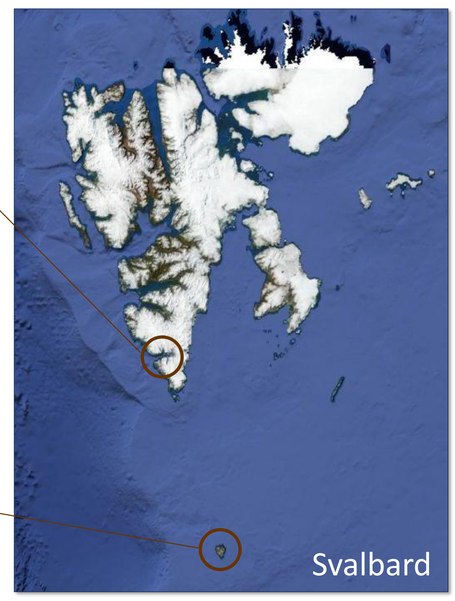
## Objective

Following soil and limnoterrestrial invertebrate species density and diversity within and apart from seabird nesting sites.

## Materials & methods

Hornsund, Ariekammen slope
77°01'N 15°31'E
Little auk *(Alle alle*) colony
80 SEABIRD and 80 CONTROL samples for water bear (Tardigrada) analyses

North-west Bjørnøya, plateau
74°47'N 18°76'E
Great skua (*Stercorarius skua*) nests
75 SEABIRD and 23 CONTROL samples for mite (Mesostigmata, Oribatida) and springtail (Collembola) analyses




## Results

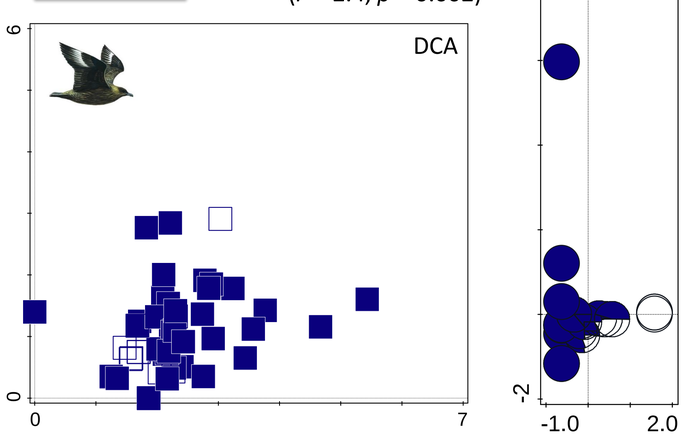
- No statistical differences between SEABIRD and CONTROL sites in the studied invertebrate density, number of taxa, or species diversity at the habitat level (α diversity) – high variability between samples
- Higher total number of taxa within both the sites together than in SEABIRD or CONTROL separately
- Slightly higher differentiation among habitats (β diversity) within SEABIRD as compared to CONTROL sites, and the highest for both the sites taken together
- Distinct species compositions within SEABIRD and CONTROL sites, significantly shaped by the SEABIRD factor – many species occurring only in the SEABIRD or in the CONTROL sites

| | | Total | Seabird | vs. | Control |
|---|---|---|---|---|---|
| Median density | Mites (ind $m^{-2}$) | | 1061.6 | ns | 707.7 |
| | Springtails (ind $m^{-2}$) | | 2830.9 | ns | 1061.6 |
| | Water bears (ind $g^{-1}$) | | 5.4 | ns | 2.3 |
| Total /median number of taxa | Mites | 20 /2 | 17 /2 | /ns | 11 /1 |
| | Springtails | 13 /2 | 12 /2 | /ns | 8 /2 |
| | Water bears | 32 /2 | 22 /2 | /ns | 24 /2 |
| α diversity (median H') | Mites | 0.32 | 0.36 | ns | 0.30 |
| | Springtails | 0.24 | 0.24 | ns | 0.28 |
| | Water bears | 0.16 | 0.22 | ns | 0.09 |
| β diversity (DCA axes' standard deviation) | Mites | 2.22 | 2.09 | | 1.48 |
| | Springtails | 1.85 | 1.71 | | 1.21 |
| | Water bears | 2.94 | 2.59 | | 2.50 |

**vs.** – results of Mann-Whitney tests, $p > 0.05$

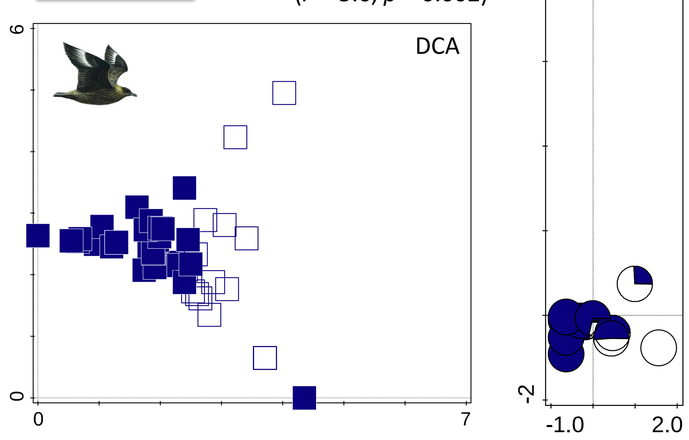
### MITES


CCA: SEABIRD explained 16.9% of the total variability ($F = 2.4$, $p = 0.002$)



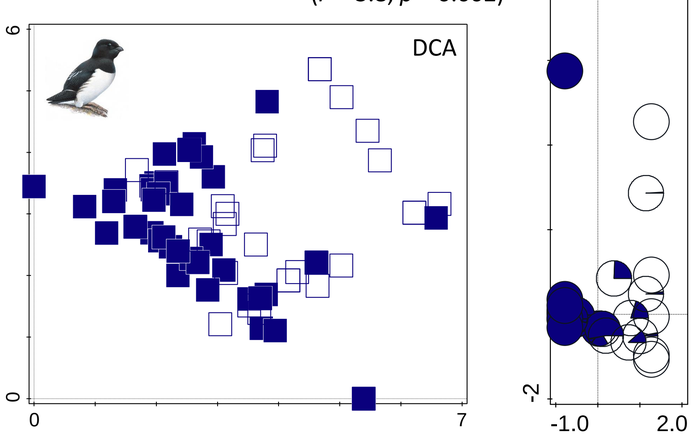

### SPRINGTAILS


CCA: SEABIRD explained 42.6% of the total variability ($F = 5.6$, $p = 0.002$)




### WATER BEARS


CCA: SEABIRD explained 33.1% of the total variability ($F = 3.8$, $p = 0.002$)




DCA (detrended correspondence analysis ) ordinations of samples classified with respect to invertebrate species composition of the SEABIRD (full squares) and CONTROL (empty squares) sites.
CCA (canonical correspondence analysis) ordinations of invertebrate species with respect to the SEABIRD factor (axis 1, horizontal). Pie slices based on the species abundances within SEABIRD (full) and CONTROL (empty) sites.

## Conclusions

Beta diversity of soil and limnoterrestrial invertebrates increases in the vicinity of seabird nesting sites due to higher total number of species, and different communities occurring close to seabird nests/colonies as compared with areas beyond their influence.

Zawierucha K, Zmudczyńska-Skarbek K, Kaczmarek Ł, Wojczulanis-Jakubas K (2016) The influence of a seabird colony on abundance and species composition of water bears (Tardigrada) in Hornsund (Spitsbergen, Arctic). Polar Biol 39:713–723

Zmudczyńska-Skarbek K, Convey P, Zwolicki A, Barcikowski M, Stempniewicz L (2015) Is ornithogenic fertilisation important for collembolan communities in Arctic terrestrial ecosystems? Polar Res 34, 25629

Zwolicki A, Zmudczyńska-Skarbek K, Richard P, Stempniewicz L (2016) Importance of marine-derived nutrients supplied by planktivorous seabirds to High Arctic tundra plant communities. PLoS ONE, 11: e0154950