ALFRED-WEGENER-INSTITUT
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The impact of top predators on the Sylt-Rømø Bight food web : assessment of harbour seal diet using stable isotope analysis

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Introduction

The **Sylt-Rømø Bight** is situated in the northern Wadden Sea**,** between the islands of Sylt and Rømø, on the western German coast (*Fig. 1*). This bight is rather well studied and its **food web** has been modeled, taking into account most of the trophic compartments. But **marine mammals** have not yet been included. This study aims to determine if **harbor seals** (*Phoca vitulina),* the main mammal species in the area (about 430 individuals in August 2013), play a significant role in the ecosystem. To determine the **seals diet** and its **seasonal variation**, **stable isotope analyses** were performed on harbor seals **muscles** and **vibrissae**. The seal compartment was then included in the existing **food web model** to study the impact on the system.

Material and Method : seal´s diet

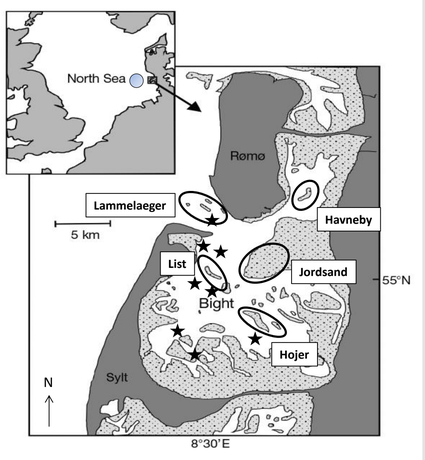
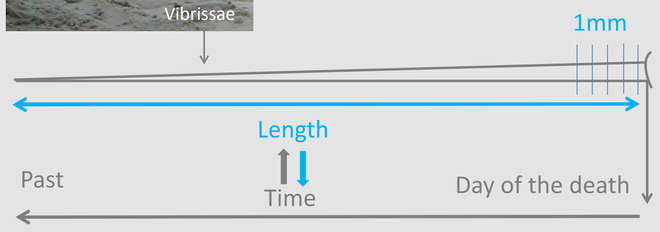


Fig. 1: Location and map of the Sylt-Rømø Bight. The intertidal area is indicated in stippled grey. Sand banks used by seals. Sampling stations of the Sylt-Rømø Bight prey items. Sampling area of prey items from the North Sea.

Stable isotope analysis on

- Seal muscle
- Seal vibrissae
- Entire prey items
  - Benthivorous species (**Benth**)
  - Benth./Piscivorous sp. (**BenPisc**)
  - Planct./Piscivorous sp. (**PlanPisc**)
  - Loligo spec. (**Lol sp.**)

Vibrissae growth rate :
May → Sept = 0.78mm/day
Oct → April = 0.075mm/day



Results : seal´s diet

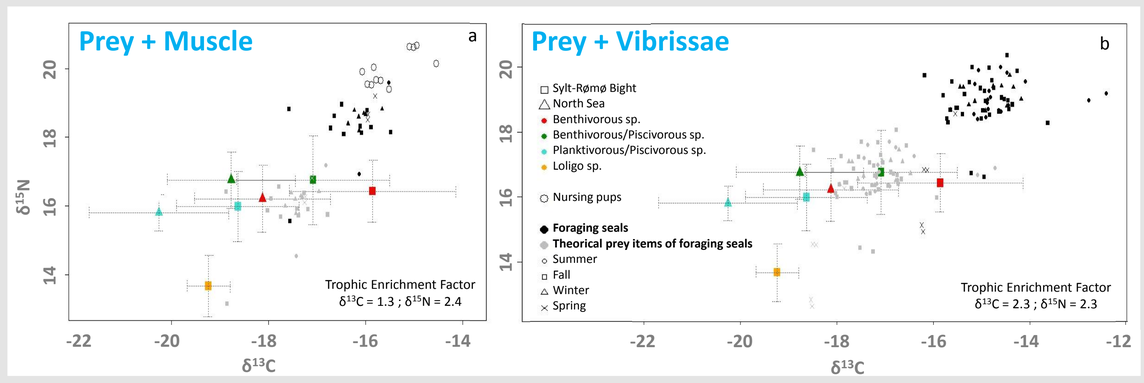


Fig. 2: Stable isotope signatures of the seal prey items sorted in trophic groups ; stable isotope signatures of the seal's a) muscle and b) vibrissae ; stable isotope signatures of the theorical prey items which are calculated by substracting the Trophic Enrichment Factor from the stable isotope signatures of the foraging seals.

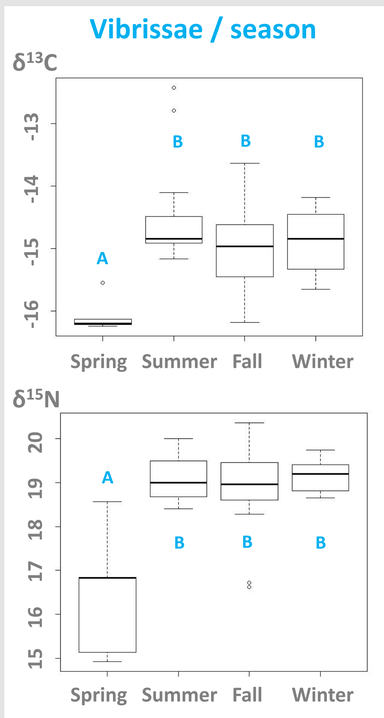


Fig. 3: Stable isotope signatures ($\delta^{13}C$ and $\delta^{15}N$) of the vibrissae per season.

The theorical prey item's signatures are lying in both cases (seal's muscle and vibrissae), between the trophic groups of prey items from the Sylt-Rømø Bight and the ones from the North Sea (*Fig. 2*).

→ Harbor seals feed on both food resources from the Sylt-Rømø Bight and from the North Sea

→ Vibrissae can be used as a good tissue for diet studies

Harbor seal vibrissae are significantly depleted in ^{13}C and ^{15}N in spring compared to summer, fall and winter (*Fig. 3*).

→ There is a change in the seals diet in spring, both in the trophic group of prey items, and in the foraging location

The SIAR mixing model estimates the most probable contribution of each prey item to the diet according to the stable isotope signatures of the prey species and the predator (*Fig. 4*).

→ In spring, seals feed more on Loligo species from the Sylt-Rømø Bight and on PlanPisc trophic group from the Sylt-Rømø Bight and the North Sea compared to the other seasons

→ In summer, fall and winter, they feed mainly on BenPisc and Benth trophic groups from the Sylt-Rømø Bight and from the North Sea

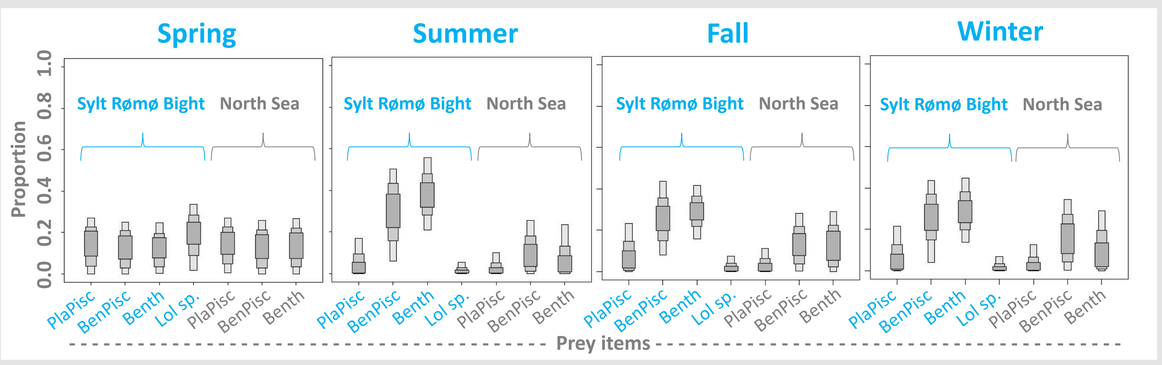


Fig. 4: SIAR mixing model results per season, computing the stable isotope signatures of the trophic group of prey items (same for all the seasons) and the stable isotope signatures of the seal's vibrissae (different per season).

Preliminary results : ENA model

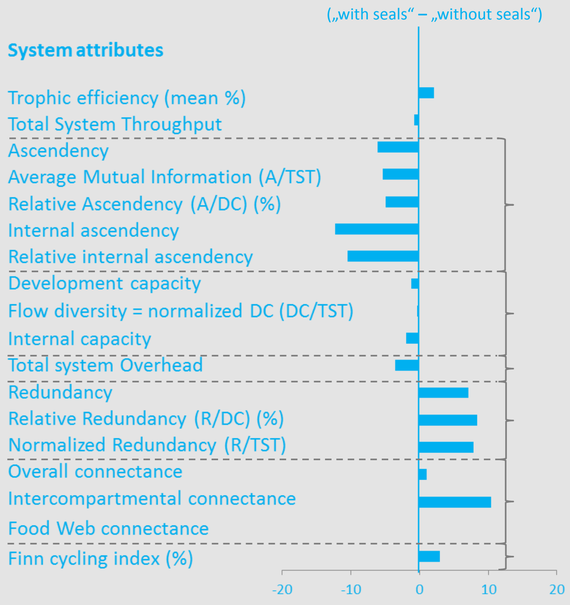


Fig. 5 : Variation of the different indices calculated by the ENA model between the cases „food web without seals" and „food web with seals"

DECREASE of :

- the **Ascendency indices** reflecting the diversity of flow between the compartments in terms of size and organisation, and the degree of specialisation of the system.
- the **Development Capacity (DC) indices** expressing the potential for the system to develop.
- the **Total System Overhead** which is the fraction of the DC that doesn´t appear to be an organised structure.

INCREASE of :

- the **Redundancy indices** which indicate the presence of multiple or parallel pathways among the compartments and the stability of the system.
- the **Connectance indices** describing the number of connections between the compartments.
- the **Finn Cycling Index** which can be a sign of the amount of recycled material.

„With Seals" (*Fig. 5*)

→ The Organisation, the Specialisation and the Complexity of the system decrease.

→ The number of interactions, the stability and the resilience of the system increase.

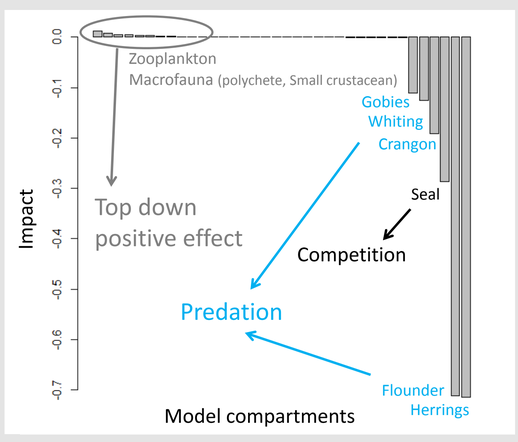
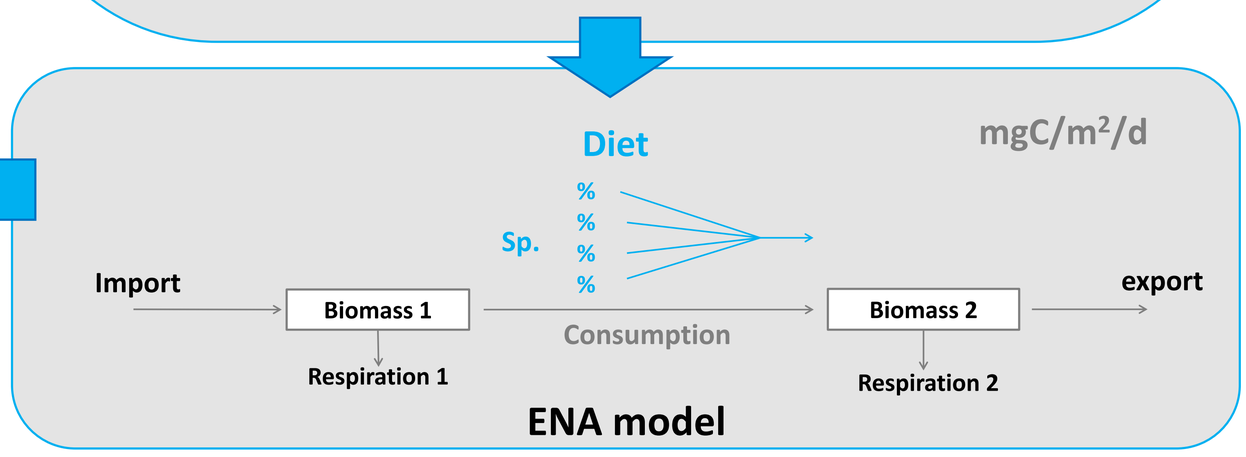


Fig. 6 : Output of the routine "IMPACTS" that quantifies the relative direct or indirect impact (or effect) that the seal compartment have on the others in the flow network.

The presence of the seals causes a top down trophic cascade effect (*Fig. 6*) :

Seals have:

- a **negative** impact on their **prey species** (named in blue in *Fig. 6*)
- a **positive** impact on the **prey items of their prey species** (named in grey in *Fig. 6*)



Conclusion

The seal colony living in the Sylt- Rømø Bight **feeds in the North Sea as well as in the bight** all the year. The depletion in heavy stable isotopes in spring is probably due to **a switch in the seal´s diet from the trophic groups** of prey items "Benthivorous-Piscivorous species" and "Benthivorous species" **to the trophic groups** "Planktivorous-Piscivorous species" and Loligo species. Despite the **cascade effect** caused by seals noticable at low level compartments in the food web, the ecosystem of the bight appears to be **more stable** and **more robust against external perturbations** and changes in biodiversity when seals are present.

Baird D, Asmus H, Asmus R (2012) Effect of invasive species on the structure and function of the Sylt-Rømø Bight ecosystem, northern Wadden Sea, over three time periods. Mar Ecol Prog Ser 462: 143–162

Zhao L, Schell DM (2004) Stable isotope ratios in harbor seal *Phoca vitulina* vibrissae: effects of growth patterns on ecological records. Mar Ecol Prog Ser 281: 267–273

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