Impact of top predators on the Wadden Sea food web
A modelling approach

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Impact of changes on Wadden Sea food webs

Replacement of one compartment
Addition of one compartment
Loss of one compartment
Marine mammals in the Wadden Sea / North Sea

Native species
- Harbor seal
- Grey seal
- Harbor porpoise

Early 20th century
Severe depletion of most of the top predators

Habitat loss
Overexploitation
Pollution

Prohibition of hunting
Regulation of fisheries
Protection area

Marine mammals in the Wadden Sea / North Sea

- Habitat impacted by human activities
- Stable population of native species due to conservation measures

Marine mammals in food webs

- Strong pressure of predation of top predators resulting in cascading effect along the food web
- Assessing their diet is necessary to understand the functioning of an ecosystem

Ecological Network Analysis

Baird et al. 2012

Heithaus et al. 2008, Lotze et al. 2005

Top predator

Top

Down

Cascading effect
Big colony in the bight (≈ 450 seals)

Potential prey species are present in the bight every season

Marine mammals in the Wadden Sea / North Sea

Habitat impacted by human activities

Population of native species stable due to conservation measure

Fish production = 99.6 kg of C per day

Consumption of harbour seals per day ≈ 4 kg

Consumption of harbour seals ≈ 99.1 kg of C per day

Hall et al. 1998; Das et al. 2003; Andersen et al. 2007; Brown and Pierce 1997
Do harbour seals use the Sylt-Rømø bight food resources?

On which prey items and in which proportions do they feed?

Does their diet vary seasonally?
Impact of Top predators: Material and methods

2 trophic markers:
- Stable Isotopes (C and N)
- Fatty Acids

Prey items
- the Sylt-Rømø bight
- the North Sea

Seal
- vibrissae

Pelagic sp.
Benthopelagic sp.
Demersal sp.
*Osmerus eperlanus*
*Loligo sp.*

Theoretical prey

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

Zhao and Schell, 2004

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\( \delta^{15}N \)

\( \delta^{13}C \)
Impact of Top predators: Results

Sylt Rømø bight

- **DemSp** – Sylt-Rømø bight
- **BenthopelSp** – Sylt-Rømø bight
- **PelSp** – Sylt-Rømø bight
- **LoligoSp** – Sylt-Rømø bight
- **Oepe** – Sylt-Rømø bight

Migration in rivers

**Pelagic Sp.** ← **Benthopelagic Sp.** ← **Demersal Sp.**

**Pelagic** ← **Benthic**

France 1995, Heckey and Hesslein 1995
Impact of Top predators: Results

North Sea

- Dem Sp - North Sea
- BenthopelSp - North Sea
- PelSp - North Sea

δ¹³C


Pelagic  ← France 1995, Heckey and Hesslein 1995  → Benthic
Impact of Top predators: Results

North Sea + Sylt-Rømø bight

- DemSp – Sylt Rømø bight
- BenthopelSp – Sylt Rømø bight
- PelSp – Sylt Rømø bight
- LoligoSp – Sylt Rømø bight
- Oepe – Sylt Rømø bight

δ\textsubscript{13}C

δ\textsubscript{15}N

North Sea + Sylt-Rømø bight

Offshore (open sea)  Inshore (coast)

Impact of Top predators: Results

Vibrissae

- **DemSp** – Sylt-Rømø bight
- **BenthopelSp** – Sylt-Rømø bight
- **PelSp** – Sylt-Rømø bight
- **LoligoSp** – Sylt-Rømø bight
- **Oepe** – Sylt-Rømø bight

Stable isotope composition of seal’s vibrissae

Stable isotope composition of the theoretical prey items of seal’s vibrissae

Foraging seals use the food resources of the North Sea and Sylt-Rømø bight in equal parts.
Impact of Top predators: Results

**Vibrissae**

- **DemSp** – Sylt-Rømø bight
- **BenthopelSp** – Sylt-Rømø bight
- **PelSp** – Sylt-Rømø bight
- **LoligoSp** – Sylt-Rømø bight
- **Oepe** – Sylt-Rømø bight

**Stable isotope composition of seal’s vibrissae**

**Stable isotope composition of the theoretical prey items of seal’s vibrissae**

Foraging seals
- Theoretical prey items
  - summer
  - fall
  - winter
  - spring

North Sea

Sylt-Rømø bight

Spring

Harbour seals use the food resources of the North Sea and Sylt-Rømø bight in equal parts. A change in the diet occurs in spring compared to summer, autumn, and winter.
SIAR mixing models

**Spring and summer**

The Sylt-Rømø bight and the North Sea have the same contribution to the diet. Switch from a *pelagic* based diet in *spring* to a *benthic* based diet in *summer*. 
The impact of top predators: Results

**Spring and summer**

The Sylt-Rømø bight and the North Sea have the same contribution to the diet. Switch from a *pelagic* based diet in *spring* to a *benthic* based diet in *summer*.

**Autumn and winter**

The Sylt-Rømø bight and the North Sea have different contribution to the diet. Harbour seals probably use more the *North Sea* than the Sylt-Rømø bight.
Discussion

**ENA model: preliminary results**

Impact of "seal compartment" on the other compartments of the food web

- Zooplankton
- Macrofauna (polychete, Small crustacean)
- Gobies
- Whiting
- Crangon
- Flounder
- Herrings

**Top down positive effect**

- Predation
- Competition
Conclusions

In spring and summer, the Sylt-Rømø bight supports approximately half of the harbour seal’s diet.

Harbour seals use the North Sea more in autumn and winter, when the food resources in the Sylt-Rømø bight are not sufficient.

The seals have a pelagic based diet in spring, and a benthic based diet in summer, fall and winter.

Top down cascading effects are visible along the food chain although the impact of seals on their prey items is not very high.
Thank you for your attention

Questions and comments are welcome!