# Temporal dynamics of the major predator interaction in the Barents Sea


Joël M. Durant *Email: joel.durant@bio.uo.no*

Mette Skern-Mauritzen, Yuri Krasnov, Natalia Nikolaeva, Ulf Lindstrøm








**Are these species interacting ? Does climate influence the relationships ? Can these species be in competition ? What does it mean for the Barents Sea management ?**

How much does the diet of these predators change between years?
What is provoking these changes when they exist?
To what extent do their diets overlap?
Is the diet overlap constant through time and if not what is driving these changes?

## Methods

All diet data were based upon analysis of stomach contents reported in various reports such as ICES (ICES Arctic Fisheries Working Group 2010)[1]. Diet data were transformed in annual average percentages. Schoener's index of niche overlap[2] was used to calculate the diet overlap among predators:

$$O_{jk} = 1 - 0.5 * \Sigma | P_{ic} - P_{ik} |$$

where $O_{jk}$ is the overlap between the species j and the species k,
$p_{ij}$ is the proportion of species j feeding on prey species/group i and $p_{ik}$ is the proportion of species k feeding on prey species/group i.
$O_{jk}$ values range from 0 to 1. Overlap in diet between species j and k is complete when $O_{jk} = 1$ and is absent when $O_{jk} = 0$. Here we considered that when mean $O_{jk} >$ 2·SD the diet overlap between species j and species k was significant.

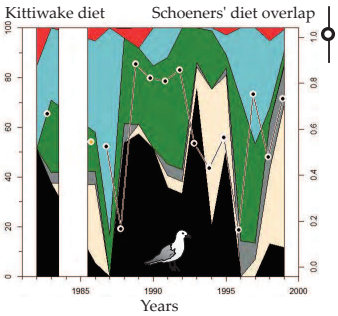
*Explanatory variables.*
Mean Barents Sea temperature (*ST*) in °C for January to December at 0-200 m depth in Atlantic water parts of the Kola section (70.5 - 72.5°N, 33.5°E) over 1921-2009[3]. The principal component based winter (December$_{t-1}$ – March$_t$) North Atlantic Oscillation (NAO) index.[4] The biomass of capelin *Mallotus villosus (Cap)* in $10^3$ t. The biomass of Norwegian Spring Spawning herring *Clupea harengus* (*Herr*) immatures (1-2 years of age) in $10^3$ t.

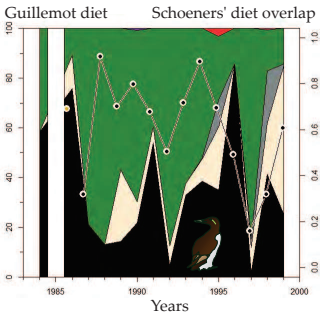
| Statistical interaction | Kittiwake | Guillemot | Whale | Cod | Seal |
|---|---|---|---|---|---|
| Guillemot | O = 0.51 | | | | |
| Whale | 0.46 | | | | |
| Cod | 0.45 | 0.32 | 0.52 | | |
| Seal | | | | | |
| Boat | | | | 0.43 | |

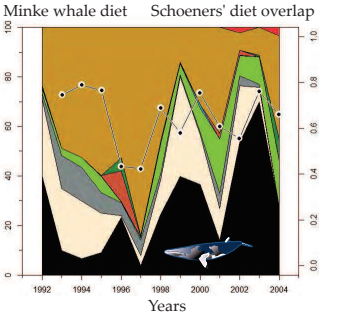
GAM

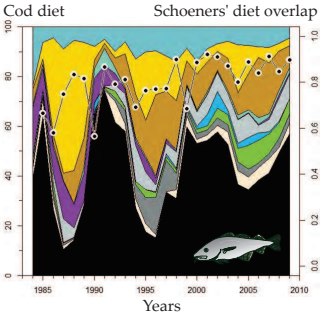
Generalized Additive Model using the '*mgcv*' library in R 2.14.1

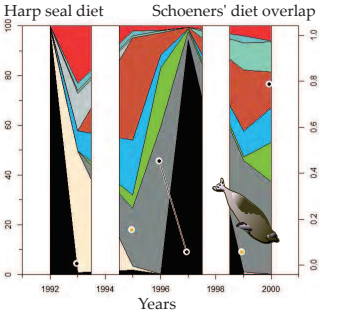
## Results

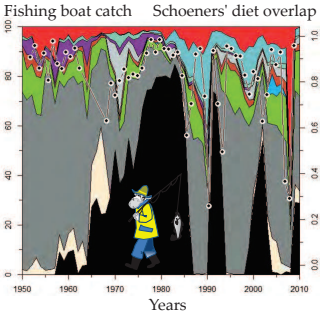


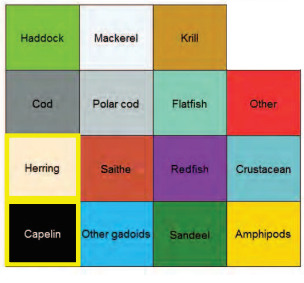

| Diet overlap *O* | Covariate $X_1$ | | Covariate $X_2$ | | n | $R^2$ |
|---|---|---|---|---|---|---|
| Whale *vs* cod | dHerr $_{(t)}$ | ↗ | ST $_{(t)}$ | ↗ | 13 | 0.57 |
| Kittiwake *vs* whale | dST $_{(t)}$ | ↗ | Year $_{(t)}$ | ↗ | 8 | 0.89 |
| Kittiwake *vs* cod | dCap $_{(t-2)}$ | ↗ | dST $_{(t)}$ | ↘ | 14 | 0.46 |
| Kittiwake *vs* guillemot | NAO $_{(t)}$ | ↗ | Year $_{(t)}$ | ↗ | 14 | 0.86 |
| Guillemot *vs* cod | Cap $_{(t)}$ | ↗ | Herr $_{(t)}$ | ↗ | 15 | 0.74 |
| Boat *vs* cod | ln(Herr) $_{(t)}$ | ↗ | | | 26 | 0.28 |

Models are written $O_t = \alpha + s_1(X_{1,t}) + s_2(X_{2,t}) + \varepsilon_t$, with $s_i$, a nonparametric smoothing function specifying the effect of the covariates $X_i$ on the Schoeners' diet overlap index *O* for year t; $\alpha$, intercept; and $\varepsilon$, stochastic noise term.

The general shape of the relationship is indicated with an arrow on the side of each covariate. The number of observations *n* and $R^2$ are given. $dX_{(t)}$ corresponds to the difference $X_{(t)} - X_{(t-1)}$

**The increase in overlap can be modeled using changes in herring or capelin abundances or sea temperature. The diet overlap models developed in this study may help to identify inter-specific interactions and their dynamics that potentially affect the stocks targeted by fisheries.**

Species categories in the diets




## References


1. Report of the ICES Arctic Fisheries Working Group 2012, Table 9.5 p 498, and Table 9.6 p 499. http://prep.ices.dk/marine-data/dataset-collections/Documents/ICES1950-2010.zip
2. Schoener TW (1968) Anolis lizards of Bimini - Resource partitioning in a complex fauna. Ecology 49:704-726
3. Tereschenko (1996, http://www.pinro.ru/),
4.Hurrell (1995, http://www.cgd.ucar.edu/cas/jhurrell/indices.html),


CEES Centre for Ecological and Evolutionary Synthesis

UNIVERSITAS OSLOENSIS MDCCCXI

ADMAR