Interactions between Plankton & Fish

Policy Briefing from UK Pelagic Habitats Expert Group (PHEG)

Fish are Fatter
Where Food is Better

Fish, fisheries and plankton data were collected on **small**, **medium** and **large** spatial scales. Data from PELTIC surveys taken in October each year were used to compare fish with plankton sampled at various distances from fish catches. On the **small scale**, abundance of most fish species correlated with abundance of copepods. Over **small** and **medium scales**, fatter fish were more often found where there were more large copepods.

Additional **medium scale** analysis compared fish condition with zooplankton taken by CPR, averaged over a few months, and OSPAR assessment areas. Fish were, generally, fatter where copepods were larger and more abundant.

Large scale analysis compared annual indicators of plankton and fisheries for certain OSPAR areas. Correlations were weak.One explanation is that interactions are complex, buffering the system against change. Another is that the fisheries time-series were shorter than the plankton time-series.

CPR data have shown significant trends in the balance of plankton lifeforms since 1958, linked to climate change. The outcomes from the small and medium scale analyses can also help interpret the long term trends at the larger scale. Reduction in plankton quality impacts on fish health and implies a deteriorating habitat for fish. Continued monitoring of fish and plankton is needed to track and better understand these changes and to help predict their likely effect on fisheries.

Data Sources

PELTIC surveys each October, in western Channel and eastern Celtic Sea, used acoustic and trawl sampling for fish and nets for zooplankton.

PELTIC surveys each October (2013-2023)

Fish abundance and size data from UK and other nations' scientific surveys, retrieved from ICES Database of Trawl Surveys.

Fish abundance and size data (1997-2020)

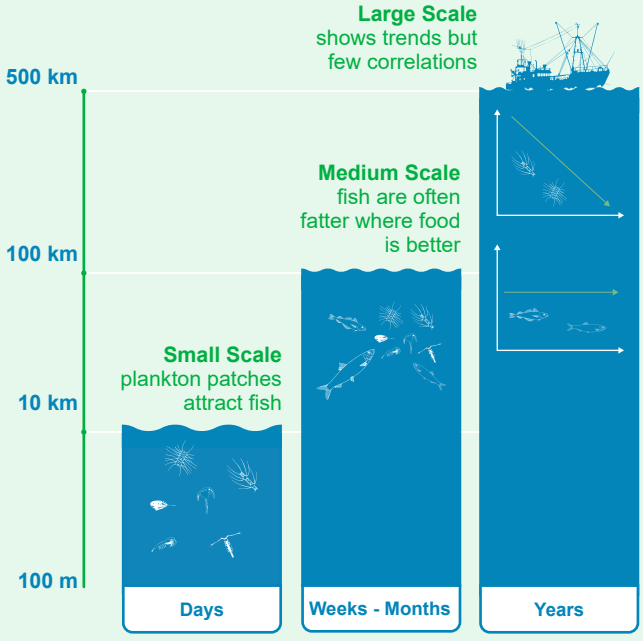
Fish landings data obtained from EC Scientific, Technical & Economic Committee for Fisheries.

Fish landings data (2003-2016)

Plankton data from Continuous Plankton Recorder (CPR) Survey.

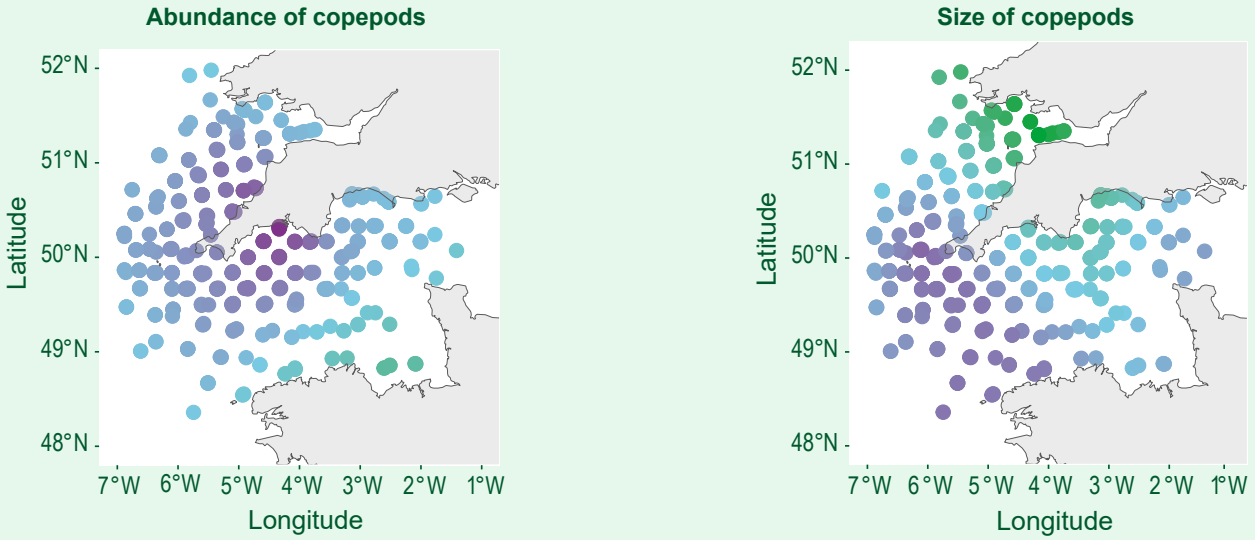
Plankton data (1958-2021)

Links Between
Plankton & Fish are Scale Dependent



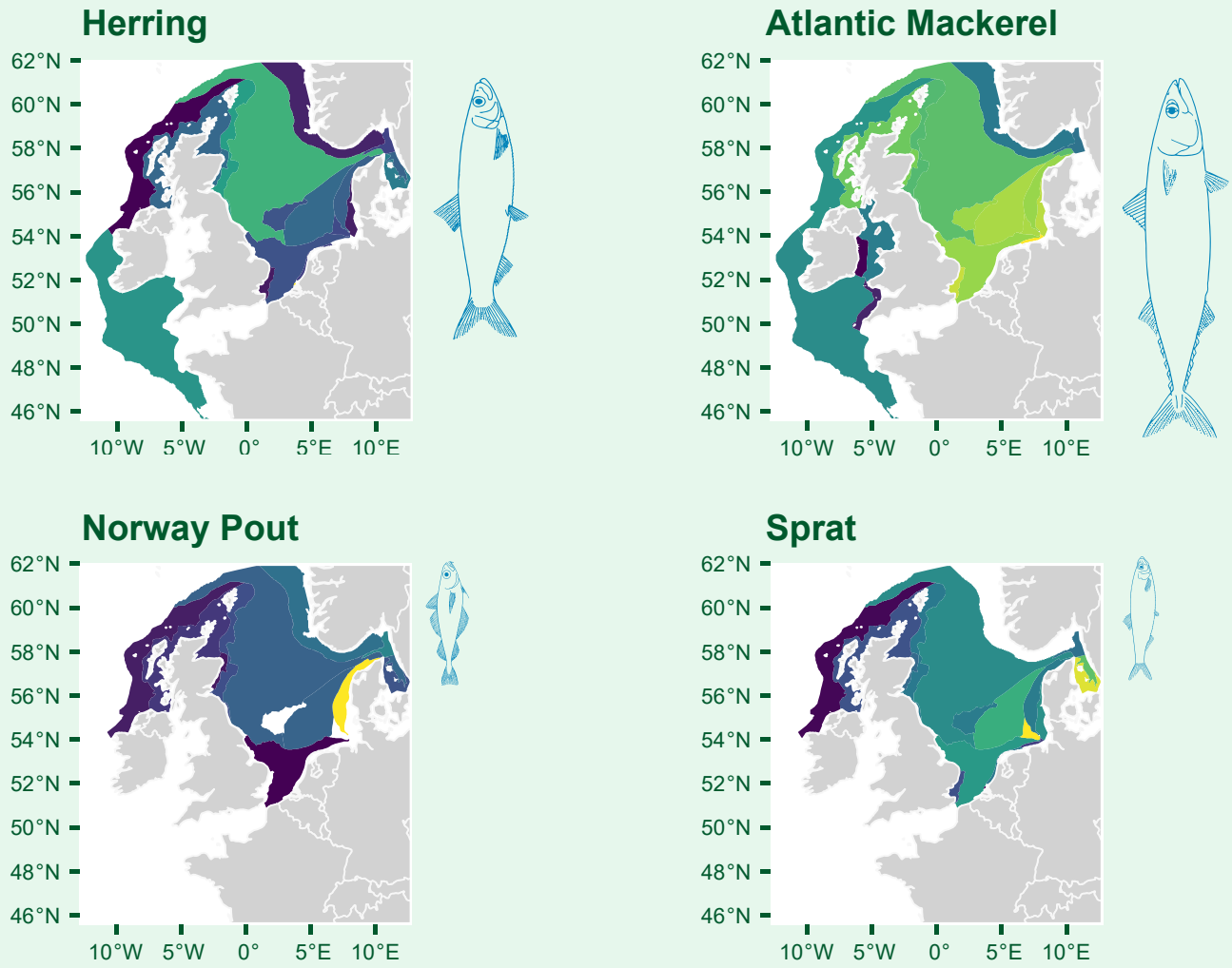
Small Spatial Scale

Peltic Zooplankton



Spatial variability in copepods during 4 years of PELTIC surveys. The spatial effects show where abundance (left) and size (right) were higher (**purple**) or lower (**green**) than the overall means. While copepod size was a better predictor of fish body condition than copepod abundance, relationships were complex and scale-dependent.

Medium Spatial Scale



Fish were thinner than average in areas coloured dark blue. They were fatter in areas coloured yellow and green, which was, in general, where zooplankton, and especially large copepods, were more abundant. (Data lacking for white areas).

Assessing the Pelagic Habitats

on the Large Scale

Plankton lifeforms group together species with similar ecologies. The Plankton Index (PI) is calculated by plotting monthly abundances of lifeform pairs against each other and comparing with a reference condition, a value of 1 showing no change and 0 showing complete change.

The table summarises changes in annual PI values from 1958 -2021 (except Irish Sea 1971 – 2021) and in the annual mean abundances of plankton lifeforms. Horizontal bars indicate no significant change.

There were no correlations between PI series and abundances of planktivore fish in scientific trawl surveys (1997-2001). There was one (🐟) statistically significant correlation of PI series with fish landings (2003-2016).

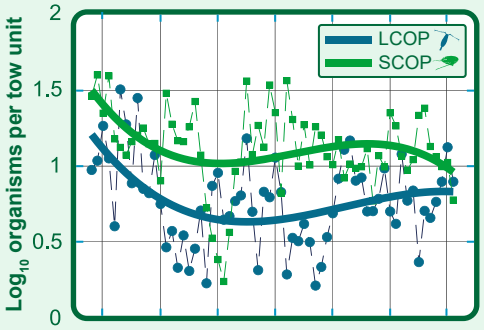
Lifeform Pair	Irish Sea	Scottish Sea	N. North Sea	S. North Sea
Diatom Lifeform	—	—	—	↑
Dinoflagellate Lifeform	—	↓	↓	↓
PI Change	Small	—	Large	Medium
L. Copepod Lifeform	—	↓	—	—
S. Copepod Lifeform	—	—	—	—
PI Correlation With Landings	—	🐟	—	—
PI Change	—	—	Medium	Medium
Appendicularian Lifeform	↑	↑	↑	↑
Euphausiid Lifeform	↓	↓	↓	—
PI change	Small	—	Medium	Medium

Combining Plankton & Fisheries Information

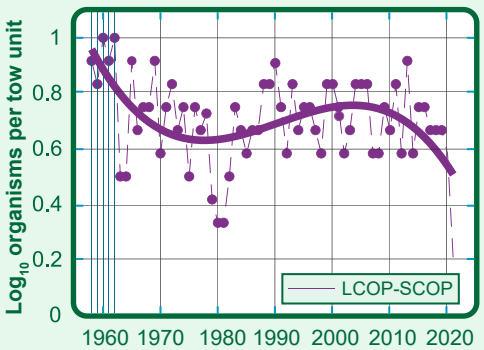
at a Large Spatial Scale

OSPAR QSR Assessment Areas
Sampled by CPR

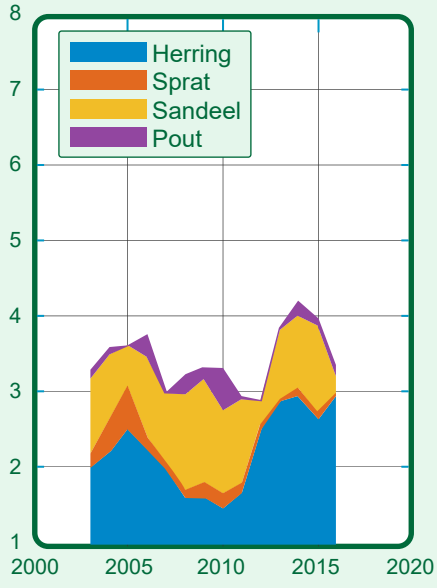
Annual Means for Lifeforms



Time series of Plankton Index (PI)



Fish Landings
x10⁵ Tonnes Landed from NNS



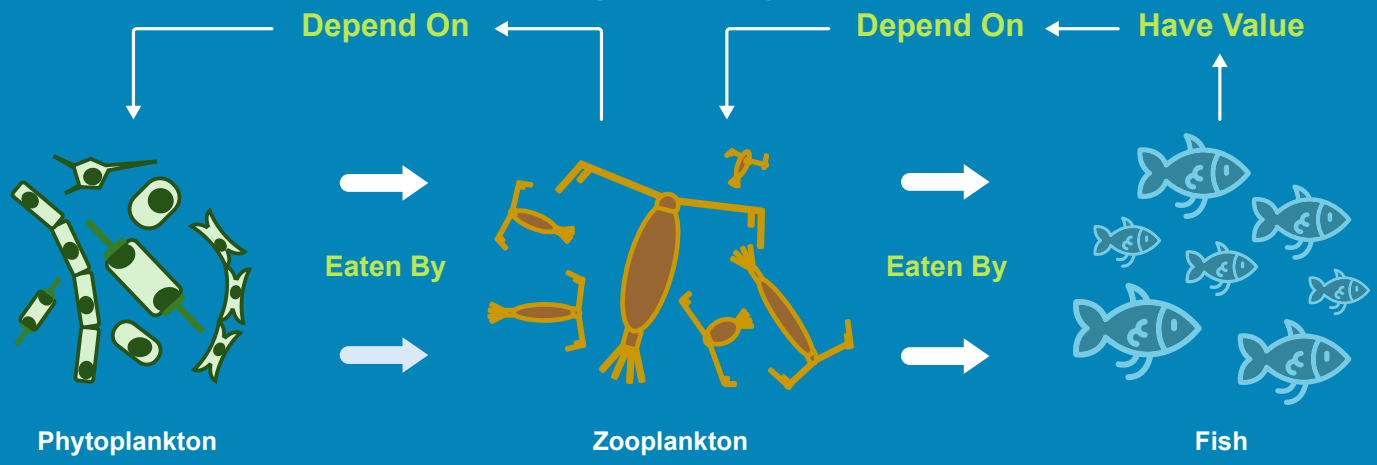
Putting it Together

Plankton & Fisheries

Fisheries Science
What are good conditions for fish?

Pelagic Ecology
What pressures, including fisheries,act on the pelagic habitat?

Pelagic Ecosystem



Discussion

Planktivorous fish, by definition, eat plankton, and so it is rational to expect correlations between plankton and fish. However, correlations found during the project were scale-dependent.

On small and medium scales, we found that fish were fatter where food was better. 'Fatter fish' were those that are heavier at a particular length than expected from a length-weight regression for their species. 'Better food' was greater abundance of oil-containing large copepods and euphausiids, in contrast to small copepods and gelatinous appendicularians.

On the large scale we found long-term trends in the balance of lifeforms in the pelagic habitats, implying deteriorating conditions in pelagic habitats for planktivorous fish. Nevertheless, observed correlations between plankton indicators and fish/ fisheries statistics were weak. This might have been because the fish time-series were too short or because of the complex interactions between fish and plankton.

Fish stocks operate on longer time-scales, and across broader spatial domains, than do populations of plankton. Herring, for example, visit most parts of the North Sea during their lives, whereas plankton dynamics are more tightly linked to areas defined by water conditions.

Furthermore, marine food webs contain many feedback loops, which complicate the discovery of causal relationships. In addition, some of these loops contribute to ecosystem stability, and thus keep pelagic habitats within the safe ecological space that allows them to deliver ecosystem services.

The UK needs to continue monitoring fish and plankton so as to better understand these crucial links and develop an early warning system for changes in pelagic habitat and the health of fish stocks.

The research summarised in this briefing note was carried out in the HBDSEG/Defra R&D project 'PIT-PAF' and the NC34 Pelagic Programme ('PELCAP').

NCEA Natural Capital and Ecosystem Assessment

UK Pelagic Habitats Expert Group