Using trophic spectra for comparative analyses of fishing areas.

Application to European fisheries.

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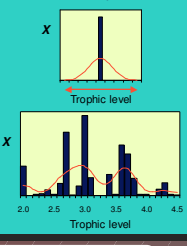
Recipe for a trophic spectrum

A trophic spectrum is a graphical representation of an ecological variable *X* (abundance, biomass, catch) distributed along "non-discrete" trophic levels.

1. Assign each species a mean trophic level (*TL*). Aggregate *X*-values by *TL* increments of 0.1
2. Smooth the *X*-distribution with a weighted moving average technique: *X*-values are spread along an empirical range of trophic levels
3. Plot the smoothed distribution *vs.* trophic levels



Using catch data and mean trophic levels to describe and compare fishing areas

- Catch data come from the International Council for the Exploration of the Sea (ICES) database using the FAO software FishStatPlus
- Mean trophic levels of each species are extracted from the FishBase database and are assumed stable from year to year within the study area

Fishery statistics and fishes database easily available and currently used: the data reliability and limits are well known

Selection of the main species in each area ⇒ Catch average per km² (surface>1000m)

Catch Trophic Spectra

Spatial Analysis: period 1992-2001

Temporal Analysis: from 1973 to 2001

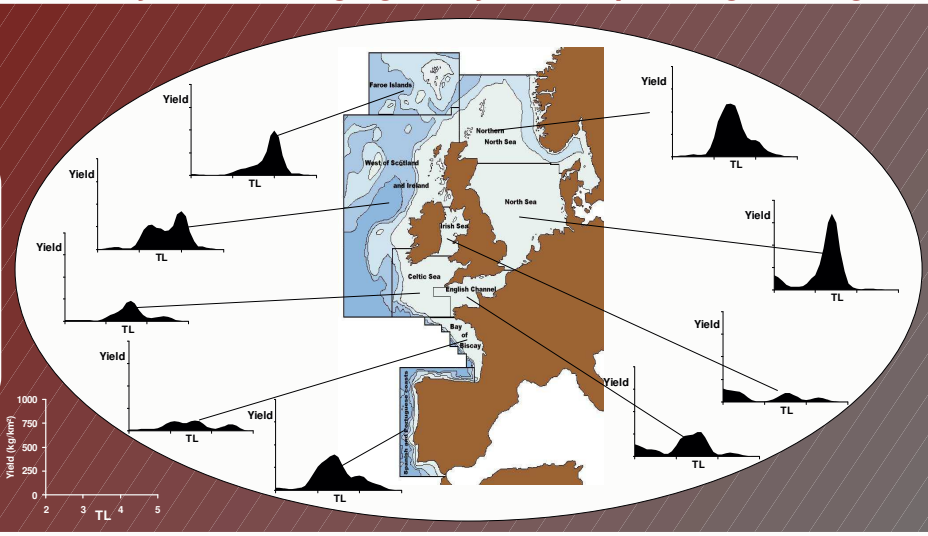
- The aim of the analysis is to describe large fishing areas in the Northeast Atlantic
- Catch Trophic Spectra (CTS) are plotted to display the catch by trophic level in each fishing area

CTS describe the amount of catch and the position of the fishery targets in the food web

Spatial analysis: encouraging the eye to compare large fishing zones

Which TL exploited?

Catch Trophic Spectra are the result of the underlying ecosystem and of the fishing strategies. They highlight different types of exploitation in Europe



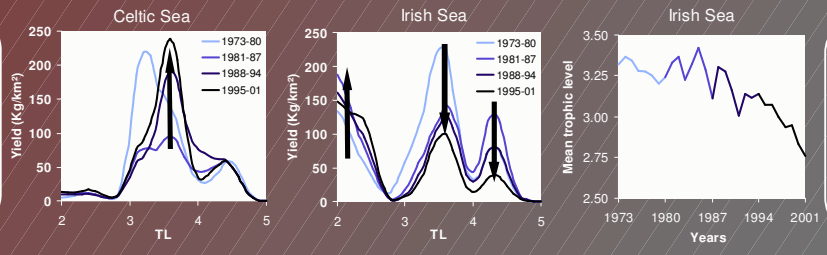
Looking for patterns

Northern areas are very productive and exploit a few trophic levels whereas southern areas display a low production, more spread along the trophic continuum

Temporal analysis: visualizing shifts in exploitation

Searching for shifts

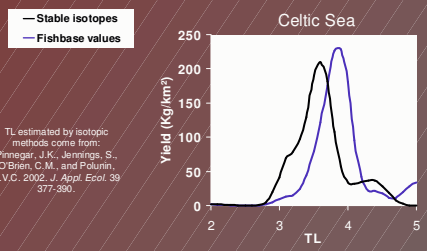
Plotting CTS for various time-periods allows to follow the fisheries evolution and observe major changes in exploitation. As an illustration, the Celtic Sea shows a progressive increase of small pelagic species in total catch (TL 3.4-3.8) in the last 20 years



Explaining trends

Temporal analyses enable to detect and precise the characteristics of a "fishing down marine food web" effect. The Irish Sea presents a continuous decrease in high and intermediate TL associated with a global increase in low TL targeted

Which sensitivity of the CTS to the TL estimation?

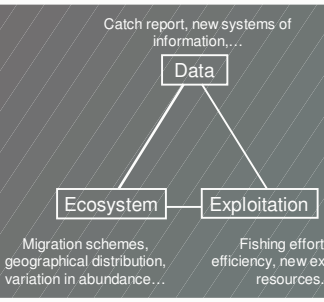


TL estimated by isotopic methods come from: Pinnegar, J.K., Jennings, S., O'Brien, C.M., and Polunin, N.V.C. 2002. *J. Appl. Ecol.* 39 377-390.

The global shape of the CTS remains unchanged when using accurate values of TL based on stable isotope methods although the curves do not match and display a lag of 0.3 TL

Which factors explain CTS variations with time?

CTS combine 3 distinct sources of variation in time: data reliability, exploitation schemes and modifications in the underlying ecosystem



Catch Trophic Spectrum (CTS) is a descriptive tool summarizing a high amount of information on the exploitation in fishing areas. It promotes spatial and temporal comparative analyses and can help in detecting ecosystem phase shifts and associated changes in exploitation.
Coupling such analyses with data on biomass and more accurate estimates of TL should improve our understanding of fishing effects on trophic structure.

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