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Analysis of species associations in deep-sea fisheries off the British Isles from an industry haul-by-haul database

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Introduction

The multi-species deep-sea fishery taking place West of the British Isles is relatively recent since it really took off in the late 1980s. Nowadays, the area is mostly exploited by French fleets operating bottom trawls.
Detailed data on landings of commercial species, collected on a haul by haul basis by volunteer trawler skippers between 2000 and 2009, possesses a spatial and temporal resolution, and a coverage that no scientific survey can compare to in this region.
The objective of this preliminary work is to identify species assemblages and characterize their variability in both space and time.

Methodology

Landings for seven species or groups of species are available: roundnose grenadier (*Coryphaenoides rupestris*), black scabbardfish *(Aphanopus carbo),* blue ling (*Molva dypterygia*), the three species which constitutes the largest part of the landings (Fig. 2), as well as sikis (Portuguese dogfish *Centroscymnus coelolepis* and leafscale gulper shark *Centrophorus squamosus*), picked dogfish (*Squalus acanthias*), anglerfish (monkfish *Lophius piscatorius* and blackbellied angler *Lophius budegassa*) and saithe (*Pollachius virens*).

Analyses

- Identification of factors governing the variability through principal component analysis (PCA) with relative landings of species as variables. Definition of stations accounting for the influence of these factors.
- Assessment of potential changes in species associations between several periods: 2000-2002, 2003-2005, 2006-2007 and 2008-2009, by means of a multi-table analysis (STATIS)
- Description of species assemblages and study of their spatial and seasonal stability between 2000 and 2009 by means of clustering. Separate hierarchical classifications for the four periods.

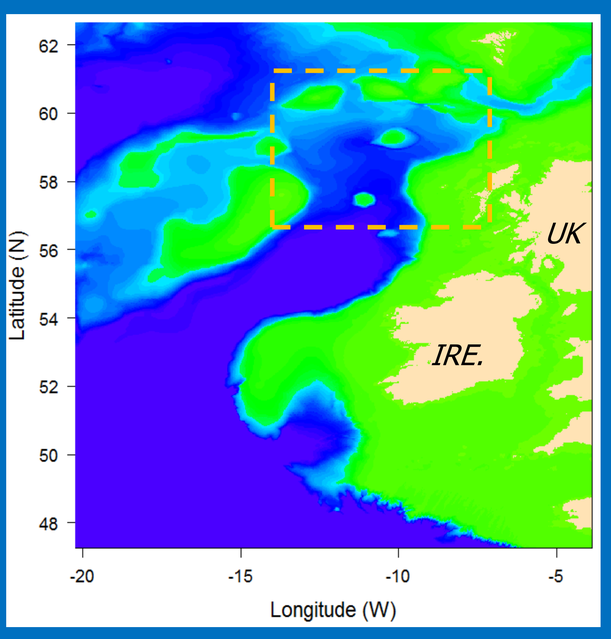

Fig. 1 Map of the study area. The region delimited by the dashed lines is the area encompassing the stations common to all time periods.

Results

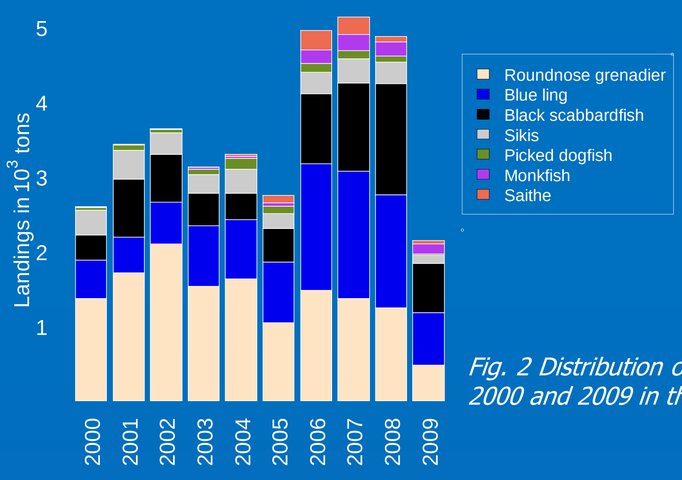

Fig. 2 Distribution of landings per species and per year between 2000 and 2009 in the haul by haul data base.

Trawling depth clearly appears as the main structuring factor of the data set. The first component opposes the first and second halves of the series (Fig. 3).

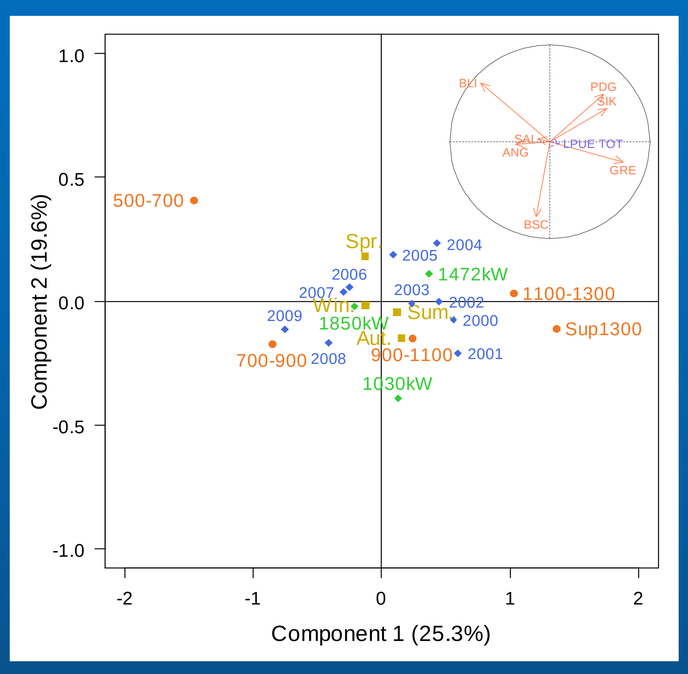

Fig. 3 Projection of illustrative variables on the first plane defined by the PCA on the whole data set. Illustrative variables are: depth class (in orange), season (in gold) and engine power (in green). The circle of correlations between the relative species abundances in a haul is displayed in the top right corner. GRE: roundnose grenadier, BSC: black scabbardfish, BLI: blue ling, SIK: sikis, PDG: picked dogfish, ANG: anglerfish, SAI: saithe. The total LPUE per haul is treated as a supplementary variable.

In order to assess the inter-annual variability in species assemblages, stations in which hauls were realized all along the study period were defined by a 7.5' latitude by 12' longitude rectangle, a depth stratum and a "season" (winter or summer).

The STATIS analysis shows that the matrices are of similar structures and their projections appear chronologically ordered along the second component of the PCA of the cosine matrix (Fig. 4).

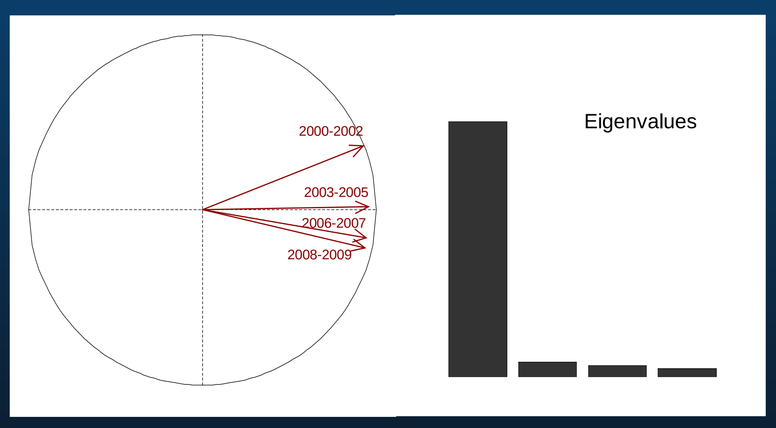

Fig. 4 Projections of the matrices corresponding to each period in the correlation circle in the first plane defined by the PCA of the cosine matrix, and associated eigenvalues.

Four main groups of stations are revealed by hierarchical clustering in 2000-2002, characterized by very distinct species assemblages.

Groups 1, 3 and 4 are characterized by a high proportion of one particular species each while Group 2 appears as a more mixed group constituted of hauls realized at intermediate depths (Fig. 5).

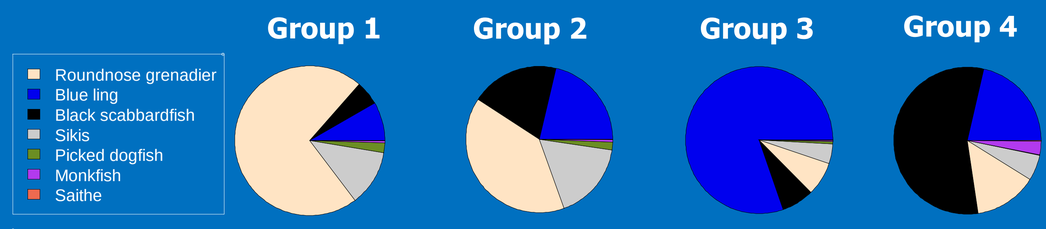

Fig. 5 Specific composition of the four groups of stations obtained from a cluster analysis of the data for the period 2000-2002.

Spatial segregation between the groups of stations is noticeable despite high degree of overlapping (e.g. stations dominated by roundnose grenadier more abundant towards South and East (Fig. 6)).

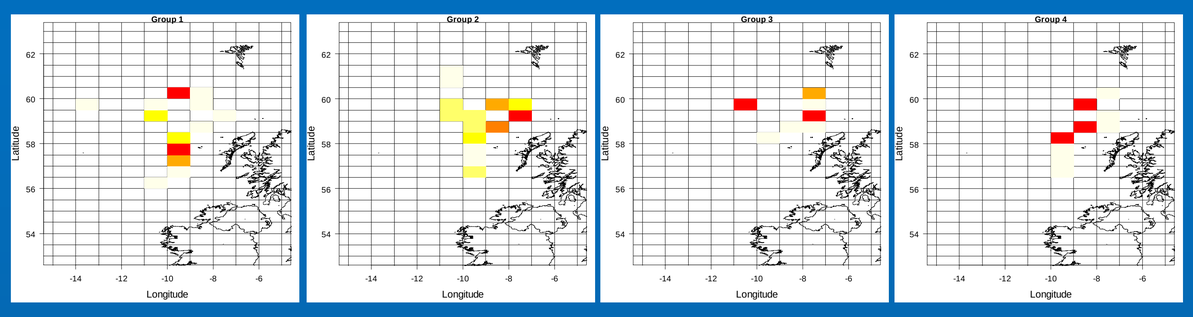

Fig. 6 Relative abundance per ICES statistical rectangle of the stations corresponding to depth stratum 900-1100m for each of the groups of stations obtained from a cluster analysis of the data for the period 2000-2002. Red color indicates high relative abundance.

The distributions of the groups dominated by roundnose grenadier and by blue ling appear to be more stable over time than the mixed group and the group dominated by black scabbardfish (Fig. 7).

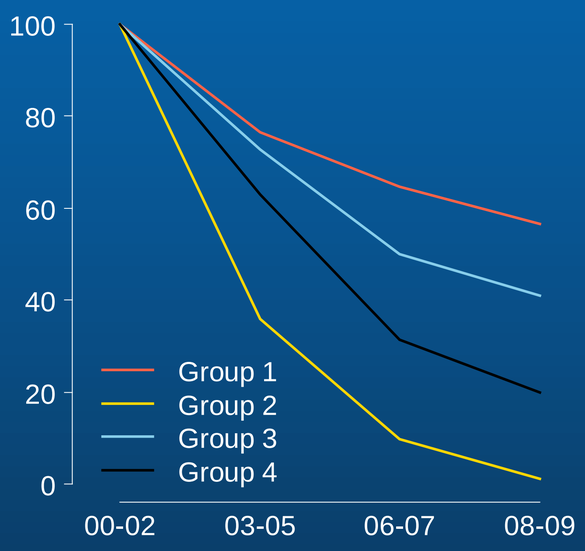

Fig. 7. Progressive decrease (in percents) of stations in groups defined for 2000-2002 successively present in homologous groups identified for the subsequent periods.

Discussion

- High similarities between successive periods, but multi-table ordination and classification analyses converge to show evidence for gradual changes.
- Modifications in black scabbardfish relative abundance in trawl hauls, and in the distribution of hauls with mixed catch appear as key contributors to the observed changes.
- No possibility of disentangling here the relative influence of ecological factors resulting in variations in local abundance, the consequence of changes in fishing strategies in time and space, and temporal changes in data collection on the observed species associations.

➔ Further analysis needed to separate the respective roles of these various factors.

Acknowledgements

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