ICES CM 2014/3777 L:14

Pelagic *versus* demersal: a process to fully understanding the blue whiting (*Micromessistius poutassou*) dynamics off the Portuguese coast

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Summary
Blue whiting *Micromesistius poutassou* (Risso, 1827), is a benthopelagic gadoid with a wide spatial distribution throughout the Northeast Atlantic, and depth ranging from the mid-shelf (50-100 m) to 1000 m and deeper. The highest densities are usually found on the upper part of the slope (200-500 m). Additionally, this species also undertakes diel vertical migrations.
Given the extensive spatial and depth distribution, fishery-independent information for management purposes may be obtained from either demersal or pelagic surveys. In Portuguese continental waters, demersal surveys are performed annually, since the 1990s. Also, two acoustic surveys aiming specifically at blue whiting were carried out in 1998 and 1999. The distinct information obtained from pelagic versus demersal surveys is presented and the advantage of their joint analysis for an improved stock management is highlighted.

Introduction
Blue whiting, is a gadoid found throughout the Northeast Atlantic. The species ranges from the Iberian Peninsula and the western Mediterranean to the Barents Sea, from the North Sea to the Mid-Atlantic Ridge, and even as far as the east coast of North America (Bailey, 1982). In terms of biomass this species is one of the most abundant teleosts in the North Atlantic, and its economic significance has been increasing since commercial exploitation began in the 1970s (Standal, 2006). Blue whiting plays an important role at the ecosystem level with studies conducted in Portuguese waters, on the feeding ecology of marine organisms, stressing its importance as a forage species (Silva *et al.* 1997).
Reliable estimates of blue whiting abundance along with its population structure are required for management purposes and for the characterization of the ecological dynamics of demersal communities. Herein, the distinct information obtained from acoustic and demersal sampling hauls is compared.

Materials and Methods
Data were obtained from samples collected during the daytime by: (i) bottom and pelagic trawl (120 – 1000m depth) during two acoustic surveys conducted in May 1998 and February 1999 at the Portuguese coast and (ii) International Bottom Trawl Survey (IBTS) (36-710m depth) performed

between 1990 and 2011 along the Portuguese coast. Total length (cm), total weight (g) and sex of all fish sampled from the surveys (i and ii) were recorded.
T-tests and Kolmogorov-Smirnov tests were carried out of mean length and length-class distribution for comparison, respectively. Sex-ratios among samples were compared by proportion tests (Zar, 1999).
To modelling the females and males composition in samples due to the sampling strategy, a generalized linear model was fitted to our data by survey type.

Results

In the acoustic surveys (i), and for the same depths profiles, blue whiting presence were significantly higher using bottom trawl than pelagic trawl, even for shallow and deeper waters.
Females and males samples composition, obtained from pelagic and bottom trawl (surveys (i)), were similar. Although, the sex-ratio composition of bottom trawl samples varied from station to station, is ratio is approximate to 1:1.
In the bottom trawl stations, the species length range and the whole maturity stages were sampled, for both surveys (i) and (ii).
The majority of samples where blue whiting occurs were confined between the 100 and 200m and above 200m bathymetric line.

Discussion

In blue whiting, growth is sexually differentiated; females are in general larger and heavier than males. Thus, a biased sex-ratio sampling could have impact in the age-length key applied in the assessment and consequently in the management options.
The current IBTS sampling scheme, allowed sampling blue whiting throughout their life cycle, from the juvenile to the adult fraction of the population in the Portuguese waters. Since, this species presents diel migrations in water column, with highest densities in shallow waters (<350 m) at night (Johnsen and Godø, 2007), according to diel variations observed in acoustic recordings.
Considering the blue whiting distribution in the water column, in deep water (bottom depth > 600 m) were mainly distributed without close association with the seabed, whereas in shallower water (bottom depth < 500 m), the mean distance from the seabed tended to decrease with decreasing bottom depth (Johnsen and Godø, 2007).
Data from bottom and pelagic, could be combined for a sampling scheme along day and night. Although, evidences of a large escape of blue whiting from the pelagic trawl nets, which can have impact on abundance estimates (Skúvadal et al. 2011), should be taken into account.

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