

## **A comparison of the seasonal abundance of hake (*Merluccius merluccius*) and its main prey species off the Portuguese coast.**

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### Abstract

Hake is an important predator in the Atlantic off the Portuguese coast. Its diet has been studied between 1997 and 1999 and the main fish species it preys on have been identified. This poster compares the seasonal abundance of hake and the availability of its main prey species in three physically distinct regions of the continental Portuguese shelf and slope using trawl fishery catches. The main prey species, which vary in order of importance according to season, are: blue whiting (*Micromesistius poutassou*), mackerel (*Scomber scombrus*), chub mackerel (*Scomber japonicus*), anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*). It is shown that there is some correspondence between the seasonal and spatial variation in abundance of prey species in the ecosystem and the proportion of these prey in the diet. This confirms that hake is an opportunistic feeder. Hake and these species are all commercially important, so these interactions are important for an ecosystem approach to their management.

### Introduction

This poster compares the seasonal abundance of hake and its main commercial prey species in three physically distinct regions (north – above 40°00' latitude, centre – between 39°00' and 37°30' and south – below 37°20') of the continental Portuguese shelf and slope.

Hake is a ubiquitous species present in all areas of the Atlantic off the Portuguese coast. It is most abundant between 100 and 200m depth, but is also found in deeper waters (Cardador 1995). It is commercially important, and a top predator from a size of 20 cm (Cabral & Murta in press), it feeds mainly on other fish. Many of its prey species are also commercially important, meaning that an understanding of the diet of hake is important for an ecosystem approach to management. However, the relative importance of the main prey species of hake varies according to season.

Commercial catch data for captures by trawls were used as an indication of the availability of the commercial prey species in the ecosystem. Trawls were the chosen gear type as they operate demersally, and hake is a typically demersal species. Commercial catch data were used rather than survey data as these data are available for all quarters (surveys are only carried out in July and October). Data are available for the following commercial hake prey species: anchovy (*Engraulis encrasicolus*), whiting pout (*Trisopterus luscus*), hake (*Merluccius merluccius*), chub mackerel (*Scomber japonicus*), mackerel (*Scomber scombrus*), sardine (*Sardina pilchardus*) and blue whiting (*Micromesistius poutassou*). These data are collected within the context of the national program for biological sampling (PNAB) (Connolly *et al.* 2000).

### Methods

7587 hake stomachs (704, 2162, 3517 and 1204 in quarters 1, 2, 3 and 4 respectively) were collected between 1997 and 1999 and the main fish prey species were identified. Prey species include commercial and non-commercial species that are not captured by the trawl fishery (table 1). For each prey species, stomach contents data are presented as a percentage of the total number of prey items in all stomachs. This percentage was calculated including non-commercial species, however, only the data for commercial species are used in the comparisons here.

Catch data are used as an indication of prey species abundance (availability) in the environment. The following commercial species: horse mackerel (*Trachurus trachurus*), plaice (*Pleuronectes platessa*) and silver scabbard fish (*Lepidopus caudatus*) are also present in hake's diet, but were not used in this comparison. Horse mackerel were eliminated as they dominate catches in all regions and in all quarters, but are not a major prey item (never exceeding 3.5% of total stomach contents). Plaice were not included as catches are low and they were only present in stomach contents for 2 quarters and regions. Silver scabbard fish were not included as the size of fish preyed on is much smaller than the size of fish caught in the fishery. Flounders (*Arnoglossus* spp.) and soles (*Solea* spp.) are classified as non-commercial species as these two groups of species are not sampled in the national program for biological sampling, so catch data were not available for them.

The two data sets (availability of prey in the environment and the percentage prey in stomachs) were grouped according to quarter and to the three geographical regions (north, centre and south). These data were plotted on a separate graph for each region in order to compare whether quarterly changes in the availability of the prey in the environment were reflected by changes in the importance as a prey species.

## Results and discussion

Figure 1 shows the relative importance each quarter of commercial vs. non-commercial species in the diet of hake in each region. In the north commercial species are decreasingly important throughout the year, whereas in the centre they are increasingly important in the diet. In the south they are of fairly constant importance.

Figures 2 – 4 show the abundance of the 7 commercial prey species in the environment each quarter (bars) and the percentage of these 7 species in the diet (◇) for each region. From these graphs it can be seen that there is some relationship between catches and the importance of the prey in the diet of hake. However, it must be remembered that factors such as technical limitations on the fisheries (minimum size for capture, mesh size limitations, target species for other gear types, etc...) or the biology of the prey species (vertical and horizontal migrations for reproduction and feeding, etc...) will affect the abundance as indicated by commercial catches. This is liable to cause some problems, as, for example, the size of individuals hake is preying on is often smaller than the minimum allowable catch size. According to this analysis, these fish do not therefore make up the available abundance of prey. Furthermore limiting the analysis to trawl fisheries means that certain species that are not targeted by this gear type will be under represented here.

It can thus be seen that, due to the nature of the available data, this analysis is not precise. It only provides a broad indication of the possible relationships between hake and the commercial species it preys on. It is however useful as even this general analysis shows trends that lead towards a better understanding of ecosystem interactions.

## Conclusions

This work leads to the following conclusions about hake in this area off the Portuguese coast:

- Blue whiting is always one of the most important species, both in terms of availability in the environment and in terms of importance in diet. However, in the south, where blue whiting is less abundant, there is correspondingly less blue whiting in the diet.
- However, similarly to other studies (Du Buit 1996; Hill *et al.* 1999), it is shown that hake is an opportunistic feeder. When one prey species becomes less available (less abundant), hake will feed on another more available species. For example, in the North, in quarter 2 there are less blue whiting available in the ecosystem, and sardine becomes more important in the diet, or in the same region, in quarter 4, blue whiting are less available again, and the importance of whiting pout, hake and sardine in the diet increases. Another example is in the south, in quarter 1, mackerel is the most abundant of the seven species in the environment, and is the most important commercial prey species in the diet of hake.
- Cannibalism is observed throughout the year, but is highest in quarters 1 (in the central region) and 4 (in all regions). This coincides with what has been observed in the Cantabrian Sea by Velasco & Olaso (1998). These quarters are when there are more recruits available for predation in the ecosystem. Recruit abundance is highest in the central region (Cardador 1995).
- In the south, species such as anchovy, sardine and mackerel are more abundant. They correspondingly play a more important role in the diet of hake in this region.

## References

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Table 1. Classification of prey species as commercial or non-commercial species

Commercial species	Non-commercial species
Anchovy ( <i>Engraulis encrasicolus</i> )	Argentine ( <i>Argentina sphyraena</i> )
Blue whiting ( <i>Micromesistius poutassou</i> )	Atlantic saury ( <i>Scorpaenopsis scorpaena</i> )
Chub mackerel ( <i>Scomber japonicus</i> )	Bluefish ( <i>Pomatomus saltatrix</i> )
Hake ( <i>Merluccius merluccius</i> )	Boar fish ( <i>Capros aper</i> )
Horse mackerel ( <i>Trachurus trachurus</i> )*	Bogue ( <i>Boops boops</i> )
Mackerel ( <i>Scomber scombrus</i> )	Dragonet ( <i>Callionymus lyra</i> )
Plaice ( <i>Pleuronectes platessa</i> )*	Flounders ( <i>Arnoglossus</i> spp.)
Sardine ( <i>Sardina pilchardus</i> )	Red bandfish ( <i>Cepola macrophthalma</i> )
Silver scabbard fish ( <i>Lepidopus caudatus</i> )*	Sandeel ( <i>Ammodytes tobianus</i> )
Whiting pout ( <i>Trisopterus luscus</i> )	Silvery pout ( <i>Gadiculus argenteus argenteus</i> )
	Snipe fish ( <i>Macroramphosus</i> spp.)
	Soles ( <i>Solea</i> spp.)
	Spotted flounder ( <i>Citharus linguatula</i> )
	Thick back soles ( <i>Microchirus</i> spp.)

\*commercial species not used in the comparison (see methods section).

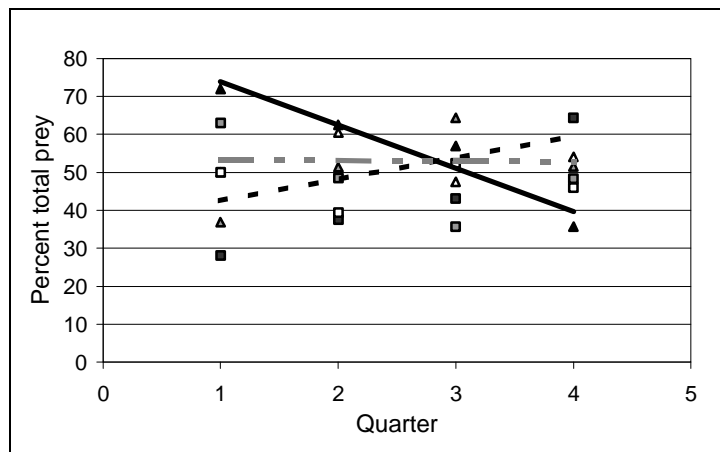


Figure 1. Percentage of commercial (△) vs. non-commercial (□) prey in hake's diet for each quarter and for each region. (— North; - - - Centre; . . . South).

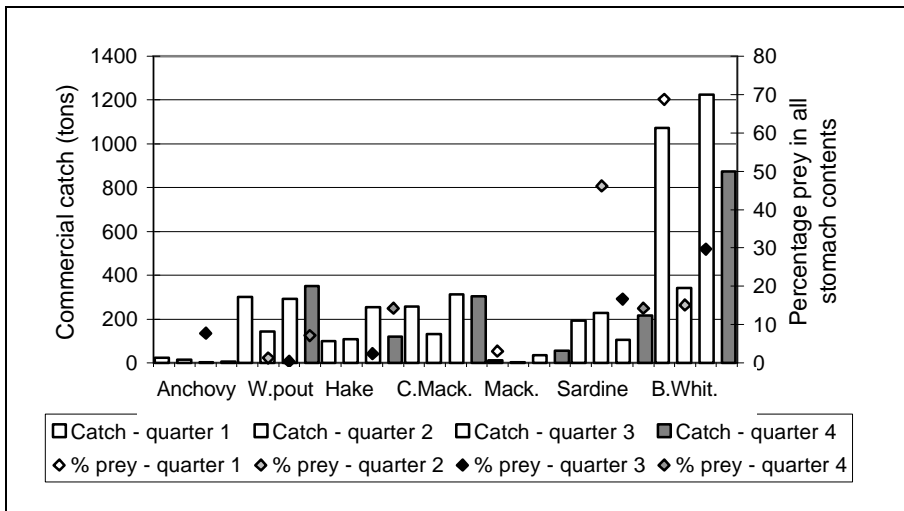


Figure 2. Comparison of the abundance of 7 commercial species in the ecosystem (bars), and percentage of these species as prey in the diet of hake (◊) in the Northern region.

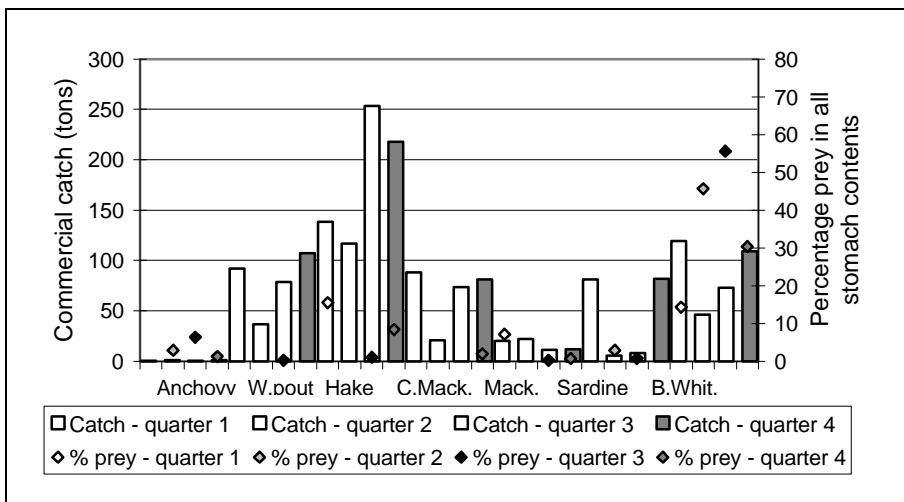


Figure 3. Comparison of the abundance of 7 commercial species in the ecosystem (bars), and percentage of these species as prey in the diet of hake (◊) in the Central region.

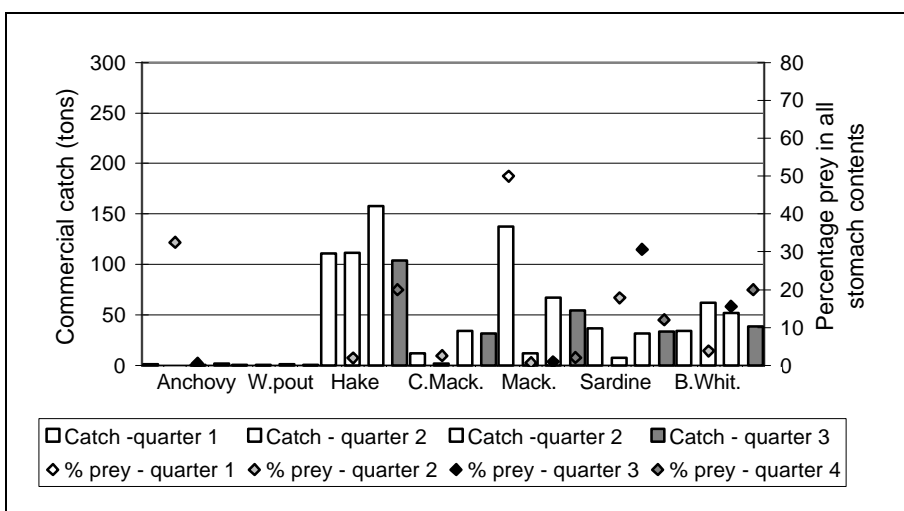


Figure 4. Comparison of the abundance of 7 commercial species in the ecosystem (bars), and percentage of these species as prey in the diet of hake (◊) in the Southern region.