

Competition between whiting and cod in the western Baltic Sea

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Summary

Whiting (*Merlangius merlangus*) and cod (*Gadus morhua*) are the main fish predators in the western Baltic Sea (WBS). The cod stock is assessed yearly in this area, whereas no assessment is available for whiting. Research survey indices suggest that the abundance of whiting is high and since whiting is only targeted in the fishery for a limited period of the year, its fishing mortality is low. Whiting is, thus, likely to play a central ecological role by preying upon key commercial species such as herring (*Clupea harengus*) and sprat (*Sprattus sprattus*) and by being a potential competitor to the highly exploited cod.

Stomach contents from whiting caught quarterly during the extended BITS surveys in ICES SDs 22 and 24 were analysed to shed light on its diet. In order to study the interspecific interactions, existing cod stomach data from the 1980s were included. Temporal and spatial differences in stomach content were investigated qualitatively.

The analyses show interesting results regarding ontogenetic shifts in diet from invertebrates to fish, relative predation on clupeids and cannibalism. Based on the results we discuss the implications of ignoring whiting predation when providing management advice for the cod, herring and sprat stocks in the WBS.

Introduction

Management advice for North Atlantic fish stocks are based on single species assessments, but there is an increasing tendency to include data from ecosystem- and multispecies assessment models, e.g. natural mortality and stock-recruitment relationship parameters, which take into account environmental effects and species interactions. This development has increased the need for knowledge about population dynamics, feeding ecology and growth for major fish stocks in the marine ecosystems.

The interactions between cod, sprat and herring are well studied in the eastern Baltic Sea, but so far little consideration has been given to the potential competition between cod and whiting in the WBS, and to the impact of whiting on the herring and sprat stocks. Evaluating whiting's role in the ecosystem is an important task in relation to management of the westerly distributed Baltic stocks such as the spring-spawning herring and the western Baltic cod, as well as to better understand main parameters in the fish ecosystem dynamics of the WBS.

The aim is to investigate the diet of whiting in the WBS and to compare it with the diet of cod. Qualitative and preliminary quantitative analyses of stomach content of whiting and cod from ICES SDs 22 and 24 are performed to examine ontogenetic shifts in diet, predation on clupeids and the extent of cannibalism and gadoid predation.

Materials and Methods

Stomach data from 1,000 whiting was collected in 2011-12 during the extended BITS surveys, conducted on a quarterly basis in ICES SDs 22 and 24 with the standard ICES BITS TV3 bottom otter trawl, and analysed in the laboratory. Existing stomach data from 8,400 cod, collected quarterly in 1978-85 with the standard GOV bottom trawl under the auspices of ICES, was used for the comparative analysis. The cod data consisted of pooled stomachs from cod > 20 cm. The whiting data was treated similarly by pooling

stomachs across 5-cm length groups, quarters and hauls. Data on whiting < 20 cm was solely included when studying ontogenetic shifts in diet.

The relative mass composition of the prey items in the stomachs was investigated by aggregating prey into three main groups: invertebrates, clupeids (herring, sprat) and other fish (e.g. cod and whiting). Additionally, a quantitative analysis of the average stomach content mass of clupeids was conducted by bootstrapping (with 10,000 resamples), followed by a χ^2 test. The analysis was only performed for the more data-rich predator length groups (20-50 cm) and quarters (1st and 4th).

Results and Discussion

The analyses show differences in the relative prey composition of the two species with whiting having a larger proportion of fish in the stomachs. Cod appear more omnivorous and prey to a greater extent on invertebrates. The ontogenetic shift to a fish-based diet occurs earlier (at smaller predator length) for whiting than for cod, especially in SD 22 where stomachs from 11-15 cm whiting on average contain 56% fish. Gobies (*Gobiidae*) contribute significantly more to the diet of whiting in SD 22, and this may explain the earlier shift to a fish-based diet compared to whiting in SD 24. Whiting from SD 24 changes to a fish-based diet around 36-40 cm, a bit later than in the North Sea (Floeter & Temming 2005), but at a similar size as cod in both WBS subdivisions. The observations are in agreement with cod in the North Sea, which undergo a later ontogenetic diet shift and prey proportionally more on invertebrates (Link *et al.* 2009).

The relative mass composition of clupeids differs between the two species with clupeids constituting a larger proportion of the whiting stomachs across all length groups, e.g. for length groups > 40 cm clupeids comprise > 90% in whiting and < 60% in cod. Nevertheless, when looking at the absolute mass content of clupeids, there is some degree of dietary overlap between cod and whiting in SD 24 during the fourth quarter ($P = 0.85$). Stomachs from whiting and cod > 30 cm do not have a significantly different content of clupeids ($P = 0.50$).

The clupeid content of cod and whiting is dominated by herring and sprat, respectively, but the observed differences may be caused by the low biomass of sprat in the early 1980s compared to now (Link *et al.* 2009). There is a general trend towards an increasing proportion of herring in the diet with increasing predator size. Herring attain a larger size than sprat, and the change towards a herring-dominated diet is, thus, in line with the optimal foraging strategy (Floeter & Temming 2005).

Cannibalism is more common in cod, especially for the larger length groups (15-18% in cod > 60 cm). The extent of cannibalism show large annual variations and serve as a regulatory mechanism at high population densities (Link *et al.* 2009). Whiting exhibits low gadoid predation in the WBS, whereas it is one of the main predators on cod in the North Sea (Link *et al.* 2009).

Diet overlap between similar-sized whiting and cod is primarily seen for the larger length groups, and cod exhibit a more omnivorous diet, perhaps relying to a lesser extent on particular prey groups. Nevertheless, competition for clupeids across length groups, i.e. between medium-sized whiting and large cod, is not unlikely considering that cod prey upon a wide range of fish sizes (Link *et al.* 2009) and whiting consume prey of relatively larger sizes (Floeter and Temming 2005). The extent of competition and the predation pressure on sprat and herring exerted by whiting requires further examination. Increased knowledge about interspecific interactions will improve the basis for management of commercially important species in the WBS.

References

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