



**CEPHS  
&  
CHEFS**

# Ecosystem Assessment

## WP.4.3 Deliverable

### Cephalopod Fisheries within ecosystem models

#### Executive Summary

During the project, the role of cephalopods within the ecosystem and in particular within food webs was the subject of three analyses of unequal importance.

In order to take into account the well-known inter-annual variability in cohort strength the consequences of the cephalopod compartment's biomass variation on the food web model previously developed in the Western Channel were investigated.

The consequences of increased fishing mortality and the possible impact of removal on the ecosystem were analysed with simulations of the Moray Firth Squid Fishery.

At last a preliminary trial to better describe cephalopod trophic relationships was prepared using DNA meta-barcoding of squid stomach contents.

Each analysis is detailed in a separate document and the abstract or main outputs are copied below.

The Western Channel Ecopath model was developed with only one "Cephalopods" compartment (Araujo et al., 2005). The variability of English Channel squid and cuttlefish population indices suggests that the biomass of this compartment can vary between half and double the average used. Balanced models were obtained in both situations although this required only to change biomasses of other compartments (and in particular prey biomass) in high cephalopod biomass whereas biomass and predators diets needed adjustments in low cephalopod biomass. Cephalopods have a direct or indirect impact on important species in the Channel such as sharks, but also on protected species such as dolphins (positive impact) and seals (negative impact). In view of the results, it cannot be said that cuttlefish and squid are "keystone" species (particularly of interest in the protection of endangered species), but it is undeniable that they are important species within the English Channel ecosystem. Finally, it seems that cephalopods are an important compartment for fish species with commercial interest such as John Dory and whiting. At present, cephalopod stocks in the Channel do not seem to be endangered, but it seems obvious that the question of stock assessment and the establishment of management is essential for these species.

The squid *Loligo forbesii* is the most economically important cephalopod species in Scottish waters. This study aims to describe the ecological role of *L. forbesii* and to determine the potential impact of increased squid fishing on trophic flows within Moray Firth ecosystem. An ecosystem model for the

Moray Firth was constructed using EwE (Ecopath with Ecosim) software (Version 5.1), adapted from existing North Sea and Irish Sea models. Diet information for *L. forbesii* was obtained from results of analysis of stomach contents of squid landed at the port of Fraserburgh (2006–2007). A satisfactory balanced model was obtained with ecotrophic efficiency <1 and gross food consumption efficiency of in the range 0.1-0.3. Model results suggest that squids have both direct negative impacts on their prey (e.g., juvenile cod, poor cod, four-bearded rockling), and indirect negative impacts on other predators (e.g., monkfish, large demersal fish, and seabirds). Simulating increased squid fishing mortality shows the possible impact of squid removal on most groups in the system, not only groups with direct trophic relationships with squid as prey or predators. Declines in squid biomass associated with increased fishing mortality can lead to significant increases in small to medium-sized fish prey and competitors, but these changes can also lead to decreased abundance of predators of squid, notably in several large fish species.

Attempts to determine squid prey from molecular markers and DNA bar codes are motivated by the fact that the squid diet often contains a large proportion of indeterminate teleosts. DNA extraction from Channel squid stomach contents was performed on samples collected from commercial trawlers landings. PCR amplification of the COI gene and sequencing of the amplicons made it possible to obtain a species-specific determination in almost half of the sequences. This will enable the analysis of diet differences between the two *Loligo* species (*Loligo forbesii* and *L. vulgaris*). It is worth noting that it also showed that cuttlefish was present in 31% of predators stomachs. This trial is the first application of DNA meta-barcoding to the diet of European cephalopods.