

Ecosystem Structure and Fishing Impacts in the NW Mediterranean Sea using a Comparative Approach

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Introduction

The NW Mediterranean Sea is one of the most impacted regions of the Mediterranean basin, mainly exploited by French and Spanish fleets. This region is a strategic area for conservation, as it includes important habitats for several species, holds important seabird colonies and several species of mammals and sea turtles are present in the area. Previous analysis indicated intense exploitation of the marine ecosystem and changes in its trophic structure.

Aims

A food web **Ecopath model** of the NW Mediterranean Sea (NWM) area was developed to:

- Characterize the **structure and functioning** of the ecosystem during the early 2000s;
- Assess the **impact of fishing activity** on the ecosystem and
- Compare** the results with other food-web models developed in several areas of the Mediterranean and adjacent waters of the Gulf of Cadiz

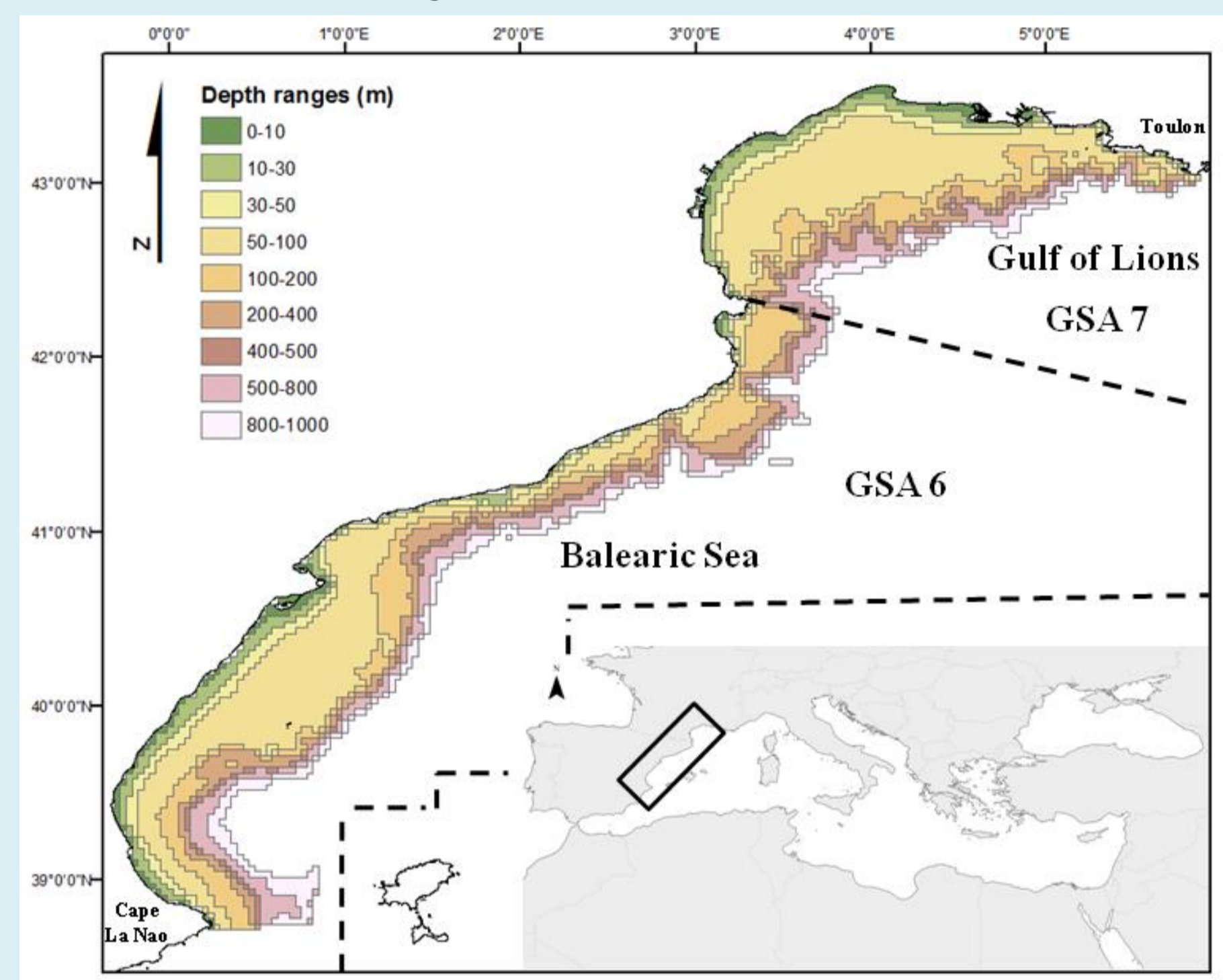


Fig. 1. The NW Mediterranean Sea (GSA 6 and 7), showing the modelled area (0-1000m) and depth ranges.

Methods

- The NWM model includes previous areas modelled with the Ecopath approach (www.ecopath.org) in the NW Mediterranean (Coll et al. 2006; Banaru et al. 2013) (**Fig. 1**) and expands their ranges considering important **hydrodynamic events** in the region that enhance the connectivity between both regions including **shared-fish stocks**
- The model covers 45547 km², represents the **early 2000s** and includes depths of 0 to 1000 m (**Fig. 1**)
- Input data are based on local scientific surveys and fishing statistics, published data and the application of empirical equations
- The model is composed of **54 functional groups**, from primary producers to top predators, including **Spanish** and **French** fishing fleets
- The Ecopath modelling tool is used to analyze results and a **comparative approach** is developed to put the results into a wider context (**Fig. 2**)

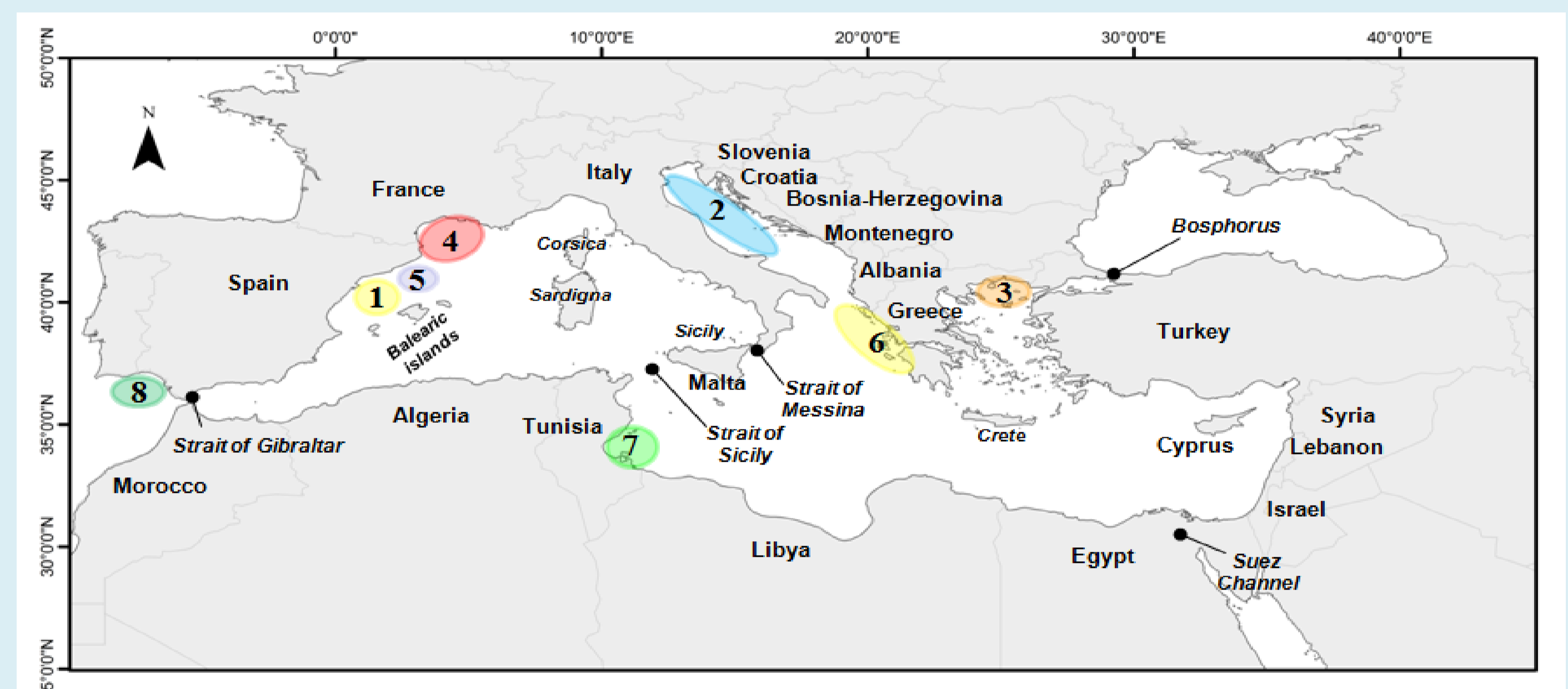


Fig. 2. Location of Ecopath models used in the comparative analysis. 1: S Catalan Sea (SCS, Coll et al., 2006); 2: NC Adriatic Sea (NCAS, Coll et al., 2007); 3: N Aegean Sea (NAS, Tsagarakis et al., 2010); 4: Gulf of Lions (GoL, Banaru et al., 2013); 5: Lower continental slope of the Catalan Sea (DCS, Tecchio et al., 2013); 6: Greek Ionian Sea (IS, Moutolopoulos et al., 2013); 7: Gulf of Gabes (GoG, Hattab et al., 2013); 8: Gulf of Cadiz (GoC, Torres et al., 2013)

Results and discussion

- The model highlights the dominance of the **pelagic fraction** and a strong **benthic-pelagic coupling** (**Fig. 3**)
- Several indices show that the ecosystem was heavily impacted by the **fishing activity** in 2000s (such as the gross efficiency of the fishery, mTLc and the PPR) (**Table 1**)
- The **trawl fleet** has the greatest impact on the ecosystem
- The comparative approach shows that Mediterranean ecosystems share **common features** in **structure** and **function**, such the keystone and structural groups (**Table 2**), the dominance of the pelagic fraction and a strong benthic-pelagic coupling (Corrales et al. Submitted; Corrales, 2013)

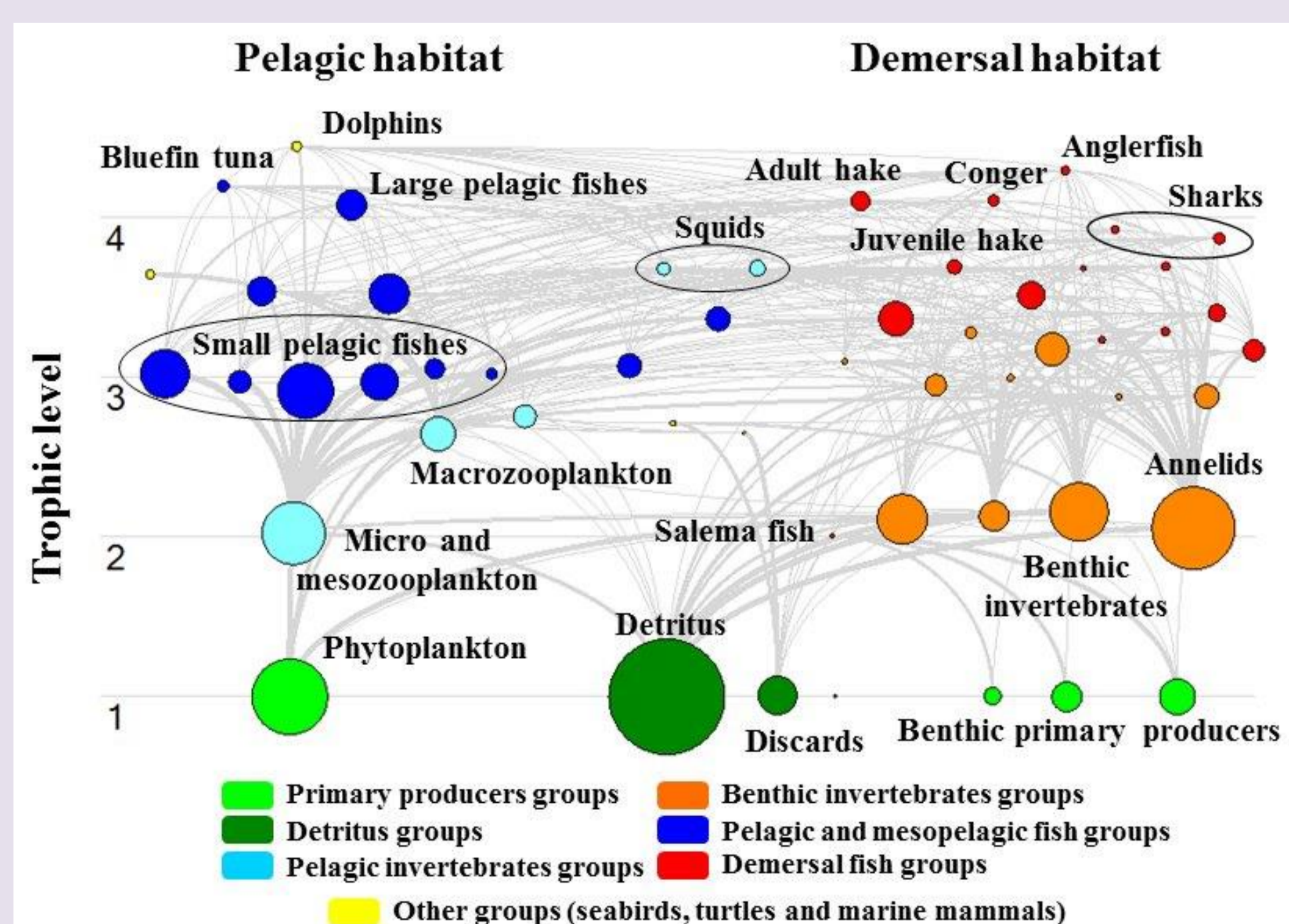


Fig. 3. Flow diagram of the NWM model. The size of each circle and lines is proportional to the biomass of the functional group and the flow between groups.

Table 1. Ecological indicators for the NWM model

Indicators	Value	Units
Mean trophic level of the catch (mTLc)	3.13	
Primary Production Required to sustain the fishery (PPR, considering PP + detritus)	17.36	%
Gross Efficiency of the fishery	0.003	

Table 2. Functional groups identified as a) keystone and b) dominant species/groups in the Mediterranean Sea and the adjacent Atlantic area

	NWM	SCS	GoL	DCS	NCAS	NAS	IS	GoG	GoC
a)									
Dolphins	X	X	X		X				X
Benthopelagic cephalopods	X	X	X			X			X
Large pelagic fish	X					X			
Sharks				X			X	X	
b)									
Phytoplankton	X	X			X	X		X	X
Micro- and mesozooplankton	X	X	X		X	X	X	X	X
Macrozooplankton	X	X	X			X		X	X
Benthic invertebrates	X		X	X	X		X	X	

Conclusions and future plans

- The NWM model represents an advance in the analysis of NW Mediterranean exploited ecosystems
- The model confirms previous results about the impact of **fishing activity** in the area
- The comparative modelling approach highlights **commonalities** of Mediterranean exploited ecosystems
- The model sets the baseline to investigate further issues related with the productivity of the area, fish distribution and habitats, connectivity and fleet dynamics and to analyse fishing management options and future scenarios of global change

References

Banaru et al. 2013. *J. Mar. Syst.* 111-112, 45-68; Coll et al. 2006. *J. Mar. Syst.* 59, 63-96; Coll et al. 2007. *J. Mar. Syst.* 67, 119-154; Corrales et al. Submitted. *J. Mar. Syst.*; Corrales, 2013. Master thesis. Univ. Alicante; Hattab et al., 2013. *J. Mar. Syst.* 128, 159-174; Moutolopoulos et al. 2013. *J. Mar. Syst.* 113, 13-28; Tecchio et al., 2013. *Deep-Sea Res. PT 1.* 75, 1-15; Torres et al. 2013. *Ecol. Model.* 265, 26-44; Tsagarakis et al. 2010. *Estuar. Coast Shelf. S.* 88, 233-248.