

MODELLING THE FOOD WEB OF THERMAIKOS GULF (NORTHEASTERN MEDITERRANEAN SEA, GREECE)

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Introduction

Ecosystem modelling is an integral part of the holistic ecosystem approach to fisheries management, which requires shifting from single-species assessments to more complex models that include multi-species trophic interactions, as well as environmental and anthropogenic driving factors. Ecopath with Ecosim (Christensen & Walters 2004 Ecol Model 172: 109-139) has been widely used to describe the trophic flows and interrelationships, energy fluxes and food web structure of marine ecosystems and therefore assess the impact of artisanal, recreational and commercial fishing around the world. In the Mediterranean Sea, most Ecopath models have been constructed for ecosystems along the northern coastline of the western and central parts of the basin. In the present work, which was conducted in the framework of the EU DG-MARE funded research project PROTOMEDEA, we developed an Ecopath base model, with 33 functional groups, aiming to depict the food web structure of an important fishing ground in the northeastern Mediterranean Sea, Greece.

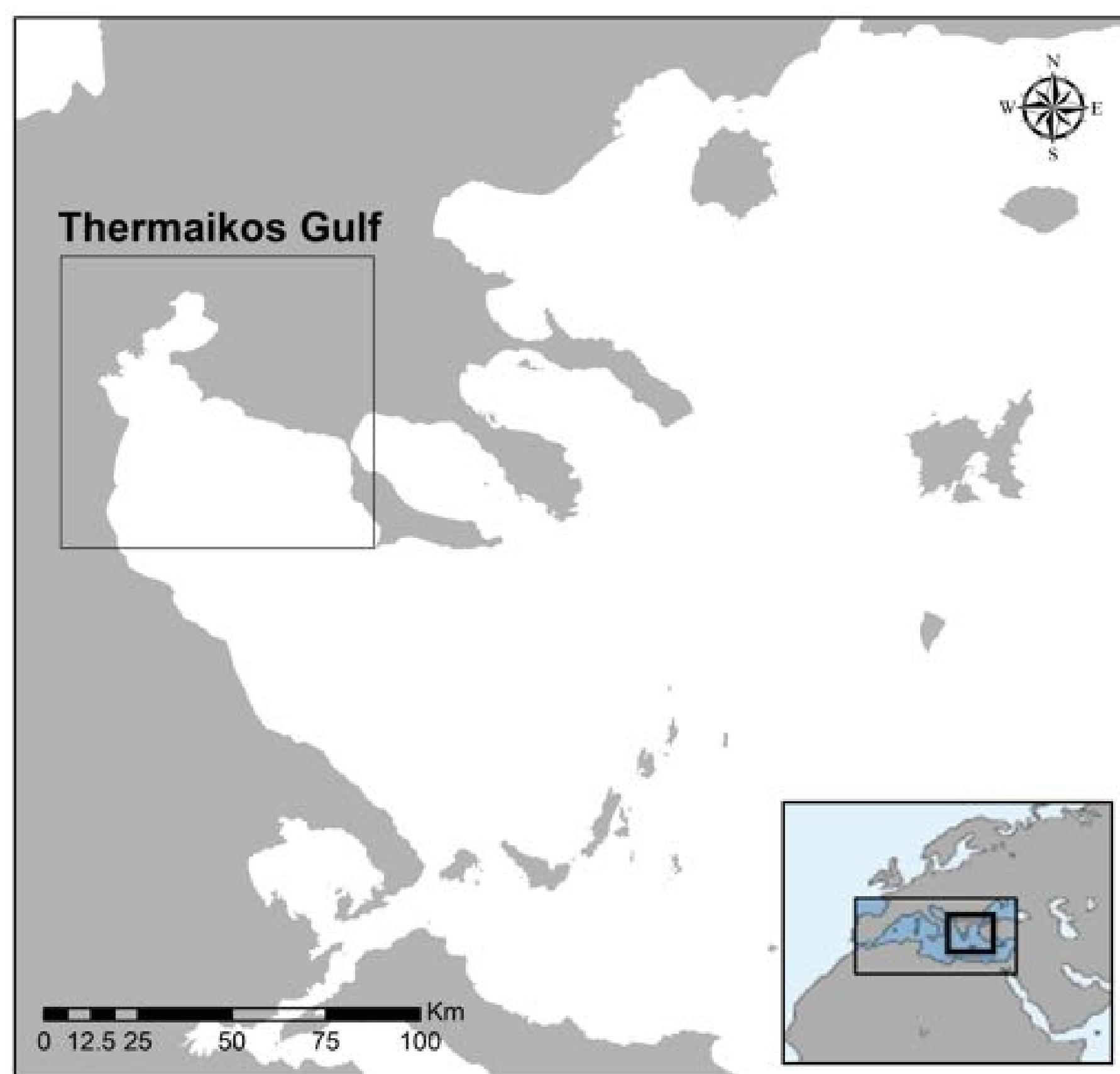


Figure 1 Thermaikos Gulf in the NW Aegean Sea, Greece, NE Mediterranean Sea.

Materials and Methods

Thermaikos Gulf is a shallow gulf (not exceeding 100m depth) located in the NW Aegean Sea, Greece (Fig. 1) that constitutes one of the major fishing grounds of the northeastern Mediterranean Sea (Dimarchopoulou et al. 2018 Sci Rep 8: 5967). This relatively small area (~3400 km²) concentrates the second highest fishing effort of trawlers and purse-seiners in the Aegean Sea (GSA 22) producing more than 20% of the total greek catches. The food web of Thermaikos Gulf was described by 33 functional groups (FGs), that encompassed 2 planktonic, 7 invertebrate, 19 fish, and 2 detritus groups, as well as sea turtles, seabirds and dolphins, covering the entire trophic spectrum of the ecosystem. Biomass data for each FG was obtained from scientific surveys in the area or the literature; landings and discards data as well as diet compositions were obtained from the literature; production and food consumption values were calculated using published empirical equations or the relevant life-history tools in FishBase.

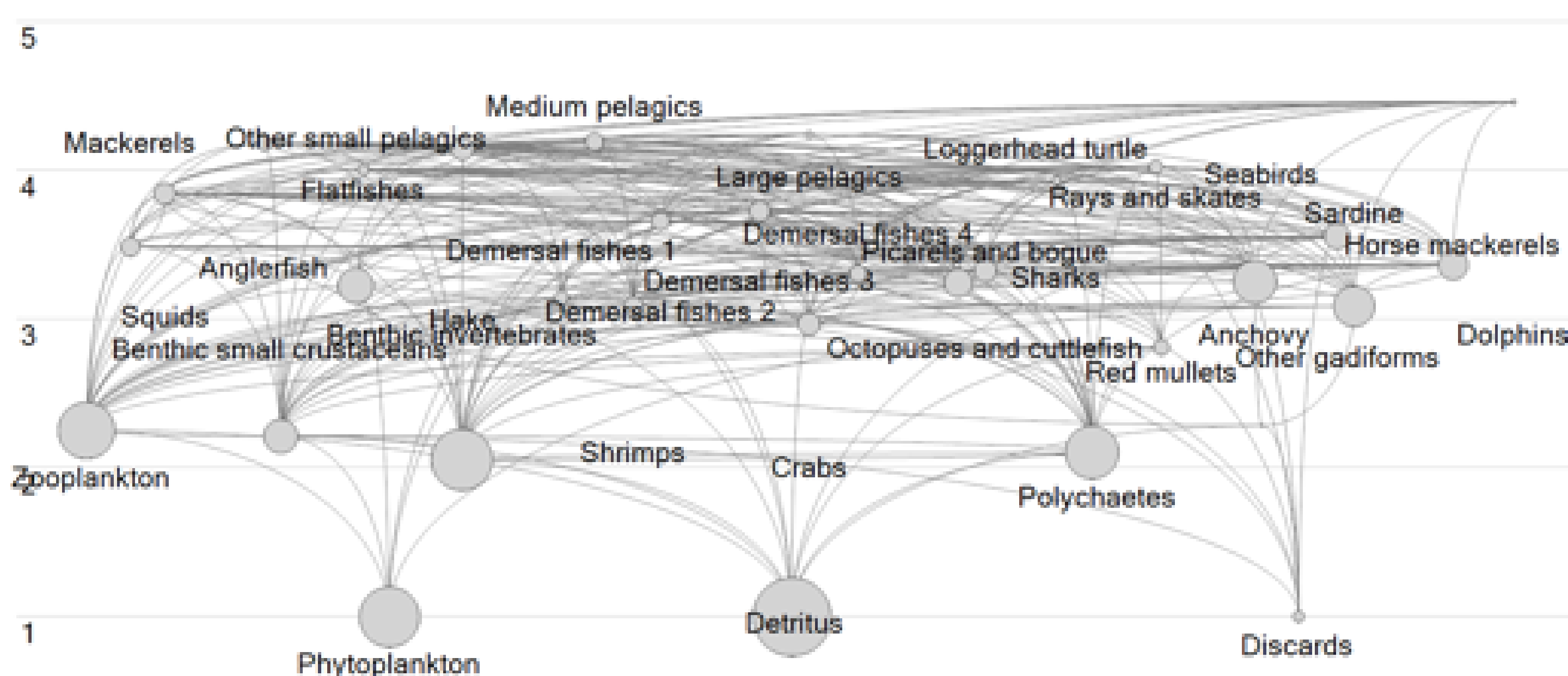


Figure 2 Flow diagram of Thermaikos Gulf organised by the trophic levels of 33 functional groups.

Main Results

The trophic linkages among the different compartments of the studied ecosystem are depicted in a flow diagram (Fig. 2). According to the summary statistics that describe Thermaikos ecosystem as a whole, the output parameters were within those of previous models in the Adriatic (Coll et al. 2007 J Marine Syst 67: 119-154) and northeastern Aegean Seas (Tsagarakis et al. 2010 Estuar Coast Shelf Sci 88: 233-248). These values indicate a medium sized system in terms of flows, with a total system throughput of about 3200 t/km²/year, and also an immature ecosystem, probably as a result of the intense fishing pressure by small-scale coastal vessels, with high system production exceeding respiration. Overall, squids had a high relative total impact meaning that they play an important role in the food web with relatively low biomass, and out of fishes, other gadiforms had the highest overall impact and keystoneeness (Fig. 3). The mixed trophic impact analysis shows the relative direct and indirect impact that a hypothetical very small increase of the biomass of the impacting groups have on the biomass of the impacted groups (Fig. 4).

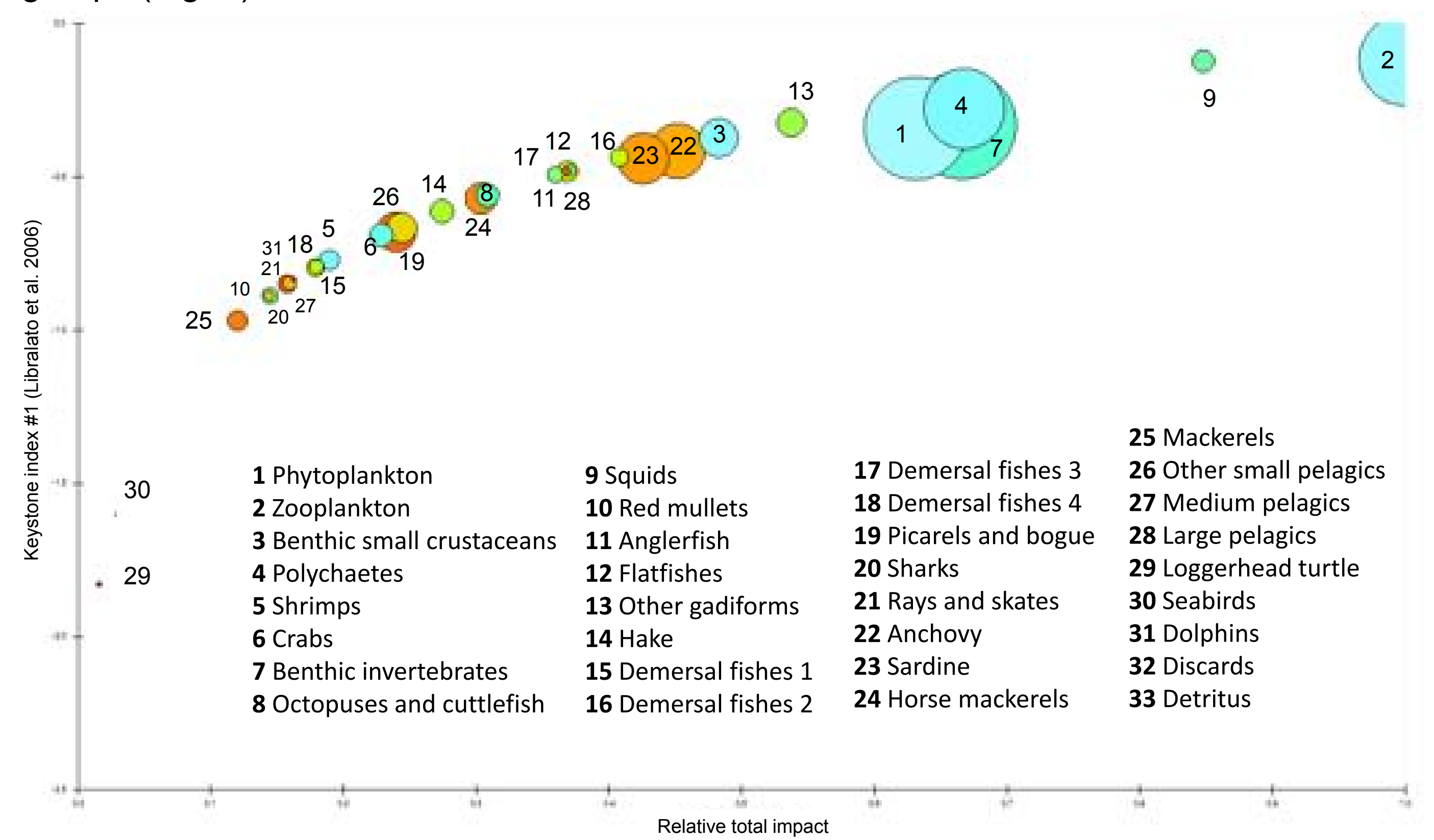


Figure 3 Keystone index and relative total impact of each functional group of the model. Circle size indicates the % relative biomass of each group.

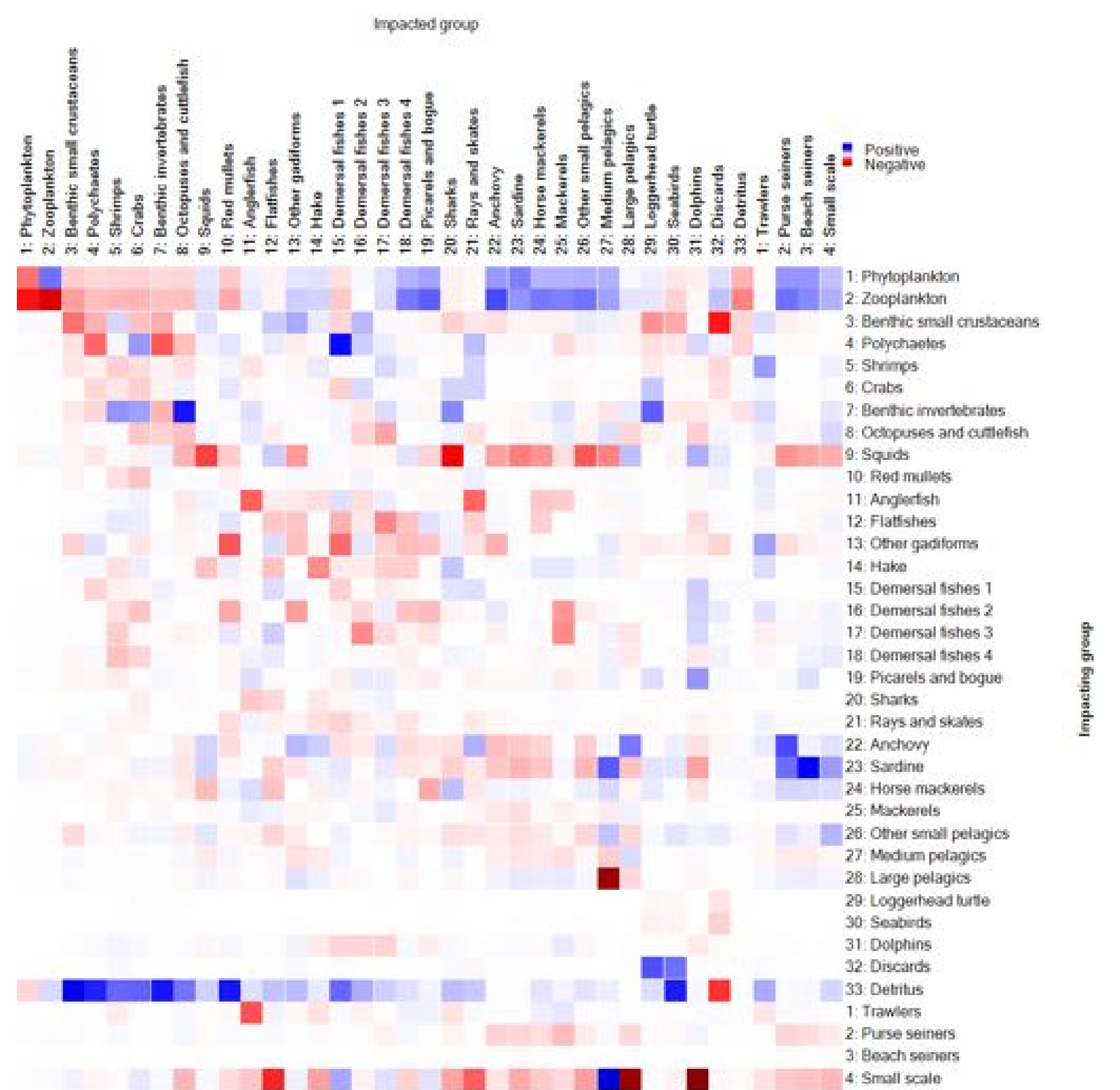


Figure 4 Mixed trophic impact analysis. Impact on and by the four fishing fleets are also shown (1-4).