CONTRIBUTIONS OF COASTAL MPAs TO MARINE ECOSYSTEM RECOVERY AND FISHERIES SUSTAINABILITY IN THE NW MEDITERRANEAN

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Introduction

Overexploitation of many marine stocks in the Mediterranean Sea calls for the development and assessment of tools to support recovery, rebuilding and conservation of marine resources, while contributing to fisheries sustainability.

Marine Protected Areas (MPAs) are designated to enhance the long-term conservation of natural resources and sustainable use and management of marine resources and the socio-economic development.

Most MPAs combine different levels of protection within a spatially zoned management scheme, from fully protected to partially protected areas.

We quantified structural and functional changes between Management Units (MUs) in MPAs.

Materials and methods

We built 9 food-web quantitative models for three MPAs in the NW Mediterranean Sea (Cerbère-Banyuls MPA, Cap de Creus Natural Park and Medes Islands MPA) (Fig. 1) using the EcoPath with Ecosim (EwE 6.6) approach1.

For each MPA, we constructed 3 models representing the 3 different MUs (Fully Protected Area – FPA; Partially Protected Area – PPA; Unprotected Area – UPA) in each site.

We followed the same mass-balance procedure and a similar food-web structure in order to facilitate the comparison of each MU within and between MPAs.

Cerbère-Banyuls MPA model represented 2013, while Cap de Creus and the Medes Islands MPA models represented 2005-2008 and 2000-2004, respectively. These time periods were selected considering the best available biomass data from underwater visual census.

Main results and discussion

Differences between MUs within MPAs may be related with different levels of enforcement: higher in Cerbère-Banyuls and Medes Islands than in Cap de Creus (Fig. 3).

The model of Cerbère-Banyuls MPA was built with 64 functional groups (2 marine mammals, 3 seabirds, 1 sea turtle, 8 pelagic fishes, 25 demersal fishes, 3 cephalopods, 14 invertebrates, 2 primary producers, 2 zooplankton, 2 phytoplankton and 2 detritus groups) (Fig. 3).

The sum of exports (Fig. 3) showed higher values for FPA and PPA in Cerbère-Banyuls and Medes MPAs, suggesting a higher connectivity and higher level of carrying capacity of these MUs, in comparison with the UPAs.

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In general, similarities in terms of ecosystem structure and functioning were found between Cerbère-Banyuls and Medes Islands due to similar spatial configuration, enforcement and establishment.

These models represented the baseline to develop a geographically nested ecosystem modelling approach to assess the ecological and fisheries benefits of MPA networks in the Western Mediterranean Sea.

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Figure 2. Flow diagram of fully protected areas (FPAs) of (a) Cerbère-Banyuls MPA, (b) Cap de Creus and (c) Medes Islands MPA models organized by Trophic Level (y-axis). The size of each circle is proportional to the biomass of the functional group. The width of the connecting lines is proportional to the magnitude of their flow. Primary producers and detritus are represented in blue and top predators in orange.

Figure 3. Sum of exports of three MU (FPA: fully protected area; PPA: partially protected area; UPA: unprotected area) models for each MPA (Cerbère-Banyuls, Cap de Creus and Medes Islands).

Figure 4. Keystone Index analysis of three MU models for each MPA. The size of each circle is proportional to the biomass of the fishes functional groups. The number identify the functional group with highest keystoneness index and relative total impact. (1. Groupers; 2. Common dentex; 3. Other commercial medium demersal fishes.)