

FROM COASTAL FISH SPECIES REPRESENTATION TO PHYLOGENETIC AND FUNCTIONAL DIVERSITY COVERAGE: NEW CHALLENGES FOR MEDITERRANEAN MARINE PROTECTED AREAS

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Abstract

Here we assess gaps in the representation of taxonomic, phylogenetic and functional diversity components among coastal fishes in Mediterranean MPAs. We assessed gaps in the representation of coastal fishes and then asked whether MPAs protected phylogenetically and functionally more distinct species or whether there was a tendency for conserving more common ones and evaluated the overall conservation effectiveness for these two biodiversity components. We show that the Mediterranean MPA system fails short in achieving an effective conservation of coastal fish taxonomic, phylogenetic and functional diversity and does not provide better biodiversity coverage than random MPA systems. This study reveals multiple ongoing challenges for the extension of the Mediterranean MPA system in the context of the Convention on Biological Diversity.

Keywords: *Conservation, Coastal systems, Fishes, Biodiversity, North-Central Mediterranean*

The Mediterranean Sea is a remnant of the Tethys Ocean and has shown exceptional levels of marine biodiversity since the late Middle Eocene (42 to 39 Ma; 1). Most of this biodiversity is located on the continental shelf (2), an area that has been historically impacted by numerous anthropogenic threats (3). Amongst those threats, overfishing, often making use of destructive fishing gears is considered as the most prevalently affecting coastal fish populations (4). To counteract those threats about 100 coastal MPAs have been established in the Mediterranean Sea since the sixties (5). Despite their overlap with areas of high taxonomic fish diversity (6), recent investigations revealed that Mediterranean MPAs do not deliver on several important aspects (7).

Here we develop a gap analysis for Mediterranean coastal fishes and measure the MPAs ability to represent three key biodiversity components: taxonomic, phylogenetic and functional diversity. We first assessed gaps in the (taxonomic) representation of coastal fishes in Mediterranean MPAs, with targets being inversely proportional to species' range sizes. We then asked whether MPAs protected phylogenetically and functionally more distinct species or whether there was a tendency for conserving more common ones. We evaluated the overall conservation effectiveness of the MPAs using a metric that weights favorably MPA systems that maximize phylogenetic and functional diversity coverage as well as species representation. The effectiveness of the MPA system at protecting biodiversity was assessed by comparison with a null model defined by selecting MPAs at random over the study area. Among the 340 coastal fish species, 16 species were total gaps not covered by any MPA. All the remaining species only partially achieved their representation target. Current Mediterranean MPAs yield less total gap species than expected from locating MPAs at random. However, 30% of the species achieved significantly higher representation targets in random areas than in the current MPAs. Functional and phylogenetic distinctiveness were weakly correlated with target achievement. The observed coverage of functional and phylogenetic diversity was not different than for random systems.

The Mediterranean MPA system fails short in achieving an effective conservation of coastal fish taxonomic, phylogenetic and functional diversity and does not provide better biodiversity coverage than systems where current MPAs are sited randomly. The critical conservation status of the different components of Mediterranean coastal fish biodiversity highlighted here, as well as their spatial mismatches (6), demonstrate that the establishment of transnational conservation strategies would be of great benefit for biodiversity. Whether such pattern was verified for other taxa and habitats, it could have significant implications for the extension of the

Mediterranean MPA system in the context of the Convention on Biological Diversity.

References

- 1 - Renema, W., Bellwood, D.R., Braga, J.C., Bromfield, K., Hall, R., Johnson, K.G., Lunt, P., Meyer, C.P., McMonagle, L.B., Morley, R.J., O'Dea, A., Todd, J.A., Wesselingh, F.P., Wilson, M.E.J. & Pandolfi, J.M. (2008) Hopping hotspots: Global shifts in marine Biodiversity. *Science*, **321**, 654-657
- 2 - Coll, M., Piroddi, C., Steenbeek, J., Kaschner, K., Ben Rais Lasram, F., Aguzzi, J., Ballesteros, E., Bianchi, C.N., Corbera, J., Dailianis, T., Danovaro, R., Estrada, M., Froglia, C., Galil, B.S., Gasol, J.M., Gertwagen, R., Gil, J., Guilhaumon, F., et al. (2010) The Biodiversity of the Mediterranean Sea: Estimates, Patterns, and Threats. *PLoS ONE*, **5**, e11842.
- 3 - Claudet, J. & Fraschetti, S. (2010) Human-driven impacts on marine habitats: A regional meta-analysis in the Mediterranean Sea. *Biological Conservation*, **143** 2195-2206.
- 4 - Guidetti, P., Milazzo, M., Bussotti, S., Molinari, A., Murenu, M., Pais, A., Spano, N., Balzano, R., Agardy, T., Boero, F., Carrada, G., Cattaneo-Vietti, R., Cau, A., Chemello, R., Greco, S., Manganaro, A., di Sciara, G.N., Russo, G.F. & Tunesi, L. (2008) Italian marine reserve effectiveness: Does enforcement matter? *Biological Conservation*, **141**, 699-709.
- 5 - Abdulla, A., Gomei, M., Hyrenbach, D., Notarbartolo-di-Sciara, G. & Agardy, T. (2009) Challenges facing a network of representative marine protected areas in the Mediterranean: prioritizing the protection of underrepresented habitats. *ICES Journal of Marine Science*, **66** 22-28.
- 6 - Mouillot, D., Albouy, C., Guilhaumon, F., Lasram, F.B.R., Coll, M., Devictor, V., Meynard, C.N., Pauly, D., Tomasini, J.A., Troussellier, M., Velez, L., Watson, R., Douzery, E.J.P. & Mouquet, N. (2011) Protected and Threatened Components of Fish Biodiversity in the Mediterranean Sea. *Current Biology*, **21**, 1044-1050.
- 7 - Grorud-Colvert, K., Claudet, J., Carr, M., Caselle, J., Day, J., Friedlander, A., Lester, S., Lison de Loma, T., Tissot, B., Malone, D. (2011) The ecology of marine reserve networks: challenges and opportunities for design and monitoring in Claudet J (ed.) *Marine Protected Areas - A Multidisciplinary Approach*. Cambridge University Press - Ecology, Biodiversity and Conservation Series, Cambridge, UK.

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