

Functional diversity loss in coralligenous habitats: effects of small-scale fisheries in a Mediterranean MPA

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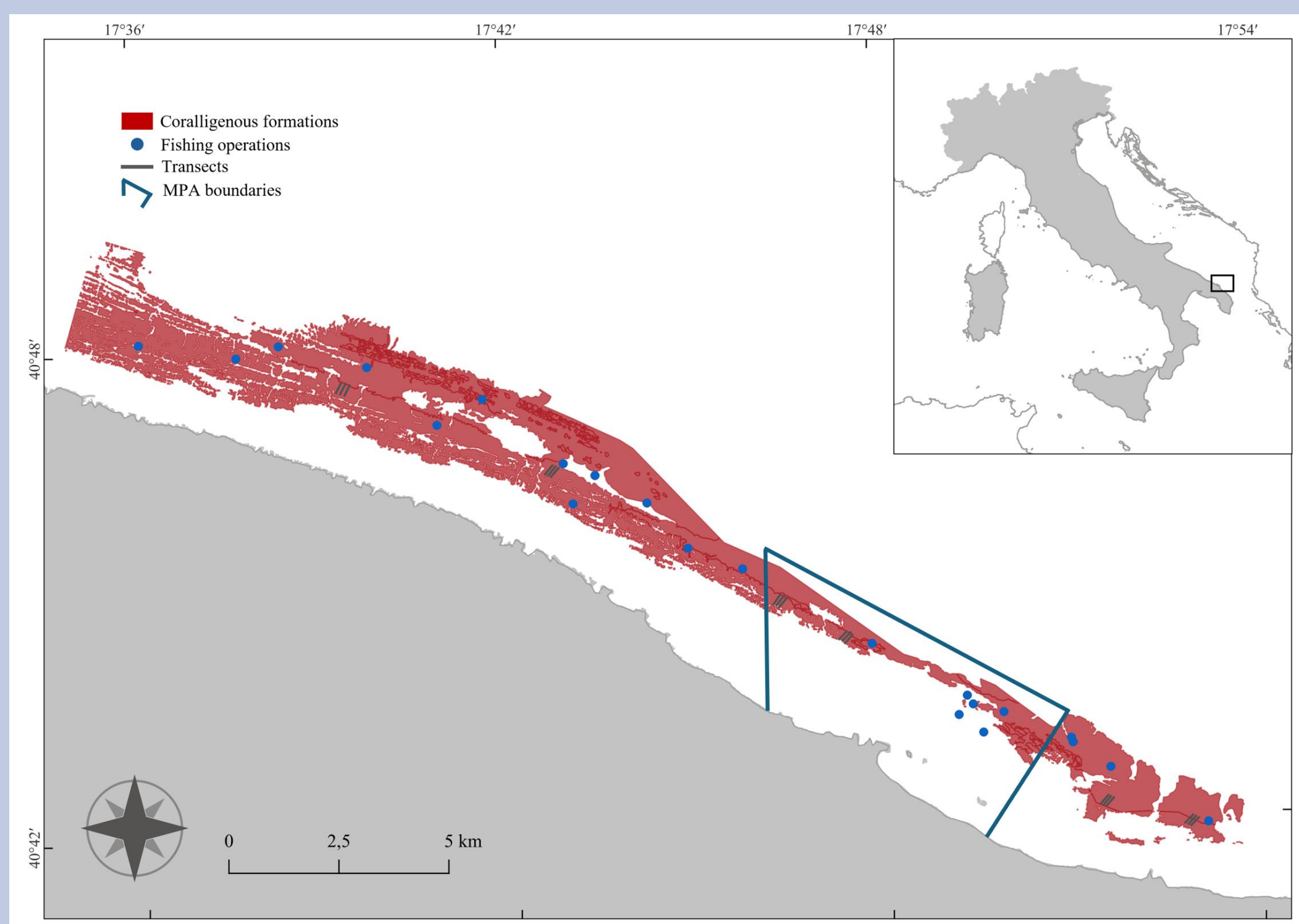
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Introduction and objectives

Small-scale fisheries (SSFs) represent the vast majority of the global fishing fleet and play a crucial socio-economic role in coastal communities. Conducted by small, low-powered vessels using selective, static gears and deeply rooted in local traditions, within Marine Protected Areas (MPAs), they are often among the few extractive activities allowed, yet their ecological impacts on benthic habitats remain largely overlooked. Understanding these effects is essential, as SSFs can significantly influence the structure and functioning of marine ecosystems. Functional trait-based approaches offer a powerful framework to explore how species' biological characteristics translate into ecosystem processes and how these processes respond to human pressures. This perspective is fundamental for developing sustainable management strategies that balance conservation goals with the socio-economic importance of artisanal fisheries, fostering a truly ecosystem-based approach to marine resource management.

Methods



Map of the study area within the Torre Guaceto MPA (Apulia, Italy).

The effects of trammel net operations on coralligenous habitats were investigated between April and September 2023 within the Torre Guaceto MPA (southern Italy). A total of 22 fishing operations were conducted using trammel nets with a 30 mm mesh size and 1000 m length. In addition, 18 transects of 100 m² each (three replicates per six sites) were surveyed to characterize coralligenous assemblages. Sessile benthic bycatch collected during fishing operations was photographed, measured, weighed, and identified to the lowest possible taxonomic level.

Using a functional trait-based approach (including traits such as morphology, size, growth rate, longevity, and feeding strategy), we quantified key functional diversity indices: **Functional Richness (FRic)**, measuring the range of functional traits represented within the assemblage and expressed as the percentage of the total coralligenous functional space (convex hull volume) occupied by the bycatch; **Functional Identity (FI)**, indicating the position of the assemblage's abundance-weighted centroid within the functional space; and the **Community Weighted Mean (CWM)**, representing the mean trait values weighted by the relative abundance of each species.

Conclusions

Benthic bycatch caused by SSFs exerts a measurable ecological impact on coralligenous assemblages, compromising 26% of the total functional space. The bycatch predominantly removes habitat-forming species, which are key to maintaining the structural complexity and functioning of these biogenic reefs, while opportunistic species are virtually absent. The Functional Identity analysis further indicates that fishing activities directly erode the structural integrity of coralligenous habitats by detaching their foundational builders. These findings are crucial for the development of sustainable management strategies and highlight that, to reconcile conservation objectives with the socio-economic relevance of artisanal fisheries, a truly ecosystem-based approach to marine resource management is essential.

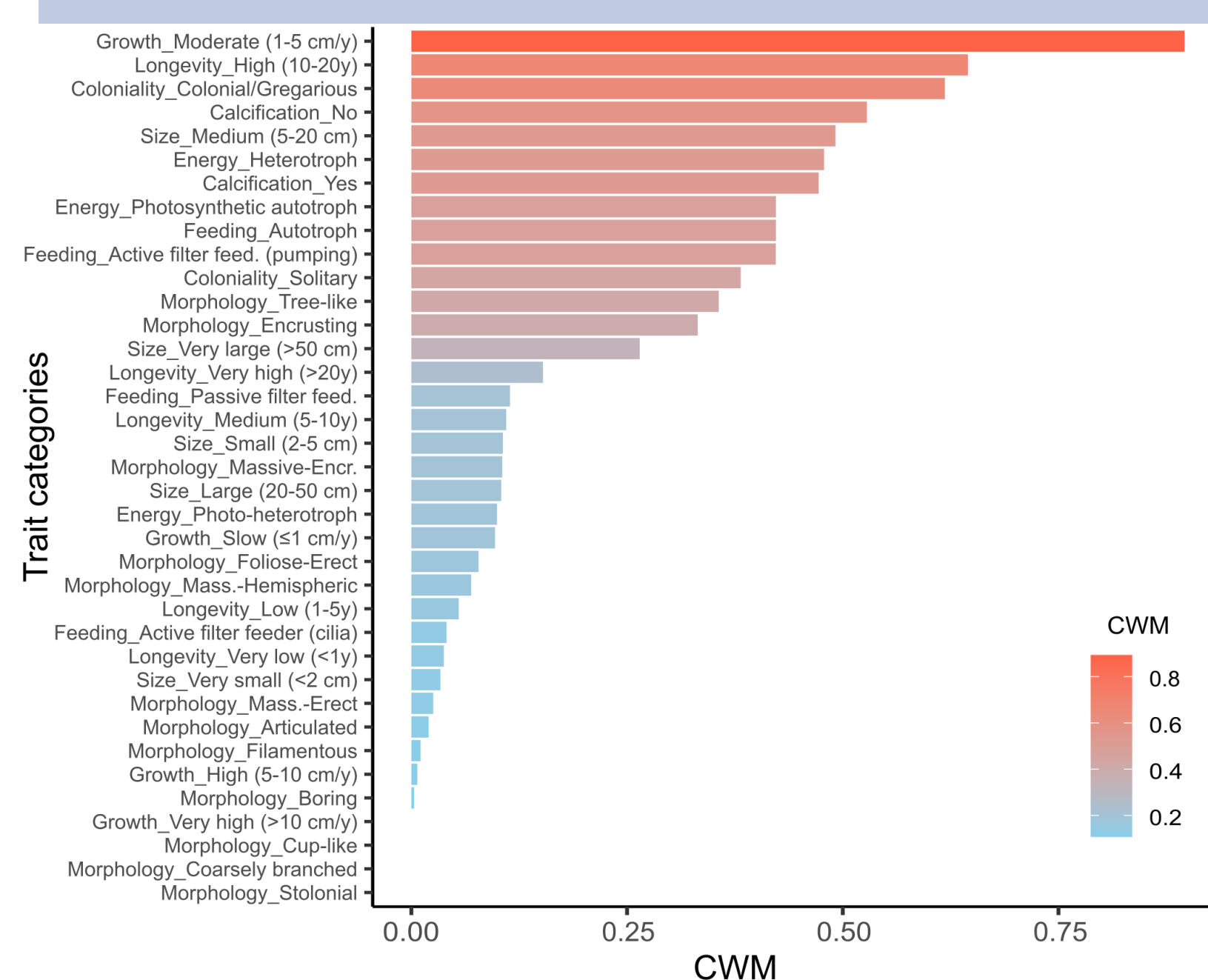
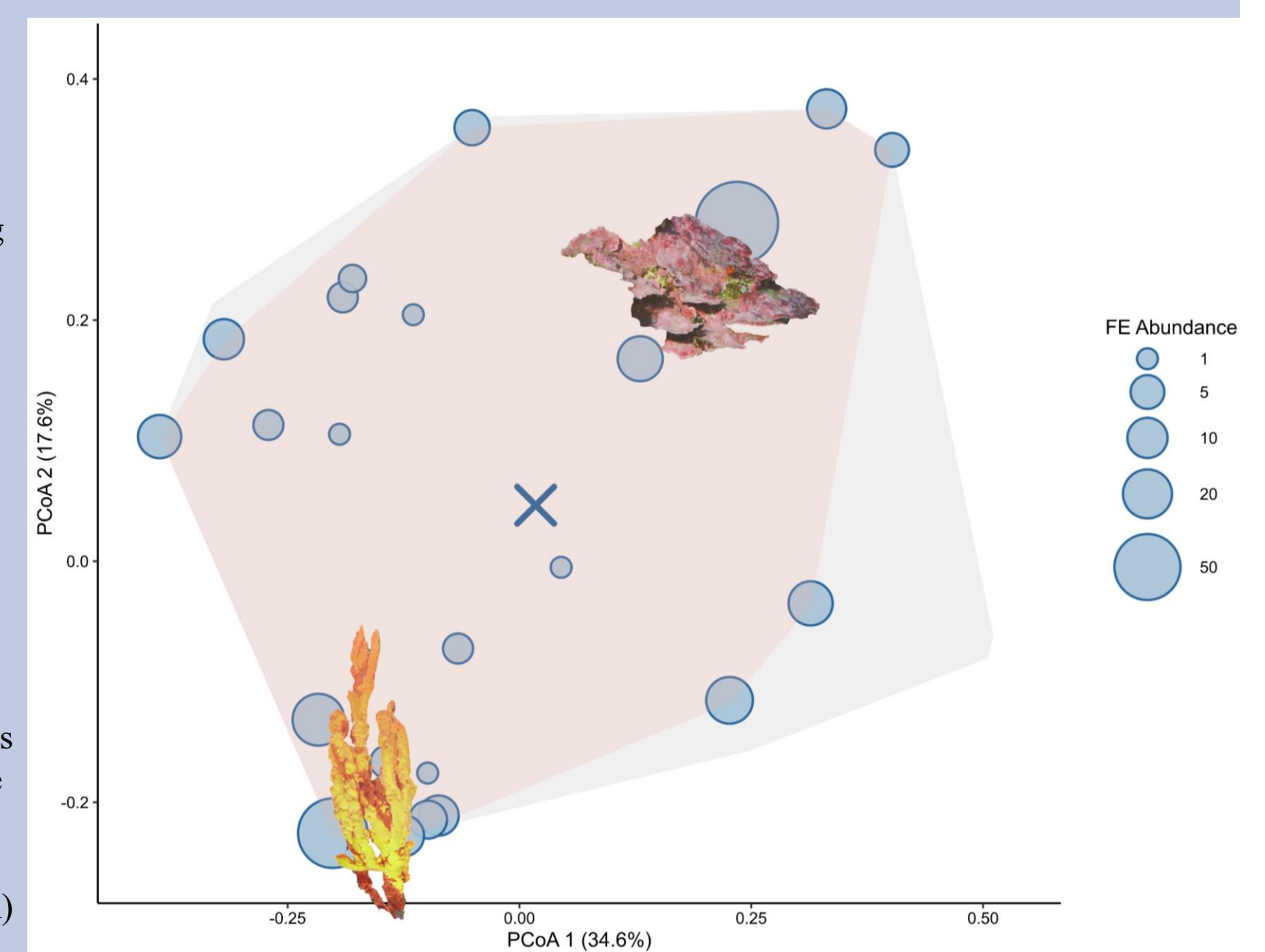
*Chiara Silvestrini, Alessandro Ciccolella, Paolo D'Ambrosio, Francesco de Franco, Luciana Muscogiuri, Simonetta Frascchetti. Small-scale fishery as a driver of habitat loss in marine protected areas, Journal of Environmental Management, Volume 394, 2025, 127464, ISSN 0301-4797, <https://doi.org/10.1016/j.jenvman.2025.127464>.

Results



Representative samples of sessile organisms extracted during fishing operations. Bycatch primarily consists of the sponge *Axinella cannabina*, the gorgonian *Leptogorgia sarmentosa*, and scleractinian corals (e.g. *Balanophyllia europaea*), often attached to rock fragments. Scan the QR code for video documentation of fishing impacts on coralligenous habitat*

Bycatch functional richness and identity: The pink polygon represents the FRic occupied by bycatch assemblages, corresponding to 26% of the total functional space characterized from coralligenous transects (grey polygon). Functional entities (FEs), groups of species sharing identical trait combinations, are shown as circles whose size is proportional to their abundance in the bycatch. The blue cross indicates the FI (abundance-weighted centroid) of bycatch assemblages. Photographic insets illustrate the main components driving the functional identity of the sessile benthic bycatch: *Axinella cannabina* (yellow sponge, lower) and encrusting coralline algae (ECR) on rock fragments (upper).



Bycatch functional traits profile: The bar plot displays **Community-Weighted Mean (CWM)** values, illustrating the relative abundance of each trait category within the bycatch assemblages (color gradient: red = highly prevalent, blue = rare or absent). Bycatch assemblages are dominated by organisms with moderate growth rates (1-5 cm/y), high longevity (10-20y), colonial organization, non-calcified structures, and heterotrophic nutrition (passive filter feeders). In contrast, traits associated with fast-growing, short-lived, small-size organisms, with articulated/filamentous morphologies, are almost absent from the bycatch.