

UNDERSTANDING THE EFFECTS OF FISHING ON FISH BIODIVERSITY : A CHALLENGE FOR THE ECOSYSTEM APPROACH TO FISHERIES MANAGEMENT

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Abstract

Maintaining species diversity has been recognised internationally as a priority for sustainable fisheries. An appropriate indicator of fish diversity trends resulting from fishing exploitation is still lacking. To shed light on underlying mechanisms of fish communities' responses to fisheries in terms of biodiversity, we analysed predator-prey interactions within demersal fish communities. In particular, we contrasted size-based fish diversity patterns with the spatial distribution of commercial fishing in the Central Tyrrhenian Sea.

Keywords : Biodiversity, Demersal, Fisheries, Trophic Relations, Tyrrhenian Sea.

Following the emphasis given to biodiversity within international agreements for sustainable development (Rio 1992 CBD, Jakarta Convention) and in line with the recent shift towards an ecosystem-based approach to fisheries management (EAFM), biodiversity protection has been adopted as a specific objective within fisheries policies (FAO Code of Conduct For Responsible Fisheries, 1995). Fisheries researchers are asked to provide indicators of ecosystem health to underpin such ecosystem-based management approaches [1]; however the way that fish assemblages respond to fishing exploitation in terms of diversity remains poorly understood - available studies show contradictory or inconclusive results [e.g. 2]. As a consequence, indicators of fish biodiversity are considered unsatisfactory metrics for management purposes [3], raising concerns regarding the adequacy of scientific support to these political commitments [4]. In particular, the Mediterranean basin, where phenomena such as climate change-driven tropicalization enhanced by Lessepsian immigrations of southern species, are compounded with over-harvesting effects, understanding biodiversity changes represents a crucial challenge for future environmental protection and human activities management.

We argue that an ecologically meaningful approach to the study of fisheries-driven species diversity changes is required. In this view we suggest that diversity should not be measured considering fish assemblages as a whole, as commonly done, but should instead be estimated within each trophic level present within the fish community, since diversity (i.e. species evenness) is known to be related to competition/predation interactions [5]. In marine ecosystems, trophic level scales with size and fishing is also a size-selective activity, generally targeting larger individuals. Thus fishing disturbance, while affecting the size distribution of fish communities, is also affecting their trophic structure [6]. Based on all these observations, we propose that an appropriate indicator of fishing effects on fish species diversity should be size-based.

The analysis of the distribution of biomass or diversity versus individual body size (size-spectra) provides a method to detect the differential response of large versus small size classes to fishing disturbance [7]. It has been frequently observed in strongly exploited marine communities that a reduction of top-predators, compounded with a positive selection induced by fisheries for smaller faster growing species, has triggered an increase in abundance of smaller fish. Based on Huston's Dynamic Equilibrium Model [5], we hypothesized that a further consequence of this is that a few dominant prey species, no longer kept under control by predatory pressure, expand at the expense of other species sharing the same resource, causing diversity to decline within this size-range. Our previous results from a case-study based in the North Sea [8] suggest that over-fishing of large piscivorous fish has indirectly caused a decline of species evenness of smaller forage fish through a predatory-release mechanism. However, the particular character of the Mediterranean basin, where an oligotrophic regime is expected to result in stronger bottom-up limitation than seen in the highly productive North Sea waters and stronger competitive interactions [9]. The fish community spans a smaller size-range, thus showing a lower degree of piscivory than northern regions, and harvesting strategies are more prevalently mixed fisheries. Therefore, different mechanisms are to be expected and call for specific testing of our hypothesis in the area.

We present here diversity and biomass size-spectra of demersal assemblages from the Central Tyrrhenian sea, sampled during routine trawl surveys from 1985-2005 (GRUND) and 1994-2005 (MEDITS) (for details see [9]). To detect fishing effects on these communities we compared the

diversity patterns of fish assemblages from an area that suffered intense commercial fishing exploitation with those from an area where disturbance has been less intense. Furthermore, in an attempt to disentangle changes in smaller size-classes due to predatory release effects from fisheries-driven positive selection of smaller fast-reproducing individuals, we estimated the predator-prey size ratio for piscivores, based on stomach-content analyses, and explored life-history characteristics of the component of the fish assemblage at the lower end of the size spectrum.

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