

Loss of functional diversity of fish due to intense fishing causing ecosystem-wide effects in Mediterranean sublittoral rocky reefs

By Paolo Guidetti

MARINE ECOSYSTEMS MAY undergo dramatic changes (for example, shifts between alternative community states, changes in ecosystem functioning and food-web disruption) because of the wide array of anthropogenic impacts they are usually subjected to (Pauly *et al.*, 1998; Jackson *et al.*, 2001).



The sea bream *Diplodus sargus sargus*, predator of adult and juvenile sea urchins in Mediterranean sublittoral rocky reefs.

This is especially true in regions like the Mediterranean basin where human populations tend to concentrate in coastal areas and where extractive activities (especially fishing) are historical and intense. Assessing direct and indirect impacts of fishing on natural communities (and the spatial and temporal scales at which they act) is one of the major challenges marine ecologists have to tackle worldwide in order to refine appropriate policies for an ecosystem-based management of fishery (Pikitch *et al.*, 2004).

As in many other temperate regions, there is increasing evidence that sublittoral rocky reefs in many sectors of the Mediterranean Sea are shifting from macroalgal beds to barrens or areas without vegetation, usually caused by excessive grazing. This transition has often been attributed to changes in the rate herbivores (especially sea urchins) feed upon erect macroalgae as an indirect consequence of human activities (Sala *et al.*, 1998; Guidetti *et al.*, 2003). In coastal waters, erect macroalgae (together with seagrasses) exert paramount ecological roles: they are among the most important primary producers, contribute to the availability of detritus (which can also be exported into deep seas) and provide sizeable structure where many fish and invertebrate species (both as juveniles and adults) find shelter and food. Biodiversity in macroalgal beds, in addition, is far higher than in coralline barrens, as observed in other temperate regions (Graham 2004).

Sea urchins overgraze erect macroalgae especially when at high density, a condition that depends on several factors such as recruitment and the occurrence of mass mortalities, but there is increasing evidence that predators can be capable of controlling sea urchin population density (Sala & Zabala 1996; Guidetti 2004a; Hereu *et al.*, 2004). The most effective sea urchin predators in the Mediterranean Sea are a few species of fish, mainly represented by sea breams (preying upon juvenile and adult urchins; e.g. *Diplodus sargus sargus*, pictured), and, secondarily, by wrasses (that feed only upon juvenile urchins; e.g. *Coris julis*) (Sala 1997; Guidetti 2004b). Density and size of sea breams, in particular, can be drastically reduced by fishing (to their functional extinction), which may be reflected as lower predation impact on sea urchins (Guidetti 2004a). When released from predator control, sea urchins increase in abundance and overgraze erect macroalgae, thus causing the transition to barrens. Fishing, by strongly and selectively impacting sea breams (Harmelin *et al.*, 1995; Guidetti & Sala, unpublished data), may thus decrease the functional diversity of the fish predator assemblage in subtidal rocky reefs. This, consequently, may have cascading effects on the entire community and ecosystem functioning, as macroalgal beds and coralline barrens are structurally and functionally very different.

Scientific evidence of the trophic cascade involving fish, sea urchins and macroalgae triggered by fishing is restricted to a few areas of the Mediterranean basin. Trophic interactions, however, may change depending on the species (or trophic groups) involved, and may be context-dependent (O'Connor & Crowe, 2005). Both assemblage diversity and environmental contexts, from this perspective, may change in space (e.g. with latitude) and time (e.g. seasonally or on a multi-annual basis).

Further experiments, correlative and/or historical analyses, therefore, are more than welcome with the aims (1) to depict scenarios that may help understand possible thresholds in the density of strongly interactive species (e.g. keystone predators) that may push ecosystems to the brink, and (2) to plan appropriate management of fisheries based on the perception that ecosystem functioning and community structure may depend on the intensity of exploitation of high-level fish predators. The MarBEF RMP "Causes and consequences of changing marine biodiversity: a fish and fisheries perspective," led by Brian MacKenzie and Pascal Lorange, will provide an opportunity to deepen existing knowledge in some of these key areas and also to compare and contrast different results and experiences from areas outside of the Mediterranean, thus helping to refine management decisions, for example the management of coastal fisheries.

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Biodiversity Conservation

Europe's role in conserving biodiversity through a sustainable marine aquarium trade

By Paul Holthus

EUROPE IS THE second major importer of coral reef organisms for home aquariums. Marine ornamentals come primarily from developing countries with high marine biodiversity. International certification now enables importing countries to transform their ecological footprint in the aquarium trade from one that potentially supports destructive fisheries to one that conserves biodiversity, reduces poverty and creates sustainable livelihoods – thereby implementing the Convention on Biological Diversity. Several European marine ornamentals importers are MAC-certified, with many retailers soon to follow.

Despite the importance of coral reefs in sustaining human life and livelihoods and as one of the world's most diverse marine systems, the majority of the world's reefs are threatened by human activity. A responsible marine ornamentals trade has great potential to provide an incentive to coastal communities to protect their coral reefs from these threats and to thus ensure that they can continue to support biodiversity and economic benefits.

Approximately 45 countries, mostly in the developing world, supply marine ornamentals, with the Philippines and Indonesia as the largest exporters, with an estimated 7,000 marine aquarium collectors in the Philippines alone. Aquarium animals are the highest value products possible to harvest sustainably from coral reefs. Aquarium fish sell for about EUR 90.00/kg compared to food fish at EUR 1.00/kg. On average, live coral is worth EUR 1.30/kg, while crushed coral for lime sells for EUR 0.01/kg. An environmentally responsible high-value aquarium fishery can alleviate the poverty that drives people to use destructive fishing practices, such as blasting with dynamite to gather food.

Marine Aquarium Council (MAC) certification

Many aquarium-fish collectors and industry members use practices that prove it is possible



Collectors' gear, Bohol, The Philippines.

to harvest marine ornamentals in a responsible, environmentally-sound manner. However, in some areas collection methods are used that destroy coral reefs. For example, some collectors use sodium cyanide to stun fish for easy capture, at the same time harming target and non-target species, including the reef-building corals themselves. Some collectors, exporters, importers and retailers also use poor post-harvest handling and transport practices resulting in unnecessary mortality of harvested animals.

The Marine Aquarium Council (MAC) is an international not-for-profit organisation that brings together the marine aquarium industry and hobbyists, public aquariums and conservation groups as well as government agencies and international organisations to support reef conservation and a sustainable marine aquarium trade. MAC certification was launched in late 2001, following years of input and review through an international, multi-stakeholder process to develop standards of best practice for quality and environmental sustainability. The certification provides third-party verification and labelling to identify responsible operators and their products that comply with MAC standards, allowing consumers to choose and support responsible operators and sustainable products.

MAC certification is designed to transform the existing marine ornamentals trade and does

not promote the trade where it does not exist. For example, only non-destructive methods are allowed, and catch levels must remain within the limits of sustainability as proved by independent scientific assessment and monitoring. MAC certification also requires a reef management plan developed through multi-stakeholder involvement at the community level, including establishing a marine protected area, such as a 'no-take sanctuary' for reef fish.

Reef, fish and fisheries monitoring/management

It is critical to have a sound scientific understanding of the status of marine aquarium organisms and their coral reefs so that an informed decision can be made about sustainable-use levels and reef management. MAC requested the Global Coral Reef Monitoring Network (GCRMN) to develop methods to assess the status and condition of reefs and fish stocks in collection areas and evaluate the effectiveness of management by monitoring coral reefs and populations of exploited organisms and 'control areas' to determine if marine ornamentals collection has ecologically significant effects on overall reef ecosystem health or target species' populations.

Reef Check (a GCRMN member) developed the Marine Aquarium Trade Coral Reef