

The Importance of Marine Protected Areas (MPA's)

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Coral reefs are one of the marine ecosystems that face numerous threats around the globe. Over-fishing, pollution and elevated seawater temperatures are all human induced disturbances that have severe effects on coral reefs. Several studies have pointed on the importance of undisturbed environments as essential sources of genetic material and functions for marine ecosystems.

A large part of the human population lives along tropical coasts and are depending on the sea as one of their main sources of food and income. The migration toward the coastal cities are increasing and as a result also the pressure on the coastal resources. Decreasing resources and increasing population is a critical situation for most countries. One of the most affected systems are the marine ecosystems. Fishing has gone from being a local traditional source of knowledge to become a new income source for young migratory people. To increase the catches, the fishing methods have changed from small boats to larger vessels, more fishermen, finer nets and longer hours at sea. The traditional hook and line method are being replaced by other techniques which of many are harmful to the marine environment. Since such a large part of the population is depending on the marine environment for their everyday living, it is important that the exploitation is sustainable.

All ecological systems in the world are made up by different functional groups. A functional group is a group of species that perform the same function (e.g. piscivores, herbivores, planktivors etc). Herbivory is one essential ecological function on reefs. Herbivorous species feed on algae and therefore keep the algae population in control and prevents it from growing over corals and dominate the reef. Algae and coral compete on the reef for sunlight and space and without herbivorous species present, algae would grow over corals and shade them, leading to coral death.

The herbivorous function is not just performed by fish but also sea urchins contribute to the grazing on algae. Three different herbivorous feeding modes are yet known to the scientists: grazing,

scraping and bioeroding. One family of fish can be categorized into all three modes; the parrotfish (Scaridae) (fig.1). This makes the family of parrotfish essential for herbivory on coral reefs. By grazing algae they keep them in an adequate height and prevent them from overgrowing and shading corals. Some parrotfish species also scrape the surface on the coral and as a result opens up bare substratum beneficial for new coral larvae settlement. Bioeroding species have a stronger jaw and make bites of more notable depth than other parrotfish and contribute to the bioerosion of fragile substrate on the reef and help maintain a healthy structure of reef.

A study conducted at Zanzibar comparing three reefs (Chumbe (marine sanctuary), Nyange and Bawe) of different level of disturbance for one scraping species of parrotfish (*Scarus niger*), showed that these parrotfish were better at scraping and had a higher daily scraping function in the protected area compared to the non-protected areas (Johansson unpublished). This indicates that *S. niger* on Chumbe is better at removing algae and thus opening up more bare surface where coral larvae can settle. The main reason for this is the lack of fishing pressure at Chumbe. Since no fishing is allowed within the protected area, the system holds larger individuals, more individuals and a less disturbed environment to feed in.

The study further indicates that the largest individuals are the best and most important scrapers. Fishing always targets the large individuals first and considering the fact that these are the most important scrapers it can have devastating effects for the coral community. Furthermore, targeting large individuals can also result in a decrease of the fish population, because the quantity and quality of fish eggs will reduce with reducing fish size.

Bearing these results in mind, over-fishing of this species would have severe effects on the coral reefs since the algae population loses a significant predator. This would benefit the algae population which could increase, overgrow and shade corals leading to coral death.

Fishing is one of the main threats to herbivory and has developed into being a non-selective method and targets all species. Large predatory fish is often prime target and when these populations decrease in number, large herbivores become targets. A reduction in large herbivorous fish has in many parts of the world resulted in a shift from coral dominated reefs to algal dominated reefs. This has led to major changes in the coral species composition on the reefs which in turn has come to affect man. However, there are herbivorous species that might not be targets of fishing like sea urchins (Echinoderms) who can maintain an herbivorous

function on the reefs and graze the algae population (fig. 2). Sea urchins have one major drawback, they are important bioeroders and do not just feed on algae but also bite the coral surface. They are good reproducers and can easily increase their population to numbers that make them harmful for the coral reef instead of beneficial.

To maintain a good marine environment it is important that there are numerous species present from each functional group (piscivores, herbivores, planktivors etc). This is hard to uphold when the pressure on the marine resources are as high as today. Marine protected areas (MPA's) of any kind contribute to diversity by acting as disturbance-free zones, where the ecosystem gives a chance to develop a rich web of functions and species. These protected areas become sources to other adjacent reefs in terms of exchange of genetic material. Further they can act as seasonal spawning grounds and zones free from anthropogenic disturbances (such as fishing, boating, diving etc.) and contribute to the dispersal of different functional groups between reefs. Studies have stated that the 'catch-per-unit-effort' (CPUE) is higher close to reserve borders, meaning that the number of fish caught close to the protected area is higher than further away from the reserves.

In the study of reefs at Zanzibar discussed earlier, fish on the protected reef, Chumbe, were the best scrapers. The second best scrapers were found on Nyange, which was the closest reef to Chumbe. The fish on Bawe, situated closest to Zanzibar Town, did not turn out to be good scrapers. For Nyange, the closeness to Chumbe most likely played a significant role for the *S. niger* population in terms of migrating species between the two reefs. An other important factor is the difference in fishing pressure and anthropogenic disturbances like tourism and pollution between Nyange and Bawe, indicating that stressors affect the scraping function for the *S. niger*. The study therefore demonstrates that in the protected marine environment, fish have a higher herbivorous impact on the reef and are better scrapers regardless of size.

Protected marine environments are beneficial tools in the attempt of having sustainable ecosystems. The advantages gained from protected areas can also be seen in adjacent reefs and has proven to increase the fish catches and creating new sources of income (eco-tourism etc). Management of an open resource, such as coral reefs, is tricky. Restrictions and regulations may exclude people from doing what they have always done and may not always be welcomed. But protections are needed to create a sustainable environment which can act as source for food and income in decades to come.



Fig. 1. Parrotfish are a diverse family of fish with a world wide distribution. Their name originates from their parrot-like mouth, shaped as a beak. Parrotfish are diurnal implying activity only during days and can be found sleeping in caves and holes covered by a mucus cocoon at night. Parrotfish are sex-changing species and go through three life phases all followed by a different colour phase. The upper photo showing *Scarus niger* (initial phase). Middle photo showing parrotfish bite marks on live coral. Below to the left: parrotfish jaw. Below to right: sleeping parrotfish in mucus cocoon (the two upper photos by Lokrantz).



Fig. 2. Sea urchins feeding on coral (photo by Lokrantz).