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Are Closed Areas the Solution for Fisheries Management?

Cheryl Rita Kaur
Senior Researcher / Head of Centre for Coastal & Marine Environment

There is strong scientific consensus that closed areas contribute towards increased abundance of fish, protect against the risk of fishery collapse, and guard against the shortcomings of other environmental management tools. Studies at some areas have shown that protected spots experienced a rapid increase in fish numbers. While closed areas may offer promise for the conservation and management of marine fisheries and their habitats, there are however, mixed views on their benefits. Critics argue that most commercial species are too mobile to benefit from closed areas; whereas fishermen worry that it would reduce their fishing grounds, and thus affect their catches. Cheryl summarises that well enforced closed areas have great potential to maintain or enhance fishery catches and increase sustainability, but they cannot be considered as the solution to the problem of dwindling global fisheries stocks. The potential in improving fisheries management towards better yield will be limited unless the roots of management failures are addressed. These hugely requires reductions in fishing mortality, better enforcement strategies, improved design and selection of suitable sites as fisheries closed areas, and increased transboundary cooperation among countries on migratory fish species.

Introduction

Global distribution of fishing grounds is patchy and localised, with the primary and most important fishing grounds concentrated along continental shelves within less than 200 nautical miles of the shores (Garcia et al., 2007; Nellemann et al., 2008; Roberts et al., 2006). Over the last decade, there has been continuing exploration and depletion of fisheries stocks in these areas, with varying degree of recovery among species. For instance, the published data by the Food and Agriculture Organisation (FAO) (2010) indicated that many fish stocks are under pressure from overfishing (Figure 1). Various other literatures show that the trend continues, if not worsen in many areas globally.

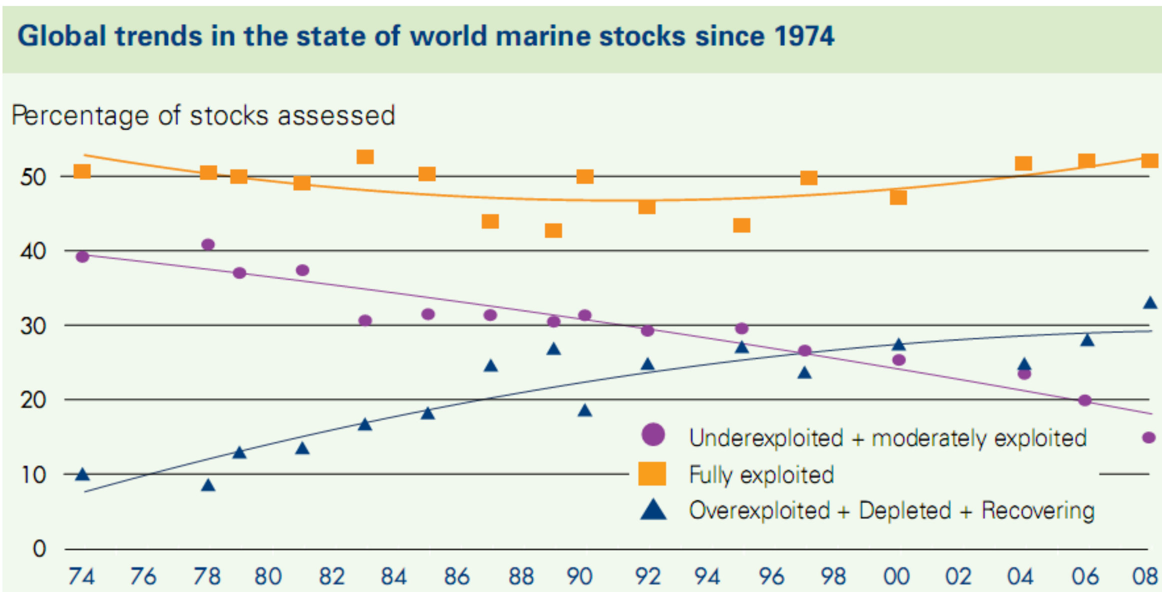

Figure 1. Many fish stocks monitored by FAO are under pressure from overfishing.
Source: FAO (2010)

The increase in global fishing efficiency due to technical improvements and investments has been contributed to the overall increase in fishing capacity. If more fishes are caught than the amount of fish being added to the stock through reproduction, hence the size of the stock decreases or even collapses. Catches are generally declining as most fish are being taken at a premature age when they are still small, and thus the regeneration of stocks would be adversely affected. This is further causing a decline in mean trophic level of catches (Watson & Pauly, 2001).

Fish biologists are generally concerned that it is not the direct global extinctions of species, but the regional or local extinctions being more common, as abundance declines (Hutchings, 2001). There are further indications that marine extinctions may be significantly underrated (Casey & Myers, 1998; Edgar et al., 2005). Impacts brought about by large-scale, long-term fisheries exploitation have been also reported to cause permanent changes to the ecosystems (Dayton et al., 1995; Jennings & Kaiser, 1998; Russ & Alcala, 1989). It is forecast that more depletion and species extinctions may follow if fishing intensity is not reduced, especially in sensitive environments (Morato et al., 2006). Unfortunately, scaling back commercial fisheries exploitation has been somewhat difficult, mainly due to the overcapitalisation of fisheries, which makes it difficult for those with investments in fisheries to reduce effort (Pollack et al., 2008).

Measures to address overfishing

Several measures were introduced at national and international levels to control fisheries. For example, the concept of maximum sustainable yield (MSY) was introduced to avoid overfishing, and this was perhaps one of the longest used global measures. This limited the greatest quantity of fish that can be caught without the stock being adversely affected (Bousquet et al., 2008). Later, the setting of a total allowable catch (TAC) was introduced which prescribes how much fish may be caught from a particular stock over a specified period (Karagiannakos, 1996), with the setting of quota systems. In addition, gear regulations were introduced, which include the minimum allowable mesh sizes (to reduce bycatch of non-targeted species) and types of fishing gears used by fishermen. Other important measures included limiting the number of vessels allowed to fish, zoning fishing areas according to types of fishing vessels, limiting the number of days allowed for fishing, as well as providing subsidies to fishermen. Unfortunately, all these measures had their peculiar drawbacks. One major limitation was especially the inadequacy of reliable data to support the measures, besides enforcement issues. With the dwindling fishery resources, it is apparent that these regimes have not led, so far at least, to improved management of fisheries.

Further, as the damage caused to the marine environment become more widely acknowledged, marine closed areas began to feature in international agreements as well as in national conservation programmes. These areas are increasingly being used not only to protect biologically rich habitats and restore degraded areas, but also to restore overexploited fisheries stocks based on an ecosystem-based management approach (Beddington, 1995; WCPA-IUCN, 2008).

Introduction to closed areas

The definition of 'closed areas' as used in most studies, is not clear and is often used inter changeably and causes semantic difficulty (Agardi, 2000). They have been referred to as *fisheries closed area, fisheries refugia, natural reserve, harvest refugium, marine park, marine protected area,* and *marine sanctuary*. Their establishment not necessarily, but often, eliminate all consumptive uses, and in particular fishing activities.

Closed areas can, however, differ from being small areas to vast reserves intended to achieve a range of conservation, economic, and social objectives which encompass different types of protection levels (i.e., ranging from multiple use to areas of complete protection; as well as in being permanent or seasonal closures). The scales of establishment vary between global, regional, and national levels. Global initiatives are fostered through international conventions such as the Convention on Biological Diversity (CBD), regional efforts by nations working together to ensure ecological important areas (i.e., spawning grounds) are managed through coordinated enforcement, and the critical role of national governments in ensuring coordination across agencies (i.e., fisheries, port authorities, and environmental departments) (Orbach and Karrer, 2010).

In general, there are different means for the design of closed or protected areas. These can be categorised into three basic approaches according to the nature of the intervention by which they get established (Table 1).

Table 1. *Basic designs of closed areas*

Approach	Nature of establishment	Nature of intervention
Preservation of ocean or coastal 'wilderness' areas that remain relatively pristine and are usually chosen for their high diversity.	The protection strategy is adopted before degradation occurs.	Proactive
Resolution of conflicts among users (current or future).	The protection strategy aims to resolve conflicts between users.	Interactive
Restoration of degraded or overexploited areas.	The protection strategy is designed to avert continued degradation.	Reactive

Source: Adapted from Agardi (2000)

Expected benefits of fisheries closed areas

The promotion of closed areas for fisheries management is not something new, and has been in existence for more than a decade now. They are, however, being increasingly emphasised via the growing body of research on the matter. The basic expectation of designating closed areas for fisheries management is that the spatial closure will act as a refuge for local fish communities, enhancing their densities and diversity; which would then have a positive effect on fishery resources in the surrounding waters as adult fish may migrate and/or fish larvae might disperse beyond the park areas (Lauck et al., 1998; Roberts & Polunin, 1991). One can basically define five basic expectations of marine reserves, both inside and outside the designated area (Table 2). Generally, to be effective as a fisheries management tool, a closed area should display net export of fish biomass that more than compensates for the loss of fishing area required to set up the area (Russ, 2002).

Table 2. *Expectations of marine closed areas.*

Effects inside reserves	**Effects outside reserves**	
1. Lower fishing mortality than in fished areas. 2. Higher density of target species. 3. Higher mean size/age of target species. 4. Higher biomass of target species. 5. Higher production of propagules (eggs/larvae) of target per unit area.	Effects number (1-4) results in net export of adult fishes (the "spillover effect"). These simply arise because higher densities of larger than average fishes occur in reserves and these fishes flux randomly across the unfished-fished boundary.	Effects number (1-5) results in net export of eggs/larvae (the "recruitment effect"). The result is an enhanced supply of recruits to fished areas.

Source: Adapted from Russ (2002)

Fishery benefits from closed areas: Success stories

In many cases, traditional fisheries management (i.e., effort and catch controls) has generally failed to prevent massive overfishing globally. Therefore, closed areas are increasingly seen as portions of the sea that could provide refuges where populations of exploited species can recover and habitats modified by fishing could regenerate (Gell & Roberts, 2003). To some extent, experiences at some closed areas have shown a rapid increase in fish numbers. For examples, below are some of the related findings (this list is non-exhaustive):

i. Buxton and Smale (1989) highlighted that the densities of a commercially important sparid fish, *Chrysoblephus laticeps*, were estimated to be 42 times higher in the Tsitsikamma National Park in South Africa than in nearby fishing grounds.

ii. Francour (1991) proved that the densities of 11 fish species in the Scandola Nature Reserve in Corsica were five times higher in the reserve than in the fished sites (after 13 years of protection).

iii. Russ and Alcala (1996) demonstrated a significant decline in catch rates and total catch of the coral reef fishes at Sumilon Island in the Philippines (under 10 years of protection from 1983-1993), after the marine reserve was heavily fished.

iv. Work by Murawski et al. (2000) showed that the seasonal closing of three large areas totalling 17,000 km^2, which were important to groundfish spawning and juvenile production on George Bank in the Canadian portion and in Southern New England afforded significant protection to the shallow-sedentary assemblage of fishes. However, the closures afforded less year round protection to migratory fish groups. Their study emphasised that with new regulations imposed on gear restrictions in the open areas contributed further to the observed reductions in stock-wide fishing mortality rates. This case is also particularly interesting as it showed that the level of protection afforded to various fishery stocks by closed areas is basically determined by the (1) proportion of a particular stock encompassed by the closures, (2) extent of movement by vulnerable sizes out of closed areas (either random or seasonal movements), and (3) level of fishing-effort and other regulations in adjacent open areas.

v. Albogast et al. (2004) compared the density of the blackspot snapper, *Lutjanus fulviflamma* (Forsskal 1775) in Mafia Island in Tanzania with adjacent intensively fished areas. The species was four times more numerous, its biomass 6-10 times higher and individual sizes on an average 37 percent larger on reefs in the protected area compared to the fished area.

vi. Roberts et al. (2006) argued that reserves should be incorporated into modern fishery management as they can achieve many things that conventional tools cannot. However, the publication further suggested that only complete and permanent protection from fishing could save sensitive habitats and vulnerable species.

vii. A spatially explicit dynamic population model developed by Quesne and Codling (2008) to examine factors on optimal closure size and the resulting yields showed that for over-exploited stocks, greater benefit from closed areas can be obtained for highly mobile species; but this requires a closure of 85 percent of the total area. This study also proved that using several closed areas rather than a single larger one would reveal the same effect. Additionally, it was illustrated that adult spillover had greater potential to improve yield compared to larval transport.

Challenges faced in using closed areas for fisheries management

Marine closed areas are principally different from terrestrial areas, mainly due to the nebulous nature of boundaries in the marine environment (Steele, 1998). Most fish stocks migrate often considerable distances during the course of their life cycle. This has important implications as far as jurisdictional boundaries in the sea are concerned. Furthermore, most stocks are inter-related, either in the sense that one stock feeds on another, or in that they inhabit the same area (Hilborne et al., 2004) often resulting in fishermen fishing for one species ending up taking other species as by-catches. It is therefore important to also reduce pressure outside closed areas. The study by Hannesson (1998) suggested that little would be gained by establishing fisheries reserves without applying some measures that constrain fishing capacity and effort outside the areas.

The long-distance dispersal and the vastness of linkages between critical habitats in coastal and marine ecosystems require comprehensive understanding and management (Mooney, 1998). The major limitation however includes critical considerations of scientific evidence of where recruits come from and what affects their success (Gaines & Bertness, 1992). Perhaps one way to address the issue of scientific uncertainty would be the establishment of a network of closed areas, mainly as there would be a high probability that productivity will be maintained (Agardi, 1994; Allison et al., 1998).

It is acknowledged that short-term reductions in use may be necessary to ensure the long-term viability of the population or habitat (Pressey & Taffs, 2001). However with increasingly scarce resources, setting aside additional areas for conservation can be a highly contentious and complex process involving many tradeoffs. Protection of a fish stock, for example, often involves reducing the economic, social, and nutritional benefits from the harvest of that species or population. The major concern here would be to obtain participation from the fishermen. It is anticipated that only until the effectiveness of protected areas in maintaining and even increasing catch is demonstrated, there would always be opposition especially from the fishing community.

Governance and enforcement are also among the critical factors in managing protected areas. There are several different arrangements such as national governance systems, co-management, and community governance (Samonte et al., 2010). These arrangements can be at the national level or extend across boundaries. As for enforcement, it can be in the form of soft measures (i.e., education and partnerships) or hard measures (detection, interception, prosecution, and sanctions). For instance, addressing issues such as illegal, unreported, and unregulated (IUU) fishing undermines national and regional efforts to manage fisheries sustainably. However, financial or logistical factors are often seen as the limiting factors towards governance and enforcement capabilities.

While there are projections of collapse in global fisheries as a result of over-exploitation, it is also a concern that such collapse may arise even earlier as a result of multiple stressors on the ecosystems and habitats required to sustain fisheries (Brander, 2007). These include climate change, degradation caused by pollution from land and sea-based sources, and destructive fishing practices. Hence, building resilience and strengthening the natural buffers of marine ecosystems or habitats has to become an essential element and consideration in the conservation for maximum success in fisheries management. Establishing closed areas in this case, would not only help achieve fishery conservation, but also broader biodiversity and ecosystems resilience objectives. This however requires focused studies on the appropriate size and location of closed areas and their combination into networks, as well as careful planning and evaluation.

Reflecting on the situation in Malaysia

Although there is evidence to suggest that closed areas play an important supporting role to the fisheries industry, almost all of this evidence came from research and published materials outside of Malaysia. In general, there is limited information available on the fish larval dispersal patterns, fish population distribution, as well as species abundance inside and outside the marine parks islands in Malaysia. There is still uncertainty on the level of contribution and success of these marine parks as one of the important fisheries management tool available in the country.

The dearth of research in Malaysia on this issue is a cause for concern because of the size of the fisheries sector, its impact on the marine parks and the growing importance of the sector for the country's food security. This relationship however should not be viewed in isolation of the other activities occurring in the marine parks and on the marine park islands. Development and visitors also impact the marine ecosystems the marine parks are meant to protect and would indirectly impact the fisheries sector. The links between these activities highlight the importance of cooperation between the various stakeholders involved in the management of marine parks (be it the enforcement authorities, fisheries administration, environmental protection, development planning or the private sector) in ensuring that marine parks are able to continuously support the fisheries sector and vice-versa.

The way forward

It is often claimed that sound policy making requires sound science. Research on the role of closed areas in supporting the fisheries sector needs to therefore be improved to provide empirical evidence of this relationship, and subsequently to enhance fisheries management. If carefully planned and grounded in good scientific understanding of ecosystem dynamics, closed-area designations can be an effective tool to complement other fisheries regulation. Collaborative research is important as the information has to come from many disciplines, not just marine biology or ecology, but also social and economic. This information would serve as important tool in convincing policy-makers as to the need for more judicious development of closed areas for fisheries management.

It needs to be acknowledged that the effectiveness of a close area depends on its objectives, design, and level of enforcement. These entail a number of crucial actions which include: (i) optimising design of a closed area based on the interaction between larval dispersal, adult mobility, and fishing mortality, (ii) evaluating the effectiveness of the area in achieving its intended objectives by continuous monitoring, and (iii) reducing fishing efforts outside the closed areas.

An increased focus must also be devoted towards building and strengthening resilience of coastal and marine ecosystems as a whole. This is necessary as they are of crucial importance as fisheries habitats. Actions towards reduction of coastal pollution, establishment of more protected areas through the protection of critical ecosystems, and stronger regulation of fisheries have all to go hand in hand. Unless these actions are taken immediately, the resilience of most fishing grounds and their ability to recover will diminish.

Conclusion

The establishment of closed areas for fisheries management can contribute to a strong foundation to address challenges in fisheries resource conservation. However, they are not the solution to global fisheries management problems due to their limitations. To achieve their objectives, closed areas need to be designed and managed effectively, taking into consideration the socio-economic needs of their surrounding communities. They also need to be part of an effective broader framework that addresses management across sectors by taking into account effective policies, planning and management at local level as well as beyond national boundaries. At the same time, their potential in improving fisheries management and fisheries yields will be limited unless the roots of management failures are addressed, for example reducing fishing mortality outside the closed area, better enforcement strategies, and improved design and selection of suitable sites as fisheries closed areas.

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