5.6.2 Bans or moratoria

Definition

A long-term cessation or prohibition of fishing, i.e. for periods >1 year.

In contrast with other permanent closures like MPAs or No-take zones, bans or moratoria are temporal closures and cover a large part, or all, of a fishery.

Use

A "ban" or "moratorium", allows sea cucumber populations to recover to levels at which breeding stocks can be dense enough to allow positive per-capita population growth. They are generally set in place where the resource is overexploited to the extent that other management measures would not be enough to allow populations to recover within a satisfactory time frame. Here, a complete ban on further fishing is a necessary admission that the previous management regulations were insufficient.

Moratoria can also be placed at the onset of a developing fishery or where the status of the resource (i.e. abundance and body size frequency) is uncertain. These measures allow the manager some time to develop management plans or to evaluate the current status of stocks. In this case, moratoria are the most precautionary regulation in the interim period of developing other management plans.

Limitations

An immediate consequence of imposing bans can be conflicts with fishers who depend on the resource or have a traditional or historical attachment to fishing sea cucumbers. Social acceptance is low where fishers have limited options to shift to other means of gaining income for their livelihoods. Where there is strong attachment to the resource, a ban can lead to a black market in illegal capture of sea cucumbers (Conand, 2008), resulting in poor processing and wastage because animals are not sold to experienced processors.

A secondary effect of moratoria is increased fishing pressure on other resources. Fishers who collected sea cucumbers may shift to harvesting other marine animals like sharks for the shark fins (Kinch *et al*., 2008b).

How to implement

Sensibly, bans should be imposed as soon as possible after recognizing that stocks are depleted, before critical damage to sea cucumber populations occurs (see Section 2.4). There is a hard trade-off that managers must make between giving fishers ample notice of a forthcoming ban and minimising the cost in recovery time of the resource when fishers exploit stocks at a maximal rate prior to a ban.

Regular communication with fishers will help managers understand how they will cope with a moratorium. If this is yet clear, consult with fishers about the impact on their livelihoods. Implement an education program to ensure that all fishers are aware of the ban, through the media and signposting (Section 6.6).

Likewise, managers should also gather the support and commitment of decision-makers to maintain the ban in the face of public opposition and influence from buyers. Support will be best won if they are well informed about the basic biological need to conserve/restore adequate breeding populations and the costs of delaying the imposition of a ban.

Managers should meet with policy makers to decide the criteria by which a ban can be lifted in the future. This may logically be a certain average density of sea cucumbers in populations of certain species or species-groups on designated reefs to be monitored (Skewes *et al*., 2006). At the onset of the ban and periodically thereafter, stocks should be monitored to document recovery (Section 6.1.2). The data also gives a subjective ground for lifting the ban in years to come, if stocks have recovered to pre-determined levels.

There are two main fields of information needed by the fishery manager before deciding to impose a complete fishery ban; socio-economic impacts and status of stocks.

It would be best practice to determine the dependency that fishers and communities have for collecting sea cucumbers as an income source (Section 6.1.4). Which communities will be most impacted and what other income-generation activities do they have to fall back on if a moratorium is set? Managers may then need to work with other government sectors and NGOs to mitigate economic hardship on communities through development and training in other ways of meeting people's livelihood needs. Sea cucumbers are also important for provincial and/or national revenues through taxing exports, so the likely economic impacts of the ban on these broader economic needs should be gauged and weighed up against the ecological risks to the resource of continued fishing. The likely impacts on other resources should also be considered, as fishers shift their activities to other income streams.

In order to gain social acceptance of bans, managers should seek to obtain data on population densities or abundance over different areas of the fishery (Sections 6.1.2 and 6.1.3). Is a ban needed throughout the entire fishery, or is it really needed just in one sector? Fishers and processors may also argue that animals can still be found and that a complete ban is unnecessary. A simple analysis of data from underwater visual census or trends in CPUE or exports (separated by species) will support the need for such drastic measures. This sort of data also provides a baseline for further monitoring in years after a ban is imposed. It is also useful to consider the approximate densities at which breeding populations need to exist to reproduce successfully, although there is little scientific data available for sea cucumbers (Bell, Purcell and Nash, 2008). A critical question is: at what densities do sub-populations of the different commercial species need to reach to start spawning successfully and replenishing recruitment for the fishery? The answers to this question can be used to place target reference points on population recovery before the fishery is re-opened (Skewes *et al*., 2006; Section 3.4). Similarly, the manager should find out the current size-structure of the population and may want to place a management goal to re-open the fishery after animals measured in the field have attained a certain average size.

EXAMPLES AND LESSONS LEARNED

Australia

The Torres Strait sea cucumber fishery, between the north-eastern tip of continental Australia and Papua New Guinea, experienced declines in several high-value sea cucumber populations after years of commercial fishing. A ban was instigated in 1996–2000 for sandfish (*Holothuria scabra*), but no significant recovery of populations occurred. The ban was extended thereafter, based on follow-up underwater visual censuses. Likewise, fishing for surf redfish (*Actinopyga mauritiana*) and black teatfish (*Holothuria whitmaei*) was banned in the Torres Strait in 2003 after a survey showed that the stocks were overexploited (Skewes *et al*., 2006). There were several lessons from the moratoria in the Torres Strait:

1. Some populations of sea cucumber may take many years to recover, or may not recover at all, after imposing a moratorium. There can be many reasons for the lack of recovery of the populations:
   (1) densities of spawners may be fished too low prior to the moratorium to allow natural recovery of the population;
   (2) the population may rely heavily on larval supply from another population, which may also be depleted;
   (3) recruitment may be naturally infrequent in the target species due to intrinsic factors such as the frequency of spawning in adults, or to extrinsic factors such as certain particular environmental conditions required for successful development or transport of larvae (e.g. seawater temperature, a narrow range in current speed or

direction, or availability of particular microalgae in the water column on which the sea cucumber larvae feed during development in the water column).

2. Fishery managers should take steps to monitor stocks and implement conservative management so that moratoria are not needed, since these measures may not always allow stocks to recover within acceptable timeframes.
3. Placing a moratorium on fishing of one species can increase the fishing pressure on other species in the fishery. Therefore, the need for a moratorium due to overexploitation of one species suggests that fishing strategies are not sustainable, with regard to the resource stocks. Fishery managers should therefore consider setting stricter companion regulatory measures for other, fishable, species when imposing fishing moratoria on a subset of the species in the fishery.

In the sea cucumber fishery of the Great Barrier Reef, in the state of Queensland, *H. whitmaei* became overfished in the late 1990s. A fishery ban (zero TAC) has prohibited the collection of that species since 1998. At that stage, the densities of this species on reefs fished was 20–25 percent of that on reefs protected from fishing. Surveys after the closure showed no measurable recovery up to 4.5 years after fishery closure, suggesting that recruitment in this species is very low. The main lesson, again, is that a measurable, or significant, recovery of stocks after the start of a moratorium may take years or decades. Managers should not expect that all sea cucumber populations will recover quickly after ceasing fishing through a moratorium.
Source: S. Uthicke.

Solomon Islands

The importance of the beche-de-mer fishery to the people of Solomon Islands is revealed by the 1999 census. The village-level nature of the fishery directly impacts the sociological and economic well being of rural coastal communities. At the time of the census, almost 6 000 households had recently been involved in catching and selling sea cucumbers as beche-de-mer. The number of people fishing for sea cucumbers increased greatly during the subsequent years of ethnic tension, when the national systems for exporting copra and cocoa broke down and many rural communities had no other source of income. In the southern islands of Rennell and Belona, where cyclones have recently destroyed plantations, beche-de-mer remains the main source of cash. In the atoll of Ontong Java, beche-de-mer has been the main source of income for decades.

The heavy fishing pressure on sea cucumbers in the Solomon Islands has resulted in a downward shift in species composition of harvests and decreasing catch rates over the last decade. Levels of personal debt of sea cucumber fishers (among others), even in remote village communities, are quite high, mainly to local business entrepreneurs. The great surge in dependence on beche-de-mer by rural communities is reflected in the number of companies licensed to export beche-de-mer, which increased from 9 in 2000 to 23 in 2003.

In December 2005, the Solomon Islands Government declared a ban on the export of beche-de-mer in response to declines in the fishery (Nash and Ramofafia, 2006). The ban made it difficult (or impossible if alternative sources of income were not available) to service these debts (Nash and Ramofafia, 2006). Villages in Isabel Province where a survey was conducted were found to be heavily dependent on beche-de-mer for income, and this was lost when the ban came into effect. A serious consequence of this loss of income was that parents found it difficult to find school fees, particularly those whose children were studying at the secondary level. In the absence of school fees, students would be temporarily removed from schools until fees were paid. Another impact highlighted was the increased fishing pressure on other fisheries, particularly *Trochus* and shark fin. The potential of increased social problems due to lack of income was also raised (WorldFish Centre, 2006).

In April 2007, following an earthquake and tsunami that damaged stretches of coastline in the Western and Choiseul Provinces of Solomon Islands, the Ministry of Fisheries and Marine Resources lifted the ban (Ramofafia *et al.*, 2007). After one year, the cabinet in Solomon Islands had approved the closure of the fishery again (from 1 April 2008). The fishery will remain closed until the interim management plan is finalized and implemented.
Source: J.P. Kinch and K. Friedman.

Indian Ocean

Several countries that have experienced overexploitation of sea cucumbers decided to implement bans on the collection, processing and trade of commercial species. This has been the case, for example, of Egypt and India (Conand, 2008). Despite the official bans, there are often illegal captures. In several countries bans have been abandoned under the pressure of fishers and exporters.
Source: C. Conand.

5.7 AREA-BASED MEASURES

5.7.1 Marine protected areas, including no-take zones

Definition

A marine protected area (MPA) is a portion of the marine benthos and water, with its associated biota, reserved to protect part, or all, of the enclosed environment (Kelleher, 1999).

In the broad context, MPAs are areas managed to enhance conservation of marine resources and many MPA types allow fishing at regulated levels (Lubchenco *et al.*, 2003; Hilborn *et al.*, 2004). They include many sub-classes, defined mainly upon the level of protection and primary conservation goal; e.g. marine sanctuaries, no-take reserves, harvest refugia, multiuse MPAs, marine reserves, ecological reserves (Browman and Stergiou, 2004; Sale *et al.*, 2005). “No-take zones” (NTZs) or “fully-protected marine reserves” are a special class of MPA, which prohibit any extractive activities such as fishing. MPAs and No-take zones are one type of spatial closure.

Use

Although there are few well documented cases, marine reserves are believed to act as a management tool by supplementing fished stocks in surrounding areas (Sale *et al.*, 2005). They may achieve this in two ways:

1) through “spillover”, as increasing abundance of juveniles and adults within the MPA will make some animals to move out to surrounding areas where they can be fished, and
2) through larval supply, as a build-up of breeding adults in the reserves allows for more active spawning and fertilisation of eggs, which are carried by currents to settle in fishing grounds.

Marine reserves may be particularly useful for sea cucumbers because effective spawning and fertilisation seems to require high densities of spawners, which may not occur in most of the “open” fishing grounds (Bell, Purcell and Nash, 2008). MPAs therefore aim to provide “insurance” of future fishery recruitment in a “meta-population” by promoting dense breeding populations that can spawn successfully. For sedentary species, like sea cucumbers, spatial management through marine reserves may achieve larger reproductive outputs than global controls for comparable harvest rates (Hilborn *et al.*, 2004).

In some cases, marine reserves may be designed or established to improve ecosystem conservation. Reserves that provide a sanctuary for large or rare sea cucumbers could also improve the attraction of sites for tourism, extending economic benefits beyond fisheries. They also present a useful tool for conserving stocks in multispecies fisheries, common to sea cucumbers (Section 2.3), where it is difficult to control catches of individual species through catch quotas or size limits (Hilborn *et al.*, 2004). For example, there are thousands of fishers in various districts of the Philippines who exploit more than 30 species of sea cucumbers (Choo, 2008b). Quotas and rotational harvest strategies would be impossible to regulate, but there are more than 500 MPAs in the country, which should protect breeding populations of sea cucumbers in some locations.

For both science and management, NTZs provide a baseline reference of unexploited populations by which to compare fished populations. They are perhaps the best basis for understanding the broader impacts of fishing on ecological systems, through comparing trends in fish production, age, size and sex structure of the stock, and effects on habitats, with fished areas (Schroeter *et al.*, 2001; Hilborn *et al.*, 2004). Similarly, they provide important opportunities for research that may not exist in fished areas, e.g. easy access to high-value species and ability to work with dense populations.

Limitations

Implementation may be difficult where the marine reserves are relatively large and exclude users from traditional grounds. The implementation of marine reserves close to communities will probably force fishers to travel further to unfamiliar grounds or reduce the short-term gains of the fishers with limited mobility (Hilborn *et al.*, 2004). The loss of short-term gains in fishing may be a main cause for low acceptance. Conflicts can arise among user groups, not necessarily just fishers (e.g. tourism operators, marine traffic and conservationists).

Carving out marine reserves from traditional fishing grounds will naturally cause fishers to collect sea cucumbers elsewhere, which could have undesirable consequences. Fishing effort or catch quotas may then need to be lowered, and this presents an economic loss to the fishery. Protecting 30 percent of available habitat area in marine reserves, for example, may require a reduction in effort of the same magnitude to avoid overfishing. The impact of effort re-allocation may, therefore, be substantial (Hilborn *et al.*, 2004).

Active enforcement of reserves near the coast may require a cost to communities in paying surveillance officers or rostering "guardians". Small and numerous marine reserves away from the coast mount the difficulty in enforcement, since fishers can stray within the reserve boundaries beyond sight of guardians on shore. While there are hundreds of MPAs in the Philippines, only 10–15 percent are reported to be effectively managed and many may not serve their purpose to rebuild breeding populations of sea cucumbers because they are too small and illegal fishing is difficult to control (Choo, 2008b).

Another challenge of marine reserves lies in the need to judiciously decide on the areas to be protected. Few reserves have been established just for sea cucumbers – more likely they are designed and sited as refugia for other resources (e.g. predatory fish) or to benefit a suite of biota. The locations of existing MPAs may have been decided by socio-political factors more than bio-ecological factors (Browman and Stergiou, 2004). The locations may not be favourable for species that need them the most. Marine reserves, unless very large, will rarely satisfy the conservation objectives for all species in a multispecies fishery because the various habitats required by the various species cannot all be represented in one reserve (see Section 2.3). This will commonly be the case for tropical sea cucumber fisheries. Likewise, populations at some sites may contribute little to fishery recruitment for various reasons. A network of relatively small reserves has been advocated for sea cucumbers as a means of spreading risks of irregular reproduction or poor siting (Purcell and Kirby, 2006). Managers should seek data on the existing or historical densities of sea cucumbers at various locations and the potential migration of target species as fundamentals to deciding the site and size of reserves. Poor planning of marine reserves, or MPAs, can lead to unfulfilled expectations, the creation of disincentives and a loss of credibility about their role in resource management (Hilborn *et al*., 2004).

A further and most controversial limitation is the difficulty in confirming the effectiveness of marine reserves for improving fisheries (Hilborn *et al*., 2004; Sale *et al*., 2005). Increased abundance or size of animals in the reserve is all good and well for scientists and tourists, but affords no direct fishery benefit. It is the greatly enhanced reproductive potential of such populations (and, to a lesser extent, "spillover" of juveniles and adults) to surrounding fishing grounds that affords marine reserves a place as a fishery management tool, and it is this effect that is difficult to prove rigorously. In the absence of evidence to show their effectiveness for boosting sea cucumber fisheries, the use of marine reserves should be balanced with other management tools (Stefansson and Rosenberg, 2005; Section 8.3).

How to implement

Stakeholders should be part of the process of planning and implementation of marine reserves. A first step should be discussion with stakeholders and biologists on the value and implementation of marine reserves. Decide what class of MPA is best: a protected area that allows some fishing under certain conditions, a no-take zone prohibiting fishing only for sea cucumbers or a fully protected reserve. Some compromises may be needed to keep some sites open to fishing that can be practically accessed, particularly where women and children collect by wading from shore.

Managers should also gauge which areas will be easily monitored by compliance officers or community guardians and which areas will be prone to poaching. It should also be determined who will be in charge of doing the surveillance. The legal framework in which the MPA regulations are situated should be understood and the regulations and penalties should be made as simple as possible (Kelleher, 1999).

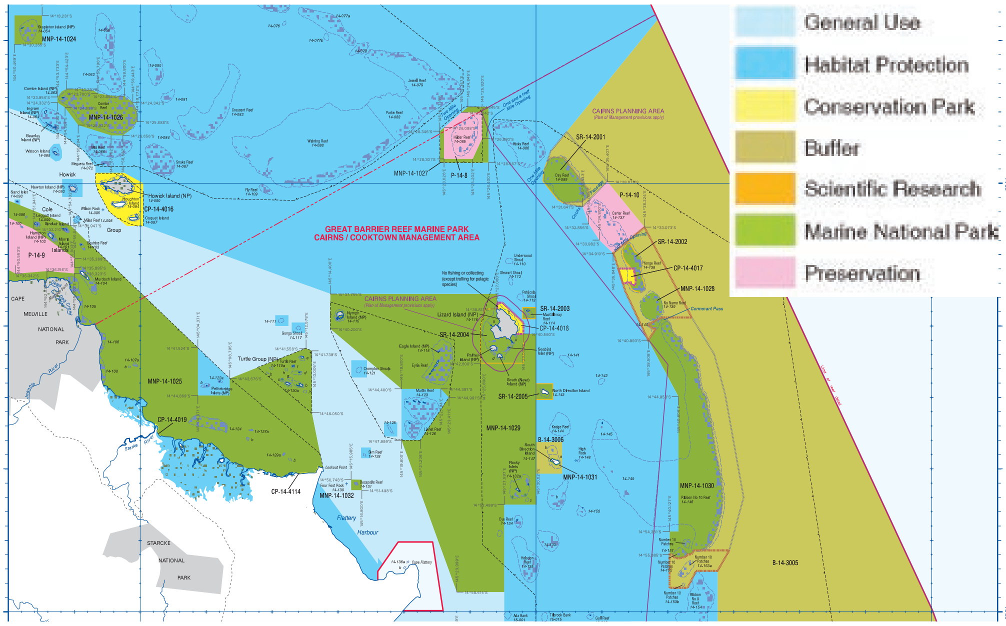
Decide on a minimum size for the reserves. For rebuilding nucleus breeding groups of sea cucumbers alone, these need not be very large (e.g. 50–300 ha) because most species do not appear to migrate long distances. Very small reserves (i.e. <10 ha) will be unlikely to deliver real fishery benefits since they will probably not contain enough adults nor allow for animals to move around without migrating beyond the boundaries where they can be legally fished. Some stocking of wild adults into reserves may boost reproductive output for stock rebuilding (Bell, Purcell and Nash, 2008). More likely, the reserves will be developed with an intention to also protect mobile animals like fishes, in which case they should be considerably larger (e.g. several hundred hectares). For biodiversity conservation of various marine species, larger reserves will be more effective (Sale *et al*., 2005).

Consider a network of multiple marine reserves within the fishery and protecting a significant proportion of the habitat. As an example, the Representative Areas Program (RAP) on Australia's Great Barrier Reef allocated one-third of the total marine park area as no-take reserves (Figure 24). A common target in fisheries management has been to place 20 percent of representative habitat in marine reserves, but recent studies suggest that more than 35 percent of available grounds should be fully protected to avoid recruitment overfishing (Sale *et al*., 2005).

Delineate a large enough area of suitable habitat for sea cucumbers and limit fishing by MPA or NTZ regulations; e.g. limit fishing effort or prohibit fishing. The boundaries should be described or marked clear enough for all stakeholders to identify the reserve borders when at sea. For example, the geographic waypoints of boundary limits can be listed in fishery handbooks and brochures and marked at the sites with buoys or markers. Also, compliance is less ambiguous when marine reserve boundaries are delimited by waypoints joined by straight lines rather than defined by a certain distance from shore.

FIGURE 24

A section of the Great Barrier Reef Marine Park (GBRMP) that is important to the sea cucumber fishery. Licensed fishers are allowed to collect sea cucumber by hand only in General Use and Habitat Protection Zones



Source: Great Barrier Reef Marine Park Authority, MPZ5 Cooktown Detailed Zoning map, with modification.

The key information needs arise from the questions of where to site the reserves, how big they need to be, how closely should they be spaced and how to ensure they will be respected by users. As mentioned, the establishment of the reserves will seldom be divorced from the conservation and fisheries objectives for other resources. Where a network of reserves is planned principally for sea cucumbers, managers need some information on four attributes of the populations to design the network structure:

1) how many separate populations are there in the metapopulation?
2) how are the populations distributed (close together or far apart)?
3) how abundant are the animals in each population? and
4) how variable are the population abundances over time (Browman and Stergiou, 2004)?

One key piece of information needed at the onset of designing a network of reserves is the extent of connectivity among local populations of the target species, a feature about which we know relatively little (Sale *et al.*, 2005). Thus, the fishery manager may need surrogate information to best-guess such processes.

Current patterns should be sought from hydrographic studies to judge the direction that larvae from marine reserves will disperse. Up-current sites will be best in terms of placement for improving recruitment to neighbouring unprotected sites via the reproduction of breeders in reserves. Some larvae may recruit back to the natal site, while others will disperse some distance to rebuild stocks elsewhere (e.g. on fished areas).

How far sea cucumber larvae disperse from natal sites is a question for which we have few confident answers (Section 2.1). Although some tank-based studies tell us about the longevity of larvae, less is know about how sea cucumber larvae act in the water column to mediate their dispersal (Conand, 2006a; Lovatelli *et al.*, 2004). They are far from *passive* particles and are unlikely to behave like the floating beacons used to determine surface currents. Studies assessing the population genetics of sea cucumbers