

Social and political barriers to the use of Marine Protected Areas for conservation and fishery management in Melanesia

Simon Foale and Bruno Manele

Abstract: *In this paper we examine the strengths and weaknesses of state-supported Customary Marine Tenure (CMT) systems in two independent Melanesian states (Solomon Islands and Papua New Guinea) in the context of the management of rapidly intensifying commercial and subsistence fisheries. We focus particularly on the proposed use of permanent no-take Marine Protected Areas (MPAs), which are at present strongly favoured by scientists and environmentalists around the world, as the most versatile marine fishery management tool, especially in poor developing countries. We argue that, with some exceptions, typical Melanesian CMT regimes make MPAs difficult to establish, primarily due to issues of scale. We look closely at the ecological rationale for no-take MPAs, for different coral-reef based species, and assess the likelihood that populations of these species are self-replacing on the same scale as CMT territories for most of coastal PNG and Solomon Islands. We argue that with some exceptions (mainly species with short-lived larvae), the dynamics and scale of population replacement processes for most fished species make no-take permanent closures largely incompatible with traditional CMT systems, and therefore unlikely to prove a successful management tool in this socio-political context.*

Keywords: *fishery management, Customary Marine Tenure, Marine Protected Areas, coral reefs, Melanesia*

All over the world fisheries are collapsing (Hutchings, 2000; Pauly *et al.*, 2002). What is happening is referred to as 'recruitment failure', or 'recruitment overfishing' in fisheries parlance (Cushing, 1981: 143). In a given population

Corresponding author: Dr Simon Foale, Resource Management in Asia Pacific (RMAP) Program, Research School of Pacific and Asian Studies, Australian National University, ACT 0200, Australia. Email: sfoale@coombs.anu.edu.au

of fish, if an excess of fishing pressure removes too many breeding adults, the population's capacity to replace itself is undermined, and numbers crash. In the Asia-Pacific the problem is exacerbated by the fact that in some places, desperate fishers, chasing the dregs of already severely depleted fish stocks¹, are resorting to a range of destructive fishing techniques, such as blast-fishing, which destroy entire ecosystems. This only compounds the problem by increasing the amount of time it will take for the system and the fishery to recover (Fox *et al.*, 2003). Given the failure of the classical maximum sustainable yield (MSY) models to effect management even for many of the ecologically simpler temperate fisheries (Spurgeon, 1997), and the difficulty of enforcing quotas and related management tools due to the weakness of the state apparatus in most countries of the Asia-Pacific region, the management tool of choice now appears to be the Marine Protected Area (MPA), or Marine Reserve (Jones, 2001). In theory, no-take MPAs act as a hedge against large-scale fishery collapse by exporting both larvae and adults to neighbouring fished areas. While there are many more publications extolling the theoretical virtues of MPAs than those documenting scientific evidence of their efficacy (Willis *et al.*, 2003), there are now enough empirical studies validating the theory for existing MPAs (Alcala and Russ, 1990; Roberts *et al.*, 2001), that support for the idea is almost universal.

An MPA can only be regarded as successful if the fishery yield *outside* of the MPA can be demonstrated to increase. Increases in density or average size of (non-migratory) target species *within* any area closed to fishing are virtually inevitable over time (unless the entire region has been completely fished out). But if this build-up of the stock is then reversed as a result of the closed area being opened again for fishing, this defeats the purpose of the exercise, i.e. that the larger reproductive potential of the stock inside the reserve benefits the neighbouring unprotected areas through the above mentioned spill-over effects. This important point will be discussed again below in relation to so-called traditional conservation practices in Melanesia. An advantage of MPAs in tropical latitudes is that they protect whole coastal zones, not just populations of a single species (Jones, 2001). Given the immense diversity of Indo-Pacific fisheries, and the obvious need to protect coastal habitats from destructive fishing methods, this makes good sense.

Here we review some of the institutional and cultural barriers to the effective implementation of MPAs in the independent Melanesian states of Papua New Guinea (PNG) and Solomon Islands, and we single out one particular case study for more detailed attention. We begin by looking at the difficulties of establishing MPAs on coral reefs and coastlines held under Customary Marine Tenure (CMT). We then discuss the difficulties inherent in the propagation of an ethic of 'husbanding' resources in a region where powerful cultural norms militate against it, and the low human population density² means that people have only just started to come up against their limits in terms of marine resources. Throughout most of coastal PNG and Solomon Islands, subsistence fisheries are under considerably less pressure than in many parts of Southeast Asia.

On the other hand, certain commercial (artisanal) fisheries, such as trochus shells (*Trochus niloticus*) and beche-de-mer (sea cucumbers or 'Trepang') are either chronically overfished or comprise 'boom-bust' fisheries (Foale and Day, 1997; Kinch, 2002). Pressure on fin-fish is also set to be increased by the opening up of export markets for these commodities via the recent wharf construction project in PNG, and the Southeast Asian Live Reef Fish trade. There are also a few areas where dynamite fishing (or 'bombing') is degrading reefs, and their associated fisheries. The recent failure of the state in Solomon Islands following a militia coup in June 2000 has meant that most of the existing (already weak) management capacity of the government is now even weaker.

Husbanding marine resources is in fact conceptually no different from husbanding money; indeed conservationists and resource management advisors often compare marine resources to money in the bank, imploring reef owners to try to harvest only the 'interest' (i.e. sustainable yield), and not to eat into their capital. But this aspect of capitalist enterprise is confronted by significant socio-political obstacles in Melanesia³, and an understanding of these is important if we are to have a clear vision of the challenges for fishery management in the region. Hernando de Soto (2000) has presented compelling explanations of why capitalism has failed in Latin America, the former Soviet Union and a number of other third world countries, but both his explanations and his solutions are in our view inappropriate for Melanesia, as we will show later in the article.

THE IMPORTANCE OF SCALE IN FISHERIES MANAGEMENT

The *geographic scale* at which the stock-recruitment (i.e. population replacement) relationship operates varies enormously among the many species that are of commercial or subsistence importance in Melanesian near-shore marine habitats. The scale of the relationship is strongly related to the dispersal range of the planktonic larvae of each species. The vast majority of the marine organisms under consideration here reproduce by releasing eggs and sperm into the sea, whereupon external fertilisation takes place, and the fertilised eggs develop into microscopic larvae that drift about in the currents for a period of time, after which they swim down to the sea bed (assuming they are over a sea-bed when they are ready to do this), and metamorphose into miniature versions of the adults.

It is the distance that larvae are dispersed away from their parent population that is of primary concern to our case here, because it determines the scale at which the stock-recruitment relationship operates, and hence the scale at which management must also be effective. Dispersal distance is roughly related to the time that larvae spend in the plankton (Shanks *et al.*, 2003), though this is not a strictly linear relationship for many species. Larval longevity is, nevertheless, known for many species. The larvae of trochus shells (*Trochus niloticus*) for example, can survive for about three days in the plankton, before they exhaust their energy reserves and must settle and metamorphose,

or die (Heslinga, 1981). They probably disperse on a scale of hundreds of metres to tens of kilometres, depending on current regimes, bottom topography, and a number of other factors. The larvae of the Ornate Rock Lobster (*Panulirus ornatus*), on the other hand, can feed on microscopic algae while they are drifting in the plankton, and can survive at sea for up to a year (Pitcher, 1993). As a result they can (and usually do) end up being carried many hundreds of kilometres from their natal reef (Dennis, 2001).

The situation for reef fish is more complicated and a large amount of research effort has been focused on larval fish dispersal over the past decade or so (for a review see Mora and Sale, 2002). Despite the potential for most reef fish larvae to disperse distances of tens to hundreds of kilometres (Cowen, 2002), a number of studies show that the larvae of many species of reef fish behave in ways that maximise their retention close to their natal reef (Swearer *et al.*, 1999; Leis, 2002). Topographic complexity of the near-shore seabed also tends to retard dispersal by reducing current speed (Sponaugle *et al.*, 2002).

These biological and ecological issues are highly relevant to the potential success of the MPA as a management tool. This is because the geographic scale of stock-recruitment relationships must be similar to, or smaller than, the scale of CMT if the MPA concept is to gain political acceptance at the community level. Both land and marine tenure⁴ in Melanesia are highly fragmented, i.e. the coastlines of many islands can be quite finely divided among separate clan or tribal groups, which we will call polities. The fishing rights of most coastal Melanesians for the most part do not extend much beyond the boundaries of their polity's territory. If they do, they are usually not as strong, or as frequently exercised, as the rights they enjoy close to home⁵. The sizes of the territories of most coastal polities, in terms of coastline, are on a scale of hundreds of metres to a few kilometres (for examples see Hviding, 1996; Foale and Macintyre, 2000; Aswani, 2002).

We therefore encounter a serious political problem if a fished stock is not predominantly self-recruiting (or self-replacing) within the CMT boundaries of a given polity, i.e. if larval longevity, behaviour, and the prevailing current regime means that the majority of larvae produced within one group's coastal territory disperse out of that territory and recruit (i.e. settle) into the territories of neighbouring or even distant groups. In economic terms this means that even if the custodians of a given coastal territory choose to close part of their coastline to fishing, on a permanent basis, following the MPA rationale presented above, this does not guarantee that their sacrifice will be rewarded by an increase in recruitment, and therefore fishery production, within their own territory. Indeed for most species of fish, the majority of larvae recruiting to a given territory are likely to have come from other territories. As such, there would appear to be little reason for any one CMT polity to embrace the MPA as a management tool, unless all other groups were doing the same.

One obvious response to this dilemma is to focus more attention to coastal zones *not* under customary ownership. In Solomon Islands around 15 per cent of the land in the country is not under customary ownership. This category of

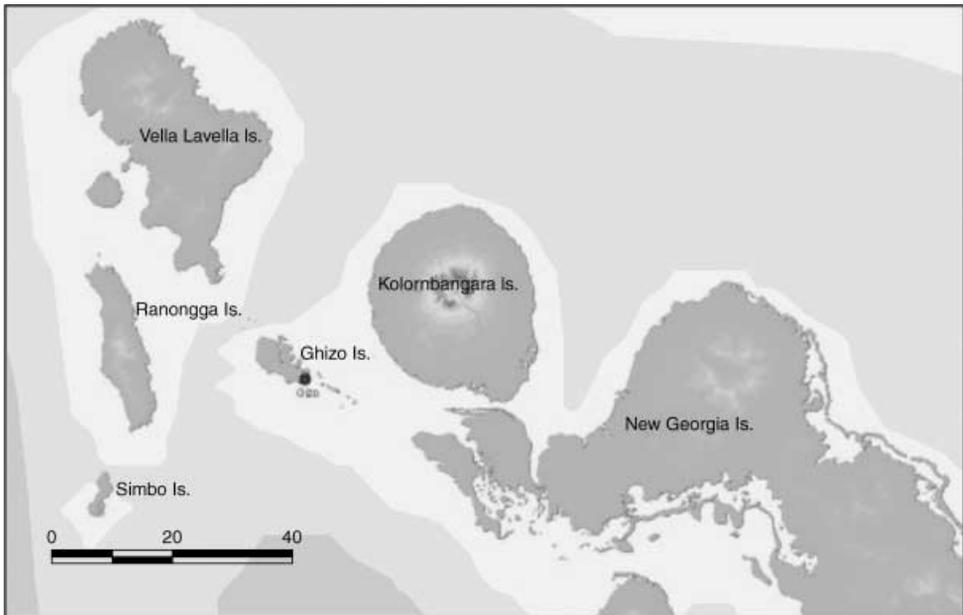


Figure 1. The central part of Western Province, Solomon Islands, showing the location of Ghizo Island

land includes the island of Ghizo, and a number of small islands around it. Ghizo is where the administrative capital of Western Province, Gizo town, and the headquarters of the World-Wide Fund for Nature's (WWF) Solomon Islands Country Program are located (Figure 1).

THE GHIZO MARINE PROTECTED AREA PROJECT

In the late 1990s the WWF Solomon Islands Community Resource Conservation and Development Project (SI-CRCDP) commenced an initiative to establish MPAs at four sites around the island of Ghizo (Figure 2). The sites were selected partly for their aesthetic value, and popularity as tourist dive sites. Despite the assumption that these reefs were not customarily owned, recent research findings arising primarily through a process of engagement with various community groups by one of us (BM) has unveiled a new set of complexities, which we shall outline here.

The majority of land on the main island of Ghizo, as well as the surrounding small islands, was alienated from the original customary owners by the British colonial administration around 1900. A small section at the western end, encompassing three villages, is still under customary ownership and is inhabited by people from the neighbouring island of Vella Lavella to the northwest. These people claim to be the descendants of a handful of refugees who fled from an attack by warriors from New Georgia Island (to the east), possibly sometime in the 19th century⁶. When the British colonial administrators

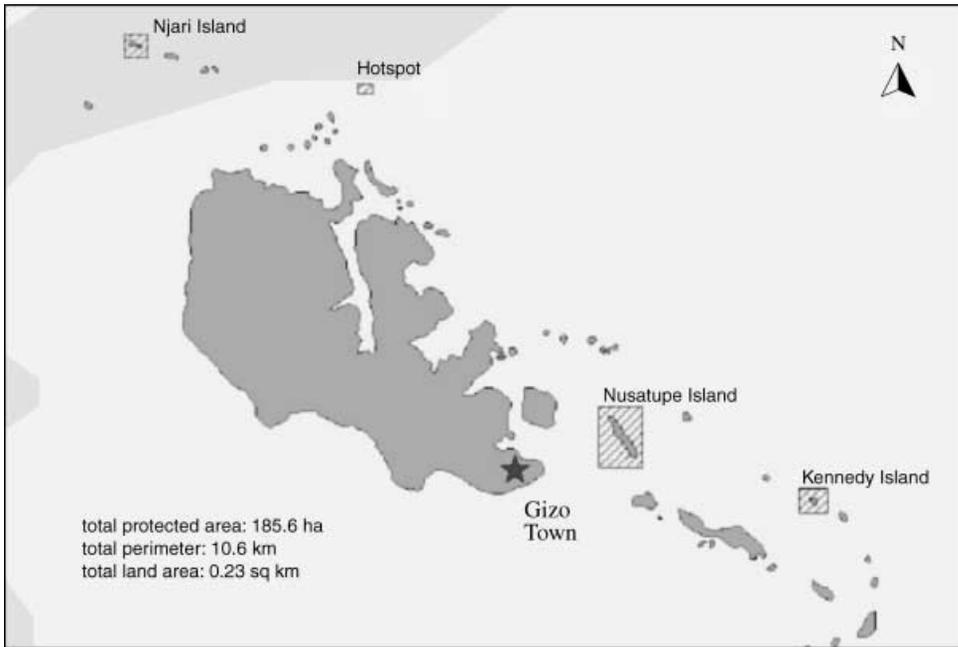


Figure 2. Ghizo Island, showing location of areas targeted for protection as MPAs

first came to Ghizo they found it depopulated as a consequence of this raid, which undoubtedly made it easier for them to acquire it from the few remaining inhabitants.

A number of Ghizo people are presently asserting their rights over portions of alienated land as part of a push (supported in principle by the government) for a reversion of title to customary ownership. Unfortunately the patterns of migrant settlement subsequent to the original alienation, which were in part engineered by the colonial administration, mean that reclaiming all of the alienated land will now be quite difficult. All of these migrants (mostly from Kiribati as well as some of the islands around Ghizo) and their descendants are heavily dependent on the marine resources of the reefs around Ghizo Island for both subsistence and cash. Nevertheless the Lands Department in Gizo town has recently (late 2003) ruled that all of the *reefs* around Ghizo, and the small islands, are held under customary ownership.

This decision, whether it is based on the Lands Department's interpretation of the law, or the outcome of negotiations with landowners, essentially defeats the purpose of the exercise as far as WWF's original intent of finding (and zoning as MPAs) reefs that are not customarily owned. It should be noted at this point that the law relating to ownership of the foreshore and seabed in Solomon Islands is still rather confused and ambiguous⁷. Kabui (1997) details a number of court cases in which customary claims over foreshore and seabed mostly lost to the government. If it came down to a court case over each reef, there is no guarantee that the people presently claiming customary ownership

over those reefs would win. On the other hand, customary claims over the seabed have been respected by the pole-and-line tuna industry in both Solomon Islands and PNG, as evidenced by the regular payments of baitfish royalties to landowners adjacent to lagoonal bait-fishing grounds by foreign-owned commercial fishing companies (Turner, 1994; Hviding, 1996: 321–325)⁸.

Despite these specific barriers to the easy implementation of no-take MPAs in the Ghizo area, we are certainly not advocating that this strategy be abandoned in the future. However this path is fraught with difficulty if we enlarge our scale of analysis. Even if there are successes with a handful of government-backed or privately owned (or even customarily owned) closed areas, these will be small specks in a large area which is rapidly coming under more and more pressure as human populations burgeon, markets expand, and global warming-induced coral bleaching adds further stress to reef ecosystems. Should we be looking at another approach? Can fishery management be effected without the use of permanent closures, and if so, how?

WHY TRADITIONAL FISHERY ‘MANAGEMENT’ DOESN’T WORK IN MELANESIA

Throughout most of coastal Papua New Guinea and Solomon Islands there exists a system of periodic fishing closures, usually on inshore reefs, and this is normally referred to in Solomon Pijin or PNG Tok Pisin as a *tambu*. It involves the closure of fishing (and the closure may not even apply to all species) on a particular stretch of coastline for a specific period of time, usually from a few months to a year or in some cases a few years (on average less than a year). The closure is quite often associated with a death within the clan that controls rights to that stretch of coastline and is a ritual component of a cycle of feasting associated with that death, though this is by no means always the case (Polunin, 1984; Foale and Macintyre, 2000).

The value of the *tambu* as a management tool for fisheries has significant limitations, despite the tendency for some researchers to advocate it as the ideal management tool for Melanesia because of its perceived cultural appropriateness⁹. This is because the closures are almost always opened again, usually after less than a year, and the accumulated stocks of many species, particularly benthic invertebrates, are then removed, often with alarming efficiency (Foale and Day, 1997). *Tambus* are essentially a means of stockpiling resources, often for a specific purpose, such as a (funerary or other) feast; they have nothing to do with maximising and sustaining yields. If fishing pressure is high, stocks of most fished species can be severely depleted, despite the application of periodic closures using the *tambu* institution. Long-lived species are more disadvantaged than short-lived ones, since their populations take longer to recover. If the typical length of a *tambu* is a year or less, then most species of invertebrates and reef fish are vulnerable to overfishing. If the majority of customarily owned reefs in a given region are over-harvested, then rates of recruitment will slow down over time, and fishery productivity will decline. For this reason, *impermanent* closures such as the *tambu* system

cannot be relied upon to prevent depletion and inevitable recruitment failure of subsistence and commercial fisheries in Melanesia.

The problem in our view is a cultural one that has as much to do with the difficulties most Papua New Guineans and Solomon Islanders have with the accumulation of *capital* (in the broader context of economic development) as it has to do with fishery management. Fishery management is so akin to this aspect of capitalism it is worth some discussion here. As mentioned in the introduction, a fished stock is indeed like money in the bank – the more you have, the more interest it generates. Analogously, if a fished stock is large and healthy, it produces a lot of fertilised eggs, and enjoys high rates of recruitment (at the geographic scale determined by the distances that larvae disperse). High rates of recruitment eventually translate into higher yields. The optimal harvest strategy therefore, on the scale at which a stock is self-recruiting, is a compromise between maximising the catch and maximising the reproductive potential of the population. All of this can be, and often is, modelled mathematically (e.g. Foale and Day, 1997), assuming enough information about the stock is available (Foale, 1998). However most of this information is usually not available, and in developing countries such as PNG and Solomon Islands it is difficult or impossible to obtain (Johannes, 1998). Therefore such yield-based approaches are for the most part too costly and time-consuming to bother with. More importantly, the very *idea* of maximising and sustaining yields, for fisheries at least, is one that does not appear to have a lot of traction in many parts of coastal Melanesia¹⁰. There are important insights to be gained on why this is so by looking at the social context of the many failures of capitalist business enterprises in the region.

Sally Brooks (1996) provides an excellent analysis of the cultural reasons for the failure of the majority of small business efforts in PNG. She points out that one of the key barriers to the accumulation and maintenance of capital, whether it is in the form of assets or cash, is social pressure on the would-be entrepreneur to be seen to be generous, which is inevitably achieved by redistributing accumulated wealth among kin and/or the community. This pressure is intense, and is greater for individuals who have, or aspire to have, high status. In addition to this, Brooks emphasises the *cyclical* nature of traditional forms of communal co-operation, and contrasts these with the linear kind of co-operation necessary in a Western model.

In a PNG community, cooperation can be visualised as cyclical. Very high levels of cooperation are required, planned for and achieved, for a single event or goal (e.g. feast, brideprice ceremony). After this goal is achieved, the level of cooperation falls, temporary alliances break down and village communities naturally fragment into the smaller units that are more meaningful for daily living. (Brooks, 1996: 8).

One way of looking at this is to consider the Tok Pisin word **bisnis**. People talk about *doing bisnis* as opposed to *having a bisnis*. **Bisnis** is an activity (possibly on a single occasion). Western business, on the other hand, is seen as something which exists apart from the person. In rural PNG, a **bisnis** [that] achieves a set goal, then ceases to exist *is a success*. (Brooks, 1996: 11; original italics and bold).

This analysis is just as appropriate for the *tambu* institution used for reefs as it is for the behaviour of business entrepreneurs. The *tambu* is a cyclical process of accumulation and redistribution – ‘saving’ and ‘spending’. The crucial aspect is the impermanence of the accumulation. Cycles of redistribution of wealth as a means of obtaining status are a common pattern in many parts of coastal Melanesia. Many foreign aid-assisted development projects collapse because those managing them come under pressure to redistribute assets and/or operating capital to relatives or other members of their community. Profits are inevitably spent on consumption rather than reinvested or amortised.

The reason this sort of behaviour is viable in PNG and Solomon Islands, compared with many parts of Southeast Asia, is that the population density is still low enough that most people do not depend for their survival on the success of a business. If and when businesses fail, most people know that they can still eat – the subsistence economy is still supporting the majority of people in both these countries. Cultural resistance to the sustained husbanding of accumulated material wealth is contingent upon the capacity of the environment to continue providing. Obviously this will not be the case forever.

Hernando de Soto’s (2000) analysis of why capitalism has failed in many developing and former communist countries is centred on property law. He argues that legal systems in these countries (and he does not specifically include any Melanesian or Pacific states among his examples) need to be restructured so that people’s rights to their property can be formalised, thus enabling property to be used as collateral for low interest loans and such that would enable them to start businesses and gain entry to the market economy. If he were including Solomon Islands and PNG in his analysis, he would almost certainly be arguing for land registration. This is undoubtedly one of the most controversial and hotly debated issues in the history of both countries. University students rioted twice in Port Moresby and in urban centres across PNG, in 1995 and 2001, in protest against World Bank-driven moves to register land in PNG (Filer, 1997, 2000: 32–33). Customary land tenure in PNG and Solomon Islands is immensely complex, flexible, and open to multiple interpretations, particularly when economic contexts are transformed by development projects (Ballard, 1997; Holzknicht, 1999; Foale and Macintyre, 2000). It has also been extensively studied and described by anthropologists and other intellectuals, both foreign and national, in both countries (Larmour, 1979, 1991a; Sullivan, 2002). The idea that land can be easily and quickly registered and that this will facilitate an immediate and successful engagement with the global market, while fondly embraced by economists and bankers alike, is not supported by historical or anthropological evidence to date.

But more importantly, as Sally Brooks’ work illustrates so clearly, even if land were registered, and people were happy about it, mortgaging land against a loan for a business has an obvious risk. Given that the vast majority of businesses will inevitably collapse, for the reasons Brooks has outlined, what would happen to the land? The worst-case scenario is that it would become the legal property of the banks and people would be forced into peri-urban shantytowns, where they would have nothing to sell but their (mostly

unskilled) labour, in an economy where there is little demand for it. However at present the risk of this outcome does not seem to be high, for PNG at least, for a variety of reasons including a number of clauses in the Land Tenure Conversion Act (1963), and various other legal mechanisms which limit the freedom of landowners to mortgage or sell their land (Fingelton, 1991; Larmour, 1991b; McKillop, 1991). In any case, de Soto's (2000) solutions fail to deal with the cultural complexities embedded in Melanesian tenure systems, which are also in many ways inextricable from the other cultural obstacles to capitalist enterprise that we have outlined above.

It is the commodification of land, trees, reefs and fish that underpins the majority of conflicts over property rights in Melanesia, but there also appears to be no way of avoiding the increasing engagement of Melanesian landowners and fishers with the global market, despite the crushing handicaps it imposes and escalating inequalities it generates (Macintyre and Foale, 2004; Koczberski and Curry, this issue). As human populations grow and markets expand, or new ones open up, densities of fished stocks will continue to decline across the region. The traditional stockpiling model (the *tambu*), in its current incarnation at least, will inevitably be recognised as an ineffectual management tool, for the majority of species. In some places this has already been demonstrated (Foale and Day, 1997).

However some species, such as the mangrove bivalves *Polymesoda* spp. and *Anadara* spp., which have larvae that are predominantly self-recruiting on the scale of CMT territories (Tawake Pers. Comm, Tawake *et al.*, 2001), may well prove to be a notable exception. However the very short dispersal distance of these species is what makes them an exceptional case in this respect, and successes with these species should not be hailed as indicative of potential successes for species with larger dispersal distances. On the other hand, such situations provide excellent educational opportunities for stock-recruitment processes, particularly considering the many factors that can potentially delay post-closure recovery for many other species, and the difficulties involved in quantifying it (Jennings, 2001).

In the absence of MPAs or some other form of proper management for most of the fished species with longer-lived larvae, the rate of recruitment throughout the region will in all likelihood continue to slow, and the use of temporary closures will do little to mitigate the consequent declines in yields.

WAYS FORWARD

While fishers all over the world complain about how there are fewer fish now than there used to be, relatively few of them seem to connect their own activities to the problem. But this is exactly the issue that fishers in Melanesia must be engaged about if the current decline in fishery stock densities is to be halted or reversed. The threat of coral bleaching (Hoegh-Guldberg, 1999) will only exacerbate the problem by adding stress to the system, which will further extend recovery times (Hughes and Connell, 1999) for both reefs and fisheries.

What is needed most urgently in Melanesia is a well-funded, long-term and broad-based educational campaign that explains in as much detail as possible the relationship between stock density and recruitment strength for the relevant fisheries, including discussions of the scale at which the stock-recruitment relationship occurs for each species, and the problems that CMT territoriality poses for a closure-based approach to management. Most rural Melanesians are unaware of the existence, much less the biology and behaviour of pelagic larvae, or the link between overfishing and recruitment failure. The fact that recruitment for most marine species occurs at a scale considerably larger than that of CMT boundaries is a highly problematic issue if MPAs are to be pursued as the only means of management. Permanent closures will probably only be viable where ownership of reefs is not communal *and* the owners are happy to close their reefs to fishing. In practice this is unlikely to be a common opportunity in either PNG or Solomon Islands.

Education programmes should involve communities, particularly high-school aged youth, in stock assessment and reef monitoring work, as part of well-structured environmental education modules aimed at primary and secondary school levels as well as adult villagers. However if education does eventually generate some form of grass-roots reform that facilitates political co-operation on a scale that makes MPAs effective (e.g. if *all* reef owning groups set aside part of their territory as a permanently closed MPA), it will probably take at least a generation to happen. Moreover, even with education, there is a tendency for conservatism about subsistence strategies that would further slow any process of introduced change.

If education campaigns include practical experience with stock assessments, ideally as part of longitudinal studies of the density of fished stocks, and the health of ecosystems, particularly among school age children, the potential for future political reform will be increased significantly. Moreover, if indigenous knowledge, for example of current regimes, and fish migration patterns (Hamilton and Walker, 1999; Johannes *et al.*, 2000; Johannes and Hviding, 2001), is included in such education programmes, they are also much more likely to succeed.

ACKNOWLEDGEMENTS

Work was carried out at WWF Solomon Islands Country Program, Ghizo, Solomon Islands (by both authors), and at ANU. Thanks to the following people for reading and commenting on earlier drafts of this paper: Catherine Black, Martha Macintyre, Ian Scales, Dan Afzal, Colin Filer, Mike Bourke, Rick Hamilton, Jeff Kinch, Chris Chevalier and Robin Hide.

NOTES

- 1 The term 'stock' in fisheries refers to a given population of (usually) one species. It can either refer to a geographically isolated population, or in cases where a population might span a wide area, a stock might be simply an arbitrarily determined subset of this population.

- 2 Population density for Solomon Islands: 16/km². For PNG: 10.2/km². For Indonesia: 111.8/km²; For Java alone: 945/km².
- 3 There are some exceptions, such as in the Highlands, and the Rabaul district in PNG.
- 4 In most parts of coastal Solomon Islands, Papua New Guinea, and many other Pacific countries, people regard reefs as an extension of the land, and boundaries of coastal properties are extended seawards to divide reefs, sea, offshore islands, and the resources associated with these (Allan, 1957; Johannes, 1978; Ruddle, 1988).
- 5 While it would be inaccurate to depict fishing territories as completely nucleated and rigidly bounded (many people have rights to neighbouring or distant territories through inheritance, marriage or various forms of exchange), most people fish on a regular basis within a few kilometres of where they live.
- 6 There is a richly detailed set of interviews obtained by BM recounting the events during and surrounding the pre-colonial warfare that depopulated Ghizo.
- 7 It is much less ambiguous in PNG where state recognition of Customary Marine Tenure is enshrined within the National Fisheries Management Act, 1998 (Part 3, Section 26, page 19).
- 8 Both of these authors have described the ways in which the commodification of fishing grounds generated social upheaval and acrimonious disputes among and within the reef- and lagoon-owning groups involved.
- 9 And it is pertinent to mention here that the use of the *tambu* on marine resources only started after missionisation in many parts of Melanesia (Foale and Macintyre, 2000; Kinch, 2002).
- 10 However the idea of maximising yields in relation to *labour*, in the context of farming, does have some currency.

REFERENCES

- Alcala, A.C. and G.R. Russ (1990) A direct test of the effects of protective management on abundance and yield of tropical marine resources, *Journal du Conseil International pour l'Exploration de la Mer* 46: 40–47.
- Allan, C.H. (1957) *Customary Land Tenure in the British Solomon Islands Protectorate*, Honiara: Western Pacific High Commission.
- Aswani, S. (2002) Assessing the effects of changing demographic and consumption patterns on sea tenure regimes in the Roviana Lagoon, Solomon Islands, *Ambio* 31(4): 272–284.
- Ballard, C. (1997) It's the land, stupid! The moral economy of resource ownership in Papua New Guinea, in P. Larmour (ed.), *The Governance of Common Property in the Pacific Region*, Canberra: National Centre for Development Studies: 47–66.
- Brooks, S. (1996) *Small Business Development in Papua New Guinea: Lessons*, Port Moresby: Department of Environment and Conservation/ United Nations Development Programme.
- Cowen, R.K. (2002) Larval Dispersal and Retention and Consequences for Population Connectivity, in P.F. Sale (ed.), *Coral Reef Fishes: Dynamics and Diversity in a Complex Ecosystem*, Amsterdam: Elsevier: 149–170.
- Cushing, D.H. (1981) *Fisheries Biology: A Study in Population Dynamics*, Madison, Wisconsin: University of Wisconsin Press.
- de Soto, H. (2000) *The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else*, London: Black Swan.
- Dennis, D.M. (2001) Distribution and transport pathways of *Panuliris ornatus* (Fabricius, 1776) and *Panuliris* spp. larvae in the Coral Sea, Australia, *Marine & Freshwater Research* 52: 1175–1185.
- Filer, C. (1997) Compensation, rent and power in Papua New Guinea, in S. Toft (ed.), *Compensation for Resource Development in Papua New Guinea*, Canberra and Port Moresby: National Centre for Development Studies, Australian National University; Resource Management in Asia and the Pacific, RSPAS, Australian National University; Law Reform Commission of Papua New Guinea, 156–189.
- Filer, C. (2000) *The Thin Green Line: World Bank Leverage and Forest Policy Reform in Papua New Guinea*, Boroko: National Research Institute.

- Fingelton, J. (1991) The East Sepik Land Legislation, in P. Larmour (ed.) *Customary Land Tenure: Registration and Decentralisation in Papua New Guinea*, Port Moresby: Papua New Guinea Institute of Applied Social and Economic Research. Monograph 29: 147–162.
- Foale, S.J. (1998) Assessment and management of the trochus fishery at West Nggela, Solomon Islands: an interdisciplinary approach, *Ocean and Coastal Management* 40: 187–205.
- Foale, S.J. and R.W. Day (1997) Stock assessment of trochus (*Trochus niloticus*) fisheries at West Nggela, Solomon Islands, with notes on management, *Fisheries Research* 33: 1–16.
- Foale, S.J. and M. Macintyre (2000) Dynamic and flexible aspects of property tenure at West Nggela, Solomon Islands: implications for marine resource management, *Oceania* 71: 30–45.
- Fox, H.E., J.S. Pet, R. Dahuri and R.L. Caldwell (2003) Recovery in rubble fields: long-term impacts of blast fishing, *Marine Pollution Bulletin* 46: 1024–1031.
- Hamilton, R. and R. Walter (1999) Indigenous ecological knowledge and its role in fisheries research design: A case study from Roviana Lagoon, Western Province, Solomon Islands, *Secretariat of the Pacific Community Traditional Marine Resource Management and Knowledge Information Bulletin* 11: 13–25.
- Heslinga, G.A. (1981) Larval development, settlement and metamorphosis of the tropical gastropod *Trochus niloticus*, *Malacologia* 20: 349–357.
- Hoegh-Guldberg, O. (1999) Climate change, coral bleaching and the future of the world's coral reefs [Review], *Marine & Freshwater Research* 50(8): 839–866.
- Holzknacht, H. (1999) Customary property rights and economic development in Papua New Guinea, in T. van Meijl and F. von Benda-Beckman (eds) *Property Rights and Economic Development: Land and Resources in Southeast Asia and Oceania*, London: Kegan Paul International, 139–164.
- Hughes, T.P. and J.H. Connell (1999) Multiple stressors on coral reefs: A long-term perspective, *Limnology & Oceanography* 44(3): 932–940.
- Hutchings, J.A. (2000) Collapse and recovery of marine fishes, *Nature* 406(6798): 882–885.
- Hviding, E. (1996) *Guardians of Marovo Lagoon: practice, place and politics in maritime Melanesia*, Honolulu: University of Hawaii Press.
- Jennings, S. (2001) Patterns and prediction of population recovery in marine reserves, *Reviews in Fish Biology & Fisheries* 10: 209–231.
- Johannes, R.E. (1978) Traditional marine conservation methods in Oceania and their demise, *Annual Review of Ecology and Systematics* 9: 349–364.
- Johannes, R.E. (1998) The case for data-less marine resource management: examples from tropical nearshore finfisheries, *Trends in Ecology and Evolution* 13(6): 243–246.
- Johannes, R.E., M.M.R. Freeman and R. Hamilton (2000) Ignore fishers' knowledge and miss the boat, *Fish and Fisheries* 1: 257–271.
- Johannes, R.E. and E. Hviding (2001) Traditional knowledge possessed by the fishers of Marovo Lagoon, Solomon Islands, concerning fish aggregating behaviour, *SPC Traditional Marine Resource Management and Knowledge Information Bulletin* 12: 22–29.
- Jones, P.J.S. (2001) Marine protected area strategies: issues, divergences and the search for middle ground, *Reviews in Fish Biology and Fisheries* 11(3): 197–216.
- Kabui, F. (1997) Crown ownership of foreshores and seabed in Solomon Islands, *The Journal of Pacific Studies* 21: 123–144.
- Kinch, J. (2002) Overview of the Beche-de-mer fishery in Milne Bay Province, Papua New Guinea, *South Pacific Commission Beche-de-mer Information Bulletin* 17: 2–16.
- Larmour, P., (ed.) (1979) *Land in Solomon Islands*, Suva: Institute of Pacific Studies, University of the South Pacific, and the Ministry of Agriculture and Lands, Solomon Islands Government.
- Larmour, P., (ed.) (1991a) *Customary Land Tenure: Registration and Decentralisation in Papua New Guinea*, Port Moresby: Papua New Guinea Institute of Applied Social and Economic Research.
- Larmour, P. (1991b) Introduction, in P. Larmour (ed.) *Customary Land Tenure: Registration and Decentralisation in Papua New Guinea*, Port Moresby: Papua New Guinea Institute of Applied Social and Economic Research. Monograph 29: 1–8.

- Leis, J.M. (2002) Pacific coral-reef fishes: the implications of behaviour and ecology of larvae for biodiversity and conservation, and a reassessment of the open population paradigm, *Environmental Biology of Fishes* 65(2): 199–208.
- Macintyre, M.A. and S.J. Foale (2004) Global imperatives and local desires: competing economic and environmental interests in Melanesian communities, in V. Lockwood (ed.) *Globalisation in the Pacific*, Englewood, New Jersey: Prentice-Hall.
- McKillop, R. (1991) Land mobilisation in the highlands, in P. Larmour (ed.) *Customary Land Registration and Decentralisation in Papua New Guinea*, Port Moresby: Institute of Applied Social and Economic Research Monograph 29: 73–86.
- Mora, C. and P.F. Sale (2002) Are populations of reef fish open or closed?, *Trends in Ecology & Evolution* 17(9): 422–428.
- Pauly, D., V. Christensen, S. Guenette, T. Pitcher, U. Sumaila, C. Walters, R. Watson and D. Zeller (2002) Towards sustainability in world fisheries, *Nature* 418: 689–695.
- Pitcher, C.R. (1993) Spiny Lobster, in L. Hill and A. Wright (eds) *Nearshore Marine Resources of the South Pacific*, Suva and Honiara: Institute of Pacific Studies, Suva, and The Forum Fisheries Agency, Honiara: 539–608.
- Polunin, N. (1984) Do traditional marine ‘reserves’ conserve? A view of Indonesian and New Guinean evidence, in K. Ruddle and T. Akimichi (eds) *Maritime Institutions in the Western Pacific*, Osaka: National Museum of Ethnology, 267–283.
- Roberts, C.M., J.A. Bohnsack, F. Gell, J.P. Hawkins and R. Goodridge (2001) Effects of marine reserves on adjacent fisheries, *Science* 294(5548): 1920–1923.
- Ruddle, K. (1988) Social principles underlying traditional inshore fishery management systems in the Pacific basin, *Marine Resource Economics* 5: 351–363.
- Shanks, A.L., B.A. Grantham and M.H. Carr (2003) Propagule dispersal distance and the size and spacing of marine reserves, *Ecological Applications* 13(1): S159–S169.
- Sponaugle, S., R.K. Cowen, A. Shanks, S.G. Morgan, J.M. Leis, J.S. Pineda, G.W. Boehlert, M.J. Kingsford, K.C. Lindeman, C. Grimes and J.L. Munro (2002) Predicting self-recruitment in marine populations: Biophysical correlates and mechanisms, *Bulletin of Marine Science* 70(1): 341–375.
- Spurgeon, D. (1997) Canada’s cod leaves science in hot water, *Nature (London)* 386: 107.
- Sullivan, N. (2002) *Culture and Progress: The Melanesian Philosophy of Land and Development in Papua New Guinea*, Madang: Divine Word University Press.
- Swearer, S.E., J.E. Caselle, D.W. Lea and R.R. Warner (1999) Larval retention and recruitment in an island population of a coral-reef fish, *Nature* 402(6763): 799–802.
- Tawake, A., J. Parks, P. Radidedike, W. Aalbersberg, V. Vuki and N. Salafsky (2001) Harvesting data and clams, *Conservation Biology in Practice* 2(4): 32–35.
- Turner, J.W. (1994) Sea Change: Adapting customary marine tenure to commercial fishing. The case of Papua New Guinea’s bait fishery, in G.R. South, D. Goulet, S. Tuqiri and M. Church (eds) *Traditional Marine Tenure and Sustainable Management of Marine Resources in Asia and the Pacific*, Suva: International Ocean Institute – South Pacific: 141–154.
- Willis, T.J., R.B. Millar, R.C. Babcock and N. Tolimieri (2003) Burdens of evidence and the benefits of marine reserves: putting Descartes before des horse?, *Environmental Conservation* 30(2): 97–103.