# Is coral reef conservation possible without science education in Melanesia?
# Is science education possible without development?

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**Abstract** In Papua New Guinea and the Solomon Islands the state has little or no control over inshore fishing, and customary marine tenure is fragmented at a scale often smaller than that at which fish stocks are self-recruiting. Therefore fishery management in these locations will depend on the capacity of local communities to perceive the relationship between fishing effort and recruitment strength – a concept that is mostly not present in traditional ecological knowledge frameworks. An understanding of the biological and ecological underpinnings of population replacement processes is vital if such institutions are to evolve at the local level, and this can only occur with a dramatic improvement in the level of scientific education available to children in these countries. This in turn requires a much greater engagement by the donor community with the broader development problems in these countries.

**Keywords** Fishery Management, Governance, Marine Tenure, Marine Protected Areas, Population Processes, Education, Ecological Knowledge, Pacific, Melanesia

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## Introduction

Both Papua New Guinea and Solomon Islands are developing countries with low population densities, very weak central and provincial governments, poor to non-existent services, and extremely politically fragmented populations. An important feature of their legislation is the ratification of customary land and marine tenure by the constitution. Across this region there is a growing impatience for development, and there are at present few options beside primary resource extraction, which includes reef fish. As pressure to "develop" this resource grows, so does the need for precautionary management. This paper focuses on Marine Protected Areas (MPAs) since they are widely assumed to be the optimal management tool for both fishery management and biodiversity conservation. While there are many growing threats to reefs in the area, including sedimentation and coral bleaching, I will concentrate here on fishing pressure.

Subsistence fishing in this region is mostly not a serious threat to reef fish because of the very low human population densities across most of the region, with the exception of urban centres and a number of small islands with high population densities. Compare the densities of 12 and 16 people per square km (for PNG and Solomon Islands respectively) with 600 for Jamaica and 900 for Java. However population growth is high (2.5% and 3.5%) in both countries and there is both the desire and the potential for a large increase in fishing effort, including the Live Reef Fish Trade and various artisanal fishery developments around the region. Therefore MPAs seem a logical and timely intervention, even despite scientific uncertainties about fish larval dispersal distances (Leis 2002), and they are probably a better management option than most of the others at present.

### *Customary Marine Tenure and the scale of larval dispersal*

However the first of two major challenges for the successful implementation of permanent closures is the *scale* of Customary Marine Tenure (CMT) (Foale and Manele 2004). CMT is communal, more or less, *within* clan or lineage territory boundaries. In both countries sea tenure is seen as an extension seaward of coastal land tenure. It is true that most people can invoke weaker rights to other clan reefs, but these rights are often dependent on the type of fishing being done; fishing for cash, which most commonly involves fishing for benthic invertebrates such as trochus or beche-de-mer, is the kind of fishing that is normally prohibited outside of one's own clan territory in Melanesia (Foale and Day 1997; Foale and Macintyre 2000). The importance of knowing the scale of tenure territoriality is that it may not necessarily correspond to

the scale at which a fish stock is self-recruiting. If the majority of the larvae produced by fish within one group's territory are being exported beyond the boundaries of that territory, then it is not in their economic interest to put a permanent closure on their own reef. Their neighbours, or people on the next island might benefit but there is no guarantee the former will have access to fish on the latter's reefs. Obviously this is going to vary depending on species, but it is an important issue and needs to be considered carefully by those who think that MPAs can be applied universally without consideration of the social and political environment.

If larvae are effectively being shared across multiple territories, then any lack of cooperation between territories is a problem. As it happens, tenure exclusivity is not particularly strong for *fin-fishing* in most parts of the region, because for most people fish are mainly used for subsistence. But it is a very different story for anything that has a dollar value.

In the Solomon Islands and PNG, land (and marine) rights appear to be inevitably subject to contestation as resources become commodified. The vast numbers of land disputes in both countries that erupted in the wake of logging operations during the 1980s and '90s are ample testament to this; there are also plenty of examples in the marine realm (Kabui 1997; Foale and Macintyre 2000). With some exceptions, the concept of CMT barely existed before the advent of commercial invertebrate fisheries during the early colonial era (Foale and Macintyre 2000).

Commodification of resources frequently leads to increased social fragmentation, and alienation of property, as is also exemplified by the trend towards registration of land around large development projects like mines and oil palm plantations (Koczberski and Curry 2004). So as pressure for commercial inshore fishery development increases, so the prospects for the use of MPAs decreases.

*Local Knowledge and fish population dynamics*

But surely if people understood that MPAs were in their long term best interests they would be jumping at the chance to put them in place all over the region? Unfortunately this is an assumption that is unsupported in many instances. Most indigenous knowledge of marine biology and ecology is geared towards locating fish in space and time, and maximizing catches. It typically does not include the kind of information that is necessary to effectively husband fish populations, i.e. an understanding of growth rates, life-spans, the existence of pelagic larval dispersal, the ranges over which pelagic larvae disperse, and the home ranges of adults (there are some exceptions for this last point) (Foale 1998b).

Much of this information is also fragmentary or even unknown among scientists, as many of the papers presented at this year's ICRS have made obvious. As my own research (Foale 1998a,b) and that of others (see below) has shown, most rural Melanesian fishers believe that the abundance of fish is something that is ultimately beyond their control, and in fact has no limits.

I must make an important caveat here. There is clearly an understanding of *some* human agency over fish abundance, as evidenced by the ubiquitous use of the serial prohibition, or *tambu*, across most of the region (see also Dwyer 1994). People know that leaving an area un-fished for a period usually results in an increased yield for that area, which comes in handy for feasts or raising cash to pay school fees. However this is really a stockpiling technique and bears no relation to the ecological rationale that underpins the idea of using a permanent closure to hedge against recruitment failure. Alone, this practice will not prevent overfishing; once human populations and markets place enough pressure on stocks to seriously deplete adult biomass across the region, the intensity of harvesting during the open season, combined with reductions in spawner biomass on the larger scale, will slow the rate of recruitment during the closed seasons to a trickle, and essentially render them ineffective.

Because most of the people in this region have always lived at very low population densities, most of them (except for a few groups on small islands) have never encountered the limits of their marine resources and are therefore not equipped with the knowledge or the cultural institutions to manage this eventuality. Anthropologists including Ralph Bulmer (1982), James Carrier (1981, 1987) and many others have all documented the attribution of abundance of resources to God or the spirit realm. This has inevitably lead to a fatalistic attitude towards fished populations, though there appears to be at least one interesting exception evident in recent work on the small barrier island of Ahus, north of Ponam in PNG, by Cinner *et al.* (this volume), which is likely to be strongly related to the long history of high levels of dependence on reef resources for both subsistence and trade for this group.

In support of the above argument I present below some interview data from recent research on Lihir Island in PNG (see also Macintyre and Foale 2004a,b), to give some idea of the way people there are thinking about population replacement processes in fish and other organisms. The data are extracted from detailed structured interviews of a total of 29 fishermen, covering a wide range of topics, most of which will not be included here.

In response to the question "Do fish have babies?" a small but significant proportion of the sample (14%) remarked that sharks had babies because

they had seen them in their guts. Around 30% of the interview sample admitted some uncertainty to how fish reproduced. Most believed that fish (except for sharks) had eggs but were unsure of what they did with them. 13% thought that fish released eggs in the water column, and 17% thought that fish put their eggs under stones or somewhere on the reef. Two men elaborated theories relating to why juvenile fish were often found around logs and sticks drifting at sea. One fisherman who did a lot of spearing had observed reef fish broadcast spawning but had not recognized it as such until I described this process to him.

About half of the fishermen interviewed stated categorically that fish populations were unlimited as far as they could tell, and even complete removal by fishing would always be followed by recovery. A smaller number probably believed this, but were not as dogmatic about it.

This and the rest of the data from these surveys collectively show a lack of awareness among these people about the biological and ecological processes involved in fish population replacement. One important result from this work however is that people are very pragmatic with regard to environmental knowledge, and are constantly willing to test received wisdom against their own observations, or to incorporate new information that they think is credible. I have observed a number of examples of people who were willing to alter their existing model of a biological or ecological process, based on new scientific information.

*The importance of education*

Thus the most effective means of engendering support for locally managed marine protected areas is clearly through education about basic fishery biology and ecology, combined with resource monitoring work that is done by the villagers. The LMMA work being done by Alifereti Tawake and colleagues in Fiji (Tawake et al. 2001), shows that involving people in the monitoring of populations of clams, which have short generation times and short dispersal distances, is ideal for illustrating the process of recovery from a state of recruitment collapse, by documenting dramatic increases in recruitment outside of permanent closures, with resulting economic benefits for local communities. While the same benefits obviously take much longer to demonstrate for fish, it appears that rural Fijians are taking this on faith based on the results they have seen with clams. In any case, the time frames required for recovery of fish populations using MPAs - at least 5 and up to 15 years (Roberts *et al.* 2001; Russ 2002, Russ *et al.* 2004), depending on species, will require a vastly higher level of local *governance* of resources (Foale and Manele 2004), as well as environmental education, than exists at the moment in Solomon Islands and PNG.

The time is now long overdue for Donors and NGOs to start looking seriously at the broader development crises in these small pacific countries. PNG and the Solomon Islands at present are profoundly dysfunctional as nation states. People are relatively resource-rich, and the majority still has plenty to eat, but they are cash poor, and the standard of living of most people is very low. It is also impossible to ignore the very high level of dissatisfaction about this state of affairs, particularly among the youth. The standard of health and education services is abysmal, and nurses, doctors and teachers in both countries are paid a pittance. Moreover they are often not paid for many months or even years, and sometimes not paid at all. The standard of scientific education is very low, and about half the population drops out of school after grade 6 in both countries.

There is a palpable frustration with the lack of development, which conventional economic models are clearly not capable of delivering (Escobar 1995; Trainer 1989). The reasons for the failure of development is something relatively few coral reef scientists think about, much less understand, and in the meantime rural people all over these countries enthusiastically embrace logging and mining and oil palm projects (Filer 1997; 1998; Filer and Sekhran 1998, Foale 2001), all of which have substantial environmental impacts, particularly on reefs, and even more substantial social impacts. They do this because these projects deliver major benefits in health, standard of living, and even education (Macintyre and Foale 2004b). This is hardly the ideal pre-requisite for a transformation of the education system to one that includes locally relevant scientific material on coral reef fishery ecology.

Most schools cannot afford furniture or textbooks, much less a microscope. However the students have energy and curiosity in abundance, and despite the catastrophic attrition of Traditional Ecological Knowledge since missionisation there is still a great deal of environmental knowledge in their heads. Melanesian school children are immensely enthusiastic about their indigenous knowledge heritage, and if this approach is used for the introduction of science, they are much more likely to absorb scientific ideas, and test them against, or incorporate them with, local knowledge (c.f. Foale 2002)

**Conclusion**

The biodiversity hotspot approach to reef conservation impresses scientists and environmentalists from rich countries, but has little relevance to rural Melanesians, who are the people who both control and depend economically on the coral reefs in that region. A much greater commitment to locally relevant science education with hands-on reef fishery monitoring and management, and documentation of the ways in which

this delivers real economic benefits, will be much more likely to deliver results in this part of the world.

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