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LIVE REEF FISH

The live reef fish export and aquarium trade

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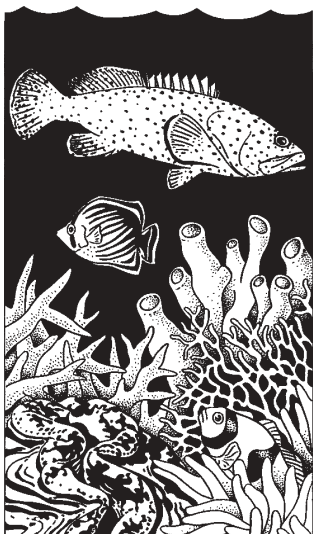

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Editor's mutterings

Blaming the victims

Corruption, as we have pointed out before in this column, can be a huge impediment to cleaning up the live reef food fish trade. Indonesia, which Economic Risk Consultancy Ltd (1998) found to be the most corrupt of the twelve Asian countries it considered, has suffered enormously from this problem.

Although the World Bank, Asian Development Bank, International Monetary Fund and many other organisations and individual observers have focused recently on the need for broad policy changes to address corruption in Indonesia, there seems to be little research available on how corruption actually works at the village level.

One recent major national policy change has been the decentralisation of bureaucratic authority. The stated philosophy behind this is that local people are more likely to make political and bureaucratic decisions consistent with their needs, and corruption is less likely to flourish. But if the appropriate local institutions are not in place, or are malfunctioning, this is wishful thinking.

We are pleased to publish here an article by Dr Lowe (p. 7) that shows how this malfunctioning actually forces villagers to engage in cyanide fishing for live reef fish, *even though they do not want to.* They are forced into doing so by a system that is corrupt from top to bottom.

Such intimate studies are few in the corruption literature. In China, for example, about which there are many research publications on corruption, most of the information comes from newspapers! With Dr Lowe's study we have a rare situation in which a research worker has been in the field observing from close up just how corruption operates.

Inside this issue

One hears enough similar stories from other parts of Indonesia and some other countries in the region to know that Dr Lowe's account is not unusual. What is unusual is that she has published, and thereby recorded for us, an intimate picture of how corruption works at the village level in the live reef food fish trade. Indeed, it shows us how village corruption works in a more general sense as well. It also reveals how villagers, who so often receive much of the blame, may disapprove, but have no option but to participate. We hope this article will be widely disseminated.

It also is worth adding that Dr Stowe's account demonstrates that well-chosen anecdotes can sometimes be at least as valuable in defining resource management problems as statistics.

The article on war on destructive fishing practices by Mark Erdmann (p. 17) presents an interesting, provocative and somewhat different view of some of these issues. Mark has quite a few years of experience in nearshore fisheries research, including considerable work on the live reef food fish trade in eastern Indonesia.

GBR LRFF managers mean business

Australia's Great Barrier Reef probably has the best-managed live reef food fishery in the world. But even here, illegal fishing is a problem. In the last financial year, 50 commercial line-fishing dories associated with 27 different primary boats have been apprehended illegally operating in Green Zones (no-fishing) according to Mick Bishop of the Great Barrier Reef Marine Park Authority (GBRMPA). Bishop tells me that the great majority of these dories were involved in the live reef food fish trade. Most of these violations occurred shortly before the Chinese New Year when the demand for live coral trout peaks in Hong Kong and mainland China, where Australia exports nearly all of its live reef food fish. GBRMPA is confident, says Bishop, that most of these cases will go to court and that 'many successful prosecutions will result'. Fines for fishing in a Green Zone can be up to AUD 220,000 (about USD 120,000).

Ethnoaquaculture

Ethnoveterinary medicine is a vital part of community-based animal health care, especially in developing countries where commercial medicines and treatments are often unavailable or too expensive. The latest (2001) bibliography on this subject has 1240 entries (up from 261 entries in 1989 as noted in an earlier issue of this bulletin).

I've never seen an article on ethnoaquaculture. Isn't it time that research began in an area that is bound to unearth inexpensive and useful methods for disease prevention and treatment of live reef food fish? The need is certainly there. See in this issue, for example, Yvonne Sadovy's article, Death in the live reef fish trades (p. 3).

Other useful aspects of rural aquaculture could also undoubtedly be uncovered by the study of ethnoaquaculture, such as the use of cheap local materials for construction, locally designed gear, knowledge of relevant fish behaviour in different cage designs, needs of rural fish farmers with which governments and NGOs might better assist, etc.

Bob Johannes

Note added in press: The most recent issue of *Aquaculture Asia* (12(1):17–20), contains the first of a series of articles on (fish) farmers as scientists. This is a start on what I am calling for here. I hope the series thrives.

Death in the live reef fish trades

Yvonne Sadovy[1]

When we think of trade and marketing in live reef fish, — larger species destined for food, brightly coloured ones for aquarium display — we tend not to consider a darker side; death before reaching the consumer or, for aquarists, prematurely after purchase. Yet the mortality associated with these trades can be significant and, if this causes more fish to be harvested, is also wasteful. On the upside, much of this mortality could probably be avoided, and can certainly be reduced. This article highlights what is known and, more importantly, what is being done, about unnecessary mortalities in the live reef fish trades. I also touch briefly on some associated questions of animal welfare.

Estimates indicate that cumulative fish mortality from capture to consumer are incredibly variable and can often be high, producing significant wastage in both trades (Johannes and Riepen 1995; Wood 2001; Sadovy and Vincent 2002). Mortalities typically range from a few per cent to more than 80 per cent according to one or, more likely, a combination of, poor capture and handling, inadequate husbandry practices, facilities and transportation, and the inclusion of unsuitable species.[2]

While some problems arise from inexperience and could be solved, others may be symptomatic of prevailing attitudes or lack of knowledge within a particular sector. These are not likely to be resolved without training, introduction of alternative methods, changes in perception, or the development of legislation or codes of conduct. Several examples serve to illustrate some of the problems involved and the approaches being taken to deal with them.

The live reef food fish trade (LRFFT) involves the wild capture of both marketable size fish and juveniles destined for mariculture grow-out[3] to saleable size (hatchery production of juveniles will not be considered here) of certain reef fish, particularly groupers (Serranidae). High mortalities from capture to consumer can be a problem for adult fish especially when they are caught with chemicals such as sodium cyanide, caught by hook and line but improperly degassed (i.e. the process of removing air from the gas bladder, which expands when fish are rapidly retrieved from deeper waters), or foul-hooked, and when generally handled or shipped poorly or inexpertly. Mortality rates are relatively low for net-caught fish, unless taken with the fyke or bag nets used to capture post-settlement juveniles for grow-out (reviewed in Sadovy and Vincent 2002). Juveniles destined for grow-out are often maintained and shipped in stressful conditions that doubtless contribute to high levels of mortality prior to export and while in culture[4] (Sadovy 2000).

The marine aquarium trade (MAT) includes the capture and shipment of over 1000 species globally, particularly smaller species, and often juveniles of medium-sized reef fish. Mortalities may be associated with physical damage, use of sodium cyanide, poor conditions in holding and transport, and stress (Wood 2001). For example, in the Philippines, a major source of aquarium fish and where cyanide is often used, mortalities can reach 20 per cent within a few days of capture when fish are held under poor conditions prior to collection by middlemen (Baquero 1995). The inclusion of species that cannot withstand capture and shipping or do not adapt readily to aquarium life adds further to overall losses (Wood 2001), while as much as 40 per cent of species currently traded may not be suitable for the average aquarist (Sadovy and Vincent 2002). A survey of over 300 aquarium fish retailers indicated that mortality levels of fish imported from the Philippines (where various middlemen are often involved) ranged

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2. The term 'unsuitable species' means species that are unlikely to survive shipment or captivity for a considerable proportion of their potential lifespan (MAC 2001).
3. Grow-out refers to the process of maintaining sub-market sized fish in captivity until attaining marketable size.
4. Refers to any fish grown-out in captivity irrespective of whether its was hatchery-reared or taken from the wild as a juvenile.

from 30 to 60 per cent within three days of arrival in the United States (Rubec et al. 2000). On the other hand, in countries where the collector is also the exporter, good practices often keep mortality levels very low.

What is being done to reduce wasteful mortality? The good news is that several projects specifically aim at reducing mortality levels, although in many cases it is still too early to be able to gauge long-term overall success rates. Examples include alternatives to sodium cyanide by introducing less destructive gears such as hand or barrier nets (for the MAT), or hook and line coupled with proper air bladder deflation (for the LRFFT) (e.g. Barber and Pratt 1997). Many facilities at the import stage of the MAT now have excellent filtration systems and include practices that minimise mortality levels (Wood 2001). For the LRFFT, growing experience has much improved survival at the import level, while in transit the use of aerated or oxygenated bins, as opposed to oxygenated bags in polystyrene boxes, has reduced mortality (Frazer McGilvray, International Marinelife Alliance, pers. comm.).

For the MAT, industry standards are now being developed, which 'outline the requirements for third-party certification of quality and sustainability in the marine aquarium industry from reef to retail'. These standards address, among many other issues, best practices for harvesting, holding, packaging and transport to ensure the optimal health of harvested organisms, including during export, import and retail. The final working version of the Marine Aquarium Council (MAC) Core Standards provisionally sets the allowable limits of marine aquarium organism mortality at the species level at one per cent dead on arrival and one per cent dead after arrival per species and per shipment for each link in the chain of custody.[5] Businesses that comply with these standards (whether industry operators, facilities or collection areas) can be MAC-certified, the benefit ultimately being that such certification should be good for business (MAC 2001).

Other organisations in the industry have also developed their own codes of conduct to address many of the problems, in addition to voluntarily not trading in species considered to be impossible to keep (Wood 2001; Sadovy and Vincent 2002). For the LRFFT, plans are now being drafted to develop a voluntary code of contact for industry standards, through a collaboration of several NGOs with a major industry player, which will address the problems of both wild-caught and cultured fish (Frazer McGilvray pers. comm.). Two final points must be considered. The first is that follow-up studies after implementation of such measures are needed to evaluate their effectiveness in reducing mortalities and other wasteful practices and to improve implementation. The second is that, in any fishery, dealing with a problem such as unnecessary mortality is only part of the much bigger problem of resource management, which must always be integrated into the overall solution.

The not-so-good news is that fishing practices producing high levels of mortality in both target, and sometimes non-target (or bycatch), species continue. Mortalities are typically undocumented and unsuitable species are still traded. In this context, 'unsuitable' also encompasses species that are unmanaged and readily threatened by overfishing (examples include several angelfishes, seahorses, *Epinephelus lanceolatus*, and the humphead wrasse, *Cheilinus undulatus*) (IUCN Red List of Threatened Species 2000; http://www.iucn.org/themes/ssc/red-lists.htm). Trade or volume estimates, if made at all, tend to rely on export or import figures, points in trade after which much mortality may have occurred. This means that actual volumes and extraction rates are typically higher than import or export records would indicate. This is particularly likely in many of the major producer countries where mortalities tend to be highest and monitoring least developed. Moreover, trade in species unsuitable for life in the average aquarium continue in the MAT, despite a great variety of suitable species. The massive fry trade, involving millions of post-settlement and juvenile fish for mariculture grow-out, is also associated with significant losses at all levels (Sadovy 2000).

A final, and more controversial, point to consider — and one that goes beyond the more general issues of animal health and welfare — is quality of life for fish that enter the live reef fish trades. In some countries there is growing public concern that even for terminal markets, animals should not experience pain and suffering, especially unnecessarily, while *en route* to retail markets (Olin 2001). Without entering the debate on what might constitute pain and suffering for fish, it is clear that this issue needs to be addressed by the industry, and ideally, proactively. As just one example of possible implications, in San Francisco's Chinatown, animal rights groups, including Chinese groups, brought a cruelty suit against merchants 'for keeping live fish and other animals under conditions of pain, suffering, distress and deprivation' (Rollin 2001).

5. There are typically at least four such links. Chain of custody refers to the sequence of commercial operations or people responsible for the collection and trade in marine aquarium organisms, from collectors to retailers and buyers. For the retailer to be able to offer certified marine organisms, all components of the chain of custody handling the organisms must be certified (MAC 2001).

It is clear that considerable progress, particularly in the MAT that attracted attention much earlier than the LRFFT, has been made in the last decade. However, much remains to be done to reduce wastage through unnecessary mortalities and to factor mortality reduction into the much greater challenge of natural resource management. In particular, the role of an informed and discerning public in effecting change has yet to be developed.

Wood (2001) concluded for the MAT there are three reasons to avoid premature deaths, and I suggest that similar arguments apply to the LRFFT. The first is that every fish that dies early puts extra pressure on natural resources because of the take of replacements. The second reason is that there is a general consensus in many countries that it is not ethical to trade in live animals, unless their health and welfare are ensured, while unnecessary and early deaths give the trade a poor image. The third reason is that mortalities also mean economic losses for business. Success for both current and developing initiatives attempting to deal with the problem of mortality, therefore, should ultimately be of benefit to both resource and resource user. Adoption of good practices could be much enhanced by the participation of a critical public who to demand responsible use of limited natural resources.

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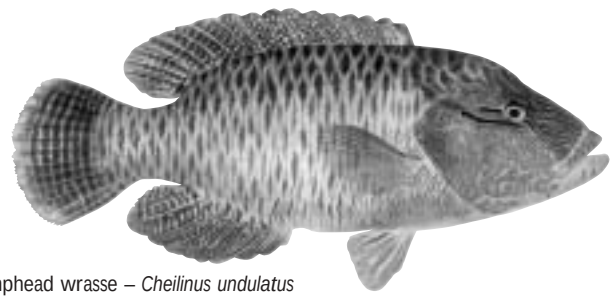

Humphead wrasse – *Cheilinus undulatus*

The humphead wrasse – a threatened reef fish

Yvonne Sadovy[1]

The humphead, Maori or Napoleon wrasse (to mention but a few of its many names[2]), *Cheilinus undulatus*, is the largest member of the family Labridae and is widely distributed across the reefs of the Indo-Pacific. It is particularly susceptible to overexploitation due to its life history, which involves late sexual maturity, long life and sex reversal. It appears to be highly vulnerable to overfishing wherever it is unmanaged, or where management is not enforced, and especially so where an export trade has developed. Despite its widespread distribution, the species is not particularly common. Indeed, as far as we can tell, it is becoming increasingly uncommon.

Historically, the humphead wrasse has been prized for its flavour and texture. Considered in some areas to be a stately fish, it is valued in many cultures where it was formerly used for special occasions, or only by high-ranking members of society. More recently, it has come to form an important part of the live reef food fish trade (LRFFT) in Southeast Asia, at times commanding over USD 100 per kg at retail — among the highest prices in the trade.

Traditionally this species was fished by hook-and-line gear, hand spear (more recently speargun using SCUBA), or trap, depending on fish size. Larger fish may sometimes be taken at night from their resting places where they are easy targets. To keep them alive for the LRFFT, cyanide is frequently used in some areas because it is not an easy fish to catch.

It is becoming clear from a range of studies, surveys and anecdotal accounts that the humphead wrasse cannot withstand anything other than light levels of fishing pressure (summarised in: The humphead wrasse *Cheilinus undulatus*, Ruppell 1835: synopsis of a threatened and poorly known species. Y. Sadovy et al., unpubl. ms).

The humphead wrasse appears to be threatened wherever an export LRRFT market has developed, where night fishing on SCUBA is unchecked, where significant local fisheries are unmanaged, or where management is not enforced. Annual landings for local use in source countries rarely exceed about 10 t while a minimum volume for the export LRFFT between 1997 and 2000 was between 78 and 132 t a year. These figures are Hong Kong import estimates for this species and Hong Kong is probably its major importer.

Despite such low volumes for a commercially important food fish, over the last few years live fish traders have found it increasingly difficult to find adults. The majority of individuals now in the Hong Kong retail sector are less than 60 cm total length, most of them juveniles. Thus, trade in this species is currently largely one of juveniles, a pattern that will doubtless exacerbate the threatened status of this species. The humphead wrasse cannot yet be hatchery-reared, despite claims to the contrary, and all fish in the trade are wild-caught.

Due to documented declines, the humphead wrasse is listed as vulnerable on IUCN's Red List of Threatened Species and is variously banned from export from several countries. However, there is no regional management plan for this species and overfishing (even where the species is protected by law) and illegal export (especially from Indonesia) evidently continue. The status of this species as a luxury food means that its market value is likely to increase as it becomes less available, thereby encouraging continued exploitation even as populations decline.

Because of widespread concern over the status of the humphead wrasse the IUCN Grouper / Wrasse Specialist Group is launching an awareness campaign using funding from the Brookfield Zoo (Illinois, USA) and the University of Hong Kong. If you would like to receive one of our information packets on this species, or know of others who might, please contact me.

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2. Other names include: ramkop-lipvis, variivoce, mem, namen, man, dagava, pian-pokon, podar-takai, mameng, so mei, maml, and many more.

Who is to blame? Logics of responsibility in the live reef food fish trade in Sulawesi, Indonesia

Celia Lowe[1]

Cultures of culpability

The fishers of the Togean Islands of Sulawesi, Indonesia are in a bind. On the one hand, the live reef food fish (LRFF) trade is an attractive source of employment. On the other, wild reef fish, which provide fishers with an income through longstanding markets for salt fish, and which are also an important local food resource, are becoming rare. Due to cyanide use, the LRFF trade has quickly proven harmful for the majority of fishers, and to coral reef environments. Fishing communities along the shores of Indonesia's more remote islands are experiencing the surveillance, enforcement and sharp criticism associated with cyanide. Both Indonesian bureaucrats and national and international conservationists, through similar logic, focus on intervention at the community level. While the state threatens Togean fishers with fines, incarceration, physical violence and extortion, conservationists are wondering why fishers destroy their own reefs, and, in some cases, they too support militarised interventions against Indonesia's most vulnerable citizens.

This approach, however, leaves the political, social and economic factors that promote cyanide use unexplored. It fails to examine important questions of culpability, corruption and causality among bureaucrats and traders, and it holds at arm's-length distance questions of the cultural and ideological norms that determine who will be blamed for environmental degradation and who will profit the most from natural resource trades in Indonesia. Using examples from my two years of fieldwork in central and north Sulawesi in the mid-1990s, this paper examines the extended contexts of cyanide use in the LRFF trade and why these questions are important for thinking about marine conservation.

As I will argue, the outcomes of the live fish trade are not logically explained either by the 'three Ps' of conventional wisdom (poverty, population and proximity) or by fisher ignorance. We need an explanation that encompasses the social, political, economic and legal contexts of cyanide use. To better understand the issues involved, we need to ask the following questions: 'What is the role that elite Indonesians and non-local people play in cyanide use?', 'How do trade practices and individual traders and trading companies influence the methods of fish catch?', 'How do legal frameworks intersect with the LRFF trade?', and 'What is the relationship between enforcement of live fish regulations, empowerment of local fishers and possible conservation outcomes?'

Of all these questions, the issue of corruption helps us most to contextualise culpability in cyanide use. Practices of corruption that underwrite the trade start at the top of the Indonesian bureaucracy and filter down to the community level. These practices affect Togean people's own control over reef resources while allowing a few local bureaucrats and outside entrepreneurs to become wealthy from the trade. Legal frameworks in Indonesia also support elite business interests at the expense of local people and their environments. Indonesia's fishers are caught within the matted fibres of market, law, bureaucracy and identity that determine who will fish with cyanide, who will profit most by it, and who will suffer its legal and ecological consequences. These factors reveal the complexities of cyanide fishing in Indonesia and help us to think through the sometimes misdirected logic of contemporary conservation practices.

Live reef food fishing in the Togean Islands

The Togean Islands are a small archipelago in the eastward-facing Gulf of Tomini and have been a site for international marine resource trades for hundreds of years. For example, Sama and Bugis peoples in Eastern Indonesia trade marine products in networks that have connected them with mainland Southeast Asia and China for at least a millennium (Warren 1981). Sama and Bugis trade in sea cucumbers and turtle shell were first noted for the Togean Islands in mid-19th century colonial records (Von Hoevel 1893). In the 1850s, New England whalers hunted whales off Togean shores (Hussey 1855). In the 1980s, Togean people col-

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lected giant clams for export to Japan. In the 1990s, Australians, Japanese and Bugis opened up pearl farms in Togean waters. And dried fish have always been a Togean export to parts of mainland Sulawesi. The islands have also been a site for natural history or biodiversity conservation since the 19th century beginning with Viscount Walden's survey of birds in the 1870s (Walden 1871, 1872) and J.H.F. Umbgrove's study of corals in the 1920s (Umbgrove 1930, 1939). The archipelago is inhabited by people from at least a half a dozen ethnic groups represented on the surrounding mainland (e.g. Sama, Saluan, Ta'a, Bugis, Gorantalo, Kaili), by others from distant parts of Indonesia (Chinese, Javanese, Minahassan), and by people of one ethnicity (Bobonko) whose population is not found outside the Togean Islands.

In biodiversity conservation in Indonesia certain local peoples and ethnic groups are commonly imagined to be more implicated in coral reef destruction than others (see, for example, Pet-Soede and Erdmann 1998). In the Togean Islands, all ethnicities practice live fishing but Sama people are presumed to be the most engaged with cyanide use. This perception is related to the politics of ethnic representation in Indonesia. In the first place, Sama peoples are inaccurately thought of as 'sea peoples' (*orang laut*) or 'sea nomads' and, thus, both traders and conservationists have concentrated their energies on Sama communities. While traders have sought out Sama people for their fishing knowledge, conservationists presume just the opposite, that fishers are ignorant of coral reef biology and the damage they are doing to reefs. Togean Islanders, in general, are also thought of as '*suku terasing*,' a term meaning ethnic groups alien to, or left behind in, the process of national modernisation. These simplifications of Togean identities and practices have made local Togean fishers, especially Sama fishers, easy to blame for cyanide use.

The LRFF trade in the Togean Islands is a multiethnic and economically stratified enterprise, however. At the local level, the trade is managed through a series of fish camps run by bosses from Java and Kalimantan. Togean fishers work as harvesters in the trade and are also occasionally hired to do physical labour at the camps. Live fish businesses are owned by wealthy Indonesians of Chinese and Javanese descent who live in Jakarta. These elites operate through established connections with foreign buyers. They also have the protection of local and national level bureaucratic elites of many ethnicities who are linked to resource extraction and responsible for 'law and order'. These elites are thought of as contributing to 'national development'. They are well-respected businessmen and generally not considered responsible for coral reef destruction in a tiny archipelago in a remote part of Sulawesi. They do not experience surveillance or police action for their role in the LRFF trade.

Ethnic and class-based hierarchies in the live fish business place Javanese, Chinese and other urban elites at the centre of lucrative extractive economies, and Indonesia's diverse farmers and fishers at the periphery. This pattern has a historical basis in Dutch colonial rule and mirrors the way most natural resource production continues to be organised in Indonesia today (see Peluso 1992; Robeson 1986). At the same time, ethnic economies link up with bureaucratic ones when, as often happens, government workers (in the Togean case, Fisheries Department officials, police, army, village heads and other civil servants) also become entrepreneurs.[2] The patterns of the live fish trade differ from earlier marine resource trades (such as sea cucumber) in that the contemporary bureaucracy works to suppress political resistance among the populace, domesticating it through ideas of who is central and who is marginal within the nation, and demanding compliance as a means to facilitate bureaucratic and entrepreneurial control.

Live fish businesses, however, supply cyanide directly to Togean fishers. Fishers report cyanide was not used in the Togean Islands before the arrival of the LRFF trade when fish traders came and taught fishers how to use it. Live fish operators have then proceeded to supply cyanide to fishers for free. Cyanide is most commonly found in Indonesia in the mining industry, which is a commercial enterprise closely linked to the army. It has been reported that the Indonesian army is responsible for the circulation of cyanide between the mining industry and the live fish trade.[3] And cyanide isn't the only thing fish camps supply to fishers. Fish camps supply compressor equipment used to catch live fish in deeper waters and in more difficult locations. Conservationists have observed that using compressed air allows some live fishers to target literally every single sizeable grouper and wrasse on a given reef. Compressors and hookah rigs go hand in hand with cyanide use since there is no other way for a diver using a hookah to catch live fish.

While most *fish* caught for the LRFF trade in the Togean Islands are caught with cyanide, the *majority* (roughly 85%) of Togean Sama *fishers* actually

2. See Stoler (1985) for a discussion of the articulation between political and commercial economies in Indonesia.
3. I have discovered this through personal conversations, but see also Adhuri (1998).

Map of Indonesia

Map of Sulawesi, showing the Togean Islands

use conventional handline techniques.[4] Most fishers use methods that don't poison reefs and extract fish at lower, arguably more sustainable, rates of harvest. Paradoxically, the live fish trade is generally thought by biologists to potentially yield widespread sustainable benefits for fishers (Johannes and Riepen 1995). For this reason, it is incumbent upon us to examine why fishers become involved with cyanide when they actually do. Fish camps are a place to begin this inquiry.

Togean fishers and cyanide use

Many fishers work independently from fish camps choosing when and how to fish for live fish or when to pursue other livelihoods. Fish camps, however, want to have a monopoly over fishers' catch and to encourage fishers to catch as many fish as possible. To do this they provide fishers with outboard motors on credit. In a small archipelago where sail and paddle are the most prevalent means of moving about, outboards are highly desired, though difficult for most to afford. Through the live fish trade, outboard motors have become available to ten per cent of Togean Sama fishing households, largely through loans from LRFF camps. Fishers pay for their motors with irregular payments taken out of their live fish sales. The camps maintain the outboard, changing oil and spark plugs, as long as the fisher continues to deliver live fish to them. Fishers are required to put down some cash each time they sell a fish, but they can decide for themselves how much to deposit. A look at fishers' accounting books shows that they make random payments of between one and six dollars up to four times a month. Fishers pay off one quarter to one third of their debt in a year and frequently believe they have paid off more than they actually have. By the time the motor is free and clear it will typically have little life left in it.

While fishers want to own outboards, they often regret their ties to fish camps. A camp's profits are not in the loan but rather in guaranteeing its supply of fish. They want to force fishers to keep looking for live fish and they forbid them to sell fish to any other buyer. So if a fisher wants to keep his outboard, he must continue to supply live fish at a rapid pace. One Togean fisher, who grows cacao and coconuts as well as trading in live fish, explained to me the regrets he had over his ties to a fish camp. Every morning he fished, and in the afternoon he would come home to work in his garden. He was tired of fishing and would like to spend more time farming, but he had to keep going or the camp would take his outboard away. The

4. Conservationists often find this hard to believe. I was once approached by a "Big Ten" conservation organisation that planned to 're-introduce' handline techniques to Togean fishers. It was assumed that a programme already developed for the Philippines would be equally appropriate for the Togean Islands even though there had not been any specific research done by this organisation on the Togean fishery. I do not believe the handline fishers in the Togean Islands follow the pattern of 'evolutionary' process from cyanide to apocalypse described by Pet-Soede and Erdman (1998). Togean handline fishers used this method from the moment the trade was introduced to the islands.

camp boss always noticed if he did not bring fish around. Another Togean fisher used his outboard to fish for pelagic tuna. He needed his outboard to get to the offshore fish aggregating devices where the deepwater fish school. Yet, he was told his outboard would be confiscated if he did not start catching live fish again for the camp.

Although this analysis suggests that fishers themselves are not the primary instigators of cyanide use, I have said that fifteen per cent of Togean fishers *do* use cyanide. Conservation interventions would be more effective, however, if we had a more nuanced idea of who those fifteen per cent are, since we have often defined blame for cyanide use along community lines. In other words, whole communities, villages and even ethnicities are considered to be responsible for harming reefs. This suggests that fishers are not thought of as individuals, but as *types* of individuals. If, however, we look at the fractures within communities over cyanide use, we can see that the 'community' is the wrong scale for culpability. One salient division within communities is gender.

While not all men who fish for the LRFFT use cyanide, all the cyanide users I encountered during two years of research were young men. This is for several reasons. High live fish profits through cyanide use are a way for young men to build houses and establish new, independent families. Cyanide also has a status that is most appealing to young people. Cyanide fishers demonstrate their wealth and status by controlling outboard motors and they also have the money to smoke expensive cigarettes and wear fashionable new clothes. Since the activity is illegal, it further demands their daring and indicates their closeness with officials who will protect them from prosecution.[5] Young men are more capable of diving than older men are; diving is physically strenuous and older men complain of the cold. When older men participate in cyanide use they tend to do so as distributors or as middlemen in live fish purchasing.

Women, on the other hand, participate in the live fish trade but they never use poison to catch fish. The comments of women fishers reveal the level of disagreement in the community over cyanide use. When fishing off a reef at night, I once asked why everyone was trying to catch small sardines rather than larger fish. A woman answered, '*we are looking for sardines because all the big fish have been poisoned.*' Women fishers are doubly affected by cyanide use: they lack fish to catch when poison is used, and they lack food to feed themselves and their children at home. While women will sometimes cover up for a spouse or son using cyanide to protect their families, it is also women — and women fishers in particular — who most openly criticise destructive fishing practices.

Contrary to many informal village and family power arrangements, the Indonesian State, religious institutions and conservation organisations teach that men are the heads of families. Government representatives in the Togeans, for example, order people to paint their fences in gender coded colours: against a white background of vertical pickets, two low blue stripes symbolise the number of children allowed in the government's family planning program, a bar near the top signifies mother, and a blue fence cap represents the paternal rule that unifies the family and binds it together. When government officials and conservationists discuss cyanide use (or most any issue besides cooking and family health) they direct their comments to men. By officially promoting male authority these efforts bypass women's interests and structures of political authority which could be effective in opposing cyanide use. They overlook women's habits as fishers and as community members invested in environmental outcomes.

Togean peoples are in the ironic position of being ridiculed for their cultural and economic impoverishment, and at the same time encouraged to come up with means for their own financial advancement. Although some of them, have found the means to 'develop' — build new houses, wear new clothes, own motorised transport through the live fish trade — they are then chastised for being environmentally destructive. This double bind, or double standard, that fishers face seems to be one important context for understanding cyanide use. It also helps us to recognise the multiple, shifting, and complex positions fishers do have on cyanide use.

Fishers' biological knowledge and opposition to cyanide use

It turns out, perhaps surprisingly, that most Togean people, men and women, are against the way the live reef fish trade is conducted. They *do* believe that cyanide is harmful but feel helpless to oppose it. In better times, Togean people told me, the walls of their fishing houses, and all the space on the decks of their fishing boats, would be layered with fish drying, and the air around them would reek of fish. People blame cyanide for their declining fish catch. Although under current conditions in the

5. Jos Pet and Lida Pet-Soede (1999) observe that 'Even if fishermen have other options to make a living at sea, in many cases they deliberately choose this lucrative practice'.

Togeans poison produces a higher yield, most people choose to avoid it. Though Togean communities appear unified to outsiders on the issue of cyanide, individuals do complain to each other. For example, I heard one fisher say to another passing by, '*don't bother fishing here, they won't eat your hook. Someone from my village was using cyanide here this morning. You should get your village head to report him*.' Another woman, spotting someone using cyanide, said, "*Tie him to a rock and dump him in a deep spot'*, and cyanide fishers are frequently insulted as 'rock heads'. Fishers who use traditional hook-and-line techniques to catch live fish are one constituency who oppose the use of poison; many report that their fish take has dropped to nothing. Ordinary fishers are angry at the ones using what they call '*teknik*'. Cyanide fishers, they say, make lots of money while everyone else's take of reef fish, for both trade and food, disappears.

We can hear a certain fatalism in the words of one fisher who I will call 'Puah'. '*If people were using poison and my take dropped to only a little, I would accept it'*, Puah said. '*But I feel heartsick; people have used cyanide here and then I catch nothing at all. I have not caught a big fish in a month so there's no point in going fishing this afternoon. There won't be any results.*' Puah has only taken up live fishing himself in the past few years. At first he would go out to the reef, paddling his canoe two hours in the morning as the stars faded around him, count out twenty arm spans of nylon line and drop it over the side, then look deep into the water, waiting, forearm resting on the canoe's edge, the heavy line wrapped three times across his palm. But he has had competition; younger men who motor along the reef's edge also on the lookout for live fish species and don't use handlines — only chalky clouds of poison from their plastic squirt bottles to stupefy otherwise wary fish. Puah is torn; he also wants to be able to catch live fish to sell to the fish camps that pay him very well for his effort. He manoeuvres, in our conversations, to protect and perpetuate the industry, defending this camp, or that, as 'clean', not supporting poison. Yet, he also recognises that live fishing has brought his community to a difficult place — because of cyanide use, there are fewer fish for people to catch.

Puah is a Sama fisher and Sama people are thought of as the 'usual suspects' in cyanide fishing. My ethnographic research indicates that Sama fishers may actually be *less* likely to use cyanide than fishers from other places. While bureaucrats and conservationists blame Sama people for degrading their environment, Rili Djohani of The Nature Conservancy has been one of the few people to propose that Sama (Bajau) peoples' experience with the sea could make them important marine conservators in Togean and other Indonesian settings (Djohani 1993, 1996). While cyanide use on coral reefs is attributed to fisher ignorance, the biological knowledge of Togean fishers concerning the marine world is quite extensive. They demonstrate intricate knowledge of species, currents, and the location, movements, and behaviour of fish. This constitutes a reservoir of knowledge about fish and reefs that is largely unexplored by conservationists.

When I interviewed a Javanese migrant fisher about the presence of cyanide-caught live fish in fish camp holding pens, he responded '*All Napoleon wrasses are caught using cyanide'*. Yet, whenever I fished with Sama handline fishers and observed them fishing selectively for Napoleon wrasse (*Cheilinus undulatus*), their ecological knowledge of habitat and bait narrowed the territory of catch locations and enabled them to catch fish without poison. The fisher first would catch squirrelfish in the shallows with a spear gun before paddling out to a reef precipice to wait for Napoleon wrasses. Experienced Sama live-fishers can name eleven separate species of squirrelfish that work well as Napoleon wrasse bait. While cyanide fishers swept the seas catching any possible reef fish they wanted, Napoleon wrasse fishers were sedentary, waiting for the mobile fish to swim along a favoured path. Non-Sama fishers, on the other hand, who have less marine ecological knowledge, were more inclined to use cyanide because they couldn't recognise the appropriate bait to use, or the appropriate spatial tactics for Napoleon wrasse fishing. As new entrants into the market, they were less inclined to take up these practices and more likely to go directly to easier and more destructive ways of fishing.[6]

While many fishers share with conservationists a concern that groupers and wrasses remain abundant and that coral reefs remain healthy, a productive collaboration between the two groups has not yet emerged. We tend to imagine that conservation science is the only relevant form of environmental knowledge and that a degree in biology is the best means to understand the habits of fish. Urban Indonesians and multi-national conservationists hold the view that Togean people are 'pirates' plundering reefs and coastal seas, or maritime 'primitives'. Fishers can not be 'knowers' from this perspective, and thus it is very difficult for them to represent their position to bureaucrats and conservationists who are imagined as 'modern' and

6. This presents a different theory of the balance between cyanide fishing and handline fishing than that proposed by R.E. Johannes (1998) in its 'Editor's mutterings'.

'rational' and whose knowledge and ideas are widely received as credible and valuable. Since we don't invest as much time in understanding people as we do in making biological surveys, it can be hard for us to realise that so many fishers might actually oppose cyanide.

Corruption I

Culpability in cyanide use cannot be understood apart from the larger structures of corruption that permeates resource extraction throughout Indonesia. The Indonesian State bureaucracy extends from Jakarta down to the village level, and radiates out into villages through kinship connections. It is the factor most tightly correlated with illegal trade in natural resources throughout Indonesia. While some young men catch fish with cyanide, some older men participate by using the attachments to bureaucracy and bureaucrats they develop as village leaders. In fact, it is often difficult to become a village head unless one is willing to help higher-ups facilitate lucrative resource trades. The story of one village level enforcement event in the Togean Islands reveals these aspects of cyanide activity.

One Togean village official, under pressure to appear to be enforcing cyanide laws, ordered 'sea operations', also called 'sweeping', and his subordinates were instructed to go out and 'clean up the ocean'. I went along with a party of five 'sweepers', all wearing khaki uniforms, who set off with their boat drivers in three directions. Only our boat had any 'success'; we caught five skinny boys, none of them older than ten, using cyanide to catch anemone fish. Children like to play with these fish which symbiotically inhabit sea anemones by making them fight each other in a small container of seawater. The boys all yelled at once, begging us not to report them. They feared the police would be angry, and it was common knowledge that angry police are physically violent.[7] A solution emerged: the boys would deliver edible anemones to the village official's house. Conspicuously, their poison was not confiscated and they were left to resume their activity.

From there, we proceeded to a less affluent part of the village, far from where any officials live, and the parents were informed that their children had been caught using cyanide. In the same breath, the khakied bureaucrat made a casual inquiry as to whether there were any ripe mangoes. We were soon sitting on the porch, chins dripping with mango juice. He asked again for fried sago (don't forget the coconut!) which they procured with ingredients quickly borrowed from a neighbour. Coffee with tablespoons of expensive sugar was served after the mangoes; 'gifts' of limes and chillies were taken before leaving. Conversation between the high status village officials and their subordinate fellow villagers had been smooth, never strained, polite. The threat was always left implied, wound around, sweet and hot, in-and-out of discussions of mangoes and chilies.

Fishers involved in cyanide use, if not immediate family members of bureaucrats, are frequently closely related. Top officials provide protection against prosecution for their relatives and workers. '*He uses a code when he directs us not to use cyanide which indicates that in his heart he will not really be mad if we do'*, said one fisher about the village head. Ties to bureaucrats also help determine who pays bribes and who is prosecuted; the children collecting anemone fish were from families without strong ties to village leadership and were thus vulnerable to demands for payment. Local leaders of cyanide operations worked closely with fish camps and tended to channel financial opportunities and protection benefits to family members whom they could both trust and control.

Outside of this circle, fishers, even small boys, use poison at their own risk. Subsequent to the 'sea operation', a friend who was part of the village faction opposed to cyanide use pointed out that the manner of our operation was all wrong — not *really* designed to catch anybody. It was conducted at the wrong time of the day, and not where most people fish. More importantly, he said, the people involved in the operation were heavily implicated in cyanide fishing themselves. Village level bureaucrats, nested tightly in live fish procurement networks, worked closely with fish camps who supplied cyanide and bought the cyanide-caught fish. Our 'boat drivers' had steady work as cyanide fishers in the employ of these leaders.

It would be easy to be swept up by a theory that local officials who profit from cyanide are just greedy people but village officials surely do not invent these ways of organising economic life. Corrupt networks originate in, and are patterned on, an entrepreneurial culture that starts at the top. At one point, former President Suharto was rumoured to have a net worth of 15 billion US dollars through his own

7. I am aware of two examples of such violence in the Togean Islands. On the first occasion, a tourist's walkman was stolen and the thief was beaten until blood ran from his ears. On another occasion, some teenage boys stole fish from a fish trap and the ones who couldn't pay a fine were beaten and brought to the police station and made to stay there for an entire month and cut the police station's grass on their knees using clippers.

entrepreneurial activities, many of them based on Indonesia's natural resources (Colmey and Liebold 1999). Moreover, powerful northern nations have acted as guarantors of an Indonesian bureaucracy that has facilitated international trade while suppressing political opposition. This officially choreographed subversion of opposition is effective in Indonesia right down to the village level. From this perspective, it can be seen that local fishers are not autonomous agents solely responsible for the use of cyanide in live fishing. As conservationists, we should pause to reflect on why we participate in blaming and intervening with only those at the bottom of the entrepreneurial ladder.

Legal contexts

An examination of Indonesian legal frameworks adds another dimension to our understanding of why cyanide fishing is illegal yet widespread. In official discourse, Indonesia calls itself a 'legal state' (*Negara Hukum*), and at one level it does have laws generous in their protection of both ordinary people and the resources they depend on. Environmental laws, for example, prohibit the use of destructive technologies, the harvest and export of endangered species, and the penetration of foreign fishing vessels into Indonesian waters. But laws can also have unstated agendas: the design and implementation of law reflects cultural norms and dominant ideologies as well as political capacity and will. Indonesian resource law, which I will explore in relation to Napoleon wrasse regulation, apportions blame, expertise and profit differently among fishers, businesses, and government agencies.

In a country, indeed a world, where 'development' is a privileged ideology, environmental legislation in Indonesia creates, in effect, a protected environment for business, while focusing conservation responsibility, enforcement and blame onto communities. For example, we can see how official structures claim to protect people and ecosystems while actually protecting the interests of bureaucrats and traders by looking at the legislation for the Napoleon wrasse. The decrees titled '*Ban on the Napoleon Wrasse Fish Haul*' (Government of Indonesia 1995a) and '*Ban on Export of Napoleon Wrasse Fish*' (Government of Indonesia 1995b) appear by their titles to insulate this species from catch and sale, since markets are almost wholly foreign and export is 'banned'. Both laws, however, contain kernels of exception that actually *facilitate*, not hinder, the catch and export of fish.

Fish camp operators, exporters and government officials are the direct beneficiaries of these laws. For example, Article 8 of the ban on haul states '*fish shall weigh not less than one kilogram and not more than three*', while Article 9 says fish '*weighing more than three kilograms or those weighing less than one kilogram will be allowed to be sold locally to a marketing entrepreneur*'. Although the law formally 'disallows' their export, fish that weigh too little or too much may legally enter the hands of traders whose only intent is to sell fish abroad. Further, Napoleon wrasse laws also allow catch for research purposes, but collecting companies (fish camps) are not set up as research stations. For instance, no research is facilitated through any Togean Island fish camp. Local markets for live fish are minimal and there aren't any good reasons other than export to purchase Napoleon wrasse from fishers. It is unrealistic, therefore, to believe that the fish bought by camps will not be exported (or that large fish will shrink to permissible export sizes!).

Laws that enable trade in live fish, simultaneously empower bureaucracies and enrich individual government workers. This is organised through the government's reporting, evaluating, and permit-granting roles outlined in live fishing laws. Government agencies grant permits for the haul of fish and require other permits to export live fish. For legal export, each Napoleon wrasse also needs an official 'letter of origin'. The provincial fisheries department is further obliged to oversee the biological sustainability of the fishery: it '*shall determine the fishing ground by evaluating the resource and its environment*'. Despite these regulations, the Napoleon wrasse is on the endangered species list, indicating a deficit in the will, funding, expertise and even intent of bureaucrats to carry out their role as resource guarantor. Fees are collected for permits and 'services' ensuring that the government's oversight practices create conditions for maximum exploitation and minimal protection of live fish and other natural resources.

In Indonesia, most bureaucracies need to secure their own funding for all but the most rudimentary operations, and the personal incomes of government workers are rarely dissociated from office income. Granting permits and facilitating trade are routine profit-making activities of many branches of government. Permits for fish camps in the Togean Islands reportedly cost USD 1000 in 'official money', and fishers claim that unmeasurable hidden fees surpass this figure. It is in the self interest of bureaucrats to *grant* permits, not to restrict access to natural resources. Johannes and Riepen report that exporters without proper permits call Napoleon wrasse 'grouper' on customs forms and pay officials not to inspect their shipments (Johannes and Riepen 1995:40). In the case of the live fish industry in Sulawesi, permit requirements that provide personal income for officials are the rule, not the exception. Evidence from the Togean

case doesn't support the idea that enforcement limits, or is even intended to limit, cyanide use.

In another regulation, the '*Decree of the Director General of Fisheries Regarding Size, Location, and Manners of Hauling Napoleon Wrasse Fish*' (Government of Indonesia 1995c) we see the role fishers are supposed to play in the interstices between traders and bureaucrats. Rules pertaining to fishers focus on techniques and equipment. This law allows catch and trade by 'traditional fishers' defined as persons or groups whose means of livelihood is catching fish using non-motorised craft or small outboards and '*which utilise fish catching devices and substances that shall not harm the fish resource or its environment*' such as '*lines, traps, and nets*'. The law's positioning of fishers as responsible for cyanide use is transparent in the text since its emphasis on catch method proposes fishers as the party responsible for how fish are caught.

Corruption II

In the Togean Island fishery, a story of how a law prohibiting the use of air compressors to catch fish reveals the manner in which the Indonesian 'Legal State' functions on the ground. Representatives from the police, navy and fisheries departments descended on the Togean Islands one day in 1997 to perform what they called a 'secret operation'. They were looking for air compressors that normally require permits to possess. A local village leader was first told to notify the owners of the compressors of their permit violations. Since he was involved himself with cyanide fishing, he claimed that he had 'influenza' and couldn't leave his house. Unlike the 'sea operation' I described previously, which was run by a village level official, these outsiders were successful in finding 'culprits' and three compressors were temporarily confiscated.[8] A rumour floated briefly around the village that the equipment owners would be taken to Poso, the regency capital, to face charges. Clearly, the way out of the difficulty involved cash, and the sooner the problem was dealt with, the less expensive it would be. If money was fast flowing (*kencang*) then the problem would be put to rest and this is, in fact, what happened.

Togean people consistently revealed the opinion that it is only poor folks who end up in trouble with the law; those with the means can pay their way out of difficulties. One fisher said *'I want to help* [those arrested], *but to help with money — there isn't any money. To help with advice — I don't want to seem like I go along with the position of the police. What do I do? Poor people just aren't able to evade these things.*' On average, a Togean fisher might have access to fifty or a hundred dollars in savings; everyone seems to know (and fear) that getting out of jail would cost the impossible sum of USD 5000 should matters progress to an extreme. This forces local people who do become caught in enforcement webs to turn to village officials and entrepreneurs who trade immediate cash and protection for future illegal resource harvests.

Even when village people do not break the law, they find that laws are not meant to be employed by people like them. They usually find it impossible to protect their legal interests when confronted by men in uniforms. In another instance I witnessed in North Sulawesi, village people tried to arrest the captain of a boat belonging to a cartel that was in Indonesian waters illegally and using cyanide on local reefs. The captain of the fishing boat was from the Sangir Islands, a small Indonesian island group near the Philippine border and all of the crew were Filipino. Someone from the village told the boat captain, '*The problem is that the villagers here are small fishers. There is nothing for them if you take their fish.*' The captain, with great bravado, replied that he could do as he pleased since he had friends in the police all over the Province.

Two weeks later, the fishers involved in the arrest were summoned to speak with a policeman who, sidearm over his shirt, bullets lined up across his chest, chastised them for their action. To diminish it significance in the face of this intimidation, villagers protested by saying what they did wasn't really an 'arrest'. The policeman said, though, that the villagers had been wrong and the captain might have to be compensated with village funds for lost revenues. In the end, the villagers were warned, the policeman was paid, and the captain was free to use cyanide where and when he wished. '*The village has the right to regulate its own affairs, but the police want to mix their hands in it*', someone grumbled.

In conclusion

Poor fishers are the first to suffer penalties and to assume the greatest risks in live fishing, and they are also excluded from the highest live fish profits and from protection from prosecution. Rules as they are enforced within the entrepreneurial Indonesian bureaucracy tend to enrich bureaucrats

8. With the right permit, compressors are not illegal, even though they still would be most productively employed, from an owner's perspective, in catching live fish with cyanide.

and traders while failing to protect either species or citizens. The live fish trade could benefit many of Indonesia's fishers over the long term. Instead, it is organised around making a small number of officials and entrepreneurs wealthy at the expense of coral reef ecosystems and the local communities that depend on them. While conservationists *desire* to live in a world with healthy coral reefs, imagining this ideal world as aesthetically beautiful, scientifically captivating, and organically whole, Indonesia's fishers *must* live in such a world. They don't share with conservationists, bureaucrats, or traders the ability to search out other, better places.

Up to this point, conservationists have tended to explain environmental degradation as the result of poverty, population, proximity, ignorance or recalcitrance and we too easily blame those who are really the victims of cyanide fishing. We can explain this culture of blame, perhaps, by the political risk inherent in confronting powerful elites. We are, in other words, in the same position as fishers; to frame our environmental concerns in terms of a critique of elite practices makes *us* vulnerable too. This suggests a potential space for alliance and collaboration with fishers. Rather than condemn the industry and its fishers, I have argued we need to understand who participates in the destructive aspects of live fishing, what bureaucratic, social and legal structures facilitate participation, and how and why have they come to exist. By recognising that the most substantive ecosystem abuses are not organised locally, but rather underwritten by an interconnected bureaucracy and commercial community, we may find a basis for alliance with Togean and other local peoples.

We might also find we have success helping Indonesia's fishers combat cyanide use by coming out fully in *support* of live fishing as the sustainable industry that it potentially is. Thus, the question would become not one of how to prevent local people from doing x or y — how to restrict their activities — but rather how to help Indonesia's fishers respond to the power dynamics that reward gluttonous resource extractions in the name of economic development. This could lead us to a future that conservationists, Indonesia's fishers, and coral reef fish might all be able to live with.

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Perspective: The *WAR* on destructive fishing practices

M.V. Erdmann[1]

In a recent international magazine article, The Nature Conservancy (TNC) Indonesia's Komodo National Park programme came under fire for its strong enforcement programme, which purportedly clamps down on blast and cyanide fishers in the park without offering alternative livelihoods. While this accusation is clearly misguided (TNC has arguably the most comprehensive and well-managed fisher alternative livelihood programme of any coastal management initiative in Indonesia), it begs the question: Do governments, conservation NGOs and international development aid programmes have an *obligation* to provide alternative livelihoods to fishers who engage in destructive fishing practices (DFP) such as cyanide and blast fishing? After all, these are illegal activities that imperil food security for thousands of villagers in return for the short-term economic improvement of a select few. Moreover, it is been shown to be extremely difficult to provide jobs that are as lucrative as those in the live reef food fish trade.

If one examines enforcement programmes around the world that are fighting other blatantly illegal (but economically enticing) activities that are deemed harmful for the future of society (narcotics peddling, child pornography, and even hired murder come to mind), very few indeed seem to have 'alternative livelihood' programmes attached to them. Psychological counselling, perhaps, but not extensive and expensive efforts to retrain drug sellers to become grocery store owners.

And yet, this perception of deep sympathy for blast and cyanide fishers seems to permeate the thinking of enforcement agencies, the court system, and much of society at large in Southeast Asia. It is maddening to watch judges dismiss court cases of destructive fishers on the grounds that they were 'simply looking for food'. Yes, perhaps, but at the cost of multiple others' (including future generations) right to fish sustainably on healthy reefs? In my experience throughout Indonesia, the average village fisherman takes a rather dim view of this perspective, and would gladly support stronger enforcement efforts against these livelihood-wrecking activities. Unfortunately, the big businessmen who frequently are behind the 'little guy' bombers and cyaniders know this weakness of the system only too well and adeptly exploit the hesitation to punish DFP perpetrators.

I was recently invited, along with the head of Bunaken National Marine Park, to attend a workshop on illegal logging and endangered wildlife hunting in north Sulawesi's (Indonesia) protected forests, in order to provide a 'marine perspective' on these enforcement issues. After listening patiently to NGOs and government officials complain about the difficulty of finding other jobs for loggers / hunters in order to 'decrease' the prevalence of these illegal activities, Mr Arief Toengkagie (Bunaken's head) spoke up. 'The problem,' he said, 'is that none of you are looking at these illegal activities as something serious enough to prosecute to the fullest. If you want to stop these activities, it's time to declare *WAR* on them. No more mealy-mouthed talk about "decreasing the prevalence" and "finding economically-viable alternatives"; an all-out war must be declared, with the clear objective of *eradicating* these activities.'

These are, of course, strong words for the normally conflict-avoiding, consensus-building Southeast Asian cultures. But Pak Arief is an Indonesian, and speaks from experience. Beginning in late 2001, Pak Arief and others on the Bunaken National Park Management Advisory Board publicly declared war on blast and cyanide fishing, and set the definitive goal of completely eliminating these activities from the park by the end of 2002 (note that development of alternative livelihoods was NOT an attached prerequisite). While enforcement in the park had been noticeably improving since mid-2000 (in part due to generous grants from WWF–Wallacea to the patrol system), it was this strong and open resolution to end DFP in the park that was the catalyst needed to *really* bring things under control. Within weeks of the declaration, joint patrols consisting of park rangers, water police and trained villagers began systematically confiscating and destroying every live fish cage in

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the park. Villagers throughout the park (there are 30,000 of them!) put the newly-installed VHF village radio system to good use — cyanide and blast fishing incidents were reported immediately to the patrols, who quickly arrested those involved and confiscated compressors, boat engines, and bombs and cyanide.

Bombing in the southern section of the park, previously rampant, was halted completely in a matter of months. Big businessmen behind the live fish cages tried numerous ploys to stop the campaign (including lobbying hard to senior police force members and even the governor for the transfer of the newly-invigorated water police chief), but an active media campaign to 'glorify' the police, rangers and villagers involved in the war seems to have provided job security (at least for now) for these key players. Just as importantly, several judges in the court system have taken note of the declaration of war, and have been actively cooperating in sentencing the perpetrators to the fullest extent of the law.

And what of the average villager in Bunaken National Park? That's always a tough question to answer, but the general impression is that most are very satisfied with the tough stance on DFP. To be sure, there are those complaining loudly (i.e. those with a direct economic stake in DFP), but the fact that villagers from the more remote islands in the park are calling for an expansion of the patrol system to include posts in their area is positive proof that most fishers would prefer to make their own choices on how to use their reef resources rather than have DFP criminals unilaterally deciding to destroy them. Perhaps most interestingly, there have been very few calls for alternative livelihoods. Folks in Bunaken seem to have the attitude that it is a person's own responsibility to choose a legal livelihood. Governments, NGOs and aid programmes should give this perspective serious consideration…

Two responses to:

The live fish trade on Queensland's Great Barrier Reef: Changes to historical fishing practices.

by Mapstone et al., this Bulletin #9 (Dec. 2001): 10–13.

1. Comments by Melita Samoilys[1]

The article by Mapstone et al. (2001) was a summary of their extremely detailed and comprehensive study on the commercial line fishery on the Great Barrier Reef (GBR) and the impacts of the live reef food fish trade (LRFFT) on that fishery, which is reported in full in a Cooperative Research Centre Technical Report (Mapstone et al. 2001). This work is part of the broader Effects of Line Fishing Project (ELF) of which I was a part from 1995–1999. There are two main points I would like to make in response to their article. One concerns the viability of a live reef food fish trade, and the other concerns the targeting of spawning aggregations.

Although there have been various statements that the LRFFT is managed well on the GBR and does not have a detrimental effect on fish populations, Mapstone and co-workers provide the first set of comprehensive data to support this statement. This finding is extremely relevant to the debate on whether the LRFFT is a sustainable fishery. In most parts of the Pacific it is clearly not (see many articles in this Bulletin).

However, on the GBR Mapstone and co-workers show that the LRFFT has actually resulted in decreased catch rates of the target species, coral trout, probably from increased handling time. In addition, fishing for live fish significantly reduces the catch of byproduct. Therefore, if fishers are switching from dead to live product because it is value adding, it is likely to have both economic and ecological benefits for the commercial fishery. These workers point out, the LRFFT may have been responsible for an increase in effort in the fishery, but this reflects poor effort control within the fishery rather than inherent problems with the LRFFT (see Mapstone et al. 1996, 2001; QFMA 1996, 1999 for details on the fishery and its regulations).

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The GBR fishery provides an example that other countries considering the LRFFT should examine. Herein lies the challenge: What are the dynamics and behaviour of the fishery in other countries that are comparable to those of the GBR? Is the GBR fishery a good example for Pacific Island and Southeast Asian countries where the LRFFT is prevalent and spreading? I believe the answers will lie in the species being targeted, the methods of targeting and the dynamics of the fishery. Mapstone and co-workers focus on coral trout, predominantly *Plectropomus leopardus*, because it forms the bulk of the commercial catch on the GBR (Mapstone et al. 1996; Turnbull and Samoilys 1997). In contrast, the LRFFT in Pacific Island countries targets *P. areolatus*, as well as *Epinephelus fuscoguttatus* and *E. polyphekadion* (e.g. Johannes et al. 1999). There are large differences in the population abundance, spawning aggregation characteristics and other life history parameters of these species that will all have a bearing on their vulnerability to fishing, whether live or dead. *P. leopardus* mature early, are fast growing and occur in relatively high numbers on the GBR compared with other *Plectropomus* species and other LRFFT targeted serranids in the Pacific Islands (Ferreira and Russ 1994; Samoilys et al. 1995; Froese and Pauly 1998; Ayling et al. 2000; Samoilys 2000; S. Adams unpubl. data). Furthermore, spawning aggregations of *P. leopardus* are relatively small, and there are probably more of them per unit area of reef, compared with other LRFFT serranids (Johannes 1988; Samoilys 1997; Johannes et al. 1999; Samoilys 2000).

The second point I wish to make concerns the lack of evidence for targeted fishing of spawning aggregations of coral trout found by Mapstone and co-workers. As regular readers of this Bulletin will know, spawning aggregations are highly vulnerable to targeted fishing in many parts of the world, therefore the GBR situation needs to be carefully examined.

Mapstone and co-workers' study was comprehensive and involved three different methods for assessing the commercial GBR fishery: 1) compulsory logbooks (number not given, but up to nearly 600 vessels are involved (QFMA 1999)); 2) voluntary logbooks (n = 126 fishing trips from 17 fishers selling their catch frozen, and 17 fishers selling their catch alive); and 3) observers on board commercial fishing trips (n = 29, 16 'dead trips', 13 'live trips'). (The fourth method mentioned interviews with fishers was not used to look at the issue of targeting aggregations).

Assessment was based on comparing daily catch and effort data between moon phases since coral trout aggregate to spawn on the new moon (Samoilys 1997). Most analyses appear to come from the compulsory log book data. The accuracy of the compulsory log book data depends on fishers faithfully recording their catch and effort on a daily basis, and this has never been formally validated. Extensive analyses of this data indicate that they are useful and effective for revealing broad patterns, trends, and dynamics in the fishery, particularly over years, seasons and regions (Mapstone et al. 1996, 2001). Their reliability for detecting daily patterns in catch and effort has not been tested.

To detect a correlation between effort, catch or CPUE and lunar phase within a short spawning season is highly dependent on log books being recorded accurately to the day, and this is questionable. Of greater interest is the fact that the observer programme was unable to examine fishing of spawning aggregations because those skippers participating in the programme were not structuring their fishing to correspond with the lunar phase. This in itself is revealing, because it suggests that these fishers were not structuring their trips to target spawning aggregations.

However, fishers often guard their knowledge, though the ELF project has developed an impressive relationship of trust with commercial operators (pers. obs.). Probably of more relevance is the fleet structure of the GBR commercial fishery. The fishery is dominated in terms of effort, catch and catch rate by a relatively small proportion of large vessels run by highly experienced skippers (Mapstone et al 1996). These vessels operate over large areas of the GBR and are therefore far less likely to operate with local or traditional knowledge of specific reef sites, the sort of knowledge that enables the targeting of spawning aggregations. They are therefore not likely to be targeting spawning aggregations. The observer programme was based on these vessels and therefore it is not surprising that Mapstone and co-workers could not structure their observer programme around the lunar phase.

The lack of evidence for changes in catch and effort at the time of spawning aggregations of coral trout is not conclusive evidence that targeted fishing of spawning aggregations is not occurring. Since we lack historic data both on the fishery and on spawning aggregations, it is difficult to progress this debate. I can provide a small example of possible targeted fishing on a spawning aggregation of *P. leopardus*. My research with the Queensland Department of Primary Industries established a long-term monitoring programme of two spawning aggregations of *P. leopardus* that started in 1990 (Samoilys 1997).

Recent surveys have shown that one aggregation has collapsed and information from local fishers suggests this was caused by targeted fishing by local commercial vessels that know the spawning site. These results have been presented to ELF, the Great Barrier Reef Marine Park Authority and two conferences (Australian Coral Reef Society 1999 and the Indo Pacific Fish Conference, 2001) but remain unpublished (Samoilys et al. in prep.) and therefore, understandably ignored. This example illustrates that the state of knowledge of reef fish spawning aggregations and their vulnerability to fishing on the GBR is close to zero.

In conclusion, the real issue is the dearth of information on spawning aggregations of exploited reef fish species on the GBR. To my knowledge there have only been two studies, both on *P. leopardus*, spanning three reefs (Samoilys and Squire 1994; Samoilys 1997; Zeller 1998). This is extraordinary considering there are close to 3000 reefs on the GBR where a wide range of commercially exploited serranids and lutjanids occur, and these species are known to form consistent, large, spawning aggregations elsewhere (e.g. Domeier and Colin 1997). The article by Mapstone and co-workers should provide a strong impetus for research in this very open field. Comparative studies across the Pacific would be especially revealing and relevant to the management of the LRFFT.

2. Comments by Lyle Squire[2]

I applaud the extensive work by Mapstone and co-authors (this Bulletin, #9:10–13) on the live reef fishery on the Great Barrier Reef (GBR). I would like to comment, however, on their statements that there is 'little evidence of the consistent targeting of spawning aggregations of coral trout by commercial fishers' and that because aggregations of this species (*P. leopardus*) are small, this would make them 'difficult to find and the benefits of searching for them minimal'.

Here I would like to provide information that casts some doubt on these assertions, although I realise that scientific proof is absent. Although aggregations of *P. leopardus* (henceforth 'coral trout') are typically small,[3] there are a great many of them. As an aquarium fish collector my work has sometimes involved many hours per day working in shallow water while covering large areas of reef. During this work my research interest in spawning aggregations of coral trout (e.g. Samoilys and Squire 1994; Johannes et al. 1999) have prompted me to make particular note of them. In the course of single days during peak coral trout spawning aggregation periods I have counted more than 100 coral trout spawning aggregations spread over reef complexes on the order of 5 km^2.

Only a small percentage of coral trout may join spawning aggregations at any one time (Fulton et al. 2000). But this is where these fish are found to be most heavily concentrated during spawning periods. Fishers who search for 'hangs' (areas where the fishing is especially good) are thus most likely to find them when aggregated during these periods.

This is true whether or not they recognise them as spawning aggregations. Some do not; it may not be apparent if they don't gut the fish, and since a catch of 10 to 20 per aggregation today is much less than what one normally associates with spawning aggregations of many other species. For these fishermen they are just good 'hangs'. In recent years I have found that at any one time the average coral trout aggregation site holds about 30 fish at peak spawning time.

However, other fishermen do recognise when they are fishing from spawning aggregations. After reading the Mapstone et al. article I asked the managers of two live reef fish facilities to question their fishermen on my behalf on whether or not they targeted spawning aggregations. Eight out of twenty replied that they did.

To get a better handle on this issue, I suggest that some form of validation of fishers' logbooks be introduced, so that they provide information on fishing trends in which fisheries managers can have more confidence. For validation one might periodically pick fishers at random to see how well their logbooks match their invoices or tally with buyers' records. Eventually a more reliable picture of fishing trends should emerge, including improved time-related catch data that will provide a better indication of whether or not targeting of spawning aggregations of coral trout is important. I believe it is.

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3. Coral trout have been fished on the GBR for three generations and they have been and continue to be the most important species by far in the commercial fishery. Most of today's aggregations could be mere remnants of once much larger aggregations. I was involved in a study of an aggregation that consisted of 50–75 fish ten years ago (Samoilys and Squire 1994). We considered it to be quite large by the standards of the day. It has since been largely protected from fishing. The last time I visited it at peak spawning time in 2001 there were over 400 fish in it.

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The status of grouper culture in Southeast Asia

Excerpt from:

Robert Pomeroy[1], Rene Agbayani, with Joebert Toledo, Ketut Sugama, Bejo Slamet and Tridjoko. 2002 (in press). The Status of Grouper Culture in Southeast Asia. Financial Feasibility Analysis for Grouper Culture Systems in the Philippines and Indonesia. Draft Chapter 6 in: Farming the Reef: A State-of-the-Art Review of Aquaculture of Coral Reef Organisms in Tropical Nearshore Environments. Robert Pomeroy, John Parks and Cristina Balboa (eds.) World Resources Institute, Washington DC.

Full-cycle aquaculture (the use of hatchery-reared fingerlings) of many grouper species is becoming more common throughout Asia. Grouper are cultured at various scales in every country of Southeast Asia — Hong Kong, Indonesia, Malaysia, Philippines, Taiwan, Thailand and Vietnam. While currently making up only about 10–15 per cent of the total trade, there is an increasing supply of full-cycle, cultured fish. The most important source countries are Taiwan, Indonesia and Thailand. Grouper culture is also ongoing in Australia and the People's Republic of China, although the industry in these countries will not be discussed here.

A brief review of the status of the grouper aquaculture industry in each of the seven Southeast Asian countries is presented below.

Hong Kong

Grouper culture has been undertaken for over 30 years in Hong Kong. Groupers are cultured in floating cages in 26 designated aquaculture zones. The industry depends entirely on grow-out. The average farm size of rafts is about 250 square meters (Chan 2000). The colder winter water temperatures in Hong Kong restrict both the type of species to be cultured successfully, and the mortality and culture period of several species. Commonly cultured species include *Epinephelus tauvina, E. lanceolatus, E. malabaricus, E. areolatus* and *E. bleekeri*. A number of other fish species are also cultured.

There are no fry hatcheries in Hong Kong. Fry for culture were once provided from local capture but now almost all fry are imported from other countries in Southeast Asia. Traditionally, grouper were fed with trash fish supplied by purse seiners and trawlers. The use of trash fish was identified as one of the major sources of pollution around culture areas. In the early 1990s a moist pellet was developed by the government to replace the use of trash fish, and fish farmers are slowly adopting it.

In the early 1990s grouper production in Hong Kong was about 3000 t a year. In the last few years, production has dropped to 1000 t a year due to a number of production and environmental problems and stresses (Sadovy 2000). High levels of mortality exist from stress during the first few weeks or months after introduction of fry to the cages, and during water temperature changes, which occur twice a year, increasing in April/May and decreasing in November (Sadovy 2000). Differential growth rates of individuals lead to cannibalism. Poor water conditions and disease are also serious problems. Water quality in the culture zones is getting worse due to the high density of cages, build up of waste on the sea bottom, overfeeding using trash fish, algal blooms (including a recent red tide), and poor water flow. Viral infections and disease result both from infected imported fry and from poor water quality. Access to medication to treat diseases is limited in Hong Kong (Chan 2000).

Indonesia

Grouper culture is expanding in many areas of Indonesia. While there is no statistical data available on grouper culture in Indonesia, national aquaculture statistics show brackish water and cage culture growing at 8 and 16 per cent, respectively, during the 1990s. The primary areas for

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grouper grow-out culture in Indonesia are Aceh, north Sumatra (Nias and Sibilga), Riau Islands, Bangka Islands, Lampung, west Java, Karimunjawa Islands (central Java), Teluk Saleh (west Nusa Tenggara), south Sulawesi, north Sulawesi and southeast Sulawesi. Grouper culture is generally characterised in Indonesia by the use of wild-caught seed and use of trash fish for feed. There is limited use of hatchery-reared seed, although this is growing. Grouper are primarily grown-out in net cages. There is some limited pond grow-out culture, particularly for small size classes, but a general shortage of land for ponds has been identified (Sadovy 2000).

There has been a good deal of research on hatchery production of grouper. This has been stimulated by the development of a large number of milkfish hatcheries near the Gondol station and by increased interest from these private hatcheries in Bali and throughout Indonesia to produce grouper seed on a commercial basis. At the Gondol Research Institute for Mariculture on the north coast of Bali, the mass seed production of *Cromileptes altivelis* has been successful. Broodstock have been able to spawn naturally all year round, although the survival rates of larvae are low at the early stage. There are slow growth rate and disease problems at the grow-out stage.

Some private hatcheries have succeeded in seed production, applying technologies learned from the Gondol station. In addition, humpback grouper seed has been provided from the station to many aquaculture operations in Bali and elsewhere in Indonesia and Southeast Asia for grow-out. The Gondol station has also succeeded in full-cycle culture of *E. fuscoguttatus*. The spawning period for this species in the hatchery has been found to be very short, only three to four days a month, and not all year round. Survival rates are low due to high levels of cannibalism, although survival rate and growth rate in cages is high. Many of the hatcheries in Bali culture several species of fish in addition to grouper such as sea bass, milkfish and humphead wrasse (*Cheilinus undulatus*).

Research on a variety of species has also been undertaken at the Regional Brackishwater Aquaculture Development Center in Situbondo in eastern Java. At the Marine Finfish Production and Research Center (MAFPREC) in Besut, Terengganu, natural spawning of *E. fuscoguttatus* was achieved in 1995 in a 150-t tank. Research at MAFPREC continues to improve spawning and larval culture. Other research work has been carried out at the Research Institute for Coastal Fisheries in Sulawesi and the Mariculture Development Center at Lampung.

The Nature Conservancy has developed a full-cycle mariculture operation in the area of the Komodo National Park in western Flores. The project was originally started as an alternative enterprise for local fishers who were utilising destructive fishing practices. Fingerlings were obtained from the wild, but after a trial period it was decided to enter into full-cycle grouper culture. A number of species are being used as broodstock, including *E. coioides*, *E. fuscoguttatus*, *Cromileptes altivelis*, and *Lates calcarifer*. The first spawning of *Cromileptes altivelis* and *E. fuscoguttatus* occurred during the project in late 2000.

There are currently some problems with expansion of grouper culture in Indonesia. There is an oversupply of grouper seed available due to too many hatcheries being built. While the grow-out of grouper seems to provide considerable economic profit to small producers, the expansion of net cage grow-out operations are limited by high initial investment costs and lack of funds and credit. This oversupply of seed has led to a recent sharp decline in seed prices, which has caused hatcheries to stop producing seed. Thus, there is a need for improved market information for hatcheries on seed demand and on wholesale and retail prices and markets for grow-out operations. There is also a need for extension assistance to potential and existing small culturists, as many lack the technical skills to grow grouper. In some areas, water quality is emerging as a serious problem (Dr Ketut Sugama pers. comm. 2001). It is important to note that the Indonesian government has given aquaculture development a high priority for support.

Malaysia

There are over 2000 fish farmers involved in marine finfish culture in Malaysia. Grouper make up over 16 per cent by weight and 30 per cent by value of total marine finfish produced by aquaculture in Malaysia (Subramaniam 1999). Approximately 15 per cent of the fish seed are collected from the wild and/or produced in government or private hatcheries. The remaining 85 per cent is imported, primarily from Taiwan and Thailand (Subramamiam 1999). Net cages are the most popular grow-out system. The major grow-out sites for grouper in Malaysia are in Sabah, particularly Tuaran and Sandakan, and Sarawak (where wild seed are also captured) in East Malaysia. In Sabah, it is reported that there are two types of grouper culture — 'system' culture and 'real' culture (Sadovy 2000). System culture is the feeding of a variety of large captive juvenile or small adult grouper species in net cages. Real culture is the raising of wild-caught fry/fingerlings, primarily *E. coioides* and *E. malabaricus*.

Grouper are also cultured in Peninsular Malaysia in protected coastal areas in Johore, Selangor, Penang and Kedah. Several species of grouper are being grown-out in floating net cages including *E. coioides, E. tauvina, E. fuscoguttatus, E. lanceolatus, Plectropomus leopardus*, and *Cromileptes altivelis*. Wild seed are the major source of local supply of grouper seed.

Fish farmers in Malaysia have also been importing large numbers of hatchery-produced fish fry / juveniles from Taiwan in the last few years. The primary species imported are *E. lanceolatus* and *E. fuscoguttatus* and *Cromileptes altivelis*. It is reported that the survival rate of *E. lanceolatus* and *C. altivelis* was not very good and that the fish are susceptible to disease. The survival rate of *E. fuscoguttatus* was higher (Seng 2001).

There are few grouper hatcheries in Malaysia. There are two private hatcheries in Sabah working on grouper and other species. It is reported that they have had some problems with post-hatch larvae mortalities (Sadovy 2000). The University of Malaysia–Sabah has research underway or planned on several species including *C. altivelis*, *E. fuscoguttatus* and *E. lanceolatus*. It is important to note that no grouper fry / fingerlings can be imported into Sabah, thus the importance and need for hatcheries is significant (Sadovy 2000).

The Marine Finfish Production and Research Centre, at Terangganu in Peninsular Malaysia, a government facility, conducts research and produces fish fry for culturists, private hatcheries, and nursing. It also provides training to local finfish hatchery operators. The Centre is working on *E. coioides* and *E. fuscoguttatus* (Subramaniam 1999). There is a private hatchery in Penang working on *E. coioides* and *E. fuscoguttatus* using techniques learned from Taiwan (Sadovy 2000).

Trash fish is used to feed groupers but with decreasing amounts of trash fish available, some private feed mills have been producing a formulated diet for groupers. There is a need for more disease-free seed and fingerlings for industry development. There is also a need to maintain healthier broodstock. The government of Malaysia is encouraging an increase in the number of hatcheries. The government has identified aquaculture zones and provided infrastructure for aquaculture development. Research and development is also being encouraged. To protect grouper fry, there is a closed season on their capture during November and December, and only permitted from January to April in West Malaysia (Subramaniam 1999).

Philippines

Grouper aquaculture in the Philippines is based on the grow-out of wild-caught fry and fingerlings. Grouper fry and fingerlings are caught using a variety of methods including hook and line, scoop or dip nets, traps, *gango* or fish nest, fish corral, and several types of nets. In the Philippines, the major sources of grouper fry include the provinces of Pangasinan, Cavite, Mindoro, Quezon, Masbate, Bulacan, Cagayan, Dadiangas, Zamboanga del Sur and Negros Oriental. The Philippines is one of the largest suppliers of wild-caught grouper fry, fingerlings and juveniles in Southeast Asia.

Grouper culture in the Philippines is limited by the lack of enough fry and fingerlings of the preferred size for grow-out, poor quality of the fry due to capture method, and by sufficient supply of trash fish for feed. Overfishing, destructive fishing and the large amount of fry and fingerling exported are all stated reasons for the supply problem. The high dependence upon wild-caught fry and fingerlings in the Philippines is due, in part, to the lack of commercial hatcheries in the country (Marte pers comm. 2001). Some fish farmers in the Philippines are importing fingerlings from Taiwan and from the Gondol station in Bali, Indonesia.

Increasing numbers of fish farmers in the Philippines are now engaged in grouper culture. Grow-out is carried out using floating net cages, fixed net cages, and in ponds which were formerly used for shrimp culture. In addition to the lack of fry and fingerling supply, other problems with grow-out include disease, water quality and storm damage to cages (Sadovy 2000).

The Southeast Asian Fisheries Development Center-Aquaculture (SEAFDEC) in Tigbauan, Iloilo, is the primary source of technical information and research on grouper in the Philippines. SEAFDEC's work focuses on *E. coioides* and *E. malabaricus*. SEAFDEC's research is on broodstock development, seed production, and nursery and grow-out culture of groupers. SEAFDEC is now transferring the results of its research to the private sector (Marte 1999; Quinitio 1999; Baliao et al 2000).

There is reportedly one private broodstock operator in the country and several small private hatcheries. Three main species of grouper produced are *E. coioides*, *E. malabaricus* and *E. lanceolatus*. It is reported that spawning is still a problem, hatcheries are having problems with post-hatch larvae and diseases, and production is not at commercial levels. Recently, a development project in the province of Samar constructed hatchery facilities to produce fry and fingerlings of *E. coioides* and

E. malabaricus. The project was designed to produce fry and fingerlings for grow-out as an alternative livelihood for local people. SEAFDEC provided technical assistance to the project.

A model of grouper culture that has been discussed for the Philippines is to have one broodstock facility in an area or region of the country that would supply larvae to a number of satellite hatcheries. While the spawning and egg production of several grouper species can be achieved on a commercial level in the Philippines, a limiting factor to development is the reliance on trash fish for feed. A commercial diet for grouper will need to be made available. Parasitic infestations of grouper are causing increasing mortality (Marte 1999).

Chinese Taipei (Taiwan)

Hatcheries in Taiwan are currently able to hatch more than 40 species of marine fish for mariculture, with *E. coioides, E. lanceolatus, Trachinotus blochii, Lutjanus argentimaculatus, L. stellatus* and *Acanthopagrus latus* being the species in greatest numbers. Early grouper culture in the 1970s and 1980s consisted of growing-out wild-caught fry from Taiwan and other Southeast Asian countries. Full-cycle grouper aquaculture of *E. coioides* and *E. malabaricus* was achieved in the early 1980s. Currently, fifteen species of grouper are being cultured in Taiwan, many on demand. The most common grouper species are *E. lanceolatus, E. coioides, E. malabaricus* and *E. fuscoguttatus*. By 2001, more than 600 hatchery and grow-out farms produced over 20 million fry and over 7000 t of grouper annually from a production area of more than 700 ha. Both hatchery produced and imported seed are used in production. Taiwan supplies fertilised grouper eggs and seed to export markets.

Grouper mariculture operations in Taiwan are usually specialised in one of several areas of production system such as broodstock / eggs, hatchery, nursery, and grow-out. The specialisation has led to a decrease in the price of fry and fingerlings (Cesar and Hempel 2000). Broodstock are kept in outdoor ponds and are induced to spawn artificially or allowed to spawn naturally (Sadovy 2000). Larviculture uses both indoor and outdoor methods. Two-pond culture systems are used for the nursery phase — a small pond, 100 m^2 in size with small cages, and a large pond used during winter (Rimmer 1998). Grow-out occurs in both floating net cages and in ponds. The majority of Taiwanese grouper farmers now use moist pellet, artificial feed. Water quality and diseases are increasing problems (Rimmer 1998).

Cesar and Hempel (2000) reported that the reasons for the relative success of Taiwan's grouper aquaculture industry include: 1) success in mass production of fertilised eggs, 2) advances in the fry production system, 3) highly specialised subsystems and division of labour, 4) high efficiency in the production of live feeds, 5) aggregated hatchery business, 6) wide use of formulated feeds, 7) thoroughly experienced hatchery operators, and 8) sound research and development infrastructure. To this list should be included strong government support for the industry and well organised industry associations.

Thailand

Grouper aquaculture is growing rapidly in Thailand. Grouper culture is primarily undertaken in floating net cages in the southern and eastern provinces of Thailand including Suratthani, Chumpon, Nakhonsrithamarat, Songkhla, Pattani, Satul, Krabi, Trang, Phangnga, Chachengsao, Rayong and Chantaburi. As the shrimp farming industry in these provinces declined during the 1990s due to lower prices, disease and environmental problems, many farmers shifted to brackish water finfish culture including grouper. The two most important species cultured in Thailand are *E. coioides* and *E. malabaricus*; in addition *E. lanceolatus, E. areolatus, E. fuscoguttatus, Plectropomus maculatus* and *Cromileptes altivelis* are cultured.

Thailand is a major supplier of wild-caught grouper seed in Southeast Asia, although some local seed is also used to support the growing grouper culture industry in the country. A constraint to industry growth, is however the insufficient supply of suitable size and quality of seed. It has been reported that without the export of seed, there would be enough seed available to meet the demand in the country (Sadovy 2000). Hatchery production will need to be increased to meet the demand.

The government of Thailand has made grouper culture a priority for the country. There are several research institutions in the country working on grouper culture. The most prominent is the National Institute of Coastal Aquaculture (NICA) located in Songklha in southern Thailand. NICA works on *E. coioides, E. malabaricus* and *E. lanceolatus*. NICA provides grouper seed to farmers and well as technical assistance. There are several other research stations associated with the Department of Fisheries working on grouper in Phuket, Krabi and Satun. There is reportedly one private hatchery located in southern Thailand producing *E. malabaricus* seed.

Viral diseases and parasites are an increasing problem for grouper culture in Thailand. The availabil-

ity of trash fish is another problem and even though artificial feed is available, it is too expensive for many farmers.

Vietnam

Grouper culture is a relatively new enterprise in Vietnam. There has been considerable growth in grouper grow-out culture, and other finfish, in net cages throughout the 1990s. Culture is centred in a number of provinces including Hai Phong and Quang Ninh in the north, and Phu Yen and Khanh Hoa in the south central. The Ministry of Fisheries has reported that marine fish aquaculture production was 5000 t in 1999, mostly groupers (Sadovy 2000).

Grow-out in the country is based primarily on the use of wild-caught fry and fingerlings. Most operations are small-scale and family-operated. Commonly cultured grouper species include *E. coioides, E. malabaricus* and *E. bleekeri*.

In addition to floating net cages, fixed net cages and ponds (formerly used for shrimp) are used for grow-out. Only locally caught trash fish are used for feed. Disease is currently reported as not being a significant problem.

Although grouper hatchery technology has been developed, there are no private grouper hatcheries in Vietnam. The Research Institute for Aquaculture-1 (RIA-1), located in north Vietnam, maintains broodstock and a research programme at Cat Ba Island. The Fisheries University in Nha Trang has begun grouper hatchery research and maintains broodstock of several grouper species. It is reported that RIA-1 is building a hatchery research station and grow-out cages with foreign development assistance in Nghe An Province (Sadovy 2000).

Grouper seed supply and poor quality of seed due to catching and handling practices are two constraints faced by the industry. In addition, there needs to be cost-effective alternatives to trash fish for feed (Nguyen and Hambrey 2000).

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SPC Pacific Regional Live Reef Fish Trade Initiative update

Being M.Yeeting[1]

Here is an update of activities implemented under the Asian Development Bank (ADB) funded SPC Pacific Regional Live Reef Fish Trade Initiative (referred to here as the 'Pacific LRFT Initiative').

1. Aquarium and LRFF resource surveys of Efate, Vanuatu

From 13 to 24 August 2001, the Secretariat of the Pacific Community (SPC) Live Reef Fish (LRF) Specialist together with the International MarineLife Alliance (IMA) assisted the Vanuatu Department of Fisheries in assessing their live reef food fish resources.

Given the logistical difficulties, the work was concentrated around Efate with the hope of using the fieldwork as a training opportunity for the local fisheries officers on the assessment method who could then extend assessment work to the other islands.

38 transects (2 x 15 minutes time swims done at 10 m and at 20 m depths) were conducted in 19 sites comprising fished and unfished areas selected based on local fisheries officers' knowledge. The sites were mostly on the leeward side of the island where the sea conditions were more suitable for surveys. On each transect potential LRFFT species were counted and their sizes were estimated. Aquarium trade fish species were also recorded (number, sizes and number of harems). General preliminary observations indicated low abundance of LRFFT species. The aquarium fish resources however seemed to show better prospects for some export.

During the surveys, several Fisheries staff members were trained in the survey method which was quite straight-forward especially given previous experience with other underwater visual assessment methods. Fish identification was the main problem. The use of fish identification templates or fish picture cards, which can be used underwater, is a possible solution. A set of these waterproof identification cards for 16 LRFFT species has been developed by SPC and will be available as part of an LRFFT awareness package.

The full result of the survey will be described in a formal report covering the potential of the trade, the management framework, problems and some recommendations.

2. Assessment of the live reef food fish resources of Ha'apai, Tonga

An interest by some Chinese foreign investors to start LRFFT operations in Tonga in early 2001 triggered some concern by the Tonga Ministry of Fisheries. Through SPC, assistance to look into this was provided.

In late 2001, a survey team comprised of SPC and IRD (French Institute for Research and Development) staff conducted fisheries surveys in Ha'apai. IMA were also able to come and participate for a couple of days. With three teams of divers, a total of 131 50-m transects using UVC (Underwater Visual Census) was conducted. 97 of the transects targeted commercial reef fish species and 34 targeted all reef fish species on mainly fringing and intermediate reefs. The dive sites for UVC were selected in consultation with the socio-economic team members to ensure coverage of most frequently harvested fishing grounds. The diving depth was 7–15 m, which were assumed adequate to get a good coverage of the reef fish populations given the time available.

The surveys indicated a fairly low abundance of LRFFT fish species. Additionally the species observed were mostly low to medium value. As with all the other one-time assessment surveys done under the Pacific LRFT Initiative in other countries, repeat surveys are required to verify the observations. The data from the Ha'apai survey will be presented soon in a formal report.

3. Sustainable Management of Coastal Fishery Resources Workshop and assessment of LRFFT management capacity and framework, Papua New Guinea

At the end of October 2001, a workshop was organised by the PNG National Fisheries Authority (NFA) in collaboration with Gillett, Preston and

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Associates (GPA) on behalf of the Asian Development Bank at the Kavieng Fisheries Training College.

The aim of the workshop was to discuss and review the Kavieng area LRFT proposed management guidelines for a trial LRFT operation and to identify and discuss other potential sustainable coastal fishery resources projects that could be developed for local communities. The workshop was attended by a good cross section of both governments (provincial and national levels) and the public (community leaders, NGOs, industry) as well as external bodies (donors, regional organisations).

Main outcomes of the workshop were that:

- The proposed LRFFT management guideline needs to be further reviewed to ensure its practicality and effectiveness in controlling a LRFFT operation.

- Dive operators stated that saving the groupers and wrasses for dive tourism would be a far more beneficial and sustainable use of these resources for the local communities compared to LRFFT operations. The local resource owners on the other hand claimed that from their experience, the dive tourism industry have only benefited the dive operators and that with the LRFFT they have been able to earn a cash income to pay for their school fees, church donations and basic needs.

Evaluation of the management capacity and framework for the LRFFT

Evaluating capacity and framework for managing the LRFFT was also undertaken through interviews with local fishermen, local stakeholders, provincial government officials, NFA staff, NGOs present and the industry people (dive operators, tourist operators and the LRFFT Company) both in Kavieng and Port Moresby.

In Kavieng, the holding facility of the one operational LRFFT company was visited. There were 5.3 t of fish in the cages. The species consisted of the humphead wrasse (35%), groupers (25%), coral trouts (20%) including the least favourable species such as *Plectropomus maculatus* and *P. oligacanthus*, and other species (10%) which included even the least valued rock cod species such as *Cephalopholis miniata, C. urodeta* and *C. argus*. The conditions of the holding facilities and the fish themselves were not good, indicating poor handling practices and poor management of the facilities. This was further confirmed by a mortality rate of 70 per cent.

4. Workshop on Sustainable Management of Live Reef Food Fish Trade in the Solomon Islands

A workshop to discuss sustainable management of the LRFFT in the Solomon Islands was held on 14 to 15 November 2001 in Honiara.

It was organised jointly by the Fisheries Division and Southern Cross University as part of the Australian Center for International Agricultural Research (ACIAR) funded collaborative LRFFT project for the Solomon Islands.

Participants included paramount Chiefs, leaders and spokespersons from the different provincial communities, business operators, environmental NGOs and senior officials from both the Provincial and National Fisheries offices. The SPC LRF Specialist was invited as a resource person.

The workshop had two main objectives:

1) to present the findings from the ACIAR funded study and to discuss management issues and a management plan;
2) to look at the legal framework required for the plan and measures to be effective. For the latter, the Forum Fisheries Agency (FFA) Legal Counsel was invited to give an overview of the legal framework in the Solomon Islands.

Management measures considered include:

- measures to address the issue of targeting spawning aggregations such as:
  - temporal closure of fishing on spawning aggregations,
  - using marine protected areas for spatial closures of spawning aggregation sites;
- limiting the number of licenses and areas for LRFFT to operate in;
- using quotas; and
- monitoring, all levels of the operation (i.e. fishers, middlemen and overseas buyers).

Issues emerging included:

- The jurisdiction at which regulations should be implemented and enforced.
- Which input versus output controls are more effective?
- Who should be involved in the fishery at the different levels?
- What systems could put some control on middlemen prices?
- How can customary owners be involved in terms of management and enforcement?

5. A visit to update the Kiribati LRFT situation

In early January, 2002, the SPC LRF Specialist was in Tarawa to complete the assessment of the management framework for the Kiribati LRFFT.

For an update, the Chinese company, BrightFuture Industries that had the permission to operate has had poor success in Abaiang Atoll. The company has recently indicated an interest to move their operations to Butaritari, an atoll further north. Apparently two independent assessments of the LRFFT resources in Butaritari Atoll have been conducted using different methods. The Fisheries team used a more scientifically based UVC method, whilst the company's method was based on general observations of the reef areas and experimental fishing. The company representative claimed that their assessment showed abundant resources. Butaritari currently does not have any management conditions and control for any LRFFT operations. Management would depend largely on these being implemented by the Island Council.

6. Assessment of the management capacity for the LRFFT in the Marshall Islands

A two-week visit to the Marshall Islands was made by the SPC LRF Specialist in late January 2002 to evaluate the management framework and capacity for management. With the assistance of the Ministry of Marine Resources Authority, information from people in the national government, local government and private sector, including the operators, was collected. There is one RFFT company, Pacific Marine Resources Development Inc. The company is a joint venture — 75% Taiwanese (Mr Thomas Tse based in Hong Kong) and 25% local (Mr. Phillip Muller, former Minister of Foreign Affairs). The company has collected fish from four outer islands, shipping to Hong Kong every two months. They currently employ 70 Filipinos who are the main fishers but locals are allowed to fish if they want to. With the operations being based in the outer islands, no field observations were possible.

There are three main aquarium fish operators. The Robert Reimers Mariculture facility focuses on giant clams, experimenting on the side with reef fish (clown fish and some Pomacentrids). OK Davies runs a very simple small operation. He also buys fish regularly from an aquarium fish exporter in Tarawa, Kiribati. The Tarawa fish exporter is also hoping to start up an operation in Majuro, but waiting for his permit.

A report on the findings and recommendations from the trip should be available by July 2002.

7. A handbook of guidelines for the management of the live reef food fish trade

In response to the continuous request from Pacific Island countries seeking assistance in drawing up LRFFT management guidelines, SPC and TNC agreed to put their extensive experiences together in addressing the LRFFT management problems and issues in a recipe type handbook of generic management guidelines. This handbook is not expected to be the complete solution to the problems of managing the LRFFT but should be useful in providing some practical possible answers based on real experiences elsewhere.

The SPC LRF Specialist met with TNC (Dr Andrew Smith and Paul Lokani) in March 2002 to discuss and agree on the outline and contents of the handbook, which is expected to be completed and published before the end of the year 2002.

8. Future activities under the Pacific LRFT Initiative

Most of the activities scheduled under the Pacific LRFT Initiative have been implemented except for a number of in country workshops. The ADB funds for the project ends at the end of June 2002, and it is hoped that all the materials and reports being prepared under the project would be ready by then.

To mark the end of the ADB funding, a regional LRFT workshop will be held to make a final presentation of the project results and findings, to evaluate its impact in relation to the progress of management and development of the LRFT in the Pacific and to get an update of current issues and problems that may need to be further addressed. It will most likely be in the next 2–3 months in Suva, Fiji. An official announcement will be prepared and circulated soon.

The Pacific LRFT Initiative will not finish at the end of the ADB funding. Funding from the MacArthur Foundation has already been secured, with some possibility of ADB extending some of their present funding. The activities under the MacArthur Foundation focus on building local capacity of Pacific Islands to assess, monitor and manage their LRFT. A number of short-term local attachment positions with the SPC Pacific LRFT Initiative will be made available to allow SPC member countries fisheries officers to get hands-on training in addressing LRFT problems. In addition, a series of training handbooks will be developed and published as references.

Spawning aggregation closures for the live reef fish fishery in Solomon Islands

Melita Samoilys[1]

A landmark agreement was reached last November in Honiara by the management workshop for the live reef food fish trade (LRFFT) in Solomon Islands. The LRFFT targets three groupers in Solomon Islands: *Plectropomus areolatus*, *Epinephelus fuscoguttatus* and *E. polyphekadion*. The management workshop unanimously agreed that the spawning aggregations of these groupers would be totally protected. Considering the LRFFT fishery focuses heavily on targeting spawning aggregations, the decision was remarkable. Protection would be ensured through a total ban on all fishing at those sites identified by traditional resource owners as spawning aggregation sites for the three target species. It was agreed that the fishing ban would be for a 10 day period over the new moon, for three consecutive new moons each year, to coincide with the likely spawning aggregation times of the three species. Sites and spawning aggregation times would be determined by resource owners and fishers in conjunction with Fisheries Division officers.

The workshop was the culmination of a two year project 'Sustainable Management of the Live Reef Fish Trade-Based Fishery in Solomon Islands', a collaboration between Southern Cross University in Australia and Solomon Islands Fisheries Division, funded by the Australian Centre for International Agricultural Research (ACIAR, Project No. ANRE1/1998/094). Over 30 representatives, ranging from traditional resource owners, LRFFT operators and government officials to international researchers, participated in the two day workshop, which was run by Ryan Donnelly (Southern Cross University) and Greg Bennett (S.I. Fisheries Division), and chaired by Melita Samoilys (Project Seahorse, McGill University & Zoological Society of London).

The workshop participants were responsible for devising a LRFFT management and monitoring plan that recognises customary ownership. The resulting draft plan adopted two main conservation strategies: license limitations (initially proposed at two for the country), and seasonal area closures to protect spawning aggregations.

Licenses will operate through Reef Owner Agreements, with technical advice provided by the Fisheries Division. This gives traditional resource owners considerable control over the operation of the fishery.

The questions now are how and when is the draft management plan likely to be implemented? The termination of the ACIAR project has meant that the researchers are no longer working on this project because they were all on contract, therefore continuity is an issue. The Solomon Islands Fisheries Division remains under-resourced, and therefore is unlikely to be able to pursue the plan to completion. If the workshop's hopeful outcomes are to have any real impact, further external funding and technical assistance is likely to be necessary.

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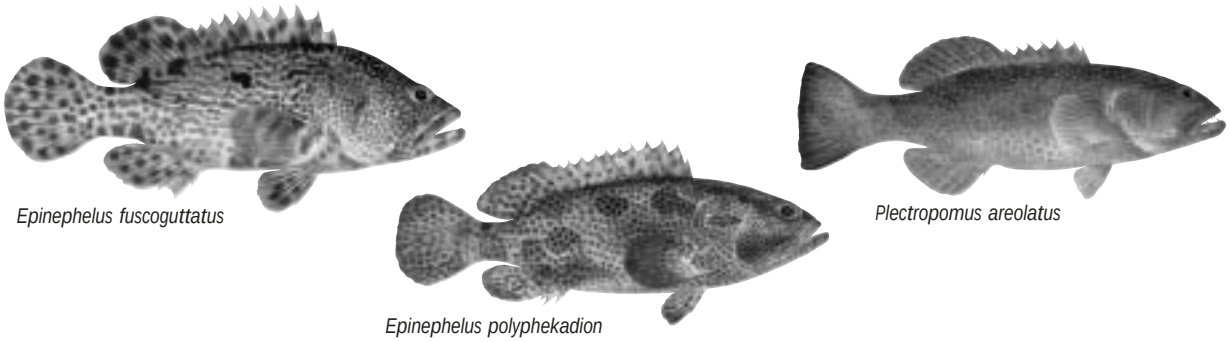

Epinephelus fuscoguttatus

Plectropomus areolatus

Epinephelus polyphekadion

1. Project Seahorse – Zoological Society of London

Reef fish post-larvae collection and rearing programme for the aquarium market

Vincent Dufour[1]

Report on the first year of operations at the AquaFish Technology farm in French Polynesia

This reef fish and invertebrate post-larvae collection and rearing programme was launched in 1999 by AquaFish Technology, a company based in Pérols, France, with the establishment of the AquaFish Technology pilot farm on Moorea Island, French Polynesia.

Like most marine organisms, reef animals experience a pelagic dispersal phase at the beginning of their life cycle, in the form of countless larvae. The purpose of this project is to collect the oldest larvae ('post-larvae') as they return to the reef environment to develop into juvenile fish or benthic invertebrates.

The project was designed after a scientific experiment carried out in 1978 involving American, Australian and French scientists that had made it possible to quantify the mortality occurring after the colonisation of coral reefs by larvae. This experiment on a species of unicornfish (*Naso unicornis*) in Moorea, French Polynesia demonstrated that 90% of the larvae reaching the reef have disappeared one week after their arrival. It was calculated that post-larvae mortality during the first 24 hours was as high as 60%. This experiment was repeated at various time scales and on other species by the French team at Moorea, in order to validate the feasibility of collecting post-larvae prior to reef colonisation. In this way, fish that would not otherwise have developed were 'saved'. Also, the reefs and their inhabitants remain intact, which is compatible with better conservation of fish already living in the protected marine area, which act as natural larvae spawners. The impact in terms of biomass loss for predators remains limited to the biomass taken, which is generally less than 1 kg per day.

Funding for this programme was provided by the AquaFish Technology company with assistance from the *Agence française de l'innovation* (ANVAR – French innovation agency) and the French Ministry of Research and Technology. In 2000, this technique was given 'good coral reef practice' status by the International Coral Reef Initiative (see their website: www.icriforum.org).

The pilot farm built in 2000 on Moorea Island was commissioned in late 2000 and production began on a regular basis early in 2001. The purpose of the farm was to demonstrate the technical and operational feasibility of this innovatory and environmentally safe process of exploitation and sustainable management of marine resources.

The commercial objective for the first year was the production of aquarium fish from collected larvae, essentially for the French market.

The collection technology is based on crest nets designed by the EPHE research team of Perpignan, France and the *Centre de Recherches Insulaires et Observatoire de l'Environnement* (CRIOBE, Moorea) extensively enhanced by AquaFish Technology.

A total of 25,000 aquarium fish were exported from French Polynesia to France in the first year. The fish were exported when they were fairly young so as to finish off their growth at a second AquaFish farm at Pérols. The first fish exported were low commercial-value species in order to test mortality at every stage of production. Then, once weaning and growth techniques had been mastered, exportation of the valuable species could begin.

Also, the number of fish post-larvae collected on the reef was much greater: some 50,000. Of this number, half were released alive on the reef because they were not export species. These species were predators such as snappers targeted by local fishers and species with no economic importance that could be re-introduced into this environment (cardinalfish, goatfish, etc).

As a result of the large numbers of fish released, AquaFish decided to develop the restocking activity by enabling species with potential value locally to be re-introduced into the environment after a short period of tank storage and feeding to satiation on live food. After having captured and reared thousands of post-larvae from over 150 species, we have clearly identified the transition stage from pelagic to reef behaviour for each species. We believe that the persistence of pelagic behaviour is highly prejudicial to the survival of fish in the natural environment and must be the cause of the very high predation observed during the early days of

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life. Thus, by keeping the fish for 48 hours in our farms and feeding them copiously on live food (plankton) we see the fish rapidly adapt to a benthic environment. They are then released into the natural environment. We are now going to monitor the fish released in 2002 with CRIOBE.

The species to be farmed showed promising growth rates. The great diversity of the species collected prompted us to implement multi-species rearing programmes, which is a new venture for aquaculture. However, we also noted the benefits of certain species associations. We worked extensively on weaning so as to deliver fish totally accustomed to inert food. To do so, we developed a specific feed making it possible to double the growth rate of certain species (damselfish and lionfish) as compared to rates obtained with industrial pellet-type feeds.

We also observed that the behaviour of species kept in captivity from the larval stage was like that of domestic animals. In other words, they behave differently from their older wild counterparts, even when they are kept under similar conditions. A striking example concerns the Holocentridae family, which lives in open water in aquaria, even when cover is available, and which are therefore more compatible with the interests of aquarium lovers.

Generally speaking, the species are more gregarious, accept much more varied food and are less sensitive to the stress effects engendered by this activity (especially delivery by air). The main consequence is a big reduction in mortality, usually 20–30% with this activity, which reduces in this case to 5%, for a much longer tank storage time.

Our efforts also revealed the essential influence of the quality of the environment for raising post-larvae. All the hatchery specialists know that water quality, food, light and other parameters (noise, daily feeding cycle) are essential to the development of the early larval stages. This is also true of reef fish post-larvae and water supply equipment must be top quality, otherwise many diseases may develop, in particular immediately after collection. These come from skin wounds or parasites.

The consequence is also that this type of collection work will continue for some time to be done by people with sufficient technical knowledge to handle it. The risk is of course that the larvae collected experience very high mortality, which would lead to overfishing to offset the losses. This would already appear to be the case for juvenile groupers (see article by Y. Sadovy, this bulletin, #8) while careful handling can considerably reduce mortality during collection and appropriate equipment can then provide suitable transport and tank storage.

Commercially speaking, the benefits of reef fish husbandry were enough to make the company well known quickly. Then the quality of our fish did the rest. Today, demand is much greater than what we can supply. This prompts us to develop a network of collection sites entirely based on this technique to expand and diversify our range.

As regards the other potential uses of this technique, we wish to develop the rearing of post-larvae of aquaculturally suitable species. We sold 4000 young groupers (*Epinephelus merra*, the only consumed local species) to a local fish farmer last year after one month of fattening. We also collect snappers, kingfish and other carnivorous species. However, French Polynesia is poor in sought-after species like the grouper, and we wish therefore to develop the local fattening of species like the unicornfish, which the local people like very much. The advantage of these fish is that they are herbivorous, meaning that they can be reared with cheaper and more environmentally appropriate food than the trash fish. Also, contrary to the grouper, the herbivores are more gregarious and clean the tanks by browsing on the algae. Lastly, in addition to the local population, many Latin residents also like this kind of fish. Our activity will therefore diversify through the development of larvae from products with less added value than aquarium fish, but which are popular locally and which would also make it possible to develop a form of aquaculture compatible with cheaper feeds.

The programme in French Polynesia will continue in 2002 with the development of a second farm entirely based on this technique and which was built in record time, taking into account the experience acquired in Moorea. This farm already produces several thousand fish per month and in particular species in great demand on the aquarium fish market. The case of the butterflyfish, which is difficult to rear in captivity, is a good example. This family is not used by the local population and its price as a farmed fish makes it an asset in our activity. The fish have recently been offered on the American market on which French Polynesia, by its geographical location, possesses an undeniable advantage.

AquaFish Technology has developed a new generation of post-larvae collectors (crest nets, light-traps) that enable collection work to be done at many reef locations. The collectors who wish to use this promising and environmentally sound method will be able to capitalise on the experience and the unique technology of AquaFish Technology. The main benefit for local communities will be the truly sustainable development of this new use of reef resources, through respect for the fauna and its environment.

Conservation of Banggai cardinalfish populations in Sulawesi, Indonesia: An integrated research and education project

Kristin E. Lunn and Marie-Annick Moreau

Background

The Banggai cardinalfish (*Pterapogon kauderni*), endemic to the Banggai Islands of Sulawesi in Indonesia, is extensively traded in the international aquarium market. Its attractive appearance and unusual mouthbrooding behaviour have made it popular among aquarists. Despite its widespread appeal, very little is known about the ecology or conservation status of this species in the wild, or about the habitats in which it lives. The Banggai cardinalfish — with its relatively low fecundity, highly restricted geographic range, tendency to live in groups, and low reproductive rates — has been flagged as being especially unsuitable for high levels of exploitation. Yet the aquarium trade in this species, suspected to take large numbers of fish directly from the wild, is currently legal and unregulated by national and international laws. Quite apart from the direct threats it faces, the species is also subject to many indirect threats posed by coastal pollution, habitat degradation, and destructive fishing practices throughout the Banggai Islands.

Goals and objectives

With the help of Yayasan Pemerhati Lingkungan (YPL), a non-governmental organisation based in central Sulawesi, we undertook a three-part conservation project in the Banggai Islands in March and April 2001, aimed at improving the current state of knowledge of the Banggai cardinalfish trade and biology and at starting up a much-needed environmental education programme for the region. In particular, we sought to: 1) document the nature and scale of the aquarium trade in this species, 2) observe the movement patterns and habitat associations of these fish in the wild, and 3) develop a marine environmental education programme for local schools and community groups. Taken together, we hope that these initiatives will contribute to better management plans for the Banggai cardinalfish fishery and increase public awareness of the current plight of this species in the wild.

Overview of findings

Aquarium trade surveys

Fifty-eight interviews with fishers, government officials, and buyers in north and central Sulawesi has revealed a large and growing trade for Banggai cardinalfish, with an estimated minimum of 700,000 fish being bought in the Banggai region during the period 2000–2001. Travelling in small dugout boats, fishers use simple nets and little other gear to collect Banggai cardinalfish from coral reef and seagrass habitats. Since the early 1990s, buyers from north Sulawesi and Bali have collected and, in later years, bought Banggai cardinalfish from fishers and regional collectors residing in the region. By early 2001, the trade for this species had spread to all five major islands of the Banggai Archipelago and to several smaller islands in the area, covering a large part of the species' known geographic range. From north Sulawesi, Banggai cardinalfish are shipped to Indonesian exporters in Bali, Jakarta and Surabaya, before entering the international market. Fishers and domestic buyers receive low prices for Banggai cardinalfish when compared with many other aquarium fishes. Nonetheless, the ease with which fishers can catch large numbers of fish using inexpensive gear in shallow water has led many fishers with few other economic options to participate in this emerging trade.

Movement pattern and habitat association study

Upon completing our trade surveys, we collected data on the movement patterns and habitat associations of Banggai cardinalfish in a small, protected bay on Banggai Island. Understanding the mobility and habitat requirements of this fish has important applications for the conservation of the species, particularly with regards to the design of marine protected areas (MPAs). Underwater visual censuses were conducted along six transects distributed throughout the bay and at three 10-m^2

study sites. Densities of Banggai cardinalfish on each transect ranged from 0.28 to 1.22 fish · m^{-2}, with a mean overall density of 0.63 ± 0.39 fish · m^{-2} (n = 6). Group sizes varied from 2 to 33 individuals, with a mean group size of 12.4 ± 9.7 individuals (n = 18). Seventy-three per cent of Banggai cardinalfish individuals or groups observed on our transects were associated with *Diadema* sea urchins, 18 per cent were found with sea anemones, and 9 per cent with branching *Acropora* coral (n = 22). Sea anemones appeared to be particularly important to juvenile fish. The species displays some level of site fidelity, based on our observation of similar numbers of fish found within the same 10 m x 10 m area for at least seven days, from the time the study sites were established to the study's end.

Marine environmental education

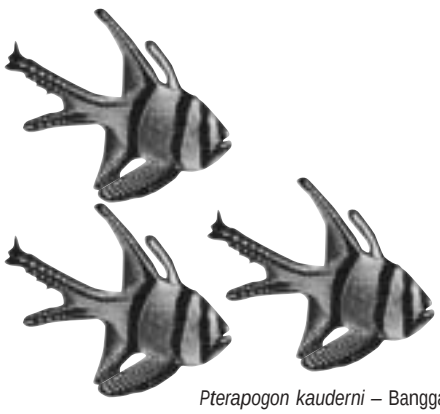
Together with YPL, we developed a one-hour environmental education session using materials that were donated by a variety of Indonesian and international conservation organisations. These sessions, which combined lectures, a food-web game, and class discussions, were conducted at four elementary schools in Luwuk and on Banggai Island. A staff member of YPL led all four sessions while we helped by putting up props and answering questions. The programme, targeting students aged 9–12, focused on the biodiversity of Indonesian seas, the current threats to their marine ecosystems, and possible conservation solutions. In addition to these sessions, we held a colouring contest for children in Tinakin Laut on Banggai Island, the fishing village we stayed in while carrying out our underwater study of Banggai cardinalfish.

Conclusions

Whether the aquarium trade exerts enough pressure on Banggai cardinalfish populations to threaten their continued persistence in the wild cannot be precisely determined from our initial trade surveys. Nevertheless, we support proactive management measures to safeguard wild Banggai cardinalfish populations given that: 1) the species' biological characteristics make it especially vulnerable to exploitation; 2) the current annual trade for the international aquarium market involves hundreds of thousands of fish and appears to be expanding; and 3) local reef habitats are under increasing pressure from destructive fishing, among other factors. We propose that a number of steps be taken to ensure the long-term persistence of this species in the wild, including the institution of trade regulations and the development of community-based management initiatives for the Banggai region.

Acknowledgements

Financial support for this research project was provided by a Rufford Small Grant (Whitley Awards Foundation, UK), Chester Zoo (UK), Columbus Zoo and Aquarium (USA), Reef Conservation UK and PADI's Project AWARE. Environmental education materials were donated by The Nature Conservancy (Indonesia), Coral Cay Conservation (UK), Ocean Voice International, the Vancouver Aquarium (Canada) and Terangi (Indonesia).



Pterapogon kauderni – Banggai cardinalfish

If you are interested in more details about the project, or would like a copy of the full report, please contact:

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FADs for aquarium fish – an alternative capture method?

Lida Pet-Soede[1,2], Fini Lovita[1] and Imam Musthofa Zainudin[1]

While watching a few young fishers in the strait between Bali and Java cling to floating debris such as tree branches and banana tree stumps, among numerous plastic bags and food wrappers, three thoughts came to mind. The first was that the household waste problem is now becoming a huge issue that needs to be dealt with in that area to protect the marine environment and to provide a worthwhile experience to diving tourists. The second thought was that timber is still being cut somewhere nearby, and the third thought was more a question: 'What are these fishers doing?' It turned out that the fishers were catching many live juvenile and adult reef fish, which trade for high prices in the ornamental industry. During the rainy and windy season, aquarium fish collectors diving with hookah compressors and cyanide have difficulty in operating. Strong currents restrict their operations, which is good from a conservation perspective, but not from the fishers' perspective. Creatively, and with their knowledge of fish behaviour, they float with the current, while scooping their little treasures from under the debris, where a variety of species, even those that are known to stay close to the reef substrate, appear to have aggregated.

A few weeks later, while we were discussing artificial reefs and, in particular, that many studies show artificial reefs to aggregate reef fish rather than add fish biomass or reef structure, the thought struck. Why not aim at developing a structure that acts as a fish aggregating device (FAD) for aquarium fish so as to provide fishers with an alternative capture method. The work plan was made and the fishers who were approached to join in the design and testing of the aquarium fish FAD were very enthusiastic.

Since early 2002, and together with a group of fishers from Sumber Kima, a village in west Bali known to house cyanide and blast fishers, a number of FADs have been designed. The designs fall in two main categories: portable FADs and permanent FADs. The conditions for FAD design include:

- The material and making should be cheap.
- Discarded fishing material should be used as much as possible (recycling).
- The design should allow for easy capture, while at the same time provide an interesting structure for the fish.

Field-testing of the various designs, both the portable and permanent types, started in April. Parameters that were varied and measured included:

- distance of the FAD to the reef,
- time lapsed before particular number of fish inhabits the FAD,
- species composition of the fish that inhabit the FAD,
- ease of harvesting (either with snorkel / hookah and scoop net, or with surrounding net in combination with scoop net),
- effect of disturbance from harvesting on the time required for recolonisation of the FAD, and
- longevity of the FAD material.

FADs may not serve all needs of the trade. Some species or sizes will be attracted to FADs whereas other may never be lured to inhabit it. Also, the colonisation process may take too long before a commercially interesting number of fish inhabit the FAD. Thus, a portable FAD, intended to be taken on long-range boats to remote areas, may not be as economically viable as for example a permanent FAD. Also, in case the FAD would be highly effective for a selection of species, the issue of species- or size-overfishing must still be addressed. However, by providing an opportunity to catch high-demand fish away from the actual reef with its delicate structure, direct damage from use of cyanide or coral breaking, may be minimised, at least for some target species.

The WWF team invites a large audience to join in developing and applying this methodology. At this stage, creative designs and other input is highly valued. Together with groups such as the Marine Aquarium Council, we aim at transforming the ornamental fish trade into a non-destructive, ecologically sustainable and economically healthy business.

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New aquarium species database

Dr Edmund Green[1]

The UNEP–World Conservation Monitoring Centre (UNEP–WCMC) is pleased to announce a new database on the trade in aquarium species, the Global Marine Aquarium Database (GMAD), which is available at http://www.unep-wcmc.org/marine/GMAD/

Users of the database will have access to approximately 50,000 records of trade in live aquarium species and may query these geographically (e.g. the number of fish exported from the western Pacific to North America) and taxonomically (e.g. the top ten most traded families of invertebrates in global trade).

A more detailed description of the database and supporting project is below. Further data collection is ongoing and the database is continuously being updated, with the release of the next version scheduled for April. Comments, and notification of any errors especially in the names of invertebrates, would of course be appreciated.

Some background

Since April 2000 the UNEP–WCMC and the Marine Aquarium Council (MAC) have been collaborating with members of trade associations to establish the GMAD as a freely available source of information on the global aquarium industry. Our common objective is to centralise, standardise and provide fast and easy access to information on the aquarium trade.

Description of GMAD

There is no monitoring or reporting framework for the global aquarium trade. This means that the best source of quantitative data is the wholesale import and export companies who link the supply and retail ends of the business. As a matter of routine business practice companies keep records of their sales, either as paper copies of their invoices or on company computer databases. The exact nature of these records varies, but all record the quantity of any individual species bought or sold, the date of each transaction and the source or destination of the shipment. Company sales records are therefore an excellent source of data on marine aquarium species in trade, and the only source for species not recorded under any other process (e.g. CITES).

UNEP–WCMC and MAC have established good working relationships with such companies from all around the world. They have provided us with access to their sales records, which are the core data in GMAD. These data have been through a careful and methodical period of data conversion (e.g. paper-based records have been computerised) and formatting (e.g. data from different electronic systems have been placed into a single standardised format). Data from 45 representative wholesale exporters and importers of marine aquarium species have been harmonised by this process into a single publicly available database.

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News from the International Marinelife Alliance (IMA)

Ornamental and live reef food fish surveys in Christmas Island and Vanuatu

Source: *International Marinelife Alliance Information Bulletin* #2, 17 October 2001.

In June 2001, following the April 2001 survey undertaken in Fiji, IMA's Terry Donaldson, (IBRP Director) and Steve Why (Pacific Program Director), together with SPC's Being Yeetlng and host country Fisheries Division staff conducted survey training and Underwater Video Census (UVC) assessments of fish communities, population densities of selected species, and habitat quality on coral reefs in both Christmas Island (Kiribati) and Vanuatu in the South Pacific.

Kirtimati (Christmas Island)

Gerry Reyes provided underwater video coverage on Christmas Island — which is located 1000 miles south of Hawaii, on the Equator — the Kiribati government having requested IMA and SPC assessment of the status of Christmas Island's ornamental trade under the regional ADB-funded Regional Technical Assistance (RETA) project.

During the two-week survey, the team found the heavily exploited flame angelfishes *(Centropyge loricula)* to be significantly smaller and lower in numbers in collection areas, with population density, distribution, harem size and habitat association also being assessed as a basis for management. Similar data was gathered for other target aquarium species, plus groupers and humphead wrasse — presently being compiled in a report to the Kiribati Government. Christmas is a very large and desolate atoll over 100 miles in circumference. About 4000–5000 residents depend on the sea, and the aquarium trade is an important source of income for over 40 divers (and their families) who work for nine collecting companies. All appear to be using barrier net capture (BNC) methods. The two week visit was for Steve a trip down "Memory Lane" since he first worked with Fisheries in 1980–81 farming *Eucheuma* seaweed on Christmas Island, which has turned out to become a successful industry.

The team found the Kiribati Fisheries Division working positively on issues such as oversupply, Petfish Association coordination, marine reserve establishment, diver education and insurance following the high numbers of diver deaths. Once IMA secures funding for Christmas Island, we will be able to follow-up, responding to requests for assistance on implementing the management plan. Meantime, Steve has been helping the Honolulu importers of Christmas Island fish to improve handling practices in view of the Department of Fish and Wildlife closing down shipments on Aloha Airlines due to poor boxing techniques that have caused very high mortalities.

Efate Island, Vanuatu

In August 2001, heading this time to Vanuatu in the Melanesia islands of the South Pacific, the IMA / SPC survey team dove around the high tropical island of Etafe — the central island in this 85-island archipelago — primarily assessing grouper distribution and abundance, also looking at aquarium fish communities, population densities of selected species and habitat quality. Groupers were neither abundant nor diverse, we believe due to ecological biogeographic reasons (natural low abundance), subsistence fishing pressure and a trial live grouper fishery already having an impact in a number of areas. This trial operation, run without the approval of Vanuatu Fisheries, may already have intercepted a spawning aggregation. Vanuatu Fisheries Director and staff who dove with us throughout the survey were able to see first-hand the paucity of stocks and the impacts caused by the trials. Although the final report with SPC has not been submitted, Fisheries concluded that licenses for LRFFT should not be given out on Efate because of poor stocks and the lack of manpower to control the industry and monitor it effectively. However, the Director of Fisheries, whose job it is to promote sustainable economic development, also wants to complete surveys on some of Vanuatu's other islands since he expects other foreign fishing companies to apply for licenses.

Vanuatu's aquarium trade seems more likely to be sustainably practiced. Only one company has operated over a long period of time using nets to catch

flame angelfishes *(Centropyge loricula),* coral beauty angelfishes *(Centropyge bispinosa),* and the lemon peel angelfishes *(Centropyge flavissimus).* Other angelfishes, assorted damselfishes, anthiases, hawkfishes, and hovering gobies are also collected to a lesser extent. Ultramarine *Tridacna crocea* clams used to be crowbarred from the reefs, but acting on IMA-supported recommendations, Vanuatu Fisheries is working towards a long-term ban on this practice, exports to be replaced by cultured clams. IMPA / SPC's survey of aquarium fish gave special attention to analyses of patterns of distribution, population density, harem size (where applicable) and habitat associations for angefishes (Pomacanthidae), butterflyfishes (Chaetodontidae), hawfishes (Cirrhitidae), damseflefishes (Pomacentridae), burrowing gobies (Gobiidae: *Valenciennea* spp.), triggerfishes (Balistidae), selected surgeonfishes and tangs (Acanthuridae: *Paracanthurus hepaticus*, *Zebrasoma* spp.), sandperches (Pinguipedidae: *Parapercis* spp.), puffers (Tetraodontidae), and wrasses (Labridae). Data will be included in a regional database.

Investigating the live reef fish markets in Southern China

Source: *International Marinelife Alliance Information Bulletin* #3, November 2001

IMA-HK conducted a preliminary investigation of the fish markets in Shanghai, People's Republic of China (PRC) from 19–22 October 2001. Shanghai is the busiest metropolis in the PRC and a city becoming more important as a demand centre for live reef food fish.

The freshwater and marine products wholesale (and retail) market at Tong Chuan Lu (Road) is the biggest market in Shanghai. It is located about 6 km west of Shanghai Train Station. The market sells marine fishes, lobsters, crustaceans and shellfishes, freshwater fish, prawns, Chinese mitten crabs, and dried marine products like shark fins. There are about 400 shops selling freshwater and marine products, with about 20 shops selling solely live reef food fish and lobsters. Compared to the market at Huang Sha, Guangzhou, the shops are scattered along both sides of a section of about 400 metres at Tong Chuan Lu.

In term of species, lobsters (especially Australian rock lobsters) were in abundance. Wild-caught fishes (reef food fish) were relatively few and only about eight shops had fishes in the tanks. In terms of number, the red coral trout (*Plectropomus leopardus*) was the majority (about 75%), followed by the humphead wrasse (*Cheilinus undulatus*) (15%), and the highfinned grouper (*Cromileptes altivelis*) (10%). Only one individual of the flowery grouper (*Epinephelus polyphekadion*) was observed.

IMA-Fiji launches operations

Source: *International Marinelife Alliance Information Bulletin* #3, November 2001

IMA–Fiji began its operations in response to a request by the Fisheries Division to assess the live reef food fish trade and to conduct investigative and stock assessment study in the Lau Group in Apri12001. The Secretariat of the Pacific Community (SPC), in accordance with its initiative within the region, also supported this work. This was followed by the recruitment of the Fiji Coordinator, Iliapi Tuwai to establish the office in Suva on June 2001.

IMA-Fiji was also set up to support the Fisheries Division in assessing its reef and coastal resources, with emphasis on advising government on policy and good management practices that will conserve and ensure sustainable development. It will also support the Ministry of Environment on the Sustainable Bill that was recently passed through Parliament and likewise work in close collaboration with the University of the South Pacific (USP), SPC and SPREP to support the Fiji Government on marine-related issues — the first being assessment and monitoring o coral harvesting in Fiji, towards management planning and mores sustainable use. IMA also has opened its doors to other NGOs such as WWF to coordinate work on similar issues.

Iliapi has continued to provide leadership on the work initiated by the Fisheries Division at Motoriki Island. This work is focus on complete stock assessment of the Customary Fishing Right (CFR) areas of the island, leading to recommendations on conservation and sustainable development using community-based management and empowerment procedures. This is just the start of the many similar tasks that will be undertaken on over 400 CFR areas in Fiji, in line with the change in policy on marine tenure that seeks to decentralise ownership of coastal areas. Other IMA programmes on Marine

Protected Areas (MPAs) like Waisalima in Kadavu and Vanuaso in Gau are already underway, in collaboration with the University of the South Pacific (USP) and other NGOs. The setting up of a new MPA committee composed of representatives from the government, institutions and NGOs has made a big impact in such a short time showing that there is a lot of demand and interest in MPAs from new areas around Fiji. IMA–Fiji (Iliapi) is currently chairing this national level committee.

The live reef food fish trade operation is still under stable condition as a result of the survey that was conducted at Lakeba this year. Two of the companies have stopped operation. The third one in Vanua Levu is exporting at a very small scale. IMA-Fiji is monitoring this fishery very closely and will advise the Fisheries Department accordingly.

The aquarium trade, particularly that of live rock and corals, is an area that IMA-Fiji is concentrating on in order to come up with policy and management recommendations to the government to sustain this fishery. This is an important area since Fiji is ranked as one of the largest exporter of corals in the world today.

One of the major challenges for IMA-Fiji is the dissemination of information on marine issues to the locals and specifically to the young generation. Efforts are ongoing with USP, IMA, other NGOs and some resort owners to translate booklets into the local language to be used in villages and for monitoring purposes. These will also be submitted to the Education Department for future use in schools, and for inclusion in the curriculum of primary and secondary school levels.

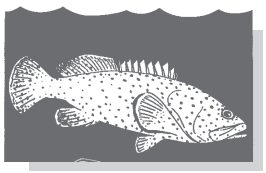
Fishing community wins back rights

Source: Condensed from an article, submitted to MAP's *Late Friday News* e-mail newsletter, 87th edition, by Ben Brown of YARL seagrassroots@indo.net.id

A fishing community in the newly established province of Gorontalo, Sulawesi, has made use of new opportunities arising from regional autonomy to regain control over their traditional fishing grounds. In April and May this year, Saronde, the United Fisherfolk of Kwandang Bay, called in the grass-roots coastal management NGO, Kelola, to address the main problem faced by the bay: trawlers. A fleet of 17 small commercial trawlers were fishing the waters around Kwandang Bay as close as 1 km from the shore. Their crews were also involved in cyanide fishing on local reefs for the live fish trade. Several high-ranking police and navy officers were known to be colluding with the trawler operators. After a series of consultations, the community decided to collect signatures for a petition to be presented to government officials. The aim was to enlist support from the newly formed provincial and district governments for re-establishing the traditional fishing zone for the exclusive use of small-scale fisherfolk.

Under regional autonomy law, districts have authority over four nautical miles, from the shore and provinces up to 12 miles. It was determined that the Kwandang district government would declare its 4-mile zone (as set under regional autonomy laws) as traditional fishing grounds. A draft government regulation was prepared. The head of Kwandang district also intervened with local branches of the navy and police to enforce compliance and to identify non-corrupt officers to whom local people could report infractions.

Within 24 hours of this intervention the 17 trawlers had disappeared. Six months later, the trawlers had not returned, cyanide fishing had also ceased and the fishing community was holding regular meeting to exchange patrolling information.



Noteworthy publications
live reef fish

Financial feasibility analysis for grouper culture systems in the Philippines and Indonesia

Pomeroy, R., R. Agbayani with J. Toledo, K. Sugama, B. Slamet and Tridjoko. 2002 (in press). Financial feasibility analysis for grouper culture systems in the Philippines and Indonesia. Draft Chapter 6 in Farming the reef: A state-of-the-art review of aquaculture of coral reef organisms in tropical nearshore Environments. Robert Pomeroy, John Parks and Cristina Balboa (eds). World Resources Institute, Washington DC.

Below is a summary of the financial portion of this chapter. See page 22 in this issue for extracts of country statements from this same publication.

This section has presented a financial feasibility analysis for the culture of *E. coioides* and *E. malabaricus* in the Philippines, and *Cromileptes altivelis* in Indonesia. The analysis provided financial information on individual broodstock, hatchery / nursery, and grow-out stages and for an integrated broodstock / hatchery / nursery / grow-out system. The findings of the analysis indicate that, based on the assumptions, all four scenarios are financially feasible. The capital requirements for the broodstock, hatchery / nursery, and integrated system may be beyond the financial means of many small producers. These stages of grouper culture may need to be developed as a larger project by private investors or government or subsidised by government. However, the capital investment requirements for grow-out (not including purchase of transport boxes) is within the financial means of small producers. Loans or other incentives will need to be made available for the small producer, but the cash flow indicates that these loans can be repaid in the first year of production. Returns are high enough to encourage small producers and lenders to consider investment in grouper grow-out systems. When a sensitivity analysis is conducted for changes in price, yield and variable costs, all stages of production are still financially feasible. It should again be noted that the analysis was based on a set of base technical assumptions. These assumptions will change in a real world operation.

Several potential problems will need to be overcome with grouper aquaculture. The future of the industry will depend on having a regular supply of hatchery-raised seed and fry. The collection of seed and fingerlings from the wild is not sustainable in the long-term and the export of wild-caught grouper seed needs to be regulated or prohibited. The collection of wild-caught grouper seed is often wasteful and impacts on other species. There is a need to shift from using trash fish as feed to the development and availability of cost-effective formulated feed. A number of diseases at various stages of production are affecting the grouper industry. Vaccines will need to be developed as well as improved health management methods. Grouper aquaculture in coastal areas will need more regulation to address real and potential problems of pollution from nutrient and organic matter and the use of medications and chemicals. In most countries in Southeast Asia there is a lack of regulations to site and manage coastal aquaculture, both pond and cage culture.

Cultured grouper can be certified for quality and good culture practices. Grouper grown from hatchery reared seed, as compared to wild-caught seed and fingerlings, can be certified. Mariculture development can be managed with regulations and a legal framework to reduce environmental impacts. One example is the Mariculture Park's project in the Philippines. Mariculture Parks are developed as an industrial zone with infrastructure and services to support cage culture. Certification and production standards need to be put in place for cultured fish.

For more information contact Dr Robert Pomeroy at rpomeroy@marine.org

Current status and trends of finfish market in Hong Kong

Ms Louise W.H. Li
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This paper describes the marine finfish market in Hong Kong and also briefly the import requirement for live, chilled and frozen fish species. It provides statistics on the consumption of fisheries products in Hong Kong from 1996 to 2000, the local fisheries and aquaculture productions of marine finfish in 1998–2000, and the net import volume of finfish from 1998–2000. The average wholesale prices of several live coral reef species such as *Epinephelus coioides, E. lanceolatus, Lutjanus argentimaculatus, Cheilinus undulatus* and *Plectropomus* sp. are provided.

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Country status overview 2001 on reef fisheries exploitation and trade in Indonesia

International Marinelife Alliance (IMA) Indonesia, Ministry of Marine Affairs and Fisheries, and Telapak Indonesia Foundation

This report covers reef fisheries exploitation and trade in Indonesia, describes the type of commodities, fishing grounds and trading centers for ornamental fish, live coral and reef food fish. It also covers the price structure for both ornamental and food fish. Destructive fishing methods used such as cyanide, blasting, coral extraction are also described. It also describes the interventions implemented for controlling destructive fishing activities such as temporal and spatial controls, and the introduction of sustainable methods such as hook and line, bubu (fish traps), barrier net, and the introduction of mariculture.

Country Status Overview (CSO) 2001 is the first part of a series that will be developed and published annually. CSO is an open document that can be, and is expected to be, written by as many parties as possible with interest in Reef Fisheries in Indonesia. Data for the compilation of CSO collected / gathered from as many involved players as possible, including parties that cause the decrease in the quality of the habitat. and of the life of the community, indirectly or directly.

Most of the data collected is secondary, and varies from export tables issued by several government institutions, to the observations and reports made by export and science agencies. Interviews have been done to substantiate supporting data. There are three main monitoring sites (Jakarta, Denpasar and Makasar, which are the main export gates) In addition information was obtained from several other fishing areas (Nias, Lampung, Ujungkulon, Thousand Islands, Karimun Jawa, Sumenep, Maluku Tenggara, and Biak).

For the full report see the International Marinelife Alliance website at : http: / / www.imamarinelife.org /

Proceedings of The Live Reef Fish Trade Workshop, 23 April 2001

International Marinelife Alliance

This report includes summaries of the papers presented at the Live Reef Fish Trade workshop in Hanoi, Vietnam on 23 April 2001 and it also provides a record of the discussions and recommendations from the workshop. The following are the list of presentations given:

- Overview of the worldwide live reef fish trade, IMA's Indo-Pacific Destructive Fishing Reform Initiative
- Overview of live reef fish trade in Vietnam
- The impact of cyanide fishing on coral resources in Vietnam
- Activities for coral reef conservation in Vietnam
- Legal issues concerning the management of fisheries resources, including the live reef fish trade
- Marine culture strategies in Vietnam, the concept of coastal resources co-management

The full report can be obtained from International Marinelife Alliance – Vietnam website at :
http: / / www.ima-vietnam.b2vn.com /

Husbandry and management of grouper

SEAFDEC. 2001. Husbandry and management of grouper. Aquaculture Department, Southeast Asian Fisheries Development Center, Tigbauan, Iloilo, Philippines. 94 p.

This is a very practical guide for farmers with many 'how to' illustrations. It covers species of groupers farmed, choosing farm location, facilities, sourcing grouper seed, nursery and grow-out operations, harvesting and marketing, and keeping groupers healthy. One does not need to be a highly trained specialist in order to understand it, yet it is packed with valuable information. It is currently being translated into various Asian languages.

Territorial use rights in fisheries to manage areas for farming coral reef fish and invertebrates for the aquarium trade

Peter J. Rubec, Vaughan R. Pratt and Ferdinand Cruz

Source: *Aquarium Sciences and Conservation* 3:119–134, 2001.

Reef fish, corals, and other marine invertebrate species associated with coral reefs need to be managed in a sustainable manner to halt destructive fishing in the Philippines and other Southeast Asian countries. As part of the Coastal Communities Empowerment Project, the International Marinelife Alliance (IMA) plans to implement Territorial Use Rights in Fisheries (TURFs) to help manage municipal waters; while creating alternative livelihoods for small-scale fishermen and their families. Changes to the Local Government Code allow Philippine municipal councils to regulate fishing and mariculture in waters within 15 km from shore. The councils can lease TURFs to local fisherfolk and prevent their use by those outside the community. The IMA plans to help create several types of TURFs. These include TURFs used by aquarium-fish collectors, for rearing giant clams, and for farming live rock and coral fragments. The TURFs are part of a larger strategy to conserve marine biodiversity, protect and restore marine habitats, and promote sustainable use of marine resources by local people. Fish and invertebrates harvested from the TURFs will be used in programmes to restore marine habitats and to generate income from exports that supply the aquarium trade.

Cyanide-free net-caught fish for the marine aquarium trade

Peter J. Rubec, Ferdinand Cruz, Vaugan Pratt, Richard Oellers, Brian McCullough and Frank Lallo

Source: *Aquarium Sciences and Conservation* 3:37–51, 2001.

The International Marinelife Alliance (IMA) has been training collectors in the Philippines and Indonesia to use barrier-nets rather than sodium cyanide to capture marine-aquarium fish. Despite the training, collectors have been slow to switch to using nets because they can earn more using cyanide A new Philippine-export company has agreed to pay the collectors more for net-caught fish and to adhere to standards being set by the USA-based Marine Aquarium Council. The IMA is monitoring the collectors and conducting cyanide testing to certify that the fish are net-caught and totally cyanide-free. Clearance certificates now accompany shipments of these marine-aquarium fish being shipped to wholesalers and retailers associated with the American Marine Dealers Association (AMDA) situated in the USA and Canada. AMDA members are being surveyed to assess whether the net-caught fish are more cost competitive compared to cyanide-caught fish for the marine ornamental fish trade because of reduced mortality through the chain from reef to retailer.

Other references

Leong Tak Seng, 2001. Diseases of cultured marine fish. Aquaculture Asia 6(3):24–27.

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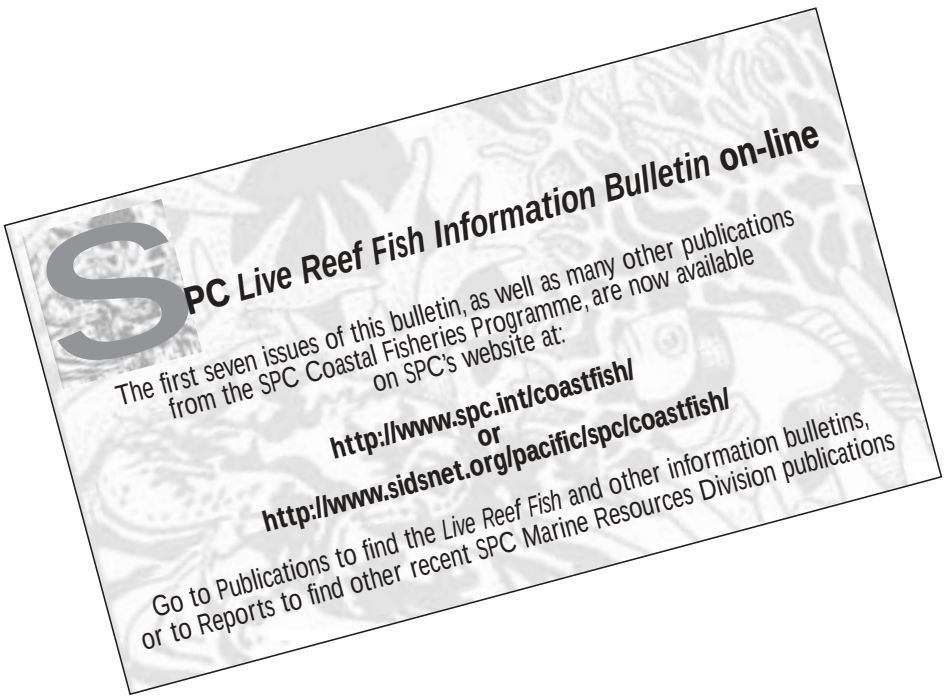
Bombeo-Tuburan, E.B. Coniza, E.M. Rodriguez and R.F. Agbayani. 2001. Culture and economics of wild grouper *(Epinephelus coioides)* using three feed types in ponds. Aquaculture 20:229–240.

Sluka, R.D. 2001. Grouper and Napoleon wrasse ecology in Laamu Atoll, Republic of Maldives: Part 3. Fishing effects and management of the live fish-food trade. Atoll Research Bulletin 993, 18 p.

Donaldson, T.J. and Y. Sadovy. 2001. Threatened fishes of the world: *Cheilinus undulatus* Ruppell, 1835 (Labridae). Env. Biol. Fish. 62:428

Sadovy, Y.J. and A.C.J. Vincent. 2002. Ecological issues and the trades in live reef fishes. In: P.F. Sale (ed). Coral reef fishes: Dynamics and diversity in a complex ecosystem. San Diego: Academic Press. 18:391–420.

McGilvray, F. and T.T.T.C. Chan. 2002. The trade in live reef food fish: A Hong Kong perspective. Aquaculture Asia 12(1):21–26.



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