been declined. The Authority considers that the risk of damage to reefs, as suggested from experience in other countries, is greater than the potential benefits to the country.

Other threats to coral reefs

During 1998 there were extended periods of unusually high water temperatures on the Mahe Plateau. This caused the widespread bleaching of corals in the area. Around the islands of Mahe, Praslin and La Digue up to 90% of corals were bleached. However, the majority of the countries' reefs in the south of the country appear to have been less affected.

Dynamite fishing has not been traditionally used in the Seychelles, and its use as well as that of noxious substances is strictly prohibited by the Fisheries Act. The fishery on the Mahe Plateau for coral reef fish destined for the local and export markets is not considered to be heavily overexploited. However, the SFA is encouraging local fishers to shift towards offshore pelagic resources to reduce the pressure on demersal fish stocks.

Discussion

The Seychelles Fishing Authority has managed the fishery for live reef fish to minimise damage to coral reefs and reduce the risk of overexploitation. From the beginning, the SFA has maintained a high level of control over the fishery through the clear definition and effective enforcement of licence conditions. The risk of overfishing is reduced by placing limits on the area fished and the quantity of fish caught. Damage to reefs has been minimised by allowing only hook and line fishing. These central conditions are supported by ancillary conditions that make enforcement easier. Effective enforcement has been possible because the number of licences allocated—only one—is appropriate given the enforcement resources of the SFA. Considering that some of the islands are as far as a thousand kilometres from the main island, regulations would be difficult to apply if more licenses were allocated.

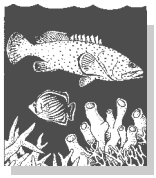
Despite the success in managing the fishery, the SFA is still considering its future. The situation will be reassessed at the end of the present license, but it is clear that the SFA will not encourage the further development of the fishery. With the present level of the export quota, the logistics and costs involved in fishing at the southernmost islands of the Seychelles and costs of transport of fish to the markets in Hong Kong, the fishing company itself is not sure whether the venture is viable.

References

JOHANNES, R. & RIEPEN, M. (1995). Environmental, economic, and social implications of the live reef fish trade in Asia and the western Pacific. The Nature Conservancy, Jakarta.

SEYCHELLES FISHING AUTHORITY. (1997). Annual Report 1997. Victoria, Seychelles. 44 p.

SMITH, A.J. (1997). Management suggestions for the sustainable development of live reef fish food fisheries in the Pacific Islands region. SPC Live Reef Fish Information Bulletin 3: 47–51.



Live reef food fish trade in the Banggai islands (Sulawesi, Indonesia): A case study

by Mochamad Indrawan [1]

Abstract

A field survey of the live reef fish (LRF) trade in the Banggai Islands was conducted in 1997, ten years after the trade began to flourish systematically. Napoleon wrasse had initially been the main target fish, but attention had shifted more toward the groupers. The structure of the LRF trade was relatively simple, involving mainly exporter and buyer. Johannes and Riepen' (1995) indicators of decline were encountered during this survey. The impacts of over-exploitation will be borne mainly by resident fishing folks and not by the exporter, making it a classic case of externality. There seems to be no easy way out of this problem, but some priorities were identified for consideration including the need to develop local stewardship and alternative livelihoods.

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Introduction

The Banggai Island group (between 1°8' to 2°15' S and 122°44' to 124°8' E) lies south of the eastern arm of the Indonesian Island of Sulawesi, from which it is separated by a 900 m deep channel. Administratively the archipelago forms part of Luwuk–Banggai District, Central Sulawesi Province. The rest of the Luwuk Banggai district is located on the mainland. The Banggai Islands have a land area of about 12 km^2. The islands are populated by 337,000 people including indigenous Banggainese as well as Saluanese and migratory Butonese and Buginese.

Recent surveys by Coral Cay in 1995 and 1996 (Harborne *et al.*, 1997) indicated that the islands' marine fauna is probably one of the most biologically diverse on earth. The island group contains barrier reefs, atolls, and fringing and patch reefs.

An overview of the live reef fish (LRF) trade was provided by Johannes and Riepen (1995) and Erdmann and Pet-Soede (1996), covering, respectively, Asia–Western Pacific and Eastern Indonesia. Whilst Johannes and Riepen emphasised on the ecologically destructive nature of cyanide used in LRF collection, Erdmann and Pet-Soede cautioned against the environmental consequences engendered by overexploitation. Both pairs of authors predicted that the LRF trade as currently practised would collapse at any given location within a few years due to overharvesting.

The present survey aimed to document the local nature and impacts of the LRF trade. Particular attention was paid to the socio-economic status of the stakeholders. The Banggai Islands were chosen as the study area due to the apparently high levels of diversity and productivity and my earlier familiarity with the island group and its people.

Between 1 November and 3 November 1997, I carried out informal interviews with actors and stakeholders in the LRF trade—seven traditional fishing folks, three commercial divers, three middlemen and four exporters involved with the LRF trade. A cold storage exporter and the director of the regional shipping agency (personally involved with the LRF industry, as a co-exporter) were also interviewed. To avoid eliciting interdependent responses, localities in which the interviews were conducted were chosen as far apart as possible and the respondents were usually selected from different islands. Five large holding pens (floating cages or 'rakit') in three different islands (Banggai I., Bandang I., Bangkurung I.) were also visited. One of these cages, in Bangkurung, had been abandoned two months earlier.

Since the accuracy of the given responses was unknown, cross-checking between the answers was repeatedly carried out whenever possible. For example, the local fishers' information that the import vessel came once or twice a month was checked with that from the regional fishing agency. A breakdown of costing for a holding pen cum regular catching operation which was obtained from a diver was matched with the figures from two different exporters.

Prices documented were in Indonesian Rupiah, and the rate of exchange was 2400 Rupiah to 1 US Dollar.

Cold storage venture in Banggai Islands

I did not consider in detail the cold storage business, but one exporter of fresh dead fish volunteered information of possible relevance to the LRF trade. The exporter was a resident expatriate who had been conducting business locally for the previous two years. He appeared to have no local competitor in the business. The venture included the same species that entered the LRF trade. The frozen fish were exported to Hong Kong either directly via a chartered Hong Kong vessel, or shipped to Jakarta or Surabaya and air-freighted onward. Export capacity was approximately 3 tons per shipment, once per month.

The exporter volunteered that the cold storage business could also profit from customers' willingness to pay high prices for live reef fish. He would buy fresh dead fish at 30% to 50% of the LRF price. In the destination country some restaurants would display LRF but discreetly serve the dead ones fish as their customers could not tell the difference[2]. The exporter claimed he could sell his fish at 70 to 90% of the live fish price and in that way make a good profit.

History and nature of the trade in live fish

Before the advent of LRF trade, Banggai Island fishers focused mainly on pelagic fish—mainly tuna, skipjack and squid. The LRF trade in the Banggai Islands started in 1987 and expanded in the early 1990s. In the mid-1990s an export peak was reached, followed by an immediate decline in the following

2. Editor's note: Hong Kong LRF connoisseurs maintain that they can readily distinguish between just-killed and frozen fish after they have been cooked. If this is correct, then restaurants that substitute one for the other would have to target only certain customers, such as less discriminating Western tourists.

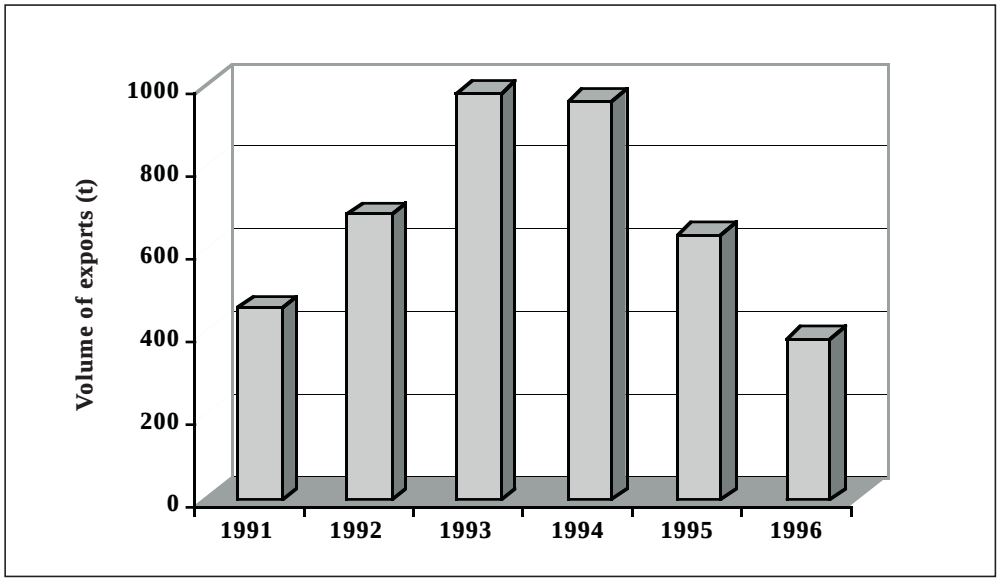

Figure 1. **Live fish export volume (in tons) from Luwuk Banggai District. Data covered the whole island group of Banggai and half the coast of eastern arm of Sulawesi**

years. This pattern of boom and bust appeared to be consistent with that for the whole district of Luwuk Banggai, as indicated by statistics displayed at the Fishery Services of the District Office (Fig.1).

There were an estimated ten large floating cages in the archipelago, all of which were owned and maintained by exporters. The fishes in the floating cages were kept and cared for two weeks to one month. Once the numbers held in the pens was sufficiently high, the exporter contacted a buyer (principally in Hong Kong but also sometimes from Taiwan, Singapore, Japan or another export destination) who would arrange shipment through a shipping agency.

The transport vessels usually visited each holding cage in the island group before heading back. In 1993 one of the largest exporters in Central Sulawesi attempted to ship live grouper by air, but this turned out to be expensive because the plane was able to hold only a total of 300 kg of live fish. Whereas an ocean shipment would take about two weeks to reach destination an air shipment might take a mere 15 hours. But an air shipment from this location involved numerous stops, namely Luwuk, Manado, Davao, Manila, Hong Kong, making the practice impractical.

Ten years earlier the average volume shipped per trip was of the order of 10 tons of live fish per shipment. But by 1997, 3 tons per shipment was about average. Based on an interview with-shipping agency and assuming that the 10 floating cages would produce approximately 3 and 6 tons per month, total export weight from the Banggai Islands would range between 30 to 60 tons per month. Assuming that exporters would make 80,000 Indonesian Rupiah per kilo for the average grouper, the export value would have been in the range of 2.4 to 4.8 billion Indonesian rupiah (or approximately 1 to 2 million USD) per month, for the Banggai Island group alone.

The LRF trade is characterised by a high degree of mobility. For example, of the ten known large floating cage owners, at least three had come from as far away as Riau (islands between Sumatra and Peninsular Malaysia) in the previous three years. Riau was the first area in Indonesia to be involved in the LRF trade beginning in the 1970s, and its own LRF resource had been severely depleted (Pet-Soede & Erdmann, 1996). One of the largest local Banggai owners who sold his business to a Riau operator moved out to another region. Fish-collecting operations whose business declined in Banggai moved east to, for example, Tomini Gulf (Togian Islands), Flores, Tual or Irian Jaya. This is a manifestation of the eastward-moving wave of depletion recorded by earlier observers (Johannes & Riepen, 1995; Pet-Soede & Erdmann, 1996).

Prices and catching methods

Species that entered the LRF industry in Banggai were primarily from the grouper (Serranidae) group, especially the subfamilies Epinephelinae (groupers) and Serraninae (coral trout). As elsewhere throughout the region, humphead wrasse were also targeted.

The most sought-after species was the humphead wrasse, followed by baramundi cod. Humphead wrasse were sold in the Hong Kong market at between 90,000 and 360,000 rupiah per kg, depending on the quality and size of the fish. The prices had been increasing steadily over the previous five years. At the end of the survey the price of this species was about to increase again, by close to 30%.Subsequently prices for live reef fish increased greatly in terms of rupiah, but dropped in terms of US dollars due to the Asian economic meltdown and severe rupiah devaluation (Pet & Pet-Soede, 1999).

Humphead wrasse were reportedly rarer in 1997 than 5 years earlier. Moreover, whereas maximum size for freshly caught wrasse was about 45 kg in the early 1990s, by 1997 25 kg was the greatest size obtainable according to fishers.

Recently attention had shifted more toward the groupers and coral-trouts, because divers had discovered that during spawning the groupers would aggregate in large numbers and were then much easier to catch (see Johannes, l997).

Catching methods can be classified according to the gear used, as follows.

- **Hand nets.** The fish were be chased and caught underwater by divers. Sometimes catching was done at night, using torches (flashlights) to spot the sleeping fish. Netting was considered effective for all species, including Napoleon wrasse.

- **'Bubu' (bamboo traps).** The traps were sunk to a depth of 7 to 20 metres and left for an unspecified time before checking. Traps could also be sunk to as deep as 30 metres but this would require divers with compressors, which only exporters could afford[3]. Bubu were not considered ideal for catching Napoleon wrasse and groupers because they were not specific enough for those species.

- **Handline.** This was the principal method used according to local fishers (who were not necessarily associated with fishing ventures). It was considered effective for most groupers, but risky for the humphead wrasse, which were prone to damaging themselves when hooked. In addition, larger ones are very strong and hard to land.

- **Poison.** The poison used was primarily potassium cyanide, which was water soluble. The solvents were kept in plastic bottles and once the fish was located and cornered the content was squirted to stun the fish.

I observed cyanide tablets being sold under the counter at some traders' shops in Banggai Island. In addition, a holding cage employee and a middleman both said that the Hong Kong vessels sometimes carried cyanide tablets for local distribution. More recently other poisons had been used, including 'tuba' roots (probably from the angiosperm *Derris* spp.) and a mixture of detergent and tobaccos, all of which were believed by the user to be less potent and environmentally less destructive than cyanide. In Eastern Indonesia the 'tuba' root is a traditional poison, widely used to catch fishes for local consumption long before cyanide fishing was introduced.

Floating cages and the catching operations

Live reef fish were occasionally obtained from local fishers, and more rarely from middlemen. But the main source was from the export company's own catching operations. At the base of operations were the floating cages. Associated infrastructure typically included a base camp, a 15 ton wooden boat which served as carrier skiff, several 4–5 m fiberglass speed boats and one or two diving compressors. All boats were equipped with fish holding boxes in their hulls. The floating cages consisted of wooden planks and nylon nets, tied to plastic drum buoys. One holding pen usually included 4 to 8 cages measuring 3 by 3 by 4 metres.

The cost of the infrastructure was estimated to be in the range of 50 to 100 million rupiahs. Based on interviews with two divers it was possible to figure at the typical cost of setting-up and operating a floating cage. Assuming that the floating cage had a team of five divers, each of which could locate and catch fishes on their own, monthly costings would be (mid-1997 prices, in Indonesian rupiahs).

Approximate costs for live fish collecting, borne by the exporter

- Floating cage (including wooden planks, plastic barrel and nylon nets) approximately @ Rp. 7,000,000
- 5 speed boats @ Rp. 200, 000
- 5 outboard motors @ Rp. 3,000,000
- 5 sets of skin diving equipment @ Rp. 400,000
- 15-tonne boat with diesel engine @ Rp. 10,000,000
- diving compressor and hose @ Rp. 20,000,000

3. Editor's note: Compressors are not truly essential to set traps at these depths, but are preferred because they enable positioning the traps optimally, and piling coral on top of them to secure and camouflage them.

- potassium cyanide, 2 kg for one month of operation diver's salary @ Rp. 150,000
- Fuel, each speed boat @ Rp. 200,000 per month

The above costing excludes packaging and shipment charges, as well as marketing fees.

Typically the boats went out together for as long as two weeks. Each speed boat would be manned by one or two divers. One man would drive and the other spot fish. If the diver was experienced enough, he would do both tasks as well as the diving itself. Sometimes one diver would chase the fish through a coral tunnel while the other waited on the either side, with a net in hand. Poison was considered by fishers associated with the camps to be an important tool due to its high efficiency, and the 'bubu' traps were only second to this.

Table 1. **Prices for the main species weighing 1–5 kg**

Species	Local price (rupiah)
Cromileptes altivelis Baramundi cod, 'Sunu tikus'	10,000 to 15,000
Plectropomus maculatus Spotted coral-trout	10,000 to 12,000
Plectropomus leopardus Leopard coral-trout, 'Sunu'	10,000 to 12,000
Epinephelus spp. Rock-cods (including *E. fuscoguttatus*) or flower- cod, 'Krapu'	7,000 to 10,000
Cheilinus undulatus Humphead (or Maori or Napolean) wrasse 'Maming', 'Langkowe'	12,000 to 15,000

Upon transport to and transfer to the holding pens, the fish were weighed by the divers. The air bladders of some fish had to be punctured (see Johannes and Riepen (1995) for details). Use of antibiotics was not observed.

Interviewed divers and exporters suggested that 10 to 50% of fish died between the point of capture and export shipment. Humphead wrasse were said to be more durable than serranids.

Profile of the players in the live reef food fish trade

The buyers were usually from Hong Kong, Taiwan, China, Singapore or Japan.

The exporters typically owned and operated their own floating cages, and employed their own imported divers. An operation in Bangkurung Island was known to have employed as many as 30 people on site. Dependency on middlemen and local fishers existed but this was kept to a minimum. Exporters did not rely entirely on the LRF trade, but typically ran other businesses as well.

The divers employed by the fish camps were mainly Bajonese and Butonese, most of whom had settled in the Banggai islands. Some were employed as full time members of the collecting team; they received salaries and bonuses and all of their equipment (including 'bubu', speed boat, fuel etc.) was supplied. Alternatively, some worked on commission, being loaned all equipment but receiving no salary.

Four middlemen operated in the Banggai Islands, fewer than half the estimated number of exporters. Their holding pen operations were less professional than those of the exporters. As a consequence, they said, they experienced higher fish mortalities, and much lower profits.

Handlining was the main method used by Bajonese fishers who sold to LRF buyers. Ten years ago these fishers systematically targeted fish for the LRF trade. But due to the increasing scarcity of the latter, attention then shifted back to pelagic fishes. Fish that were not saleable to the LRF operators were sold at the local markets, sometimes as far away as Luwuk. The average income for these fishers was of the order of Rp. 50 000 per week at the time of the interview.

Law and enforcement

In 1995, three decrees from two governmental departments were issued to regulate the LRF industry. The Minister of Agriculture issued a decree (Surat Keputusan Menteri Pertanian Nomor: 375/KPTS/IK.250/5/95, dated 16 May 1995), which restricted the catching of humphead wrasse, whereas the Minister of Trade prohibited the export of this fish (Surat Keputusan Menteri

Perdagangan Nomor: 94.KP/II/95, 24 May 1995). This decree also claimed sole authority for trade in this species, in that exemptions could be made off the discretion of the Ministry of Trade, without even mentioning the Ministry of Agriculture. Later in the year, the Directorate-General of Fishery (under the Minister of Agriculture), issued a decree (Surat Keputusan Direktur Jendral Perikanan: Nomor: Hk 330/DJ.8259/95, dated 6 September 1995) which regulates the methods, sizes and locations for catching the humphead wrasse. In Central Sulawesi, the regulations were further elaborated by means of a provincial decree by the Governor of Central Sulawesi Province in 1996, which included the following points:

- Humphead wrasse could be caught only by scientists undertaking research, subject to permission from the Directorate-General of Fishery as well as the (Central Sulawesi) province's Fishery Office, or by traditional fishers with permission from the provincial Fishery Office.
- Registered fish cage ventures, that is those having a Fishing Venture Permit from the DG of Fisheries, could obtain live fish only from the traditional fishers, under a cooperative arrangement, in order to use these fish as parental stock for cultivation [sic].
- The LRF venture must be equipped with captive breeding facilities and employ breeding specialists.

The province's Fishery Office was authorised to issue catch permits and to decide where the fishing may take place, taking into account the carrying capacity of the chosen fishing ground(s).

Only fish with weight in the range of 1 to 3 kg were allowed to be traded, domestically or for export. Fish of sizes outside the range allowed for the LRF export trade could be traded domestically to breeding ventures. Gears allowed for catching live fish were limited to hook and line, 'bubu' and gill net. (Dipnets must have been meant here, since gillnets would be totally inappropriate.)

Although some motivated personnel were employed in the Banggai District's Fishery Office in the Investigations Unit, full enforcement of the regulations was impossible, given the understaffing.

Judging by my interviews and observations, violation of the regulations occurred routinely. The fish cages still operated their own collections and depended very little on the local fishers. The size limit for humphead wrasse appeared to be ignored by at least one large venture. Cyanide appears to have been used in all the fish cages visited. No evidence was observed that any of the fish cage venture farms attempted captive breeding programmes as required by the regulations.

Practically all interviewees understood that destructive fishing was outlawed by the government. However, few in the industry seem to have understood the environmental link between destructive methods and declining reef resources. Within the past few years, though, resident fishers have begun to relate cyaniding operations to coral damage and the death of non-target fish and invertebrates. Cyanide and dynamiting were thought to be equally destructive.

The most effective law enforcement against destructive fishing, according to both fishers and exporters, appeared to be the joint (or integrated) patrolling operations, which included local Police and Fishery officers and were led by the Navy. But given that the nearest Navy base was in Kendari (SE Sulawesi) the patrols were not frequent enough.

Discussion

Decrees from Ministry of Agriculture (MoA) and Ministry of Trade (MoT) concerning humphead wrasse were contradictory, and confusing. Whereas the MoT prohibited export and claimed sole authority for trade of this species, the MoA allowed catching under certain conditions. If the fish were caught only for export, local consumption would not be profitable, making the MoT's exporting prohibition difficult to implement. Although the MoA (c.q. DG of Fishery) cited the MoT regulation ('no export') as its legal reference, it did not follow up, and suggested measures that would lead to good exporting possibilities instead.

Government figures show the total LRF catch in 1996 was 400 tons. My estimate for 1997, based on surveying the fish cages, suggests a catch for that year of between 30 and 60 tons. Although 1996 was probably a better fishing year and covered a total area perhaps twice the size of the Banggai Islands, the difference is difficult to explain. Figure 1 shows the annual catch rates between 1991 and 1996

The overall picture of life fish trade fits the broader pattern drawn by Johannes and Riepen (op. cit.) and Erdmann and Pet-Soede (op. cit.), especially the methods for fish catching and keeping. The mobile nature of the trade and infrastructure was further illustrated by this study. Furthermore, as in the previous studies, this study identified that fish mortality was a major problem.

This study also highlighted several things that are important for LRF trade monitoring efforts:

- Firstly, the current structure of the LRF trade is relatively simple, involving mainly exporter and buyer.

- Secondly, humphead wrasse in particular appeared to be exclusively an export item; this species was not known to have a good local market.

- Thirdly, Johannes and Riepen's (1995) concern that collapse of the fishery would happen three to five years after their study was supported by this survey, especially given that statistics for the whole Luwuk Banggai district already suggested occurrence of the boom and bust pattern. Other indicators of overexploitation were apparent from this study: at least two (of the ten large) floating cages have been abandoned or moved to other regions. The fishermen had actually complained about the decline of the reef stock during the last three years, and alleged cyanide use as the cause. The maximum size of the humphread wrasse catch had been decreasing and the divers indicated that they have had to collect increasingly farther away than before, to the Bowokan group south of Banggai, for instance. That middlemen were few and decreasing might also indicate the business has not been so profitable.

- Fourth, overexploitation will affect the fishermen more than any other group. They are not as highly mobile as the others in the trade, nor able to switch to other venture(s) as readily.

The LRF industry is a classic example of unlimited entry. Careless use of technology and the driving forces of the cash economy have intensified the problem. As the market failed externalities arose so that the fishers did not make a good profit but had to bear the environmental cost of the industry.

As pointed out by Johannes and Riepen (1995) there seems to be 'nothing inherently wrong, environmentally or socially with supplying the demand for live reef fish', but the observed state of the fishery warrants careful managerial considerations. What are the management options for the LRF trade in Banggai?

If nothing is done the decline will probably continue until the business expires. The fish stock may or may not recover. If something is to be done, the following actions are needed.

More frequent patrols by the integrated team, led by the Navy, should be encouraged. This should be a high-level policy approach to which the Chief of Staff must be personally committed.

Research for captive breeding and business investment for mariculture should be encouraged. Some species of groupers can now be raised from the egg, but many other species, including humphead wrasse, are not yet raised from the egg on a commercial basis. Efforts should be concentrated on the humphead wrasse. The currently unpolluted Banggai islands offer plenty of first class sites for breeding.

NGO presence would be useful for local capacity-building of the fishers. There have been no conservation-oriented NGOs in the whole district. Aside from helping the local communities to empower themselves, NGOs would be able to review and advise on ongoing marine resource use. They could also help to raise awareness of conservation needs and sustainable use, as well as helping the local communities to diversify their marine harvest, identify alternative livelihoods and recognise the concept of externality.

Fishers should be encouraged to assume the role of fish wardens. The inclination is already present; in the island of Timpaus (South of Banggai), for instance, the local people have been known to throw bombs at fish bombers.

References

ERDMANN, M.V. & L. PET (1999). Krismon & DFP: some observations on the effects of the Asian financial crisis on destructive fishing practices in Indonesia. SPC Live Reef Fish Information Bulletin 5: 22–26.

ERDMANN, M.V. & L. PET-SOEDE. (1996). How fresh is too fresh? The live reef food fish trade in Indonesia. Naga (19) 1: 4–8.

JOHANNES, R.E. (1997). Grouper spawning aggregations need protection. SPC Live Reef Fish Information Bulletin 3: 13–14.

JOHANNES, R.E. & M. RIEPEN. (1995). Environmental, economic, and social implications of the live reef fish trade in Asia and the Western Pacific. The Nature Conservancy, Jakarta, Indonesia.

HARBORNE, A., CHURCH, J., RAINES, P., RIDLEY, J., RETTIE, L., & R. WALKER. (1997). The Banggai Islands Conservation Project, Central Indonesia: 1996 summary report by Coral Cay. Yayasan Pengembangan Sumber Daya Laut and the Ministry of Environment (unpublished).

PET, J.S. & L. PET-SOEDE. (l999). A note on cyanide fishing in Indonesia. SPC Live Reef Fish Information Bulletin 5: 21–22.

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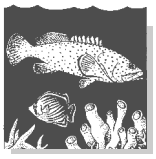

Grouper aggregation protection in proactive Pohnpei

by Kevin L. Rhodes [1]

Overfishing has been implicated in the disappearance of grouper aggregations worldwide, including the U.S. (Gilmore & Jones, 1992), Australia (Domeier & Colin, 1997), Belize (Carter, 1989), Mexico (Aguilar-Perera & Aguilar-Davila, 1996), the Caribbean (Olsen & LaPlace, 1978; Colin, 1992), western Atlantic (Sadovy, 1993) and Indo-Pacific (Wase[2], pers. comm.; Johannes *et al.*, 1999).

In the western Atlantic and Caribbean, overfishing has primarily been by local fishermen, whereas in the Indo-Pacific the driving force has generally been (directly or indirectly) the Hong Kong-based live reef fish trade (LRFT). Aggregation overfishing in the Indo-Pacific by locals for local consumption and sale, however, is less documented, but was recently observed by the author in Pohnpei, Micronesia, during a biological survey of marbled grouper (*Epinephelus polyphekadion*).

Until the 1960s, Pohnpei had fished aggregations under the traditional customary marine tenure system (CMTS) (Martin[3], pers. comm.). Under the CMTS, only one or a few master fishermen were allowed to venture to outer reefs where grouper aggregations typically occur. Catch was limited to the small number of fish needed to feed the clan or municipality for a brief period, which by nature conferred a reasonably high level of conservation on spawning stocks (Johannes, 1978). However, after the 1960s, the CMTS gradually dissolved, such that fishing pressure on aggregations increased as access to sites throughout Pohnpei became open (Ioanis[4], pers. comm).

By 1997, an unabated increase in aggregation fishing pressure for local sale and consumption and reports of illegal destructive aggregation fishing by Pohnpei's only licensed LRFT operator (Kingfisher Marine Products, Inc., Hong Kong) spurred the Pohnpei Department of Resource Management and Development (DRMD) to pass its first legislation directed at grouper conservation by limiting the impacts on aggregations. Under this new law, commercial catch and sale of grouper were prohibited during March and April, although catch was allowed for subsistence, i.e., personal sale and consumption. At the same time, the DRMD developed two new marine sanctuaries at two known spawning sites: (1) at the largest known site (hereafter, Site A) for marbled grouper, dusky grouper (*Epinephelus fuscoguttatus*), and coral trout (*Plectropomus areolatus*), and (2) the second at nearby Oroluk Atoll.

In 1998–99, however, a survey of spawning sites in Pohnpei found that aggregations at Site A form outside the ban period (March–April in 1998; February–March in 1999) and that marbled and dusky grouper aggregations lay just outside sanctuary boundaries (up to 400 m).

Between 1997–99, fishermen exploited this situation and over a seven-day period in February 1999 captured an estimated total of 4,000 individuals, roughly equivalent to one-third of the aggregation. Poaching was also observed frequently during the ban period in 1998, due to a shortage of conservation officers within the DRMD.

1. University of Hong Kong, Department of Ecology & Biodiversity, Hong Kong
2. Danny Wase, Director, Marshall Islands Marine Resource Authority, Interview, July 1997.
3. Valentin Martin, Chief, Pohnpei State Department of Marine Resources, Division of Coastal and Marine Resource Management, Interview, July 1997.
4. Benito Ioanis, Statistician, Pohnpei State Department of Marine Resources, Division of Coastal and Marine Resource Management, Interview, July 1997.