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LIVE REEF FISH

The live reef fish export and aquarium trade

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INFORMATION BULLETIN



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Editor's mutterings

The APEC-sponsored conference on destructive fishing held in Hong Kong in early December 1997 produced some noteworthy papers on the live reef-fish trade. Revised and updated versions of two of them are presented in this issue. (Recommendations arising from the meeting had not been finalised in time for this issue, so they will appear in the next issue.)

At the workshop, Yvonne Sadovy predicted that ciguatera (a kind of toxin that makes reef fish poisonous to human consumers) was likely to become a problem in Hong Kong sooner or later (see her ciguatera article, this issue, p. 51). It proved to be sooner; within weeks an outbreak occurred, with over 100 hospital cases (see her appendix to the above article). Consumption plummeted along with prices.

This was not the only cause of reduced consumption in Hong Kong, however. One of the major figures in the Hong Kong live reef food-fish trade told me at the workshop that Asia's economic dive was taking its toll on the demand for live reef fish. His company supplies live reef fish to a hotel chain over the Chinese new year period, a time of many banquets and much consumption of live reef fish. This year, he said, the hotel chain ordered 40 per cent fewer fish than it did last year at this time, anticipating a major slump in demand because of the plummeting Hong Kong stock market.

Another paper given by Lida Pet-Soede and Mark Erdmann at the workshop provided a lot of food for thought. Among their interesting conclusions (see their article in this issue, p. 28) is that, in at least some parts of Indonesia, fishermen are making an extremely good living from the trade, which is driven more by 'greed than need'. They also speculate that repeated use of cyanide by aquarium fish collectors in an area is more likely to

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cause serious damage to reefs than typical live reef food-fish cyaniding operations. In addition, they provide evidence that, as predicted, target stocks are rapidly diminishing in Indonesia, and that as they decline, fishing methods appear to evolve from (a) cyanide fishing, to (b) hook-and-line and trap fishing, to (c) trap fishing for juveniles for grow-out, to (d) an 'almost post-apocalyptic' no live reef fishery at all.

Ignorance of the most basic procedures for handling and holding fish seems to be the rule rather than the exception among live reef food-fish operators in Indonesia, the Philippines and the Pacific Islands. Improper decompression of fish brought up from deep water continues to damage fish unnecessarily. Fish are often much too crowded in holding pens. Diseased fish are not quarantined. Antibiotics are not used properly. Feeding is often haphazard and feed quality is poor. Water quality is poor. Because the industry is made up of many small, competing companies, there is little incentive for good operators to disseminate their knowledge.

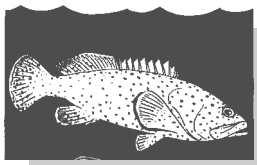
Such bad practices help explain why there are so many reports of high to very high mortalities in the trade. This is not just harmful to the companies involved; every fish that dies before it reaches the plate means that an additional fish is needed to sat-

isfy consumer demand. If efforts were made to educate the industry everyone would benefit—including the fish.

Recent experience in some Pacific Islands shows that governments should give their fisheries departments the primary responsibility for granting permits for live reef-fish operations and ensure that department personnel are trained appropriately. If other agencies, such as foreign investment boards, are given the responsibility, they run a much higher risk of promoting activities that are harmful economically and environmentally because of lack of familiarity with the pitfalls of the trade. Fisheries departments should be trained in appropriate licensing procedures and, in turn, should assist traditional fishing rights owners in negotiating fair contracts with LRF companies.

How many times have we heard that humphead (Maori, Napoleon) wrasse must be caught with cyanide because they cannot be caught with hook and line. I am convinced that at least some of the fishermen who say this actually believe it. Can anyone explain how this unfortunate myth arose?

R.E. Johannes



Letters to the Editor

The Live Reef Fish Information Bulletin welcomes 'Letters to the Editor'. This column may be useful for those who have something to say but don't want to write a full-length article, or who wish to comment on previous material in the bulletin. We start this column with a letter from Peter Doherty.

Poodle-mania

In the second issue of this bulletin, you expressed concern about the paucity of information available on the biology and ecology of the largest reef fishes. I share some concern for what we do not know about these charismatic stocks, but I do not blame this gap upon 'poodle-mania'. You lambasted a literature replete with work on small, territorial, demersal-spawning species, which you designated as atypical and insignificant taxa. You questioned whether convenience had triumphed over relevance and implied that ecologists were shirking a moral imperative to research the species most at risk of overexploitation.

A contrary case can be based on the poor sampling characteristics of animals that are often mobile, or cryptic, and rare. These attributes limit the power of surveys and contraindicate destructive sampling, although much critical information about fish demography is only available post-mortem. The absence of direct information need not paralyse managers and conservationists, however, given the strength of the arguments that can be established by analogy, especially when interpreted in the context of the 'precautionary principle'. My main point, of course, is that small reef fishes are suitable analogues for their larger relatives.

Damselfishes are the laboratory rats of reef-fish ecology. Their abundance and easy access facilitates intensive study, allowing understanding based on manipulation and falsification. They have provided the opportunity for two generations of students to gain a close and holistic understanding of the dynamics of wild reef-fish stocks; a situation that is qualitatively different from the training and work experience of many fisheries biologists who have access only to industry catches. Damselfishes have inspired novel techniques and new ideas.

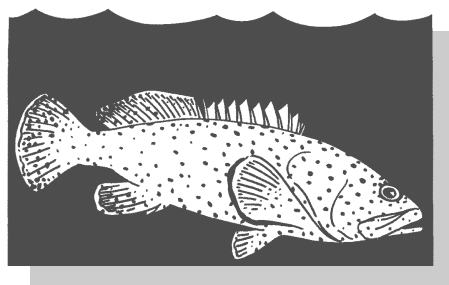
One surprise from the study of damselfishes has been their longevity: 20 years, matching many of the larger species. Despite the potential of sedentariness and territorial behaviour to produce density-dependent feedback and population regulation, variable replenishment has been shown to have stronger influence on abundance at reef-wide scales. Environmental forcing of recruitment in long-lived species is a characteristic that has contributed to past collapse of temperate fish stocks, and emphasises the central importance of replenishment to sustainable fishing. Recent work has confirmed the same phenomena in the dyna-

mics of large commercial fishes taken from the Great Barrier Reef.

We do not need further research to know that *Cheilinus* and the largest serranids have life histories that make them vulnerable to overfishing. Even if it were desirable, the scale and economies of coral reef fisheries in the Indo-Pacific will not support sophisticated management regimes that might demand accurate determination of biological reference points and detailed monitoring. Instead, the recruitment function may be protected best by quarantining adequate broodstock within no-fishing zones. For obvious reasons, networks of marine protected areas will not be designed on data about the larval dispersal and recruitment of large rare species. Instead, the job will continue to be done on the basis of knowledge gained from the poodles and their close relatives. In this task, we are fortunate that there are not separate ecologies for small and large fishes.

Peter Doherty

Australian Institute of Marine Science



info
live reef fish

Turning the poison tide: The International Marinelifers Alliance's Cyanide Fishing Reform Pilot Program in Indonesia

by Charles Victor Barber, World Resources Institute, USA
& Ferdinand P. Cruz, International Marinelifers Alliance, Philippines

A poison tide threatens the Amazon of the Oceans

The coral reefs of Indonesia number among the most important on the face of the earth. Covering some 75 000 km², Indonesia's reefs constitute one-eighth of the world's total and lie at the very centre of global marine biodiversity. Hundreds of thousands of small-scale fishers rely on reef fisheries for a living. Their potential for dive tourism, barely tapped, is immense.

Unlike the Philippines, where cyanide fishing was invented for the aquarium trade in the 1960s and grew to encompass the Hong Kong-based live food fish trade in the late 1970s, large-scale cyanide fishing is a relatively recent phenomenon in Indonesia. But beginning around 1990, live-fish operators moved aggressively into Indonesia, seeking new sources to replace depleted Philippine stocks and feed a growing market fuelled by the booming East Asian economies (Johannes & Riepen, 1995).

At the present time, an out-of-control live reef fishery based on the use of cyanide threatens reefs across Indonesia, compounding damage from blast fishing, coral mining, overfishing, and runoffs of sediment and pollution. More than 50 per cent of the wild-caught live food fish in international trade are thought to originate from Indonesia (Johannes & Riepen, 1995). The aquarium fish trade is also immense and growing, with at least 4000 fishers thought to be involved, although accurate estimates are hard to come by (Cesar, 1996). Cyanide is thought to be used by the vast majority of live-fish operators—a survey inquiring about the extent of the live fish trade and the use of cyanide sent out by the Worldwide Fund for Nature Indonesia Programme to non-governmental organisations and university researchers around the country in 1996 elicited depressing results. In more than a dozen regions, observers on the ground responded that the trade was booming, and that cyanide was an integral part of it (Barber & Pratt, 1997).

Discussions about stopping cyanide fishing in Indonesia tend to draw expressions of helplessness, resignation and fatalism from government officials, international aid agencies and big environmental groups. 'Indonesia is so vast,' the argument goes, 'there is so much corruption, powerful people are involved, government enforcement capacities are weak, there will never be any way to stop it—but let's have another workshop to talk about it!'

The International Marinelife Alliance – Philippines (IMA) has heard this before. When IMA began its work in the mid-1980s that led to the establishment of the government's Cyanide Fishing Reform Program (CFRP) in 1992, many of the same arguments were made about the Philippines. Some 13 years later, it is true that cyanide fishing has not been completely stamped out in the Philippines. But the CFRP has been effective in significantly reducing the problem, and with increased resources now beginning to flow to the programme from the United States Agency for International Development (USAID) and the Asian Development Bank, there is real hope that even more progress can be made in the next several years.

IMA believes that something *can* be done to reduce cyanide fishing in Indonesia, and has put itself on the line to prove it.

IMA's investigation of cyanide fishing in North Sulawesi

In late-1995, concerned by rumours that Filipino live-fish operators were moving into Indonesia's North Sulawesi province (which is just south of the Philippine island of Mindanao), IMA decided to

conduct an investigation in the area, with support from the USAID-funded Biodiversity Conservation Network (BCN).

In approaching a potential project area, IMA believes that a thorough field assessment of the live-fish trade in the area is a key prerequisite, and that the assessment must be carried out by people with direct, practical experience in cyanide fishing. IMA's investigators are mostly people who themselves were cyanide fishermen or exporters in the past. Fishermen tend to trust them faster, and they cannot be easily fooled—they have been there. Secondly, a good investigation requires a committed local partner with access to information that is often difficult to get, such as the identities of key exporters and boat owners and the locations of cyanide fishing grounds and fish-holding cages.

At the outset, the investigation in North Sulawesi was a bit of a cloak-and-dagger operation, with the IMA investigator staff hot on the trail of Filipino cyanide divers working the waters in the areas of Minahasa District (*Kabupaten*) and operating out of the provincial capital of Manado. First off, IMA needed to gather basic information: In what specific areas where these modern-day ecological pirates collecting fish? How many Indonesian fishermen were working with them? Who were the exporters, and by what routes were they getting the catch out of the country? These Filipino divers and their boss were aware of IMA's strong campaign in the Philippines against use of cyanide. Keeping the fact that he was from IMA under wraps, the investigator found it easy to befriend the Filipino boss of the operation and his employees, who were initially glad to meet a countryman with whom to pass the time over a few beers one night.

Both the boss and his divers, it turned out, were well aware of the Cyanide Fishing Reform Program in the Philippines and the Cyanide Detection Test Labs and monitoring activities that IMA operates under contract from the Bureau of Fisheries and Aquatic Resources (BFAR) as part of the programme. They complained that the CFRP was a big hindrance to their highly lucrative business. But here in Indonesia, they said, there were no such obstacles. 'It only takes money to solve the problem of legality' in Indonesia, the boss told IMA's investigator.

This Filipino operator, it turned out, was running a widespread cyanide fishing operation, stretching from Manado on Sulawesi's northern tip all the way to Ujung Pandang, in the far south of the huge island. Learning fast that it pays to have a partner skilled in navigating the complex and often corrupt local government bureaucracy, the Filipino had

brought an Indonesian businessman from Manado into his operation. Working together, they were able to capture large volumes of groupers and Napoleon wrasse. Indeed, the harvest was big enough that the partners chartered Hawker Sedely aircraft—each plane capable of carrying ten tons of cargo—to transport their cyanide-caught catch to Manila. From there the Filipino operator moved the fish on to the booming Hong Kong market. IMA's investigation also discovered that several other smaller cyanide-fishing operators were working the area, shipping their catch through Bali and Jakarta rather than Manila. Since exports of Napoleon wrasse from Indonesia are restricted to those smaller than three kilograms, the operators were routinely mislabelling the wrasse as groupers.

The investigators also heard numerous stories of large 'mother ships' to which a fleet of smaller cyanide fishing vessels would bring their fish. Once its live well holding tanks were full, the ship would return to Hong Kong. One such ship from Indonesia was photographed and filmed by IMA in August 1996 while unloading in Hong Kong. Aboard were some 8 t of Napoleon wrasse and an additional 12 t of various grouper species (Barber & Pratt, 1997).

Most disturbing, the IMA investigators were told by the Manado cyanide fishermen that they had been systematically introducing the cyanide fishing technique to new areas of North Sulawesi province and to part of adjacent Central Sulawesi province. In the Banggai island chain of Central Sulawesi, for example—an extensive coral reef area rich in stocks of grouper, Napoleon wrasse, and rock lobsters—fishermen had been recently taught how to use cyanide and supplied with the poison by exporters.

In short, the live fish operators were running a mirror image of IMA's CRFP—working with communities to systematically convert them to the use of cyanide.

The Filipino exporter who had shared beers and trade secrets with an IMA investigator eventually found out that IMA was on his trail. Soon, he packed up and went back to the Philippines. But the damage had already been done—Indonesians had proven quite adept at cyanide fishing, and were fully capable of spreading the technique without Filipino assistance.

IMA's Cyanide Fishing Reform Initiative at Tumbak, North Sulawesi

IMA felt it had to act. But how and where? With what local partner? As a Philippines-based organisation new to Indonesia, IMA felt strongly that it could not move beyond investigation to working with fishing communities without a local ally, and clear support from members of the target community. Discussions with a sympathetic Manado dive operator concerned about the destruction of the province's reefs—which are world famous in diving circles—let to a strategy. The dive operator, it turned out, was also a leader of Primkoveri, the provincial cooperative of military veterans, and Primkoveri became a key local partner.

One of the areas where IMA had investigated the local live reef fishery—in this case, for aquarium fish—was a village called Tumbak, on the south coast of North Sulawesi province, about three hours by road from Manado. Ringed on three sides by the sea and backed by mangroves, Tumbak is virtually surrounded by water. Its 135 hectares of land are unsuitable for agriculture, and its 257 families (nearly 1200 people) all gain their living from the sea. Net, spear and hook-and-line fishing, collection of marine invertebrates (molluscs, sea cucumbers, lobsters, etc.) and seaweed farming are all important parts of the local economy. But the live-fish trade has played a growing role in recent years. In early 1997, the buyer who held the local monopoly on the trade reported that he was shipping six-to-eight thousand aquarium fish from Tumbak *every week*—more than 120 fish per family per month (Pollnac et al., 1997).

With support from Primkoveri and initial funding from the Worldwide Fund for Nature Indonesia Programme, IMA began a dialogue with Tumbak fishermen to assess their interest in learning the barrier net method for collecting aquarium fish¹ and receiving assistance in marketing their catch.

IMA also conducted a survey to better understand the lives and interests of the fishermen who would be trained. Initial responses were favourable—a number of the fishermen expressed interest in learning the new method for catching aquarium fish as an alternative to using cyanide.

In July 1997, an IMA training team including two new Indonesian trainers recruited in Manado

1. The barrier net method of capturing live aquarium fish involves setting up a wall-like transparent net around the perimeter of the target coral area. The collector then scares the fish with sound or movement, and they instinctively dart back in the direction of their coral refuge. The barrier net, however, denies the fish access to coral crevices, giving the collector enough time to harvest them with scoop nets and specially-designed buckets with fine-mesh, zippered net tops. Unwanted fish are released, and the reef is left virtually undamaged.

began a formal training programme for 50 aquarium fishermen. The programme was inaugurated at a village ceremony featuring some 600 people from the village, a local brass band, speeches from numerous local and provincial officials, Primkoveri, IMA, and a visiting group from the World Resources Institute, a Washington-based policy-research institute with whom IMA has been collaborating for several years in developing an Asian regional cyanide-fishing reform programme.

The first few days of training with the Tumbak fishermen were tough. For one, there was the language barrier. IMA staff had to coordinate with an Indonesian interpreter who was heavily involved during training and lectures. Secondly, the fishermen lacked proper and safe equipment. Their regular gear consisted of make-shift bamboo goggles which easily filled up with water, made it difficult to see underwater, and thereby limited dive time. They dove wearing only their underwear.

Soon however, when the fishermen-trainees saw that they could catch as many or more fish with a barrier net, they embraced the new technology. Immediately they recognised that barrier net collection reduced fish mortality rates. After three weeks of training and their first successful shipment, the fishermen were pleased with their new technology and were willing to keep using it.

At present, IMA has helped the fishermen organise an association through which they have linked to buyers in Europe. No longer dependent on one middleman, they are able to obtain better prices for their fish. And with IMA guidance, they are now capturing some 35 species, where previously they only captured and sold five species.

Reduced mortality in the capture and post-harvest process, lack of by-catch (non-target fish killed by cyanide on the reef), and a wider variety of target species (meaning less pressure-per-species) mean that a clearly unsustainable fishery has been replaced with one that is certainly far more sustainable. More studies need to be carried out to determine what the maximum sustainable yield is for the Tumbak live reef fishery, but whatever that level may be, the barrier net training programme has moved Tumbak a long way towards meeting it.

The struggle to reform the cyanide fishery in Tumbak is not over, of course. More training and continuous monitoring are needed to ensure that the barrier net tradition is firmly implanted in the village's values and traditions. And the association needs long-term assistance in managing its relationship to the international market for optimum advantage. USAID's ongoing Coastal Resources Management Project is providing support for some

of the follow-up activities, and IMA is working with WRI to identify other sources of longer-term funding to ensure that the work thus far at Tumbak endures into the future, and to expand the project to neighbouring villages where other fisherman are interested in joining.

Thinking ahead to the thousands of villages like Tumbak throughout Indonesia where the same process needs to be carried out, IMA is hoping to utilise Tumbak as a centre for training Indonesian trainers. This will give the prospective trainers real-world experience, and will further institutionalise Tumbak's cyanide-free live fishery tradition. In addition, as IMA and its partners begin to work in other parts of Sulawesi and beyond, IMA hopes to be able to bring fishermen from other areas currently using cyanide to see what the fishermen of Tumbak are doing with their own eyes, and to hear about it from the residents of Tumbak themselves.

Conclusion: Do *not* abandon hope, all Ye who enter Indonesia

IMA concludes from its initial experience in Tumbak that cyanide fishing can be stopped in villages like Tumbak throughout Indonesia. Some will be more difficult, and some may be impossible. In other cases, cyanide fishing is being carried out by large 'mother ships' far from population centres, a situation where repressive enforcement approaches are more important than community-based programmes. But there are plenty of Tumbaks throughout Indonesia, and if just 20 of them in key coral reef areas can be weaned from cyanide, the impact will be considerable.

It is important to remember, too, that once a village is organised and is getting a good income from a sustainable live reef fishery, it becomes much more easy to talk with villagers about reducing other destructive fishing practices such as hunting of sea turtle, blast fishing and shark finning.

IMA will continue to report on progress at Tumbak and at other sites in Indonesia where IMA plans to work with local partners to develop similar programmes. And IMA and its partners in North Sulawesi would welcome others to have a look at what is going on in Tumbak and judge progress and obstacles there for themselves.

There is no magic bullet, and IMA has no illusions about saving the whole world, or even all of Indonesia's coral reefs. But with committed partnerships among NGOs, local governments, donors, and, most importantly, with a clear focus on field-level initiatives founded in trust, respect, and collaboration with fishermen themselves, maybe together we can save at least a piece of it.

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About the authors

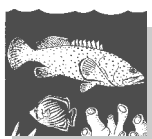
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Together with IMA President Vaughan R. Pratt, he is the author of *Sullied Seas: Strategies for Combating Cyanide Fishing in Southeast Asia and Beyond* (WRI and IMA, 1997). Currently WRI is working with IMA and various other partners to develop an Indo-Pacific Destructive Fishing Reform Program. E-mail: cbarber@mnl.sequel.net

Ferdinand P. Cruz is currently IMA's Indonesia project coordinator. Mr Cruz has been with IMA for four years managing training programmes in cyanide-free capture techniques for live reef fishermen. Prior to joining IMA, he was involved in the live reef-fish export business. His family's firm was one of the first live-fish exporters in the Philippines to promote net capture of aquarium fish as an alternative to cyanide.

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The Haribon Netsman Training Program

The net training programme of the Haribon Foundation was conceived in 1989 as a result of the growing problem of cyanide use and its effects on coral reefs.

In 1984, Steve Robinson, a professional fish collector from the Sea of Cortez, Mexico, returned to the Philippines to participate in a programme to train Filipinos in the use of nets for collecting marine fish. Sponsored by the Environmental Center of the Philippines, a 10-day training course was developed and implemented for two classes of fishermen from Santiago Island, Bolinao and Pangasinan. A third training course was held in Bohol.

Since then, a number of international agencies have shown interest in supporting the net training pro-

gramme. In January 1989, a grant from the International Development and Research Center of Canada was obtained to implement a nationwide training programme. The Haribon Foundation and International Marinelife Alliance Canada were chosen to implement the programme then known as the Netsman Training Program.

Local conditions indicated that training alone was not sufficient to ensure conversion of cyanide users to net use, and that the training programme must be part of a holistic approach that helped steer communities toward community-based coastal resource management. Thus a combination of approaches—community organising, training, and research—was used to effect resource management, with the net training as the entry point to the community.

Operational framework

Community organisers and resource specialists are assigned in the selected sites to persuade the community of the importance of the training project and to meet with cyanide fishermen and their families. Logistical preparations and invitations, courtesy calls to local Department of Agriculture offices, local government officials and exporters are undertaken.

The preliminary social investigation includes identification of participants, visits and meetings with aquarium fisherfolk and their operators and managers, and the conduct of a baseline survey. A questionnaire is used to assess the trainees' knowledge, skills and attitudes in fish collection, handling, packing and diving safety to guide the trainers.

After the preparation phase, the training team visits the area to begin the training proper. A training site is set up for seven days, usually in schools, public spaces, or under the trees. Blackboards, enlarged drawings and slides are used to convey ideas, usually in Tagalog. The theoretical instruction lasts for three days. The next four days are allotted for open-water training exercises where the trainees are taken to the reefs and shown how to use nets, then allowed to try the net method themselves.

As a way of ensuring family and community support for conservation efforts, wives are encouraged to participate in selected activities together with boat operators, barangay officials, and other residents.

After training, participants are evaluated on the basis of attendance, performance in open-water sessions, and written examinations. Before members of the community, each graduate recites an oath to completely stop cyanide use. The list of successful graduates are submitted to the Department of Agriculture provincial office for accreditation.

Post-training activities

Immediately after the training, a community organiser is deployed to continue activities that lead to the formation of local organisations. Core groups are organised, trained and motivated to increase their membership, thereby facilitating wider participation and collective action on community problems. Networks with local, national and international agencies were also established. Due to lim-

ited resources, only three sites in Patnanungan, Quezon, Matalbis, and Palauig, Zambales were selected for intensive organising activities.

After the actual training sessions, the trainers were deployed to different sites to monitor the progress of the trainees. Whenever possible, they went fishing with them, retraining them when needed, or engaged trainees in one-on-one discussions. Catch and effort data were also collected from the trainees.

The feasibility of establishing marine sanctuaries and reserves was also looked into. Local officials were consulted to introduce this concept and gain their support.

Underwater surveys were conducted to check on the recommended sites and to establish baseline information. Marine sanctuaries were set up in San Salvador, Zambales and proposed in Isla Verde, Batangas and Bolinao, Pangasinan.

Training results and evaluation

From 1990 to 1992, 475 trainees participated in 15 training sessions from eleven different sites on the island of Luzon. Of the 176 trainees monitored, 29 per cent were fully converted, 40 per cent remained questionable, and 31 per cent admitted to continued cyanide use but at a reduced rate (50–90% less than their usual consumption) (See Tables 1 and 2).

Factors restraining net use

A number of restraining factors to net use have been identified, highlighting the need to fine-tune assumptions and theories underlying the net training programme, and improve the course curriculum. External factors that contribute to persistent cyanide use are examined so that adequate policy and other forms of responses can be formulated.

Table 1: Post-training monitoring results (Pajaro, 1992)

Training site	Number of trainees	Not using cyanide		Admittedly using cyanide
		Sure	Doubtful	
San Salvador Is.	30	30	0	0
Other sites	146	21	71	54
Total	176	51 (29%)	71 (40%)	54 (31%)

Middlemen and exporters

It is often said that the 'economics of the stomach' is the overwhelming reason that drives fishermen in the Philippines to engage in illegal fishing. In their daily struggle for survival, poor collectors fall prey to middlemen-cum-creditors where money is made available for lending, but under usurious terms. According to fishers interviewed, the use of cyanide is also imposed upon them. These middlemen not only earn from trading fishes but also from peddling cyanide tablets.

These middlemen buy fishes from collectors at very low prices. This drives collectors to catch more fish in order to compensate for the lower prices. Since the collectors have to pay for the boat and the owner's share of the catch, they are forced to adopt means that are expedient and cheap, in order to generate a larger catch and bring home a reasonable sum for their efforts.

Collectors have few alternative channels for selling their fishes except through local middlemen. Otherwise they would have to transport their fishes directly to Manila to avoid them. The temptation to use cyanide is hard to resist under a trading system that imposes low prices, compounded by high costs of operation and inequitable sharing of the produce. This serves to highlight the oppressive trading system faced by the collectors and the need for holistic solutions (other than net training) to eradicate the cyanide problem.

Lack of market incentives

The absence of a price differential for net-caught fishes in the rural areas does not encourage trainees to shift to nets, especially if prices for net-caught and cyanide-caught fish remains the same. Why bother using nets if their catch will be bought at the same price anyway? A price premium for net-caught fish above current prices may convince fishers to shift to net use, but current market forces that operate in the field do not allow for such incentives.

Exporter members of the Philippine Tropical Fish Exporters Association (PTFEA) have banded together to standardise their purchase prices from collectors in the hope of averting price wars among them. Whether there is compliance among their members is difficult to determine. The demand for cheap

Table 2: Variations in cyanide consumption of trainees who admitted using it (Pajaro, 1992)

Number of users	Cyanide use* (in kg)	
	Before	After
15	4–5	0.25–1.5
25	3–4	0.25–1.5
8	2–3	< 0.5

* Calculated for a 5-day fishing trip with 2 divers

Table 3: Fishes identified as difficult to catch with nets

Pomacanthidae (Angelfishes)	
<i>Centropyge bispinosus</i>	Coral beauty
<i>Pomacanthus imperator</i>	Imperator
<i>Centropyge flavissimus</i>	Yellow angelfish
<i>Pomacanthus semicirculatus</i>	Blue koran
<i>Holocanthus venustus</i>	Halfmoon
Serranidae (Groupers, Anthiids)	
<i>Anthias pleurotaenia</i>	Square anthias
Labridae (Wrasse)	
<i>Pseudocheilinus hexataenia</i>	Six-lined wrasse
Gobiidae (Gobies)	
<i>Stonogobiops xanthorhinica</i>	Bamboo spot
Pseudochromidae (Dottybacks)	
<i>Pseudochromis diadema</i>	Diadema
<i>Pseudochromis porphyreus</i>	Strawberry
Plesiopidae (Longfins)	
<i>Callopleksiops altiveles</i>	Cometa

fishes from abroad is huge, and many dealers rake in money by selling cheap fishes which they compensate for through higher inventory turnover. This demand is served by a significant number of Philippine exporters who, by competing on the basis of lower prices and shipping larger volumes, tolerate or even encourage the use of more efficient but destructive methods which cyanide fishing provides.

Difficult-to-catch fishes

For selected species (Table 3), cyanide use is persistent due to higher prices (e.g. imperators, blue koran, etc.) and their elusive nature (e.g. cometa and half moon angels). For higher-priced species, fishermen are driven by the knowl-

edge that if they didn't catch the fish, somebody else would. Fisherfolk with prized catches are able to bargain forcefully with middlemen in negotiating prices and selling their entire stock.

Some fishes (e.g. imperators) were reported by divers to suffer from scale and fin damage when subjected to net capture methods. Their struggle in the barrier nets causes some of their fins and scales to fall off. This deters net-use by some collectors because these fishes, although very healthy, are rejected by exporters for aesthetic reasons.

Lack of enforcement

In areas where local organisations are weak and police enforcement is absent, cyanide use proliferates and continues. This is true in some barangays, where local officials tolerate (and benefit) from the illegal fishing activities in the area. Attempts to conduct follow-up net-use training in these barangays were thwarted by traders, who have a firm hold with the native collectors in the area.

By contrast, a significant number of conversions (100% for 30 trainees) is noted among trainees from San Salvador Island where a community-managed sanctuary is in place and where fishing regulations are enforced by local officials. It is on this site that ongoing community support and enforced regulations sustain the net-use method.

Lack of common property rights

The nomadic nature of fisherfolk does not provide a sense of ownership or 'home' to their fishing grounds. Most collectors in Luzon are migrants from the Visayas, with no sense of ownership or affinity to the marine resources on which they depend, and they therefore lack the motivation to conserve and protect their coral reefs. If an area is degraded, they merely move on. Attitudinal factors such as these are difficult to address in any net training programme.

The theory behind the Tragedy of the Commons (Hardin, 1968) suggests that the open access nature of fisheries or any other common property does not invite self-restraint among fishermen to conserve dwindling resources but rather encourages maximisation of resources for self gain, sometimes by using destructive methods. Similarly, the exclusivity principle in open fisheries suggests that one fisherman's gain is another one's loss, which under game theory is a zero-sum or win-lose game. Under such a scenario, there is no incentive for one fisherman to forego catching a high-priced fish since he knows somebody else will. This drives the fisherman to carry cyanide for 'emergency' purposes. The success of the net training method may be impeded without

corresponding exclusive use rights granted to fishermen to their fishing grounds, which could provide long term incentives to conserve resources.

Lack of nets

Persistence in cyanide use may also be due to the lack of fine-meshed nets of good quality available locally. The knotless, transparent nets which can last for two years are imported from Japan and are not accessible to ordinary fisherfolk. The local variety are less durable, and can last only two months. Fine-mesh net-making was introduced as a livelihood option to the local communities, but proved to be too laborious and an inferior substitute to imported nets. Some exporters who embark on their own net training programmes import and distribute nets to their suppliers.

Recommendations

Enforcement

Current policies on the capture of marine ornamentals need to be enforced more vigorously. Fisheries Administrative Order No. 148 regulates the gathering, catching, taking or removing of marine tropical aquarium fish. The logistical requirements to enforce the law in an archipelagic country such as the Philippines make enforcement virtually impossible. Cyanide detection tests are implemented in airports in selected sites throughout the country. As a deterrent, their reliability needs to be improved so that courts can prosecute on the basis of the evidence that the tests provide.

Penalties for cyanide use must be imposed not only on collectors, but also on their buyers (exporters) who must assume the burden of ascertaining the source of their fishes. As an adaptation of the anti-fencing law, both seller and buyer of cyanide-laced fishes could be punished.

Fair trade

For some time, fishermen, who are the primary suppliers and foot soldiers of a multi-million dollar industry, have been left out in the cold. The prices of their catches are driven by external forces beyond their control, while the traders, exporters and overseas dealers make vast sums of money. Until now, these collectors remain poor and marginalised and have to suffer the disdain of other fishing groups, local officials and NGOs who label them as 'killers of the reefs' within their community. They have to contend with local bans, which forces them to seek their livelihood elsewhere.

Fair trade brings collectors to the decent footing that they deserve. By forming local cooperatives

and linking themselves to lucrative markets, fishermen can be rewarded adequately and be motivated to conserve the reefs. Fishermen are entitled to the equitable sharing of the benefits from resource use alongside the traders, exporters and hobbyists.

Price competition

Competition based on quality and healthy fishes is a better business strategy, as it drives fish prices upwards, and that will benefit the industry (and the net fisherman) in the long run. Hobbyists and fish importers must realise that competition to sell more fishes cheaply regardless of quality cannot continue, as this drives the use of destructive methods of fish collection. Some exporters encourage the use of cyanide as it enables them to sell fishes more cheaply and in greater volumes to the market.

Eco-labelling

Eco-labelling schemes should be encouraged to differentiate net-caught fishes and establish a firm market niche. This entails monitoring of fishes from the collector to the exporter and establishing the paper trail to document the fishes to the point of shipment. However, the use of accountable forms are non-existent in the provinces, where most traders operate informally, often without receipts and proper documentation of fishes traded.

Resource management

The conservation status of the fishery resources has long been ignored, and does not enter into the economics of the aquarium industry. The depletion of fishery stocks may lead to local extinction, reducing local marine biodiversity. Evidence of local extinction for certain species (blue tang, majestic angel, blue faced angels) was noted by local collectors in Luzon.

The establishment of marine reserves and sanctuaries ensures that fishery habitats are conserved for the benefit of future generations. The monitoring of fishery stocks should be continuously undertaken to facilitate managing the resources effectively.

Education

Education to the net method should be expanded to bring the technology within reach to as many collectors as possible, especially in remote areas. Many collectors are not aware of the technology that is readily available.

Regulation

Left on its own, the trade will continue to exploit the fishery resources in an unsustainable manner

as reef destruction from cyanide use and overfishing continues. A purge of the industry is needed as well as a re-accreditation process for exporters and collectors. Exporters should be required to install appropriate aquarium systems that meet the highest standard of operations of fish husbandry. Their staff must meet the technical knowledge and skills requirements to operate and maintain a holding facility. Fish collectors must be trained in net use before a permit to collect is given by the Bureau of Fisheries. Fish exporting countries such as Palau and Australia have progressive laws which govern their aquarium industry. Compliance with established standards is monitored closely by their fishery agencies.

Conclusion

The cyanide issue underscores the interrelatedness of other issues where holistic (not bandaid) solutions are needed. This requires the cooperation of all concerned agencies and stakeholders.

The success of the net method relies on shifting incentives to net use combined with other remedial measures, most important of which is the strict enforcement on the use of poisonous substances. Without the latter, there will be little conversion from fishermen to more friendly methods.

It is encouraging to note that a local federation of aquarium collectors (aka Pederasyon ng Mag-aakwaryum sa Pilipinas) has taken steps to protect reef resources and has embarked on activities on its own—marine sanctuary establishment, net-use training, environmental education, livelihood development, advocacy, data collection and peer monitoring on net use. The sustainability of the trade and its future depends on such efforts. This will ensure that fisherfolk, businessmen, hobbyists and coral reefs can co-exist in harmony under the banner of sustainable development.

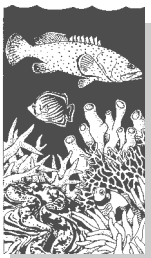
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Who can challenge them? Lessons learned from attempting to curb cyanide fishing in Maluku, Indonesia

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Introduction

While the practice of fishing with *bius* (i.e. intoxicant), the vernacular name of cyanide, was public knowledge in a Maluku regency where I did a year's field research in 1995 and 1996, it was nevertheless treated in official discourse as if it did not exist. The practice was well known publicly for several reasons. It had been carried out since the early 1990s, and had generated various conflicts

between villagers and outside fishing companies, as well as among villagers themselves. In addition, some companies employed local people whom it proved impossible to keep silent concerning cyanide fishing.

Yet cyanide fishing had attracted no official attention, and not a single case had been brought to court. We may wonder why. The following experience helps shed some light on the question.

The incident

Rumours of the presence of cyanide fishing on DL village's traditional fishing grounds had been in the air for about two weeks when the *Kepala Desa* (village head) and two villagers apprehended four cyanide fishermen on 2 August 1996.

They were patrolling DL Island's water when they spotted a strange speed boat. When they approached, they saw a fishermen holding a hose extending into the water from an air compressor. This, they knew, was an almost certain sign of cyanide fishing. The *Kepala Desa* was very upset. He hit the offender and asked him to pull up the air hose. Another fisherman, wearing a wetsuit, proved to be on the other end of it.

When the second fisherman was on board, the *Kepala Desa* again lost his temper and slapped him. The *Kepala Desa* asked the fishermen whether others were involved. They pointed to another nearby speed boat. Investigation revealed two more men, also using cyanide.

The four men and their boats were brought to the village. On board was diving gear and torches, as well as some pointed metal tubes, about the size and diameter of drinking straws, with wooden handles. These are used to release the pressure from the distended air bladders of fish brought up from deep water.

There were also some live fish in a holding tank on one of the boats. One of the fish was a Napoleon wrasse, a species forbidden by national law to be exploited commercially, except through a very complicated procedure. Two cyanide pills were also found hidden on one of the boats.

The fishermen said they were employed by a fishing company owned by a businessman in Ujung Pandang. They also confessed to cyanide fishing, recounting how they prepared the cyanide, searched for the fish, squirted the contents of their cyanide bottle under stones or coral where they had chased and cornered the fish, caught the stunned fish, and stored them in the holding tank after depressurising them by puncturing the air bladders.

Clearly these four fishermen had violated both the Indonesian Government and local customary laws. The former prohibit pollution and the destruction of natural resources. Customary law prohibits outsiders from fishing commercially in the village fishing grounds.¹ According to customary law, the

apprehended men had thus stolen fish, and by using a destructive fishing method, degraded the villagers' sea territory.

The *Kepala Desa* decided to confiscate the boats and fishing gear. This is the customary action by a *Kepala Desa*, who in this context is considered as the leading village official.

Traditionally, a *Kepala Desa* would only return confiscated items if certain customary procedures were completed. Today, in cyanide fishing cases, however, one or more military officials often come to the *Kepala Desa* and ask him to return confiscated goods. In these cases the company gives a certain amount of money to the *Kepala Desa* as *bukman* (usually smoke and betel nut, traditional tokens of exchange). In this instance, however, the *Kepala Desa* decided to try to prevent this by reporting the case officially to the government before any military intervention occurred.

The attitudes of the government and military officers

I accompanied the *Kepala Desa* to report the case to the local police officer in the regency capital (regencies are Indonesia's sub-provincial political units). We met the commander of the intelligence Unit of the *Polres* (the regency police post) and the commander of *Polsek* (sub-regency police post).

After we reported what had happened, these officers told us that this case was very difficult to prosecute. First, they said, it was difficult to prove; they had no expert to examine whether the cyanide fishing causes damage to the environment. We argued this point. But the discussion stopped when they told us what was apparently the real reason for their reluctance, namely that, 'we have a problem in prosecuting this case because our superiors are involved in this business'.

They seemed to sympathise with us, but felt that they could do nothing. Nevertheless, they took the four fishermen to their office for questioning. They also suggested that we deal with the issue by means of customary law. This would put the *Kepala Desa* in charge, and prevent the involvement of government officials, including the military.

On 3 August 1996, an army officer from a *Koramil* (sub-regency army post) came to DL village to 'invite' the *Kepala Desa* to meet his commander, or *Danramil*. Apparently, the *Kepala Desa* told me later, the fishing company had reported the case to

1. According to customary law, outsiders can only make use of resources in people's territory when they ask permission and it is given. In this part of Indonesia, customary marine tenure is still practiced with varying degrees of rigour.

Danramil and asked him to persuade the *Kepala Desa* to give the company back their speed boats and all their equipment, and settle the problem 'peacefully.' However, the *Kepala Desa* refused his proposal. He argued that he had planned to report the case to the *bupati* (head of regency), so it would be up to the *bupati* to decide how to handle it.

Later that day, we went to the *bupati's* house. The *bupati* responded to our report by saying that this case was not the first. He had known of such cases for some years, but it was a difficult problem. To demonstrate this, he told us about a case in a village where a military person was involved directly in the illegal activities. He told us, in essence, that there was nothing, under such circumstances, that he could do; in other words, the military was not under his authority.

The *bupati* asked us to meet the *Dandim* (commander of the regency army post, *Kodim*). This seemed like an odd suggestion, since we believed that this particular problem had nothing to do with the army.

Later, the purpose became clear when I was shown a letter signed by the *Dandim* (on behalf of the regency army cooperative's commander) and Mr AR, a customary leader from DL village. The letter asserted that Mr AR had received an outboard engine from the *Dandim* in return for the right to construct a base camp and fish cage and to operate a grouper fishing company in village's territory.

The company was one of those that engaged in cyanide fishing. It also operated in official collaboration with the regency army cooperative. This makes it seem likely that, in the present case, the *bupati* had warned the *Dandim* that the army's cyanide fishing operation was being challenged.

The head of the fishery office in the regency gave me a similar explanation when I questioned him concerning cyanide fishing. He told me that the involvement of Indonesian military officers had made the problem difficult to handle. However, it seemed that he used this situation for his own benefit. One of his staff told me that, in fact, he was the local representative of the company that employed the fishermen we caught! Moreover, the fisheries chief's brother told me that he, himself, arranged all papers needed to export the catch.

I also found the company's licensing situation was unusual. The company had written a letter to the regency fisheries office asking for a letter of recommendation. Such a letter from the regency fisheries office is one of the requirements that must be met before a fishing company is allowed to operate in that regency's water. In some cases, the letter of recommendation must be produced before a fish-

ing license can be granted by a provincial or central fisheries office.

The letter was dated 2 August 1996—the same day that the cyanide incident took place. The requested letter, signed by head of the Fisheries Office, was issued on 5 August 1996. It thus appears as if the operation had been unlicensed, and that the letter had been requested so the company could use if they were asked to produce a license before a court.

At the time he signed the letter, the head of the Fisheries Office could not have been unaware of the cyanide incident. He told me, in fact, that he had sent one of his staff to invite the *Kepala Desa* to discuss it on 4 August.

When I told the acting commander of the regency navy post about the cyanide incident, he said that this post had only very limited resources. There were not enough speed boats and personnel to carry out patrols. It was thus very difficult to observe illegal fishing practices.

The customary court

Frustrated by the lack of support from government officials, the *Kepala Desa* decided to handle the case according to customary law. Although this meant that he became the master of the game, it was still a difficult situation.

Customary law required him to arrange a customary court. Village functionaries essential to the court were busy preparing some marriage ceremonies. As a result he could not organise the court before all of the marriage ceremonies ended. On the other hand, he could not ignore the pressure coming from the fishing company which, through its representative and *Danramil*, pushed him to hold the customary court as soon as possible.

The customary court was finally held four weeks after the incident. It was attended by an army official, a fishing company representative, and representatives of all origin kin groups in the village. After an opening speech from the army representative, the *Kepala Desa* explained that the fishing company had violated both customary and government laws.

'The case is in the hands of the officials in the capital,' he said. 'Our concern in this meeting is the fact that they had violated our customary law. It is our right to decide the fine for that violation.' Although the final court decision would be his, he said, he would like to discuss the matter with all customary court committee members, and asked for their opinions.

A representative from the Christian hamlet² within the village said that the company should pay ten million *rupiah*,³ an amount prescribed, he said, in the Indonesian Law. This idea was not agreed upon because it was not based on the customary law (moreover the stipulation of such a fine in national law could not be found).

Mr AR said that because the *Kepala Desa* had beaten the fishermen, the company should decide how much they should pay. This suggestion was controversial, because some court participants considered it as benefiting the company. However, it was understandable once we know who Mr AR was. Mr AR was the leader of the *Kepala Desa*'s political opposition. He habitually denied the legitimacy of leadership of the *Kepala Desa*, led his own group of villagers, and ran his own village programmes.⁴

Moreover, to support his position in the community, Mr AR had tried to develop a good relationship with the military officials in the capital. He had also sought support from certain businessmen to run his programmes. One example of this was his agreement with the *Dandim* mentioned earlier. While criticising the *Kepala Desa* by implying that his act of beating the fishermen was wrong, Mr AR tried to show his sympathy with the company.

Finally, the court agreed to fine the company six million *rupiah*. In return, the *Kepala Desa* was to return all company property. In part this approach was due to the custom that villagers should not trouble outsiders, so that their relatives who go or live outside their village or region will be treated well by others. In addition, the people needed some money to continue the construction of a church and a mosque. Not wanting to be too hard on the company, the villagers decided that six million was a sufficient amount. This figure was not final, however. The company representative was asked to discuss it with his boss in Ujung Pandang. Another customary court would then be arranged to reach the final decision.

The latter was held two weeks later, attended by the same people, plus the *Danramil* himself. His presence was interesting, because he ensured that, unlike the first customary court, the outcome of the

second was carefully prearranged. Before the court was held, the *Danramil*, the *Kepala Desa* and the company representative discussed their plan. The company representative said that he had convinced his boss in Ujung Pandang to pay the six million *rupiah*.

The *Kepala Desa* told me later, however, that the *Danramil* had taken one million *rupiah* to be distributed among his friends. The *Kepala Desa* was upset, but he was powerless to refuse the *Danramil*. Interestingly, the *Kepala Desa* also took two million *rupiah*, and asked the representative of the company to say in the court that his company could only pay three million *rupiah*, the amount proposed by the company representative in response to Mr AR in the first customary court.

When I asked the *Kepala Desa* why he took the two million, he replied that this was not corruption but *bukman* which was his right as leader of the customary court.⁵ According to the customary law, he explained, it was the price of his effort of settling the problem. Additionally, he also argued, why should the *Danramil*, who had nothing to do with the case, be allowed to take one million if he was not.

The court was run as planned. The representative of the company paid three million *rupiah* to the court. He also distributed 10 000 *rupiah* to each of the customary court committee as *uang alas meja* ('table cloth money'). Representatives of church and mosque construction committees were each given half. The case was closed when the *Kepala Desa* returned the two speed boats and other equipment to the company representative.

Conclusion

What I have learned from this experience is that cyanide fishing flourishes because of the lack of enforcement of both Indonesian Government laws and of customary sea tenure. The first is due to corrupt government and military leaders at the regency level. Their collusion with fishing companies that use cyanide may have isolated the regency from government or military forces at the higher levels. If this is true, then those who collude

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2. In eastern Indonesia rural areas, people with different religious denominations mostly live in separate hamlets or villages.
 3. About US\$ 430 at the time. It is interesting to note that such a fine might not have been considered adequate if the villagers had known the magnitude of the profits derived from cyanide fishing. In Hong Kong restaurants, this amount of money is equivalent in value to 3 kg of live Napoleon wrasse (Ed.)
 4. This political opposition to the *Kepala Desa*, a common occurrence in Indonesian villages, derives from the frequent incompatibility between customary village leaders and those appointed by the Indonesian Government procedure. Mr AR was the traditional village leader; the present *Kepala Desa* was appointed by the government law.
 5. He was quite right, since I observed in several customary courts that the *Kepala Desa* or his representative (in the case when *Kepala Desa* was absent) were given part of the fine. However, in this case, we might question the amount of money taken by the *Kepala Desa*.

with the companies are the ultimate power holders; whatever happens in the regency is under their control. If they wish to profit from cyanide fishing, who can challenge them?

Alternatively, this corruption and collusion could be part of a bigger game played at higher official and military levels. One fishing company known to use cyanide, for example, was a joint venture between private businessmen and a cooperative centre of the Indonesian army (*Puskopad*).

The lack of firm enforcement of customary marine tenure appears to be due to some people regarding the long-term economic benefit and the conservation value of their marine tenure as less important than short term economic gains, having a good mosque and church, and, for Mr AR, a leading position in the local political scene.

Internal conflict within the community had often occurred between those who supported the above ideologies and others who were aware of the environmental damage and suffered from declining catches due to cyanide use. In DL village, the climax of one such conflict occurred in March 1997. It was triggered by the fact that Mr AR had granted permission to another fishing company which, it was suspected, would use cyanide to operate in the village's territory.⁶

In conclusion, I would like to suggest an approach to the control of cyanide fishing in addition to those proposed by Johannes and Riepen (1995) and by various writers in the first three issues of the *SPC Live Reef Fish Information Bulletin*. I propose the establishment of an agency which can stimulate mutual cooperation between government agencies (including military forces), local communities and fishing companies to eliminate cyanide fishing practice and promote a sustainable live reef fish business.

This agency should provide sufficient incentives to government agencies and local communities to enforce both government and customary laws. Other than economic incentives such as enhancing local income from the live fish trade and other sources (see Barber & Pratt, 1997)⁷, the incentive provided by knowledge about all aspects of cyanide fishing will also help to heighten local communities' and government officials' awareness of the problem. If all people were assured of the

destructive impact of cyanide fishing, in contrast to the possible magnitude of the profits taken by the fishing companies, I believe people would think twice before supporting cyanide fishing. Of course, this is based on the assumption that alternative sources of income are available, and the enforcement of customary marine tenure can be 'isolated' from social and political problems.

The proposed agency would have to have a good understanding of the local socio-cultural issues. This would be needed not only for developing effective communication and gaining local support for reform, but would also be essential if the agency was to serve effectively as a mediator between local communities and fishing companies. I observed, for example, that conflict between some fishing companies and local communities has been caused not only by the companies using cyanide, but also, and more importantly, by the companies lack of understanding of local customary marine tenure.

It is also obvious that the companies are not aware that some villagers respond enthusiastically to the live reef-fish demand in legal ways. The company did not know, for example, that the people in the village where I stayed bought hundreds, even thousand of fish pots (*bubu*) and constructed fish cages in order to catch groupers and keep them alive when they became aware that there was a good market for them. If such a response were known by the company, I believe, they would have considered collaborating constructively with the locals and considered alternatives to cyanide fishing.

Additionally, the proposed agency could promote sustainable but profitable live reef fisheries. It could be done, for example, by introducing alternative fishing techniques and/or aquaculture. This agency could also communicate the proper procedures for handling the live fish, starting from catching, up to the shipping or packing for air transportation, to avoid the high mortality rates reported by Johannes and Riepen (1995).

It is clear that to achieve its goals, this agency should be powerful in terms of authority and financial resources. What kind of agency could play these roles? I would suggest that it be a collaborative effort between the central government of Indonesia and international organisations such as TNC, WWF, WRI, CI, USAID, ADB or the

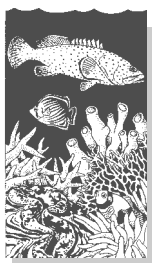
6. In January 1998, a friend wrote me that this company was using cyanide, and they had been granted permission to operate in the territory for three years paying 350 000 rupiah (about US\$ 140 at that time) per year.

7. Although I do not discuss the fact that the people's economic problem is one of the factors that has stimulated local communities to take part in cyanide fishing, the problem of poverty in fishing communities in Indonesia is very obvious (see for examples, Mubyarto et al., 1984; Johannes & Djohani, 1997; Jacques, 1997).

World Bank. Indonesian Government support would be essential to legitimise the agency's activities. This support would not only acknowledge internationally the importance of such a programme in Indonesia, but also help to fulfil its financial needs to make the agency capable of working independently.

By proposing that international organisations help establish such an agency, I do not mean that I do not believe in the Indonesian Government's ability to act constructively in fisheries matters. The trawler ban in 1980 is undeniable proof of the Government's successful intervention in fisheries (without the involvement of any outside agency; see Bailey, 1997).

However, the cost, of establishing the agency proposed above, if borne by the Government, would be considered prohibitive in present economic conditions. But if we wait until the Government develops the ability to manage these fisheries effectively, I am afraid that destructive fishing practices such as cyanide fishing will have already ruined Indonesia's nearshore marine resources, and further impoverished its many fishing communities.



Combating destructive fishing practices in Komodo National Park: Ban the hookah compressor!

by Jos S. Pet¹ & Rili H. Djohani¹
The Nature Conservancy, Indonesia Program

In efforts to quantify and combat destructive fishing practices in Komodo National Park (KNP), The Nature Conservancy has learned that patterns of marine resource use are complex. While patrols have successfully decreased the incidence of large-scale dynamite and cyanide fishing, considerable further protection is needed before the park is truly a Marine Reserve. Currently, live reef fish have priority for places on the airplane out of Labuan Bajo, while visitors who come to see the Komodo dragon and the world's richest coral and fish life must take a 12-hour ferry! The demersal fish stocks and coral reefs, which have suffered considerable damage already, continue to be threatened by a variety of destructive methods, including the use of hookah compressors, reef gleaning, fish traps, gillnets and bottom lines. In particular, banning the use of hookah compressors, which are used in both dynamite and cyanide fish-

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ing, is recommended. On paper, legislation protects all animals, plants and habitats within the National Park, yet park authorities and police officers are not aware of the destructive impact of commonly-practised fishing methods like compressor (hookah) fishing.

1. Komodo National Park

Komodo National Park (see Figure 1 on next page) is located between the islands of Sumbawa and Flores in Indonesia. The park was established in 1980, and has a management unit with 88 staff. The park was declared a Man and Biosphere Reserve and a World Heritage Site in 1986. KNP includes three major islands, Komodo, Rinca and Padar, and numerous smaller islands, together totalling 41 000 ha of land. KNP is famous as the habitat of

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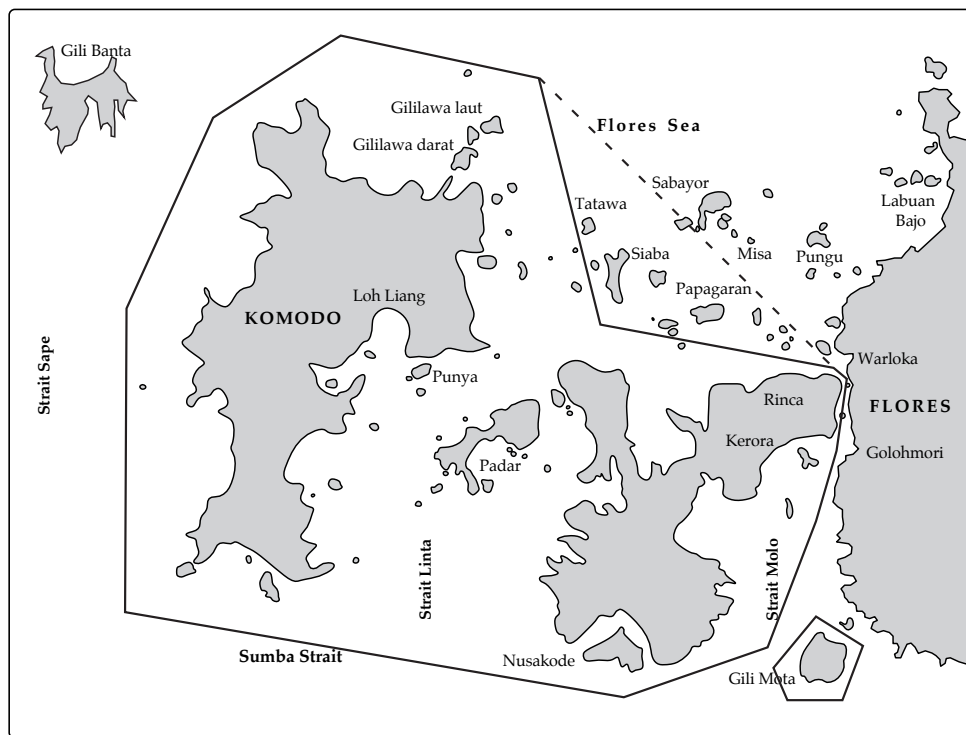


Figure 1: Komodo National Park (KNP)

the Komodo dragon, *Varanus komodoensis*, but it is also one of the richest areas for coral biodiversity in Indonesia, and has one of the richest fish faunas in the world with an estimated 1000 species. The park contains 132 000 ha of marine waters, with a high diversity of habitats including coral reefs, rocky shores, sea grass beds, sandy bays and mangroves.

There are presently some 2300 inhabitants living within the park, spread out over three settlements (Komodo, Rinca and Kerora). An estimated 15 000 people live in fishing villages directly surrounding the park. Park inhabitants mainly derive their income from a pelagic lift net ('bagan') fishery (95% of their yield comes from this gear type) which is targeting squid and small schooling pelagic fish.

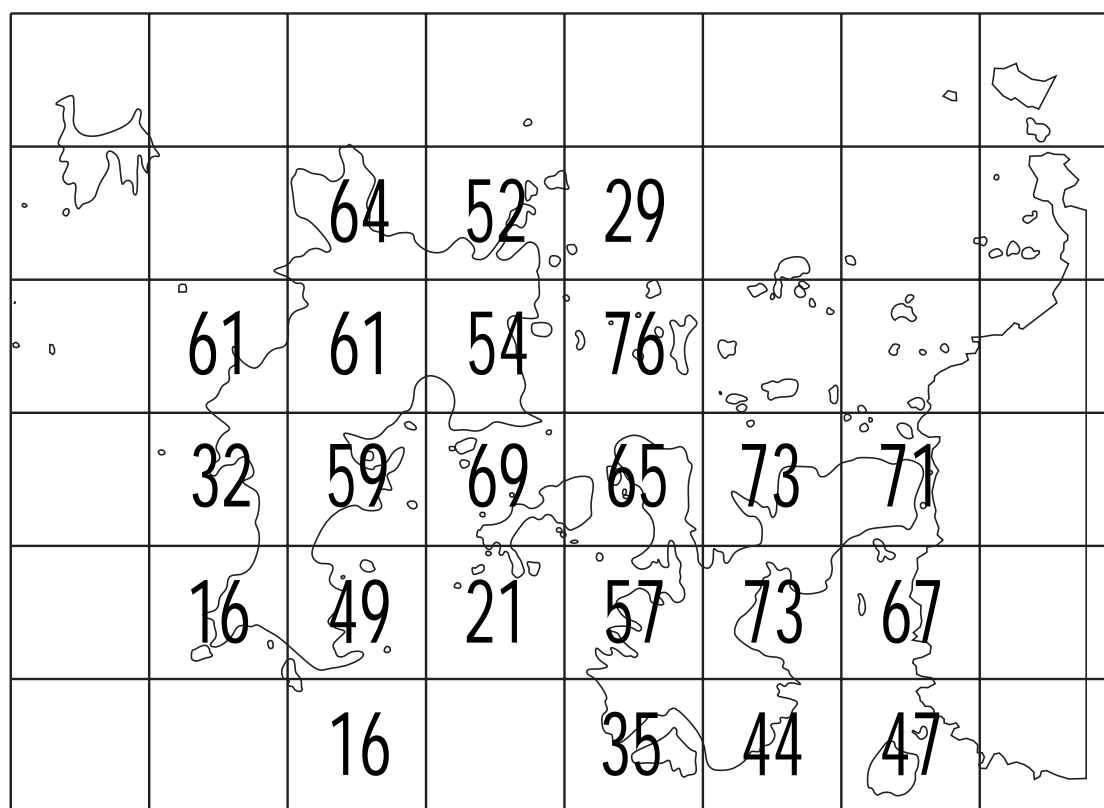
Additional income and food is derived from 'meting', a method whereby corals are destroyed in search of marine invertebrates. This method includes practices ranging from walking and searching with a stick on the reef flats at low tide, to diving with compressors or dive tanks, using steel bars to break the corals. In our experience, all of these methods are quite destructive. In its simplest version, 'meting' results in the trampling of live corals and other organisms and the breaking of corals with sticks and other tools in search of a variety of invertebrates (abalone has been the prime target in recent years). The reef flats are cleaned out and coral rubble remains.

Non-inhabitant fishermen use pelagic lift nets and a variety of other gear types in KNP waters. Although the pelagic lift net forms the most important gear type in KNP in terms of yield, other fishing methods form a major threat to the Park's marine resources. Destructive fishing practices such as dynamite and cyanide fishing (with the use of hookah compressors), reef gleaning and local overfishing destroy both the habitat and the targeted resource itself (fish and invertebrate stocks).

2. A management plan for the marine component of Komodo National Park

Upon request from the Ministry of Forestry, The Nature Conservancy (TNC) is assisting the National Park's authority with the management of the marine component of the park. In October 1996, a draft management plan was completed for the marine component of KNP. The objective of the park management is 'To protect the demersal and sedentary marine life forms of Komodo National Park, their ecosystems and their habitats, and to maintain the natural population and community structures of these life forms'. Key modules in the management plan are:

- I. Designation of a marine park zonation plan and specification of regulations.
- II. Implementation of a cross-sectoral enforcement programme with park authorities, police,



64 means 64% of hard coral is dead

Figure 2: Results of coral reef monitoring, 1996

army, fisheries service, local government and communities.

- III. Involvement of local communities through: (1) community awareness programmes, (2) participatory planning, and (3) establishment of a local NGO.
- IV. Building of partnerships with private enterprise to develop alternative livelihoods in a variety of compatible enterprises such as: ecotourism, mariculture and fisheries for large coastal pelagic species.
- V. Implementation of an environmental mooring buoy programme to prevent anchor damage from boats bringing tourists to popular snorkelling and diving sites.
- VI. Implementation of a comprehensive monitoring and research programme to evaluate management measures and suggest the most desirable and effective interventions. The monitoring and research programme includes the following sub-modules:
 - a. monitoring of the status of the coral reefs,
 - b. monitoring of the status of commercially-targeted fish populations and their spawning aggregation sites,
 - c. monitoring of fisheries resource utilisation patterns,
 - d. applied research and monitoring of the sus-

tainability of proposed compatible enterprises (alternative livelihoods), and

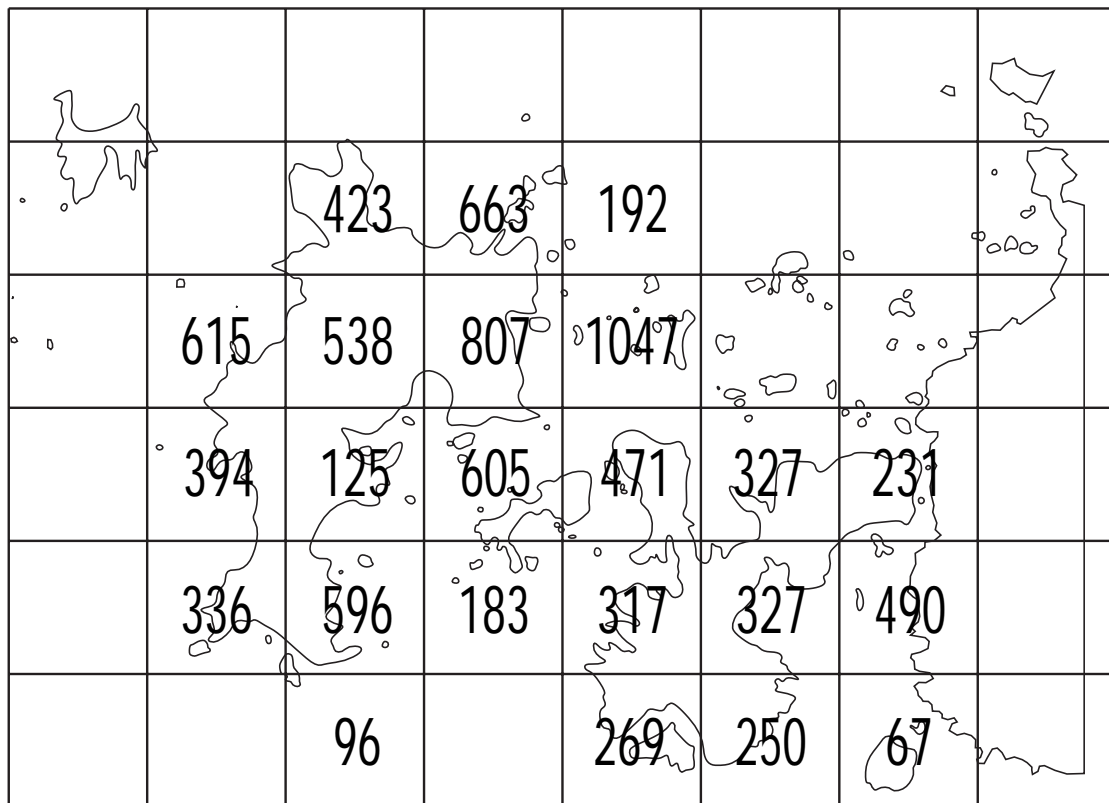
- e. applied research and monitoring of the effectiveness of different methods to enhance coral reef rehabilitation.

The present paper focuses on the results from monitoring programmes and on the need for effective law enforcement. This focus does not imply that other programme modules are less important, on the contrary, it is our strong belief that the park management will only achieve their goals by implementing a comprehensive programme in which community involvement and alternative livelihood strategies are very important modules. These other two modules will therefore be discussed in separate papers.

3. Present status of the resource and patterns in resource utilisation

3.1 The coral reefs

The coral reef monitoring programme covers 185 sites, which are all surveyed every two years and at three different depths. Averages over 25 square mile areas of the park are used to estimate the overall status of the coral reefs (Figure 2).



423 means 423 fishing operations per year

Figure 3: Results of resource utilisation monitoring, 1997

Results of the 1996 monitoring round show that serious damage has occurred in most areas inside and outside the park. The most heavily affected areas inside the park are found in areas bordering the buffer zone in the north-eastern region of the park, namely the reefs off north-east Komodo, north Padar and north and east Rinca. In all these areas 65 per cent or more of the hard coral was dead in 1996. The least damage (less than 45% mortality) occurs in the south-western and southern areas of the park, with some healthy (hard coral) reefs found especially in the south Komodo and south Padar regions. A few locations in the far north-east of Komodo also remain in good condition. The amount of damage generally increases from south to north and from west to east. Most fishing communities have their settlements on the north-eastern side of the park, except for Sape which is on the west side of the park.

3.2 Fish spawning aggregation sites

By monitoring the size frequencies of a number of commercially-targeted fish species on a number of known aggregation sites, it will be possible to evaluate developments in the fish populations in a cost-effective manner. By identifying mass spawn-

ing sites for important fish species it will be possible to select areas which need special protection. A number of aggregation and spawning sites have been positively identified in the north-eastern and south-eastern areas of Komodo. Spawning aggregations of four species of grouper and of Napoleon wrasse were observed to occur in these areas around the month of October. The sites contain concentrations of these species during all months of the year. Many more fish spawning aggregation sites are thought to exist within the borders of Komodo National Park, and additional site surveys will be conducted in October 1998.

3.3 Patterns in marine resource utilisation

A routine patrolling and enforcement programme started on 28 May 1996, with the intention to have two-day patrols covering the entire park area on a weekly basis, and to investigate all capture fisheries activities encountered. The number of incidents of dynamite and cyanide fishing dropped significantly during the first period of intensive patrolling. A reduction of more than 75 per cent was recorded for dynamite incidents, and several arrests were made of fishermen using destructive fishing methods in and around the park.

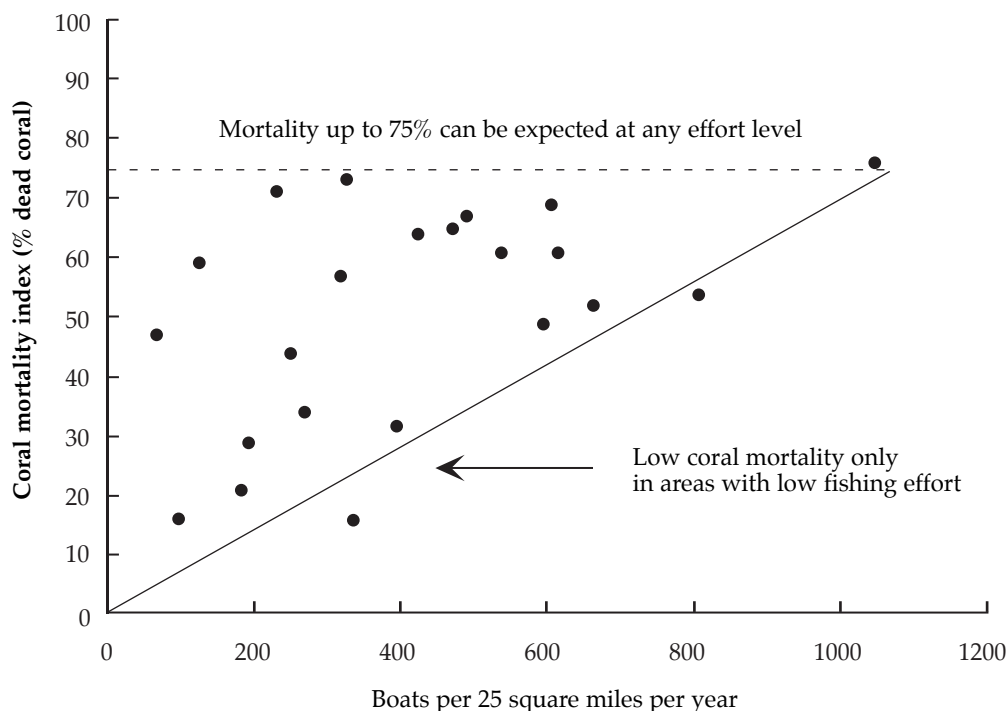


Figure 4: Coral mortality versus total non-bagan fishing effort

Members of the enforcement team have been trained to record data on resource utilisation patterns during routine patrols in the KNP area. This data includes number, type and origin of fishing crafts, their catches and their distribution in space and time. Each non-bagan (non lift-net) fishing vessel or fishing group encountered during the routine patrols is investigated. Bagan are excluded, since they form a separate type of pelagic fishery which is not considered a threat to the demersal and sedentary marine resources of Komodo National Park. Bagan boats are investigated when they engage in non-bagan activities.

The objective of this monitoring programme is to determine who is doing what, where and when in the park. The database on resource utilisation patterns shows park managers which community groups are involved in which fishing activities, where they fish, and when they fish.

Over time this data will also show any changes in the behaviour of fishermen due to management measures, and it will indicate which groups of fishermen or areas in the park may need extra attention.

Non-bagan fishing effort in the park ranges from less than 300 boats per 25 square miles per year in

the south to more than 1000 boats per 25 square miles per year off the coast of north-east Komodo (Figure 3). The area with the highest fishing effort is also the area with the highest coral mortality.

Areas with low coral mortality are typically those areas where fishing effort is low (Figure 4), although high coral mortality is also found in a few areas where fishing effort is relatively low. There are no areas where fishing effort is high and coral mortality low. It is also clear that fishing effort is relatively high in areas where fish spawning aggregation sites are located, and fishing therefore forms a direct threat to the fish species aggregating at these sites.

Communities in the park, the villages of Komodo, Rinca and Kerora, represent only 21 per cent of the non-bagan fishing effort in the park. Communities directly surrounding the park (Mesa, Papagarang, Labuan Bajo and Warloka) represent 36 per cent, communities from Sape (east Sumbawa) represent 29 per cent. Outsiders from further away represent 14 per cent of the effort. Fishermen from Komodo and Rinca are involved in reef gleaning (see Figure 5 on next page), those from outside the park mainly in bottom hook-and-line fishing, gillnetting, compressor and 'bubu' trap fishing.

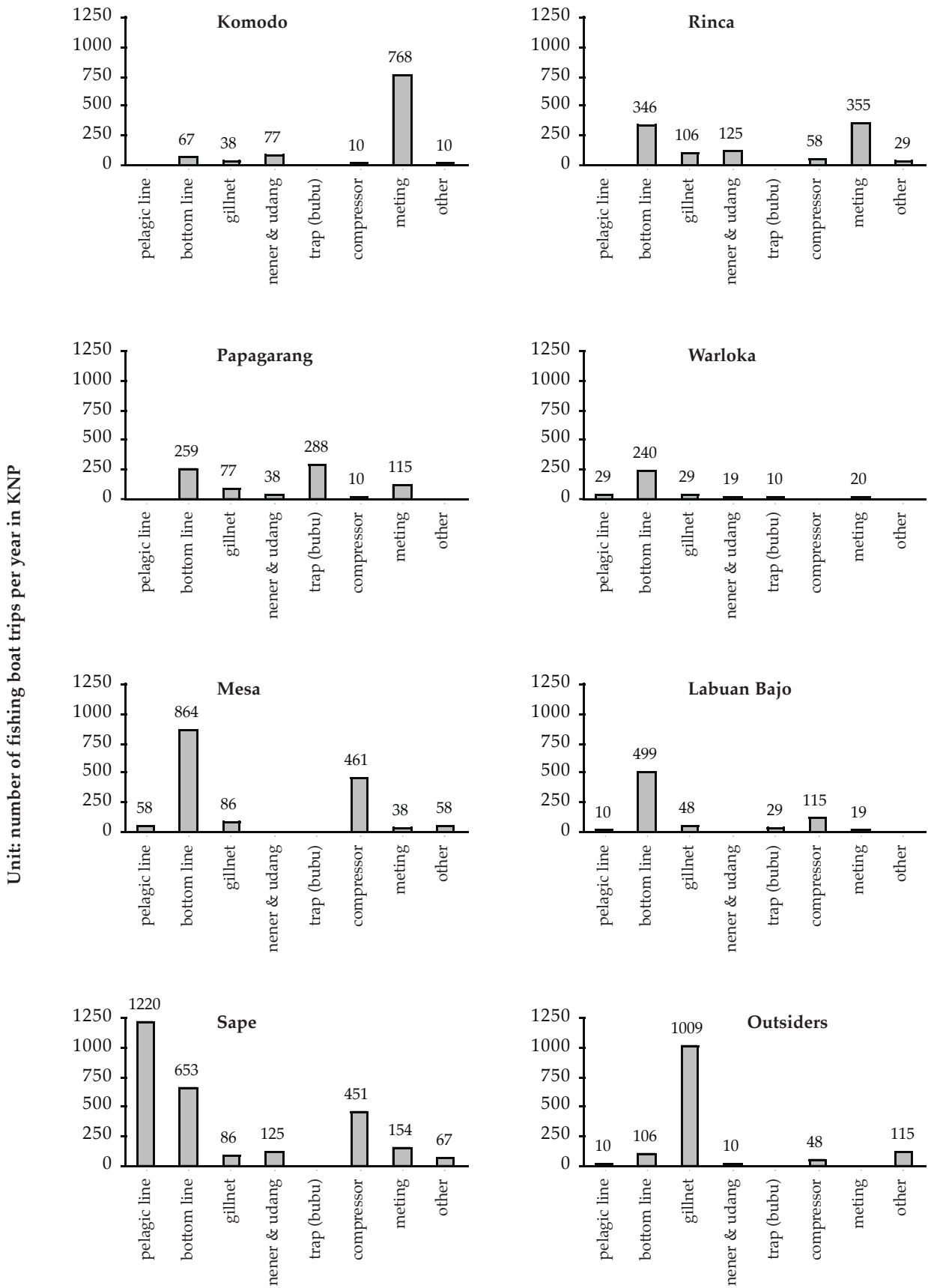


Figure 5: Non-bagan fishing effort per gear type and origin

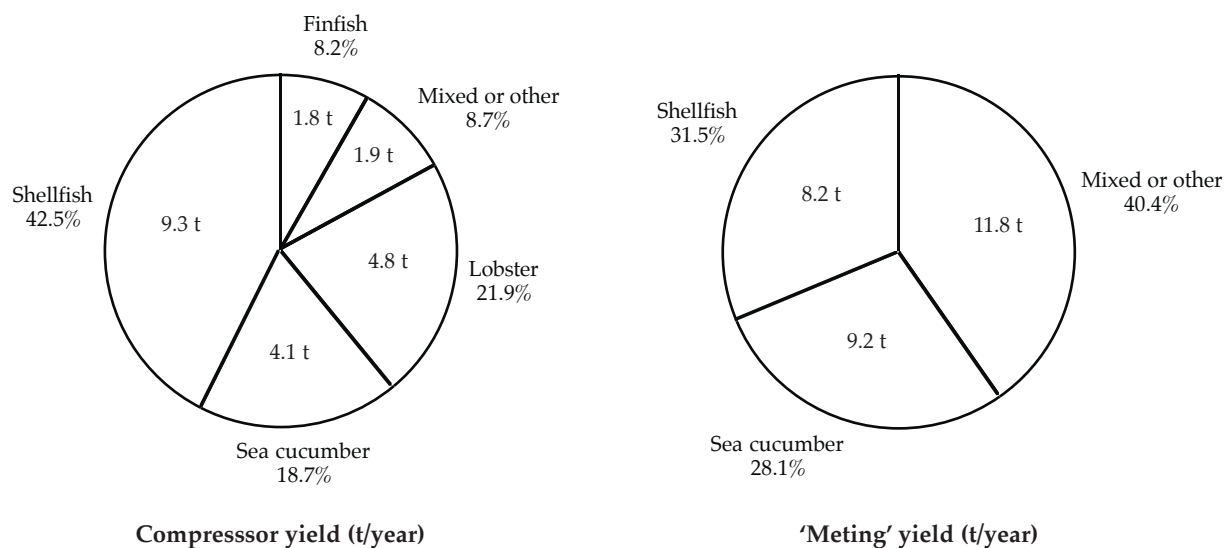


Figure 6

Yield categories per gear type for compressor fishing and 'meting', in KNP, 1997

Most gear types yield single products except for 'compressor' (hookah) and 'meting' (Figure 6). The latter two gear types typically yield a widely varied catch, ranging from live fish and lobster (often caught with cyanide) to sea cucumber, shellfish (mostly abalone and pearl oyster), coral and seaweed. These two gear types or methods form major threats to the marine ecosystem of Komodo National Park. It should be noted here that dynamite and cyanide fishermen (at least the larger operations) always involve the use of compressors.

Non-destructive and low-impact methods such as pelagic hook-and-line together account for only 18 per cent of the non-bagan catch, whereas the highly destructive methods of 'meting', compressor fishing, trap fishing and 'other methods' (including bomb and cyanide fishing) together account for 34 per cent of the total non-bagan effort. The most common gear types used in the park, are bottom hook-and-line and gillnets. These gear types together account for 48 per cent of total effort in the park, and are direct threats to sedentary fish stocks in the park, especially when they are used in areas where fish are aggregating to spawn. Large amounts of spilled nylon fishing line were encountered at fish spawning aggregation sites, and certain species like square tail coral trout (*Plectropomus aeorolatus*), which aggregate on shallow coral reefs, have been decimated on these sites.

The non-bagan yields represent only a small percentage in terms of weight of the total yield (bagan + non-bagan) harvested by inhabitants plus non-inhabitants. It is estimated that around 1000 t of fish, lobster, shrimp, pearl oyster and abalone were harvested from Komodo National Park (by all users

combined) in 1997, whereas the yield from bagan was an order of magnitude greater. The exact figure for the total bagan yield from National Park waters is unknown. For park inhabitant alone, non-bagan yields represent only five per cent in terms of weight of the total yield (bagan + non-bagan). Fishermen from Komodo comment that non-bagan activities are disproportionately important to them, however, since the bagan fishery is exploited by middlemen who leave very little of the profits for local fishermen. Freeing the fishermen from the claws of these middlemen, and helping them to gain higher profits from their bagan activities may be an important strategy to keep them from destroying the reefs.

4. Destructive fishing methods and law enforcement

Although the frequency of dynamite fishing in the park has been low during recent years, destructive fishing practices and local overfishing remain a constant threat to the Park's sedentary marine ecosystems. We can not really speak of a 'Marine Reserve' when harvesting, and destruction of marine life is occurring at the present rate in Komodo National Park. We have a long way to go before the KNP waters will be a marine reserve where all living creatures and their habitats are fully protected. The local Fisheries Service, for example, feels that the KNP waters are fishing grounds where yields have to be maximised. Park managers, however, comment that legislation is already in place to protect all animals, plants and their habitats within National Parks in Indonesia. Enforcement of this legislation, however, has not been implemented. Supporting materials from outside sources would help to convince the park authorities of the need of a ban on hookah

compressors. The protection of the marine environment in KNP has to be taken seriously, and the following phases of increasingly strict law enforcement need to be implemented:

- I. Remove all large-scale dynamite and cyanide fisheries from within the Park's borders. Large-scale dynamite operations work with big boats and dive crews in canoes with hookah compressors. Large-scale cyanide operations consist of motherships with several work-boats with hookah compressors.
- II. Combat large-scale dynamite and cyanide fishing in the buffer zone (north-east of KNP) and further outside the park.
- III. Remove small-scale dynamite and cyanide fisheries (with compressors in small boats) from within the Park's borders.
- IV. Combat small-scale dynamite and cyanide fishing in the buffer zone and other areas directly adjacent to the park.
- V. Prohibit key destructive gear types from within the Park's borders. The most urgent need here is to ban the hookah compressor.
- VI. Close the park for demersal gear types like gillnets and bottom hook-and-line. Only by banning the widespread use of gillnets and bottom hook-and-line from the park, starting with a closure of fish-spawning aggregation sites, can sedentary fish stocks truly be protected. Exceptions will have to be made for park inhabitants.
- VII. Establish multiple-use zones near settlements in the park, where inhabitant fishermen have exclusive fishing rights to use demersal gear types. The park waters should remain open for pelagic fisheries, preferably with exclusive fishing rights for park inhabitants and neighbouring communities.

In the section below, the different phases are discussed, and examples are given to highlight the specific problems which are encountered while trying to achieve the goals.

I. Remove large-scale dynamite and cyanide fisheries from KNP waters

The first objective is the most easy to achieve once a routine patrolling programme has been installed. Large-scale operations, run by outside fishermen, are simple to identify and have in fact been reduced by more than 80 per cent from Komodo National Park. Serious confrontations took place, especially in 1996. After that, the message had become clear and such operations became rare inside the park. Live-aboard recreational dive vessels still occasionally report bombing in remote corners of the park, and these are sometimes larger operations. If reports come in time, a patrol can be

sent out and the bombers can usually be arrested. Large-scale cyanide fishing for aquarium fish is still occasionally encountered, and is difficult to prosecute. Boats from east Java have been chased out of the park on various occasions, but police and park wardens seemed unwilling to make arrests, supposedly since ex-military personnel are present on these boats. [See *Adhuri*, p. 12 of this issue, for similar problems elsewhere in Indonesia—Ed.]

Example from one recent occasion: Our monitoring crew reports two large boats (15 and 20 GT) inside the park, off north-east Komodo. Judging by their design, these boats are from Banyuwangi or Madura (east Java), and they are using hookah compressors, probably fishing for aquarium fish with cyanide. We receive the report at 3 p.m., immediately inform the park authorities and the police and are told to keep one speedboat standing by. We suggest sending two speed boats immediately. The next morning, the KNP authorities and the police send some people to go out after the cyanide boat, using one of our speedboats. The enforcement team reports later that they found the cyanide boats that morning. They were from Banyuwangi and they were fishing with cyanide for aquarium fish. One man is arrested and our speedboat driver finds some eight to 10 litres of cyanide solution, which is taken in as evidence. One person is arrested and placed in the speedboat. According to our boat driver, the police officers wanted to let the boats go right away, but the KNP staff did not agree. After that, the enforcement team orders the cyanide boats to go to Labuan Bajo immediately. They do not put any guards on the boats and they do not follow them either. Instead they go in to a park ranger station on Komodo Island to have their lunch. When they finally go to Labuan Bajo, the cyanide boats are obviously not there. The arrested person, who is still on the speedboat, is ex-Navy, and he would later be released because of 'lack of evidence'.

This is an example where competence and bonafide leadership were clearly lacking in the enforcement team. Since late-1997, TNC has hired a pensioned Chief of Police from the region, who has an excellent patrolling record and who has joined all patrols since early-1988. A successful arrest of a large-scale cyanide operation was made outside the park under the leadership of this ex-policeman.

II. Combat the large-scale dynamite and cyanide fisheries in the buffer zone and other areas outside the park

Our present strategy is to combat the large-scale destructive fisheries as soon as they enter the park buffer zone or other waters in the immediate park surroundings. The minimum objective of this strategy is to make these operations leave the area

before they enter the National Park, the maximum objective is to have these operations prosecuted as an example and warning to other operations. Unfortunately, National Park staff are not allowed to patrol outside the park under their present leadership, but fortunately the local police has recently obtained 'water police' status, which means they can and should react immediately to any report of illegal activity in the waters of Komodo District. In practice this means that any suspected activity outside the park can now be checked by calling the police, who will normally send two constables with us in our speedboat to investigate the activity.

In 1997, this strategy led to violent clashes with outside large-scale dynamite fishermen who tried to throw bombs in the speedboats and were answered with gun fire. Although actual arrests are difficult and dangerous, usually these boats do not return after this type of engagement. In the case of one serious clash, the crew of a dynamite boat was arrested in Maumere Hospital, on the north coast of Flores Island, where they reported in with several gunshot wounds. Fortunately nobody was killed.

Fish bombing on a larger-scale still takes place at Gili Banta, north west of Komodo, by boats from Sape (east Sumbawa). This island is too far for intervention from Labuan Bajo and belongs to the Nusa Tenggara Barat (NTB) Province, where Police from Labuan Bajo have no jurisdiction. Nothing can be done here from our side. In February 1996, Banta Island was recommended for addition to KNP and NTB provincial authorities pledged commitment to protect the Island. Nothing happened after that.

No fewer than seven large cyanide boats (fishing for aquarium fish) from Banyuwangi have been spotted working in and just outside the buffer zone, north of KNP, in December 1997. Most of them were checked by the police and cyanide was found on all occasions. Still, these boats were only chased away and not a single person was apprehended. The district Chief of Police was present when one of these boats was investigated. Most of these boats seemed to have ex-Army or ex-Navy personnel on board. We have to have our own strong leadership on the patrol boats to make sure that arrests are made.

In December 1997, four 'Hong Kong-type' metal dinghies (blue and red) with modern outboard engines, compressors and well-equipped dive crews were working around the north-western tip of Flores Island. We decided that it was most likely a cyanide operation based on a mothership, although we couldn't locate that vessel. This case was reported to the Fisheries Service, who did not react. We decided to see if we could locate the mothership, and found it a few days later (the

operation had moved east, away from Labuan Bajo), with the same dinghies working nearby. Again they were diving and we suspected cyanide fishing for live reef food fish. In Labuan Bajo we reported to the police and fisheries and we went out with two speedboats.

We apprehended the mothership and five speedboats equipped with professional gear. The divers were surprised and asked us what was going on since their boss had already 'talked to the authorities'. Four of the dinghies were equipped for diving and working when we arrested them. One dinghy seemed to be on standby. The divers were using Technisub dive suits, modern regulators and well-maintained hookah compressors. All dinghies had brand new Yamaha outboard engines. Each dinghy had two divers and two helpers in the boat. We came in at very high speed to minimise their time for reaction. When we approached the speedboats, the divers were just surfacing and they threw several plastic squirt bottles in the water which we were able to recover. On all speedboats and on the mothership we found many squirt bottles with unknown contents.

The divers had caught groupers (flowery cod, *Epinephelus fuscoguttatus*); barramundi cod, *Cromileptes altivelis*; coral trout, *Plectropomus leopardus*; Napoleon wrasse, *Cheilinus undulatus*; and lobsters. One dinghy had caught 13 large flowery cod in a few hours, and from the look of this catch we suspected they were in the process of cleaning out a spawning aggregation. Each dinghy had a small reservoir build next to the live fish well, where they were mixing a solution of sea water with Sunlight soap bars and, we suspected, cyanide. We do not know what the soap is for, but we have thought of a few options:

1. The soap actually increases the effectiveness of the cyanide solution.
2. The soap increases the solubility of the cyanide.
3. The soap forms a white cloud underwater, showing where the solution is and facilitating manipulation.
4. The soap disguises the cyanide.

(If this practice has been observed elsewhere and/or if it is known why the soap is used, we would like to hear the answer to this question.)

On the mothership we found several bottles with a solution containing white powder (but no soap). We suspected this to be cyanide. The concentration in these bottles seemed to be high since the powder was not dissolving. On the mothership there was a large box with sunlight soap bars. In total there were eight hookah compressors (four on the mothership and one in each dinghy). The mothership had a

large, well-maintained inboard engine and two auxiliary Yamaha outboard engines. The mothership could work with eight divers in the water and each dinghy with two divers. It was about 25 metres long and had several large, live fish wells. There were 23 crew in total, and all were brought to Labuan Bajo where they were processed by the police.

The captain showed us some letters, with signatures from the local Fisheries Service and other local government officials which would allow this boat to fish with 'hook-and-line' and 'traps'. No gear of this kind was found on any of the boats, and the letters were not official licences but 'locally-arranged papers'. The crew told us that their boss was called Arifin, from Kendari, Sulawesi, and this person would be staying at the house of Pak Haji Idris (a local live-fish trader) in Labuan Bajo. It is rumoured that the whole operation is actually financed by a Korean person who is using Arifin as a front man. We have agreed with the local head of police that we will supply travel money for one policeman to bring the evidence to the Criminal Laboratory in Jakarta.

We also obtained several bottles (which were not recorded as evidence) which we had analysed separately to enable cross-checking of results. One set of five bottles was sent to the International Marinelife Alliance (IMA) and these samples tested positive for cyanide. A second set was sent to PT Sucofindo in Jakarta, and these also tested positive with reported results for cyanide concentration:

'Sample 1' : 762.50 mg/l
 'Sample 2' : 1251.00 mg/l (with soap)
 'Sample 3' : 2017.50 mg/l
 'Sample 4' : 2.30 mg/l (with soap)
 'Sample 5' : 1401.00 mg/l

'Sample 4' was filled out of the reservoir in the dinghy, into a used squirt bottle. This result suggests that the cyanide was not yet mixed in that reservoir. The low concentration was probably leftover cyanide from the used bottle.

In the meantime the local Fisheries Service has reported to its upper echelons that the arrested fishermen were just using soap to catch fish and that there was no cyanide. The boat is still being held because it didn't have all the right papers, but the rumours are that this will be 'fixed' before the trial starts. The police sent one constable to the criminal laboratory after only three weeks, and when we checked the evidence they were bringing, it was clear that 'unsoaped' cyanide solution had disappeared. Some of the 'soaped' solution was still there, and we still have hope that the manipulation of evidence has been insufficient. We fear, however, that the criminal laboratory will not find any cyanide.

We are confident, however, that our 'minimum objective' will have been achieved, and that this operation will leave the area before ever having entered the waters of Komodo National Park. The fishermen on this operation will hopefully also bring the message back home (if they do not end up in jail).

III. Remove small-scale dynamite and cyanide fisheries from the park

Although the small-scale dynamite fishery is no longer a very large threat inside the park, small-scale cyanide fishing by surrounding communities remains a major problem. Many boats from the Pulau Mesa and Sape communities are fishing with compressors inside the park, and patrol data show that they normally catch lobster and live reef fish (mostly barramundi cod). Many of the compressor fishermen are using cyanide, but this is difficult to prove. They keep their cyanide containers connected to large stones which are dropped overboard as soon as they see the patrol boat. No cyanide is found when these boats are searched, and it is picked up by the divers after the patrol has left. These type of small-scale cyanide operations can only be stopped by banning the use of hookah compressors.

Inspection of holding cages outside the park (where these boats are landing their catch) showed large numbers of Napoleon wrasse, barramundi cod, groupers and coral trout. Fishermen who were interviewed upon landing admitted the use of cyanide in front of police, Fisheries personnel, park authorities and the press, but nothing was done by the authorities. Although the trade in Napoleon wrasse is prohibited without a special licence, this means nothing in practice, since local traders, who do not have any licence, can apparently continue even after serious complaints in the press. Local government officials do not seem to have any incentives to make problems for the live reef-fish trade. (On the contrary, we are forced to conclude.) Live fish fly out of Labuan Bajo to Bali every day, and, in the small plane, take priority over tourists, who are forced to take an old ferry to Sumbawa. The supply of oxygen for these live fish transports is larger than the one that is available for SCUBA-diving emergencies.

IV. Combat the small-scale dynamite and cyanide fisheries in the Park's buffer zone and in other areas surrounding the park

Small-scale bombing and cyanide fishing is still a problem in areas just outside the park, and is very difficult to combat. Our strategy is to invest in intensive interaction with communities. Arrests are made when certain groups are becoming a clear problem.

But, rather than placing of criminal charges, communication is the key after arrests. We try to involve small-scale fish bombers in our community work or in alternative livelihood projects after they have been arrested. Their communities will also receive extra attention in terms of awareness programmes and surveillance. An example of combating small-scale fish bombing is described below.

In October 1997, fish bombing is suspected on reefs north of the Park's buffer zone, by boats of a style like those from Palue Island (north Flores). The boats seem to be based in the area around Labuan Bajo, since this is where they are sailing to and from. Many fishermen with boats of the 'Palue style' are camping at a beach on Bajo Island, near Labuan Bajo. Fishermen from Labuan Bajo complain that these people are bombing the reefs where they normally fish with hand lines. They report that the Palue people are selling fish from fish bombing every day at Pulau Mesa.

In November, bombing fish is observed on a reef not far from Labuan Bajo. We observe a small green boat of the Palue model. Many dead fish are floating around while that boat returns in the direction of Bajo Island near Labuan Bajo.

We find out that there is a settlement of Palue origin near Labuan Bajo in an area called 'Nangena'. These people keep strong connections with their 'home island', work together with fish bombers from that island and are notorious dynamite fishermen themselves. This community has now become the focus of our attention, and the Police are also starting to collect information in their village.

In December, our fish monitoring team reports a dynamite fishing operation at work at Kanawa Island, north of the Park's buffer zone. A small boat of the Palue type is at work, and this boat is probably from the Nangena settlement. We decide to organise an arrest, and go out in the company of two policemen. A successful arrest is made of a 'Palue' fisherman from Nangena. The fisherman confesses quickly, and we confiscate around 200 kg of dynamited fish. This fishermen is roughed up a bit by the police, and made to promise he will stop this practice. Our community workers recruit the man for one of their projects, and he is now helping our efforts. Dynamite fishing by 'Palue fishermen' is presently on the decline in areas bordering the park.

V. Ban the hookah compressor, the reef gleaning practices and the 'bubu' fish traps from the waters of Komodo National Park

This is our greatest challenge, and is expected to have the greatest impact given the present situa-

tion. The compressor fishermen are fishing out the lobsters and valuable reef fish, whether it be with cyanide or not. They also decimate the valuable shellfish like pearl oysters, abalone, and giant clams, the sea cucumbers, the whip corals and many other life forms, destroying marine habitats in the process (corals are broken in search of the lobsters and shellfish). The Park's authorities are still not doing anything against these practices and the local Fisheries Service is even giving out licences to fish with compressors inside the park. Komodo National Park should not allow compressor fishing to continue in this World Heritage Site and Man and Biosphere Reserve.

VI. Ban the widespread use of gillnets and demersal hook-and-line by outsiders from the waters of Komodo National Park, starting with a ban on fishing at the fish spawning aggregation sites

This will be a difficult task, and can only be achieved when there is true political will to make a marine reserve out of the waters of Komodo National Park. At present the demersal fish stocks are under heavy pressure from these gear types, and population and community structures of these stocks are undoubtedly affected. Although complete closure for gillnets and bottom hook-and-line would be the logical intervention, it cannot be expected that this will happen soon. Much greater chances exist to achieve closure of fish-spawning aggregation sites, since the need for this measure is much easier to communicate to park managers. It is therefore extremely important that as many spawning aggregation sites as possible are identified in the park, and that the need for closure of these sites is urged upon decision-makers.

VII. Introduce exclusive fishing rights for park inhabitants to use demersal gear in multiple use zones and for both inhabitants and surrounding communities to use pelagic gear in the National Park waters

TNC is initiating a legal study to find out what the scope is for a zonation system with exclusive fishing rights for inhabitants of National Parks in Indonesia. Implementation of such a system should coincide with a proper licensing system under the control of National Park authorities. Interventions on this level are only beginning to be discussed on a local level, and will be part of the 'long-term planning' for a few more years.

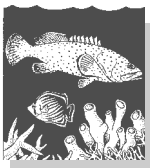
5. Conclusions

- I. Eventually, Komodo National Park should be closed for demersal harvesting techniques, except for exclusive fishing rights for park inhabitants in multiple-use zones. The most

urgent intervention is an active ban of hookah compressors for the entire park, for which no new legislation is needed. Compressor fishermen from neighbouring fishing villages should be targeted in alternative livelihood programmes such as the development of a fishery for large coastal pelagics or mariculture initiatives.

- II. A second important intervention would be to stop 'meting' by park inhabitants. The latter intervention may be facilitated by freeing local fishermen from the exploitation of middlemen, so they can earn sufficient income from their bagan activities. Park inhabitants should also be directly targeted in alternative livelihood programmes such as eco-tourism and/or extensive mariculture in multiple-use zones.
- III. The marine resources of Komodo National Park cannot be protected without an effective enforcement programme, including frequent patrols of all the Park's waters. If the park management cannot afford or is not willing to organise these patrols, other institutes, including NGOs, can make sure that law enforcement is indeed implemented.
- IV. Corruption and lack of political will at the local level is a major barrier to be overcome before marine reserves can be successfully implemented in Indonesia. Community awareness and education therefore has to be taken to higher levels and should include government awareness and cultivation of political will.
- V. The present status of the resource can be described with the following characteristics:

- a. highly damaged and continuously degrading coral reefs,
 - b. continuing destructive fishing practices inside the park,
 - c. high fishing effort and pressure on demersal stocks like lobsters, shellfish, groupers and Napoleon wrasse,
 - d. few economic alternatives available to local communities, and
 - e. questions without answers on how to speed up coral reef rehabilitation.
- VI. Detailed management objectives should:
- a. stop degradation of the coral reefs and keeping the damage at a level which is not higher than what was recorded in 1996,
 - b. stop all destructive fishing practices, including compressor fishing, 'meting' and fishing with 'bubu' traps,
 - c. implement full protection of demersal stocks, at least by banning the use of hookah compressors and by closing all known fish-spawning aggregation sites to all types of fisheries,
 - d. promote a shift of fishing effort from demersal fishing inside the park area to pelagic fishing inside and outside the park area,
 - e. support members of local communities to enter into compatible enterprises like eco-tourism, mariculture or pelagic fisheries,
 - f. develop a feasible methodology for the enhancement of coral reef rehabilitation.
- VII. We need supporting materials from outside sources to convince the park management of the need for a hookah ban!



An overview and comparison of destructive fishing practices in Indonesia

by Lida Pet-Soede¹ & Mark Erdmann²

Introduction

Indonesia is richly endowed with marine natural resources, and its people are highly dependent upon them for food, coastline protection, and other ecosystem functions. Despite this strong dependence, and an adequate legal framework to protect them, destructive fishing practices (DFP) continue to pose some of the greatest threats to the sustainability of Indonesia's marine ecosystems, particu-

larly its coral reefs. Here we present an overview of DFP in Indonesia, with detailed descriptions of those fishing techniques most destructive to its coral reefs. For each of these capture methods, we describe the technique as practised in Indonesia (with regional variations noted when applicable), the species most commonly targeted by each capture method, data on typical yields and profitability (when available), as well as a subjective assessment of which of these destructive techniques pre-

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sent the greatest threat to Indonesia's coral reefs. This overview draws upon the scattered literature which has been published on Indonesian DFP, but is based primarily upon our own personal observations and surveys throughout the archipelago, with a focus on the fisheries of the Spermonde (Sulawesi), Riau (Sumatra), and Kepulauan Seribu (Java) archipelagos.

Additionally, we briefly examine some of the socio-economic and cultural factors influencing the use of DFP in Indonesia. An understanding of these forces is critical in order to design effective education and enforcement programmes to promote the adoption of more reef-friendly capture techniques.

Definition of DFP

With increasing attention being focused on the use of DFP worldwide, it is inevitable that varying interpretations of what constitutes a 'destructive practice' will arise. For example, although blast fishing may be considered a 'consensus DFP', some workers have also considered such practices as live-finning of sharks as destructive. For the purposes of this paper, a destructive fishing practice (DFP) is one which results in direct damage to either the fished habitat or the primary habitat-structuring organisms in the fished habitat (e.g. scleractinian corals in a coral reef fishery). Examples of DFP in Indonesia include blast fishing, cyanide fishing, bubu trap fishing, muroami and inshore trawling.

Blast fishing

First introduced by the Japanese during WWII, blast fishing is so pervasive in Indonesian coral reef fisheries that it might in some respects be considered a 'traditional' fishing method. Although the explosive used has evolved from actual dynamite (first from WWII munitions, then from international development civil engineering projects) to home-made kerosene and fertiliser bombs in beer bottles, the basic technique remains the same. Schooling reef fishes are located visually, after which the capture boat moves within close range (within 5 m) and throws a lighted bomb into the middle of the school. After the bomb has exploded, fishermen enter the water to collect the fish which have been killed or stunned by the resulting shock wave, using either free-diving or hookah (surface-supplied compressed air) techniques. Typical target species include schooling reef fishes such as fusiliers, surgeonfish, rabbitfish, and snappers, as well as small pelagics such as scad and sardines.

The associated damage of such blasting to the reef framework is well-documented; branching, tabu-

late and foliose hard corals are shattered, while massive and columnar corals are often fractured. Depending upon the distance from the substrate at explosion, a typical 1 kg bottle bomb can leave a crater of rubble of 1–2 m in diameter (McManus et al., 1997; pers. obs.). While this effect is quite localised, reefs which are subject to repeated blasting are often reduced to little more than shifting rubble fields, punctuated by the occasional massive coral head. These reefs face dim prospects for recovery due to the unsuitable nature of unconsolidated coral rubble as a recruitment substrate for coral larvae. Additionally, the greatly-reduced three dimensional structure of such reefs makes them less attractive to emigrating adult and settling larval fishes, reducing their fishery potential for years to come. Finally, in addition to damaging the reef framework, blast fishing results in extensive side-kills of non-target and juvenile fish and invertebrates.

Although blast fishing is illegal in Indonesia, it is still widely practised. In the Spermonde Archipelago in Sulawesi, we estimate that up to 15 per cent of the fishers in some villages are blast-fishermen, with their catches supplying 10–40 per cent of the total landings for the 16 000 km² reef fishery (Pet-Soede & Erdmann, in press). Operations range from individual fishermen using 1–3 bombs per day for subsistence yields (up to 5 kg/day), to large-scale operations involving crews of 15–20 on board 15 m vessels. These larger operations may range several hundred kilometres from their home islands, remaining at sea for 7–10 days and catching up to 2 t of fish per trip. The financial rewards of this risky trade are alluring; divers working for medium- and large-scale operations can clear US\$ 50–150 *per week*, more than many government officials and up to ten times the wage of the average day-labourer in Indonesia.

Blast fishing appears to be much more prevalent in eastern Indonesia, where much lower human population densities lessen the chances of detection and capture by police patrols. Furthermore, observations in the Riau and Kepulauan Seribu archipelagos suggest that schooling fish stocks (and water clarity) are often so reduced in areas of western Indonesia as to make blasting financially non-viable (Erdmann, in press). The situation in these areas may unfortunately be a harbinger of the future of eastern Indonesia as well.

Cyanide fishing

Perhaps the most publicised DFP in Indonesia today is the use of sodium cyanide (in sea water solution) to stun reef organisms which are desired for live capture. Cyanide (locally referred to as 'bius' or 'drugs') is the 'gear' of choice in three

main fisheries in Indonesia: ornamental fishes, live reef food fishes (mostly grouper and Napoleon wrasse), and rock lobsters (*Panulirus* spp.). In each of these fisheries, the basic technique involves divers, often supported by hookah, using bursts of cyanide solution from squirt bottles to stun their targets. While an 'overdose' results in death of the target organism, a properly calibrated squirt allows the diver to easily remove the anaesthetised animal from its refuge in the reef framework, often after some breakage of the coral surrounding the refuge. In addition to decimating target species populations, this practice often results in what Johannes and Riepen (1995) term 'extensive collateral environmental damage'. Cyanide solution in concentrations used to capture large reef fish has also been shown to be lethal to most reef organisms, including smaller fishes, mobile reef invertebrates, and most germane to this discussion, hard corals (e.g. Jones, 1997).

By far the most prevalent of these cyanide fisheries in Indonesia is the live reef food-fish trade, which we focus upon here. This trade in Asia and the western Pacific has been extensively documented by Johannes and Riepen (1995), with additional details of the trade specific to Indonesia provided by Cesar (1996) and Erdmann and Pet-Soede (1996). Here we focus on trends which seem to have developed in the trade since those reports were made.

In extensive interviews conducted by one of us (LPS) during July–August 1997, fishermen, live-fish exporters, and buyers from the primary export destination of Hong Kong all expressed similar concerns over the rapid decline in live fish catches throughout the Indonesian archipelago. Independent evidence from a number of lines of investigation strongly support the claim that the wild-capture of live grouper in Indonesia is declining. In our region of primary focus, the Spermonde in S. Sulawesi, the larger cyanide operations are forced to travel much further afield than was the case in 1995, and the interval between pick-up times by live fish transport vessels (LFTV's) has increased. Part of this is explainable by the trend towards air shipment of live fish (now accounting for approximately 75 per cent of export volumes from S. Sulawesi), but even this trend towards more expensive air shipment hints of a demand for the product which is in excess of supply.

Furthermore, we have witnessed an impressive increase in the prices paid to fishermen for live fish. Since late 1995, prices paid to fishermen for live coral trout (*Plectropomus leopardus*) and Napoleon wrasses (*Cheilinus undulatus*) have almost doubled, from US\$ 11/kg to \$ 18.8/kg for 'super'-sized *P. leopardus* (0.6–1.2 kg) and from US\$ 22.2/kg to \$ 40/kg for *C. undulatus*.¹ While declining stocks are not the only explanation for the increased prices, it definitely appears that demand is outstripping supply.

Underwater observations also suggest declining target species' populations. In underwater visual surveys conducted throughout the Spermonde, the highest-valued species (including *Plectropomus* spp., *Cheilinus undulatus* and *Cromileptes altivelis*) were extremely rare. Even in the Bunaken National Marine Park (which at the time of this writing had three live fish cages anchored within park boundaries), divers report disappointment at the general dearth of grouper and Napoleon wrasse. Additionally, divers working within the live-fish trade report declining sizes of target species, with juveniles now accounting for a substantial percentage of the catch (see description of Riau archipelago below).

Finally, additional evidence of declining catches comes from estimates of overall export volumes. As explained in Johannes and Riepen (1995), the overall export volume of live fish from Indonesia is an extremely elusive figure, complicated by rampant under-reporting of volumes for tax purposes and by potentially large volumes of fish that are caught and exported illegally by foreign LFTV's. Those estimates which have been made have used different sources of information, and have generally not been repeated during successive years, making it difficult to analyse trends in export volumes. Estimates of total wild-caught export volumes in 1995 range from the official government figure of 1003 metric tonnes (t) to 2200 t (Erdmann & Pet-Soede, 1996), upwards to 6000–9000 t (Johannes and Riepen, 1995). By comparison, projected 1997 total export volume ranges from 1080 t (from our own catch estimations²) to 2000–3000 t (Bentley, pers. comm.³), with an intermediate estimate of 1200 t by a prominent Hong Kong buyer (LPS, unpub.). Although comparing these estimates is admittedly a suspect exercise, the general trend does support the hypothesis of a decline in

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1. The price paid to fishers for Napoleon wrasse has actually decreased in S. Sulawesi, apparently owing to the high risks associated with storing these fish, whose export is banned. The July 1997 price for Napoleon wrasse there was US\$ 16/kg.
 2. Based on extensive surveys in 1997, we estimate a total export production (mortality accounted for) of 45 t of live grouper and wrasse per month from Ujung Pandang (note that official fisheries statistics report an average of 16.6 t/month from UP). Assuming that UP accounts for 50% of current Indonesian exports, this gives a projected total export volume of 1080 t.
 3. Based on field interviews and analysis of trends in official fisheries statistics.

wild-caught live fish export. This is in keeping with predictions of a collapse of the Indonesian wild-caught grouper fishery by the year 1999 (Johannes & Riepen, 1995; Cesar, 1996).

An associated trend we have observed recently in the live food-fish trade in South Sulawesi is the move away from direct capture by cyanide-squirting divers to the prevalent use of both hook and line, and especially bamboo mesh 'bubu' traps to catch serranids. These bubu traps are often baited with cyanide-tainted fish, with the objective of anaesthetising the trapped groupers to prevent self-inflicted injury. We estimate that of the total volume of fish exported from S. Sulawesi, almost 55 per cent are now caught by traps and 15 per cent by hook and line, with the remaining 30 per cent caught by cyanide divers.

The reasons behind this apparent shift in capture method appear to be twofold. Most importantly, declining stocks on many of the reef systems of the Makassar Strait make the use of large cyanide catcher boats less efficient and far less profitable than the less capital-intensive medium-scale trap operations. According to Panayotou (1985), this is a common phenomenon in overexploited Asian fisheries; as stocks dwindle, large-scale operations typically experience a negative return to capital while small- to medium-scale operations remain profitable. A further factor contributing to this shift may involve increased 'enforcement' resulting from the publicity over cyanide fishing; owners of large-scale cyanide operations complained that the expensive reputation of the live fish trade meant that they had to pay ever-more-exorbitant 'fees' to continue exporting. Small- and medium scale trap-fishers largely avoid this official censure.

A comparison of live food-fish capture in other regions of Indonesia reveals an interesting spectrum of techniques, which may prove to be a natural progression for the fishery as grouper stocks are progressively decimated. The large-scale cyanide catcher boats described in Johannes and Riepen (1995) are still active on the reefs of remote eastern Indonesia, where grouper are still plentiful enough to make them profitable. Based upon recent observations in the Komodo National Park, these large-scale operations are believed to be efficiently targeting spawning aggregations of groupers on these remote reefs. As adult grouper stocks are decimated, these operations simply move on to new, under-exploited reefs—in much the same way that farmers involved in shifting agriculture cultivate new forest areas as previously-cleared fields become infertile. The situation described above for the reefs of the Makassar Strait appears to be an intermediate step, whereby adult grouper have become too rare to make large-scale

cyaniding profitable, but are still plentiful enough for medium-scale trap fishers to make an excellent living (divers in these trap operations can earn up to US\$ 200 per week, compared to \$ 50 per week for cyanide divers in S. Sulawesi). In the Riau archipelago of Sumatra, a terminal stage in the live grouper fishery appears to have been reached. Here, almost all capture is also done using bubu traps (with no evidence of cyanided bait), but the collected fish are rarely of marketable size. Instead, most fish collected are fingerlings of the 100–300 g size. Practically every village visited in Riau is involved in grow-out of these fingerlings, which are typically fed 'trash' fish for 4–8 months before being exported to Singapore at 500–700 g. Johannes and Riepen (1995) discuss the poor conversion ratios achieved during grouper grow-out, as well as the dangers of fingerling capture in recruitment-limited fish species such as some serranids appear to be.

Finally, the situation in Kepulauan Seribu (NW Java) is almost post-apocalyptic in nature: serranids appear so rare that no targeted fishery for them was observed (Erdmann, in press). In its place, teams of 6–10 rag-clad skin-divers were frequently observed methodically combing the reefs for ornamental fishes. These men were each outfitted with cyanide squirt bottles and hand nets, diving amongst the mostly dead coral heads in search of any flash of bright colour. Sadly, this form of cyanide fishing is the most destructive observed; with a wider range of target species, much larger volumes of cyanide are used, often with daily-repeated exposures. Moreover, this is a small-scale, relatively high value fishery with little capital investment required, rendering it virtually impervious to economic overfishing. It appears the sad fate of these reefs that they may be cyanided until they are reduced to barren carbonate skeletons supporting little more than a community of bioeroders and algae.

Trap fishing (bubu)

The use of bamboo mesh traps, locally known as bubu, is widespread throughout Indonesian reef fisheries. As described above, this gear is experiencing a resurgence of popularity due to its use in the live reef food-fish trade. Although this gear is not intrinsically destructive, the process of setting and retrieving the trap is largely responsible for the destruction, if any, wrought on the reef. Bubu traps set and retrieved by hookah divers are typically the least damaging, as these traps are often set at the base of the reef slope (though they are occasionally 'camouflaged' by covering with live coral fragments). Those traps set by simply lowering the trap from boatside via a buoyed rope are responsible for the most reef damage. These traps

are often heavily-weighted with wooden 'runners', and can destroy entire stands of branching and foliose corals on the reef slope during their installation and especially removal (by pulling on the rope). If the current trend towards trap-use in the live grouper fishery continues, bubu trap activities will become an increasingly important source of reef damage in Indonesia.

Muro-ami

Muro-ami is a type of drive-in net fishing technique whereby a line of fishermen in the water use scare-lines (typically a line with pieces of sheet or plastic tied off at regular intervals, with a weight on the end) to drive fish down a reef towards a bag net. The scare lines are rhythmically lifted and dropped into the reef framework, often breaking live corals while the fish are driven ahead. Despite the reported widespread prevalence of this technique in the Philippines and elsewhere, the authors have only observed this DFP on a few occasions in Indonesia, notably in the international border areas of Sangihe-Talaud and Riau, as well as in Pulau Seribu. Muro-ami is historically widespread in Pulau Seribu, with the main target being caesionids (fusiliers). In 1995, one of us (M. Erdmann) observed a modified form of muro-ami in Kepulauan Seribu involving a mother ship, three canoes and 20 men, including eight divers on hookah support. In this operation the divers used a wall of exhaled bubbles as their scare line, in addition to banging on the reef framework with hollow metal pipes. The yield from this three hour operation was roughly 15 kg of fusiliers and 15 kg of 'trash' fish. In sharp contrast to the lucrative DFP discussed above, the men in this operation reported making an average of US\$ 25–40 *per month*, plus daily portions of trash fish.

'Tiger' nets

The final DFP we shall mention are inshore bottom-trawlers, locally known as 'harimau' or 'tiger' nets. Commonly operating over soft-bottom communities, these trawl nets (which frequently target prawns) can severely disturb the seabed and result in large percentages of unwanted bycatch. For these and other reasons, trawl nets have been banned from use in Indonesia since 1980. Because of this, trawl net operations are rarely observed in Indonesia, though they are frequently reported in the international border areas of Riau (allegedly Thai trawlers) and Sangihe-Talaud (reputedly Filipino trawlers). Recently, however, another type of tiger net has been reported from N. Sulawesi, the so-called 'curtain of death' in the Lembeh Strait (Cochrane, 1997). Though not considered a DFP by our definition, this Taiwanese-sponsored trap net has had such a devastating effect on the marine

resources of N. Sulawesi as to merit a brief mention here. Set across the narrow, plankton-rich Lembeh Strait, this extensive trap-net system operated for at least 11 months in 1996 and 1997, capturing during that time over 1400 manta rays, 750 marlin, 550 pilot whales, 300 sharks (including whale sharks), and 250 dolphins, among others (Cochrane, 1997). Though the net has been removed (at least temporarily), its effect on the budding ecotourism/diving industry in North Sulawesi is only beginning to be realised.

Comparison of DFP effects

While all of the above mentioned techniques are considered destructive, it is useful to examine the comparative damage wrought by each in order to prioritise management/enforcement activities. Such a comparison is obviously dependent on two factors: 1) the amount of destruction caused by one 'unit' of each DFP (e.g. one bomb), and 2) the frequency of use of each DFP (making this comparison site-specific). In our Indonesian experience, muro-ami and inshore trawling are generally so infrequent as to place them low in this comparison, despite their potential for habitat degradation. Likewise, bubu traps are not intrinsically damaging, though the increase in frequency of use for the live fish trade coupled with damaging installation techniques indicate that this is a growing source of reef degradation in Indonesia. In terms of overall destructive capacity though, blast fishing and cyanide fishing are indisputably the 'heavy-weights'. But which one poses the greatest threat?

In our opinion, blast fishing in Indonesia is by far the more destructive force. While reports from the Philippines indicate that cyanide fishers there often use vast quantities of the poison (Johannes & Riepen, 1995, report an incident of dumping 200-litre drums on the reef flat!), our experience in Indonesia has been that fishers are quite sparing in their use of cyanide. The observed result is that one bout of cyanide fishing on a reef kills far fewer corals than a day of blast fishing. This comparison is supported by McManus et al (1997), who suggest that coral death from cyanide exposure 'may not be that high.' A modeling exercise reported by those authors suggests that blast fishing is significantly more destructive to reefs, both in terms of causing higher mortality and greater reduction in the regrowth capacity of hard corals. In an economic analysis of Indonesian coral reefs, Cesar (1996) also shows that blast fishing accrues a larger cost to society than cyanide fishing, primarily by destroying a wider fisheries base and by impairing the coastline protection function of fringing reefs. Interestingly, many of the exporters in the live grouper trade made these points as well during interviews. One exception to this generalisation

was the situation observed in Pulau Seribu, where teams of divers were subjecting reefs to daily exposures of high concentrations of cyanide while searching for ornamental fishes—this type of treatment may actually be worse than blasting.

We do not mean to suggest that cyanide fishing in Indonesia is a minor environmental threat with reduced need for management. To the contrary, cyanide fishing may in large part be responsible for local extirpation of grouper stocks throughout Indonesia, and its use precludes the development of what could be an extremely lucrative *and* sustainable fishery (Johannes & Riepen, 1995). Our point is simply that although blast fishing is a more decentralised fishery with a lower public profile than the 'big-money' cyanide trade, it is nonetheless an extremely damaging practice which is deserving of top prioritisation in reef management and enforcement agendas.

Ethnic groups involved and socio-economic background

Although destructive techniques are practised throughout Indonesia, certain ethnic groups seem particularly partial to the use of DFP. These groups include the Bugis, Bajau and Makassarese of Sulawesi, and the Madurans of NE Java. Representing the strongest sea-faring traditions in Indonesia, these four groups range widely throughout the archipelago, occasionally travelling over a thousand kilometres from their homes in search of under-exploited reefs. This extreme mobility results in two important characteristics of DFP in Indonesia: 1) Paradoxically, the most remote reefs in Indonesia are often the most destroyed; and 2) As these fishers are not bound to a 'home' reef system, they are never forced to deal with the destruction they bring to bear. Rather, as one reef system becomes unproductive, they simply move on. An interesting counter-example of this phenomenon comes from a Bajau village in the Tukang Besi archipelago, where these normally nomadic fishers were settled into a permanent village. One of the elder fishermen in this village explained that their fishermen had mostly given up blast-fishing after dramatic declines on their home reef were attributed to this DFP (Jos Pet, pers. comm.). This isolated experience provides support for the widely-held belief that education and especially marine tenure systems may be an excellent means of controlling DFP (see below).

One further important socio-economic characteristic of DFP in Indonesia is that the fishers involved typically earn very high salaries, often much more than government officials or university professors. This is in sharp contrast to the widely-held belief that small-scale fishermen in Asia are typically

'forced' to enter destructive fisheries by poverty from Malthusian overfishing (Pauley and Thia-Eng, 1988; Sloan and Sugandhy, 1994). In many cases on remote eastern Indonesian reefs, DFP may actually be the *first* technique to be used to capture reef fishes (local villages often focus traditionally on fisheries of small pelagics instead). Surprisingly, Panayotou (1988) notes that the socio-economic status of small-scale fishermen in Asia in general is often much higher than supposed, with incomes often equalling or surpassing national averages. In Indonesia, it definitely seems the case that the driving force behind the use of DFP is as much greed as it is need.

Scope for management

Managing the diverse range of DFP used in Indonesia will undoubtedly require a multi-faceted approach, involving such actions as increasing enforcement of the existing laws against DFP, educating both fishers and government officials involved directly and indirectly with DFP, curbing the demand for DFP products, and promoting reef ownership rights within Indonesia. Below we briefly touch on each of these approaches while noting primary obstacles to their implementation.

Enforcement of Indonesia's existing anti-DFP laws faces a number of challenges, but we envision a three-pronged approach involving restricting access to materials needed for DFP, enforcement in the field, and enforcement at the landing sites and point of export. Restricting access to materials is perhaps the most difficult approach, as most Indonesian DFP utilise commonly-available materials, including fertiliser and kerosene for home-made bombs and sodium cyanide (which is used widely in the electroplating and mining industries). However, one of the materials needed for making bombs is both illegal and in short-supply—waterproof fuses. Truly restricting the availability of these fuses may help deter bomb production.

Enforcement in the field is often difficult as well; blast fishers and cyanide fishers simply dump bombs and squirt bottles overboard when a police vessel approaches. One innovative approach to combating this in the Komodo National Park is the outright ban of hookah equipment within the park—fishers are presumably much less apt to drop their compressor overboard when approached by a patrol (Jos Pet, pers. comm.).

Enforcement at landing sites and point of export is currently not an option in Indonesia, as the laws against DFP generally require that fishers are caught 'in the act' in order to prosecute them. If the

laws were expanded to make it illegal to possess cyanide-tainted fish or blast-caught fish, the potential for prosecution would be greatly enhanced. Such a change would allow the use of cyanide-detection tests such as those used in the Philippines (Barber & Pratt, 1997). The increasing trend towards air export of live fish would facilitate this process; cyanide-detection labs could be strategically located in each of the international airports in Indonesia. Using this approach on blast-caught fish is more logistically challenging; not only are these fish marketed at a much more decentralised network of landing sites, it is also more difficult to indisputably prove that fish were caught by blasting. The sale of schooling reef fishes with characteristic shattered backbones, bulging eyes and burst capillaries could at least provide the evidence needed for further investigation. With any of these enforcement approaches, the full cooperation of government officials is obviously a prerequisite, something which the extremely lucrative nature of these DFP often prevents.

Though seemingly obvious, educating fishers and government officials to the extremely short-lasting economic benefits of DFP and the long-term effects on local reef fisheries is an approach which is still desperately needed in Indonesia. In our experience, fishers rarely show any ecological appreciation of the maxim that 'healthy reefs = healthy fisheries', and the government officials charged with enforcing anti-DFP laws are rarely given any explanatory background on *why* such practices are illegal. An encouraging example of the value of such education involves the villages in the Senayang district of Riau, one of the chosen sites for the Indonesian COREMAP (Coral Reef Rehabilitation and Management Project). Pre-COREMAP educational activities in the district have resulted in both a district chief and fisher communities which can at least clearly verbalise the threats of DFP and their commitment to alternative methods. For policy-makers in Indonesia, the 'bottom line' seems to be an effective approach; the results of Cesar's (1996) 'Economic analysis of Indonesian coral reefs' have received widespread media coverage and generated a lot of discussion within government circles (M. Erdmann, pers. obs.). Continued educational efforts towards these ends are badly needed.

Curbing the demand for DFP products, especially those from the export-oriented live capture fisheries, is another important approach which unfortunately faces strong consumer resistance. Johannes and Riepen (1995) describe the obstacles faced by aquacultured grouper in the Chinese market, where 'rarity and wildness are major gastronomic virtues.' It may be a bitter pill to swallow, but those governments involved in exporting and

importing these products may have to face the very real possibility that the current demand for live, wild-caught grouper, wrasse and rock lobsters is so far in excess of the supply that 'sustainable' fisheries for these groups are impossible.

A final approach to combating DFP that has been widely-suggested is the promotion of local marine tenure systems as a means of encouraging villagers to protect their own reef resources (Panayotou, 1985; Johannes & Riepen, 1995). This approach has been highly successful in protecting marine resources in both Asian and Pacific Island cultures with long-standing tenure systems. As described above, the example of the settled Bajau village in Sulawesi demonstrates that 'owning' a reef not only encourages better management of reef resources but also promotes greater ecological understanding of reef processes.

Unfortunately, the current Indonesian framework for coastal resources management is highly sectoral and relies mostly on agencies at the national level; a current management priority is transferring some of this national authority over marine issues to provincial governments (Sloan & Sugandhy, 1994).

Furthermore, marine tenure systems require a strong, socially-structured community of fishers, a condition which is uncommon in our Indonesian experience. Rather, many fishing communities in Indonesia, especially those in South Sulawesi, seem to support the open-access nature of reef fisheries there, and show little interest in efforts to restrict this access. Again, this is likely related to their ultra-mobile fishing style; these fishermen rarely share the perception that overfishing is a problem, and may even view reef ownership as an unwanted infringement which would restrict their current mobility. Even in the Maluku region, the well-known *sasi* system of traditional marine tenure has generally ceased as the social structure of the fishing communities has been eroded by unemployment, emigration and short-term economic aims (Zerner, 1994). Against this social and infrastructural backdrop, village-based reef ownership schemes face an uphill battle in many parts of Indonesia.

Despite these problems, progress is now being made in strengthening village-based management of coral reefs in some areas of Indonesia. A notable example is the USAID-sponsored Coastal Resources Management Project (CRMP) in North Sulawesi, which is applying several different approaches in instituting community-based reef management schemes in three villages there, based upon models developed in the Philippines (Malik et al., in press). Progress to date is encouraging, and both provincial

and national-level officials appear very interested, if not outright supportive (Crawford, pers. comm.). The initial successes the CRMP has registered serve to highlight the value of applying lessons learned from countries with well-developed local marine tenure systems to establishing such systems in Indonesia. Indeed, there is now a wealth of information on the successes and failures of co-management of coral reefs from a number of Asian, African and Pacific Island nations (e.g. White et al., 1994) which should help to guide development of reef ownership schemes in Indonesia.

The preceding overview of DFP in Indonesia details more obstacles to than successes in efforts to curb the use of habitat-destructive fishing practices. Nonetheless, increasing public awareness of DFP and its devastating effects on Indonesia's reefs, especially among government policy-makers, provides reason for optimism in efforts to promote a reef-friendly fishing tradition throughout Indonesia.

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Authors' note on effects of Asian monetary crisis

The preceding discussion of the economics of DFP in Indonesia is based upon data from interviews with fishermen through October 1997, before the effects of the current Indonesian financial crisis were being felt. It is not yet clear how the crisis will affect the use of DFP in Indonesia. On the one hand, more fishermen may be tempted by the relatively large financial rewards of using DFP, especially now that more traditional methods may not provide enough income to purchase now-expensive basic commodities like cooking oil. On the other hand, many of these DFP involve relatively expensive operations, including hookah compressors (requiring expensive imported spare parts) and the use of large, far-roving motorised vessels. If fuel subsidies are backed off in April 1998 as planned, those activities, which require large amounts of petrol, may become less profitable. This seems especially likely considering the fact that although prices for

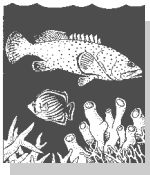
almost all basic commodities in Indonesia have risen up to 500 per cent since the rupiah devaluation in November 1997, the price of fresh fish has remained the same (owing to its perishability). This should make blast fishing, for example, much less profitable.

A related issue is the effect of the rupiah devaluation on prices paid for live reef food fish. As of January 1998, prices paid to fishermen in S. Sulawesi had only increased slightly (10–20% over those reported herein for September–October) compared to a 75 per cent devaluation of the rupiah. The net effect is that fishermen are now being paid a lot less (in terms of US\$) for the same fish. We intend to continue tracking the effects of the financial crisis on Indonesian DFP and will report further in the next issue of the *Live Reef Fish Information Bulletin*.

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Wild collection of juveniles for grouper mariculture: just another capture fishery?

by Yvonne Sadovy¹ & Jos Pet²

Heavy fishing pressure in Southeast Asia has led to declines in fish catches and overexploitation of many demersal fish stocks, yet demand for fish is projected to grow rapidly, especially in certain sectors such as the high-value live reef-fish trade (LRFT) (e.g. Johannes & Riepen, 1995; Sadovy, in press). Mariculture is viewed as one possible way of relieving pressure on fish stocks, as well as a means of filling the increasing demand–supply gap for marine fishes (Williams, 1996). In discussing the contribution of aquatic resources to global food security, however, Williams (1996) cautions that ‘There is potential for aquaculture to make a large contribution to world food supply, but only if it is environmentally sustainable’.

Most fish culture in Southeast Asia is based on the collection of juveniles (fry or fingerlings) from the wild and their grow-out in captivity to marketable size. Fish production based on grow-out is generally considered, for statistical and management purposes, to represent ‘mariculture’, rather than ‘capture fishery’, production, even though juveniles are taken from the wild, because there is intervention (feeding) in the rearing process to enhance production (e.g. the Food and Agriculture Organization). The possible impacts on stocks of the removal of juveniles from the wild for mariculture, and whether or not production is actually

enhanced through this kind of mariculture practice, are rarely considered. This is despite general concerns that ‘For too long fisheries and aquaculture have been treated as sectors in isolation, a practice that has ignored important linkages and externalities’ (Williams, 1996). We need to examine some of these linkages.

A critical question is whether mariculture practices based on the capture of juveniles from the wild are sustainable, or could be modified to become so. We examine these questions using groupers as an example, because groupers are widely cultured in the region, and are highly desired and valued in the LRFT. They are also among the most vulnerable of the reef fishes to exploitation (e.g. Huntsman et al., 1993; Sadovy, 1996).

In pelagic spawning (in which eggs are released and then drift away) fishes, such as the groupers, early natural mortality rates must be extremely high between egg production and settlement (when young fish change from their planktonic to their benthic phase). This follows from the fact that, in her lifetime, each female is capable of producing millions of eggs but will, on average, only produce two young that survive to adulthood under stable population conditions. What is not known is where the bulk of this early natural mor-

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tality occurs. If natural mortality remains high for some time after settlement, then the removal of young juveniles for mariculture grow-out may have little impact on adult stocks, because most juveniles taken would otherwise perish due to natural causes. If, on the other hand, early natural mortality rates have dropped to low levels *prior* to juvenile capture, then fishing mortality will represent an important source of total mortality (which is fishing mortality plus natural mortality). If this is the case, such capture may not be sustainable and should be managed as a capture fishery. What do the existing data indicate about early natural mortality rates in reef fishes?

Natural mortality drops rapidly during the early post-settlement period in tropical reef fish, i.e. several weeks or months following settlement. In juvenile gag grouper (*Mycteroperca microlepis*), for example, which settle into seagrass beds in the Gulf of Mexico, survivorship in the first three months following settlement is highly variable, but can reach 100 per cent (Koenig & Colin, in press). In non-grouper reef species, mortality rates vary markedly but, overall, they drop quickly; of 17 species examined for the first 45 days after settlement, the highest levels of mortality occurred in the first one to two weeks with substantial drops in mortality after the first month (Sale & Ferrell, 1988; S. Holbrook, pers. comm).

In New Zealand's lobster fishery the relationship between the number of puerulus (i.e. settlement) stage lobster and adult stock size is acknowledged through recently enacted legislation, which imposes a quota system for puerulus collections because of their presumed impact on adult stock size (Michael Riepen, personal communication). In sum, these examples strongly suggest that post-settlement mortality drops within a few weeks or months of settlement on a reef across a wide range of species and, moreover, that harvest after this early period can negatively influence subsequent stock size.

The sizes of grouper juveniles taken for mariculture range from 20 to 120 mm total length (TL), depending on location, species, time of year, and capture method used, among other factors (Sadovy, unpubl. data). Juvenile grouper settle at about 20–25 mm TL and data on their early growth rates indicate these to be about 10 mm/month (e.g. Beets & Hixon, 1994; Sadovy et al., 1992; Light & Jones, 1997). This means that fishes taken for culture may be anything up to a year old at capture and, therefore, that many are probably taken well beyond the early weeks or months post-settlement. If this is the case, then fishing mortality represents a substantial proportion of total mortality and the fishery should be managed to avoid overfishing.

It could reasonably be argued that, if current juvenile collection methods are unsustainable, juveniles could be caught at an earlier stage, for example as they settle out from the plankton. It may indeed be possible to develop such techniques for groupers (e.g. Vincent Dufour, pers. comm.). However, some species of grouper evidently settle out of the plankton over very limited time periods each year, often into quite specific habitats (Shenker et al. 1993; Doherty et al., 1994). It is possible, therefore, that heavy targeting at such times or places may threaten local stocks, because annual recruitment pulses are so spatially and temporally concentrated that a substantial proportion of the annual recruitment into a particular area could be removed. In sum, we need to understand much more of the biology and population dynamics of target species before advocating the introduction of techniques that are potentially harmful.

It has also been proposed that artificial habitats might enhance the survivorship of settling juveniles by providing supplementary shelter, thereby increasing net survivorship through protection from predation. The critical question here is whether natural mortality is reduced by artificial habitats such that the 'excess' survivors, i.e. the juveniles that would otherwise have perished, can be harvested, or, alternatively, whether artificial habitats attract significant numbers of juveniles that would otherwise settle successfully in natural habitats thereby increasing total mortality.

To understand the basis for fishery production and to evaluate possible ways of improving it, two key questions must be resolved: (1) are fish stocks recruitment (or habitat) limited, i.e. limited mainly by the number of fish settling out of the plankton (e.g. Doherty & Williams, 1988; Lewin, 1986), or, alternatively, by sufficient shelter (habitat) to allow recruits (settling fish) to survive after settlement (e.g. Smith & Tyler, 1972), and (2) *if* populations are habitat-limited, do artificial habitats increase survival or simply concentrate recruits making them easier to catch. These are difficult but important questions that must be addressed rigorously before promotion of large-scale implementation of artificial habitats is advocated as a possible means of enhancing fishery production. Evidence for increased survival conferred by artificial habitats is limited, and their possible role in fisheries enhancement, in general, remains controversial (Bohnsack, 1989).

One harvest method which may enhance survivorship of settling juveniles (i.e. allow more juveniles to survive than would do so naturally) is the fish nest or 'gango' that has been developed in the Philippines (Ogburn & Ogburn, 1994; Johannes, 1997). The gango is essentially an artificial habitat

of rock sand branches into which fish settle or migrate. What is needed is an Environmental Impact Assessment (EIA) of gangos based on appropriate monitoring and experimental protocols to assess their capacity for enhancing the net survivorship of settling groupers. Such a study is being proposed under the auspices of The Nature Conservancy and The University of Hong Kong.

If wild capture of juveniles is not a sustainable basis for grouper mariculture and threatens to increase the risk of overfishing local stocks; if, in answer to the title to this article, it is just another capture fishery, then what are the possible options to supply mariculture? The most promising alternative is hatchery-rearing. While still in its early stages for the groupers, it could be pursued aggressively so that hatchery-reared juveniles could increasingly replace those taken from the wild. The reliable and stable hatchery production of juvenile grouper on a commercial scale is an excellent basis for the large-scale development of mariculture. Hatchery-based mariculture operations are already commercially viable for several *Epinephelus* species in Taiwan (e.g. Liao, 1993; Johannes & Riepen, 1995) and *E. coioides* has been successfully cultured in Bahrain (Uwate & Shams, 1997). The potential exists; what is needed is the economic commitment to proceed.

To evaluate the sustainability of using wild-caught grouper juveniles for mariculture, we concur fully with Johannes (1997) that we need to learn a lot more about the biology of, and fisheries for, juveniles caught for grow-out. We also agree that such research is only really possible if funded by governments, regional agencies or large NGOs. We would go further to suggest that funding from such sources also be sought to seriously explore ways of promoting and developing a hatchery-based mariculture industry and to plan on a more long-term basis for mariculture to contribute increasingly to world food security.

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Grouper and snapper aquaculture in Taiwan

by Mike Rimmer

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A previous article outlined the status of marine finfish aquaculture in Taiwan (see Austasia Aquaculture 11(5)). Some of the highest value finfish species being cultured, or developed for culture, in Taiwan are groupers (Family Serranidae) and snappers (Family Lutjanidae). Groupers and snappers are in demand not only in Taiwan but also in other parts of Asia, for example, in the live markets of Hong Kong and southern China, where they bring up to \$A 87/kg (Dragon Search, 1996). This article deals with the technical aspects of production of groupers and snappers in Taiwan.

Broodstock

A particular feature of marine finfish aquaculture in Taiwan is that broodstock of most, if not all, species cultured are maintained in outdoor ponds. These ponds are up to 0.3 ha in area and 2–4 m deep. Stocking density is usually around 300 fish in a single 0.2–0.3 ha pond, which for king grouper (*Epinephelus lanceolatus*) represents a biomass of up to 10 tonnes (t) in a 0.3 ha pond. Some other fish species—e.g. milkfish—may be held at lower density (100 fish per pond) due to their greater space requirement. Broodstock ponds have one or two paddlewheels to aerate and circulate the water, but only low rates of water exchange. The fish are fed every three days with trash fish, and every two or three weeks with squid stuffed with a vitamin supplement.

Generally, the fish breed naturally in the ponds. At the height of the breeding season up to 20 kg of eggs (c. 30 million eggs) are produced per day by the 300 broodfish in a single 0.2 ha grouper broodstock pond. Eggs are sold by weight. Hormone

induction appears to be rarely carried out, although I did observe king grouper and sea bass (*Lates calcarifer*) on two farms being injected with HGG as they were transferred between ponds. According to the farmers, hormonal induction is usually carried out to encourage the fish to breed earlier in the season than would occur without this intervention. Fingerlings produced early in the season, when demand is great and supply is small, attract higher prices than those supplied later in the season, so there is an economic rationale for inducing broodstock to spawn early. Researchers from the Taiwan Fisheries Research Institute (TFRI) have developed techniques for cryo-preservation of grouper sperm, and this technique has reportedly been used in at least one Taiwanese hatchery (Chao et al., 1992), but it appears not to be in widespread use.

Larviculture

Larviculture is undertaken using either the 'indoor method' or 'outdoor method'—i.e. in concrete tanks indoors or in outside ponds. The compara-

tive advantages and disadvantages of each technique are listed in Table 1. To a large extent, the use of a particular method depends on the location of the hatchery; the indoor method is more common around the Pingtung district in southern Taiwan, while the outdoor method is common in the Tainan district in southwestern Taiwan. The larval-rearing technique used also varies with the species cultured. Groupers are reared using both indoor and outdoor methods, as is red sea bream (*Pagrus major*), but red snapper (*Lutjanus argentimaculatus*) is reared using only the outdoor method.

Indoor method

The indoor method is basically traditional Asian intensive larval rearing, undertaken in large fibreglass or concrete tanks up to about 100 m³. The rearing tanks are circular or rectangular in shape, flat-bottomed and with a white or light-coloured interior. Larviculture is undertaken using either greenwater or clearwater techniques. The algal density used for greenwater culture ranges from 50 000 to 500 000 cells/ml. Variables such as algal density are measured only in research hatcheries; commercial hatcheries just add algal cells until the desired shade of green is reached.

The eggs are generally added directly to the larval-rearing tanks. Occasionally they are placed in hatching tanks, and then the newly hatched larvae are transferred to the rearing tanks; this process enables larval density to be estimated more accurately. Grouper larvae are fed oyster trochophores from first feed (usually D4) for two days. Rotifers are also added to the rearing tanks, generally com-

mencing from first feed. Recent research at TML indicates that a combination of oyster trochophores and small rotifers (either SS-strain, sieved S-strain, or neonates) is the best initial feed (Su et al., 1996). Rotifer densities are maintained at about 2–3/ml until the grouper larvae are large enough to eat brine shrimp or adult copepods, which is when the dorsal and pectoral spines reach the end of the caudal fin. Generally, grouper larvae are able to feed on adult copepods from D16 (water temperature >26°C) or D22 (<26°C).

Outdoor method

The outdoor method of larval rearing is undertaken in concrete or earthen ponds ranging in size from 200 m² to 0.5 ha, and, less commonly, to 1 ha. The ponds are filled only 1–2 days before being stocked with eggs. The inlet is screened with a fine mesh 'sock' filter to exclude potential predators and nuisance species. Stocking density for grouper ranges from about 1 kg of eggs (i.e. circa 1.5 million eggs) in 0.1 ha to 2 kg (c. 3 million eggs) in 0.2–0.5 ha larval-rearing ponds. For red snapper eggs, stocking densities are 2–3 kg (c. 3–4.5 million eggs) for ponds up to 1 ha.

One or two enclosures formed by a tarpaulin set around a floating support structure are set up in the pond, usually with shade cloth overhead to reduce light intensity and mild aeration to ensure adequate dissolved oxygen and mixing of the water within the enclosure. The enclosures range in size from 5 m³ in small concrete ponds to 8–10 m³ in earthen ponds 0.2–0.5 ha in area. The enclosures are pumped full of pond water and fer-

tilised grouper or snapper eggs are added to the enclosures. Oyster trochophores are added to the enclosures from first feed (usually D4) for two days, then the larvae are released into the pond. The enclosures allow smaller quantities of oyster trochophores to be fed while retaining relatively high prey densities. They also allow farmers to visually estimate larval survival after the first few days of culture, which is the period when most mortality occurs. If survival is very low, the farmer may choose to restock the enclosure with another batch of larvae, rather than release the survivors into the pond.

Rotifers (and, incidentally, other zooplankters) are cultured in small concrete or earthen ponds,

Table 1: Comparison between the indoor and outdoor larval-rearing systems (from Liao, 1995)

	Indoor	Outdoor
Tank or pond depth	1.0–2.0 m	1.0–1.5 m
Water volume	< 100 t	> 100 t
Survival rate (early stage)	High	Unstable
Feed supply and water control (late stage)	Poor	Easy
Larval growth	Slow	Fast
Seed quality	Poor	Good
Production cost	High	Low
Filamentous algal growth	Impossible	Possible

usually about 0.05–0.1 ha. The rotifers are cultured using trash fish placed in fertiliser bags and left to decompose in a corner of the pond, or by the addition of organic wastes. A paddlewheel aerator is placed in the pond to assist with aeration and to generate a current in the pond. Zooplankton is harvested using a fine (c. 85 µm) mesh net that is set downstream from the paddlewheel aerator for 1–2 hours. The collected zooplankton is added to the larval-rearing pond. Farmers attempt to maintain rotifer density at about 3–4/ml, but like other aspects of pond management, rotifer density is not measured, but is maintained 'by eye'. Later in the larval-rearing cycle, adult copepods are harvested from the zooplankton production ponds using the same technique, although with a larger mesh (c. 210 µm) mesh net. Some farms pump water from rotifer production ponds into the larval-rearing pond, and may also pump zooplankton-rich water from growout ponds into larval-rearing ponds.

The larvae are reared in ponds until they reach 2.5–3 cm total length (TL), when they are harvested. In the case of grouper and snapper, this takes about four weeks. Pond temperatures need to be above 20°C to ensure any larval survival for grouper; if they drop below 18°C, the grouper larvae will die. For this reason, some farms will not buy grouper larvae until April, even though eggs are available from early March. In addition, farmers feel that the quality of eggs produced early in the season is inferior to those produced later.

Survival of groupers and snappers using both indoor and outdoor larval rearing methods is highly erratic, but generally low. One farmer using the outdoor method told me that he would be very happy to harvest 100 000 fingerlings from his 0.1 ha larval-rearing pond, which would correspond to 7 per cent survival. Researchers at TFR's Tung-kang Marine Laboratory (TML) report that a major constraint to grouper aquaculture is the irregular nature of larval survival. The major problem, according to TML researchers, is high mortality at first feed, although there is often low-level mortality throughout the larval-rearing process.

Nursery

Grouper

Two pond-culture systems are used for the nursery phase of grouper farming: the small pond and large pond systems. The small pond system uses ponds about 100 m² in size, within which are placed small cages (1.2 m x 0.8 m x 0.8 m). Maximum stocking density per cage is 2000 fingerlings at 6 cm TL. The large pond system is usually used during winter, since handling juveniles at low water temperatures will cause disease and mortal-

ity. Imported grouper fingerlings are cheaper in autumn and winter (\$US 0.2–0.4/fish for fingerlings 2–2.5 cm TL) than in spring (\$US 2–3/fish), so farmers may purchase fingerlings and stock them in large ponds over winter. Before the ponds are stocked with fish, small shrimp (*Palaemon* spp.) are stocked to provide prey for the juvenile groupers. Chopped small trash shrimps and fish are also supplied as supplementary feed. However, results of this type of culture are reported to be inconsistent. Grouper fingerlings are fed a range of different feed types, including adult brine shrimp, small shrimp (*Acetes chinensis*), small gobies (*Gobiidae*), and mosquito fish (*Gambusia* spp.) (see Liao et al. 1995).

Grouper fingerlings are fed four to six times a day at the beginning of stocking, but feeding is gradually reduced to twice a day when they reach about 6 cm. Groupers are fed to satiation to reduce cannibalism. Food conversion ratios (FCRs) for *Epinephelus marabanicus* range from 2.2:1 to 3.6:1 for wet nursery feeds and 0.8:1 for eel (dry) feed, for a fish body weight of 3.4–14 g. Growth to 6 cm takes about one to one-and-a-half months during summer (26°C), and three months during winter (20–24°C). Continuous grading at five-day to seven-day intervals is necessary during the nursery stage to reduce cannibalism (Liao et al., 1995).

Red snapper

The main diet for red snapper in the nursery phase is the shrimp *Acetes chinensis* and chopped trash fish. Red snapper fingerlings produced during summer are usually sold directly to growout farmers, but fry produced in autumn are usually stocked in nursery ponds for over-wintering and sold the following spring for higher prices. Prices for red snapper fingerlings are low: \$US 0.04–0.08/fish at 2.5–3 cm TL, and most fry are exported (Liao et al., 1995).

Growout

Grouper

Grouper are farmed in cages and in ponds. Growth rates for *E. coioides* are better for cage culture: 8–10 months from 6 cm TL to market size of 400–800 g in cages, versus 10–14 months in ponds. King grouper (*E. lanceolatus*) are prized because of their rapid growth. According to Mr Tai (Long Diann Trading Company Ltd, Pingtung), from 75 mm fingerling (c. three months old) they reach 2.4 kg in 12 months and 15 kg in two years. King grouper are also being cultured in Thailand, which reports similar growth rates of 2–3 kg in 12 months (R. Yashiro, pers. comm.).

Although trash fish has traditionally been the preferred feed for grouper growout, more farmers are

now utilising pellet feeds (mainly moist pellet feeds). About 70 per cent of Taiwanese grouper farmers now use artificial feeds. Fish are initially fed twice a day, but this is reduced to once a day when they reach 200 g. In winter, fish are fed every other day before sunset; in other seasons, they are fed every morning. FCRs for grouper range from 4:1 to 5:1 for trash fish, and 1.2:1 to 1.4:1 for moist pellets. Grouper in ponds are stocked at 2–7 fish/m² and typical production rates are 10–30 t/ha/crop (Liao et al., 1995).

Red snapper

Red snapper are stocked at 3–5 fish/m², and take about 12–18 months to reach the preferred market size of 400–1000 g. Typical production rates are 15–20 t/ha/crop. Red snapper are fed moist pellet feed, dry floating pellet, or trash fish. FCRs range from 2.2:1 to 2.5:1 for moist pellet and from 7:1 to 9:1 for trash fish. Red snapper are graded one month after stocking, when the fingerlings have reached 9–12 cm TL (Liao et al., 1995).

Red snapper are tolerant of low oxygen conditions, with a lethal oxygen concentration of 1.2 mg/l for fingerlings 4.7–5.2 g at 30°C and 25 ppt. The body colour of red snapper darkens when the fish are fed artificial feeds and cultured at low salinity (3–10 ppt). Dark-bodied fish bring lower market prices. Body colour can be improved by supplementing the feed with shrimp heads, xanthophyll or astaxanthin for two-to-three weeks before harvesting (Liao et al., 1995).

Disease

Grouper

Grouper diseases in the nursery include swim bladder inflation syndrome, white spot (*Cryptocaryon irritans*), and whirling disease (possibly viral nervous necrosis or VNN). Swim bladder inflation syndrome mainly occurs during metamorphosis and may be due to a deficiency of highly unsaturated fatty acids (HUFAs) in the diet. An unknown factor causes high mortality of fish 3–4 cm TL; symptoms include darkened body colour, loss of appetite, reduced activity, and aberrant behaviour such as facing the pond wall and sitting on the substrate while maintaining swimming motions (Liao et al., 1995).

The predominant disease of grouper in growout is white spot (*Cryptocaryon tritans*), which causes high mortalities in autumn. In the early stages of infection the fish can be treated with 30 ppm formalin and 0.35 ppm copper sulfate. Infected fish may be moved to another pond. The fish leech *Piscicola* sp. is also a problem in grouper growout.

Although this parasite does not cause mortality, infected fish lose their appetite and their market value is diminished due to their appearance. Taiwanese farmers state that fish leech infestations can be reduced or avoided by stocking shrimp in the grouper ponds (Liao et al., 1995).

Red snapper

Mortalities in the nursery and growout phases may be caused by *Amyloodinium ocellatum* and *Trichodina* sp. Dense diatom or dinoflagellate blooms can cause bubble disease, impede gill function and may lead to high mortality (Liao et al., 1995).

Constraints

The two major constraints to the development of grouper culture in Taiwan appear to be consistent production of fingerlings and an apparent increase in disease-related mortality. Larviculture of grouper has always been unreliable, with highly variable but generally low survival. Taiwanese farmers have overcome the problem of low survival to some extent by adopting cheap fingerling production methods and stocking extremely high numbers of eggs. According to TML researchers, the unreliable nature of fingerling production is at least partly related to survival in the first few days after the commencement of exogenous feeding, although mortality continues throughout much of the larval rearing systems.

Reports from farmers suggest that grouper fingerling survival is generally decreasing, and that they are seeing problems that they did not experience a few years ago. TML staff are also concerned about the apparent increase in disease incidence, particularly syndromes apparently related to viral nervous necrosis (VNN). A huge, uncontrolled trade in broodstock, larvae, fingerlings, and market-sized fish in Asia effectively and rapidly spreads any new diseases throughout the region.

If, indeed, the future of grouper aquaculture in Asia is now threatened by the widespread occurrence of VNN, there are implications for Australia. Relatively little is known of VNN and its relationship to other viral diseases of finfish, such as barramundi picorna-like virus (BPLV). It is possible that Australia, being relatively isolated from the trade in live fish in Asia, is free of VNN. If so, we should endeavour to maintain this disease-free status as we have successfully done with salmonids.

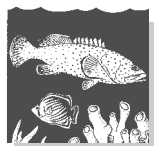
Acknowledgments

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Culture of coral reef fishes

by Suresh Job, Michael Arvedlund & Michael Marnane

Source: *Austasia Aquaculture*: 11 (3), August/September 1997, 56–59.

Over the past couple of years, a number of different coral reef fish species have been successfully spawned and reared at James Cook University, with relatively high rates of survival. A list of these species is shown in Table 1 (see next page). Some of the species listed have been spawned, but the larvae have not yet been reared.

Breeding set-up

The University's Research Aquarium Facility comprises two recirculating seawater systems. The main system has a holding tank of 150 000 litres (l) and a smaller system of 50 000 l. Together, these systems service a total of 40 satellite tanks of 1000 l and approximately 80 smaller tanks in covered areas, and five temperature controlled laboratories. High quality water is maintained using algal scrubbers, biological trickle filter towers, protein skimmers and high-pressure sand filters. A heater/chiller unit ensures that critical outside areas and the five laboratories receive temperature controlled water (26°C – 28°C), allowing the coral reef fish breeding programme to continue throughout most of the year.

In all the breeding tanks, good water movement is maintained using submersible pumps to ensure high levels of oxygenation. With the exception of

the anemonefish (Family Pomacentridae) species, all the breeding fish are maintained outdoors with a 50 per cent shade cloth roof over them. Outdoors, the fish spawn consistently for about 10 months of the year. The anemonefish are maintained in pairs in indoor tanks and breed consistently throughout the year. The temperature in all the breeding tanks is maintained between 26°C and 28°C, with the exception of those containing *Premnas biaculeatus*, which is most successfully bred at a water temperature of 28°C – 30°C.

The most important considerations when trying to breed reef fishes are to provide an appropriate environment and to feed broodstock adequate levels of nutritious food. The tank sizes recommended in Table 2 (see page 45) are a rough guide to the sizes required for breeding. Breeding fish are territorial and extremely aggressive toward members of their own sex. The underlying rule is that group spawners require enough space so that smaller individuals can form territories of their own and avoid aggression from their tank mates. Pair spawners can usually be bred in much smaller tanks. As far as food goes, our preference is to mix high cholesterol foods such as shrimp (which apparently improves egg quality) with vitamin-enriched flake foods.

Table 1: Species reared at James Cook University

Species	Spawned	Reared
Damselfish		
<i>Amphiprion melanopus</i> (Red and black anemonefish) ^{a,b}	X	X
<i>Amphiprion percula</i> (Clown anemonefish) ^{a,b}	X	X
<i>Premnas biaculeatus</i> (Spinecheek anemonefish) ^{a,b}	X	X
<i>Neopomacentrus bankieri</i> (Chinese demoiselle) ^a	X	X
<i>Pomacentrus amboinensis</i> (Ambon damselfish) ^{a,c}	X	X
<i>Pomacentrus coelestis</i> (Neon damselfish) ^a	X	
Cardinalfish		
<i>Cheilodipterus quinquilineatus</i> (Five-lined cardinalfish) ^a	X	X
<i>Apogon cyanosoma</i> (Yellow-striped cardinalfish) ^a	X	X
<i>Apogon compressus</i> (Split-banded cardinalfish) ^a	X	X
<i>Archamia fucuta</i> (Narrow-lined cardinalfish) ^a	X	
<i>Sphaeramia nematoptera</i> (Pyjama cardinalfish) ^a	X	
Angelfish		
<i>Centropyge bicolor</i> (Bicolour angelfish) ^a	X	

Reared is defined as rearing the larvae to adulthood.

a: S. Job; b: M. Arvedlund; c: M. Marnane

Larval rearing

Larvae are reared in tanks as small as 70 l for some of the anemonefish, up to 150 l for some of the other species. The most commonly used and versatile tank sizes are 150 l glass aquaria and 100 l circular plastic tanks. The temperature in the rearing tanks is generally maintained between 28°C and 30°C. Water in the larval tanks is gently aerated during the day, and changed gradually each night from the main aquarium via a gentle flow-through which returns the water to the aquarium. A 'stand-pipe', constructed from 50 mm PVC pipe with numerous holes covered in very fine mesh, prevents the larvae from being siphoned out of the tank during water changes.

The most critical requirement for larval rearing tanks is to prevent 'head-butting syndrome'. This is the phenomenon in which the larvae will swim towards any light reflected off the sides or bottom of the tank and will continue to 'head-butt' the sides of the tank until they eventually die. This occurs in the early larval stages of many species of coral reef fish and, in the damselfishes, may continue until a few days before settlement. In order to reduce this behaviour, three measures are

taken: First, the insides of the plastic tanks are painted with a food grade, black fibreglass resin or black epoxy paint. The outsides of glass tanks are painted black or completely covered with black plastic sheets. This reduces the reflection of light from the sides and base of the tank and prevents outside light from shining in. Second, dark tank covers, with the middle section cut out, are used to reduce light reflecting off the sides of the tanks. Third, all rearing is conducted using 'green-water' techniques, which essentially means that phytoplankton (*Nannochloropsis* sp.) is used to 'green-up' the tanks during the day until the bottom of the tank can no longer be seen. This generally stops headbutting syndrome and also improves the water quality since the algae also improve water quality. The green water also improves the quality of the food (rotifers and *Artemia*) and is reported to improve prey contrast and visibility. Several species of algae are available from commercial hatcheries and are easily cultured, given sufficient light and nutrient enrichment (most water soluble plant fertilisers will suffice).

Light intensity is another critical factor for larval rearing, not only during the day, but also at night.

The light intensity during the day has to be sufficient for the larvae to easily detect and capture food. We use between two and four fluorescent tubes (depending on the tank size) suspended well above the tank. The photoperiod used is 14 light : 10 dark. We suggest that a minimum 'daylight' duration would be about 10–12 h, especially for younger larvae.

We also provide low intensity diffuse lighting during the night. This is especially important in the earlier stages as it helps to keep the larvae swimming towards the surface at night rather than sinking to the bottom. While overnight lighting is preferable with damselfishes and anemonefishes, it is essential for young cardinalfish larvae, which otherwise show high overnight mortality. A common, low intensity 'night light' of around 10 watts works well if suspended above and well away from the rearing tank.

Feeding

Most larval fish are driven by an instinctive need to feed and will do so if live prey of the right size are provided. We have achieved reasonably high survival in most species using a diet of rotifers (*Brachionus* sp.) for the first half of the larval period followed by newly-hatched *Artemia* nauplii when the larvae are large enough to take them.

Rotifer 'starter kits' are available from many commercial hatcheries and are easily cultured using either algae or brewers yeast. Several strains of rotifers of different sizes are available, and the larvae may require a smaller strain for the first few days before switching to a larger strain.

As an example, *P. amboinensis* larvae show better survival if fed with a small strain of rotifer for the first three days before being weaned onto a larger strain. These foods will suffice for most of the species listed above. However, species with very small larvae may require copepod nauplii for the first few days until they are large enough to be weaned onto rotifers.

Rotifers are fed to the fish larvae at densities of approximately 2–8 per ml, while *Artemia* nauplii

Table 2: Suggested breeding tank size

Species	Breeding tank size
<i>Amphiprion melanopus</i> *	70 l glass aquaria
<i>Amphiprion percula</i> *	70 l glass aquaria
<i>Premnas biaculeatus</i> *	70 l glass aquaria
<i>Neopomacentrus bankieri</i> +	1000 l oval plastic tanks
<i>Pomacentrus amboinensis</i> *	100 l circular tank, 350 l circular plastic tanks
<i>Pomacentrus coelestis</i> +	1000 l circular plastic tanks
<i>Cheilodipterus quinquilineatus</i> +	1000 l oval plastic tanks
<i>Apogon cyanosoma</i> +	1000 l plastic tanks, 350 l circular plastic tanks
<i>Apogon compressus</i> +	1000 l oval plastic tanks
<i>Archamia fucata</i> +	1000 l oval plastic tanks
<i>Centropyge bicolor</i> * +	1000 l circular plastic tanks

* indicates breeding pairs, + indicates breeding groups

are fed at densities of 1–2 per ml. Both rotifers and *Artemia* nauplii are rinsed thoroughly before adding them to the rearing tanks to remove any waste nutrients from the culture tanks. In the case of the larval anemonefish, rotifers are used as the first food for about 6 days for *Premnas biaculeatus* and for about 2–3 days for the *Amphiprion* spp. The larvae are then weaned onto newly hatched *Artemia* over a 2-day period. The damselfish larvae are fed rotifers for approximately 9–10 days before weaning them onto *Artemia* nauplii over 3–4 days. *Apogon cyanosoma* larvae have been relatively tricky to rear with high survival rates, and do better if wild-caught plankton are used for the earlier part of the larval period, followed by *Artemia* nauplii.

Water quality

Maintaining high water quality is possibly the most critical factor when rearing larval reef fish. Poor water-quality management results in extremely high mortality.

As the mortality is often very sudden (a whole batch of larvae can be lost in just one night due to poor water quality!), efforts must be taken to ensure consistently high water quality. This is especially true in situations such as ours, where relatively high numbers of larvae (about 500–1000) are reared in relatively small tanks (100 l and 150 l).

Three main steps should be taken to maintain high water quality. First, the addition of too much food can rapidly reduce the water quality (even when using live foods). Reef fish larvae can survive at relatively low food densities (although it does effect growth rates). Therefore, it is better to add too little food initially and have to top-up later in the day than to add too much initially. Secondly, a bacterial build-up on the sides and bottom of the tanks, present as a slimy layer, can also effect water quality by producing compounds which may be toxic to the larvae. The bottom of the tank should be cleaned regularly (daily if possible) and any dead larvae removed. Third, regular water changes must be carried out. An adequate rule of thumb seems to be a one-third water change every day. We use a very gentle flow-through of water overnight which results in about a 100 per cent water change.

Growout tanks

Post-settlement juveniles are reared in 350 l circular plastic tanks at high densities to reduce aggression. The use of UV sterilisers to reduce the incidence of disease is often useful, especially when juvenile fish densities are high. The juveniles are generally switched from *Artemia* nauplii to finely-chopped fish or shrimp within 1–2 weeks. Due to their relatively high growth rates, they need to be fed at least twice a day to satiation.

Survival rates

Using the rearing method described, we have generally achieved about 70 per cent survival for damselfish and up to 90 per cent survival for most species of cardinalfish and all species of anemonefish through to settlement. It is likely that these methods will prove to be effective for a wider range of species, with the possible exception of those with extremely small larvae.

Future directions

There is currently no regular commercial-scale breeding of any coral reef fish species in Australia for the aquarium trade. Conversations we've had with both marine aquarium fish collectors and retailers strongly suggest that the current demand for some species by the aquarium trade, is far greater than supply. Of the species successfully cultured at James Cook University this is probably most true of anemonefish as a group, and of *A. percula*, in particular. Considering that wild-caught anemonefish retail in aquarium shops at about A\$ 30 a pair, and that captive-bred fish reach marketable size in approximately 3–6 months, the potential for the commercial breeding of these fishes seems obvious.

Another important consideration is that the commercial breeding of coral reef fish would reduce the need to exploit wild populations from coral reefs. It seems a shame that species still be collected from the Great Barrier Reef and other reefs in the Indo-Pacific. However, with the current trend towards greater protection of coral reefs worldwide, it appears likely that there will be greater restrictions on their exploitation in the near future, and more emphasis will be on the captive breeding of coral reef species.

Suggested further reading

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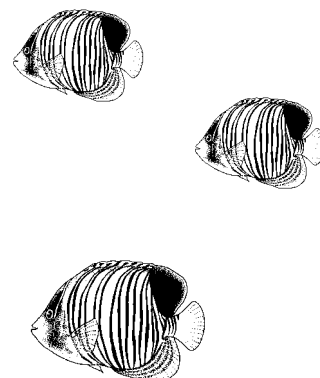
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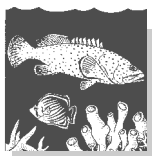
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Marketing and monitoring live reef fishes in Hong Kong, an update

by Yvonne Sadovy¹

The key role of Hong Kong as the major importer in the live reef fish trade (LRFT) was first recognised by Johannes and Riepen (1995). Hong Kong accounts for about 60 per cent of the annual regional trade of about 25 000 tonnes (Johannes & Riepen, 1995). Live reef fish is, economically, Hong Kong's major seafood commodity. To put this into perspective, a conservative estimate of the total value of imported live fish is about US\$ 300 million (using an average wholesale price of US\$ 20/kg based on Sham 1997 and Johannes & Riepen, 1995) which exceeds Hong Kong's total annual seafood production of its entire traditional capture fleet for chilled fishes (US\$ 278 million—1995 figures) (Lee & Sadovy, in press). As an update on the marketing and monitoring of live reef fish in Hong Kong, I present the results of a preliminary survey of the species commonly marketed, their sizes and retail turnover rates and discuss the current monitoring system and concerns with this trade.

The survey was conducted from December 1995 through February 1996 at one of the two principal live food fish markets in Hong Kong, Lei Yue Mun, where about 40 shops operate. During each survey month, three randomly selected shops were sampled every morning and afternoon for one week. For each shop visit, counts were made of the total number and species composition of all fishes present and size estimates made of the more common species (Lee & Sadovy, in press).

Over 60 species were observed on at least 10 occasions each (Table 1—both common and scientific names are provided—see next page). The eleven most commonly noted species are given in Table 2 (see page 49), in order of decreasing abundance, with size ranges and modal sizes provided. Species were dominated by the snappers (Lutjanidae), *Lutjanus* spp., and groupers (Serranidae), mostly *Plectropomus* spp. and *Epinephelus* spp. Although not common, the giant grouper is included because it is highly valued in the trade. Groupers were the most abundant fishes noted, in

terms of both numbers of species and of individuals, making up 64 per cent of all fishes counted. A follow-up visit to the same market in April 1997 produced a very similar species list, and recent interviews with about 50% of major traders indicated that, by weight, 60% of imports were coral trout, 20% *Epinephelus* species, 4% giant grouper, 2% Maori wrasse (Napoleon, humphead), 2% highfin (rat, mouse) grouper, with the remainder classed as miscellaneous (Sham, 1997; Louise Li, pers. comm.).

Not surprisingly, groupers figure among the most valuable species, although the Maori wrasse fetches one of the highest prices per kg. In 1997 mean retail prices (US\$/kg) ranged from over \$ 100 for highfin grouper and Maori wrasse down through the coral trouts, to \$ 20–30 for *Epinephelus* sp. grouper (see also Johannes & Riepen, 1995). Very large individuals of a number of species sold at lower prices per kilogram than smaller conspecifics because they usually had to be sold after being divided into pieces.

Modal sizes of the eleven most common species were 35–40 cm in total length. Using estimates of the size of sexual maturation for these fishes (Heemstra & Randall, 1993; Sadovy, 1996, unpubl. data), it is clear that the larger species are mainly sold within their juvenile size range, particularly Maori wrasse and the tiger and Malabar groupers. This was exclusively the case for the giant grouper.

Using length–weight conversions, the fish in Table 2 largely fall within the weight range of approximately 0.5–2.0 kg spanning the sizes preferred by consumers (i.e. 0.6–1.5 kg), as noted by Johannes and Riepen (1995). The giant grouper, long considered a special fish, was an exception: individuals spanned 45 to 90 cm and, although not common (only 22 were seen during the survey), they were present in almost every shop, often for extended periods. This is partly because they confer good luck (for example, they are occasionally

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Table 1: Species noted in Hong Kong's retail outlets on at least 10 separate occasions. Species also included in mariculture grow-out and which are potentially ciguatoxic are indicated by * (e.g. Lewis, 1986 and Hong Kong Department of Health)

Family	Species	English common name	
Carangidae	<i>Trachinotus</i> spp.	Pompano	
Centropomidae	<i>Lates calcarifer</i>	Giant perch, seabass	
	<i>Psammoperca waigiensis</i>	Pink-eyed bass	
Haemulidae	<i>Plectorhynchus cinctus</i>	Sweetlips	
Labridae	<i>Cheilinus undulatus</i>	Humphead, Maori, Napoleon wrasse	
	<i>Choerodon anchorago</i>	Blunt-headed parrotfish	
	<i>Choerodon azurio</i>		
	<i>Choerodon schoenleini</i>	Green wrasse	
Lethrinidae	<i>Gymnocranius griseus</i>	White seabream	
Lutjanidae	<i>Lutjanus argentimaculatus</i> *	Mangrove red snapper	
	<i>Lutjanus bohar</i> *	Two-spot red snapper	
	<i>Lutjanus johnii</i>	John's snapper	
	<i>Lutjanus russelli</i>	Bubble lip snapper	
	<i>Lutjanus sebae</i>	Emperor red snapper	
	<i>Lutjanus stellatus</i>	Star snapper	
	<i>Symphorus nematophorus</i> *	Chinamanfish	
Scatophagidae	<i>Scatophagus argus</i>	Scat	
Scaridae	<i>Scarus forsteni</i>	Toothed wrasse	
	<i>Scarus ghobban</i>	Bluebarred parrotfish	
Scorpaenidae	<i>Synanceia verrucosa</i>	Stonefish	
Serranidae	<i>Aethaloperca roga</i>	Redmouthgrouper	
	<i>Anyperodon leucogrammicus</i>	Slender grouper	
	<i>Cephalopholis argus</i> *	Peacock hind	
	<i>Cephalopholis sonnerati</i>	Tomato hind	
	<i>Cromileptes altivelis</i>	Humpback, rat, mouse, highfin grouper	
	<i>Epinephelus akaara</i>	Hong Kong, red grouper	
	<i>Epinephelus areolatus</i>	Areolate, dotted grouper	
	<i>Epinephelus atvoara</i>	Yellow grouper	
	<i>Epinephelus bleekeri</i>	Duskytail grouper	
	<i>Epinephelus caeruleopunctatus</i>	Whitespotted grouper	
	<i>Epinephelus coioides</i>	Orange-spotted, green grouper	
	<i>Epinephelus cyanopodus</i>	Speckled blue grouper	
	<i>Epinephelus fuscoguttatus</i> *	Brown-marbled, tiger grouper	
	<i>Epinephelus howlandi</i>	Blacksaddle grouper	
	<i>Epinephelus lanceolatus</i> *	Giant grouper	
	<i>Epinephelus maculatus</i>	Highfin grouper	
	<i>Epinephelus malabaricus</i>	Malabar grouper	
	<i>Epinephelus merra</i> *	Honeycomb grouper	
	<i>Epinephelus polylepis</i>	Smallscaled grouper	
	<i>Epinephelus polyphemadion</i> *	Camouflage flowery grouper, cod	
	<i>Epinephelus tauvina</i> *	Greasy grouper, estuary cod	
	<i>Epinephelus tukula</i>	Potato grouper	
	<i>Plectropomus areolatus</i>	Squaretail, spotted coral grouper, trout	
	<i>Plectropomus laevis</i> *	Blacksaddled coral grouper, trout (dark form)	
	<i>Plectropomus laevis</i> *	Blacksaddled coral grouper, trout (pale black saddle form)	
	<i>Plectropomus leopardus</i> *	Leopard coral grouper, trout	
	<i>Plectropomus maculatus</i>	Spotted coral grouper, trout	
	<i>Plectropomus oligacanthus</i>	Highfin coral grouper, trout	
	<i>Plectropomus pessuliferus</i> *	Roving coral grouper, trout	
		<i>Variola louti</i> *	Yellow-edged lyretail
	Sparidae	<i>Sparus latus</i>	Yellow seabream
		<i>Mylio macrocephalus</i>	Black seabream
<i>Rhabdosargus sarba</i>		Gold-lined seabream	

* Indicates potentially ciguatoxic fish.

Table 2: The ten most frequently recorded species with minimum and maximum size classes recorded (5 cm size classes used for total length), in cm, the modal (most common) size, the sample size used and the approximate size of sexual maturation (see text). NA – data not available.

Species	Minimum size	Maximum size	Mode	Number of specimens sampled	Size at sexual maturity
<i>Epinephelus coioides</i>	25	80	40–45	478	25–30
<i>Epinephelus bleekeri</i>	10	50	30–35	356	30–35
<i>Lutjanus argentimaculatus</i>	25	70	35–40	287	NA
<i>Epinephelus polyphkadion</i>	15	95	35–40	276	30–35
<i>Epinephelus fuscoguttatus</i>	15	90	35–40	258	40–45
<i>Plectropomus areolatus</i>	25	65	35–40	219	35–40
<i>Plectropomus leopardus</i>	10	75	35–40	196	30–35
<i>Epinephelus malabaricus</i>	35	85	40–45	150	45–50
<i>Plectropomus maculatus</i>	20	60	35–40	147	30–35
<i>Cheilinus undulatus</i>	20	100	35–40	143	60–65
<i>Trachinotus blochii</i>	15	90	35–40	113	NA
<i>Epinephelus lanceolatus</i>	45	90	55–60	22	105–110

sold alive to Buddhist groups who return them to the wild for spiritual purposes), possess medicinal value, and are reportedly used as a indicator of tank water quality (Lee & Sadovy, in press). They are also highly valued; current (1997) retail prices range up to US\$ 100/kg (depending on fish size). In 1996, several particularly large giant grouper were sold for about US\$ 10 000 each (*South China Morning Post*, 14-4-1996).

Turnover rates were high. Over the three-month survey period, an average of 22 per cent of the fish brought into a shop on any one day was sold on the same day, with 85 per cent sold within 6 days (Lee & Sadovy, in press).

The government of Hong Kong collects import statistics on live reef fish through the Census and Statistics Department (CSD) using the internationally applied Harmonised Code System. From 1 January 1997, following an initiative by the Agriculture and Fisheries Department (AFD), the existing codes were elaborated to distinguish key

Table 3: Harmonised codes for live food fish from the Hong Kong Department of Census & Statistics as of 01/01/97

Code	Description
0301 1010	Live freshwater ornamental fish
0301 1020	Live marine ornamental fish
0301 9912	Fish fry, marine
0301 9921	Giant grouper (<i>Epinephelus lanceolatus</i>)
0301 9922	Highfin grouper (<i>Cromileptes altivelis</i>)
0301 9923	Spotted grouper/coral trout (<i>Plectropomus</i> spp.)
0301 9929	Other groupers
0301 9931	Humphead wrasse (<i>Cheilinus undulatus</i>) (Maori, Napoleon)
0301 9939	Other wrasse & parrotfish
0301 9941	Snooks & basses
0301 9999	Other marine fish

species, or species groups, in the LRFT (Table 3). This is a major advance over the earlier system, and is potentially valuable in providing further details of trade imports (Sham, 1997; Sadovy, in press). It is hoped that other nations will adopt the

revised harmonised codes of Hong Kong to enable a regional database to develop for this trade.

Problems remain, however, with Hong Kong's monitoring system. Under current laws, CSD collects statistics from live fish imports entering by air, and by sea on foreign (i.e. not registered in Hong Kong) vessels. Those vessels registered in Hong Kong, on the other hand, are exempt from declaring their cargo partly because of their misclassification as fishing vessels, despite their obvious function as cargo vessels, and partly because live fish are exempt from declaration: in fact live fish are not even considered to be food under current Hong Kong legislation! This means that the import data are seriously incomplete for live food fish because an unknown volume and species composition of live fishes enters on the one hundred-or-so Hong Kong-registered vessels. Although these vessels are informally monitored by AFD, the data do not include details of sources or species composition of imports.

There are several reasons why the LRFT needs to be monitored more effectively, particularly by the major importer, Hong Kong; these relate to three issues of concern: destructive fishing practices; human health and species conservation status.

The use of sodium cyanide to take live fishes began with the capture of certain ornamental fishes in the Philippines, and has now been reported from as far afield as the Maldives, to the west of Hong Kong, and into the Pacific Ocean, possibly as far east as the Solomon Islands and Marshall Islands (Barber & Pratt, 1997). Its use for fishing is prohibited throughout much of the region. Nonetheless, it is evidently widely used with a significant proportion of Hong Kong imports likely taken with cyanide; this inference is based on percentage of fish testing positive for cyanide in the Philippines and on the large numbers of Indonesian fishermen who use cyanide, and that fact that Hong Kong is the major export destination for both countries (Barber & Pratt, 1997; Mark Erdmann, pers. comm.).

Two of the species included in the live reef fish trade for food, the Maori wrasse and the giant grouper, both frequently seen in Hong Kong, were recently classified as 'vulnerable' in the 1996 IUCN Red List because of concerns over their conservation status as a direct result of the LRFT (Hudson & Mace, 1996). Such species are slow-growing, probably long-lived and, hence, particularly vulnerable to overfishing, and cyanide is reportedly used extensively for the Maori wrasse. Trade statistics and biological data are needed for these species to evaluate the volume of trade and the current status of exploited stocks. Current data collection in Hong Kong does not record these species in repre-

sentative numbers; while both species were evident throughout 1997, very few were reported in official statistics because of shortcomings of the monitoring system.

Imports into Hong Kong come from the Philippines, Indonesia, Thailand, Malaysia, the Maldives, Australia and increasingly from the western Pacific, from the Solomon Islands, the Marshall Islands, Micronesia and possibly Kiribati and Tonga. A recent consequence of the move into the Pacific has been that ciguatera fish (fish containing natural fish poisons) have started turning up in Hong Kong [see ciguatera article in this issue, p. 51], because certain areas in the western Pacific, for some unknown reason, produce such fish. A spate of cases in January of 1998 markedly depressed prices, a drop from which the market has yet to recover. To reduce the risk of importing ciguatera fish, information is needed on source of fish. Spot checks for ciguatera on those species most susceptible (see Table 1) and from known sources of ciguatera fishes, could be targeted if such data were available. This would be to the benefit of both consumers and the industry.

Hong Kong continues to consider ways of tackling the shortcomings of its monitoring system. As part of this initiative, Hong Kong recently co-hosted, under the Asia-Pacific Economic Community, a workshop on destructive fishing and is now following up on its recommendations. While there are always concerns by trading nations over the possible negative impacts on free trade of imposing restrictions or obstacles to trade in the form of monitoring or checking of cargo, it is becoming increasingly apparent that responsible trade practices should not be sacrificed solely in the name of free trade (e.g. Code of Conduct for Responsible Fisheries incorporated into the Law of the Sea, 1994) by ignoring health and conservation concerns. Much depends on the commitment and interest of importing countries to play their part in ensuring responsible practices in fishing and trade.

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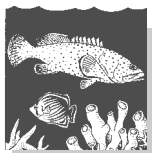
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Ciguatera hits Hong Kong live food-fish trade

by Yvonne Sadovy¹

The demand for live fish for the South East (SE) Asian food market has grown rapidly in the last 10–15 years (Johannes & Riepen, 1995), especially in Hong Kong, Taiwan and China where retail prices for the most favoured species can exceed US\$ 100 per kilogram. Originally, most of the fish included in this trade came from the South China Sea but, as demand increased and stocks close to the major importing nations became depleted and could no longer supply the market, fish were increasingly sought from further afield. By the 1990s, live food fish entering Hong Kong, the major importer and accounting for 60 per cent of the trade, came from as far west in the Indian Ocean as the Maldives and as far south and east as the Marshall Islands, Solomon Islands, the Great Barrier Reef of Australia, and adjacent areas (Johannes & Riepen, 1995). So valuable is this trade that market prices can accommodate the long and expensive transportation costs from these more distant locations to Hong Kong where the total annual wholesale value of the live reef fish trade exceeds that of the entire traditional (i.e. chilled fish) capture fishery (Lee & Sadovy, unpubl. ms.)!

The growing trade in live reef fish for food has spawned a number of concerns which relate to both resource use and to issues of human health. Over-harvesting of resources is obvious in some areas, for example, from the fishing of spawning

aggregations, the taking of large numbers of juveniles and worrying declines of certain particularly vulnerable species such as the humphead (Maori or Napoleon) wrasse. The use of sodium cyanide to catch fish for this market is also of concern since sodium cyanide is toxic to reefs (Jones, 1997) and reef communities, and may be used to take a significant proportion of fish marketed (e.g. Barber & Pratt, 1997). The consequences for humans of consuming fish caught with sodium cyanide are not known.

What is evident, however, is that there is a growing risk to consuming nations in SE Asia of ciguatera fish poisoning because of the species being marketed, i.e. a number of top reef predators species often implicated as ciguatoxic (e.g., *Cheilinus undulatus*, *Lutjanus argentimaculatus*, *L. bohar*, *Symphorus nematophorus*, *Cephalopholis argus*, *Epinephelus fuscoguttatus*, *E. lanceolatus*, *E. merra*, *E. polyphkadion*, *E. tauvina*, *Plectropomus laevis*, *P. leopardus*, *P. oligacanthus*, *P. pessuliferus*, and *Variola louti*), and the expansion of the trade into areas known for producing ciguatoxic fish of some of these key desired species. As a consequence, there is a growing likelihood of ciguatoxic fishes being imported into major consuming nations.

Ciguatera fish poisoning is recognised as a serious health problem in the tropics and subtropics (Chan et al., 1992) and is likely to grow with increasing

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international trade in reef fishes. Ciguatera poisoning has not historically been a problem in SE Asia (ciguatoxins have rarely been reported in fish from the northern South China Sea) and so the general public is largely unaware of ciguatera. However, with many potentially poisonous species of live fish brought in Hong Kong from known hotspots of ciguatoxic fish in the Indo-Pacific (e.g. Lewis, 1986; Glaziou & Legrand, 1994), ciguatera is expected to represent an increasing problem for Hong Kong, and for other importing nations, as demand for live fish grows.

Indeed, available figures indicate a marked increase in confirmed ciguatera poisonings in Hong Kong from the 1980s into the 1990s. Although evidently little known prior to 1984, between 1984 and 1988, inclusive, there were 23 cases of ciguatera poisoning reported affecting 182 people (Hong Kong Standard, 27/5/88). In the last decade, the number of reported cases has increased from 7 cases, between 1988 and 1990, inclusive, to 31 cases and 245 victims in 1991-92, and 39 cases with 182 victims, in 1993-94; in 1995 13 cases and 53 victims were recorded (Hong Kong Department of Health). Doctors, however, believe that the actual number of cases is much higher and that most are either unreported, or misdiagnosed as food poisoning (Chan et al., 1992).

The Hong Kong Department of Health is aware of ciguatera as a health issue and has periodically issued warnings of the risk. It also carries out a number of tests on imported fish, including one for ciguatera. However, these tests are only carried out on dead, chilled, fish since live fish are not, surprisingly, classified as food in Hong Kong under current legislation. This means that the species most likely to carry ciguatoxins, the larger reef fishes imported live, are not currently screened for ciguatera on import into Hong Kong. Moreover, since monitoring of the live food fish trade in general is incomplete, it would not, at present, be possible to determine the sources of most live reef fish coming into Hong Kong, and thereby to identify fish most likely to be of risk in harbouring ciguatoxins. Representations have been made to the government to address this human health issue by improving monitoring and by testing of live fish on import, especially those fish coming in from high risk areas.

Ciguatera is a significant health and resource problem in tropical areas because of its erratic and often unpredictable spatial and temporal distribution (Lewis, 1986). This is a problem for those nations where ciguatoxic fishes occur that wish to develop their demersal marine resources (Dalzell, 1992). It is also a problem for places, like Hong Kong that are largely naïve to the risk of ciguatera poisoning,

which do not have a monitoring or testing programme with which to tackle the issue and which have overfished their own resources and hence rely on those from elsewhere.

Moreover, importers themselves appear to be largely unaware of, or simply unconcerned about, the potential risks of importing ciguatoxic fishes.

There is also a broader issue that should be considered. Sodium cyanide is used to catch a significant proportion of live reef fish for food (it is also used to catch fish for the aquarium trade and to take juveniles for mariculture). Cyanide has been shown to be damaging to the reefs themselves (Jones, 1997). Bearing in mind that there are already links between cyanide and habitat damage and that habitat damage has been associated with providing surfaces for the settlement of dinoflagellates implicated in ciguatera fish poisonings in French Polynesia, Pacific, and in the Caribbean's Virgin Islands, (Bagnis et al., 1988; Kohler & Kohler, 1992), it would be prudent to address the various problems of the live reef fish trade as a whole, rather than piecemeal. Such an approach is necessary to ensure a sustainable and healthy fishery of live fish that continues to be lucrative well into the future and for as many countries as possible.

Addendum

Since this article was written, in the first few weeks of 1998 one or more shipments of fish came into Hong Kong from the western Pacific containing ciguatoxic fish. So far this year, 113 people have suffered from ciguatera. There have been no mortalities to date but there is a lot of public concern. The suspected species of fish is the tiger grouper although the source of the fish has not been officially confirmed. At the date of writing, the Hong Kong Government has not decided what measures to use to reduce the probability that ciguatoxic fishes will enter the local markets. Until now, public health warnings have simply suggested that the public avoid eating reef fish larger than 1.8 kg and to reduce fish intake in general.

A recommendation was also made to select cultured fish where possible. Demand for live fish has fallen along with prices. Problems have been encountered with an estimated hundreds of tonnes of imported fish piling up due to poor sales. Moreover, large shipments will have arrived in Hong Kong prior to the Chinese New Year period, starting on 28 January, when fish consumption usually increases. The government and industry are looking for ways of dealing with this problem which has been a major blow to the live reef fish trade.

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Live fish exporter concerned about fish stocks

by Dos O'Sullivan

Source: *Austasia Aquaculture*: 11(4), October/November 1997, 15–16.

After five years of producing fibreglass tanks for aquaculture, Tony Walton moved to seafood processing and marketing. Tony is manager of Aqua Cairns, which sells both live and fresh-chilled product. Aqua Cairns manages two fishing boats, as well as buying fish from other boats along the north Queensland coast. This enables the company to export almost 100 t of live fish a year. Tony is concerned that fish stocks do not become overexploited.

Located in Cairns, north Queensland, Aqua Cairns is the largest and one of the longest-running live-fish exporting companies in the country. Manager Tony Walton runs a very tight operation; however, he is always concerned about the sustainability of reef-fish stocks.

'There's a large number of new players in the industry, and this effects quality and market prices,' he told *Austasia Aquaculture*. 'More fisheries regulations are required to prevent continuing oversupply and overexploitation of the stocks. There are too many boats, and a buyout of some licences is needed.'

Data published by CRC Reef Research show that live reef fish exports from Cairns exceed A\$ 2 mil-

lion per year. The CRC research team is maintaining detailed catch records with cross-referencing of boats, volume, species weight, and ratio of large fish to small fish. 'This is showing that some areas are fished year round,' Tony said. 'Such areas need to be closed to both recreational and professional fishermen during spawning periods. I believe that a closure starting around October or early November and extending till mid-December will provide more protection for the stocks.'

Large boats required

Tony believes that the fishing boats' small size (less than 14 m) means that there is only a limited area of coverage, usually a 3–4 hour voyage from port. 'This in turn means that there is only a small number of reefs that can be fished,' he said. 'Larger boats (20 m, say) would allow more than 24 hours' steaming to fish in new areas and so spread out the fishing pressure. The special design of our onboard recirculation systems means that we can hold fish at sea for up to six days.'

He is also very concerned about the taking of small fish. 'We've installed plastic measures on all our

boats to allow easy measurement of all fish caught. Undersize fish are quickly returned to the sea.'

'We manage two fishing boats and we also buy product off other companies. The fish are taken in the Gladstone-Mackay region and north up the coast to Cooktown. The distribution centre is here in Cairns. The majority of our product is exported; however, we also sell around 200 kg a week into Sydney and Melbourne.'

Coral trout: main species

About 70 per cent of the fish sold by Aqua Cairns is coral trout (*Plectropomus* spp.); the remainder consists of barramundi cod (*Cromileptes altivelis*) and other cod species. 'We aren't selling Maori wrasse (*Cheilinus undulatus*) any more because we don't like taking them for conservation reasons. We bought 42 kg of Maori wrasse a few months ago, and then with the help of the local SCUBA club released it back onto a reef.'

The maximum size of fish for export is around 5 kg, although larger fish can be sold domestically. 'The maximum time for safe travel for most fish is around 21 hours,' Tony explained, 'so an ice pack is included to keep the temperature down. We've had a temperature monitor in the boxes and have found that the range is between 18 and 22°C.'

Polystyrene boxes are used for fish transport for both domestic and export markets, and Tony believes that these are better than plastic bulk bins. 'Many domestic buyers are not equipped to handle bins,' he said. 'The styrene boxes are easy to distribute to our customers and allow simple on-forwarding to the retailers. Also, the bulk boxes allowed too many people to operate live-fish export facilities. I don't like them, as the failure in the temperature control or oxygen supply can lead to the loss of up to 300 kg of fish. On the other hand, the styrene boxes hold 3.5 kg, so you'd lose a lot less fish.'

Tony said that Aqua Cairns packs its fish in the polystyrene boxes, and puts 126 boxes onto an airline pallet. 'This gives a shipment of some 450 kg of fish. However, some countries, such as Singapore, can take the bins' he said.

According to Tony, a number of other countries are also supplying live fish into the same markets as the Australian product. 'These are sourced from both aquaculture operations and wild catch,' he said. 'Export prices for lower quality fish would be unprofitable, so you need to ensure the highest fish quality. In March this year, coral trout less than 1.5 kg are worth some A\$ 68/kg, so each fish could be worth over A\$ 100. The scarcity of barramundi

cod ensures that prices stay higher, around A\$ 135/kg for fish less than 1.5 kg. However, the prices can fluctuate rapidly.'

Competitive edge

The industry is very competitive, but Tony Walton believes that his company's owning and operating its own boats gives it an edge. 'We are able to monitor catches around the fishing areas and can examine and improve handling and transport procedures. We've had a 200 per cent increase in our survival rates over the past few years.' Aqua Cairns employs about 30 people for packaging fish. Three direct flights each week out of Cairns allow the company to move shipments of live fish between 2.5 and 3.0 tonnes into Hong Kong and China.

Like the other live fish companies, Aqua Cairns uses recirculating tanks. 'Our facility has the capacity to hold six tonnes, so we always have fish on hand for our established buyers,' Tony explained. 'However, fluctuating market prices can cause problems, and we always need to watch currency exchange rates.'

'We're looking at a number of new species. For example, flowery cod has a red skin and white flesh, and small fish (1.5 kg) are readily available for 4-5 months of the year. Some species are not acceptable, for example footballer trout (*P. laevis*) and cut-throat trout.

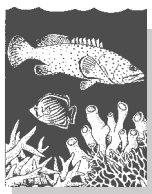
'It should be recognised that the live-fish industry is a relatively new development, so the early years are expected to be turbulent. Many people enter the industry believing that it is an easy way to make money, but they soon find that it requires a certain amount of skill, organisation, and capital.'

According to Tony, fish anaesthesia is another area that has needed improvement. MS222 is used throughout the industry, but recently the use has been reduced to calm the fish during packing. 'It's now only used in small doses, and the buyers are well aware of how MS222 is used in Australia, but they still check some fish for residues. We've undertaken a number of trials and have reduced the residues to very low levels.'

Aqua Cairns is developing an excellent reputation for quality live fish and efficient service. With its work on preventing the over-exploitation of fish stocks, it is likely that Tony and Aqua Cairns will assist the live-fish industry to continue to grow.

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COVARE 98 International Mission: Quantification of recruitment in reef fish

by Vincent Dufour

An unprecedented (in terms of number of scientists) research project on reef fish has just been completed in French Polynesia. Conducted as part of the COVARE (standing, in French, for 'Larval Colonisation and Variability of Reef Fish Stocks'), programme of the EPHE Ichthyology Laboratory, (URA CNRS 1453), the project was carried out by a team of 20 scientists, seven Americans, four Australians and nine French, supported respectively by NSF (the Americans), AIMS and UTS (the Australians), and INSU-CNRS (national coral reef programme) (the French).

This project, carried out on the island of Moorea in French Polynesia, was designed to quantify the recruitment of reef fish post-larvae in a 120 ha reef area and to monitor their mortality after settlement. Using crest net technology developed by the French team, a cohort of 540 000 surgeon fish, *Naso unicornis*, was studied during recruitment to and settlement on the reef. These results represent the first quantitative monitoring programme on reef fish covering the period from the end of the pelagic phase until recruitment. The very high

mortality sustained by fish at recruitment was demonstrated, since 90 per cent of the original stock had disappeared after one week, the main cause being predation.

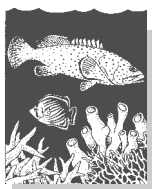
This study confirms that the flow of post-larvae entering the lagoon is not a limiting factor in reef fish abundance. This work yields important information for the management and exploitation of reef fish stocks, which are in increasing demand on the world markets for live reef food fish and aquarium fish.

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Grouper web page: A new resource for people with an interest in aquaculture of groupers and coral reef fishes

A major recommendation of the workshop on Aquaculture of Coral Reef Fishes and Sustainable Reef Fisheries (4–7 December 1996) held in Kota Kinabalu, Sabah, Malaysia, was to improve exchange and dissemination of information and strengthen research coordination at national, regional and international levels on grouper and coral reef fish aquaculture. A specific recommendation to NACA (Network of Aquaculture Centres in the Asia and Pacific Region) was the development of a web page for grouper and coral reef fish aquaculture. In response, NACA with the assis-

tance and cooperation of AIT (Bangkok) and CenTER (Denmark), had launched a web page on grouper and coral reef fish aquaculture in June 1997. The web site can be accessed through the following URL:

<http://www.agri-aqua.ait.ac.th/grouper>

Although NACA had launched the initiative, its scope and success will depend upon support and contributions from all those involved in reef fish research and development, including both public

and non-government organisations and the private sector. It is hoped that interested organisations and individuals will also contribute to the development of this new initiative. The web page has the following outline:

Welcome and introductory page

Grouper aquaculture research

This section is devoted to summaries of the latest grouper research. Experts will be invited to write short articles summarising the latest research findings. The summaries of the Sabah workshop are also available.

Current research bibliography

This section features a comprehensive list of research papers and abstracts. On-line searches of the bibliography are possible.

Contacts page

This introduces contacts for individuals, institutions and organisations involved in grouper or coral reef aquaculture.

Commercial services

This will include a list of hatchery producers offering grouper fry and fingerlings, and other commercial services.

News and events

This section contains information on news and recent or forthcoming events.

Discussion page

This page is for individuals who wish to raise major issues, share views or solicit information.

Cases database

This page—still under development—may involve specific case studies of farms and hatcheries involved in grouper and coral reef aquaculture.

To enable the further build up of the contacts database and bibliography, NACA is inviting interested persons to send the following information:

- Name and address of organisation:
- Type of organisation:
- Contact person:
- Fax:
- E-mail:
- Web page address (if any):
- List of current research related to grouper / coral reef fish aquaculture:
- List of species being studied and/or produced:
- Recent reports/publications (since 1990)—If possible send copies to NACA for inputting to the regional bibliography/library:
- Services offered by your organisation (training, research, etc):

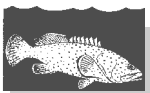
All interested parties are requested to send this information as soon as possible to:

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<http://www.pop.bio.aau.dk/~naca>



Noteworthy publication

ABRAHAM, N.R.G. (1996). Management practices of selected exporters of ornamental marine aquarium fish. Unpublished thesis, University of the Philippines at Los Banos. 54 p.



Ecotourist turns ecoterrorist

by R.E. Johannes

Ms Inge Sterk, a German tourist residing for some weeks in the Togian Islands off the island of Sulawesi, sent me an account of her campaign against the illegal capture and sale of sea turtles and oversize humphead wrasse in the area. It seems that two other German tourists had previously cut the nets of holding pens in these islands, releasing reef fish being held for shipment to Hong Kong for the live reef food-fish market.

She warned one local middleman that she would likewise cut his nets if he did not release humphead wrasse larger than the legal limit (3 kg). She subsequently made good her threat, and awaited the arrival of the police after the owner of the nets brought charges against her. With a borrowed motor attached to a dugout canoe, the police arrived after a seven-hour journey from the nearest police station, and took her back there to make a statement in answer to the pen-owner's complaint. There the chief of police and his wife gave up their bed so she would have a place to sleep! Upon finding that the police had not so much as a mask and snorkel with which to investigate the illegal holding of turtles and large humphead wrasse in sea pens, she bought two sets for them. She was not charged, and the police subsequently used their new diving gear to investigate suspected illegal practices in the local live reef-fish trade.

On a later trip to the region Ms Sterk discovered live reef-fish holding pens within the boundaries of Manado's famous Bunaken Marine Park. Once

again, she cut holding pen nets and freed some of the fish.

Ms Sterk sent me a photograph showing the practice of cutting the front teeth of humphead wrasse with pliers in order to prevent them from biting and injuring one another when crowded in the cages.

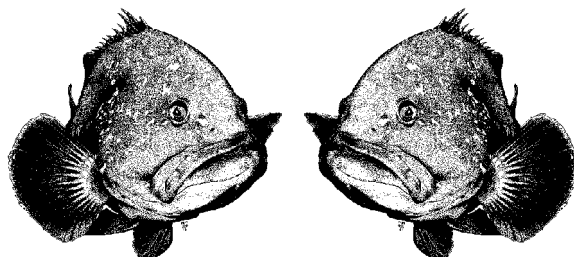
Ms Sterk's account of her activities and observations reveals a number of interesting facts.

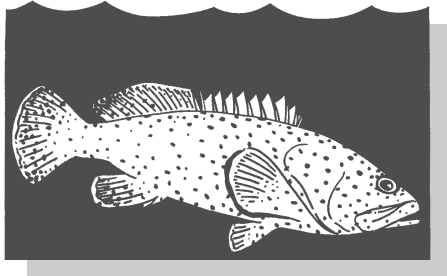
One is that some local middlemen who hold live reef fish for pick-up by live reef-fish transport vessels have no concept of how to hold their fish so as to maintain them in good health. In consequence, disease problems are severe and losses are very substantial. This has been my observation throughout the region too, see 'Editor's mutterings' in this issue.

In the Togian Islands dead fish may be dried—in which condition their ulcers are not readily visible—and sold on the local market.

She also reports that many local people disapprove of the excesses of the live reef food-fish trade, but feel helpless to combat it. The police in the Togian Islands seemed sympathetic to the problem, but have no boat, nor money for fuel.

We cannot condone Ms Sterk's actions, but we can understand the dismay and frustration that prompted them.





workshops & meetings live reef fish

Cultural links to the live reef food-fish trade: call for workshop participants

by Joris Oomen

Similarities between coral-reef life forms and mythical creatures appear to be the origin of today's practice of consuming hand-picked live reef-fish; the gourmet seeks public recognition of his private link between material affluence and benign celestial support.

By choosing a live reef fish, ordering it to be prepared according to a culturally-acknowledged recipe and consuming the dish with appropriate manners, the consumer takes part in an ancient performance, viz. eating effigies of mythical creatures to strengthen one's life force. It thus appears to be the cultural image of special kinds of coral-reef life forms which lead to the live reef food-fish trade, with its environmentally-destructive consequences.

This phenomenon is not overly apparent in the buzz of gourmet parties. But in Hong Kong, a shaman sometimes still augurs an auspicious day and place for an important party. This happening is given public notice in newspapers. Orally-transmitted tales adopt 1000-year-old effigies of specific reef-fishes, like humphead wrasse, leopard and spotted coral trout and tiger grouper, to rebirth celestial beings, e.g. the dragon.

It is said that by consuming these fish one can redeem 'life strength'. And this suggests a congruence between filial ancestral piety and 'rebirthing' of celestial beings.

I propose a systematic effort to record this rather diffuse, ethnically-defined cultural practice and make it more widely known through books, docu-

mentaries and teaching. Experts of disciplines like Sinology, cultural anthropology, mythology, and Asian art, might wish to contribute to this effort. Collectors of folk tales, conservators of art collections and persons who take an interest in the manner in which coral-reef life is linked to prehistoric concepts of life-forces might also contribute. The construction of an Internet website would speed up the process and help attract contributors.

Hopefully we can disentangle the economic and cultural forces which control the live reef-fish trade step-by-step. And perhaps we can improve our efforts to regulate the trade by networking with marine biologists inventorying ecological damage, governmental agencies wondering how to implement effective measures, educationists looking for sophisticated means to correct today's attitude towards marine exploitation, activists looking for ways to support conservation of coral reefs involved and the multitude of storytellers conversant with myths, legends and folk tales.

The workshop would encourage all sorts of contributions, including, for example, the results of interviews with participants in these special gourmet meals. Interviews on the private meaning and impact of the happening with the host and the guests of differing generations, viz. young, adult, middle-age, old and very old, but also metropolitan, urban and rural. The workshop should assess and categorise the contributions into documents easily-accessible for writers, journalists and researchers for movies and documentaries. In the long run, special educational means employed in primary and sec-

ondary schools could become a practical means of correcting today's attitude towards marine exploitation by means of documentaries, movies and chat corners in appropriate websites.

Anyone interested in pursuing an internet workshop on this issue please contact:

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Marketing & Shipping Live Aquatic Products - 98

2nd International Conference and Exhibition, 22-24 November 1998,
** immediately following Fish EXPO in Seattle **,
Marriott Hotel at Sea-Tac Airport, Seattle Washington USA

Global markets for live aquatic products are expanding rapidly. Goals of this Conference are to bring together international practitioners, researchers, scientists, and regulators to discuss strategies of meeting that demand.

Proceedings from the first Conference have been published and are available.

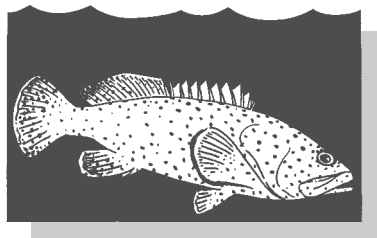
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late news
live reef fish

Anti-cyanide campaigner murdered in the Philippines

The head of the Bantay Dagat (Sea Watch) in Guiuan, Samar Province, Philippines was shot and killed in late March shortly after apprehending cyanide fishermen along with a quantity of cyanide.

This is at least the second such murder in the Philippines. We will have more details in the next issue of the *SPC Live Reef Fish Information Bulletin*.

Sabotage at the harbour

Condensed from the Bowen Independent newspaper (Australia), 25 March 1998.

Bowen could lose part of a major industry following criminal damage to a net at a live fish pen at the harbour early Friday morning. About 4000 kg of fish valued at around A\$ 100 000 escaped from two 38 cm holes cut in the net below the waterline. The net was cut just hours before the arrival of a chartered boat, the *Wind Song 28*, to load live fish for Hong Kong.

Owner and manager of Pioneer Seafoods, Mr Barry Young, has threatened to move his export operation out of Bowen because of the town's attitude to his operation. Mr Young said his decision to pull the boat out of Bowen would have a marked effect on the town.

'The fishermen will be the ones to lose out in the end,' Mr Young said. 'I pay a lot for the fish when they are unloaded. And I keep them here until the market is right. It is I who must wear the cost until the fish are sold in Asia. I have had up to A\$ 700 000 tied-up here waiting to be loaded.'

Mr Young said he was sickened by the attitude of the town when word got around (very quickly, he said) that his fish were back in open water. Mr Young said he could not believe the number of people who flocked to the harbour to fish over the weekend.

Red tide devastates Hong Kong live reef fish trade

A massive red tide destroyed an estimated 80 per cent of the fish in mariculture facilities in Hong Kong waters in mid-April. So far, well over 1000 t of floating dead fish have had to be disposed of.

It is not known what percentage of these were wild-caught reef fish that were being held in floating pens after off-loading and prior to sale to restaurants, but an average of 17 per cent of the pens in these waters are reported to be used for this purpose. In addition, cultured groupers

constituted a significant portion of the cultured fish that died in the other pens.

Within a week, live reef fish prices have risen by 20 per cent and many pen owners were reported to be bankrupt, with total losses estimated to be around HK\$ 120 million (≈ US\$ 15.5 million).

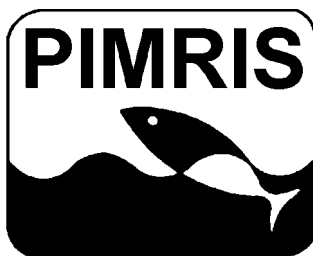
A more detailed report will appear in the next issue of the *SPC Live Reef Fish Information Bulletin*.



The views expressed in this Bulletin are those of the authors and are not necessarily shared by the Secretariat of the Pacific Community and The Nature Conservancy.



PIMRIS is a joint project of 5 international organisations concerned with fisheries and marine resource development in the Pacific Islands region. The project is executed by the Secretariat of the Pacific Community (SPC), the South Pacific Forum Fisheries Agency (FFA), the University of the South Pacific (USP), the South Pacific Applied Geoscience Commission (SOPAC), and the South Pacific Regional Environment Programme (SPREP). Funding is provided by the Canadian International Development Agency (CIDA) and the Government of France. This bulletin is produced by SPC as part of its commit-



Pacific Islands Marine Resources
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ment to PIMRIS. The aim of PIMRIS is to improve the availability of information on marine resources to users in the region, so as to support their rational development and management. PIMRIS activities include: the active collection, cataloguing and archiving of technical documents, especially ephemera ('grey literature'); evaluation, repackaging and dissemination of information; provision of literature searches, question-and-answer services and bibliographic support; and assistance with the development of in-country reference collections and databases on marine resources.