



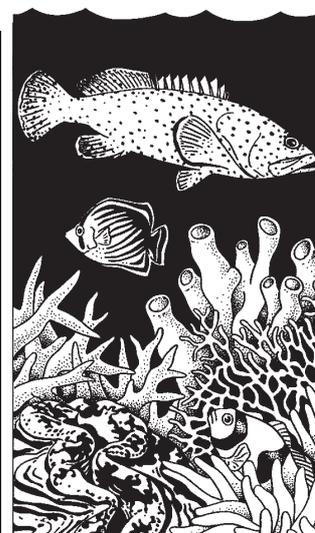
Secretariat of the Pacific Community

# LIVE REEF FISH

*The live reef fish export and aquarium trade*

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INFORMATION BULLETIN



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## Editor's mutterings

It seems almost inconceivable that grouper spawning aggregations have been ignored by fisheries biologists and marine resource managers throughout tropical Asia — despite their being documented throughout much the rest of the tropics in many dozens of articles published over the past four decades.

Why is this? Certainly it isn't because they don't occur in the region. Live reef food fishers have been telling us about them for a number of years (e.g. this publication: Johannes, issue #3, p. 13; Pet and Pet-Soede, issue #5, p. 21; McCullough and Hai, this issue, p. 12).

The almost total absence of research on protection of grouper spawning aggregations in the region is especially worrying because it is the epicentre of live reef food fish fisheries, which target these aggregations unrestrained by any of the restrictions placed upon their exploitation elsewhere. And, judging by experience elsewhere, destruction of grouper spawning aggregations can be accomplished in as little as three or four years of intensive fishing. Once destroyed, they apparently never recover.

It seems very likely then, that some, if not many, such aggregations and associated stocks have already been destroyed in Southeast Asia — although we may never be able to prove this because there is no biological information. Despite the undeniable importance of spawning aggregations of groupers (as well as many other species of reef food fish), it seems that, in Asia, nobody (except, of course, fishermen) can be bothered with them.

There is a small sign of hope, however, in Indonesia. In 1998 The Nature Conservancy (TNC) brought Lyle Squire to Komodo National Park to locate the grouper aggregations there. He had no

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difficulty in doing so (e.g. Pet and Djohani, issue #5, p. 17). Building on this work the Komodo Park Authority, in consultation with TNC, plans to implement a zoning system that will effectively close all known spawning aggregations inside the park for any kind of fishing. This appears to be a first for Southeast Asia. Hopefully, these efforts will be widely copied elsewhere in the region.

In related good news, the use of hookah compressors inside Komodo National Park has been banned. This is a major step by the local government to support TNC's efforts to protect Komodo's reef ecosystems, especially groupers, which were suffering heavily from cyanide fishing using hookah compressors (for background see Pet and Djohani, issue #3, p. 17).

### *Disappearance of large reef fish*

When spawning aggregations are fished out, the fish stocks that they represent tend to disappear too, judging by research on various grouper fisheries. This may help explain the apparent disappearance of large reef fish even from remote eastern Indonesian waters, as described by Jack Randall in this issue (p. 21).

### *Corruption*

In the previous issue in this column we called for more attention to be paid to the problem of corruption in connection with enforcement of marine environmental laws. In this issue, we are pleased to be able to publish a stimulating article by Mark Erdmann describing a promising new model for confronting corruption in connection with cyanide and blast fishing in Sulawesi (see p. 19). Those who despair over ever being able to combat Indonesia's endemic corruption as it relates to conservation laws should read and take heart.

### *Grouper stock enhancement*

In this issue (p. 32), Mr Patrick Chan, Chairman of the Hong Kong Chamber of Seafood Merchants Limited, suggests that green (i.e. conservationist) groups might want to buy — for release into the wild — the excess fry of giant grouper, *Epinephelus lanceolatus*, hatched by Taiwanese fish culturists.

The use of hatchery production for wild stock enhancement is an interesting idea and should not be dismissed out of hand. But stock enhancement of marine finfish is not simple or straightforward or necessarily even environmentally benign. Although Bahrain, Taiwan, Japan (Okinawa) and Hong Kong have been experimenting with hatchery-based stock enhancement of groupers, no one has apparently released information showing a resulting, clear-cut improvement in net fishery production. Attempts at stock enhancement of other marine finfish around the world have often failed; some have been little more than expensive public relations exercises.

Because the idea is increasingly being discussed in the region, there is a need for a comprehensive analysis of the pros, cons, pitfalls and likelihood of success of wild stock enhancement of groupers. But until such an analysis becomes available, anyone thinking of trying to enhance grouper stocks by releasing hatchery-produced fish should check the guidelines of the Re-Introduction Specialist Group of IUCN: <[www.iucn.org/themes/ssc/pubs/policy/reint-english.htm](http://www.iucn.org/themes/ssc/pubs/policy/reint-english.htm)> and consult widely with relevant experts before proceeding.

### *FAO misdefines fish farming*

I read recently that FAO defines fish farming as implying “some sort of intervention in the rearing process to enhance production.” This definition is misleading (and a good example of why deconstructionists attack science for its deep-seated, albeit often unconscious biases).

For fish farmers, whose view of their own activities surely ought to carry more than a little weight, fish farming has less to do with increasing production than with increasing *profit*. The two are by no means synonymous. Whether the wild resource actually suffers as a result of fish farming and total production is thus *not* enhanced (as, perhaps, when wild juveniles are farmed — see Sadovy this issue, p. 22 — or wild fish are used to feed farmed fish) is not uppermost in most fish farmers' minds.

**Bob Johannes**



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



## Erratum

Patrick Chan points out that there were two mistakes in fish names in his article on marketing in the Hong Kong live reef food fish trade in issue #7. The corrections are:

*Plectropomus leopardus* = Red coral trout = Tung Sing  
*Plectropomus areolatus* = Spotted coral trout = Sai Sing

## Trial community fishing and management of live reef food fisheries in Papua New Guinea

*Leban Gisawa<sup>1</sup> and Paul Lokani<sup>2</sup>*

### Live reef food fish operations

The live reef food fish (LRFF) trade began in PNG in 1990 at the Hermit Islands in Manus Province. This operation lasted until 1992 when it ceased as a result of socio-economic concerns raised by the islanders and other factors associated with over-fishing. Since then LRFF operations have occurred in Milne Bay, Bougainville, New Ireland and East New Britain Provinces. Handlines and traps were the most common types of gear used but investigations by National Fisheries Authority during the time when the companies were operating revealed that cyanide was also used secretly. Investigations also revealed that cyanide was stored on some fishing vessels/carriers operating at the time.

Up to 32 target species of fish were recorded in the catches and comprised fish from the families Serranidae (19 spp.), Labridae (1 sp.), Lutjanidae (8 spp.), Carangidae (1 sp.), Lethrinidae (2 spp.) and Scorpaenidae (1 sp.). Catch rates were relatively low (ranging from 0.5 to 20 kg per fisherman per day) compared to catch rates recorded in the Philippines and Indonesia. Annual harvest of live reef food fish in PNG has been relatively low, ranging from 3 tonnes in 1993 to just over 35 tonnes in 1997.

Operators in Hong Kong considered PNG to be the “next frontier” for the live reef fish trade in the early 1990s. It didn’t turn out that way, however, for a number of reasons related to restrictions on the issue of LRFF licences, customary marine tenure and the introduction of a moratorium on the issuing of new licences.

### Moratorium

Briefings to the National Fisheries Authority Board and efforts of international NGOs led the Board to impose an indefinite moratorium on issuing new licences for the LRFF fishery. The moratorium came into effect in late 1997 and the last licensed operation ceased in 1998. Realising that there was strong interest in the LRFF and that there was an opportunity for village communities to benefit from the LRFF fishery, the National Fisheries Authority Board approved two trial LRFF operations in December 2000. The trial licences will be issued for a period of one year. The Board will maintain the moratorium other than for the two trial licences approved to operate at M’Buke Islands in Manus Province and Tingwon Islands in New Ireland Province.

### Interest in live reef food fish

A number of companies and communities have expressed interest in the LRFF trade. Among the communities is a village community from Goodenough Island in Milne Bay Province that was involved in the LRFF trade with a foreign-licensed operator. Between 1997 and 1998 a total of 12 license applications and or expressions of interests were lodged with the National Fisheries Authority to be involved in the LRFF fishery. Between 1998 and 2000 three companies expressed interest in the LRFF fishery and maintained infrastructure by getting involved in some other fishery. Two of these companies have been issued with trial LRFF licences while the third has a business

1. National Fisheries Authority, P.O. Box 2016, Port Moresby, Papua New Guinea.  
 2. The Nature Conservancy, P.O. Box 2750, Boroko, Papua New Guinea.

arrangement with one of the companies undertaking trial fishing.

### Consultative process with stakeholders

A series of meetings in 2000 were held with stakeholders of the LRFF trade in anticipation of the Board lifting the moratorium. The consultative process was undertaken by officers from the National Fisheries Authority and focused on management of the LRFF fishery. Key stakeholders consulted included LRFF operators in Kavieng and Port Moresby, two village communities, and the New Ireland and Manus Provincial Governments.

Key issues and concerns raised by LRFF operators were that:

- they wanted to fish spawning aggregations,
- they wanted to be allowed to use hookah gear,
- they wanted to fish as soon as possible,
- they would cooperate with the management of the live reef food fish fishery.

Key issues raised by the communities were that:

- they were not aware of the destructive potential of the live food fish trade,
- they realised that management was needed,
- they wanted higher prices,
- they wanted greater involvement in management,
- they wanted to do their own fishing and sell or export to buyers.

During the consultative process stakeholders had the opportunity to comment on the draft national and area specific management plans.

Following the Board decision in December 2000 to issue two trial licences, the National Fisheries Authority convened another consultative meeting with the two companies that will be issued with trial licences. The meeting clarified the Board's decision and outlined the implications for the companies. It also gave stakeholders the opportunity to give input towards the monitoring regime during the one-year trial period.

### Trial fishing

The National Fisheries Board approval of the two trial licences is conditional on the trials being monitored intensively. One full-time observer has been assigned to each of the two trial operations. The observers are experienced in fishery data collection, and as part of the preparation, will be participating in a grouper spawning aggregation survey to be undertaken between 13 and 27 March 2001.

Very specific licensing conditions will be imposed on the two trial licences and include:

- no interference with traditional fishing;
- only fish from the villagers will be bought by the company, which will not undertake any fishing itself;
- only handlines and traps will be used for fishing;
- use, storage and transportation of explosives, noxious substances (including cyanide in any form) for the purpose of killing, stunning, disabling or capturing fish is prohibited;
- specific data must be recorded on the forms provided and submitted in a timely period as specified; and
- free access to be granted to observers to all company facilities while conducting their duties.

The company that will be operating at M'Buke village in Manus is owned exclusively by the people of M'Buke Islands while the company operating in New Ireland Province is a national company but owned by people from outside of Tingwon Islands.

### Monitoring trial fishing

The monitoring of trial fishing will be conducted by an observer in each of the two LRFF operations. The observers will be funded by the National Fisheries Authority and will be on site for the full duration of the one-year trial fishing. A number of forms have been designed for collecting data when fishing, buying fish, and during the transshipment of fish from the boats to the cages.

It is anticipated that after the spawning aggregation survey, which will be conducted in March 2001, the observers will be involved in monitoring the spawning aggregations identified in the survey.

### National Live Reef Food Fish Fishery Management Plan

Although the National Live Reef Food Fish Fishery Management Plan has not been approved by the Board, it is anticipated that by April 2001 a final draft will be available for the Board to consider. The National Live Reef Food Fish Fishery Management Plan provides a broad framework for the management of the fishery through area-specific plans. Strategies under the plan include management through a total allowable catch limit for each of the specific fisheries, closures of spawning aggregation areas, limits on fishing effort and management of bycatch.

The formulation of area fishery management plans enables communities to be active participants in the management of the LRFF fishery. The National

Fisheries Authority wants to use the LRFF fishery management plans and the experience as a model for other coastal fisheries in PNG.

## Community Fishery Management Plans

The draft community fishery management plans (area specific) are designed to enable communities to manage the fishery. Control of licensing is still with the National Fisheries Authority but the latter is only a co-manager of the fishery. Among the management measures being proposed under the Community Fishery Management Plans are the closure of spawning aggregations areas, gear restrictions, size limits, total allowable catches and restrictions on fishing by foreigners and outsiders.

## Information needs

Key gaps in information required for basic management of the fishery have been identified, and include the standing stock of target species, the level of stock that can be fished sustainably, spawning areas, spawning seasons and size at sexual maturity. Information required for the national and area specific management plans will be extrapolated from similar tropical areas (in-country or regionally), gathered during the one-year trial fishing and from other relevant sources. The National Fisheries Authority is working collaboratively and exploring ways to address the information gaps with NGOs and other scientific organisations.



# Protecting grouper spawning aggregations, a potential target of the live reef food fish trade in Ysabel and Wagina Islands, Solomon Islands

R.E. Johannes<sup>1</sup> and N. Kile<sup>2</sup>

## Introduction

The Solomon Islands government has lifted the moratorium on the live reef food fish (LRFF) trade in its waters. The single worst biological threat posed by the trade in this country is its ability to eliminate spawning aggregations<sup>3</sup> of certain target species, especially groupers (serranids), through heavy fishing pressure. The destruction of grouper spawning aggregations in more than ten different tropical countries has been documented; and apparently none of these aggregations has become reestablished (Johannes et al. 1999). Once these aggregations disappear, the fisheries associated with the stock also collapse.

It is important, therefore, that Solomon Islands fisheries authorities obtain details concerning the existence of grouper spawning aggregations in their waters so that they can ensure their protection from the LRFF trade. To this end, between 7 and 15 December 2000, we interviewed fishermen along the east and north coasts of Ysabel Island and on Wagina Island in order to find out what they knew about the location and timing of spawning aggre-

gations of groupers in their waters. We interviewed in the villages of Bualo, Baolo, Kolopakisa, Kia, Babahayo, Cookesin and at a few isolated locations west of Sabahayo. The purpose was to find out as much as possible about these spawning aggregations in order to prepare contingency management plans for use in the event that the LRFF trade targets these waters.

If it does not, such plans could nevertheless prove useful to future generations. Although the fishing pressure on these marine resources is relatively low (see below) this may not be the case indefinitely; Solomon Islands has one of the highest birth rates in the world.

We used the excellent photographs in Lau and Li's Identification Guide to Fishes in the Live Seafood Trade of the Asia-Pacific Region (Lau and Li 2000) to identify those species fishermen were familiar with. Fishermen leafing through this guide demonstrated a sophisticated appreciation for grouper taxonomy, having specific local names for the majority of the 36 *Epinephelus* and *Plectropomus* species<sup>4</sup> pictured in the book.

1. R.E. Johannes Pty. Ltd., Bonnet Hill, Tasmania 7053, Australia

2. Box 302, Honiara, Solomon Islands

3. The use of cyanide in this trade has been a serious problem in some Southeast Asian countries (e.g. Johannes and Riepen 1995), but appears to have posed little or no threat in Solomon Islands.

4. Members of the grouper genera *Cephalopholis* and *Variola* were not included in our discussions because members of this genus do not tolerate holding and long-distance transport well and are thus not targeted by the LRFF trade in Solomon Islands.

## Results

Ysabel fishermen confidently pinpointed eight spawning aggregation sites of *Plectropomus areolatus* on our hydrographic map of their waters. *Epinephelus fuscoguttatus* was also reported to form spawning aggregations at several of these sites in the same months. Similarly, *Epinephelus polyphekadion* was also said to spawn at least one of these sites<sup>5</sup>. These are the same three grouper species that were targeted in their joint spawning aggregations by the LRFF trade in Roviana and Marovo Lagoons, Solomon Islands (Johannes and Lam 1999) as well as in Palau (Johannes et al. 1999).

Fishermen were consistent in their assertions that *P. areolatus*, which is caught in the waters east and northeast of the northwestern end of Ysabel, was the most important species of potential interest to the live reef fish trade, whereas *P. leopardus* was the most important species caught in reefs of waters northwest of the northwestern end of Ysabel and the reefs off Baolo, southeastern Ysabel.

Fishermen described only two spawning aggregation sites for *P. leopardus*. This may be because this species typically forms relatively small spawning aggregations (e.g. Samoils 1997), and these would probably be harder to find than the larger aggregations of *P. areolatus*.

It is nevertheless likely that Ysabel fishermen have not located all (nor perhaps even most) spawning sites of *P. areolatus* in their waters. This is because they have no need to search out carefully the best fishing spots as they would in more heavily fished waters. Two to three men can often fill two 100 kg eskies (ice chests) in a single day's fishing. As one of them said to us, "there are probably more of these spawning aggregations, but I need only to target the one I first discovered in order to get plenty of fish." It is noteworthy that he first located this spawning aggregation only three years ago, providing more evidence that the process of local discovery is incomplete.

Not all of the 17 fishermen, or groups of fishermen, we interviewed were able — or perhaps willing in the case of Wagina — to tell us where and when spawning aggregations of groupers occurred. The most knowledgeable fishermen turned out, in general, to be the older ones, and not necessarily those reputed to make the biggest catches.

The reefs around Ysabel appear to be more lightly fished, on average, than those of many Pacific Island areas, including some other areas in Solomon Islands. This is because the ratio of population to reef fishing grounds is low. Collectively, commercial fishermen operating out of Kia, the main population centre on northern Ysabel, land an average of about 3000 kg of fish per month according to Kia Fisheries Centre figures. The area of the shallow fishing grounds available to these fishermen (i.e. running northwest from Ghizunabeana Passage as far as Suramingini reef, and southwest around Ysabel as far as Allardyce Harbour) was roughly calculated by laying a transparent grid over the hydrographic chart of the area, counting the number of squares occupied by shallow reef and lagoon areas and multiplying this number by the area represented by a single square. This area is roughly 900 km<sup>2</sup>. The commercial catch of finfish in the area is, therefore, about 0.04 t · km<sup>-2</sup> · yr<sup>-1</sup>. If we add an estimated subsistence consumption of 100 g of finfish per day per person<sup>6</sup> for the roughly 1500 people in the Kia area, we arrive at a total (i.e. commercial plus subsistence) annual catch of 90,000 kg, which is equivalent to about 0.1 t · km<sup>-2</sup> · yr<sup>-1</sup>.

These figures are only rough approximations, but they are adequate for demonstrating that fishing pressure on the reefs in this area is light. The average yield per unit area reported for ten Pacific Island countries by Dalzell et al. (1996) was 6.0 t · km<sup>-2</sup> · yr<sup>-1</sup> (4.4 t · km<sup>-2</sup> · yr<sup>-1</sup> if we omit the extremely high figures from Western Samoa, which includes a large invertebrate catch). These authors estimate that the average reef and lagoon area can yield 5–20 t · km<sup>-2</sup> · yr<sup>-1</sup> of finfish sustainably. Clearly the fisheries in the shallow waters off the northeastern end of Ysabel Island are taking only a small fraction of the potential sustainable yield.

To look at the data another way, the catch per unit of effort (cpue) in these fisheries averages around 170 kg per day in boats with two or three man crews (unpublished Department of Fisheries data). If we assume that each of three crew fishes for 8 hours, then the cpue is about 7 kg · man<sup>-1</sup> · hr<sup>-1</sup>. In contrast, the average cpue for shallow reef fish in nine Pacific Island line fisheries listed by Dalzell et al (1996) is only 1.7 kg · man<sup>-1</sup> · hr<sup>-1</sup> with the highest cited cpue being 3.5 kg · man<sup>-1</sup> · hr<sup>-1</sup>.

Kia and other Ysabel fishermen we interviewed were, moreover, in agreement that catch rates of

5. Other foodfish reported to form spawning aggregations at some of the same sites, but which are not sought by the LRFF trade in Solomon Islands, are two snappers, *Lutjanus bohar* and *L. gibbus*. These two species (along with many others) were similarly found to aggregate to spawn at *P. areolatus* spawning sites in Palau (Johannes et al. 1999).

6. Local clams and tinned meats and fish were very much in evidence in the diets of villagers during our trip.

reef fish have not declined noticeably in their lifetimes<sup>7</sup> (although fishermen now range further from their villages than they used to).

## Discussion

Nothing we say below should be construed as implying that we recommend managing rather than banning the live reef fish trade. But if the trade is to be allowed, then it must be managed rigorously in order to minimise negative environmental, social and economic impacts. Johannes and Lam (1999) discuss the general requirements for this in Solomon Islands.

Banning the targeting of spawning aggregations does not fully guarantee protection of grouper stocks from overfishing. Too many fish might still be caught outside the spawning season. But it is generally agreed by biologists, that protecting spawning aggregations is both the simplest and most effective way to reduce overfishing (e.g. Johannes et al. 1999; Sadovy 1994). Another reason for prohibiting the live reef food fish trade from targeting spawning aggregations is that female fish are reported by the trade to be more susceptible to stress when they are ready to spawn and, therefore, they do not survive handling and caging as well as at other times. (And it is the fishermen, not the companies, that lose when the fish die in their cages.) This is one reason why commercial live reef fishermen in Queensland, Australia have asked the government to ban LRFF fishing during the grouper spawning season (L. Squire, pers. comm.).

In Marovo and Roviana Lagoons it is possible to imagine protecting most spawning aggregations on site, location-by-location. This is because grouper spawning aggregations are located in waters that are relatively close to fishing villages and regularly frequented by fishermen<sup>8</sup> who could police them.

It is not practical, however, to do the same in Ysabel–Wagina waters. Many of the aggregation sites are too far from fishing villages and too far out of the main flow of boat traffic. In addition, at Wagina there seems to be little concern with marine conservation issues and, thus, little evidence that local enforcement of management regulations would work in the near future.

However, there is a more practical alternative means of protecting grouper spawning aggrega-

tions in these waters; that is, by closing the live reef fishery entirely during June and July, the main spawning season for the most vulnerable four species of aggregating spawners. (We include *P. leopardus* here because, although fishermen know few of its spawning aggregation sites, it spawns during the same months as the other three grouper species according to fishermen. Moreover, because of its coloration it is the most highly valued of the four species in the Hong Kong LRFF market.)

Judging by temporal spawning trends elsewhere, it is possible that smaller aggregations of some of these groupers form in the months preceding and following June and July. Depending on the size of these aggregations, it might be desirable to extend closure of the fishing for live reef fish beyond June and July. Determining the months, if any, in question could be determined by gonad sampling at the fisheries centres, or dive-monitoring of the spawning aggregation sites. Because of the remoteness of these sites, dive monitoring would be a very expensive option.

The imposition of any fishing regulations on people who for centuries have owned their fishing grounds just as surely as they own their lands, is bound to arouse suspicion and resistance. “You are suddenly telling us, who have been exploiting our fin-fisheries without depleting them for centuries that we have to limit our fishing activities?”

Clearly, under the circumstances, sensitive consultation with the villagers (in their villages, not just among leaders in Honiara) is needed to pave the way for local acceptance of any regulation of fishing for the LRFF trade. If any such regulation is to gain their support and cooperation, villagers must understand the reasons for it and, moreover, have an opportunity to suggest and discuss modifications or alternatives. Without their support such regulation will be much harder to enforce. It cannot be overstressed that, according to both traditional and modern law, it is *their fishery* we are proposing to regulate.

Our results demonstrate the value of interviewing fishermen in order to quickly and inexpensively pinpoint spawning aggregations of reef fish. Another option for finding spawning aggregations is to use hydrographic charts and dive at likely locations. This would undoubtedly be too expensive by orders of magnitude to be used as a routine

7. Fishermen say that yields of commercial marine invertebrates have, in contrast, declined significantly. These include trochus, beche-de-mer, green snail, pearl shell and rock lobsters. This is a Pacific Island-wide trend.

8. Most are in, or at the mouths, of channels that are the focus of travel in and out of these lagoons and are also the focus of significant general fishing activity.

approach. There will be dozens of such locations in some areas. In addition, some species aggregate at depths beyond the safe limits of SCUBA. The approach could only be used economically in areas where reefs, and thus potential spawning sites, are few and within safe diving depths.

Where site-based management is impractical, but seasonal closures are an option, determining the seasonality of spawning would be all that is needed in order to protect spawning aggregations. This could be done by monitoring the catch throughout the year when it is gutted.

This approach also has the virtue of not risking the dissemination of information on spawning aggregations that could lead to their eventual overexploitation. This inexpensive form of applied research on spawning aggregations might be considered for other areas in Solomon Islands as well as for other countries.

## Summary and conclusions

Interviews with reef fishermen along the eastern and northern coastal portions of Ysabel Island revealed considerable knowledge of the timing and location of spawning aggregations of the coral trout, *Plectropomus areolatus*, and two other grouper species that aggregated to spawn at the same times and locations.

Our key findings are:

1. *P. areolatus* aggregates to spawn at at least eight locations. Ysabel fishermen from different villages were virtually unanimous in asserting, moreover, that the peak months for these aggregations are June and July.
2. *Epinephelus fuscoguttatus* and *E. polyphkadion* were sometimes reported to form spawning aggregations at the same times and locations. These and *P. areolatus* are the three main species that have been collectively targeted in their spawning aggregations by the live reef food fish trade in Solomon Islands in Marovo and Roviana Lagoons and Ontong Java, although their reproductive seasonality differs in each area.
3. *P. areolatus* is reportedly the most important grouper of potential interest to the LRFF trade in catches made in the north-eastern quadrant of Ysabel's reefs, but *P. leopardus* is more important in catches on Ysabel's north-western reefs and the reefs off Baolo along the south-east coast.
4. Fishermen said that *P. leopardus* is most likely to be found with well-developed gonads, like the

three other grouper species mentioned above, during June and July.

5. Fishermen of Wagina did not provide much useful knowledge about spawning aggregations. But given the proximity (and even some possible overlap) of their fishing grounds with those of northern Ysabel fishermen, it is likely that spawning aggregations in their waters are similarly timed.
6. Finfishing pressure on the reefs off the north-western end of Ysabel is significantly less than the area could withstand sustainably.

Recommendations arising from these findings:

1. If the LRFF trade is allowed to operate in these waters (although we are not recommending it), then the spawning aggregations of *P. areolatus* and the two associated grouper species must be protected to sustain the fishery.
2. It would be impractical to protect individual spawning sites in this area by on-site enforcement; they are far too distant from population centres and too widely dispersed.
3. It would, however, be practical to ban the catching (and holding in cages) of these groupers during the main spawning months of June and July.
4. Consensus-building should precede implementation. In order to gain local support and cooperation, sensitively conducted discussions in fishing villages should precede any attempt to introduce such a management measure.

In addition:

Our results demonstrate that not all reef fishermen can be expected to know where and when key grouper spawning aggregations occur — or divulge that information if they do. Nevertheless, more than enough fishermen were able to provide consistent information on the subject to enable us to determine the best strategy for protecting these aggregations from overexploitation by the live reef food fish trade.

## Acknowledgements

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## An integrated attitude survey on live reef food fish consumption in Hong Kong

Noel W.W. Chan

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This report presents the results of the first integrated survey to document and elucidate the attitudes and eating habits of Hong Kong people in relation to the consumption of live reef food fish (LRFF), their attitude towards possible alternatives, and their supportiveness of conservation and regulatory measures. The results should assist in the development of strategies for a consumer awareness campaign and the implementation of conservation measures for LRFF. The integrated survey includes three parts: a telephone survey of 1,604 people representing the Hong Kong general public, a face-to-face survey of 321 Chinese seafood restaurant customers, and a qualitative survey of 36 LRFF stakeholders (seafood traders and restaurant managers).

Hong Kong is the largest consumer of LRFF worldwide. Annual imports of LRFF into Hong Kong in 1997 totalled 32,000 tonnes from over 10 different countries, mostly in the Southeast Asia region. The sheer volume documented immediately raises doubt about the sustainability of the trade and coral reef resources.

Further, the high demand for LRFF in Hong Kong has led to the LRFF trade becoming a lucrative business, driving many fishermen in Southeast Asia to use sodium cyanide to catch the fish alive. Cyanide may leave the structure of coral reef intact, but can kill corals and the surrounding marine organisms. Moreover, the preference for giant grouper *Epinephelus lanceolatus* and hump-

head wrasse *Cheilinus undulatus*, both listed as “Vulnerable” on the IUCN Red List of Threatened Animals and also for small and probably sexually immature specimens of these and other species are issues of great concern.

To address the threats of overexploitation of coral reef fish and destructive fishing practices, *in situ* conservation of LRFF and legislation measures in source countries are needed. It is also important to adjust demand for LRFF by changing the consumption attitudes and behaviour of Hong Kong people.

## Survey results

The telephone survey found that about 60 per cent of the polled population liked eating fish and 40 per cent liked LRFF. The major consumers identified in the two surveys were middle-aged professionals, blue-collar workers and clerks, and housewives. The majority gave their reasons for eating LRFF as good taste, good texture and freshness of the fish. Consumption was frequent, usually once a week to once a month, and most often at Chinese seafood restaurants located in urban areas (“Downtown Restaurants”), followed by at home and at Chinese seafood restaurants located in tourist areas famous for seafood (“Premium Restaurants”). Family/social dinners and banquets were the two most usual occasions to order LRFF. Over 50 per cent of respondents usually asked for the recommendation of restaurant managers or chose from the menu when ordering LRFF.

Popular LRFF species identified were: leopard coral grouper *Plectropomus leopardus*, mangrove snapper *Lutjanus argentimaculatus*, humphead wrasse *Cheilinus undulatus*, orange-spotted grouper *Epinephelus coioides* and Russell’s snapper *Lutjanus russellii*. In particular, over 50 per cent of the respondents had eaten humphead wrasse *Cheilinus undulatus* or giant grouper *Epinephelus lanceolatus*; 40 per cent of the general public preferred wild-caught to cultured LRFF while 23 per cent held the opposite view.

Fish ordered usually weighed 1–2.5 catties (c. 0.6–1.5 kg) and cost less than HK\$ 200 though higher-income customers usually ordered fish costing HK\$ 200 to HK\$ 400 (*Editor’s note: HK\$ 1.00 = US\$ 0.128, Feb. 2001*). In addition, customers at Premium Restaurants were more selective, exhibiting a marked preference for particular species. They also preferred wild-caught LRFF to cultured fish.

When sufficiently informed of conservation concerns, respondents exhibited a high willingness to change consumption behaviour. About 80 per cent expressed a willingness to reduce or stop eating

species that are vulnerable or declining, and about 60 per cent would support the HKSAR Government in banning the import and sale of vulnerable species.

However, general awareness of conservation concerns related to LRFF was low. Over 70 per cent of the polled population did not know that humphead wrasse and giant grouper were vulnerable species; 49.3 per cent had never heard of cyanide fishing, and over 80 per cent did not know that cyanide might kill many fish and destroy the coral reef habitat.

Cultured LRFF or freshwater fish were acceptable substitutes for wild-caught LRFF to over 60 per cent of those polled because of lower risks of ciguatera poisoning (73% of the respondents) and cheaper price (68% of the respondents). However, willingness to change to substitutes might be constrained by lack of true understanding of the issues; although 86.5 per cent of the respondents knew that wild-caught LRFF might contain ciguatoxin, 50.6 per cent did not know that cultured and freshwater fish were ciguatoxin-free. Meanwhile 22.5 per cent of the surveyed customers refused to accept any alternatives primarily because of the perceived inferior taste of cultured specimens and freshwater fish.

A qualitative survey of LRFF stakeholders found that most traders were aware of the decreasing supply of LRFF from Southeast Asia and the destructive effects of cyanide fishing. The outbreak of ciguatera and the economic downturn of the last two years had severely affected their business. Some of them believed that cultured reef fish techniques should be developed in order to reduce pressure on wild stocks, lower the risk of ciguatoxin, and at the same time improve the taste and texture of the fish. However, they were not optimistic about eco-labelling of LRFF in view of the complexity of the trade and the fact that over 40 species and 10 countries were involved.

Interviewed restaurant managers were less aware of the unsustainability of LRFF fisheries and said they usually purchased LRFF as small as 14 taels (c. 0.53 kg). Most of the Downtown Restaurant managers expressed little objection to the proposed ban on the import of giant grouper and humphead wrasse. In addition, they were more willing to serve cultured fish that were more affordable to general customers. All the interviewed managers strongly opposed the use of cyanide to catch LRFF and said they would refuse to purchase fish known to be caught with cyanide. Lastly, most of the managers said they supported the implementation of conservation measures and eco-labelling of LRFF.

## Recommendations

Educational campaigns aimed at effectively shaping consumer preferences regarding LRFF consumption should be launched to target the major LRFF consumers: middle-aged (31 or above) professionals, blue-collar workers, clerks and housewives. These three groups together accounted for 80 per cent of LRFF consumers in Hong Kong.

In view of the unsustainable volume and destructive fishing methods of the LRFF trade, which often involves the capture of vulnerable species and sexually immature specimens, the message of the campaigns should encourage consumers to:

- avoid the consumption of humphead wrasse and giant grouper, which are vulnerable species;
- reduce the consumption of wild-caught LRFF specimens such as leopard coral grouper whose capture involves destructive fishing methods and are in high demand;
- avoid the consumption of sexually immature or undersized LRFF specimens; and
- when necessary, change to substitutes such as cultured LRFF and freshwater fish.

The appeal to the various consumer groups for behavioural changes are formulated based on analyses of their profiles, eating habits and attitudes towards LRFF consumption and conservation.

Middle-aged professionals should be reached through electronic (i.e. internet) and print media, such as magazines and newspapers, and presented with evidence and problems of LRFF stock over-exploitation in Southeast Asia, especially regarding wrasses and groupers, growth overfishing of sexually immature individuals, and cyanide fishing driven indirectly by mass consumption demand in Hong Kong. In addition, the plea should focus on the lower risks of ciguatera poisoning by substitutes. Since customers tend to forget about the ciguatera problem soon after an outbreak and return to eating LRFF, the campaign should be periodically revived. Supplementary information on availability of cultured substitutes in local markets should be provided.

Middle-aged blue-collar workers and clerks could be effectively reached by mass media such as television and advertisements in the MTR. The surveys also found that this group is less choosy and more sensitive to price considerations. Hence, in addition to the lower risk of ciguatera fish poisoning, the appeal should emphasise that substitutes are cheaper in price and better value for money. Again supplementary information on available

substitutes, in the form of seafood guides or pamphlets, could be provided.

In terms of consumptive behaviour, the survey found that housewives and blue-collar workers and clerks were similar. Campaigns through the mass media channels should also reach housewives. This survey discovered the importance of domestic consumption — the home is the second most important place to eat LRFF in Hong Kong. There should therefore be an in-depth trade survey to understand the quantity, price, species and size of LRFF traded through local municipal markets and supermarkets.

Occasions when LRFF are most often consumed, banquets for festivals and celebrations, and dinners with family and friends in restaurants, should be highlighted in the campaign. Information on possible alternatives such as cultured fish or freshwater fish, and guides for making environmentally-sound choices in LRFF for banquets should be produced and provided to banquet holders, such as via the marriage registry.

The younger generation are potential LRFF consumers and therefore, where resources are available, travelling exhibition displays and pamphlets distributed in schools could be used to provide conservation information on LRFF issues.

Substitutes acceptable to the consumers must be available in order to lead to behavioural changes. Any substitutes must be demonstrated to have a taste comparable to that of wild-caught specimens. Further blind taste tests on popular LRFF species should be conducted with Hong Kong consumers to demonstrate that cultured fish could be equally as tasty as wild-caught specimens. This could provide an opportunity for a publicity event.

Meanwhile, research into improving the texture and taste of cultured species should be undertaken. Further research into hatchery mariculture should be encouraged as currently most mariculture operations are based on grow-out wild-caught juveniles that may be unsustainable. Possible environmental problems associated with commercial mariculture operations would also need to be addressed.

The restaurant sector plays an important role in influencing the choice of customers in selecting LRFF in terms of species and their size. Therefore, both restaurant managers and fish merchandisers should be targeted in future educational campaigns so that they could advise their customers to make environmentally-sound choices in LRFF. Engaging Downtown Restaurants, in particular, since these were the most usual outlets where peo-

ple consumed LRFF, should also facilitate dissemination of supplementary information about LRFF to consumers.

In view of the high public support and low opposition from the industry, the HKSAR Government should consider banning the imports and sales of humphead wrasse and giant grouper. At minimum the government should legislate in line with the laws of other countries, such as the Philippines and Maldives where the export of humphead wrasse is prohibited and Indonesia and Australia where size restrictions are imposed on the export of humphead wrasse and leopard coral grouper respectively. The Government should also recommend that wild-caught LRFF species in high demand, especially leopard coral grouper from the Philippines and Indonesia, be subject to catch and export restrictions in these countries. In parallel, there is an

urgent need to conduct further biological research into stocks and population trends of certain LRFF species for refining catch and export limits.

To help deter cyanide fishing in Southeast Asia, the HKSAR Government should ban the import of LRFF which test positive for unnatural cyanide, and the import of future LRFF from the same source. This would require research into a more sensitive cyanide detection device to be used in Hong Kong.

Finally, so that Hong Kong people might continue to enjoy LRFF sourced from sustainable managed fisheries and caught with non-destructive fishing methods, international cooperation and efforts should be encouraged to further explore the feasibility of establishing an eco-labelling scheme or cyanide-free certification scheme for LRFF.



## The live reef fish trade in Vietnam: a preliminary report from the field

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### Introduction

The International Marinelife Alliance (IMA) office in Hong Kong has noted for some time that significant numbers of live reef food fish are arriving from Vietnam. Little information is available on the fishery there, although anecdotal reports from importers and others indicate that the use of cyanide is widespread.

In October 1999 IMA, World Resources Institute, and Institute of Fisheries and Economic Planning (IFEP) met in Hanoi to discuss the possibility of initiating work under the Destructive Fishing Reform Initiative in Vietnam. Government officials noted their concern over reports of cyanide use in the live reef fish trade — and widespread use of other destructive fishing methods such as explosives, electricity, and fine-mesh nets — in several areas of northern and southern Vietnam. They admitted, however, they had little further information, and would be interested in collaborating with IMA to gather field information and develop a strategy for both controlling the live reef fish trade and combating destructive fishing practices.

IMA established an office in Hanoi soon thereafter, and in June 2000 conducted a preliminary field assessment at four sites, in collaboration with staff from IFEP and the People's Aid Coordinating Committee (PACCOM). This paper provides a preliminary assessment of the live reef fish trade and related issues in these four areas.

### Cat Ba Island and environs, Hai Phong Province

Hai Phong Province has a coastline of 125 km, and large areas of coral reef, as well as one of Vietnam's largest industrial and fishing ports. Fishing has long been important for the province, but its marine resources have been severely depleted by destructive fishing methods including explosives, cyanide, and the use of "sweeper" (fine-mesh) nets. The province's mangroves have also been largely eradicated.

Prior to 1979, the province's fisheries were quite well developed by skilful ethnic-Chinese fishermen who had settled in the area. After 1979, however, nearly 30,000 of them emigrated to China, and Hai

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Phong's fisheries declined due to the loss of fishing expertise and high quality boats and gear. This exodus was one of the reasons that remaining fishermen turned to destructive fishing methods.

Since the mid-1990s, provincial authorities have begun to try to revive the fishing sector by investing in new vessels, promoting aquaculture, and replanting mangroves. A marine police force was also established to counter destructive fishing practices, but has not been very effective, due to a lack of human and financial resources. In addition, fishermen are among the poorest people in the province, and feel that they have no alternative but to catch fish for their daily needs, by whatever means necessary.

Local fishing fleets work nearshore waters, continuing to deplete already exhausted fish stocks. Landings declined continuously from 1979 to 1995 because of overfishing, and the destruction of habitat caused by the widespread use of explosives, cyanide, and "electro-rod" gear (which uses electrical charges to indiscriminately kill large numbers of fish). Meanwhile, the size of the local fleet has continually increased, adding additional pressure; currently there may be as many as 2500 fishing boats in the province's four main fishing grounds at any one time. Some vessels are reportedly not local, but rather come from China or as far away as Thailand.

Most local fishermen are very poor, and utilise small boats — often hand-built — which are either non-motorised or use very small motors to fish nearshore waters. Catches are low, and fishermen therefore must travel farther and farther out to sea, and turn to destructive methods.

One commune in Don Son village organised a fishing cooperative in order to pool their resources for the purchase and running of larger boats that could travel farther, to less depleted fishing areas. The cooperative chairman, a retired naval captain who has fished the area for 36 years, reported that habitat destruction, mostly from blast fishing (which was extremely common in the late 1980s and early 1990s), has been the main culprit behind declining catches. He also noted that higher-valued fish such as groupers have been virtually extirpated from local waters.

Today the cooperative owns three boats (one 22 horsepower and two 18 horsepower). The main fishing grounds lie around Cat Ba Island, and each trip takes 2–3 days with crew of 10 fishermen. The main gear is long drift nets that are pulled in by hand, and the target species is squid, with bycatch of groupers and snapper (usually only about

20–30 kg per trip) sold to traders on Cat Ba Island before the fishermen return to Don Son. Live fish weighing 1–1.5 kg sell for US\$ 5–6/kg on Cat Ba. The Cat Ba middlemen are reported to resell the fish to exporters for about US\$ 12/kg. By contrast, the fishermen get US\$ 2/kg for their squid in Don Son, and less than US\$ 0.50/kg for fresh fish.

The overhead cost per trip is about US\$ 135–170 per boat (depending on its size). Net profits are split 40/60 between the cooperative and the crew. Each crewmember nets anywhere from US\$ 70–340 per month, depending on the catch. Cooperative members are quite satisfied with the arrangement, but worry about the future of fishing in the area, lamenting that 10 years ago, fishing boats on such trips could catch 10–15 t per trip, while the current average is only 0.5–1.5 t.

Hai Phong's live reef food fishermen are centred in two villages on Cat Ba Island, and two on neighbouring Cat Hai Island. Most fishermen use traps and hook and line, and sometimes nets. Cyanide use is not unknown, but is much more prevalent farther north in Quang Ninh Province, as discussed below. Apart from being the main trading centre for live reef fish in the area, Cat Ba Island is also a national park, and is included in the boundaries of UNESCO's Ha Long Bay World Heritage Site.

Phu Long village is one of the two main live reef fishing villages on Cat Ba. Fishermen here use hook-and-line gear to capture live groupers. Some fishermen fish very close to shore in non-motorised vessels, while others with motors work farther out. Fishing trips are short (1–3 days), and the average catch is only 1 kg per day. April to October is the main fishing season, with highest catches usually recorded between June and September. Cyanide is not thought to be used very often by the poorer fishermen right around Cat Ba; they cannot afford it and in any case the island is located near a freshwater outfall, making the waters too murky for cyanide-based diving to be practical.

Small-scale fishermen in Phu Long reported that hookahs and cyanide are used by larger-scale operators working around Long Chau, which is farther out to sea, where the water is much clearer. These fishermen come from Coto Island, to the north, or are recruited from Mong Gai, a large trading center for live reef fish on the Chinese border. The cyanide is brought from Mon Gai, along with fishermen trained in how to use it. The catch is sold to middlemen on Coto Island. Cyanide seems to be used by some fishermen in many parts of the area, but its use is not as widespread as in some other parts of Vietnam (discussed below).

Live reef fisherman in the Cat Ba area capture and sell both grouper fingerlings for aquaculture and mature fish. Mature fish are either sold to middlemen who export them to Hong Kong or mainland China, or directly to restaurants serving the growing tourist trade at Cat Ba and Ha Long Bay, an increasingly important market. One floating fish cage and trading station operator, for example, noted that he did not export any of the fish he grows out or buys directly, since he can buy groupers at US\$ 5–7/kg from the fishermen and sell them directly on the local market at over US\$ 10/kg. This complex included some 30 pens, making it one of the larger operations in the area (only 4 or 5 others are that big). Most of the over 100 other middlemen are smaller-scale operators, with between 4 and 10 pens.

Middlemen sell to exporters, who divide their stock between cultured and wild-caught fish, and make shipments of about 5 t each to China, when prices are favourable. Cultured fish are generally sold in mainland China, while wild-caught stock ultimately goes to Hong Kong. Cell phones have become ubiquitous in the area, and exporters are in constant contact with buyers in China to determine when they can get the best prices. In general, prices in China are 15–50 percent higher than on the local market.

The middlemen are very adept at selecting only healthy and unmarked fish from the fishermen, who are well versed in using a decompression needle to avoid problems with expanding swim bladders. Middlemen reported that most fishermen use hook-and-line gear and nets. Some used longlines, but experienced high fish mortality levels with this method.

There is a parallel fishery for grouper fry. Fry fishermen set about 100 traps four times per day, collecting each set after two hours. Daily average catch is about 20 grouper fry with an average weight of 200 g, sold at US\$ 1.50 apiece during the high season from February to March. By the middle of April the catch starts to decrease, and by May is negligible. More fry become available in June and July. During the months of January, March and April and again in July and August, the fry are plagued with disease, and middlemen prefer not to buy fry during this period, and so offer lower prices.

### Ha Long Bay and environs, Quang Ninh Province

Quang Ninh Province, which adjoins Vietnam's border with China, has a 250-km-long coast and more than 2000 islands — 70% of all Vietnam's islands. Every year, 20,000–25,000 t of marine products are

harvested from the fishing grounds around these islands. However, the marine resources of Quang Ninh have become severely exhausted by overfishing and destructive fishing practices.

Fishermen commonly use fine mesh nets in the breeding season, compounding the general overfishing problem. As in neighbouring Hai Phong Province, fishermen are quite poor and their lives are very hard, especially the ones living in floating fishing villages. Explosives, chemicals, and electro-rods are widely used, especially in more distant fishing grounds around islands such as Dau Be, Bach Long Vi, Co To and Ha Mai. Only a few cases of cyanide fishing have been conclusively proven, largely because the enforcement capacity of local authorities is extremely limited. Discussions with fishermen in the area, however, indicate that in fact, the number of fishermen using cyanide to capture live reef food fish is actually quite high, although restricted to the islands and reefs farther out, since visibility in the bay is generally very poor for diving. Local officials claim that most fishermen using illegal destructive methods come from Ha Long city (the bay's main town) and Coto Island, with lesser numbers coming from distant parts of central Vietnam.

Cua Van is a floating village in Ha Long Bay where many fisherman are engaged in the live reef fish trade, using hook-and-line gear. Many houses have fish pens underneath them. Blast fishing was widespread in the area as recently as five years ago, but recently most fishermen have switched to capturing live groupers to sell to local restaurants. Fishermen generally catch only smaller-sized groupers, because they cannot afford to buy fishing line strong enough to catch larger ones, and stick to nearshore areas around the many islands in the bay. Undersize fish are sold to small middlemen, who grow them out. A variety of groupers are caught, but the main target species are *E. coioides* and *E. quoyanus*. Local knowledge of post-harvest care requirements appears relatively high, and fishermen use antibiotics and other medicines in their pens to reduce disease.

Apart from these small-scale fishermen who sell their catch to local restaurants, there are also larger-scale operators who sell the most highly-valued species to middlemen, for export to China. These species are caught as adults, and only held for a short time before being sold to buyers. The most important species for this export trade are red snapper (*Lutjanus stellatus*), leopard coral trout (*Plectropomus leopardus*), flowery cod (*Epinephelus fuscoguttatus*), camouflage grouper (*E. polyphkadion*) and the honeycomb grouper (*E. merra*). Nets have been used to catch these species in the past,

but due to high mortality rates, many of these larger-scale, export-oriented fishermen have converted to cyanide fishing, according to local fishermen. Cyanide fishing operations are usually carried out around some of the more distant islands, such as Long Chau, Bach long Vi, Dau Be and Co To islands. Co To is a main trading and supply location, and many of the cyanide fishermen operating in the area come from there, as well as from around Ha Long city. As is the case with live groupers from neighbouring Hai Phong, fish are transported by land to the border town of Mong Gai, and sold to Chinese traders.

In Quang Ninh, the network of trading is well developed. Middlemen purchase live fish and resell them to restaurants or bring them to markets in Mong Cai. The Mong Cai live reef fish trade is quite lively, although volume has dropped of over the past years, since more fish are being sold on the local market to restaurants catering to growing numbers of tourists. Fishermen generally get about US\$ 9–10/kg for adult groupers from middlemen, and about US\$ 4–5/kg for live red snapper. When fry are sold, they fetch about US\$ 1.50 apiece

## Phu Yen Province

A province along the coast of South Central Vietnam, Phu Yen has a coastline of more than 180 km, with 37 fishing villages. Phu Yen is considered one of the poorest provinces in Vietnam, and many villages lack basic health and sanitation facilities. Many of the coastal areas and marine resources have been heavily exploited and resource protection by the authorities is only concentrated in two districts, so explosives, cyanide and electrode rods are openly and widely used.

Live reef fish are caught in Phu Yen with hookah and cyanide, as well as with traps (which are also used to capture fingerlings). In Dan Phu village, juvenile fish are reared in a lake and sold to floating-cage middlemen for about US\$ 5/kg (with 3–4 fingerlings/kg). Target species for the live food fish trade are *Cephalopholis argus*, *Plectropomus leopardus* and spiny lobster, for export markets in Hong Kong. Some aquarium fish are also captured, and sold through middlemen to traders in Ho Chi Minh City who export to Europe via Singapore. Coral is also harvested for the growing tourist curio market.

Cyanide fishing is practised at many locations along the province's coast, and cyanide fishers from neighbouring Nha Trang and Binh Dinh Provinces come to exploit these fishing grounds. With the high prices offered for live groupers, the cyanide-based live reef fishery is very attractive to many poor coastal fishermen, and the government has little

capacity to crack down. Other destructive practices such as blast fishing, electrode fishing, and use of fine-mesh nets are also prevalent in the area.

In Middle and New Hamlets and My Quang village, An Chan commune, and Tuy An districts, fishermen are traditionally divers and target live marine products. With many other species depleted, these fishermen are currently targeting lobsters, which are caught as juveniles and raised to market size in submerged cages. Lobsters command an even higher price than live fish and are easier to raise, but in addition to lobsters the fishermen harvest virtually every organism that falls into their nets. The main technique is to surround the coral with a barrier net and spray cyanide into the coral head, which drives all the organisms out into the net. The adult live food fish captured in this way are sold to Chinese middlemen around Nha Trang, or to tourist restaurants. Under-sized *Cephalopholis argus* are sold to floating-cage culture operators at about US\$ 1.50/fish. Fish that die are sold fresh to traders as well. Aquarium fish are sold to middlemen in the Nha Trang area.

In Dan Phu village No 1, Xuan Phuong commune, Song Cau district, the live reef fishery focuses on lobster and groupers. The average catch for a fishing/diving trip is 100–200 small lobsters (100 g each). A few are retained by the fishermen for growout, but most are sold to local floating-cage middlemen or outsiders from Cam Ranh town, at the price of US\$ 3.50 each. Middlemen keep the lobsters about 18 months until they weigh 1–1.5 kg, and then sells them to traders for US\$ 27/kg for grade 1 (more than 1 kg), US\$ 24/kg for grade 2 (0.8–1 kg), and about US\$ 20 kg for grade 3 (0.5–0.7 kg).

## Khanh Hoa Province

Khanh Hoa Province has a coastline of 385 km (13 per cent of the country's total coastline), with hundreds of small islands. According to official records, the province has some 5,000 fishing vessels of varying sizes, and some 27,000 fishermen. Fisherman all along this coast use a variety of destructive fishing practices, and the use of cyanide and explosives is especially rampant in Nha Trang. Diving is often combined with the use of lamps, spear guns, or barrier nets with cyanide sprayed to chase the fish into the net. Electric rod fishing is frequently used in lagoon areas, and is used during particular lunar phases to target spawning fish.

The live reef fish trade is very important in Khanh Hoa, compared to other provinces, and Nha Trang is one of the major live reef fish trading centres of southern Vietnam. Cyanide fishing was only introduced about 5–7 years ago, according to local

sources. Local government officials believe that Hong Kong-based middlemen and traders supply cyanide to fishermen to guarantee the supply of certain volumes and species. The fishing grounds where cyanide fishing is most common are around Hon Cha La, Hon Gom, Hon Lon, Hon Do, Hon Dung, Hon Mieu, Hon Tre, Hon Mun, Hon Tam, Hon Noi, Hon Ngoai, Bai Tien up to Ninh-Binh Thuan. Khanh Hoa live reef fishermen and traders also travel to Phu Yen, and Ninh-Binh Thuan to fish and trade with live reef fishermen and traders from those provinces.

Vinh Tho is a typical fishing village near Nha Trang city, with 40 ships and 20 boats specialised in hookah diving to capture live food fish, lobsters, and ornamental fish. Live food fish are sold to floating-cage middlemen who mainly grow out and trade in *Plectropomus leopardus* and lobsters. The price of live *P. leopardus* paid by these middlemen is US\$ 10-17/kg, depending on size and grade. (Middlemen, in turn, sell the fish to exporters for around US\$ 22/kg, who ship them on to Hong Kong and Taiwan.) By contrast, fresh fish of the same species only fetch US\$ 5.50/kg for the fishermen. As small percentage of the live catch is sold to local tourist restaurants.

Fishermen sell live lobsters to middlemen for as much as US\$ 24-27/kg, who sell them to restaurant traders in Ho Chi Minh City. Most aquarium fish are sold by fishermen to middlemen for only US\$ 0.35 apiece for various species of butterflyfish and triggerfish. Middlemen are able to resell them in Nha Trang, however, for considerably more.

## Conclusion

These four "snapshots" of the live reef fish trade in Vietnam are initial and incomplete pictures of the situation. IMA is currently working with national and local officials to address the many problems associated with the live reef fish trade, especially the apparently widespread and indiscriminate use of cyanide. One of the first steps will be to continue to collect better information on the status of the trade with respect to collection areas, methods used, and volumes and species collected and exported. Nevertheless, it is clear from this initial survey that the live reef fish trade in Vietnam is of significant size, and is plagued with the widespread use of cyanide that has caused so much damage in other countries in Southeast Asia.



## Destructive fishing practices mini symposium

by Lida Pet-Soede<sup>1</sup>

The mini symposium, Destructive Fishing Practices - Towards a Global Understanding of Causes, Effects and Management Solutions, took place in October 2000 at the 9th International Coral Reef Symposium, Bali, Indonesia. Seventeen papers were presented, covering the wide range of impacts from different destructive fishing practices (DFP) on corals and reefs, experiences with enforcement, and suggestions for creating incentives to stop using destructive methods. The discussions, triggered by the presentations, continued in an evening session with the aim of summarising the current state of knowledge of all aspects of DFP and to point to a clear direction towards both proven and innovative new management solutions. A panel discussion was held in which both a selected panellist and the general audience discussed four provocative questions at length. The issues presented and discussed at the mini symposium and evening session are summarised here.

A number of other participants illustrated the destructive impacts of fish traps, derelict fishing gear and pa-aling (a modification of the well-known muro-ami method) to reef ecosystems. In Puerto Rico, 44% of a sample of 100 fish traps were found to cause damage to the reef — 23% to hard coral colonies and 34% to gorgonian colonies. In Hawai'i, derelict fishing gear originating from trawl, seine and other gill nets destroys coral habitat, entangles reef fauna and may accelerate introduction of alien species. In the Philippines, pa-aling may indeed be less destructive than the muro-ami from which it evolved, but appears to be a highly efficient and non-selective gear that easily clears reefs of fish.

Various papers focused on blast fishing and cyanide fishing. Evidence shows that blast fishing in Malaysia not only results in rubble fields but also in seriously reduced fish species diversity — fewer

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individuals per species — and an overall smaller average fish size. Overfishing issues in Indonesia were discussed in relation to the live food fish trade. A model compared habitat impacts of cyanide fishing and blast fishing assuming different levels of fishing effort. Reactions of corals to cyanide exposure were illustrated by a series of highly detailed results from gel electrophoresis analyses at different NaCN exposure levels of corals in laboratories. Implications were drawn for field situations. Rates of natural recovery of coral rubble fields generated by blast fishing at a number of sites in Indonesia were shown to be extremely low or non-existent especially in areas with high currents. Long-term implications were discussed.

Motivations for destructive fishing practices were illustrated by case studies from the Philippines and Indonesia. Economic need, financial greed, and regional differences in social structures and attitudes towards resource exploitation were discussed.

The suggestion was made to focus on monitoring live food fish transport vessels more closely based upon some evidence that these are sometimes involved in cyanide smuggling. Common conclusions were that management is needed now. A series of papers discussed different approaches and successes or failures, while some new ideas regarding the effective banning of DFP were proposed.

Preliminary results of the Indo-Pacific destructive fishing reform initiative are promising. Large numbers of fishers have been trained in using different capture methods. Current changes in the composition of live food fish in the Hong Kong markets were presented and suggest that fish from farther afield are taking over the market. Fish from these other sources appear to come from mariculture mostly.

Although the forces behind these changes are more related to health (rumours of ciguatera poisoning) and socio-economic issues (Asian economic crisis and political unrest) than to environmental awareness, they indicate that the live food fish trade will be going through major changes in the near future. The importance of supporting alternative livelihood strategies was discussed with examples from Malaysia, and a number of creative market and policy initiatives to transform the current live food fish trade were listed.

On the aquarium trade side, a very comprehensive list was presented of large numbers of fish and invertebrates that are unsuitable for the aquarium trade due to special requirements for food, handling or holding. The fact that the United States is one of the largest importing countries of coral reef resources provides a good opportunity to imple-

ment innovative trade measures where the burden of proof that the products are harvested sustainably or derived from mariculture would be shifted to the producing countries.

Discussions continued into an evening session and centred around four questions:

- How do DFP differ from other anthropogenic impacts on coral reefs in terms of both effects on the reef and rates and manner of reef recovery?
- On either a regional or worldwide basis, how do the various forms of DFP compare in terms of their contribution to reef destruction?
- Are fishers “forced” into DFP as a last resort under Malthusian overfishing conditions, or is the adoption of DFP more often a case of greed rather than need?
- What is the role of corruption in finding a solution for the DFP problems and what types of enforcement and management solutions have proven effective in combating DFP in local situations, and are these applicable on a global basis?

Helen Fox (University of California) was the panelist for the first question and discussed how blast and cyanide fishing in combination with other anthropogenic impacts can become disastrous. Rates of recovery and the scale of different anthropogenic influences are important factors that determine which impact is greater. Discussions among the group revolved around examples of reefs that have adapted in response to regular storm events such as in Belize or to regular sediment influxes. The point was made that the relative importance of impacts will differ in different circumstances, such as those of small island reefs compared with reefs around large land masses.

It was also pointed out that whereas the issue of global climate change seems to revolve around using less fossil fuel, using fish bombs concerns the need for people to catch fish to sell. One response was to suggest that a regional prioritisation of anthropological threats is needed along with a lobby to direct effort and funding to the most serious threats. It was agreed that the quantification of the different anthropological threats in different regions is needed so that decisions can be made to make the most of the limited funding and logistic capacity available to conserve and protect coral reefs locally.

Herman Cesar from the Institute for Environmental Studies at the Free University of Amsterdam was the panellist for the second question. He pointed out that blast fishing appears to be a global problem, whereas cyanide fishing seems to be largely limited to the central Indo-Pacific but is

not an issue on east African or Caribbean reefs. (In the Caribbean, tourist SCUBA operations have proliferated and damage done by divers walking on the reefs has become a major problem.) From the group it was added that the base of the cyanide problem is the live fish trade, more so because fishers wipe out spawning aggregations of groupers and other target species.

A clear definition of DFP was sought. It was agreed that although overfishing need not be covered by such a definition, it is strongly related to DFP and that it would be better to talk about destruction to the 'life support system' rather than to 'habitat'. A discussion started around the point that the Hong Kong market claims to aim at being part of a sustainable industry so as to allow fish trading and consumption to continue. This was debated and it was suggested that there is little evidence of this.

The possible banning of hookah compressors in the live food fish industry<sup>2</sup> was put forward and supported by the entire group as a means to reduce both the use of cyanide and the risk of over-fishing. However, the use of hookah in the net-capturing of aquarium fish would then also be at stake, so a suggestion would be to ban hookah and only allow certified groups to use it, which will make enforcement and control more complex.

Allowing the use of clove oil in the live reef fish trade was briefly discussed as it is apparently used in Australia and was a common anaesthetic in Indonesia; however, it was also maintained that this would not resolve overfishing issues at spawning sites or, in general. Blast fishing is in some ways unique. For example, bombs are often used in open water to catch pelagic fish very effectively without harming reef substrate. Patrol and enforcement were considered potentially valuable solutions but would require major inputs in most countries to be effective.

Sofia Bettencourt of The World Bank, Washington, the panellist for the third question, discussed issues of poverty and population growth as factors driving the use of DFP. The abuse of common property by a few people has different management implications than a situation where most of the resource users engage in abusing, destroying or wasting a common property resource. In Bettencourt's experience, detailed studies fail to find a link between alternative income strategies (AIGs) and conservation success. From the group the question arose as to the reasons for examining economic issues and determining whether need or

greed fuels DFP. The answer given was that once one knows the economic or social reasons for fishers using DFP, it becomes clearer whether a certain AIG or combination of AIGs would be a suitable management strategy or not.

The discussion then moved to a number of possible negative side effects of AIGs, where newcomers could move into the space left by people who enter the AIG programme. Also, the comparison was made with bank robbers or contract killers that are criminal offenders for whom no AIGs are sought. This issue remains open.

Robert Johannes a private consultant and editor of the *SPC Live Reef Fish Information Bulletin* was the panellist for the last question. He stated that judging from the literature on DFP, corruption is not a serious problem because it is almost never mentioned. Once this issue — which is related to enforcement — comes out, it can be dealt with, otherwise efforts directed at management might be fruitless.

The group discussed the fact that it is sometimes difficult to write about this issue safely. Examples from the field indicate that situations can become very intimidating when stakes are high especially in the stage before a case is led before court. Other experience relates of situations where corruption issues were reported repeatedly without anything happening and the option of large-scale sanctions was discussed. To this it was debated that a positive approach would work better than a negative approach with sanctions. Recent examples from Indonesia show how positive local media coverage of a recent arrest of fishers using DFP increased the feeling of peer pressure amongst law enforcers and led to a serious follow up in court<sup>3</sup>. Possibilities of giving enforcement authority to local communities were discussed but it was agreed that this creates risks and that trained authorities could better maintain legal rights. The session ended with the positive remark that it should be acknowledged that over the past 2–3 years local groups exert new and stronger voices that address corruption issues.

DFP have been recognised as important regional threats to coral reefs for at least two decades, yet the global significance of this problem is perhaps underestimated and continues to take a back seat to such commonly-cited reef threats as sedimentation, eutrophication, overfishing in general, and global climate change. In a number of developing countries, however, DFP is the most immediate and significant threat to the continued existence of

2. The use of hookah compressors has recently been banned at one location in Indonesia — see Editor's Mutterings, this issue.

3. See Erdmann, this issue, p. 19.

coral reefs and steps need to be taken to both eliminate these practices and promote recovery of DFP-damaged reefs.

Convenors of the symposium were Dr Annadel Cabanban, Dr Mark V. Erdmann and Dr Lida Pet-Soede.

Abstracts are available from the author and full papers are under review for publication. For further information contact Lida Pet-Soede at: <lidapet@attglobal.net>.



## Who's minding the reef? Corruption and enforcement in Indonesia

*M.V. Erdmann<sup>1</sup>*

The recent mini symposium on destructive fishing practices (DFP) at the 9th International Coral Reef Symposium in Bali (October 2000) confirmed that now more than ever, blast and cyanide fishing are decimating reefs throughout the Indian and Pacific Oceans. Participants at that symposium suggested that in Southeast Asia, these DFP are the most significant threat facing coral reefs today — even more so than coral bleaching. Unlike coral bleaching, however, DFP damage has a clear and directly preventable human cause. So why does it still continue? Why have we failed to stop blast and cyanide fishing?

Certainly this failure is not due to a lack of legislation. Blast and cyanide fishing are strictly illegal in most countries with coral reefs (though significant legal loopholes may be present). Rather, the problem is often one of lack of enforcement and prosecution of the fishers and companies using these destructive techniques. A recent email survey requesting information of previous DFP court cases in Indonesia suggested that there is an appalling lack of such cases on the public record. Why has this situation arisen, despite the fact that significant legislation exists to prevent and punish DFP?

In Indonesia, the reasons for such a poor enforcement record are manifold. Police and park rangers often lack incentive and the facilities to investigate DFP incidents, and are frequently woefully ignorant of the pertinent laws and the reasons for them. More often than not, however, the real reason for a lack of enforcement against DFP is more sinister — corruption. Blast and cyanide fishing are very lucrative businesses in Indonesia, and for the average coastal policeman, a cyanide boat is viewed more as a source of “extracurricular funding” than as an enforcement problem. Individual blast fishermen are happy to pay significant “protection money” to ensure that police never happen to be on the scene when blasting is happening.

Often the police and military are involved directly, either in supplying explosives or cyanide, or as the owners of the fishing company. Even in the rare cases where some external force (such as an NGO or a minister's visit) has increased the resolve of police and rangers, the arrested fishers hardly ever make it to court — their boss will usually pay off the police or the court to make sure the case is never brought to trial. Finally, in the exceedingly rare instances where a blast or cyanide case is brought to trial, the company for which the fishers work will undoubtedly take advantage of the most corrupt arena in Indonesian society — the legal system — and pay the judges directly for a ruling in favour of the fishers.

Under this system, it is perhaps not surprising that blast and cyanide fishing continue unabated throughout much of Indonesia. With few exceptions, the only reason for lessening bomb and cyanide use is financial unviability (when the reefs are too degraded to bomb and target species too rare to catch with cyanide).

Models for effective enforcement from the field are few. The Nature Conservancy's Indonesia program, working in conjunction with the Komodo National Park rangers (see Pet, this issue) looks promising, however. Here, an international conservation NGO supports local conservation enforcement agencies with funding, equipment and expertise.

Here I describe a different model for enforcement that is proving successful in North Sulawesi — the involvement of the private sector in protection of the reefs from which they make their livelihoods. The North Sulawesi Watersports Association (NSWA) is a group of 13 environmentally-concerned marine tourism businesses operating in the Bunaken National Marine Park and beyond. In the late 1990s, as declining reefs and grouper and humphead wrasse populations around Indonesia

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resulted in even stronger pressures from illegal fishers on the few marine protected areas, the NSW became so frustrated with the lack of enforcement in Bunaken that they took matters into their own hands. They signed a memorandum of understanding with both the water police and the park rangers, in which they agreed to fund a joint patrol system (with both day and night patrols to catch the increasingly wily cyanide fishermen) and occasional special undercover operations. To finance this patrol system, the NSW members agreed to charge a voluntary US\$ 5.00 “preservation fee” from each of their diving guests.

This joint patrol system quickly produced results. In May 2000, a team of seven cyanide fishers were found operating at night on Bunaken Island. Unfortunately, while they were positively identified, they managed to escape. Photographs were taken of the damage and local witnesses were produced, and the NSW hired a lawyer to press the (terrestrial) police to investigate the case. Within days the seven suspects were placed in jail while under investigation. Though they were eventually released due to lack of evidence, ten days in jail was enough to “reform” this team to the point that they later assisted the NSW patrols with information on a second team of five cyanide fishermen. This team was caught in the act of cyaniding for humphead wrasse, groupers and other reef fish on Mantehage Island in June 2000. The five fishers were sent to jail, and their boats, engines, hookah compressor, dive gear and cyanide containers were confiscated as evidence. Over one hundred captured reef fishes, including juvenile humphead wrasse and groupers, were also taken as evidence. At the present time, four of the five fishers have been released from jail due to their youth (under 18), while the leader of the team is being tried in court in what has become a lengthy battle between the NSW patrol team’s strong evidence and obvious attempted bribery of the judges by the cyanide “boss” behind the five fishers.

Finally, a special undercover operation, executed in late August 2000, succeeded in capturing a team of four bomb fishermen in the act of blasting a reef for fish. All four fishermen were put in jail and are awaiting court trial; their boat, engine, hookah compressor, diving gear, eight unused fish bombs and 13 kilograms of blasted fish were confiscated.

Patrols are ongoing (and are set to receive additional funding from WWF-Wallacea), and it appears that a strong message is being sent to those behind the illegal fishing activities. While the NSW has not yet entered the higher stakes game of paying judges for a decision, it seems that a few weeks’ or months’ of jail time while awaiting trial

may be enough to dissuade a number of fishers from this unethical livelihood.

Given the apparent success of both the NSW private sector model in Bunaken and the TNC conservation NGO model in Komodo, it is tempting to question why such models have not been replicated widely. While the reasons for this are undoubtedly many, it strikes me that one huge obstacle is that many international organisations (both NGOs and development aid projects) and local Indonesian NGOs don’t like the word “enforcement” — it is not a warm and fuzzy concept. Many seem stuck on the notion that blasting and cyaniding are last resort measures by desperately poor fishermen whom we should all pity.

Not only is this paradigm highly inaccurate in Indonesia (e.g. Pet-Soede and Erdmann 1998), it tacitly ignores a very important point. Blast and cyanide fishing are illegal activities that ruin the livelihoods of coastal peoples for years to come. Blasting and cyaniding can easily be likened to murder of a coral reef. Murder is illegal throughout the world, and when it is committed by a person of a lower socioeconomic class we do not simply forgive him because he is poor. In my opinion, the same moral standard should be held against blast and cyanide fishers, period.

In this regard, it is instructive to take note of how the local communities themselves view enforcement activities. In the NSW case in Bunaken National Park, local villagers have strongly supported the patrols and have actually requested more! Several villagers have asked to join the patrols, pointing out that for every bomb or cyanide incident the dive operators hear about, there are fifty more that the communities know about and would like to see dealt with.

It seems that while for years the majority of villagers in the park just held their tongues about the destruction they witnessed (knowing it was often done in collusion with authorities), these same people are now relieved and happy to finally see the law being upheld. Unfortunately, as they have pointed out, there is an awfully long way to go.

## Reference

Pet-Soede, L. and M. Erdmann. 1998. An overview and comparison of destructive fishing practices in Indonesia. SPC Live Reef Fish Information Bulletin 4:28–36.



## IUCN Grouper/Wrasse Specialist Group news

Members of the Specialist Group met again, this time in Bali, at the International Coral Reef Symposium, and there will be another meeting in Durban, for those fortunate enough to attend the Indo-Pacific Fish Conference in May. We continue to gather speed with our Red List Assessments with the welcome addition of a research assistant, Andy Cornish, to the Hong Kong office. Andy will be collecting information on a key list of about 30 species of groupers and wrasses that we have identified as priority species for listing because of concerns expressed over their status in some areas. These include, from the Indo-Pacific, the red grouper, *Epinephelus akaara*, the longtooth grouper, *E. bruneus*, the orange-spotted grouper, *E. coioides*, the tiger grouper, *E. fuscoguttatus*, the potato grouper, *E. tukula*, the humpback grouper, *Cromileptes altivelis*, the California sheepshead wrasse, *Semicossyphus pulcher*, with a revision of the listing of the humphead wrasse, *Cheilinus undulatus*, because more information is available on this species. From the tropical Atlantic, we are currently looking at the gag

grouper, *Mycteroperca microlepis*, and the red grouper, *E. morio*, amongst other species.

We should be very grateful to learn of any unpublished information on any of these species. Also, we would be interested to learn from readers what other species need to be assessed as a priority. Note that it is the ultimate aim of this group to assess the condition of all groupers and wrasses, irrespective of their conservation or management status, to better understand the overall status of these two families, to enable us to take a closer look at species that might need management follow-up and to identify where we need to address data shortfalls. We shall soon have a website to keep those of you who are interested up-to-date with the activities of this group.

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## Jack Randall sees dramatic decline in large reef fish in Indonesia

*A recent conversation with Jack Randall, the most experienced coral reef fish taxonomist in the world, revealed some alarming observations he has made on the state of populations of large fish in eastern Indonesia. In response to my request for a written account of his observations for this publication, he emailed me the following. Bob Johannes*

I have been diving in Indonesia since 1975. In late 1980s I was guest lecturer for several cruises from Ambon to Bali or vice versa on the dive vessel *Island Explorer*. To ensure that the divers would see sharks and large bony fishes, most of our dive locations were well away from heavily populated areas where fishing was already impacting the numbers of larger fishes.

In 1994 I was guest on a dive cruise on the 43-m *Cehili* to the Sangihe Islands north of Manado. These islands are sparsely populated compared to most of the islands of Indonesia, so we were expecting to see reefs with an abundance of large fishes. After several days of diving I asked the other divers if they had seen any groupers, snappers, emperors, or jacks of any reasonable size. All said no. We went ashore at one of the islands and asked why there were so few large fishes. The answer was that Taiwan fishing vessels had been fishing off the islands.

Commencing on 29 September 1999 I was guest on the 35-m *Pelagian* for a two-week dive cruise from

Sulawesi to Bali via the Molucca Islands and the Banda Sea. The person who chartered the vessel asked Captain Matt Hedrick to go to remote islands and reefs with the hope of seeing some large fishes and sharks for underwater photography (all the divers were ardent underwater photographers). Here is what I wrote in my Christmas Newsletter, "I did not see a single shark the whole cruise, only one grouper larger than 18 inches, and no Napoleon wrasses." In the late 1980s where I had dived on some of the same reefs, there were always large fishes to be seen.

My observations on the severe depletion of the large food fishes from Indonesian reefs are those of many other concerned persons. What needs to be done, and soon, is the establishment of a system of no-take marine reserves throughout Indonesia so that breeding populations of these valuable fishes can be restored, and their larvae can then seed the areas where unrestricted fishing is allowed.



## Summary of regional survey of fry/fingerling supply for grouper mariculture in Southeast Asia

Yvonne Sadovy<sup>1</sup>

**Source:** Regional survey for fry/fingerling supply and current practices for grouper mariculture: evaluating current status and long-term prospects for grouper mariculture in Southeast Asia by Yvonne Sadovy. Final report to the Collaborative APEC Grouper Research and Development Network (FWG 01/99). The full report is available on NACA website: <<http://www.enaca.org/grouper/default.htm>>

### Introduction

The demand for, and value of, live reef fish for food, particularly the groupers (Family Serranidae), have grown markedly in the last two decades in parts of Southeast (SE) Asia. For 1997, the volume of live fish traded in the region was estimated at about 53,000 metric tonnes (t), comprised of approximately 30,000 t of grouper (based on figures calculated for Hong Kong and assuming that Hong Kong (and China) represents about 60% of regional trade) (Johannes and Riepen 1995; Lau and Parry-Jones 1999). Approximately two-thirds of this demand is met by capture fisheries of market-sized fish, the rest is from 'cultured' fish. Most of these cultured fish are grown out from smaller wild-caught fry/fingerlings or juveniles, although Chinese Taipei also produces hatchery-reared fry.

There are three issues that must be addressed if the trade in this family of reef fishes is to remain viable in the future. The first is the vulnerability of the groupers, like other large and slow-growing reef fishes, to overfishing, as well as indications that in many areas overexploitation of groupers has already occurred (e.g. Cesar et al. 2000; Sadovy and Vincent in press). The second is the use of destructive fishing practices, especially cyanide, and the threats these pose to habitats on which reef-associated species depend for shelter and food and other reef inhabitants (e.g. Johannes and Riepen 1995; Barber and Pratt 1997). The third concern is over human health; as wild sources of market-sized fish have become depleted within SE Asia, buyers have looked ever further into the Indian and Pacific Oceans for new supplies and, unwittingly at first, brought back to major consumption centres fishes that bear naturally-occurring ciguatoxins (Sadovy 2001). There is, therefore, an urgent need to develop alternative sources of grouper to take pressure off wild stocks, to reduce the use of cyanide-caught fish and to provide safe, ciguatera-free, fish.

As a partial solution to these problems, as well as a means of generating foreign exchange and enhanc-

ing livelihood options in coastal communities, there is a keen interest in expanding and improving the mariculture of grouper and other high-value, marine species. Presently, however, in SE Asia, grouper mariculture is not well-organised, is largely based on the grow-out of wild-caught grouper seed (i.e. fry, fingerlings and juveniles) which are often insufficient and unreliable in quality and quantity to meet demand, and is confronted by a series of problems (disease, mortality, poor feed conversion, etc.) that significantly hinder its expansion (Leong 1998; Napitupulu 1999; Quinitio 1999; Chao and Chou 1999; Ruangpanit 1999; Yashiro et al. 1999; Yongzhong 1999; Johannes and Ogburn 1999). The most pressing of these problems is the fishery of wild-caught seed that may be unsustainable at current levels (Ahmad and Sunyoto 1990; Chou and Lee 1997; Sadovy and Pet 1998; Quinitio 1999).

There is clearly a need, therefore, to examine current mariculture practices more closely in terms of capture, trade and utilisation patterns of grouper seed destined for mariculture grow-out, to determine how better to focus mariculture development in the region and to assess the respective roles of hatchery and wild-capture in supplying seed of the appropriate quality. A comprehensive survey and review of available data/literature on seed-capture from throughout the region was carried out over 18 months from summer 1999. The aims of this study were to survey the species and sizes of juveniles taken, species preferences, capture practices, transport routes, major sources of mortality, and other details of the practice of wild grouper seed harvest and trade in relation to mariculture. This information should allow a better understanding of the constraints, problems, needs and bottlenecks in the wild fry and fingerling supply component of this rapidly developing industry.

### Methods

The survey included the principal economies in Southeast Asia where significant grouper capture,

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culture or trade is practised commercially for fry/fingerlings/juveniles. The survey included visits, interviews through questionnaires, literature review and personal communications, including telephone interviews and letters. The economies surveyed were: Thailand, Vietnam, Philippines, Indonesia, Malaysia, People's Republic of China (PRC), Hong Kong Special Administrative Region (HKSAR) and Chinese Taipei. The broad scope of the country surveys precluded a comprehensive analysis of any one country. However, the focus on all levels of seed fishery, trade and culture across eight economies and over a relatively short time period allow a unique insight into key issues and the identification of major problems of, and possible solutions for grouper seed supply.

## Results

About 180 interviews were conducted, and indicated that approximately 15 grouper species are cultured in SE Asia. Dominant species tend to vary somewhat regionally. However, overwhelmingly, the most consistently abundant species (synonyms commonly used in the aquaculture literature are included) captured wild for culture and also reared in hatcheries are *Epinephelus coioides* (= *suillus*) and *E. malabaricus* (= *salmoides*). Other important species are *E. bleekeri*, *E. akaara*, *E. awoara* and *E. areolatus*. Also cultured in small amounts are *E. amblycephalus*, *E. fuscoguttatus*, *E. lanceolatus* (although hatchery production of this species has recently increased, see Chan, this issue), *E. sexfasciatus*, *E. trimaculatus* (= *fario*), *E. quoyanus* (= *megachir*), *E. bruneus* (= *moara*), *Cromileptes altivelis*, *Plectropomus leopardus* and *P. maculatus*. Note that *E. tauvina* is often referred to in the literature but it is very probably a misidentification of *E. coioides* (or *E. malabaricus*) as it has not been confirmed from most economies in the region, with the exception of Chinese Taipei (Heemstra and Randall 1993). Moreover, reports of *Epinephelus akaara* caught in central and southern Vietnam may be misidentifications of *E. fasciatomaculosus*. Although many results are semi-quantitative or anecdotal in nature, the following section was based on a clear consensus and on strong patterns that arose from the information collected.

## Discussion and recommendations arising from survey results

### *Availability, capture and trade of grouper seed destined for mariculture grow-out in SE Asia*

Grouper seed are caught in coastal areas, particularly around seagrass, mangrove and shallow brackish-water areas near river mouths and estuaries, as well as in tidal pools and around reefs

throughout the region. They are collected using a wide range of fishing gears by small-scale fishers. Often the catch has a strong seasonal component, at least for the smallest size classes of fry, while fingerlings and juveniles are often taken year-round. Although a wide range of species is cultured region-wide, most are of the genus *Epinephelus* and by far the greatest volumes cultured, from both wild and hatchery sources, are *E. coioides* and *E. malabaricus*. Seed are traded both domestically and internationally, often through a complex network of buyers, middlemen and exporters.

The sizes of grouper seed caught and traded vary between 1 and 25 cm, i.e., from the moment of settlement out of the plankton to well over one year of age. Most capture, however, focuses on fish up to about 15 cm (about one year of age; sexual maturation occurs above 25 cm TL in *E. coioides*). The smallest size classes of fish, 1–2 cm fry are caught by the millions over short periods each year, while smaller quantities of larger size classes are typically taken over more extended periods. There is often a tidal or lunar component to catches, especially for the smallest size classes.

Gears used to take various sizes and species of seed were of about 8 different categories: large fixed nets (e.g., fyke nets); traps and shelters; hook and line; scoop/push nets; artificial reefs; fish attractors; tidal pools and chemicals. Some gears, especially of the 'fish shelter' type, have been specially developed to take fish seed and show potential for taking seed sustainably. Other gears take high levels of bycatch, produce poor quality seed (or cause high mortalities) and some may be damaging to the habitat. As examples of destructive gears, those dragged across the substrate, like the scoop net, can cause habitat damage. For this reason scoop nets are controlled or banned in several places. Cyanide, although not widely reported for seed capture, is also destructive of habitat. Lights are sometimes used to enhance the catches taken in fish shelters but seed mortality with lights is higher than when no light is used. High mortality is also associated with fyke nets (these are banned in some places). A second concern with fyke nets is that single units can take a significant amount of seed from a given area leading to possible social inequalities (see Johannes and Ogburn 1999, for discussion). Also worthy of attention are gears that take high levels of bycatch, much of which may be wasted. A 12-month study in Indonesia demonstrated that a very high percentage of total catch taken in artificial reefs (*gangos*) are non-target species and the method of harvesting the *gango* leads to mortality in much of the bycatch (Mous et al. 1999). Although such high bycatch may not apply where the *gango* is widely used (Philippines),

or may vary with season, it is clear that a better understanding of gear operation in general could lead to less wastage and mortality. For many other gears, and during certain periods, bycatch can be high. While some of this bycatch may be used for fish feed, its possible impact on local resources cannot be ignored. As an example, wasteful bycatch of small rabbitfish (*Siganus* spp.) juveniles, most of which perishes, was often high, yet this species is a favoured food fish at larger sizes. There is clearly a need to examine the function of selected fishing gears in terms of waste and damage.

The volumes of seed caught each year and cultured/traded regionally, as indicated by interviews, trade figures and by crude calculations, exceed hundreds of millions of individuals. The greatest volume is of the smallest size classes (1–3 cm), the catch of which during peak seasons can reach several tens of thousands by one unit of gear in one night by one fisher (e.g. fyke net). Even larger sizes of fish are being taken in massive numbers region-wide each year. It is sobering to realise that the amount of seed not untypically produced in the region's hatcheries (outside of Chinese Taipei at least) in one year (i.e. 20–80,000 fry), can be the same as the catch of a single peak night by one fisher using one gear!

If we calculate the numbers of seed that go to producing a particular volume of market-size fish, the numbers are astonishing and strongly suggest crude and wasteful culture practices. To produce the regional estimate of 23,000 t of table-size live fish from culture annually (roughly 10,000 t of which is included in the regional LRFT volume provided above), about 60 million seed are necessary. Yet, crude estimates indicate that hundreds, maybe thousands, of millions of fingerlings, are traded annually in the region implying enormous mortality and wastage of biomass. The magnitude of such wastage, which does not include mortalities following capture and transport to demand centres, calls for examination of its causes and a significant reduction for better use of wild resources. Given the global depletion in marine fisheries, it is no longer acceptable to consider such high levels of mortality as inevitable or unavoidable.

Mortality levels were often exacerbated when demand from exporters/buyers was high. This was because large volumes of seed were caught in a short time, less care was taken in capture, more destructive gears were used and there was generally less interest in delivering animals in good quality. High mortality levels were also noted when the price of market-sized fish was low, producing a situation of reduced interest in local cul-

ture and more interest in rapidly collecting and shipping out large volumes of seed.

The trade in grouper seed throughout SE Asia is complex and extensive. Major trade routes for grouper seed involve Hong Kong, China and Chinese Taipei as major destinations. Major source countries are Philippines, and Thailand, and to a lesser extent Indonesia, Malaysia and Chinese Taipei (about two-thirds of production from Chinese Taipei is based on the grow-out of hatchery reared fry; note also that Chinese Taipei exports both hatchery produced seed and imports and re-exports wild-caught seed).

Some trade is probably illegal because of a concern in some countries about keeping adequate numbers for local use, or of importation of disease with the seed (e.g. between Malaysia and Hong Kong, Chinese Taipei and Thailand, from Johor (Malaysia) through Singapore to Chinese Taipei, between Myanmar and Thailand, and from Chinese Taipei to the PRC). Some trade from Vietnam to the PRC may also be illegal, but this could not be substantiated.

Other, possibly more minor, trade routes identified were from Indonesia and the Philippines to Brunei, and from PRC to Hong Kong. Sri Lanka has supplied seed to Hong Kong. Seed also enters the PRC from Thailand and Chinese Taipei through Hong Kong. In this survey, note that the roles of Singapore, Sri Lanka, Japan and Korea have not been included although they play a minor part in various aspects of the live reef fish trade. The absence of detailed trade data makes it difficult to fully evaluate trade routes.

***Potential for wild-caught juveniles to supply mariculture grow-out in SE Asia and implications of wild seed capture for natural stocks of both target and non-target species***

Despite the enormous numbers of seed caught compared with numbers of fish grown out, there is a widely acknowledged shortage of grouper seed and strong indications that in many areas wild seed supplies are declining, especially those that have been long and heavily harvested. Reasons for the declines cannot be evaluated without careful, controlled studies, but may include, one or a combination of the following: overfishing of grouper adults, adult and seed, habitat destruction, destructive fishing techniques, pollution, and high export (i.e., market) demand. Several examples indicate that real declines in seed supply have occurred with the virtual disappearance of seed of popular species like *E. akaara* from the northern sector of the South China Sea (also see Johannes

and Riepen 1995). Hong Kong, Chinese Taipei and China, the major demand centres for live fish, no longer have viable grouper seed fisheries.

It is noteworthy that the fishery and trade for grouper seed have received such limited attention despite the interest taken in some areas in seed fisheries for other commercially important fishes such as milkfish (*Chanos chanos*) and rabbitfish (*Siganus* spp.). Apart from a few restrictions on exports (e.g., Vietnam, China and Malaysia), controls on grouper seed harvest and trade are limited despite declines noted in several places. Clearly there is an urgent need for more attention to be given to this fishery. It is suggested that well-designed, long-term studies be established in a few key areas to examine the fishery over time, inclusive of socio-economic components, market factors, habitat and adult fisheries of seed-producing species of interest, i.e. a more holistic approach that acknowledges the links between adults and juveniles. In the meantime, it is also clear that a precautionary approach to grouper seed harvest is needed if significant seed are to persist well into the future. "For too long fisheries and aquaculture have been treated as sectors in isolation, a practice that has ignored important linkages and externalities" (Williams 1996). The effect of aquaculture, including wild seed capture, on world capture fisheries in general is only recently receiving serious attention (Naylor et al. 2000).

It is important to understand the basics of the reproductive biology of the groupers to better understand the kinds of questions we need to be asking regarding the sustainability of the capture of grouper seed. Groupers are pelagic spawners — the eggs are released into the plankton, where they hatch and develop into larvae before 'settlement' in shallow coastal areas. Millions of eggs are produced by individual females when they spawn and there is clearly a high natural mortality of eggs and/or larvae and, possibly, of small post-settlement fish since, on average, each female will produce two individuals that survive to breed in the next generation. What is not clearly understood is when the bulk of this natural mortality occurs. If it remains high after settlement, then some removal of fry or fingerlings for culture may have little impact on adult stocks since the probability of any one seed surviving is very low. If, on the other hand, natural mortality drops quickly after settlement and before their capture, then seed removal could have a significant effect on future adult numbers. In the latter case, such a high volume capture fishery may not be sustainable (Sadovy and Pet 1998). The critical question is how quickly do early mortality rates decline to adult levels?

From what we understand about post-settlement mortality, removal of fingerlings and juveniles could have a significant impact on adult stock. Our country reviews indicate that there is a substantial fishery, and demand, for fingerlings and juveniles in the 5–10 cm range, many of which may have entered the adult fishery had they not been captured. Juvenile and adult fisheries of target fisheries thus seem inextricably linked.

To safeguard regional supplies we should not wait until we can gauge sustainable harvest levels for seed fisheries before we regulate and manage them, especially those for seed in the larger size classes. There is also a need to protect the adult stock, and especially the spawning aggregations, where the seed are produced (Johannes 1997). Given the likelihood of high natural mortality in the smallest settling fish, several workers have already proposed fisheries for very early post-settlement, or even pre-settlement, seed (e.g. Dufour 1999) as a way exploitation that does not affect long-term persistence of the resource. These initiatives are to be lauded, but I caution that we still do not know enough about these very early life history phases to know how much harvest of which size classes is advisable. There is a need, therefore to exercise the precautionary principle in developing such approaches on a wide-scale basis.

Given the apparent insufficient supply of seed for regional demand, unsustainable seed capture practices and apparent widespread declines in seed resources, I recommend strongly that export of wild-caught seed throughout the region be banned. This measure, in various forms, is already in place in several economies. It is the best single measure to address many of the most pressing problems in the grouper culture industry in the region. It will help to preserve seed for source countries to culture locally (for example, in Thailand and the Philippines local seed supply is probably sufficient for local demand but high exports of grouper seed periodically produce local seed shortages). It should also significantly reduce the risk of disease transfer around the region, place responsibility and accountability for local resources in the hands of local governments and stakeholders, and enhance the economic value of local resources to the source country through the value-adding process of grow-out to market-size. Moreover, it is very likely that if seed resources are cultured in source countries, there will be greater incentive to develop capture methods that make better use of the resource by producing appropriate sizes of better quality seed in a non-destructive or wasteful way. Seed transport is stressful; less mortality will occur during transport to local culture facilities than during the longer transport times

usually involved in export to other countries. Local seed will also be better adapted to local conditions. Finally, reduced trade should restrict the introduction of genotypes around the region into areas where they do not occur naturally

### *Scope and potential of wild-caught versus hatchery produced fry in grouper culture and coastal livelihoods*

The wild-capture of grouper seed is expected to persist into the foreseeable future. Suitable areas for grow-out (i.e., where there is good water quality) to market-size and the production of seed by hatcheries have consequences for coastal communities and grouper demand and supply regionally. For example, successful hatchery production in Chinese Taipei depressed demand and prices in countries that supply wild seed, while deteriorating water quality has recently led to reduced demand for seed for grow-out in a major demand centre, Hong Kong. With the exception of Chinese Taipei, there are no strong indications that hatchery production is close to meeting demand for seed and for markedly increasing the diversity of cultured species in the short-term. It is, therefore, important to examine both the implications of wild-capture of seed and the consequence(s) of hatchery production in relation to regional grouper seed supply and their possible social and economic implications. It is also important to determine whether wild sources of grouper seed could be used less wastefully.

Aquaculture is defined by the Food and Agriculture Organization (FAO) of the United Nations as: "...the farming of aquatic organisms, including fish farming, implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated..." The key here is the word 'enhance'. In examining grouper culture it needs to be considered whether current grouper mariculture activities and practices indeed enhance marine resources and address regional objectives for mariculture development.

The contribution to production of market-size grouper through culture (compared to wild-caught market-size fish) is significant in SE Asia. Cultured fish have the potential to take pressure off wild stocks, be a source of safe-to-eat (ciguatera-free) fish, and provide livelihood options in coastal communities (Cesar et al. 2000). However, to effectively fulfil this role, the culture sector needs to ensure that it recognises and rewards good practice, as well as to carry out quality control on production and culture conditions. Moreover, when culture is

based on the grow-out of wild-caught fry or fingerlings, such capture must be maintained at sustainable levels. Towards such ends, a certification system (along the lines of the Marine Stewardship Council) could be introduced to encourage sustainable harvest, and internationally accepted guidelines, such as HACCP (Hazard Analysis Critical Control Point) and the FAO International Code of Conduct for Responsible Fisheries, adopted respectively to ensure fish are safe for human consumption and are taken sustainably.

Turning to the role of hatchery production in relation to the earnings of coastal communities, we need to ask several questions. How will hatchery production of grouper seed address issues such as price control, control of the means of seed production, better use of existing (biological) resources, access to good quality fry, species diversity for the live fish market, a sustainable culture sector and community earnings from seed capture and culture? Will hatchery produced seed be widely available to small-scale culture operations and to what extent might the private sector be able to control prices of hatchery produced fry? Moreover, what controls might there be on hatchery production to avoid over-production and low prices due to gluts? In Taiwan recently, for example, business interests have been keen to see grouper fry overproduction (in some seasons) purchased for 'restocking' (usually done as large public events), the benefit of which, for fishery enhancement, is questionable at best, and certainly unproven for groupers (see "Editor's mutterings", this volume).

In terms of control of prices and means of production, hatcheries have the potential to take the former away from traders/middlemen and the latter away from the fishers and their communities. A recent case in point is the successful hatchery production in Chinese Taipei that has had a marked effect on demand for grouper seed. Exporters and importers were generally not enthusiastic about hatcheries because of concerns that the increased production would diminish the value per fish. The exception to this position was from a businessman who took a long-term interest in the stability of seed production, rather than considering only immediate business goals and constraints. On the other hand, if fry capture is largely replaced by hatchery production, fishers may well find that grouper seed capture no longer provides much-needed income.

Hatchery production also has other advantages and disadvantages. Advantages are the potential for high volume production of standard and good quality seed, a diversification of the species available for culture (especially high value species for which seed

are not readily available) and reduction of pressure on wild stocks. However, given the low volumes currently produced (Chinese Taipei is an exception for a few species) and difficulty in procuring broodstock in many cases, the potential for large-scale production of a diverse range of high quality reef fishes is unlikely to materialise in the near future. Moreover, the most successful culture model for grouper, that of Chinese Taipei is unlikely to be one that is readily transferable, at least not in its complete form, to coastal communities. Its success is in organisation and specialising, not in reducing mortalities. It, therefore, seems likely that large-scale hatchery production will be limited to government institutes and private companies.

There are many tens of thousands of fishers in SE Asia who practice grouper seed capture for part or much of the year. There is, therefore, a compelling reason to ensure that coastal communities benefit from small-scale seed fisheries, and promote low intensity grouper culture operations, while ensuring that resources (both the seed and habitats on which they depend) are properly managed. Government assistance at the community level is also going to be necessary to improve the possibility for fishers to move into culture operations, assist them in breaking away from relationships of indebtedness that characterise some communities, and provide cheap, good quality hatchery-produced seed to make up shortfalls from healthy, but limited, wild seed sources.

#### *Recommendations in respect of future developments of mariculture in the region arising from the survey results*

1. Prohibit all export of wild-caught grouper seed. Grouper should be cultured to market-size within source countries.
2. Develop and implement careful and controlled studies on selected grouper seed fisheries whereby information is integrated on catches, socioeconomics, market forces, associated adult fisheries and habitat.
3. Reduce or eliminate the use of destructive (i.e. of habitat) or particularly wasteful (i.e. producing high mortality in, or damage to, target and/or non-target species) fishing gears or methods for grouper seed. Conduct studies on preferred gears to ensure that their operation does not incur unnecessary waste or damage.
4. Ensure better use of existing resources and reduce wastage of wild grouper seed biomass (and bycatch) arising from unnecessary mortality from harvest, transport and culture.
5. Examine, scientifically, the possibility of focusing the seed capture fishery on life history stages with the highest levels of natural mortality. Also, improve the means of nursing this phase to one suitable for widespread, small-scale culture. One possible approach might be to establish 'nursing' stations in areas where there is a seed capture fishery and culture operations.
6. Develop management approaches to protect key seed settlement and nursery habitats, such as mangrove areas and seagrasses in river mouths and estuaries, and protect the production of those seed by safeguarding the spawning adults (i.e. in spawning areas or spawning aggregations).
7. Provide government assistance in terms of incentives or low-interest loans to enable small-scale fishers to enter the culture sector to produce low intensity, high quality, cultured grouper, in suitable grow-out areas. Provide assistance in breaking relationships involving indebtedness.
8. Develop certification systems for quality products and address food safety issues; ultimately, high quality, certified, fish should command higher prices. Actions: (a) distinguish between hatchery-produced and wild-caught seed; (b) identify seed of good quality through biochemical testing; (c) identify good mariculture practices; (d) identify cyanide-free seed and ciguatera-free market-size fish; (e) encourage food safety guidelines, such as HACCP. Classify 'live fish' as a food item in Hong Kong.
9. Examine the role of hatcheries in supplying grouper seed for culture and how these might best complement the objectives of grouper culture development in the region.
10. Promote the application of the precautionary principle in the exploitation of grouper resources and adopt the FAO International Code of Conduct for Responsible Fisheries.

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## Opportunities and constraints of grouper aquaculture in Asia

*Herman Cesar and Erik Hempel*

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### Abstract

This study examines the future potential and possible pitfalls of grouper aquaculture in Asia. This culture could contribute to the protection and sustainable use of coral reefs and associated ecosystems by supporting a transformation of current destructive fishing practices — cyanide fishing, harvesting of spawning aggregations, and so on — to an economically viable and environmentally friendly live reef food fish business. Grouper aquaculture is one of the few options to achieve this transformation. And it could create jobs and income for rural and coastal populations and, thus, indirectly feed poor coastal communities. It would also bring in foreign exchange. Yet, aquaculture has so far mainly benefited owners of sufficient capital. And as groupers are piscivores, successful grouper aquaculture may push up the demand for trash fish, so that fish prices for the poor might go up. Also, if grouper aquaculture leads to lower prices for groupers, demand might increase. At the same time, it is argued that piscivore aquaculture should not be stimulated in the first place because of current levels of overfish-

ing, unless applied research can alter the food conversion factors to levels similar to those of herbivorous fish. Additionally, grouper aquaculture would rely heavily, at least for the time being, on catching wild breeders and, to some extent, also on catching wild fingerlings. Such a practice is only sustainable if very well managed.

Given these pros and cons of grouper culture, a cautious approach is needed, consisting of four tracks.

First, research is needed. Currently, the food conversion factor for grouper culture is such that large amounts of trash fish are needed, and stimulation of the sector would only increase this demand. Also, mortality of cultured fingerlings is still high and for most species, breeding is not even economically viable. Besides, there are disease problems that will only grow once the sector is further developed. A close relationship between the industry and the aquaculture research community — nationally, regionally and globally — is needed in order to solve biological problems.

1. For the complete report contact Surhid Gautam <sgautam@workbank.org>

Second, on business development, it appears that, regardless of the political system in an individual country, the responsibility of developing the industry must reside with the industry itself and its supporting investors. Only the industry will have the necessary know-how with regard to production, marketing and distribution to launch an effective development of the industry. However, the industry must be given a proper framework within which to function responsibly.

Third, there is an obvious need for the establishment of a proper regulatory framework for this industry at the outset of its development to avoid large future costs. The regulatory framework must be based on water utilisation plans and coastal zone management plans, taking other industries competing for the same resources into considera-

tion. International organisations and funding agencies could take on some of this responsibility, both through technical assistance and funding.

Fourth, there is scope for proper marketing and “green” labels. If the initial concerns of grouper culture are adequately dealt with, this industry could replace — at least partly — the current destructive wild catch of groupers that is largely based on poison fishing. And hence, the industry could position itself with selling a “green(er)” product. Currently, the market values wild-caught groupers higher than cultured groupers, although blind tests do not confirm these preferences. Marketing of cultured groupers as “green” adds to awareness of the cyanide problem and this would both help the consumer and the coral reefs.



## Regional workshop on sustainable seafarming and grouper aquaculture

*Yvonne Sadovy<sup>1</sup>*

This workshop was held in Medan, Indonesia, 18–20 April, 2000, and was organised by the Government of Indonesia, the Bay of Bengal Programme (BOBP/FAO), Asia-Pacific Economic Cooperation (APEC) and the Network of Aquaculture Centres in the Asia-Pacific (NACA). The focus of the meeting was on grouper aquaculture and the management strategies necessary to support the sustainable development of seafarming in the Asian region.

There is a lot of interest in grouper culture throughout the region for income-generation and for livelihood improvement, and also as a means of reducing fishing pressure on wild grouper populations and an alternative source to cyanide-caught fish. Moreover, cultured fishes offer a means of reducing the risk of ciguatera food poisoning. Such promise of grouper culture can only be fulfilled, however, if it is operated sustainably and with human food safety in mind, as well as being based on practices that are widely accessible to coastal communities.

A major emphasis of the workshop was on technology transfer and management strategies for the benefit of farmers and coastal people. In relation to grouper aquaculture, presentations ranged from overviews and country status reports on grouper aquaculture in the region, to difficulties in the transfer to grouper hatchery technology to farmers in coastal communities, and the often-discussed

problems of disease and health management and the continuing problem of feed management practices. Interesting perspectives on seed supply from the capture of settlement-stage larvae in Solomon Islands and on the possible future direction of grouper farming in the region were given.

In the latter presentation, serious problems of marketing were discussed, including the wide variability in prices over time and the possible impact on prices of becoming too successful in mariculture! The limits of seed supply based on wild-capture were discussed as a major constraint on culture development. Updates on the regional markets for grouper and marine fishes were given as were the use of mariculture as an alternative livelihood to destructive fishing practices in a marine park in Indonesia, and its role in community development in the Philippines. The talks were interesting and the debate and discussion lively with a real concern to develop grouper culture along sustainable lines.

The workshop concluded by establishing working groups to discuss coastal livelihoods and socio-economic issues, markets and certification issues and technology and management.

The report of the workshop will be available soon, and may be obtained by contacting:  
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## A possible new candidate for grouper aquaculture

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Grouper culture in the western Pacific can serve to: 1. reduce fishing pressure on wild groupers that are heavily overfished in Southeast Asia, 2. provide an alternative source to cyanide-caught fish in the live reef food fish trade, and 3. offer a means of reducing the risk of ciguatera food poisoning, which has caused serious problems in Hong Kong twice in two years. (Whether it can operate sustainably, however, is an important question to which we do not have satisfactory answers yet.)

Because estuarine waters typically vary greatly in temperature, salinity and particulate and organic loads, groupers that live in estuaries would appear to have natural advantages in withstanding the environmental insults typically associated with tropical finfish aquaculture. It may therefore be no coincidence that the two species of grouper that have proven easiest to culture, *Epinephelus coioides* and *E. malabaricus*, both spend significant portions of their lives in mangrove estuaries (e.g. Sheaves 1996). In addition, a third species, *E. lanceolatus* that also lives, in part, in estuaries has also proven recently to be a very suitable species for aquaculture (see Chan this issue, p. 32).

The literature on fish assemblages in tropical Indo-Pacific estuaries suggests that these three species are the only groupers that are commonly found in mangrove areas in the western Pacific (e.g. Heemstra and Randall, 1993). In parts of this region a fourth species, *E. polystigma*, is reported from estuaries, but, according to Heemstra and Randall (1993) “seems to be a rare species; consequently it is of little interest to fisheries.” Here I provide evidence that it is probably not rare in at least one part of its range, and why it may be of interest, not for fisheries, but for aquaculture.

During interviews with Solomon Islands fishermen concerning spawning aggregations of other species of groupers (see Johannes and Kile, this issue, p. 5), the fishermen described some unusual features of the behaviour of *E. polystigma*. These features suggest why it is thought by ichthyologists to be rare, although it is apparently common in Solomon Islands, and why it has received so little attention from researchers. The following description is based on highly consistent informa-

tion provided independently by fishermen at four different localities in Ysabel Province.

The fish is known as *kobiri* or *kobili* in a number of different Solomon Island languages (G. Bennet, R. Hamilton, N. Kile, E. Hviding, all personal communications) and was described by fishermen as reaching weights of between 4 and 6 kg. It is said to inhabit shallow estuarine waters, often aggregating in water so shallow that the backs of the fish protrude from the water as they rest on the bottom. The fish was described as being very ‘lazy’ and exceptionally easy to approach and spear. For this reason it is said to have disappeared completely from some estuaries in Roviana lagoon, Solomon Islands as far back as the 1970s (R. Hamilton pers. comm.) The species is also said by fishermen to be tolerant of domestic and latrine pollution and capable of living out of water for many hours if kept in the shade. Nothing seems to be known, either by researchers or the Ysabel fishermen we interviewed, about its reproductive habits.

In the last village we visited during our interviews we were told that there were still some *kobiri* living in a small nearby estuary because it was polluted by village waste and people did not want to eat fish from such a source. I expressed interest in seeing a specimen but was not taken up immediately on this request. However, I was awakened that night when a fisherman appeared outside my door and shook a still-living *kobiri* off his spear. He had just speared it by torchlight only 200 m away in the estuary near the edge of the village.

It was only then that I was able to identify the species as *E. polystigma*. Its stomach contained four undigested crabs. I made the mistake of leaving it outside until I could examine it further in the morning. By morning, however, it had disappeared, probably having been appropriated by one of the village cats. That same morning we had to leave and there was no opportunity to make further observations.

Ysabel fishermen at four locations all told us that the fish was abundant and easily caught in the estuaries of rivers and streams that are not close to human habitation. There are many such streams on Ysabel because rainfall is very high and human set-

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lements are few; the human population of this 100-mile-long island is only about 18,000, 75% of which are concentrated in one small area.

Some fishermen said that they had never seen *kobiri* other than in estuaries. Several others asserted, however, that they had seen it in coastal waters where, in contrast to its coloration in estuaries, it possessed small white blotches.

In addition to *E. polystigma*'s ability to live in estuarine conditions, other characteristics make it appear worth investigating for aquaculture. It is said by fishermen to taste as good as other groupers. It is attractively coloured; the body is a uniform chocolate brown, without the pale abdomen of many species. Small circular yellow spots densely cover the body and all fins except the ventrals. The fact that it can apparently live out of water for a long time suggests that it would withstand air-shipment well. In addition, the species is apparently rare in Southeast Asia, and rarity is seen as a gastronomic virtue among Cantonese consumers. How appealing it would be to satisfy this demand for rarity with a species that is apparently common in at least one part of its range.

## Acknowledgements

I thank Gregory Bennet for first drawing my attention to the existence of this fish, and Nelson Kile, who very capably organised our field trip, and interpreted during the interviews.

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## Taiwan grouper hatchery production in 2000

Patrick Chan<sup>1</sup>

Two million giant grouper (*Epinephelus lanceolatus*) fry were produced in Taiwan hatcheries and sold in 2000. The price dropped from HK\$ 25 per 3-cm-long fish at the beginning of the season to HK\$ 2.5/fish at the end of the season<sup>2</sup>. A large quantity of fry was sold to Hainan and some to Hong Kong, Sabah, Malaysia and Vietnam, but the survival rate was reported to be unsatisfactory. Overseas markets could not be found to absorb all the fry produced and large quantities are now being reared by Taiwanese culture fishermen.

The current price of the (eating-sized) giant grouper in Hong Kong is around HK\$ 90/catty and we believe the price will drop to HK\$ 60/catty when the fish start going into the Hong Kong market in August and September in 2001<sup>3</sup>. This will also badly affect the price of *Epinephelus coioides*, which could be replaced by giant grouper. It is believed that the harvest of fry in Taiwan will continue to be good in 2001.

Since the price of fish is low, green groups may want to consider raising funds to buy the fry for release in order to improve the population of this type of fish in the wild.

A hatchery in Penang is working hard to produce giant grouper but no news of success has been heard.

About 300,000 tiger grouper (*Epinephelus fuscoguttatus*) fry were produced by Taiwanese hatcheries. The majority of the fish were sold to the local culture fishermen. The survival rate of the fish has been very good and they grow very fast. Hatcheries from Bali, Indonesia, and Penang, Malaysia, also produced some fry of this species, but information on the quantities is unavailable. Tiger grouper fry are being reared in Thailand, Vietnam, Sabah, West Malaysia, Hainan and Hong Kong.

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2. HK\$ 1.00 = US\$ 0.128 (Feb. 2001)

3. 1 catty = 600 g

The price of this fish remained stable in 2000. Cultured fish of 0.5–0.8 kg could be sold at about HK\$ 95–100/catty.

At least one hatchery in Taiwan and two hatcheries in Bali, Indonesia, produced high-finned grouper (*Cromileptes altivelis*) fry. Taiwan culture fishermen are not interested in this species because it grows very slowly and cannot be reared in ponds there.

The asking price was very high at the beginning of the season at HK\$ 55 per 6-cm-long fish. No culture fishermen wanted to take the risk. The price dropped to HK\$ 8/fish for fish 2–3 cm long but there were still no buyers from Hong Kong or PRC.

We believe at least 20,000–30,000 high-finned grouper fry were hatched and grew bigger than 3 cm but we do not know their fate, as no buyers were available.

Hatcheries in Taiwan are currently able to hatch more than 40 species of marine fish for mariculture with *Epinephelus coioides*, *Trachinotus blochii*, *Lutjanus argentimaculatus*, *L. stellatus* and *Acanthopagrus latus* being the species raised in greatest numbers. Giant grouper (*E. lanceolatus*) joined this list in 2000.



## Seed supply for grouper cage culture in Khanh Hoa, Vietnam

Le Anh Tuan<sup>1</sup> and John Hambrey<sup>2</sup>

**Source:** Condensed from *Aquaculture Asia* 5(2):39–41, April–June 2000.

Grouper culture has developed in recent years in Khanh Hoa in response to high market value, the availability of unused shrimp ponds because of disease, and a cage culture tradition related to the fattening of lobsters. Grouper culture is dependent on wild seed.

A broad-based study was undertaken between January and July 1998, which examined technical, environmental, and socio-economic issues related to wild grouper seed supply in Khanh Hoa in order to assess the prospects for the sustainable development of grouper culture in the province as well as elsewhere in Vietnam. Field work for the study was carried out from December 1997 to April 1998 in four districts of Khanh Hoa Province (Van Ninh, Ninh Hoa, Nha Trang, and Cam Ranh) which are the main areas for grouper seed supply and grouper culture in Central Vietnam.

The study used existing information, supplemented with an interview survey of fishermen, and a physical/ecological survey of catching grounds. Parameters related to grouper seed supply, such as physical and ecological characteristics of catching areas, technical attributes of seed fisheries, and market and socio-economic aspects of seed supply, were recorded and investigated using a framework adapted from the “Handbook for

rapid appraisal of fisheries management systems” (version 1) (Pido et al. 1996).

The method of determining the coverage of seaweed, seagrass and coral samples were collected and identified based on the FAO key. The ecological data was analysed using cluster analysis, as developed in the ADE 4 package (University of Lyons). The methodology and results have been described in detail elsewhere (Tuan 1998).

Field work for the study was funded under the DFID Renewable Natural Resources Knowledge Strategy: Improved management of small-scale tropical cage culture systems in Asia.

### Ecological attributes of catching areas

Four *catching areas* were identified: Van Phong, Nha Phu, Nha Trang and Cam Ranh, corresponding broadly to the four coastal districts of Van Ninh, Ninh Hoa, Nha Trang and Cam Ranh, respectively. These areas were all characterised by the presence of seagrass “forest” or seaweed beds. Two seagrass species were common to all areas: *Thalassia hemprichii* and *Enhalus acoroides*. Within each area were several catching sites where the bulk of fishing for seed took place, amounting to a total of 16 catching sites. Cluster analysis revealed

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three broad types of catching site, corresponding closely to the conventional classifications of coral reef, lagoon and estuary.

### Species and habitat preference

In total, seven species of seed grouper were caught regularly at the various sites. Using the key provided by Heemstra and Randall (1993), the species were identified as in Table 1.

Seed production from the catching sites was related to ecological variables, and the nature of the relationship varied between species. Production of most species increased with increasing sea grass cover. *E. akaara*, on the other hand, was collected at sites with a specific level (31–50%) of seagrass cover. Seagrass cover was the most important variable explaining variation in abundance of seed of most grouper species. For example, it explained 94 per cent of the variation in seed production of *E. coioides* and *E. merra*, but less in other species. In the six “black grouper” species, seed production declined with increasing depth and increasing salinity. Production was negatively related to coral cover in all species except for *E. coioides* (no relationship) and *E. akaara* (positive relation). Production of *E. akaara* and *E. merra* was positively associated with seaweed cover, while this relationship was negative for other species.

### Status and management of grouper seed habitat

Recently, many seagrass beds, especially in the Nha Phu lagoon, have been heavily damaged by motorised push-nets and trawling nets. There were about 200 motorised boats fishing in the lagoon using these gears, despite a prohibition on their use.

Coral reefs have become overexploited recently. Approximately 30 explosions were heard a day in

the Van Phong Bay in 1996, especially around coral reefs. In addition, dead coral, the main raw material for Hon Khoi Cement Plant, is exploited in the south-west of the bay. Cement production has increased from 5000 tonnes/year to 10,000 tonnes/year in recent years (Long et al. 1996). Coral reefs may also have suffered some damage from tourism, especially in the Nha Trang Bay.

Seaweed in the Khanh Hoa Sea, especially *Sargassum* spp. “forests” has almost disappeared in recent years. This may be related to the overexploitation of one species of sea urchin for export, allowing an increase in the population of another. The latter may have overgrazed the *Sargassum* seaweed. However, the ecology of these systems is poorly understood.

Much mangrove has been destroyed for constructing shrimp farms around Nha Phu lagoon. From 1994 to 1997 approximately 500 ha of mangrove was destroyed out of a total area of 810 ha recorded in the years of 1981 to 1983 (Cho 1996).

### Fishing for seed

A total of 649 households (6.5% and 0.6% of fishing households and rural households in the province, respectively) collect approximately 200,000 seed each year, mainly “black grouper”: *Epinephelus akaara*, *E. bleekeri*, *E. coioides*, *E. malabaricus*, *E. merra* and *E. sexfasciatus*.

Among the fishing gears, seine net, scoop net and push net were mainly used for collecting small fish of 1–3 cm. Seine nets provided the highest yield (catch per unit effort) in terms of number of pieces per trip. For larger seed, encircling nets, used together with artificial reefs, were the most important in terms of quantity and quality of catch. The seasonality of use of different gears reflects the growth of the seed and their move to deeper water as the season progresses.

Table 1. Grouper seed species collected in Khanh Hoa Province

Scientific name	FAO English name	Local name
<i>Epinephelus akaara</i>	Hong Kong grouper	Ca mu cham do, Ca mu tieu do
<i>Epinephelus bleekeri</i>	Duskytail grouper	Ca mu soi, Ca mu tieu den
<i>Epinephelus coioides</i>	Orange-spotted grouper	Ca mu song
<i>Epinephelus malabaricus</i>	Malabar grouper	Ca mu me
<i>Epinephelus merra</i>	Honeycomb grouper	Ca mu cham to ong
<i>Epinephelus sexfasciatus</i>	Sixbar grouper	Ca mu sau soc

## Status of the fishery

The fishermen had to spend more time to catch the same amount of seed compared with previous years. Seed production appears to be in decline, as is the capture trend for grouper in the province, and the demersal marine finfish.

The reasons for the decline of fishing production of commercial demersal marine finfish in general, and grouper in particular, probably include over-exploitation, especially of broodstock; using harmful fishing gears such as motorised push-nets, trawling nets, dynamite, and sodium cyanide; and nursery habitat destruction.

## Market attributes

The fishing production of grouper seed in the province has remained at about 200,000 pieces per year in recent years. The four species *E. malabaricus*, *E. coioides*, *E. sexfasciatus* and *E. bleekeri* were the main cultured species. Six species had the common name “black grouper”, and commanded similar price. The pricing system varied according to time and location. The price ranges by fish size in 1998 are shown in Table 2.

The primary buyers were nursing farmers, grow-out farmers and middlemen. The middlemen were the main buyers, and their price was up to double the fishermen’s price. In some cases, especially between February and March, the middlemen price could peak as high as VND 13,000–14,000/piece.

The price has shown an increasing trend year to year, probably related to the increase in total culture area and limited production. Most seed were purchased for grow-out locally, either directly by farmers, or through middlemen. Other seed was sold by middlemen to exporters who in turn sold mainly to Taiwan and Hong Kong. The latter were usually more than 100 g in size, and were mainly “red grouper” *Cephalopholis miniata* (Phan 1997). Small quantities of seed were sold to Ho Chi Minh City.

In the past, the fishing production of Khanh Hoa met the demand for grouper seed. There was almost no pressure on the seed supply except for

the period just after Tet Holidays (Chinese New Year’s days). Recently, the local grow-out farmers had to import grouper seed from neighbouring provinces such as Phu Yen and Ninh Thuan. The percentage of the imported grouper seed was 15% for the 1998 crop.

The estimated provincial government’s target marine finfish production for 2010 (820 ha of ponds and 800 cages) corresponds to a requirement for about 8.3 million seed to produce 4200 t of fish. This compares with current production of grouper seed of 200,000 and a production of 140 t. Clearly, current levels of seed production are totally inadequate to meet the targets.

## Socio-economic benefits

The average income of collector households from seed collection was VND 720,000 per year (ca 11% of total household income), and return on labour varied between VND 10,906 and 37,135 per person per day.

The seed collecting households were divided into three classes according to their annual income. The proportion of collector households in the three classes was broadly similar to that for the wider community, although there were marginally fewer in the highest class. This suggests that seed collection has relatively little impact on household wealth, and vice-versa.

In recent years, the number of collectors has decreased as some have moved to offshore fishing activities, which were funded by the central government.

The fishermen prefer the new job where they can receive a higher return on labour than that in the collecting seed,

Table 2. Price ranges by fish size

Type of fish	Typical price range per piece (in VND)	
	Fishermen to primary buyers	Middlemen to farmers companies
0.5–5 cm (av. 1–3 cm)	500–1000	1000–3000
5–10 cm (av. 5–8 cm)	2000–3000	3000–5000
10–20 cm (av. 10–15 cm)		
• <100 g	4000–5000	6000–7500
• 100–500 g (VND/kg)	40,000–50,000	60,000–70,000

## Discussion and conclusions

Poverty, lack of access to alternative livelihoods, and lack of environmental awareness has resulted in overexploitation of nearshore resources, and continuing poverty in coastal areas of Khanh Hoa Province. Alternative non-fishing jobs such as aquaculture could help the fisherfolk in lower income classes to escape from this “poverty trap”.

Small-scale, mainly family-run cage culture of grouper in Khanh Hoa Province is now a significant activity, providing a relatively high return to labour compared with existing alternative activities (Trai and Hambrey 1998). Internationally there is strong and continuing demand for high quality marine finfish. However, culture of grouper in Khanh Hoa depends on a supply of seed from the wild.

The seed are caught in lagoon, estuarine and coral reef habitat, and are commonly associated with seagrass, considered as “indicative” by local fishermen. A significant proportion (almost 40%) of the seed came from one catching area, Nha Phu lagoon, a well-known nursing ground for many marine organisms. All inshore areas are under intense pressure.

The supply of wild grouper seed to the cage culture industry appears to be unsustainable in the short-term and inadequate in the longer term. There are several reasons for this:

- catch per unit effort of seed appears to be in decline;
- catch and catch per unit effort of adult stocks also appears to be in decline;
- nursery and adult habitat (seagrass, mangrove, coral) has been, and continues to be, severely damaged from habitat conversion, destructive fishing practices, coral extraction and possibly local pollution;
- government targets for cage culture are high (an estimated trebling of cages by 2010);
- stocking densities have shown an upward trend, and this is likely to continue; and
- the cost of seed is already high, and is likely to increase, threatening the competitiveness of the grow-out sector.

It is clear that even to maintain the current wild seed supply will require substantial improvements in stock and habitat management. This should not be difficult in theory — seed production is highly concentrated in a few key areas. Broad frameworks for coastal area management plans and programmes have been developed in the past, but there is an immediate need to take these forward in

practice at a local level. Improved grouper seed habitat management might offer an important starting point for these initiatives.

For the future, hatchery production will be the only way to provide sufficient seed to allow the industry to expand. The high and increasing price of seed should make hatchery production economically viable, despite its technical difficulty.

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## An update of the Komodo Mariculture Project

**Source:** Grouper Electronic Newsletter #10

The Nature Conservancy's Coastal and Marine Program is developing a full-cycle fish culture enterprise in the Komodo area, central Indonesia. The objectives of this project are to: (1) provide fishers who presently use destructive fishing methods with an alternative livelihood in growing out hatchery-produced fingerlings, and (2) contribute to the market transformation of the trade in live food fish from unsustainable, capture-based to sustainable culture-based. The fish culture project is an integral part of the management plan for Komodo National Park, a World Heritage Site and a Man and Biosphere Reserve with a surface area of 1817 km<sup>2</sup>.

The broodstock that has been collected over the past three years now consists of 2548 kg of five species: mouse grouper *Cromileptes altivelis* (82 kg), tiger grouper *Epinephelus fuscoguttatus* (496 kg), estuary grouper *E. coioides* (1015 kg), sea bass *Lates calcarifer* (235 kg) and mangrove jack *Lutjanus argentimaculatus* (720 kg). Natural spawning in cap-

tivity was first observed in tiger grouper on 30 September 2000 and in mouse grouper on 1 October 2000 (around new moon). Since then, all species except mangrove jack have successfully spawned in the holding cages.

On 21 December 2000, the support of a private donor enabled The Nature Conservancy to secure a nearly 150,000 m<sup>2</sup> plot that will be used for the construction of the hatchery. Construction will start as soon as a team of grouper culture specialists is recruited. The project is still looking for a manager (who will supervise all aspects of the mariculture project) and for professionals with experience in the following aspects of grouper culture (a) nursery/larval rearing, (b) live feed supply, and (c) grow-out in fish cages.

Those interested are invited to contact Peter J. Mous at <pmous@attglobal.net>.



## Work starting on certification of Pacific aquarium trade

Although the Pacific Islands have an international reputation for providing high-quality marine fish and other ornamentals caught without using destructive methods, there is currently no independent system to check exporters' claims of quality and sustainability.

However, the region is now taking its first steps towards solving this problem by hiring a manager to initiate a project to implement international standards and practices in the region's growing marine ornamentals industry. The joint South Pacific Forum Secretariat in Fiji and Hawaii-based Marine Aquarium Council (MAC) pilot project involves three Forum Island Countries — Solomon Islands, Cook Islands, and Fiji Islands.

Recently, MAC — the project's implementing agency — hired Esaroma Ledua as Project Manager of Marine Ornamentals Certification. Ledua has a MSc from the University of Stirling in the United Kingdom and is a former Principal Fisheries Officer - Research and Development with the Fiji Government's Ministry of Agriculture, Fisheries and Forests. He also spent

two years at the Secretariat of the Pacific Community (SPC) as a Fisheries Integrated Coastal Management Associate.

"It's quite an interesting and challenging project," Ledua says. "The long-term goal of the project is to transform the existing marine ornamentals industry using market forces. But, it's not going to be easy to come up with a certification and labelling program that's acceptable to everyone."

Ledua will work with the three countries over the next two years to introduce a certification and labelling system for their marine ornamentals industries. Government, industry, NGOs, and individual communities will all be involved in the process. The key objective of his work will be achieving a balance between developing profitable reef-based industries, maintaining reef health, and minimising environmental impacts.

The industry, if managed in a sustainable manner, can also provide jobs and income through the collection and export of marine aquarium organisms in rural island areas with few resources.

Containing the world's greatest number of coral reefs, the Pacific region is home to an unparalleled diversity of marine life that is vital to the environmental and economic health of Pacific Island countries. In 1990, the region is estimated to have supplied 4 to 10 per cent of the world's marine ornamentals, consisting of 200,000 to 250,000 fish, worth US\$ 1–1.5 million.

This project is part of the Canada-South Pacific Ocean Development (C-SPOD) Program, Phase II, which is funded by the Canadian International Development Agency (CIDA) and coordinated by the South Pacific Forum Secretariat and participating regional organisations. The project is approved and managed by a Program Management Committee including CIDA, the South Pacific Forum Fisheries Agency, the South Pacific Forum Secretariat, the South Pacific Regional Environment Programme, and The University of the South Pacific. All C-SPOD projects are designed to ensure equity and balanced benefits for all Pacific Islanders including children, women, and men.

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## Second International Conference Marine Ornamentals '01. Collection, Culture, Conservation. 27 November – 1 December 2001, Lake Buena Vista, Florida, USA

### Background

The first International Marine Ornamentals '99 (MO '99) Conference was held in Hawai'i, USA in November 1999. Over 300 industry representatives, scientists, agency representatives and students attended. The consensus of attendees was to continue the conference every two years, scheduling the next one for Florida, USA in 2001.

### Sponsors and contributors

Sponsors as of 8 September 2000 are Florida Sea Grant College Program and the Florida Department of Agriculture and Consumer Services/Division of Aquaculture. Co-sponsors are the Hawai'i, Oregon, Virginia and Mississippi/Alabama Sea Grant Programs and the University of Florida Department of Fisheries and Aquatic Sciences/Tropical Aquaculture Laboratory. Contributors are the Texas, North Carolina, Maryland and Louisiana Sea Grant Programs, Florida International University, FAO/Fisheries Industries Division and Ornamental Fish International. Other support is provided by New York Sea Grant.

### Marine Ornamentals '01

**Conference goal:** Improve collection practices from wild stocks, increase the number of species cultured and enhance and restore marine ornamental fish habitat. This will create an economically viable industry and environmentally sustainable habitat. The program will be organised around the collection, culture and conservation of marine ornamental fish, and guided by a series of recommendations from MO '99, which focus on how government, research, education, the Marine Aquarium Council, incentives and certification, industry organisation, resource management, communication and marketing and industry development can be used to achieve the overall conference goal. Plenary sessions will feature keynote and invited speakers. A call for papers will be issued that will result in multiple breakout sessions and poster sessions.

**Attendance:** The attendance goal is 400+ and special attention is being placed on the development of a trade show with space for about 35 booths. All who are involved with the collection, culture and conservation of marine ornamental fish should attend.

**Location:** The location is the Wyndham Palace Resort and Spa in the Walt Disney World® Resort, Lake Buena Vista, Florida, USA, just 18 miles from the Orlando International Airport.

**Date:** 27 November–1 December 2001.

**Organising committee:** A program organising committee of about 25 people representing industry, universities, research institutions, agencies and organisations worldwide is being formed.

**Sponsorship:** Additional sponsors, co-sponsors and contributors are being solicited at this time. If you would like to participate, please contact James C. Cato or Beth Miller-Tipton.

**Conference Web site:**  
<http://www.ifas.ufl.edu/~conferweb/MO>

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## Global Marine Aquarium Database going strong

The partnership between the Marine Aquarium Council (MAC) and the World Conservation Monitoring Center (WCMC) to create the world's central facility for assembling and analysing data on the international trade in marine aquarium organisms is building rapidly. This has been renamed as the Global Marine Aquarium Database (GMAD) to more readily convey its primary function (replacing the initial Marine Ornamentals Information System - MOIS title).

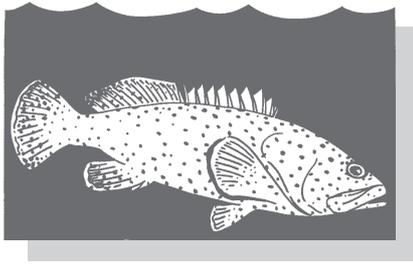
GMAD is supported by ornamental trade groups such as the Ornamental Aquatic Trade Association (OATA), Ornamental Fish International (OFI), the Pet Industry Joint Advisory Council (PIJAC), the Philippine Tropical Fish Exporter's Association (PTFEA) and Asosiasi Koral Kerang dan Ikan Hias Indonesia (AKKII), key government agencies in the primary export and import countries and inter-governmental agencies such as the UN FAO and the CITES and Ramsar Secretariats. Funding has been obtained from the Packard Foundation for a 2–3 year start-up project. The long-term plan for

GMAD is for it to become part of the MAC certification scheme which will be fully funded by the as part of the role of responsible industry operators.

Many of the world's largest exporters and importers have already provided their data for entering into the system but we need a more complete dataset to provide consistent, comprehensive, quality information. The preliminary compilations are already shedding light on the mis-information that clouds the discussion on sustainability and the marine aquarium trade and an initial "State of the Global Marine Aquarium Trade" will be produced as soon as possible this year.

We strongly encourage those who have not yet provided their data, which is kept confidential, to contact WCMC through Dr Ed Green, Head, Marine Program at [Ed.Green@unep-wcmc.org](mailto:Ed.Green@unep-wcmc.org) (WCMC is now part of the UN Environment Programme). Information on GMAD and information for industry members is posted on the MAC website at <http://www.aquariumcouncil.org/>.





# Noteworthy publications

live reef fish

Cesar, H.S.J., K.A. Warren, Y. Sadovy, P. Lau, S. Meijer, and E. van Ireland. 2000. Marine market transformation of the live reef fish food trade in Southeast Asia. pp. 137–157 In: H.S.J. Cesar (ed) Collected essays on the economics of coral reefs. CORDIO, Department for Biology and Environmental Sciences, Kalmar University. Kalmar, Sweden.

An unusually rich source of information on, and analysis of, the live reef food fish trade, coupled with suggestions for market and policy changes that could transform the trade into one that is non-destructive and sustainable.

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Murphy, R.J. and J.M. Lyle. 1999. Impact of gillnet fishing on inshore temperate reef fishes with particular reference to the banded morwong. (Australian) Fisheries Research and Development Corporation Final Report. 136 p.

Describes an unusual temperate zone fishery developed mainly to supply live food fish to Asian restaurants in Australia, although small amounts go to Southeast Asia. There are several noteworthy features of this fishery: 1. Gillnets are used. The nets are pulled after a very short soak time. So valuable are the fish that they are actually cut gently out of the nets and the nets re-sewn. 2. Until the advent of this fishery the banded morwong had no market value other than as lobster bait; most Australians don't like its flavour. 3. Within several years of the commencement of this fishery, Tasmania imposed a seasonal closure on it during the spawning season. (Why don't we see this simple but valuable management measure used more often in tropical live reef food fisheries?)

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Anonymous. 2000. Farming 'has little effect on stocks': leading feed firm refutes study on aquaculture and wild catch. Fish Farming International. September: 6–9.

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Cabanban, A.S. and M. Phillips (eds). 1999. Aquaculture of coral reef fishes. Proceedings of the Workshop on Aquaculture of Coral Reef Fishes and Sustainable Reef Fisheries. Kota Kinabalu, Sabah, Malaysia, 6–10 December 1996. Institute for Development Studies, Sabah. 274 p.

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Collins, M.R., J.C. McGovern, G.R. Sedberry, H.W. Meisster and R. Pardiek. 1999. Swim bladder deflation in black sea bass and vermilion snapper; potential for increasing post-release survival. North American Journal of Fisheries Management 19:828–832.

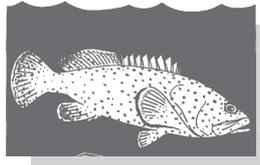
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Donnelly, R., D. Davis and M. Lam. 2000. Socio-economic and biological aspects of the live reef food fish trade and its development in Solomon Islands. Aquaculture Asia 5(3):36–42.

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Woods, C.M.C. 2000. Preliminary observations on breeding and rearing the seahorse *Hippocampus abdominalis* (Teleostei: Syngnathidae) in captivity. New Zealand Journal of Marine and Freshwater Research 34:475–485.

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## Miscellaneous

live reef fish

### Andamans LRF activities recommence

The live reef fish trade started again recently in the Andamans using hook and line according to Frazer McGilvray of the International Marinelife Alliance.

The majority of the catch is shipped to The People's Republic of China.



### Grouper news

Of potential interest to readers of this Information Bulletin are some of the items in Grouper News Issue No. 9, Nov–Dec 2000. These include:

- Natural spawning of *Cromileptes altivelis* in Komodo, Indonesia.
- Abstracts on marine finfish culture.
- Annual report for ACIAR Project FIS/97/73 "Improved hatchery and grow-out technology for grouper aquaculture in the Asia-Pacific region".
- APEC FWG 01/2000 "Development of a health and husbandry manual for grouper farming".

- Asia regional technical guidelines on health management for the responsible movement of live aquatic animals.

Grouper News is an Electronic Newsletter of NACA, in cooperation with ACIAR, APEC, Queensland DPI, and SEAFDEC Aquaculture Department. To subscribe to this newsletter, send a blank email message to <naca@inet.co.th>. In the subject field include the words: Subscribe Grouper Electronic Newsletter.



### Reminder: Live Reef Fishery Listserver opened by SPC for e-mail discussion

The Secretariat of the Pacific Community (SPC) has set up an e-mail discussion group to service its "Live Reef Fishery" (LRF) network — a special interest group covering the live reef fish trade. This network was originally set up to cover the LRF trade in the Pacific Islands — SPC's only mandated work area — but has attracted interest, articles and correspondence from a much broader area.

The network's *Live Reef Fish Information Bulletin* is also available on the web at <http://www.spc.int/coastfish/News/lrf/lrf.htm>. While it is an excellent resource for substantial news items and primary information, it cannot

possibly respond quickly enough to cover some of the shorter-term issues arising in this rapidly-moving trade.

This e-mail discussion group has been set up at SPC to provide a more immediate way of exchanging news and information between members of the network, and to enable faster responses to issues.

We have found e-mail discussion group listservers to be an excellent way of sharing professional "intelligence" between groups of like-minded, interested individuals scattered among the islands. SPC's public health surveillance and communica-

ble diseases alert listserver, "Pacnet," has proven to be a great success. While most Pacific Islands do not have good enough internet linkages to provide useful access to the worldwide web, e-mail linkages are now becoming common in many areas, and there is now only one SPC member that does not have at least one e-mail linkage in-country.

The purpose of the list is to provide a means of disseminating announcements and information quickly and also provide a way for you to ask questions in the reasonable hope of getting a useful response from someone who is knowledgeable. It is also a forum to discuss the best way of doing things. If you send an e-mail message to the list address it will be automatically copied to everyone else on the list. It is very simple in principle but can be remarkably effective.

Note that the "live reef fish trade" in the Pacific Islands region can be split into two main components: the "live reef food fish" trade and the much longer-standing and generally less fragile "aquarium fish" trade, which is "live" by definition. We will tend to concentrate on the live food fish trade, because that is the main management issue of concern in the Pacific Islands region; however, we welcome discussion on aquarium fisheries as well. We will leave it up to the list to decide its own direction, and if it becomes necessary at a later stage to split the list into two, we will happily support that.

You can subscribe to the list by sending an e-mail to the address <join-live-reef-fish@lyris.spc.int> and the listserver computer will automatically add your name to the group and send you an e-mail with instructions on how to send messages to the group, unsubscribe, or find out who else has joined the group, etc. Alternatively, you can enter the address <<http://www.spc.org.nc/cgi-bin/lyris.pl?enter=live-reef-fish>> in your worldwide web-browser's address bar and follow the instructions on the page.

SPC is the figurehead of the "Pacific Islands Live Reef Fishery Initiative" — an informal, loose association of organisations devoting part of their capacity to the LRF issue in the Pacific. SPC's particular interest is in assisting and advising its Pacific Island member countries and territories to assess, develop and manage fisheries in an environmentally and economically sustainable way, and the live reef fish trade is naturally a topical subject in many islands, particularly in the west and north of the region. SPC recently entered into an understanding with The Nature Conservancy, the International Marinelifelife Alliance and the World Resources Institute about more formally implementing part of this "Pacific Islands Live Reef Fishery Initiative", supported by

funding from each organisation and, in the coming months, through a project of the Asian Development Bank as well.

The main people within SPC helping with the initiative are Being Yeeting (Acting Live Reef Fishery Specialist), Aymeric Desurmont (Fisheries Information Specialist) and Pierre Labrosse (Reef Fisheries Assessment and Management Adviser). Being's salary is currently funded by The Nature Conservancy, while other support for SPC LRF work comes, or has come, from the governments of France, the UK, Australia, and SPC core funding. The Nature Conservancy also funds most of Bob Johannes' editing time in the LRF Bulletin.

There are several other agencies associated with SPC in the family of Pacific Island regional inter-governmental organisations called "CROP" (Council of Regional Organisations in the Pacific), and other CROP agencies, including the University of the South Pacific, the Pacific Islands Forum Secretariat and the South Pacific Regional Environment Programme, have interests in the Initiative. The Forum Secretariat, for example, is collaborating with the Marine Aquarium Council to investigate the potential role of consumer-targeted sustainability certification in the aquarium fishery (see article on p. XX, this issue). Other organisations actively associated with the Initiative include the International Center for Living Aquatic Resources Management (ICLARM) South Pacific office, which is carrying out research on reef fish larvae.

Finally, and to reassure our members in the eastern part of the Pacific Islands region where the live reef food fish trade is not yet an issue, this LRF Initiative is still just one aspect of SPC's work on reef fisheries in general, and reef fishery assessment and management activities as a whole will receive a major boost from the European Union in 2001, if current project proposals continue on track. The LRF Initiative is a test-bed for several new kinds of linkages, this listserver included, that will be extended to other areas if they prove their worth.

Dr Tim Adams  
 Director, Marine Resources Division  
 Secretariat of the Pacific Community  
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 E-mail: [tima@spc.int](mailto:tima@spc.int)  
 Fax: +687 26.38.18



## The Nature Conservancy seeks Live Reef Fish Trade Coordinator

### Job Description

**Title:** Live Reef Fish Trade Coordinator  
**Supervisor:** Director, Coastal/Marine Program  
**Location:** Hong Kong  
**Date:** January 2001

### Summary of position:

The Nature Conservancy's Asia/Pacific Coastal/Marine Program is working to develop and refine its live reef fish trade strategy to help minimise the trade's destructive impact on marine biodiversity in Indonesia and the Pacific. Recognising the unsustainable nature of the live reef fish trade and its immense threats to marine biodiversity, the Conservancy is working to catalyse a trend that will convert the trade's dependence on wild caught groupers to the use of groupers raised in hatcheries. The Conservancy believes that this market transformation can be achieved through the mariculture of target species in the supply (or exporting) countries such as Indonesia and mainland China. Sustainable mariculture will help abate the damaging effects of destructive fishing methods on coral reefs, while relieving fishing pressure on the breeding populations of targeted species.

Leading this effort will be a Live Reef Fish Trade Coordinator. S/he will build and maintain partnerships within the wide range of business, government, NGOs, and intergovernmental parties involved in the trade. The Coordinator will also be responsible for hiring and managing consultants; promoting critical policy changes; implementing the demand component of the Conservancy's live reef fish trade strategy and ensuring integration with supply side country activities; and, helping secure additional financial support (funds and in-kind) to execute the strategy. S/he will report to the Director of the Coastal/Marine Program.

### Duties:

1. Initiate and strengthen collaboration among regional partners to develop and implement a coordinated strategy for exporting countries and in Greater China to support a sustainable live reef fish trade.
2. Recruit, hire and manage two consultants, an International Trade Specialist and a Mariculture Specialist, and work with them to develop a coordinated approach to address the demand side of the industry.
3. Together with the International Marinelifelife Alliance (IMA), TRAFFIC, Hong Kong Chamber of Seafood Merchants, other individuals and agencies, and the International Trade Specialist, develop and implement a system to monitor market trends for the live reef fish trade and disseminate the information internationally as appropriate for active management of the trade.
4. Work with partners to determine the price-demand relationship in the live reef fish trade and explore the possibility of manipulating the price structure to regulate the trade.
5. Determine the best roles of demand markets (Taiwan, Hong Kong, and mainland China in particular) in assisting the Conservancy to achieve its objectives in mariculture development. Work with the Greater China Team, the Mariculture Specialist and other key players to develop and implement sustainable strategies. Such key players include the Taiwan Fish Breeding Association, Taiwan's Overseas Fisheries Development Council, the Hong Kong Government's Agriculture and Fisheries Department, seafood restaurant associations, and the Hong Kong Chamber of Seafood Merchants, as well as other major players in mariculture technologies (e.g., Queensland Department of Primary Industries, Gondol Fisheries Research Institute, etc.).
6. Frequently assess and evaluate the Conservancy's collaborative, multi-partner, Integrated Live Reef Fish Trade strategy, update as necessary and develop an implementation plan for the Conservancy's component, including helping to secure resources.
7. Engage APEC and other government partners in promoting regional policies and regulations, a certification system, and enforcement programs to support sustainable practices.

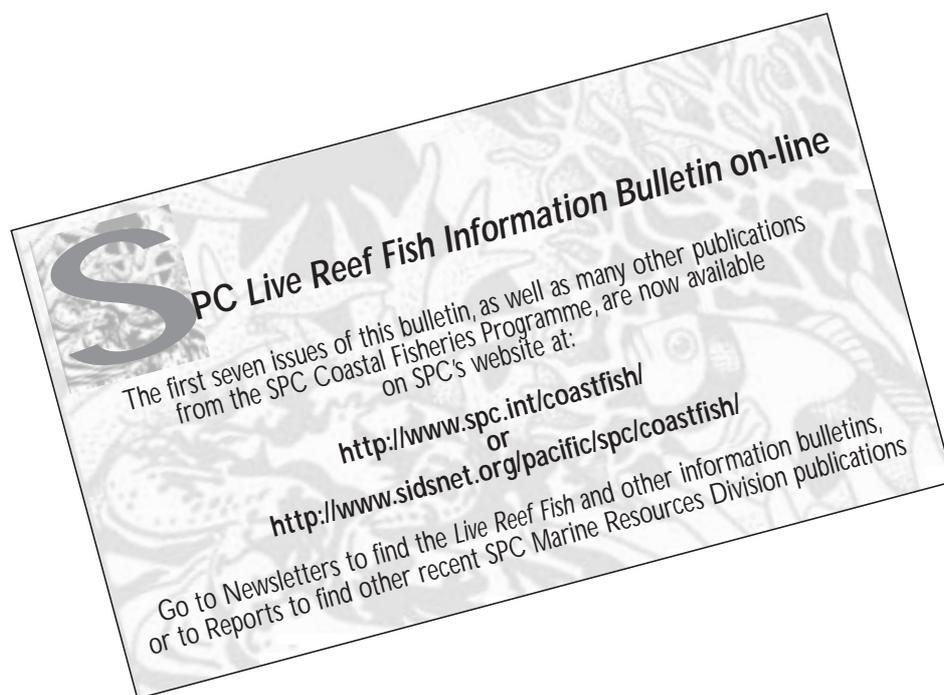
8. Identify and encourage private and public investors in mariculture in Indonesia and mainland China. Work with Conservancy staff to catalyse financial investments in mariculture linked to the conservation of marine biodiversity, such as through a Biodiversity Enterprise Fund.
9. Prepare reports and presentations and attend meetings as may be required by the Director, Coastal Marine Program and the Director, Greater China Program.
4. Experience working with government agencies and international policy organisations; good lobbying skills.
5. Fishery or environmental conservation experience preferred but not required.
6. Excellent communications and writing skills.
7. Fluency in spoken English and Chinese (Mandarin required; Cantonese preferred but not required).

### Requirements:

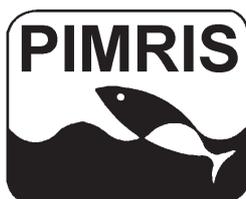
1. Excellent business background with experience in the development and implementation of marketing programs.
2. Strong experience in macroeconomics and/or international trade policies.
3. Strong working experience in Greater China (especially Taiwan and Hong Kong).

### Send resume to:

Shari Walker  
Coastal Marine Program  
Asia Pacific Region  
The Nature Conservancy  
923 Nuuanu Avenue  
Honolulu, HI 96817  
Fax: 808-545-2019  
Email: [swalker@tnc.org](mailto:swalker@tnc.org)



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). This bulletin is produced by SPC as part of its commitment to PIMRIS. The aim of PIMRIS is to improve



Pacific Islands Marine Resources  
Information System

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.