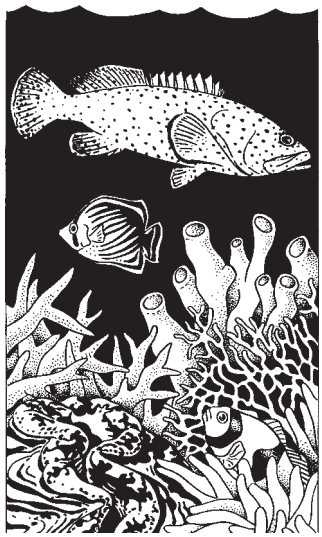
MARINE RESOURCES DIVISION
INFORMATION SECTION

The Nature Conservancy®

LIVE REEF FISH

The live reef fish export and aquarium trade



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INFORMATION BULLETIN

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Editor's mutterings

In the past year the environmental problems generated by the live reef fish trade have received wide media coverage, with major articles in, for example, the *New York Times*, *TIME*, and *New Scientist*, as well as solid TV coverage by CNN and various national and regional stations. Several television documentaries on the subject are also being prepared. This publicity is clearly helping to generate accelerating efforts to combat the problem.

Until recently the Philippines was the only country that paid serious attention to the issue. But a number of other countries, most notably Hong Kong and Indonesia, have woken up to the problem within the past year. This issue of the *Information Bulletin* includes a summary of the actions initiated by Hong Kong in response (p. 3).

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As described in this issue by Yvonne Sadovy (p. 13), efforts are currently being made to get the humphead wrasse, *Cheilinus undulatus*, listed on CITES as a means of helping to halt its reportedly drastic decline in South-east Asian waters and beyond. One of the problems facing proposals to list it, is the dearth of information on its general biology and the status of various stocks—despite its being the second largest coral reef fish in the world[1], the most expensive of all live reef food fishes, a very popular fish with recreational divers (a coral-reef candidate for 'charismatic megafauna' status?), and an exceptionally fine food fish.

How can this be when the literature is full of papers on tiny, often territorial, often demersal egg-laying, and in general atypical and commercially insignificant reef fish? Why do they continue to receive so much attention from reef fish biologists, when the biology of many commercially important species of groupers, snappers, emperors, jacks, as well as the humphead wrasse, remain almost unknown?

Damselfish are far and away the most studied of all reef fishes. Could it be because convenience usually triumphs over relevance?

Inside this issue

Surely, in these days of shrinking budgets and fast-expanding ecological threats to the world's coral reef communities, it is time to put work aside on the 'toy poodles' of the reef and get serious about the species most endangered by overexploitation.

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A variety of environmental NGOs is also generating new or expanded programmes in order to combat the cyanide fishing problem. This issue of the Information Bulletin carries articles on some of these plans, by The Nature Conservancy (p. 26) and the Word Wildlife Fund for Nature (p. 28), with more to come in future issues.

It is too early to judge the effectiveness of these new initiatives. It is too early, in fact, even to assume that the problem can be licked. One of the biggest stumbling blocks in some of the main countries involved is the widespread corruption among the military, police, government officials and politicians, some of whom actually engage in the trade or take bribes from those who do.

Environmental law enforcement desperately needs upgrading throughout the region for reasons of which cyanide fishing is only one of many.

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Reef-fish stock enhancement is a natural extension of aquaculture of reef fish for marketing, and grouper stock enhancement provides a potential means of countering some of the pressure brought to bear on wild fish stocks by cyanide fishing. Grouper stock enhancement is currently being carried out in Okinawa and Bahrain.

We have decided to expand the ambit of this information bulletin to include this subject, starting in the next issue with an article by Roger Uwate on grouper stock enhancement in Bahrain. Other contributions on this subject are welcomed.

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I've been preaching for years that marine biologists would learn a lot if they spent more time listening to fishers. Two groups of fishers I have come into contact with recently while investigating live reef fisheries are aquarium fish collectors and collectors of wild juvenile groupers for growout.

I will include a description of some of what can be learned from the latter in a later issue of this bulletin. Let me just give one illustration here of the valuable information available from aquarium collectors.

There are at least three groups of marine aquarium fish, I am told, that have proven so susceptible to cyanide that they are rarely collected using it since they almost invariably die. These are members of the genera *Nemateolotris* (dartfish), *Synchiropus* (dragonets or mandarin fish), and *Pseudochromis* (dottybacks).

On the other hand, angelfish, especially the large ones, e.g. *Pomacanthus*, are usually caught with cyanide—otherwise they go so far back into holes in the reef when chased that it is very difficult to net them. (One Australian aquarium fish collector told me of a technique for forcing them out of the holes without using cyanide or breaking corals, but it would not be fair to divulge his method).

Such information might be useful for those responsible for monitoring shipments of aquarium fish for cyanide traces; if my informants are correct, shipments dominated by the latter group of fish are much more likely than those of the former to have been caught with cyanide.

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It's nice to know they really care. Statement made on a Voice of America radio broadcast concerning the live reef food-fish trade by reporter Max Ruston: 'In Hong Kong, representatives of the fishing companies are reluctant to discuss the use of cyanide in their work. But one executive, who declined to be named, admitted to its use, and said he is aware of the damage it does to the environment. He said that because there is no alternative, his company has no immediate plans to change methods.'

In a similar vein, *TIME*, 3 June 1996, reports in its four-page story on the live reef-fish trade: '"We are traders and businessmen," asserts Yeung Wei-sung, managing director of Wing Sang Sea Products, a major (Hong Kong) importer. "We only buy the fish. We don't care how they are caught."'

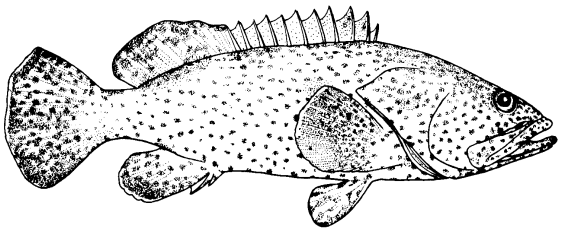
R.E. Johannes

Authorship corrections

We must apologize for errors made in connection with the authorship of two articles in the first issue of this Information Bulletin. The article entitled 'Exploitation of seahorses and pipefishes' was written by Dr Amanda Vincent, not Mark Prein. The co-author of the report on the 'Environment, economic and social implications of the fishery for live coral reef food fish in Asia and the Western Pacific' was Michael Riepen, not Ripen.

[1] There is also very little biological information available on *Epinephelus lanceolatus*, the largest of all reef fish. Yet this species and the humphead wrasse are both on the list of marine fishes recently proposed for inclusion in the IUCN Endangered Species list.

LIVE REEF FISH
INFO



Hong Kong's actions with reference to the live reef food fishing [1]

Dear Dr Johannes,

Thank you for your letter of 21.1.96 expressing concerns in the progress of our actions to tackle the problem of cyanide fish. Taking the questions raised in your letter in sequence, I am pleased to provide you with the following information:

1. *We have collected data on live fish imports for the previous six months for the Census and Statistics Department, live fish traders and local fishermen engaged in capturing and transporting live marine fish. It is known that live marine fish are imported into Hong Kong from Taiwan, Malaysia, Thailand, Indonesia, Philippines, Australia and Maldives by airfreight, foreign registered vessels engaged in transporting live marine fish, and local fishing vessels engaged in capturing and transporting live marine fish. Preliminary annual estimates of live marine fish imported into Hong Kong are around 13,000 t, the breakdown of which is attached for your reference. We will continue to monitor the live marine fish trade to obtain more comprehensive data on live reef fish imports, particularly those species susceptible to cyanide fishing.*

2. *We have reviewed the Fisheries Protection Ordinance with a view to increasing the maximum fine for possession and use of toxic substances to capture fish from HK$ 10,000 to HK$ 200,000. We are in the process of amending the Ordinance.*

3. *We are regularly holding seminars for and sending information to fishermen and live fish traders, reminding them of the need for marine conservation and the damage caused by cyanide fishing. Sign posts on cyanide fishing with complaint hotlines will also be erected in popular places around the coastline of Hong Kong.*

4. *We are regularly collecting, at points of entry, samples of fish susceptible to cyanide fishing for cyanide testing. These include mariculture facilities known to be used for temporary stocking of imported marine fish.*

5. *We have improved the classification system for fish imports to enable government to obtain comprehensive information on quantity, species group and country of origin, of live marine fish imported by airfreight and foreign vessels engaged in transportation of live marine fish into Hong Kong. The new classification system would be implemented in January 1997.*

6. *We have compiled a list of local vessels engaged in capturing live fish in Philippines and Indonesia and foreign vessels transporting live fish to Hong Kong and collected information on live fish imports from these vessels. A preliminary list of 102 local fishing vessels and nine foreign vessels has been prepared and sent to the Marine Police to step up enforcement of the laws against carriage of cyanide on vessels. We are also liaising with Dr Pratt of International Marine Line Alliance in Philippines to provide us with a list of Hong Kong based fishing vessels engaged in capturing or transporting live marine fish in the Philippines and Indonesian waters.*

7. *The Marine Police has stepped up enforcement action against cyanide fishing. In June a total of 68 local fishing vessels and two foreign vessels engaged in transporting live marine fish was searched by Marine Police in June 1996 and no cyanide was found on these vessels so far.*

8. *The issue has been raised in the Asia-Pacific Economic Co-operation Marine Resources Conservation Working Group Meeting in Taiwan in April 1996 and the APEC Fisheries Working Group Meeting in Chile in May 1996. The representatives from the United States indicated that they would research into the possibility of listing the species,* Cheilinus undulatus, *under the CITES Appendix 3 while the Philippines Government has reservations in the proposal. Hong Kong is not a range state for the species.*

9. *According to our records, there were two prosecution cases in 1995 in relation to cyanide fishing. One was*

[1] From letters and information sent by Dr S. F. Leung, Hong Kong Agriculture and Fisheries Department

charged to use cyanide for the purpose of fishing in local waters and the other was charged for the possession of cyanide on board a fishing vessel. Two offenders in the two cases were convicted and fined HK$ 2,000 and HK$ 5,000 (HK$ 1.00 ≈ US$ 0.13) *plus two months imprisonment (suspended), respectively.*

I would like to inform you that Hong Kong presented a paper (see p. 5) *at the meeting of APEC Fisheries Working Group and Marine Resources Conservation Working Group, inviting member economies to adopt the problem of cyanide fishing in Asia and the Western Pacific as an issue requiring urgent consideration in the working groups and to define areas of action and co-operation through which the problem can be addressed. It was agreed that the issue should be urgently addressed and that, in addressing this matter, the exporting/producer economies should be actively involved. It was also agreed that the PRC, Hong Kong and Chinese Taipei should develop a project proposal to address the environmental impacts of cyanide fishing in coral reef areas for consideration at the next meeting of the Marine Resources Conservation Working Group in Thailand in September 1996. The Fisheries Working Group agreed that a technical workshop should be convened by the United States in mid-1997 in conjunction with the next Fisheries Working Group meeting, to address the fisheries resource and fisheries trade issues related to cyanide fishing.*

I trust that the above would help you to know more about our effort taken in the past few months to help tackle the problem of cyanide fishing in Asia and the Western Pacific.

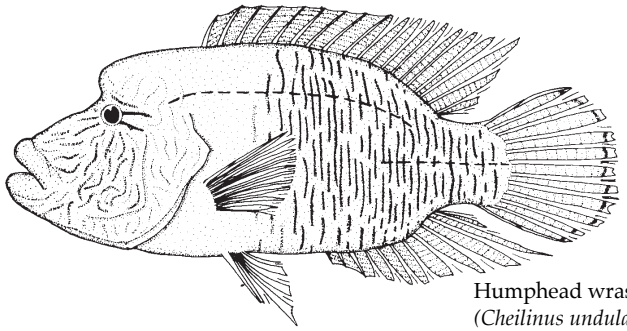
(Signed)
Dr S. F. Leung
for Director of Agriculture and Fisheries

Annual estimates of live marine fish imported into Hong Kong by local fishing vessels

Species	Weight (t)	%
Tiger grouper	608	31.68
Flower cod	331	17.23
Humphead wrasse	160	8.36
Leopard coral trout	159	8.28
Coral trout	133	6.93
Green grouper	132	6.90
Spotted coral trout	86	4.47
Giant grouper	64	3.36
Red grouper	57	2.95
High-finned grouper	14	0.74
Green wrasse	13	0.70
Yellow grouper	11	0.56
Seabream	8	0.42
Rabbit fish	2	0.11
Stonefish	2	0.09
Others	139	7.22
Total	**1919**	**100.00**

Annual estimates of live marine fish imported into Hong Kong by airfreight and foreign vessels

Species	Weight (t)	%
Leopard coral trout	4,864	44.22
Spotted coral trout	1,489	13.54
Tiger grouper	1,245	11.32
Flower cod	866	7.87
Green grouper	363	3.30
Humphead wrasse	207	1.88
High-finned grouper	177	1.61
Green wrasse	145	1.32
Others	1,643	14.94
Total	**11,000**	**100.00**



Humphead wrasse
(Cheilinus undulatus)

Cyanide fishing in Asia and the Western Pacific

This paper was prepared by the Hong Kong Government in March 1996 for the Asia-Pacific Economic Cooperation Marine Resources Conservation Working Group

Introduction

1. This paper proposes that members economies agree to examine the problem of cyanide fishing in Asia and the Western Pacific, with a view to defining areas for action and regional cooperation through which the problem can be addressed.

Cyanide and the live reef fish trade

2. A report entitled 'Environmental economic and social implications of the live reef fish trade in Asia and the Western Pacific', produced by the South Pacific Forum Fishery Agency and the Nature Conservancy, by Dr R. E. Johannes and Mr M. Riepen, was published in October 1995. The report documents the practice of using cyanide to capture certain species of reef fish, notably humphead wrass (*Cheilinus undulatus*) and some species of grouper, for the live reef fish trade and the adverse impacts of this practice on coral reefs nearby village communities.

Hong Kong's views

3. Hong Kong considers that trade in live reef fish is a legitimate use of marine resources, provided that it is conducted sustainably and responsibly. However, it shares the concern expressed over the destruction of coral reefs brought through the use of cyanide by fishermen supplying the restaurant trade in the region with live reef fish.

4. Hong Kong considers that the most effective way to address this issue is:

   (a) for the economies which produce and export live reef fish to take firm action against cyanide fishing in their waters; and

   (b) for trade in fish species that may become, or are already, endangered to be regulated and monitored by listing those species under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (possibly through an initial listing under Appendix III of the Convention by the relevant member economies).

5. Hong Kong believes that the above measures will provide the legal framework and impetus both for protection of species under threat from cyanide fishing and regulation of the trade in those species.

6. Hong Kong understands that one member country economy intends to require all live fish exports to be covered by a 'cyanide free' certificate. Hong Kong wishes to explore ways of cooperating with authorities implementing such measures.

Further consideration

7. Member economies are invited to adopt the problem of cyanide fishing in Asia and the Western Pacific as an issue requiring urgent consideration in this Working Group and to define areas of action and cooperation through which the problem can be addressed.

Dear Dr Johannes,

Thank you for your letter of 17.11.97. Please feel free to use the material we sent to you earlier for the second issue of the Live Reef Fish Information Bulletin. I would also like to provide you with information on the progress of our actions to tackle the problem of cyanide fishing as follows:

Enforcement

1. *From June to September 1996, a total of 206 local fishing vessels (65 of which are on the target list) and 2 foreign vessels engaged in transporting live marine fish was searched by the Marine Police and no cyanide found on board these vessels so far.*

2. *An alleged local cyanide fishing case was reported in October 1996. Prosecution will be made pending the results of cyanide testing.*

Monitoring

3. *From June to September 1996, samples of assorted grouper species and humphead wrasse were collected from the points of entry for cyanide testing and no cyanide trace was found in these samples so far.*

Regional cooperation

4. *At the APEC Marine Conservation Working Meeting held in Thailand in September 1996, it was agreed that Hong Kong will host a workshop on the impacts of destructive fishing practices on the marine environment in collaboration with PRC and Chinese Taipei in late 1997.*

(Signed)
Dr S. F. Leung
for Director of Agriculture and Fisheries

Pacific Island countries and the aquarium fish market

by Vincent Dufour [1]

Introduction

The marine aquarium-fish market is supplied through international trade in fish captured live in their natural environment, as very few ornamental sea fish breed in captivity. This difficulty is linked to their early life history when the fish are larvae a few millimetres in length, living in the open ocean. Larvae develop in this environment for two weeks to three months. The life cycle of coral reef fish therefore consists of two stages, i.e. a planktonic larval stage in the ocean, followed by juvenile and adult stages on the reef. As marine fish harvesting (100 t annually worldwide) is still based on collection in the natural environment, the impact of gathering ornamental fish appears low in comparison to fishing, although it does account for millions of specimens.

The marine aquarium fish market

Marine fish represent approximately 20 per cent of a total world ornamental fish market worth three billion dollars annually (Andrews, 1990). The unregulated economies of the exporting countries, which are often also developing countries, make it difficult to obtain quantitative data about the species exploited for the aquarium-fish trade. In addition, control in importing countries is often limited to packaging, which prevents monitoring of the exact number of fish. Estimates are made from the total weight, including water, of imported packages (Sieswerda & Marquardt, 1995).

The aquarium fish trade has probably doubled since the early 1980s and salt-water fish account for a growing proportion of this activity. There are three main reasons why the market has developed: 1) improvement in farming techniques and in aquarium equipment, 2) within the flourishing pet business, aquariums represent decorative and exotic ecosystems attractive to residents of temperate countries who spend long periods indoors, and 3) increase in air traffic (a major factor). Since 1980, increased tourism to tropical countries has led to more flights to and from exporting countries, making the supply of ornamental marine fish more diversified and less costly.

Importing countries

The largest importers of ornamental fish are the United States, the United Kingdom, Germany, France and Italy. In Asia, Japan is a major importer and China also has a tradition of keeping ornamental fish. The retail turnover of ornamental marine fish in the United Kingdom was worth £ 4.10 million in 1987, with an import value (CIF) of £ 1.10 million (Andrews 1990; Wood, 1992).

Exporting countries

We identified the destinations of three different exporting countries (Table 1). The USA was followed by some European countries: the United Kingdom, Germany, France, Italy. There was little variation in percentages between these destinations. The strong ties which exist between the United Kingdom and the three countries studied explains the high proportion of exports it accounted for.

International regulations

The international trade in wild animals, which is governed by the Washington Convention (CITES) has not yet endangered ornamental marine fish. However, some endemic ornamental fish species could be wiped out if large-scale harvesting were carried out in their restricted habitats. Sea-horses, whose large-scale harvesting was recently revealed, are probably responsible for a growing awareness of the risk of extinction facing some reef fish species (Vincent, 1996).

Marine aquarium fisheries in Island countries

The impact of aquarium fisheries on natural populations has been studied in detail only in the Maldive Islands, by Edwards and Shepherd (1992). Fish were harvested from an area of reef in a radius of 15 km from the capital, Malé. Almost 100,000 fish were being gathered annually in this zone (1 specimen/year/100 m^2), but this figure was very low for the Maldives as a whole. According to the abundances observed at fishing grounds and the number of specimens exported annually per species, 27 species seem to be threatened with overfishing and 12 of these species are being exploited at a rate equal to or higher than estimated yields, even if some are only collected in small quantities (Table 2). From the economic point of view, the study revealed both a turnover of 600,000 French francs (FOB value) and 25 full-time jobs. The price of fish varied by a factor of 100 depending on the species (average: US$ 2.43).

[1] École Pratique des Hautes Études, URA CNRS 1453, Université de Perpignan 66860 Perpignan Cedex France; and Centre de recherches insulaires et observatoire de l'environnement, (*Island Research Centre and Environmental Observatory*), BP 1013, Moorea, French Polynesia

Table 1: Destinations and trade percentages for marine fish exported from Sri Lanka (Wood, 1985), the Maldives (Edwards & Shepherd, 1992) and Singapore (Wood, 1992). The reference year is given in parentheses.

SRI LANKA (84)	800*	MALDIVES (86)	233**	SINGAPORE (89)	4 ,190**
United Kingdom	22%	Sri Lanka	69%	USA	31%
USA	20%	United Kingdom	14%	United Kingdom	18%
RFA	15%	RFA	6%	Germany	8%
Italy	9%	France	5%	Italy	8%
France	7%	Singapore	3%	France	7%
Belgium	7%	USA	1%	Switzerland	5%
Singapore	5%	Japan	1%	Japan	4%
Others	15%	Others	1%	Others	19%

* Value (£'000,000)
** Quantity (thousands of fish exported).

Table 2: List of fish species exported from the Maldives in quantities (specimens per year) greater than the theoretical yields in the fishing areas

Species	Quantities exported
Chaetodon auriga	1,840
Chaetodon lunula	230
Chaetodon unimaculatus	60
Chaetodon xanthocephalus	1,320
Apolemichthys trimaculatus	330
Pterois antennata	230
Pterois radiata	1,910
Balistoides conspicillum	80
Rhinecanthus aculeatus	1,570
Coris formosa	100
Macropharyngodon bipartitus	49,110
Novaculichthys taeniourus	1,860

Table 3: Number of specimens caught and value of the four main species of marine organisms concerned by the aquarium fish trade in the State of Hawaii in 1994

Species	Quantities caught	Value (US$)
Zebrazoma flavescens	199,359	318,262
Ctenochaetus strigosus	22,512	32,092
Acanthurus achilles	17,824	71,000
Zanclus cornutus	11,617	34,145
Total	**251,312** *	**455,499** **

* 59 % of total quantities exported
** 54% of total value of exports

The study pointed out that the average price of fish increased by a factor of seven between 1980 and 1989.

Hawaii

In 1994, 430,000 ornamental fish were collected in Hawaii. Of the 210 species captured, four accounted for 71 per cent of the total number of specimens (Table 3). Two-thirds of the fish were sold locally to exporters or retailers (Miyasaka, 1991; 1994). The fish caught were valued at US$ 850,000 (US$ 1.97 per fish). In 1994, 220 commercial licences were issued, but fishing and trading represented less than 100 full-time jobs.

Sri Lanka

A study carried out in 1984 (Wood, 1985) gave a list of the fish exported from Sri Lanka which included 29 species of Chaetodontidae, 13 of Labridae, 11 of Balistidae, 10 of Pomacentridae and 9 of Acanthuridae. The estimate given was 200,000 fish exported annually, equivalent to a turnover of US$ 600,000 to US$ 1,200,000 (FOB). The number of jobs was estimated at less than 500, many of which were probably only occasional.

Puerto Rico

Sadovy (1992) reports that 160,000 to 200,000 ornamental fish are harvested annually around the island and exported. Five fish species account for two thirds of the exports: *Gramma loreto*, *Opistognathus aurifrons*, *Holocanthus tricolor*, *Pomacanthus paru* and *Balistes vetula* . The author estimates that some species are already being over-fished. This activity has created about 70 jobs, including 40 full-time ones.

The Philippines and Indonesia

Few data are available on these two countries, although they are the two largest exporters of ornamental marine fish in the world. In the Philippines, this trade increased by a factor of 20 between 1970 and 1979 and continued to expand until 1990, with more than a million fish exported. It seems to have stagnated in the meantime due to the negative effects of cyanide fishing (Hingco & Rivera, 1991). More than 2,500 people were thought to participate in this activity. Indonesia exports ever-increasing numbers of ornamental marine fish. Damage to fishing grounds, by either increased cyanide fishing or overexploitation, is now posing severe problems in that country (Dayton, 1995).

Techniques used to harvest ornamental fish

Destructive fishing methods are currently the most serious problem for this sector. In the Philippines, fishing with sodium cyanide is prohibited, but is still used in 80 per cent of cases (Hingco & Rivera, 1991). This poison kills many fish during fishing or in the weeks that follow and is also dangerous for the fishermen themselves. Courses to train fishermen in other techniques are being tried. Amongst the other toxic substances used to harvest ornamental marine fish are organophosphorous insecticides, quinaldine, chlorine, diesel fuel and dynamite (Randall, 1987, Sadovy, 1992).

Quinaldine is thought to carry a risk for the divers' thyroid glands. Although some people do not see any disadvantage in using quinaldine, Australian scientists, for example, now use other alternative substances. But all the various chemical substances put in the water to harvest ornamental fish have been shown to be harmful, either to the environment or to the fish or the fishermen. We strongly urge that any use of synthetic chemical products or natural substances to collect ornamental fish be banned.

Of the other fishing techniques used, the barrier net is best. This is a 2 m high net, 10 to 15 m long, with a mesh size under 2.5 cm (Randall, 1987). Hand nets or dip nets are used for fishing with diving equipment, as they are selective. There is also a large variety of traps and scoop nets which can be used to catch ornamental marine fish. Care should be taken to ensure that live coral is not knocked over or broken by fishermen who want to capture the ornamental fish which hide there. Only nets with a mesh size under 2.5 cm should be used, as many small species are likely to be injured by bigger mesh. Stationary nets, dip nets, scoop nets and breathing apparatus may all be permitted.

Choice of species and quantities harvested

If harvests remain localised they do not endanger the natural stock, because it can be replenished through the movement of fish from adjacent areas or through colonisation by fish larvae from the ocean (Couchman & Beumer, 1992; Edwards & Shepherd, 1992; Randall, 1987; Wood, 1992). For that reason, it is preferable to have an 'after-the-fact' inspection of fish which have already been captured, to record the species, fishing ground location and harvesting conditions (dates, methods, etc).

Study of natural stocks of ornamental fish should only be considered if fishing activity increases significantly. However, in order to avoid any possible risk of overfishing, the *precautionary approach* (Garcia, 1994) should be taken, so as to define temporary fishing quotas for ornamental fish with high commercial value and low abundance on the reef.

These quotas should be applied on a species-by-species basis (e.g., annual harvest of 100, 1000 or 10,000). The quotas could be increased after verification that the natural stocks of the various species are not threatened if they are exceeded. In a similar manner, a quota could be set for endemic species, when they are sufficiently abundant.

Limits to the management of fish stocks

A pre-requisite of stock management is an estimate of the population from which harvesting will occur, followed by a count of the number of fish harvested. However, fish abundances sometimes contradict harvest forecasts based on estimated stocks, even with commercial fishing. One of the principal factors in the natural fluctuation of ornamental marine fish stocks is the number of larvae colonising the reef, which represent true natural fish production. As fishing for the aquarium trade is based on the number of specimens and not on biomass, the colonisation rate could yield a theoretical maximum harvest.

However, for many species, the number of larvae colonising any given island in any one year depends on how well the larvae survive in the ocean and cannot be used to predict figures on another island or even for the following year. On a smaller scale of time and space, the colonisation rate is more easily predictable by species (Dufour & Galzin, 1993).

Also, the mortality rate for young reef fish, which is very high on the reef during this period, decreases rapidly. The number of very young fish colonising the reef is therefore much higher than the number of adults already settled in the reef (Dufour et al., 1996).

In contrast to the normal fishery management methods, which optimise biomass and not the number of specimens harvested, it would be preferable in this case to collect the fish as young as possible, since about 90 per cent of them will disappear before adulthood. This practice would conserve the stock of adult fish, which are the natural producers of these larvae. But little is yet known about very young fish, which are difficult to catch alive.

Table of regulatory methods used in the main ornamental fish exporting countries

Country	Regulatory body	Number of fisherfolk	Authorisation	Fishing method	Restrictions	Follow-up / comments
USA (Florida)	Marine Fisheries Commission	100–125 full-time	Fishing licences and state legislation	Drop net, seine, dip net, quinaldine	Size limits and daily quotas for certain species; limited net-mesh size	No initial assessment of populations
USA (Hawaii)	Marine Fisheries Services	220 fishing licences, 60 full-time jobs	Fishing licence (commercial or non-commercial), project operator's licence	Net, scoop net	Special permit to collect live rocks (restrictions on madrepores)	Monthly monitoring of fish by species and island; monitoring of exports (quantity and value)
Sri Lanka	None	500 or less	No permit	Dip net	No	No
Philippines	Department of Agriculture	1500 to 3000	Licensed operators and divers, licensed and inspected breeding sites	All types of nets, scoop net, spear guns (cyanide)	Cyanide is illegal; restrictions on fishing in certain areas	No previous studies, collection monitored in certain areas.
Maldives	Marine Research Section, Ministry of Fisheries and Agriculture	About 25 full-time jobs	No permits	Dip net, net	Uncontrolled collection on about 10% of the reef. Overall quotas of 100,000 fish; more detailed quotas for 22 species	Quotas based on estimates of the yields in the authorised zone (studied by Edwards & Shepherd, 1992).
Kenya	Department of Fisheries	8 part-time	Annual fishing licences (but very lax legislation)	Dip net	Chemicals prohibited; fishing prohibited in reserves; export approval for adult fish	No monitoring
Fiji	Fisheries Division	10 full-time, 20 part-time	Licensed fishermen	Dip net	Poison and destruction of coral prohibited; fishing zones; export quotas by company: 50 to 100,000 fish annually	List of species required with each shipment exported
Australia (Great Barrier Reef)	Department of Primary Industry	20 full-time; 80 part-time	Licensed fishermen	Net, dip net	Fishing allowed outside protected areas; chemicals prohibited; destruction of habitat prohibited	No monitoring before collection, quantities taken quarterly requested
Palau *	Ministry of Resources and Development	?	Fishing licence and inspection of operators	Authorised nets, poison prohibited	Hard corals prohibited; limit of 20 fishing permits per year	No follow-up or quotas
Puerto Rico	None	40 full-time; 30 part-time	No permits	All types of nets, quinaldine	Export of hard corals prohibited	Proposed Regulations (Sadovy, 1992)

* From: Graham, T. (1996). Managing Palau's aquarium fishery. SPC Live Reef Fish Information Bulletin #1: 13–18

Small Island countries' participation in this trade

Collection of ornamental fish and lagoon fisheries

Aquarium-trade fish species are not those normally harvested for food, which enables diversification of the species targeted (Couchman & Beumer, 1991; Edwards & Shepherd, 1992). Collection of ornamental fish can also help diversify fisheries, without any particular effect on the resources which are already being exploited. Conflicts of interest are, however, possible with some users of the reef, particularly tourists, who visit the lagoon.

Assessment of economic impact

Although ecological considerations must be applied in a way that ensures the natural environment is better protected, economic criteria remain decisive in this type of activity. Regulatory requirements for the collection of fish must not hamper the economic viability of the activity, or fishing will go on either illegally or without providing any economic benefits. For example, it would be pointless to authorise collection of fish only on remote islands, because the cost of local transport would then make these fish more expensive than those produced in other exporting countries. For these reasons, absolute ecological requirements must take the form of regulatory constraints which do not threaten the economic viability of this activity. They should allow for sustainable development of the activity while preserving the natural environment.

An assessment of this activity in Island countries

By comparing this market in exporting countries, it can be determined that the export of 100,000 fish represents an annual turnover of approximately US$ 200,000 and 10 to 20 full-time jobs. Except for a few countries which have very limited reefs, it seems reasonable to assume that the ichthyological fauna and the extent of the reef structures in most of the island countries in the Indo-Pacific zone permit a level of production comparable to that of the Maldives or Fiji. It is also important to know whether the cost of harvesting and exporting the fish will be competitive in comparison with competing countries.

Air freight represents 50 per cent of the price and its cost cannot be locally controlled. However, as the FOB value of ornamental fish includes the cost of fishing, storing, packaging and local transport, it must also be very competitive. Fishing costs (boats, fuel, gear etc.) can be quite high, as can labour costs, and this is significant, as the fish are caught by hand. Labour costs will therefore be a determining factor in the economic viability of this fishery, since some exporting countries have very low-priced labour. This type of fishing is also often a secondary professional activity. In order to encourage it, local regulations must lessen the salary-related costs and grant customs-duty reductions on the gear needed for this activity.

Recommendations and conclusions

The harvest of ornamental marine fish is of economic interest for Island countries. If the costs of transport and salaries can be controlled, the development of this activity could quickly yield, for an annual harvest of 100,000 fish, a turnover of US$ 200,000 and 10 to 20 permanent jobs. In order to conserve resources, the first thing to be done is to ensure that are no transgressions of authorised fishing methods. Arrangements must be made to ensure that inspections are carried out during fishing or later if necessary and dissuasive penalties must be applied.

We propose that catches of the most vulnerable species be regulated according to the *precautionary approach*, by setting quotas. Monitoring of the quantities exported, together with visits to the fishing grounds, should make it possible to adjust the quotas. If the activity increases significantly (say more than 250,000 fish annually), monitoring of the densities of exploited populations would be needed at the fishing grounds in order to ensure sustainable development of this activity. Tax incentives should also be devised.

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Wild-caught juvenile reef-fish for farm growout: more research needed on biology and fisheries

by R.E. Johannes

The Sabah workshop on reef-fish aquaculture, discussed on page 37 in this issue, has highlighted the need for accelerated research on the biology of the late larval and early post-settlement fish of species important in the live reef-fish trade, and of fisheries for the latter. Published information on how, when, where and what species of wild juveniles can be caught to supply reef-fish farmers in the region is sparse.

A quick and relatively inexpensive way to get vital portions of this information would be to interview fishers who specialise in catching reef-fish juveniles for growout. They possess much valuable knowledge concerning seasonality, habitat preferences, and year-to-year trends in abundance of the targeted fish in their waters—information often largely unknown to researchers.

Some may dismiss such information as 'anecdotal', but the fishers who possess it depend upon it for their livelihoods. Information obtained from small-scale tropical fishers can be highly informative, reliable, and invaluable to researchers and industry (e.g. Johannes, 1981). Often, moreover, such knowledge cannot be obtained by conventional biological research without the expenditure of a great deal of time, money and effort.

For example, large numbers of juvenile specimens of the panther or mouse grouper, *Cromileptis altivelis*, one of the most highly valued species in the live reef-food-fish trade, are captured for growout by fishermen in Indonesia (H. Sanger, pers. comm.). Yet the scientific literature yields no information concerning the kind of habitat preferred by the juveniles of this species.

We should be asking appropriate fishers and middlemen throughout the region what species can be supplied as juveniles in large quantities from the wild, as well as where and when are they most accessible and what local catch trends have been in recent years. A

synthesis of such information could provide the live reef-fish-farming industry with a regional overview of fish-farm stock supplies and greatly assist in future planning and more efficient deployment of resources.

Local methods for catching these fish also need more study. To attract juvenile reef-fish, growing numbers of fishers employ a variety of artificial habitats, such as the **gangos** of the Philippines (Ogburn & Ogburn, 1994) and the **temarang** of peninsular Malaysia (Ali & Ali, in press) and 'brush parks' in Sri Lanka. Studies on artificial habitat that provides shelter for juvenile groupers indicate that it greatly increases survival rates rather than simply concentrating them (e.g. Beets & Hixon, 1994; Teng & Chua, 1979.)

Such artificial habitats, if properly understood, might be exported to appropriate habitats in areas where such fisheries do not presently exist, such as Papua New Guinea and Irian Jaya, to provide new sources of employment for coastal villagers. Fishing for juvenile reef-fish requires extremely low capital investment (US$ 27 per family in one such fishery in the Philippines examined by this writer). It thus offers an important source of employment for the poorest segment of coastal societies.

There are reports of dwindling supplies of wild juveniles in some areas (e.g. of *Epinephelus akaara* and *E. coioides* in Hong Kong and the adjacent waters of mainland China, as well as other grouper species in warmer waters). But research has seldom, if ever, documented these declines nor established the cause(s). Is it overfishing of the juveniles, overfishing of the adults which produce the juveniles, habitat degradation and pollution or a combination of these? Or is it an artefact of the great natural interannual variation in recruitment that is known to occur in a variety of species of reef-fish?

The rapid growth in the quest for juveniles of tropical fishes and invertebrates for farming requires much research if stocks are to be exploited and managed effectively. One obvious need is for reassessment of legal size limits. If wild-caught juveniles are to be used legally for farming, then size limits—in countries where they exist—must be adjusted accordingly. This may not prove to be a trivial task if it is done in such a way as to limit collection of small individuals to those to be used for farming, while preventing the collection of 'undersize' individuals for direct consumption.

Research described by Dr Vincent Dufour at the Sabah workshop suggests that if we harvested late-stage pelagic larvae instead of post-settlement juveniles, this could enable us to catch more juveniles for farming while having less impact on subsequent adult wild stocks. Making this idea commercially attractive would require considerable additional research, however.

To encourage the construction of artificial habitats for juvenile reef-fish, government resource managers also need to understand something of the social and economic dynamics of the relevant fishing communities. For example, fishers should be assured the right to protect their artificial habitats from poachers and destructive fishing practices. Without this right they have little incentive to build them or protect those that are built for them.

Where such rights are in effect, fish aggregating devices (FADs) can, moreover, provide the impetus for improved, locally-based marine conservation. That is, they may stimulate a proprietary and protective interest in surrounding fishing grounds, with a consequent decline in destructive practices such as fishing with explosives and poisons (e. g. Galvez, 1991).

In summary, if reef-fish farming is to achieve its full capacity to exploit sustainably the large and fast-growing demand for live reef food fish, then greater efforts must be made to investigate the biology of, and fisheries for the juveniles that are—or could be—caught for growout. There will be little incentive for the industry—which is composed of innumerable small competing units—to fund such research. This would therefore seem to fall logically to governments, regional agencies and/or large NGOs.

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Live reef-fishery species feature prominently in first marine fish IUCN Red List

by Yvonne Sadovy

The protection of marine fishes, particularly those exploited commercially, has historically fallen within the general purview of fisheries management. Even under extremes of exploitation, the likelihood that marine fishes could be threatened with extinction, has not, at least not until recently, been viewed as worthy of serious consideration. Should commercial exploitation prove excessive, or management ineffective, for certain species, then (the logic goes) fish numbers become too low for fishing to be commercially viable and fishing will cease. Exploited species, therefore, are protected by a 'safety valve' of economics and numbers which operates well before species, or populations, become seriously threatened. Or so many believe.

This long-held view is rapidly changing. Serious management failures far exceed any successes, with some spectacular collapses in recent years that few people would have believed possible not long ago; Atlantic cod is just one example. For a number of reasons, fishery management has not been as effective as we once hoped and, especially for species that appear to be particularly susceptible to even light levels of exploitation, conservation measures may be necessary to maintain a healthy fishery. Moreover, the safety valve may not always work. Some fishes are so highly prized that it is still worth fishing for them even at very low population levels. Indeed, in some cases, rarity itself is valued thereby maintaining or even enhancing 'cash' per unit of effort despite (or rather because of!) increasing scarcity. Examples of such species in the Indo-Pacific region, unfortunately, include many fish traded alive, either for the marine aquarium trade (MAT), for food in the live reef-fish trade (LRFT), or valued in traditional Chinese medicine (TCM).

In response to growing concerns over the status of marine fishes in general and the apparent failures of fishery management in particular, as well as recognising that marine species have long been under-represented on conservation lists, a meeting was held in April 1996 in London. This meeting was organised by the Institute of Zoology (Zoological Society of London) and the International Union for the Conservation of Nature (IUCN), which produces the internationally recognised and influential Red List of threatened species; additional funding came from the World Wide Fund's Endangered Seas Programme. The principal aims of the meeting were to discuss the applicability of various IUCN criteria, used to assess different levels of threat or endangerment in animals in general, to marine fishes and to develop a first listing of candidate marine fish species for inclusion in the 1996 Red List.

Using IUCN criteria, 148 marine fishes were included on the 1996 Red List. This list numbered 40 different families and 18 orders, with many commercially important species among them. Tropical species ranged from sharks, tunas and billfishes, to groupers, seahorses, snappers, chaetodontids and a wrasse. The criteria used to list these species, or specific populations, were mostly centred on inferred, estimated, observed, suspected or potential declining populations and/or dependence of a critical phase in life history on a small, or limited, area or habitat. Particular concerns arose from actual or likely severe overexploitation in traditional fisheries and from activities linked to a growing number of rapidly expanding 'new' fisheries especially those for the LRFT, MAT, and for TCM.

Major tropical groups included in the red-listing were the groupers (at least 14 species of serranid), the humphead wrasse (Napoleon fish or Maori wrasse), *Cheilinus undulatus*, and the seahorses, *Hippocampus* spp. For these animals, serious concerns were raised because of known, or strongly implicated, heavy declines in many exploited populations throughout the tropics as a direct result of their high value and trade. A rapidly growing demand is anticipated in many areas of the western Indo-Pacific because of the high value of species for the LRFT (e.g. groupers and humphead wrasse) and trade in seahorses for the MAT and for traditional medicines. Indeed, it is exclusively because of the apparent impact of the LRFT on the humphead in some areas that this species was red-listed.

In the live food-fish trade, groupers and humpheads are important species and fetch extremely high prices in gourmet restaurants in Southeast Asia. The humphead can retail at over US$ 100/kg. Because of its high value, this species is being heavily fished in some places, sometimes using sodium cyanide, and severe depletions are suspected in many areas as a result of increasing demand for and trade in this wrasse. Another extreme example of the value of certain species in the live food-fish trade was a recent US$ 10,000 price tag for a giant grouper, *Epinephelus lanceolatus*. As far as we know, this animal is not common anywhere in its range, yet its value makes it a highly desirable target and extremely susceptible to excessive trade.

Species of grouper, seahorse and the humphead are generally recognised as particularly vulnerable to exploitation because of certain of their life-history traits. Aside from their generally long lives (many decades in some cases) and slow growth rates which

generally accompany low replacement capacity, many groupers spawn for extremely limited periods each year, at spawning sites often well known in time and place. These aggregations are frequently heavily exploited and several have completely ceased to form, almost certainly as a result of fishing; they represent important areas on which these species depend for reproduction. In specific examples in the Caribbean, it is likely that much of the population or sub-population dependent on lost aggregations has also disappeared as a result of excessive aggregation fishing.

A different suite of biological characteristics renders seahorses susceptible to fishing. Loss of critical habitat (such as seagrass beds) combined with low natural seahorse densities and the reproductive habits of many species (such as faithful monogamy and low rates of production of young) mean that recovery from anything other than light fishing levels may be very slow.

The red-listing produced in April was a first draft and represents a warning flag alerting us to species exhibiting symptoms of, or potential for, endangerment at the population or species level. Debates will doubtless continue over the true vulnerability of marine species to extinction. However, populations at severely reduced numbers are clearly at risk of extinction through randomly determined environmental events; in the absence of any management at all, such risks may be particularly acute. The species listed that are currently traded alive appear to be particularly vulnerable because of their high value and the rapidly growing demand.

While red-listing has no legal muscle, it is useful as a guideline by policy makers and as a warning. Fisheries biologists and managers should heed this warning and look carefully at fishery developments in their region. The seas are not as bountiful as we once thought. Certain species, such as some of the groupers and seahorses and the humphead wrasse, will not live up to high economic hopes for them in the long term unless we resist the greed that serves nothing but short-term gain and invites the scrutinising eye of the conservationists.

While there is concern for the status of stocks, there is still very little information on the biology or trade of the humphead wrasse and the giant grouper. If anybody is carrying out any studies, or has any information on humphead wrasse or giant grouper populations, such as numbers being caught or exported, sizes of individuals observed in the field or being fished, or any confirmed cases of ciguatera poisoning from either species, I should be most interested to hear about it. This information could help us to understand better the conservation status of these species.

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Exploitation of reef resources, grouper and other food fishes in the Maldives

by Hassan Shakeel & Hudha Ahmed [1]

The following is extracted from a paper presented at the Workshop on Integrated Reef Resources Management, 16–20 March 1996, Maldives.

Abstract

Exploitation of reef resources in the Maldives has become an important component of the country's fisheries sector. Two forms of reef-fish fisheries are recognised: the general fisheries, targeting a large number of different commercial species; and the grouper fishery, targeting commercial grouper species. Both these fisheries are expanding today.

The developing new fisheries pose two main threats: over-exploitation of resources and conflicts among resource users. To address the consequences of fisheries diversification, intensification and interactions with other resource users, fisheries management has become a necessity.

In order to come up with recommendations for developing and managing reef fish fisheries, the available qualitative and quantitative information has been analysed in the present scenario of expanding reef-fish fisheries and increasing competition for reef resources among different interest groups. For the grouper fishery a minimum commercial size limit of 12 inches has been recommended (16 inches for the medium and large size-groups of fish). Other recommendations include maintaining the fishery below the maximum sustainable yield, keeping some areas temporarily

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closed to fishing, and doing experimental aquaculture of groupers. Improving the collection of statistics is a recommendation common to both fisheries.

Introduction

Exploitation of marine resources has intensified in the Maldives in the last ten years. Tuna is still the dominant fishery, but other existing fisheries have increased in scale and new ones have started. In addition to fish, other reef organisms are also being commercially exploited. Reef-fish fisheries, which remained subsistence for a long time, have now developed to a commercial scale. A recent development is fishing for some species of grouper to export them live or fresh.

Today, marine resources are being shared by two important economic sectors: fisheries and tourism. The investment of the private sector in small-scale fisheries is increasing, particularly for the exploitation of reef fish. These small scale fisheries, which are supplementary to the tuna fishery, have considerable social and economic benefits. These activities provide additional employment for the fishermen when tuna fishing is poor. If the supplementary opportunities are not there, fishermen have to look for non-fishery employment during such times, often in the heavily populated capital, Malé. As the exploitation of reef resources is expanding in terms both of variety and quantity, reef-based tourism is also developing, bringing a considerable amount of foreign currency into the country. Diving, snorkelling and recreational fishing on reefs have become major tourist attractions. Thus, fisheries and tourism—the two most important economic sectors—have to make compromises for their development.

The developing new fisheries pose two main threats: over-exploitation of resources and conflicts among resource users. Coral reef habitats in the Maldives are rich in variety, but poor in abundance of individual species—a characteristic common to many tropical habitats. Hence, a commercial fishery wholly based on the natural stocks will soon be under the threat of over-exploitation, if the fishery is not properly managed. Poor management also leads to conflicts among different interest groups or economic sectors sharing common resources.

Tourists do not like fishing activities at dive sites. On the other hand, fishermen believe that diving is a problem to bait fisheries. According to them, baitfish get scared and scatter because of divers. Fishermen also hold the belief that removing groupers from reefs has a negative impact on bait fisheries, as, in the absence of predatory groupers, baitfish tend to scatter. As in the fisheries sector, there are groups with conflicting interests in the tourism sector: for example, divers and night-fishing tourists.

To address the consequences of fisheries diversification, intensification and interactions with other resource users fisheries management has become a necessity. Fisheries management calls for collaborative efforts of policy makers, researchers, administrators and island communities. When formulating management strategies, consideration has to be given to the fact that fisheries management involves imposing restrictions in some form or other on free access to resources, and dealing with conflicting interest groups. The aim of this paper is to analyse the status of reef-fish fisheries and give recommendations for their development and management.

Methods

In order to come up with recommendations for developing and managing reef fish fisheries, the available qualitative and quantitative information has been analysed in the present scenario of expanding reef fish fisheries and increasing competition for reef resources among different interest groups.

The source of fisheries catch statistics was the Economic Planning and Co-ordination Section of the Ministry of Fisheries and Agriculture (MOFA) (1995).

The stock size given for groupers was calculated by Shakeel (1994), based on the data from exploratory surveys. The theoretical size (length) at maturity of groupers was estimated assuming that a fish generally spawns for the first time at half the maximum length it attains (Maicev et al., 1981). The maximum total lengths of groupers as reported by Heemstra and Randall (1993) were used to estimate the theoretical length at maturity. The theoretical length at maturity of grouper species was compared with the actual size of the smallest mature individuals (female, maturity stage ≥ 3; information taken from a report being prepared by Huda) caught during the exploratory fishing survey (Table 1). The length at maturity was suggested as the minimum size that should be allowed to be caught in commercial fishing, as it will allow the fish to gain considerable biomass and spawn at least once in its life. Groupers recorded from the Maldives were categorised into small, medium, large and extra-large size-groups; and for each group, the average maturity length was calculated, so that it would be proposed as the minimum size allowed to be caught for species belonging to each group. When grouped like this, all commercial and few non-commercial species fell into the medium and large size-groups.

Fishermen will be able to distinguish the members of one commercial group from those of the other, making a clear distinction between the two groups. Having a minimum number of easily distinguishable commercial groups is an important condition if it is to be practicable for size-limited fishery to be carried out.

Grouper fishery

Groupers are popular marine food fish of high market value in many parts of the world, including Kuwait, Indonesia, Malaysia, Singapore, Japan, China and Mexico. Their habitats are coral reefs and stony envi-

Table 1: Minimum size (length) at maturity of commercially important grouper species

Species	Maximum total length reported in literature (cm)	Maximum total length of fish caught during exploratory fishing survey (cm)	Minimum total length of matured fish caught during exploratory fishing survey (cm)	Theoretical maturity length (cm)
A. Medium size-group				
Aethaloperca rogaa (Forsskal, 1775)	60	43	28	30,0
Anyperodon leucogrammicus (Valenciennes, 1828)	52	44	26	26,0
Cephalopholis argus Bloch and Schneider, 1801	55	36	27	27,5
Cephalopholis miniata (Forsskal, 1775)	40	37	23	20,0
Cephalopholis sexmaculata (Ruppel, 1830)	48			24,0
Cephalopholis sonnerati (Valenciennes, 1828)	57	53	32	28,5
Epinephelus areolatus (Forsskal, 1775)	40	42	25	20,0
Epinephelus caeruleopunctatus (Bloch, 1790)	59			29,5
Epinephelus chlorostigma (Valenciennes, 1828)	75			37,5
Epinephelus fasciatus (Forsskal, 1775)	40			20,0
Epinephelus longispinis (Kner, 1864)	54 *			27,0
Epinephelus ongus (Bloch, 1790)	31			15,5
Epinephelus spilotoceps (Schults, 1953)	31	46	23	15,5
Epinephelus macrospilos (Bleeker, 1855)	50 *			25,0
Epinephelus melanostigma Schultz, 1953	33			16,5
Epinephelus miliaris (Valenciennes, 1830)	53		35	26,5
Epinephelus morrhua (Valenciennes, 1833)	73			36,5
Epinephelus octofasciatus (Griffin, 1926)	80			40,0
Epinephelus poecilonotus (Temminck and Schlegel, 1842)	63			31,5
Epinephelus retouti (Bleeker, 1868)	50			25,0
Epinephelus tauvina (Forsskal, 1775)	75			37,5
Gracila albomarginata (Fowler and Bean, 1930)	38			19,0
Mean	52,65	44,375	27,375	26,295
Standard deviation	15,277	6,566	4,24	7,273

* Total length calculation based on actual standard length

Table 1 (continued): Minimum size (length) at maturity of commercially important grouper species

Species	Maximum total length reported in literature (cm)	Maximum total length of fish caught during exploratory fishing survey (cm)	Minimum total length of matured fish caught during exploratory fishing survey (cm)	Theoretical maturity length (cm)
B. Large size-group				
Epinephelus fuscoguttartus (Forsskal, 1775)	95			47,5
Epinephelus polyphekadion (Bleeker, 1849)	75	58	39	37,5
Epinephelus flavocaeruleus (Lacepede, 1802)	80			40,0
Epinephelus multinotatus (Peters, 1876)	100			50,0
Plectropomus areolatus (Ruppell, 1830)	68 *	60	39	34,0
Plectropomus laevis (Lacepede, 1801)	125	82	62	62,5
Plectropomus pessuliferus Fowler, 1904	63	59	37	31,5
Variola albimarginata Baissac, 1952	47	38	22	23,5
Variola louti (Forsskal, 1775)	81	58	41	40,5
Mean	83,25	59,16	40,00	40,78
Standard deviation	23,81	13,95	12,81	11,42
C. Small size-group				
Cephalopolis aurantia (Valenciennes, 1828)	30		15	
Cephalopolis boenak (Bloch, 1790)	26		13	
Cephalopholis leopardus (Lacepede, 1802)	20		10	
Cephalopholis spiloparaea (Valenciennes, 1828)	22		11	
Cephalopholis urodeta (Forster, 1801)	28		14	
Epinephelus merra Bloch, 1793	32		16	
Mean	26,33		13,17	
Standard deviation	4,63		2,32	
D. Extra-large size-group				
Epinephelus lanceolatus (Bloch, 1790)	231	204**		115,5

* Total length calculation based on actual standard length

** From MRS museum records

ronments. Because of their voracious feeding habits and shallow habitats, these fish are easy target for small-scale fishermen. Groupers have also been farmed in the coastal waters of the tropics and subtropics for a long time.

About 40 species of grouper of the sub-family Epinephelinae have been recorded from Maldivian waters (Randall & Anderson, 1993) and a few are currently being exported commercially. The commercial fishery for groupers began in 1993. Grouper exports have increased from about 200 t in 1994 to 1000 t in 1995 (Figure 1), bringing in estimated revenue of MRf 7,688,000 and 46,223,500 respectively.

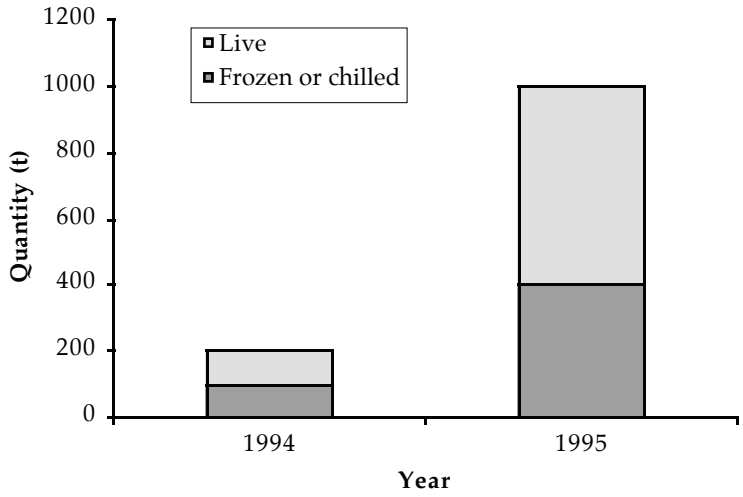

Figure 1: Export of groupers from the Maldives

At first, grouper fishing was concentrated in the central atolls of Alifu, Vaavu and Meemu. The fishery has now spread to all the atolls of the country. Fishing is carried out in all types of fishing boats: rowing boats (**bokkuras**), sailing or mechanised trolling boats (**vaudhonis**), and mechanised pole-and-line fishing boats (**masdhonis**). Two or three people go fishing in a **bokkura**, 3–4 in a **vadudhoni**, and 4–8 in a **masdhoni**.

The usual fishing grounds are island reefs, ring reefs and patch reefs. Handlines, the most widely used gear for reef fishing in the Maldives, are also used to fish for groupers. Handlines are normally baited with livebait, particularly gold band **fusilier (Mas Muguran**), *Pterocaesio chrysozona.* Though less preferable than livebait, cut pieces of tuna and big-eye scad **(Mushimas**), *Selar crumenophthalmus,* are also used as bait. Daily catches of a sailing **vadudhoni** and a mechanised **masdhoni** are in the range of 50–80 and 100–170 fish respectively.

The grouper catch is kept alive in **dhoni** holds. Large tuna-fishing **masdhoni** hold groupers in the same manner as livebait holding. To maintain constant circulation of good-quality water, seawater is allowed to enter through the inlet openings at the bottom of the vessel and water is bailed out by a petrol pump. Smaller vessels, **vadudhoni** and **bokkura**, circulate seawater in the same way as tuna fishing vessels. The main difference is that, in this case, instead of a mechanical pump, a hand pump or bailer is used to discharge water.

During the fish-holding operation, which lasts from the moment of catch to transferring to cages (about 5–10 hours), the mortality constitutes about 5–20 per cent of the catch. The groupers caught by the fishermen are sold live to the exporters or to their agents. These fish are stocked in cages for exporting live or chilled later.

Grouper stocks

Based on the total reef-fish and grouper catch in the exploratory survey, and using similar methods to those employed by Anderson et al. (1992) to calculate the maximum sustainable yield of reef fish, Shakeel (1994) did stock assessment of groupers. The maximum sustainable yields of grouper for the three major habitats are given in Table 2. The total yield is broken down in proportion to reef areas of atolls.

It should be emphasised that, like the total yields of reef fish, these figures are also crude and they serve only as guidelines. Hence due caution should be exercised whenever they are used.

Discussion

Until recently the Maldives have been commercially exploiting mainly pelagic fish that have no or little association with the reefs, particularly tuna. Traditionally reef resources exploitation was carried out on a small scale, mainly for subsistence. Therefore, the exploitation of reef resources posed no significant threats to fish populations or the environment. Today the resources are being more intensively exploited for commercial purposes. Coral mining, one of the most ancient forms of exploiting reef resources, has expanded to meet the increasing demand for corals in the construction industry. The existing reef fisheries have also expanded to cater to both the local tourist and export markets. While the general reef fish

Table 2: Estimated sustainable yields of grouper

Habitat	MSY (t/yr)	Ratio of grouper in the survey catch
Atoll basins	810 ± 370	0.16%
Shallow reef areas	960 ± 320	4.15%
Deep reef slopes	60 ± 15	17.91%
Total MSY	**1800 ± 700**	**7.95%**

fisheries continue to expand, the export-oriented grouper fishery has gained importance. The increased commercial exploitation of reef resources has resulted in two major threats: conflicts among resource users and over-exploitation of resources

Tourism sometimes finds itself in conflicting situations within the sector and also with the fisheries sector. Tourism has created a huge domestic market for reef fish. Tourists prefer reef fish, while the majority of local people prefer tuna. Dive-tourists love to see the fishes freely cruising on the reefs, without hooks or lines projecting from their mouths. Another group of tourists would like to celebrate their successful night-fishing excursion with a barbecue. Dive-tourists complain about groupers, aquarium fish and reef sharks being caught from popular dive sites. On the other hand fishermen complain that they are disturbed by divers during reef fishing or bait fishing.

Although the total reef-fish resources seemed underfished when the yield of 30,000 t from the whole country for all reef-fish species is considered, some fish species, such as groupers, and other organisms, such as sea cucumbers, are under the threat of over-exploitation.

The grouper fishery, which started in the central atolls, has now spread to all the atolls. This fishery has already started to show signs of overfishing: relatively poor catch, higher prices offered, and quick shifting of fishing operations from one atoll to the other. The estimated export of grouper in 1995 was about 1,000 t. Assuming that there was a mortality rate of 20 per cent during fish holding both in **dhanis** and cages, an export figure of 1,000 t represents a total catch of 1,600 t in 1995.

Taking into account the crude nature of the maximum sustainable yield (MSY) of 1,800 t/year and the requirement that this yield should be tapped from all the reefs of the country, it can be concluded that the grouper fishery reached MSY and probably surpassed it in 1995. Up to 1995 the fishery was mainly in the central atolls. This region must have experienced very high fishing pressure, and it now urgently requires low fishing pressure for the fish populations to attain normal size. Therefore it is advisable to close these atolls for at least one year and impose a minimum size restriction on the fishery.

Fisheries and tourism provide more than 70 per cent of total government revenue, create a large number of jobs in the central and outer atolls, and attract foreign investments. Therefore, the reef resources need appropriate management measures so that reef fisheries develop in parallel with the tourism sector. In its development, the tourism sector also has to take into account the traditional dependency of the country on fisheries and other living marine resources. This is more easily said than done. It is this difficulty of finding compromise solutions that calls for an integrated resource management approach which considers the interests of all concerned sectors.

The fisheries sector and inter-sectoral co-development are complicated by a number of issues, including insufficient resource knowledge, insufficient trained manpower, lack of specific statistics, lack of integrated management approaches, difficulty of adopting management measures without having negative effects on the livelihood of the people, and involvement of diverse interest groups.

Resource-use conflicts and stock depletion are new problems to Maldivian fishermen, mainly due to the historical exploitation of relatively abundant pelagic resources, such as tuna. These problems have started with the recent exploitation of the less abundant inshore resources. The fishermen, whose perception of a fishery has been mainly formed by the tuna fishery, need time and guidance to get used to today's new, changing situations.

Recommendations

Grouper fishery

Limit fishing in each atoll

Grouper-targeted fishing should be limited in every atoll, depending on each atoll's annual sustainable yield of grouper. For this purpose, the potential yields calculated for different atolls can be used with due caution. When fishing in an atoll has reached the annual sustainable yield, the atoll should be closed for grouper fishing for the rest of the year. This measure will help to prevent localised overfishing.

Limit exports

The total exported from the whole country should be limited to the maximum sustainable yield of 1,800 t/year. Once this figure has been reached, exports can be prohibited for the rest of the year.

Close some areas for long periods

As an additional precaution to ensure a sustainable fishery, along with other measures such as size limit and fishing below MSY, some areas of the country could be closed for grouper fishing at least for one year or more. To implement this measure, the country could be divided into northern and southern regions, starting from Malé. Each region could be further divided into two zones. When one zone in a region is temporarily closed for grouper fishing, the other zone in the same region could be kept open for fishing. The two zones in a region could be opened and closed alternately, based on the intensity of fishing.

Size restrictions

For commercial use, the removal of groupers less than the average maturity length of 12 inches (30.5 cm) from the medium size-group and 16 inches (40.5 cm) from the large size-group could be prohibited. The small and extra-large size-groups contain species which are non-commercial because of either small size

or rarity. Catching a fish larger than 12 inches (30.5 cm) from the small size group will do no harm, as the members of this group reach maturity at a length of about 6 inches (15 cm). The extra-large group contains one very rare species that is not caught in commercial fisheries. These two size restrictions are expected to result in about 80 per cent of commercial and potentially commercial grouper species being caught after they have spawned at least once in their life.

Review statistics collection

To implement most of the recommended measures effectively, catch-and-effort and export data are required. Therefore, it is important to review the present system of collecting grouper statistics to improve the quality of data.

Aquaculture

Experiments in grouper aquaculture should be done with the long-term aim of increasing grouper production through cultured stocks and sea ranching. The Marine Research Section of MOFA has already initiated such experiments.

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Destructive fishing methods in and around Komodo National Park

by Jos Pet [1]

Introduction

Interviews and surveys in and around Komodo National Park (KNP) have resulted in the description of eight different categories of destructive fishing, which are described below. Almost all the information is anecdotal, since documented material is not available. Informants are reluctant to give details on destructive fishing practices and it is therefore most difficult to obtain detailed information on the history of destructive fishing, especially when it comes to locations and time periods of occurrence of certain practices.

Some data on frequency of occurrence (Figures 1 and 2) and locations (Figure 3) of destructive fishing methods (mainly fish bombing) have been available at the National Park Authorities since 1988. The park authorities have started documenting detailed information on fishing activities—resource utilisation patterns, described by locations, dates, type of activity, yield, etc.—only since 1996. The local fisheries service cannot provide any such data. It is therefore not possible to come up with detailed historical data on temporal and spatial patterns in destructive fishing effort.

A lot of the information on spatial and temporal differentiation within the KNP area has to be obtained by monitoring the present status of the reef. The Komodo Field Office of the Nature Conservancy (KFO) has therefore started a coral reef survey in which 192 locations are surveyed at three different depths: 0–5 m (manta tow), 5–15 m (diver) and 10–15 m (diver). The status of the reefs is recorded in terms of percentages of 1) live hard coral, 2) dead hard coral standing, 3) coral rubble, 4) soft coral, 5) sand, 6) algae & weeds, 7) rock, and 8) others. This survey will be completed by the end of 1996 and a good picture of

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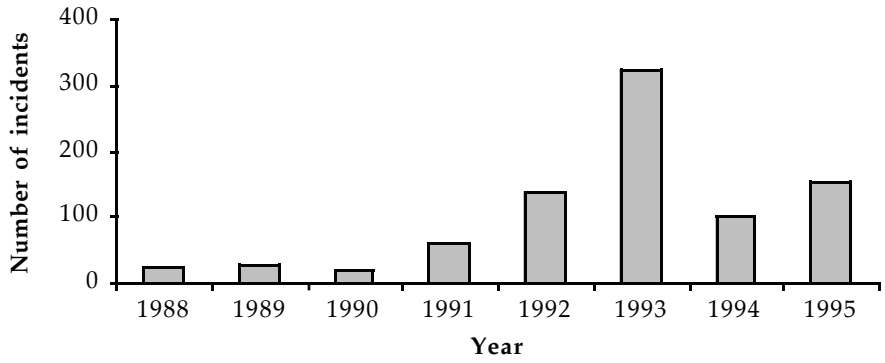


Figure 1: Number of fish-bombing incidents recorded annually in Komodo National Park

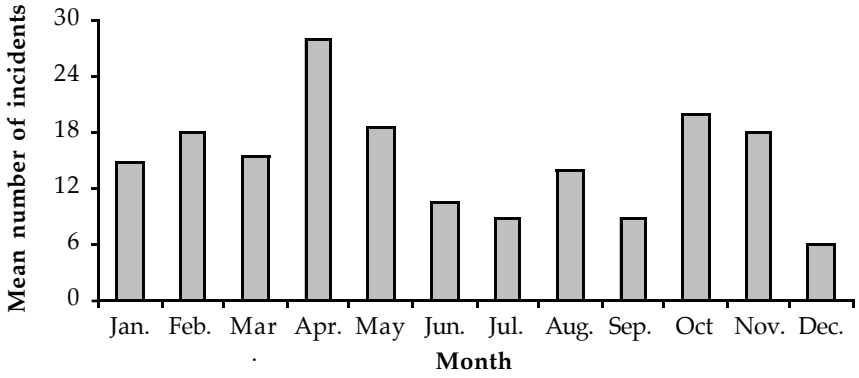


Figure 2: Mean number of fish-bombing incidents per month in Komodo National Park, 1992–1995

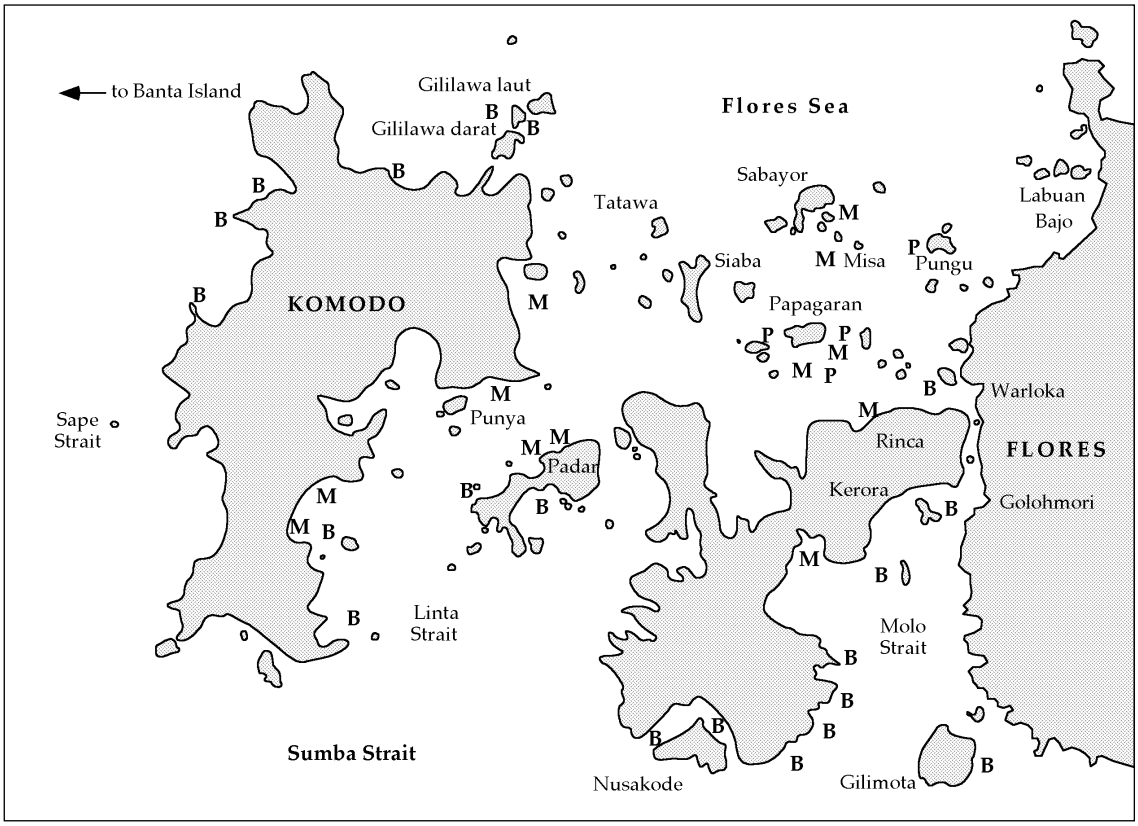


Figure 3: Locations of destructive fishing methods
B: Bombing — **M:** 'Meting' — **P:** Poisoning

the status of the reefs should result. Preliminary results show the following overall mean percentages (for 72 locations at the north side of the park): 1) 15% live hard coral, 2) 15% dead coral standing, 3) 35% coral rubble; 4) 15% soft coral, 5) 15% sand, and 6,7,8) 5 % algae, weeds, rock and others.

The variation between locations seems to be high. The areas of coral rubble that are overgrown with soft corals were probably destroyed earlier than the areas which consist of large percentages of pure (white) coral rubble. Coral rubble with a thick layer of algae may form an intermediate stage.

Categories of destructive fishing

1. Fish Bombing

'Modern' fish bombs are usually made from glass bottles filled with fertilizer (urea) which has been mixed with diesel or kerosene. Dynamite is sometimes added. Bombs with a burning fuse are thrown from the boat when 'shallow-water bombing' (0–10 m). When 'deep-water bombing' (more than 5–10 m), the bomb, which is connected to an electric ignition cable, is brought down to a good position by a diver when a fish aggregation is spotted. This bomb is then detonated from the boat by the use of batteries. In choosing an area for fish bombing the fishermen do not look for a particular type of habitat, although the water depth should preferably be less than 10 m for boats without compressors and less than 25 m even for boats with compressors (diving fishermen).

Fish bombers look for fish aggregations, using face masks, snorkelling around areas where fish are expected. When no fish aggregations are encountered they are sometimes 'created' by chumming a reef area with small fish or chopped-up larger bait A typical bombing operation takes around one week at sea and yields around 500 to 1000 kg of dried fish.

In general it can be said that all reefs, rocks, seamounts and bays are potential bombing areas (and have been in fact bombed in the case of KNP). Figure 3 shows confirmed bombing locations as recorded by National Park Authorities. Places which are less affected (and still have good coral) are usually small seamounts in the middle of the straits (very heavy current) where it is difficult for fish bombers to operate successfully. A potential bombing area should preferably not be too close to any village or ranger station, although several hard-core bombers have been known to operate in full sight of the park rangers (defending themselves with bombs if arrests are attempted).

Fish bombing in the KNP area is said to have already started on a very small scale before the second world war. During the war the Japanese soldiers introduced fish bombing on a much larger scale and local fishermen adopted the method, using different kinds of ammunition and grenades. Since that time it has apparently been very easy for fishermen to obtain or make explosives, and bombing has been practised throughout the area on a very large scale since the early 1950s.

No regulations or enforcement limited fish bombing until the early 1980s when the National Park was established. Virtually all fishing communities in and around KNP were involved in fish bombing between roughly 1950 and 1980. No detailed and/or documented material is available for this period. KNP data show an increase in the number of recorded fish bombings between 1988 and 1993 (Figure 1) but it is unclear whether this represents an actual increase in occurrence. Increased law-enforcement effectiveness (fast boats; sufficient funds for operations; cooperation of KNP, the police and the army; use of firearms) have resulted in a decreasing occurrence of fish bombing since 1993 and this occurrence has become very low since early 1996 when the Park Authorities implemented a weekly marine patrol which investigates all fishing activities in the park. A number of bombing crews were arrested in 1996, including one of the leading figures who unfortunately died when he tried to throw a bomb at the patrol boat.

At present (August 1996) it is said that fishing communities in and around KNP are no longer involved in fish bombing, Only a small group of 10 local persons from Bajo Pulau, Sape (a former hard-core bombing community) is said to be still involved in bombing. Outside bombers from Pulau Palue, Maumere and Ende still visit the area but the frequency has become very low. Many former dynamite fishermen say they have stopped bombing because enforcement has become too effective for them to take the risk. Accidents with fish bombings have also played a role, but there are no signs of much 'increased awareness' of the effects on the habitat and the resource itself.

The fish bombers are most active in the periods between the monsoons (April – May and October – November, see Figure 2), when there is little wind and their work is therefore easier (the north-west monsoon peaks in January – February, the south-east monsoon peaks in July – August).

2. Cyanide fishing for aquarium fish

Cyanide fishing for aquarium fish is said to have been widespread around 5–10 years ago, but is now rarely observed in the KNP area. Fishermen from Madura (East Java) were traditionally involved in this practice and are still visiting the area regularly in search of sea cucumber, anemones and other species. Lombok fishermen are also said to have been involved in the aquarium-fish trade. The aquarium-fish catchers usually operated in the area just north of the National Park where many coral reefs are found (now largely destroyed). Main locations were Pulau Kanawa (up to five years ago, now protected by the owner who used to be heavily involved in cyanide fisheries but now has a tourist operation on the island) and Pulau Seraya (still visited occasionally by aquarium-fish collectors).

The solutions which are used in this fishery vary but are usually around 1 tablet (ca. 13 grams) per litre of water. Cyanide tablets are dissolved in water in half-litre squirt bottles or battery-water bottles and the solution is squirted around individual fish or small aggregations.

Aquarium-fish collectors are said to work a specific area (reef) for about three days, after which they will move to a next location. A typical trip takes around two weeks and covers four locations. These fishermen are said not to return to a specific location for a second time, since the reefs where they worked would be empty of target species for long periods. However, different groups have been observed to work on the same location at intervals of several weeks to several months. An important reason not to return to any specific location is the fear of law enforcement, local fishermen often inform the authorities of outside intruders.

3. Cyanide fishing for live groupers and Napoleon wrasse

Informants from the KNP area (former cyanide fishermen and divers who used to work for the Hong Kong-based operation) were reportedly always supplied with ready-to-use solution of cyanide in water and they did not know the concentration. Informants from other areas (Bima, Ujung Pandang) confirmed the use of tablets dissolved in water (1 tablet of about 13 grams per litre of water), in the same concentration as was mentioned for aquarium fish.

This type of fishery has only been active for a few years and virtually disappeared after 1995 (leaving behind one of the Hong Kong built motherships which is still lying abandoned in the harbour of Labuan Hajo), reportedly since enforcement and public awareness became too much of a problem. Former employees of the Hong Kong-based operation say that catches were still good and declining yields were not the reason for stopping the operation. Handlining for groupers still continues, mainly in areas north of the park where numerous holding cages contain live groupers which are supposedly caught by hook and line.

Former employees/divers of the Hong Kong traders say that the main area of operation for the live reef food-fish traders was the southern part of Rinca Island and its bays. This is a rocky area where barramundi cod *(Cromileptis altivelis,* a valuable species) is still abundant (pers. obs.). The former divers say they worked mainly at depths of 10 to 20 m.

They reportedly moved continuously from one location to the next, never returning to locations which they had fished out. Other sources say that a lot of cyanide fishing for grouper and wrasse also took place around the coral reefs north of the National Park. This is also where most of the holding cages were (and are) situated and where there is still an active hook-and-line fishery for live grouper.

4. Cyanide fishing for lobster

Fishermen from Bajo Pulau, Sape, East Sumbawa, have started fishing intensively for lobster in Komodo National Park since around 1990. They reportedly use cyanide to stun the lobsters before taking them (undamaged) from holes. This fishery is mostly concentrated around the rocky southern shores of Komodo, Padar and Rinca. There are also coral reefs in these areas which are undoubtedly affected by this fishery. The lobster fishery is very profitable and it is therefore still growing. Around 40 boats, equipped with compressors, are presently active in this fishery. The number of active units is said to be still increasing.

The total amount of cyanide used by this type of fishery is probably much higher than the accumulated amounts of all other types of cyanide fisheries presently operating in the area. Law enforcers and park rangers are not yet checking lobster boats for the presence or use of cyanide, so they can work freely inside the park. The lobsters are transported to Bali where they are sold in the hotels and restaurants. The concentration of the cyanide solution used in this fishery is again reported to be 1 tablet (13 grams) per litre of water.

5. Cyanide fishing for consumption fish

Fishermen from the area between Komodo and Labuan Bajo are reported to have used cyanide also to catch fish for local consumption, although this method has apparently not been used in the area for a few years. Fishermen used fishbait (small fish or chopped-up larger fish) mixed in drums with cyanide solution and then spread out over reef flats and crests. The fish that ate the chum died or were stunned and were then collected. Local fishermen seem to have switched to other types of poison to be used with this same method (see Sections 6 and 7 below).

6. Fishing with natural poisons for consumption fish

A traditional fish poison which is used on the coral reefs of Komodo National Park is called **tuba**. It is a powder made from the seeds of trees. Tree species which were mentioned are *Croton argyratus, Croton tiglium* and *Anamirta cocculus,* but this has not yet been confirmed. The powder of the ground seeds is mixed with water which is then spread out mainly over sea-grass beds to catch rabbitfish (Siganidae). The fish are reportedly only stunned by the poison and do not die of it. Stunned fish are collected for local consumption and dried for sale on local markets. Reefs around northern Rinca and Papagaran were mentioned as main target areas. This method is reportedly widespread and about 60 per cent of all fishermen in the area use **tuba** every now and then. Since this natural poison is difficult to obtain and not very effective (not 'strong' enough), fishermen are starting to introduce chemicals like herbicides and pesticides that they still call **tuba**. This can be confusing in interviews.

7. Fishing with herbicides and pesticides

Whereas fishing with natural poisons has long been used in the KNP area, mostly over sea-grass beds in search of rabbitflsh, agricultural poisons have been introduced recently to fish for small groupers, emperors and snappers over the coral reefs. Fishermen from the area between Komodo and Labuan Bajo are reported to use several types of poisons for this purpose.

Two readily available cheap, and therefore popular, poisons are 'Teodal' (a herbicide/fungicide) and 'Endrin' (a pesticide) which are used to catch a variety of small reef fish for consumption. Both poisons are mixed with drums full of sand which is then dumped over the reef flats and crests. Everything dies. Fishermen say that the sand–poison mixture remains active for three days, so they can keep on collecting fish which pass over the reefs which they have poisoned. Fishermen also report that they do not encounter any fishes over a poisoned reef for at least one week after the operation. They do not fish these reefs for a long period after they have poisoned them.

Teodal is reportedly only used in the sand–poison-mixture-method but Endrin is also used as a replacement for cyanide in the mentioned earlier method (see Section 5), in which the poison is mixed with bait to kill fish eating the chum. Teodal is sold in 0.25 l cans which cost only Rp 12.000 each. Endrin is sold per litre from large drums. A single can of Teodal or 0.25 litre of Endrin is mixed with a large bucket of sand (about 30–40 kg) and this mixture is enough to poison an area of 50 x 50 m of reef. Poisoning the reefs is therefore as cheap as Rp 48,000 or US$ 20 per hectare.

The fish caught with poison are dried and sold at low prices on local markets. This method of using herbicides and pesticides is said to have been introduced in 1993 and is rapidly expanding since it is a 'cheap, easy and effective' method. It also seems to be extremely lethal to the coral reefs and deserves immediate attention from park authorities.

The potential group of users—those who are used to fishing with **tuba**—is very large (60 per cent of all local fishermen). Fishermen from Papagaran (KNP buffer zone, reefs in very bad condition) have been mentioned as users of Teodal and Endrin. Outsiders from Longos at the north coast of Flores are also reported to enter the area and fish with these poisons. It is unclear what percentage of **tuba** fishermen are presently already using Teodal and/or Endrin. It is also unclear whether this method is used in other parts of Indonesia.

Some fishermen say they are opposed to this method, and there have been cases where local fishermen were caught by their fellow community members and fined as much as Rp 100,000 by 40 village leaders. Other reports say, however, that these fishermen were caught only because they poisoned the reefs and collected the fish before their colleagues could get a piece of the pie.

Apparently poisoning operations are collectively planned by larger groups and fixed locations and dates for the operation are decided upon. If one fishermen decides to go out and work over the particular reef before the rest of the group does, he will get a good catch, whereas the people following him will be left empty handed. Such 'private enterprise' is not appreciated by the rest of the community.

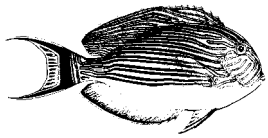
8. Fishing for abalone by breaking corals ('meting')

The fishery for abalone (**mata tuju**) has recently (1995–1996) destroyed more coral reefs in the area than any other destructive fishing method. While dynamite and cyanide fishing are becoming less important (on the coral reefs), many fishermen are digging through the reefs, using compressors and steel bar tools (the method is called **meting**), in search of abalone and other invertebrates.

The fishermen break and turn over all the corals (which are also trampled by them in the process) and leave behind them fields of near 100 per cent dead coral rubble. Some of the worst affected reefs are found around the northern islands between Komodo and Labuan Bajo, but also in bays further to the south.

Collecting invertebrates from the reef flat is a traditional activity which was usually focused on sea cucumber and carried out during very low tides. The high price for abalone (Rp 15,000 per kg) and the availability of dive gear (hookah compressors) since 1995 have resulted in a marked increase in this activity. The application of steel tools to break is causing major damage. The most important groups involved in this practice are fishermen from Komodo (inside KNP) and Pulau Misa (just north of KNP).

The fishermen from Komodo do not have compressors. Since early 1995, around 5 boats go out each low tide from Komodo, bringing around 75 people to search for abalone. From Pulau Misa, around 25 boats with compressors have worked the reefs during 1995 and 1996. These fishermen reported that there is now hardly any more abalone to be found in the area and they have now switched to the collection of whip corals (**tali arus**), sold around Rp 3,000 to Rp 4,000 per kg, for which there is apparently a market in Ujung Pandang, South Sulawesi. The whip corals are mostly collected from reef slopes and drop offs in areas of strong currents.



The live-fish fishery of California

by M. J. Tegner[1] *& P. K. Dayton*

Relatively new to California, live-fish fishing started in 1988, mainly to supply local Asian communities. What began as small trapping and hook-and-line operations has now become a complex, multimillion dollar fishery using diverse gear types, targeting many species, and delivering fish in a variety of ways.

The 1995 landings for live fish were estimated at 449 metric tonnes (t), 10 per cent more than in 1994. Fifty-four different species were landed live, with an ex-vessel value of more than US$ 3 million. Landings are likely to be underestimates for various reasons, including fish buyers failing to code landings as live, or not bothering to report landings at all.

In 1995, hook-and-line gear was used to capture 63 per cent of the reported landings statewide; trap gear landed 23 per cent. The live-fish fishery has grown as an alternate use of lobster traps in the off season, with the prohibition of commercial gill nets within three miles of shore in 1994, and with the identification and rapid expansion of overseas markets.

Target species include California sheephead (*Semicossyphus pulcher*), California halibut (*Paralichthys californianus*), cabezon (*Scorpaenichthys marmoratus*), lingcod (*Ophiodon elongatus*), scorpionfish (*Scorpaena guttata*), and several species of rockfish (*Sebastes* spp.). Statewide the landings jumped in 1989 to 1995 from 16,203 t to 194,942 t for sheephead, 1,473 t to 115,879 t for California halibut, and 163 t to 179,785 t for cabezon. Live-fish landings were mostly made in Southern California; 377 t were landed from Morro Bay South and only 72 t in Northern California in 1995.

In addition to the issue of unsustainable levels of harvest, kelp-forest ecologists are concerned about the effects of the live-fish fishery on community structure. We have evidence that many of these fishes were once important predators on benthic prey: cabezon on abalones, scorpion fish on octopuses, and sheephead on sea urchins.

Some insight into the effects of the live-fish fishery on sheephead populations is offered by California Department of Fish and Game (CDFG) logbook data from commercial-passenger sport-fishing vessels (anglers). From 1981 to 1986, an average of 1809 sheephead per year was taken from the Point Loma kelp forest near San Diego; by 1994–95, the average number had dropped to 145. While there are many animals which graze on kelps, by far the most important in terms of the frequency and severity of destructive overgrazing are sea urchins. The changes to sheephead populations suggest that outbreaks of destructive grazing by the minimally-exploited purple sea urchin, *Strongylocentrotus purpuratus*, will become more frequent.

The live-fish fishery is taking essentially all fishes that respond to bait in a trap (with one legislated exception), and many of these are now rarely seen. Neither densities nor ecological relationships are known for any of a host of fishes that have functionally if not virtually disappeared from the habitat.

This fishery focuses on animals sized for a single entree (about 1 kg), visually attractive, and hardy enough to survive the rigours of capture and transportation. Small animals bring from US$ 4 to US$ 14/kg ex-vessel prices; larger fishes were also sold live, but at considerably reduced prices (with the exception of California halibut).

Sheephead are especially problematic; these fishes are sequential hermaphrodites and the fishery takes only small females which may be pre-reproductive. Rock fishes are not hermaphrodites, but the small size of harvested animals also suggests little chance for reproduction.

These fisheries are minimally regulated, require inexpensive gear and low effort, and have the potential for virtual elimination of the community roles of these species. In 1995, legislation created a limited-entry programme (there are 273 trap permits), which included numbers of traps, trap construction requirements, and incidental catch restrictions.

There are no size limits or quotas. In addition to the small sizes on which this fishery is focusing, management concerns include the illegal use of juvenile lobsters as bait for sheephead and chronic underreporting.

California Department of Fish and Game (CDFG) biologists report that fishermen often refuse to allow their catches to be measured, and through the use of mobile phones, will move among the different landings of a harbour to avoid samplers (K. McKee-Lewis, CDFG, personal communication). There is a strong need for stock data independent of the fishery, but funds are not available.

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The Nature Conservancy marine conservation programme in the Asia-Pacific Region

by Heidi Kirkpatrick[1] *& Chuck Cook*[1]

Despite heightened awareness and concern surrounding the live reef-fish trade, demand for live fish—and the destructive methods used to capture them—continues to present a daunting challenge.

Prompted by cyanide fishing incidents at two of its flagship conservation sites—Helen Reef in Palau and Komodo National Park in Indonesia—The Nature Conservancy (TNC) realised that unless cyanide fishing was addressed on a regional basis, the trade could easily continue its aggressive geographical expansion into other TNC sites, protected areas and coral reefs throughout the region.

Working with key NGO and government partners, the Conservancy has developed a two-tiered action strategy to address cyanide use and other destructive fishing practices on both regional and site-specific levels.

Regional action plan

TNC's regional efforts will be directed toward 1) promoting sustainable fisheries, 2) developing a preventive plan for Papua New Guinea, and 3) advocating policy reform.

Sustainable fisheries

TNC is working with aquaculture experts, Dr Nepheronia Ogburn and Mr Damian Ogburn, to develop environmentally friendly grouper mariculture operations. This industry will provide alternative livelihoods for destructive fishermen as well as relieve pressure on wild stocks. With a goal of eventually gaining market share over wild-caught grouper, TNC plans to establish a grouper mariculture hatchery and demonstration centre in Indonesia that can be replicated across the archipelago.

The Conservancy is also conducting consumer-preference live reef-fish taste tests in Hong Kong, Taipei and Shanghai. Comparisons of wild-caught to maricultured fish will help guide development of farmed fish that meet consumers' standards for taste, texture and appearance.

In addition to mariculture development, TNC is working with destructive fishers to divert them to sustainable pelagic fisheries and eco-tourism. These efforts are being pursued at Komodo National Park, but will serve as models for other threatened areas in the Asia-Pacific Region.

Papua New Guinea preventive plan

Dr Robert Johannes and Michael Riepen report that Papua New Guinea (PNG) is being looked to as the 'new frontier' for live reef fisheries. In response, TNC has initiated a prevention effort in PNG before the cyanide fishing industry can consolidate its foothold. The Conservancy is working with the PNG Government and local NGOs to draft and enact fisheries regulations to restrict use of poisons and compressed air and establish strict licensing requirements.

TNC will also join forces with PNG's Department of Environment and Conservation and marine-oriented NGOs, such as Conservation Melanesia, the Village Development Trust, the PNG Dive Association, the Motupore Island Research Department (University of PNG) and the Christianson Research Institute. This team will design and implement a major conservation education campaign to combat destructive fishing practices.

Policy reform

TNC will continue to pursue reform at the national level in Indonesia, the Philippines, PNG, United States, Hong Kong, and China, and at the regional level through the Asia Pacific Economic Cooperation (APEC). TNC is working to maintain a dialogue with

[1] The Nature Conservancy, San Francisco

APEC to seek regional solutions, including a regional ban on cyanide fishing. The APEC Fisheries Group is holding two workshops in 1997 to discuss destructive reef fishing. A workshop early in the year will focus on causes and potential solutions. Another workshop covering impacts will be held in October 1997.

Other initiatives

Local marine tenure in Indonesia

Indonesia's national government is responsible for establishment and enforcement of marine laws. However, effective government-based protection against destructive fishing practices by both foreign fisheries and local villagers is not practical in Indonesia's vast waters. Nor does this system address the varying circumstances of individual communities.

TNC advocates the reinstatement of traditional marine tenure where it existed and devising co-management systems for marine resource management in other areas. Through the World Bank's Coral Reef Rehabilitation and Management Project (COREMAP), the Conservancy is encouraging the Indonesian Government to transfer more control to local communities so that villagers can manage their own resources and participate in law enforcement. Where fishing communities possess secure, exclusive rights to fish in an area, they will be more likely to harvest on a sustainable basis, given the subsequent future benefits. These communities are also best positioned geographically to patrol against outside infringements.

Documentation

To raise awareness and encourage policy reform in the International Year of the Coral Reef in 1997, TNC hopes to document on film actual cases of sodium cyanide fishing and its effects on coral reefs. Target audiences will include government officials, live reef-fish buyers (aquarium and food), threatened communities, and the general public.

Certification

The Conservancy will collaborate with other organisations in the establishment of two separate certification programmes for the food and aquarium-fish trades. Both initiatives are being designed to encourage sustainable fishing practices. The World Wide Fund for Nature (WWF), Environmental Solutions International, TNC, National Aquarium, PETSMART, and others are supporting The Marine Aquarium Fish Council, an independent organisation that will set standards and oversee environmental certification and education in the aquarium industry. The Marine Stewardship Council, formed by WWF and Unilever, will establish market incentives via a certification system.

Site-based protection action plan

TNC will continue to work closely with local and national partners to protect four of the region's most diverse and threatened sites from destructive fishing practices. These sites will serve as 'learning beds' to develop innovative approaches for effective marine resource management. Emphasis is on alternative livelihood development, education, and building the capacity of local partners to ensure long-term self-sufficiency.

Komodo National Park, Indonesia

Led by Dr Jos Pet, TNC's Komodo field office is dedicated to strengthening the marine resource management capacity of the Park Authority (under the Directorate of Forest Protection and Nature Conservation, PHPA), and to engaging local communities in planning for tourism and fisheries development. In the next two years, the Conservancy and the Park Authority will initiate the following activities:

- establish a zoning system to allow for a variety of marine activities (e.g., traditional subsistence fishing, research, tourism, mariculture and pelagic fisheries);
- launch participatory planning and co-management activities through workshops with PHPA and local communities; conduct community surveys; and, establish a local NGO;
- strengthen enforcement of Park regulations by coordinating the efforts of the Park Authority, police, the Army, fisheries services, and local communities; and
- conduct marine monitoring and research to provide information for updating the management plan and marine reserve system, including the rehabilitation of coral reefs.

In addition, TNC staff will work closely with the three enclaves inside the Park and adjacent communities to build support for the conservation objectives of the Park. This will best be accomplished by providing economic alternatives that 1) reduce exploitation of demersal and sedentary resources, 2) diversify fishing methods and target species via the development of pelagic fisheries and mariculture, and 3) enhance ecotourism opportunities, such as marine safaris (e.g., bird, dolphin, whale and turtle watching), and an ecolodge and dive centre.

Finally, the Conservancy and our partners are seeking funding for a three-year investigation of the short- and long-term effects of fishing with sodium cyanide and explosives on coral reef communities at Komodo National Park. If funding is secured, the project will include scientists from the Australian Institute of Marine Science (AIMS), DuPont and the University of Guam.

Palau, Micronesia

The Nature Conservancy is working with local NGO partner, Palau Conservation Society (PCS), to pro-

mote sustainable fisheries, including sports-fishing enterprises, in two states known for their exceptional beauty and robust fish stocks, Ngerchelong and Kayangel. Developing a catch-and-release sports fishing industry will help protect local fish stocks and will provide re-training for Palauan fishermen as sports fishing guides.

The two organisations are also participating in the establishment of the US$12 million Coral Reef Research Center and Aquarium. The Center will offer conservation education and provide a venue for international and regional scientists to conduct applied marine research (including mariculture studies) that enhances coastal and marine conservation in the region. It will also have programmes to train Asians and Pacific Islanders in research and monitoring techniques.

Kimbe Bay, PNG

In Kimbe Bay, TNC is working in partnership with the West New Britain Tourist Bureau, the European Union and Walindi Plantation Resort (a local dive resort) to establish a small-scale conservation and research centre to be operated by a new NGO, Machonia Na Dari (Guardians of the Sea). The Centre will encourage local and international scientific research on the unique and highly diverse coral reef ecosystems of the bay.

Arnavon Islands, Solomon Islands

In the Arnavon Islands, the Conservancy and partners have worked closely on a sustainable development strategy to support three local communities and their commitment to conservation. With TNC guidance, the communities, local and national governments, and regional partners came together to establish the Arnavon Marine Conservation Area, the first community-managed conservation area in the Solomon Islands.

To allow the area's reefs to recover, the conservation areas are now closed to harvesting for three years. In order to meet the communities' economic needs, the Management Committee will pursue development of a fisheries enterprise that will:

- target the under-exploited deep-slope finfish in the area;
- provide training and equipment to fishing groups in the three communities;
- establish fisheries centres to purchase their catch, provide cold storage and supply fishing equipment; and
- coordinate the transportation and sale of the fish to overseas and local markets.

Forging ahead with partners

The extensive analysis of the live reef-fish trade by Dr Robert Johannes and Michael Riepen coupled with the hard work of NGOs such as IMA-Philippines, has helped bring together an impressive consortium of partners. The Nature Conservancy looks forward to continued work with these important allies in the effort to protect the world's richest and most diverse coral reef habitats.

World Wildlife Fund for Nature cyanide project

by Jo Ruxton [1]

The report on the live reef fish trade by Johannes and Riepen, released in November 1995, focused attention on Hong Kong's involvement in cyanide fishing; it is the world's largest importer of live reef fish for human consumption. Many of the target species destined for Hong Kong have been caught using cyanide. The WWF family is addressing the growing threat of this practice in the Asia-Pacific region.

WWF Philippines has been working with the International Marinelife Alliance – Philippines, WWF Indonesia, WWF Malaysia and WWF Hong Kong, along with WWF International's Endangered Seas Campaign, using their experience to address the problem in each of their countries. The Nature Conservancy is also working in this field, and it is envisaged that each organisation will cover specific aspects so that each effort complements the other.

Early in 1997, WWF Hong Kong will recruit a full-time staff member to work exclusively on the cyanide issue for a six-month period and half-time for the following eighteen months.

The overall goal of the project is to conserve coral reefs and their associated fauna in the Indo-Pacific region through the promotion of sustainable non-damaging fishing practices, and, in particular, to stop the use of cyanide to capture target species for the live-fish food trade. Since Hong Kong is seen as driving the cyanide fishing industry, WWF Hong Kong will concentrate their efforts on the traders.

[1] Formerly of World Wildlife Foundation, Hong Kong

The first task is to open discussion with the main importers of live reef fish in Hong Kong and make them aware of the implications of using cyanide, including the threat to the future of their own businesses. The International Marinelife Alliance – Philippines has already initiated talks with one of the largest importers and WWF will continue this dialogue and introduce more traders to the concept of sustainable fishing. The aim will be to steer traders towards a sustainable source of live fish, that is, traditional catching methods. (These are already identified in the Philippines and the intention is to encourage them in Indonesia and other source countries).

WWF Hong Kong plans to conduct a market survey amongst the public to establish a baseline of public attitudes towards eating fish sold live, the effect of cyanide on distant coral reefs, and the long-term prospects if this method of fishing is allowed to continue. If the results show that a significant percentage of the population is unaware of the consequences of cyanide fishing for the live food-fish market, a programme will be planned to change public attitudes by raising public awareness and increasing general concern for the future of coral reefs.

An informed public will promote demand for 'reef-friendly fish' produced from sustainable, well-managed sources, and methods will be developed to provide information to consumers to allow them to choose where they buy fish or which restaurants they frequent. Through WWF's Endangered Seas Campaign, the organisation will work to establish a restaurant 'labelling' method to enable the public to make informed choices of seafood from sustainable sources.

WWF will also consider the possibility of CITES listings for species threatened by the live food-fish trade. This is, however, a very long-term solution since there is little biological data available for many of the target species, such as Napoleon wrasse. Currently, in addition, no country where these species are found and which is signatory to CITES has called for a national ban on the export of such species. These issues need to be resolved before any listing can occur.

WWF also supports village-based initiatives to put their live reef fisheries on a sustainable basis. For example, it is helping support a programme run by an NGO, Fund for Nature of the Philippines (KKP) in the Turtle Islands, Philippines. The programme involves groups of 15 people, representing a cross section of each community, including conservation wardens, teachers, youth leaders, police officers, local government officials, etc. These are being asked to identify their communities' problems. Prominent among these, as has already been established, is destructive fishing methods, including the use of cyanide.

Action plans are being developed that include education for environmental sustainability in the schools and communities. A reef-monitoring programme has been established in one area. Socio-economic studies are also being carried out with the objective of identifying approaches, from the communities' perspectives, for setting up viable community enterprises based on the ornamental and live food-fish trade. Outside assistance is being obtained from local exporters and coral reef scientists, as well as a fisheries certification expert who will help establish a certification system for the export of ornamental reef fishes.

Asian gourmets taste fish to help save coral reefs

by Carol Fox [1]

Reef fish such as grouper and wrasse are highly prized by Asian gourmets, but the practice of using cyanide poison to stun and capture them is degrading coral reefs in Indonesia and throughout the South-East Asian region. The Nature Conservancy, concerned over the growing destruction of the world's biologically richest marine ecosystems, is working to create a joint venture with Indonesia to save reefs and ensure the trade in these fish is practiced in a sustainable manner.

Traditional fishing methods once allowed for a sustainable supply of wild reef fish, but current methods threaten the availability and affordability of these creatures, as well as many other varieties of seafood. High prices and decreasing fish supplies have driven fishermen to use large quantities of sodium cyanide, a deadly poison, to stun these large fish so they can be captured and transported live to market. Unfortunately, the cyanide is creating a mosaic of dead and dying reefs in the targeted areas, eliminating them as a source of food and income for locals, as well as for other fishermen who follow.

Destructive fishing has already resulted in the decimation of the majority of the reefs in the Philippines, and of large areas of Indonesia's rich underwater environment. Hong Kong fishing companies note that the continuation of these unsustainable practices is driving fishing fleets farther afield, for example to the Maldives

[1] The Nature Conservancy, Hawaii

and Papua New Guinea. As fish stocks decline, prices of seafood will continue to rise, and favoured species may become unavailable within three to five years.

The Nature Conservancy is working with government and private investors in Asia to develop a sustainable alternative for cyanide-caught wild fish by developing a dependable source of reasonably priced, high-quality fish raised in community-based aquafarms in Indonesia, and possibly in other countries in the region. The farms could use a combination of abandoned shrimp ponds and/or sea-pen culture, depending on local conditions and experience with successful results.

The first step toward establishing such an industry, however, was to determine the present differences in taste, texture and appeal between wild-caught fish and their aquacultured counterparts. To that end, in November 1996 The Nature Conservancy brought together approximately 100 leading gourmets for a series of three fish-taste comparison tests, at three separate dinners in Shanghai, Hong Kong and Taipei.

By comparing farm-raised malabar grouper with wild-caught specimens, the participants helped the Conservancy obtain a clearer idea of the relative strengths and weaknesses of aquacultured fish as a competing product. The taste tests were conducted by the market survey firm OmniTrak Group, and compared wild-caught Malabar grouper (*Epinephelus malabaricus)* against farm-raised grouper from two different hatcheries and finally against coral trout (*Plectropomus leopardus)* .

The tests yielded some very promising results. While participants in all three cities, and particularly Hong Kong (where most of these live reef fish are consumed) asserted prior to the tastings that they could tell the difference between wild and farmed fish, and would prefer wild-caught, in fact the majority in all three locations preferred farmed fish from Taiwan's Chou Lien Fong farm. Follow-up investigations will pinpoint the differences in the rearing of this farm's fish that may be responsible for its superior marks.

In all three cities, however, coral trout ranked higher than any of the three varieties of Malabar grouper. Because techniques for raising coral trout and other desirable species such as the humphead wrasse have not yet been perfected, the Conservancy is encouraging Taiwan aquaculture specialists to perfect the spawning and grow-out of these higher-value species as an even more attractive market option.

These first taste test results clearly demonstrated that a market exists for aquaculture fish, particularly for those raised in good water and general environmental conditions, on specially formulated feed, on well-managed farms. The successful development of a market for these fish, however, will depend on upon properly marketing them as an alternative to wild-caught: better in taste, better in diet, and better for the environment.

The Conservancy is talking to both Taiwan and Indonesian investors, and is very optimistic about developing grow-out locations for these fish. Reef-fish farming, combined with more effective cyanide testing, industry monitoring of the trade and improved enforcement, should help shift demand pressure for these fish off the reefs. It will also provide local employment. All aspects of the project are being reviewed for environmental sustainability, including sourcing of the fingerlings, waste run-off, and genetic mixing.

Aquarium fish market boom bodes well in Isles

by Edwin Tauji

Dennis and Luana Mitchell are just small aquafarmers who still support a hobby-turned-business with real jobs. But their tanks of ornamental angelfish are part of an aquarium-fish industry that is measured in billions of dollars world-wide.

State aquafarmers stand to earn a bigger share of that market because of the explosive growth of the hobby and because of a Florida winter freeze that devastated the aquarium-fish industry there. Commercial sales of ornamental tropical fish are booming by 10 to 15 per cent a year in the United States, which has the biggest market in the world, according to studies of the industries. 'It's a slow-growing process. You have to sell a lot of little fish at 50 cents a piece to make it pay off,' said Dennis Mitchell, who raises angelfish in his Upper Waiehu garage. But 1995 Mitchell shipped out 25,000 little fish from Maui. Some prime angelfish specimens can fetch US$ 5 to US$ 10 each. The growth in sales is helping Dennis and Luana pay off the US$ 35,000 investment that got them started three years ago in a converted garage full of fish tanks. What a really has Dennis and Luana smiling is the feeling that it's going to get better.

For Hawaii breeders, sales this winter boomed because a freeze in Florida—where ornamental tropical fish is a US$ 60 million-a-year (1994 value) industry—killed thousands of fish. US wholesalers normally expect to import fish during the winter anyway, but the Florida fish freeze fuelled demand from Hawaii. 'In the last six months, the price doubled,' Mitchell said. 'In New York, angelfish were selling for US$ 1.75 (wholesale) and I was selling for 45 cents.

One breeder called me and said, 'Don't do that, you're driving the price down.' Whatever the price, Mitchell said he sold out his available stock. 'If I had more, I could have sold more,' he said as he and Luana inspected rows of empty tanks.

Big Island fish-farmer Bob Kern agreed. 'The potential is there. If we had more fish, we would sell them,' Kern said. The Pahoa special-education teacher said he raised tropical fish as a teen-ager. 'Selling tropical fish paid for his college degree,' he said. After he moved to Hawaii from Alaska, he said he got back into the business with help from the University of Hawaii Sea Grant extension service programme. In just two years, he got production up enough to sell about 1,000 fish last year. 'I teach because it's something I like doing. Ornamentals are going to send the kids to college and I need that because there's five of them,' he said.

The ornamental freshwater-fish business is just getting into the water in Hawaii, Sea Grant extension agent Brian Cole said. Gross sales of freshwater ornamental fish from Hawaii totalled US$ 1.2 million in 1989. They've grown since then, although sales data are not available. Cole was recruited by the Sea Grant Program from Florida, where he had been manager of a tropical fish farm. He has a master's degree in aquaculture from Auburn University. 'Sales of ornamental fish in the United States have been growing 10 to 15 percent a year for the past eight years,' he said. Spending on fish and aquarium supplies is topping US$ 1 billion a year, which makes the industry the second largest 'hobby' in the United States after photography, he said.

'I think it's a combination of factors,' he said. 'As a country, we're becoming more urbanised and instead of a dog or a cat for a pet, we think of fish. In some places, dogs or cats may not be allowed, but an aquarium is no problem,' he said. Another factor is that a tank full of colourful fish is seen as an element in interior decorating. 'In the last couple of years, it seems that having a fish tank is supposed to be something special,' he said.

Sea Grant extension agent, Richard Bailey said Hawaii has advantages in being part of the United States, having a better climate than Florida and being closer to the Mainland than the biggest fish-farming countries of South-East Asia. A five-year study showed 75 per cent of fish imported to the United States are coming from Asia—Singapore, Thailand, the Philippines, Hong Kong and Indonesia. But Bailey said Hawaii-raised fish get to Mainland markets faster, don't go through US customs and don't need to be transshipped through a major city. 'Time in shipping and extra handling increases stress mortality and costs,' he said.

The potential of the aquarium market got the attention of Richard Spencer, whose Hawaiian Marine Enterprises is successfully growing **ogo** and **manavea** (edible seaweed) in Kahuku. Spencer has an advantage. He's chairman of the advisory committee for the US Department of Agriculture Center for Tropical and Subtropical Aquaculture, which funded studies on the ornamental fish industry. He said he did test production and marketing of tropical fish based on predictions of the studies. 'The numbers held up,' he said. Since last April, Hawaiian Marine Enterprises has been putting in production facilities to breed ornamental tropical fish on a commercial scale.

For backyard fish farmers, there still is a place in the market. There are 1,539 different species that are sold for home aquariums and plenty of room for growth. 'Production itself hasn't been keeping up,' Bailey said. 'Stocks of fish netted in the wild are dwindling, creating even more potential for growth in captive breeding,' he said. It is also an industry more suited to small individual breeders than to corporate farming. A small farmer can recover more quickly from a disease that kills off all breeding stock. Small producers like the Mitchells and Kern also can take their time developing production and markets, while holding other jobs. Dennis is a cook, Luana a sales clerk, Kern a teacher and tax-preparation specialist.

'Anybody who wants to go into fish farming should go into it because they want to raise fish,' Dennis said. 'Not because they want to make money'. Luana wasn't so sure at first. The only fish she'd raised before she met Dennis 'were the ones you got at the Country Fair and they died a week after you got them home,' she said. 'But now, I like this a lot better than what I was doing'.

Source: *The Honolulu Advertiser*, 31 March 1996.

New rules open way for lucrative aquaculture

by Bruce Dunford, Associated Press writer

Honolulu, Hawaii has an abundant mineral resource that, on a per pound basis, can be made to be worth more than pure silver. New rules approved this week by Governor Ben Cayetano open the way to get that resource to market. It's called live rock and can sell for as much as US$ 100 a pound in the growing international market of saltwater aquariums, according to Michael Wilson, chairman of the Department of Land and Natural Resources (DLNR).

In the effort to preserve the delicate ecology of the coral reef, Hawaii has for several years banned the

taking of coral from off-shore waters. But the new rules open the way for licensed aquaculturists to dig up ancient coral pieces on the land and put them into an ocean environment such as a shoreside fishpond to attract a colony of sea life.

After a few months, when colourful anemones and other small sea creatures and plants indigenous to Hawaii's tropical water set up housekeeping on the old coral piece, it becomes a valuable commodity in the international aquarium market, Wilson said. He points to an aquarium tank in his Kalanimoku Building office containing a large creature-covered coral piece he estimates would be worth US$ 1,000.

Other rule changes approved by the governor allow the year-round, unlimited commercial sale of fish such as the highly-priced **moi** (or threadfin, *Polydactylus sexfilis*) and the more common mullet if they are raised in aquaculture ponds. **Moi**, a silver fish that feeds on ocean-bottom crustaceans, once was reserved exclusively for Hawaii's **alii** (chiefs). In modern times it has been tightly regulated with a bag limit and season on commercial sales because of the dwindling offshore populations.

However, **moi** has proved to thrive in Hawaii's aquaculture ponds and the changes of the rules allow its sale as long as the retailer can provide documentation it was obtained from a licensed aquaculture facility, said John Corbin, manager of the State's Aquaculture Development Program. Commercially raised **moi** also has great potential as an export to international markets for fine cuisine restaurants because of its superior taste and quality, Corbin said. He noted that in a taste test, **moi** was the star attraction at a recent food show in Chicago.

Not only will the raised **moi** find a good market, the aquaculture farms will be raising the fish for restocking offshore waters, similar to the mullet restocking efforts now underway in the Hilo area, Corbin said. 'These rules will go far to accomplish one of DLNR's goals to sustain Hawaii's unique natural resources by taking fishing pressure off ocean fishing', Cayetano said in signing them. He said it also will help expand Hawaii's aquaculture industry and provide more jobs.

Because **moi** has been banned for sale for many years, one of the tasks for the sellers will be to get local shoppers familiar with the quality and taste of the fish, Corbin said. Guy Tamashiro, seafood manager of Tamashiro Market, agreed that many shoppers are unfamiliar with **moi** because it is seldom available and is 'one of our more pricier fish' when it is available.

'*Tomiei-Maru* no. 17', a Japanese-built live-fish carrier

by Ikuhya Ohtagaki

A growing demand for live seafood in Japanese restaurants and the need to transport fry from overseas for farming in Japan have led to the construction of a number of purpose-built live-fish carriers in Japanese yards in recent time.*Tomiei-Maru* no. 17 is 58.2 m long. She is the sixth such vessel to join the fleet of Tomiei-Suisan. Like her five predecessors, she was built by Ishii Shipbuilding which is situated in Chiba Prefecture. The yard has thus gained a considerable amount of expertise in the construction of such vessels. Its basic philosophy in the construction of *Tomiei-Maru* no. 17 was to 'carry live fish in good health and without giving stress'.

In order to achieve this aim the 10 fish holds, totalling 645 m^3 in volume, have 'fresh' seawater circulating through them. The method by which this is achieved is perhaps the most notable feature of the vessel. The seawater enters a hold automatically through holes in the bottom of the hull when the ship is under way and flows up through the hold and then out through holes in the vessel's side. The time required to completely fill the holds after removal of a plug was said to be about one minute during trials.

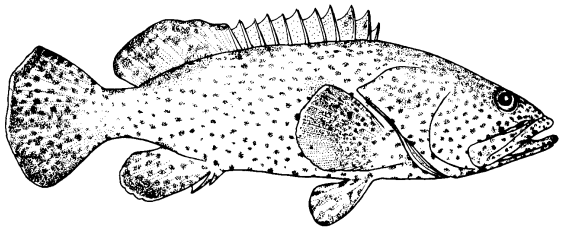
In order to load fish into or out of a cage, *Tomiei-Maru* no. 17 is first brought alongside the cage. In order to make this as efficient as possible, the designers of the vessel have equipped her with a flap rudder and bow thruster to enhance manoeuvrability. Fish are transferred from a cage to the vessel by positioning the cage next to one of the four gates fitted in the vessel's side. The cage is then tightened, forcing the fish to swim in to the flooded hold.

When the fish are to be transferred into a cage, the water level in the holds is first lowered by pumping out the water. Ten pumps from Daiei are used for this purpose. The top of the hold is then covered with a hatch, darkening the hold. The fish are then naturally inclined to swim toward the light at the gate leading to the cage. Any fish that do not find their own way out are forced out using a drive-net installed in the hold.

Tomiei-Maru no. 17 hull has been designed to minimise wave-making resistance and incorporates a bulbous bow. A highly skewed propeller is fitted to reduce hull vibration.

Source: *Fishing Boat World*, Vol. 8, no. 4, July 1996

LIVE REEF FISH ABSTRACTS, PUBLICATIONS & REVIEWS



Review of report on the international trade in seahorses

by Yvonne Sadovy [1]

'The international trade in seahorses' is the title of a recently released (1996) report from the TRAFFIC network and one of their 'Species in Danger' series. This report is the first to document the heretofore little known, but important and rapidly-growing, global trade in seahorses for use as curios (e.g. jewellery, keyrings), in the marine aquarium trade (MAT) and, particularly, for traditional Chinese medicine (TCM). Concern is expressed over the burgeoning size of the trade and growing demand for seahorses, and their possible impact on seahorse populations. Indications are that this valuable fishery is currently unsustainable.

Although the largest trade in seahorses is for TCM, a substantial trade also exists for live seahorses to be sold to marine aquarists. Species used in aquaria represent just 4–5 out of the 35 currently recognised seahorses (*Hippocampus* spp.). Virtually all aquarium seahorses are wild-caught, and survival in aquaria is characteristically very low.

High mortalities are caused by damage during collection and transport, poor aquarium management at all levels of the trade, disease, poor diets and incompatible aquarium inhabitants. Indeed, even public aquaria concede that these are among the most difficult fishes to maintain and rear in captivity. In short, they are not really suited to the MAT or maintenance in captivity by non-experts.

Seahorses are collected by hand or nets in directed fisheries in which many of the fishers are largely dependent on seahorses for income; hand- and net-caught animals are those most suited for the MAT. Large numbers of specimens are also taken incidentally as a bycatch of trawling. Current rates of seahorse extraction appear to be having a serious impact on populations. Fishers report dwindling catches and there are strong indications that demand exceeds supply. Sample populations from 5 countries may have declined by as much as 50 per cent over past the 5 years and seahorse sizes are also reportedly declining.

While the major demand seems to come from TCM, the MAT is also having an impact on populations; although many fisheries are individually small, cumulatively they are substantial. Many aquarium fishes go to North America and Europe, but some are also included in the MAT in Japan and Taiwan. Major exporters of live seahorses are the Philippines, Indonesia and Sri Lanka.

Seahorse biology makes them particularly vulnerable to over-exploitation. They are unusual animals because it is the males that incubate eggs and release the developed young; loss of pregnant males, therefore, also condemns the young they carry. Parental care and small brood size may limit reproductive output and strict monogamy means that re-pairing is likely to be slow if mates are removed. Their low mobility and small home ranges mean that recolonisation rates are likely to be low. The general vulnerability of seagrass beds, an important habitat for many species, exacerbate these problems.

To better understand and sustain this valuable trade, a number of recommendations are made and two projects have been initiated. Recommendations include the urgent need for biological research, especially on the most heavily exploited species and improved monitoring of international trade; in the case of MAT, the industry should be able to track volumes and sources of live seahorse imports, be able to examine ways of reducing demand and improve shipping practices. Other recommendations address fisheries management initiatives and communication with

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TCM and marine aquarium hobbyists regarding conservation concerns. In one of the management and conservation projects based in the Philippines, pregnant males are not immediately harvested but are retained alive until the young are released to enhance local populations. In Vietnam, seahorse culture and biological studies began in 1995 and are combined with public education. These projects represent just two of the possible innovative and practical approaches to seahorse conservation and promotion of sustainable use. Others include finding alternatives to seahorses, where possible, in TCM, reducing the use of these animals as curios and discouraging their trade for marine aquaria, because of their poor survival rates.

This excellent report was published by TRAFFIC International and the World Wide Fund for Nature – UK and prepared and written by Amanda Vincent. Amanda can be contacted at:

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Noteworthy publications

Aquaculture Asia is a new journal published four times a year by the Network of Aquaculture Centres in the Asia-Pacific. This is an unusually informative, well-written and attractively laid-out publication containing reviews of interest to both researchers and the industry. Judging by the first two issues, it provides a much better overview of the industry and its concerns than the more typical compilations of research publications or country reports. The first issue focuses on feeds, shrimp viruses, and trade and the environment. The second issue is on 'Mangroves in Asia: land use economics and options, conservation and management, and success stories.' It is clear from the contents that the magazine's stated commitment to aquaculture that is not just profitable, but also responsible, is taken seriously.

The contact address for this publication is N.A.C.A., P.O. Box 1040, Kasetsart Post Office, Bangkok, Thailand. Subscriptions are US $30 for Asia/Pacific countries, US $50 for other countries.

Some of the articles in Aquaculture Asia that may be of interest to SIG members include:

- NEW, M.B. (1996). Responsible use of aquaculture feeds. Aquaculture Asia 1(1): 3–15.

  Reading this article makes one aware that grouper aquaculture has a long way to go before its feeds and feeding regimes have as little environmental impact as is currently feasible for some other cultured marine fish (but see the paper by Wong, below).

- HALTER, F. (1996). Improving environmental aspects of aquaculture through law. Aquaculture Asia 1(1): 26–27.

  Review of the Asian priorities identified by participants in a recent workshop on this subject.

- FEGAN, D.R. (1996). Sustainable shrimp farming in Asia: vision or pipedream? Aquaculture Asia l(2): 22–28.

  Much of the information in this unusually thoughtful and even-handed article is equally applicable to the culture of reef fishes. (See also in this issue several other articles on sustainable tropical mariculture, as well as 'India's guidelines for sustainable brackishwater aquaculture' on page 15.)

- WONG, P. S. (1996). Low pollution feed boosts Hong Kong's mariculture industry. Aquaculture Asia 1(2) 29–31.

  Trash fish is often the major source of pollution from mariculture. This article describes the successful substitution of trash-fish-based moist pellets for groupers and snappers.

CESAR, H. (1996). Economic analysis of Indonesian coral reefs. World Bank Environment Department, Work in Progress. 97p.

This is a comprehensive, thought-provoking and ground-breaking attempt to assign monetary value to Indonesia's coral reefs. It includes, among many other things, an estimate of what cyanide fishing costs Indonesia. Cesar estimates that 'the large scale poison fishery creates a net quantifiable loss to Indonesia of US$ 46 million over four years. On the other hand, a sustainable hook-and-line fisheries option could create foreign exchange for the country, jobs for an estimated 10,000 Indonesian fishers for many years to come, and net benefits of some US$ 328.1 million.'

For many influential people (e.g. many politicians and aid donors) monetary value is the bottom line when it comes to determining the significance of natural resources. Cesar's efforts provide us with some invaluable ammunition for convincing these people to take coral reefs and their resources more seriously. He

concludes: 'Coral reef protection measures are often presumed to conflict with economic development and require sacrifices for economic growth. This study shows, however, that this perception stems mainly from a failure to recognise the economic costs resulting from reef degradation, and that improved management of reefs is in Indonesia's best economic interest in the long run.'

Cesar's conclusions are bound to attract criticism because the data available for the analyses are often poor or non-existent . Some of the conclusions are inevitably, therefore, easy targets for critics. It takes courage to enter this arena! Hopefully others will build on the foundation this report provides and extend these analyses to other regions. Copies can be obtained from Ms Elizabeth George, E-mail: ebgeorge@worldbank.org@internet

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NELSON, S.G. (1996). The culture of groupers and humphead wrasse in Taiwan and Indonesia in reference to the development of sustainable aquaculture and the reduction of illegal fishing. Report to the Nature Conservancy, August 1966.

Copies of this very useful and up-to-date 12,000-word report, based on a trip made to Taiwan and Bali by Dr Nelson, can be obtained from Nancy Mackinnon, The Nature Conservancy, 1 Sutter Street, Suite 308, San Francisco, CA 94104. USA. Fax: 415-362-3199. E-mail: Nmackinsf@aol.com

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Reef fish aquaculture feasibility study. Business brief.

This eight-page brief, issued in 1996 by the Queensland (Australia) Department of Primary Industries, summarises seven reports it commissioned on the future prospects of the live reef food fish industry on the Great Barrier Reef.

For copies of this brief, or information on how to obtain the reports from which it derives, contact Mark O'Sullivan, Manager, Rural Development Unit, Department of Primary Industries, Brisbane, Queensland, Australia. (The brief is free; the reports can be purchased, collectively, for 1280 Australian dollars!).

ENGELMANN, N. (1997). Status of coral reefs in Southeast Asia with an emphasis on destructive fishing habits such as cyanide use. Report to the Humane Society International.

This is a useful brief review of the subject, with an interesting critique of recent research on the effect of cyanide on fish. You *may* be able to obtain a copy from Mrs Janet D. Frake, Executive Director, Humane Society International, 2100 L Street N, Washington, DC 20037 USA. Phone (1 301) 258 3010; Fax (1 301) 258 3077.

There are many accounts of the overuse and inappropriate use of antibiotics in the live reef-fish trade—most of it due to ignorance. Here is the abstract of a paper that can help combat the problem. Please address reprint requests to: Paul Bowser, Department of Microbiology and Immunology, College of Veterinary Medicine, Cornell University, Ithaca, New York, 14853, USA.

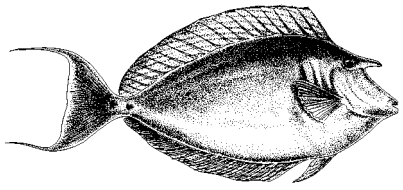
STOFFREGEN, D.A., P.R. BOWSER & J.G. BABISH. (1996). Antibacterial chemotherapeutants for finfish aquaculture: A synopsis of laboratory and field efficacy and safety studies. Journal of Aquatic Animal Health 8: 181–207.

Abstract:

This review summarises the extensive and disparate world literature pertaining to antibacterial chemotherapeutants which may be of use in finfish aquaculture. Currently, the veterinarian or fish health professional in the USA has only two legal antibacterials available—Teramycin for Fish® and Romet-30®—each with limited and specific indications for use including treatable fish species and pathogens. If an indicated bacterial pathogen is not sensitive to these chemotherapeutants, the producer has limited treatment options.

Extra-label usage of these or other antibacterials is not permitted via the feed (currently the only practical route for treating large populations of fish) without specific US Food and Drug Administration approval, including the Investigational New Animal Drug (INAD) process or an emergency INAD exemption. Research to develop and approve new antibacterials to treat commercial aquaculture species has identified specific fluoroquinolones (enrofloxacin, sarafloxacin), macrolides (erythromycin), penicillin derivatives (amoxicillin), and chloramphenicol-like (flofenicol) antibacterials as the best candidates for current registration efforts in the USA.

R.E. Johannes



Internet sites

Home pages

- Pacific Region Aquaculture Information Service for Education – Honolulu, Hawaii:
  http://lama.kcc.hawaii.edu/praise/
- Link for marine aquarium enthusiasts:
  http://www. reeflink.com/reeflink/
- Availability lists and prices for fish and supplies:
  http://www.io.com/-kslandry,Aquarium_ World_Market.htmt
- Usenet newsgroup:
  rec.aquari.marinereefs.

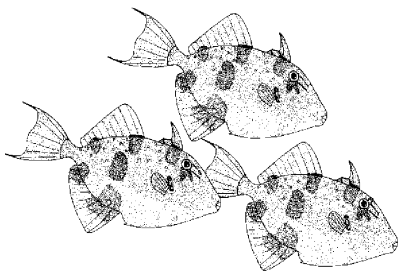
PRAISE opens a 'Web home page'

The Pacific Regional Aquaculture Information Service for Education, or PRAISE, has its own home page on the World Wide Web. PRAISE's home page offers:

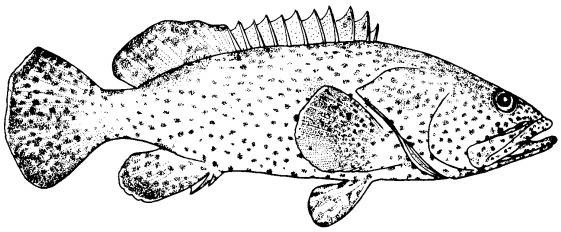
- a critical News section;
- an Information Services section;
- an Aquavet News section, which includes Aquatic Health Information;
- an Aquaculture Legislation section;
- a Pacific Vendors section;
- a Pacific Organisations section;
- a Marine Information Centres section;
- a Grey Literature Bibliography section providing Links to Internet Resources;
- a section on Marine Research Laboratories;
- a section listing Commercial Vendors and Buyer's Guides; and
- a section on Aquaria and Tropical Fish.

The URL that leads to the PRAISE wave is : http://lama.kcc.edu/praise

Source: CTSA Regional Notes, Fall 1995



LIVE REEF FISH WORKSHOPS & MEETINGS



Workshop on the Impacts of Destructive Fishing Practices on the Marine Environment, 16–18 December 1997, Hong Kong

The Asia-Pacific Economic Cooperation (APEC) Marine Resources Conservation Working Group is convening a workshop to address the impacts of destructive fishing practices on the marine environment. The purpose is to define areas for action and regional cooperation to tackle the problem.

Suggested themes of the workshop:

- Impacts of destructive fishing practices;
- Protection of the coral reef environment;
- Promotion of environmentally friendly fishing practices; and
- Legislation, enforcement and management strategies.

Venue:

- The Hong Kong University of Science and Technology.

Organisers:

- Agriculture and Fisheries Dept., Hong Kong;
- State Oceanic Administration, The People's Republic of China; and
- Environmental Protection Administration, Chinese Taipei.

Deadlines:

- The deadline for submission of abstracts is 15 July and the deadline for early registration is 30 September 1997.

Contact:

Dr S.F. Leung ,
Secretary Organizing Committee
Department of Agriculture and Fisheries
100a Shek Pai Wan Road, Aberdeen, Hong Kong
Fax: (852) 2814 0018; tel: (852) 2873 8331.

Coral reef fish aquaculture workshop in Sabah

by R.E. Johannes

A workshop on Sustainable Aquaculture of Coral Fishes and Sustainable Reef Fisheries was held in Sabah, Malaysia on 4–8 December 1996. Sponsored by the Network of Aquaculture Centres in Asia (NACA) and collaborating agencies[1]. Its purpose was to review the status of the culture of coral reef fishes, to review the social, economic and ecological impacts of the live reef fishery and related aquaculture, to identify research, training, information and policy needs for promoting responsible aquaculture and sustainable management of reef-fish resources, to identify common problems related to reef-fish aquaculture in the Asian region, and to explore ways for regional cooperation.

[1] Institute for Development Studies (Sabah); Department of Fisheries, Sabah Malaysia; Universiti Malaysia, Sabah; and Sabah Parks.

The subjects discussed were too numerous to cover here, but some points that may be of particular interest to readers of this *Information Bulletin* are briefly discussed.

Reviews of reef fish aquaculture were presented for Thailand, Malaysia, the Philippines, Indonesia, Singapore, Hong Kong and Taiwan. Other speakers discussed disease problems, market trends and the feasibility of catching pre-settlement reef fish larvae for growout. A recurring theme among speakers from throughout the region was the shortage of juveniles. This appears to be the biggest impediment to the expansion of farming of coral reef food fish in South East Asia.

It is unlikely that hatcheries will be able to supply the demand within the near future. Whereas a long list of reef food-fish has been raised from the egg experimentally, it appears that only two species of groupers, *Epinephelus malabaricus* and *E. coioides,* can, as yet, be hatchery-raised on a commercially sustainable basis.

Despite almost two decades of research in at least 16 different countries, commercial success has proved elusive because of the fragility of grouper larvae, cannibalism, and the difficulty of obtaining suitable food for them. Mortality rates have been either uniformly high or unpredictably variable.

Even with *E. malabaricus* and *E. coioides*, larval survival rates are erratic and brood stock numbers must be very large to guarantee enough surviving fingerlings to supply even local needs. Hatcheries occasionally report larval survival of several tens of per cent, but they rarely, if ever, manage to attain such relatively high survival rates consistently.

Moreover, if mariculture is ever able to fully exploit the growing demand for reef-fish fingerlings, hatcheries will have to be able to raise far more than just two species commercially.

As long as the economic boom continues in South-East Asia, consumers of live reef food fish will continue to be willing to pay high prices for species that cannot be supplied by hatcheries, such as plectropomid groupers (coral trout) (*Plectropomus* spp.), the mousehead or panther grouper (*Cromileptes altivelis*) and the humphead, napoleon or maori wrasse (*Cheilinus undulatus*).

A recent Australian study of the feasibility of achieving commercially viable hatchery-based production of these species, which was discussed by Michael Rimmer at the workshop, rated the chances at 20 per cent for plectropomids, 15 per cent for *Cromileptes altivelis* and a mere 7.5 per cent for *Cheilinus undulatus*.

Given such unimpressive odds, as well as the slow progress of researchers in rearing many other reef fish species commercially, workshop attendees recommended that more effort should be devoted to determining how to get more juvenile reef fish sustainably from the wild.

Dr Vincent Dufour pointed out that most coral reef fish have a pelagic larval stage ending with the colonisation of the reef as juveniles. The abundance of the larvae is orders of magnitude higher than of adult fish but numbers decline sharply during settlement and colonisation, probably because of heavy predation.

Therefore, he said, 'if reef fish larvae could be harvested before settlement, their abundance would probably allow sustainable farming techniques and the juvenile and adult coral reef population would be preserved.'

Grouper fry and juveniles are imported to South-East Asian countries from as far away as Sri Lanka, which exports its entire catch (over a million individuals in some years) because it does not, as yet, farm groupers. Some countries with their own grouper growout industries have banned, or are planning to ban the export of grouper fry. One province in the region is planning on an experimental basis to introduce a closed season for grouper fry collection and limit the fishery to licensed residents in order to see if this will result in larger sustained catches. A ban on the export of government hatchery-produced fry in Taiwan was lifted in 1996 because of production excess to the country's needs.

Mr Sudari of INFOFISH estimated the live reef-fish trade had more than doubled in the past five years and that this rapid growth was expected to continue.

Unfortunately there was no representative of the People's Republic of China (PRC) at the workshop, although one had been invited. The PRC is expected to overtake Hong Kong soon to become the world's largest importer of live reef food fish (Johannes & Riepen, 1995). Moreover, the domestic PRC production of farmed grouper in 1990 (the latest figure I have been able to locate) is said to have been 43,000 t. This is greater, even today, than the farm production of grouper of all other countries in the region combined. Clearly China is an immense player in this arena, and until we have a basic understanding of its operations, we will be unable to formulate a reliable regional overview of the live reef food-fish industry. To this end it would be very useful to hold a future workshop on the live reef fish trade in China.

The proceedings of the Sabah workshop are scheduled for publication early in 1997. This publication should prove invaluable to anyone interested in the live reef fish industry. For more information contact Mr. Rooney Biusing, Fisheries Research Center, 89400 Likas, Kota Kinabalu, Sabah, Malaysia. Fax (06) 088 425890; e-mail: biusing@ppps.po.my

References

Johannes, R.E. & M. Riepen. (1995). Environmental, economic and social implications of the live reef fish trade in Asia and the Western Pacific. Report to The Nature Conservancy and the Forum Fisheries Agency. 83 p.

Marketing & Shipping Live Aquatics 96, conference and exhibition

The first international conference of Marketing and Shipping Live Aquatic Products was convened in Seattle on 13–15 October 1996.

Over 200 growers, harvesters, shippers, buyers, researchers and regulators of live finfish, shellfish and plants met to discuss transporting live aquatic products for food and ornamental use. Speakers addressed over 50 topics to representatives of this rapidly expanding industry.

Central to the Conference were discussions of technological refinements of fish handling and transportation, and improved understanding of the physiological needs of fish and shellfish. Frequently, live aquatics are shipped thousands of miles, often with extremely small amounts of water, for consumption, propagation, growth or display.

Philosophers addressed the humane considerations of live aquatic transport. Fishermen and growers compared harvesting and handling methods with other practitioners and explored new market and business opportunities. Buyers found new product sources. Researchers and innovative shippers discussed containers, packaging, reconditioning and improved holding methods. Equipment suppliers demonstrated products to a focused and attentive audience. Regulators addressed the need for national and international controls.

Participants represented New Zealand, Bahrain, Fiji, South Africa, Brazil, Iceland, Norway, Puerto Rico, Denmark, Great Britain, Canada, British West Indies, Samoa, Mexico, Chile, Taiwan, Hong Kong, Sri Lanka, Australia, Hawaii, Alaska and mainland United States.

Hosts were the University of Alaska Marine Advisory Program and Nor Westerly Food Technology Services. The Proceedings will be available. A second conference is planned and papers are solicited.

For further information, including how to obtain a copy of the conference proceedings, contact:

John B. Peters
2743 - 56th Avenue SW
Seattle, WA 98116, USA
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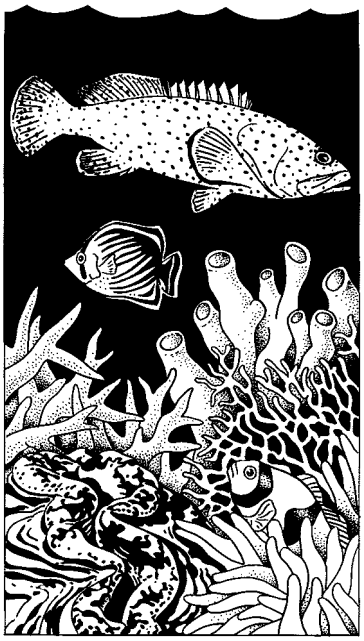
Fax: (1) 206 933 7937
E-mail: JohnBPeters@compuserve.com

Mr Peters informs us that another 'Shipping Live' conference, which may include a session on live reef fish, is planned for late 1998. Anyone interested in learning more should contact him.



Late news

The live reef food-fish trade has recently expanded even further east into the Pacific. An operation involving two Chinese companies has been established in the Marshall Islands. Meanwhile unverified reports also coming from the Marshall Islands tell of the recent finding of dinghies, hookah gear and cyanide aboard a Chinese vessel apprehended for an unrelated offence. The owners were reportedly fined $US 250,000 and forfeited their boat. Also rumored is the payment of the chief of each atoll $US 9000 for the right to fish in their waters. We hope to have more on these events in the next issue.

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The Network of Aquaculture Centres in Asia Pacific (NACA) proposes to launch a web page on grouper and coral reef fish aquaculture in early June 1997. We will provide more information in the next issue of the *Live Reef Fish Information Bulletin*. In the meantime, additional information can be obtained at the following e-mail address: 'grouper' <NACA@mozart.inet.co.th>. Or you can access the NACA web pages at: www.pop.bio.aau.dk/~naca for updated information on this new initiative.

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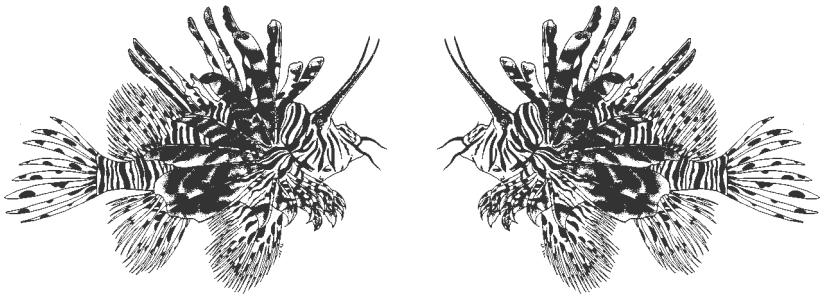
A book by Vaughan Pratt of the International Marine Alliance-Philippines and Chip Barber of World Resources Institute entitled, 'Sullied Seas - Strategies for combating cyanide fishing in Southeast Asia and beyond' is due to be released in June, 1995. For more information contact Vaughan Pratt at: imaphil@mnl.sequel.net (Dr. Pratt).



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 South Pacific Commission (SPC), the South Pacific Forum Fisheries Agency (FFA), the University of the South Pacific (USP), the South Pacific Applied Geoscience Commission (SOPAC), and the South Pacific Regional Environment Programme (SPREP). Funding is provided by the Canadian International Development Agency (CIDA) and the Government of France. This bulletin is produced by SPC as part of its commitment to PIMRIS. The aim of PIMRIS is to improve the availability of information on marine resources to users in the region, so as to support their rational development and management. PIMRIS activities include: the active collection, cataloguing and archiving of technical documents, especially ephemera ('grey literature'); evaluation, repackaging and dissemination of information; provision of literature searches, question-and-answer services and bibliographic support; and assistance with the development of in-country reference collections and databases on marine resources.

PIMRIS

Pacific Islands Marine Resources Information System