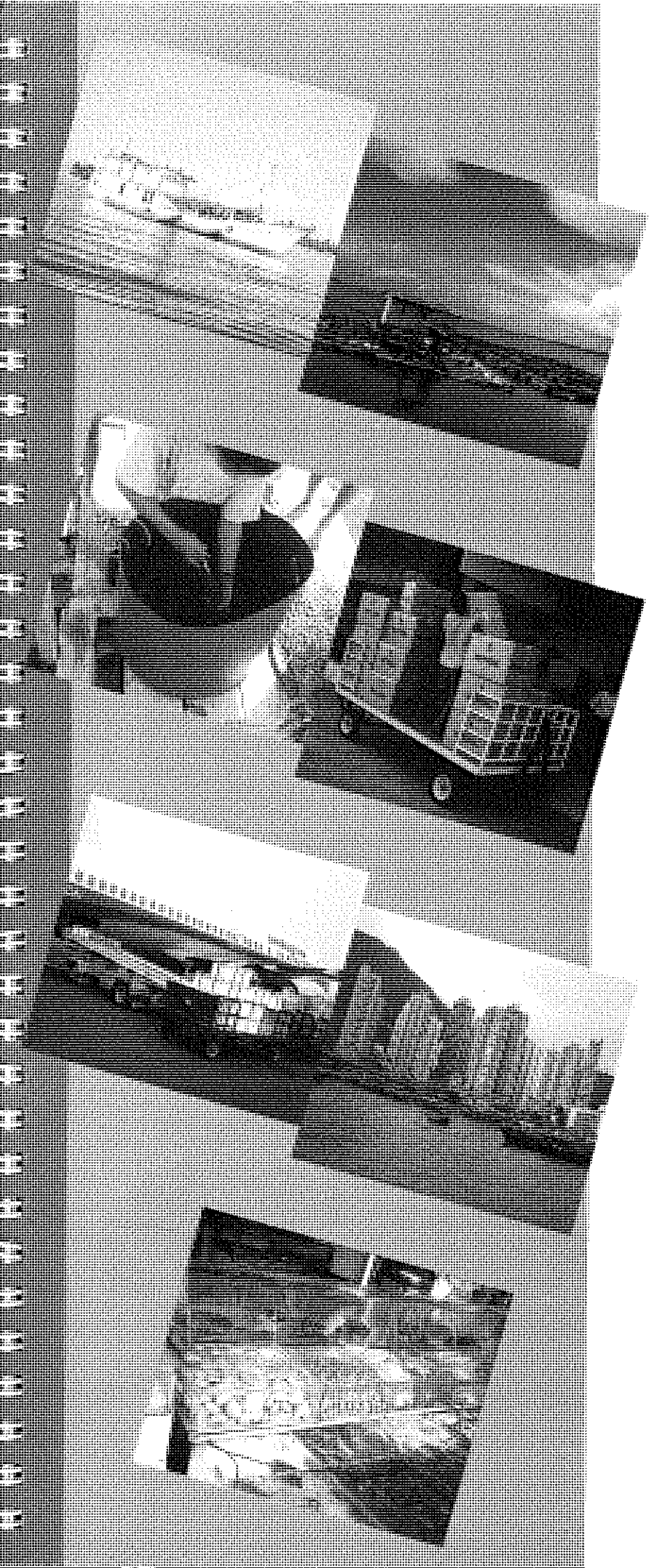

TRADE REVIEW

FISHING FOR SOLUTIONS: CAN THE LIVE TRADE IN WILD GROUPERS AND WRASSES FROM SOUTHEAST ASIA BE MANAGED

By

Nokome Bentley

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Front cover photograph: (From top; Left to Right)

1) Large scale cyanide fishing vessel off Ujung Pandang, Indonesia
2) Live fish holding cages, Guiuan, the Philippines
3) Coral trout being injected with antibiotics to reduce infection during holding and transportation, Spermonde Archipelago, Indonesia
4) Fish in boxes awaiting air shipment, Guiuan, the Philippines
5) Live fish being loaded onto a plane, Tawau, Sabah, Malaysia
6) Hong Kong, the destination of a large majority of live fish exports
7) Live fish at a restaurant, Hong Kong

Photo credit: Nokome Bentley/TSEA

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By

NOKOME BENTLEY

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This report owes a lot to those who shall remain anonymous. Members of the live food reef fish industry including fishers, dealers, exporters and transporters provided invaluable information. I hope that this report contributes to the sustainability of their fishery as partial repayment for their trust and assistance.

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EXECUTIVE SUMMARY

The expansion of the live food reef fish industry had its beginnings in Southeast Asia. As the waters around Hong Kong and China became depleted of wild stocks, fishing vessels targeted the coral reefs of the Philippines, Malaysia and Indonesia. With the possible exception of small isolated reefs and well-guarded reserves it is now unlikely that any coral reef in South East Asia has not at some time been fished for live food reef fish.

The pervasiveness of the fishery is one of the few generalisations that can be made about this diverse and dynamic industry. With characteristics ranging from the methods used to catch fish through to the mode of exportation, this report aims to describe the trends, patterns and diversity of the live food reef fish industry in South East Asia. This analysis is then used to identify appropriate management interventions at various points in the trade to ensure the sustainability of the fishery.

The four major Southeast Asian countries involved in the industry were investigated in detail for this report: Indonesia, the Philippines, Malaysia and Singapore. Most of the information presented was collected during 1997 and describes the industry up to that year. Official government trade statistics were complemented with interviews of industry members to provide a broad overview of the temporal and spatial trends and patterns in the live food reef fish industry. Although attempts were made to validate this information, it should be remembered that these data are not conclusive and are to some degree inaccurate.

Several localised case studies within Southeast Asia were done to provide details on the exploitation and trade of live food reef fish at the local level. These histories provide insights into the diversity of methods used to catch live fish and of local trading structures. Where possible, locations for case studies were chosen where links between researchers or non-government organisations and the industry existed.

The official export data suggests a rapid expansion of the live food reef fish industry during the early 1990s. Exports from Southeast Asia rose by more than one order of magnitude, from an estimated 400t in 1989 to over 5000t in 1995. Despite this impressive increase, it appears that the industry's boom has come to an end because in 1996, there was a 22% decline in total recorded exports from the region.

Exports from individual countries reflect this overall trend. Between 1991 and 1995, the vast Indonesian archipelago provided about 60% of the live food reef fish harvested from Southeast Asia. The country's main areas of coral reef lie in the east and the west and the live food reef fish operations in each area have operated relatively independently. Though the western reefs of Indonesia were the first to be targeted in 1985, the industry quickly became established amongst the extensive reefs of eastern Indonesia, where by 1993 this area accounted for more than three-quarters of the country's exports. The bubble finally burst in 1996 when exports from eastern Indonesia fell by over 450t.

The Philippines was the first Southeast Asian nation recorded as being fished for live food reef fish. However, between 1991 and 1995 it accounted for only 27% of the region's total exports.

Until 1993, annual exports increased significantly, but after remaining steady at around 1100t for three years, they then fell by almost 50%.

Malaysia has coral reefs around its peninsular states and Sarawak, but the greatest area of reef occurs around its easternmost state of Sabah. Malaysian companies first started exporting live fish from Sabah during the mid-1980s, but it was not until 1987 that the industry really developed. Exports reached a peak in 1993 at around 500t, but have since declined by over 30%.

Singapore is the primary live food reef fish consuming country within Southeast Asia. Increasing amounts of live fish are demanded by Kuala Lumpur, in Malaysia and other centres with large Chinese populations. However, these amounts are small compared to Singapore's consumption of around 500t per year. Most of the live food reef fish imported by Singapore comes from nearby Indonesian islands.

The industry has progressively expanded into the more remote areas of the region. This is illustrated well in Indonesia where official export data are available for each port. Analysis of these data reveals some striking trends. For most regions, once exports began, it took only three to four years for them to reach a peak before declining. Like a wave, the industry has spread throughout the country with live fish exports rising and falling in its wake.

The live food reef fish industry in Southeast Asia is complex. Involving several tiers of trade, the characteristics vary from region to region and have changed over time. Although the fishery began with foreign vessels and crew, there was a rapid turnover to local operations. The high value of live food reef fish, was a persuasive attractant to local fishers. At the same time, exporters found it cheaper to employ locals than bring in their own crew. Thus the fishery, which had been dominated by large, self-contained foreign vessels, soon became a local based industry in many areas. The mode of export of live food reef fish has also changed considerably. When foreign vessels dominated the industry, they often took fish to the market themselves. However, with the shift towards local operations, live fish transport vessels took over this role. Although these vessels are still important in some areas, air shipments have become increasingly more common. Airfreight is now responsible for all of the live fish exports from Sabah and most of those from the Philippines. In Indonesia, exports by air rose from 5% to 40% between 1991 and 1995.

The dominance of Hong Kong as the main export destination has also diminished. China and Malaysia in particular are demanding increasing quantities of live food reef fish. Although much of the product that is exported to China first travels through Hong Kong, an increasing proportion reaches there directly. For instance, direct exports to China from Indonesia increased from 0% to 27% between 1991 and 1995, probably facilitated by the shift towards air exportation.

The shift to local operations was accompanied by an inevitable increase in the industry's diversity. The influence of local fishing methods was particularly strong. Although some local fishers were trained by foreign fishers to use cyanide as a stupefacient, others found that they could catch live food reef fish using traditional methods, or variations of them. Though they vary among regions, villages and fishers, the most common methods are cyanide, hook and line, and trap fishing.

The available evidence suggests that there has been widespread over-exploitation of live food reef fish stocks in Southeast Asia. Global experience has shown over-exploitation often occurs when access to the fish stocks is open to all and when commodity prices are high. This situation is exacerbated by the poverty of many coastal communities in Southeast Asia. A fisher's considerations of the long-term sustainability of the resource are often overridden by the need to feed his family. In the unlikely case that the live food reef fish stocks of Southeast Asia are not already overexploited, they will be in the near future without some form of management.

There is further concern that some of the methods used to catch live food reef fish cause damage to the coral reef ecosystem. The use of such destructive fishing methods not only impacts directly on the industry itself by degrading the reef habitat, but also impacts on the wider coral reef ecosystems. As an important resource for Southeast Asia; coral reef attributes extend far beyond the extraction of fish thus necessitating the eradication of destructive fishing methods associated with the industry.

It is easy to dismiss the over-exploitation that is currently occurring in the live food reef fish industry as another example of the 'tragedy of the commons'. The lack of data on which to base management decisions could also be used as an excuse for inaction. Such procrastination would be irresponsible because implementation of export quotas would provide an effective means of controlling exploitation rates of live food reef fish. Initially, quotas could be set conservatively based on existing information and then refined as further reports become available on the population dynamics of reef fish. Furthermore, complementary regulations on the allowable sizes of fish and their method of capture could be applied across all trading levels.

The involvement of members of the live food reef fishery is critical to the success of these management strategies. They already recognise that over-exploitation has occurred and have a vested interest in ensuring the sustainability of the stock. Given the forecasts for increases in wealth of the Chinese population, demand for live food reef fish is likely to increase significantly. Combined with the fact that live food reef fish are associated with 'conspicuous consumption', suppliers may be able to demand higher prices if market quantities became restricted. If this is the case then there will be incentives for the live food industry, from fishers through to wholesalers, to reduce the current catch to ensure the industry's sustainability in the future. Co-operation at the international level is also imperative; especially since some reef fish stocks cross borders as with fishing operations and the transport of live fish. Without formulation under an international agreement, voluntary reductions in trade are unlikely to arise or to succeed.

The live food reef fish industry is a valuable fishery for Southeast Asia. Effective co-operation of governments, industry and other stakeholders has the potential to ensure live food reef fish stocks are sustainably managed, thus providing a sustainable livelihood for coastal fishers and an incentive for coral reef conservation throughout Southeast Asia.

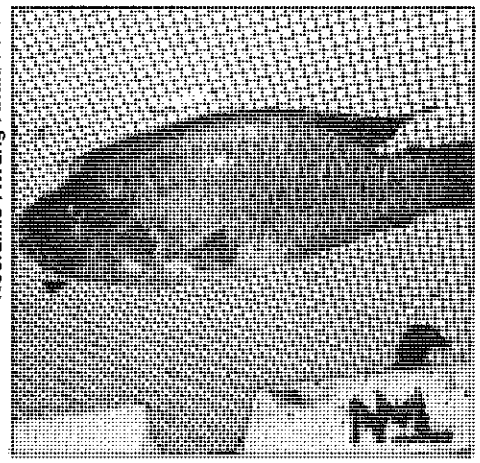
INTRODUCTION

The demand

For centuries, Cantonese diners have put a premium on eating their fish freshly killed. A tradition has developed by which restaurant diners choose their seafood meals while the animal is still alive. During the 1960s, as the wealth of Hong Kong increased, so too did the demand for live food fish. Consumers preferred fish caught from the wild to those reared in ponds, and wild stocks in local waters soon became depleted. Fishing vessels based in Hong Kong extended their fishing activities, moving south into the South China Sea and the reefs of the Paracel and Sprately Islands. Coral reef species such as Humphead Wrasse (*Chelinus undulatus*) and coralgrouper (*Plectropomus spp.*) gained popularity in Hong Kong markets and soon became preferred varieties.

The fish

Several species of wild fish are now commonly targeted in Southeast Asia for the live food fish market including groupers (Fam. Serranidae), one species of wrasse - Humphead Wrasse *Chelinus undulatus,* and stonefish (Fam. Synanceia). Although juveniles of these species are often found in tidal pools (eg. Yellow Grouper *Epinephelus awoara*) and seagrass beds (eg. Brown Marbled Grouper *Epinephelus fuscoguttatus,* Greasy Grouper *E. tauvina*) adults usually live on coral reefs and are major predators of the coral reef ecosystem. Many are generalist carnivores (eg. Brown Marbled Grouper *Epinephelus fuscogattus,* Malabar Grouper *E. malabaricus,* Humphead Wrasse *Chelinus undulatus* and Stonefish *Synanceia* spp.) and others are exclusively piscivores (Greasy Grouper *Epinephelus tauvina,* Blacksaddled Coralgrouper *Plectropomus laevis*).



Humphead Wrasse *Chelinus undulatus,* Kota Kinabalu, Sabah

They are usually solitary, site-attached fish, often remaining resident on a reef for long periods of time. A number of species form spawning aggregations (eg. Hong Kong Grouper *Epinephelus akaara,* Squaretail Coralgrouper *Plectropomus areolatus,* Humphead Wrasse *Chelinus undulatus)* during a brief spawning season that often lasts only a couple of weeks. At this time they are also highly vulnerable to fishing.

Many species of grouper and wrasse are protogynous hermaphrodites, that is, they change sex from female to male. After several years of breeding as a female, the ovaries are transformed into testes, and the fish becomes a male. As a result, the larger fish tend to be older and male and there tends to be less males than females in a population. Fishing that focuses on large fish may therefore result in a significant reduction in the proportion of males.

These factors, combined with their slow growth rates, makes some reef fish stocks susceptible to over-fishing. Most live food reef fish species are not listed in the IUCN Red List and do not have formal protection within any of the countries of Southeast Asia. The Humphead Wrasse

Chelinus undulatus is listed as 'vulnerable' by the IUCN Red List and has specific regulation regarding its capture and trade in some countries.

The fishers

By the mid-1970s Hong Kong fishing vessels were operating in the nearby waters of the Philippines and the live food reef fish industry has since spread to Indonesia, Malaysia, Papua New Guinea, the Solomon Islands, the Marshall Islands, the Maldives and Australia. Although the fishery began with foreign vessels and crew, there was a rapid turnover to local operations. The high value of live food reef fish was a persuasive attractant and locals soon discovered a good income could be made by catching them. At the same time, exporters found it cheaper to employ locals than bring in their own crew. Thus the fishery, which had been dominated by large, self-contained foreign vessels, soon became a local based industry in many areas. Elsewhere, particularly in more remote regions, logistical constraints on smaller operations meant that foreign vessels remained longer.

The trade

There is considerable diversity in the trading structures within and between countries: the path between the sea and the restaurant table can involve many, or a few, parties. For example, fishers catching fish on local reefs may transport them directly to wholesalers. At the other extreme, fishers may supply fish to village middlemen, whom deal with cage owners, who then sell stocks to live fish transport vessels. When foreign vessels dominated the industry, they often took fish to the market themselves. However, with the shift towards local operations, live fish transport vessels took over this role. Although these vessels are still important in some areas, air shipments have become increasingly more common.

The result

The rapid, largely unchecked, expansion in quantity of catch, number of fishers and area fished has raised concerns about the sustainability of the fishery. The trade is characterised by its open access: there are few or no restrictions on entry to the fishery. The potential for overfishing is particularly high in Southeast Asia because poor fishers, with few alternative income sources, are more likely to remain in an overexploited fishery (Pauly *et. al.* 1989, Pauly 1990, McManus 1996). The 'goldrush' nature of the industry has undoubtedly caused significant pressure to stocks of live food reef fish.

Most attention associated with the industry has, however been, focused on its use of destructive fishing techniques. One method used to catch reef fish alive is the application of cyanide as a stupefying agent. Fishers search for valuable reef fish and pursue them into holes in the reef. Once the fish is trapped, a solution of cyanide is squirted into the hole using a plastic bottle. The cyanide inhibits the fish's respiration and it either emerges or is extracted from the reef in a stunned state. It is then easily captured and taken to the surface to be put in holding tanks on the boat.

As long as the dose of cyanide administered has not been too high, and given appropriate care while handling, the fish will survive the potentially long journey to market. Fish are able to excrete cyanide through normal metabolic processes (Heming & Thurston R.V 1984) and by the

time they are served at a restaurant, the levels will usually be well below those safe for human consumption[1].

Unfortunately, coral and other reef organisms in the vicinity of cyanide sprays may not be as lucky as the restaurant diner. Cyanide is a broad-spectrum poison capable of killing all coral reef organisms. Although quantitative data on the impact of cyanide fishing is lacking, anecdotal evidence and video footage of cyanide fishing operations indicate that small fish in the immediate vicinity are killed or injured. There are also claims that cyanide fishing has caused the destruction of large areas of coral reef.

The rapid expansion and covert nature of the live food reef fish industry in Southeast Asia, was not well documented in its early years. Robinson (1986) and McAllister (1988) gave some of the earliest descriptions as the fishery moved into the Philippines. However, it was the work of Johannes & Riepen (1995) that brought the fishery to the attention of the world. This report provided an overview of the industry, outlining its global expansion, ecological and social ramifications, as well as providing recommendations for management. Subsequent media interest was high and numerous articles emerged in the popular press (e.g. Dayton 1995, Spaeth 1996). Erdmann & Pet-Soede (1996) have described the fishery in eastern Indonesia while Cesar (1996) has provided an economic analysis of the fishery in that country. To date, Barber & Pratt (1997) have produced the most comprehensive discussion of cyanide fishing and strategies for reducing its use. Recently, a number of reports on the fishery in Southeast Asia have been published in the Live Food Reef Fish Information Bulletin from the Secretariat of Pacific Countries.

Given the extent of previous work, it is not readily apparent why there is a need for another description and analysis of the industry. However, although the trade has been described, the rapid expansion of the industry means that its characteristics are constantly changing. Of particular importance, has been the shift in the industry towards local based operations. Not only does this make it more difficult to document the industry, but it has also made the impact of regulatory measures less predictable. To predict the biological, economic and social implications of management measures before they are made detailed understanding of the industry is necessary. This report aims to provide a description of the industry at all levels as a means of identifying key points for management intervention.

The report begins with a description of the methods used to gather information and an assessment of their value and accuracy. An overview of the live fish trade in Southeast Asia, providing a brief comparison of the size and trends of the industry in each country, is then followed by a discussion of the trade within each main source country. Furthermore, within each country the industry is described from regional to local levels. An examination of trends in exports of live food reef fish is followed by case studies. Regulations that apply to the live fish trade are also described in each country. The role and operations of transportation companies, who deliver live fish from the supply country to the markets, are considered separately as they span national boundaries. Finally, the information presented was used to consider alternative strategies for management of the live fish industry, concluding with recommendations for sustainable management of the live food reef fish industry.

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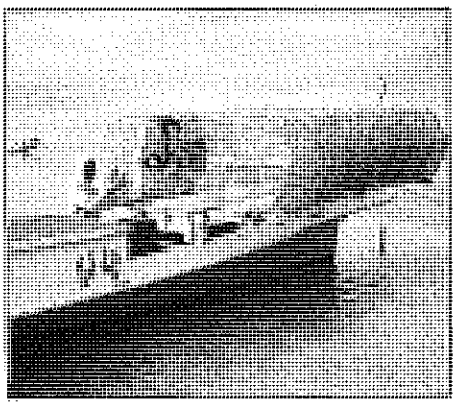
[1] V. R. Pratt, IMA, per. comm. September 1997.

METHODS

The four major Southeast Asian countries involved in the industry were investigated in detail for this report: Indonesia, the Philippines, Malaysia and Singapore. Most of the information presented was collected during 1997 and describes the industry up to that year. The primary source of information for this report was informal interviews with members of the live food reef fish industry, government officers, researchers and non-governmental organisations. Where possible, official government data on international trade of live food reef fish were also obtained. Methods used to obtain, assess and report this information are described below.

Conventions and definitions

This report considers only the exploitation and trade of wild fish that are caught for human consumption. Although the trade in fish reared in aquaculture enterprises is not considered, the capture and export of juvenile reef fish caught, from the wild, for use in aquaculture operations are briefly discussed. The term 'live food reef fish' is used to refer to fish species which inhabit coral reefs and are kept alive after capture until just before eating.



Medium scale trapping boat, Spermonde Archipelago, Indonesia

The species listed in Table 2.1 are the main species targeted for the live food reef fish industry in Southeast Asia. Within the region each language, and often each dialect or area, has its own name for each live food reef fish species. There is also a multitude of common names in English. For the purposes of this report the common names used in FishBase (1997) and by the Food and Agriculture Organization (FAO) of the United Nations (Palomares & Pauly 1997) have been adopted. The distributions and biological characteristics of these species are briefly described in Table 2.1.

All prices are in local currency and US dollar equivalents. The following exchange rates were used, which are approximate for the period during which most information was collected:

USD (US Dollar) 1 = IDR (Indonesian Rupiah) 3000 = PHP (Philippine Peso) 30 = MYR (Malaysian Ringgit) 3 = SGD (Singapore Dollar) 1.5.

Unless otherwise stated all weights of fish refer to net weights (i.e. excluding packaging and water) and are provided in metric tons (t) or kilograms (kg).

Table 2.1. Scientific and common names and range and biological characteristics of the main target species in the live food reef fishery.

Scientific Name	Common Name	Distribution & depth	Habitat	Reproduction SL = Standard length (cm)	Max Male Size - cm **(Common size)** **Max weight - kg**	Feeding
F. Serranidae	**Groupers**					
Cromileptus altivelis	Humpbacked grouper	35+N - 25+S 2-40m	Reef associated often with dead coral/silty areas		70 TL	Carnivore
Epinephelus akaara	Hong Kong grouper	40+N - 21+N	Rock strata - demersal		51 TL (30 TL)	
Epinephelus areolatus	Areolate grouper	37+N - 35+S 6 - 200 m	Fine sediments adjacent to rocky reefs/dead corals and seagrass		39.5 TL	Shrimps
Epinephelus awoara	Yellow grouper	40+N - 10+N 10-50m	Rocky and sandy-mud bottoms. Juveniles in tide pools.		60 TL (30 TL)	Carnivore
Epinephelus bleekeri	Duskytail grouper	30+N - 28+S 30-104m	Shallow banks - demersal. Not well known from coral reefs.		Male 76 TL	

Epinephelus coioides	Orange-spotted grouper	30+N - 30+S 1-100 m	Turbid coastal reefs, mangroves, swamps or marshes	Protogynous hermaphrodite. Female mature at 25-30 SL (2-3 years old). Sexual transition occurs 55-75 SL.	100 SL	Small fishes and crabs
Epinephelus fuscoguttatus	Brown marbled grouper	35+N - 35+S 1 - 60 m	Lagoon pinnacles, channels and outer reef slopes in coral rich areas. Juveniles found in seagrass beds.		120 TL (50 TL) 11 kg	Fishes, crabs and cephalopods
Epinephelus malabaricus	Malabar grouper	35+N - 35+S shore - 150m	Coral and rocky reefs, tide pools, estuaries, mangroves and sandy bottoms		234 TL (100 TL) 25 kg	Fishes, cephalopods and crustaceans (benthic animals)
Epinephelus polyphekadion	Camouflaged grouper	35+N - 35+S 1-46 m	Coral rich areas, islands and atolls - clear water	Protogynous hermaphrodite. Females mature - 38 SL and Males mature - 42 SL.	90 SL	Carnivore - crustaceans, fishes, cephalopods, and gastropods
Epinephelus tauvina	Greasy grouper	35+N - 36+S 1-50 m	Coral reef associated - clear water. Juveniles found in		75 TL (50 TL) 11.9 kg	Carnivore - fish

Epinephelus coioides	Orange-spotted grouper	30+N - 30+S 1-100 m	Turbid coastal reefs, mangroves, swamps or marshes	Protogynous hermaphrodite. Female mature at 25-30 SL (2-3 years old). Sexual transition occurs 55-75 SL.	100 SL	Small fishes and crabs
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			reef flats and tide pools.			
Plectropomus areolatus	Squaretail coralgrouper	35+N - 30+S 1-20 m	Lagoons, seaward reefs and channels in reef fronts with rich coral growth	Spawning aggregations in channels in full moon.	100 SL	Carnivore - fish
Plectropomus laevis	Blacksaddled coralgrouper	30+N - 30+S 4 - 90 m	Coral reefs and seaward edges. Frequently in channels.	Protogynous hermaphrodite. Two colour phases - smaller 8-57 SL and larger darker red-brown 25-100 SL. Maturity occurs at 50-52 SL.	110 NG 18 kg	Carnivore - fish
Plectropomus leopardus	Leopard coralgrouper	40+N - 35+S 3 - 100m	Coral rich lagoons, reef associated, non migratory	Protogynous hermaphrodite. Mature female 21-47 SL (2-4 years old). Mature male 30-54 SL (3 years plus).	70 NG (35 SL) 9.6 kg	Carnivore - fish
Plectropomus maculatus	Spotted coralgrouper	20+N - 37+S 5 - 50m	Reef associated, common in coastal areas, absent from offshore reefs		100 SL 25 kg	
Plectropomus oligocanthus	Highfin coralgrouper	20+N - 10+S	Coral reefs			Carnivore - crustaceans and fish

		4 - 40m			
F. Labridae	**Wrasse**				
Chelinus undulatus	Humphead Wrasse	- 1 - 60m	Outer reef slopes, channel slopes, reef lagoons	229 SL 191 kg	Carnivore - molluscs, fish, sea urchins, crustaceans, invertebrates and toxic animals
F. Scorpaenidae	**Stonefish**				
Synanceia spp			Reef associated, sandy, rubble, reef flats, shallow lagoons, widespread	40 - 60 SL	Carnivore - fish and crustaceans

Source: Fishbase (1997) and FAO Species Catalogue Vol 16: Groupers of the World

Interviews and case studies

Details on the capture, trade and transportation of live food reef fish primarily came from members of the industry. To provide a representative and objective account of the industry and to reduce the effect of personal biases, information was collected from a large number of people different perspectives. By considering information from a variety of sources we were able to identify and discount reports that appear to have little validity.

Overall, interviewees were frank in their description of the industry even to the extent of describing the use of illegal methods, in particular the use of cyanide. For example, one owner of a fishing company openly displayed the diving compressors installed on his boats and described how cyanide was far more efficient than using hook and line. To ensure that no information presented in this report directly leads to prosecution, the names of individuals or companies are not disclosed.

Case studies were used to provide details on the exploitation and trade of live food reef fish at the local level. These provide insights into the diversity of methods used to catch live fish and local trading structures. Locations for case studies were selected, where possible, where links existed between researchers or non-governmental organisations and the live food reef fish industry. In such areas, rapport was developed with members of the industry with the understanding that any information gathered would not be used against them. This arrangement further enhanced the accuracy and depth of information gathered. The case studies in Ujung Pandang (Indonesia) and the Calamian Island (the Philippines) are good examples of this approach.

To provide a representative sample of case studies, both geographically and in relation to export data, other areas without these relationships were also chosen. The lack of existing relations with fishers, and the short study time, lead to more sparse information from these areas. These include case studies in western Indonesia, Guiuan in the Philippines and in Malaysia. Despite these difficulties, an understanding albeit less certain of the industry in each area was developed.

To ensure that each case study can stand-alone, descriptions of the trade, are sometimes repetitive. Although there are consistencies in some industry characteristics, extrapolation of results from the case studies presented to other areas is cautioned. For each case study, a schematic diagram is given to summarise the trade and transportation of live fish up to the point of export (Figures 4.11, 4.12, 4.13, 5.6, 5.7 and 6.5). Each diagram is arranged in columns and rows. Each column represents one tier in the trading scheme, either fishers, dealers, exporters or transporters. A horizontal arrow denotes the transfer of fish from one tier to the next. The sale price of fish is indicated next to the horizontal arrow, when it is known. The rows indicate general locations and vertical arrows denote transportation of fish from one location to another. The approximate residence time and mortality of fish is given for points during trade where they spend one or more days.

International trade data

While the case studies provide details on the industry in specific areas, export data give a broad overview of the temporal and spatial trends in the magnitude and value of the live food reef fish industry within each country and the region. Knowing the magnitude of harvest is an important tool for assessing the sustainability of exploitation of the fishery. Most Southeast

Asian countries collect data on total fisheries landings of grouper, but these also include catches not taken for the live food reef fish trade. Given appropriate adjustment for pre-export mortality, the quantity of exports is usually the best available proxy of catches in the live food reef fish industry. However, all live fish export data are estimates of actual weights. For a commodity that must be kept alive in large amounts of seawater, it would be naive to think that exports could ever be weighed exactly. Of more concern is the *degree* of accuracy of these estimates and whether this can be improved by adjustment.

From comparison with estimates of exports made during our case studies, and from other sources of information, it is not clear whether these data either consistently over- or under-estimate total exports. Under reporting might be expected, however, closer investigation suggests that there is very little incentive for this to occur. For instance, exporters and live fish transport vessel operators in Indonesia allege that because export taxes are relatively low, but fines are high, that there are few exports that are not officially recorded. Further, for countries in which official export data are presented, excise for live fish is not substantial (eg. about 3% for Indonesia and about 5% for Malaysia). Thus, there is little incentive for exporters to under-report trade compared to the penalties for arising from being caught. Furthermore, the real incentive may be to under-report value rather than quantity, if export tariffs are calculated on a percentage of value.

In some instances, export declarations may actually overstate the actual amount. The manager of several live fish transport vessels operating in eastern Indonesia, explained that it is not economical to travel long distances to pick up small amounts of fish. Therefore, to make sure that transporters pick up their fish, exporters frequently quote greater quantities on export declarations to ensure transport vessels collect consignments. Though the transporters checks the weight of the fish, they will sign export declarations regardless of errors, as long as they are paying for the correct weight

Inaccuracy in export data can also arise from how live food reef fish are categorised. Although the Philippines provides a category for 'Grouper, live', for the other countries examined in this report, it can only be assumed that live food reef fish are included under categories such as 'Other live fish'. However, this may include species other than live food reef fish and thus lead to overestimation of exports.

To mitigate this effect, export data based on other information were sometimes adjusted. For example, export data in Indonesia is available for each port; data from ports where live food reef fish trade does not occur were, therefore, excluded. The adjustments made were done in a systematic and repeatable manner. In this way, the derivation of estimates can be scrutinised and altered if new information becomes available. To further validate this data, unadjusted or adjusted official export data were compared, where possible, with independently derived estimates of exports. These independent estimates are based on our case studies or data collected by other organisations or countries. For example, official live food reef fish import data for Hong Kong in 1997 was used.

Even if they are consistently biased, either up or down, resulting estimates of total exports provide an indication of export trends. Unfortunately, any systematic change in the magnitude of bias would make estimates less useful. For instance, while a reduction in under-reporting over time would be an advantage because it would make export data more accurate, it could also result in over-estimation of the rate of increase of actual exports. The extreme case would

be where actual exports are falling but, because a higher proportion are declared, recorded exports appear to rise. Although this is recognised as a problem, it is difficult to address.

In the past, there has been a tendency to disregard official data on live food reef fish exports because of perceived inaccuracies. A significant advantage of using government export data is that they are *official* government export data. It is more difficult for a government to dispute its own estimates, than someone else's. Unless there are substantive alternative information sources, it is recommended that official export data should be used as a baseline for estimating total exports. This does not imply that export data should be considered in isolation and further refinement of the export estimates presented here, based on other reliable information is encouraged.

However, there should not be an over-emphasis on estimating the absolute magnitude of exports. Knowledge of harvest levels alone is not sufficient to assess the sustainability of a fishery, even if export quantities are known exactly. Without knowing the initial size and dynamics of a population, the absolute quantity of catch is irrelevant: a harvest of 5000 t per year could be sustainable or unsustainable depending upon the size and growth rate of the fish stock. Until such information becomes available, the primary use of export data will be to provide an indication of trends in the fishery.

REGIONAL OVERVIEW

Only three Southeast Asian countries were significant sources of live food reef fish: Indonesia, the Philippines and Malaysia. Other countries in the region had coral reefs which were either over-exploited, inaccessible or too small to make them significant contributors to the live food reef fish industry. The size of the industry in Southeast Asia increased dramatically during the early 1990s. Exports from the three source countries rose by more than an order of magnitude, from an estimated 400t in 1989 to over 5000t in 1995. Despite this increase, official export data suggested the industry's boom was coming to an end.

The vast Indonesian archipelago has one of the largest areas of coral reef in the world. Between 1991 and 1995, these reefs provided 60% of the live food reef fish harvested in Southeast Asia. The country's main areas of coral reef lie to the east and west. The live food reef fish industries in each area had operated relatively independently, with mostly separate markets. Some reports suggested that the western reefs of Indonesia, around the Anambas Islands, were the primary target for the industry during the early 1980s. But the industry quickly became established among the extensive reefs of eastern Indonesia and by 1993 this area accounted for more than three-quarters of the country's exports (Table 3.1). Although annual exports from eastern Indonesia continued to rise, by 1994 those from the west had levelled off at under 500t.

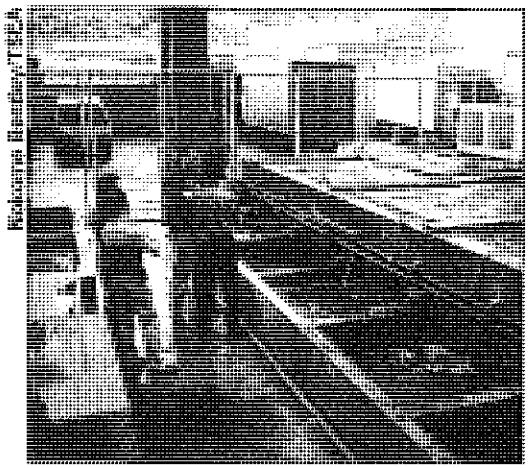
The Philippines was the first Southeast Asian nation with recorded catches of live food reef fish. However between 1991 and 1995 it accounted for only 27% of the region's total exports. Until 1993, the expansion of exports was similar to that in eastern Indonesia. In the following two years, exports remained steady at around 1100t. However, in 1996, declared exports fell by almost 50% (Table 3.1).

Although Malaysia has coral reefs around its peninsular states and Sarawak, the greatest areas exist around the easternmost state of Sabah. Companies first started exporting live fish from

there in around 1984, but it was not until 1987 that the industry really took off. Exports reached a peak in 1993 at around 500t, but have since declined by over 30% (Table 3.1).

Singapore was the primary live food reef fish consuming country within Southeast Asia. Although increasing amounts of live food reef fish were being demanded by Kuala Lumpur and other centres with large Chinese populations, these amounts were small compared to Singapore's consumption of around 500t per year. Most of the live food reef fish imported by Singapore comes from nearby Indonesian islands. Internal consumption of live food reef fish in other Southeast Asia countries was hard to estimate but was likely to be insignificant compared to export quantities.

Hong Kong was the main market for Southeast Asian live food reef fish. Figure 3.1a provides an overview of the origin and transportation of live food fish to Hong Kong. This figure was based on a collation of official export data from each country as well as other information collected during the course of this study. The map provides a picture of the trade in live food reef fish during the mid-1990s. The width of each line was based on an average of the export quantities according to official export data for 1994 and 1995. The aggregation and paths of each line were not meant to represent exact routes taken but provide a general indication of the path from capture to market.



Live fish holding facilities, Hong Kong

Figure 3.1b provides the same picture for the other markets for Southeast Asian live food reef fish: Singapore, Taiwan and Kuala Lumpur. Note that most of the fish being sent to Taiwan were grouper fry.

Table 3.1. Annual exports (t) of live food reef fish from source area in Southeast Asia

	1989	1990	1991	1992	1993	1994	1995	1996
Eastern Indonesia[1]	134	264	297	607	1030	1921	3324	2865
Western Indonesia	80	250	205	230	307	471	479	346
All Philippines[2]	NA	NA	202	457	1131	1066	1196	613
Sabah, Malaysia[3]	NA	259	325	375	503	418	372	344
Total	*400[4]*	*900[4]*	1029	1669	2971	3876	5371	4168

1. Export from points east of 114°E (a line running between the islands of Bali and Java) and Jakarta airport. Source: Indonesian Directorate General of Fisheries. 2. Includes grouper fry. Source: Philippines National Statistics Office. 3. Source: Sabah Department of Fisheries. 4. Estimates based on informal extrapolation of export trends for each country.

Figure 3.1. Schematic map of the supply of live fish from within Southeast Asia to (a) Hong Kong and (b) Singapore and Kuala Lumpur and Taipeh.

Figure 3.1 (a)

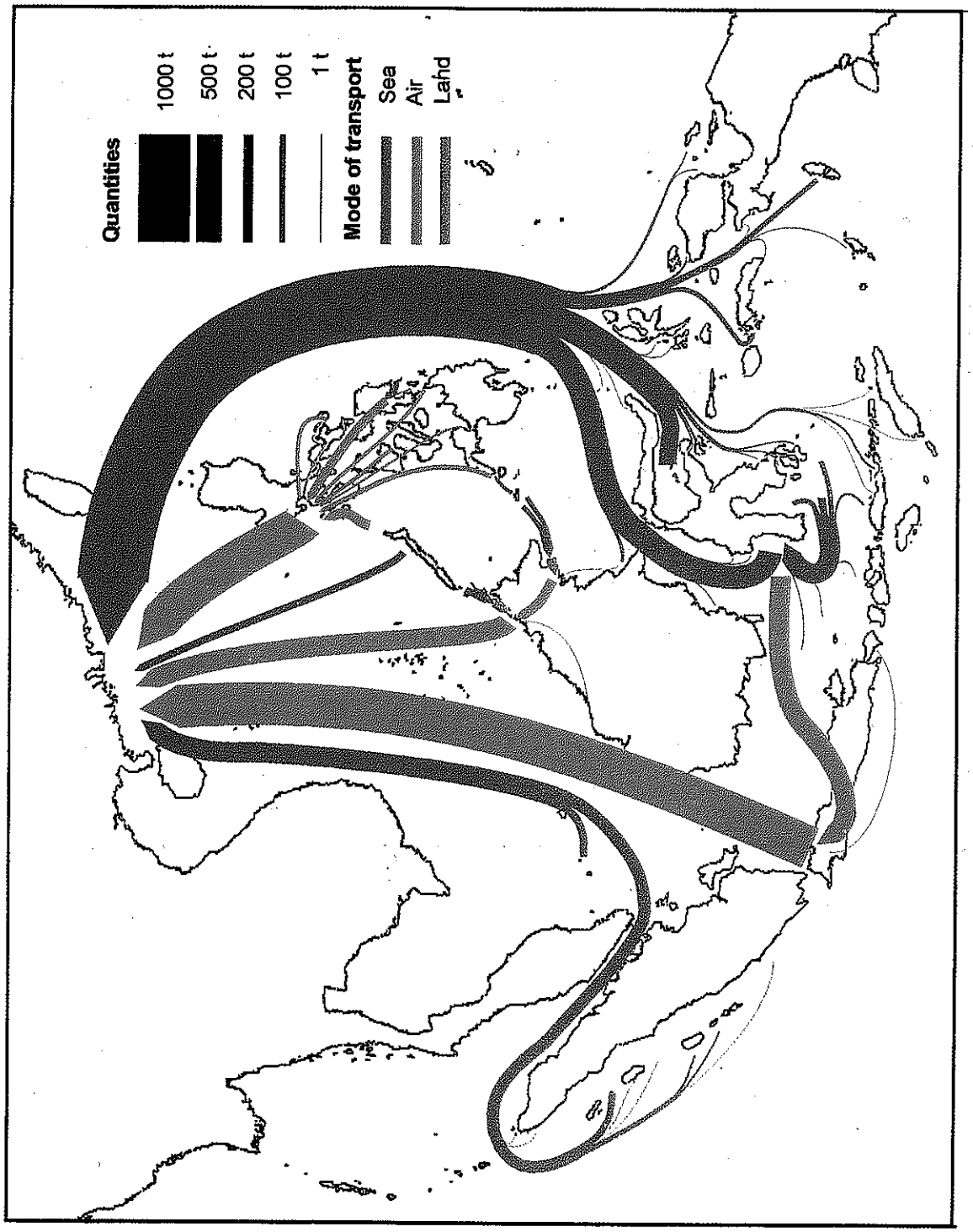
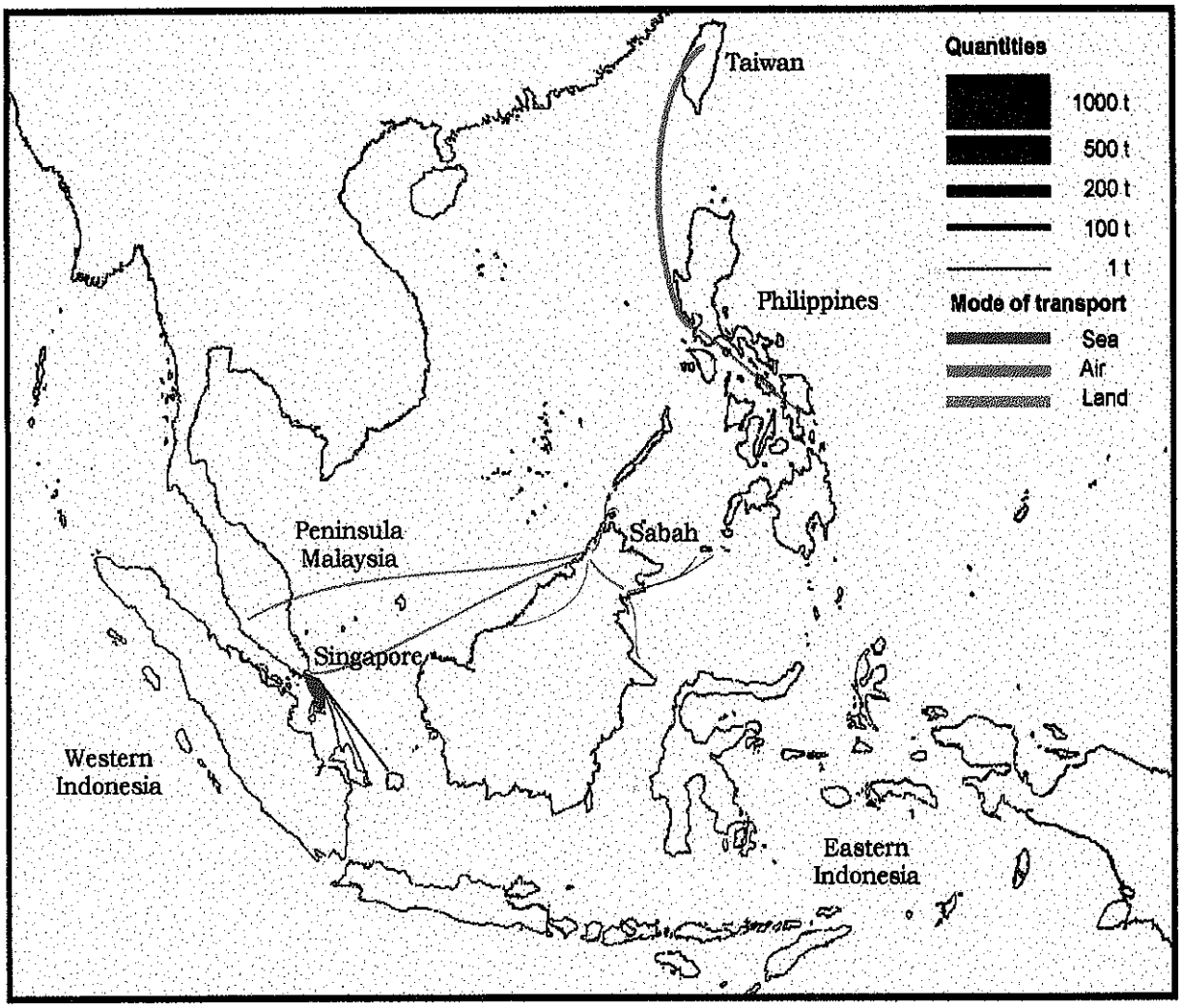


Figure 3.1. Schematic map of the supply of live fish from within Southeast Asia to (a) Hong Kong and (b) Singapore and Kuala Lumpur and Taipeh.

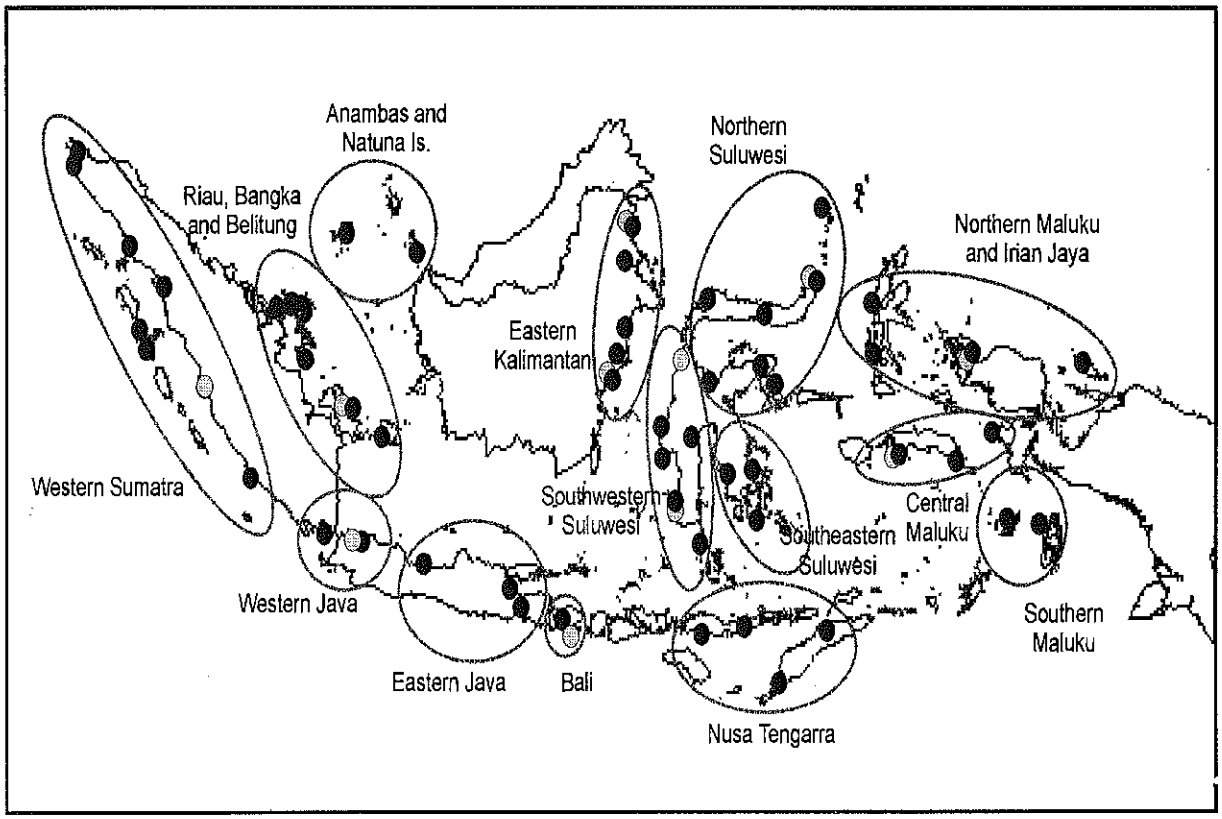
Figure 3.1 (b)



INDONESIA

The Indonesian archipelago consists of over 17 000 islands which straddle the equator for almost 5000 km (Figure 4.1). Its extensive coral reefs are the centre of global marine biodiversity. They also support significant fisheries: landings of coral reef fish alone totalled 130 000 t in 1993. One third of the Indonesian population lives in coastal areas and there is an average of 24 fisher households for each of the country's 26 974 nautical miles of coastline (Ahda *et. al.* 1995). Particularly in eastern Indonesia, many of these households rely on coral reefs as a primary source of food and income.

Figure 4.1. Map of Indonesia indicating locations referred to in this chapter.



One report from southeast Sulawesi suggests that fishing activities for live food reef fish began there as early as 1980 (C. Barber *in litt.* March 1998). According to industry sources the fishery in Indonesia began in earnest in late 1985. A few Singapore based vessels made the relatively short journey to the Anambas Islands, a remote group of islands and reefs in the South China Sea. At that time, foreign vessels faced significant difficulties operating in Indonesia, where excessive bureaucracy and possible corruption were believed to inhibit foreign operations. Nonetheless, a number of reports suggested that Hong Kong and Chinese based vessels entered Indonesian waters illegally during the late 1980s. Although Indonesia claimed its Exclusive Economic Zone in 1980, it did not begin licensing foreign vessels until 1986 (Venema 1997).

Other reports suggest that the fishery began in the far north-eastern part of the archipelago, when Philippine operations illegally fished near the Sangihe and Talaud Islands. Export data form the mid-1980s suggested that Irian Jaya was also targeted for live food reef fish. During this period, live fish data were not separated into 'aquarium fish' and 'fish for consumption'. However, the country's exports of live aquarium fish rose substantially in 1986, when 684t was exported, mostly from Irian Jaya. (It is unclear whether this figure also included live food reef fish.)

In 1990 regulations were relaxed and more foreign vessels entered Indonesia to fish. Since then, the industry has spread throughout the country and wherever coral reefs occured, live food reef fish operations have been reported.

As the major live food reef fish producing country, there has been significant interest in the magnitude of Indonesia's exports. This chapter firstly describes the official export data that were available and adjustments made to it in this report. The resulting estimates are then compared to estimates derived from other sources, followed by a discussion of the trends and patterns in the data. Four case studies were conducted in Indonesia. The most detailed of these comes from Ujung Pandang, probably best described as the centre of the Indonesian live food reef fish industry. To provide a representative geographic spread, case studies were also done in the more remote Banggai Islands and, in western and the Riau Archipelago and nearby islands. The Riau Archipelago region is unique in its proximity to the Singapore market.

Exports

Data

Official export data were available from the Indonesian Directorate General of Fisheries' *International Trade of Fisheries Commodities* (hereafter referred to as *DGF* data). Data was obtained for the years 1989 to 1996. For each year, export quantity and value was described: by country of destination; by month and; by port of origin[2]. This breakdown of data was very useful for screening the data to obtain the best estimate of live food reef fish exports.

Live food reef fish exports were recorded in the following categories: 'trout'; 'eels'; 'carp' and 'others'. Freshwater eels (Family Anguilidae) and carp (Family Cyprinidae) are cultured in Indonesia. But there are no species of trout (Family Salmonidae) which are native to Indonesia (Migdalski & Fichter 1976) and given their preference for cooler water, it was highly unlikely that they had been introduced or are cultured there. Furthermore, many of the export records labelled as 'trout' come from areas known to have had live food reef fish industries. The same was true for the 'other' live fish category. For instance, at some time between 1989 and 1996, the islands of Selayar, Aru, Kei and Banggai all exported more than 40 t of 'trout' and 'other' live fish. All are isolated islands, known to produce live food reef fish but not any other types of live fish. It is safe to assume that when live food reef fish were exported, they were recorded in either the 'other' or the 'trout' live fish categories[3]. Confidence in the official export data was increased by the recording of at least some live fish exports in such remote areas of the country.

However, there may be other instances where fish other than wild caught live food reef fish were also recorded in these categories. These could include aquaculture-reared fry or freshwater species other than eels and carp. To avoid inclusion of these species in country totals, data from ports that were unlikely to have had live food reef fish exports were excluded. In order to do this systematically, the distance of the port from coral reefs was used as a criterion for

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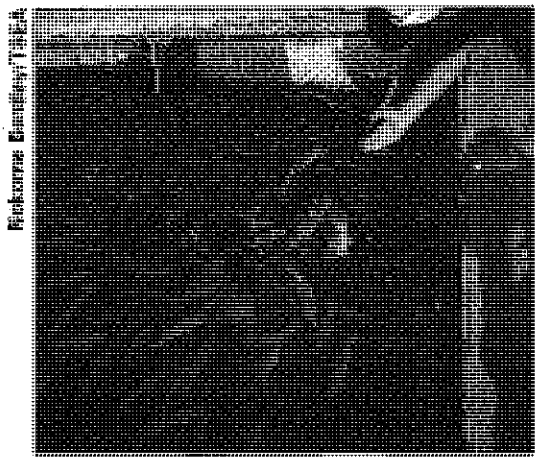
[2] Note that these breakups were available for each factor individually and not for a combination of factors such as by country of destination and port of origin. i.e. what quantity of exports from each port went to which country.

[3] Coincidentally, or not, the Australian name for the most common live food reef fish, coralgrouper, was 'coral trout'.

exclusion. All ports further than 100km from the nearest substantial area of coral reef were excluded, unless there was evidence that live food reef fish were exported from that port in the quantities suggested by the export data. Distances were estimated using the maps of coral reefs produced by the World Conservation Monitoring Centre and provided in Reefbase (1997).

Of the 94 ports with 'trout' and 'other' live fish data between 1989 and 1996, 23 were excluded[4]. In most cases, the exports of 'trout' and 'other' live fish from the excluded ports were small. However, when combined they account for 29% of exports of these categories between 1989 and 1996. This was primarily due to large exports from Polonia (the airport of Medan) and Talang Betutu (the airport of Palembang). In 1996, these two airports exported 982 t of 'trout' and 'other' live fish, representing 92% of the quantity excluded. It was thus important to verify that exports from these two ports were not wild caught live food reef fish.

Palembang is a port 80km upstream of the mouth of the Musi River in south Sumatra. Although there are no coral reefs nearby, it is possible that live reef caught on the reefs of nearby Bangka and Belitung Islands were exported via Palembang's airport, Talang Betutu. However, our research on these islands suggests that the majority of fish caught there were shipped directly to Singapore (see Case Study D). Large and increasing quantities of live fish exported from Palembang were probably cultured freshwater fish. Medan lies on the Straits of Malacca in northern Sumatra. The nearest substantial area of coral reefs was on the western coast of Sumatra near Sibolga. Most of the live fish caught in that area was taken by boat directly to Hong Kong and Singapore (see Case Study C).



Small coral trout at holding cage, Guiuan, Philippines

Despite reports that live food reef fish from the area had been transported by road to Medan and then flown out of Polonia, our findings were not consistent with a quantity as great as the 275t recorded in 1996. Furthermore, aquaculturists in Singapore had reported obtaining grouper fry from Medan. This information suggests that most exports from Polonia were of artificially reared juvenile fish.

Further, it should be noted that the average value of exports from excluded ports was USD 1.63, less than half the value of exports considered to be live food reef fish caught from the wild (USD 3.37). Although there was significant variation in reported values, most of the excluded ports had average values of less than USD 2, while those included were above this value. This also suggests that the live fish exported from those ports that had been excluded were not live food reef fish, but species of lower value.

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[4] Belawan, Dumai, Jambi, KT Pinang, Kuala Enok, Kuala Tungkal, Pal Merah, Palembang, Pangkalan Brandan, Pekanbaru, Polonia, Pontianak, Rumbai, Sambas, Senatani, Simandulang, Simpang Tiga, Sintete, Supadio, Talang Betutu, Tanjung Balai Asahan, Tembilahan.

The adjusted official export data indicate that Indonesian live food reef fish exports peaked at 3803t in 1995. There has been considerable uncertainty over the magnitude of Indonesia's live food reef fish exports. Previous estimates of total annual exports, however, span almost one order of magnitude. After "extensive interviews [and] personal observations throughout eastern Indonesia", Erdmann & Pet-Soede (1996) estimated total Indonesian exports in 1995 to be approximately 2200t. However, this may be an underestimate of the total Indonesian exports because they did not consider significant operations existing at that time in more remote parts of eastern Indonesia (C. Raymakers, in *litt.* July 1998). Johannes & Riepen (1995) suggested that Indonesia supplied half of the live food reef fish to Singapore and Hong Kong. They estimated combined imports into these two countries to be approximately 16 000t which suggests exports from Indonesia were around 8 000t. Based on this and other information, Cesar (1996) considered that the total export volume of live food reef fish from Indonesia was between 10 000 and 20 000t per year.

The official export data generally fell below or were at the base of the range of estimates based on case studies and interviews (Table 4.1). This discrepancy may arise through an evasion of reporting or errors in the collation of export data. Alternatively, our case study estimates may consistently overestimate export quantities. Despite our efforts to avoid such bias, it was possible that monthly turnover rates reported by dealers and exporters may represent their best months and were not indicative of the whole year.

When nation wide exports were examined, the official export data were greater than independent estimates from case studies and interviews (Table 4.1). The live fish transporter who provided the information for the independent assessment may have underestimated exports due to his unfamiliarity with the increasing proportion of exports travelling by air. Alternatively, on a national level, official data may be contaminated with fish that were not live food reef fish. Of particular concern was the large amount of fish now recorded as being exported from Jakarta airport. Although it was known that some live food reef fish were transhipped via Jakarta airport, it was not known whether other species were included in these data.

The comparison of Indonesian official export data with Hong Kong import data was probably the most favourable comparison made. However, its should be emphasised that both sets of data are estimates and have a degree of uncertainty. In the case of the Indonesian data, it is likely that at least some fish that is not wild caught live reef fish is included in the export total.

None of the independent estimates have enough certainty associated with them to warrant the dismissal, or further adjustment (up or down) of the official data. Therefore, we use the official data, adjusted and unadjusted, throughout the remaining analysis of export trends for Indonesia.

Table 4.1. Comparison of estimates of live food reef fish exports with those derived from the DGF data.

Exports	Derivation of estimate	Estimate	DGF Data, 1996
from Ujung Pandang	Case study	400 to 750t	461t
from Western Sumatra	Case study	200 to 300t	97t
from Bangaii and Luwuk	Case study	30 to 60t	35t
from all of Indonesia	Interview with live fis transporter	1500t	3213t[1]
from all of Indonesia to Hong Kong	Hong Kong import data[2]	1888t	2177t[3]

1. Official data adjusted by excluding some ports as discussed above. 2. Hong Kong CSD Data from Lau and Parry-Jones. 3. Unadjusted, official export data.

Trends

There was a rapid increase in the quantity of live food reef fish exported from Indonesia, between 1989 and 1995 exports rose from less than 300t to 3800t. However, in 1996 exports dropped by 15%. Although the declared value of exports also rose during the early 1990s, by 1996 they had fallen to 1989 levels of about USD 2.50/kg (Figure 4.2).

In 1989, the majority of 'trout' and 'other' live fish[5] was exported to Singapore and Malaysia (Figure 4.3). Although exports to these countries had increased through time, those to Hong Kong had increased at a far greater rate (Figure 4.4). The proportion of fish exported to Hong Kong rose steadily, to a maximum of 75% in 1994. In 1996 Hong Kong's export share weakened, primarily due to an increase in exports to China, which contributed to 27% of all exports in that year (Figure 4.3 and 4.4). However, exports to China recorded lower values than those to other countries, suggesting that exports to China included species of lower value.

As with other fishing operations in Indonesia, the live food reef fish industry is affected by the timing of the monsoon. During this time, seas are often too rough for fishing. The monsoon season occurs between October and April for most of the country. The main exception to this pattern is Maluku, where monsoons occur between April and July. Sea travel in this province was reported to be particularly dangerous during these months. Monthly export records were available, but because they were aggregated over the whole country, they could not be adjusted to remove possible contamination by cultured fish. No seasonal fluctuations were evident for countrywide exports of 'trout' and 'other' live fish.

[5] Exports by country of destination and by month were aggregated over the whole country and thus can not be adjusted in the same way as can annual totals which were based on data from individual ports.

Figure 4.2. Quantity and average value of live food reef fish exports from Indonesia by year, 1989 to 1996. Source: Indonesian Directorate General of Fisheries

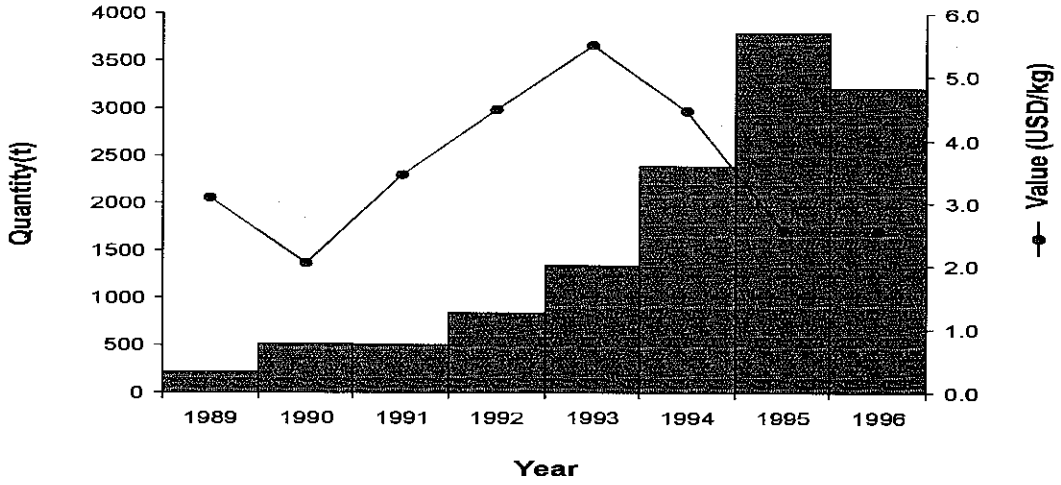


Figure 4.3. Percentage of Indonesian live food reef fish exports by country of destination, 1989 to 1996. Source: Indonesian Directorate General of Fisheries.

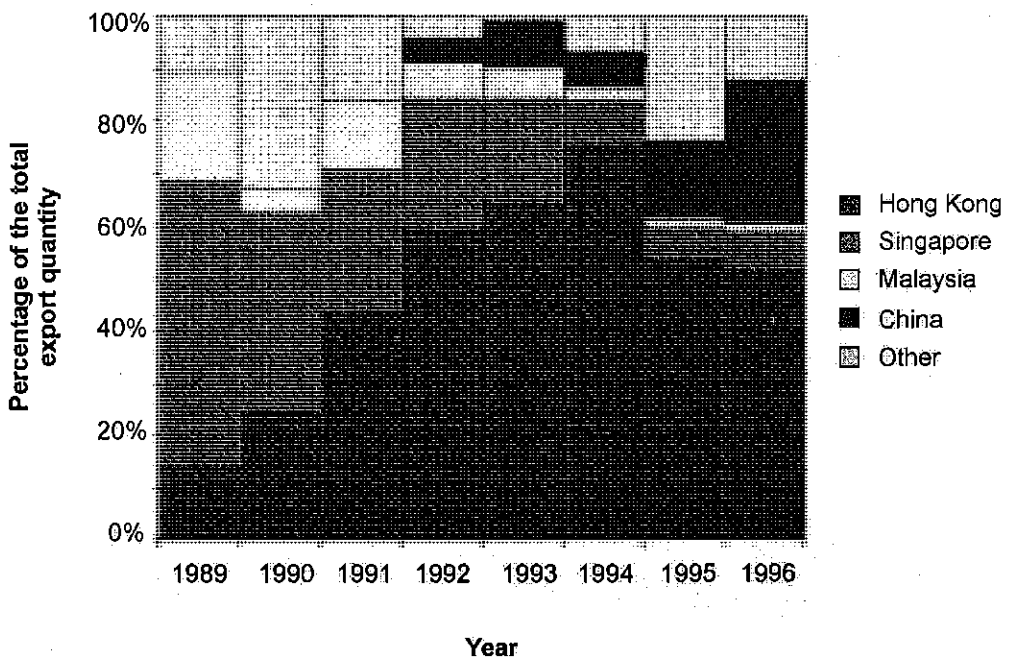
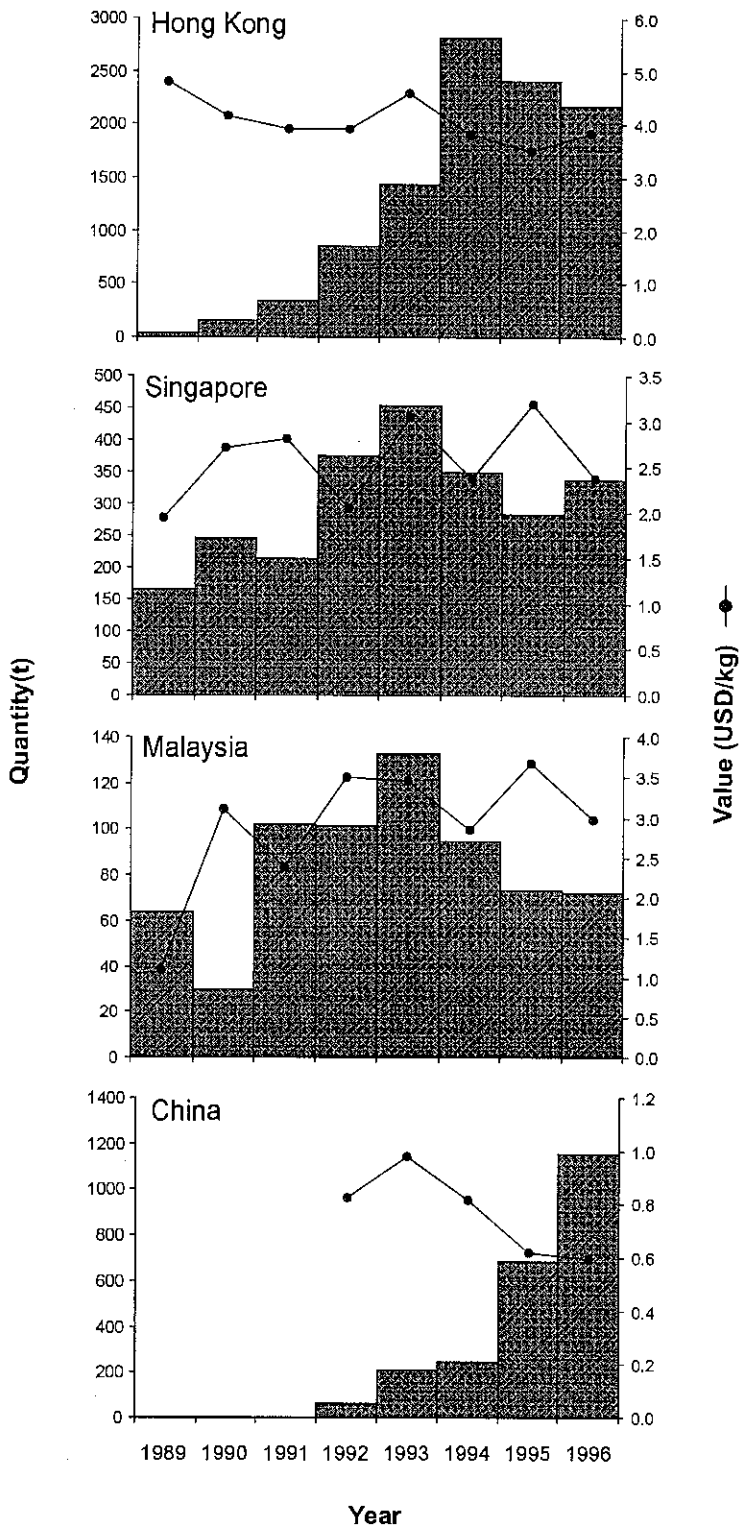
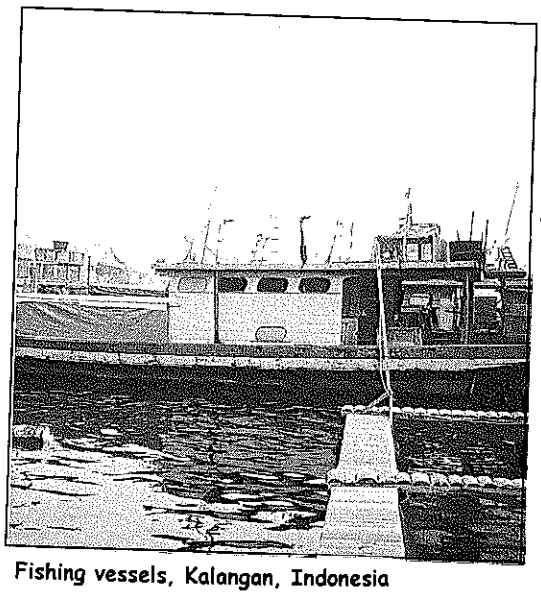


Figure 4.4. Quantity and average value of live food reef fish exports from Indonesia by year for the two major, and all other, destination countries. Source: Indonesian Directorate General of Fisheries.



Origins

A striking feature of the live food reef fish export data for Indonesia was the degree of decentralisation. Records of live fish exports span the country, from Sabang off northern Sumatra, to Biak a ninth of the way around the world in Irian Jaya. There were records of exports from very small and remote centres, such as the Tello Islands off western Sumatra and the Kei islands in southern Maluku. The progressive expansion of the live reef industry was also reflected in these data. In 1989, live food reef fish exports mainly originated from seaports in Riau and south Sulawesi and from airports in east Kalimantan, Java and Bali.



Jonathan Vea/TSEA

Fishing vessels, Kalangan, Indonesia

The geographic pattern of exports was similar in 1990, but 1991 saw the expansion into the more remote areas of southeast, central and northern Sulawesi, northern Maluku and Irian Jaya. This trend continued with exports being declared for the first time in southern Maluku and Nusa Tenggara in 1993. Although small exports had been recorded from western Sumatra in 1989, it was not until 1994 that exports from that region become significant. In 1996 there was a partial contraction in exports from most locations (Figure 4.5).

Although air exports were important during 1989 and 1990, they accounted for a small proportion of quantities up until 1993. However, in 1994 there was a dramatic increase in air exports and by 1995, they represented 39% of total export quantities (Figure 4.6). This rise was almost solely attributable to increases in exports from Jakarta and Ujung Pandang airports, which in 1995 were the largest (35%) and third largest export ports (10%) in Indonesia.

Most ports in Indonesia had small and sporadic exports of live food reef fish. To more effectively examine the patterns of fluctuations, ports were grouped into 14 regions (Figure 4.1). Western Java and Bali were separated from eastern Java because of information suggesting that Jakarta and Denpasar were important export points. Recorded exports from Bali had never been great but those from Jakarta had increased dramatically since 1994. Note also the early rise and fall of live fish exports from eastern Java (Figure 4.7a). The remaining 11 regions can be grouped based on the time at which live food reef fish exports began, which corresponds well to their relative degree of isolation. Riau, Bangka and Belitung; the Anambas and Natuna islands; southwestern Sulawesi; and Kalimantan all had significant exports of live food reef fish by 1989.

Exports in all these regions rose to a peak between 1993 and 1995 (Figure 4.7b). In the more remote areas of southeastern Sulawesi; northern Sulawesi, and northern Maluku and Irian Jaya, exports of live food reef fish were not recorded until 1990 or 1991. Here too, there was an increase in exports for the next few years, followed by a decline. Of particular interest was the similarity in trends for southeastern Sulawesi - northern Maluku and Irian Jaya (Figure 4.7c). Recorded exports from the last group of regions did not become significant until 1992 or 1993. Exports from central Maluku and Nusa Tenggara peaked in 1995, while those from western

Sumatra and southern Maluku continue to rise (Figure 4.7d). These latter two regions were among the most remote areas in Indonesia.

Despite the differences in magnitude and timing of exports among regions there was a remarkably consistent pattern. To examine for commonalities among regions, independent of timing and magnitude, differences were scaled relative to the peak year in each region and time was centred relative to the peak year. Thus, export peaks were all given a value of 1, at time 0, the peak year. For most regions, exports took only three to four years to reach their peak (Figure 4.8). The similarity was all the more notable for the fact that timing and magnitude of peaks were different. This suggests that the similarity was not merely due to multiple realisations of the same trend, but rather it was a reflection of an intrinsic characteristic of the industry in Indonesia.

The most dissimilar trend was that for Riau, Bangka and Belitung where exports rose at a more gradual rate before falling (Figure 4.8a). Also notable, was the fact that those regions which experienced a rapid rise in exports, also experienced a rapid decline after their peak (eg. Nusa Tengarra, north Sulawesi, central Maluku, southeastern Sulawesi, Figure 4.8b).

Figure 4.5. Map of quantities of live food reef fish exports by Indonesian port of exportation, 1989 to 1996. Source: Indonesian Directorate General of Fisheries.

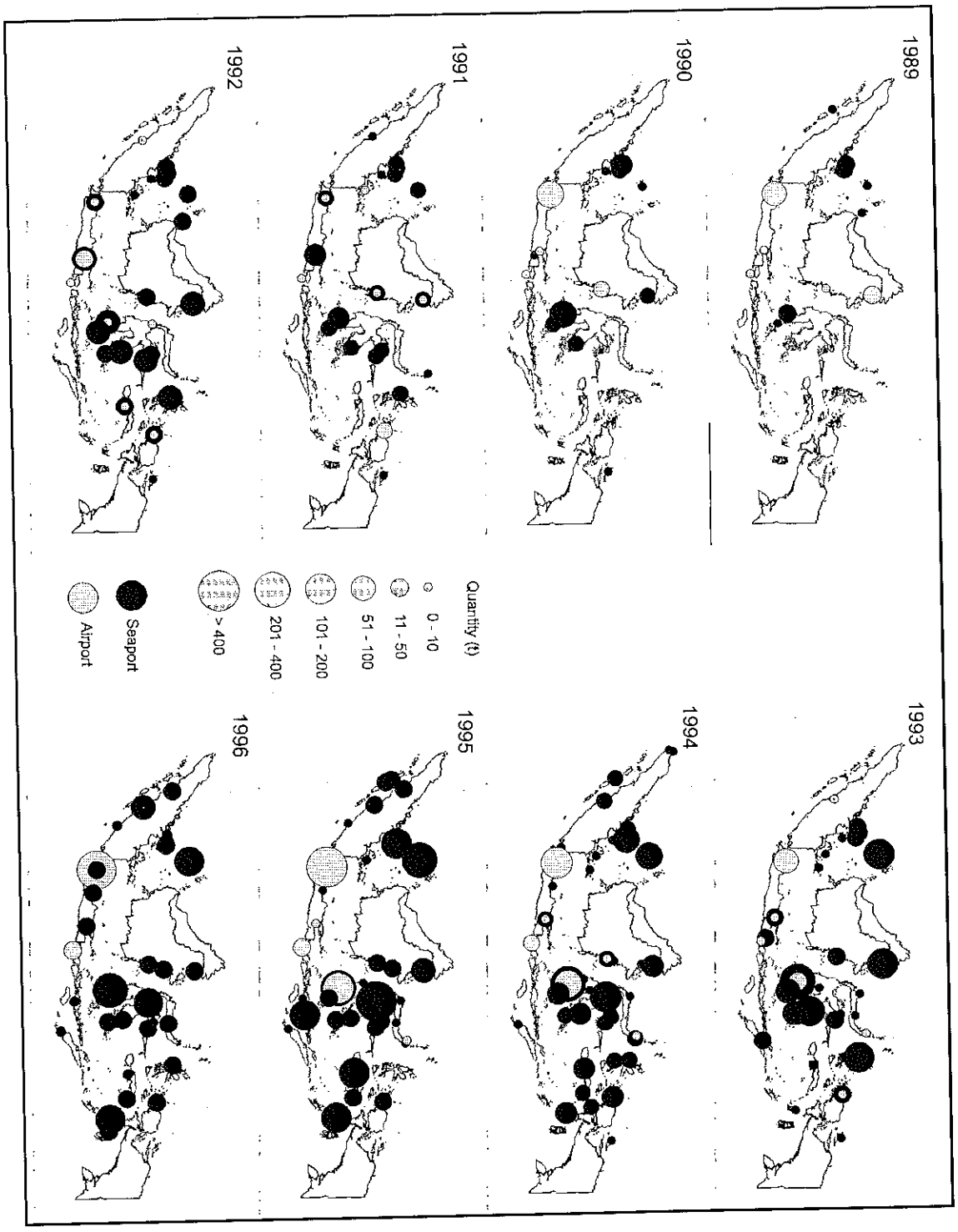


Figure 4.6. Annual quantity of live food reef fish exports by sea and by air, Indonesia, 1989 to 1996. Source: Indonesian Directorate General of Fisheries.

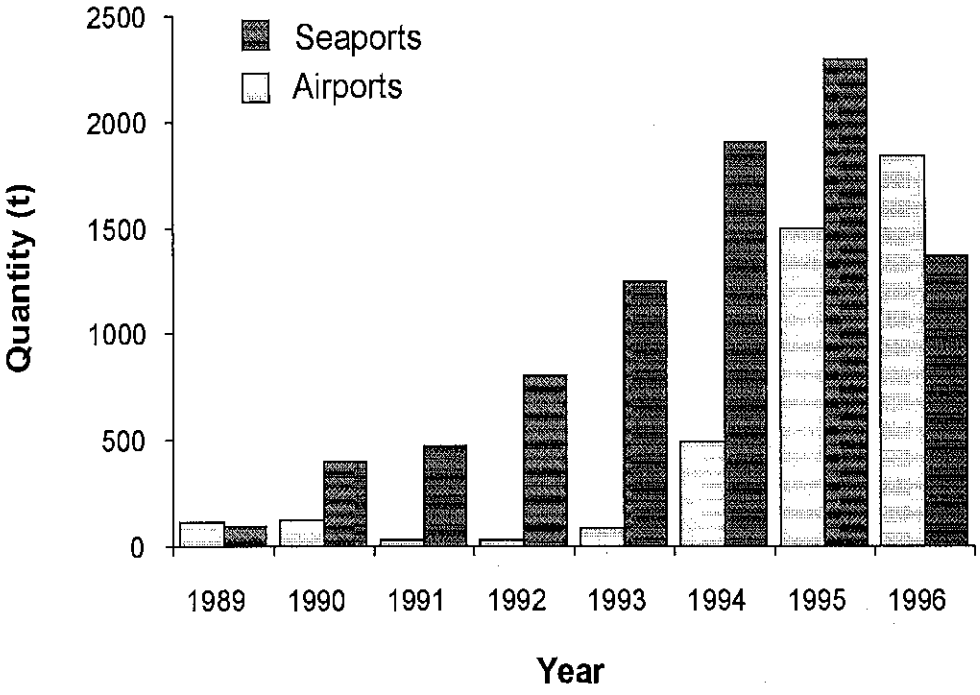


Figure 4.7. Annual quantity of live food fish exports from each of fourteen regions in, Indonesia, 1989 to 1996. Source: Indonesian Directorate

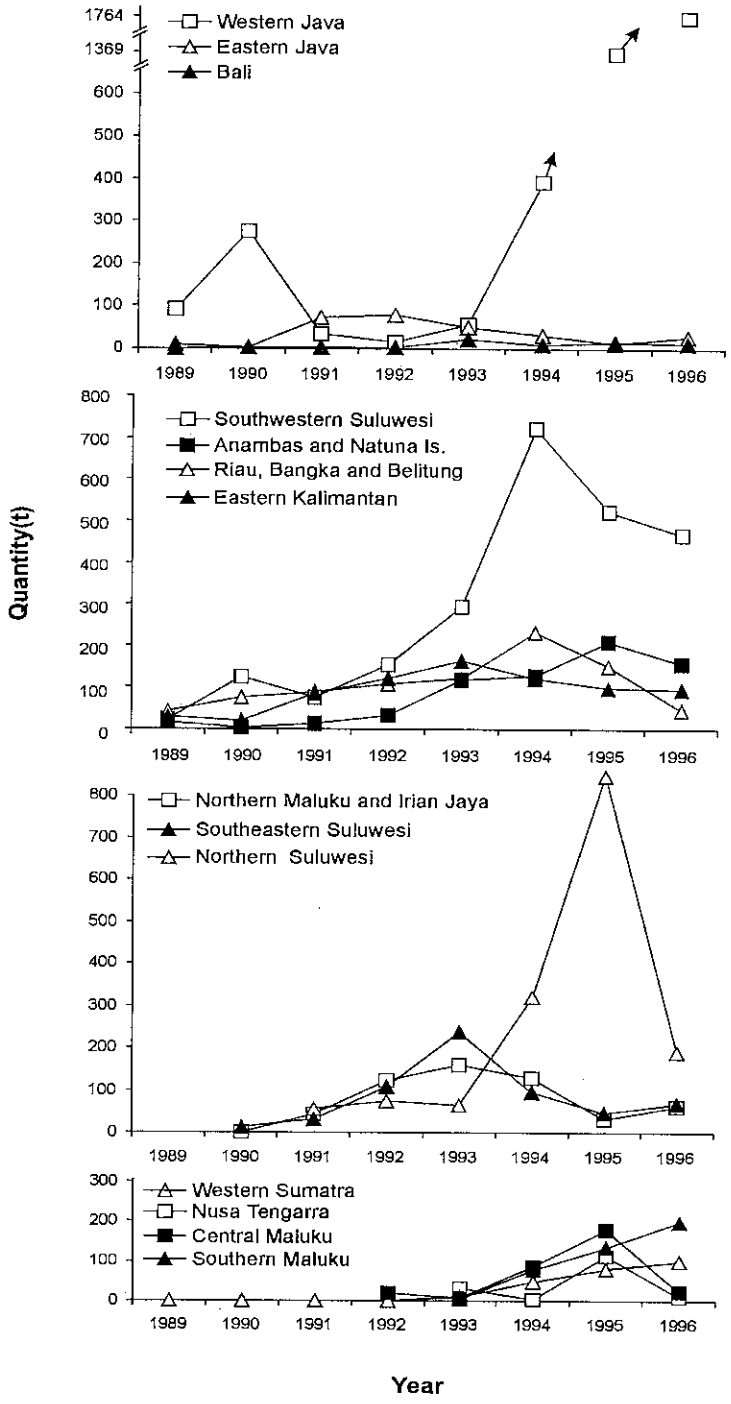
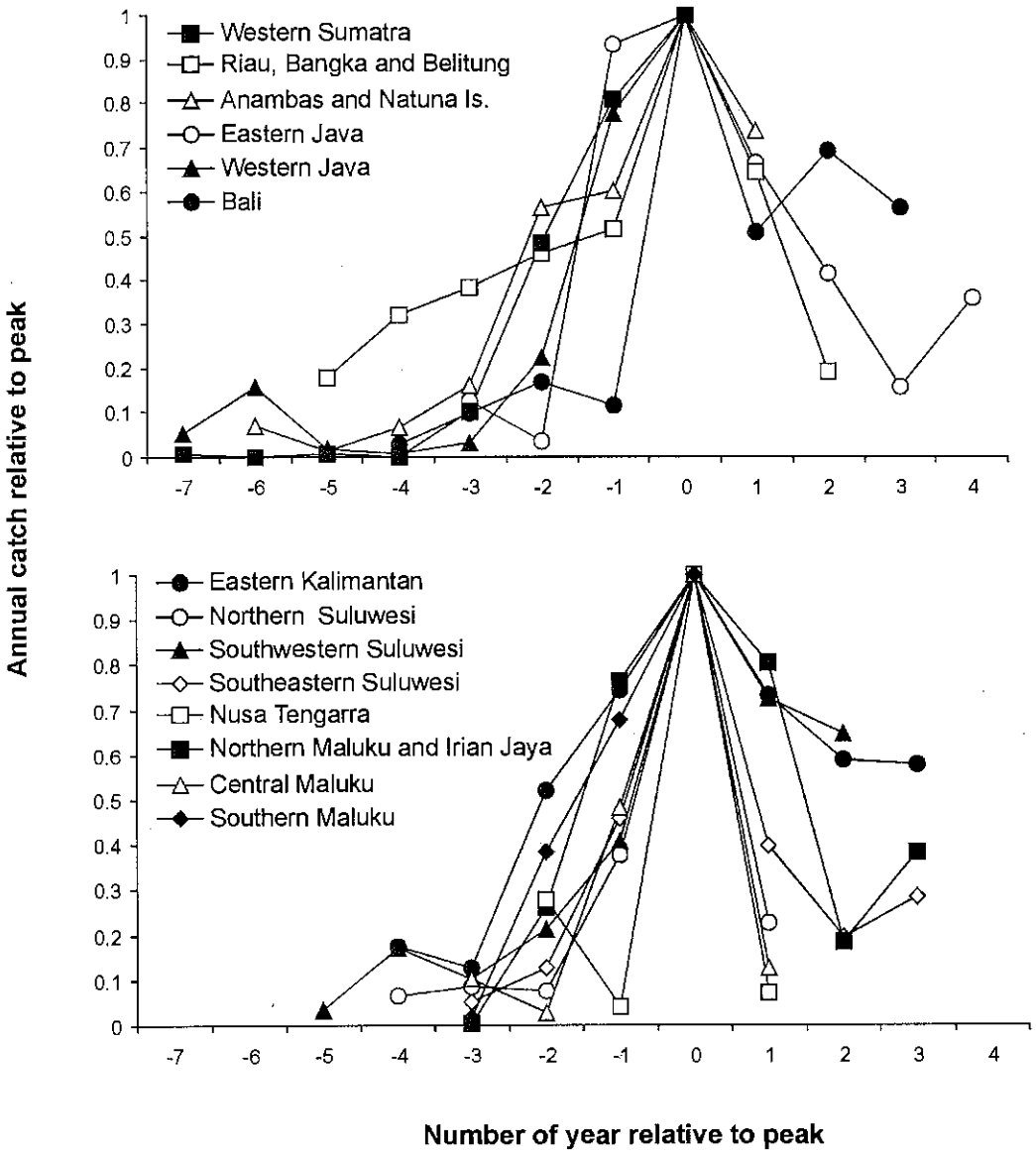


Figure 4.8. Scaled and centred (see text) live food reef fish exports from each region. Source: Indonesian Directorate General of Fisheries



Case Study A.

Ujung Pandang and the Spermonde Archipelago

Lida Pet-Soede[6] and Nokome Bentley

To the west of southern Sulawesi lies the Spermonde Archipelago, where hundreds of coral reefs and islands cover an area of over 16 000 km^2. These reefs have supported fisheries for centuries, but in the last four decades the local papulatian has increased dramatically. The area now supports two to three hundred fishing households per kilometre of coastline and is widely considered to be the largest coral reef fishery in Indonesia.

A variety of fishing methods are used in the area, including gillnets, purse seines, lift-nets, traps and hook and line. Across the Spermonde Archipelago, there is a degree of specialisation in fishing techniques in which each island tends to use more of one method than the others.

The local Makassarese and Buginese fishers are well known for their seafaring skills and for centuries have made long distance fishing trips to areas such as northern Australia (Wallner & McLoughlin 1995). This tradition continues today, with fishers often travelling long distances in search of valuable commodities such as shark fins, sea cucumbers and live reef fish.

The city of Ujung Pandang lies on the coast adjacent to the Spermonde Archipelago. It is one of the largest cities in the country and has long been the hub of sea transportation in eastern Indonesia.

This case study examines the live fish industry in the Spermonde Archipelago and Ujung Pandang. Firstly we provide a brief history of the fishery in the area and then describe the current structure of the industry from fishers through to exporters.

History

According to fishers, the capture of live reef fish was begun in 1990 by vessels from Hong Kong and Taiwan. These aperations were self contained, bringing in their own equipment and crew. Small skiffs were used to tow divers along the surface, who then used cyanide to catch a fish once spotted. Soon, foreign divers taught locals how to use cyanide. Operators found hiring local labour cheaper than bringing in their awn divers, and within a short time, many operations had predominantly Indonesian crews.

Independent local fishers also discovered that they could make good money by selling fish to foreign vessels. Local entrepreneurs took advantage of the new business and established collection facilities for live reef fish. Within a year, the fishery was dominated by locally based catching operations and the foreign vessels took over the role of transporting fish to markets overseas. This also made it easier for foreign companies to operate, as a license to fish in Indonesian waters was difficult to obtain.

During the early 1990s, most of the catch of live fish was taken around the reefs of the archipelago. Catches then began to decline and fishers started searching further afield. The sea cucumber

[6]Most of this case study is based upon research done by L. Pet-Soede as part of a PhD dissertation on the fisheries of the Spermonde Archipelago, Wageningen Agricultural University, The Netherlands and Hassanudin University, Indonesia.

fishers from Barrang Lompo Island, particularly experienced seafarers, led many of the first long distance expeditions for live reef fish. By 1996, live fish operations were going as far as east Kalimantan, southeast Sulawesi and Maluku and Irian Jaya in search of new fishing grounds. Despite the dispersal of fishing activities, exporting operations remained close to Ujung Pandang where administration and transportation facilities had been established.

Fishers

Operations based in the Spermonde Archipelago used traps, cyanide and hook and line to catch live reef fish. Within each gear type, operations can be categorised according to their scale, methods and the degree to which they specialise in live reef fish. Although the leopard coralgrouper are the most commonly caught species, trap fishers in particular commonly catch a range of grouper species.

Traps

Trap fishing operations can be divided into three categories depending upon the method used to deploy the trap (Table 4.2). On most islands, older fishers who are not necessarily targeting grouper use a rope and buoy to deploy their traps in 10 to 40m of water. On Kondong Bali Island, snorkelling is the preferred way to set and retrieve traps, although this limits fishing to depths of less than 10 m. The island of Bone Tambung has the greatest number of operations which dive using compressor and hose to deploy traps. This allows them to regularly fish in depths of 20 to 40m.

Trap fishing is usually done from medium sized vessels with four to five crew and fifteen to twenty traps. Each morning, sardines are bought from purse seiners or lift-netters and cut up to be used in the traps as bait. A recent innovation has been to soak the sardines in cyanide solution. This technique tranquillises the fish that are caught, thereby reducing self inflicted damage caused when trying to escape from the trap.

The traps are set in the morning, lifted after about two hours, catch removed and then set again. According to fishers, checking traps frequently prevents saturation: other fish being scared away by those already in the trap. Traps are usually set for a total of four to five hours per day. Trap fishing is also combined with cyanide fishing; fishers deploy traps and then search for fish to stun with cyanide administered from squirt bottles.

Trapping boats usually make daily trips within the Spermonde area or trips of 3 to 4 days to the area around Mamuju to the north. Once every three to four months, they may join sea cucumber and blast fishing operations for longer journeys to Kalimantan and southeast Sulawesi (Table 4.2).

Catch rates are highly variable, and although two grouper per trap per day is considered good, logbook records indicate that catches of up to 100 coralgrouper per day per boat are possible (Figure 4.9).

Fish mortality rates are generally between 10 to 20 % but are reduced when cyanide is used in conjunction with bait. Mortality is significantly higher, up to 100%, when the traps are left for longer periods.

Table 4. 2. Characteristics of the three scales of trap fishing operations in the Spermonde Archipelago.

	Compressor-diving	Free-diving	Rope and float
Estimated number of operations	25	25	50
Crew per boat	3 - 4	3 - 4	1 - 2
Days per trip	1	1	3
Trips per month	15	20	7
Length of boat (m)	5	5	3
Engine type	inboard	Inboard	outboard
Local name for boat	'joloro'	'joloro'	'lepa-lepa'
Area of operation	Spermonde and East-Kalimantan	Kondongbali and Kapoposang	Spermonde Archipelago
Type of buyer	mainland dealer	island dealer	island dealer
Costs per trip (IDR)	400 000	22 500	5 000
Catch per trip (kg)	60 - 100	2 - 8	0 - 1
Price (IDR/kg)	17 500	25 000	17 500

Cyanide

There are three scales of cyanide fishing operations (Table 4.3). Larger vessels have a capacity of one to two tons and go further afield to search for fish, returning their catch to holding cages after three weeks of fishing. They generally have well organised teams of divers with six to ten fibreglass skiffs, each with holding compartments for keeping fish alive. From around eight in the morning, divers search for fish for about four hours and then rest for lunch. They then dive again in the afternoon until about 3 PM. The largest costs of the operation are food for divers and fuel.

Medium scale operations are similar to those with larger vessels but do not travel so far. Each trip lasts between one to three days during which time five to ten bottles of cyanide are used per day depending upon the abundance of fish.

The smallest scale of operation are one person wooden canoes with a small engine. In these canoes, a small section of the hull is sealed off and holes drilled in the base to allow water to flow in. Fishers free dive using only a mask to catch fish and their main expense is for cyanide.

The cyanide tablets used to make up the bottles of solution can be bought locally, or are supplied by the dealer who buys bulk amounts from local chemists. Availability of cyanide is enhanced by the large number of gold shops in Ujung Pandang, which requires the chemical for processing. The amount of cyanide required for each bottle costs about IDR 5000 (USD 1.66).

Mortality rates for fish caught using cyanide depend on the size and species of fish. Improved handling techniques, including the use of antibiotics and hypodermic needles to deflate air bladders[7], have reportedly decreased mortality rates from 40 to 10%.

Table 4. 3. Characteristics of the three scales of cyanide fishing operations in the Spermonde Archipelago.

	Small scale	Medium scale	Large scale
Estimated number of operations	50	50	4
Crew per boat	1	3 - 5	15 - 20
Days per trip	1	1 - 3	25 - 30
Trips per month	20	7	1
Length of boat (m)	3	5 - 8	15
Engine type	outboard	Inboard	inboard
Local name	'lepa-lepa'	'joloro'	'kapal motor'
Area of operation	Spermonde Archipelago	South Sulawesi and Kalimantan	Northern Java to Maluku
Type of buyer	island dealer	mainland dealer	transporter
Costs per trip (IDR)	15 000	180 000	45 million
Catch per trip (kg)	1 - 3	10 - 20	1000 - 3000
Price (IDR/kg)	25 000	37 500	50 000

Hook and line

Hook and line fishers can be divided into three categories based upon the frequency with which they target live reef fish (Table 4.3). Fishers from the islands of Lanyukan, Sarappo Lompo and Barrang Caddi fish for live reef fish all year round. Others on Barrang Caddi and Lankai Islands fish for live fish and Spanish mackerel (*Scomberomorus* spp) all year round. On the island of Kapoposang, they only fish for live reef fish when frigate mackerel (*Auxis* spp) are not able to be caught.

Many hook and line fishers use four meter long wooden canoes, locally known as *lepa-lepa*, with a 5.5 horsepower outboard engine. These are traditional canoes which have been modified to include a 50 litre holding compartment with holes in the hull to allow fresh water to enter. Larger boats with an inboard engine and holding tanks of 500 litre capacity are also used.

[7] This is required to prevent the rapid change in pressure, due to the change in depth, from rupturing the fishes' internal organs.

Most hook and line fishers use monofilament synthetic line, a large hook and no weights. As with trap fishers, dead sardine or mackerel are obtained from purse seiners or lift netters each morning prior to fishing. In addition to the bait on the hook, sardines are often thrown in the immediate vicinity to attract fish. An alternative method is to troll a wire line with an artificial lure of feathers and imitation plastic fish.

Once hooked, fish must be retrieved quickly to prevent them from entangling the line on the coral reef. If the line gets caught, it is usually cut and the fish, hook and part of the line are lost. Once brought onboard the boat, fish are pierced with a hollow hypodermic needle between the pelvic and anal fins to deflate the airbladder. The main costs of fishing are fuel and line and hooks, which are frequently lost due to fouling on the reef

Catch rates are variable although it is unusual to catch more than four grouper per day. Most days one or two live reef fish are caught, and often no catch is taken (Figure 4.9).

Fish mortality rates during hook and line fishing can be high, particularly if the fish are not retrieved quickly and damage occurs on the reef while trying to escape. Fishers report a mortality rate of 40 to 50%.

Table 4. 4. Characteristics of the three scales of hook and line fishing operations in the Spermonde Archipelago.

	Full-time	Grouper and mackerel	Part-time
Estimated number of operations	300	100	50
Crew per boat	1	1	1
Days per trip	1	1	1
Trips per month	25	25	20*
Length of boat (m)	5	5	3
Engine type	inboard	inboard	outboard
Local name for boat	'joloro'	'joloro'	'lepa-lepa'
Area of operation	Spermonde Achipelago	north & south of Lankai Island	east of Kapoposang Island
Type of buyer	island dealer	island dealer	island dealer
Costs per trip (IDR)	10 000 - 15 000	10 000 - 15 000	5 000
Catch per trip (kg)	0 - 4	0 - 4	0 - 4
Price (IDR/kg)	17 000 - 35 000	25 000	17 500

* Only for about 5 months per year during the off-season for frigate mackerel.

From the data presented in Tables 4.2 to 4.4, it is possible to compare the annual production for each type of operation and to estimate a total catch for the area. We estimate that compressor

diving trap fishers account for the greatest proportion of catch and exports. Although there are a large number of hook and line fishers, their low catch rates and high rates of mortality mean that they probably do not contribute significantly to exports (Table 4.5).

There are also differences in the average size of fish caught. Generally the largest fish are taken by cyanide fishing, medium sized fish by all methods, and small fish with hook and line, and traps.

The profits made from live reef fish operations are much higher than for other forms of fishing with the same scale of capital investment. For example, the average daily profit for demersal trawler, purse seine and lift-net operations is around USD 30. An alternative to live reef fish for small scale fishers is hook and line fishing for pelagic species, which realises a profit of only USD 1 to 2 per day. Perhaps the most attractive alternative for small scale fishers is blast fishing, which nets about USD 7 per day.

From our estimates of the number of operations of each gear type, we estimate that the industry in the Spermonde Archipelago involves about 650 operations employing about 1000 fishers. These operations probably catch around 700 t, of which about 600 t survives until exported (Table 4.5).

Table 4.5. Estimated annual production for various forms of live fish operations in the Spermonde Archipelago.

	Annual catch (t)			Fish killed (t)*	Exports (t)°
	per vessel	per person	all vessels		
Trap					
rope and float	<1	<1	3	4	3
free diving	1	<1	45	56	41
compressor diving	16	5	405	506	365
Cyanide					
small	<1	<1	36	40	32
medium	1	<1	95	105	85
large	24	1	108	120	97
Hook and line					
part-time	<1	<1	10	20	9
mixed	<1	<1	30	60	27
full-time	<1	<1	105	210	95
All methads			837	1121	753

These estimates should be considered as a rough guide to the relative production of each method. Values have been calculated from estimates of averages and do not necessarily correspond to range

midpoints presented in Tables 4.2 to 4.4. * The quantity of fish killed has been calculated by taking into account the onboard mortality associated with each method as presented in the text. °Exports were calculated by taking into account a holding cage mortality of 10%.

Dealers

With the shift towards local operations in the early 1990s, two types of holding cage aperations became established. Smaller cages are now found at most islands in the Spermonde Archipelago. Here, local dealers buy and hold fish that are taken to larger holding cages every two to three days. Larger holding cages collect fish from numerous local dealers until they have sufficient quantities to be shipped. The major holding cages are now on the island of Barang Caddi and Bone Tambung. We have observed an increase in the number af holding facilities at the former island in recent years, from two operations with about eight cages in 1996, to 7 operations with over 50 cages in 1997.

As is commonly the case throughout Southeast Asia, fishers are paid different prices depending upon species and size. The most valuable species are humphead wrasse and humpbacked grouper (Table 4.6). Species such as the highfin coralgrouper are not bought because of high mortality rates. Small fish and those species that have a high mortality rate in captivity, are killed, salted and dried.

The relationship between fishers and dealers is not always ane of open exchange. Often the fisher may be obliged to sell to a particular dealer at a price that is lower than the current market price. This obligation arises from the debt that the fisher owes the dealer. During the rainy season, when seas are too rough to go fishing, fishers rely on loans from fish dealers. Similar loans are sought when household hardship such as sickness arises. The wives of fishers may also borrow money from the wife of the fish dealer. This type of arrangement is a widespread societal institution among fishing communities in the Spermonde Archipelago.

In some cases, there is an open relationship in trade and the fisher is able to sell to the highest bidder. However, such relationships are rare in the Spermonde Archipelago.

Table 4. 6. Prices paid to fishers by dealers and to dealers by exporters for various species and sizes of live reef fish.

Species category	Fisher	Dealer
Humphead wrasse		
All sizes	40.000/kg	125.000/kg
Humpbacked grouper		
> 1.2 kg	60.000/kg	110.000/pc
0.6 kg - 1.2 kg	60.000/kg	90.000/kg
0.3 kg - 0.5 kg	NA	50.000/kg
Malabar grouper		
All sizes	45.000/kg	100.000/kg

Leopard coralgrouper		
1.2 kg	40.000/pc	70.000/fish
0.6 kg - 1.2 kg	25.000/kg	50.000/kg
0.3 kg - 0.5 kg	10.000/kg	20.000/kg
Spotted and blacksaddled coralgrouper		
> 1.2 kg	20.000/kg	30.000/kg
0.6 kg - 1.2 kg	17.500/kg	25.000/kg
0.3 kg - 0.5 kg	10.000/kg	15.000/kg
Squaretail coralgrouper		
> 1.2 kg	17.500/kg	25.000/kg
0.6 kg - 1.2 kg	10.000/kg	20.000/kg
0.3 kg - 0.5 kg	2.000/kg	10.000/kg
All other grouper species		
0.6 kg - 7 kg	3.000/kg	8.000/kg
0.3 kg - 0.5 kg	3.000/kg	15.000/kg

These are prices paid in an open dealer-fisher relationship for healthy fish. Wounded fish sell for 50% less.

Exporters

There are several live reef fish exporters in Ujung Pandang[i], who transport fish by sea or air. According to official export data, there has been a strong shift toward air exports over the last 5 years (see 'Exports' section above). Fish that are to be exported by plane are brought to holding facilities on land in Ujung Pandang, where they are held for a maximum of one week before being flown to Bali or Jakarta. Here they are often held for up to one week to allow them to recuperate and are then repackaged for the flight to overseas markets.

Fish that are to be exported by sea, await collection in holding cages until large enough volumes are amassed to justify a pick up. This will depend on the rate at which fish are supplied to holding cages. In Ujung Pandang this usually takes about two weeks. The transport vessel takes about one week to reach Hong Kong.

The island of Barang Caddi is the centre of live fish trade in the Spermonde Archipelago. It has 7 collection operations, sending about 300kg of fish, eight times per month to Ujung Pandang. This is equivalent to about 200t annually. We estimate that this island handles 50% of the total trade in the area, which suggests that total exports are approximately 400t. This is lower than our estimate of 753t based on daily catches and mortality rates (Table 4.5).

Figure 4.9. Frequency distribution of daily catches by hook and line, compressor diving trap, and large scale cyanide fishing operations

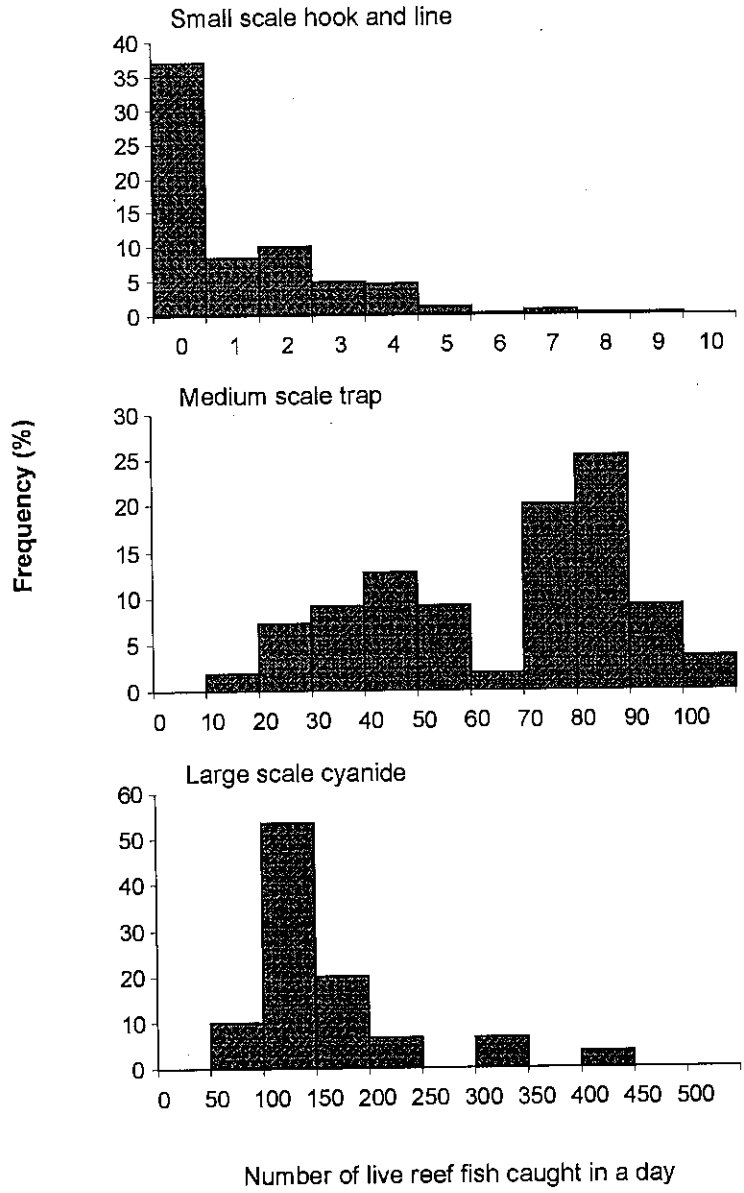
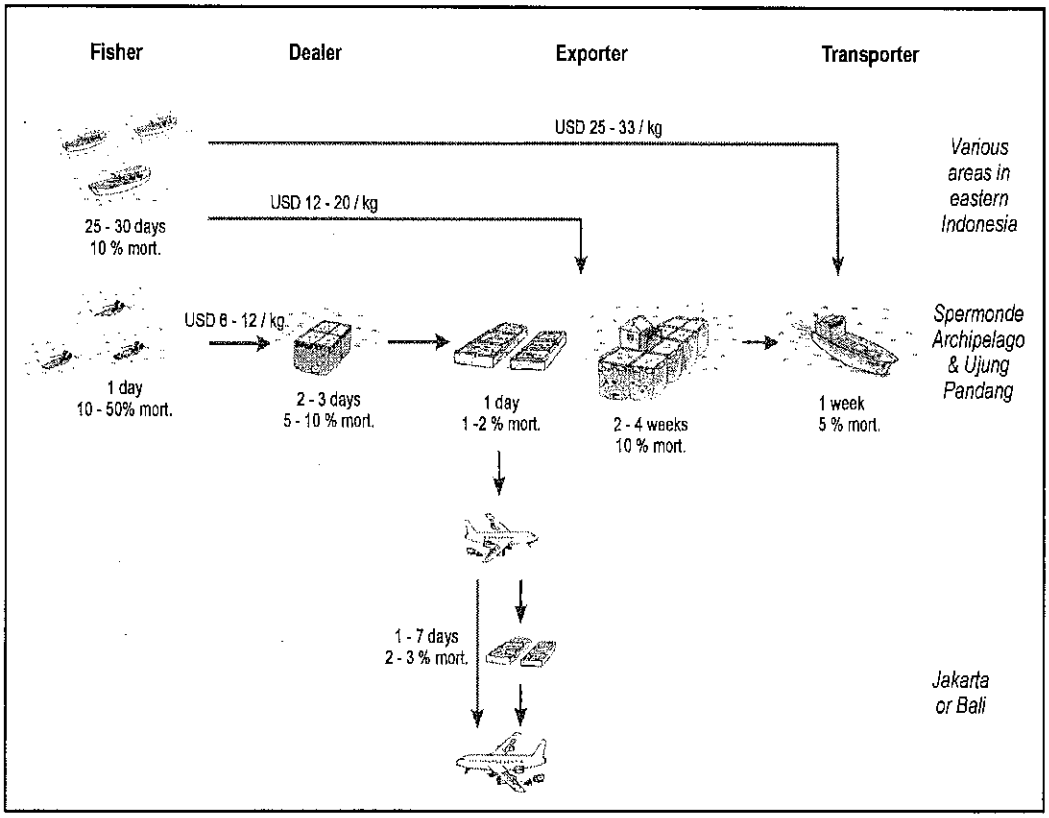


Figure 4.10. Schematic diagram of the trade and transportation of live fish in the Spermonde Archipelago



Case Study B.

Banggai Islands

Mochmad Indrawan and Nokome Bentley

To the east of Sulawesi lie the remote Banggai Islands. This small group forms a link between Sulawesi and the western islands of Maluku and contains barrier, atoll, fringing and patch coral reefs. The islands have a population of about 337 000 people from the Banggai, Sulu, Buton, Bajau and Bugis ethnic groups.

Traditionally, fisheries in the area have focussed on pelagic species such as tuna and squid, and reef species including trevallies, rabbitfish, fusiliers and eels. The Bajau, who are well known in eastern Indonesia as 'sea gypsies' with exceptional diving abilities, dominated such activities. In 1987, these people began to target live reef fish in the area using hook and line. But it was not until the early 1990s that the industry proliferated and reached its peak in the mid-1990s.

The live reef fish industry in the area is dominated by integrated catching and exporting operations. Currently, there are about ten of these operations in the area and one company in the area is reported to employ as many as 30 personnel on site.

Exporting companies employ fishers in two alternative ways. Some fishers are employed full time and receive a salary, bonuses and all equipment (including a boat, fuel and traps). Others work on a commission basis, whereby they are supplied with all necessary equipment but no salary, and are committed to selling only to one exporter.

Exporters obtain a small proportion of their fish from dealers or directly from independent fishers. Only four live reef fish dealers are known to operate in the Banggai Islands, less than half the number of exporters. There appear to have been problems with high mortality rates and hence profitability in some of these smaller operations. One dealer reported a low profit margin, about 5% of what a well-equipped and well-connected exporter would make per kilogram of fish.

Several catching methods are used to catch live reef fish. Although independent fishers favour hook and line for most species, it is not thought to be suitable for Humphead Wrasse because of the damage that could be caused to the fish's mouth.

Hand netting involves chasing fish into crevices where they can be caught. This can be particularly effective using a torch at night, when fish are sleeping and more vulnerable. According to fishers, all species, including Humphead Wrasse, can be captured this way.

Recently attention has shifted towards coralgrouper and groupers. Divers have discovered that these species can be targeted effectively when they aggregate for spawning.

Stupefacients are often used to stun fish. Potassium cyanide is the most common chemical used although less effective anaesthetics derived from tubers, detergent and/or tobacco are also employed. Fishers can obtain cyanide tablets from local trading shops. It has also been alleged that live fish transport vessels also distribute cyanide to fishers.

Fishers with equipment supplied by exporters, most often catch live reef fish using cyanide. Usually two men operate each boat, one driving while the other is towed along in the water to spot fish. Some experienced fishers can operate alone. Once a fish is spotted, often both men will enter the water to corner the fish and use cyanide to stun it. On ascent, the fish's air bladder is punctured using a sharp object to prevent it from rupturing.

Bamboo traps are set in depths of seven to twenty metres using mask and snorkel. Divers who have hookah equipment, are able to set traps in depths of up to 30 meters. Fishers do not consider traps to be the most effective means of targeting live reef fish.

The prices that fishers receive for live reef fish have been rising steadily in the last five years. Humphead wrasse and humpbacked grouper are currently the highest paying species (Table 4.7).

Table 4. 7. Prices paid to fishers by exporters for various species of live reef fish.

Species category	Price (IDR/kg)[1]	(USD/kg)
Humphead Wrasse	12 000 - 15 000	4 - 5
Humpbacked grouper	10 000 - 15 000	3 - 5

Leopard and spotted coralgrouper	10 000 - 12 000	3 - 4
Various grouper species	7 000 - 10 000	2 - 3

1. Prices for fish between one and five kilograms

Exporters have holding facilities with four to eight nets, each with a volume of about 26m^3. Each exporter has one 15t wooden carrier vessel that is served by four to five small fibreglass boats with holding boxes built into their hulls. Among these boats, one or two sets of hookah equipment may be used.

This equipment is estimated to cost around IDR 50 million (USD 16 667; Table 4.8). Often exporters are involved in other business interests. Ongoing operation costs include boat fuel (about IDR 1 000 000 (USD 333) per month), diver salaries (IDR 150 000 (USD 50) per month), cyanide tablets (about two kilograms required for five divers each month), packaging and shipment charges.

Table 4.8. Estimated costs of capital equipment for establishing live reef fish capture and export operations in the Banggai Islands

Item	Cost (IDR)	(USD)
Floating cages (incl. nylon nets, plastic barrels and wooden planks)	7 000 000	2 333
Five boats	200 000	67
Five outboard motors	3 000 000	1 000
Five sets of diving equipment	400 000	133
One 15 t carrier vessel	10 000 000	3 333
Diving compressor and hose	20 000 000	6 667
Total capital equipment	40 600 000	13 533

Once a sufficient quantity of fish has been amassed the exporter will contact the live fish transporter, in Hong Kong or other centres, wha will arrange for pick up. When the industry first started, each time a transport vessel collected fish it would take ten tons. Nowadays, shipments of three tons are more common. Exports by air of live fish from Banggai have been attempted in the past but proved to be uneconomical. Mortality rates are reported to be between 10% to 50% from the point of capture to export. Some species, such as the Humphead Wrasse, have been found to be hardier than others.

Based on interviews with exporters and the number of holding cages in the areas, it is estimated that 30 to 60t of live fish are currently exported each year.

There has been a high degree of transience in the live fish industry in the Banggai Islands. Exporters have come from as far away as Riau and have moved on further east to Nusa Tenggara and Irian Jaya, either abandoning or relocating their floating cage facilities.

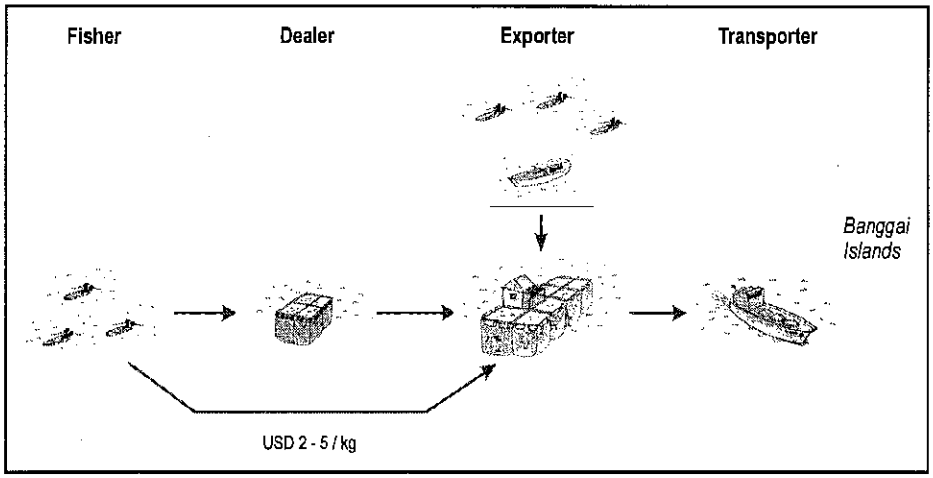
Fishers report that Humphead Wrasse are noticeably scarcer and; whereas, five years ago individuals weighing 45kg could be caught, fish over 25kg are now rare. Fishers are travelling further away, towards the Bowakan Islands to the south, in search of live reef fish.

Because of a reduction in the abundance of live reef fish, many of the Bajau people who started the industry ten years ago have shifted their attention back to pelagic species. Fishers attribute the decline in the abundance of live reef fish and other species to destructive fishing practices such as cyanide and blast fishing.

It is clear that regulations that have been imposed on the capture and sale of Humphead Wrasse (see Regulations section) are not being adhered to in the Banggai Islands. This includes the export of fish outside of the size limits specified and the continued use of cyanide.

Fishers and exporters acknowledge that the integrated patrolling operations by the local police, fisheries officers and the navy are of concern when performing illegal fishing operations. However, given that the nearest naval base is in Kendari, southeast Sulawesi, these patrols were too infrequent to have a major impact on these activities.

Figure 4.11. Schematic diagram of the trade and transportation of live reef fish in the Banggai Islands



Case Study C.

Western Sumatra

Nokome Bentley

Despite its proximity to Java, Singapore and Malaysia, the western coast of Sumatra is a remote area, with only a few roads or ports. The largest areas of coral reef are found on the leeward sides of its numerous offshore islands. Reefs also straddle the coast of the mainland in certain areas. This case study briefly describes the live fish industry in the Mentawai Islands and around the town of Sibolga.

Mentawai Islands

The Mentawais are a remote archipelago stretching from Siberut Island to South Pagai Island. They have remained isolated from the modern world for some time and many of the population still practice traditional forms of hunting and farming.

In 1993, an Indonesian company[ii] established live fish exporting operations at Sikukap on North Pagai Island, at an estimated cost of IDR 300 million (USD 100 000 in 1997) (Anon. 1993). Within a few years, it had expanded operations to include two more holding facilities at Sarabua Bay, Siberut Island and on Sipora Island. There are unconfirmed reports that the company currently also handles fish caught at Nias, Simeulue and Weh Islands, further to the north.

In the Mentawai Islands, the company has a monopoly over the live fish industry, which has become a major part of the coastal economy. Its presence has stimulated a fishery that has brought thousands of dollars to the local economy. The company employs fishers on a full-time basis and within three years of establishment had recruited and trained over 500 Mentawaians to catch live fish (Anon. 1996c, Anon. 1996b) In addition, the company buys fish from individuals who opportunistically catch live reef fish. On Siberut Island, about 200 fishers from villages such as Midappet, Limau and Sabai are involved with the company either as full time employees or by occasionally selling fish to it.

However, the company has not been without controversy. In January 1996, concerns were voiced in the west Sumatran media over the validity of its trading license and an apparent disregard for the ban on the export of Humphead Wrasse over 3kg (Anon. 1996c, Anon. 1996d, Anon. 1996a).

According to fishers, the main method used to catch live fish is hook and line. There are reports of cyanide being used to catch fish in the past (Anon. 1993). However, this practice does not appear to have been widespread and one account relates how a fisher stopped using cyanide due to community pressure. Perhaps the greatest impact on the area's already heavily degraded reefs has been the historical use of explosives for fishing.

The most commonly caught species are grouper and coralgrouper. Humphead Wrasse made up only about 5% of live fish exported by the company in 1995 (Anon. 1996a). Fishers travel for around four hours to reach their fishing grounds and some have specially designed boats with live fish holding wells that open into the sea. Peak season occurs between late October and June; during the rest of the year, seas are too rough for fishers to reach the outer reefs.

The perception that catch rates and the average size of fish have decreased in recent years is widespread amongst fishers. They report that coralgrouper are becoming increasingly rare and

Humphead Wrasse are now uncommon in the area. Fishers recall catch rates of between 50-70kg per month in 1992, and a survey done in 1994 suggested an average catch of 61kg/month (ranging between 49.5 to 72.7, (Directorate General of Forest Protection and Nature Conservation Indonesia [PHPA] 1995). Fishers now quote monthly catches between ten and fifty kilograms.

As catch sizes have dropped, the price paid to fishers has increased. In 1993, fishers were paid IDR 3 000 (USD 1)/kg for grouper and IDR 6 000 (USD 2)/kg for coralgrouper. Currently, they receive IDR 5 000 (USD 1.67)/kg and IDR 8 000 (USD 2.67)/kg, respectively. When live fish operation began in the islands, fishers received IDR 15 000 (USD 5)/ kg for Humphead Wrasse. Nowadays, they are so rare that those fishers interviewed did not know current prices. As well as live fish, fishers can also sell lower quality fish to the company for IDR 600(USD 0.20)/kg. These are used to feed the live fish awaiting transportation.

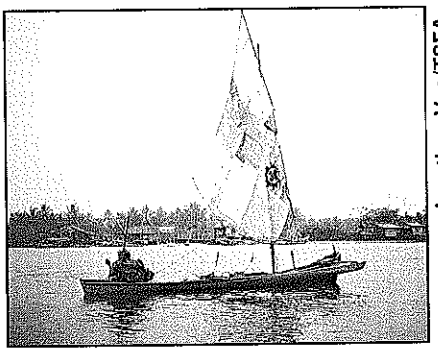
Despite the increase in prices, fishers' monthly wages have dropped. In 1992 they received around IDR 80 000 (USD 27) per day. Monthly incomes for company employed fishers have been reported to be as high as IDR 2.5 million (USD 833) (Anon. 1996b). By 1996, daily earnings had fallen by half and fishers currently earn around IDR 30 000 (USD 10) per day.

Fishing costs include about IDR 4 million (USD 1333) for a boat, and daily running expenses of about IDR 5000 (USD1.67) for fuel and IDR 300 (USD 0.10) for bait, hooks and line. The company has supplied some local fishers with equipment necessary to catch live fish. This included 40 outboard motors ((Directorate General of Forest Protection and Nature Conservation Indonesia [PHPA] 1995) and 61 motor boats (Anon. 1996b). These transactions have been on a loan basis and between 25% and 50% of fishers' wages are retained for repayment. Until the loan is repaid, fishers are obliged to sell their catch to the company.

At the end of a day's fishing, catches are taken to the company's holding pens to await pick up by a live fish transport vessel. Periodically, fish are immersed in an antibiotic solution for two minutes. Fish are transported to Hong Kong about once a month during the high season and once every three months when catches are low. It takes about 15 days to reach Hong Kong.

Mortality rates are between 30% (Directorate General of Forest Protection and Nature Conservation Indonesia [PHPA] 1995) and 40% (based on catch and export data given above). Although these rates are high, a return is made on dead fish by sending them to fish markets in Jakarta (Anon. 1993).

In 1994, 59t of live fish were caught and 35.5t exported by the company. By 1995, these figures had risen to 180t and 111.6t respectively (Anon. 1996c). The company currently exports about 6 and 10t per month during the low and high seasons respectively. This is equivalent to about 100t annually.



Jonathan Vea/TSEA

Canoe set with a small sail, Sitar Das, Indonesia

Sibolga

The town of Sibolga is a small, but busy port on the west coast of northern Sumatra. It is an important centre for the fishing industry in the area. The live fish industry has been operating from the town since the early 1990s and now involves fishers from a number of surrounding villages.

The nearby village of Sitar Das is a good example. There are seven fishers who specialise in catching live reef fish and opportunistically. They use small paddle canoes, sometimes set with a small sail, to reach nearby coral reefs. They usually fish between four and eleven in the morning and occasionally in the afternoon between three and eight. During the peak season, which lasts for only one to two months, they can catch up to 8kg per day. Coralgrouper and grouper dominate catches, although Humphead Wrasses are taken occasionally. Each day, a dealer from one of the export companies based in Sibolga visits the village to collect live fish. Fishers are paid IDR 8000 (USD 2.67)/kg regardless of size or species. On average the dealer takes 10 to 20kg per day. However, many of these fish weigh below half a kilogram and are kept in holding cages for six months to a year, until they reach an export size of around one kilogram. Fishers in Sitar Das do not perceive any reduction in the abundance or size of live reef fish and the same view is held by the fish dealer.

There are about eight villages in the Sibolga area which have similar live fish industries. Although operations are similar, in some of the larger villages there are up to three dealers collecting fish.

In addition to village based fishers, live fish are also caught by those on larger, company-owned fishing vessels. These are usually about 10 to 12m long and accommodate a crew of between five and seven.

These boats roam widely between the Banyak Archipelago and Pini Island. It usually takes one to two days to reach their fishing grounds, where they remain for between five and thirty days. These boats opportunistically collect various forms of valuable marine products. In particular, they target sea cucumbers (*beche-de-mer, trepang*) which are easier to catch and store and provide greater financial returns (about IDR 50 000 (USD 17)/kg) than live fish.

Live fish are caught whenever the opportunity arises, mainly using baited traps, hook and line, and nets. Nets are placed around coral outcrops where fish have been observed. A diver then scares the fish from the coral into the net. Although cyanide is used in the area, it does not appear to be widespread. Fishers explain that this is because using cyanide increases mortality of fish in holding nets.

While at sea, live fish are kept alive in holding tanks or in small nets held to the side of the boat. During the high season, which lasts for about three months, one boat will usually catch about 10kg per week. Some companies also own transportation vessels, which meet fishers periodically to collect their catch and re-supply them with food and water.

There are 5 large live fish companies[iii] operating in Sibolga, each with between 30 and 60 boats fishing in the region. They generally have their own holding cages and export in the vicinity of 3 to 7t per month to Hong Kong, Singapore, Thailand and Malaysia. Although one company began its live fish operations in 1990, most started in 1993 or 1994. Two companies have nets on nearby Musala Island and one has extensive cages, covering an area of about 2.5ha. In addition to their own boats, these companies may also buy from local village fishers. One company reported having holding facilities on three islands in the Batu group[iv]. On each of these islands, between thirty and seventy fishers supply fish.

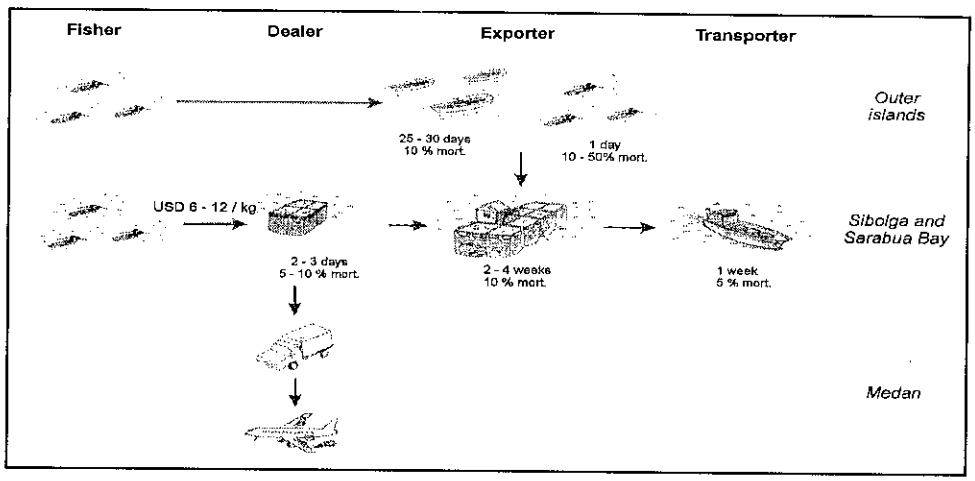
Smaller operations generally only collect fish from village fishers. They may collect from several villages and then sell to the larger company. These smaller companies generally have a turnover of less than five tonnes per year. In October 1997, five of the nine small holding cage operations near Sibolga were destroyed by storms. Some of these operations supply restaurants in the nearby

provincial capital of Medan, where there is a relatively large population of ethnic Chinese. The city is only 350km away, but the truck journey takes about six hours along a windy but sealed road. There are reports that some live fish are also shipped via air from Medan's Polonia airport to destinations including Batam Island in the Riau Archipelago. A survey of cargo companies in Medan confirmed that live reef fish are being exported by plane from there to Hong Kong, Taiwan, Thailand, Malaysia, and Singapore.

About once a month, live fish transport vessels from Singapore and Hong Kong dock in Sibolga port to collect cargo. Exporters from several companies operating in the town bring their shipments to the vessel. The vessels may also dock at holding cages to directly load catches.

Based on the number of vessels, catches and the reported exports we estimate that around 100 to 200t of live fish is currently exported from the Sibolga region each year.

Figure 4.12. Schematic diagram of the trade and transportation of live fish in the Mentawai Islands and around Sibolga, western Sumatra.



Case Study D

Riau Archipelago and Bangka Island

Nokome Bentley

Riau Archipelago

The Riau Archipelago consists of a vast number of islands extending south from the Malay peninsula towards Sumatra. Although the area has significant areas of coral reef there are increasing threats from factors such as sedimentation.

The most commonly used methods to catch live reef fish in the Riau Archipelago are baited wire mesh traps and hook and line. Fishers openly discussed their use of blast fishing and its illegality. However, when questioned about cyanide or any other poison to catch fish, they deny having heard of its use in the area.

The most commonly caught species are groupers, although other reef fish will enter traps. Fishers report that it is becoming increasingly difficult to catch live reef fish and that they must travel further to fish. The best season for catching live reef fish is in October, when the water around the coral reefs is particularly clear. The low season accompanies the monsoon season, but is short, from late November until the end of December.

Fish are stored in holding nets, often hung under stilt houses over the water. High turnovers, short holding periods and low stocking densities reduce mortality rates and diminish the need for antibiotics.

Fishers around northern Riau are peculiar in their close proximity to the end market for their fish. From the islands of Batam and Bintan it is a short journey to Singapore and many fishers deliver their own catch. In bypassing exporters in this way, fishers are able to maximise the return on their catch. Live reef fish exporters also operate in the area, but tend to collect fish from a small number of fishers. One exporter explained how two to three times a week he transported the catch from eight to fourteen fishers to Singapore. Each fisher supplies four to five kilograms of live reef fish at a time. In northern Riau, the role of dealers and centralised holding facilities is reduced, if not obsolete.

Fishers receive around SGD 38/kg (IDR 76 000/kg, USD 25/kg) for coralgrouper and SGD 18/kg (IDR 36 000/kg, USD 12/kg) for grouper. Other species caught in traps such as angelfish (*Pomacanthus* spp.), triggerfish (*Balistoides* spp.), parrotfish (*Scarus* spp.) and cuttlefish (*Sepia* spp.) are also sold alive. Fish that die during transportation are sold in Singapore or on the islands in fresh fish markets.

In addition to Singapore markets, Bantam and Bintan Islands have a relatively large number of seafood restaurants that primarily cater for Singaporean visitors. Prices of live fish vary depending upon the restaurant from around IDR 70 000/kg (USD 23/kg) for grouper and IDR 110 000/kg (USD 36/kg) for coralgrouper.

Unconfirmed reports from southern Riau Archipelago suggest that operations for growing fish to suitable sizes may be more common there.

Bangka Island

The islands of Bangka and Belitung lay off the eastern coast of Sumatra and separate the South China and Java Seas. They are better known for tin mining than their fisheries. Nonetheless, they have large areas of coral reef adjacent to them, particularly around Belitung and the south coast of Bangka and support a significant fishing industry.

Live reef fish operations exist on both islands. Near the small town of Sadai in southern Bangka one operation has holding cages and five small boats. Divers set wire mesh traps with approximate

dimensions of 1.5 x 1 x 0.5 m on nearby coral reefs. Each boat carries about 50 traps. Species of coralgrouper and grouper are caught and exported directly to Singapore. Other reports suggest that fish are also exported via Jakarta. There are said to be about twenty such operations on Bangka and Belitung, all using traps. Other methods such as hook and line and cyanide may be used opportunistically although our interviews gave no reason to suspect this.

On the northern coast of Bangka there are smaller areas of coral reef. There are reputedly three floating cages in the area, all growing-out grouper and coralgrouper. Fishers in the area use traps exclusively and are paid around IDR 30 000 (USD 10) for premium sized fish. The fish are grown to between 1.5 and 2kg weight and then collected by Singaporean boats.

Pangkal Balam, the port of Pangkal Pinang, is the base for several large scale fish trapping operations. Large vessels up to 20m in length range as far as Kalimantan set wire mesh traps on coral reefs. The main target species are grouper, which are mostly killed, stored in iceboxes and then exported to Malaysia. However, these bases also have small portable holding cages and more valuable species may be kept alive for export to Singapore and/or Hong Kong.

Other areas in Indonesia

There is limited information on the nature of the live reef fish industry from the more remote areas of Indonesia. Operations moved into areas such as southern Maluku and Irian Jaya as live reef fish stocks became depleted further to the west. In addition to relatively untouched reefs, these areas provide more privacy for businesses to operate than the more densely populated regions of the country.

One survey done in the islands around Misool Island, Irian Jaya during 1995 indicated that the industry was already well established by that time. Fishers reported easily catching 30 fish per day. One camp visited had staff of around 50 people and 20 to 25 speed boats. The company had 3 groups of cages each with 9 to 10 cages. Fishers in the area used both cyanide solution and hook and line to catch grouper (Raymakers 1995).

The operations recruited experienced fishers from Buton Island, southeast Sulawesi and employed them for three to four months. The fishers family is provided with rice and money (IRD 300 000 to 500 000; USD 100 to 167) when the fisher leaves and he is paid when he returns to the village based on records of what he has caught (Raymakers 1995).

Table 4.9. Prices paid to fishers by dealers and to dealers by exporters for various species and sizes of live reef fish

Species category	Price* (IDR)	(USD)
Humphead wrasse		
> 15 kg	2 500/kg	0.83
5.1 kg - 15 kg	4 500/kg	1.50
3.1 kg - 5 kg	25 000/kg	8.33
0.6 kg - 3 kg	7 500/kg	2.50
0.3 kg - 0.5 kg	2 500/kg	0.83

Humpbacked grouper		
3.1 kg - 5 kg	2 000/kg	0.67
0.6 kg - 3.0 kg	5 000/kg	1.67
0.3 kg - 0.6 kg	20 000/kg	6.67
Other grouper species		
> 15 kg	7 000/kg	2.33
5.1 kg - 15 kg	6 500/kg	2.17
3.1 kg - 5 kg	12 500/kg	4.17
0.6 kg - 3 kg	3 300/kg	1.10
0.3 kg - 0.5 kg	1 000/kg	0.33

*These are prices paid for healthy fish.

The Tukanbesi Islands lie off southeastern Sulawesi and are surrounded by extensive areas of coral reef. The live reef fish industry has been operating in the area for some time. One operation based in the nearby town of Bau-Bau recruits fishers from the Tukanbesi Islands and takes them to the outer reefs. This vessel, a converted tuna fishing vessel, takes up to 40 fishers and their canoes to fish for grouper using hook and line during the spawning season. Fishers are paid by the kilogram based on what they catch during the period. The fish are kept in holding cages until a transport vessel arrives, approximately every six weeks. New live reef fish operations are reported to have been established in the area in early 1998 (C. Majors, pers. comm. June 1998).

Regulations

Three regulations pertaining directly to the live fish industry have been declared by the national government. These regulations are closely linked to one another and are perhaps best considered as the same regulation.

The title of these regulations is misleading and has caused some confusion as to their effects. The overarching regulation is the decree of the Minister of Agriculture[8] regarding a 'ban' on the capture of Humphead Wrasse. This regulation states that the capture of Humphead Wrasse is illegal except for (a) research and cultivation and (b) capture by traditional fishers using methods which are safe for the 'fish resource and its environment'. The regulation goes on to add that the Director General of Fisheries[9] will stipulate the size, location and manner of capture allowed for these purposes, and that it shall conduct monitoring on the implementation of the decree.

The subsequent decree of the Director General of Fisheries[10] stipulates the sizes, locations and methods permissible to catch Humphead Wrasse under the exceptions stated by the decree of the

[8] Decree Number 375/Kpts/IK 250/5/95.

[9] The Directorate General of Fisheries is part of the Ministry of Agricultue

[10] Decree Number Sk 330/ DJ 8259/95

Minister of Agriculture. Article 1 defines traditional fishers as any person whose livelihood is fishing and who uses a boat of gross weight not exceeding five tons and/or with an engine with power not exceeding fifteen horsepower and who uses fishing methods that shall 'not harm' the fish resource and its enviranment. Article 2 states that researchers can catch Humphead Wrasse after obtaining a permit from the Director General of Fisheries. Traditional fishers can do so after obtaining a permit from the head of the Provincial Fisheries Department or a duly assigned official. According to Article 3, the local government official who grants the permit to traditional fishers should define the location to which it applies by 'considering the capacity of the fish resource and its environment'. Articles 4 through 8 state that traditional fishers shall sell Humphead Wrasse to collecting companies who have a means of cultivation and staff experienced in fish cultivation. This 'collecting company' will have its location determined by the local fisheries department and have a Business Permit for collecting Humphead Wrasse as granted by the Director General of Fisheries. Articles 8 and 9 specify that Humphead Wrasse can only be sold locally or for export between the sizes of one and three kilograms. Fish outside of this range can be sold locally to 'cultivation entrepreneurs'. According to Article 10, Humphead Wrasse to be marketed locally or for export must have an accompanying Letter of Origin from the local fisheries department. Article 11 states that only hook and line, trap or gill nets can be used to catch Humphead Wrasse. Lastly, Article 12 requires that the head of the provincial office of the fisheries department submit a report every three months to the Director General of Fisheries on the number of Fishing Permits and Letters of Origin assigned in that province.

The decree of the Minister of Trade[11] states that Humphead Wrasse shall be banned from export with the exception of those hauled with the permission of the Minister of Agriculture.

It is easier to summarise these regulations by reviewing what they allow. A fisher in a boat less than 5t gross weight or powered by an engine less than 15Hp, can catch Humphead Wrasse using hook and line, traps or gillnet, in a location specified by the permit issued by the provincial fisheries department. There are no limits on the size of Humphead Wrasse that can be caught. The fisher can sell Humphead Wrasse to a collecting company that has the appropriate Business Permit from the Director General of Fisheries. The collecting company can sell the wrasse locally or for export, as long as it has a Letter of Origin from the local fisheries department and the wrasse are between one and three kilograms in weight.

In addition to these legislation, the Fisheries Ordinance of 1920 outlaws the use of poisons to capture fish and the penalty for using destructive fishing methods is 10 years jail and/or a fine of IDR 100 million (USD 33 000).

Licensed foreign vessels are only allowed to fish outside of 12 nautical miles from the coast. There is a tax of 2.2% on the selling price of the fish caught in Indonesian waters. In addition, there are licensing fees which vary from IDR 46 to IDR 173 (USD 0.02 to 0.06) per m^3 of holding volume.

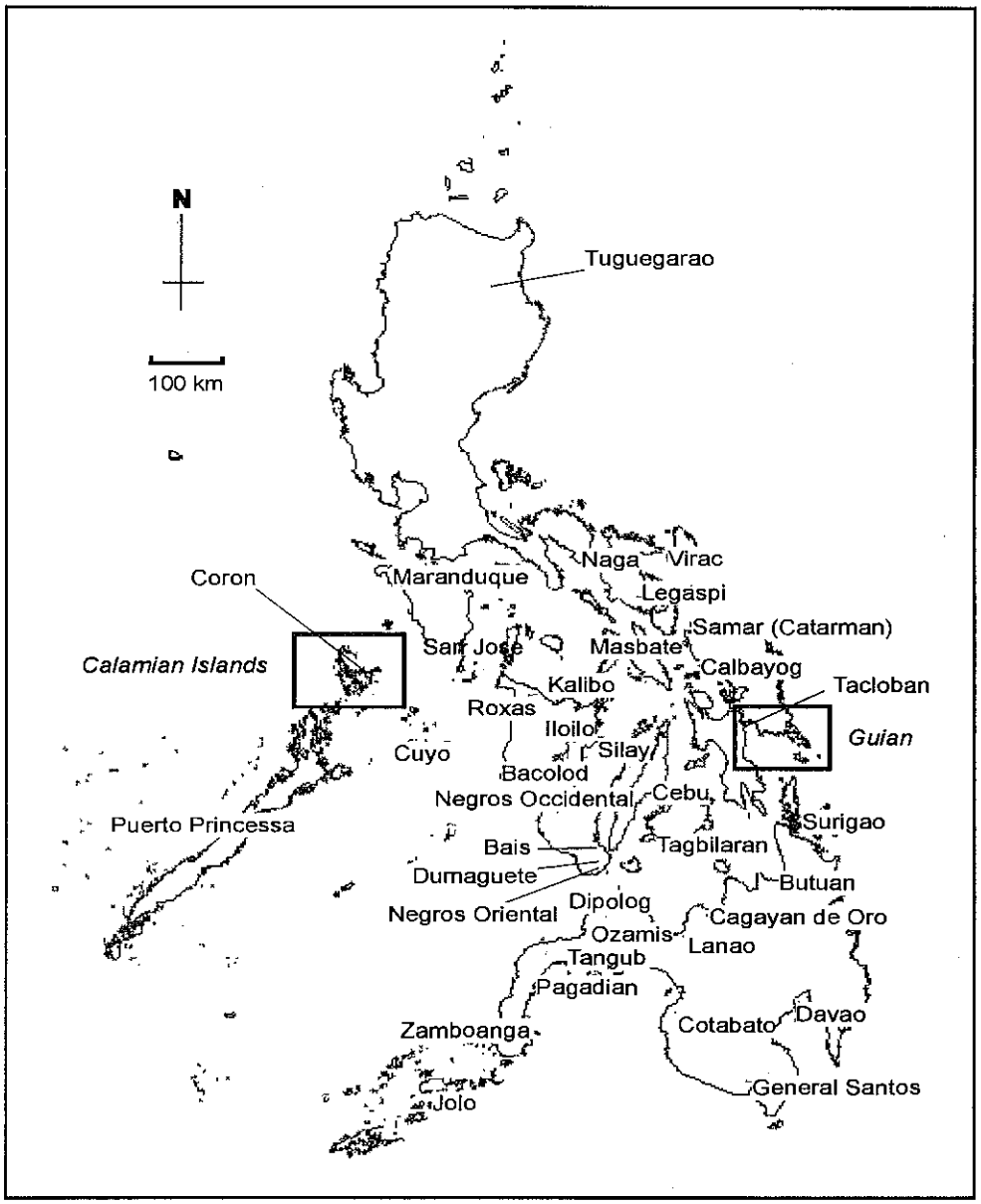
The size of export tax is not clear. In Ujung Pandang, there is an export tax of IDR 700 (USD 23)/kg for live reef fish. This is equivalent to about 1.5% of the price which exporters buy fish from exporters.

[11] Decree Number 94/Kp/V/95

PHILIPPINES

The Philippines consists of more than 7000 islands, scattered over fifteen degrees of latitude between Indonesia and Taiwan. Fisheries are an important part of the economy and directly employ almost 1 million people, about 3% of the total workforce (Delmendo 1996). A significant proportion of fisheries products come from the country's extensive areas of coral reef, which cover an estimated 44 097 km² (Figure 5.1, Reefbase 1997).

Figure 5.1. Map of the Philippines indicating places referred to in the text and in Figure 5. 5.



In the late 1950s, live ornamental fish began to be exported from the Philippines and by the mid-1980s the country provided 75% to 80% of the marine aquarium fish sold worldwide. As early as 1962, this industry became the first to widely use cyanide to commercially capture live fish (Barber & Pratt 1997).

By the mid-1980s, at least one third of aquarium fish exporters were also dealing in live reef fish for food. Live fish transport vessels from Hong Kong made regular trips to the western island of Palawan, to collect catches of coralgrouper and Humphead Wrasse. Unlike early live fish operations in other Southeast Asian countries, most of the catch was taken by Philippine, rather than foreign, fishers (Barber & Pratt 1997).

The close proximity of northern Philippine waters to Hong Kong, Taiwan and China, meant that illegal fishing by foreign vessels also occurred. In recent times, intrusions of Taiwanese vessels have been common in northern waters. In April 1995, fifty-one Chinese fishers using cyanide, in the part of the Spratly Islands claimed by the Philippines, were apprehended (Johannes & Riepen 1995, Barber & Pratt 1997).

Since the early 1990s, there has been a total ban on foreign fishing vessels in Philippine waters, except for special permits given for some pelagic fisheries. Increased patrols by the Philippine Navy, particularly in the area west of Palawan is reported to have greatly reduced the incidence of illegal foreign fishing. The crackdown on foreign vessels, along with low airfreight charges to Hong Kong, has resulted in a shift towards live food fish exports by air. Since the early 1990s, most live fish has left the Philippines via Manila's international airport.

The structure of the live food fish trade in the Philippines is quite different to that in Indonesia and Malaysia. In particular, the trade is dominated by a few companies that are highly vertically integrated. That is, they have collection points scattered throughout the country, in many of the live fish catching areas. These operations send the fish to the company's holding facilities in Manila, and from there, they are exported overseas.

Due to this trading structure, we shall provide case studies of the industry in two areas, the Calamian Islands and around Guiuan, as well as a brief description of the operations of exporting companies in Manila.

Exports

Data

The Foreign Trade Statistics division of the National Statistics Office (NSO) provides data on the export quantity and value of fisheries products based on customs receipts. Until 1990, there was only one category for live fish ("Fish kept alive for export"). However, since 1991, exports of "Grouper, Live" have been distinguished. The *NSO* data are currently available up to 1996.

For 1995 and 1996, the *NSO* data indicated exports of 5980t and 3064t respectively, well in excess of other estimates of Philippine exports (International Marinelife Alliance (IMA) unpublished data, 1997). We therefore assume that these weights are recorded as gross packaging weight (including fish and water). IMA officers estimate that an average box contains 3 to 4kg of fish and has a total weight of 17 to 20kg, making a live weight conversion rate of about 20%. This is in accordance with conversion ratios given by industry members. The

converted values of 1196t and 613t are within the range expected based on recorded Philippine imports to Hong Kong of 1100t in 1997.

The *IMA-Exporter* data set is based upon customs receipts and provides the annual quantities of live reef fish exported by each company. This data provides a means of examining the relative size and dynamics of exporting companies. This data is available from 1994 onwards.

A picture of the origin of live reef fish from within the Philippines is available through the *IMA-Domestic* data. Since 1994, IMA has monitored arrivals of live fish at Manila Domestic Airport. This data does not cover all shipments of live fish, as significant amounts also arrive in Manila by sea and land transport. However, the data still provides an indication of the relative importance of the more distant regions, where the majority of live reef fish is sent by air. This data is available from June 1994 to October 1997.

Trends

According to *NSO* data, the quantity of live reef fish exports increased rapidly during the early 1990s. In 1991, recorded exports totalled less than 200t, but by 1995 this value had risen to over 1000 t. However, in the following year exports declined dramatically to under 600t. The declared value of exports has remained at USD 4 - 5/kg for the last six years (Figure 5. 2).

Almost all of the live food fish exported from the Philippines has gone to Hong Kong or Taiwan (Figure 5. 3). Hong Kong, which accounted for 72% of exports between 1991 and 1996, took increasing quantities up to 1995. In the following year, exports dropped by more than 50% (Figure 5.4). According to exporters, this drop was mostly a result of reductions in supply of live fish rather than a drop in demand (see Case Study G).

While exports to Hong Kong are probably all adult reef fish, grouper fry probably dominate exports to Taiwan. These are used in Taiwan's extensive grouper grow out operations. Export quantities to Taiwan rose dramatically to a peak of 450t in 1993, but have since fallen to less than 100t (Figure 5.4). This is also in accordance with exporter's descriptions of reductions in supplies of grouper fry.

Exports to other countries have been small compared to the major destinations. During the early 1990s, most other exports went to Japan, USA, China, and Germany. This and the high value of exports at that time, suggests that many of these records may relate to juvenile aquarium specimens of species such as humpbacked and orange-spotted grouper. By 1995, declared values had dropped to levels similar to those declared for exports to Hong Kong. This was mostly a result of an increase in lower value exports to Singapore, which by 1996, accounted for 57% of the "Other' country category and probably represent adult live food reef fish.

IMA staff checking a shipment of live fish, Tacloban, the Philippines

Figure 5.2. Quantity and average value of live food fish exports from the Philippines by year.

Figure 5.2

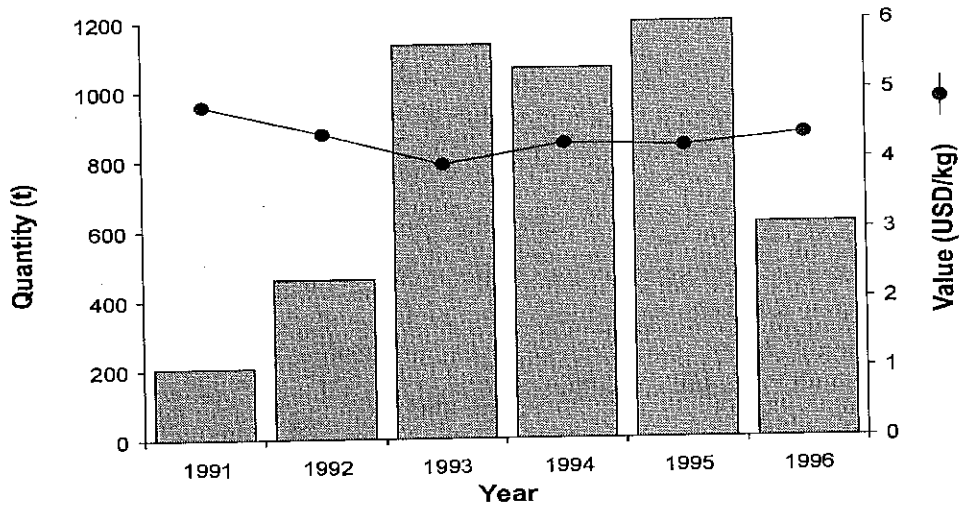


Figure 5.3. The percentage of export quantity by country of destination, 1991 to 1996.

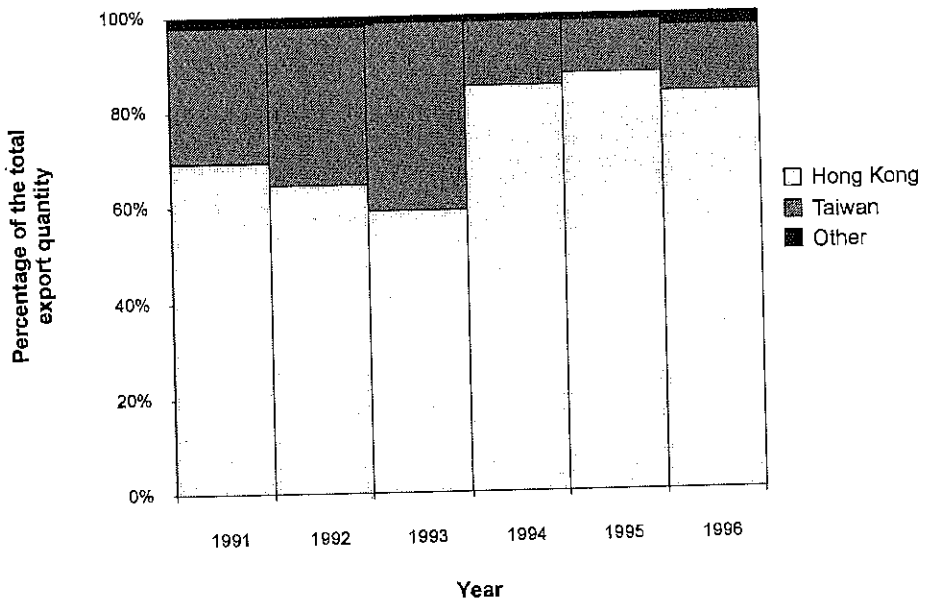
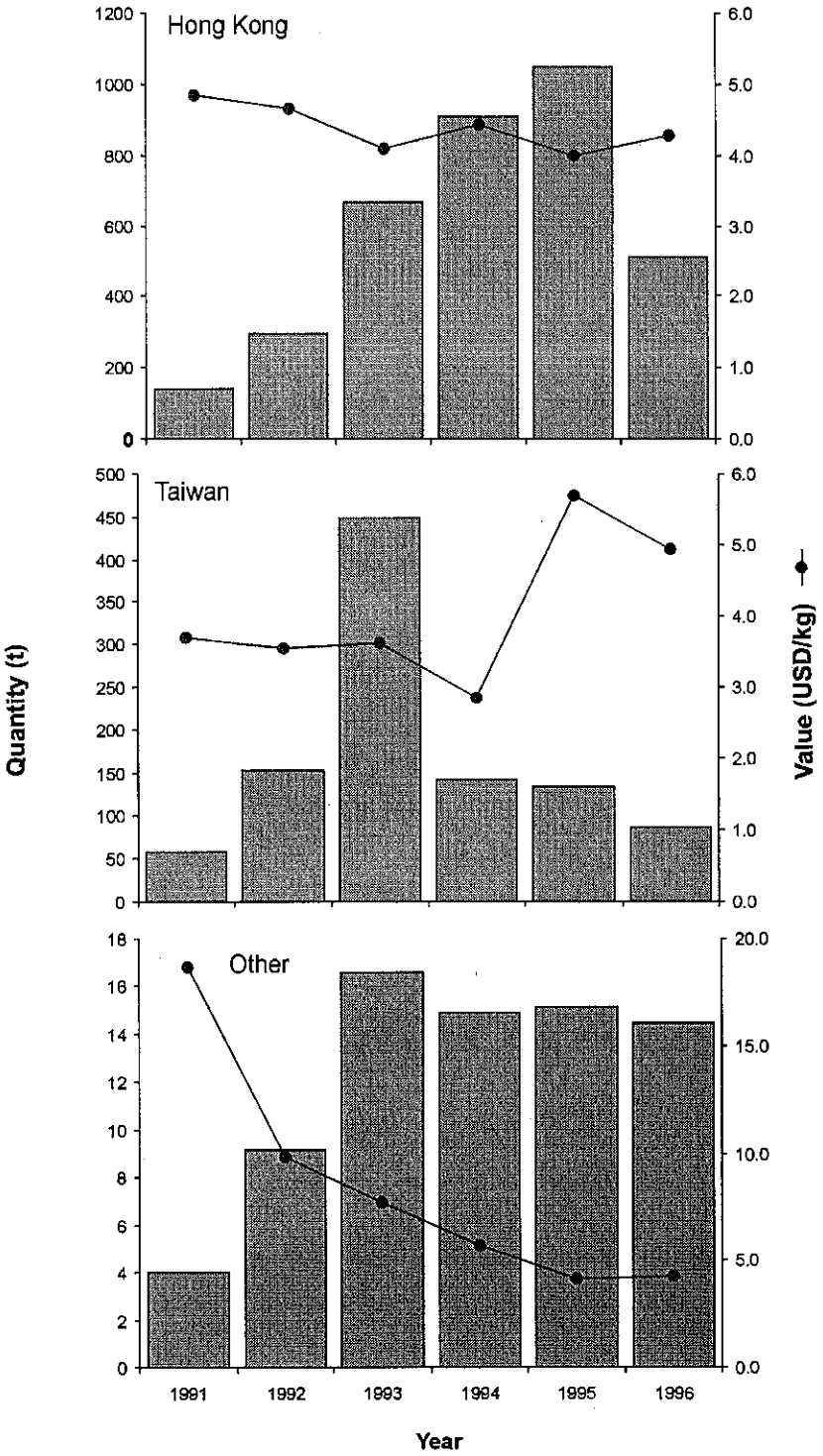


Figure 5.4. Quantity and average value of live food fish exports from the Philippines by year for the two major, and all other, destination countries.



Origins

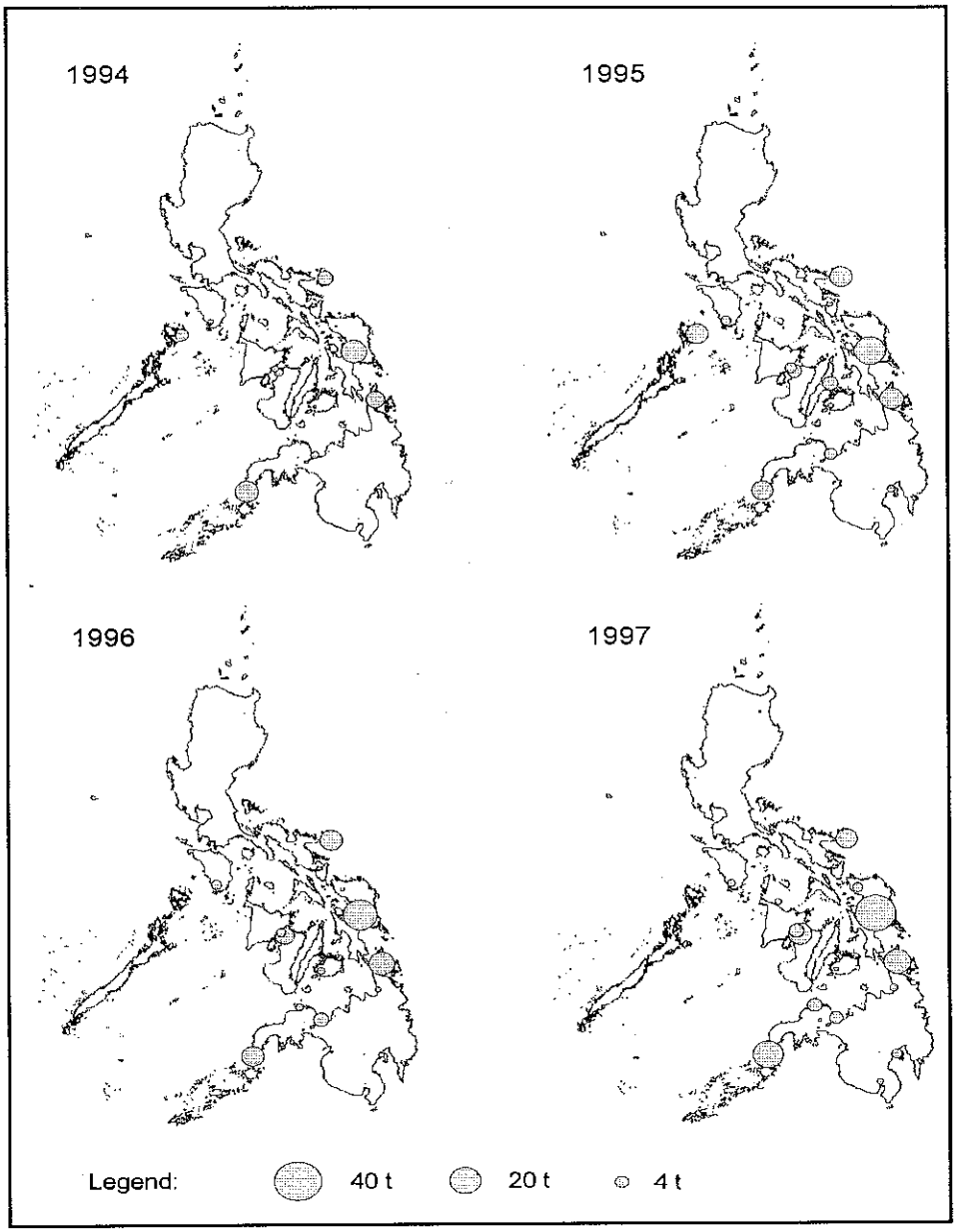
Between 1994 and 1997 most air shipments originated from the towns of Tacloban, Zamboanga, Surigao and Virac. The volumes recorded by IMA coming from each town rose slightly over the period, but these four towns consistently dominated (Figure 5. 5).

According to one exporter, the area around Coron currently accounts for more than 50% of the live food fish exports from the Philippines (see Case Study V). Much of the fish from there is flown to Manila by chartered plane. Since the end of 1995, IMA has been unable to monitor these shipments. In addition, some of the fish caught in Coron is taken directly by boat to Manila. There is evidence that due to the ban on shipment of Humphead Wrasse from northern Palawan province, some fish from Coron is being shipped to San Jose, on nearby Mindoro Province. From San Jose, it is flown to Manila as has been recorded in the *IMA* data (Figure 5. 5).

Most live reef fish arriving in Manila by truck originates from southern Luzon, in particular the provinces of Quezon, Camarines Norte and Camarines Sur. Very little live reef fish is caught in the north of Luzon Island.

In addition to exports going via Manila, there are reports of live reef fish from some areas going directly overseas. In particular, the province of Tawi Tawi in the Sulu Archipeligo is known to be a productive area for live reef fish. Information from the Philippines confirm reports from Malaysia - that almost all the live fish caught there is shipped to Sabah. There are also reports of an operation based in Tay Tay, northern Palawan that is shipping live reef fish directly to Hong Kong. Import data from Hong Kong suggest that around 2% of imports from the Philippines come by sea.

Figure 5.5. Quantity of live food fish exports arriving at Manila domestic airport by city of origin, 1994 to 1997. Note that data for 1994 and 1997 have been extrapolated from data from only part of the year.



Case Study E.

Calamian Islands

Vaughan R. Pratt[12] *and Nokome Bentley*

Over fifty islands make up the Calamian group in northern Palawan province. Fishing is the main source of livelihood in these islands and it was one of the first areas to target live reef fish. Coron is the major town in the islands and is the base for most of the live fish operations.

There are about 1,000 fishers that target live reef fish, mostly using hook and line. Cyanide is though to be used by between 15 and 20% of fishers, although recent information suggests that this be as high as 50%.

Hook and line is a traditional fishing method in the area, but additional care is required to ensure that reef fish are kept alive. Improved handling and decompression techniques have been introduced and are gaining widespread acceptance amongst the fishers. On average, a hook and line fisher will catch four to five live reef fish per day, as well as less valuable fish for his own consumption. Mortality rates can be as high as 30%, but fishers who use appropriate handling and decompression techniques usually experience mortality rates of no more than 5%. In some instances, hook and line fishers dip their bait in cyanide to reduce self-inflicted damage to the fish when it is being hauled in.

Cyanide fishers dive with compressors and hoses and often use nets to aid in capture of live reef fish. After finding a coral outcrop containing suitable fish, fishers encircle it with the net and use cyanide to flush them out. On an average day, cyanide fishers catch between nine and eleven live reef fish. However, mortality rates can be as high as 50%, far greater that that of most hook and line caught fish. Depending on the number of fish that they chase, a cyanide fisher will use one to two kilograms of cyanide in a day.

The origin and trade of cyanide is unclear. Exporters probably supply cyanide to dealers, although some dealers may have their own direct supply. Dealers sell fishers cyanide for around PHP 200 (USD 7)/kg.

An estimated 90% of the catch from the Calamian Islands is Leopard coralgrouper. Other species such as squaretail, spotted, blacksaddled and highfin coralgrouper and various grouper species are taken less frequently. Catches of humphead wrasse are rare.

According to fishers, fish abundance has declined by a third over the last ten years. They must travel further, and stay out at seas for two to three days, compared with the daily trips that they used to make. They estimate that although prices have risen, twice as much effort must be expended to get the same daily income as ten years ago.

Fishers can be separated into three categories, depending upon their relationship with fish dealers. The least common are those who own their own boats and are able to sell their fish to the dealer is offering the highest prices. Other fishers own their own equipment, but because of debt are obliged to sell to a certain dealer and accept the prices offered (Table 5.1). The final category of fishers

[12] International Marinelife Alliance – Philippines

work on boats that are owned by dealers. This type of operation accounts for about 80% of the live fish arriving in Coron.

The diffuse spread of fishers in the area has meant that many prefer to work for a dealer rather than attempt the logistics of transporting live fish to Coron. In many cases, dependency is reinforced by the dealer lending the fishers money during times of difficulty. Extending credit or food to fishers provides them with a safety net, but it also ensures that the dealer has a continuous supply of fish from that fisher. However, it also makes fishers powerless to act contrary to the wishes of the dealer.

There are about twenty dealers based in Coron, each owning about 10 boats. These boats are 10 to 20m long, have ten to fifteen crew and go on longer trips to the outer islands of northern Palawan, where they will stay for one to two weeks depending upon the weather. As well as catching fish, they will buy fish from local fishers at PHP 80 to 500 (USD 3 to 17)/kg.

Each dealer has holding facilities made up of floating cages, each about 8 x 4 x 0.5m. They generally do not use any antibiotics and discard fish if they become sick. It is common practice for dealers to separate fish caught using cyanide from those caught by other methods. Dealers will only reveal mortality rates of those fish that have not been caught using cyanide - about 10 to 25%. Depending upon the season, it usually takes a week for the cages to become full, at which time the dealer will sell his fish to exporters at PHP 200 to 1000 (USD 7 to 33)/kg (Table 5. 1).

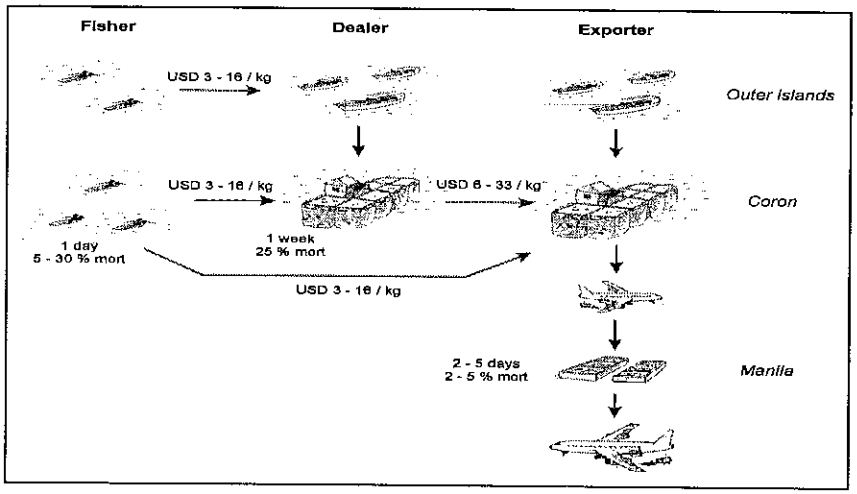
Four Manila based exporting companies have agents in Coron. Some of these also operate their own boats in the area and have set up fish collection facilities. They buy fish from small-scale fishers at the same price as the dealers. However, because many fishers are committed to selling to dealers, the majority of live reef fish goes via the dealers.

All shipments go to Manila via air. There are only two commercial flights per day using planes with limited cargo space. This forces exporters to charter planes at a cost of PHP 17 000 to 20 000 (USD 566 to 667) per flight. On average, exporters will send two shipments per week, each containing 150 to 200kg of live reef fish.

Table 5. 1. Prices (PHP) paid to fishers by dealers and to dealers by exporters for different sizes of leopard coralgrouper. Coron, December 1997.

Size (kg)	Fishers	Dealers
> 1.1	500 (USD 15)	1000 (USD 33)
0.5 - 1.1	500 (USD 15)	800 - 900 (USD 26 - 30)
0.4	<300 (USD 10)	300 - 400 (USD 10 - 13)
0.3	<300 (USD 10)	300 (USD 10)
0.2	<300 (USD 10)	200 (USD 6)

Figure 5. 6. Schematic diagram of the trade and transportation of live reef fish in the Calamian Islands.



Case Study F.

Guiuan

Nokome Bentley and Joy Alban[13]

Guiuan is a small town on the end of the south-eastern peninsular of East Samar province. There are large expanses of coral reefs nearby, which support most of the fisheries in the area. Many fishing communities live on nearby islands and bring their catch to the live fish collection points near the town.

Cyanide and traps are two main methods used to catch live fish. According to one local fisheries officer, about 60% of fishers fishing for live reef fish use cyanide. They use compressors and hoses for diving and spend the day seorching for fish, returning to the collection points in the afternoon. Because they can select their targets, cyanide fishers generally catch larger fish than the trap fishers.

[13] International Marinelife Alliance – Philippines

Eighty-nine kilograms of cyanide pellets were apprehended in Guiuan in 1996 and the area has a reputation for being one of the last major strongholds of cyanide fishing. The municipal government, which has jurisdiction over waters within 15km of land, declared the Guiuan Protected Landscape and Seascape in 1994[14]. As part of this legislation, there are bans on the collection of aquarium fish and the use of compressors. Although the former ban is apparently well enforced, the use of compressors is still widespread. Part of the problem appears to be a lack of will on the part of the municipal government to enforce the ban, since the live food fish industry is an important part of the town's economy. Furthermore, the municipal government also takes a PHP 10 (USD 0.33)/kg tax on live fish, making it an important source of revenue.

Trap fishers also use a compressor and hose and with the aid of homemade fins and goggles, they collect the traps after being deployed for one or two days. Most boats have a minimum of twenty traps which, in general, are not baited. Often they will alternate visits so that half the traps are visited every second day. Cane traps cost about PHP 80 (USD 2.67) each and will last for about three months. Wire mesh traps cost more (PHP 300 each (USD 10)), but last longer. In contrast to cyanide fishers, trap fishers usually deliver fish to buyers by mid-morning. On average each trap fishers earn PHP 500 - 1000 (USD 16 - 33)/day.

A variety of live reef fish species are caught in Guiuan including leopard, squaretail and blacksaddled coralgrouper and camouflaged grouper. Giant grouper are also caught in the area, possibly due to the proximity of deep water to the east.

Our observations suggest that fish buyers are not important intermediaries in the fish trade in Guiuan. Most fishers appear to sell their live reef fish directly to exporters with facilities in the area. Furthermore, they do not appear to be obliged to sell to particular companies. In one instance, we observed fishers selling coralgrouper to one company and then moving on to another nearby which offered higher prices for grouper species. Nonetheless, the role of dealers may be more important in more remote villages in the area.

There are currently three export companies operating fish collecting facilities in Guiuan. They buy fish directly from fishers at rates depending upon size, species and quality (Table 5. 2). Humphead Wrasse are not commonly caught in the Guiuan area. Individuals of around 3kg are bought for PHP 1500 (USD 50)/piece, larger individuals for PHP 2500 (USD 83)/piece. Fish of 300g and less are grown out in holding cages until they reach around 400g. The holding facilities at Guiuan have particularly large numbers of small coralgrouper for grow out. This may reflect the large numbers that are taken during trap fishing.

From Guiuan, live reef fish are sent to Tacloban by daily passenger ferry, or the company's own boat. Most companies have on-land holding facilities in Tacloban where fish may be reconditioned before being flown to Manila. It currently costs PHP 280 (USD 9) per box for oirfreight to Manila. The holding facilities in Tacloban also buy fry of greasy and orange-spotted grouper caught in Marqueda Bay on Samar Island. These are bought for PHP 8 - 10 (USD < 0.33) per individual of about 8cm and are also flown to Manila.

[14] Proclamation No. 469

Figure 5.7. Schematic diagram of the trade and transportation of live fish in Guiuan.

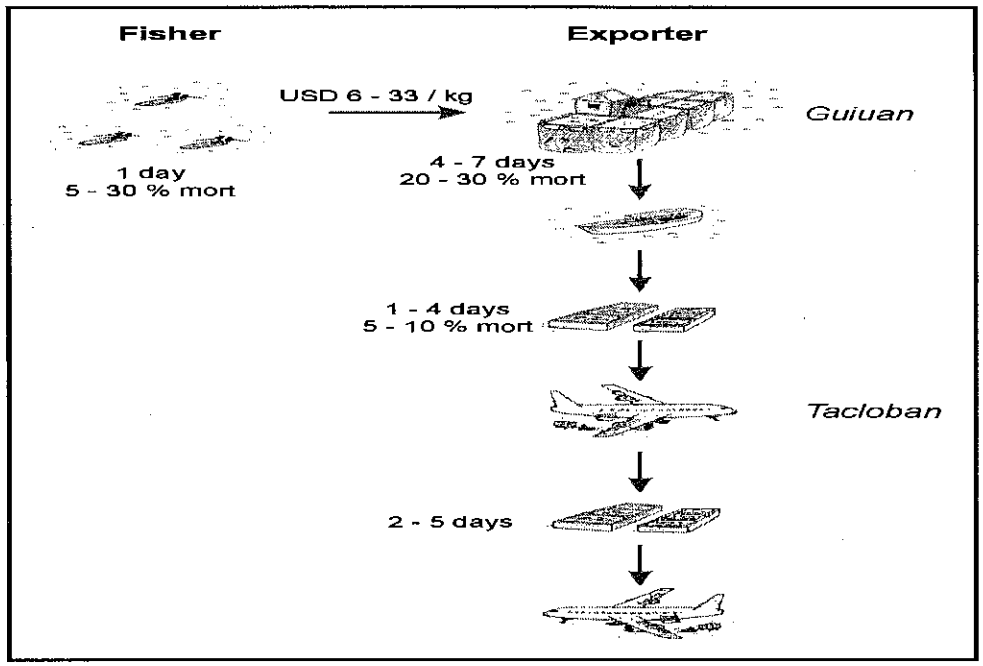


Table 5. 2. Prices paid (PHP) to fishers for various species and sizes of live reef fish. Guiuan, September 1997.

Size (kg)	Category	Leopard coralgrouper	Squaretail coralgrouper	Brown marbled grouper	Other grouper species	Humpbacked grouper
>1.0		1100/pc (USD 36)	350/pc (USD 11)	500/pc (USD 17)	450/pc (USD 15)	1300/pc (USD 43)
0.5 - 1.0		1000/kg (USD 33)	300/kg (USD 10)	450/kg (USD 15)	400/kg (USD 13)	1000/kg (USD 33)
0.4 - 0.5		300/kg (USD 10)	120/kg (USD 4)	270/kg (USD 9)	270/kg (USD 9)	200/kg (USD 6)
0.3 - 0.4		300/kg (USD 10)	80/kg (USD 3)	270/kg (USD 9)	270/kg (USD 9)	200/kg (USD 6)
0.2 - 0.3		200/kg (USD 6)	60/kg (USD 2)	100/kg (USD 3)	100/kg (USD 3)	100/kg (USD 3)

Case Study G.

Manila Exporters

Nokome Bentley and Joy Alban[15]

Manila based exporters are an important component of the live fish trade in the Philippines. They are the point of departure for fish from the country and have significant influence on live reef fish collection throughout the provinces.

As shown in the case studies, exporting companies often have buying facilities in the provinces and in some instances own their own fleets of live reef fish catching boats. In some cases, this vertical integration continues upwards; at least two companies have an office in Hong Kong, or is a subsidiary of a company there.

According to *IMA-Exporter* data, between January 1994 and December 1996, 91% of exports went through four companies[v]. The remaining companies generally exported sporadic amounts and there has been a reduction in their number. The total number of exporting companies, dropped by almost half, from 31 in 1994 to 17 in 1996. Even the larger companies have not remained entirely stable. One of the four largest companies, began operations in December 1994 and by February 1995 was the biggest exporter of live reef fish. A year later exports began to fall, and by July 1996 they had ceased operations completely.

Most of these companies send live fish to Hong Kong via air and have holding facilities close to the international airport. These facilities have concrete tanks with recirculating seawater and are capable of holding large quantities of fish. Mortality rates are usually between two and five percent but can be as high as 15% if flights are delayed and fish spend a long time packaged in boxes. When fish have been caught using cyanide, mortality rates may be much higher, although exporters are coy about such details. Airfreight to Hong Kong costs about USD 0.88/kg and there are usually several flights per day.

A number of exporters complain of severe reductions in supply. In the early 1990s, one company described export quantities of two to three hundred boxes (the equivalent of about one ton) of live fish per day. Now, they send less than a fifth of this amount, twenty to sixty boxes per day.

Some firms are involved in sending fingerlings of orange-spotted grouper to Hong Kong for grow out. Fingerlings between 7.5 and 15cm are brought from fishers in the Cavite and Bicol areas for PHP 16 (USD 0.53) per individual. In the early 1990s, one company shipped fingerlings by boat from Pangasinan province directly to Hong Kong. They exported two to three shipments of three tons each per year but by 1996 could only make one shipment, and now supply is so low that only freight by air is economical.

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[15] International Marinelife Alliance – Philippines

Regulations

A number of Philippine regulations, at a range of governmental levels, are directly applicable to the live fish industry. They include restrictions on fishing methods, trade, transportation and export. In particular they provide a firm legal foundation for controlling the use of cyanide.

According to Presidential Decree 704 of 1975, it is illegal to use cyanide or any other poisonous substance for fishing. There are stiff penalties for violators-up to 10 years imprisonment, or more if the use of cyanide causes human injury or death. Under the same decree, live reef fish dealers are liable for possessing fish caught using cyanide. It is illegal to knowingly possess, deal in, sell or dispose of for profit, illegally caught fish; a crime punishable by imprisonment of 5 to 10 years (Department of Environment and Natural Resources (DENR), Department of Interior and Local Government (DILG), Department of Agriculture- Bureau of Fisheries and Aquatic Resources (DA-BEAR) and the Coastal Resource Management Project 1997), (Barber & Pratt 1997).

The local government code of 1991 directs municipal governments to enact regulations to prohibit the use of cyanide in waters under their jurisdiction (Barber & Pratt 1997). Provincial laws can also a ffect the live reef fish industry. In 1993, the pravincial government of Palawan placed a five year ban on live fish exports from the province. This has since been lifted, but the mayor of Puerto Princessa, the capital of the province, and site of the major airport, has banned live fish exports from the town.

The Cyanide Fishing Reform Program is a government initiative aimed at reducing the use of cyanide. The program is implemented by the International Marinelife Alliance - Philippines, and is comprised of a number of components ranging from education and awareness to cyanide detection tests. The latter has become an important part of Philippine efforts to reduce cyanide use. There are now cyanide testing laboratories in Manila, Puerto Princessa, Tacloban and Zamboanga, with new facilities being built in Cebu and Davao. Monitoring stations in Coron, Virac and Batangas check live fish shipments and send samples to the labs. Since 1992, when the first lab was set up, over 6000 tests have been done, resulting in more than 50 cases against cyanide fishers in five provinces (Barber & Pratt 1997).

A draft act to control the sale and distribution af cyanide has also been introduced to parliament. It proposes a requirement that all imports of cyanide be approved in advance and its sale and distribution to be closely monitored (Barber & Pratt 1997).

The transportation and exportation of fish and fisheries products require permits. Violations of these regulations are punishable by imprisonment of 6 months to 4 years, or a fine of PHP 500 to PHP 5000 (USD 16 to 166), or both (Department of Environment and Natural Resources (DENR), Department of Interior and Local Government (DILG), Department of Agriculture- Bureau of Fisheries and Aquatic Resources (DA-BEAR) and the Coastal Resource Management Project 1997). Proposed regulations will place tighter controls on exports of live reef fish in particular. All prospective exporters must obtain approval from the Bureau of Fisheries and Agricultural Resources (BFAR) and records on the number and species of fish that are exported must be submitted to them. Live fish shipments must be randomly tested for cyanide at a rate of 1 in 50 for food fish and 5 in 100 for aquarium fish. If the cyanide detection test is positive, then the shipment can be

confiscated. Repeat offenders are liable to lose their export licenses and could face criminal charges for dealing in illegally caught fish (Barber & Pratt 1997).

Access for foreign fishing vessels to Philippine waters has been curtailed in recent years. Illegal foreign fishing vessels are liable to confiscation if caught. Foreign live fish transport vessels are given permission by Philippine Customs to pick up live fish but require a commodity clearance from the Bureau of Fisheries and Aquatic Resources before fish are loaded. This clearance includes a requirement that fish have a cyanide-free certificate. However, international laws governing rights of free passage allow vessels to transport live fish caught in other countries through Philippine waters.

MALAYSIA

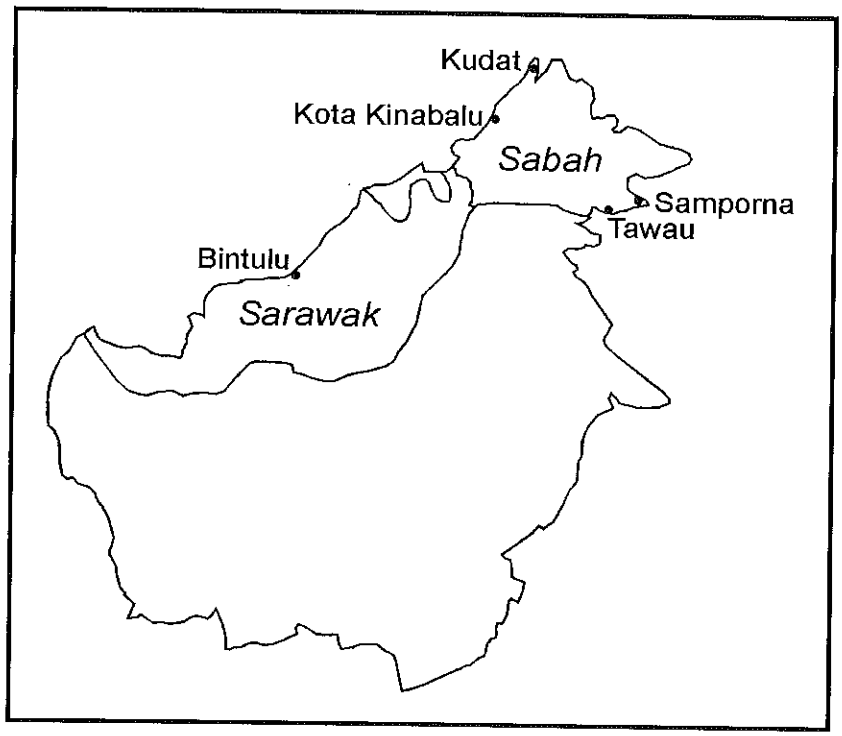
Malaysia is comprised of three principle regions. Eleven states form the western part of thecountry known as Peninsular Malaysia. The larger but less populous states of Sarawak and Sabah, lie in north Borneo. Sabah, the easternmost state, has the largest area of coral reefs and is the base for a significant live reef fish industry. The state has a coastline of 1600 km and a fishing fleet of about 9000 vessels with more than 25 000 fishers (Sabah Department of Fisheries 1996).

Live reef fish operations in Sarawak and Peninsular Malaysia are limited due to small areas of reef or the previous depletion of stocks. However, Peninsular Malaysia does produce large amounts of cultured live fish, particularly red snapper and sea perch (*Lates calcifer*). The main locations for these aquaculture operations are the islands of Penang and Ketam, and in Johor. In 1996, exports of live fish from Peninsular Malaysia included 1884 t to Singapore, 322 t to Hong Kong and 46 t to Taiwan. These are almost certainly all aquaculture produced fish.

Malaysia is demanding increasing quantities of wild caught live reef fish (Johannes & Riepen 1995). In 1996, imports of live fish, wild or cultured, to Peninsular Malaysia included 359t from Taiwan, 130t from Thailand, 195t from the Philippines and 180t from Indonesia. While imports from the latter two countries could include live reef fish it is difficult to confirm this. Most of the demand comes from Kuala Lumpur, which has a large population of ethnic Chinese. There is a similar, albeit lower, demand for live reef fish in other Malaysian cities. For example, in Kota Kinabalu live reef fish sell in restaurants for MYR 60/kg (USD 20/kg) for lower grade grouper species to MYR 200/kg (USD 66/kg) for humpbacked grouper.

Despite its increasing demand, for now, the primary role of Malaysia in the live reef fish trade is as a producer. The remainder of this chapter considers the live reef fish industry in Sabah.

Figure 6. 1. Map of Sarawak and Sabah indicating locations referred to in the text.



Exports

Data

There are two sources of live reef fish export data for Sabah (i) those compiled by the Department of Statistics from customs declarations, available from 1985 to 1996 and (ii) export weights of live fish validated by Fisheries Department enforcement officers prior to departure, available from 1990 to 1996. The latter is described as being "live fish (grouper, wrasse)" (J. Chin, Sabah Fisheries Department, *in litt.* September 1997). These data only provide total export weight, whereas customs data give value and export destination.

The category, "Other marine fish, fry, alive" (SITC 034.119.190), was introduced to the Sabah customs data in 1989. All other live fish categories are for ornamental fish, eels or carp. In 1996 a new category was included for, "Other live fish, other than trout, eels or carp" (SITC 034.119.000). In that year, the average value of exports of these two categories differed by less than 2% (MYR 27.89 (USD 9.30)/kg and MYR 27.53 (USD 9.18)/kg respectively) and exports were dominated by the same three destinations (Hong Kong, Peninsular Malaysia and Singapore). Due to the high degree of similarity between the data we have combined the two categories for 1996.

Trends

Although the magnitude of exports reported by the customs and fisheries data sets differ, they portray a similar trend. According to the customs data, exports began in 1989, three years later than suggested by industry representatives. Exports rose rapidly during the early 1990s, reaching a peak of 500 to 600t in 1993. Since then, exports have declined to 350 to 450t in 1996. Over this period there has been a progressive increase in average prices, which was particularly pronounced in 1995 and 1996 (Figure 6. 2).

Between 1993 and 1996, there was a growing discrepancy between the two data sets; customs data showing relatively stable exports, while Fisheries Department data suggests progressively declining quantities. This discrepancy can not be currently explained.

According to customs data, over 90% of live reef fish exports were sent to Hong Kong. However, in the last four years, there has been a growing demand from Singapore and Peninsular Malaysia (Figure 6. 3).

Exports quantities to Hong Kong increased until 1993, since then they have fallen (Figure 6. 4). There has also been a consistent increase in export value over the last eight years.

Figure 6. 2. Quantity and average value of live reef fish exports from Sabah, Malaysia by year, 1989 to 1996. Source: *DGF*.

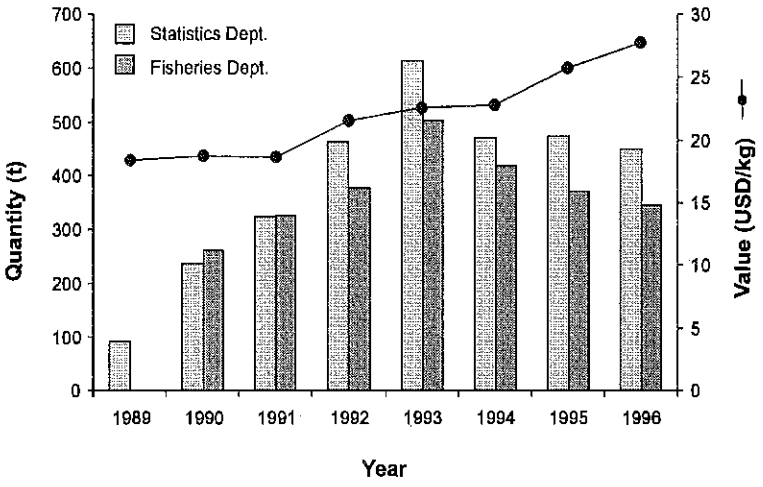


Figure 6. 3. Percentage of live reef fish export quantities from Sabah, Malaysia by country of destination, 1989 to 1996. Source: *DGF*.

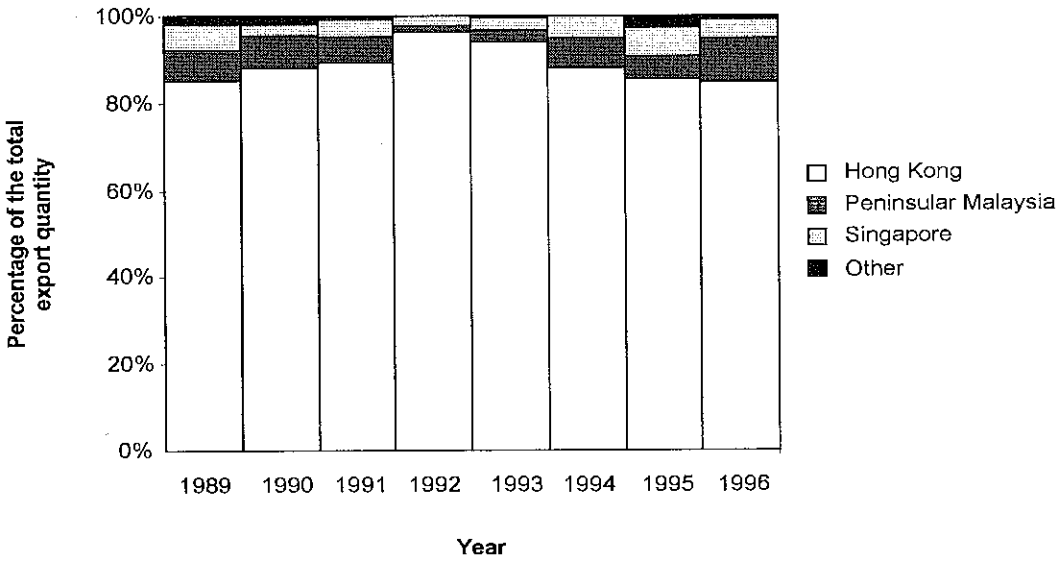
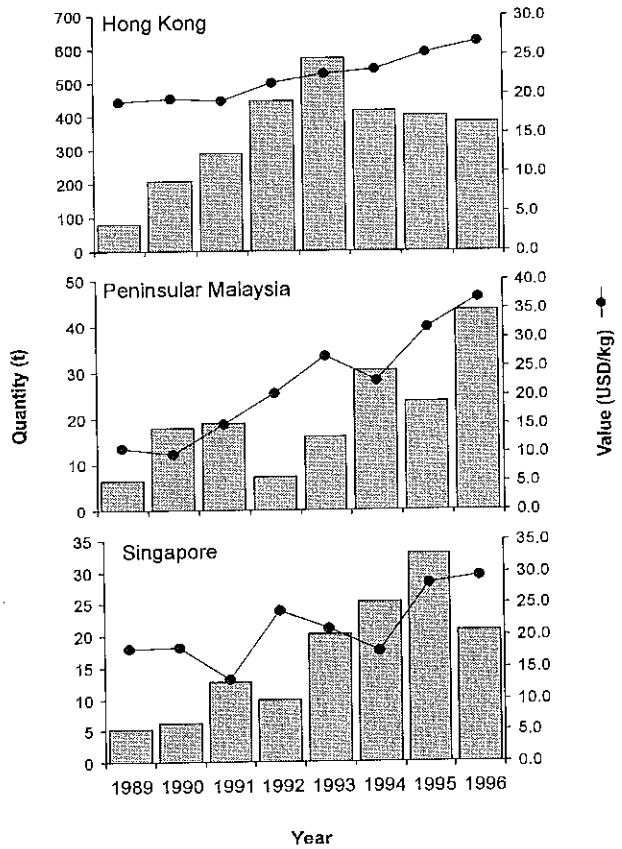


Figure 6. 4. Quantity and average value of live reef fish exports from Sabah, Malaysia by year for the two major, and all other, destination countries. Source: *DGF*.

Figure 6.4



Case Study H.

Kudat and Semporna

Nokome Bentley

Kudat and Semporna are the most northerly and easterly towns in Sabah, respectively. They both lie on the tips of peninsulas which extend from Borneo towards the nearby island chains of the Philippines. The live reef fish operations based in each town are similar and fish from both towns is exported via Kota Kinabalu.

Kudat has important trading links with the Philippines and is the fourth largest fish landing port in the state. Fishing for live reef fish began in the area in 1987. Since, there has been a rapid expansion of activities and by 1994 there were 11 companies with a total of 167 holding cages. A few of companies also have cages off nearby Banggi Island.

Semporna also has strong links with the Philippines and almost half of its population is Filipino, many of whom fled from the fighting in the nearby Sulu Archipelago during the early 1990s. There are currently four live reef fish companies operating in Semporna.

Most of the companies have their own fleet of boats and employ fishers who are often naturalised Filipinos. One company owner described how he has seven boats operating from Kudat. Each boat is 10 to 15m long and has five to thirteen crew. Each crewmember has a canoe from which they fish in the vicinity of the mothership using hook and line and traps. The boats make five to six day trips, fishing for about ten hours per day. On each trip they can expect to catch twenty to thirty kilograms of live reef fish, equivalent to a catch rate of 0.03 to 0.12 kg/hr. An unconfirmed report from Kudat suggests that cyanide is used by between 10 to 20% of fishers.

Another company based in Semporna uses cyanide exclusively. They have around 120 boots with over 400 crew. Most of the boats are 8 to 10m long and are fitted with a compressor and hoses. Four crew members take turns to dive in pairs to depths of over 40m in search of fish. They fish for two to three days during which time they can take up to 40kg of fish. Overall, the company is able to maintain a turnover of about 8t of live reef fish per month. The cyanide, which is used as a pesticide in nearby palm plantations, is reputedly brought from Indonesia at around MYR 15 (USD 5)/kg.

Operations in both towns appear to rely heavily on fish caught in Philippine waters. The area of coral reef around Kudat is not large, being concentrated around nearby Banggi Island. According to industry members these reefs were fished out early on and nowadays, most effort is directed at Philippine reefs around Mangsee Island, Silingsingan Island and southern Palawan.

The local waters around Semporna are reported to be less over-exploited than those around Kudat. This is apparently due to piracy in the area preventing the expansion of fishing effort. Boats from Semporna mainly fish in Philippine waters around Tawi Tawi Island and go as far as Siasi island, over 200 km past the border. Depending upon weather condition boats may also fish reefs towards Indonesia.

Companies in Kudat and Semporna also buy from local fishers and from Filipino fishers via their roving fleets. Coralgrouper are bought for MYR 17 - 45 (USD 5 - 15)/kg. As well as live fish, companies buy pearl shell, sea cucumbers and lobsters.

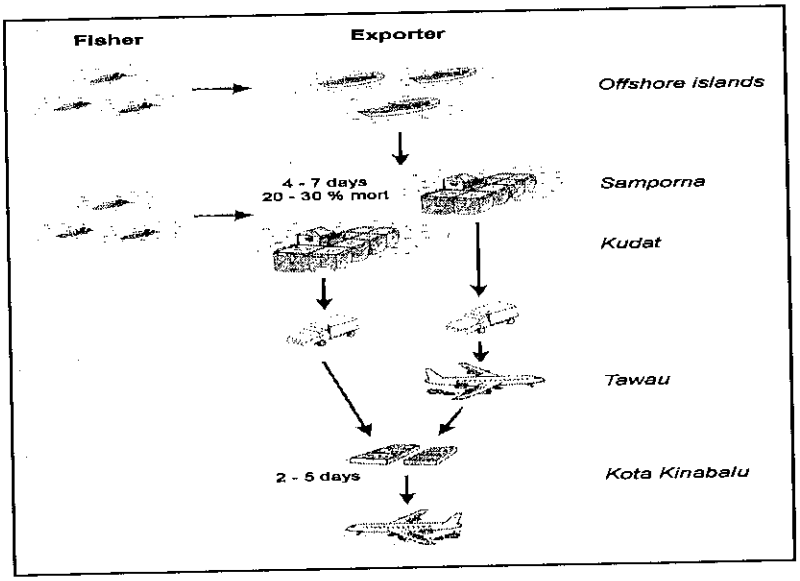
There are several reports that problems with the customs bureaucracy at the Indonesian border town of Tarakan, were leading to some fish caught in Indonesia being exported illegally to holding cages in Semporna.

Kudat probably has the highest concentration of holding cages in Southeast Asia. This is not necessarily a reflection of the magnitude of the area's catch, but rather, reflects the ideal location of the town for storage and onward transportation. Whereas floating cages in Indonesia are scattered, often relying on vessels to pick up fish, in Sabah, all fish are initially transported by road. Kudat is an ideal port, being close to fishing grounds and where live reef fish can be loaded directly into fibreglass tanks on trucks and driven to Kota Kinabalu. Here fish are packed into foam boxes ready for export by plane. Similarly, fish in Semporna are packed in boxes and taken by road to Tawau where they are flown to Kota Kinabalu.

Particularly in Kudat, industry members are currently complaining of reduced catches. Indeed the expansion of the industry in Kudat has slowed down considerably with only two companies entering between 1994 and 1996. There has also been a reduction in the number of cages, from a peak in 1996 of 181, to 164 in 1997.

There have also been reductions in the size of stocks being held in the holding cages at Kudat. Once a month, the local Fisheries Department office takes records of the quantity of fish held in each company's cages, at that time. In 1994, these records totalled 124t but had fallen to 103t in 1996 (Sabah Department of Fisheries, *in litt*, January 1997). However, these data may underestimate the reduction in catches. With an increase in the capture and grow-out of small fish, there is the potential for standing stocks observed in holding cages to remain similar despite reduction in annual turnover.

Figure 6. 5. Schematic diagram of the trade and transportation of live fish in Kudat and Semporna.



Case Study I.

Exporters

Nokome Bentley and Chen Hin Keong

The first live reef fish exporting company in Sabah was established in 1984. A second began in 1987 and by 1993 there were a large number of companies operating. Some have since left the fishery, reputedly due to over-investment of capital in boats and holding facilities. In 1996, there were 24 companies listed as exporting live fish from Sabah, most based in Kota Kinabalu, although five companies were in Tawau and Semporna (Sabah Department of Fisheries 1996).

As in the Philippines, exporting companies generally own their own boats and holding facilities in catching areas. Operations in Kudat and Semporna send fish to headquarters, where fish are usually reconditioned in preparation for export.

One company[vi] based in Kota Kinabalu, has three boats operating from Bintulu, Sarawak where there are small areas of coral reef. Fish are flown from there in foam boxes to Kota Kinabalu at a cost of MYR 1 (USD 0.33)/kg. According to official trade data, imports of live fish from Sarawak began in 1994 and during the following three years averaged 2.18t.

With an increasing proportion of small fish being caught, some holding facilities near Kota Kinabalu are used as grow out facilities. Several companies have floating cages at the small village of Kampung Trayong, near Tuaran. Here they take advantage of the sheltered waters and lack of red tides, which cause fish mortality. At another location one company has a large concrete tank (15m x 20m x 1.5m) containing several hundred kilograms of live reef fish. Every three months the tank is drained for cleaning and suitable sized fish are exported. The fish are fed bycatch from local trawling operations and it takes 4 to 5 months to grow them from 200 - 300g to 800-1000g.

According to industry, live fish transport vessels from Hong Kong used to collect fish from Sabah. However, for the last ten years, only air transport has been used. There are regular flights from Kota Kinabalu, to Hong Kong, each with enough cargo space for about 180 foam boxes. Each box contains about 4 kg of fish and costs MYR 2.60 (USD 0.86)/kg to transport. At its peak, the fishery is reported to have exported 9 to 10 t per week by airbus to Hong Kong. This is equivalent to about 500t on an annual basis, which corresponds well with official data (Figure 6.2). Since then, cargo capacity on flights has been reduced but exporters say that it still meets their requirements. They consider that it is the reduction in fish abundance, not cargo space, which has caused recent reductions in exports.

Industry members recount selling live reef fish to wholesalers in Johor on Peninsular Malaysia, who then exported to nearby Singapore. To improve profit margins, they currently sell directly to Singapore.

Exporters sell coralgrouper for MYR 45 - 70 (USD 15 - 23)/kg and export permits cost about MYR 3 (USD 1)/kg.

Regulations

The laws of Sarawak and Sabah, can differ quite substantially from those of Peninsular Malaysia and from each other. However for fisheries, the same federal legislation is used in all three states. This legislation prohibits the use of cyanide for fishing. There are no known other regulations that specifically apply to the live reef fish industry.

SINGAPORE

Singapore is a modern and wealthy city nation of 3 million people. During the 1980s and early 1990s, it had a rapid rate of economic growth and its per capita GDP is now above many western countries. It has a diverse cultural blend of mainly Chinese, Malays and Indians. Although around seventy five percent are Chinese, most are Hokkien and Teochew Chinese who have less of an affinity for seafood than the Cantonese who dominate Hong Kong's population.

Singapore has a small number of coral reefs within its territorial waters, but these are not capable of providing a significant harvest of live reef fish. This chapter focuses on Singapore's importation and consumption of live reef fish.

International Trade

Prior to 1997, the Singaporean Trade Development Board (TDB) data did not distinguish live fish from fresh and chilled fish. Between January and August 1997, 787t of "Other Marine Fish, Live" was imported, of which 99% came from Malaysia at an average value of USD 6.38/kg. Most of this product was probably fish produced by aquaculture operations. Only 10 t was imported from all other countries. According to the TDB, data on the trade of all goods with Indonesia is classified information. However, industry sources suggests that Indonesia is by far the largest supplier of live reef fish to Singapore.

The import data that we have obtained from the TDB for prior to 1997 entitled "Other Marine Fish, Fresh or Chilled" match those included in (Johannes & Riepen 1995) labelled "Live Marine Food Fish". Regardless of whether this data represents live or dead fish, the withholding of Indonesian trade data by the Singaporean government renders it useless for estimating the total magnitude of live reef fish imports.

As an alternative to Singaporean import data, export data from the major countries supplying live reef fish in Southeast Asia can be examined (Table 7.1). These data indicate that in 1996, over 90% of live reef fish imported into Singapore come from Indonesia. The Indonesian export data coincides with reports from industry sources in Singapore who suggest that imports from Indonesia total about 200 to 300t per year. We conclude that Singapore's consumption of live food fish caught from the wild does not currently exceed 500t per annum.

Table 7. 1. Exports (t) of live reef fish to Singapore from Indonesia, Sabah (Malaysia) and the Philippines.

Year	1989	1990	1991	1992	1993	1994	1995	1996
Indonesia	167	246	214	375	454	349	283	338
Sabah, Malaysia	5	6	13	10	20	25	33	21
Philippines	NA	NA	0	0	0	1	13	8
Total	172	252	227	385	474	375	329	367

There are several ports where live fish can be landed in Singapore, including Jurong, Senoko and Changi Point. Twice a week, small boats from the nearby Indonesian island of Batam, deliver live fish to Jurong Fishery Port. About once a week, larger boats with loads of one to two tons arrive from Indonesia.

Indonesian boats, mainly from Riau and the South China Sea, also land fish in fish cages in the Johor Strait adjacent to Changi Point. According to a Singaporean wholesaler, one farm in the strait takes delivery of one to two tons of live reef fish from Indonesia, once or twice each month. Fish are kept in floating cages, and batches are brought ashore each morning for distribution to restaurants throughout the island. The fish cannot be kept in the cages for extended periods as their condition deteriorates quickly. This has been blamed on declining water quality in the area.

As well as imports by sea, live fish is reported to arrive by air from Jakarta and Sabah.

Wholesale and Retail Trade

Five large companies and about fifty smaller ones deal in live fish in Singapore. They buy fish from importers at the markets or from floating cage operators at Changi Point. They then distribute fish to restaurant clients. Wholesale prices range from SGD 20 (USD13)/kg to SGD 120 (USD 80)/kg depending upon the species.

When a wholesaler obtains a particularly expensive specimen, such as a thirty kilogram Humphead Wrasse, they call their clients in advance to determine the best price available. The restaurant will then contact its regular customers, arrange for a viewing of the fish and fix a day for the meal. On the appointed day, the fish is killed, cooked and divided amongst the customers who have booked. Such banquets can cost in excess of SGD80 (USD 53) per person.

Live food fish is a luxury and are generally only eaten on special occasions, such as business meetings, weddings and other celebrations. Peak demand occurs on weekends and throughout the Chinese New Year celebrations, which occurs around the end of January or early February and extends for 15 days. According to local wholesalers, stocks of live fish are increased from October in preparation for the New Year. This is also in anticipation of reduced supply during the monsoon season from around October to April.

There are two standards of establishments that offer live reef fish in Singapore. In contrast to Hong Kong, which demands fish of at least 600g and prefers those 1 to 1.5kg, Singapore diners accept fish as small as 350g. Most seafood restaurants prefer leopard and spotted coral grouper between 400 and 800g, which serve a table of ten diners. In these cheaper restaurants, valuable species such as Humphead Wrasse or Humpbacked Grouper must be ordered two to three days in advance, as most owners do not want to risk mortality of expensive fish (L. Pet-Soede, *in litt*, October 1997).

More exclusive restaurants, such as those found in some expensive hotels, prefer larger or rarer species such as humphead wrasse and humpbacked grouper. Many of these restaurants do not advertise but rely on a regular clientele and word of mouth.

In most restaurants, prices are quoted per one hundred grams and can vary quite widely depending upon the class of restaurant (Table 7.2). After the customer selects the fish it is taken out of the display tank, weighed and cooked. Steamed fish is the most popular method of cooking although some fish are also lightly fried.

Table 7. 2. Prices of live reef fish in Singaporean restaurants, September 1997.

Species	Price
Spotted coralgrouper	SGD 60 - 90/kg (USD 53/kg)
Leopard coralgrouper	SGD 70 - 100/kg (USD 67/kg)
Humphead wrasse, Humpbacked grouper	SGD 180 - 240/kg (USD 160/kg)
Various grouper species	SGD 50 - 60/kg (USD 40/kg)

Regulations

Section 9(1) of the Wild Animals and Bird Act prohibits the importation of any wild animal or bird, whether dead or alive, with two exceptions: written authorisation of the Director of the Primary Production Department or if the animal was killed outside of selected Southeast Asian countries[16] and is to be used as food. According to the Interpretation Act, 'animals' include fish and would therefore suggest that imports of wild caught live reef fish are illegal unless they have written authorisation. However, in practice, it is unlikely that marine species would be considered under the Wild Animals and Bird Act (Lye Lin Heng 1991).

The Fisheries Act (1985 Revised Edition) forbids the use of poisonous substances with intent to stupefy, poison or kill fish. Furthermore, any person who lands or sells fish caught using such substances can be prosecuted.

[16]Cambodia, Indonesia, Loas, Malaysia, Myanmar, Thailand or Vietnam

OTHER COUNTRIES

The other countries of Southeast Asia do not currently play a major part in the live reef fish trade. Although Myanmar has significant areas of coral reefs, for political reasons these have not been fully accessible to the live reef fish industry. However, one live fish transporter expressed an interest in operating there and live coralgrouper reportedly from that country have been observed in holding cages in Hong Kong (C. Barber, *in litt.*, March 1988).

Vietnam has small areas of coral reefs and although there are reports of the live fish trade developing there, the quantity produced is not thought to be significant relative to other countries in the region.

Thailand has significant areas of coral reef on its western coast. However, perhaps due to previous over-exploitation, these have not produced large quantities of live reef fish in recent years. However, the country is involved as a stop over point for live reef fish from the Maldives. One company has a boat with a live fish capacity of thirty tons, which takes fifteen days to sail from the Maldives to Phuket, Thailand. Here, small coralgrouper (200 - 300g) are held in cages and fed by-catch from trawlers, which is both plentiful and cheap. Fish are grown out for two to three months until they reach a size suitable for sale in Hong Kong (500 - 600g). The company has two boats, which then transport the fish to Hong Kong.

TRANSPORTERS

The previous sections provided a description of the live fish trade within supplying countries of Southeast Asia. One important component of the trade has activities that span international boundaries. These are the live fish transport companies, who collect fish from throughout the Indo-West Pacific and deliver them to Hong Kong.

Although the fishery has undergone quite drastic changes in the last ten years, the need to get fish to the market alive has remained. Initially the industry was based on foreign fishing boats that had holds in which they could take fish back alive to Hong Kong. With the shift towards local operations, vessels purposely built for the transportation role emerged.

In a number of places, these operations were not able to compete with the falling price of air freight and thus the role of transport vessels has progressively diminished. For some time, most live reef fish exported from the Philippines and Sabah has been exported by plane, and only in Indonesia do boats remain an important mode of transport. The following discussion focuses on the operations of live fish transport companies in eastern Indonesia.

Operations

Usually, transporters operate by purchasing fish from exporters and selling to wholesalers in the importing country, rather than acting solely as transportation agents. One company[vii] has three boats operating in eastern Indonesia, all with about 10t live fish capacity. To avoid excessive regulations, these boats are registered in Panama or under other 'flags of convenience'. Each boat operates independently but maintains radio contact with an agent in Indonesia. The manager of the operation coordinates the movement of the vessel and regularly travels to Indonesia to pay for fish in US dollars cash.

The boats visit several ports until full and then return to Hong Kong. It takes about eight days to travel from eastern Indonesia to Hong Kong and because a few days are required for official business in each port, each trip takes at least 20 days. During one month, the three boats make a total of four to five trips, totalling about 40 to 50t of live reef fish. The company estimates that it transports about fifty percent of all the live reef fish exported from Indonesia.

Ten years ago, transport vessels would only need to visit one holding cage in order to fill their holds. Nowadays, catch rates have dropped and it may take three or four stops. Exporters telephone the transporter's agent in Indonesia to advise them on the quantity of fish available for pick up. Due to the time and money involved in going to each stop, the transport vessels generally only collect loads of greater than 3t. One transporter described how exporters often overstate the amount of fish ready to export. More frequent collections are of benefit to exporters because it reduces total mortality at their holding facility.

Transport boats must first check in with the nearest fisheries department office when travelling to collect fish. A fisheries officer is organised to accompany the transport boat to the holding cages. The officer checks the loading of fish and completes the appropriate paperwork. Sometimes the nearest fisheries office will be some distance from the site. For instance, the Ujung Pandang office of the fisheries department has jurisdiction over the Balabalangan Islands in the Makassar Strait, over 300km away, and the Kendari office is in charge of the remote Tukanbesi Islands. Even small towns such as Bontang in East Kalimantan and Tual in southern Maluku have fisheries offices that record exports.

Not all exports are made legally however. Particularly in the earlier days of the fishery, foreign boats would fish without a license to try to avoid fees. There are reports that some vessels 'worked with' the Indonesian Navy to gain protection. However, apparently such modes of operation have not been viable in the long run, either because colluding partners wanted a large share of profits, or because if they did not have such protection, there were large fines or bribes (and potentially the confiscation of the vessel) to pay when caught . Despite the opportunity to save money by avoiding fees, the chances of being caught appear to be great enough to make this uneconomic in the long run.

Mortality

Fish mortality rates as high as 40% are reported, when the industry initially began. Over the last ten years, however, companies have developed techniques to minimise mortality rates. For instance, one transporter dips all fish into freshwater for five to six minutes before putting them into the main holding tanks. This is believed to kill many of the surface bacteria on the fish. Some transporters prefer to do this, rather than use antibiotic baths. Most of the time, fish mortality on boats is around 5% on a voyage from eastern Indonesia to Hong Kong. This is still greater than the 2 to 3% mortality reported for the same distance by air. As Humphead Wrasse have a higher mortality rate, transporters may not always buy them.

After two to three days on the transport vessel, fish are sufficiently settled to begin feeding. This apparently helps to maintain the condition of the fish during transport. A high rate of water turnover is maintained in the tanks to ensure that excess food does not deteriorate water quality.

One transporter reported that, at certain times of the year and lunar cycle, spawning events sometimes occur within the vessels holding tanks. The eggs and sperm released in to the water can cause rapid deterioration of water quality, leading to increased rates of mortality.

During rough weather, mortality can rise up to 15% and toxic algae blooms and other environmental factors can result in mortality rates as high as 30%. One skipper noted that when passing Mount Pinatubo, the Philippines, during its eruption in 1991, they experienced elevated water temperatures and very high rates of mortality.

Profits

At first, the profits taken by the transporting companies appear to be great. Coralgrouper bought in Indonesia for USD 8-10/kg can be sold in Hong Kong for around USD 20/kg. Based on this, a vessel which carries 10 t could gross USD 100 000 on a single trip.

However, transporters argue that there are significant costs involved in their business. Their boats cost between USD 0.5 to 1.5 million. To lease such a vessel would cost around USD 30 000 per month, equivalent to approximately USD 15 000 per trip to Indonesia. The return trip from Hong Kong to Indonesia, requires in excess of 150 000 litres of fuel, costing around USD 50 000.

In addition to these running costs, there can be significant fees in the country of export. In particular, transporters complain about the excessive bureaucracy in Indonesia and the exorbitant official (and unofficial) fees to be paid. These fees include fishing permits, harbour master fees, customs fees, quarantine fees and fisheries department clearance. During a month long trip to Indonesia, visiting three to four ports to collect fish, these payments can total as much as USD 10 000. Operators also report live transport vessels being seized by the Navy on false charges and having to pay up to USD 10 000 for their release.

Transporters also claim that they have invested heavily in the local live reef fish industry by buying outboard motors for fishers and setting up holding cages. One company claimed to have spent a total of USD 500 000 on these types of investments during ten years of operation in Indonesia.

Despite high fees and costs, our calculations suggest that a company could make at least 50% profit on the fish bought. However, members of the transport industry say they only make 20% profit and that this is being eroded as exporters increase the price for fish because they are unable to pass this on to wholesalers.

Declining catch rates and high bureaucratic costs has meant that at least one company has ceased operations in Indonesia. Another company, one of the largest dealers in live fish, was considering leaving Indonesia because of similar problems. We have been told of newcomers to the industry who have had to invest heavily in capital equipment such as boats and cages. With high repayments on credit, several are reported to have gone bankrupt.

DISCUSSION

This discussion considers solutions to problems in the live food reef fish industry identified in this report. This is done by addressing a series of questions that form a logical pathway for formulating a cohesive management framework. Most of these questions do not have a single correct answer and in many cases there is insufficient information to answer them with absolute certainty. The pros and cons of alternative options are considered but in order to progress forward for each question a 'best' answer is proposed.

Does the live food reef fish industry in Southeast Asia need to be managed?

The case studies and summaries of export data presented in this report suggest that stocks of live food reef fish in Southeast Asia are being overexploited. Declining catch rates and fish sizes have been described by fishers, transporters and exporters. For example, fishers at Take Bone Rate, south Sulawesi describe how three years ago, when they started fishing for live food reef fish, they caught about five fish per day, each weighing on average two kilograms. By 1997 they were catching only one or two fish per day at an average size of 600g[17]. Official export data also suggests that over-exploitation may be occurring: exports from the region rose in the early 1990's by more than an order of magnitude but in 1996 declined by 22%. This trend is reflected in all three major exporting countries: Indonesia, the Philippines and Malaysia.

This type of information is not conclusive evidence that reef fish stocks are overexploited. The theory of fisheries science tells us that catch rates and sizes of fish will decrease before the optimum stock size is reached. But without detailed knowledge of the population dynamics of a stock, catch and fishing effort, it is impossible to determine when this optimum is reached. Little information exists on the biology and status of species targeted for the Southeast Asian trade. Reliable estimates of catch and fishing effort are few and research has been patchy and inconsistent. At best the status of the fish stocks remains anecdotal.
However, experience tells us that it would be irresponsible to wait until this information was available before deciding that management was necessary. There are few restrictions on entry or fishing effort in the live food reef fish trade; it is an open access fishery. The 'tragedy of the commons' (Hardin 1968) is now a well-recognised feature of open access fisheries, throughout the world. When there are no controls over access to the resource, new entrants are attracted to the fishery until catch rates reach a point at which they are no longer economically profitable (Gordon 1954). This type of over-fishing is common in developing countries because poor fishers with few alternative income sources are more likely to remain in an overexploited fishery (Pauly *et al.* 1989, Pauly 1990, McManus 1996).

The potential for over-fishing is further exacerbated by the high value of live food reef fish. Fishers in the live food reef fish trade can expect to earn up to five times that of an average small scale fisher and up to 12 times that of an average rural worker[18]. The high incomes that can be made from the industry are, therefore, enticing. The ensuing growth in the industry has

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[17] H. Cesar, World Bank, New York, *pers. comm.* July 1997.

18 "Based on figures in Case Study A and a daily income of IDR 2000 for rural workers (Cesar 1996)"

been analogous to a gold rush. None of the countries examined in this report have fisheries regulations and face of these pressures. If the live food reef fish stocks of Southeast Asia are not already over-exploited, they will be in the near future without effective management.

In addition to overfishing, the live food reef fish industry has the potential to cause damage to coral reef ecosystems through the use of destructive fishing methods. This directly impacts on the live food reef fish industry by degrading the habitat on which it is based. Further, loss of associated species and destruction of habitat may have far reaching effects on the functioning of the coral reef, potentially reducing the value of reefs for other uses. Coral reefs ecosystems are an important resource for Southeast Asia and their value extends far beyond the direct extraction of fish to such important functions as coastal protection and stabilisation (Spurgeon 1992, Cesar 1996).

Several methods are currently used to catch live fish and they vary among regions, villages and fishers. Of all the methods used to catch live food reef fish, cyanide has the worst reputation (Box 1). In some areas its use is common. For example, one operator in Sabah, Malaysia described his fleet of over one hundred vessels, which mainly fish in Philippine waters, using compressors and cyanide. Similarly, in one part of the central Philippines local fisheries officers describe the use of cyanide as rampant. Other methods used to catch live food reef fish may also impact upon coral reef habitat. There are several reports of trap fishers breaking pieces of coral to anchor and camouflage traps. Concerns have also been voiced over the impact of hook and line fishing. While this method is seemingly benign, frequent movement of the fishing boat in search of fish may cause significant anchor damage to the reef.

In conclusion, there are several environmental and social problems associated with the live food reef fish industry and there is a need for the formulation of a specific and coherent management approach to address these.

What should be the goal of management?

In the above section three threats posed by the live food reef fish industry were identified: reductions in the size of fish populations; damage to coral reef ecosystems through the impact of fishing methods and; loss of income to fishers caused by over-fishing. Managing each in isolation would not recognise the tight linkages between stock-depletion, fishers' incomes and habitat destruction; an appropriate management goal needs to encompass all these components.

The threats identified above are not solely the product of the live food reef fish industry. All three are general phenomena that are occurring on coral reefs throughout Southeast Asia; other fish stocks are being over-exploited, and other industries are damaging coral reefs. The live food reef fishery does not sit in a vacuum; it is one choice of an array of species and methods in a coral reef fishery. (Amar *et al.* 1996). Other modes of fishing range from using lift nets in lagoons to target small pelagic fish, to using homemade bombs for demersal species (Ruddle 1996). Due simply to limitations on fishers time these activities are mostly mutually exclusive; if you are catching live food reef fish you cannot be throwing bombs at the same time.

To illustrate the impact of this on formulating a suitable management goal, consider the scenario in which overnight, all consumers of live food reef fish were convinced to eat other types of fish. Within weeks, this would bring an end to the live food reef fish industry and cyanide fishing. However, the income of live food reef fishers would be drastically reduced. They

may continue to catch grouper and coralgrouper, but would be forced to sell them dead at the local market at a far lower price. In order to maintain a similar level of income they would need to catch greater quantities of fish, thus actually increasing pressure on stocks.

Alternatively, fishers may switch to other forms of fishing. There is a wide range of possibilities, including catching mackerels, sea cucumbers, or sharks for their valuable fins. But one alternative fishing method stands out in providing high levels of income - blast fishing (Pet-Soede *et al.* in prep.). Already, some fishers say that they are going back to the "easy money" provided by blast fishing due to reduced catch rates of live food reef fish. The impacts of blast fishing on coral reefs are likely to be at least as great as those from cyanide fishing. So in this scenario, although cyanide fishing would be stopped, the net result would be a reduction in incomes for many coastal communities and a potential worsening of damage to coral reefs. In this scenario, stopping the trade in live food reef fish would not necessarily aid in the conservation of reef fish stocks or coral reefs in general.

Thus, due to the tight linkages between stock-depletion, fishers' incomes and habitat destruction, an appropriate management goal needs to encompass all these components. Furthermore, because the threats that it poses are shared with other activities, the goal needs to extend beyond simply controlling the live reef fish industry. The following management goal below is used as the basis for formulating a management strategy:

"To control the industry to conserve reef fish stocks in such a way that maintains fishers' incomes and aids the conservation of coral reef ecosystems in Southeast Asia".

What are the best strategies to manage the live food reef fish industry to achieve this goal?

As suggested earlier, ending the trade in live reef fish may not aid in the conservation of coral reefs because fishers could switch to equally destructive methods to make an income. Such an effect may be mitigated by an alternative source of income to fishing. But recent research in the Philippines found that 83% of fishers would remain fishing even if another occupation was available that provided the same income (Pomeroy *et al.* 1997). So the alternative may have to be significantly more lucrative but might include aquaculture operations or land based activities.

However, when fishers are no longer dependent on the coral reef environment for their livelihood there is little incentive for them to protect it. It would be tempting for fishers to supplement their alternative income by continuing destructive fishing practices on the reef, or by allowing others to do so. Any incentive for coastal communities to conserve coral reefs is lost when the link between them is broken.

Ideally, a management strategy would involve a means of livelihood for fishers that depends upon healthy coral reefs without damaging them. Furthermore, it should be based on a resource that makes the most efficient use of the limited resource of the reefs and which reflects their importance to society.

In stark contrast to many other coral reef resources, consumers of live food reef fish place a very high value on a direct product of a healthly functioning coral reef. The prices paid by these consumers to enjoy a product of a healthy coral reef is comparable to that paid by tourist SCUBA divers. Although consuming live reef fish is necessarily extractive, it can be sustainable, and the flow of income that it generates is more likely to reach those that need to be targeted -

the coral reef fishers. Encouraging a live food reef fish industry that is sustainable (Box 2) may be the best strategy to achieve the goal of controlling the industry to conserve fish stocks and the coral reef environment in general.

What are the best tactics to implement the management strategy?

In the seemingly inadequately regulated world of Southeast Asian fisheries, the hypothetical sustainable fishery posed in Box 2 can seem far-fetched. However, management interventions at appropriate points in the trade could make a sustainable fishery for live food reef fish a reality.

Different management tactics are appropriate at each level in the trading hierarchy, not only because of their differing social and economic organisation, but also because of the spatial scales on which they operate (Adams 1996). Any intervention will have ramifications at other levels in the trade. The socio-economic relations between trading tiers are an important factor in fisheries trade in Southeast Asia (Box 3) and need to be considered in the application of management tactics.

Compliance can come through two primary means, external or internal enforcement. External enforcement is usually done by government agencies such as fisheries departments or marine police. Internal enforcement is done by the resource users and can arise from a definition of property rights (Box 4). The two are not mutually exclusive and compliance may be best achieved through a mix of the two. Below, alternative forms of management intervention at each level in the trading hierarchy and options for enforcement are examined [19].

Fishers

The proposed management strategy aims to provide a sustainable livelihood for fishers by controlling the quantity of live food reef fish harvested. It is therefore most appropriate to first examine tactics aimed at fishers. Several programmes have already taken this approach (Box 5). The focus of these has been to teach fishers how to use hook and line to catch live food reef fish. These programmes are reported to have been successful at reducing the use of cyanide (Barber & Pratt 1997). Although the current initiatives are limited to relatively small areas, it is anticipated that the popularity of hook and line will spread elsewhere. However, hook and line fishing alone does not ensure that the fishery will be sustainable. Large quantities of live food reef fish can be caught using hook and line, particularly on spawning aggregations. This may result in over-fishing of stocks. Hook and line fishing would be worthless as an 'alternative' livelihood if the fishery collapsed in this way.

To maintain a sustainable fishery, the level of exploitation must be limited. This can be done directly, by restricting the catch, or indirectly by placing limits on fishing effort. Examples of such regulations include limits on the catch taken per trip, limits on the number of fishers in an area, and limits on the type and quantity of fishing gear used.

Size limits are often used in fisheries management to control the level of exploitation on fish stocks. The minimum legal size limit is often set so that it is just above the average size at

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[19] In accordance with the scope of this report we only consider intervention within supply countries of Southeast Asia. Market oriented tactics are not considered.

which fish mature sexually. This ensures that the population retains some reproductive capacity. In the case of species which are protogynous hermaphrodites (change sex during their life from female to male), minimum and maximum size limits may be appropriate. If set appropriately this would help ensure that a sufficient number of mature females and mature males were present in the population.

A feasible alternative to regulating catches directly would be seasonal and areal fishing closures. The value of areal closures, such as marine reserves, for fisheries management on coral reefs is being increasingly advocated (Russ 1996, Roberts 1997, Russ & Alcala 1997). By closing fishing in areas where spawning occurs, large adult populations can develop and successfully reproduce, thus potentially enhancing the remainder of the fishery. A similar approach can be taken by prohibiting the taking of fish during the spawning season. Or a combination of seasonal and areal closure may be used. The advantage of closed areas is that they can form reserves for other species as well as providing areas for eco-tourism.

The large area of coral reef and dispersed nature of the fishery means external enforcement of regulations may prove difficult. Government officers would need to patrol large areas. However, resources required to do so are often lacking in the relevant agencies in Southeast Asia. Alternatively, compliance could arise from assigning property rights over the resource to the resource users. Such initiatives are gaining government support. For example, the Medium Term Philippine Development Plan (1993-1998) espouses community based resource management and envisions that fishers will assume the dual role of resource users and resource managers. It aims to achieve this by promotion of Territorial Use Rights in Fisheries (Geron 1996).

Property rights for fishers could be applied in conjunction with the formation of fisher co-operatives. At present, dealers provide an important marketing service for fishers in more remote areas. This role could be replaced by co-operatives and may enhance the livelihood value of live food reef fish by providing a standardised and higher price per kilogram. Government or non-governmental organisations could assist in the establishment of co-operatives. The Philippine government already encourages the formation of co-operatives through the Co-operative Code (Delmendo 1996). However, the entrenched power of dealers may inhibit the formation of fisher co-operatives in some areas.

Despite the long term potential of property rights for fishers, defining them may be a long legal process that could take years to develop. Furthermore, once property rights have been defined, they need to be protected through effective exclusion of others. This may be difficult to achieve particularly in remote areas and without the support of effective fisheries enforcement. Socio-cultural and political influences should also be considered when considering establishing community based management regimes. Given the high rates of poverty among coastal fishing communities, future income is often of less importance than meeting daily needs. The situation of debt and dependency that many fishers face and the entrenched power of fish dealers, may inhibit fishers attempts to independently manage the fishery on their reefs (Box 4).

It is also questionable whether the local level is the best spatial scale at which to define property rights for the management of live food reef fish. Although our knowledge of larval dispersal in live food reef fish is limited, it is likely to occur over at least hundreds of kilometres. While this alone does not provide sufficient information to estimate the spatial extent of stocks, it does suggest that managing populations on the basis of single reefs may be inappropriate.

In summary, intervention at the level of fishers should focus on reducing the use of destructive fishing practices. The training of hook and line and decompression techniques appears to be a successful means of achieving this. Ensuring sustainable harvest levels is probably more feasible at other levels in the trade.

Dealers

Dealers are the collection point for live food reef fish caught over a large area. Since there are fewer holding cages than fishers, it may be easier to enforce limits on harvests at this level in the trade. Moreover, the area over which holding cages collect fish may be more similar to the spatial scale of the fish stock, than the area of operation of an individual fisher. There are two major obstacles to enforcement of such regulations. Firstly, although there are fewer of them, holding cages are often widely dispersed and checking them all would still provide a challenge to enforcement agencies. Secondly, it would be easier to enforce limits on how much a cage owner could hold at any one time than limits on turnover. A dealer who sends fish on to exporters quickly, may have a throughput of several hundred tons without having more than a couple of hundred kilograms of fish in his cages at any one time.

Defining property rights for dealers is an alternative to external enforcement. They could be given sole rights to buy and sell fish within a given area. They would thus have an incentive to limit catches to ensure that their own income remained sustainable. Self-imposed regulations could be set on the size and number of fish that were bought from fishers by the dealer. Again, there are difficulties. Without effective protection of property rights, there would be little or no incentive to harvest sustainably. It may be difficult for dealers to prevent other operators taking fish from their area, particularly if the area was large.

However, monitoring and regulations at this level in the trade could provide a useful means of supporting other tactics in the management framework. For example, cyanide testing of fish held by dealers and fines if these were positive, could greatly enhance other efforts to reduce the use of cyanide fishing and encourage other less destructive fishing methods.

Exporters and Transporters

The revenue of exporters and transporters comes from buying and selling live food reef fish. Without a supply of fish they would be unable to make an income from their operations. Like fishers and dealers, they have a benefit stream, and thus property, that is derived from live food reef fish stocks (Box 4). Furthermore, the area over which exporters draw their benefit stream is far greater, and probably more similar to the spatial scale of live food reef fish stocks, than for fishers and dealers. As such, it may be most appropriate to define property rights in live food reef fish at this level in the trade.

Could property rights be defined and effectively enforced such that exporters and transporters took a vested interest in the conservation of these stocks? One way to define a property right for exporters would be to assign one export licence for each region. An exporter would have exclusive rights to export live fish from that region and would have the responsibility for the status of fish stocks within it. To be effective, property rights must be defendable. But governments could more easily defend the property rights assigned through export licences because it is easier to monitor who is exporting fish from tens of ports, than who is catching fish from millions of hectares of coral reef.

But the effective allocation and defence of property rights does not necessarily ensure that the resource will be harvested sustainably (Box 4). If the growth rate of the resource is slow, exporters may choose to 'mine' the resource by exporting as many fish as possible, as quickly as possible, and to reinvest the money elsewhere. In the case of live food reef fish, this would probably be an irrational choice. Firstly, it would ignore the increases in the size and affluence of the world's Chinese population, which provides the potential for increases in demand, and thus the price, of live food reef fish. Secondly, even given a constant value, reef fish populations in general are probably productive enough to make 'mining' economically irrational. Given these, the industry appears to be a sound investment.

Nonetheless, holders of export licences may act in an economically irrational way. The resulting overexploitation of the stock would be no better than is currently occurring. To prevent 'mining' of the resource, limits on the total annual exports under each licence could be set. For each region an annual limit on export quantities could be set, and equal quota entitlements allocated to each exporter. Such export quotas would again be easier to enforce than catch limits imposed on fishers. As long as the annual quota was appropriately set, there would be no incentive to compete to catch reef fish stocks. Exporters would have a vested interest in allowing fish stocks to rebuild so that in the future the export quota could be raised.

Export quotas will need to be set on a regional basis within a country, to prevent over-exploitation in the most accessible areas. Auxiliary conditions in the quota system could be used to discourage the use of destructive fishing methods. For instance, a number of quota units could be rescinded for the export of fish that tested positive for the cyanide. Such a penalty would need to be of appropriate size to make sure that exporters did not take the risk of not being tested.

While export quotas could provide benefits to sustainability, other issues also need attention. Sole licensing may be undesirable from the point of view of equity. By assigning export rights for a region to a single exporter, a monopoly is allocated. It may not be socially acceptable to allow one company to generate large profits from a community owned resource such as live food reef fish.

How should management be integrated?

To be effective, management must be integrated nationally, across all levels of trade, and internationally across live food reef fish stocks and markets.

National

> "Export fisheries are most cost effectively managed at the national level, through control of trade outlets, but may require local community cooperation to be effective."(Adams 1996, p 341).

In the previous section, management intervention at the three broad levels in the trade was examined. Each has its advantages and disadvantages, for addressing specific problems in the industry. Flow on effects can be expected from intervention at any one level. For example, if export quantities are reduced, dealers will buy fewer fish, and fishers will catch fewer fish. Similarly, fining exporters or dealers for the possession of fish testing positive for cyanide, will encourage them to only buy from fishers who they know do not use cyanide for fishing.

Despite these 'trickle down' effects, the most effective way to address all issues in the live food reef fish industry will be to simultaneously act at all levels in the trade. An integrated national strategy could involve the training of fishers in non-destructive fishing methods, the monitoring of fish held by dealers and the placing of quotas on exporters. The Philippines has already acted to implement this level of integration to reduce the use of cyanide.

International

Unlike many terrestrial resources, fish stocks often span international boundaries. This, combined with trans-border fishing activities and the transport of live fish, accentuates the need for the nations involved to have a coordinated approach to management. The live fish producing countries in Southeast Asia, Indonesia, Malaysia and the Philippines are located in an area dominated by sea, rather than land: the sea boundaries between their respective Exclusive Economic Zones are far greater than their borders on land. In many instances stocks of live food reef fish are likely to straddle these boundaries. In such cases, regulations that reduce exploitation levels on one side of the border will be essentially useless, if not accompanied by similar regulations in the neighbouring country. Furthermore, co-operation between neighbouring countries will be required to ensure that any limits on harvests are not circumvented by cross-border transport of fish.

The enforcement of export quotas would benefit greatly from the co-operation of importing nations. The latter could check that an export certificate from the country of origin accompanied shipments of live fish. This type of system has already been established under the International Convention on Trade in Endangered Species (CITES). Shipments of animals or plants listed under Appendix II of CITES can be made if they are accompanied by a CITES export permit. This permit is issued by the government of the exporting country in accordance with their assessment of whether exports are sustainable or not.

Listing under Appendix II of CITES has been suggested by Hong Kong as "...the most pragmatic and effective way to control international reef fish trade"[20] Although CITES would provide an ideal framework for implementing an export quota system for live food reef fish, it is questionable whether they would fall under the appropriate definition. The convention states that, "Appendix II shall include all species which although not necessarily now threatened with extinction may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilisation incompatible with their survival". There are difficulties in applying this definition to marine fish species because of their often widespread distribution; one stock of a species may be threatened but a stock in another area, may not.

Perhaps the strongest incentive for live food reef fish industry members towards international co-operation would be to co-ordinate marketing and thus maximise the return per live fish exported. Given the 'conspicuous consumption' of live food reef fish, a reduction in the supply of live food reef fish to markets in Hong Kong and China is likely to increase their value (Box 6). However, self-restraint will not arise without co-ordination between nations. All countries that export live food reef fish, including those outside of Southeast Asia, need to agree to limit the quantity of fish that they each supply to the markets. Such an agreement would be analogous to the Organisation of Petroleum Exporting Countries (OPEC) used by those nations to

[20] Richard Yip, Assistant Director of Fisheries, Hong Kong. South China Morning Post, 25/11/95

maximise the long-term return on their oil reserves. The principle for live food reef fish producing nations would be no different. Given the nature of live fish consumption, even the DeBeer's diamond cartel, may be an appropriate model on which to base a co-ordinated, international approach to marketing a valuable natural resource.

In summary, it is suggested that the most effective means of achieving a sustainable live food reef fish industry is through export quotas. Proper implementation of trade restrictions would require international co-ordination of the type already established under CITES. Export quotas need to be set at the regional level so as to prevent localised over-exploitation and with clauses governing the size and method of capture of fish. These trade controls should be complemented by initiatives directed at fishers, such as training in the use of non-destructive fishing techniques, and at dealers, such as fines for possession of fish that are below a minimum legal size or that are caught using cyanide.

What major factors might limit the effectiveness of management?

Uncertainty

To be effective, quotas need to be set appropriately. If they are too high then overexploitation will continue. If they are set too low then they jeopardise the viability of the industry. In both cases the sustainability of live food reef fish industry could be compromised. Ideally, quotas on fisheries harvests are set on the basis of detailed knowledge of a stock's size and dynamics. But such information can be time consuming and expensive to obtain particularly for tropical coastal fisheries (Johannes 1998).

The lack of scientific knowledge on reef fish stocks in Southeast Asia need not be an obstruction to the implementation of export quotas. Widespread anecdotal evidence suggests that reef fish stocks are overexploited. If this is the case, then past catches have been unsustainable. Quotas should initially be set conservatively, at a fraction of past catches, to allow stocks to rebuild. Although, this is not ideal, to wait until sufficient information becomes available would be irresponsible.

After the establishment of quotas, stock monitoring could then be used as a basis for adjusting quotas to the optimum level. Quota changes could be formalised using a decision rule system that utilises information from such monitoring. For example, a decision rule could be based on annual underwater visual surveys of live food reef fish densities on a representative sample of reefs in each country.

The accuracy of such monitoring will be largely dependent upon the area of reef surveyed and thus the money spent on it. Less accurate monitoring should be accompanied by a precautionary approach to quota adjustments. Thus the live food reef fish industry may find it beneficial to invest money in monitoring so that quotas can be set more confidently towards the long-term optimum.

Corruption

Entrenched corruption is often cited as a barrier to effective management of the live food reef fish industry in Southeast Asia (Pet & Pet-Soede 1999, Adhuri 1998). There is little doubt that corruption is rife in many parts of the region and it could certainly undermine attempts to place quotas on exports of live food reef fish. However, even if some exporters are able to trade more than their quota entitlement, exports as a whole, and thus the exploitation of live food reef fish,

will at least be reduced from their current levels. An imperfect quota system would not necessarily be ineffective.

Change

In the last decade, there has been rapid change in the scale, structure, and operations of the live food reef fish industry in Southeast Asia. We can be certain that its shape will continue to change in the future. This could have dramatic implications for how best to manage the industry. Since the time that the research for this report was completed, there has been significant economic upheavals in many of the countries involved in the live food reef fish trade. These changes have already impacted on the industry (Erdmann & Pet 1999). Management will need to be flexible to such changes. But a tactic such as export quota rights, that provides long term incentives for sustainability to the industry, can possibly to some extent also buffer management from short-term external fluctuations.

RECOMMENDATIONS

The fishery for live food reef fish needs to be managed to make it sustainable. A sustainable fishery could conserve fish stocks and provide a form of income for coastal communities in Southeast Asia that is based on harvesting of relatively low quantities of high value species. As such, it could provide an important incentive for these communities to conserve their coral reefs. Stopping the trade in live food reef fish would not do this. Instead, it may increase pressure on coral reefs and reef fish stocks by shifting fishing effort towards harvesting higher quantities of less valuable resources and using more destructive fishing methods.

Effective management of the industry will require intervention at all levels in the trade. Any regulations that are used must be easily enforceable. This can be achieved by co-ordinating monitoring at the national and international scales. However, equally important is that controls be implemented soon. The depletion of reef fish stocks in Southeast Asia is continuing at a rapid rate. An expedient approach to developing a sustainable fishery should place priority on limiting exploitation levels as soon as possible.

Recommendation 1: That national governments of Southeast Asia should legislate for export quotas on live food reef fish.

The most effective means of controlling exploitation levels of live food reef fish will be through a system of export quotas. This system should include the following components:

- Separate quotas should be set for each species to prevent overexploitation of the most valuable species.
- For each species, the minimum and maximum size of fish that can be exported should be set.
- Quotas should be set on a regional basis within each country to prevent localised depletion in areas that are easily accessible.

Quotas and size limits should be set based on the information currently available. For each fish species this includes histories of export levels, existing estimates of natural mortality and growth rates and the sizes of maturity of sex change. Where there is little information available and hence large uncertainty in the appropriate quotas or size limit, these should be set conservatively.

Recommendation 2: To complement export quotas, national governments of Southeast Asia should legislate regulations on the capture and trade of live food reef fish.

Although export quotas will provide the most effective means of controlling exploitation levels, other regulations should be used to complement and support them. These should include the prohibition of the capture, sale or possession of fish that are outside of the size range allowed for export. To reduce the use of cyanide, the capture, sale or possession of fish that are caught using cyanide should also be prohibited. As a precautionary measure against overfishing, seasonal or areal closures should be used for protection of spawning aggregations of reef fish.

Recommendation 3: National governments of Southeast Asia should implement a system of monitoring and enforcement of export quotas for live food reef fish species.

Monitoring at all levels of the trade could assist in enforcing export quota levels and conditions. Quantities of fish held by dealers and exporters should be monitored. The size of fish held by fishers, dealers and exporters should also be monitored. Cyanide testing of fish should be used to enforce regulations on the capture, sale and possession of fish caught using cyanide.

Recommendation 4: The International Convention on Trade in Endangered Species (CITES) should be examined as a suitable existing framework for the monitoring of the international trade in live food reef fish.

International co-ordination will improve the monitoring and enforcement of export quotas. Importing countries, of which there are only a few, can check imports of live food reef fish to ensure that they are in accordance with the regulations of the exporting country. Such a system for monitoring trade in animals and animal products already exists under CITES. The inclusion of certain species of live food reef fish on CITES Appendix II should be investigated.

Recommendation 5: Government and non-government agencies should monitor and research reef fish stocks to provide more certainty in estimates of appropriate quota levels and size limits.

The current paucity of information available on the status and population dynamics of live food reef fish stocks should not impede the implementation of management measures. However, monitoring and research of reef fish stocks and the fishery should be done so that regulations can be continually refined. Amongst the requirements are,

- improved accuracy and detail in catch and fishing effort data,
- the sizes of fish being caught,

- the growth and natural mortality rates of each species,
- the size at maturity and sex change of each species,
- a method of incorporating information gathered on population biology, fishing effort and catch to estimate appropriate quota levels and size limits,
- the relative environmental impact of fishing methods used in the live food reef fish trade (eg cyanide fishing and anchoring)

Recommendation 6: Government and non-government agencies should train fishers in the use of non-destructive fishing techniques.

Programmes that train fishers in the use of hook and line and fish decompression techniques should be done in areas where the live food reef fishery is widespread.

Recommendation 7: To provide the basis for co-ordinating a sustainable and market-conscious supply of live fish, exporting and importing companies should examine the formation of an association of live food reef fish traders.

Such an association could provide a forum for export quotas to co-operate with importers on regulating the supply of live food reef fish to ensure that maximum long-term value is obtained from live food reef fish stocks.

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BOX 1. CYANIDE FISHING AND ITS EFFECTS.

Cyanide is a powerful and broad-spectrum poison. Toxicological studies have shown that, depending upon its concentration and the duration of exposure, it is capable of injuring or killing invertebrates (eg. Jones & Steven 1997, De Zwann *et al.* 1993, Pablo *et al.* 1997) and fish (eg. Heming & Thurston R.V 1984, Rubec & Pratt 1984, Carballo *et al.* 1992, Alazemi *et al.* 1996, Lanno & Dixon 1996).

While these findings are useful, it is difficult to extrapolate them to cyanide fishing operations. The impact of cyanide fishing, both its extent and severity, will depend upon the concentration and amount of cyanide that is squirted, and the rate at which it disperses. These factors will vary substantially between fishers, with the size of fish that is targeted and depending on water movement at the time and place of fishing.

Nonetheless, anecdotal evidence and video footage of cyanide fishing operations indicate that in at least some cases cyanide fishing kills or injures small fish in the immediate vicinity. While the magnitude of cyanide fishing's effects are still uncertain, there is no doubt that it does impact coral reefs to some extent.

Cyanide fishing also has significant human health implications. These include poisoning, eye damage and decompression sickness resulting from unsafe diving procedures (for further discussion see Johannes & Riepen 1995 and Barber & Pratt 1997).

One further impact of cyanide fishing is clear – it has gained the industry the world's attention. The emotive image of a toxic chemical being dispersed over hectares of coral reef has reinforced concern over the fishery and its ecological and social ramifications. The live food reef fish industry has felt the impacts of this publicity. One live food reef fish transporter described how the widespread media attention on the fishery during the mid-1990s made operations harder and more expensive. Local officials and village leaders became aware of the value of reef fish and wanted a piece of the pie. The illegality of using cyanide provided many with a lever with which to pry money from the industry.

Despite the awareness of the industry that it has gained, it must be remembered that cyanide fishing is one of numerous threats to coral reefs and the way in which they are managed should not be influenced by its sinister name alone.

BOX 2. THE "SUSTAINABLE LIVE FOOD REEF FISH INDUSTRY"

This is a hypothetical and highly idealised example of a fishery based on live food reef fish. It is meant only to illustrate a goal for management. The complicated task of determining how to achieve this goal is intentionally left to the next section.

The Sustainable Live food reef fish Industry (SLRFI) is very similar to the live food reef fishery currently operating in Southeast Asia. It targets the same species, over a similar area of coral reef and sells fish to the same markets in Hong Kong, China and Singapore. But there are several important differences.

Primarily, catches in the SLRFI are maintained at a sustainable level. The total harvest has remained at around 2 500t per year for the last ten years. This has been achieved through,

- a limit on the quantity of fish that are caught within each region,
- fishers returning all fish less than a certain size to the water after deflating their airbladder and
- the establishment of sanctuaries at those sites where live food reef fish are known to aggregate to spawn.

Because catches have remained stable, the income of fishers has been relatively constant. This has engendered a commitment by fishers to their fishery and the reefs that support it. The SLRFI has become a powerful tool in coral reef conservation. Fishers recognise that the sustainability of their livelihoods depends on the health of their coral reefs and that species, such as the valuable Humphead Wrasse, only occur in areas which are free of pollution and have not been destroyed by blast fishing. Because of this, they have prohibited the use of destructive fishing methods in their communities and lobby against external threats to coral reefs.

The industry's own impact on coral reefs has been minimised. Since there are limits on catches in each area, there is no need to fish using cyanide. The abundance of fish means that plenty can be caught using hook and line, a method preferred by fishers over the risks and discomfort associated with diving. Although hook and lines catch smaller fish, through proper handling and care, these can be released. There have been concerns over the impacts of anchor damage but fishers aim to minimise this when possible.

The SLRFI has also benefited from changes in its consumer markets. The growing size and affluence of the Chinese population means that demand has increased significantly. But because catches have been limited, so has the supply of fish to these markets. Thus, prices have risen substantially and the benefits have flowed to all members of the trade.

BOX 3. THE IMPORTANCE OF SOCIO-ECONOMIC RELATIONS IN FISHERIES TRADE IN SOUTHEAST ASIA.

Intermediaries are an important part of any trade. By providing a link between sellers and buyers, they can provide benefits to both parties (Rubinstein & Wolinsky 1987). But in many parts of Southeast Asia, the relationship between fishers and fish dealers is more than just one of bilateral exchange. In many instances, the dealer will help fishers by providing loans during times of financial hardship or to buy fishing equipment. Such aid is often essential for fishers exposed to fluctuations in catches and weather.

But out of this relationship, a situation of debt and dependency often arises. As part of the loan agreement, fishers are usually obliged to sell their fish to that dealer at a lower than market price. Because they must sell their catch at a lower price, it may be difficult for fishers to ever escape the situation of debt.

In the case studies reported in this document, such situations occur in fishing communities in Indonesia and the Philippines. Other authors have documented similar scenarios (eg. Galvez *et al.* 1989, Peñaranda 1996). Furthermore, this is not a new phenomenon as indicated by the following excepts describing fisher-dealer relations more than seventy years ago in Indonesia and Malaya,

"[The dealers] often have the fishers completely in their control by giving them advances, completely regulate market price of the product, and take the biggest profit." (Anon. 1882 {Nietzsche 1882 #736} *in* Butcher 1996).

"In nearly all cases the fisherman is practically "bound" to sell to a specific towkay [dealer]. Not legally so, perhaps, but for all practical purposes there is no escape, as he is in the hands of the towkay financially." Stead (1923 *in* Butcher 1996).

Not only do dealers have a monopoly over a fisher's catch, they may also dictate the fishing methods used and species targeted. Dealers often supply cyanide to fishers and they have been implicated in encouraging blast fishing activities (Galvez *et al.* 1989, Peñaranda 1996, Pet-Soede *et al.* in prep.).

Are the fish dealers taking unfair advantage of fishers? It is clear that economic models which emphasise the benefits of intermediaries may be inappropriate when credit and marketing transactions are inter-linked (Russell 1987). But without a detailed analysis of the revenues and costs of dealers it would be unfair to make a judgement on the size of their profit.

Although the fisher-dealer relationship in Southeast Asia is often characterised by dependency, it does not appear that fishers are getting any worse deal than their Australian counterparts. For example, Filipino fishers receive a high price for their fish, which may indicate that exporters and dealers are passing on the reduced costs of transportation to Hong Kong.

Furthermore, the assistance that dealers provide to fishers should not be underestimated. In remote parts of developing countries, where social and health services are non-existent or inadequate, the dealers fill an important role which often the government can not.

Rather than passing judgements on the role of fish dealers, it is perhaps simply best to recognise their importance and power in the decisions of many fishers. This has implications for the formation of co-operatives and in applying incentives to change the practices of fishers.

	Leopard coralgrouper		Various grouper species	
Country	Fisher	Dealer	Fisher	Dealer
Philippines	16 – 36	33 – 36	3 – 6	6
Malaysia		6 – 15	3	
Indonesia		3 – 10	1 – 2	
Australia[1]	4 – 6	18 – 20	1 – 2	4 – 6

NB: Prices are given in USD/kg for the most valuable size category, usually 0.5 to 1.2 kg.

[1] In Australia, fishers operate skiffs from a main vessel. The boat owner (in this table 'dealer') pays fishers 20 –25% of the price that he receives. C. Davies, Cooperative Research Centre for Reef Research, Australia, *in litt.*, February 1998.

BOX 4. PROPERTY RIGHTS AND CORAL REEF FISHERIES MANAGEMENT

Giving resource users some sort of ownership over the resource may be one way to avert the 'tragedy of the commons' (Hardin 1968). If fishers can exclude others from fishing in their waters, they may take a vested interest in harvesting the resource in a sustainable manner (Berkes 1994, Ruddle 1994). This property rights approach can be extended to the situation in which a resource is owned by a community. These types of communal marine resource management systems have operated in the Pacific and Asia for centuries (Johannes 1978, Zerner 1994, Nikijuluw 1995).

In coral reef fisheries, the property rights approach has focused on defining property rights for particular areas of reef. This has lead to the idea of Territorial Use Rights in Fisheries (TURF). Under such a system, it is hoped that fishers would become guardians of a particular area of reef and protect its resources from overexploitation.

The foundation of the TURF approach is that fishers are able to exclude others from fishing their resource; to be useful, property rights must be defendable. In this regard, it is important to consider the spatial scale of the stock. Consider the case in which a fish stock moves freely between two reefs. If fisher A has rights over one reef, there is no incentive for him to control his level of exploitation if fisher B catches as many fish as possible when they swim over her reef.

Many coral reef fishes are confined to a single reef for the whole of their adult life. However, most have highly dispersive planktonic larval phases in their life cycles, which ensure that stocks are often widespread. If a fish stock spans a wide geographic area, management through applying the TURF approach at the local level may be inappropriate. Property rights may need to be applied in other ways.

In everyday usage 'property' often refers to physical objects, for example a piece of land. However, in the formal sense, to own property is 'to have control of a benefit stream' (Bromley 1991). All members of the trade in a commodity derive a benefit stream and thus have some sort of property in it. Defining property rights at any level in the trade will not confer ownership of resource but rather define how others can act in relation to the benefit stream of any individual.

Thus issuing property rights over the resource does not necessarily have to be done based on geographical entities. For instance, property rights can be defined by allocating a particular amount of catch to each fisher. This is the foundation of quota management systems that are increasingly being used in fisheries management. Neither does ownership need to be assigned over the activities of fishers alone. Defining property rights at other levels in the trade may be more appropriate when considering the scale of the stock.

It should also be noted that effectively defining property rights over a resource might not completely exclude the possibility of exploitation. It may be economically rational for the owner of the property right to liquidate the resource by harvesting it to extinction and to invest the revenue generated in a form of income with a higher rate of return on capital (Clark 1973). This applies to fishers as much as it does to rich entrepreneurs. Indeed, the poor may discount future incomes from the resource more heavily because of the burden of current needs.

BOX 5. THE LIVE FOOD REEF FISH INDUSTRY AS A STRATEGY FOR THE CONSERVATION OF CORAL REEFS: PUTTING THE IDEA TO PRACTICE

In several places the idea of using the live food reef fish industry as a conservation strategy is being put into practice. In the Philippines the International Marinelife Alliance (IMA) has been particularly active in training fishers to catch live food reef fish using hook and line. Their training programmes, which form part of the *Cyanide Fishing Reform Program*, have proved to be very successful. Over the past decade IMA has trained over 2000 fishers to use hook and line or barrier nets for aquarium fish. Each course lasts about one week and targets twenty to thirty fishers. During this time fishers are taught bait preparation, catching and fish handling techniques.

The use of hook and line has caught on. On the island of Canipo in the Philippines, a fishing cooperative was formed in 1993 that sells its fish directly to exporters. The group only uses hook and line and developed methods for decompressing captured fish thereby proving that live food reef fish could be successfully caught and kept alive using these techniques. Since that time over 400 fishers have joined the cooperative. One of the reasons that the cooperative has been so successful is that fishers receive higher prices for their fish because the role of the fish dealer has been removed.

In 1996, the Kabang Kalikasan ng Philipinas (KKP or WWF Philippines) started a project in the Turtle Islands that seeks to use the exploitation of live food reef fish resources as a conservation and livelihood strategy. The project, formally called *Live Food Fish Collection, as a Conservation-Livelihood Strategy for the Turtle Islands* has been funded for two years by WWF's Endangered Seas Campaign. The Turtle Islands lie in the southwestern Sulu Sea, and straddle the international border between the Philippines and Malaysia. Six of the nine islands occur within Philippine waters, and the largest, Tanganak Island, is being used as the pilot site. Due to falling catches, some fishers have resorted to blast fishing, and there are reportedly incursions of outside vessels using cyanide. The project hopes to reverse this trend by introducing live food reef fish fishing as an alternative means of livelihood. To this end, progress has been made towards establishing a cooperative of local fishers, which will market its fish to nearby Sandakan, Malaysia. In addition, a team from the International Marinelife Alliance - Philippines visited the island in July 1997 and ran a seven-day course for seventeen fishers on various aspects of running a live food reef fish operation. This included training on the use of hook and line to catch live food reef fish, and techniques for decompression, holding and transportation. In addition, an underwater visual survey of fish and coral communities is being done. It is hoped that the results of these surveys will be used to monitor live food reef fish populations and aid in estimating sustainable levels of catch.

BOX 6. CONSPICUOUS CONSUMPTION AND THE BENEFITS OF CATCHING FEWER FISH.

In many societies, wealthy individuals often consume expensive goods to advertise their wealth and social status. This is known as 'conspicuous consumption' - where the benefits that the consumer derives from the commodity depends not only upon its inherent qualities but also on the price paid for it (Bagwell & Bernheim 1996, Leibenstein 1950). Commodities that are subject to conspicuous consumption include diamonds and expensive cars. Live food reef fish probably fit into the same class: they are usually eaten for special occasions and business meetings and the more expensive species are a status symbol (Johannes & Riepen 1995, Lau & Parry-Jones *In press*).

One effect of conspicuous consumption is that decreasing the availability of the good can increase the value that consumers are willing to pay. In the case of live fish, this may mean that decreasing the quantity of fish that is supplied to markets increases the price per kilogram sufficiently that total revenue is not reduced. The strength of this effect is unknown for live food reef fish but is certainly worthy of further investigation. If the effect were strong then there would certainly be benefits to the industry in reducing current catches. This may not result in a reduction in revenue and allow stocks to recover so that they can continue to be productive in the future. With demand likely to increase, the benefits of reducing supply will rise and the rewards for acting conservatively now will be greater.

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