



**Preliminary
Assessment of the
Live reef fish trade
in the Kudat region:
*Final Technical Report***

WWF Malaysia Project Report



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Preliminary Assessment of the Live Reef Fish Trade in the Kudat Region

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Table of Contents

Acknowledgements.....	5
Executive Summary.....	6
1. Introduction.....	9
2. Aims.....	9
3. Study Sites.....	9
4. Methods.....	10
4.1 Surveys.....	10
4.2 Direct Observations.....	11
4.3 Secondary Data.....	11
4.4 Fish measurements.....	12
5. Trade description.....	12
5.1 History of the Live Fish Trade in Kudat.....	12
5.2 Volume of Trade.....	12
5.3 Fishing Gears.....	13
5.3.1 Hook and line - <i>Memancing</i>	13
5.3.2 Fish Traps – <i>Bubu</i>	14
5.3.3 Sodium cyanide – <i>Sujum, Ubat, Not not, Pelali</i>	14
5.3.4 Other Methods.....	15
5.4 Fishing Vessels.....	15
5.4.1 Paddled canoes – <i>Sampan dayung</i>	15
5.4.2 Pump boats.....	15
5.4.3 Mother-dory operations – <i>Kapal, Piskadul, Sendirian</i>	15
5.4.5 Larger diving vessels (<i>Kapals</i>).....	16
5.4.6 Transport vessels.....	16
5.5 Species composition.....	16
5.6 Trade Structure, Routes and Fishing Grounds.....	19
5.7 Kudat Trade Operations.....	21
5.8 Island cage operations.....	21
5.9 Prices.....	22
5.10 Governance of the live fish trade.....	23
6. Socio-economic aspects of the LRFT.....	24
6.1 Communities involved.....	24
6.2 Income from the LRFT.....	24
7. Sustainability of the live fish trade.....	26
7.1 Stock declines.....	26
7.1.1 Evidence from interviews.....	26
7.1.2 Stock declines – Evidence from secondary data.....	27
7.1.3 Stock declines - Discussion.....	30
7.2 Fish sizes.....	30
7.3 Use of destructive fishing techniques.....	31
7.4 Mortality of fish.....	33
8. Stakeholder knowledge and perceptions.....	33
8.1 Knowledge of spawning behaviour.....	33
8.2 Perceptions of stock declines and management.....	34
8.2.1 Risk of extinction.....	34
8.2.2 Reasons for stock declines.....	35
9. Priorities and opportunities for improved management of the trade.....	37
9.1 Information collection.....	37

9.2 Protection of Fish Stocks	37
9.2.1 Vulnerable species	37
9.2.2 Protected areas	37
9.2.3 Size restrictions.....	38
9.3 Mitigation of impacts of fishing gears	39
9.3.1 Traps	39
9.3.2 Bait supplies for hook and line fishermen.....	39
9.4 Reduction in the use of cyanide	39
10. Recommendations.....	41
Appendix 1 – Summary Statistics from Fisherman interviews Grouped by Study Site	42
Appendix 2 – Ethnic and age structure of interviewees.....	43
Appendix 3 – Fisherman Questionnaire questions	43
Appendix 4 – Local names for target species	45
Appendix 5 – Prices of live fish at different markets	46

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Executive Summary

An assessment of the live reef fish trade (LRFT) in the Kudat region was conducted in July and August 2002 through interviews, observations and opportunistic examination of trade records in Kudat and villages in the Banggi region, north of Kudat.

Overview of the Trade

The live fish trade is based around several cages in Kudat owned by traders or Towkays. Here live reef fish from Sabah or Philippine reefs are delivered before being transported to Kota Kinabalu by road for export. Larger fishing vessels deliver their catches directly to Kudat while many smaller fishers in the Banggi region and south-western Philippines sell their catches to local cages. Transport vessels then regularly deliver the catches to Kudat.

Species composition

The leopard coralgroupers (*Plectropomus leopardus*), known locally as *sunoh merah*, *sunoh hitam* or *sunoh batu* is the most important fish in the trade, in terms of volume and value. This fish accounts for more than half of the total volume in Kudat and along with other similar species of *Plectropomus*, accounted for 70% of the trade in 2001. The most valuable species are the humphead wrasse (*Cheilinus undulatus*, locally known as *maming*) and the humpbacked grouper (*Cromileptes altivelis*, locally *kubing*) are the most valuable species but are caught relatively infrequently.

Catches vary with fishing areas and gear types with more sunoh caught from deep water and more maming being caught by cyanide fishermen.

Source reefs

Most of the fish transported through Kudat come from the Mangsi, Balabac and Cagayan seas in the Philippines. They are either caught by Kudat based fishing operations or caught by Philippine boats and delivered to holding cages before being transported to Kudat.

Within Sabah waters, Balambangan, Malawali and reefs east of Sibogo are important for small-scale fishers while larger Kapals tend to fish at Balambangan or on the many reefs between Malawali, Tigabu and the Philippine border.

Holding Operations

While most fish purchased by cage owners are held only for a few days before being sold on, the majority of cage owners have started to keep undersized (<400g) fish to grow them on to marketable size. Typically, humphead wrasse, leopard coralgroupers and spotted coralgroupers (*Plectropomus maculatus*) are kept and fed with small fish either bought from fishing vessels or caught using fish bombs. High mortality rates are occasionally experienced during periods of poor water quality or with cyanide-caught fish within the first few days of captivity.

Gears used

Hook and line fishing, fish traps and sodium cyanide are all used from small pump boats and larger Kapals with inboard engines to supply live fish for the

trade. All of these methods can have an associated environmental impact. Fish-bombs are used to provide bait for hook fishing, corals are broken and used to camouflage fish traps and corals exposed to cyanide die. It was difficult to establish the extent of use of cyanide but it is clearly widely used, often in conjunction with trap fishing. There are seasonal variations in the methods used, with cyanide becoming favourable during calm periods. Cyanide appears to be readily available and affordable from Kudat or Mangsi.

Trade volumes

Official statistics of the Fisheries department in Kudat report a total volume of 70 tonnes of live fish transported through Kudat in 2001. However interviews with Towkays in Kudat suggest that this may be a considerable underestimate.

Volumes vary seasonally according to fish behaviour and suitability of the weather, with June and July being the busiest months. The lowest period is in November and December.

Governance of the Trade

There are currently few controls on catching or trading live fish in the Kudat region. Some informal management of fishing grounds exists in the Banggi area with local village chiefs allegedly responsible for allowing or disallowing outsiders to fish on their local reefs. In practise, however fishers are often unaware of management and villagers appeared reluctant to initiate conflicts with other communities by enforcing access rules.

Socio-economic Importance of the LRFT

The LRFT in Kudat is controlled by mainly Chinese "Towkays" who own cages and/or fishing vessels based in Kudat. Most also have partnerships with fishers or cage owners in Banggi or the Philippines who supply them with fish. Within Banggi, the Ubian group is the most heavily involved in catching live fish while the Suluk and Kagayan contribute some of the catches. Bajau Sama fishers interviewed during the assessment were not involved in the trade.

Large vessels operating from Kudat employ Ubian fishers from nearby kampongs as well as Filipinos and Indonesians. Boats operating in Philippine waters are particularly likely to be crewed by Filipinos.

In Ubian communities visited, the LRFT was sited as the most important livelihood for fishermen. Sales of live fish typically accounted for 60-100% of their income and over 90% of fishermen interviewed took part in the trade. Due to the high prices of live fish that have been available since the early 1990's, fishermen can earn an averages of about RM40/day using hook and line and double that if they use cyanide.

Trends in catches

Interviews with stakeholders indicated steep declines in catches within the last five years (in the region of 40-90%) but the few records obtained from catches of large vessels and the official fisheries department figures do not show such dramatic declines. These data are probably too limited in duration and/or too spatially crude to detect the changes on local scales which are so obvious to fishermen and traders.

Stakeholders perceptions and knowledge

All traders and 95% fishermen and interviewed agreed that the stocks of LRFT species have declined sharply within the past 5 years. Fishermen typically perceived declines of 40-90% in the past five years in terms of numbers or weight of catches. Fish sizes are also believed to have declined with many more undersized fish now being caught. The most commonly cited reason for the decline in stocks was increased fishing pressure from large numbers of fishers including fishers from other villages. Increased fishing pressure was seen as particularly harmful in conjunction with new, efficient catching technologies including sodium cyanide, echo sounders and diving compressors, which allow easy capture of fish from previously un-fished deep reefs. Trawlers and in some cases purse seiners operating illegally close to reefs were strongly blamed for fishery declines in western Banggi. Habitat destruction by cyanide and blast fishing were also perceived as problems although fishers felt that blast fishing was necessary to obtain bait for hook and line fishing.

Although the resource was seen to be declining fishers did not generally think that fish species could become extinct due to the belief that some fish will always be able to breed. Many fishermen appeared unconcerned at the prospect of a few species becoming extinct, pragmatically stating that the market for other species would improve if the currently valuable species were to disappear.

Fishermen are aware of several spawning aggregations of *Plectropomus spp* and *Cheilinus undulatus* but many of these have already ceased in the face of fishing pressure.

Recommendations

- More detailed monitoring of the trade to support management
- Protection of spawning populations through the establishment of sanctuaries that include spawning aggregation sites
- Prohibition of the export of the humphead wrasse or maming (*Cheilinus undulatus*)
- Stronger action against the trade and use of cyanide, including testing of fish if feasible
- Schemes to provide reliable supplies of bait to hook and line fishermen and development of less environmentally damaging trap fishing techniques
- Consultation with and education of fishing communities about issues relating to the sustainability of the live fish fishery

1. Introduction

This report presents the findings of an assessment of the live fish trade (LRFT) in Kudat, northern Sabah, Malaysia. The assessment was conducted from July to August 2002 as a preliminary stage in the WWF Malaysia project, Understanding the Live Reef Fish Trade in Sabah under the WWF Sulu-Sulawesi Marine Ecoregion initiative.

2. Aims

The aims of the assessment were to:

1. Describe the trade in live coral reef fish in the Kudat region
2. Assess the sustainability of the trade
3. Investigate opportunities and priorities for improved management of the trade

Specific objectives within these aims were:

1. Description

- Investigate trade routes, volumes, frequency etc.
- Verify Kudat's reputation as a main supply point
- Identify proportion of fish in Kudat coming from outside Sabah's borders
- Describe species composition of the trade
- Identify source reefs supplying the trade in Kudat
- Record prices for each species at each level of the marketing chain
- Compile local taxonomy of species involved in the trade

2. Sustainability

- Investigate trends in supply over time
- Investigate use of destructive fishing to support trade
- Investigate size frequency structure of fish
- Investigate stakeholders' perception of sustainability of the trade

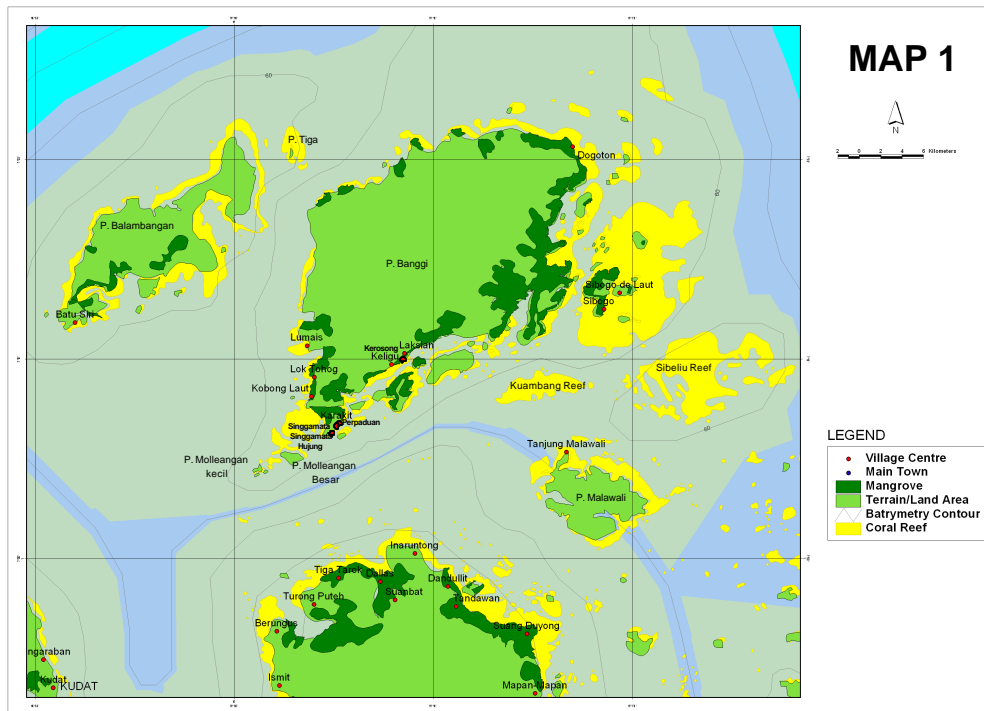
3. Management opportunities

- Investigate socio-economic importance of the trade to fishing communities in the Banggi region
- Collate contact details of stakeholders
- Investigate stakeholders' views on priority issues and improved management
- Solicit stakeholders' knowledge of ecology of target species
- Identify existing formal or informal management structures that could be supported and strengthened.

3. Study Sites

The town of Kudat in Northern Sabah was the initial study site to investigate traders and sources of fish. However, most of the study was based from the village of Karakit, the capital of the Banggi sub-district, north of Kudat. From Karakit, villages on mainland Banggi and surrounding islands were visited for 1-3 days to conduct

interviews and observations. These villages are shown in Map 1 and listed in Appendix 1.



Map 1. Islands and reefs in the Banggi region showing communities visited for the study.

4. Methods

4.1 Surveys

The assessment was conducted from 19th July until 3rd September 2002. Semi-structured interviews were held with traders, fishermen, boat owners and other key informants in both Kudat and Banggi. A questionnaire survey was conducted with fishers at 16 kampongs in the Kudat area (see Appendix 1) to obtain quantitative data on fishing effort, perceptions of yield declines and incomes from the trade while focus group interviews were held to discuss the history of the trade, potential management and observations of spawning behaviour of the target species. Table 1 lists the number and type of interviews conducted. For interview guides and questionnaires see Appendix 2.

Table 1. Number and type of interviews conducted during the assessment

Semi-structured interviews with traders in Kudat	9
Semi-structured interviews with cage owners in Banggi	8
Questionnaire surveys with individual fishermen	119
Focus groups with fishermen	8

The survey team together were fluent in Malay, Ubian, Hakka and English allowing questions to be asked in the language most favoured by the interviewee. Fisherman interviews were normally conducted in Malay with explanation or clarification given in Ubian if necessary. Focus groups were conducted in a Malay and Ubian with records taken in Malay. The meetings were recorded on minidisc to allow extra translations from Ubian to be conducted later.

Questions were reviewed and adapted during initial surveys to take account of problems with translation or understanding. For example, the team often had difficulty explaining to fishermen that they were interested in the proportions or percentage of their income that was from live fish so the question was re-phrased to simply ask how much was earned from each income source per week or month. Some questions were not answered satisfactorily so that percentages or proportions given in the text may refer to less than the totals given in Table 1.

Fishing villages were selected from a range of geographical locations mainly in the Banggi region. Those communities known to take part in the trade were selected with the exception of Keligau. Within each community, fishermen were selected for the questionnaire survey opportunistically or randomly (by selecting groups of four houses throughout the village and determining which houses to visit by tossing two coins). Efforts were also made to obtain a variety of ages. Only males were interviewed as women do not normally take part in fishing activities except collecting products from the reef. Due to the abundance of the Ubian group in Banggi and their importance within the live fish trade, the majority of fishermen interviewed were Ubian. Appendix 2 includes a profile of the ethnic group and age interviewees.

4.2 Direct Observations

Direct observations were made of handline, blast and trap fishing activities, cage operations and transportation of live fish. Photographs were also taken. An interview was held with an experienced cyanide fisherman to describe the exact methods used and information and photographs were available from a previous observation of cyanide fishing by the first author.

4.3 Secondary Data

In some cases it was possible to consult receipts or records of traders and fishermen, which described quantities, species and prices of fish sold previously. At three fish cage collection points in Banggi, the worker on the cage was asked which fishing methods had been used to catch the fish on each receipt to allow a comparison of catches between the methods.

The supply records from one Kudat trader were available dating back to March, 1995 excluding the period from January 1998 to September 1999. Due to the large number of records and the time constraints available, the records were sub-sampled by recording the total deliveries for the months of March and July for each year (corresponding to low and high seasons). All deliveries from one vessel captain who had always sold fish to that particular towkay were extracted and entered into a Microsoft Access database for analysis.

Catch records from one other vessel were obtained from a selection of 45 receipts dating from 5/4/98 until 3/6/00 supplied by the vessel owner.

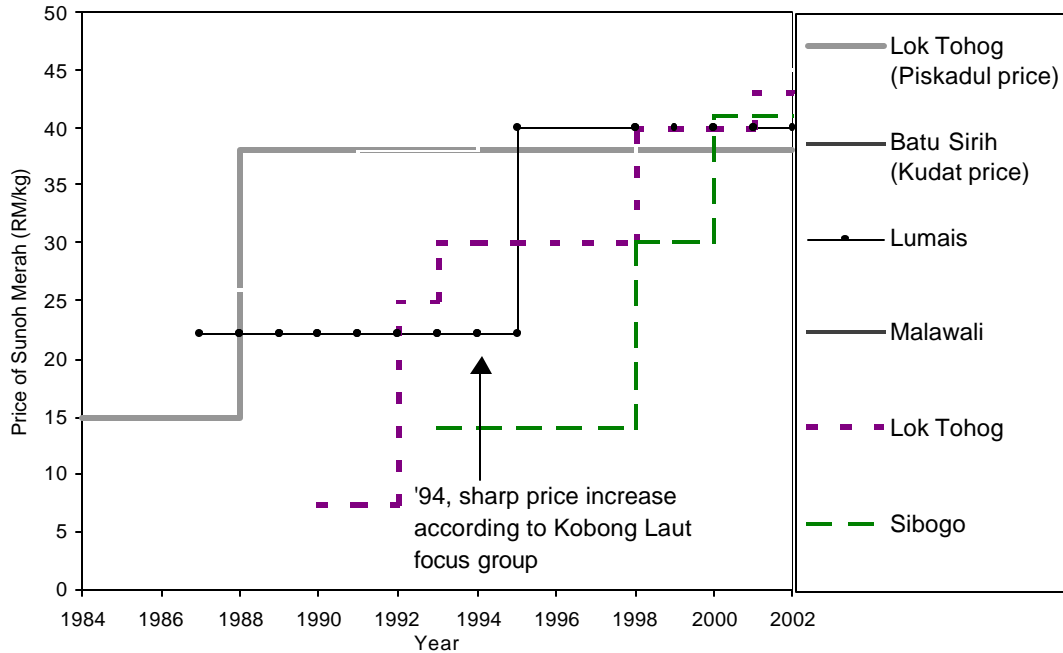


Figure 1. Changes in the prices of sunoh merah (*Plectropomus leopardus*) as recalled by focus groups in different locations around Banggi.

4.4 Fish measurements

The opportunity was taken to measure fish from a large shipment that arrived in Kudat from Mantagule in the Philippines to obtain a preliminary impression of the size structure of the fish in that area.

5. Trade description

5.1 History of the Live Fish Trade in Kudat

Of the nine traders interviewed operating in Kudat, the earliest began operations in 1986. Staff at the Kudat branch of Sabah Fisheries Department stated that the first 3 traders started in 1985. However, several fishermen in Banggi reported selling live fish to Sandakan as early as the 1970s and one boat owner claimed that he had been buying live fish in Kudat for export to Hong Kong 30 years ago.

Many people indicated that the trade had grown significantly since the early '90s when the price for live fish started to increase dramatically. This agreed both with price histories as told by focus groups (see Figure 1) and the results of the fisherman questionnaire interviews, in which 60% of interviewees had started trading live fish within the last ten years.

5.2 Volume of Trade

Statistics collected monthly by the Kudat branch of Sabah Fisheries Department from traders in Kudat suggest that 70 tonnes of live fish (including 4 tonnes of lobsters) were “produced” in Kudat in 2001. Interviews with seven of the 12 traders at the Kudat esplanade gave a rough estimate of 90 tonnes per year based on quoted

monthly volumes. However these interviews notably did not include two of the busiest traders (as observed during time spent at the esplanade and according to conversations) while the traders' representative estimated that 20-30 tonnes of fish passed through Kudat per month amounting to about 300 tonnes per year.

All traders stated that there was a seasonal variation in volumes. Generally it was agreed that the high season was from June to September with the peak being in June and July. The lowest period is in November and December. The main reasons given for this seasonality by traders was that unfavourable weather conditions sometimes prevented vessels fishing. Other reasons given, particularly by fishers, were that aggregations of fish occur in May to July making fish easier to catch, and that fish do not take baits well in the early part of the year because there are many small fish on the reef to feed on.

5.3 Fishing Gears

The assessment identified three gear types used to catch live fish (see below).

5.3.1 Hook and line - *Memancing*

One to three people generally fish for live fish from small pump-boats or paddled canoes. The fishers anchor over reef slopes and fish with handlines.

If fish are caught from depth, a sharp plastic straw or grooved or hollow metal spike is inserted into the anus of the fish to puncture the swim bladder and the abdomen is squeezed to expel expanded air. Alternatively if a fish is adversely affected by decompression, fishermen may use a small cage manufactured from a plastic pipe to return the fish to 20m for 15 minutes before slowly bringing them back to the surface.

Quality, fresh or even live bait is seen as essential to catch the valuable, live-fish-trade species with hook and line. Small, silvery species, which have firm enough flesh to reliably stay on the hook during casting, are favoured as bait. The most popular species is a Clupeid locally called *Tamban* (*Sardinella spp*). One fisher related how he used no. 13 hooks to catch live baitfish although it appears that most fishermen either buy small fish or use blast fishing to catch fresh bait. Supply of bait often appears to limit hook and line fishing in the Banggi region. On several occasions fishermen did not go to sea because of a lack of bait or because a heavy police presence or murky water prevented the use of fish blasting to catch bait. On one observed occasion, the bait provided to the fisherman at the start of the day by a local cage owner had spoiled after about three hours and catch rates had declined. The fisherman then prepared a fish bomb¹ and proceeded to search for shoals of baitfish by swimming in front of the boat wearing a diving mask in several shallow (~2m depth) reef areas. After over an hour of searching in five different locations, a shoal was located. The fisherman slapped the water to encourage the fish to form a tight school before quickly returning to the boat to light the fuse and throw the bomb. Two bombs were used in this manner but both failed to detonate. With no more bombs or bait the days fishing ended. Several sources indicated that hook and line caught fish were of superior quality to trap or cyanide caught fish.

¹ The bombs were made from a 500ml brown glass bottle sealed with foam of the type used in flip-flops. They had been bought in the village for RM10 each although in other villages the materials cost as little as RM4. Fuses are supplied from the Philippines, while the bottles and chemicals are sourced in Sabah.

5.3.2 Fish Traps – *Bubu*

Fish traps observed during the study were manufactured from wire or plastic mesh. The traditional bamboo appears now to only be used for the frame or rarely the entrance funnel. The traps are placed on the seabed by a diver using a compressor or free diving. On the observed occasion, each trap was placed at 8-12 metres on sandy substrate at the bottom of the reef slope. Corals or large pieces of rubble were then removed from the reef and built up over the trap until it was completely camouflaged.

Many fishermen interviewed claimed to use traps, but some others admitted that they only carried traps to disguise the fact that they used sodium cyanide to catch fish. Traps may therefore not be used as frequently as suggested by their presence in villages and boats.

5.3.3 Sodium cyanide – *Sujum, Ubat, Not not, Pelali*

A solution of sodium cyanide is used by divers (either using compressors or breath-holding) to anaesthetise LRFT species. The chemical is bought as dry tablets², dissolved in seawater at a concentration of 0.5-3 tablets per litre depending on the target species and then administered from a plastic bottle with ~30cm of hose attached. If fishing alone from a pump boat, fishers use a technique called *tora tora* to search for fish. A small rope is tied to the bow of the pump boat, which the fisher holds to be slowly pulled along in front of the pump boat. A line to the engine allows the fisher to quickly stop the boat if a target fish is seen. Unless particularly inquisitive fish (e.g. kubing, *Cromileptes altivelis*) are targeted, they are generally chased into a hole in the reef by slapping the surface of the water, diving and shouting and then the cyanide is squirted into the hole and, in the case of maming (*Cheilinus undulatus*), the surrounding holes in the reef. A one-litre bottle of solution is generally good for about only 4 squirts. The fisher then waits for the fish to be flushed out and anaesthetised by the poison, allowing easy capture by hand net. Maming are usually slow to come out and so are usually well anaesthetised while sunoh exit the reef as soon as they sense the poison and sometimes have to be followed for almost 20m before they become “drunk”. Kerapu kelabu (*Epinephelus malabaricus* and *E. tauvina*) and ketumbang (*Lutjanus rivulatus*) usually flee from their hole when they sense the cyanide and hide in another coral typically requiring the process to be repeated in three different places before the fish can be captured. Some large groupers (e.g. *E. fuscoguttatus*, *E. lanceolatus*) do not fully enter the coral and so have to be approached stealthily. The whole contents of the bottle are squeezed out into the water in front of the fish and the poison is wafted towards the grouper. Large groupers, when ready to be caught usually swim to the surface and then become buoyant with swollen swim bladders. Large fish require more cyanide. One fisher related how he used four bottles of cyanide solution, at a concentration of three tablets per bottle, to catch a 57 kg kuatong (*E. lanceolatus*) and seven 1-tablet bottles to catch a large male lankawit (*Cheilinus undulatus*).

Sodium cyanide is widely viewed as the easiest way to catch live fish while rare, valuable species like maming (*Cheilinus undulatus*) or kubing (*Cromileptes altivelis*) are difficult to catch by other means.

² Cyanide tablets appear to be supplied from the Philippines and several fishers thought that they originally came from Taiwan. Prices quoted were between RM40-50 for 1 kilo containing 40-50 small or 25 large tablets.

5.3.4 Other Methods

Although one story was heard about an expert bomb-fisher in Semporna using a fish bomb to stun a live maming, no evidence was found of blast fishing being used to support the trade in the Kudat area other than for catching a supply of bait or food for caged fish. The use of strong bleaches or other poisons as an anaesthetic to catch live fish was also not reported.

5.4 Fishing Vessels

5.4.1 Paddled canoes – *Sampan dayung*

Small canoes about 3m long are used by individual fishermen to fish with hook and line either close to their home kampong or from a mother-ship. They are favoured for the smaller mother vessels as they can easily be lifted aboard. If used for the live fish trade they have a small live fish hold at the front.

5.4.2 Pump boats

Wooden boats powered by water-pump engines are the most common vessel in use for the live fish trade in the Banggi area and come in a range of sizes. One-man pump boats can be as small as 3m while large boats can reach over 10m and be powered with two or three engines. They are used to carry 1-3 fishermen on all types of fishing operations. Pump-boat trips range from a few hours to one week and distances of up to 30 km. The boats are usually modified for the LRFT by the inclusion of a small well with holes drilled in the hull to allow water exchange and many have small compressors on board, which can be driven by the pump engine. Smaller pump boats are used with mother ships while larger pump-boats are sometimes used to transport live fish from cages to Kudat.

5.4.3 Mother-dory operations – *Kapal, Piskadul, Sendirian*

Large fishing vessels (called *Kapals*) with 33-120 hp inboard engines act as “mother vessels” for 6-30 individual fishermen catching fish from small pump boats or canoes at more distant reefs for 4-10 days. Catches are delivered direct to Kudat at the end of each fishing trip. There are two classes of mother-dory operations. In some, each fisher’s catch is weighed as he returns to the mother vessel and he is paid for the fish that he catches. The prices paid are only about 70% of those paid by island-based cage operations although the fisherman benefits from free food and accommodation as well as the opportunity to transport their small boat to fish on less heavily exploited reefs. These tend to use larger kapals and are called *piskadul*. Less-commercial mother ship operations also exist in which the catch is not weighed for each individual fisherman and the profits from the trip are shared between the fishers. These operations, called *sendirian*, tend to be smaller scale than *piskadul*, favour the use of sampans rather than pump boats and are usually conducted with relatives or close friends.

Large kapals are now normally fitted with echo sounders to help search for reefs and identify hard bottoms. One Kapal captain in Kudat claimed that his vessel was one of only two that were also fitted with a global positioning system satellite receiver (GPS).

5.4.5 Larger diving vessels (*Kapals*)

Kapals equipped with diving compressors carry 4-10 fishers and deliver catches direct to Kudat traders at the end of each fishing trip. They are usually fitted with a compressor with two hoses for divers. Each hose can be divided to allow four divers to work at once. The compressors also have a pressurised tank, which can continue to supply air for about five minutes if the engine unexpectedly cuts out but there is no filtration of the air supply.

These vessels are also used to catch lobsters and sea cucumbers and for collecting bombed fish.

5.4.6 Transport vessels

Large pump-boats and kapals regularly deliver fish from cages in Banggi or the Philippines to Kudat. Such vessels have a specialised hold with holes through the hull to allow an exchange of water with the sea around the boat. Some vessels are also equipped with air pumps to aerate the water during the journey.

5.5 Species composition

The most important species at all levels of the trade is the leopard coralgroupier (*Plectropomus leopardus*) which is known locally as *sunoh merah* if red or *sunoh hitam* or *sunoh batu* in the dark form, which is found in shallower waters. Interviews with Kudat traders indicated that it generally makes up more than half of the volume of catches especially in boats fishing in deeper waters and in the Philippines. When fishing on shallower, coastal reefs, the spotted coralgroupier (*Plectropomus maculatus*) is an important constituent of the catch. It is commonly known by its Chinese name *tai sing* although this name is sometimes used for *Plectropomus laevis* when sold at the same value. *Sunoh* is often used as a general term for all species of *Plectropomus* which together made up 70% of the trade volume in Kudat in 2001 (Table 2).

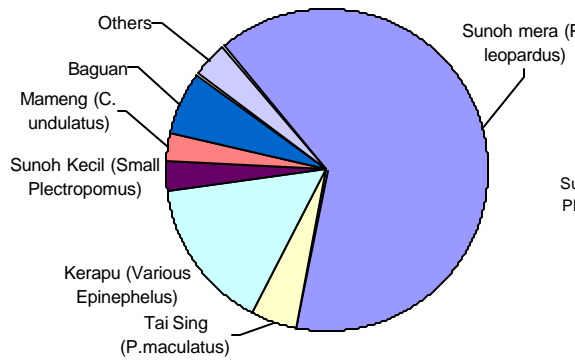
Table 2. Total weight of live fish categories exported via Kudat in 2001. (Figures courtesy of Sabah Fisheries Department.)

Group	Weight (kg)
Sunoh (<i>Plectropomus leopardus</i> , <i>P. maculatus</i> , <i>P. laevis</i> , <i>P. areolatus</i>)	49,506
Maming (<i>Cheilinus undulatus</i>)	3,510
Kerapu (<i>Epinephelus malabaricus</i> , <i>E. tauvina</i> , <i>E. coioides</i> , <i>E. fuscoguttatus</i> , <i>E. lanceolatus</i> , <i>E. maculatus</i> , others)	13,057
Kubing (<i>Cromileptes altivelis</i>)	419
Ikan Merah (<i>Lutjanus spp</i>)	40
Lobster spp	4,089
Kalawi (<i>Plectropomus oligocanthus</i>)	74
TOTAL	70,695

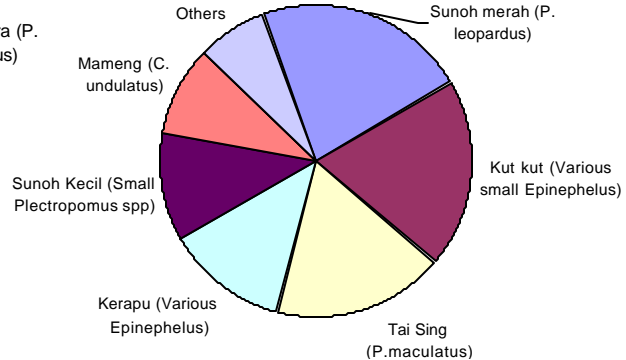
The composition of the trade varies with fishing ground, gear type and possibly the seasons. If certain species were being overfished one would also expect the composition to change over time as favoured fish become rarer and a smaller proportion of the catch.

Figure 2 shows the species composition as described in receipts obtained from four different live fish operations over different time periods. The three cages featured in Figure 2 were supplied from small-scale fishermen fishing with a combination of traps, cyanide and hook and line, mainly on coastal reefs within 30 km of their village. The mother-dory operations were targeting more remote offshore reefs either close to or across the Philippine border and using hook and line only. It can be clearly seen that the small-scale fishermen caught a wider variety of species with significant proportions of tai sing. The mother-dory operations and small-scale fishers in Balambangan catch large proportions of sunoh merah and it is interesting to note that undersized sunoh make up a higher proportion of the catch of the vessel fishing within Sabah waters.

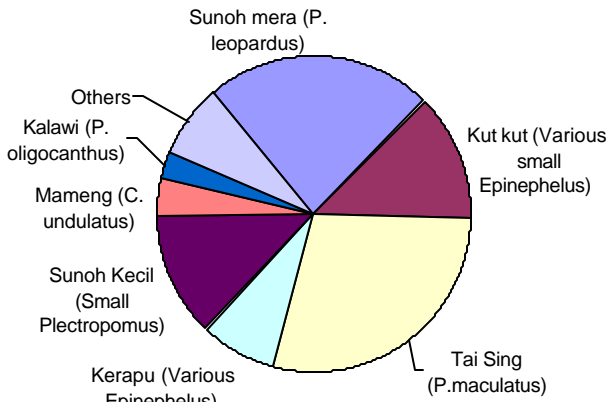
Focus groups of fishermen in Banggi Batu Sirih, Lumais and Lok Tohog also ranked sunoh merah as the most common species to be caught, while in Sibogo, Kobong Laut and Dogoton in NE Banggi, the less valuable kut kut (including several small species of *Epinephelus*) was ranked as the most common.



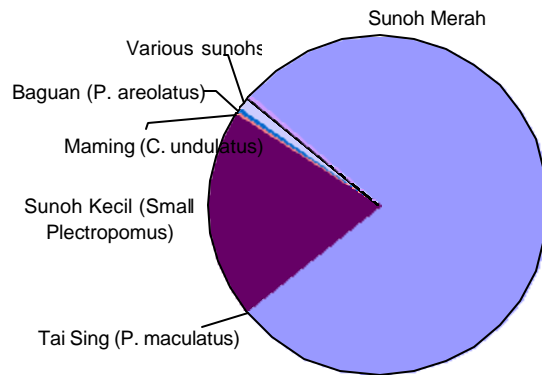
Balambangan, cage



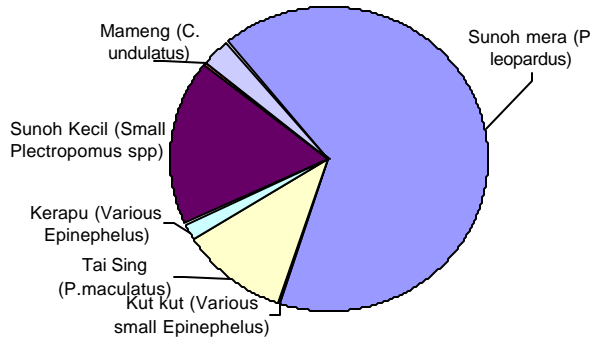
Karakit, cage



Sibogo, cage



NE Sabah Reefs, mother/dory operation



Philippine Reefs, mother/dory operation

Figure 2. Composition of fish caught and traded by various components of the Kudat live reef fish industry. Figures are taken from receipts provided by fishers or traders. Periods covered are: Karakit, 4/2/02-14/4/02 & 2/6/02; NE Sabah reefs, 5/4/98-3/6/00; Sibogo, 14 days from 26/7/02-22/8/02; Balambangan, 16 deliveries from 1/9/01-4/8/02; Philippine reefs, 18/2/99-4/8/02.

Figure 3 shows total catch composition from records at three fish cages separated by gear type. The worker on each cage indicated which gears had been use to catch the fish on each record. The most obvious difference between the gears is the relative abundance of maming and lack of kut kut in the cyanide catch. These trends support comments by other key informants that maming is difficult (but not impossible) to catch using traps or handlines. Cyanide fishing is highly selective and so it is unsurprising that the fishers would avoid catching the less valuable kut kut.

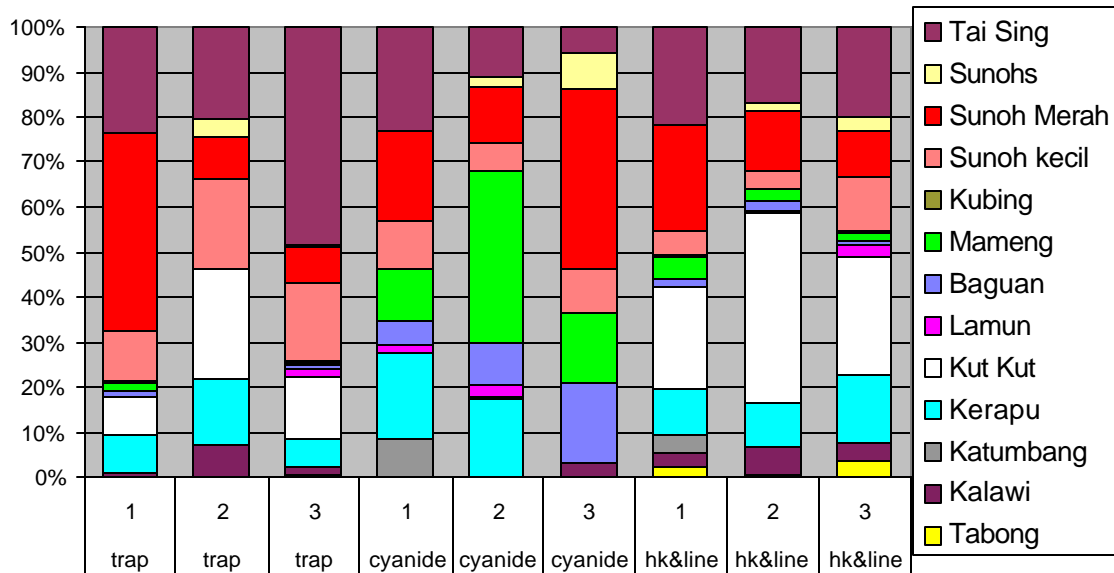


Figure 3. Composition of catches delivered to three different live fish cages in the Banggi region using different gears. Compositions calculated from totals of the following number of records for each gear type and from each location: Traps: 1–20 records, 2-14, 3-25; Cyanide: 1-20, 2-12, 3-10 and Hook & line: 1-35, 2-114, 3-70. Names used are those on receipts and translate to: Tai Sing – *Plectropomus maculatus* and *P. laevis*; Sunoh Merah – *P. leopardus*; Sunohs – Various *Plectropomus* spp; Sunoh Kecil – Various *Plectropomus* less than 400g; Kubing – *Cromileptes altivelis*; Mameng – *Cheilinus undulatus*; Baguan – *P. areolatus*; Lamun lamun – *Choerodon schoeleinii*; Kut Kut – various small, cheap *Epinephelus*, Kerapu – larger, more valuable species of *Epinephelus*; Katumbang – *Lutjanus rivulatus*; Kalawi – *Plectropomus oligocanthus*; Tabong – Various red species of *Lutjanus*.

It should be noted that live lobsters are also commonly caught by live-fish fishermen³ and sold through the same marketing chain. Dead reef fish (either LRFT species which have accidentally died or other species not valuable live) are also often bought and sold along with live fish. In order to limit the scope of this rapid assessment the focus was only on live reef fish.

5.6 Trade Structure, Routes and Fishing Grounds

Figure 4 shows a summary of the main routes by which fish, caught from reefs in northern Sabah and the south-western Philippines, are ultimately transported to Kota Kinabalu for export. Fishing boats either deliver their catches direct to Kudat or sell them to a local collecting operation from where they are transported to Kudat when enough fish accumulate.

³ Fishermen also use compressor diving and sometimes cyanide to catch lobsters.

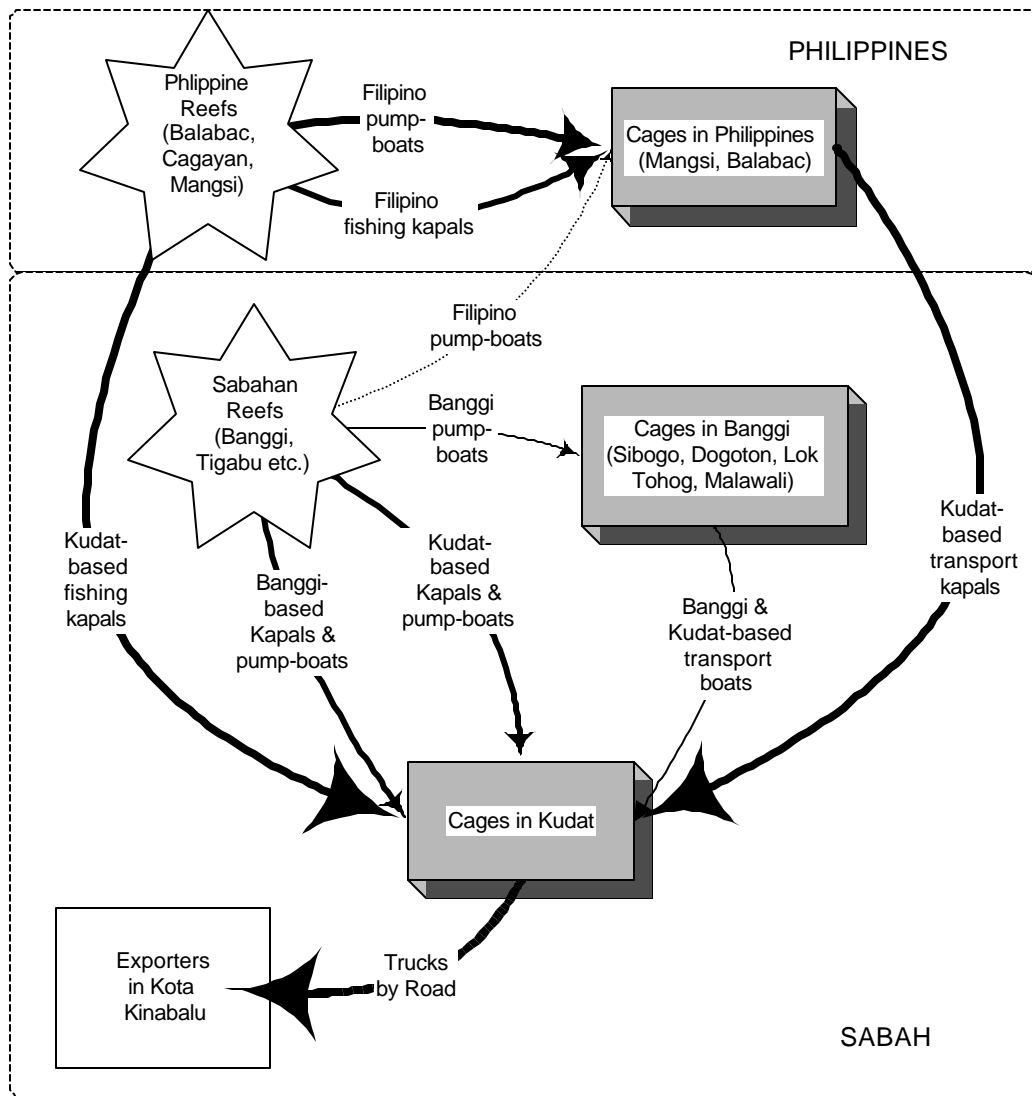


Figure 4. Trade routes for live reef fish in the Kudat region. Thickness of arrows gives a crude indication of the importance of each route according to impressions gained during this assessment but is not necessarily proportional to the volume of each route.

The majority of fish stay a maximum of a few days in cages at Kudat before being transported by road to Kota Kinabalu. Most fish are exported to Hong Kong where many are re-exported to mainland China. Fish are also exported to Taiwan, Kuala Lumpur and Singapore or consumed within Sabah.

The trade bosses (or “Towkays” as they are locally known) in Kudat control much of the trade, as they often own or at least have a share in fishing vessels and cage operations. Many fishers are therefore tied to a particular Towkay giving a proportion of the revenue from each catch to pay back a loan for their boat. Some of the Kudat towkays export fish themselves but the majority sell to separate exporters in KK. One former trader in Kudat related that transport vessels from Hong Kong used to collect fish from local boats around Balambangan seven or eight years ago. No-one claimed that this was still continuing today but several Kapal fishermen claimed that they encountered large-scale Taiwanese vessels fishing on distant reefs in Sabah water.

Informants interviewed in Kudat stated that the majority (60-90%) of live fish in Kudat originated in the Philippines. Captains of Kapals based in Banggi seemed reluctant to cross the Philippine border but many of the Kudat-based kapals now fish around Cagayan Island, Mangsi Reef or Balabac Island.

Large numbers of fish are also delivered to Kudat from cages in the south western Philippines having been caught by local boats there. There are apparently about 10 fish cages operating in Mangsi, which are owned by Kudat Towkays and large deliveries were also observed from cages in Marabun, Balabac.

Within Sabah waters, reefs around Balambangan and Malawali, Kuambang (Carrington) reef and reefs east of Sibogo are important for small-scale fishers in Banggi while larger Kapals tend to fish at Balambangan or on the many reefs between Malawali, Tigabu and the Philippine border, particularly Sibeliu reef and around Sinmagot island.

5.7 Kudat Trade Operations

The trade in live fish in Kudat is currently centred on two jetties beside the new esplanade. These replaced an informal collection of cages, jetties and huts, in early 2002. Ten units, each comprising a small house and a raft of cages are rented by (mostly) Chinese traders or “towkays” as a base to receive shipments of live fish before they are transported to Kota Kinabalu by road. On arrival at the jetty, fish are sorted by value, size and condition, weighed and transferred to cages to await shipment. Normally, in the case of large shipments, they only stay a few hours at the holding facilities and one of the units has no cages at all; the trader transfers all catches directly to trucks for transfer to Kota Kinabalu. One Kudat resident claimed that traders also sometimes unload fish directly from kapals to trucks at other sites, including the Kudat shipyard.

Many traders now also use the cages to keep and grow out undersized or unusual fish for sale in the future. Species kept to be grown out included maming (*Cheilinus undulatus*), Sunoh (usually *Plectropomus leopardus* and *P. maculatus*) and various species of Kerapu (*Epinephelus spp*). Fish from 100-350g are purchased at a cheap rate and then kept until they reach “size” at 400g. This typically takes 5-6 months although maming are sometimes kept for up to two years. The growing fish are fed on trash fish purchased from purse seiners although during full moon there is a lack of supply because the purse seiners cannot make good catches. Each day the fish are typically fed approximately 10% of their bodyweight over two feeding occasions if food is available.

One small operation is also located at Kampong Sebeyan Laut in another part of Kudat but this was not visited during the assessment.

5.8 Island cage operations

Many villages in the Banggi region also have live fish cage operations where small-scale fishermen sell their catch. These operations usually comprise 1-4 floating cages and a platform where fish can be weighed and sorted and where an employee remains to guard the cage and pay fishermen as they arrive with their catch. A transport vessel delivers the fish to Kudat every few days when about 50-100 kg fish are collected.

During the assessment several sources indicated that large vessels were more important in terms of volume than small operations. However, small boats supply

significant quantities of fish to the trade via these island based cage operations. One of the two largest cage operations, in Sibogo, apparently buys RM5000-6000 worth of fish from 60-70 fishermen per day when the weather is favourable. The worker on the cage stated that approximately 50 kg fish were collected per day and that the transport vessel delivered 80-100kg fish to Kudat each 3 days. These points give an indication of 11-50 tonnes per year from that cage alone.

These enterprises are often owned by or set up with financial assistance from one of the Kudat towkays although Sabah Fisheries Department has also supplied materials to some individuals to construct cages in order to encourage the development of cage culture of fish in Banggi.

Undersized fish (100-350g) are now often kept for grow-out as with the Kudat operations. The island-based cages have the advantage of better water quality but do not have access to buy trash fish from purse seiners or trawlers and so are more apt to use blast fishing to catch food for the growing fish.

5.9 Prices

Maming and kubing are the most valuable species traded, being significantly more valuable than any other fish species at all levels of the trade. The least valuable fish observed to be traded live are kut kut at about 10% of the value of Maming (Table 3).

Table 3. Prices in RM per Kilo for six fish types at four different levels of the Kudat live fish trade as recorded by interviews, focus groups and receipts.

<i>RM/kg for "size" fish</i>	<i>Species name</i>	<i>At cages in Banggi</i>	<i>Piskadul operation</i>	<i>Wholesale to Kudat Towkay</i>	<i>Wholesale to exporter</i>
Maming & Kubing	<i>Cheilinus undulatus, Cromileptes altivelis</i>	45-65	45-55	70-75	95-120
Sunoh merah	<i>Plectropomus leopardus</i>	35-42	30-37	45-52	65-70
Tai sing	<i>P. maculatus</i>	28-30	20-27	35-38	50
Baguan	<i>P. areolatus</i>	10	10	15	28-35
Kerapu	<i>Epinephelus spp.</i>	4-8	7	8-10	18-35
Kut kut	<i>Epinephelus spp</i>	3-5	-	6	15

Prices paid to fishermen for their catch are about 40-60% of the final wholesale price paid by the exporter. Prices at fish cages are generally higher than prices paid on piskadul operations although fishermen on piskadul operations do not have to pay for food during the trip or fuel to reach the fishing ground or deliver the catch. A summary of all prices observed for all species can be found in Appendix 5.

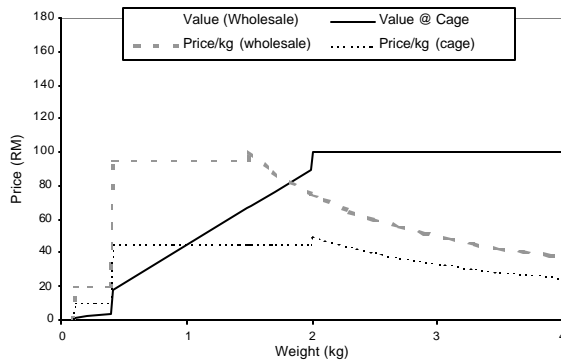


Figure 5. Variations in the price of maming value per fish and per kilo with changing fish size.

The price per kg of the more valuable species (maming, kubing and all sunoh) is related to the size class and condition of the fish. Different price regimes operate for different sizes of fish as illustrated by Figure 5. The price per kg of fish less than 400g in weight is generally only 10-30% of the price of “size” fish. When fish reach over a particular weight, they are classed as “oversize” and are worth a standard rate per fish irrespective of size. The threshold for over-sized fish on the wholesale market is 1.5 kg whereas fish in Banggi and

Kudat are currently still classed as “size” up to 2kg.

According to some Kudat towkays, wholesale prices fluctuate seasonally and can be elevated by 50% over normal prices during the lead-up to Chinese new year. This also falls on the period when catches and supplies are the lowest levels. However this price fluctuation does not appear to be translated to the cage level as no fishermen or traders in Banggi mentioned it.

5.10 Governance of the live fish trade

Official controls on the LRFT include licensing by the Fisheries Department for fishing vessels and individual fishermen although these are not specific to the LRFT. Most kapals are thought to have licences but the majority of small-scale village fishermen probably do not. The Fisheries Department plans to bring in licensing for live fish cages in the near future.

There was some evidence from conversations with villagers and fishermen that informal reef ownership arrangements exist between kampongs and their local reefs. One Karakit resident told how fishermen from that village used to often fish at Jambongan Island until the inhabitants there objected. Such strong assertion of access rights appears to be rare. The headman of Tanjung Malawali related that he gives permission for outsiders to fish on the local reefs if he knows them but does not like them using bombs or cyanide. However, several people in the same village said that outsiders came and used cyanide and the locals did nothing about it. Villagers generally seemed reluctant to cause conflicts with other communities (probably with some common families) and had a sympathy for other fishermen just *cari makan* (making a living) like themselves. Some examples of individuals getting around other communities’ access rules included one cyanide fisher who would tell local people he was collecting *Trochus* shells while cyanide fishing and another who had a Fisheries Department licence for his traps. He used this official licence as leverage to gain access to communities’ reefs: “they can’t say anything because I have a licence to fish with traps anywhere as far as Sandakan.” Ironically this fisherman used the traps as a cover for cyanide fishing.

Two examples were found of individuals attempting to instigate protected areas. The sole inhabitant of Molleangan Kecil related that he had been preventing people from

using fish-bombs and cyanide on the reef beside his land for five years. He admitted that he was not always there to protect the reef but claimed that the coral and fish life was noticeably better than in other areas as a result of protection.

The headman of Batu Sirih also claimed that he had had a rule in place for two years that only subsistence hook and line fishing was allowed within three miles of the village. However, none of the 12 fishers interviewed in Batu Sirih thought that there were any restrictions on locations or methods of fishing.

6. Socio-economic aspects of the LRFT

6.1 Communities involved

Within the Kudat region, the Ubian (or Bajau Ubian) ethnic group are most heavily involved in catching fish for the LRFT as well as the most numerous group in Banggi. For these reasons the surveys were naturally biased towards Ubian communities and individuals. The less numerous Suluk and Kagayan fishermen also contribute to the trade. The single Bajau Sama fishing community that was visited (Keligau) were not involved in the LRFT (Table 4). Ubian fishers generally work as crew on Banggi-based Kapals while Kudat-based operations are crewed by local Ubians as well as Filipinos and Indonesians. Vessels operating in Philippine waters are particularly likely to be crewed by Filipinos.

All of the island-based traders interviewed were also Ubian while the majority of towkays in Kudat were Chinese.

Table 4. Proportions of fishermen interviewed from each ethnic group involved in the live fish trade

Ethnic group	Nos. useable interviews	Don't sell live fish		Sell live fish	
		No	%	No	%
Ubian	97	7	8%	90	92%
Cagayan	11	2	18%	9	82%
Suluk	6	0	0%	6	100%
Bajau	3	3	100%	0	0%
Balabac	1	0	0%	1	100%
Total	118	12	10%	106	90%

6.2 Income from the LRFT

Ninety percent of fishermen interviewed were involved in the trade (Table 4) and it was the main source of income for 75% of fishermen (Table 5). The popularity and importance of the trade is unsurprising when the high values of target species are considered. In Sibogo for example, live fish are typically worth RM5-45 /kg depending on species while typical mixed reef fish, *Ikan Batu* (e.g. Lethrinidae, Haemulidae, Nemipteridae) are only worth RM1/kg and *Ikan putih* (Carangidae) are worth RM2.5/kg. These prices mean that even if a fisherman's catch is mostly non-LRFT species, the majority of his income is often earned from the few high-value LRFT species.

Table 5. Proportions of fishermen interviewed who derived less than half, half and most of their income from the live fish trade.

Ethnic group	Nos. useable interviews	Less than half		Half		Most	
		No	%	No	%	No	%
Ubian	95	14	15%	5	5%	76	80%
Cagayan	11	3	27%	2	18%	6	55%
Suluk	6	2	33%	0	0%	4	67%
Bajau	3	3	100%	0	0%	0	0%
Balabac	1	0	0%	0	0%	1	100%
Total	4	22	19%	7	6%	87	75%

Fishermen were also involved in catching and selling dead reef fish, lobsters, abalones, sea cucumbers, shells, dried salted fish and tenggeri (Spanish mackerel, *Scomberomorus commersoni*). Other than fishing, some fishermen sometimes travelled to Kudat for contract work in construction, some had coconut plantations or other agriculture and two owned small village shops.

From conversations with villagers and fishermen, it appears that involvement in the LRFT has a seasonal aspect. In Malawali live fish are most important from about May to October. From November to February many fishermen switch to concentrating on catching the large cuttlefish available at that time. Catching dead fish for drying then becomes an important income until Sunoh become easy to catch again in May. In Batu Sirih, May until August are the favoured times for catching Sunoh while many fishermen target tenggeri for the rest of the year. The timing of this assessment, during the peak live fish season may therefore have lead to an overemphasis on the live fish trade. Had the interviews been conducted at another time less fishermen may have stated that the trade is their main source of income. However, it is clear from receipts that the trade is still active during other times of the year even if some effort is diverted into other fisheries.

Actual daily or weekly income from selling live fish is dependent on which species are caught and therefore highly variable. Individual catch values for small-scale pump-boat fishermen were obtained by looking at receipts at three fish cages in Banggi and categorised according to gear type. The results are shown in Figure 6. A clear trend can be seen that the average value of catch from a cyanide fishermen at each site is double that of a hook and line fisherman giving a strong economic incentive for people to use cyanide. The data on fish traps is less clear and complicated by the fact that traps are usually left on the reef for 3-4 days (the hook and line and cyanide yields quoted are generally from one day's fishing) and that different fishermen use different numbers of traps. In addition, there was suspicion that some of the trap users also use cyanide⁴ so that it is difficult to completely separate catches caught by these two methods.

⁴ One "trap fishing" boat was observed arriving at a fish cage to sell an 8 kg Kerapu (*Epinephelus fuscogutattus*) which, despite the claims of the fishers, could not have fitted inside the traps being used. The same boat also unloaded small tai sing which may well have been caught by the traps.

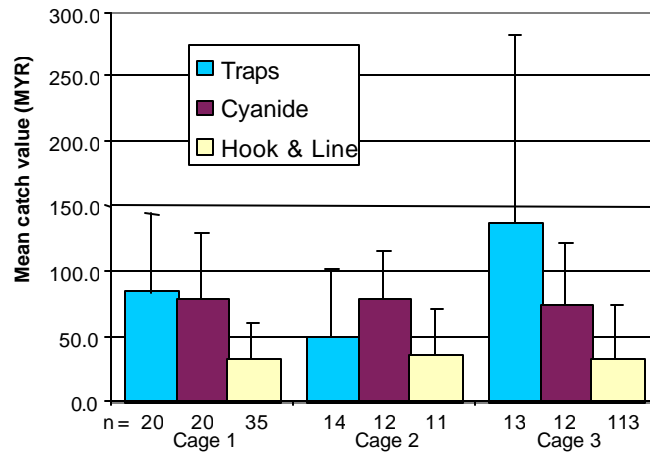


Figure 6. Mean total catch value per sale for each gear type at three different locations in Banggi. Error bars show standard deviations and numbers indicate the number of records analysed for each category.

Income levels from selling live fish according to fishermen interviews ranged from 65 to RM300 per week with the potential to earn well over RM100 in a day if the fisherman is lucky enough to catch sizeable Maming, Kubing or Sunoh. One fisherman expressed the view that he can earn higher wages than teachers or government officials when the weather is good while another related how he had previously worked as a graphic designer in Kota Kinabalu before opting to return to fishing in Banggi. Clearly, the high prices of the LRFT have elevated the incomes of fishermen well beyond usual fishermen's incomes despite reports of declining catches (see next section). Several fishermen related that the decline in fish numbers had not affected their income as these declines had been accompanied by rises in value.

7. Sustainability of the live fish trade

7.1 Stock declines

7.1.1 Evidence from interviews

There was virtually unanimous agreement (e.g. 95% of interviewed fishermen, 100% of interviewed towkays) among all stakeholders that the live fish stocks had declined within recent years.

Interviews with Kudat towkays suggested that supplies of fish have reduced significantly within the past 10 years. All of the eight traders who were asked about trends in supply stated that the quantity of fish was declining. Declines were first noticed by the traders between 1994 and 2000 and constituted a 35 % to over 50 % drop in fish. As a result, their fishing vessels also had to fish at more distant reefs (including the Philippines) to maintain catches. One trader related how his vessels started to cross the border to fish near Cagayan in 1999 and now were having to risk fishing further north towards Palawan due to reduced catches in Cagayan.

During interviews and focus groups, fishermen also agreed that yields were declining. Some suggested that kubing, maming and sunoh had declined the most while others asserted that all species, including non-LRFT species had declined together. During

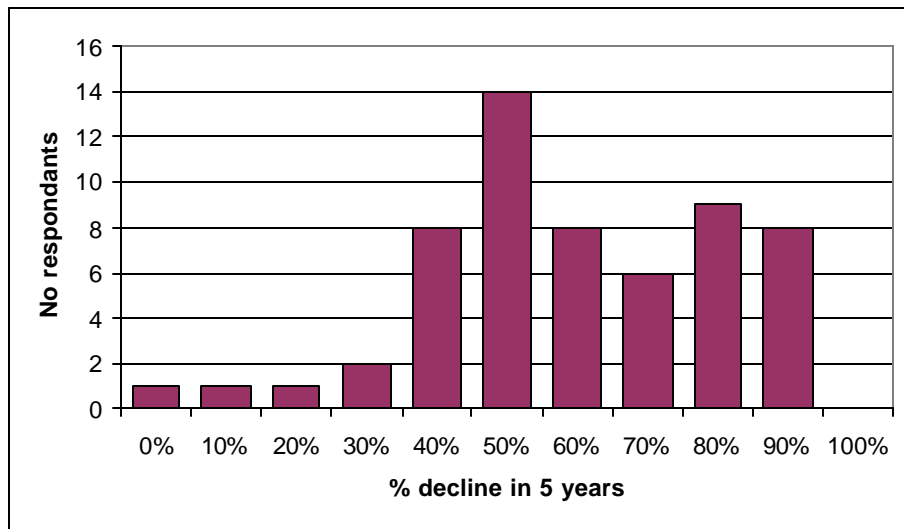


Figure 7. Percentage decline of live fish yields during the past five years as perceived by interviewed fishermen

surveys, fishers were asked about their average or best yields now and 5 years before. The majority of fishermen responded that yields had declined by more than half with some citing 80 or even 90% reductions in yields (Figure 7)

Declines were perceived in terms of numbers of fish, weight of catches and size of fish.

7.1.2 Stock declines – Evidence from secondary data

Statistics from the Kudat office of the Sabah Fisheries department since 1996 show the total weight of live fish traded in Kudat since 1996 (Figure 8). The figures fluctuate but do not show declines in line with those described by interviewees.

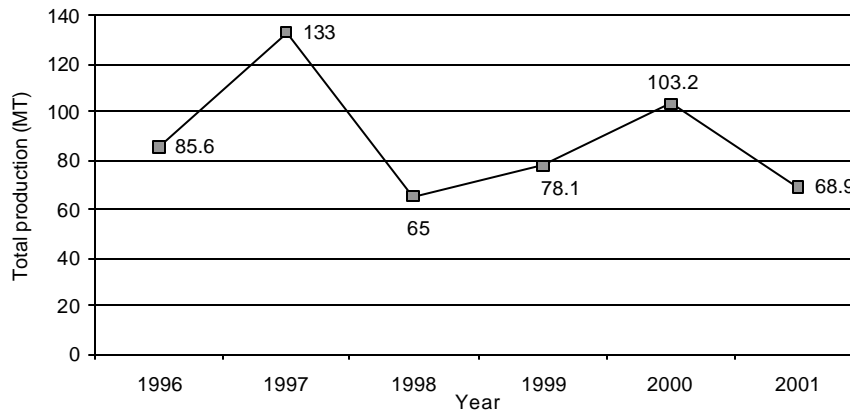


Figure 8. Trends in the total supply of live fish to the Kudat trade according to Fisheries department statistics.

However these trends do not take into account changes in effort, location of fishing grounds or sophistication of gears while the totals do not agree with other estimates of species volumes. With the increasing value of live fish and improving catching technologies, one would expect the effective fishing effort to increase. If this is the case, the lack of an increasing trend would agree with a reduction in catch per unit fishing effort.

Actual monthly supply volumes from the March and July records of one Kudat towkay appear, on average, to have declined since 1995 (Figure 9). Supplies show wide fluctuations prior to the data gap in 1998 but never dropping below 1 tonne per month. When the figures resume in 2000 supplies are still of the same magnitude but then drop to their lowest values in 2001 before beginning to recover in 2002. The towkay in question believed the declines in his supply were due to a combination of declining stocks and increased competition with other buyers. These data are complicated by changes in fishing vessels, fishing grounds vessel numbers or improved technologies.

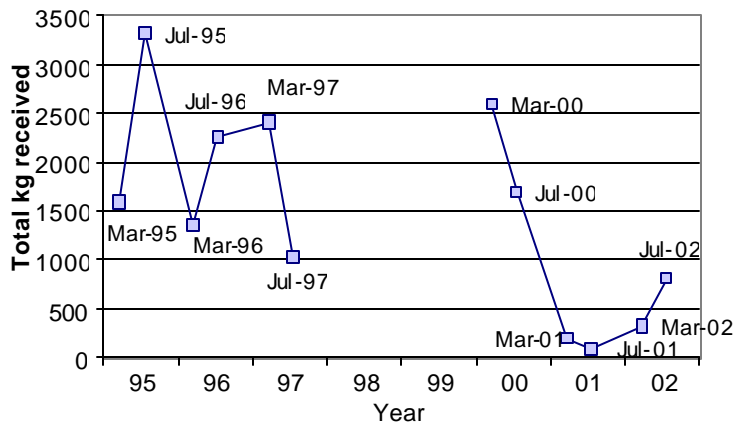


Figure 9. Total kg of live fish sold to one Kudat trader during March and July since 1995.

The same dataset does show a change in the species composition of the catch over time when the three main price categories are compared (Figure 10). Sunoh merah dominates all the catches throughout and the important of tai sing fluctuates without

any obvious pattern but it can be seen that maming and kubing have become rarer relative to other species over time.

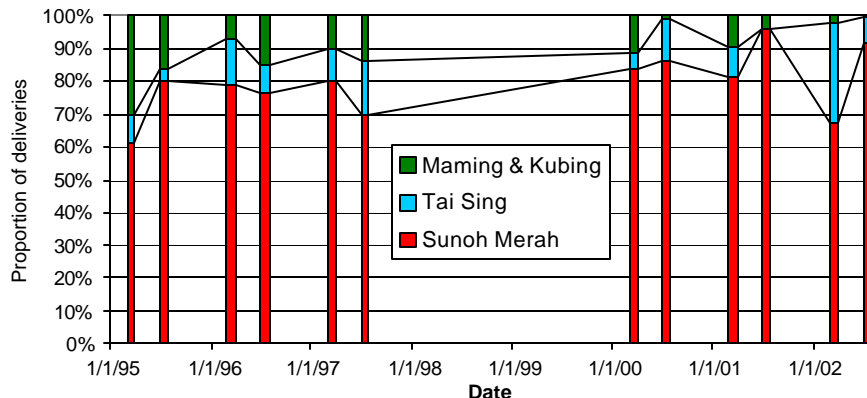


Figure 10. Relative proportions of the 3 main categories of live fish sold to one Kudat trader each March and July.

Data from single vessels give a smaller sample but can be expected to reflect a more consistent effort over time. Figure 11 shows the catches per trip of three different piskadul vessels which were believed to fish in similar grounds (two within Sabah and one in the Philippines) with similar methodologies and number of fishers over the course of the time series.

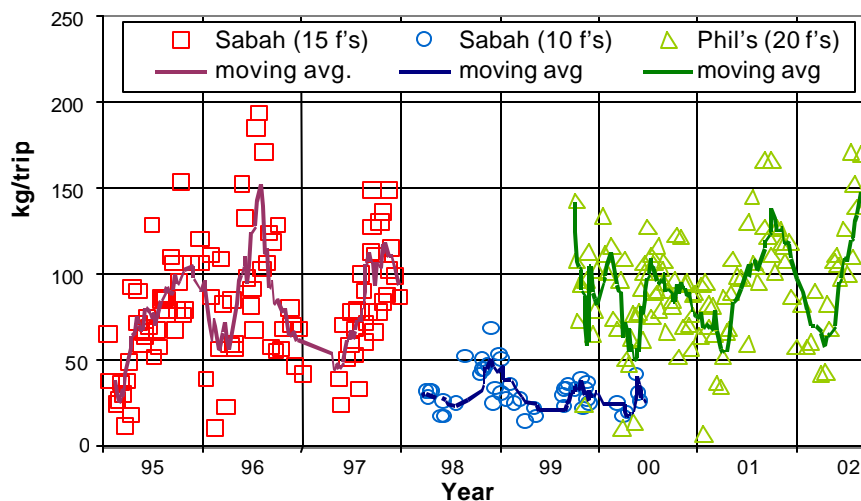


Figure 11. Total catches per trip for three separate Piskadul operations plotted against date of sale. The vessels indicated by squares and triangles had the same captain. Moving averages are calculated with a period of five trips. Figures in parenthesis indicate typical numbers of fishers on each boat.

The data clearly show the seasonal variation in catches with peaks in the third or fourth quarter of each year but provide no strong evidence for a long-term decline. The 10-fisherman vessel shows the lowest variation in catches and possibly indicates that the end of year peak yield was lower in 2000 than it was in 1999. A longer time series would be needed to determine if this trend continued

7.1.3 Stock declines - Discussion

The major declines in catch levels perceived by stakeholders at all levels of the trade are not borne out by the few numerical data that were available for this assessment which only tentatively suggested declines. The data available may be too crude and short term to indicate trends that are more obvious at the level of the individual fishermen. Declines in fish stocks at individual reefs or locations could be masked by changes in fishing grounds especially in the case of kapals, which can move to more remote, deeper reefs if stocks become over exploited. Overfishing would also not be demonstrated by total catches if catch-per-unit-effort was maintained by technological advances (e.g. increased use of echo sounders or compressors) or if total effort was increased by more fishers entering the fishery.

Overfishing of certain species could occur with little impact on the total catch volume. This is perhaps illustrated in the case of declining catches of the valuable maming and kubing relative to sunoh and tai sing (Figure 10). Several informants highlighted these two species as having declined the most. For example one towkay related that *ten years ago 200kg of maming could be collected in Sibogo "with closed eyes" whereas they are now lucky to get 20kg per week.*

7.2 Fish sizes

One of the concerns of the LRFT is that most of the target species are large, long-lived, slow-growing species as well as being protogynous hermaphrodites (fish which initially mature as females and then change to males with growth). Reduction of mean size of fish with these life history traits (due to heavy fishing pressure) may disrupt reproduction by not allowing fish to reach sexual maturity before being caught and by altering sex ratios (e.g. if fish only become male at 40cm and most fish are caught before they reach 35cm there will be a shortage of males).

There was a certain amount of anecdotal evidence that fish sizes have declined. All focus groups agreed that there were less large fish now. The sentiments of one Sibogo fisher were typical, although only 14 years old, he had been fishing long enough to observe: *"Before, lots of fish because they were always large. If you caught four fish you'd already have 4-5kg and now if you catch ten fish maybe you only have 2 kg"*. Others related how they used to discard small fish and that people only started to keep undersized fish for grow-out within the last few years.

Deliveries of fish to the Kudat esplanade gives the opportunity to measure large samples of fish as they arrive. This was conducted on one shipment only due to time constraints and the necessity to be one site when the vessel arrived and have the prior cooperation and permission from the towkey to handle all the fish as they are weighed. The sampled shipment of fish was delivered from a cage in Mantagule, near Balabac in the Philippines. Figure 12 shows the size-frequency histograms obtained for *Plectropomus leopardus* and *Cheilinus undulatus*, the two species that were present in substantial numbers. Although this small sample from one location cannot be assumed to be representative of the trade, it is interesting to note that 30 of the 31 maming were probably immature. The sunoh merah were larger than the female maturation size but generally smaller than the size of changing to males. These findings must be viewed with caution both because of the small sample sizes and the lack of any studies on the life history of these species in the region.

7.3 Use of destructive fishing techniques

Observations and descriptions of fishing methods have highlighted that fact that all methods used to catch live fish in the Kudat area can be associated with habitat damage.

Fish traps are entirely camouflaged with corals, which must be removed from the adjacent reef. Large foliose or table corals are likely to be most useful for this purpose. Large pieces of rubble or dead coral could presumably be used for this purpose but it is likely that live colonies would be used if they are more conveniently available. Some experiments were previously conducted off Pulau Molleangan Kecil by a local fisherman and staff of the UMS Projek Rumpai Laut with large wire traps lowered into deep water without diving or camouflaging the traps. The trial apparently yielded good catches of large groupers but it is not known whether this method would be successful in other locations. Another possible ecological impact of the plastic-mesh traps which some fishermen use is the problem of lost traps “ghost fishing”. As the plastic is not biodegradable, a trap left on the reef would continue to catch and kill fish for much longer than a traditional bamboo or even wire mesh trap.

The use of cyanide is widely acknowledged to be damaging to reef habitats as it can kill corals and other reef fauna. However, there is a lack of documented direct

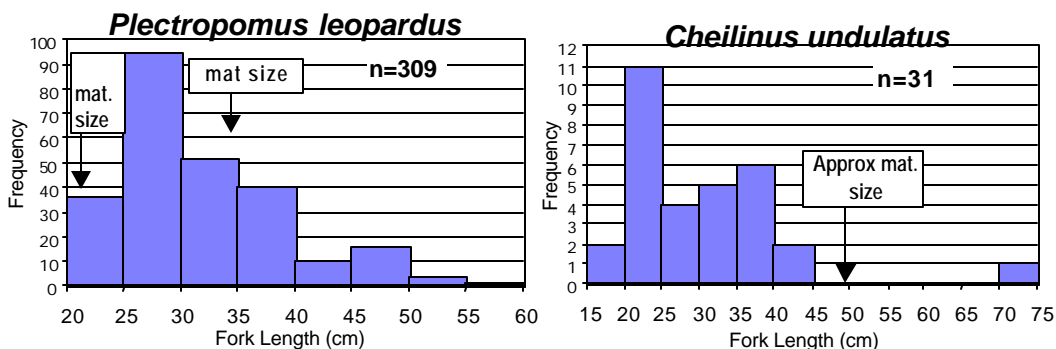


Figure 12. Length-frequency of live *P leopardus* (sunoh merah) and *C. undulatus* (maming) from a shipment delivered to Kudat from a fish cage in Mantagule Island, Philippines. Arrows show approximate maturation sizes for males and females for *P. leopardus* (according to www.fishbase.org) and approximate size for maturity of *C. undulatus* (Y. Sadovy pers comm.).

observation of impacts. Fishermen with direct experience often related how cyanide killed coral (within 20 minutes according to one fisherman) and stated that areas of reef had been made unproductive by the use of cyanide. From the description of the methodology in section 5.3 it becomes apparent that the damage from cyanide would vary according to the species and size of the fish being targeted. For example maming requires all holes in the reef to be treated with cyanide and some large groupers require several squirts of high concentrations. The impact of damage from cyanide on habitats would be likely to be disproportionately severe as it is squirted into the holes where the fish hide. The cyanide is therefore not randomly applied to the reef, but directly to those areas that are most important habitats for the target fish.

The illegal nature of cyanide fishing and reluctance of villagers to speak about it makes it difficult to determine what proportion of fishermen is using the poison. It is especially difficult to know whether fishermen use traps or cyanide as both require diving or snorkelling and cyanide-users appear to use this ambiguity to pretend they use traps⁵. Estimates of the proportions of fish caught with cyanide range from 30 to 50% although this proportion probably fluctuates. Some cage employees explained that cyanide is less popular now because of reduced stocks on shallow reefs. The deeper reefs where stocks are less impacted are more easily fished with hook and line. The weather and subsequent water clarity also affects the success of cyanide fishing as in poor visibility it is difficult to see target fish and easy to lose them if they flee before becoming fully anaesthetised. Therefore, in periods of poor water visibility nearly all fish will be caught by hook and line or traps. This view was supported by the team's observation during periods of poor visibility that known cyanide fishermen either fished with hook and line or waited at home for conditions to improve.

Hook and line fishing, often viewed as one of the most environmentally benign fishing methods for coral reefs, had in this case a direct link to blast fishing for the provision of bait. Unlike cyanide, which was viewed by many as a relatively new and negative arrival in Banggi communities (of no more than about ten years), blast fishing appeared to be a well-established and accepted way of obtaining bait. The impacts of blasting to supply bait for hook and line fishing is probably less severe than blasting for dried fish due to fewer bombs needed to catch the small quantities of bait required. Fishermen also claimed that it is not necessary to damage the reef when blasting for pelagic species. However, the favoured bait species, Tamban is found around reefs and on the observed fishermen during this assessment attempted to blast target bait fish over very shallow (~2m) reef. A blast observed in similar depths of water near P. Balak damaged 25 m² of coral.

In the absence of any reliable quantitative information on the impact of these three methods, approximate parameters have been used to estimate the highest and lowest possible area of reef impacted from each method over one day. It can be seen from Table 6 that with the current level of understanding it is not possible to say which method is the most damaging.

⁵ One fishermen aboard a Kapal loaded with traps initially related that he was not willing to use illegal fishing methods having spent three months in jail for blast fishing. After talking to the team for some time he disclosed that they used cyanide to catch live fish, the fish traps were never used and that he believed most other Kapals with fish traps did the same.

Table 6 Theoretical estimates of areas of reef disturbed by one day's fishing for live fish with three destructive fishing techniques.

<i>Method</i>	<i>Range</i>	<i>Multiplier</i>	<i>Area of reef disturbed per impact</i>	<i>m² reef damaged fisher⁻¹ day⁻¹</i>
Fish traps	High	30 traps /3days	3m ² /trap	30 m ²
	Low	8 traps / 3days	0.5m ² /trap	1.3 m ²
Cyanide	High	10 fish x 3 squirts	3m ² /squirt	90 m ²
	Low	5 fish x 1 squirt	0.5m ² /squirt	2.5 m ²
Hook and line (with bait from bombing)	High	1 bomb /fisherman	25 m ² /blast	25 m ²
	Low	1 bomb /6 fishermen	10 m ² /blast	1.6 m ²

7.4 Mortality of fish

Mortality rates of 2-30% were quoted for fish in grow-out cages and are dependent on the species, condition of the fish and water condition. Kalawi (*P. oligocanthus*) is the most susceptible species, sunoh and tai sing are quite sensitive and maming and kerapu are the most hardy. Several cage managers claimed that fish that are damaged or caught with cyanide are more likely to die and mortality often occurs within the first few days of captivity. Fish are sometimes affected by a parasitic isopod, which infests the nostrils and gills especially in the months of April and May. These infestations can be fatal if severe, although one trader reported that he could treat affected fish by immersing them in fresh water for one minute while one cage owner in Lok Tohog apparently used crushed sea cucumbers to attract the parasites out of the fish. Occasional periods of poor water quality can kill up to 80% of the stock. Pollution is worse for Kudat operators when northerly winds hold water in the bay and one trader moved his grow-out operation from Kudat to Sibogo because of poor water quality.

Mortality also occurs during transport or in the hold during Kapal trips, especially in rough weather or when the vessel is stationary and therefore not flushing fresh water through the live fish hold. Mortality per Kapal trip or during transport was estimated at 10-30%.

8. Stakeholder knowledge and perceptions

8.1 Knowledge of spawning behaviour

Fishermen were asked during five focus groups whether they ever saw spawning aggregations (*mullak* in Ubian) of the LRFT species. All groups confirmed that they were aware of aggregations, although several known aggregations had ceased to exist. Table 6 summarises the information offered on spawning aggregations. Although some fishermen remembered aggregations of maming, none of the interviewees believed that they still occurred in Banggi. Some fishermen suggested that

aggregations of maming could still be seen in the Philippines. Sunoh aggregations appear to persist at several sites in Balambangan from May to July although the known aggregation in Dogoton has been eradicated by unsustainable fishing pressure. It is unclear whether sunoh aggregations still persist in Sibeliu reef or Malawali.

The important points from these descriptions are that fishermen are aware of and actively target spawning aggregations and that several (especially maming) have already been extinguished.

Table 6. Information on spawning aggregations of LRFT species seen by fishermen from five focus groups in Banggi

Fish	Focus Group	Location	Timing	Last seen	Notes
Kut kut (<i>Epinephelus</i> spp)	Batu Sirih	P. Tiga	Feb-Mar	This year	Can catch 150 kg
	Lumais	Balambangan	Dec	Last year	
	Sibogo		April	?	
Maming (<i>C. undulatus</i>)	Lumais	P. Tiga	March	1994	
	Dogoton	P. Latoan	July	1990s	
	Lok Tohog	P. Lankayan & P. Bilean	?	1980s	2-3 fish
Sunoh (<i>P. leopardus</i>)	Lumais	Sorok (Balambangan)	Jun-Jul	This year	2-3 days only
	Lok Tohog	Balambangan	May	This year	Lasts ~15 days
	Batu Sirih	P. Kalutan (Balambangan)	May-Jun	This year	20-30 fish
	Dogoton	Rock nr Dogoton	?	1990s	“rock is now dead due to lots of cyanide fishing”
	Sibogo	Sibeliu	April	?	

8.2 Perceptions of stock declines and management

8.2.1 Risk of extinction

As described above, focus groups agreed that stocks were declining so fishers were asked whether fish species could become extinct, which species could become extinct and their views on extinction of fish species.

Initial reactions from fishermen were (realistically) that reef fish in general will never completely run out. Some qualified this with examples of species that they felt would always be available (*ikan batu* and *sulig*). Several groups suggested that kubing may be vulnerable to extinction because of its low abundance and high value. Other than kubing, fishers generally believed that other important LRFT species like maming and sunoh could not become extinct. The most often cited reason was that fish will breed and that individual fish can produce thousands of eggs. When questioned about the implications of reduced numbers of large fish (*Maybe there are no more mother and father fish?*) there were several reactions. Most believed that all the large fish could not be caught for several reasons:

- Weather and lack of water clarity often prevented fishing.
- When fishing e.g. with cyanide, they may well not see individual fish.
- They do not manage to catch all the fish that they see. “Sometimes we see 3 fishes but only manage to catch 2. The third will be able to breed.”
- Deep reefs exist, which are difficult to fish and where large fish remain.
- A belief that some large, intelligent fish that lived in deep places could never be caught.

Some fishers also maintained that large fish were not necessary to sustain the population. Species of sunoh had been seen to have eggs at sizes of 200-400g and one Lok Tohog fisherman related that he believed that old fish were not important because of the observation that young chickens produce more eggs than old individuals. On another occasion it was pointed out that it was no problem to catch the old fish as they were going to die anyway (like old people). No stakeholders spoken to knew that the target species were sequential hermaphrodites (change sex with age). One fisher in Lok Tohog and one in Sibogo felt that larger fish were males but was unsure of the reasons for this.

The natural seasonality of the fishery was also perceived by some as important for the sustainability of stocks. During the season when it is easy to catch sunoh a large proportion of the stock are harvested. Then, during the difficult season the remaining fish have the opportunity to breed and replenish their numbers for the next fishing season. Finally, the religious view was expressed by some individuals that God will not allow sunoh to become extinct as he will ensure that the villagers are provided with an income. The observation that cuttlefish are easy to catch when catching live fish is difficult enforced this belief that God manipulates the sea to provide for the local people.

8.2.2 Reasons for stock declines

Several different reasons were given when fishers were asked why there were less fish than before and discussions usually led to a consensus that several interacting factors have contributed to stock declines. These included:

- High levels of fishing effort (i.e. many fishermen)
- Increased catching efficiency due to new technologies (i.e. easy to catch or find fish) including the use of sodium cyanide, diving compressors, echo sounders and GPS.
- Disruption of fish habitats by destructive fishing methodologies including sodium cyanide, fish bombs, and trawlers
- The indiscriminate killing of small fish, by trawlers, purse seiners and fish bombing, which are necessary as food, or juveniles of target species.
- The loss of previously unfished sanctuaries where fish can escape capture in order to grow and breed.

Increased numbers of fishermen trying to catch LRFT species, was the commonest and most obvious reason given. Several fishers pointed out that fishing effort had increased in the early 1990s as a result of the extremely high value of the fish, which attracted individuals or ethnic groups who had not traditionally fished for live reef fish

to join the fishery. A typical response was: “*everybody is catching live fish now.*” Villagers in Batu Sirih, Malawali and Dogoton blamed large numbers of fishers from other communities or even the Philippines for the unsustainable level of fishing effort and often claimed that outsiders used more unsustainable practices like cyanide fishing.

Increased fishing effort is observed to be more of a problem in conjunction with new, efficient fishing technologies like the use of sodium cyanide, diving compressors, echo sounders and GPS to add even more pressure on resources.

Sodium cyanide, fish bombing and trawlers fishing illegally close to the shore were cited as responsible for breaking or killing coral thus destroying the fish habitat. Most communities were well aware that cyanide was poisonous to corals and one fisherman explained that a coral would start to bleach only twenty minutes after being exposed to cyanide. Other fishers claimed that cyanide was not immediately fatal to coral but that repeated use in the same area could result in the death of large areas of reef. Several individuals explained that the coral was not suitable as fish habitat once it had been killed *if the slime is removed from the coral the sunoh cannot go inside*. One village elder rhetorically asked: *If house has no roof, no floor, no wall, only posts. Who wants to live there?*

There appeared to be a reluctance to blame bomb fishing as a major contributor to declining fish yields, perhaps because blasting is still seen as necessary to catch bait. Some fishers pointed out that fish declines have only been seen recently whereas bombs have always been used. It was also pointed out that bombing for bait does not necessarily break the corals if midwater shoals of baitfish are targeted and one bomb fisher claimed that the broken corals frequently observed in the region were the result of storm damage not blast fishing. Despite these views, most focus groups did come to the conclusion that fish bombing was partly responsible for the decline of the habitat and killing small fish.

Complaints against trawlers and purse seiners were particularly acute in communities on the Western shore of Banggi and in Balambangan although when asked, all fishers agreed that trawlers were a problem. Apparently vessels frequently encroach within the legal limit of 3 miles from land at night when no patrols are around. Complaints have been made to the authorities but this is perceived to have an insignificant and temporary effect. This has created a feeling of powerlessness and apathy towards reporting. Most fishers agreed that trawlers could directly capture reef fish but there was some debate as to whether purse seiners were capable of attracting and capturing LRFT species.

An observation by some fishermen and especially the headman of Tanjung Malawali was that deep or distant reefs, which they were traditionally unable to fish may have been crucial breeding sanctuaries for the replenishment of exploited shallow, nearshore populations. These are now no longer protected as they can be easily found using echo-sounders, relocated using GPS and fished out using diving compressors, perhaps with cyanide.

9. Priorities and opportunities for improved management of the trade

9.1 Information collection

The data on catches currently available are not of a high enough quality or resolution to determine the status or dynamics of fish stocks. The use of various different gears to exploit different stocks in different locations confuses the picture. Stakeholders' interviews indicate there is a serious problem of declining stocks so more detailed data is needed to assess this decline, preferably with identification and comparison of fish from different source areas.

Centralisation of the fishery around Kudat and KK will help with this data collection. Extensive use of detailed receipt books at all levels of the trade is a good opportunity for data collection if the cooperation of traders is forthcoming. There will be difficulty trusting data if traders believe it is in their interests to lie. Perhaps NGOs could assist with research as research is best not conducted by a law-enforcement agency.

9.2 Protection of Fish Stocks

Although overall catches have been maintained according to gross figures, stakeholders indicate that individual fish populations are declining due to very high numbers of fishermen. A reduction of fishing effort appears to be warranted but this could have serious economic impacts on coastal communities in Banggi (and probably other regions) due to the very wide involvement in the trade as a primary income source.

9.2.1 Vulnerable species

According to stakeholders, the numbers of maming have declined and spawning aggregations have ceased. Large adults are now absent or very rare and most fish caught are immature. The species is biologically vulnerable to overexploitation due to its large size and life history. Therefore, maming may warrant an export ban to prevent local extinction. Although maming is the most valuable species in the trade, the economic impact of a successful ban may be less significant for Malaysian fishing communities than might be expected because a) it is already sufficiently scarce to be rarely caught using legal methods, b) much of the supply appears to come from Philippine reefs and c) many of the fish caught are undersized, being worth only RM7-10/kg rather than the full RM65/kg for "size" fish. Kubing may warrant similar attention due to its equally high value and extreme rarity.

9.2.2 Protected areas

Several points raised during this assessment support protected areas as a strategy for managing fish stocks.

- Traditionally unfished areas have been lost as sanctuaries due to technological advances allowing them to be fully exploited
- Mean fish sizes are declining with the risk of reduced reproductive output or disrupted sex ratios

- Spawning aggregations are targeted by fishers and many have already ceased due to fishing pressure and habitat destruction.

The effective establishment of a network of totally protected areas could partially compensate for the loss of deep sanctuaries, allowing some fish to grow to large sizes. This would be beneficial because large fish produce disproportionately large numbers of eggs and sex ratios would be maintained in the case of sequential hermaphrodites (species which changes sex with growth).

The location of protected areas at spawning sites would prevent disturbance of spawning activities and prevent the rapid removal of large proportions of the mature fish population at one time.

When questioned, villagers agreed that a sanctuary to allow fish to breed was a good idea but felt that enforcement of the area against outsiders would be difficult or impossible, especially at night. Fishermen in Dogoton had heard of an attempt to establish a marine protected area in Palawan which was unsuccessful because of an inability to enforce it. Substantial support in policing would be needed for any protected area to be successful. The presence of extra fisheries, military or police personnel may be unpopular in communities where locals were involved in illegal activities like blast fishing. However several villages already have a permanent presence of army or PGA units (e.g. Tanjung Malawali, Batu Sirih, Karakit, Dogoton) which could perhaps be given a mandate to assist with surveillance and enforcement of any protected zones.

9.2.3 Size restrictions

Several stakeholders expressed concern about the number of small fish being caught. Undersize are worth a fraction of “size” fish over 400g (e.g. Sunoh kecil is worth 7 rather than RM41) so that fishermen lose out on the premium for live fish by catching them while small. For example a sunoh merah of 200g would be worth about RM1.40 whereas on reaching 400g several months later it would be worth RM16.40. Although there are no data available on growth rates of these species in the wild or natural mortality rates at different sizes, it would appear to make economic sense to allow fish to attain “size” wild. Currently a “tragedy of the commons” situation exists so that any individual fisherman is rewarded by catching small fish even if he believes it would be better to let it grow. Several fishermen expressed this by saying that: *if I don't catch the undersized fish someone else will*. A ban on keeping or selling wild-caught undersized fish could be enforced simply by inspecting cages regularly and could reduce the demand for small fish. The initial economic impact on a ban would be limited as the proportion of fishermen's income earned from undersized fish is small because of their low value. For example, from the receipts collected from the three fish cages in Banggi, only 6%, 4% and 3% of the value of the catch was from undersized sunoh, kubing and maming (i.e. those more valuable fish for which an undersize category exists). It would be hoped that the long-term economic effect of an effective ban on fishermen's incomes would be positive due to the higher proportions of fish caught at larger sizes. However in practice, even if no market is available for undersized fish, it is questionable whether fishermen would actually release undersized fish that they caught rather than just keep them for their own consumption.

9.3 Mitigation of impacts of fishing gears

9.3.1 Traps

Trap fishing (*bubu*) as it is currently practised can disturb considerable areas of corals around each trap. It can also be wasteful in that small low-value fish species are also caught. Experiments have shown that large groupers can be caught with non-camouflaged traps but further trials would be necessary to demonstrate that they work effectively before fishermen will be willing to change from the established method. Larger mesh sizes on the traps could be used to reduce the capture of undersized fish. Trials of the effects of changes in mesh type would have to be conducted and then if effective, alternative large-mesh netting made available to fishermen at competitive prices.

9.3.2 Bait supplies for hook and line fishermen

Blast-fishing is used in Banggi for the provision of bait for hook and line fishing and to provide feed for caged fish (as well as for subsistence fishing and commercial fishing for the production of dried-salted fish, *ikan masin*). A combination of continued surveillance and enforcement against blasting and the provision of alternative supplies would persuade fishermen to stop the practice. Possible sources could include the establishment of a trade (perhaps subsidised) between Kudat and the kampongs to deliver and sell fish caught by Kudat-based purse seine vessels or directly from the purse seiners, which often fish within a few miles of the kampongs. Alternatively, villagers could be provided with materials and training to catch baitfish by traditional lift-net traps (*bagan*) or by gill net around fish aggregating devices on site. To compete with bombing, any alternative source of bait would need to be cheap, reliably available and good quality. This was discussed with one villager in Karakit who thought that fishermen would buy bait at RM1/kg but that at RM2/kg it would still be more attractive to use a fish-bomb. The supply of small fish from purse seiners and *bagan* are interrupted by periods when the moon is bright as the lamps used to attract the fish are ineffective. Storage facilities for bait would help to maintain the supply of bait during these periods. Ice and salt are currently used to preserve bait successfully for only about 4-5 days so freezer facilities may be necessary to provide a reliable supply over longer periods.

9.4 Reduction in the use of cyanide

It appears that some fishermen do not use cyanide to catch live fish and that many fishermen who use cyanide also sometimes use traps or hook and line to fish. This readiness to switch between methods, along with the understanding of the negative effects of cyanide demonstrated by fishermen in focus groups may facilitate attempts to change fishermen's behaviour away from the use of cyanide. Table 7 shows an attempt to examine the factors that may influence a live-fish fisherman's choice of gears. As some fishermen are already choosing to use methods other than cyanide, it should be possible to encourage more to make the same decision by adjusting these factors. Initiatives which may have this effect are also listed.

Table 7. Factors affecting choice of gear for live-fish fishermen and how they can be manipulated by interventions. Arrow bullets indicate factors that can be affected by management.

Method	Incentives	Disincentives
Hook and line	<ul style="list-style-type: none"> • Ability to easily fish deep reefs • Comfortable (no need to dive) ➤ High quality fish ^a 	<ul style="list-style-type: none"> • Requirement for bait ^b • Unreliable catches ➤ Skill required ^c
Cyanide	<ul style="list-style-type: none"> • Easy (very likely to catch any fish seen) ➤ Ability to select high value species not easily caught by other methods e.g. maming ^d 	<ul style="list-style-type: none"> ➤ Risk of capture and prosecution ^e • Requirement for clear water • Health impacts from contact with cyanide ^f ➤ Cost of cyanide purchase ^g ➤ Environmental costs ^h
Traps	<ul style="list-style-type: none"> • Only short time spent at sea • Can provide cover for use of cyanide 	<ul style="list-style-type: none"> • Risk of loss of traps ➤ High capital cost for traps ⁱ

How interventions can affect incentives/disincentives

^a Support incentives which provide a price premium for high quality cyanide-free fish e.g. cyanide testing and certification

^b Develop infrastructure and systems to provide reliable source of bait for fishermen (e.g. fish traps or FADs in remote villages, transport vessels from Kudat, bait freezing facilities)

^c Training workshops on hook and line capture and decompression of LRFT species.

^d Ban on export of rare, high value species targeted by cyanide (maming)

^e Increased surveillance and publicity of penalties

^f Research and education on health effects for fishers

^g Increased surveillance of trade from Philippines and retailers Kudat, perhaps with international cooperation to stem the supply of cyanide and increase the retail cost of cyanide

^h Research and education on effects of cyanide fishing on reefs

ⁱ Grants for purchase of traps

In reviewing methodologies in this way, it must be appreciated that other livelihoods not related to the LRFT will be available to fishermen so that the whole system needs to be taken into account. For example, if cyanide was not available, cyanide fishermen may switch to fish bombing for dried fish rather than using hook and line for the LRFT.

Although some fishers may be accustomed to switching fishing gears there is also likely to be a “hard-core” of accustomed cyanide users who will be more reluctant to change their habits and are not skilled at catching LRFT species with hook and line.

If cost effective and reliable cyanide testing of fish could be introduced in Sabah it would have the double benefit of acting at the high levels of the trade to deter cyanide use and allowing the extent of the problem to be estimated and the success of anti-cyanide strategies to be evaluated. Any programme of cyanide testing would have to be flexible and unpredictable so that it was not possible to avoid testing by landing shipments at particular times or places.

10. Recommendations

The results of this assessment suggest that the following actions would contribute towards the aim of a sustainable live-reef fish trade in the Kudat region.

- Data collection
 - Collection of more detailed catch data by species, source area and type of operation to allow the status of the different fisheries which make up the trade to be established.
 - Appeal to traders to allow access to records to see trends in supply volumes, species and sizes. Long-term records from Banggi cages would be particularly useful to examine the status of nearshore stocks in one location.
- Prohibition of the export of maming (*Cheilinus undulatus*) from Sabah to prevent local extinction of this species and reduce the incentives for fishermen to use cyanide fishing.
- Development of bait supplies and storage capacity for hook and line fishers in remote villages.
- Support for individuals and communities already trying to establish sanctuary areas with logistical and legislative backup to create fully-protected marine reserves wherever possible encompassing active spawning aggregation sites.
- Experiments with trap designs and deployment strategies to identify whether less damaging techniques are economically viable.
- Stronger enforcement against cyanide trading and use, especially the supply chain from the Philippines and in Kudat.
- Investigation of cyanide detection technologies available with the aim of initiating a cyanide testing programme with *random* inspection and testing of cages and vessels and certification of cyanide-free shipments.
- Work with fishing communities to educate them in the ecological and health risks of cyanide fishing, the reproductive ecology of commercially important fish, the case for marine protected areas and sustainable catching technologies. Also work to learn ideas and feedback on existing intervention and fishers' knowledge of stock conditions and spawning sites.

Appendix 1 – Summary Statistics from Fisherman interviews Grouped by Study Site

Kampong	Location	Nos. Interviews	Nos. selling Live fish	Year started LRFT		Avg. % income from LRFT	Avg % perceived yield reduction (yr ⁻¹)	Vessels used for catching fish			
				Earliest	Average			Canoe	Pump-Boat	Outboard	Kapal
Batu Sirih	Balambangan	12	7 (58%)	1975	1991	40%	14%	2 (17%)	8 (67%)	0	1 (8%)
Lumais	W. Banggi	8	8 (100%)	1982	1989	88%	9%	0	7 (88%)	1 (13%)	0
Lok Tohog	W. Banggi	22	21 (95%)	1972	1989	84%	15%	1 (5%)	10 (45%)	1 (5%)	12 (55%)
Kobong Laut	W. Banggi	8	7 (88%)	1977	1989	73%	13%	0	8 (100%)	0%	2 (25%)
Molleangan	Molleangan	4	4 (100%)	1975	1984	80%	10%	1 (25%)	4 (100%)	0%	0
Singgamata Hujung	S. Banggi	4	4 (100%)	1980	1992	59%	13%	0	4 (100%)	0%	0
Singgamata	S. Banggi	6	6 (100%)	1982	1989	81%	11%	0	6 (100%)	0%	2 (33%)
Perpaduan	S. Banggi	9	9 (100%)	1982	1990	60%	11%	0	9 (100%)	0%	3 (33%)
Indalupi	S. Banggi	6	5 (83%)	1989	1995	57%	12%	0	2 (33%)	0	5 (83%)
Keligau	S. Banggi	3	0	-	-	0%	14%	0	2 (67%)	1 (33%)	1 (33%)
Korosong	S. Banggi	3	2 (67%)	1982	1984	90%	15%	0	3 (100%)	0%	0
Laksian	S. Banggi	4	3 (75%)	1990	1994	25%	14%	0	4 (100%)	0%	0
Tanjung Malawali	Malawali	5	5 (100%)	1970	1986	76%	10%	1 (20%)	3 (60%)	0%	2 (40%)
Sibogo	E. Banggi	7	7 (100%)	1972	1987	71%	12%	0	6 (86%)	0%	2 (29%)
Dogoton	NE Banggi	8	8 (100%)	1984	1993	72%	7%	0	6 (75%)	0	1 (13%)
Tanjung Kapur	Kudat	10	10 (100%)	1972	1986	81%	11%	2 (20%)	5 (50%)	0%	3 (30%)
Total		119	106 (89%)	1970	1989	68%	12%	7 (6%)	87 (73%)	3 (3%)	34 (29%)

Appendix 2 – Ethnic and age structure of interviewees

Ethnic Group	Age group								Total
	11-20	21-30	31-40	41-50	51-60	61-70	71-80	Unknown	
Ubian	3	22	22	23	10	3	2	13	98
Suluk		3	1	1	1				6
Cagayan		4	6	1					11
Balabac			1						1
Bajau			2		1				3
Total	3	29	32	25	12	3	2	13	119

Appendix 3 – Fisherman Questionnaire questions

- | | |
|--|--|
| 1. When did you first sell live fish? | 1. Bilakah kamu start jual ikan hidup? |
| 2. What kind of boat do you use to catch live fish? | 2. Apa jenis bot yang kamu pakai untuk tankap ikan hidup? |
| a. Canoe | a. Dayung |
| b. Pump boat | b. Pumbot |
| c. Kapal | c. Kapal |
| d. Use pump boat from mother vessel | d. Ikut kapal dengan pumbot |
| e. Use canoe from mother vessel | e. Ikut kapal dengan dayung |
| 3. Who does the boat belong to? | 3. Siapa punya bot itu? |
| 4. How many people fish from the boat? | 4. Berapa orang dalam bot? |
| 5. How often do you go to sea per week/month? | 5. Berapa kali turun ke laut dalam satu minnggu/bulan? |
| 6. How long do you spend at sea? | 6. Berapa lama di laut? |
| 7. Where are live fish caught from? | 7. Di mana tankap ikan |
| 8. Do you use a compressor? | 8. Kamu pakai kompressorkah? |
| a. How deep? | a. Berapa dalam? |
| b. For how long? | b. Berapa lama? |
| 9. How much live fish can you catch per week/trip now? | 9. Berapa banyak ikan hidup kamu dapat tankap dalam satu minggu/trip sekarang? |
| 10. How much live fish could you catch per week/trip 5 years ago? (1997) | 10. Berapa banyak kamu dapat tankap dalam satu minggu/trip lima tahun dulu? (tahun sembilan puluh tujuh) |
| 11. (If less fish) In your opinion, why are there less fish now? | 11. (Kalau kurang) Rasa kamu, kenapa ada kurang ikan sekarang? |
| 12. Do you have another income other than selling live fish? | 12. Selain daripada jual ikan hidup, kamu ada pendapatan lain? |

13. How much do you earn from
 - a. Selling live fish?
 - b. Selling dead fish?
 - c. Other income?
15. Who do you sell your live fish to?
16. What is your name?
17. What ethnic group are you from?
18. How old are you?

14. Berapa banyak kamu dapat dari
 - a. Jual ikan hidup?
 - b. Jual ikan mati?
 - c. Lain lain?
13. Dengan siapa kamu jual ikan hidup?
14. Siapa nama kamu?
15. Apa bangsa kamu?
16. Berapa umur?

Appendix 4 – Local names for common target species

Commonly used local name (used in this study)	Other names collected	FAO English Name	Species
Maming	Mamin, Mameng Ikan licin (lge adults) Lankawit (lge adults)	Humphead wrasse	<i>Cheilinus undulatus</i>
Kubing	Kerapu tikus	Humpbacked grouper	<i>Cromileptes altivelis</i>
Katumbang		Blubberlip snapper	<i>Lutjanus rivulatus</i>
Tai sing	Sunoh bunga Sunoh	Spotted coralgroup	<i>Plectropomus maculatus</i>
Pamantan	Tai sing Sunoh batang Kalawi pamantan Sunoh mantis (yellow morph) Batang soka (dark morph)	Blacksaddled coralgroup	<i>Plectropomus laevis</i>
Kerapu	Kuhotong, Korotong, Kuatong Kohatong sahanay (w/yell fins)	Giant grouper	<i>Epinephelus lanceolatus</i>
	Tiger garupa Kerapu tiger Kerapu merah Kerapu petak	Brown-marbled grouper	<i>Epinephelus fuscoguttatus</i>
	Kuapo abu Kerapu kelabu	Malabar grouper	<i>Epinephelus malabaricus</i>
	Kuapo pisak	Wavy lined grouper	<i>Epinephelus undulatus</i>
		Camouflage grouper	<i>Epinephelus polyphekadion</i>
Ikan merah	Baan baan	Humpback red snapper	<i>Lutjanus gibbus</i>
	Tabung		
Lamun lamun	Dukan (small)	Blackspot tuskfish	<i>Choerodon schoenleinii</i>
Baguan	Sunoh hitam Chen pen	Squartail coralgroup	<i>Plectropomus areolatus</i>
Sunoh merah	Sunoh Sunoh hitam (dark colour) Sunoh batu (dark colour) Sunoh keat (red) Sunoh negro (black)	Leopard coralgroup	<i>Plectropomus leopardus</i>
Kut kut		Honeycomb grouper	<i>Epinephelus merra</i>
		Longfin grouper	<i>Epinephelus quoyanus</i>
		Hexagon grouper	<i>Epinephelus hexagonatus</i>
Kalawi	Tiger	Highfin coralgroup	<i>Plectropomus oligocanthus</i>

Appendix 5 – Prices of live fish at different markets

Species	class	Price Unit	Piskadul (Lok Tohog foc)	Batu Sirih (foc)	Dogoton (foc)	Lumais (foc)	Kobong (foc)	Lau (foc)	Sibog (rec)	oKaraki (rec)	Kudat pump boat	Kudat cage owner	KK Wholesale	Foc – Prices from a focus group interview
Sunoh merah	size	RM/kg	30-37	35	38	40	42	42	42		43	45-52	65-70	Foc – Prices from a focus group interview
Sunoh merah	osize	RM/pc							50			60-70		
Sunoh merah	small	RM/kg							7	7		12-17	15	Rec – Prices from receipts
Sunoh merah	dead	RM/kg							4				18	
Tai Sing	size	RM/kg	20-27	28	28	30	28	28	30		30	35-38	50	
Tai Sing	osize	RM/kg										60		
Katumbang		RM/kg	20	8	4	20	20		20		20	15	80-100	
Ikan merah		RM/kg			5				5			8		
Maming	size	RM/kg	45-55	50	48	60	65	45	65-70		60	70-75	95-120	
Maming	osize	RM/pc						100					150	
Maming	small	RM/kg						10	7-10			10-20	20	
Lamun Lamun		RM/kg		8	7	5		7	4			7	30-35	
Kubing	size	RM/kg	45-55	50	48	60	65	45			60		120	
Kubing	small	RM/kg						10						
Kut Kut		RM/kg		5	4	3	4	3	4		5	6	15	
Kerapu		RM/kg	7	8		8	7-8	4	7-6		10	8-9	18-35	
Kuhatong		RM/kg					10							
Kalawi		RM/kg		10		10	10	5				14-15	30-35	
Baguan		RM/kg	7-10	10		10	10	10	10		12	15	28-35	
Sunoh Mantis		RM/kg	37	28			28				43		30-35	
Batta		RM/kg		5										
Ikan Batu	dead	RM/kg						1				1-24		
Red&Green Lobster	size	RM/kg						25	25		33	30-37	43	
Red&Green Lobster	small	RM/kg						7	10			10-12		
Flower Lobster	size	RM/kg						60	47-48		60	60-65		
Flower Lobster	small	RM/kg												
Ikan putih	dead	RM/kg						2.5				6		



WWF's mission is to achieve the conservation of nature and ecological processes by:

- Preserving genetic, species and ecosystem diversity;
- Ensuring that the use of renewable natural resources is sustainable both now and in the longer term, for the benefit of all life on earth;
- Promoting actions to reduce, to a minimum, pollution and the wasteful exploitation and consumption of resources and energy;

WWF's ultimate goal is to stop, and eventually to reverse, the accelerating degradation of our planet's natural environment, and to help build a future in which humans live in harmony with nature.

Let's leave our children a living planet!

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