A PRELIMINARY SURVEY OF THE PRAWN TRAWLING INDUSTRY IN SABAH AND ITS NON-COMMERCIAL FISH CATCH

by

P.J.I. Snell
Fisheries Department
Kota Kinabalu
Sabah, Malaysia[1/]

Abstract

Six survey trips were conducted over a one-year period on three commercial trawlers in the Kota Kinabalu area to determine the percentage weight of marketable and unmarketable catch and the approximate composition of the catch. A further survey trip around the entire coast was conducted using Fisheries Department trawlers and the breakdown of the catch into both family and categories of marketable and unmarketable catch was determined. Based on these data and on questionnaires returned by the fishermen, a calculation of the total weight of fish discarded in Sandakan, Sabah's major prawn trawling centre, was made. The data are discussed in relation to the present status of the Sabah trawling industry and the possibility of making greater use of this resource.

INTRODUCTION

The existence of considerable prawn trawler by-catch has been noted in a number of Southeast Asian countries (Campbell, 1975). In view of the considerable importance of the prawn trawling industry to the economy of Sabah, it was decided to conduct an initial study of the amount and composition of this by-catch prior to the investigation of possible uses for this raw material.

THE SABAH PRAWN TRAWLING INDUSTRY

Sabah is situated in the northern part of Borneo, bordering on the Indonesian state of Kalimantan in the south, and has a population of 836 519, which is concentrated primarily in the coastal areas, due to the inaccessibility of the interior. The economy is based on the export of raw materials such as timber, palm oil, cocoa, prawns, copper concentrates and oil.

Trawlers were first introduced in the early 1950s but a rapid increase in trawling activity occured only during the early 1960s with the establishment of the first prawn freezing factories. During 1976, 2 316 tonnes were exported at an estimated total value of M.$ 22 032 262 (U.S.$ 9.3 million). Because the market price for prawns is far higher than the price of the bulk of the fish landed (principally. Dorosomatinal, Leiognathidae, Nemipteridae and Sciaenidae), almost all the trawling effort is directed toward the prawn fishery (Shaari *et al.*, 1976). Since the east coast has long been recognized as the best breeding area for prawns (possibly because of its extensive mangrove swamps), trawlers are concentrated on this coast. The recognized trawling areas around the coast are shown in Figure 1. Details of the number and sizes of licensed trawlers operating from each fishery centre together with estimates of the number of unlicensed trawlers are given in Table 1.

Two types of trawling license are issued; one allows trawling outside the 12-mile limit and the other permits trawling outside 5 fathoms and excludes certain other areas which are believed to be fish breeding grounds or traditional fishing grounds for artisanal fishermen. Fishing regulations, however, have been widely disregarded due to the limited number of policing vessels but, recently, the Fisheries Department has begun to take strong action against offenders and has introduced several new licenses conditions in an attempt to protect in-shore areas.

1/ The paper was written during the author's assignment in Sabah with the U.K. Voluntary Service Overseas (VSO)

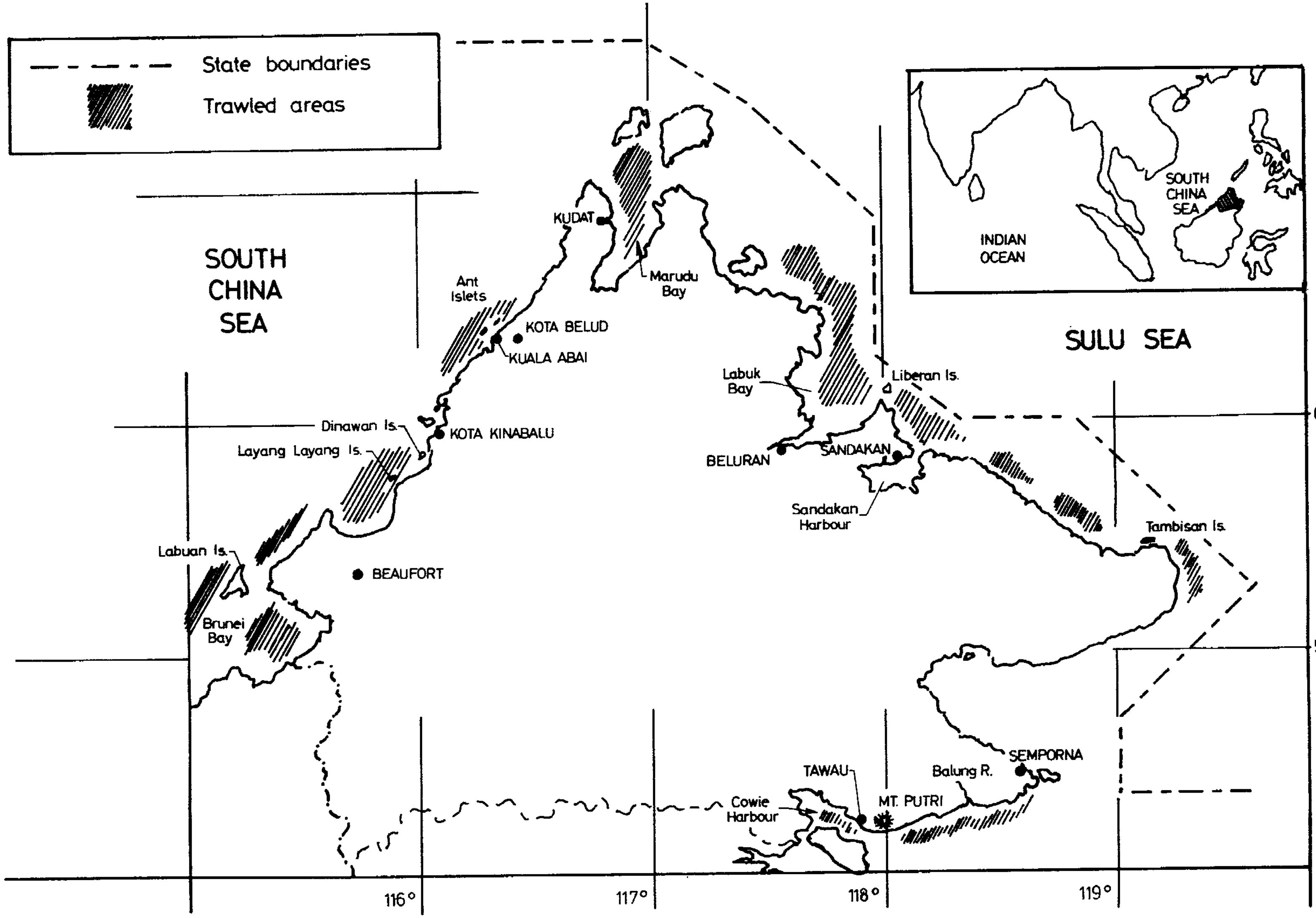

FIG. 1. SABAH - MAJOR TRAWLING AREAS

Table 1

The number of trawlers operating from fishing centres in Sabah in 1976

District(s)	Number of licensed boats a/	Average engine horse power b/	Number of unlicensed boats c/	Average engine horse power c/	Remarks
Tawau	68	52	19	12	Horse power figure for licensed boats based on figures for 28 boats only
Semporna	8	Not available	–	–	
Sandakan	174	79	230	20	Horse power figure for licensed boats on figures for Sandakan and Beluran
Beluran	31	79	300	20	Horse power figure for licensed boats on figures for Sandakan and Beluran
Kudat	12	50	6	20	
Kota Kinabalu and Kota Belud	41	69	8	20	Horse power figure for licensed boats based on figures for 10 boats only
Beaufort	16	Not	10	20	
Labuan	10		–	–	Licensed boats not operating during 1978

a/ Draft of Fisheries Department Annual Report, 1976

b/ Records of licensing officers

c/ For the east coast estimates of local fisheries officers were used (after consultation with local fishermen)
For the west coast and Murudu Bay estimates by the author are given

Although no figures are available on the different forms of trawler ownership, it is believed that the majority of boats are owned by the skipper. If the owner is not present on the boat, the crew will often sell the prawn catch and not declare the full proceeds to the owner. Although bones schemes have been used successfully by fleet owners on the west coast, these are less effective on the east coast where a number of prawn freezing factories are competing for the catch.

Due to the heavy emphasis on prawn trawling, most trawling gear is designed primarily for prawns as described by Chin and Goh (1967) and the trawlers may be either single or double rigged. There is, however, a limited number of trawlers of Peninsular Malaysian origin, which are designed for catching fish.

On-shore facilities vary widely and depend on the location of the prawn freezing factories. At the wharves of prawn freezing factories in Sandakan, Tawau and Labuan, trawlers are able to moor and obtain various supplies including crushed ice which is sold at M.$ 2.00 per 100 lb (U.S.$ 0.84 per 45 kg). However, in areas such as Kota Kinabalu, where the freezing factories are not close to the sea, there are often no suitable wharves and uncrushed ice may coast as much as M.$ 5.00 per 100 lb (U.S.$ 2.11 per 45 kg). Unless landing facilities and cheap ice are available, fishermen will often use insufficient ice and deliver their fish catch to various minor centres. The fish markets have limited cold store facilities and the catch stored overnight by fishmongers is relatively small. Medium-sized businesses freeze some of the larger fish for export but the value of this export is far lower than that of prawns.

The prawn trawler by-catch

The heavy fishing for prawns provides a large catch of the more common demersal fish. When trawling was first introduced, one condition of the trawling license was that all such fish should be brought to market but, because the smallest fish could not be sold, this condition is no longer enforced. Fish are discarded at sea if they would taint the rest of the catch when stored with them (i.e., Ariidae and Euselachii), if they are considered too small for human consumption (i.e., most species of Leiognathidae and juvenile Nemipteridae and Sciaenidae) or too bony to be acceptable (i.e., Trichiuridae and Synodontidae), or because they are poisonous (i.e., Lagocephalidae).

Although small amounts of fish from the major fish markets are used for animal feed, these are believed to be fairly insignificant. However, in the Kota Kinabalu area, a farmer buys up to 500 kg per day of small fish direct from the fishermen for drying over wood fires and rough milling into fishmeal. The supply of fish is erratic and is believed normally to be considerably less than this. It is not known if any similar operations exist on the east coast.

In addition trawlermen will often keep the unmarketable fish from the last haul of the day and exchange these for fruits with people living in small villages along the coast. Such fish, although unmarketable in urban centres, may be saleable in smaller rural markets.

Although a number of fishermen have made inquiries about buying modern fish meal processing plants only one factory has been built. This has been set up in Tawau with secondhand Taiwanese equipment and is reported to be capable of handing 1500 tonnes of fish per year. It has not, however, started operation.

Few figures exist of the proportion of fish discarded by prawn trawlers. Between 1962 and 1965 survey figures from Fisheries Department vessels, reported by Chin and Goh (1967), indicated that the percentage of unmarketable fish varied between 68.0 and 83.5 percent along the west coast and the percentage of prawns in the catch varied between 1.9 and 45.9 percent. A trawl survey, conducted in 1972 between 5 and 60 nautical miles from the west coast, indicated that the amount of 'trash' fish in the total catch varied between 0.0 and 89.8 percent in each haul whist there was 44.1 percent 'trash' fish in the total catch (shaari *et al.*, 1976). Neither survey gave a species breakdown of the unmarketable fish catch and it is not known whether the criteria for judging marketability were applicable to the local market since one of the species listed as marketable in the latter survey is never landed by trawlers operating trom Kota Kinabalu. No survey figures existed for trawler catches on the east coast.

Factors affecting the trawler by-catch

The size of fish brought to market by trawlermen will depend on the supply of fish which is in turn affected by the weather, tides and the quality of the fishing grounds. Areas of the east coast, particularly in the Tawau area, are noted for their very strong tides and a number of smaller-engined boats are unable to go out during spring tides or rough weather. Also, it is generally believed that prawn catches are better after heavy rain and during slack tides so the fishing effort is greater during such periods and more larger fish are caught.

The types of fish supplied to market will vary with consumer preferences which often differ for the various ethnic groups. Ariidae, which are not very bony but have a 'muddy' taste, are acceptable for the curry dishes of non-Chinese races but are not liked by the Chinese who predominate in urban areas. Since they will taint other fish when stored with them, trawlers operating from urban centres will not normally bring any of these fish back to port. In addition, because of the greater affluence of consumers in urban areas, fish which could be sold at rural markets such as the weekend markets in Tuaran and Kota Belud would be considered too small by consumers in Kota Kinabalu.

SURVEY METHODS

Since it was not possible to accompany commercial trawlers from all the major trawling centres in the state, it was decided to concentrate on three commercial trawlers based in Kota Kinabalu and, subsequently, to conduct a survey of commercially fished trawling grounds using Fisheries Department trawlers around the entire coast.

As it was not practicable to sort catches on boats of less than 10 m in length, the initial survey was conducted on three relatively large trawlers. The first (boat 1) was a double-rigged 15.5 m trawler, owned by the Fisheries Cooperative in Kota Belud and the crew was paid on a flat rate weekly basis. The second (boat 2) was a 14.5 m single-rigged trawler; the skipper was paid a generous bonus based on prawn catch. Both of these trawlers were permitted to fish within the 12-mile limit. The last trawler (boat 3) was 14 m long and had been brought from Penang by its skipper/owner. It was designed for catching fish and its license permitted trawling only outside the 12-mile limit.

Six survey trips were made at intervals of approximately two months so that two trips were made on each trawler at approximately six-monthly intervals. No attempt was made to influence the choice of trawling ground for each trip and the crew was allowed to sort out the marketable fish and prawns from each haul. Then the remaining catch was weighed and a small sample retained for sorting by family on deck. The weight of each family in the sample was recorded and the total weight of each family in the haul was estimated from the percentage breakdown of the sample. The fish were identified using a simple guide of Shaari (1971) and their identification was checked in Kota Kinabalu using the more exhaustive keys of Fischer and Whitehead (1974) and Weber and de Beaufort (1911). The total weights of various categories of marketable catch were measured at the end of the trawling trip and recorded.

It was not possible to use one Fisheries Department vessel for the round coast survey since the boats were either unfit for long trips or were in great demand by other officers. Five trawls of one-hour duration were conducted in each of nine major trawling grounds around the coasts at depths of between 6 and 40 m. All trawlers were single-rigged and the nets had been constructed by Fisheries Department staff apart from one (FF6) which had been made commercially in Sandakan. A line to depth ratio of 5:1 was used for all trawls, this being the ratio used by nearly all commercial trawlers in Sabah. The entire catch was classified, wherever possible, by family and into marketable/unmarketable for each family; the weights of each classification were recorded. This classification into marketable and unmarketable fish was made according to an average subjective standard based on that used by the three commercial trawlers in the first survey. In a few cases it was impracticable to sort the entire catch; the unsorted fish were weighed and discarded. The percentage breakdown of the total haul was then estimated from the catch which was sorted. Identification of the fish was carried out on deck using two keys of Fischer and Whitehead (1974) and Shaari (1971).

No accurate calculation of annual trawler fish catches is made by the Fisheries Department because of the large number of unlicensed trawlers and the inaccuracy of the statistical returns by fishermen. A questionnaire was therefore sent to each licensed trawler owner in the state requesting details of the number of hours trawled in each month, from July 1976 to June 1977 inclusive, and the weight of fish sold on the fish market in each month. It was thought that this questionnaire, which was far simpler than the normal departmental form and did not inquire about the prawn catch which is of much higher value, might be answered more accurately by fishermen.

SURVEY RESULTS

Commercial trawlers

The results of the initial survey in the Kota Kinabalu area are shown in Table 2 and Table 3. Both trips on boat 3 were conducted over a single night since this boat had no wharf at which to moor and so had difficulty obtaining ice. For this reason Ariidae and sharks could be stored on deck without danger of tainting the remainder of the catch.

The sample of catch was sorted into the most common families present; small quantities of other families were classified as 'remainder'. However, after two survey trips it was noted that Ariidae, flatfish (var.), Leiognathidae, Nemipteridae, Pomadasyidae, Sciaenidae, Synodontidae and Trichiuridae were present in large quantities and, to ensure that accurate total weights were measured, they were weighed even when present in very small amounts. The weights of other families continued to be taken only if present in large amounts within a haul; the total catch weight for such families during a trawling trip may therefore be slightly inaccurate.

Fisheries Department trawlers

The results of the round coast survey are shown in Tables 4, 5 and 6. The breakdown of the non-fish catch has not been given since it would be misleading. Commercial trawlers normally carry out a series of trial trawls until a school of prawns is located and then trawl repeatedly over them. However, during this survey the widest possible area was covered and the catch of prawns would not therefore be typical of commercial operations. The high non-fish catch in the three areas close to Sandakan was principally composed of crabs (var.) but in the area south of Sandakan Harbour a large number of shovel-nosed lobsters (Scyllaridae) were also caught.

In most areas it was possible to sort the entire catch. However, it was necessary to restrict sorting to a section of the catch in the following areas: Murudu Bay (28.3 percent), Labuk Bay (67.3 percent), Tambisan Island to Sandakan Harbour (77.0 percent) and Cowie Harbour (76.7 percent) (the figures in brackets denote the percentage of catch which was sorted).

Questionnaires

The number of correctly completed questionnaires returned was 103. Since Sandakan is the major prawn centre and returned 51 of the questionnaires, it was decided to estimate the annual weight of by-catch in this area. Assuming a binomial distribution of the percentage breakdown of fish into marketable and unmarketable categories, it was found that there were no significant differences between the three fishing areas near Sandakan which were surveyed (Tambisan Island to Sandakan Harbour, Sandakan Harbour to Libaran Island and Labuk Bay). The total percentage breakdown of fish into marketable and unmarketable categories was 6.5 and 93.5 percent respectively. To give a conservative estimate of the percentage of fish discarded, the percentage figure of unmarketable fish was reduced by three standard deviations to 87 percent.

Linear regression analysis of the hourly catch rates calculated from the returned statistics initially gave a low correlation coefficient. However, it was noted that one company which sent in returns for seven trawlers consistently reported a lower catch rate than the other owners. Linear regression of returns of the other 44 boats for engine horse power against hourly catch rate in pikuls/h gave a best fit straight line which almost passed through the origin, had a slope of 9.97×10^{4} and a correlation coefficient of 0.593. The average number of hours trawling per year for all boats in Sandakan and Beluran was assumed to be the same as for these 44 boats (1 214 h/year) and the total landings of marketable fish were calculated from the figure for numbers of trawlers and trawler horse power given in Table 1 using the relationship: hourly catch rate (pikuls/h) = Boat engine horse power x 10^{-3}

The annual catch of marketable fish by Sandakan and Beluran trawlers was estimated at 1 967 tonnes/ year and, therefore, if 87 percent of the fish caught were unmarketable, 13 165 tonnes of fish were discarded during that period in the Sandakan area.

DISCUSSION

In the survey of commercial boats it was notable that boat 3 brought the largest proportion of fish to market; this may be due to the different net design used. However, the lower overhead costs of one-night trips in which ice is not used and the fact that this boat was owned by the skipper may also have influenced the classification of fish.

In considering the catch breakdown of by-catch on commercial trawlers in the Kota Kinabalu area it should be noted that the method of sorting will have led to some inaccuracy. However, it was impossible to carry out more careful sorting without interfering with normal fishing operations. In spite of this, it was clear that Leiognathidae was the most commonly caught family of unmarketable fish but Ariidae, Nemipteridae, Pomadasyidae and Synodontidae were also present in sizeable quantities. Trichiuridae were occasionally present in very large quantities. Other families present in sufficient quantities in the Kota Kinabalu area to be worthy of further study were Mullidae, flatfish (var.), Platycephalidae and Sciaenidae.

The by-catch in all areas surveyed in the departmental trawlers was high relative to that recorded on the commercial trawlers. However, fishermen claim that at the time of this survey their catches were also very poor. Leiognathidae were present in the largest quantities overall, although only relatively small quantities were found close to Sandakan. Ariidae, Nemipteridae and Synodontidae also formed a significant proportion of the by-catch although in each case they were totally absent in some areas. Pomadasyidae were present in almost all areas but were caught in fairly small quantities, and the catch of Trichiuridae varied widely. Lagocephalidae and Sciaenidae, which had not figured prominently in the earlier surveys on commercial vessels, were found in large quantities in the by-catch in certain areas of the east coast. Other families which were present in sizeable quantities in some areas were Apogonidae, flatfish (var.), Mullidae and rays (var.).

Bearing in mind the differences in trawl speeds and net sizes it would appear that the highest catch rate was obtained in Murudu Bay and the next highest from Kuala Abai to Ant Islets. The survey results for in-shore waters therefore resemble those of Shaari *et al.*, (1976) for waters further off-shore. It is of interest that the catch rates per swept area for the east coast fishing grounds were lower even though these have traditionally been regarded as the best fishing grounds.

Due to the lack of information on the by-catch breakdown for prawn trawlers there are few comparable figures for other countries. Jones (1976) has noted that the percentage of 'trash' fish in commercial trawl landings was 54 percent in Malaysia in 1973, 40 to 50 percent in Thailand in 1974 and between 22 and 33 percent in the Philippines in 1975. Although these figures are lower than those obtained for Sabah it is quite possible that trawlers are discarding large amounts of such fish at sea. Surapon and Montol (1974) report that the catch of 'duck' fish on five trawlers in the Gulf of Thailand varied between 55.4 and 95 percent of the total fish catch. Thai marine fisheries statistics produced by the Department of Fisheries (1972) indicate that *Saurida* spp. and *Trichiurus haumela* are listed separately from 'trash' fish whereas in the Kota Kinabalu area even the largest of these are not taken to market by commercial trawlers. It therefore seems likely that some of the by-catch in Sabah would be marketable for human consumption in countries with a higher population density.

From data available on the composition by family of the trawler by-catch in different countries, the family breakdown in Sabah seems to resemble closely that of Peninsular Malaysia, as reported by Jones (1976). However, there are also many similarities with the occurrence of dominant family 'trash' fish at Kangar fish market in Singapore as reported by the Marine Fisheries Research Department (1975) and the composition of 'duck' fish in Thailand as reported by Sarapon and Montol (1974).

The striking difference between Sabah and other countries would seem to be that no market exists for such fish. Jones (1976) states that throughout the South China Sea "it appears that nothing is too small to land" whilst in Singapore it is reported that there are never any surplus trash fish landed (Marine Fisheries Research Department, 1975). In this context it is important to state that the estimate of fish discarded by boats operating in the Sandakan area, as given above, is thought to be an underestimate for two reasons. Firstly, statistical returns from trawler owners often give an unrealistically low report of the catch and, for this reason, large correction factors have to be computed when estimating the annual prawn catch for departmental statistics. Secondly the author believes that the estimate of unmarketable catch made during the round coast survey was conservative by commercial standards and yet, in the calculations, it has been assumed to be too generous.

Therefore, there would appear to be a large unutilized resource of fish in Sabah. It seems likely that, with cheaper trawler overhead costs for such commodities as ice, and with better marketing facilities, a certain amount of this resource could be sold in less affluent rural areas even if it were not acceptable to consumers in urban areas. Also, it might be possible to export certain species which are not acceptable to consumers in Sabah, although this may not be economic. Alternatively, if there are facilities for the production of animal feeds, such as fishmeal and fish silage, this may encourage the trawlermen to land otherwise unmarketable fish. However, the operator of the simple fishmeal plant in Kota Kinabalu reports that trawler operators are reluctant to land their by-catch for his price of M.$ 7.00 per pikul (U.S.$ 3.00 per 60 kg) and it is possible that, since prawns provide such a good return to the fishermen, there will be little interest in less profitable outlets for their catch.

The development of meat/bone separators has opened up the possibility of using species of unmarketable fish for making minced products. Since the use of the by-catch for human consumption in a processed state would probably give a larger return to trawlermen than its use for animal feeds, the development of widely acceptable products from separated minced flesh is of great importance to the trawling industry in Sabah.

CONCLUSION

The percentage of unmarketable fish in the catch on six trips of commercial trawlers operating out of Kota Kinabalu, Sabah, was found to vary between 58.7 and 79.4 percent. Ariidae, Leiognathidae, Nemipteridae, Pomadasyidae and Synodontidae were found to predominate within the by-catch of fish. A subsequent survey trip around the coast indicated that the percentage of fish catch which was unmarketable varied between 70.4 and 95.6 percent although it is recognized that, at the time of the survey, poor fishing results were obtained throughout the state. The principal families of fish identified within the by-catch were Apogonidae, Ariidae, flatfish (var.), Lagocephalidae, Leiognathidae, Mullidae, Nemipteridae, Pomadasyidae, rays (var.), Sciaenidae, Synodontidae and Trichiuridae. The use of this resource might be increased markedly by the development of marketing and processing facilities within the state.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the kind permission of the Director of Fisheries, Mr. Chin Phui Kong, to proceed with the work, the assistance of various members of the Fisheries Department, Sabah, for their help with the identification of fish species and their information on the local trawling industry and the advice of Mr. J. Pope in the preparation of this paper.

REFERENCES

Campbell, M. (Ed.), Stable tropical fish products. Report on a workshop held in Bangkok, Thailand, 8-12 October 1975 1974. Ottawa, IDRC, 27 p.

Chin, P.K. and S.K. Goh, Prawn otter trawl fishery in Sabah, Malaysia. Jesselton, Fisheries Branch, Department 1967 of Agriculture, 25 p.

Fischer, W. and P.J.P. White head (Eds.), FAO Species identification sheets for fishery purposes. Eastern Indian
1974 Ocean (fishing area 57) and Western Central Pacific (fishing area 71). FAO, Rome, pag. var.

Jones, R., Mesh regulations in the demersal fisheries of the South China Sea areas. Manila, South China Sen Fish-
1976 eries Development and Coordinating Programme

Shaari, M.B.S.A.L., A guide to trawl species in Penang waters. Kuala Lumpur, Malaysia, Ministry of Agriculture
1971 and Lands

Shaari, M.B.S.A.L. *et al.*, Demersal fish resources in Malaysian waters. 6. First trawl survey off the coasts of
1976 Sarawak, Brunei and the west coast of Sabah. Kuala Lumpur, Malaysia, Ministry of Agriculture and Rural Development, 64 p.

Singapore Marine Fisheries Research Department, Marine Fisheries Department annual report, 1975. *Annu.Rep.*
1975 *Mar.Fish.Res.Dep.Southeast Asian Fish.Dev.Centre,* (1975):48 p.

Surapon, V. and E.S. Montol, Baby trawl fishery in the east coast of the Thai waters. Bangkok, Department of
1974 Fisheries (Internal report)

Thailand, Department of Fisheries, The marine fisheries statistics 1972 based on the sample survey. Bangkok,
1972 Department of Fisheries, Ministry of Agriculture and Cooperatives

Weber, M. and L.F. De Beaufort, The fishes of the Indo-Australian archipelago. Leiden, E.J. Brill, 8 vols.
1911-1936

Table 2

Cathh breakdown from three commercial trawlers

Trawler	Boat 1	Boat 2	Boat 3	Boat 1	Boat 2	Boat 3
Dates	4+5.8.76	5+6+7.10.76	10+11.12.76	26+27+28.3.77	3+4.4.77	31.5.77+1.6.77
Length of bottom line (metres)	25	27	23	25	27	23
Average trawler speed (km/h)	3.1	3.1	Not known	3.3	3.5	Not known
Time net in water (h : min)	10 : 45	16 : 55	9 : 0	19 : 30	14 : 15	9 : 30[d/]
Hourly catch rate (kg/h)	142.0[b/]	75.1	51.5	36.0	36.0	100.2[d/]
Percentage catch breakdown:						
Prawns	2.6	4.0	6.4	8.4	8.8	5.5
Cephalopoda	–	–	–	–	–	0.3
Crabs	–	–	2.7	–	–	
Marketable fish[a/]	23.2	29.1	34.9	25.8	11.8	24.6
Ariidae	--	–	5.8	–	–	)
Sharks	–	1.8[c/]	4.2	–	–	) 2.2
Stromateidae	–	1.2	–	–	–	)
Others	23.2	26.1	24.9	25.8	11.8	22.4
Unmarketable catch	74.2	66.9	56.0	65.2	79. 4	69.6
Exchanged with villagers	8.0	16.2	–	–	3.7	–
Thrown away	72.2	50.7	56.0	65.2	75.7	69.6

a/ This figure does not include fish eaten by the crew (less than one percent)
b/ Only one net effective on one haul of 1 h 25 min due to twisting of the lines
c/ Figure includes sharks which followed the net in and were caught on hand lines by the crew
d/ Catch from last 3 h-haul confiscated by police due to fishing in a restricted area. Catch rate is therefore based on the first two hauls only

Table 3

Unmarketable catch breakdown from three commercial trawlers

Trawler	Boat 1[e/]	Boat 2	Boat 3[f/]	Boat 1	Boat 2	Boat 3
Dates	4+5.8.76	5+6+7.10.76	10+11.12.76	26+27+28.3.77	3+4.4.77	31.5.77+1.6.77
Percentage breakdown to family of unmarketable catch [a/]						
Ariidae[b/]	18.4	8.6	9.1	8.2	14.7	8.7
Carangidae	0.7	–	–	–	–	–
Clupeidae	4.4	–	–	–	–	–
Engraulidae	1.0	–	–	–	–	–
Flatfish (var.)[b/]	1.3	2.5	4.7	6.5	3.3	2.6
Gerreidae	0.1	2.8	–	–	–	–
Lagocephalidae	0.3	0.3	–	2.0	–	14.1
Leiognathidae [b/]	3.7	39.6	48.0	12.7	16.0	18.9
Mullidae[c/]	–	–	–	1.7	2.3	5.9
Nemipteridae[b/ c/]	5.0	10.5	1.4	4.9	2.4	6.1
Platycephalidae	0.2	0.1	21.3	–	–	–
Pomadasyidae[b/ d/]	8.2	7.8	9.9	10.2	7.7	3.5
Rays (var.)	3.1	–	–	9.1	–	–
Sciaenidae[b/ d/]	0.8	2.4	4.2	13.1	26.9	1.4
Sharks (var.)[b/]	–	0.7	–	–	–	–
Sphyraenidae	0.4	–	–	–	–	–
Synodontidae[b/]	0.4	8.4	–	12.9	1.8	0.5
Theraponidae	0.3	–	–	0.3	–	6.2
Triacanthidae	–	0.6	–	–	–	–
Trichiuridae[b/]	45.3	11.4	–	2.7	2.1	–
Remainder	6.5	4.4	1.5	15.5	22.7	32.1
Hourly catch rate of unmarketable catch (kg/h)	105.2	50.3	28.8	23.5	28.6	69.8

a/ Breakdown based on sample size of between 2.2 and 37.5 percent by weight of the catch. Average size was 10.3 percent

b/ These families were noted to be present in sizeable quantities on the first two trips and in all subsequent trips their weight was accurately recorded even when very small quantities were present

c/ For sale purposes *Nemipterus* spp. and similarly coloured *Upeneus* spp. are classified together. Only from trip three onward were they differentiated

d/ During early trips the crew would often sort Sciaenidae and *Pomadasys* spp. together and percentage breakdown figures for these are probably slightly inaccurate for the first three trips
e/ Due to lack of time the percentage breakdown of one 1 1/2 h trawl was assumed to be identical to the subsequent trawls
f/ The total weight of one trawl of 2 h 15 min was estimated by the captain while its breakdown was based on that of the other two trawls

Table 4

Catch breakdown from Fisheries Department survey around the Sabah coast

	Brunei Bay	P. Layang Layang to P. Dinawan	Kuala Abai to Ant Islets	Murudu Bay	Labuk Bay	Sandakan Harbour to Libaran Island	P. Tambisan to SAndakan Harbour	Mt. Putri c/ to Balung River	Cowie Harbour
Trawler	FF7	FF7	FF8	FF6	FF6	FF6	FF6	FF5	FF5
Date(s)	19.7.77	20+21.7.77	11+12.8.77	8.8.77	6.8.77	5.8.77	3.8.77	16+17.8.77	25+26.7.77 15.8.77
Average depth (metres)	24	20	14 b/	17	9	15	15	13 b/	12 b/
Hourly catch rate (kg/h)	21	47	57	112	60	30	77	19	18
Catch rate per swept area (kg/km^2) a/	240	710	1 100	1 210	790	350	770	230	270
Marketable fish (percent)	27.2	11.8	9.9	22.7	7.8	3.5	3.1	27.4	3.7
Unmarketable fish (percent)	64.7	86.4	89.5	75.7	81.9	51.6	66.5	70.1	63.8
Non-fish (percent)	8.2	1.8	0.5	1.6	10.3	44.8	30.5	2.5	32.5

a/ The speed of the boat was estimated from the time taken for a floating object to pass the boat. Due to the inaccuracy of such a method the catch rates are only given to the nearest 10 kg/km^2. The area swept per hour was estimated as the boat speed x length of the trawl bottom line
b/ The depths on these trips were estimated from charts since the survey boats did not have working echo sounders
c/ The results of the survey in this area may not be typical since the tidal currents were very strong at the time and the crew were inexperienced and seasick

Table 5

Marketable fish catch breakdown from Fisheries Department survey around the Sabah coast

Area surveyed	Brunei Bay	P. Layang Layang to P. Dinawan	Kuala Abai to Ant Islets	Marudu Bay	Labuk Bay	Sandakan Harbour to Libaran Island	P. Tambisan to Sandakan Harbour	Mt. Putri to Balung River	Cowie Harbour
Date(s) of survey	19.7.77	20+21.7.77	11+12.8.77	8.8.77	6.8.77	5.8.77	3.8.77	16+17.8.77	25+26.7.77 15.8.77
Percentage breakdown to family of marketable catch:									
Carangidae	–	–	3.0	12.0	2.5	8.5	–	–	–
Clupeidae[a/]	2.3	0.5	5.2	4.4	58.6	63.0	–	10.1	31.1
Drepanidae	12.6	22.9	–	–	–	–	–	–	–
Ephippidae	–	0.6	–	–	–	–	–	–	–
Flatfish (var.)	8.8	10.8	17.4	9.8	1.9	15.9	35.3	–	–
Gerreidae	–	1.2	4.3	2.6	–	–	–	0.2	–
Lactaridae	–	–	2.0	1.2	12.7[c/]	–	–	0.6	–
Leiognathidae	3.8	–	11.6	0.8	–	–	–	2.1	–
Lutjanidae	3.2	–	–	1.4	–	–	6.8	16.3	–
Muraenesocidae[b/]	–	–	–	–	–	–	–	32.6	–
Nemipteridae	3.6	37.6	48.1	53.4	1.0	–	57.9	–	–
Pomadasyidae	–	19.3	2.0	–	–	–	–	–	–
Priacanthidae	–	–	–	–	1.7	–	–	–	–
Sciaenidae	1.2	0.6	5.5	6.3	10.9	5.3	–	28.1	26.9
Scombridae	–	–	0.8	–	3.9	–	–	3.4	21.8
Serranidae	64.5	–	–	0.9	–	–	–	4.1	–
Sphyraenidae	–	1.6	–	5.6	6.9	7.4	–	–	–
Stromateidae	–	–	–	1.5	–	–	–	2.4	20.2
Theraponidae	–	4.9	–	–	–	–	–	–	–
Catch rate per swept area (kg/km^2)	70	80	110	270	60	10	20	60	10

a/ Since *Dorosomus* spp. are rarely caught near Kota Kinabalu, the classification of marketable and unmarketable sizes was not known. Since there was relatively little size variation, 50 percent of the fish caught were placed in each category

b/ Since *Muraenesox* spp. are rarely caught on the west coast, the larger fish caught were categorized as marketable on the advice of the crew

c/ Possible mistaken identification

Table 6

Unmarketable fish catch breakdown from Fisheries Department survey around the Sabah coast

	Brunei Bay	P. Layang Layang to P. Dinawan	Kuala Abai to Ant Islets	Murudu Bay	Labuk Bay	Sandakan Harbour to Libaran Island	P. Tambisan to Sandakan Harbour	Mt. Putri to Balung River	Cowie Harbour
Date(s) of survey	19.7.77	20+21.7.77	11+12.8.77	8.8.77	6.8.77	5.8.77	3.8.77	16+17.8.77	25+26.7.77 15.8.77
Percentage breakdown to family of unmarketable catch:									
Apogonidae	12.3	0.9	0.1	0.3	0.3	3.5	1.4	0.5	1.2
Ariidae	9.2	5.4	19.3	4.6	–	–	2.0	2.5	4.9
Balistidae	0.3	–	–	0.4	–	–	–	–	–
Carangidae	0.7	0.1	0.2	0.7	1.6	12.4	2.1	0.2	3.0
Chirocentridae	–	0.1	–	–	1.0	1.9	0.5	–	–
Clupeidae	4.1	0.2	0.7	1.7	6.5	6.8	–	5.3	10.6
Diodontidae	0.6	–	–	–	–	–	–	–	–
Drepanidae	4.4	0.3	*	0.1	0.2	–	0.3	0.4	1.0
Echineidae	–	–	–	–	–	–	0.1	–	–
Engraulidae	0.3	1.0	–	–	0.1	0.7	–	0.8	–
Ephippidae	0.3	–	–	–	–	–	–	–	–
Flatfish (var.)	2.1	1.7	–	1.1	4.2	6.9	9.3	0.1	0.2
Gerreidae	–	1.3	1.1	0.5	1.4	3.4	0.9	–	2.5
Lactariidae	–	0.8	0.4	0.1	–	–	–	1.4	–
Lagocephalidae	5.5	2.5	1.2	0.9	3.8	14.7	2.9	0.6	12.6
Leiognathidae	14.4	56.0	63.4	33.8	56.4	3.0	1.5	11.2	19.4
Lutjanidae	0.6	–	–	0.8	2.1	–	1.3	–	–
Megalopidae	–	0.1	–	–	–		–	–	–
Mullidae	0.8	4.8	1.7	14.8	4.0	7.3	1.9	0.2	3.2
Muraenesocidae	–	–	–	–	–	–	–	–	0.9
Nemipteridae	15.5	11.9	0.3	10.0	1.6	5.7	23.5	–	–

Platycephalidae	0.1	0.3	–	0.7	0.5	1.5	0.3	–	0.4
Polynemidae	–	–	0.1	–	0.1	–	–	0.3	–
Pomadasyidae	1.9	1.9	2.6	6.2	3.6	0.8	2.7	0.3	–
Priacanthidae	1.0	–	–	0.7	–	0.6	–	0.3	–
Rays (var.)	3.2	3.5	–	2.1	2.3	–	23.3	–	1.4
Sciaenidae	0.5	2.7	0.8	0.6	1.4	1.9	–	50.9	27.6
Scombridae	0.1	–	–	0.1	–	0.6	–	–	1.0
Scorpaenidae	–	0.1	–	0.6	–	–	–	–	–
Serranidae	0.5	–	–	0.1	–	–	–	–	–
Sillaginidae	–	–	–	–	1.4	–	–	–	0.6
Sharks (var.)	–	–	–	–	0.1	–	0.7	1.3	–
Sphyraenidae	–	1.2	–	–	0.1	–	–	–	–
Stromateidae	–	–	–	–	*	–	–	–	1.0
Synodontidae	15.5	0.7	1.9	16.4	5.9	25.9	21.0	–	0.2
Theraponidae	6.1	2.3	0.7	2.1	1.1	1.1	*	0.8	3.9
Triacanthidae	0.3	–	0.2	–	1.0	0.5	3.3	–	–
Trichiuridae	–	0.2	5.1	1.0	–	–	–	22.5	3.3
Uranoscopidae	–	–	–	–	–	0.5	–	0.2	–
Remainder a/	–	–	0.1	–	0.2	0.3	1.0	0.3	1.2
Catch rate per swept area (kg/km^2)	160	610	980	910	650	180	510	160	170

a/ Fish were placed in this category if they were relatively uncommon and, therefore, of little commercial interest and if they were difficult to identify

Signifies that although the family of fish were available in the area they were present as less than 0.05 percent of the total catch for the area