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# FISHERIES RESOURCES SURVEY IN THE EXCLUSIVE ECONOMIC ZONE OF MALAYSIA

# 1997 - 1999

# EXECUTIVE SUMMARY

DEPARTMENT OF FISHERIES
MINISTRY OF AGRICULTURE
MALAYSIA

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## EXECUTIVE SUMMARY

DEPARTMENT OF FISHERIES
MINISTRY OF AGRICULTURE MALAYSIA

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## Preface

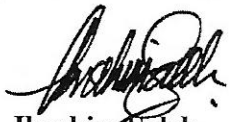
The summary presented in this volume comes from the Fisheries Resources Survey conducted in the Malaysian Exclusive Economic Zone. On the West Coast of Peninsular Malaysia, the survey was carried out from 15th September to 9th October 1997. Three surveys were undertaken in 1998: the first covering the waters on the East Coast of Peninsular Malaysia from 21st March to 2nd June, the second covering Sarawak waters from 7th July to 17th September, and the third covering Sabah waters from 13th October to 6th November. In 1999, the survey on the East Coast of Peninsular Malaysia was repeated, but this time the study was undertaken during the pre-monsoon period from 6th September to 1st November 1999.

The area surveyed extended seawards beyond the 12 nm line from shore up to the 100 fathom depth contour. K.K. MANCHONG, a research trawler based at Fisheries Research Institute in Kuching, Sarawak, was employed throughout. The trawl net used was made of polyethylene with a cod-end mesh size of 38 mm. The polyvalent otter-boards used weighed 350 kg each. Because the sampling gear used was the trawl net, a study was conducted initially in Sarawak waters using SCANMAR to examine the net opening properties in a wide range of water depths, prior to convening of the actual survey.

Besides K.K. MANCHONG, K. L. CERMIN a training vessel of the Training Institute of the Department of Fisheries was also employed during the survey. However the studies undertaken on this vessel emphasised more on oceanographic and environmental parameters. The cruises of K.L. CERMIN were conducted on the West Coast of Peninsular Malaysia from 24th to 30th March 1998, on the East Coast of Peninsular Malaysia between 23rd May and 6th June 1998 and in Sabah and Sarawak waters from 8th July-5th August 1998.

This volume provides the summary on the status of the fisheries resources of the Exclusive Economic Zone of Malaysia for both demersal and pelagic resources using bottom trawl and acoustic survey respectively. Recommendations for the proper development and management of the fisheries resources of Malaysian waters are also included.

Lastly, the Department of Fisheries Malaysia wishes to record its great appreciation to all who have made this survey a success: researchers and technical staff of Fisheries Research Institute (Penang), Marine Fishery Resources Development and Management Department (Kuala Terengganu), Fisheries Research Institute (Bintawa) and Fisheries Research Centre (Likas). The wholehearted contributions from the crew of K.K. MANCHONG and K.L. CERMIN during the course of sampling are especially worth mentioning.



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# TABLE OF CONTENTS

# EXECUTIVE SUMMARY OF THE FISHERIES RESOURCES SURVEY IN THE EEZ WATERS OF MALAYSIA

## 1. INTRODUCTION

The enactment of the Malaysian Exclusive Economic Zone (EEZ) Act in 1984 extended the fishing grounds beyond the traditional areas. In line with the requirements for fisheries management, fisheries resource surveys were conducted to estimate the fish biomass, level of exploitation and density distribution in these new grounds.

The first fisheries resource survey in the EEZ of Malaysia was conducted from 1985 – 1987 using the FAO research vessel, RV RASTRELLIGER. The survey estimated the demersal and semi-pelagic/pelagic fish biomasses, as well as their potentials, in the waters of the Malaysian EEZ, covering both the West and East Coasts of Peninsular Malaysia, and the South China Sea area off Sarawak and the West Coast of Sabah. Results from this survey provided the Department of Fisheries Malaysia (DoFM) with baseline resource information needed for the formulation of plans to further develop the offshore fisheries. The development of the offshore fishing industry is expected to increase fish production to meet the demand for food.

This paper summaries the main results obtained in the second fisheries resources survey in the EEZ of Malaysia, which is the first comprehensive study fully undertaken by the DoFM. The study covered various important research components like demersal resource survey, acoustic survey and oceanographic survey. Biological studies on a considerable number of fish and squids were also undertaken during the demersal resource survey. Acoustic and oceanographic surveys were likewise conducted at the same time.

The main objective of this study is to assess the present status of the offshore fisheries resources and to examine possible relationships that might exist between the resources and oceanographic parameters. The study areas are the West and East Coasts of Peninsular Malaysia, Sarawak and the West Coast of Sabah. The researchers from various sections of the DoFM; Fisheries Research Institute (FRI), Marine Fishery Resources Development and Management Department (MFRDMD) Fisheries Research Institute, Sarawak Branch (FRISB), Fisheries Research Institute, Likas, Sabah (FRIS) analyzed the data, with some assistance from consultants in the acoustic survey.

The results from these surveys will be used by both the Planning and Development Division, and the Fisheries Management and Protection Division, of the Department of Fisheries Malaysia, to formulate policies and plans in the development and management of the resources.

## 2. SURVEY PROCEDURES

Two types of resource surveys were conducted in the study area, *i.e.* demersal fish survey using bottom trawl and pelagic fish survey using the acoustic technique.

### 2.1. Bottom Trawl Survey

#### *2.1.1. Description of the survey area*

A total area of 75,240 nm$^2$ was surveyed, including areas from 12 nm off the western coastline of Peninsular Malaysia to the limit of EEZ (9,983 nm$^2$), and from 12 nm off the eastern coastline of Peninsular Malaysia to the continental shelf boundaries (27,785 nm$^2$). The study area also included Sarawak and western Sabah waters, which extends from the limit of the territorial waters to the depth of the 100-fathom line (32,034.39 nm$^2$, and 5,437.36 nm$^2$ respectively).

The survey areas were further divided into their respective sub-areas and three main depth strata *i.e.* Stratum 1 from 10–30 fathom (18–55 m), Stratum 2 from 30–50 fathom (56–91 m) and Stratum 3 from 50–100 fathom (92–185 m). The division of the survey area into sub-areas followed the standard procedure used by FRI in the earlier coastal demersal resource surveys (see Figures 1, 2, 3 and 4).

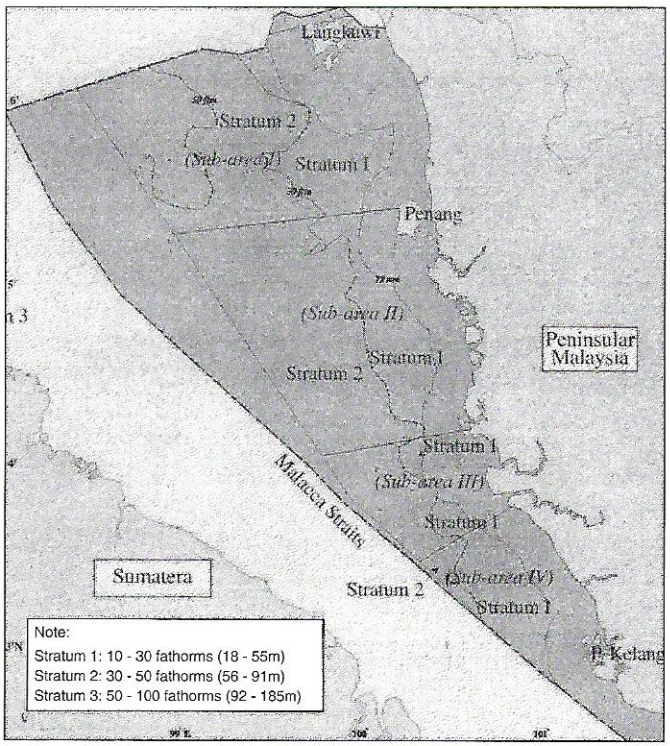


*Figure 1:* Map of the West Coast of Peninsular Malaysia showing the sub-areas (I, II, III and IV) and depth strata (1, 2 and 3).

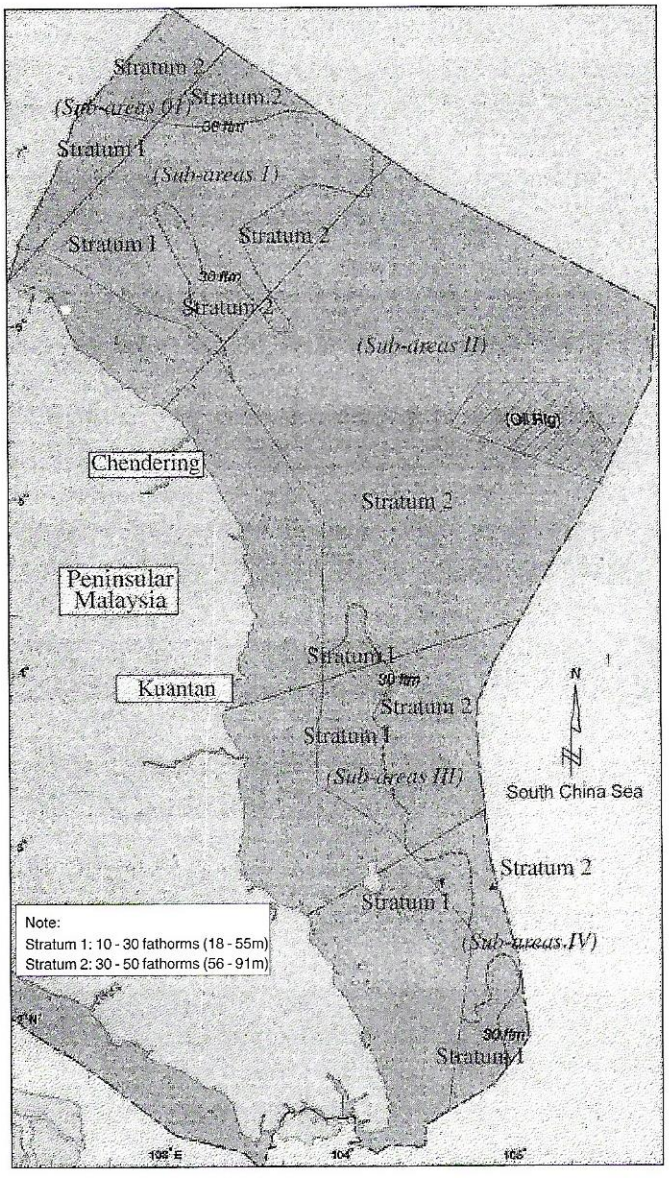


*Figure 2:* Map of the East Coast of Peninsular Malaysia showing the sub-areas (I, II, III and IV) and depth strata (1 and 2).

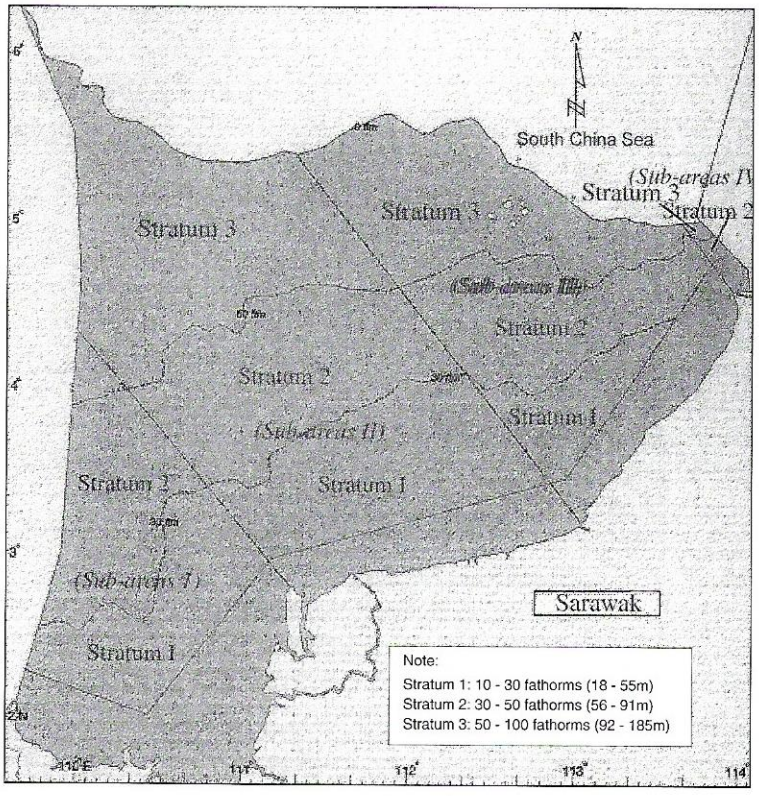


*Figure 3:* Map of Sarawak showing the sub-areas (I, II, III and IV) and depth strata (1, 2 and 3).

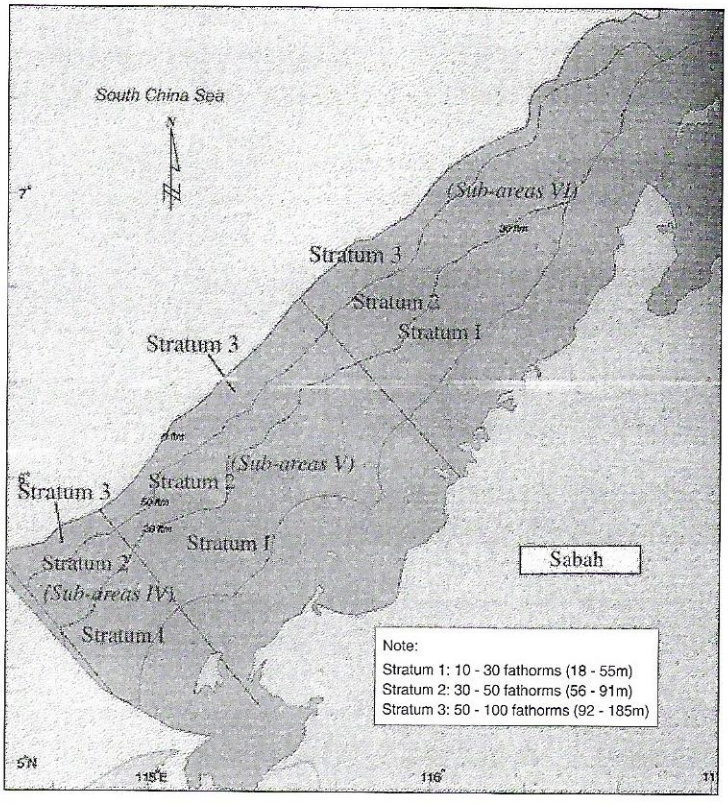


*Figure 4:* Map of the West Coast of Sabah showing the sub-areas (IV, V and VI) and the depth strata (1, 2 and 3).

### *2.1.2. Research vessel and fishing gear specifications*

The survey was conducted using K.K. MANCHONG (Plate 1), a 150-GRT research trawler, and the sampling net used was a high opening bottom trawl, made of polyethylene, with the head rope length of 47.1 m and the cod-end mesh size of 38 mm, the trawl net has a maximum resistance of 4.2 tonnes. A pair of oval-shaped otter boards, made of steel, weighing 350 kg each, was used. The mean head rope opening of this net was estimated to be 19.0 m (Figure 5).

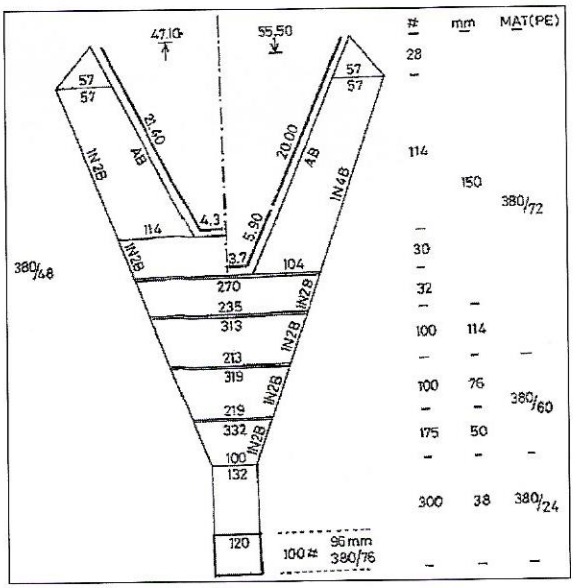


*Figure 5:* The design of the trawl net made of polyethylene, with the head rope length of 47.1 m and the cod-end mesh size of 38 mm, mean head rope opening of the net was estimated to be 19.0 m, polyvalent otter-boards weighed 350kg each, used by K.K. MANCHONG during the fisheries resources survey in the EEZ of Malaysia, 1997-1999.

*Plate 1:* K.K. MANCHONG, 150GRT, research trawler used during the Fisheries Resources Surveys in the EEZ Malaysia, 1997-1999, based at FRI, Sarawak Branch, Bintawa, Kuching. Overall length 27.5 m, draft 2.2 m, trial speed 12.48 knots, crew complement 22 persons.

### *2.1.3. Survey design and sampling stations*

Sampling was conducted using the stratified random sampling technique. Within each stratum, trawl stations were selected randomly such that one trawl station would be covered in each grid of 15 nm x 15 nm. The cruise track was fixed after considering the port at the beginning and at the end of each cruise. Each cruise lasted six days. The durations of the survey were from 17 September 1997 - 9 October 1997 in the West Coast of Peninsular Malaysia, 21 March – 2 June 1998, and 6 September - 11 November 1999 in the East Coast of Peninsular Malaysia, 1 July - 24 September 1998 in Sarawak, and 13 October - 6 November 1998 in West Coast of Sabah.

The ports that were used as bases were Pulau Pinang, Chendering, Kuantan, Kuching, Labuan, Kota Kinabalu and Kudat.

### *2.1.4. Sampling procedure*

A total of 333 hauls were made during the survey period, covering both pre- and post-monsoon. Each trawl haul was of a one-hour duration and a trawling speed of four knots was maintained throughout (Plate 2).

*Plate 2:* Hauling of the high opening bottom trawl net after one-hour duration at a trawling speed of four knots.

Catches were sorted and recorded. All species irrespective of size were weighed, placed into plastic bags, labeled and stored in the fish hold for further work in the laboratory.

*Plate 3:* Samples obtained in one of the sampling station.

*Plate 4:* Activities on board research vessel. Samples were sorted into fish groups, kept in plastic bags and label with detail information of sampling station. Samples were kept freeze in fish hole for further detail examination in laboratory.

All samples were sorted further at the laboratory. Fish were identified to species level, weighed and recorded onto species composition forms according to stations. Length measurements (dorsal extreme length) to the 0.5 cm below (except for some larger species where 1.0 cm interval was used) were taken and recorded onto length frequency forms by station for all species (Plate 5). All sub-samples were raised appropriately to the total catch per haul per station.

Fish samples intended for sex ratio and gonad studies were taken from selected stations that lie on a transect perpendicular to the coast and in the different depth strata. For cephalopods, the samples were grouped into squids, cuttlefish and octopus. They were then sorted into species, sex and gonad maturity stages. Measurements on the mantle length to the nearest 1mm and weight to the nearest 0.01g were taken for individual specimens (Plate 6 and 7).

*Plate 5:* In the laboratory, fish samples were sorted into species and weighed. Fish length and other biological data were also recorded.

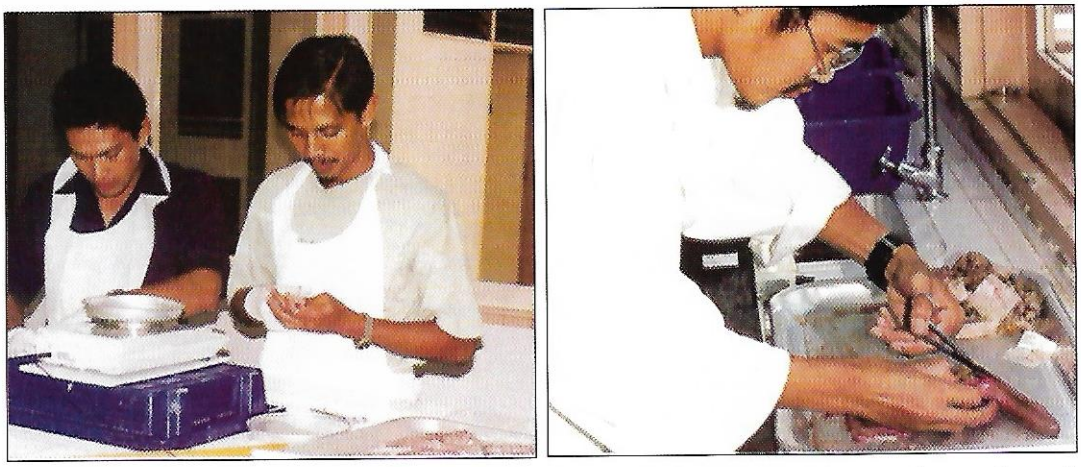

*Plate 6:* Some of commercial fishes and squids were examine in detail for gonad maturity and stomach content study.

### *2.1.5. Data analyses*

The swept area method was used to determine the density of fish. All catch data were processed and analyzed to produce catch rates and species composition using the software NAN-SIS obtained from the Food and Agriculture Organization (FAO). Analyses were done in FRI, MFRDMD, FRISB, the Labuan Fisheries Department, and SSDoF. Length frequency data for selected species were analyzed using FiSAT (FAO-ICLARM Stock Assessment Tools-Version 1.10) to extract the von Bertalanffy growth parameters, mortality and exploitation rates by species.

## 2.2. Acoustic Survey

### *2.2.1. Description of the survey area*

The survey area covered the whole of coastal and offshore waters of Peninsular Malaysia, Sarawak and West Coast of Sabah, extending from the shoreline to the limits of EEZ waters in the West Coast of Peninsular Malaysia and the continental shelf limits in the East Coast of Peninsular Malaysia, Sarawak and West Coast of Sabah.

### *2.2.2. Research vessel and Acoustic Equipment*

The acoustic survey was carried out using K.L. CERMIN, a 250 GRT training vessel. (Plate 8). A FURUNO scientific echo sounder FQ-70M (Plate 9) was used to estimate the pelagic stocks.

*Plate 8:* K. L. CERMIN, a 250 GRT training vessel, equipped with a FURUNO scientific echo sounder FQ-70M, used for the acoustic and oceanographic surveys.

### *2.2.3. Survey design and sampling stations*

The acoustic survey was conducted from 24 - 30 March 1998 in the West Coast of Peninsular Malaysia, 24 May - 6 June 1998 in the East Coast of Peninsular Malaysia, and 8 July - 5 August 1998 in Sarawak and the West Coast of Sabah. The survey was repeated in the West Coast of Peninsular Malaysia from 8 - 24 November 1998 for comparison with the survey in March 1998.

A total of 16 tracks (each track having an interval distance between oceanographic stations of 30 nm) and 19 tracks were covered during the first and repeated surveys respectively in the West Coast of Peninsular Malaysia. In the East Coast of Peninsular Malaysia, 23 tracks were covered, excluding the restricted areas such as the oil and gas fields in offshore waters. In Sarawak and the West Coast of Sabah, a total of 56 tracks were covered, excluding the coastal and offshore waters of Brunei Darussalam (Figure 6).

*Plate 9:* Paper recorder on FURUNO scientific echosounder FQ-70M.

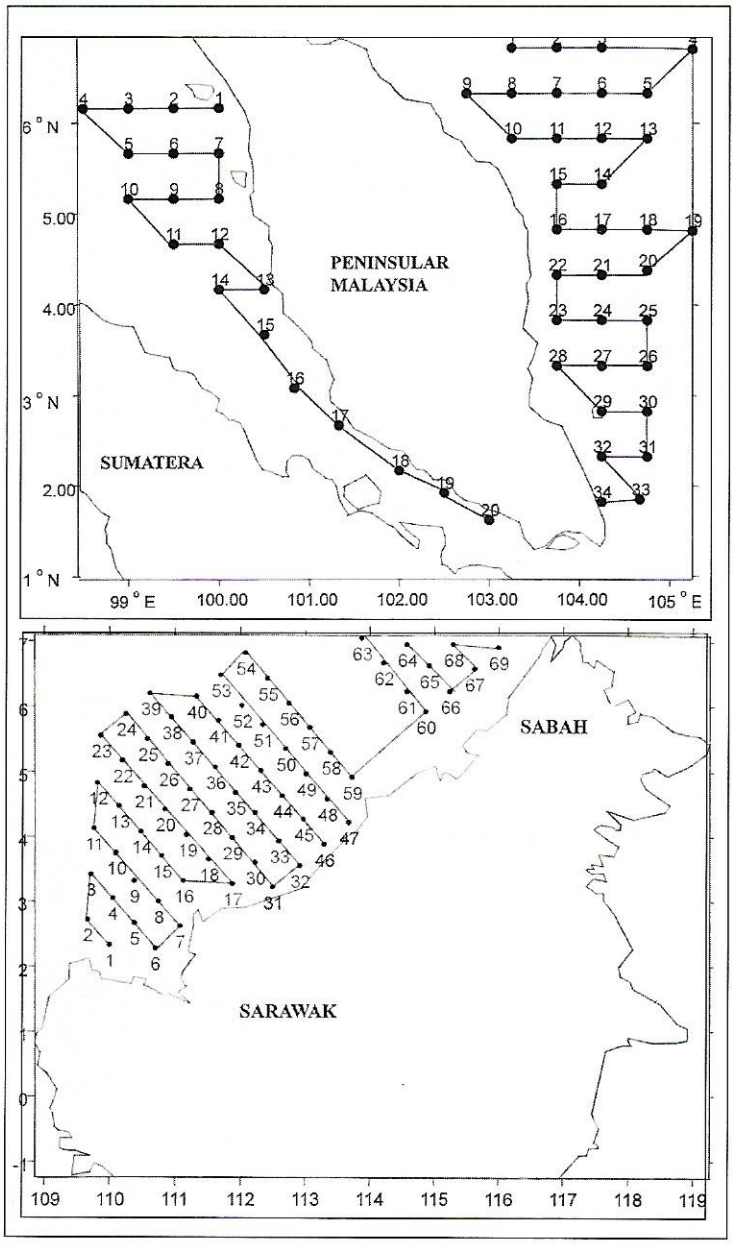


*Figure 6:*
Acoustic and oceanographic transects off Peninsular Malaysia and off Sarawak and Sabah waters.

### *2.2.4. Data analyses*

The data were processed and analyzed jointly by lead researchers from DoFM, FRI FRISB, SASA Labo Company (Japan), and scientists from the National Research Institute of Far Seas Fisheries (NRIFSF, Japan), in September-October 1998 at MFRDMD, in Kuala Terengganu.

The fish density in each survey area was produced from the volume scattering strength (SV) data obtained after extensive data processing and target strengths (TS) of representative species. The TS values of dominant species were determined using a formula, and generally, these values would be dependent on the standard length of the target species. Large sized fish will produce higher TS value than smaller ones. The density map and contour map of fish resources were produced using the Geographical Information System (GIS) technique.

Correlations of fish densities with several oceanographic parameters such as sea surface temperature (SST), salinity, bathymetry and plankton density were also attempted. Comparison was also made against the fish landing data for each area.

## 3. RESULTS

### 3.1. Demersal Resources

The results obtained in the surveys discussed below were also compared to those obtained in the first EEZ survey in 1987 to provide indications of the different states of resources between the two periods.

#### *3.1.1. West Coast of Peninsular Malaysia*

The density distributions of the total commercial demersal and semi-pelagic fish are as shown in Figure 7.

(a) The mean catch rate of demersal fish was 49.1 kg $hr^{-1}$, differing by 59% from the first survey in 1987, which was 118.7 kg $hr^{-1}$. The difference would be larger if the cod-end mesh size used was taken into account. The 1987 survey used a cod-end mesh size of 50 mm, but the current survey used 38 mm.

(b) *Loligo* spp. is more prominent in the present survey, but *Saurida* spp. and *Priacanthus* spp. were dominant in the previous survey.

(c) The overall density of demersal fish (commercial and trash fish) using the catchability coefficient (q) of 0.6 is 1.99 tonnes $nm^{-2}$ compared with 4.96 tonnes $nm^{-2}$ ten years ago. The density of demersal fish has declined by 60%.

(d) The total biomass of demersal fish calculated from the present survey is 20,482 tonnes at q=0.6. The total area used in this calculation is 9,984 $nm^2$. Ten years ago the estimated biomass was 32,834 tonnes in an area of 6,619 $nm^2$ at the same q value. The biomass has declined by 39%, not considering the larger area covered in the current survey. If the same total area of the current survey were used, the total biomass at that time would have been 49,520 tonnes.

(e) Estimation of exploitable potential from the biomass estimates gives a range of values of 55,600 – 72,000 tonnes. These estimates are derived from using assumptions for values like the catchability coefficient (q), natural mortality (M), and yield from the fisheries (Y), estimated from the landings of commercial trawlers (including encroaching foreign vessels). Changes in any of these variables would result in different values obtained for the estimated Maximum Sustainable Yield (MSY) and potential yield.

(f) The estimated exploitation rates (E) that are above 0.61 indicate that the demersal fisheries on the West Coast of Peninsular Malaysia are fully exploited.

(g) Length frequency analyses on 15 demersal fish and three cephalopods also give a mean E value of 0.60 to confirm the existence of the over-exploitation problem. These selected species contributed up to 60% of the demersal fish caught in the survey.

### *3.1.2. East Coast of Peninsular Malaysia*

The density distributions of the total commercial demersal and semi-pelagic fish are as shown in Figure 8.

(a) The mean catch rate of demersal fish obtained in the first survey was 197.5 kg $hr^{-1}$, which is six times more than that obtained in the current survey (31.6 kg $hr^{-1}$).

(b) Some species or groups of species that are found to be dominant in the present survey include the squids (*Loligo* spp.), lizardfish (*Saurida* spp.), threadfin breams (*Nemipterus* spp.), ribbonfish (*Trichiurus* spp.), goatfish (*Upeneus* spp.) and barracudas (*Sphyraena* spp.). Some of these species were also dominant in the first survey. Other groups of species such as the groupers, priacanthids, lutjanids, *Lethrinus* spp., and *Pentaprion* spp. are no longer in the list of dominant species, as they once were. *Pristipomoides* spp. and the sciaenids, such as *Johnius* spp. and *Otolithes* spp., although found in large numbers in the previous survey, are almost totally absent.

(c) The overall density of demersal fish (commercial and trash) using q=0.6 is 1.28 tonnes $nm^{-2}$ compared with 8.23 tonnes $nm^{-2}$ in 1987. Thus, the density of demersal fish has declined by 84%.

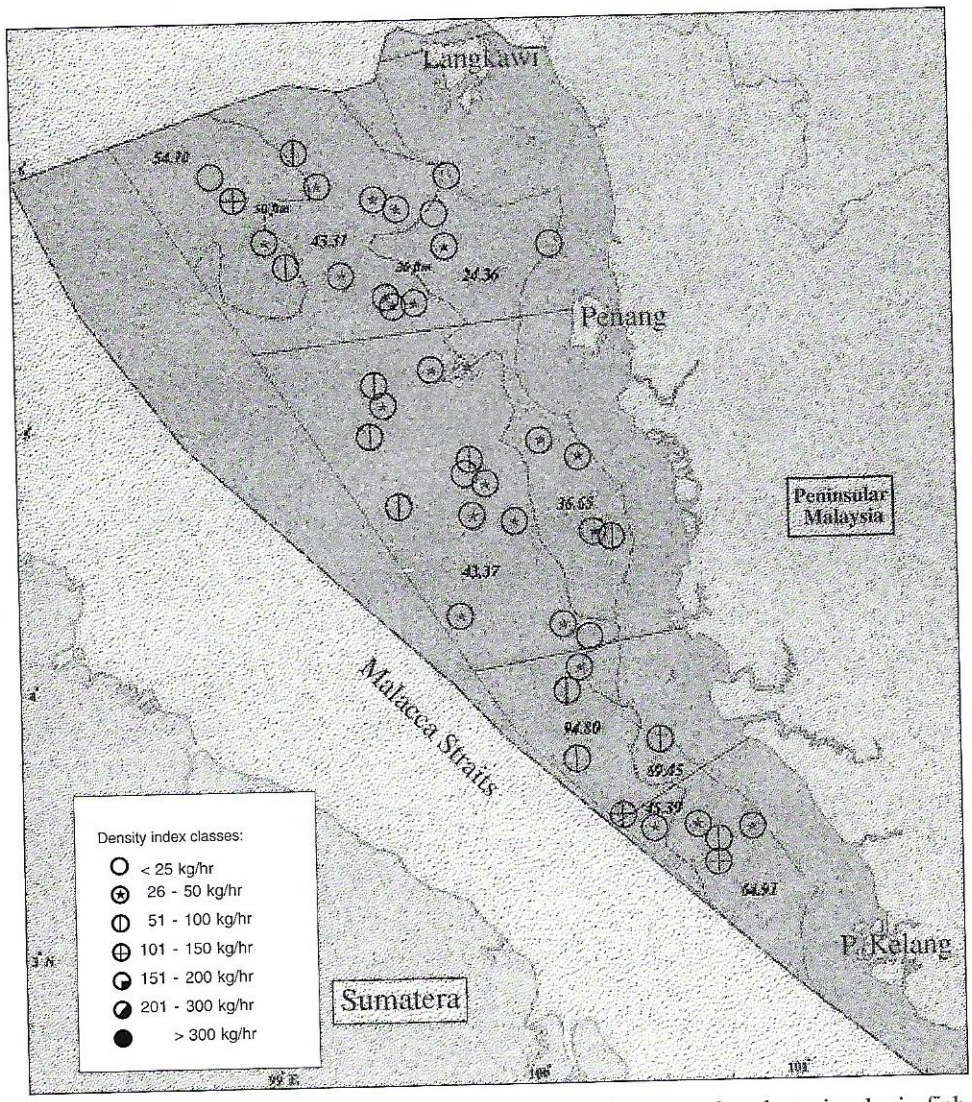


*Figure 7:* Density index (kg $hr^{-1}$) of total commercial demersal and semi-pelagic fish off the West Coast of Peninsular Malaysia, 1997.

(d) The total biomass of demersal fish calculated from the 1999 survey is 35,700 tonnes at q=0.6. The total area used in this calculation is 27,785 $nm^2$. Previously, the estimated biomass was 205,873 tonnes in an area of 25,005 $nm^2$, at the same q value. The biomass has declined by 83%, not considering the larger area covered in the present study. If the same total area were to be applied, the total biomass at that time would have been 228,762 tonnes.

(e) Estimation of the exploitable potential from the biomass estimates gives a range of values of 37,000 – 81,000 tonnes. These estimates are derived from using

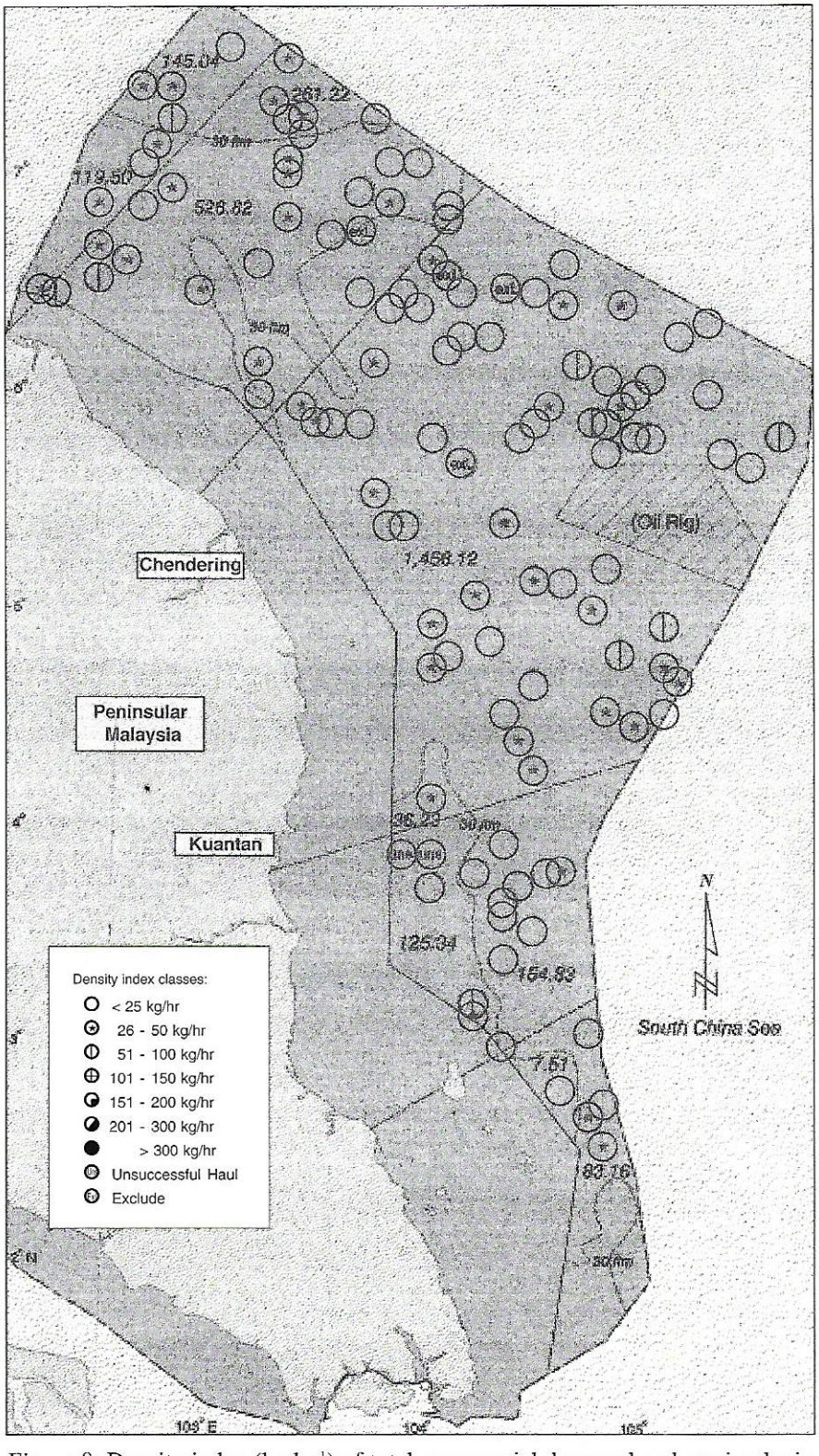


*Figure 8:* Density index (kg $hr^{-1}$) of total commercial demersal and semi-pelagic fish off the East Coast of Peninsular Malaysia, 1998.

the same assumptions for q, M, and Y values. Changes in any of these variables would result in different values obtained for the estimated MSY and potential yield.

(f) Estimates of E values=0.62-0.89 (at M>=1), reveal that demersal fisheries on the East Coast of Peninsular Malaysia are fully exploited.

(g) Length frequency studies on 24 demersal fish and 4 cephalopods, comprising 33% of the total catch during the survey, provided a mean E value of 0.58 to confirm the existence of the over-exploitation problem.

### *3.1.3. Sarawak*

The density distributions of the total commercial demersal and semi-pelagic fish are as shown in Figure 9.

(a) In the first survey, the mean catch rate was 134.2 kg $hr^{-1}$, whilst the present mean catch rate is 121.34 kg $hr^{-1}$, a difference of only 19%.

(b) The dominance of *Thamnaconus hypargyreus*, is only for the present survey. Some high quality fish like *Lutjanus* spp., *Pomadasys* spp. and *Pristipomoides* spp. no longer appear to be dominant. Low quality fish like *Leiognathus* spp., however, shows greater prominence now.

(c) The density of 4.93 tonnes $nm^{-2}$ recorded now is slightly lower than that previously, *i.e.* 5.81 tonnes $nm^{-2}$, a decrease by about 15%. The density of commercial fish at 4.51 tonnes $nm^{-2}$ in the present survey is higher than the previous (3.12 tonnes $nm^{-2}$). This is due to some of the species, which categorized formerly as trash because of small sizes, are now reclassified as commercial.

(d) The estimated demersal biomass recorded from the present survey is 157,903 tonnes, within an area of 32,034 $nm^2$, 14% lower than the amount of 184,368 tonnes recorded in the previous survey, with the area of 31,730 $nm^2$.

(e) The potential yield estimates range from 84,338 tonnes to 86,983 tonnes, with the average potential yield at 85,661 tonnes. In 1997, the estimated landing of demersal fish from the offshore area was only 20,000 tonnes. This leaves some 65,661 tonnes of demersal fish still being unexploited. This shows that the demersal fish resources in the offshore areas are under exploited.

(f) The fish group, MONACANTHIDAE was abundant at depths beyond 92 m at the continental shelf edges in Sub-Areas II and III. In these areas, the calcu-

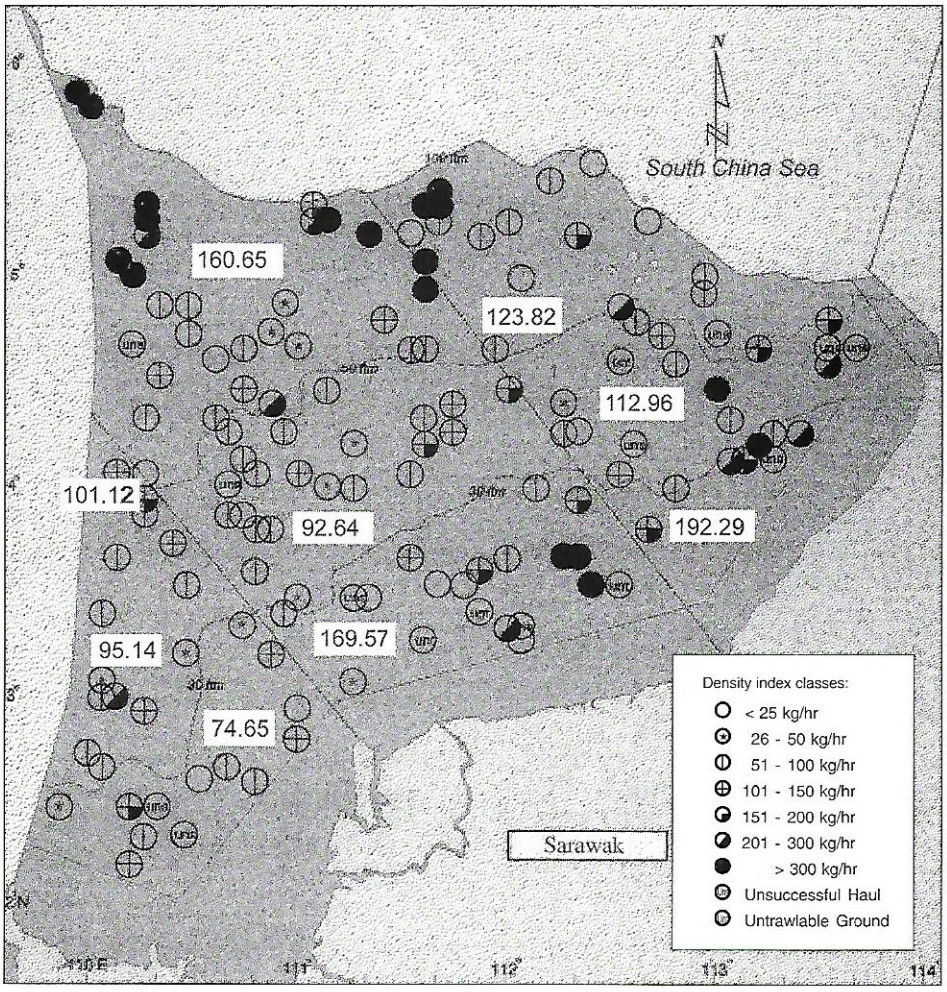


*Figure 9:* Density index (kg $hr^{-1}$) of total commercial demersal and semi-pelagic fish off the Coast of Sarawak, 1998.

lated demersal fish densities (including MONACANTHIDAE in the calculation) are 13.63-21.01 tonnes $nm^{-2}$, about 3-4 times greater than the overall density of 4.93 tonnes $nm^{-2}$. The biomass of MONACANTHIDAE is estimated at a massive 161,920 tonnes, in an area of 11,470 $nm^{-2}$. The estimated potential yield for MONACANTHIDAE as a single fish resource is 80,960 tonnes, and this group has the potential for greater commercial exploitation.

(g) The exploitation rate of the resources (excluding MONACANTHIDAE) is estimated to be 0.17 (at q=0.6 and M=1) indicating that the resources can be exploited further.

### 3.1.4. West Coast of Sabah

The density distributions of the commercial demersal and semi-pelagic fish are as shown in Figure 10.

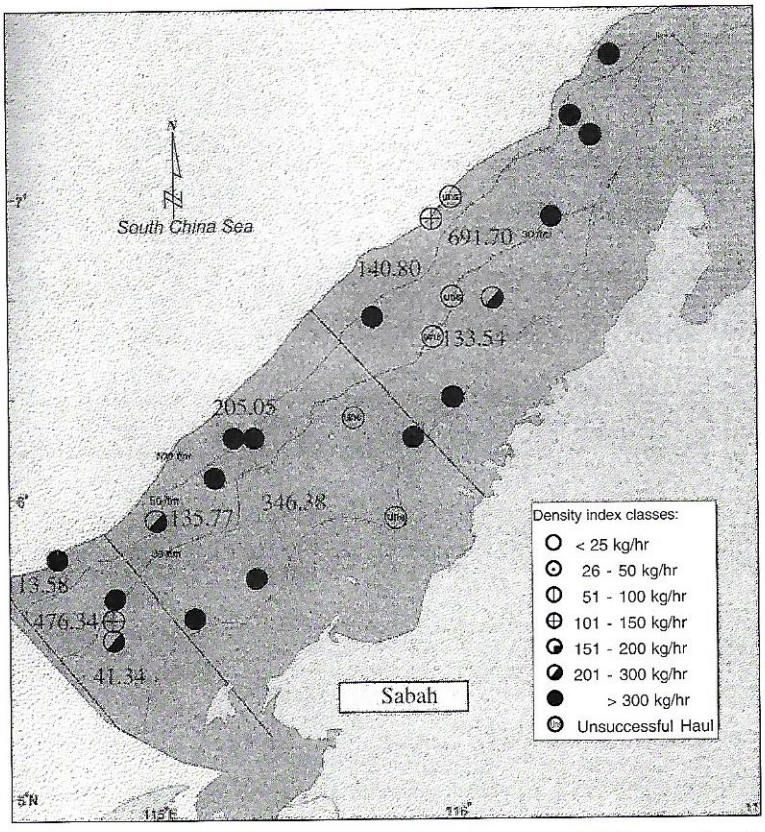


*Figure 10:* Density index (kg $hr^{-1}$) of total commercial demersal and semi-pelagic fish off the West Coast of Sabah, 1998.

(a) The mean catch rate of demersal fish is 107.4 kg $hr^{-1}$, 40% lower than the previous survey, which was 178.7 kg $hr^{-1}$. The difference would be larger if the cod-end mesh size of 50 mm was used as in the previous survey. The current survey uses a trawl with a cod-end mesh size of 38 mm.

(b) *Lutjanus* spp. is no longer dominant. Other good quality fish like *Thanus* spp., *Penulirus* spp., *Pomadasys hasta* and *Pristipomoides* spp. are also absent in the catch composition. *Priacanthus* spp. has instead become more dominant.

(c) The overall density of demersal fish (commercial and trash) using q=0.6 is 4.36 tonnes $nm^{-2}$, compared with 7.74 tonnes $nm^{-2}$ in 1987, declining by about 36%.

(d) The total biomass of demersal fish calculated from this survey is 23,723 tonnes at q=0.6, in a total area of 5,437 $nm^2$. Twelve years ago, the estimated biomass was 31,380 tonnes in an area of 4,056 $nm^2$ with the same q value. The biomass has declined by 24%, not considering the larger area covered in the current survey.

(e) The MSY of the demersal fish resources estimated from the biomass estimates, that gives a value of 23,550 tonnes (at q = 0.6, M = 1.0 and Y = 23,400 tonnes), is presently acceptable for exploitation.

(f) The estimates of E range from 0.33 to 0.62. Analyses on the length frequency data of ten selected demersal fish and one cephalopod provided an average E value of 0.62. The selected species analyzed contributed about 45% of the total demersal fish caught in the survey, indicating that the resources have probably entered the overexploitation stage.

## 3.2. Pelagic Resources

### *3.2.1. Densities and Biomass*

*Rastrelliger brachysoma, Selar crumenopthalmus* and *Decapterus macrosoma* have been identified as the most dominant pelagic species landed in the West Coast of Peninsular Malaysia, East Coast of Peninsular Malaysia, and Sarawak and West Coast of Sabah respectively. The percentages of the species are 28.7%, 46.4% and 39.1% for each survey areas. These species have thus been used as the fish representing the stocks in the areas. Data on species composition were obtained from sampling of commercial trawlers, purse seiners and hand liners during the survey period. However, in the West Coast of Peninsular Malaysia, the actual composition of species was derived from monthly landings of pelagic fish by commercial fishing vessels.

The target strengths (TS) were calculated using the formula and based on the dominant species found. The TS values for each dominant species used in these survey areas were –43.36 for *R. brachysoma*, –41.47 for *S. crumenopthalmus*, and –42.75 for *D. macrosoma*. The average lengths and weights of the species are 13.5 cm and 68.5 g, 16.8 cm and 69.9 g, and 14.5 cm and 45.0 g respectively.

The estimated average densities of pelagic fish were 9.8 tonnes $km^{-2}$, 6.2 tonnes $km^{-2}$ and 5.6 tonnes $km^{-2}$ in the respective area. The highest fish density of 29.6 tonnes $km^{-2}$ was found in Sarawak waters, at depths between 100-200 m (Figure 11). Areas of high fish density are observed in the coastal waters in the West Coast of Peninsular Malaysia, in the offshore waters of Kuala Terengganu, and in the shallow waters and continental shelf zone in the Sarawak and West Coast of Sabah waters. The maximum fish densities obtained are 25.1

tonnes km$^{-2}$ in the West Coast of Peninsular Malaysia, 24.0 tonnes km$^{-2}$ in the East Coast of Peninsular Malaysia and 29.6 tonnes km-$^{2}$ in the Sarawak and West Coast of Sabah waters.

The total biomasses of pelagic fish were estimated around 311,000 tonnes in the West Coast of Peninsular Malaysia, 733,000 tonnes in the East Coast of Peninsular Malaysia, and 1,705,000 tonnes in the Sarawak and West Coast of Sabah waters (Table 1).

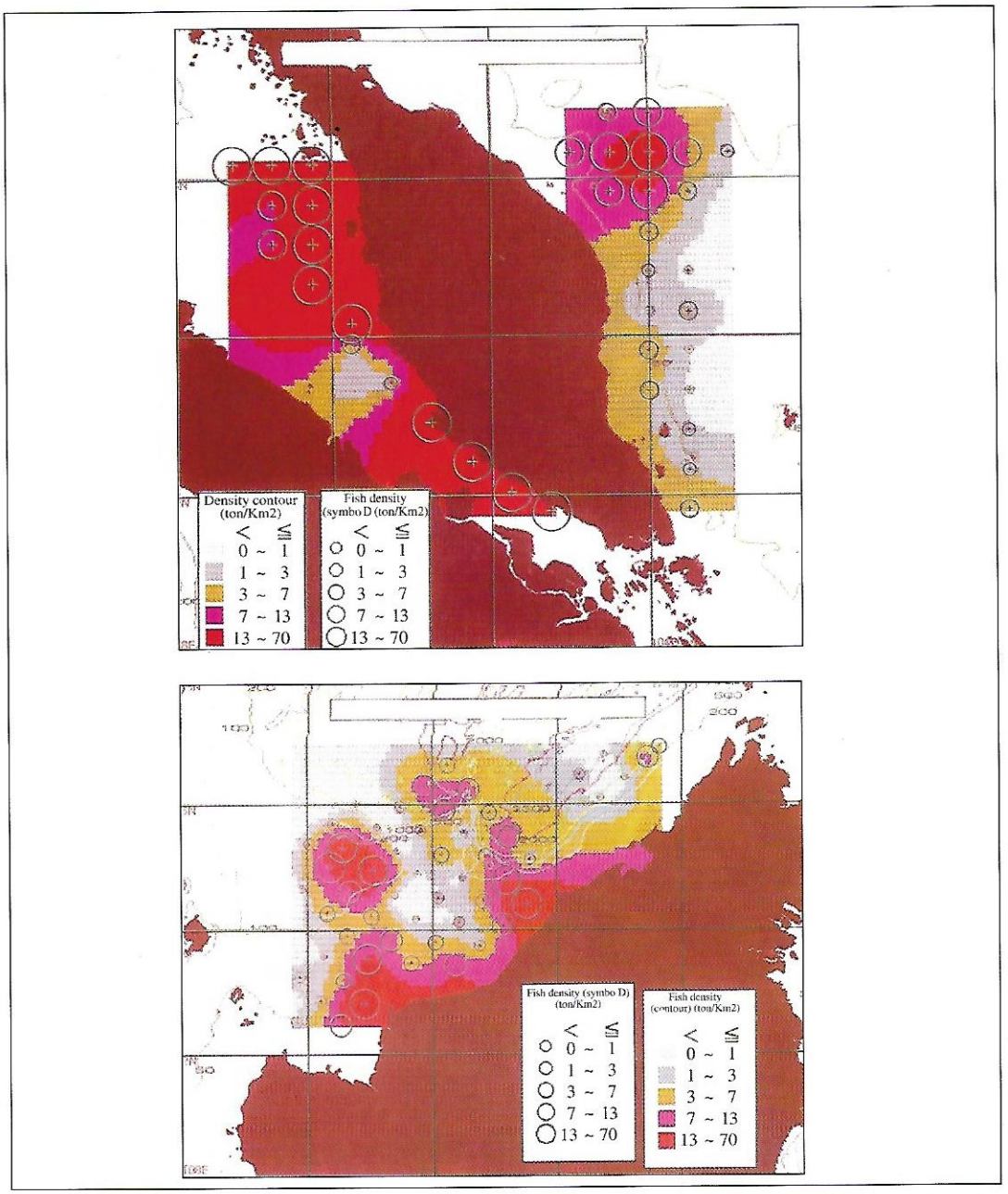


*Figure 11:* Pelagic fish density contour on the West and East Coasts of Peninsular Malaysia, Sabah and Sarawak waters.

*Table 1:* The biomasses and potential yields of the various resources in Malaysian waters.

| RESOURCES | Indicators | West Coast of Peninsular Malaysia | East Coast of Peninsular Malaysia | Sarawak | West Coast of Sabah and Labuan | TOTAL |
|---|---|---|---|---|---|---|
| Demersal | *Biomass* | 19,909 | 35,700 | 157,903 | 23,723 | 238,168 |
| | *Potential Yield* | 62,000 | 55,500 | 86,661 | 38,327 | 240,488 |
| Pelagic | *Biomass* | 311,000 | 733,000 | 1,705,000 | | 2,749,000 |
| | *Potential Yield* | 155,500 | 366,500 | 852,500 | | 1,374,500 |
| Total | *Biomass* | 331,482 | 768,700 | 1,886,626 | | 2,984,708 |
| | *Potential Yield* | 217,500 | 422,000 | 977,488 | | 1,616,988 |

### *3.2.2. Comparison with other similar surveys*

Comparison with other acoustic survey results such as the National Acoustic Survey collected by KL PAUS, a 560 GRT training purse seiner, using SIMRAD EK-500 was also carried out. Other results included those obtained by MV SEAFDEC, a 1,250 GRT training purse seiner in the East Coast of Peninsular Malaysia, Sarawak and West Coast of Sabah waters. The average fish densities recorded in the East Coast of Peninsular Malaysia were 6.2 tonnes $km^{-2}$ by the KL PAUS, and 1.9 tonnes $km^{-2}$ by the MV SEAFDEC, those in Sarawak and West Coast of Sabah waters were 5.6 tonnes $km^{-2}$ and 5.5 tonnes $km^{-2}$ respectively.

## 4. GENERAL DISCUSSION

### 4.1. Discrepancies between research and statistical data in demersal fisheries

Some differences have been observed between research data obtained in the trawl surveys and the annual statistics data collected and recorded from the catches of commercial trawl fishers. In a considerable number of cases, particularly in the West Coast of Peninsular Malaysia, the high landings shown by the commercial trawl fishers in recent years appeared to contradict the general belief that the present demersal resources have in fact been greatly reduced.

Such discrepancies probably arise from the following reasons:

(a) Commercial fishing vessels could also be fishing in waters of less than 12 nm from the shores of islands, where a lot of resources are known to be available.

(b) The results from these trawl surveys cover only the waters beyond 12 nm from shore. Fish resources within the 0-12 nm zone are known to be still available in comparatively large quantities, which probably contribute to the observed high landings shown by the commercial vessels.

(c) Trawl fishers are known to fish in specific targeted areas, which are usually highly productive in nature (good fishing grounds), while research vessels sample randomly during surveys over a much wider area.

(d) The peculiarities of fisheries in tropical waters are that they are multi-species and multi-gear in nature. Most of the resources present are known to have higher fecundity, faster growth, but shorter life span, compared to the resources in temperate waters. These factors also probably contribute to the observed high landings by the commercial fishermen.

(e) Timing of study and effects of monsoon (seasonal variation), as well as oceanographic and spatial variations, also probably play an important part in the obtainment of the catch, and thus the results.

## 4.2. Management Control and Further Fisheries Development

Under the Third National Agriculture Policy (DPN3), the DOF has been requested to formulate policies gearing towards an increase in fish production, while at the same time ensuring the different fisheries are being exploited at the sustainable level. In Peninsular Malaysia, the demersal fish resources, both in the coastal and offshore waters, have been fully exploited, and therefore more efforts are now directed towards conserving and enhancing these resources, *e.g.* the setting up of Marine Parks in the waters of some of the islands, and deployment of artificial reefs in suitable areas.

For the pelagic fish resources, the number of gears catching these resources are requested to remain constant on the West Coast of Peninsular Malaysia, if not slightly reduced in number, while some increase in the number of gears catching these resources is perhaps possible on the East Coast of Peninsular Malaysia.

In the waters of Sarawak, the survey results support the policy towards the general increase in landings production of both the demersal and pelagic resources in the offshore waters.

In West Coast of Sabah and Labuan waters, the survey findings indicate that the effort in exploiting the demersal resources should be maintained, but an increase in the effort in exploiting the pelagic resources is possible in the offshore waters.

## 4.3. Resource Exploitation

The great reduction in the amount of demersal resources seen at present as compared to the 1980s is probably due to the following factors:

(a) Use of destructive fishing gears like the trawlers that are known to be greatly non-selective in their catch. These gears are capable of catching juveniles fish and other benthic communities in greater proportions than other gears, and as such provide adverse impacts on bottom resources that are present in these waters.

(b) Fishing capacity of gears like the trawl is still not fully assessed. Information on related factors (such as engine power, gear efficiency), including the general increase in fishing power from various modifications and innovations that are known to occur, is needed besides limiting their numbers in operation.

(c) Encroachment by local fishing vessels into prohibited areas (*e.g.* in the immediate coastal areas and estuaries which form the nursery and spawning areas for fish), compounded by encroachment of foreign fishing vessels into Malaysian Fisheries Waters, have contributed greatly to the observed reduction in the amount of fish present in these waters. Some fish species have seemed to be lost in the area.

(d) Uncontrolled coastal development and pollution, especially within fish spawning areas in the inshore waters, greatly increase natural mortality and reduce the amount of fish that may be recruited into the fisheries. Oil spillage from passing tankers or steamers that frequently ply these waters also provides some adverse effects to the general well being of fish.

## 5. RECOMMENDATIONS AND CONCLUSIONS

The fisheries sector is an important sector in the Malaysian national economy. Besides providing the main source of protein, this sector provides employment to about 80,000 fishers and fisher folks. In this study, the total estimates of exploitable potential of demersal fish and pelagic fish in the area surveyed are found to be 180,450 tonnes and 2,749,000 tonnes respectively. The landings of fish and its sustainability could be further realized by the following means:

(a) It is clear that the demersal fisheries on the West and East Coasts of Peninsular Malaysia as well as the West Coast of Sabah could not be further developed through the addition of fishing effort. Instead, proper management measures must be implemented and enforced to ensure the sustainability of the demersal fish resources. One such measure is to reduce the total fishing effort through the reduction in the number of licenses fishing for the demersal resources, particularly the trawlers. In addition, technical measures *e.g.* increase in mesh size of not only the trawl cod ends, but also the trawl net itself, should be implemented to reduce the catch of small/juvenile fish. Fishing activities in the fish spawning and nursery grounds should be discouraged and probably, there is a need to enforce closed seasons on these areas.

(b) Demersal fisheries could be developed using suitable gears in the continental slopes of the deep-sea areas fringing Sarawak and West Coast of Sabah in the South China Sea. However, trial fishing using larger vessel of sizes 150 GRT or more, by the DoFM should be conducted to ascertain its viability.

(c) Development in the pelagic fisheries could be considered since the waters in the East Coast of Peninsular Malaysia and Sarawak and West Coast of Sabah

are still under-exploited. Experiments using mid water trawls by single vessel should be considered since the current techniques of deploying purse seiners seemed to fail. In such ventures, supporting downstream activities should be in emplaced so that increased catches could be utilized economically and efficiently. Emphasis should be placed on those resources that are still being exploited at very low levels and also those with high recruitment such as the pelagic fish.

(d) Apart from the biological considerations, the formulation of management measures should incorporate aspects such as socio-economics of the community directly involved.

(e) In order to evaluate the effectiveness of any management measure implemented, continuous monitoring and research, preferably by annual experimental surveys, should be undertaken following the implementation and effective enforcement of such a measure. Monitoring the performance of commercial fishing boats should be conducted in parallel to experimental fishing by research vessels to ensure the current status of the fisheries is known. This is also to ensure that new and additional information is made available for the formulation of up-to-date measures and the refinement of existing ones.

(f) In waters where fish resources have been excessively exploited, reducing the number of non-selective fishing gears operating to a level that can ensure sustainable exploitation of the resources should be enforced immediately. Illegal and unauthorized fishing should likewise be prohibited. Fishers should also be encouraged to use environmental-friendly fishing gear to catch the resources.

(g) The ecosystem approach in fisheries management, a relatively new concept, might provide an effective alternative to conventional fisheries management in Malaysia. Research into the development of environmental-friendly fishing gear should be enhanced. Importantly, other management regimes such as Community Based Resource Management (CBRM) and Integrated Coastal Management (ICM) could likewise be considered should they prove suitable and viable for the effective management of the fishing community.

(h) A set of time-series surveys in selected waters is needed to obtain first hand information on the various degrees of the effects of monsoons on the resources.

Achieving results from these recommendations could be long term. The holistic approach of managing resources should be adopted and fishers' awareness on the needs for managing the resources has to be at the top in the list of agenda.