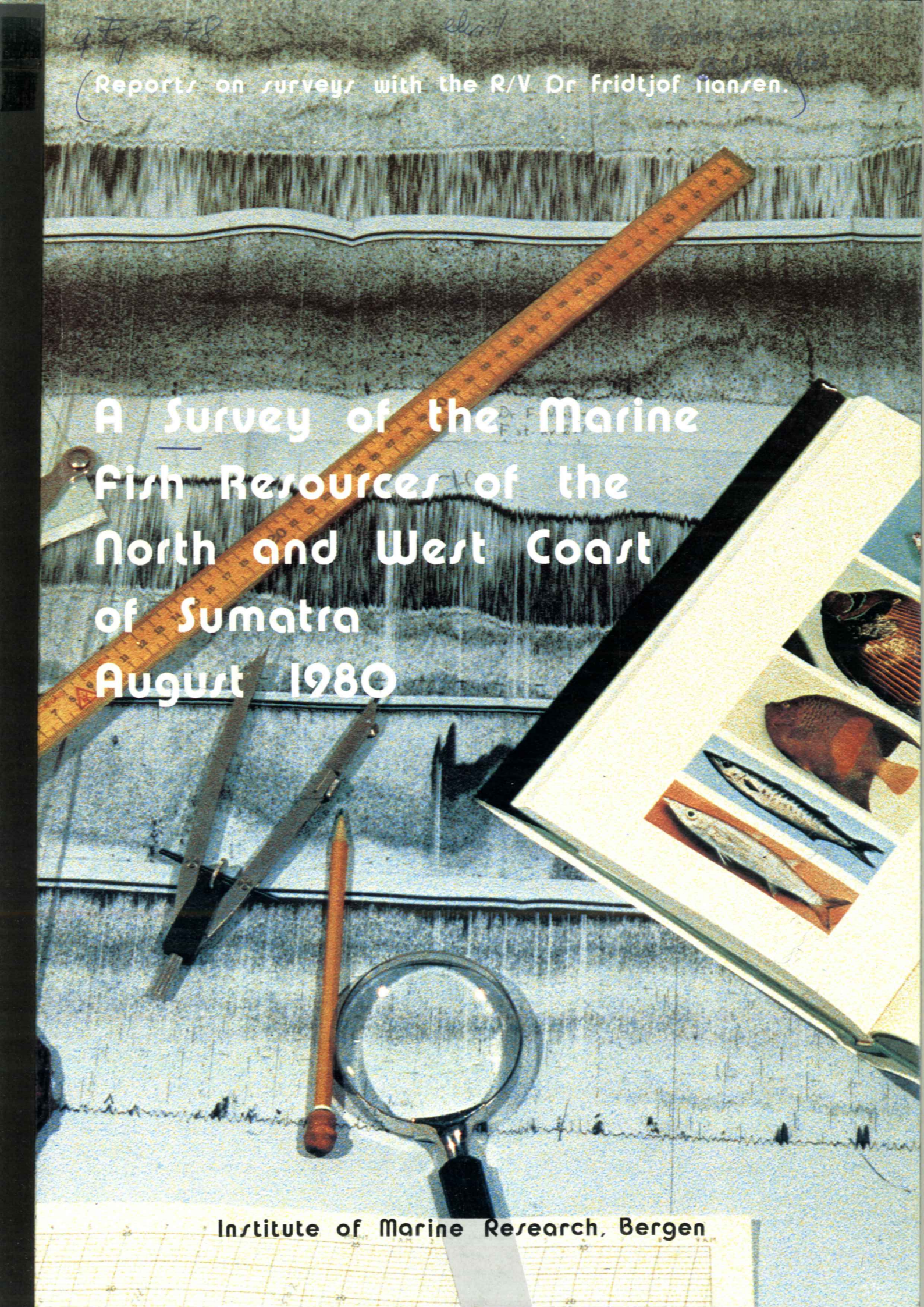
Reports on surveys with the R/V Dr Fridtjof Nansen.

A Survey of the Marine Fish Resources of the North and West Coast of Sumatra August 1980



Institute of Marine Research, Bergen

«Dr. Fridtjof Nansen»

The fishery research vessel «Dr. Fridtjof Nansen» belongs to the Norwegian Agency for International Development (NORAD). It was designed and built for scientific and exploratory investigations of fishery resources of developing countries, under a joint plan with the Fisheries Department of FAO based on a funding of operation to be shared by FAO and Norway.

(Reports on Surveys with the R/V "Dr. Fridtjof Nansen")

A SURVEY OF THE MARINE FISH RESOURCES OF THE NORTH AND WEST COAST OF SUMATRA AUGUST 1980

by

A. Aglen, L. Føyn, O.R. Godø,
S. Myklevoll and O.J. Østvedt

Institute of Marine Research

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1. INTRODUCTION

A programme of investigation of the marine fish resources of Thailand, Malaysia and Indonesia during June-August 1980 was agreed between the United Nations Food and Agriculture Organization (FAO) and the Norwegian Agency for International Development (NORAD). In accordance with this the fisheries research vessel "Dr. Fridtjof Nansen" was commissioned to survey the north and west coast of Sumatra between 6 and 30 August 1980. The Institute of Marine Research, Bergen was responsible for the details of planning in consultation with the UNDP/FAO South China Sea Fisheries Development and Coordinating Programme and the Government of Indonesia.

The acoustic/exploratory fishing survey reported here includes the following observations:

Acoustic system observing depth, bottom type, and fish biomass by categories.

Fishing system observing catch, its amount and composition, biological data of fish, fishability.

Oceanographic observations (temperature, salinity, oxygen, nutrients).

The analysis and processing of these data provide information on the quantity and distribution of the fish resources, their composition and aspects of their behaviour and their environment. The survey system has certain limitations, particularly as regards the interpretation of the acoustic observations. These will be discussed later. Similar work in other areas has, however, demonstrated that findings from these types of surveys can provide good if often conservative indications of the availability of fish resources.

The participating scientific and technical staff is listed in Annex I. All the staff took part in observational work and carried out analyses and processing of the data to the extent possible onboard the vessel. The preliminary results were presented in a short cruise report. The preparation of the final report was done at the Institute of Marine Research, Bergen.

2. METHODS

2.1 Vessel and equipment

The R/V "Dr. Fridtjof Nansen" is a 150-feet stern trawler with a main engine of 1500 horsepower. The vessel is equipped for acoustic surveying, bottom and midwater trawling, hydrography and plankton observations.

The bottom trawl was a 134-feet headrope shrimp trawl adapted for demersal fish trawling. The footrope was equipped with 0.5 m rubber bobbins. Bridles of 40 m gave it a horizontal distance between the wings of about 20 m. The effective vertical opening of the net was about 6 m. A pelagic trawl of about 120 m circumference was used. The vertical opening was normally 13 m. The pelagic trawl had an inner net of mesh size 1 cm in the cod end. Pelagic trawl operations were usually monitored by aid of a 50 kHz acoustic net sonde. In addition a 24 kHz searchlight sonar was used while fishing on pelagic schools.

Hydrographic observations were carried out with Nansen bottles with which temperature readings and samples for salinity, oxygen and nutrients determinations were collected at standard depths. The salinity was determined with an inductive salinometer and dissolved oxygen by the Winkler method on board, while the samples for nutrients determinations were deep-frozen and analyzed by means of an autoanalyzer at the Institute in Bergen.

Two echo sounders, 120 kHz and 38 kHz connected to echo integrators were run continuously. Settings and performance of the two acoustic systems were:

	120 kHz	38 kHz
Basic range	0-100 m	0-100 or 0-250 m
Transmitter	1/1	Ext. transmitter
Transducer (ceramic)	10^{o} (circular)	$8^{o}x8^{o}$
SL + VR	102 dB	133 dB
Bandwidth and pulse length	3 kHz, 0.6 m.sec.	3 kHz, 0.6 m.sec.
TVG and gain	20 logR+2αR -0dB	20 logR+2αR -0dB
Recorder gain	3	1
Integrator treshold	8(0.2 volt peak)	8(0.3 volt peak)
Integrator gain	20 dB (xl0)	l0 dB (xl0)
Depth intervals	According to recordings	According to recordings

With these settings echoes from plankton and small fishes (less than about 5 cm) were integrated by the 120 kHz system only when they occurred in high volume densities, while bigger fish were always properly integrated. The settings chosen for the 38 kHz system made it more sensitive to smaller organisms, while signals from bigger fish sometimes ran into saturation in the receiver. Therefore integrator values from the 120 kHz system were used for abundance estimation of fish, while the 38 kHz values were used as an aid during the daily scrutinizing of the echo recordings.

2.2 Sampling and processing of data

For each trawl catch the weight, number and average total length of each species (or family) were estimated. Species determinations were mostly based on FISCHER and WHITEHEAD (1974) and partly SMITH (1972). All fish belonging to the families Carangidae, Clupeidae, Engraulidae, Gerreidae, Leiognathidae and Scombridae were classified as pelagic fish whether they occurred in the pelagic trawl or the demersal trawl.

The echo recordings and their interpretations

Assessment of the abundance of fish resources based on acoustic observations combined with experimental fishing is a method which especially lends itself to fish found in schools or other aggregations in mid-water. This is a type of behaviour which characterizes some of the fish species found in

Indonesian waters. But there are also notable exceptions, e.g. surface schooling tunas and tuna-like species and strictly bottom dwelling fish as rays and flounders. Any fish found very close to the bottom ($\frac{1}{2}$-1 m) or in the very surface layer will escape echo sounder detection. For navigational reasons the work with the R/V "Dr. Fridtjof Nansen" is limited to waters deeper than about 15 m. The extreme inshore waters could thus not be covered.

Because of differences in behaviour and size, different species or groups of species may give rise to different types of echo recordings. Small-sized pelagic fish are for instance often found in well-defined schools. These recordings can be distinguished from those of the looser aggregation in which semi-demersal larger fish are often found. Such classification of the echo recordings is of considerable assistance in interpreting the acoustic observations, but a positive identification by fishing operations is still indispensable and also provides the only means of sampling fish in this type of combined survey.

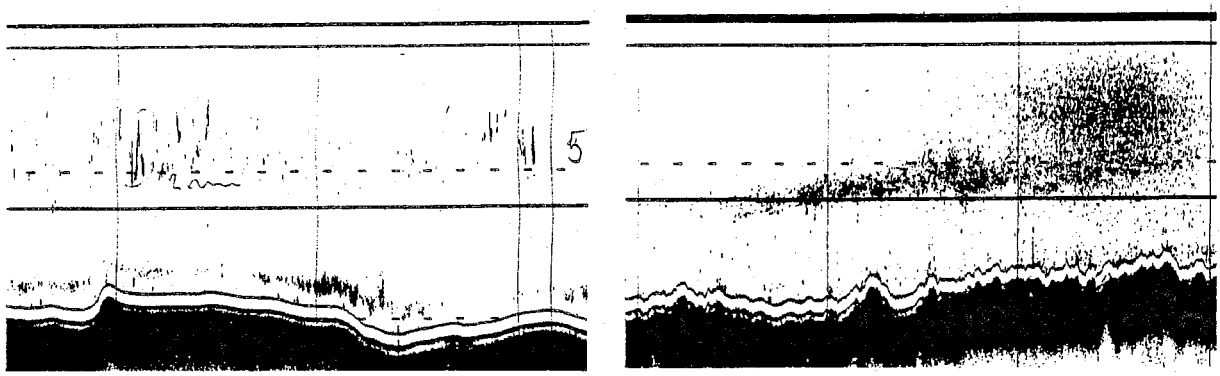
Based on previous experience and on identification by fishing, the fish recordings in the Sumatra waters were classified as follows:

(i) Recordings of true larger schools or layer mostly in upper waters, Fig. 1. These will most often derive from pelagic schooling fish usually of smaller size, e.g. clupeoids, scads. This type was common in the coastal areas.

(ii) Fish recordings close to bottom. These are ascribed to demersal or semi-demersal fish such as croakers, grunts, breams, snappers, sharks etc. This type of recording was also common, and examples are shown in Fig. 2.

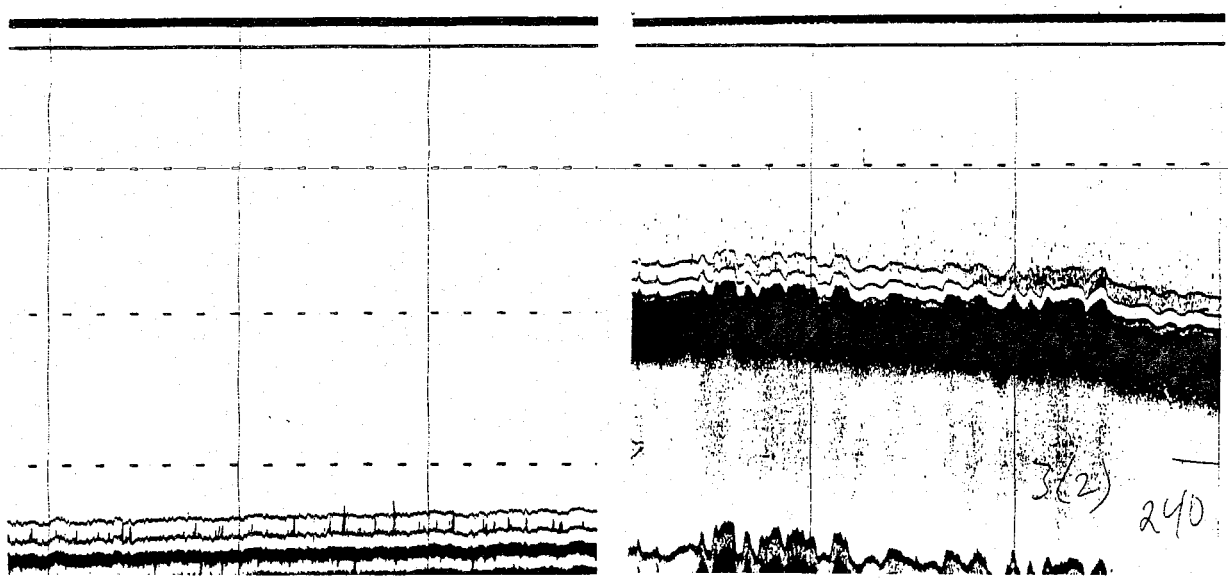
(iii) "Smoky" recordings of plankton and juvenile fish mostly distributed in scattered layers in upper water.

One should note, however, that the terms "pelagic" and "demersal" only indicate a general tendency of behaviour. Pelagic fish are often caught in quantities in bottom trawls and pelagic trawls can be used to catch demersal fish when distributed in mid-water. An example of mixed recordings is shown in Fig. 3.



Day Night

Fig. 1. Recordings of typical "pelagic" fish.



Day Night

Fig. 2. Recordings of demersal fish.

Day Night

Fig. 3. Mixed recordings of pelagic and demersal fish.

Acoustic abundance estimation

Average integrator deflection per nautical mile was calculated each five nautical mile steamed.

Average values ($\bar{M}$) for pure pelagic fish and fish close to the bottom were calculated within subareas, and average densities ($\bar{D}$) were estimated by the formulae $\bar{D}=0.25\ \bar{L}\ \bar{M}$ (tonnes/nm^2). $\bar{L}$ is the average fish length (cm) in the trawl catches within the subarea. The conversion factor $0.25\ \bar{L}$ (tonnes/nm^2 per mm integrator deflection) were estimated from an intercalibration between the acourstic systems onboard R/V "Dr. Fridtjof Nansen" and R/V "Johan Hjort" in March 1979. This gave a conversion factor of 10 tonnes/nm^2 with reference to a cod type fish of 40 cm length. This becomes $0.25\ \bar{L}$ tonnes/nm^2 when the acoustic scattering cross section per unit weight is assumed to decrease linearily with fish length. This value corresponds to an average target strength of -10 log L -21 dB per kg fish (at 120 kHz).

The fraction of pelagic fish included in the category "fish close to bottom" was estimated simply as the average weight percent of pelagic fish in the bottom trawl catches.

Abundance estimation of demersal fish by the swept area method

Fish density (D) is estimated from catch per unit effort (d) by using the formulae

$$D = \frac{d}{a\ c}$$

where a is the area swept by the trawl per unit effort and c is the catchability coefficient (the proportion of the fish within the swept area caught by the trawl).

Various authors working in the tropics have used various definitions of a and different values for c as the following table shows:

Authors	C	a	Area
ISARANKURA (1971)	0.5	a = distance between danlenos x towing speed	West coast Thailand & Malaysia
SHINDO (1973)	0.5	a = (head rope length/1.5) x towing speed	South China Sea & Gulf of Thailand
SÆTRE & SILVA (1979)	0.5	a = distance between wings x towing speed	Mozambique
BLINDHEIM, DE BRUIN & SÆTERSDAL (1979)	0.5	- " -	Sri Lanka
ANON. (1979c)	1	- " -	Western Indian Ocean South of Equator
STRØMME, NAKKEN, SANN AUNG & SÆTERSDAL (1981)	1	- " -	Burma
SAVILLE (1977)	≤ 1	- " -	

ANON (1979c) refers a workshop discussing fish resources estimation in the tropics. It was suggested to use a catchability coefficient (c) for demersal fish, equal to 1 while awaiting the results from further investigations. The total effect of herding by the bridles and escaping through the wings is then assumed to be zero.

c=1 is used in the calculation of the demersal fish density from the bottom trawl catch rates, although SÆTRE (1981) discusses experiences from other surveys with the same gear indicating that the catchability coefficient may be closer to 0.5. The abundance estimates in this report are therefore most likely to be minimum estimates.

In this report the area swept by the trawl is defined as the distance between the wings multiplied by the towed distance. The catch rate unit is kg per hour, and the area swept by the trawl in one hour (STRØMME et al. 1981) is estimated to be 0.03 $n.mile^2$.

All other families than Carangidae, Clupeidae, Engraulidae, Gerreidae, Leiognathidae and Scombridae are included in "demersal fish".

3. RESULTS

3.1 Survey coverage

The continental shelf off north-western Sumatra extend from a few nautical miles to about 40 nautical miles offshore. The investigations were mostly limited to the narrow continental shelf, which means the areas of 10-300 m bottom depth.

In most of the area the edge of the shelf is marked with grounds of shallow water and the slope is very steep. In some places there are coral reef peaks extending almost to the surface. This was a hindrance to safe navigation throughout the area to be surveyed. Particularly south of Kutanibong a lot of reefs made the navigation very difficult. Therefore the coverage of the area had to be somewhat uneven.

Fig. 4 shows the survey route and the location of fishing stations and hydrographic stations worked. The shelf area off West Sumatra was surveyed from 6^{o}N to 1^{o}S. The northern part of the west coast was given a thorough study on the return voyage. The shelf area of the north-east coast included in the survey extended only a few nautical miles off-shore, and consequently the main fishing effort was used on the west coast.

Five hydrographic sections were worked and fishing gears were operated at 79 stations, mainly with bottom trawls.

The total surveyed shelf area has been estimated to about 25 000 square nautical miles.

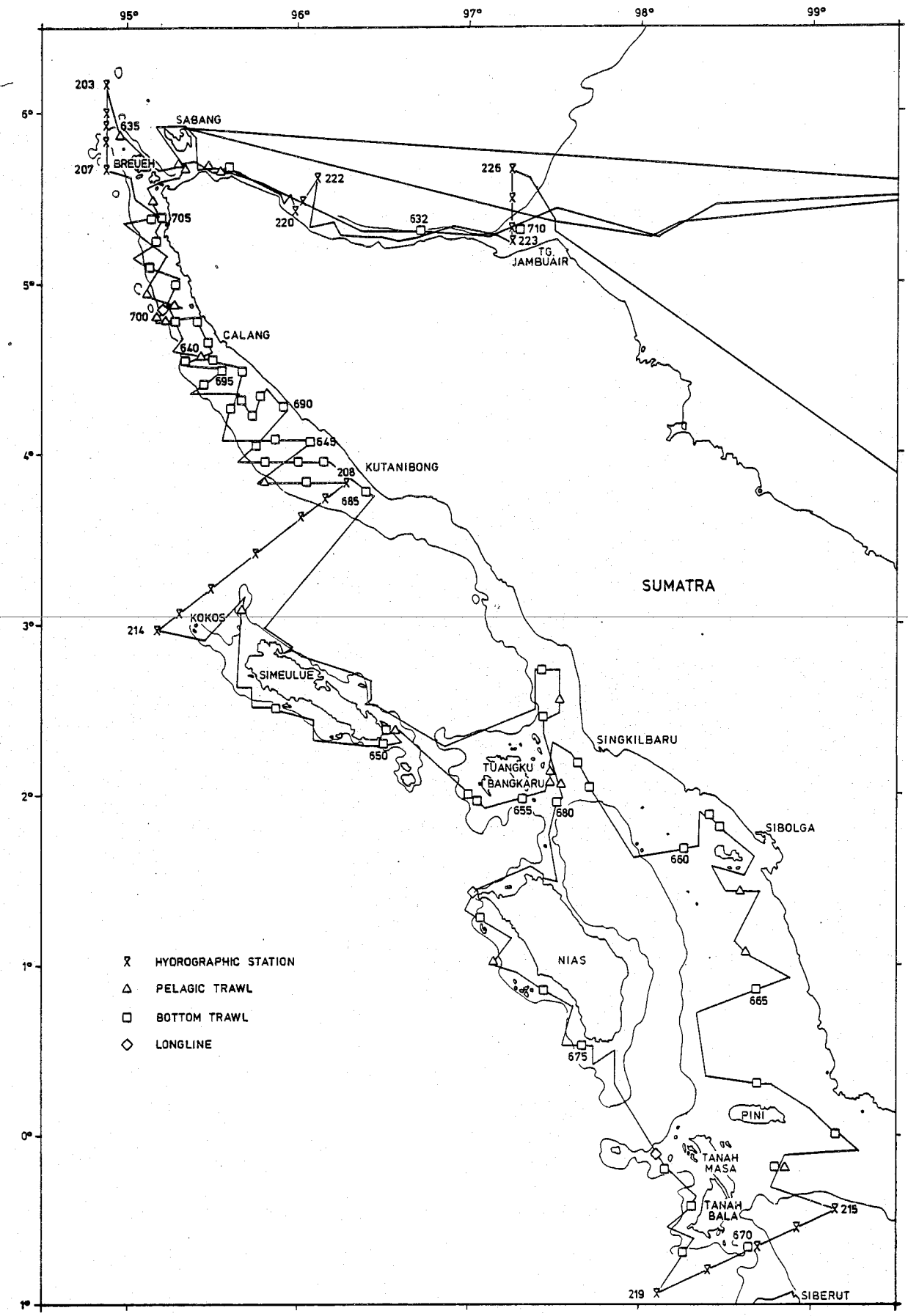


Fig. 4. Survey route and stations. North and west coast of Sumatra, 6 - 30 August 1980.

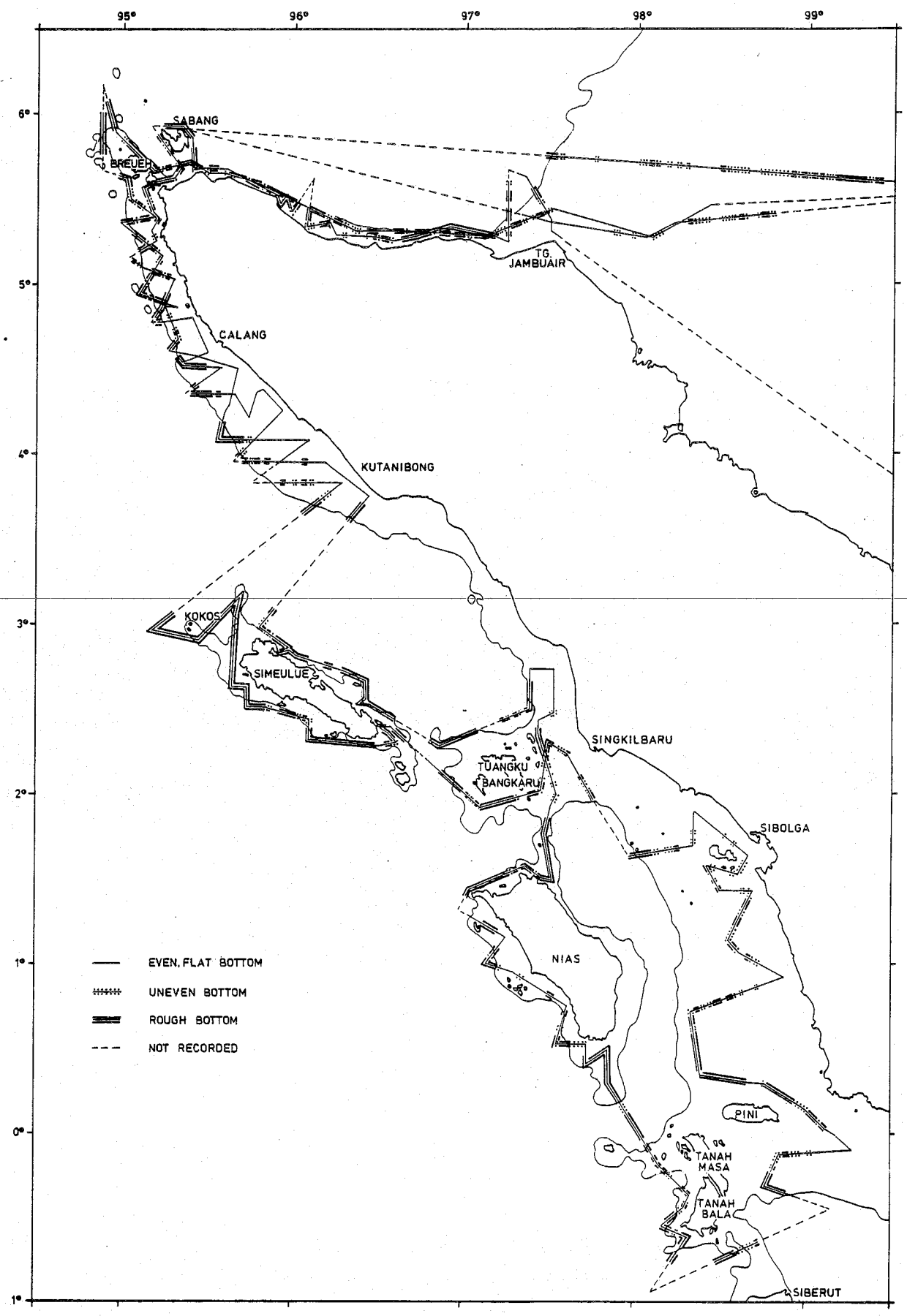


Fig. 5. Observations of the character of the bottom.

3.2 Bottom conditions

The type of bottom observed by echo sounder along the cruise tracks was classified according to its assumed suitability for bottom trawling as follows:

1. Even flat bottom suitable for all kinds of bottom trawl.
2. More uneven bottom where the use of bobbins would be preferable.
3. Rough bottom, unsuitable for trawling.

The bottom conditions were not observed in areas of more than 500 m bottom depth.

Figure 5 shows the total observations regarding bottom conditions. The widest area of even bottom was found between Calang and Kutanibong. In the other areas just small spots with flat bottom was found. Rocks, corals and steep slopes were frequent.

3.3 Environmental conditions

Five hydrographic sections were worked during the cruise. The temperature was recorded and salinity and oxygen from water samples down to 500 meters were measured onboard. Samples for nutrients analyses were collected from the same standard depths and stored deep-frozen for analysis in Bergen.

Hydrography

Figs 6-10 show profiles of hydrographic sections.

The temperature profiles show a pronounced thermocline between 100 and 125 m with an almost homogeneous upper layer. At some stations off the west coast, temperatures below $10^{o}C$ were measured deeper than 400 meters.

The salinity profiles show the same tendency as the temperature, although a sharp boundary layer is not so pronounced. The profiles from the hydrographic section extending north on the west side of Breueh Island show some distinct differences at the two sides of the underwater ridge

(Fig. 8). On the northern side the 35 per mille isohaline is found at about 250 m while 35 per mille salinity is found below 150 m at the southern stations. The discontinuity found in the profiles may reflect the strong currents in this area. Strong currents were as well observed visually at the surface.

The oxygen profiles show a distinct difference between the different sections. While the oxygen content decreases to under 1 ml O_2 per litre below the thermocline north and north-east of Sumatra, the deep waters (down to 500 meters) off the west coast contain more than 1 ml oxygen per litre.

Nutrients

Samples for nutrients were collected on 20 ml "used" polyethylen tubes and immediately deep-frozen, and further transported in deep-frozen condition for analysis at the Institute of Marine Research, Bergen. Samples for calibrations were prepared simultaneously onboard in order to give the calibration samples the same treatment as the collected nutrients samples.

The samples were analyzed for nitrate, phosphate and silicate by means of an autoanalyzer. The distribution of phosphate, nitrate and silicate for the five sections are plotted in Figs 11-15.

In comparison with the salinity and temperature distribution, the nutrient profiles give a more complicated picture, as the nutrients are influenced both by the hydrographic conditions and the biological processes taking place in the particular water masses. The nutrient distributions follow, however, the main pictures of the hydrographic situation. Above the thermocline the water masses are almost depleted of phosphate, nitrate and silicate. Below the thermocline there is a general increase in nutrients towards the maximum observation depth of 500 m with phosphate values from 1.5 - 2 µM, nitrate values from 15 - 23 µM and silicate from 16 - 23 µM.

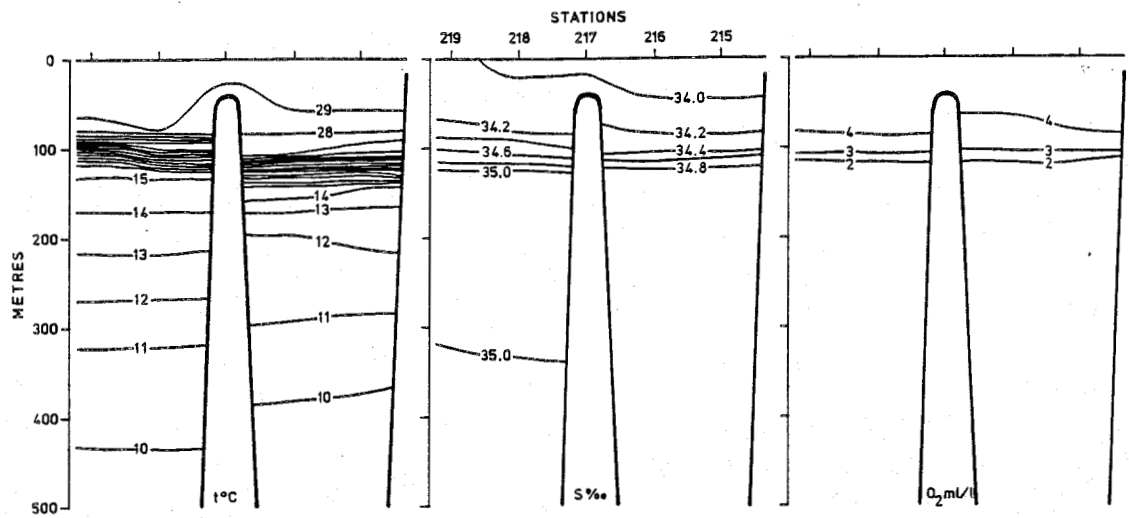


Fig. 6. Temperature, salinity and dissolved oxygen at hydrographic section Selat - Siberut, 20 August 1980.

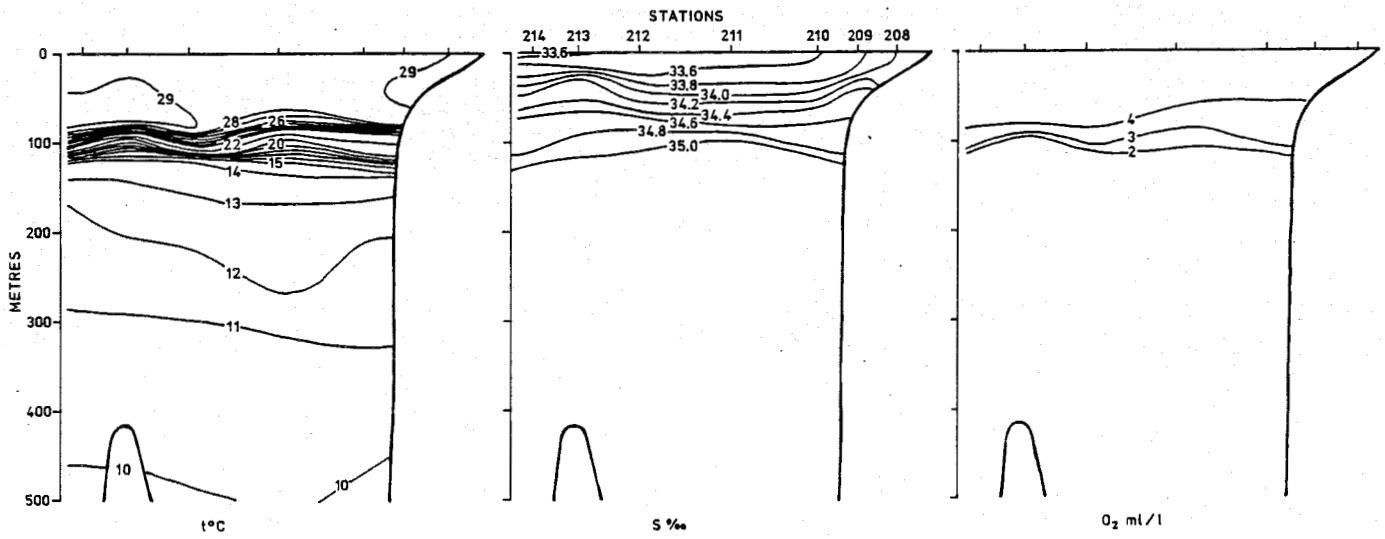


Fig. 7. Temperature, salinity and dissolved oxygen at hydrographic section Kutanibong - Kokos, 14-15 August 1980.

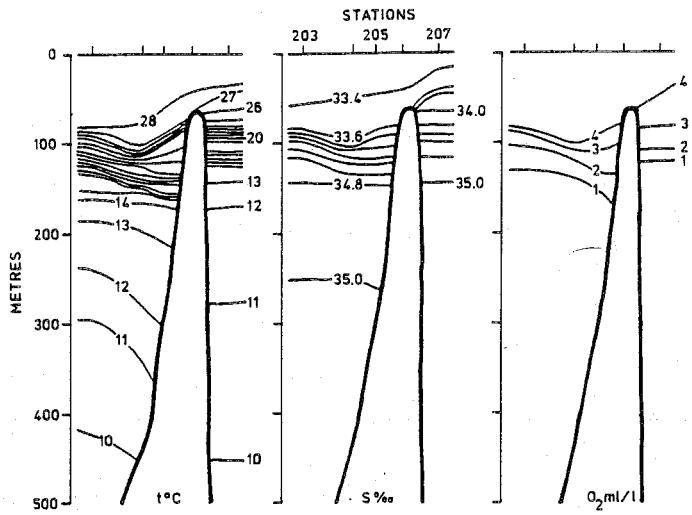


Fig. 8. Temperature, salinity and dissolved oxygen at hydrographic section Breueh Island - North, 13 August 1980.

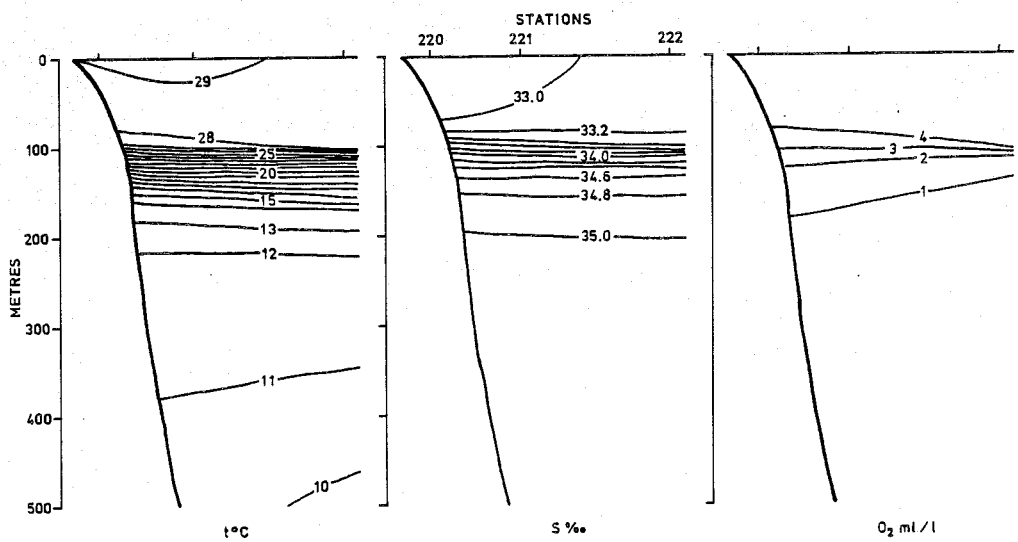


Fig. 9. Temperature, salinity and dissolved oxygen at hydrographic section Sigli - Northeast, 27 August 1980.

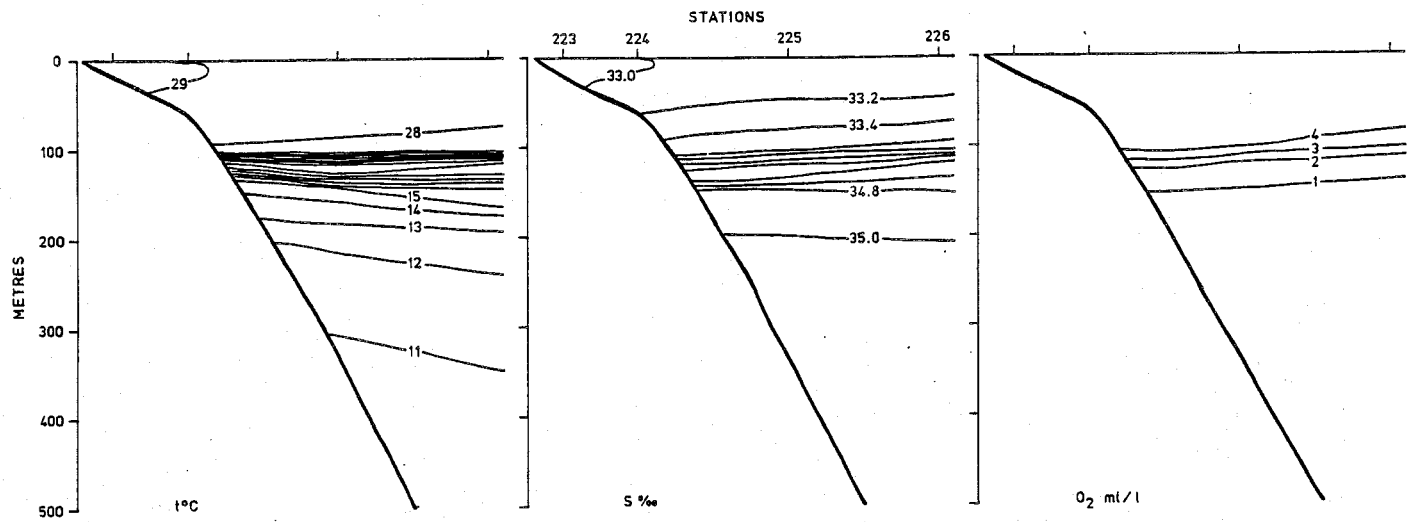


Fig. 10. Temperature, salinity and dissolved oxygen at hydrographic section Lhokseumawe - North, 27-28 August 1980.

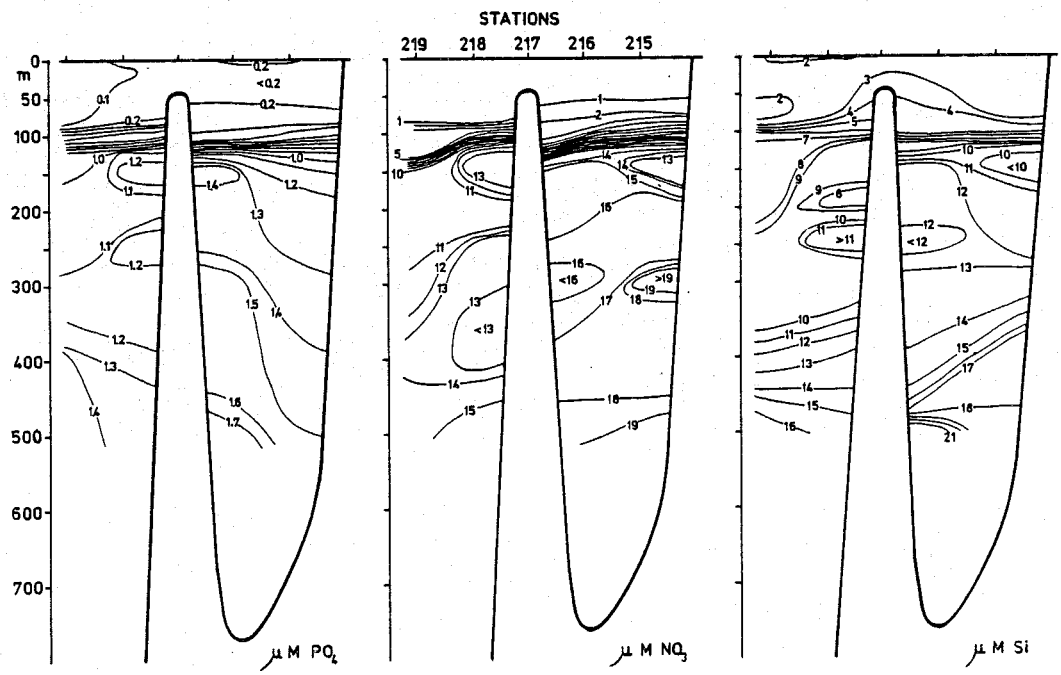


Fig. 11. Phosphate, nitrate and silicate at hydrographic section Selat - Siberut, 20 August 1980.

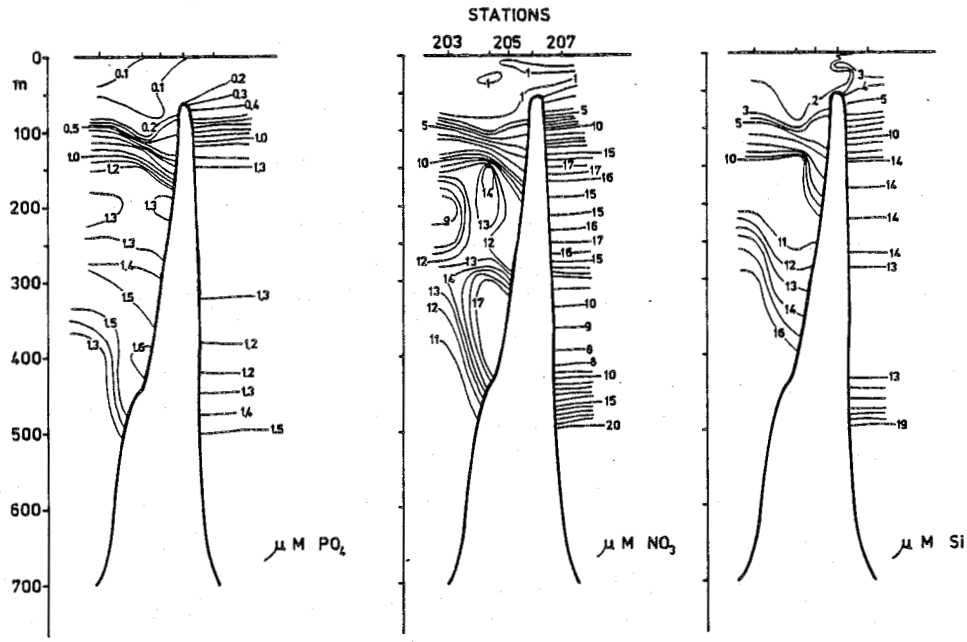


Fig. 12. Phosphate, nitrate and silicate at hydrographic section Kutaniborg - Kokos, 14-15 August 1980.

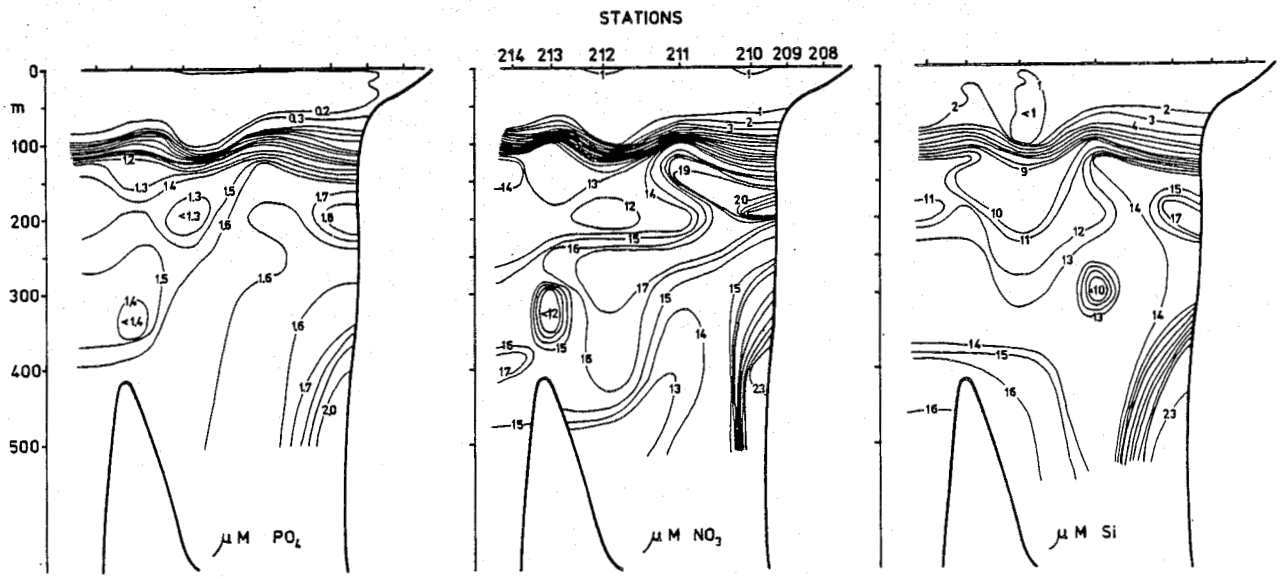


Fig. 13. Phosphate, nitrate and silicate at hydrographic section Breueh Island - North, 13 August 1980.

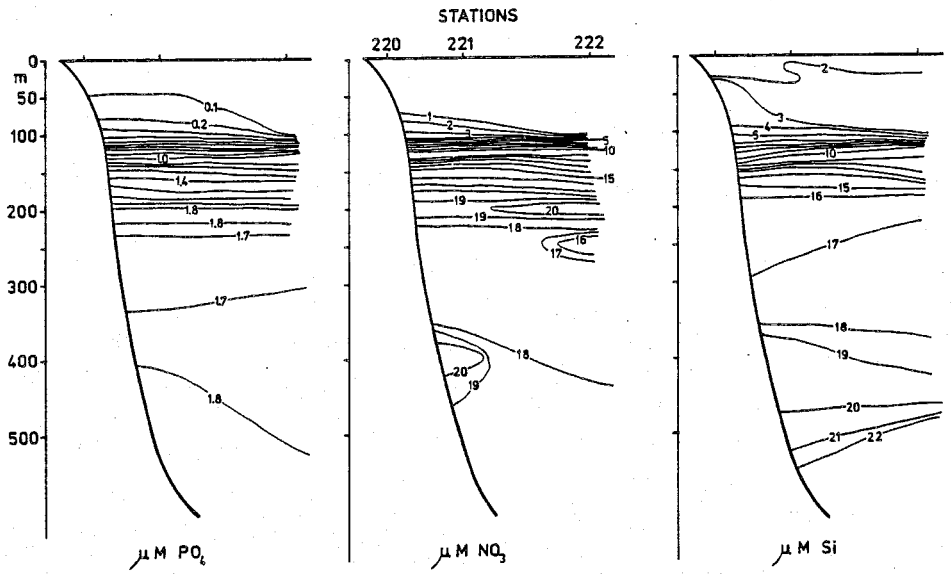


Fig. 14. Phosphate, nitrate and silicate at hydrographic section Sigli - Northeast, 27 August 1980.

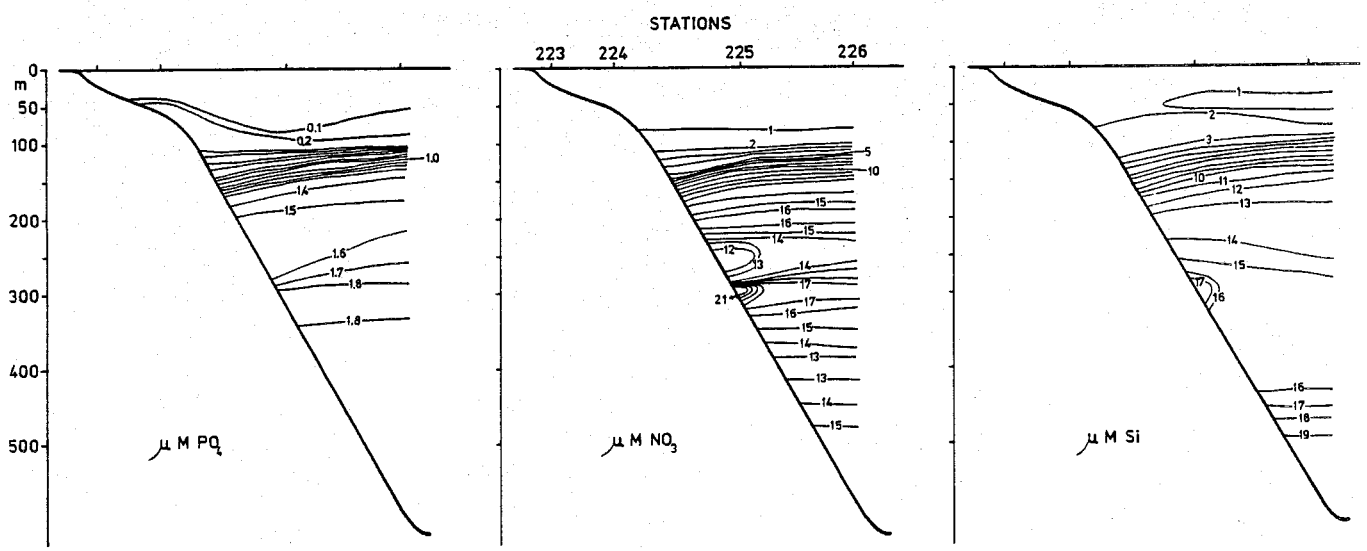


Fig. 15. Phosphate, nitrate and silicate at hydrographic section Lhokseumawe - North, 27-28 August 1980.

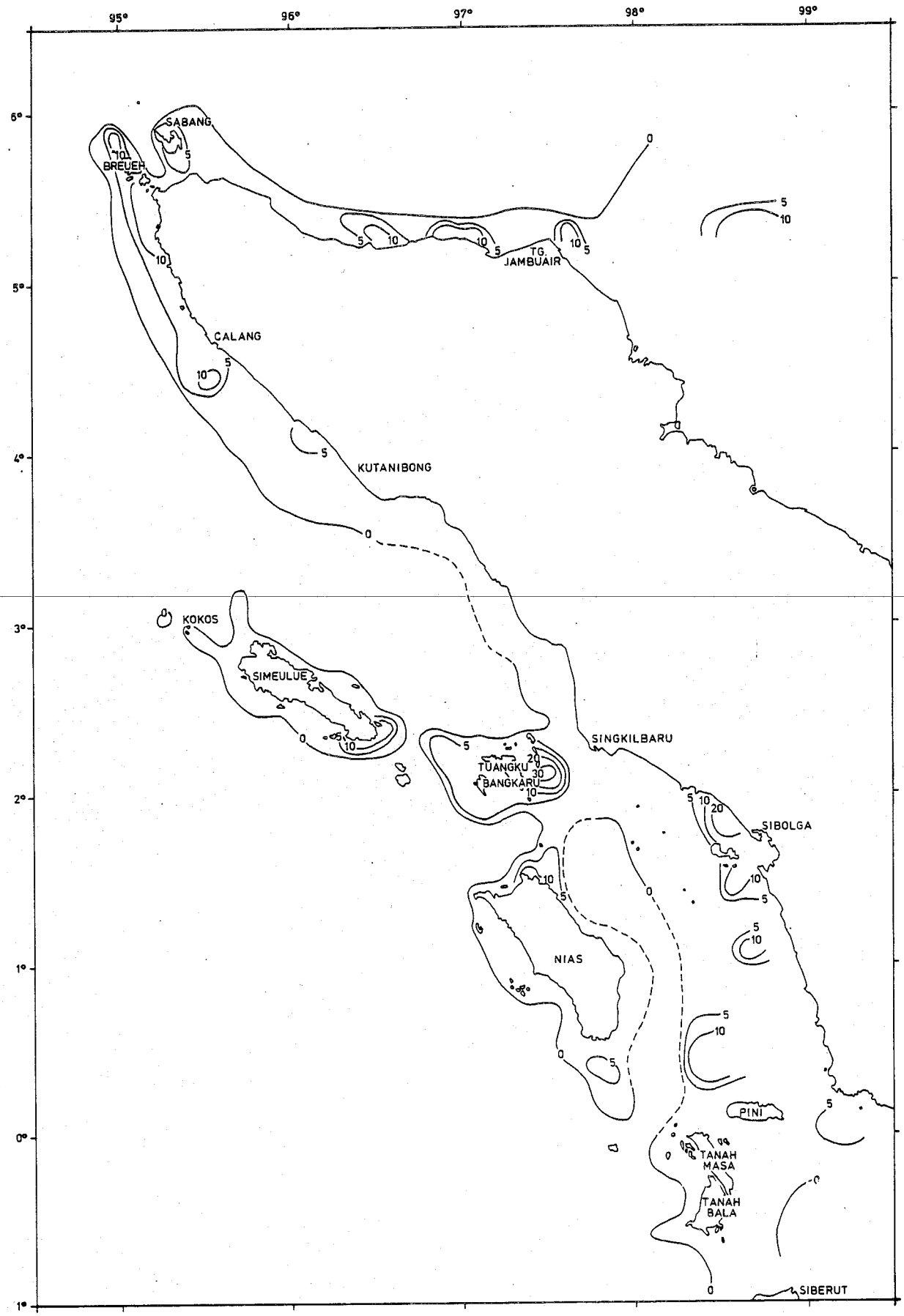


Fig. 16. Pelagic and demersal fish. Distribution of echo intensity (mm/nautical mile).

The profiles show a clear difference between the north and west part of Sumatra in that the vertical distribution indicate a more stabilized system on the north coast (Figs 14 - 15). The three transects from the west coast (Figs 11 - 13) show a vertical distribution which indicate fairly much movements in the deeper layers.

Both in the deep basins inside the islands Simeulue and Siberut and close to the western shelf higher nutrient values are found than in the more open ocean stations. This is most clearly demonstrated in Fig. 11, showing the profiles from the section north of Siberut, and in Fig. 12, showing the nutrient profiles in the section Kutanibong - Kokos.

3.4 Fish distribution and catch composition

As described under section 2.2 the integrated echo intensities were allocated on three main categories according to the appearance of the echo recordings and the composition of the trawl catches. The categoreis were: pure pelagic fish, fish close to bottom and plankton/juvenile fish.

"Pelagic" fish tended to stay close to bottom during daytime, while it scattered and raised slightly from the bottom during night. The separation of demersal and pelagic fish is accordingly likely to be doubtful. The distribution of integrator readings for demersal and pelagic fish are therefore combined in Fig. 16.

Fish recordings were limited to the areas of less than 200 m depths. Outside these areas only small quantities of mesopelagic fish were observed (mainly in the north). Both the recordings and the trawl catches increased from the edge of the shelf to the shore. Really high densities of fish were not observed in any area.

The recordings were seldom sufficiently above bottom to be identified by pelagic trawling. Therefore most of the recordings had to be identified by aid of bottom trawl. Longline was used in areas where the bottom was too rough for trawling. The longline was, however, easily damaged and the catches were small.

54 hauls were taken with bottom trawl and 22 with pelagic trawl.

The catches of the dominating species are listed for each fishing operation in Annex II, and all recorded fish species are listed in Annex IV. Length frequency distributions for some important species are given in Annex III.

Table 1 shows the average catch rate of each family in the bottom trawl hauls. Table 2 shows the average catch rate of typical deepwater fishes in four bottom trawl hauls.

Maximum catch rate was 3 050 kg/hour (Stn No 665, south of Sibolga), containing 30 % Leiognathidae which were dominant in most of the trawl hauls near the shore. Trichiurus haumela and various Carangidae (especially Carangoides malabaricus) occurred in most of the hauls taken in shallow waters. Other frequently occurring families were Nemipteridae, Mullidae and Synodontidae. Lutjanidae and Serranidae were mostly restricted to the areas along the edge of the shelf. Commercial fish constituted about 2/3 of the bottom trawl catches at less than 100 m depth. Bottom trawl catches at deeper waters (about 200-350 m) gave some shrimps, Myctophidae, Triglidae and Chlorophthalmus agassizi, and about 10% were commercial fish.

Table 3 shows the average catch rate of each family in the pelagic trawl hauls.

Some of the pelagic trawl hauls gave very small catches because the large pelagic fish avoided the trawl. The successful hauls in shallow waters were dominated by Clupeidae and Engraulidae. An exception was Stn No 657 which gave about 2 tonnes of Diodon sp. Off the shelf, Myctophidae dominated in the catches.

Table 1. Average catch rate (kg/hr) within depth zones. Sumatra, August 1980.

Family	Average catch rate (kg/hr)				
Depth:	10-25	26-50	51-75	76-100	230-350
Acanthuridae	-	0.4	0.3	-	-
Acropomatidae	-	-	-	+	-
Antennariidae	0.1	-	-	-	-
Apogonidae	+	+	+	+	0.6
Ariidae	0.4	1.1	1.1	-	-
Balistidae	-	3.1	2.1	1.3	0.4
Bothidae	+	+	+	+	+
Bregmacerotidae	-	-	+	-	-
Carangidae	6.6	18.5	10.9	1.1	-
Chaetodontidae	-	0.1	-	-	-
Chirocentridae	0.2	0.1	+	-	-
Clupeidae	4.7	3.8	0.8	-	-
Cynoglossidae	0.2	-	+	-	-
Dactylopteridae	-	+	0.7	0.3	-
Diodontidae	-	0.2	0.2	0.2	-
Echeneidae	-	+	-	+	-
Emmelichthyidae	-	-	-	+	-
Engraulidae	2.4	0.4	0.1	-	-
Ephippidae	+	0.8	+	-	-
Exocoetidae	-	-	+	-	-
Fistulariidae	-	0.4	+	0.6	-
Formionidae	0.2	0.9	0.5	-	-
Gerreidae	0.1	6.6	2.2	0.3	-
Harpodontidae	4.5	-	0.9	-	0.1
Holocentridae	0.1	0.5	-	+	-
Labridae	-	+	+	-	-
Lactariidae	2.2	6.7	0.8	-	-
Leiognathidae	25.7	151.2	4.4	0.1	-
Lethrinidae	-	0.9	2.3	-	-
Lobotidae	0.6	-	-	-	-
Lutjanidae	-	11.3	20.0	13.4	-
Menidae	0.2	+	+	-	-
Mullidae	1.2	14.2	2.8	1.1	-
Myctophidae	-	-	+	-	2.9
Nemipteridae	0.1	1.5	1.8	0.7	0.1
Ogcocephalidae	-	-	-	0.1	0.2
Ophidiidae	-	-	-	+	1.6
Ostraciontidae	-	0.5	0.3	0.2	-
Paralepididae	-	-	+	+	0.1
Pentapodidae	-	1.0	1.1	3.3	-
Pempheridae	-	-	-	+	-
Platycephalidae	+	+	+	-	-
Pleuronectidae	-	-	+	+	0.3
Polynemidae	0.4	2.6	0.3	-	-
Pomacentridae	-	+	-	-	-
Pomadasyidae	6.9	16.7	1.4	1.0	-
Priacanthidae	-	0.6	1.6	1.0	34.2
Psettodidae	0.3	0.3	0.4	+	-

(Table 1 - continued)

Family	Depth: 10-25	26-50	51-75	76-100	230-350
Scaridae	-	0.5	-	-	-
Sciaenidae	6.4	1.3	0.1	-	-
Scombridae	10.2	4.6	1.3	+	-
Scorpaenidae	-	+	0.1	+	1.4
Serranidae	-	1.8	0.6	+	-
Siganidae	-	0.2	-	-	-
Sphyraenidae	2.1	20.5	2.1	1.2	-
Stromateidae	0.6	0.7	-	-	-
Synodontidae	4.1	1.0	5.3	1.7	0.3
Tetraodontidae	+	0.2	1.0	0.2	+
Theraponidae	2.6	1.6	0.2	+	-
Triacanthidae	-	+	+	+	-
Trichiuridae	25.8	14.3	1.9	+	0.3
Uranoscopidae	+	-	-	+	0.4
Selachimorpha	2.3	3.6	3.0	-	34.1
Batoidimorpha	0.4	2.6	13.3	-	-
Cephalopoda	2.2	0.4	0.5	0.8	2.2
Crustacea	4.9	0.6	0.1	0.2	27.1
Unidentified	+	-	2.2*	+	7.3
DEMERSAL FISH	61.6	112.4	65.9	26.5	84.0
PELAGIC FISH	49.7	185.1	19.8	1.5	-
DEEPWATER FISH (see Table 2)	-	-	-	-	30.3
TOTAL	118.4	298.5	88.5	29.0	143.3
Number of hauls	8	18	13	9	4
Average weight (%) of commercial fish	67	54	67	72	10

+) Less than 0.1 kg/hr. *) Mainly oysters.

Table 2.

Average catch rate (kg/hr) of typical deepwater fishes in four bottom trawl hauls at 230-350 m depth. Sumatra, August 1980.

Family	Average catch rate (kg/hr)
Callionymidae	0.1
Caproidae	+
Centrolophidae	0.1
Champsodontidae	+
Chaunacidae	0.8
Chlorophthalmidae	11.3
Diretmidae	2.5
Gadidae	0.4
Gempylidae	3.0
Gonostomatidae	0.1
Lophiidae	0.2
Macrouridae	2.4
Macrurocyttidae	0.8
Moridae	+
Neoscopelidae	0.1
Nomeidae	4.3
Percophididae	0.4
Polymixidae	0.3
Sternoptychidae	0.4
Stomiatidae	+
Triacanthodidae	0.7
Triglidae	2.1
Zeidae	+
TOTAL	30.0
Other organisms (see Table 1)	113.3

+) Less than 0.1 kg/hr.

Table 3.

Average catch rate (kg/hr) in pelagic trawl hauls. Sumatra, August 1980.

Family	Average catch rate (kg/hr) Bottom depth: <100m	>100m
Anguilliformes	+	+
Apogonidae	+	+
Astronesthidae	-	+
Balistidae	-	+
Bregmacerotidae	+	-
Carangidae	2.8	0.1
Champsodontidae	-	+
Clupeidae	29.7	0.1
Diodontidae	265.8	-
Echeneidae	0.1	-
Elopidae	0.9	-
Emmelichthyidae	+	+
Engraulidae	1.9	+
Exocoetidae	-	+
Gempylidae	-	+
Gonostomatidae	-	0.2
Harpodontidae	-	+
Lactariidae	0.1	-
Leiognathidae	2.4	-
Lutjanidae	+	-
Menidae	0.6	+
Mullidae	-	+
Myctophidae	8.1	34.0
Nomeidae	-	0.1
Paralepididae	+	0.1
Priacanthidae	0.1	-
Scombridae	1.7	+
Sphyraenidae	1.5	+
Stomiatidae	-	0.2
Stromateidae	0.1	-
Synodontidae	+	-
Trichiuridae	1.3	0.2
Unidentified/juv. fish	0.2	+
Crustacea	8.9	0.3
Cephalopoda	0.1	0.5
Jellyfish/salps	16.0	0.7
TOTAL	342.4	36.5
Number of hauls	15	7
Average weight (%) commercial fish	73*	1

*) Clean catches of juvenile fish excluded.

Table 4. Abundance of demersal fish estimated from bottom trawl catch rates. Sumatra, August 1980.

	No.of hauls	Area ($n.m^2$)	Catch rate (kg/hr) Mean	S.Dev.	Density ($t/n.m^2$)	Total abundance (1000 tonnes)
Coastal area (10-25m)	8	7350	62	86	2.1	15
Offshore area (26-50m)	18	9800	112	197	3.7	37
" " (51-75m)	13	4900	66	64	2.2	11
" " (76-100m)	9	2450	27	26	0.9	2
TOTAL	48	24500			2.6	65

Table 5. Fish abundance estimated from mean integrator values and fish lengths within sub-areas Sumatra, August 1980.

Sub-area	Area* ($n.m^2$)	Mean integrator value (mm/n.m) Pure Pelagic	Close to bottom	Mean fish length (cm) Pure pelagic	Close to bottom	Weight % "pelagic" fish in bottom trawl	Average fish density (tonnes/$n.mile^2$) Pure pelagic	"Pelagic" Close to bottom	fish close to bottom	Total abundance (1000 tonnes) Pelagic	Demersal
I	6700	2.8	1.5	10	17	19	7.0	6.4	1.2	55	35
II	3800	1.7	1.8		18	35	4.3	8.1	2.8	27	20
III	6100	2.7	1.5	13	17	22	8.8	6.4	1.4	62	31
IV	8200	2.3	2.2	16	16	47	9.2	8.8	4.1	109	39
Total	24800						7.8	7.5	2.5	253	124

*) Area within the seaward limit of commercial fish recordings. See Fig. 17.

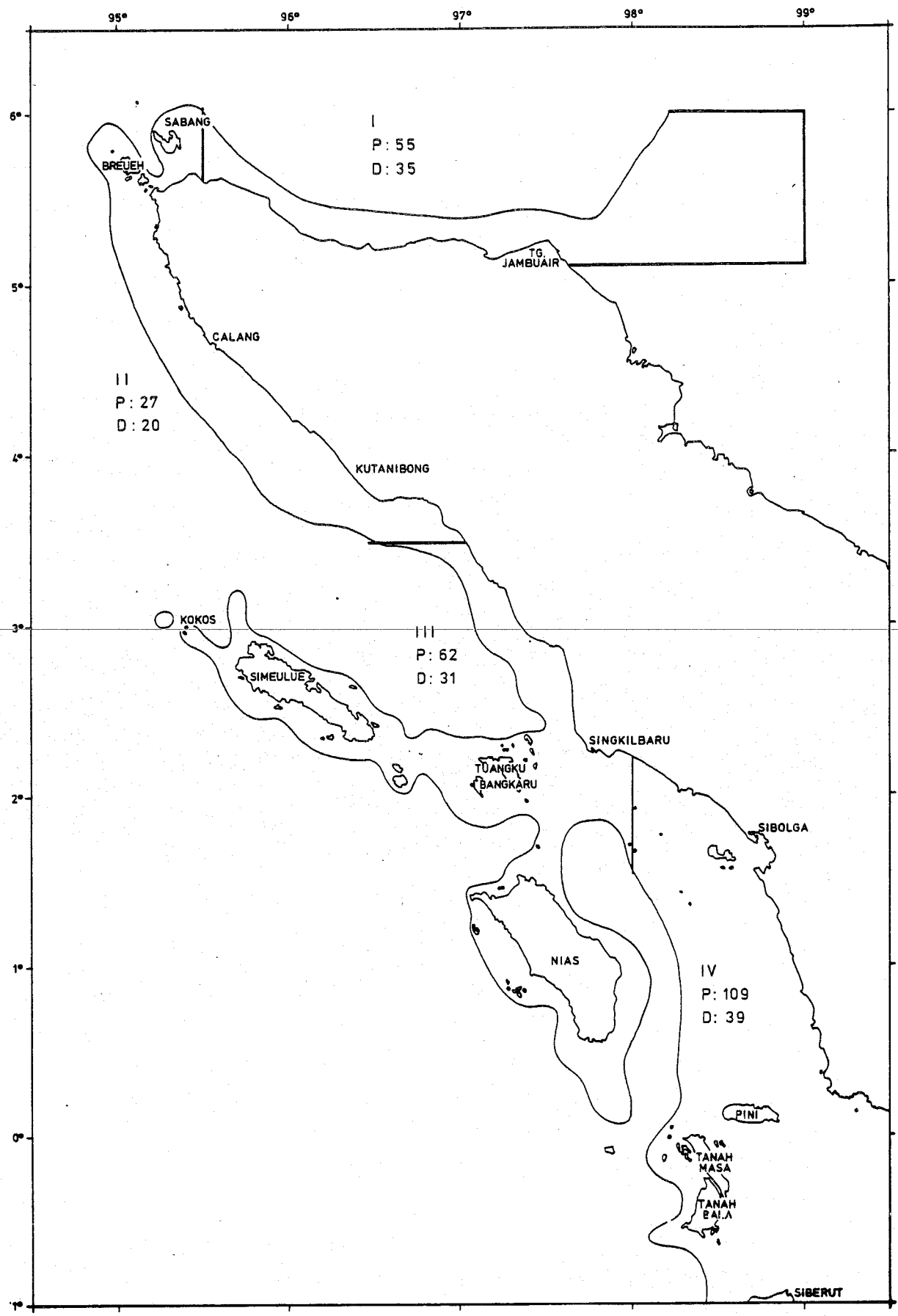


Fig. 17. Subareas used for acoustic abundance estimation. Estimates given in thousand tonnes. Seaward limit of commercial fish recordings is indicated. P: pelagic fish, D: demersal fish.

3.5 Fish abundance

The average catch rates of demersal fish shown in Table 1 were used to estimate abundance of demersal fish by the swept area method. The results are shown in Table 4. The total standing stock of demersal fish was estimated to be 65 000 tonnes only. About 80% of the demersal fish was found within the 50 m depth contour.

Fish abundance estimated from the echo integrator values as described under section 2.2 are shown in Table 5. The surveyed area was divided into four sub-areas (Fig. 17), and the average fish densities were estimated for each sub-area.

The acoustic estimate of 124 000 tonnes of demersal fish is considerably higher than the abundance calculated by the swept area method. There is, however, reason to believe that the trawl catches underestimate the abundance. The best echo recordings seemed to prevail in areas of bad bottom conditions where trawl fishing was not possible. Furthermore, the applied catchability coefficient (c=1) gives estimates which are likely to be too low.

The total stock of pelagic fish was estimated at about 250 000 tonnes. The highest abundance was recorded in sub-area IV (Fig. 17).

4. DISCUSSION AND CONCLUSIONS

The north-western part of Sumatra was surveyed during three weeks of August. The survey period was thus falling within the southwest monsoon period, but the weather conditions were good throughout the survey.

The observations made during this short period may not be representative for the rest of the year. Therefore one should be cautious in drawing precise conclusions about fish produtivity and sustainable yields based on the abundance estimates obtained from the survey.

Acoustic observations together with information on catch rates and species and size composition in the catches from 79 fishing stations form the basis for an assessment of the fish biomass.

The acoustic recordings of fish were classified in two main categories: pure pelagic fish and fish close to bottom. The latter category was further separated in pelagic and demersal fish on the basis of bottom trawl catches. All fish belonging to the families Carangidae, Clupeidae, Engraulidae, Gerreidae, Leiognathidae and Scombridae were defined as "pelagic".

For navigational reasons inshore areas of depth less than about 10 m could not be covered in this survey. These uncovered parts of the shelf comprised less than 10% of the shelf. The biomass have been raised by simple area ratios to compensate for the uncovered shelf parts. This adjustment is based on the assumption that the mean fish densities in the inshore shallow areas are the same as on the outer shelf. The fish density tended to increase towards the coast. Therefore the inshore areas may be the richest. The correction factor will then be too small and underestimate the total fish biomass.

The acoustic system does not cover the depth layer from the surface down to about 10 m, nor does it separate echoes from fish very close to the sea bottom (within about ½-1 m). The conversion factor used for calculating fish abundance in tonnes from echo intensity (mm deflection) represents "cod-type" fish (page 6), and may not be representative for the dominant fish species in these waters. Too little is known about the acoustic properties and behaviour of the fishes in the area for the evaluation of the total effect of these factors. In addition, the survey coverage was rather uneven and partly hindered by reefs. The abundance estimates given below therefore have to be used with some reservation.

The assessments of total biomass of standing stock were (thousand tonnes):

	Acoustic	"Swept area"
Pelagic fish	250	-
Demersal fish	120	(65)
Total	370	-

The biomass estimated by the swept area method is likely to be much too low, because many of the areas of recordings could not be sampled due to rough bottom, and because of uncertainties about the true value of the catchability coefficient.

Conservative estimates (ANON 1979a) of the biomass of the Indonesian fish resources in the Indian Ocean are in the order of 150 000 tonnes of pelagic fish and 100 000 tonnes of demersal fish. The central part of western Sumatra yields 2/3 of all Indian Ocean catch (ANON 1979a). If the rate of exploitation is the same in the various areas, the corresponding estimates of resources in the surveyed area would be about 100 000 tonnes of pelagic fish and 70 000 tonnes of demersal fish. Table 6 shows these estimates compared to the estimates obtained in subareas II, III and IV of this survey and landings in the same area (the provinces West Sumatra, North Sumatra and Aceh west coast). The survey estimates in subarea I is compared to the landings at the north coast of the Aceh province.

Table 6. Biomass estimates and fish landings at the west coast (the Aceh, North Sumatra and West Sumatra provinces) and at the north coast (the Aceh province), in thousand tonnes.

	Biomass estimates (Dr.F.N. 1980)	Biomass estimates (ANON 1979a)	Potential yield (ANON 1979a)	Landings 1976-77 (ANON 1979b)
West coast:				
Pelagic	200	100*	>45*	41
Demersal	90	70*	12*	13
TOTAL	290	170	57	54
North coast:				
Pelagic	55	-	-	12
Demersal	35	-	-	5
TOTAL	90	-	-	17

*) 2/3 of estimates given by ANON (1979a) for the Indonesian part of the Indian Ocean.

The survey estimate for pelagic fish is considerably higher than the one given by ANON (1979a). Although the uncertainty of the estimates are high, this indicates possibilities for increased catches of pelagic fish. One should note that the estimates from this survey does not include tuna-like fishes. Schools of tuna-like fishes were occasionally observed at the surface.

About 2/3 of the bottom trawl catches was classified as commercial fish by the Indonesian scientists. The bottom trawl catch rates were low in areas with suitable trawl bottom. There may, however, be possibilities for increased yields by shifting to fishing gears which are operative on rough bottom.

The average fish densities observed on the shelf (inside the 200 m contour) were from 12 to 18 tonnes/n. mile^2 (Table 5) in all the sub-areas. This is quite comparable to density estimates obtained with "Dr. Fridtjof Nansen" in neighbouring areas during 1979 and 1980, but considerably lower than the estimates obtained at Sri Lanka during 1979-1980 and at Pakistan during Jan-May 1977. These are compared in Table 7.

Table 7. Average fish densities within various areas of the shelf (at 10 to 200 m depth) along the Indian Ocean and South China Sea, estimated during cruises with R/V "Dr. Fridtjof Nansen" (tonnes/square nautical mile).

Area	Time	Average fish density (tonnes/n.mile^2)	References
Peninsular Malaysia			
East	June 1980	12	AGLEN & al. 1981
West	Jun-Jul 1980	19	AGLEN & al. 1981
Sumatra			
North and West	Aug 1980	15	(Table 5)
Thailand			
West	Jul 1980	15	AGLEN & al.(in press)
Burma	Sep-Nov 1979	17	STRØMME & al. 1981
	Mar-Apr 1980	34	STRØMME & al. 1981
Bangladesh	Nov-Dec 1979	16	SÆTRE 1981
	May 1980	19	SÆTRE 1981
Sri Lanka	Aug-Sep 1978	84	SÆTERSDAL & DE BRUIN 1979
	Apr-Jun 1979	60	BLINDHEIM & al. 1979
	Jan-Feb 1980	58	BLINDHEIM & FØYN 1980
Pakistan	Jan-Feb 1977	83	ANON 1978
	Feb-Mar 1977	47	"
	Mar-Apr 1977	64	"
	Apr-May 1977	48	"
	May-Jun 1977	20	"

The variation of the estimates from the repeated surveys in Burma, Bangladesh, Sri Lanka and Pakistan illustrates some of the seasonal variations which are likely to occur in these areas. Therefore it should be

stressed that the present survey was completed in a very short time period and that pelagic species in particular may show considerable seasonal fluctuations. To fully assess the potential yield, additional investigations during other parts of the year are required.

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ANNEX I

Scientific and Technical Staff of the Survey
Sumatra, 6 - 30 August 1980

Institute of Marine Research, Bergen	Lars Føyn (cruise leader)
	Asgeir Aglen
	Sigmund Myklevoll
	Bjørn Bakken
	Jens P. Maude
Institute of Marine Research, Jakarta	Edy Muljadi Amin (team leader)
	Herry Riah Barus
	Dadang Karyana
Directorate General of Fisheries, Jakarta	Enni Sutopo
	Sumarno Slamet Widodo
	Alfonsus Soepardjo

ANNEX II

RECORD OF FISHING OPERATIONS
R/V "Dr. Fridtjof Nansen", Sumatra North & West Coast Cruise 1980
BT: Bottom trawl, PT: Pelagic trawl, LL: Longline

DATE	TIME START	STN NO.	GEAR TYPE	DEPTH (M) BOTTOM	DEPTH (M) GEAR	POSITION NORTH	POSITION EAST	CATCH (KG) TOTAL	CATCH (KG) PR HR	DOMINANT SPECIES	WEIGHT (KG) TOTAL	WEIGHT (KG) MEAN
12.8	1340	632	BT	310	310	5°19'	96°43'	60.50	303.00	Chlorophthalmus agassizi	7.00	
										Priacanthus macracanthus	26.00	0.08
										Shark: Centrophorus sp.	6.60	3.30
										Shrimps	9.70	
12.8	2140	633	PT	307	23	5°39'	95°33'	103.70	207.00	Myctophidae	102.60	
13.8	0050	634	PT	333	50/75	5°41'	95°20'	14.50	16.40	Myctophidae	13.80	
13.8	0455	635	PT	52	40	5°52'	94°55'	0.30	0.80	Cephalopoda: Loligo	0.30	
13.8	1810	636	BT	45	45	5°23'	95°09'	89.30	189.00	Leiognathidae (6 spp.)	12.40	
										Upeneus sulphureus	5.80	0.04
										Pomadasyidae (3 spp.)	9.00	
										Sphyraena obtusata	6.75	0.06
										Trichiurus haumela	33.00	0.25
14.8	0005	637	PT	385	0	4°57'	95°07'	0.20	0.50	Myctophidae	0.03	
										Cephalopoda: Decapoda	0.15	0.01
14.8	0210	638	PT	42	20	4°52'	98°18'	140.00	420.00	Trichiuridae	6.10	
										Euphasiids	80.00	
										Jellyfish	40.00	
14.8	0415	639	BT	45	45	4°47'	98°17'	75.80	303.00	Caesio erythrogaster	20.50	0.39
										Lutjanidae (other, 5 spp.)	7.80	
										Pomadasyidae (2 spp.)	5.15	
										Epinephelus areolatus	4.15	0.19
14.8	0800	640	PT	48	26	4°34'	95°26'	27.70	55.00	Elops sp.	6.40	
										Leiognathus elongatus	5.30	
										Mysidae	6.40	
14.8	0950	641	BT	33	33	4°33'	95°31'	97.85	196.00	Leiognathus bindus	9.10	
										Leiognathus equulus	40.00	0.08
										Pomadasys argyreus	17.00	0.03
										Scomberomorus guttatus	7.20	0.48
										Trichiurus haumela	7.75	0.13
14.8	1212	642	BT	19	19	4°36'	95°41'	59.50	119.00	Engraulidae (2 spp.)	4.25	
										Harpadon nehereus	14.25	0.03
										Leiognathus bindus	4.25	0.01
										Pomadasys sp.	3.75	
										Rastrelliger brachysoma	3.50	0.05
										Trichiurus haumela	5.90	0.12
										Shrimps: Penaeus (3 spp.)	7.35	
14.8	1435	643	BT	74	74	4°16'	95°37'	9.70	29.00	Harpadon sp.	2.50	
										Lutjanus sanguineus	6.65	1.11
14.8	1815	644	BT	58	58	4°06'	95°52'	65.75	132.00	Leiognathus bindus	12.00	0.02
										Lutjanus sanguineus	21.60	2.40
										Nemipterus japonicus	4.00	0.07
										Saurida tumbil	5.50	0.20
										Sharks:Carcharhinidae (2 spp.)	5.60	
14.8	2015	645	BT	15	15	4°05'	96°05'	11.60	23.00	Pomadasys argyreus	4.45	0.02
										Shrimps	1.35	
14.8	2335	646	PT	720	0	3°50'	95°47'	2.70	5.40	Myctophidae (3 spp.)	0.20	
										Cephalipoda: Loligo	0.50	
										Jellyfish	2.00	
15.8	0240	647	BT			3°50'	96°04'	9.70	29.00	Saurida tumbil	2.50	0.17
										Shark: Carcharhinus sealei	3.30	3.30
15.8	2210	648	PT	83	34	3°05'	95°41'	3.80	7.60	Decapterus macrosoma	3.40	0.21
										Myctophidae	0.40	0.002
16.8	0450	649	BT	233	233	2°30'	95°56'	50.00	100.00	Priacanthus sp.	2.70	0.05
										Triacanthodidae (2 spp.)	5.00	
										Triglidae (3 spp.)	5.00	
										Shark: Centrophorus sp.	25.00	3.13
16.8	1040	650	BT	34	34	2°17'	96°31'	0.55	1.10	Diodon hystrix	1.00	0.33
16.8	1315	651	PT	79	8	2°25'	96°33'	0.05	0.10	Carangidae (larvae)		
17.8	0735	652	BT	47	47	2°24'	96°29'	0.05	0.20	Leiognathus elongatus		

DATE	TIME START	STN NO.	GEAR TYPE	DEPTH (M) BOTTOM	DEPTH (M) GEAR	POSITION NORTH	POSITION EAST	CATCH (KG) TOTAL	CATCH (KG) PR HR	DOMINANT SPECIES	WEIGHT (KG) TOTAL	WEIGHT (KG) MEAN
17.8	1250	653	BT	97	97	1°59'	97°02'	7.70	15.00	Lutjanus malabaricus	6.75	3.25
17.8	1400	654	BT	95	95	1°59'	97°01'	36.30	73.00	Pristipomoides typus	10.55	1.06
										Gymnocranius robinsoni	11.35	3.78
17.8	1645	655	BT	80	80	1°59'	97°19'	2.95	18.00	Pristipomoides typus	1.45	1.45
										Gymnocranius griseus	1.10	0.37
17.8	1850	656	PT	66	18	2°06'	97°28'			(No catch)		
17.8	2020	657	PT	58	30	2°09'	97°28'	2000.00	4000.00	Diodon sp.	1994.00	
17.8	2350	658	BT	38	38	2°10'	97°39'	20.40	41.00	Selaroides leptolepis	2.65	0.04
										Pentaprion longimnus	8.35	0.02
										Priacanthus tayenus	2.50	0.04
18.8	0230	659	BT	57	57	2°02'	97°43'	40.35	161.00	Lutjanus malabaricus	12.00	1.20
										Lutjanus sanguineus	14.40	1.60
										Mollusca (oyster)	7.00	0.14
18.8	0850	660	BT	50	50	1°41	98°17'			(trawl faulty - no catch)		
18.8	1225	661	BT	26	26	1°54'	98°25'	1.15	2.30	Rastrelliger spp.	0.40	
18.8	1520	662	BT	25	25	1°48'	98°28'	26.70	53.00	Dussumieria acuta	1.00	0.03
										Sardinella spp.	2.60	
										Leiognathidae (5 spp.)	1.35	
										Rastrelliger brachysoma	14.70	0.07
18.8	2340	663	PT	47	25	1°26'	98°36'	209.30	419.00	Dussumieria acuta	53.20	0.02
										Sardinella gibbosa	123.20	0.03
										Sardinella sirm	14.00	0.04
19.8	0435	664	PT	43	20	1°05'	98°37'	30.95	62.00	Sardinella sirm	14.50	0.07
										Sardinella fimbriata	10.00	0.05
19.8	0830	665	BT	46	46	0°51'	98°40'	1520.55	3041.00	Carangidae (5 spp.)	50.00	
										Pentaprion longimanus	37.50	0.02
										Lactarius lactarius	30.00	0.04
										Leiognathus bindus	315.00	0.011
										Leiognathus equulus	50.00	0.08
										Leiognathus splendens	635.00	0.02
										Upeneus sulphureus	100.00	0.03
										Pomadasys argyreus	65.00	0.04
										Sphyraena obtusata	90.00	0.07
										Trichiurus haumela	62.50	0.08
19.8	1545	666	BT	32	32	0°18'	98°42'	7.00	14.00	Balistidae	4.60	0.012
19.8	2000	667	BT	42	42	0°00'	99°10'	3.20	6.40	Selar crumenophthalmus	1.00	0.14
										Decapterus macrosoma	0.70	0.05
						SOUTH						
20.8	0045	668	BT	78	78	0°13'	98°49'	34.85	70.00	Abalistes stellaris	3.50	0.70
										Pristipomoides typus	9.00	0.23
										Upeneus moluccensis	3.75	0.05
										Saurida tumbil & Undosquamis	5.00	0.27, 0.06
20.8	0155	669	PT	83	7	0°11'	98°49'	0.95	1.90	Fish larvae-postlarvae-juveniles		
20.8	1015	670	BT	40	40	0°41'	98°41'	36.75	74.00	Balistidae (4 spp.)	11.25	
										Shark: Steeostoma varium	14.30	14.30
20.8	1850	671	BT	300	300	0°42'	98°15'	28.45	57.00	Cubiceps	2.20	0.03
										Shark: Centrophorus sp.	3.55	1.78
										" Squatina sp.	11.50	11.50
20.8	2335	672	BT	78	78	0°24'	98°20'	0.90	1.8	Decapterus macrosoma	0.60	
21.8	0245	673	BT	74/99	74/99	0°10'	98°08'	0.35	0.7	Cephalopoda	0.20	0.20
21.8	0430	674	LL	45/63	45/63	0°07'	98°06'			(No catch)		
21.8	1345	675	BT	69/88	69/88	0°32'	97°40'	23.10	46.00	Carangoides malabaricus	2.40	0.20
										Lutjanus sanguineus	10.25	3.42
										Sphyraena forsteri	5.60	0.15
						NORTH						
21.8	1815	676	BT	54	54	0°52'	97°26'	4.30	5.70	Selar crumenophthalmus	1.75	0.08
										Shark: Hypogaleus hyugaensis	1.40	1.40
21.8	2200	677	PT	700	0	1°00'	97°08'	0.10	0.20	Myctophidae		

DATE	TIME START	STN NO.	GEAR TYPE	DEPTH (M) BOTTOM	DEPTH (M) GEAR	POSITION NORTH	POSITION EAST	CATCH (KG) TOTAL	CATCH (KG) PR HR	DOMINANT SPECIES	WEIGHT (KG) TOTAL	WEIGHT (KG) MEAN
22.8	0130	678	BT	66	66	1°15'	97°05'	21.50	43.00	Carangoides malabaricus	3.40	0.12
										Pentaprion longimanus	1.75	0.03
										Lutjanus sanguineus	3.80	3.80
										Pristipomoides typus	3.55	0.32
22.8	0400	679	LL	63	63	1°25'	97°03'	12.40		Lutjanus argentimaculatus	4.50	4.50
										Pristipomoides typus	5.05	1.68
22.8	1350	680	BT	98	98	1°57'	97°32'	8.95	18.00	Fistularia sp.	1.30	1.30
										Lutjanus sanguineus	7.00	3.50
22.8	1545	681	PT	87	40/20	2°04'	97°31'			Fish larvae + juveniles		
22.8	1940	682	BT	36	36	2°27'	97°27'	8.65	17.00	Balistidae	1.45	0.02
										Nemipteridae (2 spp.)	3.40	
										Sphyraena barracuda	1.60	1.60
22.8	2145	683	PT	29	10	2°34'	97°32'	4.80	10.00	Selar crumenophthalmus	1.75	0.07
										Sardinella gibbosa	1.45	0.04
23.8	0050	684	BT	61	61	2°44'	97°25'	37.10	89.00	Abalistes stellaris	2.75	0.46
										Carangoides malabaricus	3.15	0.11
										Lutjanus sanguineus	6.85	2.28
										Upeneus moluccensis	3.00	0.06
										Priacanthus tayenus	5.70	0.03
										Saurida tumbil	3.45	0.23
24.8	1530	685	BT	25	25	3°46'	96°25'	151.75	304.00	Lactarius lactarius	4.75	0.03
										Pomadasys argyreus	12.10	0.06
										Saurida tumbil	9.25	0.15
										Trichiurus haumela	91.00	0.19
24.8	1755	686	BT	35	35	3°57'	96°10'	410.95	822.00	Selar boops	36.70	0.12
										Lactarius lactarius	26.00	0.04
										Leiognathus bindus	56.60	0.03
										Leiognathus equulus	102.50	0.07
										Pomadasys argyreus	27.55	0.05
										Sphyraena obtusata	49.75	0.05
24.8	1955	687	BT	69	69	3°57'	95°59'	45.00	90.00	Carangoides malabaricus	10.35	0.13
										Pentaprion longimanus	4.00	0.02
										Lutjanus lineolatus	4.40	0.03
										Lutjanus sanguineus	5.55	2.78
										Saurida tumbil	4.15	0.15
24.8	2235	688	BT	95	95	3°57'	95°48'	8.95	18.00	Pristipomoides typus	2.95	0.98
										Priacanthus hamrur	3.00	0.25
25.8	0115	689	BT	74	74	4°04'	95°46'	112.15	224.00	Pristipomoides typus	11.40	1.04
										Aetobatis narinari	85.00	85.00
25.8	0355	690	BT	18	18	4°16'	95°55'	56.50	113.00	Leiognathidae	17.60	
										Sciaenidae	6.80	
										Shrimp: Penaeus spp.	8.00	
25.8	9545	691	BT	18	18	4°21'	95°48'	27.95	56.00	Leiognathus splendens	6.40	0.01
										Pomadasys argyreus	5.50	0.02
										Saurida tumbil	5.50	0.50
25.8	0725	692	BT	64	64	4°12'	95°44'	0.05	0.10	Thenus orientalis	0.05	0.05
25.8	0910	693	BT	53	53	4°20'	95°39'	140.05	280.00	Selar crumenophthalmus	38.25	0.13
										Sphyraena obtusata	10.55	0.08
										Saurida tumbil	13.25	0.27
										Trichiurus haumela	11.00	0.35
25.8	1525	695	BT	56/76	56/76	4°25'	95°28'	1.85	2.80	Arius sp.	1.25	0.63
25.8	1525	695	BT	37	37	4°30'	95°34'	7.40	15.00	Leiognathidae (4 spp.)	1.70	
										Pomadasys argyreus	1.15	0.04
										Scomberomorus guttatus	2.85	0.32
25.8	1820	696	BT	54	54	4°33'	95°20'	30.45	61.00	Lethrinidae (3 spp.)	14.90	
										Tetraodontidae (2 spp.)	4.10	
25.8	2020	697	BT	27	27	4°38'	95°29'	31.65	63.00	Leiognathidae (3 spp.)	0.55	
										Jellyfish	30.00	
25.8	2200	698	BT	23	23	4°47'	95°25'	337.20	674.00	Leiognathus bindus	16.40	0.01
										Leiognathus equulus	21.60	0.09
										Sciaenidae	14.75	4.92
										Scomberomorus guttatus	13.30	0.39
										Jellyfish	240.00	

DATE	TIME START	STN NO	GEAR TYPE	DEPTH (M) BOTTOM	DEPTH (M) GEAR	POSITION NORTH	POSITION EAST	CATCH (KG) TOTAL	CATCH (KG) PR HR	DOMINANT SPECIES	WEIGHT (KG) TOTAL	WEIGHT (KG) MEAN
26.8	0025	699	PT	47	25	4°47'	95°15'	12.25	25.00	Stolephorus indicus	7.80	0.0025
										Leiognathus elongatus	2.40	0.0017
26.8	0245	700	PT	425	95	4°49'	95°12'	7.75	16.00	Myctophidae	4.60	0.0026
26.8	0420	701	LL	18	18	4°51'	95°13'	4.00		Carcharhinus spallanzani	3.25	3.25
26.8	0805	702	BT	38	38	4°59'	95°17'	66.40	199.00	Lactarius lactarius	1.80	0.11
										Jellyfish	60.00	
26.8	1025	703	BT	42	42	5°06'	95°09'			(No catch - trawl faulty)		
26.8	1405	704	BT	47	47	5°14'	95°10'	169.90	340.00	Carangoides malabaricus	21.50	0.14
										Gazza minuta	52.00	
										Leiognathus bindus	19.00	
										Dasyatis sp.	22.50	22.50
26.8	1620	705	BT	24	24	5°24'	95°13'	76.50	153.00	Carangidae (10 spp.)	9.00	
										Leiognathus splendens	17.60	0.01
										Jellyfish	30.00	
26.8	1800	706	PT	33	7	5°29'	95°08'	0.50	1.00	Juveniles:Clupeidae,Engraulidae		
26.8	2100	707	PT	65	11	5°41'	95°19'	66.80	134.00	Gazza minuta	3.00	0.02
										Myctophidae	60.00	
27.8	0330	708	PT	95/510	25/75	5°40'	95°27'	9.90	9.90	Myctophidae (3 spp.)	7.65	
27.8	0610	709	BT	350	350	5°40'	95°35'	56.75	114.00	Diretmus argenteus	4.90	0.02
										Myctophidae (2 spp.)	4.45	
										Centrophorus sp. (shark)	9.50	4.75
										Shrimps (several species)	20.60	
28.8	0055	710	BT	31/58	31/58	5°20'	97°15'	130.90	262.00	Pentaprion longimanus	6.80	0.03
										Leiognathus equulus	5.30	0.06
										Leiognathus fasciatus	10.75	0.05
										Lutjanus johni	26.25	2.02
										Lutjanus lineolatus	5.70	0.05
										Nemipterus tolu	4.40	0.07
										Sphyraena barracuda	29.05	1.16
										Saurida tumbil	4.50	0.25

ANNEX III

Length frequency distribution of some important species (Lt, 1 cm groups).

FAMILY Species	Stn No	N	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
CARANGIDAE																													
Alepes djeddaba Djedabba crevalle	705	8						1		3	2								2										
Atule mate Yellowtail scad	705	4								1			1				1	1											
Carangoides ciliarius Longfin cavalla	675	4													3	1													
	705	72				3	5	25	16	11	6	3	3																
Carangoides malabaricus Malabar cavalla	644	47											2	15	8	14	5	3											
	668	12	(fork length)										4	1	2	4		1											
	675	12												1	1	1	1		1				1		4	2			
	678	29															6	16	6	1									
	684	30												1	12	6	3	3	1	1			2		1				
	686	19												2	6	5	5	1											
	687	80							1	1	1			1	5	11	20	13	6	6	4	2	3	5		1			
	704	31	(fork length)										5	6	4	2	9	2	2	1									
Decapterus macrosoma Layang scad	648	16																		1	1	2			2	4	3	1	2
	657	4															4												
	664	15												2	7	5	1												
	667	15												1	9	4	1												
Decapterus maruadsi Round scad	657	25										1	2	5	7	7	2	1											
	664	12										4	4	2	1		1												
	687	21												1	14	6													
Selar boops Oxeye scad	685	8																		1	3	2	2						
	686	20															3	1	6	5	3	1	1						
Selar crumenophthalmus Bigeye scad	636	25													1	2	6	8	4	4									
	664	8												1	1	4	1			1									
	667	7																3		2	2								
	676	23													1	11	7	1	2	1									
	682	8														2	3	3											
	683	25													1	13	10	1											
	693	66															1	9	36	10	3	2		4	1				
	704	8												1	2	2	2	1											
Selaroides leptolepis Yellowstripe trevally	658	75								1	8	35	23	8															
	705	11									2	5	2	2															
CHLOROPHTHALMIDAE																													
Chlorophthalmus agassizi	671	37			1		2		2	5			1	1	4	5	5	7	4										
CLUPEIDAE																													
Dussumieria acuta Rainbow sardine	638	17										1		10	3	2	1												
	662	35						2	1	1	1	9	21																
	663	49								11	20	3	4	10	1														
	699	23		3	2	4	10	2				1		1															

FAMILY Species	Stn No	N	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Ilisha melastoma Indian ilisha	698	12												1		1	6	1	1		2							
Pellona detchela Indian pellona	636	19							1		2	2	9	4	1														
	639	45								2	13	13	15	2															
	693	30									2	10	11	7															
	705	10								3		3	2	2															
Sardinella fimbriata Fringescale sardinella	662	48								1	4	26	15	2															
	663	9											1	2	4	2													
	664	43											1	9	21	12													
Sardinella gibbosa Goldstripe sardinella	662	70					1	2	39	13	3	8	3	1															
	663	49											12	27	9	1													
	683	40											7	21	10	1	1												
	708	29				1		9	17	2																			
Sardinella sirm Spotted sardinella	657	3																1		2									
	663	56										3	39	13	1														
	664	30													3	9	15	3											
	667	9													1	2	4	2											
	683	20									3	3	3	1	5	5													
ENGRAULIDAE Stolephorus indicus Indian anchovy	663	20									11	9																	
Thryssa mystax Moustached thryssa	695	33						2	11	13	4	2		1															
FORMIONIDAE Formio niger Black pomfret	676	7												1	2	4													
GERREIDAE Gerres filamentosus Whipfin mojarra	639	30											8	6	9	4	2	1											
Pentaprion longimanus Longfin mojarra	658	51						1	7	28	14	1																	
	665	35						10	13	9		3																	
LACTARIIDAE Lactarius lactarius False trevally	641	33		1	3	4	9	7	4		1	2	2																
	665	14								1	5	2	3	1	1	1													
	685	171	2	5	8	8	10	12	18	21	22	15	25	12	8		2	2		1									
	693	21									1	1	5	6	4	3	1												
	702	16						4					1			2			1	1		4	1	1				1
	705	49						5	19	15	6		2	1			1												
LEIOGNATHIDAE Gazza minuta Toothed ponyfish	685	22			1	2	3	3	4	8	1																		
	704	28					2	14	10	2																			
	705	14				4		8	2																				
	710	33					1	7	13	6	1	2	2	1															
Leiognathus bindus Orangefin ponyfish	685	23				1	6	10	6																				
	704	35			1	4	20	9	1																				

FAMILY Species	Stn No	N	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Leiognathus elongatus Slender ponyfish	680	51	1	4	41	5																							
Leiognathus equulus Common ponyfish	641	56								4	4		6	7	15	10	7	3											
	665	13								1		4	3		3	1	1												
	685	37											2	5	10	9	6	4	1										
	695	7													2	1	3	1											
	705	10										3	3				4												
	710	89						1	1	5	2	19	32	17	8	2	1	1											
Leiognathus fasciatus Striped ponyfish	704	18							1	1				1		4	7	4											
	710	54							3	16	19	3	3	4	3														
Leiognathus leuciscus Whipfin ponyfish	704	15				1	1	2	8	1	2																		
	705	33						16	8	5	4																		
Leiognathus splendens Splendid ponyfish	665	100				4	37	39	10	5	3	2																	
	685	74	1	10	10	29	22	2																					
	704	20				2	12	5	1																				
Secutor insidiator	685	44	14	23	7																								
	704	18			1	6	8	2	1																				
LUTJANIDAE Caesio erythrogaster (Part 2) Yellowtail fusilier																													
Lutjanus johni (Part 2) John's snapper																													
Lutjanus kasmira Bluebanded snapper	654	26						3	8	4	3	2	4	1		1													
Lutjanus lineolatus Bigeye snapper	687	139						2	38	40	17	17	13	9	3														
	710	111						1	4	6	18	20	30	17	10	4		1											
Lutjanus malabaricus (Part 2) Malabar red snapper																													
Lutjanus russelli Russell's snapper	710	13																	1		6	2		1		2	1		
Lutjanus sanguineus (Part 2) Blood snapper																													
Pristipomoides typus (Part 2) Sharptooth snapper																													
MULLIDAE Upeneus moluccensis Goldband goatfish	684	53									1	5	4	18	11	10	4												
	687	27							1	1	6	1	13	3	2														
	710	12										1	2	3	3	2	1												
Upeneus sulphureus Yellow goatfish	636	145								9	35	65	29	5	2														
	641	35					1	2	7	10	6	6	3																
	665	72					2	1	12	34	10	11	2																
	685	39					3	2	6	10	8	9	1																
	710	27									2	7	11	3	4														
Upeneus vittatus Yellowstriped goatfish	710	28											1	2		1	5	9	5	3	1	1							

FAMILY Species	Stn No	N	05 06 07 08 09	10 11 12 13 14	15 16 17 18 19	20 21 22 23 24	25 26 27 28 29	30 31
NEMIPTERIDAE Nemipterus japonicus Japanese threadfin bream	687	12			1 2 3 2	1 2 1		
Nemipterus metopias Slender threadfin bream	682	19			2 2 6 2 2	3 1 1		
Nemipterus nematophorus Doublewhip threadfin bream	687	36		2 10 11	6 1 1 2 3			
	710	31		1 2 5	6 6 3 2 2	1 1 2		
Nemipterus peronii Rosy threadfin bream	682	31		1 2	2 2 3 6 4	1 8 1 1		
Nemipterus tambuloides Fivelined threadfin bream	684	13		2	4 3 3 1			
Nemipterus tolu Notched threadfin bream	658	24			4 7	9 4		
	710	62			1 12 13 13 12	4 4 2 1		
NOMEIDAE Cubiceps (natalensis)	671	67			10 45	11 1		
	708	6			2 3 1			
POLYNEMIDAE Polynemus sextarius Blackspot threadfin	685	9		2 3	2 1 1			
POMADASYIDAE Pomadasys argyreus Silver grunt	665	36		1 3 19 8 3	2			
	685	50		5 11 10	9 11 3 1			
	686	33		2 4 3 7	8 6 3			
	693	18		6 4	3 4 1			
	695	28	1	1 7 10 3 3	2 1			
Pomadasys maculatus Blotched grunt	636	35			5 8 10 6	6		
PRIACANTHIDAE Priacanthus (hamrur)	688	12			2	1 1 1	2 3	2
Priacanthus macracanthus Red bigeye	632	63			11 22 17	7 3 2 1		
Priacanthus tayenus Purple-spotted bigeye	658	68		1 13 48 4	2			
SCIAENIDAE Johnieops sina Sin croaker	636	17			4 4	1 1 4 3		
Otolithes ruber Tiger-toothed croaker	641	10			2	2 1 1	3 1	
SCOMBRIDAE Rastrelliger brachysoma Short-bodied mackerel	642	30		1	5 11 12 1			
	662	72			4 7 32 27	2		

FAMILY Species	Stn No	N	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Rastrelliger kanagurta Indian mackerel	657	2																		1	1								
	663	11								1					1	5	2	1	1										
	664	46										3	7	2	5	23	5	1											
	695	18				3	1	8	4																				
	699	7	1	1					4	1																			
Scomberomorus guttatus (Part 2) Indo-Pacific Spanish mackerel																													
SPHYRAENIDAE Sphyraena barracuda (Part 2) Great barracuda																													
Sphyraena forsteri (Part 2) Forster's barracuda																													
Sphyraena obtusata Obtuse barracuda	636	122												1	1	7	18	39	36	10	2	7		1					
	665	25																	3	3	12	5	2						
	686	59															3	27	17	5	4	2	1						
	693	30																1	4	4	11	3	3	2	2				
SYNODONTIDAE Saurida tumbil (Part 2) Greater lizardfish																													
Saurida undosquamis Brushtooth lizardfish	684	11											1	1	2		2		1		1		3						
THERAPONIDAE Therapon theraps Largescale therapon	641	27							1	4	4	4	7	3	4														
	685	96						1	4	9	16	30	21	13	2														
TRICHIURIDAE Trichiurus haumela (Part 2) Largehead hairtail																													

Part 2 - Length frequency distribution (1 cm groups), X = 50 - 99 cm,

FAMILY Species	Stn No	N	0 0 1 2 3 4	0 5 6 7 8 9	1 0 1 2 3 4	1 5 6 7 8 9	2 0 1 2 3 4	2 5 6 7 8 9	3 0 1 2 3 4	3 5 6 7 8 9	4 0 1 2 3 4	4 5 6 7 8 9
LUTJANIDAE Caesio erythrogaster Yellowtail fusilier	639	53					2 4 2	2 1 6 3 1	7 4 1 4	3 2 1 5 5		
Lutjanus johni John's snapper	710 X	13	1 1 1 1	1 3 1	1							2
Lutjanus malabaricus Malabar red snapper	653 X	3	1 1	1						1	1 1 2 1	1 1 1
	659 X	10	1									
Lutjanus sanguineus Blood snapper	643	6						1			1 1	1 1
	644 X	9	1 2	1 2 1	1							1
	659 X	9	1 1 1 1	1							1	2 1
Pristipomoides typus Sharptooth snapper	654 X	10	2			1			1	1 1	1 1 2	
	668	40	(fork length)		2 5 2 5	2 2 1 2 1	1 2 1	1 4 3 3	1	1 1		
	678 X	11	1	1 1	1 1	1 2 1 1			1		1	1 1
	688	3										
	689 X	11	1	1 1	1				1	1 2 1	1	1
SCOMBRIDAE Scomberomorus guttatus Indo-Pacific Spanish mackerel FORK LENGTH	641	15					1	1	1 1 2	2 2 1 2	1	1
	686 X	26	1 1				1		1 1	2 5 3	5 1 1 3	1
	693	12						1	2 2	1 3 1 1	1	
	695 X	9			1		2 1	1 1		1	1	1
	698	34						1 1 1 4	1 3 4 4 3	2 5 1 2	1 1	
	704	23					1 1 3 2	2 1	3 2	1 1 2 3	1	
SPHYRAENIDAE Sphyraena barracuda Great barracuda	710 X	25	1 1 1	1 2	1	1 2 3 3	1 1 1	1 1	1 1	1		1
Sphyraena forsteri Forster's barracuda	675	38					2	2 1 1 2 3	10 4 4 3 2	1 2 1		
SYNODONTIDAE Saurida tumbil Greater lizardfish	641	18				2	2 2 2 3	3 2	1 1			
	675	5							1 1 1	1 1		
	684	15						1 2 2	3 3 1	1 2		
	685	60				1 1	3 7 3 3 9	7 5 3 3	6 2 2 1	2 1 1		
	710	18					1	2 1 1 1 1	1 2 3 2	1 1	1	
TRICHIURIDAE Trichiurus haumela Largehead hairtail	636 X	40	1	1	1 1	1 1 2 2	2 3 5 6 3	1 3 1		1	1 2 1	1
	695 X	124		1 1	1 1	1 1 2 3 6	1 5 5 5 4 4 2	3 7 5 8 6 2 4 1 3	5 6 3 10 6	1 3 2 2 3	1	

List of species. R/V "Dr. Fridtjof Nansen", Sumatra Cruise, August 1980. Identification and nomenclature mainly based on Fischer and Whitehead (1974). Names in parenthesis when identification doubtful.

FAMILY SUB-FAMILY Species	English name
ACANTHURIDAE	Surgeonfishes
ACANTHURINAE	Surgeonfishes
Acanthurus (mata)	
Cyphomycter (tuberosus)	Humpnose unicorn
ZANCLINAE	Moorish idols
Zanclus canescens	Moorish idol
ACROPOMATIDAE	
Acropoma japonicum	
Anguilliformes	
Leptocephali	Eel larvae
ANTENNARIIDAE	Frogfishes
ANTENNARIINAE	
Antennarius striatus	Striped angler
APOGONIDAE	Cardinalfishes
Apogon sp.	
Apogonichthys sp.	
(Epigonus sp.)	
Synagrops sp.	
ARIIDAE	Sea catfishes
Arius thalassinus	Giant catfish
Arius sp. (adults)	
Arius sp. (juveniles)	
(ASTRONESTHIDAE)	Snaggletooths
BALISTIDAE	Triggerfishes, Filefishes
BALISTINAE	Triggerfishes
Abalistes stellaris	Starry triggerfish
Balistes sp.	
Balistoides niger	Whiteblotched triggerfish
Pseudobalistes fuscus	Brown triggerfish
Pseudobalistes sp.	
Sufflamen capistratus	Masked triggerfish
(BERYCIDAE)	
(doubtful, probably PEMPHERIDAE, q.v.)	
BOTHIDAE	Lefteye flounders
BOTHINAE	
Arnoglossus sp.	
Chascanopsetta lugubris	
Grammatobothus polyophthalmus	Threespot flounder

BOTHIDAE (continued)	
PARALICHTHYINAE	
Pseudorhombus arsius	Longtooth flounder
Pseudorhombus sp.	
BREGMACEROTIDAE	Codlets
Bregmaceros sp.	
Bregmaceros sp. (juveniles)	
CALLIONYMIDAE	Dragonets
unspecified	
CAPROIDAE	Boarfishes
ANTIGONIINAE	
Antigonia rubescens	Boarfish
CARANGIDAE	Jacks, cavallas, crevalles, pompanos, queenfishes, runners, scads, trevallies
Alectis indicus	Threadfin trevally
Alepes djeddaba	Djeddaba crevalle
Alepes melanoptera	Blackfin crevalle
Alepes sp.	
Atule mate	
Carangoides ciliarius	Longfin cavalla
Carangoides ferdau	Ferdau's cavalla
Carangoides malabaricus	Malabar cavalla
Carangoides sp.	
Caranx ignobilis	Yellowfin jack
Caranx sexfasciatus	Great or Six-banded trevally
Decapterus kurroides	
Decapterus macrosoma	Layang scad
Decapterus maruadsi	Round scad
Megalaspis cordyla	Hardtail scad
Scomberoides commersonianus	Talang queenfish
Scomberoides tala	
Selar boops	Oxeye scad
Selar crumenophthalmus	Bigeye scad
Selaroides leptolepis	Yellowstripe trevally
Seriolina nigrofasciata	Black-banded trevally
Ulua mentalis	Cale-cale trevally
Uraspis helvolus	Black ulua
CENTROLOPHIDAE	Medusafishes
Palinurichthys sp.	
CHAETODONTIDAE	Butterflyfishes
CHAETODONTINAE	Butterflyfishes
Chaetodon (vagabondus)	
POMACANTHINAE	Angelfishes
Pomacanthus imperator	Imperial angelfish

CHAMPSODONTIDAE	
Champsodon sp.	
CHAUNACIDAE	Sea toads
Chaunax picta	
CHIROCENTRIDAE	Wolf herrings
Chirocentrus dorab	Dorab wolf-herring
CHLOROPHTHALMIDAE	Greeneyes
Chlorophthalmus agassizi	
CLUPEIDAE	Herrings, shads, sardines, menhadens
CLUPEINAE	
Herklostichthys punctatus	Spotted herring
Sardinella fimbriata	Fringescale sardinella
Sardinella gibbosa	Goldstripe sardinella
Sardinella sirm	Spotted sardinella
Sardinella sp.	
DUSSUMIERIINAE	
Dussumieria acuta	Rainbow sardine
(Etrumeus teres)	
PRISTIGASTERINAE	
Ilisha melastoma	Indian ilisha
Opisthopterus tardoore	Tardoore
Pellona ditchela	Indian pellona
CYNOGLOSSIDAE	Tonguefishes
CYNOGLOSSINAE	
Cynoglossus cynoglossus	Bengal tongue sole
Cynoglossus lingua	Long tongue sole
Cynoglossus sp.	
DACTYLOPTERIDAE	Flying gurnards
Dactyloptena orientalis	Purple flying gurnard
DIODONTIDAE	Porcupinefishes
Diodon hystrix	Spotted porcupinefish
Diodon maculifer	Longspined porcupinefish
Diodon sp.	
DIRETMIDAE	
Diretmus argenteus	
ECHENEIDAE	Remoras
Echeneis naucrates	Slender suckerfish
ELOPIDAE	Tenpounders, ladyfishes
Elops sp.	
EMMELICHTHYIDAE	Bonnetmouths
EMMELICHTHYINAE	
Emmelichthys nitidus	Red sea-haarder

ENGRAULIDAE	Anchovies
Setipinna taty	Hairfin anchovy
Setipinna sp.	
Stolephorus (heterolobus)	Shorthead anchovy
Stolephorus indicus	Indian anchovy
Stolephorus sp.	
Thryssa hamiltonii	Hamilton's thryssa
Thryssa malabarica	Malabar thryssa
Thryssa mystax	Moustached thryssa
Thryssa setirostris	Longjaw thryssa
Thryssa sp.	
EPHIPPIDAE	Spadefishes, sicklefishes
DREPANINAE	
Drepane longimanna	
Drepane punctata	Spotted sicklefish
Drepane sp.	
EPHIPPINAE	
Ephippus orbis	Spadefish
EXOCOETIDAE	Flying fishes, halfbeaks
HEMIRAMPHINAE	Halfbeaks
unspecified	
FISTULARIIDAE	Cornetfishes
Fistularia sp.	
FORMIONIDAE	Black pomfrets
Formio niger	Black pomfret
GADIDAE	Cods
LOTINAE	Hakes, burbots
Physiculus (natalensis)	
GEMPYLIDAE	Snake mackerels
Epinnula orientalis	
Thyrsitoides sp.	
GERREIDAE	Mojarras, silver-biddies
Gerres filamentosus	Whipfin mojarra
Pentaprion longimanus	Longfin mojarra
GONOSTOMATIDAE	Bristlemouths, lightfishes
Gonostoma sp.	
unspecified adults	
HARPADONTIDAE	Bombay ducks
Harpadon nehereus	Bombay duck
Harpadon sp.	
Harpadon sp. (black)	
HOLOCENTRIDAE	Squirrelfishes
HOLOCENTRINAE	
Holocentrus rubrum	Red squirrelfish
Holocentrus (spinifer)	

HOLOCENTRIDAE (continued)	
MYRIPRISTINAE	Soldierfishes
Myripristis murdjan	Crimson squirrelfish
(ISTIOPORIDAE)	Billfishes
unspecified juveniles	
LABRIDAE	Wrasses
(Halichoeres sp.)	
(Lepidaplois sp.)	
LACTARIIDAE	False trevallies
Lactarius lactarius	False trevally
LEIOGNATHIDAE	Slimys, slipmouths, ponyfishes
Gazza minuta	Toothed ponyfish
Leiognathus bindus	Orangefin ponyfish
Leiognathus daura	Goldstripe ponyfish
Leiognathus elongatus	Slender ponyfish
Leiognathus equulus	Common ponyfish
Leiognathus fasciatus	Striped ponyfish
Leiognathus leuciscus	Whipfin ponyfish
Leiognathus splendens	Splendid ponyfish
Secutor insidiator	Pugnose ponyfish
Secutor sp.	
LETHRINIDAE	Scavengers, emperors
Lethrinus lentjan	Redspot emperor
Lethrinus miniatus	Longface emperor
Lethrinus spp.	
LOBOTIDAE	Tripletails
Lobotes surinamensis	Jumping cod, flasher, tripletail
LOPHIIDAE	Goosefishes
Lophiodes insidiator	
LUTJANIDAE	Snappers, jobfishes, fusiliers
Aprion virescens	Green jobfish
Caesio chrysozona	Goldband fusilier
Caesio erythrogaster	Yellowtail fusilier
Caesio sp. (red)	
Caesio sp.	
Lutjanus argentimaculatus	Mangrove red snapper
Lutjanus gibbus	Humpback red snapper
Lutjanus janthinuropterus	Yellowstreaked snapper
Lutjanus johnii	John's snapper
Lutjanus kasmira	
Lutjanus lineolatus	Bigeye snapper
Lutjanus malabaricus	Malabar red snapper
Lutjanus russelli	Russell's snapper
Lutjanus sanguineus	Blood snapper
Lutjanus sp.	
Pristipomoides typus	Sharptooth snapper

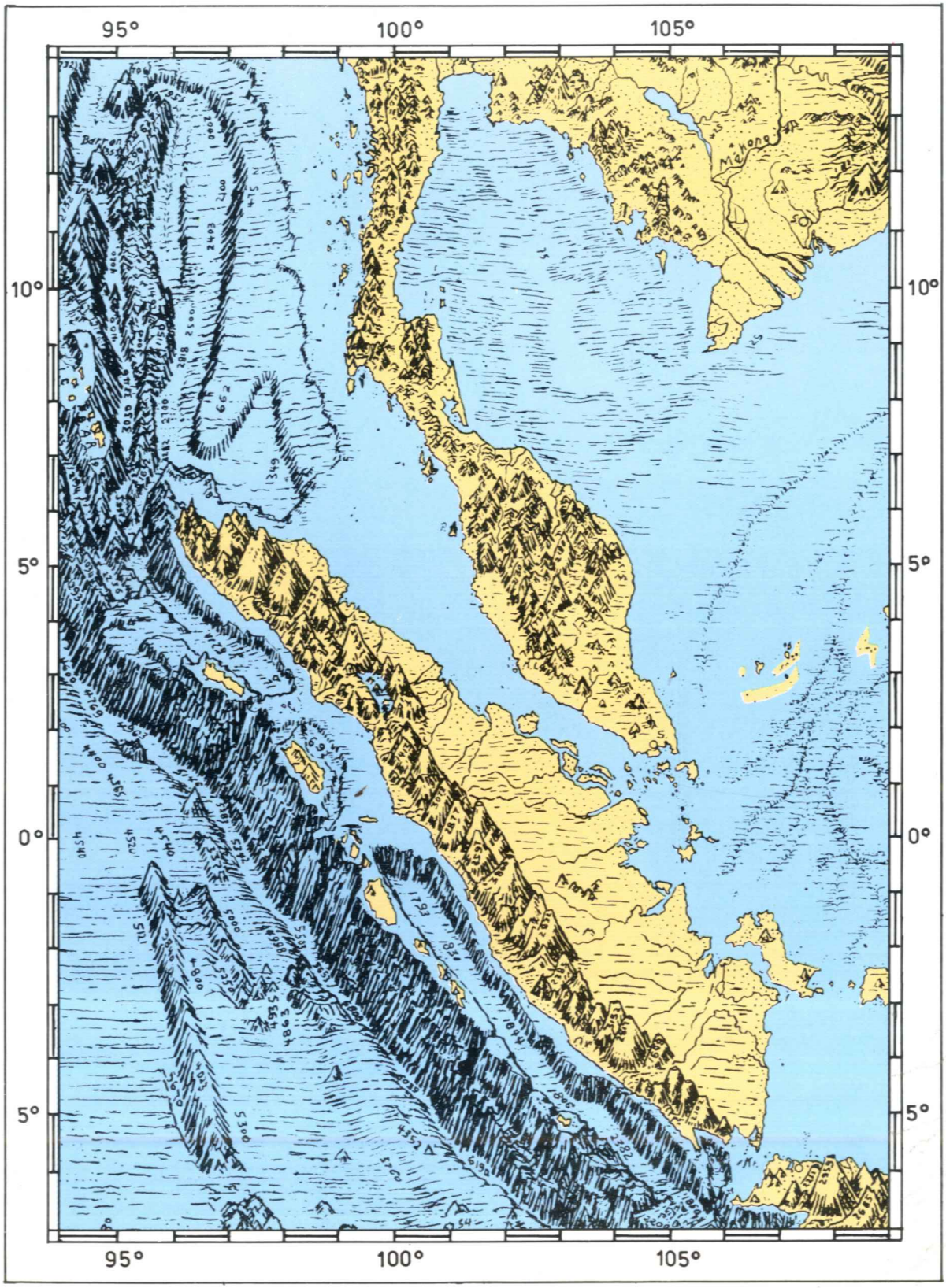
MACROURIDAE	Grenadiers, whiptails
Coelorhynchus (parallelus)	
Macrouroplus sp.	
Malacocehhalus laevis	
MACRUROCYTTIDAE	
ZENIONTINAE	
Zenion spp.	
MENIDAE	Moonfishes
Mene maculata	Moonfish
MORIDAE	Morid cods
(Laemonema sp.)	
MULLIDAE	Goatfishes
Parupeneus heptacanthus	Spotted golden goatfish
Parupeneus spp.	
Upeneus moluccensis	Goldband goatfish
Upeneus sulphureus	Yellow goatfish
Upeneus tragula	Darkband goatfish
Upeneus vittatus	Yellowstriped goatfish
MURAENIDAE	Moray eels
MURAENINAE	
Lycodontis sp.	
MYCTOPHIDAE	Lanternfishes
unspecified, various spp.	
NEMIPTERIDAE	Threadfin breams
Nemipterus (bleekeri)	
Nemipterus delagoae	Delagoa threadfin bream
Nemipterus japonicus	Japanese threadfin bream
Nemipterus marginatus	Palefinned threadfin bream
Nemipterus mesoprion	Redfilament threadfin bream
Nemipterus metopias	Slender threadfin bream
Nemipterus nematophorus	Doublewhip threadfin bream
Nemipterus nemurus	Redspine threadfin bream
Nemipterus peronii	Rosy threadfin bream
Nemipterus tambuloides	Fivelined threadfin bream
Nemipterus tolu	Notched threadfin bream
Parascolopsis (eriomma)	Rosy monocle bream
Parascolopsis sp.	
Scolopsis vosmeri	Whitecheek monocle bream
Scolopsis sp.	
NEOSCOPELIDAE	
Neoscopelus (macrolepidotus)	
NOMEIDAE	
Cubiceps (natalensis)	
Cubiceps sp.	

OGCOCEPHALIDAE	Batfishes
Halieutaea sp.	
Malthopsis sp.	
OPHIDIIDAE	Brotulas, cusk-eels
BROTULINAE	
(Barathronus sp.)	
Dicrolene sp.	
Glyptophidium longipes	
Neobythites macrops	
Selachophidium (guentheri)	
Selachophidium sp.	
OSTRACIONTIDAE	Boxfishes
OSTRACIONTINAE	
Lactoria cornuta	
Ostracion (tuberculatus)	
Ostracion sp.	
Tetrosomus gibbosus	
PARALEPIDIDAE	Barracudinas
Lestidium nudum	
Lestidium sp.	
PEMPHERIDAE	Sweepers
unspecified (doubtful, perhaps BERYCIDAE)	
PENTAPODIDAE	Large-eye breams
Gymnocranius griseus	Grey large-eye bream
Gymnocranius robinsoni	Blue-lined large-eye bream
PERCOPHIDIDAE	
BEMBROPSINAE	
Bembrops (caudimacula)	
Bembrops sp.	
PLATYCEPHALIDAE	Flatheads
PLATYCEPHALINAE	
unspecified, various spp.	
PLEURONECTIDAE	Righteye flounders
POECILOPSETTINAE	
Poecilopsetta (natalensis/plinthus)	
Poecilopsetta sp.	
SAMARINAE	
Samaris sp.	
———	
unspecified, various spp.	
POLYMIXIDAE	Beardfishes
Polymixia (japonica)	

POLYNEMIDAE	Threadfins
Polynemus paradiseus	Paradise threadfin
Polynemus plebeius	Common threadfin
Polynemus sextarius	Blackspot threadfin
POMACENTRIDAE	Damselfishes
POMACENTRINAE	
(ABUDEFDUFINI)	Sergeant-majors
Abudefduf sp.	
POMADASYIDAE	Grunts, sweetlips
Plectorhynchus pictus	Painted sweetlip
Pomadasys argyreus	
Pomadasys hasta	Lined silver grunt
Pomadasys maculatus	Blotched grunt
Pomadasys sp.	
PRIACANTHIDAE	Bigeyes
Priacanthus (hamrur)	
Priacanthus macracanthus	Red bigeye
Priacanthus tayenus	Purple-spotted bigeye
Priacanthus sp.	
Priacanthus sp. (juveniles)	
Pseudopriacanthus niphonus	
PSETTODIDAE	Psettodids, indian halibuts
Psettodes erumei	Indian halibut
SCARIDAE	Parrotfishes
SCARINAE	
Scarus (ghobban)	
SCATOPHAGIDAE	Scats
unspecified juveniles	
SCIAENIDAE	Drums, croakers
Dendrophysa russelli	Goatee croaker
Johnieops sina	Sin croaker
Johnieops sp.	
Johnius sp.	
Otolithes ruber	Tiger-toothed croaker
Pennahia argentata	Silver pennah croaker
Pterotolithus lateoides	Bigmouth croaker
unspecified, various spp.	
SCOMBRIDAE	Mackerels, tunas
SCOMBRINAE	
(SCOMBRINI)	
Rastrelliger brachysoma	Short-bodied mackerel
Rastrelliger kanagurta	Indian mackerel
Scomberomorus commersoni	Narrow-barred Spanish mackerel
Scomberomorus guttatus	Indo-Pacific Spanish mackerel
Scomberomorus sp.	
Scomberomorus sp. (juveniles)	
(THUNNINI)	
Auxis thazard	Frigate mackerel
Sarda orientalis	Oriental bonito

SCORPAENIDAE	Scorpionfishes
PTEROINAE	
Pterois sp.	
SCORPAENINAE	
Kantapus sp.	
Scorpaenopsis sp.	
SETARCHINAE	
Setarches sp.	
TETRAROGINAE	
unspecified, various spp.	
SERRANIDAE	Sea basses, groupers
Cephalopolis miniatus	Vermilion seabass
Epinephelus areolatus	Areolated grouper
Epinephelus bleekeri	Bleeker's grouper
Epinephelus spp.	
Plectropomus leopardus	Bluespotted seabass
Variola louti	Moontail seabass
SIGANIDAE	Rabbitfishes
Siganus canaliculatus	Whitespotted spinefoot
Siganus labyrinthodes	
SPHYRAENIDAE	Barracudas
Sphyraena barracuda	Great barracuda
Sphyraena forsteri	Forster's barracuda
Sphyraena jello	Banded barracuda
Sphyraena obtusata	Obtuse barracuda
Sphyraena sp.	
STERNOPTYCHIDAE	Marine hatchetfishes
unspecified	
STOMIATIDAE	Scaly dragonfishes
unspecified	
STROMATEIDAE	Butterfishes
Pampus argenteus	Silver pomfret
SYNODONTIDAE	Lizardfishes
Saurida (longimanus)	
Saurida tumbil	Greater lizardfish
Saurida undosquamis	Brushtooth lizardfish
Saurida sp. (postlarvae)	
TETRAODONTIDAE	Puffers
CANTHIGASTERINAE	
Canthigaster margaritus	
Canthigaster sp.	
TETRAODONTINAE	
Amblyrhynchodes sp.	
Arothron hispidus	
Arothron stellatus	
Chelonodon sp.	
Gastrophysus sceleratus	
Gastrophysus sp.	
Lagocephalus sp.	

THERAPONIDAE	Tigerperches
Therapon jarbua	Jarbua therapon
Therapon theraps	Largescaled therapon
TRIACANTHIDAE	Triplespines
Triacanthus biaculeatus	
Triacanthus striglifer	
Triacanthus sp.	
TRIACANTHODIDAE	Spikefishes
TRIACANTHODINAE (?)	
(Macrorhamphosodes sp.)	
TRICHIURIDAE	Cutlassfishes
LEPIDOPINAE	
Benthodesmus sp.	
TRICHIURINAE	
Trichiurus haumela	Largehead hairtail
TRIGLIDAE	Searobins
PERISTEDIINAE	Armoured searobins
Peristedion sp. (red)	
Peristedion sp. (grey)	
Peristedion sp. (brown/grey w/darker saddles)	
TRIGLINAE	Unarmoured searobins
Lepidotrigla (multispinosus)	
Lepidotrigla sp.	
URANOSCOPIDAE	Stargazers
Uranoscopus sp.	
ZEIDAE	Dories
unspecified	



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A.S JOHN GRIEG