Distribution, Abundance and Biological Studies of Economically Important Fishes in the South China Sea, Area II: Sarawak, Sabah and Brunei Darussalam Waters.

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ABSTRACT

The studies were carried out between 9th July and 3rd August 1996 (3rd cruise) and 30th April and 30th May, 1997 (4th cruise) in the Exclusive Economic Zone of Sarawak and the western part of Sabah. The species distribution, abundance, composition and length-weight relationships of some commercially important fish were investigated and compared for both cruises. The results indicates that the overall catch rate ranged from 3.5 to 194 kg/hr and averaged at 55.9 kg/hr during the 3rd cruise. For the 4th cruise, it ranged from 10.9 to 90.5 kg/hr and averaged at 50.2 kg/hr. During the 3rd cruise, 46.9% of the catch were dominated by demersal fish followed by 41.6% trash fish, 7.8% pelagic fish and 3.1% cephalopod. Priacanthidae was the most dominant family, which made up of 14.1% of the catch followed by Nemipteridae (10.8%), Carangidae (5.0%), Lutjanidae (3.7%) and Mullidae (2.1%). The ten most dominant species found during the 3rd cruise were 1. *Priacanthus macracanthus* (13.2%), 2. *Nemipterus bathybius* (3.3%), 3. *Abalistes stellaris* (2.8%), 4. *Arius spp*.(2.5%), 5. *N. nematophorus* (2.2%), 6. *Gymnocranius griseus* (1.9%), 7. *N. marginatus* (1.7%), 8. *Sepia spp*. (1.7%), 9. *Decapterus spp*. (1.6%) and 10. *Carcharhinus spp* (1.3%). During the 4th cruise, the family Nemipteridae (12.7%) formed the most dominant fish family followed by Carangidae (8.7%), Mullidae (7.1%), Lutjanidae (4.9%) and Priacanthidae (2.2%). The ten most dominant species were: 1. Loligo *spp*. (5.7%), 2. *Nemipterus bathybius* (4.2%), 3. *Abalistes stellaris* (4.0%), 4. *Upeneus moluccensi* (3.8%), 5. *Nemipterus nemurus* (3.8%), 6. *Gymnocranius griseus* (3.2%), 7. *Carangoides malabaricus* (3.2%), 8. *Plectorhynchus pictus* (3.1%), 9. *Upeneus bensasi* (2.4%) and 10. *Arius spp*. (1.8%). The morphometric study shows that the population of fish are normally distributed.

Key words: Distribution, abundance, biological, fish, Sarawak, Sabah, Brunei Darussalam

Introduction

In 1995, a total of 1,108,436 m.t. of marine fish was landed in Malaysia and valued at RM2.71 billion. Out of this total landings, 99,255 m.t. were landed in Sarawak and 166,462 m.t. in Sabah (Anon., 1995). Demersal fish was considered as one of the important fish resources in Sarawak and Sabah. The total landings by trawl net (which consisted mainly of demersal fish) were estimated at 61,958 m.t in Sarawak and 49,106 m.t. in Sabah. Pelagic fish production in Sarawak was very low (about 1,313 m.t. only) as compared to the landings in Sabah i.e. 28,875 m.t.

This paper compares the distribution, abundance, species composition and biological parameters of some commercially important fish species following the two surveys conducted using a research vessel, KK MANCHONG in the Exclusive Economic Zone (EEZ) of Sarawak and the western part of Sabah. The sampling stations selected were based on the acoustic stations which were surveyed by MV SEAFDEC.

Materials and Methods

Two surveys were conducted using KK MANCHONG, a research vessel of the Fisheries Research Institute (FRI), Sarawak Branch, Department of Fisheries, Malaysia on 9th July until 3rd August 1996 (3rd cruise) and 30th April until 30th May 1997 (4th cruise) respectively. The principal characteristics of KK MANCHONG are given as follows:

Type/Hull : Fibre Reinforced Plastic (FRP)
Length : 27.50 m
Breadth : 6.40 m
Depth : 3.00 m
Draft : 2.20 m
Gross tonnage : 150 tons
Registered tonnage : 45 tons
Main engine : 900 hp Yanmar diesel engine
Speed (trial max.): 12.48 knots
Complement (crew and scientists): 22 persons

The sampling gear used in these studies was a high opening otter trawl net as shown in Figure 1 with a horizontal net opening of 20.5 m and a cod-end mesh size of 38 m. A diagrammatic presentation of the net is shown in Figure 1. The net was towed at 3.5 knots for a one-hour duration at a specific station which coincides with its acoustic station (Figure 2).

During the surveys the total catch of each haul was sorted out according to commercial fish and trash fish without considering size categories. Subsequently the commercial fish species were sorted according to demersal fish, pelagic fish, cephalopods, shrimps, crabs, shells and true trash fish i.e. those which have no commercial values.

The dominant fish species from each sampling station were kept frozen and brought back to the laboratory of the FRI, Sarawak Branch for further biological examinations. The measurements on total length (L)an total body weight (W) of individual fish to the nearest millimeter and gram respectively were made in the laboratory.

The frequency distribution patterns for a number of fish species in the combined samples from entire samplings stations were examined. Length-weight relationships were determined separately for each fish species. Equation of the form $W=aL^b$, where a and b are constants of regression, were fitted by transforming the data into logarithms and deriving the regression line by the least square method (Sparre and Venema, 1992).

Results

Overall catch rate

Altogether 17 stations were sampled successfully with one haul per station during the 3rd cruise. During the 4th cruise, only 12 stations were successfully trawled. Appendix 1 and 2 shows the overall catch rate of the various species caught from individual stations of the two cruises. The total catch (inclusive of both commercial and trash fish) from individual stations ranged from 3.5 kg to 194.0 kg for the 3rd cruise and 10.9 to 90.5 kg for the 4th cruise. The overall average catch rate for 3rd cruise was 55.9 kg/hr. Of this, 32.6 kg (58.3%) were commercial fish and 23.3 kg (41.7%) trash fish (Table 1). During the 4th cruise, the overall average catch rate was 50.2 kg/hr. It comprised of about 34.4 kg (68.7%) commercial fish and 15.8 kg (31.3%) trash fish (Table 2).

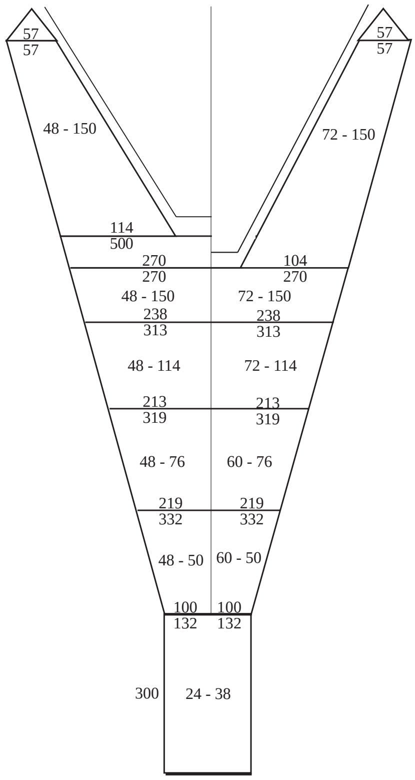

Fig. 1 Design of the high opening trawl net used by KK Manchong

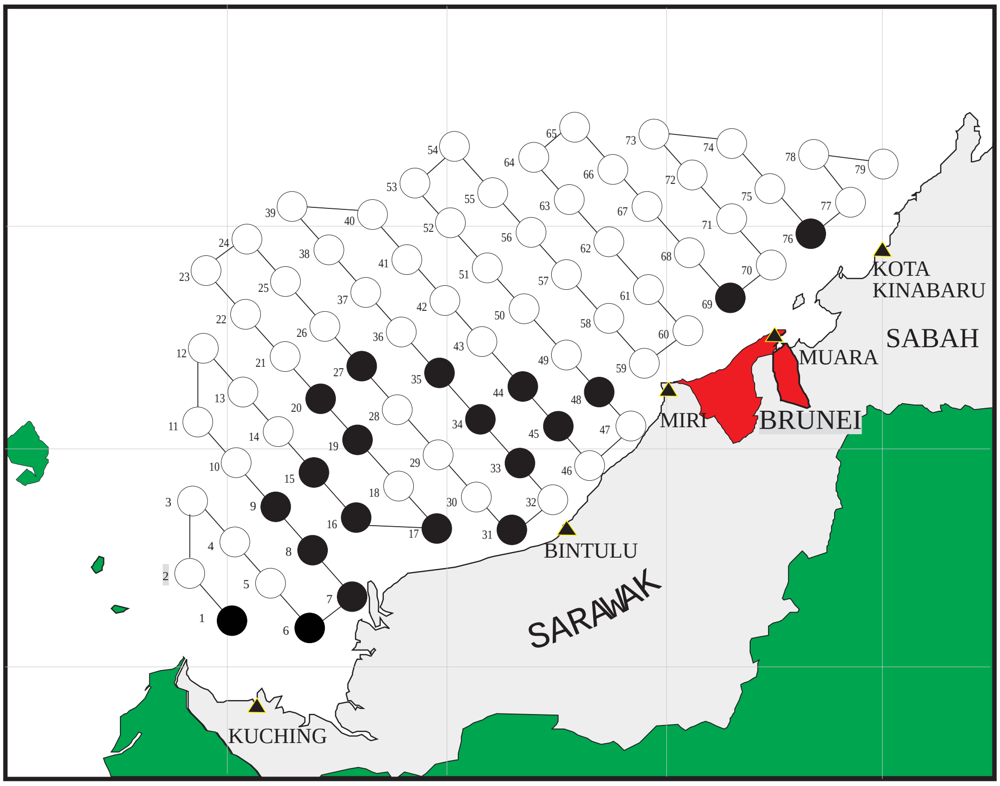

Fig. 2 Trawling stations of KK Manchong

Species composition

Catch percentage by weight of each species and family caught during both cruises were shown in Table 1 and 2 respectively. During the 3rd cruise, commercial fish formed 58.5% of the total catch while the remaining 41.5% made up of trash fish. Among the commercial fish, demersal fish group was the most dominant category making up 46.9% of the total catch followed by pelagic fish, 7.8% and cephalopods, 3.1%.

During the 4th cruise, commercial fish made up of 68.7% of the total catch and the remaining 31.4% was trash fish. The most dominant commercial fish group was demersal fish (44.6%), followed by cephalopods (11.3%) and pelagic fish (10.8%). Table 3 below shows the summarized catch composition of the major fishery group from the entire sampling stations of the cruises.

Numerous species, genera and families of fish were caught during the surveys. Some of these were much more dominant than the others in terms of catch percentage by weight. During the 3rd cruise (Table 1), the family Priacanthidae appeared to be the most dominant fish family (14.1%), followed by Nemipteridae (10.8%), Carangidae (5.0%), Lutjanidae (3.7%), and Mullidae (2.1%). On the other hand, the family Nemipteridae (12.7%) formed the most dominant fish family during the 4th cruise (Table 2) followed by Carangidae (8.7%), Mullidae (7.1%), Lutjanidae (4.9%) and Priacanthidae (2.2%).

Ten most dominant species caught during the 3rd cruise were: 1. *Priacanthus macracanthus* (13.2%), 2. *Nemipterus bathybius* (3.3%), 3. *Abalistes stellaris* (2.8%), 4. *Arius spp*. (2.5%), 5. *Nemipterus nematophorus* (2.2*%), 6. Gymnocranius griseus* (1.9%), *7. Nemipterus marginatus* (1.7%), 8. *Sepia spp*. (1.7%), 9. *Decapterus spp*. (1.6%) and 10. *Carcharhinus spp*. (1.3%).

During the 4th cruise, the ten most dominant species were: 1. Loligo *spp*. (5.7%), 2. *Nemipterus bathybius* (4.2%), 3. *Abalistes stellaris* (4.0%), 4. *Upeneus moluccensi* (3.8%), 5. *Nemipterus nemurus* (3.8%), 6. *Gymnocranius griseus* (3.2%), 7. *Carangoides malabaricus* (3.2%), 8. *Plectorhynchus pictus* (3.1%), 9. *Upeneus bensasi* (2.4%) and 10. *Arius spp*. (1.8%).

Abundance

The highest overall catch rate during the 3rd cruise was recorded at station 44 (193.7 kg/hr) and station 33 (160.2 kg/hr). The lowest catch rate was at station 35 (3.5 kg/hr) and station 10 (9.7 kg/hr). During the 4th cruise, the highest overall catch rate was attained at station 31 (90.46 kg/hr) and station 7 (82.0 kg/hr). Meanwhile, the lowest overall catch rate was registered at station 16 (12.5 kg/hr) and station 9 (22.4 kg/hr).

Commercial fish have an average catch rate of 32.6 kg/hr during the 3rd cruise. The highest catch rate was at station 44, (119.3 kg/hr) and station 33 (94.2 kg/hr) as shown in Figure 3. Demersal fish which was the most dominant among the fish group registered an average catch rate of 26.1 kg/hr and appeared to be most abundant at station 44 with catch rate of 106.7 kg/hr and station 33 (75.6 kg/hr). Pelagic fish which have an average catch rate of 4.4 kg/hr was more abundant at station 33 and 44 with catch rate of 16.1 kg/hr and 11.0 kg/hr respectively. Cephalopods attained an average catch rate of 1.7 kg/hr and were more abundant at station 69 with catch rate of 10.2 kg/hr.

During the 4th cruise, commercial fish registered an average catch rate of 34.4 kg/hr. The highest catch rate was at station 27, (62.9 kg/hr) and station 6, (51.0 kg/hr) as shown in Figure 4. Demersal fish attained an average catch rate of 22.4 kg/hr and the highest catch rate was at station 27 (57.5 kg/hr). Pelagic fish have an average catch rate of 5.4 kg/hr and was most abundant at station 7 and 6 with catch rate of 16.5 kg/hr 13.9 kg/hr. Cephalopods have an average catch rate of 5.6 kg/hr and were more abundant at station 6 (16.6 kg/hr).

Trash fish have an average catch rate of 23.3 kg/hr and were more abundant at station 44 (74.4 kg/hr) and station 7 (71.0 kg/hr) during the 3rd cruise. The trash fish was dominated by *Pentaprion*

Table 1 Average catch rate (kg/hr) and percentage composition from entire sampling stations (3rd Cruise)

COMMERCIAL FISH	**Total**	**Mean**	**%**
Selar crumenophthalmus	18.68	1.17	1.05
Atule mate	1.68	0.11	0.11
Megalaspis cordyla	0.01	0.00	0.00
Decapterus spp.	33.71	2.11	1.64
Atropus atropus	1.55	0.10	0.09
Alepes kalla	0.12	0.01	0.01
Alectis cilliaris	0.04	0.00	0.00
Carangoides armatus	0.22	0.01	0.01
C. hedlandensis	0.21	0.05	0.01
C. malabaricus	21.11	1.32	1.16
C. talamparoides	1.23	0.08	0.06
Carangoides sp.	2.90	0.18	0.14
Selar sp.	0.43	0.03	0.02
Seriolina nigrofasciata	8.38	0.52	0.44
Uraspis uraspis	4.33	0.27	0.21
Carangidae	**94.52**	**5.91**	**4.94**
Pellona sp.	0.47	0.03	0.04
Amblygaster sp.	26.01	1.63	1.26
Clupeidae	**26.47**	**1.65**	**1.30**
Rastrelliger kanagurta	0.93	0.06	0.05
Scomber australascicus	0.17	0.01	0.01
Scombridae	**1.10**	**0.07**	**0.05**
Sphyraena forsteri	20.10	1.26	0.98
Sphyraena langsar	0.56	0.04	0.03
Sphyraena jello	1.08	0.07	0.05
Sphyraenidae	**21.75**	**1.36**	**1.06**
Chirocentrus dorab	0.91	0.06	0.04
Parastromateus niger	2.18	0.14	0.12
Dussumieria sp.	5.73	0.64	0.27
Pelagic fish	**152.56**	**9.54**	**7.79**
Abalistes stellaris	55.44	3.47	2.78
Argyrops spinifer	1.30	0.08	0.06
Arius spp.	32.12	2.01	2.51
Ariomma indica	16.16	1.01	0.79
Bothidae	0.35	0.02	0.02
Carcharhinus spp.	28.34	1.77	1.56
Dasyatis sp.	15.94	1.00	0.86
Drepane longimana	2.76	0.17	0.22
Epinephelus areolatus	0.09	0.01	0.00
Epinephelus coioides	12.98	0.81	0.63
Epinephelus diacanthus	0.06	0.00	0.00
Epinephelus heniochus	1.23	0.08	0.06
Epinephelus sexfasciatus	2.45	0.15	0.12
Serranidae	**16.81**	**1.05**	**0.82**
Gymnocranius griseus	34.44	2.15	1.92
Gymnura sp.	3.03	0.19	0.15
Lactarius lactarius	0.43	0.03	0.02
Lutjanus malabaricus	21.35	1.33	1.06
Lutjanus lineolatus	11.53	0.72	0.91
Lutjanus lutjanus	3.79	0.24	0.21
Lutjanus sebae	1.37	0.27	0.05
Lutjanus vitta	18.31	1.22	0.89
Pristipomoides multidens	10.37	0.65	0.53
Pristipomoides typus	0.13	0.01	0.01
Lutjanidae	**66.40**	**4.15**	**3.66**
Parupeneus cinnabarinus	13.73	0.86	0.74
Upeneus bensasi	1.85	0.12	0.16
Upeneus moluccensis	23.44	1.47	1.17
Mullidae	**39.03**	**2.44**	**2.07**
Nemipterus bathybius	61.02	3.81	3.31
N. isacanthus	2.80	0.18	0.15
N. japonicus	9.73	1.08	0.48
N. marginatus	35.30	2.52	1.68
N. mesoprion	13.94	0.87	0.68
N. nematophorus	42.02	2.63	2.16
N. nemurus	12.10	0.76	0.65
N. oveniides	0.04	0.01	0.00
N. peronii	17.76	1.18	0.96
N. virgatus	14.83	0.93	0.72
Nemipteridae	**208.48**	**13.03**	**10.80**
Platax sp.	2.38	0.15	0.12
Plectorhynchus pictus	11.39	0.71	0.86
Pomadasys hasta	0.47	0.03	0.04
Psenopsis anomala	0.06	0.00	0.00
Psettodes erumei	16.21	1.01	0.81
Priacanthus macracanthus	268.24	16.76	13.19
P. tayenus	9.37	0.59	0.85
Priacanthus sp.	0.65	0.04	0.03
Priacanthidae	278.26	17.39	14.07
Rhynchobatus djeddensis	10.33	0.65	0.60
Saurida micropectoralis	17.68	1.11	0.87
Sciaenidae	13.00	0.81	0.91
Scolopsis taeniopterus	4.82	0.30	0.26
Sphyrna mokarran	3.99	0.50	0.19
Demersal fish	**879.51**	**54.97**	**46.96**
Shells	0.70	0.05	0.06
Trichiurus lepturus	4.39	0.27	0.21
Loligo duvauceli	17.26	1.08	0.89
Loligo chinensis	7.34	0.46	0.38
Sepioteuthis lessoniana	2.54	0.16	0.17
Sepia spp.	33.65	2.10	1.67
Cephalopods	**60.79**	**3.80**	**3.11**
Metapenaeus ensis	0.15	0.01	0.01
Metapenaeopsis stridulans	0.39	0.02	0.02
Parapenaeopsis sp.	0.04	0.00	0.00
Solenocera subnuda	0.02	0.00	0.00
Trachypenaeus fulvus	0.45	0.03	0.02
Shrimps	**1.06**	**0.07**	**0.05**
Panulirus polyphagus	1.34	0.08	0.07
Thenus orientalis	2.53	0.17	0.14
Crabs	1.15	0.08	0.06
TOTAL (COMMERCIAL)	**1104.02**	**69.00**	**58.45**
Trash fish			
Aluterus monoceros	6.29	0.39	0.33
Anthiidae	12.12	0.76	0.59
Apogon spp.	14.69	0.92	0.71
Argyrops spinifer	0.30	0.02	0.01
Bothidae	3.59	0.22	0.17
Callionymidae	0.19	0.01	0.01
Canthigaster sp.	1.97	0.12	0.10
Carangoides equala	0.02	0.00	0.00
Coradion chrysozonus	0.06	0.00	0.01
Crabs	0.06	0.00	0.00
Dactyloptena sp.	5.28	0.33	0.26
Decapterus spp.	1.17	0.07	0.06
Diodon holocanthus	13.75	0.86	0.79
Dipterygonotus balteatus	0.02	0.00	0.00
Echeneis naucrates	1.04	0.06	0.05
Eutherapon theraps	1.19	0.07	0.11
Fistularia petimba	26.08	1.63	1.28
Heterodontus sp.	4.07	0.25	0.20
Holocentrus sp.	0.35	0.02	0.02
Inimicus sinensis	0.13	0.01	0.01
Lagocephalus spp.	12.47	0.78	0.86
Leiognathus spp.	129.98	8.12	6.63
Lepidotrigla sp.	5.01	0.31	0.25
Loligo duvauceli	3.12	0.19	0.15
Nemipterus marginatus	0.65	0.04	0.03
Nemipterus nematophorus	1.54	0.10	0.07
Octopus sp.	1.23	0.08	0.06
Paramonacanthus spp.	0.66	0.04	0.04
Parascolpsis eriomma	1.82	0.11	0.09
Parupeneus cinnabarinus	0.32	0.02	0.02
Pentaprion longimanus	146.45	9.15	7.13
Platycephalus spp.	1.15	0.07	0.06
Pleuronectes spp.	3.07	0.19	0.15
Priacanthus macracanthus	4.54	0.28	0.22
Priacanthus tayenus	29.31	1.83	1.43
Pristotis jerdoni	1.21	0.08	0.11
Pterois sp.	0.61	0.04	0.03
Pterocaesio chrysozona	0.61	0.04	0.03
Rays	0.55	0.03	0.05
Rhynchostracion nasus	0.47	0.03	0.04
Round sponges	15.99	1.00	0.78
Saurida micropectoralis	82.11	5.13	4.18
Saurida undosquamis	46.35	2.90	2.27
Saurida hoshinonis	0.28	0.02	0.01
Saurida spp.	36.40	2.27	1.77
Scolopsis spp.	0.00	0.00	0.00
Sea cucumber	0.23	0.01	0.02
Sepia spp.	4.91	0.31	0.24
Shells	0.06	0.00	0.00
Stolephorus sp.	0.24	0.01	0.01
Scorpaena scabra	4.39	0.27	0.21
Starfish	0.28	0.02	0.01
Tetrosomus sp.	4.16	0.26	0.22
Torquigener sp.	2.29	0.14	0.11
Triacanthus spp.	0.76	0.05	0.04
Upeneus sulphureus	17.96	1.12	0.87
Upeneus moluccensis	49.44	3.09	2.42
Upeneus spp.	68.90	4.31	6.22
Uranoscopus sp.	0.80	0.05	0.04
TOTAL (Trash)	**772.71**	**48.29**	**41.55**
TOTAL CATCH	**1876.73**	**117.30**	**100.00**

Table 2 Average catch rate (kg/hr) and percentage composition from entire sampling stations (4th Cruise)

COMMERCIAL FISH	Total	Mean	%
Selar crumenophthalmus	0.00	0.00	0.00
Atule mate	10.46	0.87	1.74
Megalaspis cordyla	0.91	0.08	0.15
Decapterus spp.	2.60	0.22	0.43
Atropus atropus	1.20	0.10	0.20
Alepes kalla	0.00	0.00	0.00
Alepes djedaba	0.16	0.01	0.03
Alepes melanoptera	0.52	0.04	0.09
Alectis cilliaris	0.00	0.00	0.00
Carangoides armatus	0.00	0.00	0.00
C. hedlandensis	0.00	0.00	0.00
C. malabaricus	19.01	1.58	3.16
C. talamparoides	0.00	0.00	0.00
Carangoides sp.	0.10	0.01	0.02
Caranx sexfasciatus	1.00	0.08	0.17
Selar sp.	0.00	0.00	0.00
Seriolina nigrofasciata	2.64	0.22	0.44
Uraspis uraspis	0.00	0.00	0.00
R. djedeba	2.60	0.22	0.43
Selaroides leptolepis	10.96	0.91	1.82
Carangidae	52.16	4.35	8.66
Pellona sp.	0.00	0.00	0.00
Amblygaster sp.	0.00	0.00	0.00
Clupids	0.32	0.03	0.05
Clupeidae	0.32	0.03	0.05
Rastrelliger kanagurta	4.80	0.40	0.80
Scomber australascicus	0.00	0.00	0.00
Scombridae	4.80	0.40	0.80
Sphyraena forsteri	6.51	0.54	1.08
Sphyraena langsar	0.00	0.00	0.00
Sphyraena jello	0.00	0.00	0.00
Sphyraenidae	6.51	0.54	1.08
Chirocentrus dorab	0.40	0.03	0.07
Parastromateus niger	0.40	0.03	0.07
Dussumieria sp.	0.45	0.04	0.07
Pelagic fish	65.04	5.42	10.80
Abalistes stellaris	24.25	2.02	4.03
Argyrops spinifer	0.00	0.00	0.00
Arius spp.	10.70	0.89	1.78
Ariomma indica	0.00	0.00	0.00
Bothidae	1.49	0.12	0.25
Carcharhinus spp.	1.40	0.12	0.23
Dasyatis sp.	0.00	0.00	0.00
Drepane longimana	0.00	0.00	0.00
Ephippus orbis	4.40	0.37	0.73
Epinephelus areolatus	1.75	0.15	0.29
Epinephelus coioides	4.50	0.38	0.75
Epinephelus diacanthus	0.00	0.00	0.00
Epinephelus heniochus	0.00	0.00	0.00
Epinephelus sexfasciatus	0.14	0.01	0.02
Epinephelus spp.	0.12	0.01	0.02
Serranidae	6.51	0.54	1.08
Gymnocranius griseus	19.55	1.63	3.25
Gymnura sp.	1.70	0.14	0.28
Lactarius lactarius	0.20	0.02	0.03
Lutjanus malabaricus	10.34	0.86	1.72
Lutjanus lineolatus	0.90	0.08	0.15
Lutjanus lutjanus	1.70	0.14	0.28
Lutjanus sebae	0.70	0.06	0.12
Lutjanus vitta	1.04	0.09	0.17
Pristipomoides multidens	6.70	0.56	1.11
Pristipomoides typus	0.00	0.00	0.00
Pristipomoides spp	0.35	0.03	0.06
Pristipomoides pleurospilus	7.70	0.64	1.28
Lutjanidae	29.43	2.45	4.89
Parupeneus cinnabarinus	0.00	0.00	0.00
Parupeneus pleurospilus	5.23	0.44	0.87
Upeneus bensasi	14.60	1.22	2.43
Upeneus moluccensis	22.62	1.89	3.76
Mullidae	42.45	3.54	7.05
Muraenesox sp	4.10	0.34	0.68
Nemipterus bathybius	25.40	2.12	4.22
N. hexadon	0.60	0.05	0.10
N. isacanthus	0.00	0.00	0.00
N. japonicus	7.50	0.63	1.25
N. marginatus	2.67	0.22	0.44
N. mesoprion	3.87	0.32	0.64
N. nematophorus	0.00	0.00	0.00
N. nemurus	22.62	1.89	3.76
N. oveniides	0.00	0.00	0.00
N. peronii	7.80	0.65	1.30
N. tolu	0.20	0.02	0.03
N. virgatus	1.40	0.12	0.23
Parascolopsis inermis	0.95	0.08	0.16
Pentapodus setosus	3.70	0.31	0.61
Nemipteridae	76.71	6.39	12.74
Platax sp.	2.80	0.23	0.47
Plectorhynchus pictus	18.80	1.57	3.12
Pomadasys hasta	0.26	0.02	0.04
Pomadasys argenteus	0.12	0.01	0.02
Psenopsis anomala	0.00	0.00	0.00
Psettodes erumei	2.70	0.23	0.45
Priacanthus macracanthus	8.65	0.72	1.44
P. tayenus	4.33	0.36	0.72
Priacanthus sp.	0.00	0.00	0.00
Priacanthidae	12.98	1.08	2.16
Rhynchobatus djeddensis	0.00	0.00	0.00
Saurida micropectoralis	0.00	0.00	0.00
Sciaenidae	1.67	0.14	0.28
Scolopsis taeniopterus	6.10	0.51	1.01
Sphyrna mokarran	0.00	0.00	0.00
Demersal fish	268.32	22.36	44.57
Shells	0.00	0.00	0.00
Trichiurus lepturus	0.00	0.00	0.00
Loligo duvauceli	15.24	1.27	2.53
Loligo chinensis	14.34	1.20	2.38
Loligo sp	34.14	2.85	5.67
Sepioteuthis lessoniana	1.06	0.09	0.18
Sepia spp.	2.94	0.25	0.49
Cephalopods	67.72	5.64	11.25
Metapenaeus ensis	0.10	0.01	0.02
Metapenaeopsis stridulans	0.00	0.00	0.00
Parapenaeopsis sp.	0.00	0.00	0.00
Penaeus japonicus	0.06	0.01	0.01
Solenocera subnuda	0.00	0.00	0.00
Trachypenaeus fulvus	0.05	0.00	0.01
T. haumela	0.87	0.07	0.14
T. myops	1.31	0.11	0.22
Shrimps	2.39	0.20	0.40
Panulirus polyphagus	0.49	0.04	0.08
Thenus orientalis	8.56	0.71	1.42
Crabs	0.75	0.06	0.12
TOTAL (COMMERCIAL)	413.27	34.44	68.65
Trash fish			
Aluterus monoceros	0.53	0.04	0.09
Alutera	0.19	0.02	0.03
Anthiidae	0.00	0.00	0.00
Apogon spp.	1.76	0.15	0.29
Argyrops spinifer	0.00	0.00	0.00
Arothron sp.	1.10	0.09	0.18
Bothidae	0.00	0.00	0.00
Callionymidae	0.00	0.00	0.00
Canthigaster sp.	0.00	0.00	0.00
Carangoides equala	0.00	0.00	0.00
Coradion chrysozonus	0.00	0.00	0.00
Crabs	0.00	0.00	0.00
Dactyloptena sp.	0.20	0.02	0.03
Decapterus spp.	1.99	0.17	0.33
Diodon holocanthus	2.14	0.18	0.36
Diodon spp.	0.92	0.08	0.15
Dipterygonotus balteatus	0.12	0.01	0.02
Echeneis naucrates	0.00	0.00	0.00
Eutherapon theraps	0.00	0.00	0.00
Fistularia petimba	1.23	0.10	0.20
Fistularia spp	1.94	0.16	0.32
Heterodontus sp.	0.00	0.00	0.00
Holocentrus sp.	9.50	0.79	1.58
Inimicus sinensis	0.00	0.00	0.00
Labridae	0.20	0.02	0.03
Lagocephalus spp.	3.81	0.32	0.63
Leiognathus spp.	2.32	0.19	0.39
Lepidotrigla sp.	0.28	0.02	0.05
Loligo duvauceli	0.00	0.00	0.00
Lophodiodon	0.38	0.03	0.06
Nemipterus marginatus	0.00	0.00	0.00
Nemipterus nematophorus	0.00	0.00	0.00
Octopus sp.	0.00	0.00	0.00
Ostracion sp	0.19	0.02	0.03
Paramonacanthus spp.	0.00	0.00	0.00
Parascolpsis eriomma	0.00	0.00	0.00
Parapercids	0.28	0.02	0.05
Parupeneus cinnabarinus	0.00	0.00	0.00
Pentaprion longimanus	18.26	1.52	3.03
Platycephalus spp.	0.26	0.02	0.04
Pleuronectes spp.	3.76	0.31	0.62
Priacanthus macracanthus	0.00	0.00	0.00
Priacanthus tayenus	0.00	0.00	0.00
Pristotis jerdoni	14.40	1.20	2.39
Pseudomonocanthus sp	0.03	0.00	0.00
Pterois sp.	0.00	0.00	0.00
Pterocaesio chrysozona	0.00	0.00	0.00
Pterocaesis	1.07	0.09	0.18
Rays	27.05	2.25	4.49
Rhynchostracion	0.90	0.08	0.15
Rhynchostracion nasus	0.15	0.01	0.02
Round sponges	0.00	0.00	0.00
Saurida micropectoralis	0.00	0.00	0.00
Saurida undosquamis	15.12	1.26	2.51
Saurida hoshinonis	0.00	0.00	0.00
Saurida elongata	5.55	0.46	0.92
Saurida spp.	14.60	1.22	2.43
Saurida tumbil	10.60	0.88	1.76
Scolopsis spp.	0.00	0.00	0.00
Sea cucumber	0.00	0.00	0.00
Sepia spp.	0.00	0.00	0.00
Shells	0.00	0.00	0.00
Stolephorus sp.	0.10	0.01	0.02
Scorpaena scabra	0.00	0.00	0.00
Siganus oramin	0.20	0.02	0.03
Sillago	3.00	0.25	0.50
Sillago sihama	5.50	0.46	0.91
Starfish	0.00	0.00	0.00
Synodous hoshinonis	0.19	0.02	0.03
Tetrosomus sp.	1.19	0.10	0.20
Therapon theraps	12.00	1.00	1.99
Torquigener sp.	0.00	0.00	0.00
Triacanthus spp.	0.13	0.01	0.02
Upeneus sulphureus	25.00	2.08	4.15
Upeneus moluccensis	0.00	0.00	0.00
Upeneus spp.	0.60	0.05	0.10
Uranoscopus sp.	0.00	0.00	0.00
TOTAL (Trash)	188.74	15.73	31.35
TOTAL CATCH	602.01	50.17	100.00

Table 3 Summary of the catch composition of the major fish group

Fishery group	Total (kg)		Average catch (kg/hr)		Percentage (%)	
	3rd cruise	4th cruise	3rd cruise	4th cruise	3rd cruise	4th cruise
Demersal fish	444.72	268.32	26.16	22.36	46.96	44.57
Pelagic fish	74.18	65.04	4.36	5.42	7.79	10.8
Cephalopods	29.32	67.72	1.72	5.64	3.11	11.25
Shrimps	0.49	2.39	0.03	0.2	0.05	0.40
Crab	0.54	0.75	0.04	0.06	0.06	0.12
Shell fish	0.60	0.00	0.04	0.00	0.06	0.00
Trash fish	395.81	188.74	23.28	15.73	41.55	31.35
Others	3.98	9.05	0.24	0.75	0.42	1.51
Total catch	949.63	602.01	55.86	50.16	100.00	100.00

longimanus, *Leiognatus spp*., *Upeneus spp*.and *Saurida micropectoralis*. During the 4th cruise, trash fish registered an average catch rate of 15.7 kg/hr. Most trash fish were caught at station 31 (53.1 kg/hr) followed by station 7 (41.1 kg/hr). The trash fish were dominated by *Upeneus sulphureus*, *Pentaprion longimanus* and *Saurida spp*.

Priacanthids, the most dominant among the fish family in the 3rd cruise have an average catch rate of 7.9 kg/hr. The highest catch rate was at station 44, (100.0 kg/hr) and was recorded only by *Priacanthus macracanthus*. Nemipterids attained an average catch rate of 6.1 kg/hr. *Nemipterus bathybius* recorded the highest average catch rate of 1.9 kg/hr. Nemipterids were most abundant at station 33 with catch rate of 22.2 kg/hr. Carangidae, the third most dominant fish family registered an average catch rate of 2.8 kg/hr. In terms of individual species within the family, *Decapterus spp*. attained the highest average catch rate (1.0 kg/hr) and the others recorded an average catch rate of less than 1.0 kg/hr. Carangidae was most abundant at station 34 with catch rate of 8.7 kg/hr.

During the 4th cruise, the most dominant family i.e Nemipteridae have an average catch rate of 6.4 kg/hr. The highest catch rate was at station 27 with catch rate of 14.62 kg/hr. Carangidae attained an average catch rate of 4.3 kg/hr and the highest catch rate was recorded at station 7 (15.9 kg/hr). Among the carangids, *Atule mate* registered the highest catch rate (9.5 kg/hr) at station 6.

Table 4 Length-weight relationship of selected species

Species	n	a	b	r^2
Selar crumenophthalmus	123	0.0057	3.4063	0.92
Decapterus kurroides	56	0.0067	3.1937	0.88
Decapterus ruselli	204	0.0053	3.2989	0.91
Decapterus macrosoma	85	0.0076	3.1082	0.86
C. malabaricus	144	0.0104	3.2704	0.96
Carangoides equala	54	0.0323	2.8953	0.92
Dussumieria spp.	198	0.0095	3.0511	0.67
Ariomma indica	53	0.0244	3.0545	0.63
Nemipterus bathybius	250	0.0172	3.0350	0.98
Nemipterus marginatus	96	0.0152	3.1071	0.98
Nemipterus mesoprion	143	0.0139	3.1161	0.99
Nemipterus nematophorus	186	0.0194	2.9862	0.98
Nemipterus nemurus	79	0.0188	2.9585	0.90
Nemipterus virgatus	55	0.0212	2.9414	0.98
Priacanthus macracanthus	151	0.0142	2.9997	0.98

The b values obtained ranged from 2.89 to 3.40.

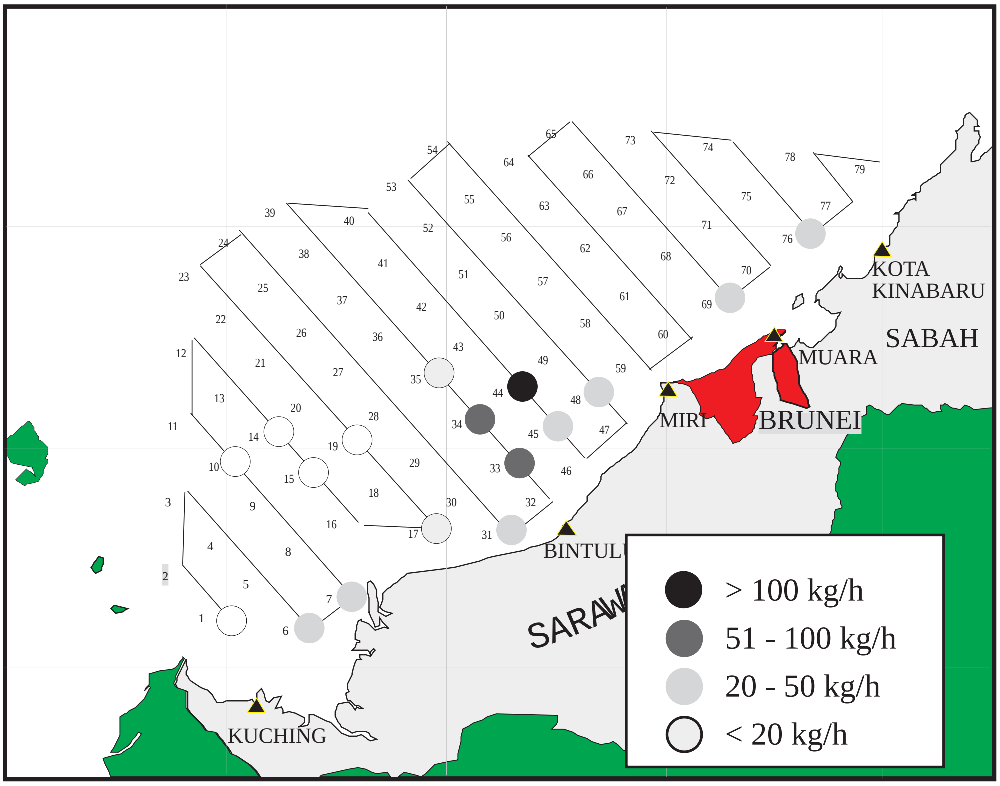

Fig. 3 Catch rate of commercial fish of individual station during 3rd cruise (9th - 3rd August 1996)

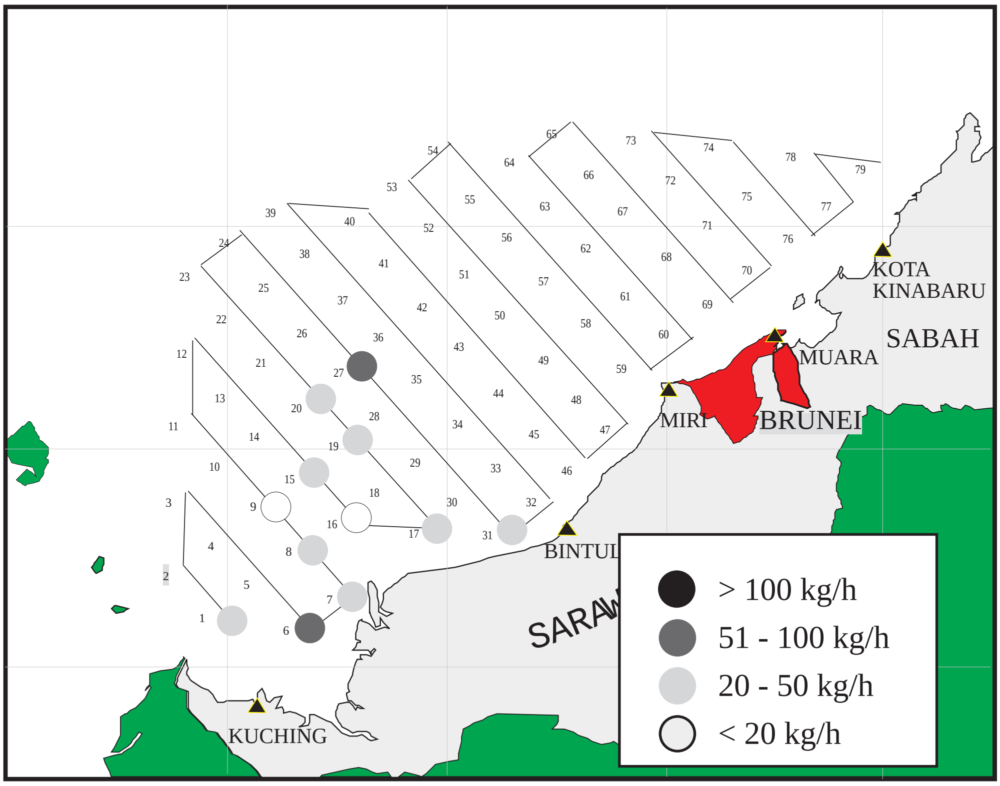

Fig. 4 Catch rate of commercial fish of individual station during 4th cruise (30th April - 30th May 1997)

Length-Weight Relationship

The length-weight relationship of the selected species are as shown in Table 4 below:

Discussions

The overall average catch rate from individual stations during 3rd cruise (55.9 kg/hr) and 4th cruise (50.2 kg/hr) is very low compared to 318 kg/hr and 210 kg/hr obtained from previous surveys within the same areas in 1972 (Mohammed Shaari et al, 1976a) and 1973 (Mohammed Shaari et al, 1976b) respectively. However, in the present survey, the number of hauls is very small in number (i.e. 17 and 12 hauls for 3rd and 4th cruise respectively) as compared to 118 hauls during the previous survey (Mohammed Shaari et al, 1976b).

The other factor that might contributed to the low overall average catch rate of commercial fish after 17 and 12 hours trawling respectively is the openning of the trawl net. It could be that the net mouth did not open properly.

For an ideal fish which maintains the same shape, b=3, and this has occasionally been observed (Allen, 1938). In the present study, it seemed that the cube law is being obeyed as most of the b values lies close to 3. In general, the fish are also normally distributed. This was based on the findings by Carlender (1969) that fish with b values equal to 3 are more representative of the population. It was found that the b values for nemipterids varies excepts for 3 species (*N. nematophorus, N. nemurus and N. virgatus*). This suggests that the nemipterids have different growth rate. The lower values of b can be considered to be the result of biological features of the species.

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