Status of Marine Fisheries Resources in Myanmar Waters: Estimates from Bottom Trawl Survey

T. Thapanand-Chaidee[1*], U. Myint Pe[2] and I. Chanrachkij[3]

ABSTRACT

Sixteen survey operations in the waters of Myanmar were conducted by the research vessel *MV SEAFDEC 2* during February to March 2007. After 15 h 40 min of overall towing time, a total of 1,434.4 kg of catch was classified into 113 fish species and 8 groups of invertebrates. Brushtooth lizardfish (*Saurida undosquamis*) was the most prevalent fish species captured (20.1% by weight). Among commercial invertebrates, loliginid squid (*Loligo* spp.) was the most abundant representing 48.9% by weight. The median total catch per unit effort (CpUE) was 74.0 kg hr^{-1}, comprising fish CpUE of 63.4 kg hr^{-1} and invertebrate CpUE of 14.9 kg hr^{-1}. The survey operations, according to the depth and total catch, could be separated into three clusters. The catch per unit area (CpUA) from each operation, estimated from the swept area, ranged from 1,541.0 to 9,684.5 kg nM^{-2}, which gave a total CpUA of 45,567.6 kg nM^{-2} from an overall research area of 13,800 nM^2.

Key words: marine fisheries resources; CpUE; CpUA; bottom trawl; Myanmar

INTRODUCTION

There is inadequate information regarding the status of fisheries resources in Myanmar waters before 1980 (Nakken and Aung, 1980). The main purposes of previous studies were to estimate marine fish biomass, identify and map non-exploited stock, and train counterparts (Druzhinin, 1970; Druzhinin and Hlaing, 1972). Nevertheless, data were collected unsystematically, i.e. neither on the basis of an explicit nor a pre-established sampling design (Pauly and Aung, 1984). The government of Myanmar, assisted by the United Nations Development Programme (UNDP) and the Food and Agriculture Organization (FAO), began engaging in marine fisheries resources exploration within its Exclusive Economic Zone (EEZ) in 1984. Another joint survey,

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conducted on *FRTV Chulabhorn*, was the collaborative program between the Department of Fisheries of Thailand and the Union of Myanmar in 1990. During that survey, four types of fishing gear were operated, namely, bottom trawl, drift gillnet, bottom vertical longline, and tuna purse seine. Oceanographic data were also collected (Poreeyanond, 1991).

The survey area covered the length of the eastern coast of Myanmar's continental shelf within the EEZ (09º30′N - 16º15′N, and 094º30′E - 098º00′E). Cruise No. 23-1/2007 operated from 1 February - 15 March 2007 (43 days), and was conducted on *MV SEAFDEC 2* research vessel. Activities in the 74 stations consisted of oceanographic survey, and bottom trawl (BT) and pelagic longline (PLL) surveys. The bottom trawl survey was conducted in the upper Gulf of Martaban and the eastern central coast of the Myanmar continental shelf (13 February - 2 March 2007). The aim of this study was to investigate the composition of marine resources from bottom trawl which is one part of this cruise. This study also offered specific recommendations for future exploration and methods for further research on this topic.

MATERIALS AND METHODS

Area of fishing operation

There were 17 bottom-trawl survey operations split into two periods. The first 8 operations were conducted from 13 to 22 February 2007 in the upper part of the Gulf of Martaban. The second period with 9 operations was conducted from 23 February to 2 March 2007 in eastern Myanmar coastal waters (Fig. 1).

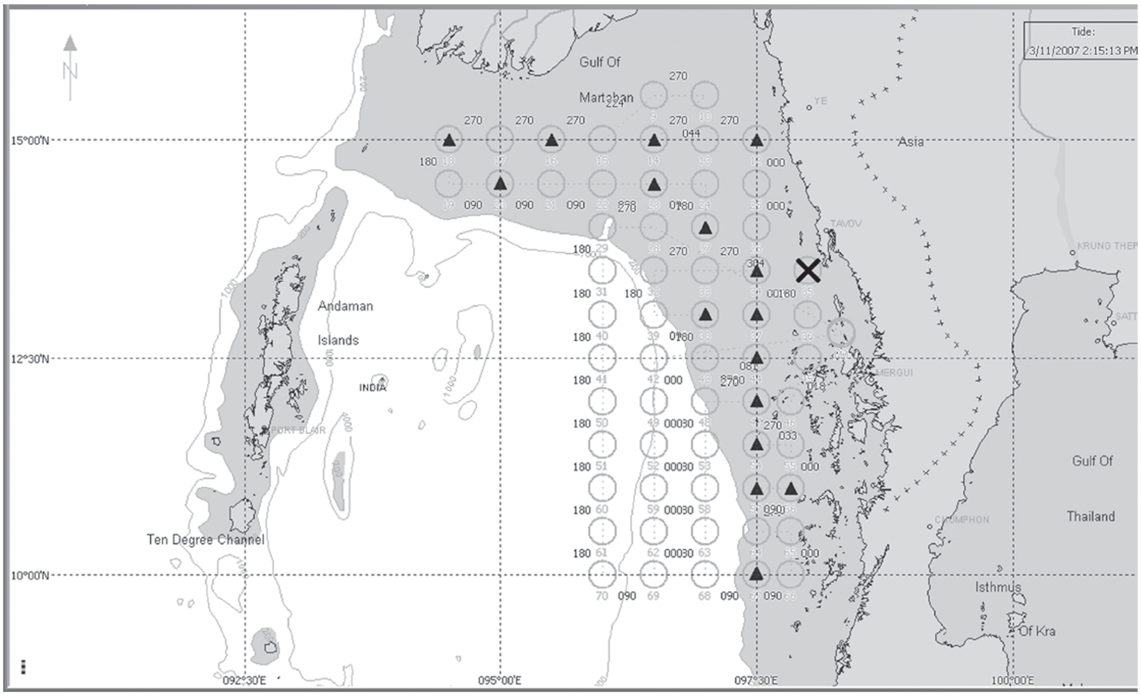


Figure 1. Planned operations of bottom trawl survey (▲)
✕ Excluded from this study due to gear damage

Fishing gear

Marine resources were sampled by otter board trawl (OBT). The trawl had four seams with a 31.6 m head rope and 37 m ground rope. The ground rope is suitable for a soft bottom. The net body was 40.55 m long. The cod-end part had a 2.5 cm mesh size made of polyethylene knotless net. The net opening was approximately 2.5-3.0 m in height with a 20-24 m wing spread. The trawl was widened by a pair of rectangular iron otter boards. The size of each otter board was 1.4 x 2.2 m. The sweep line was 30 m long with a 50 m upper and lower net pendant. Trawling speed was 3.0-3.5 knots and towing time was about 1 h. Scanmar sensors (Scanmar AS: Asgardstrand, Norway) were set up for monitoring the trawl configuration and calculation of the swept area.

Data Collection

Total catch, including fishes and invertebrates, was weighed. Fish identification was performed following the key of Masuda *et al*. (1984) and photographed for confirmation with FishBase (Froese and Pauly, 2007). Fish species were also randomly sampled for weight determination. Catch composition was reported in terms of percentage by weight. Invertebrates were separated into eight groups: jellyfish (white and red), horseshoe crab, shrimps, crabs, mantis shrimps, mollusks, squids, and echinoderms. Each group was weighed.

Data Analysis

Species composition of marine fisheries resources by weight was estimated separately according to type of organism, whether fish or invertebrate. Catch per unit effort (CpUE) was also estimated as kg per hour of towing time. Unweighted pair-group method using arithmetic mean (UPGMA) cluster analysis using "ade4" package in the R statistical program (R Development Core Team, 2009) was used to group the CpUE and depth. Catch per unit area (CpUA) and biomass were estimated by swept area method (Sparre and Venema, 1998).

RESULTS AND DISCUSSIONS

Only 16 of 17 planned operations could be employed due to gear damage in one operation. The total catch was separated into two major groups: fishes and invertebrates. In terms of fish composition, at least 113 species in 62 families (excluding sharks) were caught. Eight major groups of invertebrates, namely jellyfish, horseshoe crab, shrimps, crabs, mantis shrimps, mollusks, squids and echinoderms, were caught. The detail of species composition was already reported in Thapanand-Chaidee *et al*. (2008).

Overall, 1,434.4 kg of marine resources from 15 h 40 min of towing time were caught. The CpUE ranged from 66.2 to 245.3 kg hr^{-1}. Even though the second operation (station No.12) had the highest catch, it was mostly composed of jellyfish (86.2% by weight). The second highest catch, on the other hand, was the 14^{th} operation (station No. 67), and was almost entirely composed of fishes (99.6%). The details of catch composition are summarized in Table 1 and Figure 2.

Table 1. Catch composition of marine fisheries resources from bottom trawl survey in Myanmar waters

Operation	**Station no.**	**Depth (m)**	**Total Catch (kg)**	**Towing Time (min)**	**Fish wt. (kg)**	**% Fish**	**Invert. wt. (kg)**	**% Invert.**	**Total CpUE (kg/h)**	**Total CpUE fish (kg/h)**	**Total CpUE invert. (kg/h)**
2	12	34	164.33	44	21.87	13.30	142.46	86.70	245.27	32.64	212.63
3	14	36	68.44	60	49.40	72.18	19.04	27.82	68.44	49.40	19.04
4	16	73	75.88	60	68.27	89.98	7.61	10.03	75.88	68.27	7.61
5	18	54	78.46	60	64.76	82.54	13.70	17.46	78.46	64.76	13.70
6	20	87	66.19	60	64.68	97.72	1.51	2.28	66.19	64.68	1.51
7	23	99	107.30	60	91.30	85.09	16.00	14.91	107.30	91.30	16.00
8	27	74	68.61	60	48.21	70.27	20.40	29.73	68.61	48.21	20.40
9	37	82	129.60	60	120.69	93.13	8.91	6.88	129.60	120.69	8.91
10	34	72*	72.13	60	66.15	91.71	5.98	8.29	72.13	66.15	5.98
11	38	96	67.26	60	49.05	72.93	18.21	27.07	67.26	49.05	18.21
12	44	83*	83.38	60	71.42	85.65	11.96	14.34	83.38	71.42	11.96
13	47	80	95.37	60	43.97	46.10	51.40	53.90	95.37	43.97	51.40
14	67	98*	153.08	60	152.43	99.58	0.65	0.42	153.08	152.43	0.65
15	57	84	67.91	60	62.01	91.31	5.90	8.69			
16	56	72	66.63	60	43.68	65.56	22.95	34.44			
17	54	82*	69.87	60	44.23	63.30	25.64	36.70			
Total			1,434.44		1,062.12		372.32				

The normality of total CpUE distribution was determined using a Kolmogorov-Smirnov test and was found to be non-normal ($p<0.05$). Hence, total CpUE data were subjected to logarithmic transformation as suggested by Moranta *et al*. (2000). However, for the total CpUE, such transformation did not make the data conform to normal distribution, so the average had to be expressed in terms of harmonic mean (HM) as 82.9 kg hr^{-1}, which gave a median of 74.0 kg hr^{-1}. On the other hand, the CpUE data of fishes and invertebrates distributions had normal after transformation, with average and median CpUEs of 61.9 kg $hr^{-1}$and 63.4 kg hr^{-1} for fish, and 13.4 kg hr^{-1} and 14.9 kg hr^{-1} for invertebrates, respectively.

Fish represented the major proportion of the total catch (74.0%). Lizardfish (*Saurida undosquamis*) was the most dominant fish species, comprising 20.1% of the total catch (Figure 3). *Saurida undosquamis* was widely distributed in the research survey area while *Satyrichthys welchi* was found only in one operation (operation No. 14), but at high quantities. Other species commonly found in the study area, such as *Fistularia petimba, Dactyloptena orientalis, Leiognathus* sp., *Trichiurus lepturus* and *Lagocephalus wheeleri* were also found but at lower quantities (number and weight). Catch composition varied according to operations, such as during operation No. 3 when none of the top five dominant fish species was caught (Fig. 4).

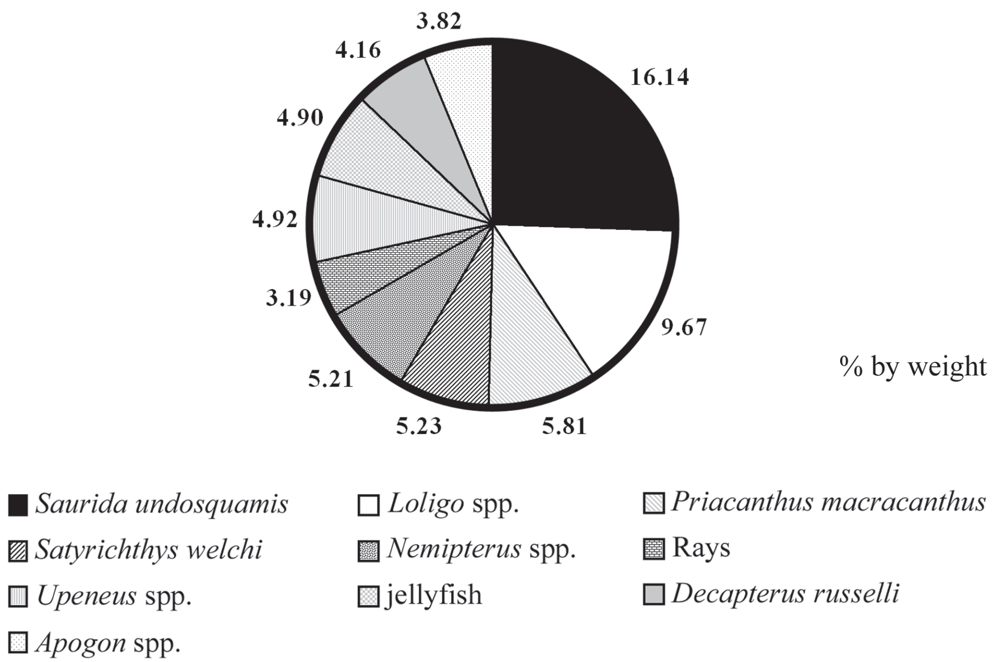


Figure 2. The top-ten ranking of the catch composition of marine fisheries (all resources, including invertebrates)

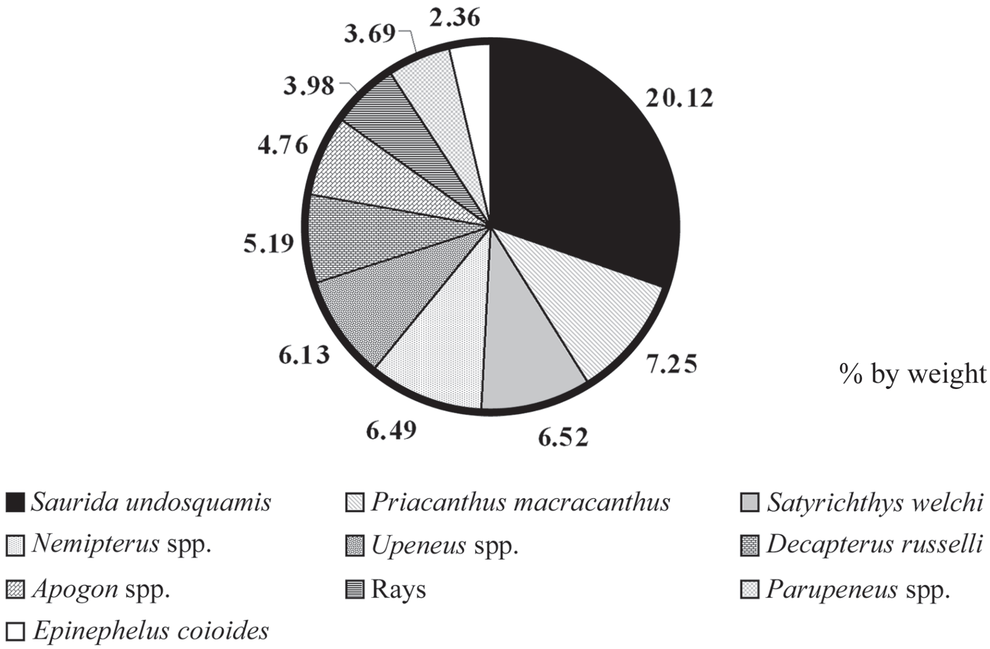


Figure 3. The top-ten ranking of the catch composition of marine fish resources based on total catch

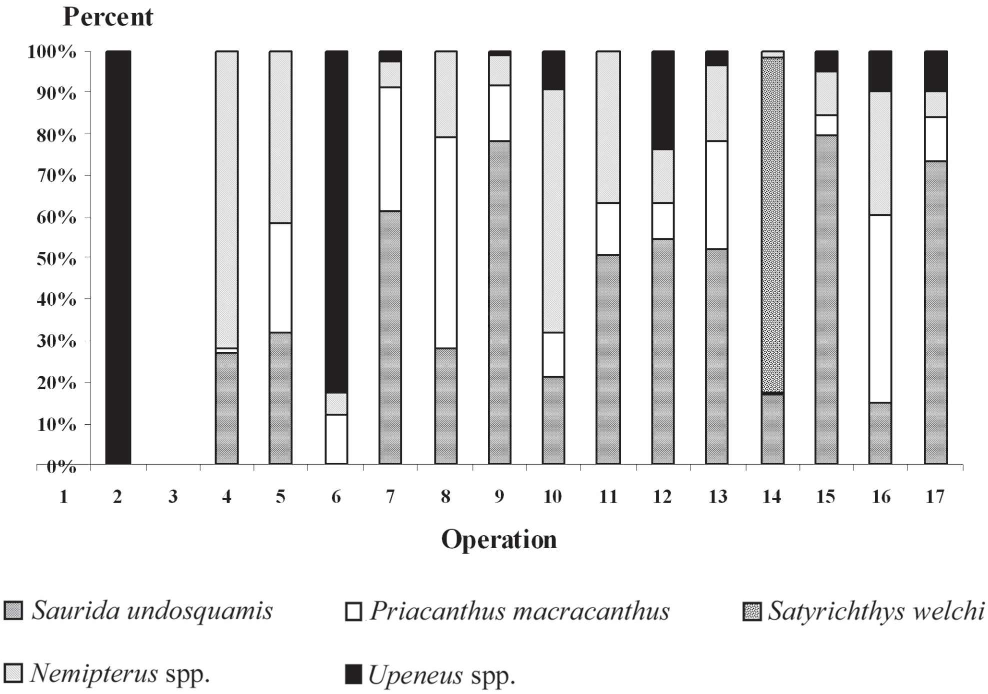


Figure 4. Distribution of the top-five ranked fish by operation

Fig. 5 shows the top five invertebrates caught which accounted for 26.0% of the total invertebrate catch. Among the eight groups of invertebrates, *Loligo* spp. catch was the highest at 48.9%. Crabs as well as cuttlefish were also dominant but in low quantities compared to the loliginids. Figure 6 shows the distribution of the top five invertebrates classified by operation number. Catch composition also varied according to operations. *Loligo* spp. was widely distributed with high percentage in all operations. Crabs, another dominant species, mostly consisted of *Charybdis cruciata* (Fig. 6).

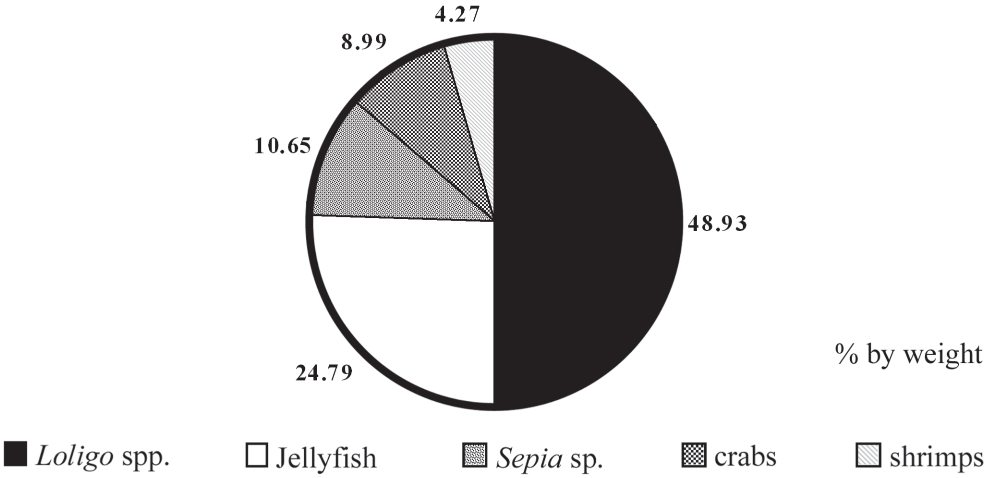


Figure 5. The top-five ranking of the catch composition of invertebrate resources

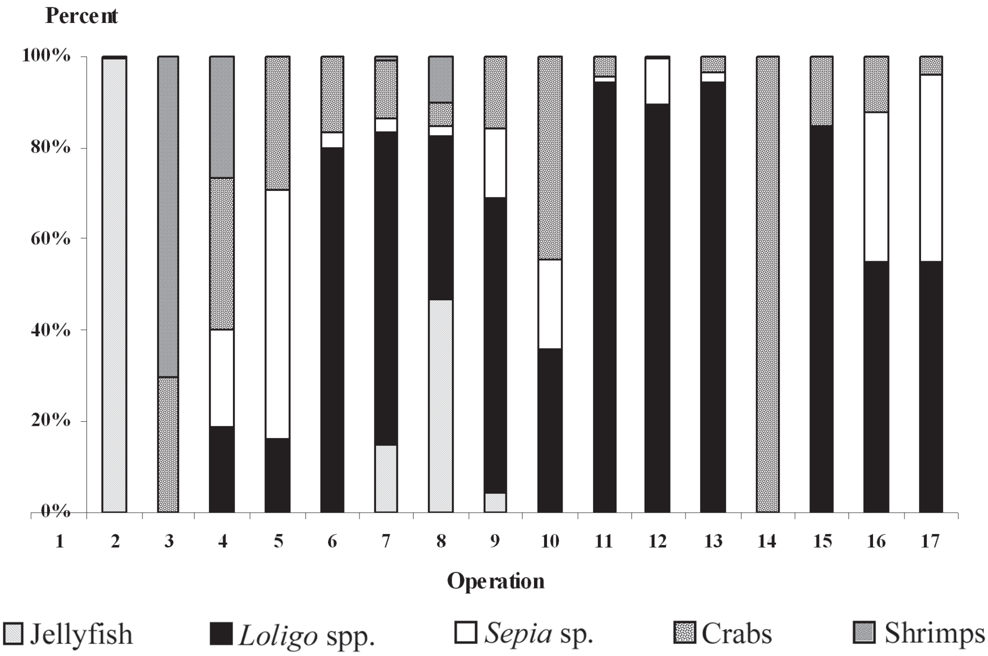
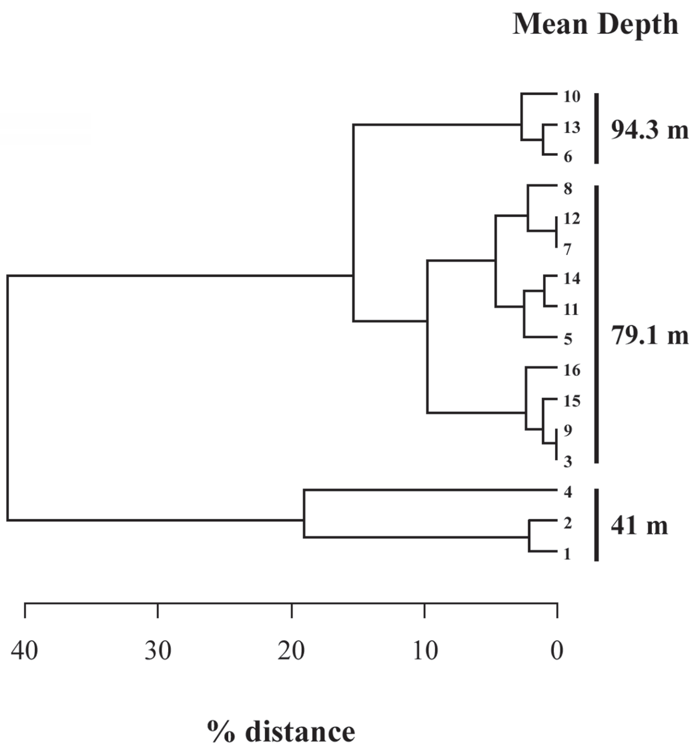


Figure 6. Distribution of the top-five ranked invertebrates by operation

Other fisheries resources were not recorded in this study due to their low quantities and fragmentation, such as sponges, soft corals, sea pens, sea fans and sea snakes.

The dendrogram resulting from UPGMA cluster analysis of the total catch showed three main clusters (Fig. 7). The first cluster (cluster A) is composed of three stations (stations 12, 14 and 18) with a mean depth of 41 m; the second cluster (cluster B) is composed of 10 stations with a mean depth of 79.1 m; and the third cluster (cluster C) is composed of three stations (stations 23, 38 and 67) with a mean depth of 94.3 m.



Note: Digit "1" in dendrogram means Operation No. 2 in the survey

Figure 7. Cluster dendrogram of total catch according to sea depth

Eighteen species were found only in cluster A, 27 only in cluster B, and 12 only in cluster C (Table 2). Twelve species were found in rather shallow waters (clusters A and B), whereas 29 species were found in the deeper zone (clusters B and C). Twenty species were commonly found in all three clusters; and only one species, *Uraspis uraspis*, could not be found in the middle depth.

Table 2. Catch composition (kg) for each group resulting from cluster analysis (see Fig. 7)

Species	Cluster (mean depth)		
	A (41 m)	B (79.1 m)	C (94.3 m)
Congresox talabon	0.90		
Coilia dussumieri	2.20		
Dussumieria acuta	0.10		
Osteogeneiosus militaris	2.00		
Plotosus sp.	3.00		
Alepes djedaba	1.57		
Atropus atropos	0.15		
Pomadasys maculatus	0.23		
Polydactylus sextarius	1.80		
Pennahia macrocephalus	2.13		
Johnius belengerii	1.33		
Chrysochir aureus	15.40		
Upeneus sulphureus	0.05		
Drepane longimana	2.15		
Terapon jarbua	0.15		
unidentified gobies	0.05		
Ephippus orbis	1.54		
Limulus polyphemus	0.04		
Sharks	1.50	0.20	
Saurida elongata	3.60	8.65	
Leiognathus sp.	0.36	20.82	
Pentaprion longimanus	1.80	16.70	
Pennahia anea	19.90	0.70	
Siganus canaliculatus	0.10	0.70	
Rastrelliger kanagurta	5.00	0.90	
Cynoglossus cynoglossus	1.89	2.18	
Tetrodon sp.	0.22	3.40	
Thenus orientalis	0.05	1.00	
Squilla mantis	0.10	0.08	
Mollusks	0.18	0.98	
Rhynchobatus djiddensis		0.40	
Epinephelus areolatus		0.50	
Priacanthus tayenus		1.00	
Apogon sp.1		0.21	
Rachycentron canadum		5.65	
Carangoides ciliarius		0.02	
Carangoides seriolina		0.20	
Decapterus macrosoma		0.76	
Selar crumenophthalmus		0.85	

Table 2. (continued)

Species	**Cluster (mean depth)**		
	A (41 m)	**B (79.1 m)**	**C (94.3 m)**
Lutjanus sebae		0.60	
Pristipomoides typus		3.00	
Seriolina nigrofasciata		1.60	
Lutjanus quinquelineatus		0.50	
Argyrops bleekeri		0.05	
Nemipterus bipunctatus		10.25	
Nemipterus nematopus		2.22	
Nemipterus peronii		2.70	
Upeneus japonicus		6.74	
Acanthocepola sp.		12.50	
Dactylopus dactylopus		0.02	
Sphyraena obtusata		0.25	
Engyprosopon spp.		3.56	
Samaris sp.		0.01	
Aluterus monoceros		0.90	
Cyclichthys orbicularis		0.40	
Octopus sp.		0.71	
Rhinobatus sp.		12.20	1.10
Saurida tumbil		0.89	1.00
Synodus hoshinonis		1.97	0.20
Trachinocephalus myops		19.85	2.95
Halieutaea sp.		2.46	3.06
Sargocentron rubrum		0.15	1.45
Fistularia petimba		4.76	1.35
Dactyloptena orientalis		2.45	5.99
Pterois sp.		6.19	0.10
Scorpaena sp.		3.04	1.80
Epinephelus coioides		13.00	12.00
Epinephelus bleekeri		4.15	7.56
Carangoides sp.		0.80	1.90
Nemipterus bathybius		5.25	1.50
Nemipterus spp.		4.24	5.20
Scolopsis sp.		0.57	2.25
Parupeneus chrysopleuron		25.70	7.00
Parupeneus heptacanthus		0.76	5.70
Upeneus moluccensis		44.15	1.40
Upeneus spp.		10.70	0.95
Uranoscopus sp.		0.57	0.93
Psettodes erumei		6.00	2.00

Table 2. (continued)

Species	Cluster (mean depth)		
	A (41 m)	B (79.1 m)	C (94.3 m)
Abalistes stellaris		11.17	4.60
Pseudotriacanthus strigilifer		3.68	2.31
Ostracion sp.		0.04	0.22
Arothron sp.		0.70	0.10
Lagocephalus wheeleri		9.93	2.38
Diodon sp.		1.90	18.95
Gymnothorax sp.			0.15
Exocetus sp.			1.50
Monocentris japonicus			5.70
Hippocampus sp.			0.02
Satyrichthys welchi			69.10
Acropoma japonicum			0.80
Lethrinus lentjan			0.07
Sphyraena forsteri			2.00
Cantherhines multilineatus			0.66
Lactoria diaphana			2.17
Lagocephalus sceleratus			0.36
Butterfly fish			0.08
Narcine indica	1.92	0.40	0.45
Dasyatis sp.	7.04	17.65	1.00
Saurida undosquamis	1.70	154.70	56.90
Strongylura strongylura	0.10	0.08	2.30
Cociella crocodila	0.28	0.20	0.55
Platycephalus indicus	0.10	1.27	0.35
Priacanthus macracanthus	1.40	53.70	21.67
Apogon sp.2	0.35	42.75	7.10
Carangoides malabaricus	0.10	1.23	1.10
Decapterus russelli	46.00	9.44	0.16
Nemipterus japonicus	2.20	31.76	3.50
Parascolopsis aspinosa	0.10	0.95	2.50
Sphyraena jello	1.40	0.45	0.06
Trichiurus lepturus	1.47	2.00	4.00
Arioma indica	0.05	0.04	1.57
Loligo sp.	2.81	96.81	28.20
Sepia sp.	7.66	19.50	0.65
Crabs	6.90	12.81	3.51
Shrimps	7.06	4.00	0.15
Jellyfish	150.40	22.00	2.35
Uraspis uraspis	1.00		1.64

Catch per Unit Area (CpUA) from clusters A, B and C, estimated from the swept area, as shown in Table 3, gave a total CpUA of 45,567.6 kg nM^{-2} from an overall research area of 13,800 nM2.

Table 3. Catch per Unit Area (CpUA) estimation by swept area of this survey

Cluster	Operation	Station	Swept Area (nM^2)	CpUA (kg nM^{-2})	Total Area (nM^2)
A	2	12	0.02533	9,684.46	900
	3	14	0.02974	2,301.21	900
	5	18	0.03396	2,310.14	900
B	4	16	0.03680	2,061.76	900
	6	20	0.04295	1,540.97	900
	8	27	0.03706	1,851.19	900
	9	37	0.03348	3,871.28	900
	10	34	0.03438	2,097.75	900
	12	44	0.03635	2,293.82	900
	13	47	0.04039	2,361.30	900
	15	54	0.03331	2,195.78	750
	16	56	0.03475	1,917.62	750
	17	57	0.03635	1,922.15	750
C	7	23	0.03724	2,881.25	900
	11	38	0.03527	1,906.86	900
	14	67	0.02762	6,370.06	750
	Total		0.55499	47,567.60	13,800.00

CONCLUSION

Marine fisheries resources in the EEZ of eastern Myanmar waters are in better condition. Nevertheless, a single-cruise survey - with estimates based either on swept areas or a holistic model – could provide only basic information on the stock status. This should be further assessed by other methods, especially by analytical models which require continuous data sampling for proper management. Additionally, the survey plan in this study utilized simple random sampling in order to provide basic information for scientists. Since the results showed that the three groups of sampling stations could be categorized by depth and CpUE, the sampling strategy in the second phase of the collaborative program could be adjusted according to depth in order to reduce operational cost (Fig. 8). However, future surveys should be circumspectly planned by skilled personnel in order to ensure the compilation of accurate data which will provide reliable estimates of the dynamics of stock. Training to provide knowledge and skills on fish population dynamics to Myanmar fisheries biologists is also necessary so that in the future they will be able to monitor the stock status themselves.

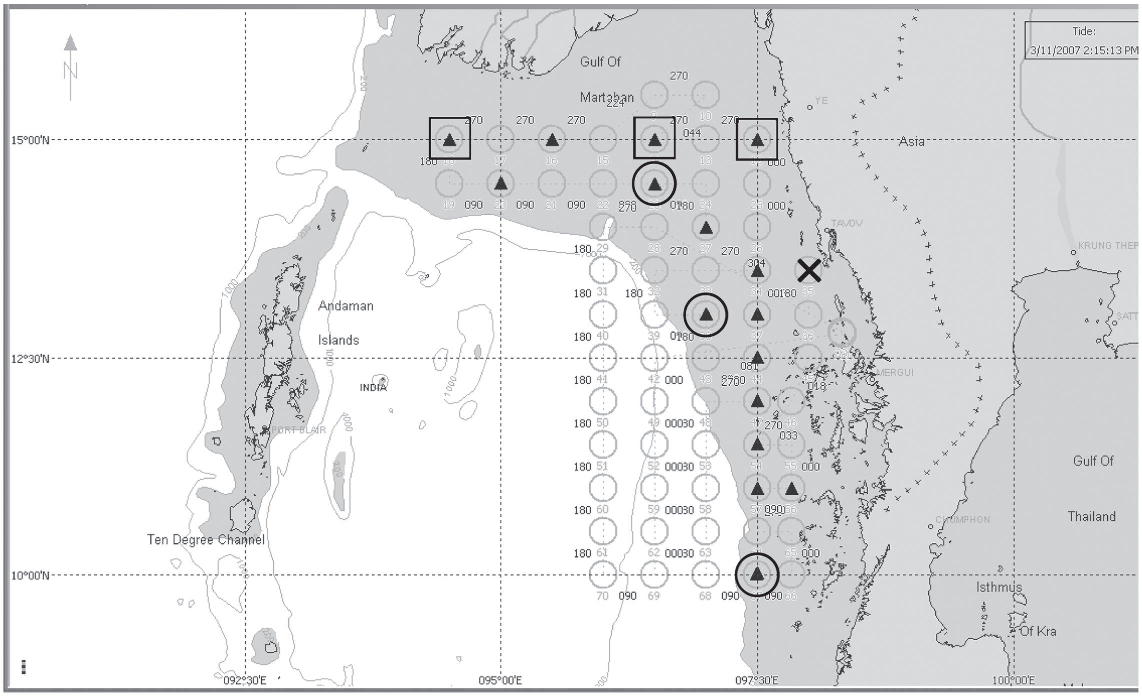


Figure 8. Three-clusters mapping guide for the second phase survey
□ = Cluster A
○ = Cluster C
✕ Excluded from this study due to gear damage

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