FISHERY RESOURCES IN THE WEST COAST OF ACEH AFTER TSUNAMI: RESULTS OF THE BOTTOM TRAWL SURVEYS

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ABSTRACT

Investigation on fishery resources in the west coast of Aceh Province was carried out during July until August 2005 and August until September 2006. One of the objectives of the investigation was to determine the state of demersal stock after the area severely hit by tsunami in December 2004. Data were collected through exploratory fishing, using modified shrimp trawl operated on R. V. Bawal Putih I platform. Stations of observation were made to distribute along the continental shelf area. The results show that a total of 117 demersal fish species were found in the study area with Leiognathidae that was the most abundant in both of the years. As for shrimps, a total of 16 species was recorded. Fish densities in 2006 tend to be higher as compared to the densities in 2005. However, statistical comparisons of the abundances between the two years showed no significant difference in the catches of the dominant demersal families. There may be signs of change in shallow water species composition and abundance, probably due to the concentration of effort in the inshore areas (<15 m depth). Conversely, less impacted deeper species show signs of increase.

KEYWORDS: **fishery resources, trawl survey, Aceh**

INTRODUCTION

The tsunami disaster in December 26, 2004 had a devastating effect on coastal fishing communities in Aceh Province. Along with destroying housing and communities facilities, the tsunami killed an estimated 10.000 fishers and destroyed over 10.000 fishing boats, countless fishing gears and associated support infrastructure (MMAF, 2006).

Before tsunami, the fishing gears used to exploit demersal resources in the west coast consisted of bottom long lines, hand lines, bottom gill nets (including trammel nets) and beach seines. In the coastal southern part of the area off Aceh Selatan, in waters less than 15 m depth, small bottom trawls are also used. Some of these have recently replaced gill nets. Hand lines are operated on the coral reef area to catch demersal reef fish.

Through aid from international and non governmental organizations, national and local governments, the replacement of boats and gears has been gradually occurred. However, the distribution of these aid varied greatly, with a few villages receiving the bulk of the aid while some villages received none at all. The boats distributed through the aid programme have been mainly smaller type of boats (mostly between 5 and 12 GT) with respect to the original fleet configuration (Garces *et al.*, 2006). These may have consequences on the overall diversity of the future fishing activities (e.g. gears used, fishing zone, and target species).

There have been a number of efforts to assess the state of the fishery resources in the Aceh area, particularly after the event of tsunami. These information are needed in order to rebuild the fishery sector consistent with the government's goal to rebuild the sector and its management better than the situation before the tsunami. Most of the previous assessments indicated that demersal resources in the area might be over-exploited already since the late 1980s (Bailey *et al.*, 1987). More recent analyses of the trends (OSRO/RAS/504/LAO) indicated declines in catches of all the main groups in later years.

Investigation of fishery resources in the west coast of Aceh Province was carried out during July until August 2005 and August until September 2006, two consecutive years after the area hit by the tsunami. This paper presents the status of demersal stock identification based on the results of the exploratory bottom trawl survey.

MATERIALS AND METHODS

The R. V. Bawal Putih I was used for conducting the survey of demersal fish both in 2005 and 2006, using a modified shrimp trawl with 36 m headrope, adapted for demersal fish trawling. The average trawling time in each

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fishing station was one hour with the towing speed of 3 to 3.2 knots. A total of 27 trawl stations were completed, distributed within and between the acoustic transect lines (Figure 1). The catch from each station was sorted and identified to either species or family weighed and counted. Individual fish length and weight of some selected species, were measured for further analysis. Species identification was based on Carpenter & Niem (1998-2001); Allen (2000); De Bruin *et al.* (1994); Heemstra & Randall (1993).

The demersal catch data were standardized to kg per hour. Individual length of the fish was measured for dominant species. Length frequency samples were weighted to total catch in each trawl haul and pooled to obtain the total length frequency for the population. The catch composition and length frequency were compared with those collected on board of R. V. Bawal Putih I first cruise in 2005. The abundance of demersal fish was calculated using the swept area method.

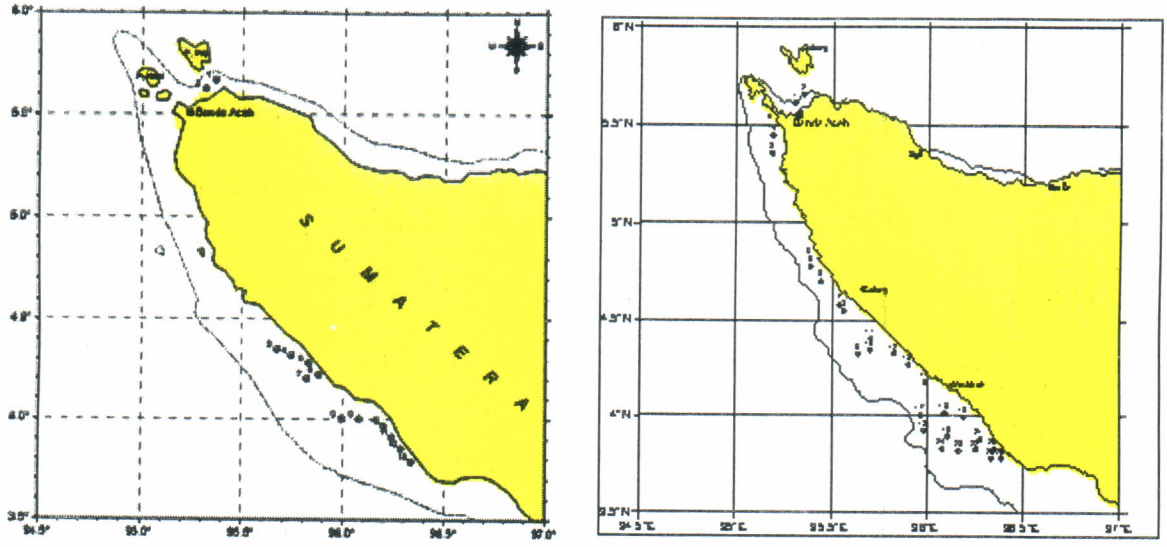

Figure 1. Stations of observation made during bottom trawl survey in 2005 (left) and 2006 (right).

RESULTS AND DISCUSSION

Species Composition

Demersal Fish

A total of 117 demersal fish species were found in the study area with Leiognathidae provide the most abundant, composing 24.3 and 32.5% of the catches in 2005 and 2006, respectively (Table 1). It had more species in 2006, being represented by 13 species compared to 8 species in 2005. The family was dominated by *Leiognathus bindus* (52.4%), followed by *Leiognathus leuciscus* (15.5%). Mullidae was in the second rank (15.2%) followed by Haemulidae (10.4%), Sphyraenidae (7.4%), and Lutjanidae (6.3%). Other families contributed of less than 5% to the total catch.

Table 1. Main demersal fish caught from bottom trawl survey in 2005 and 2006

No.	2005			2006		
	Family	W (kg/hr)	(%)	Family	W (kg/hr)	(%)
1.	Leiognathidae	9,6	24,3	Leiognathidae	18,9	32,5
2.	Mullidae	5,5	14,1	Mullidae	8,9	15,2
3.	Lutjanidae	3,3	8,4	Haemulidae	6,0	10,41
4.	Haemulidae	2,8	7,1	Sphyraenidae	4,3	7,4
5.	Synodontidae	2,5	6,3	Lutjanidae	3,6	6,3
6.	Nemipteridae	2,4	6,0	Synodontidae	2,6	4,5
7.	Trichiuridae	1,7	4,4	Lactaridae	2,3	3,9
8.	Tetraodontidae	1,3	3,3	Nemipteridae	2,0	3,5
9.	Lactaridae	1,2	3,0	Gerreidae	1,7	2,8
10.	Gerreidae	1,0	2,6	Trichiuridae	1,1	2,0

The relative abundance of the second most dominant family of the Mullidae, was likely similar between the two years. This family was dominated by *Upeneus sulphureus*, composing 94.4% of the total mullid catch. The catch of this species was eighty times higher compared to those obtained in 2005 and the statistical test wassignificant difference. The rest of the species included *U. molluccensis*, *U sundaicus*, *U. tragula*, *U. vittatus*, and *Parupeneus* spp.

Nemipteridae was represented by 11 species in 2006, having more species compared to those found in 2005 which was accounted for 7 species. There was a shifting species dominancy in the study area *Nemipterus japonicus*, which was recorded in the second rank within the family in 2005, has been most dominant in 2006 composing 62.6% of the total nemipterid catch.

The family of Pomadasydae contributed 5.4% to the total catch, and was represented by 3 species, *i.e. Pomadasys argyreus* (94.8%), *Plectorhyncus pictus* (3.8%), and *Pomadasys kaakan* (1.6%).

The Indian halibut (*Psettodes erumei*) represented 2% of the catch. This species concentrated in the waters within the depth range of 50 to 59 m. The same result was also obtained by Herianti & Rusmadji (1992) in waters of the Java Sea. However, Rusmadji & Nugroho (1987) reported that in the waters of Tanjung Selatan-South Kalimantan the fish tend to be distributed in shallow waters of less than 40 m.

Pelagic Fish

Pelagic fish are often caught in the bottom trawl. Although biomass estimation of pelagic fish from bottom trawl surveys is usually not carried out because bottom trawl is not appropriate to sample this group, the information on catch rates would be useful to detect major changes in species composition.

Dominant families of the pelagic group are shown in Table 2. These included the Carangidae (53.9%), Clupeidae (2.9%), Engraulidae (1.7%), and others. The family Carangidae was dominated by *Carangoides malabaricus* (27.0%), *Scomberomorus commersoni* (8.8%), *Carangoides armatus* (6.4%), the Clupeidae by *Sardinella brachysoma* (6.2%). The family Carangidae provide the dominant species in 2006. The abundance of this group has increased significantly as compared to 2005, from 3.5 kg per h to 7.5 kg per h in 2006.

Table 3 shows a summary of the length frequencies taken for selected demersal and pelagic fish species. Comparisons between the two years are only available for a few dominant species. For all these species the length (mode) observed in 2006 was higher. These species occur mainly at depths of 20 to 40 m. It was likely that fishermen have fished less in these depth ranges in 2006, concentrating more fishing in shallower waters (less than 15 m).

Table 2. Pelagic fish caught from bottom trawl surveys in 2005 and 2006

No.	2005			2006		
	Family	W (kg/hr)	(%)	Familiy	W (kg/hr)	(%)
1.	Engraulidae	3.5	47.1	Carangidae	7.6	54.0
2.	Clupeidae	1.9	26.0	Clupeidae	2.9	20.5
3.	Carangidae	1.8	23.8	Engraulidae	1.7	12.0
4.	Scombridae	0.2	2.6	Scombridae	1.6	11.2
5.	Stromateidae	0.02	0.3	Stromateidae	0.3	2.2
6.	Chirocentridae	0.01	0.2	Chirocentridae	0.01	0.1
	Total	**7.5**	**100.0**	**Total**	**14.0**	**100.0**

Table 3. Length frequencies of selected demersal and pelagic species

Species name	2005					2006				
	Min	Max	Mean	Med.	Mode	Min	Max	Mean	Med.	Mode
Alepes djedaba						10.0	19.0	12.6	14.5	12.0
Atule mate						11.0	16.5	12.3	13.8	12.5
Carangoides armatus						13.5	26.0	18.0	19.8	16.0
Carangoides malabaricus						10.0	20.0	13.1	14.5	11.0
Gazza minuta						8.0	10.0	9.1	9.0	8.5
Illisha elongata						9.0	14.5	12.9	11.8	13.0
Leiognathus equulus						10.0	20.0	14.0	15.0	14.0
Leiognathus bindus	5.5	11.5	9.2	8.5	9.5	6.0	11.5	9.4	8.8	10.0
Leiognathus daura						5.0	10.5	7.8	8.3	7.5
Leiognathus elongatus						8.0	12.5	10.0	10.3	10.0
Leiognathus fasciatus						13.5	20.0	16.7	16.8	18, 17, 20
Leiognathus smithursti						11.0	16.0	13.5	13.5	14.0
Lutjanus lutjanus						12.0	19.5	15.9	15.8	16.5
Megalaspis cordyla						15.5	24.5	18.7	20.0	16.5
Nemipterus tolu	2.5	13.0	6.2	7.8	3.5	16.0	22.0	19.3	19.0	18, 19, 20, 20.5
Parupenaeus sp.						13.0	26.5	20.6	19.8	20.5, 21, 26.5
Pentaprion longimanus						9.0	12.5	10.2	10.8	9.5
Polydactylus						10.0	19.5	14.0	14.8	13.5
Pomadasys argyreus	5.0	17.5	10.6	11.3	9.5	6.0	19.5	11.6	17.0	10.5
Pristipomoides filamentosus						10.0	24.0	16.6	17.0	14.0
Rastrelliger brachysoma						13.5	17.0	15.5	15.3	15.5, 16.5
Rastrelliger kanagurta						13.0	16.0	15.0	14.5	16.0
Saurida micropectoralis (TL)						24.0	37.0	30.3	30.5	31, 34
Sciaena sp.						18.0	21.5	19.1	19.8	18.5
Selar crumenolpthalmus						15.0	17.0	16.4	16.3	17.0
Sphyraena sp.						22.0	28.0	24.1	25.0	23.0
Thryssa sp.						6.0	15.0	10.6	12.8	10.0
Upeneus mollucensis						9.5	16.0	12.4	12.8	14.5
Upeneus sulphureus	1.5	14.5	8.8	8	8.5	8.5	15.0	10.2	11.8	9.5, 10.5
Upeneus vittatus						15.5	19.5	18.1	17.5	17.5, 19.5
Uraspis uraspis						6.0	9.5	8.3	7.8	9.0

Crustaceans

The crustaceans are divided into 3 groups; 1) shrimps of economic importance; 2) shrimps of non economic importance; and 3) other crustaceans that mainly consisted of crabs). The total catches were dominated by shrimps of economic importance (86.3%) followed by shrimps of non economic importance (10.9%) and other crustaceans (3.5%).

While catch rates for all shrimps have remained at the same level, it was likely that changes in species composition occurred, with a higher diversity in 2005 as compared to 2006. Furthermore, while *Penaeus* sp. species made up almost 80% of the catches in 2005, the endeavour shrimp (*Metapenaeus ensis*) was almost 50% of the catches in 2006 (Tabel 4). This species caught in deeper waters than *Penaeus* sp., and this pattern was due to the fact that fishing effort in 2006 were concentrated in shallower waters.

Table 4. Shrimps species and its composition determined from bottom trawl survey in 2005 and 2006

No.	2005			2006		
	Species	W (kg/hr)	(%)	Species	W (kg/hr)	(%)
1.	*Penaeus* sp.	0,48	40,7	*Metapenaeus ensis*	0,48	49,8
2.	*Penaeus semisulcatus*	0,26	27,4	*Penaeus* sp.	0,23	23,6
3.	*Penaeus merguiensis*	0,09	9,8	*Solenocera crassicornis*	0,09	9,0
4.	*Metapenaeus ensis*	0,08	9,0	*Parap. coromandelica*	0,08	8,6
5.	*Metapenaeus affinis*	0,03	3,2	*Penaeus semisulcatus*	0,07	7,2
6.	*Penaeus monodon*	0,02	1,8	*Metapenaeus* spp.	0,02	1,6
7.	*Solenocera crassicornis*	0,02	1,7	*Metapenaeopsis toloensis*	0,002	0,2
8.	*Metapenaeus dobsoni*	0,01	1,5	*Exopalaemon styliferus*	0,001	0,1
9.	*Penaeus canaliculatus*	0,01	1,3			
10.	*Parapenaeopsis* spp.	0,01	1,0			
11.	*Exopalaemon styliferus*	0,01	0,9			
12.	*Metapenaeopsis barbata*	0,01	0,7			
13.	*Metapenaeopsis toloensis*	0,01	0.7			
14.	*Parap. coromandelica*	0,002	0,2			
15.	*Trachypenaeus* spp.	0,001	0,2			
16.	*Metapenaeus* spp.	0,000	0,02			
	Total	**0,94**	**100,0**	**Total**	**0,96**	**100,0**

Fish Density

Table 5 shows catch rates by main groups. Demersal fish dominated the catches both in 2005 and 2006, representing about 75% of the total catch. Catch rates of the demersal group were found to be higher in 2006 compared to those for 2005. The same figures were also showed for crustaceans, pelagic, and cephalopods groups. It was likely that change in species composition and abundance in shallow waters were occurred. These were probably due to concentration of effort in the inshore areas. Conversely, some deeper species that are likely less impacted by exploitation show signs of population growth as reflected by the higher catch rate (Figure 2).

Fish densities in 2006 were higher as compared to 2005. However, the density was not statistically significant different between the two years, except for the pelagic group. Statistical comparisons of abundances between the two years showed no significant difference in the catches of the dominant demersal families (Table 6).

Table 5. Comparison of catch rates by main groups between 2005 and 2006

No.	Groups	2005		2006	
		Weight (kg/hr)	Percentage (%)	Weight (kg/hr)	Percentage (%)
1.	Demersal	39.3	75.4	58.2	76.8
2.	Pelagic	7.5	14.3	14.0	18.5
3.	Rays	3.6	6.9	0.9	1.2
4.	Crustaceans	1.1	2.2	1.6	2.2
5.	Cephalopods	0.4	0.8	0.7	0.9
6.	Bivalves	0.2	0.3	0.1	0.2
7.	Sharks	0.07	0.1	0.2	0.3
8.	Sea cucumber	0.02	0.04	-	-
	Total	**52.2**	**100.0**	**75.7**	**100.0**

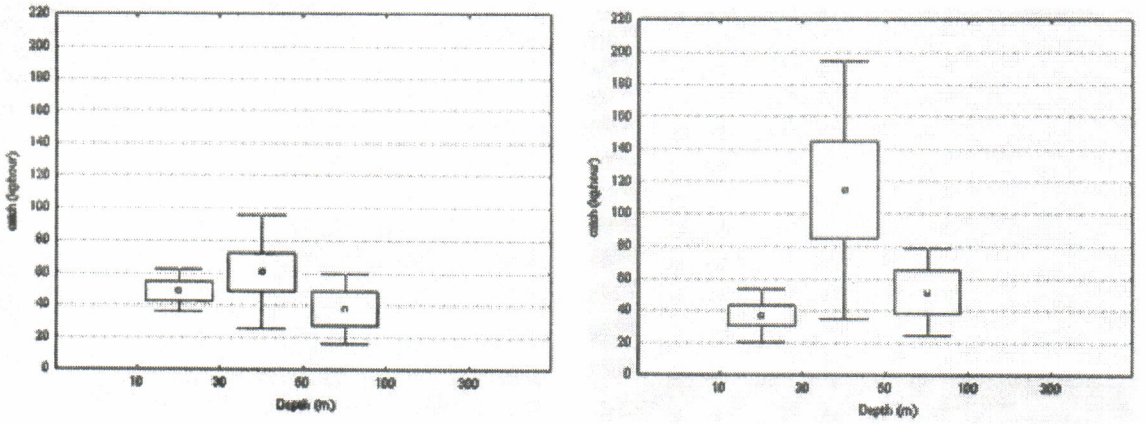

Figure 2. Catch rates by depth area in the west coast of Aceh waters in 2005 (a) and 2006 (b).

Table 6. Catch rates from Bawal Putih testing for differences between 2005 (group 1) and 2006 (group 2) using non parametric Man Whitney U tests

Tests by groups

Mann-Whitney U Test (catch rate group-ache)
By variable Year
Marked tests are significant at p <.05000

variable	Rank Sum Group 1	Rank Sum Group 2	U	Z	p-level	Z adjusted	p-level	Valid N Group 1	Valid N Group 2	2*1sided exact p
SHARK	391.0000	512.0000	212.0000	0.10167	0.919022	0.19959	0.841801	18	24	0.929901
RAYS	438.0000	465.0000	165.0000	1.29624	0.194895	1.67611	0.093718	18	24	0.201622
PELAGIC	306.0000	597.0000	135.0000	-2.05873	0.039521	-2.05873	0.039521	18	24	0.039821
DEMERSAL	369.0000	534.0000	198.0000	-0.45750	0.647315	-0.45750	0.647315	18	24	0.659828
CHEPALOPOD	356.5000	546.5000	185.5000	-0.77520	0.438221	-0.77596	0.437776	18	24	0.442341
SHRIMP	400.0000	503.0000	203.0000	0.33041	0.741088	0.33267	0.739382	18	24	0.753306
CRABS	320.0000	583.0000	149.0000	-1.70290	0.088588	-1.76762	0.073838	18	24	0.091169
MANTIS	330.0000	573.0000	159.0000	-1.44874	0.147412	-1.56578	0.117402	18	24	0.152461
LOBSTER	391.5000	511.5000	211.5000	0.11437	0.908941	0.13963	0.888950	18	24	0.909946
SHELL	402.0000	501.0000	201.0000	0.38125	0.703021	0.47820	0.632506	18	24	0.715399
Grand Total	352.0000	551.0000	181.0000	-0.88957	0.373695	-0.88957	0.373695	18	24	0.384556

Tests by family

Mann-Whitney U Test (catch rate family-ache)
By variable year
Marked tests are significant at p <.05000

variable	Rank Sum Group 1	Rank Sum Group 2	U	Z	p-level	Z adjusted	p-level	Valid N Group 1	Valid N Group 2	2*1sided exact p
[Other crabs]	20.0000	16.0000	5.0000	-0.74536	0.456057	-0.74536	0.456057	5	3	0.571429
Acanthuridae			0.0000	0.00000	1.000000	0.00000	1.000000	1	3	0.000000
Apogonidae	139.5000	50.5000	14.5000	2.43588	0.014856	2.44880	0.014334	11	8	0.012066
Ariidae	18.0000	18.0000	8.0000	0.00000	1.000000	0.00000	1.000000	4	4	1.000000
Balistidae	29.0000	26.0000	8.0000	-0.85280	0.393769	-0.85802	0.390883	6	4	0.476190
Blennidae			0.0000	0.00000	1.000000	0.00000	1.000000	0	0	0.000000
Bothidae	126.0000	45.0000	30.0000	0.24643	0.805348	0.24784	0.804256	13	5	0.848973
Carangidae	275.0000	586.0000	122.0000	-2.16995	0.030011	-2.17023	0.029990	17	24	0.029899
Calappidae			0.0000	0.00000	1.000000	0.00000	1.000000	0	0	0.000000
Carcharhinidae			0.0000	0.00000	1.000000	0.00000	1.000000	1	1	0.000000
Centridae			0.0000	0.00000	1.000000	0.00000	1.000000	0	0	0.000000
Chaetodontidae			0.0000	0.00000	1.000000	0.00000	1.000000	2	0	0.000000
Chirocentridae			0.0000	0.00000	1.000000	0.00000	1.000000	1	1	0.000000
Clupeidae	228.0000	300.0000	110.0000	0.51799	0.604468	0.51799	0.604468	13	19	0.622762
Congridae			0.0000	0.00000	1.000000	0.00000	1.000000	2	0	0.000000
Cynoglossidae	64.0000	41.0000	13.0000	1.46942	0.141721	1.48918	0.136440	7	7	0.164918
Dasyatidae	46.0000	20.0000	10.0000	0.75593	0.449692	0.75593	0.449692	7	4	0.527273
Diodontidae			0.0000	0.00000	1.000000	0.00000	1.000000	1	1	0.000000
Dactylopteridae			0.0000	0.00000	1.000000	0.00000	1.000000	0	0	0.000000
Elopidae			0.0000	0.00000	1.000000	0.00000	1.000000	0	0	0.000000
Engraulidae	237.5000	227.5000	107.5000	0.20739	0.835705	0.20751	0.835615	15	15	0.838135
Ephippidae	45.0000	91.0000	17.0000	-1.53484	0.124823	-1.53597	0.124646	7	9	0.141608
Fistularidae	81.0000	90.0000	36.0000	-0.39736	0.691103	-0.39860	0.690191	9	9	0.730440

CONCLUSION

Based on the results of these investigations, the following conclusions can be drawn:

1. Based on the results of the demersal surveys carried out after the tsunami did not show any major change in total fish abundance between 2005 and 2006.

2. The pelagic fish found in the demersal trawl catches was the only group showing a statistically significant increase in 2006 compared to 2005, with Carangidae provide the most dominant family.

3. The change in shallow water species composition and abundance were probably due to concentration of effort in the areas. Conversely, some deeper species that are likely less impacted by exploitation show signs of population growth.

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