Fish diversity in the east coastal waters area of Aceh Besar District, Indonesia

[1]Thaib Rizwan, [2]Taufik K. Nasution, [2]Irma Dewiyanti, [2]Sayyid A. Elrahimi, [3]Dedi F. Putra

[1] Department of Fisheries Resources Utilization, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh, Indonesia; [2] Department of Marine Science, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh, Indonesia; [3] Department of Aquaculture, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh, Indonesia. Corresponding author: D. F. Putra, dfputra@unsyiah.ac.id

Abstract. This study aims to identify the fish species and diversity in the east coastal waters area, Masjid raya village, Aceh Besar district, Indonesia. Thirty species representing 27 families were caught by using gill nets and nets scatter from three observatory stations. The identification result showed that *Fibramia lateralis* was commonly found in all stations and *Mugil cephalus* was present in highest abundance. The Diversity index (H') ranged from 2.01 to 2.64, uniformity index (E) ranged from 0.91 to 0.93, dominance index (D) ranged from 0.09 to 0.16, and the index of similarity (IS) ranged between 10.0 and 53.84%. We concluded that the studied area belongs to high diversity of fish resources. Further work is needed to be done to maintain fish biodiversity in order to support the conservation area in east coastal waters area, Masjid raya village, Aceh Besar district, Indonesia by using eco-friendly fishing gear.
Key Words: diversity, gill nets, nets scatter, District Masjid Raya.

Introduction. The major factor that commonly threatens the marine fish biodiversity is fishing (Dulvy et al 2003; Garcia et al 2006). For instance, in the world over 40 local populations of marine biota have gone extinct as a result of overexploitation (Dulvy et al 2003). Biodiversity is urgent for the future sustainability of marine natural resources that include commercial fisheries. Fisheries that catch several species or several populations may have more stable catches than fisheries that conquer a single species (Dulvy et al 2003; Hilborn et al 2003).

As one of the top of the biggest biodiversity spots in the world, Indonesia was placed to the second rank after Brazil (Muchlisin et al 2017). Meanwhile, Aceh has a high biodiversity that remains one of the longest coastal line Provinces in Indonesia (Putra et al 2016). Due to this strategic area, Aceh has high biodiversity natural resources including flora and fish fauna (Muchlisin et al 2016). However, very limited studies were done in this province.

The study area has no basic biological information on fish species. Therefore, the objectives of the present study were to inventory the fish diversity of this coastal area and to provide the information about fish resources as a tool for conservation using eco-friendly fishing gear in Aceh province, Indonesia.

Material and Method. The study was conducted from December to February 2015 at the east coastal waters area, Masjid raya village, Aceh Besar district, Indonesia. The purposive sampling method was used to determine the characteristics of obseravion area. All fish were collected from three different stations: station 1 located at Ladong mangrove area, station 2 located at Amat Rhang Manyang mangrove area and station 3 located at Ihouk mee mangrove area (Figure 1). Each station has three plots (replication). The sampling tools used were gill net (5 x 1 m; 1.5 inch mesh size) and net scatter (1 inch mesh size) (based on Indonesian National Standard).
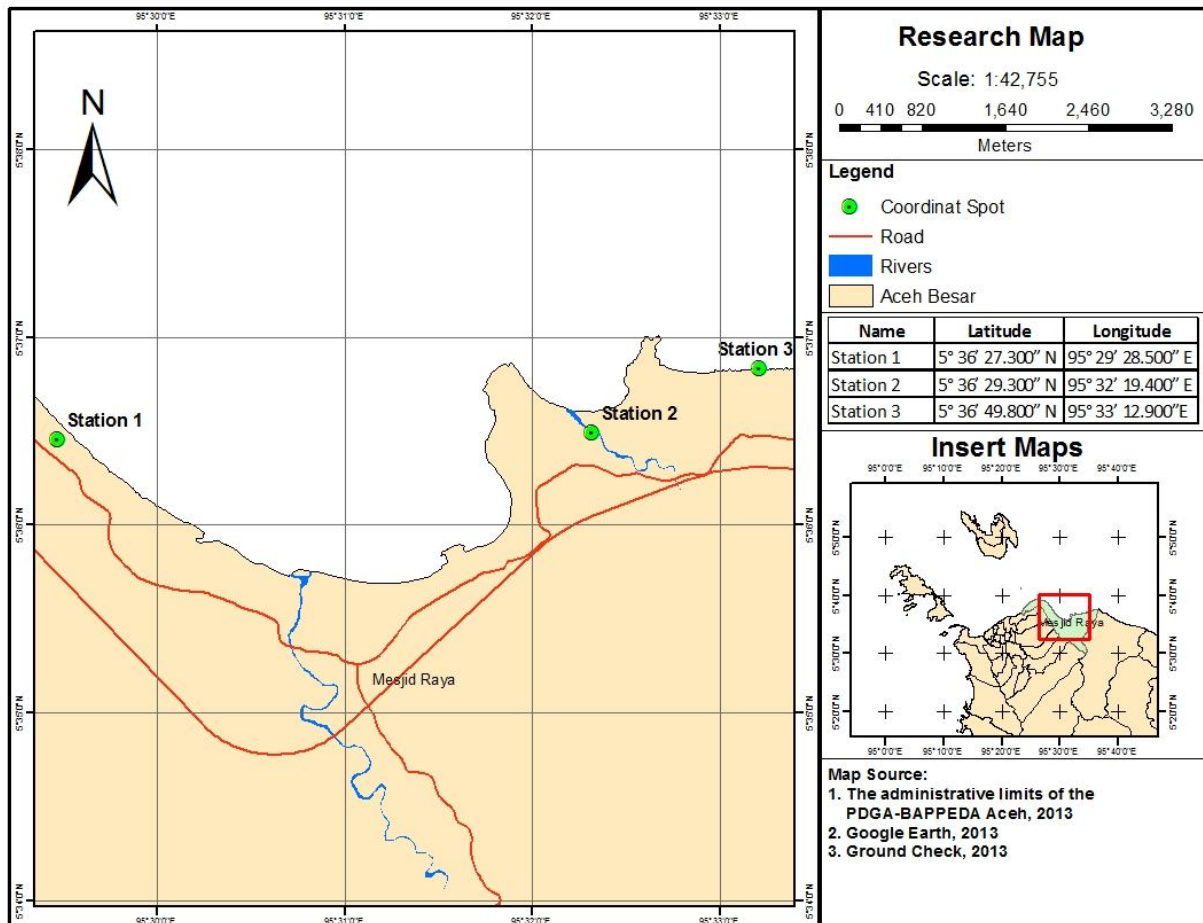
Figure 1. Sampling area (station 1 located at Ladong mangrove area, station 2 located at Amat Rhang Manyang mangrove area and station 3 located at lhouk mee mangrove area).

Sampling*.* The sampling data collection were taken two times a day at 06:00-16:00 (day) and 20:00-05:00 (night). The collected specimens were immediately dipped in 10% formalin in a suitable container to avoid fish broken. The specimens were examined in the field and classified into families, which were carried in separate containers. Each box was labelled properly against the physical data sheet of sampling and brought to the laboratory of Marine Biology at Syiah Kuala University for further taxonomic examination. Fish specimens were identified as per Kottelat et al (1993) and Saanin (1984). The data collected in the field included. Fish diversity was subjected to diversity analysis: index of dominance according to Brower & Zar (1977), index of evenness according to Krebs (1985) and index of diversity according to Brower et al (1990).

Results and Dicussion

Fish diversity*.* The present study showed that fish caught using gill net and fish scatter in Masjid Raya district consists of thirty species from 27 families. The results could be seen in Table 1. *Fibramia lateralis* or *seriding* (local name) was spread commonly. It is assumed that *F. lateralis* is able to withstand changes in salinity that ranged between 28-33 ppt. In addition, *F. lateralis* is one of fish that lives in the waters nearby mangrove area. It is in accordance with Genisa (2006) who mentioned that from 80 species caught in Mahakam waters, as many as 16 species were spread equally in all observed stations.

Table 1

Fish diversity in Aceh Besar District, Indonesia

No	Family	Species	Local name	Period	Fish caught (Ind)			Total (Ind)
					St. I	St. II	St. III	
1	Chanidae	*Chanos chanos*	Bandeng	Diurnal	3	6	0	9
2	Mugilidae	*Mugil cephalus*	Belanak	Diurnal	11	9	0	20
3	Leiognathidae	*Karalla daura*	Cirik	Diurnal	5	0	0	5
4	Haemulidae	*Plectorhinchus gibbosus*	Kakap	Nocturnal	4	0	0	4
5		*Plectorhinchus lineatus*	Sugot	Nocturnal	0	0	1	1
6	Gobiidae	*Acentrogobius cyanomos*	Meuho	Diurnal	1	1	0	2
7	Carangidae	*Carangoides plagiotaenia*	Rambeu	Nocturnal	2	0	0	2
8		*Caranx heberi*	Kitok	Nocturnal	0	3	0	3
9	Scatophagidae	*Scatophagus argus*	Sekitang	Diurnal	2	0	0	2
10	Apogonidae	*Fibramia lateralis*	Seriding	Nocturnal	6	8	6	20
11	Sphyraenidae	*Sphyraena obtusata*	Barakuda	Diurnal	2	0	0	2
12	Pristigasteridae	*Ilisha megaloptera*	Bulan	Diurnal	4	0	0	4
13	Tetraodontidae	*Arothron reticularis*	Buntal	Diurnal	1	0	0	1
14	Siganidae	*Siganus canaliculatus*	Cabe	Diurnal	2	0	1	3
15	Sillaginidae	*Sillaginops macrolepis*	Cuet	Diurnal	2	0	0	2
16	Gerreidae	*Gerres erythrourus*	Gapah	Nocturnal	2	2	0	4
17	Cichlidae	*Oreochromis niloticus*	Nila	Diurnal	2	1	0	3
18	Terapontidae	*Terapon jarbua*	Sikirung	Diurnal	2	0	0	2
19	Lutjanidae	*Lutjanus russellii*	Tanda	Diurnal	2	0	0	2
20		*Lutjanus kasmira*	Ubi	Diurnal	0	0	2	2
21	Ephippidae	*Platax batavianus*	Layang	Diurnal	0	4	0	4
22	Toxotidae	*Toxotes jaculatrix*	Sumpit	Diurnal	0	1	0	1
23	Pomacentridae	*Chromis opercularis*	Dendayang	Diurnal	0	0	1	1
24	Acanthuridae	*Acanthurus tristis*	Kawet	Diurnal	0	0	3	3
25	Serranidae	*Epinephelus faveatus*	Kerapu	Nocturnal	0	0	1	1
26	Chaetodontidae	*Chaetodon vagabundus*	Kepe-kepe	Diurnal	0	0	1	1
27	Engraulidae	*Encrasicholina heteroloba*	Meuneng	Diurnal	0	0	6	6
28	Holocentridae	*Myripristis amaena*	Selendang	Nocturnal	0	0	1	1
29	Mullidae	*Parupeneus macronemus*	Perlon	Nocturnal	0	0	2	2
30	Belonidae	*Platybelone argalus*	Todak	Nocturnal	0	0	4	4
					53	35	29	117

At station 1, the average total catch is 53 individuals, included in 17 genera and 17 families. The dominant species is *Mugil cephalus*, which is in agreement with Sunarto (2008) study in Sundaran mangrove area, where from 120 individuals caught, the dominant species was *M. cephalus*. Moreover, station 1 has higher number of fish caught compared to other stations due to high individual number of mangrove vegetation in this area. A similarity was found in station 2 that showed the average number of fishes was 35 individuals consisting in 9 species included in 9 families, and again *M. cephalus* was the main species caught with both gill net and fish scatter fishing gear. The average number of fishes in station 3 was 29 individuals, consisting in 12 species from 12 families. There are two dominant species in this station, namely *F. lateralis* (Apogonidae) and *Encrasicholina heteroloba* (Engraulidae). The average number of fish caught was less in this station compared to stations 1 and 2 due to less the number of mangrove vegetation which is represented by only one species, *Rhizophora apiculata*. Information on the number of fish in a population is important to investigate the effects of fishing, other human activities or natural climatic variations to detect any changes in the population (Cappo & Brown 1996; Jalal et al 2012). Fish diversity is threatened by many human activities, but the most significant impacts are from habitat modification, overharvest and introduced species (Safina & Duckwort 2013). In the three observations areas the fish caught were mostly in the juvenile stage. We assumed that this result is related with the function of mangrove ecosystem as the spawning and nursery ground, which is in accordance with Aksornkoae (1993) who stated that mangrove ecosystem is a primary habitat for fish that provides a suitable environment for nursery and spawning ground.

Biological indices. The results of the present study showed that the diversity index (H') from three stations ranged from 2.01 to 2.64, which was classified into high diversity index (Figure 2). Lee et al (1978) classified the ecological quality based on the value of H' into four categories, namely; H < 2.0: high diversity, 1.6 < H '< 2.0: medium diversity, 1.0 < H' < 1.59: low diversity, H '< 1.0: very low diversity. Lloyd & Ghelardi (1964) mentioned that species diversity is high when in a certain area there are many species found, species diversity being a biological index of the relation between the number of species and the number of individuals (Spellerberg 1991). The high level of species richness is influenced by many factors, for example the environmental water quality, availability of space and food, and lack of competition between species.
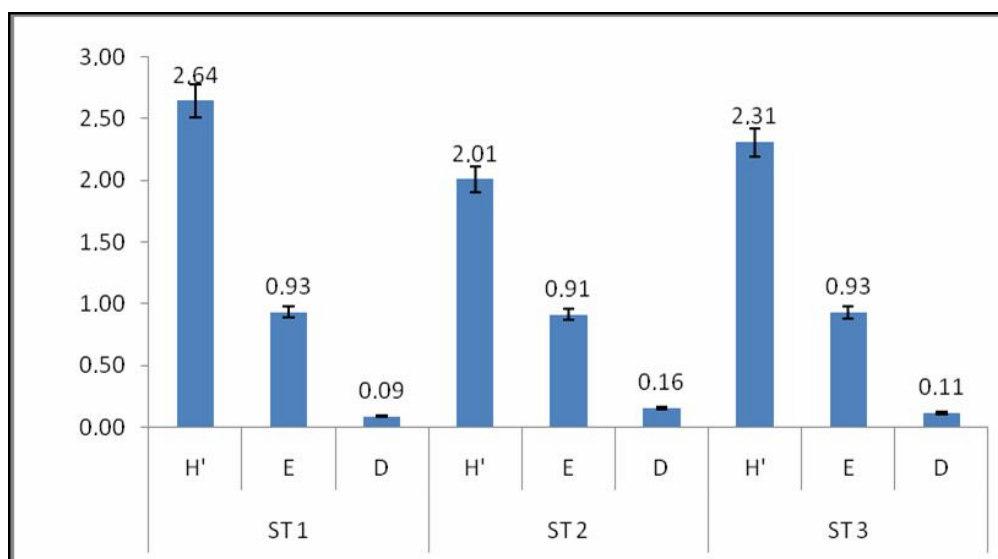

Figure 2. Fish community structure caught in study area.

The evenness index (E) has ranged from 0.91 to 0.93. These value are categorized as high evenness index and indicated that the community condition was stable because the individual number for each species in catches is almost similar. Krebs (1985) stated that

the evenness index is categorized into three categories namely; 1) $0 < E ≤ 0.5$: depressed community, 2) $0.5 < E ≤ 0.75$: community unstable, 3) $0.75 < E ≤ 1$: stable community. Moreover, Rejeki et al (2013) stated that the smaller the value of evenness index the smaller is the population uniformity.

The dominance index (D) in present study ranged from 0.09 to 0.16 indicating a low value. The dominance index showed the degree of predominance of one or a few species in an ecological community. Legendre & Legendre (1983) explained that if the dominance index values obtained are between 0.4 and 0.6 it can be categorized as moderate, above 0.6 is categorized as high index and below 0.4 is categorized as low index. Based on observation, there is no dominant fish found in the study area.

Overall, we found that the higher of diversity index, the greater distribution of fish quantities. The higher level of evenness and low individual dominance showed a stable community structure at the study site. This in accordance with Macintosh et al (2002) who explained that high dominance of one species probably indicates a stressful environment while a higher diversity and low dominance indicate a stable condition of ecosystem.

Conclusions. A total of 30 species of fishes belonging to 27 families were reported during the study. The diversity index (H') from three stations ranged from 2.01 to 2.64, which was classified into high diversity index. The use of friendly environment fishing gear is recommended to maintain the sustainable fisheries resources in this area. Further work is needed to maintain fish biodiversity in order to support the conservation area in east coastal waters area, Masjid raya village, Aceh Besar district, Indonesia by using eco-friendly fishing gear.

References

Aksornkoae S., 1993 Ecology and management of mangroves. IUCN, Bangkok, Thailand, 192 pp.

Brower J. E., Zar J. H., 1977 Field and laboratory methods for general ecology. W. M. C. Brown Company Publishers, Iowa, 194 pp.

Brower J., Jerrold Z., Von Ende C. V., 1990 Field and laboratory methods for general ecology. Third edition, W. M. C. Brown Publishers, USA, 237 pp.

Cappo M., Brown I. W., 1996 Evaluation of sampling methods for reef fish populations of commercial and recreational interest. Technical report No. 6, CRC Reef Research Centre Ltd., Townsville, Australia, 72 pp.

Dulvy N. K., Sadovy Y., Reynolds J. D., 2003 Extinction vulnerability in marine population. Fish and Fisheries 4:25-64.

Garcia S., Boucher J., Cury P., Thebaud O., Andriantsoa M., Astudillo A., Ba M., Brander K., Charles A., Dulvy N., Gauthiez F., Heip C., Jennings S., Joannot P., McDonald D., MacKenzie B., Rice J., 2006 Workshop 10, Paris Conference: Biodiversity, Science and Governance. January 24-28 (report of the debates and proposed priority actions). Ministry of Foreign Affairs, Government of France, Paris, 54 pp.

Genisa A. S., 2006 [Biodiversity of fish fauna in Mangrove area, Mahakam river, West Kalimantan]. Jurnal Oseanologi dan Limnologi di Indonesia 41:39-53. [in Indonesian]

Hilborn R., Branch T. A., Ernst B., Magnusson A., Minte-Vera C. V., Scheuerell M. D., Valero J. L., 2003 State of the world's fisheries. Annual Review of Environmental Resources 28:359-399.

Jalal K. C. A., Azfar M. A., John B. A., Kamaruzzaman Y. B., Shahbudin S., 2012 Diversity and community composition of fishes in tropical estuary Pahang Malaysia. Pakistan Journal of Zoology 44(1):181-187.

Krebs C. J., 1985 Ecology: the experimental analysis of distribution and abundance. 3rd edition, Harper and Row, New York, 800 pp.

Kottelat M., Whitten A. J., Kartikasari S. N., Wirjoatmodjo S., 1993 Freshwater fishes of western Indonesia and Sulawesi. Periplus Edition Limited, Jakarta, 221 pp.

Lee C. D., Wang S. B., Kuo C. L., 1978 Benthic macroinvertebrate and fish as biological indicators of water quality, with reference to communinty diversity index. In: Water pollution control in developing countries. Guano E. A. R., Lokani B. N., Thank M. C. (eds), Asian Inst. Tech.,Bangkok, pp. 233-238.

Legendre L., Legendre P., 1983 Numerical ecology. Elsevier Scientific Publishing Company, New York, 419 pp.

Lloyd M., Ghelardi R. J., 1964 A table for calculating the equaitability component of species diversity. Journal of Animal Ecology 33:217-225.

Macintosh D. J., Ashton E. C., Havanon S., 2002 Mangrove rehabilitation and intertidal biodiversity: a study in the Ranong mangrove ecosystem, Thailand. Estuarine, Coastal and Shelf Science 55:331-345.

Muchlisin Z. A., Maulidin M., Muhammadar A. A., Putra D. F., 2016 Inshore migration of tropical glass eels (*Anguilla* spp.) in Lambeso River, Aceh Jaya District, Aceh Province, Indonesia. Aceh Journal of Animal Science 1(2):58-61.

Muchlisin Z. A., Nurfadillah N., Arisa I. I., Rahmah A., Putra D. F., Nazir M., Zulham A., 2017 Fish fauna of Lake Lauik Tawar and Lake Laulo, Simeulue Island, Indonesia. Biodiversitas 18(2):752-757.

Putra D. F., Fanni M., Muchlisin Z. A., Muhammadar A. A., 2016 Growth performance and survival rate of climbing perch (*Anabas testudineus*) fed *Daphnia* sp. enriched with manure, coconut dregs flour and soybean meal. AACL Bioflux 9(5):944-948.

Rejeki S., Irwani, Hisyam F. M., 2013 [Community structure of fish at mangrove ecosystem in Bedono village, Sayung, Demak]. Buletin Oseanografi Marina 2:78-86. [in Indonesian]

Saanin H., 1984 [Fish taxonomy and identification]. Binacipta, Jakarta, 520 pp. [in Indonesian]

Safina C., Duckwort A., 2013 Fish conservation. Encyclopedia of Biodiversity. 2nd edition, pp. 443-455.

Spellerberg I. F., 1991 Monitoring ecological change. Cambridge University Press, Cambridge, UK, 334 pp.

Sunarto, 2008 [The role of ecology and antropogeneis in mangrove ecosystem]. Faculty of Fisheries and Marine Science University of Pajajaran, Bandung, Indonesia, 100 pp. [in Indonesian]

Authors:
Thaib Rizwan, Department of Fisheries Resources Utilization, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh 23111, Indonesia, e-mail: rizwanthaib@unsyiah.ac.id
Taufik Kemal Nasution, Department of Marine Science, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh 23111, Indonesia, e-mail: kemal_eneste@yahoo.com
Irma Dewiyanti, Department of Marine Science, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh 23111, Indonesia, e-mail: irmadewiyanti@unsyiah.ac.id
Sayyid Afdhal Elrahimi, Department of Marine Science, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh 23111, Indonesia, e-mail: sayyid.afdhal@unsyiah.ac.id
Dedi Fazriansyah Putra, Department of Aquaculture, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh 23111, Indonesia, e-mail: dfputra@unsyiah.ac.id