The assessment of demersal fish community structure in Kuala Langsa estuary, Langsa City

Muhammad Fauzan Isma[1], *Faiz* Isma[2], *Muhammad* Hatta[3], *Fitria* Mustika[4], *Syahrial* Syahrial[5*], *Cut* M. N. 'Akla[5], *Agus Putra Abdul* Samad[1]

[1] Samudra University of Aquaculture, Aceh, Republic of Indonesia
[2] Samudra University of Civil Engineering, Aceh, Republic of Indonesia
[3] Malikussaleh University of Aquaculture, Aceh, Republic of Indonesia
[4] Samudra University of Geography Education, Aceh, Republic of Indonesia
[5] Malikussaleh University of Marine Science, Aceh, Republic of Indonesia

Abstract. The research was conducted from May to July 2022 in six zones to determine the diversity, niche width, distribution, and community structure of demersal fish. Fish were surveyed using a drift gillnet at a maximum depth of 15 m, identified, and analyzed using clusters and nMDS to determine their grouping. SIMPER analysis was used to discover individual variations between zones and depth strata, while ANOVA was used to determine the significance of individual fish observed. The results of the study found 8 species, 8 genera, and 8 families with *Eubleekeria splendens* as well as *Chelonodon patoca* having the highest niche widths (04.42 dan 04.33), then *E. splendens, Terapon jarbua, Scatophagus argus, Plotosus canius, C. Patoca,* and *Johnius carouna* were relatively abundant (frequency > 80%). Aside from that, *J. carouna* is the fish with the most individuals discovered (82 ind and 32.54%). Cluster analysis and nMDS are divided into two groups, with J. *carouna* being the differentiator between fish groupings based on zonation and *C. chanos, C. patoca,* and *J. carouna* being the differentiator between fish groupings based on depth strata. Furthermore, the ANOVA test reveals that individual demersal fish between zones have a significance of < 0.05, whereas individual demersal fish between depth strata have a significance of > 0.05.

1 Introduction

Demersal fish are fish that spend most of their life at the bottom of the waters [1, 2, 3] with the primary features being that their schools are not too huge, their mobility is not too far, and their movement/activity is relatively modest [1]. According to [4], demersal fish are classified into two categories, large demersal fish and small demersal fish. Demersal fish are also divided into two types, benthic demersal and pelagic benthic demersal. They have neutral buoyancy, search for food by covering themselves in the surface layer of bottom sediment (for example, sand), or move freely actively looking for food and/or lying on the seabed to trick their prey [5]. Meanwhile, pelagic benthic fish have negative buoyancy and primarily ingest zooplankton [6]. According to [7], [8] and [9] many demersal fish

* Corresponding author: syahrial.marine@unimal.ac.id

resources have great economic value and live on muddy substrates. Other substrates include sand, gravel, and rock [3], sandy mud [10], and muddy sand [11]. These substrate types are usually found or found in estuary areas [12, 13, 14, 15, 16, 17, 18, 19].

An estuary is a coastal ecosystem that is between the sea and land (meeting area/ecotone) [20, 21], and has its characteristics when compared with coastal ecosystems [20]; both in terms of morphology, physics and as a system as a whole [22]. [23] states that estuaries are divided into 4 types based on their geomorphology, namely estuaries in the form of a drowned river valley (many of which are formed along the coast which have shallow and wide coastal plains), fjord-type estuaries (formed in deep water), estuaries with bar-built estuaries (shallow basins where part of the bottom of the water will appear at low tide) and estuaries formed by volcanic processes (formed from indentations due to geological faults or local subsidence of the earth's surface where this process is generally followed by fresh water in large numbers entering it).

As stated by [24] estuary areas are very productive, and serve as habitats for various types of coastal and marine biota [25] so they have high biodiversity [22, 25, 26, 27, 28]. [29] claimed that the estuary ecosystem is used by biota (particularly fish) as a spawning area, nursery, food storage area, and migration route; in an estuary environment fish are generally euryhaline [20]. However, estuary areas are now widely utilised by humans for economic development [25, 26, 27, 28, 30, 31, 32]. The estuary area of Kuala Langsa, Langsa City, has also been used as a port area, ecotourism, residential areas, aquaculture, capture fisheries, and ship transportation. According to [21] and [25], the high level of utilization of estuary areas by human activities will cause the ecological balance to be disturbed (physically and as a system as a whole), this will affect the existence of associated biota contained therein such as fish communities.

Given that demersal fish resources are frequently exploited due to their high selling value [7], demersal fish resources in the Kuala Langsa estuary of Langsa City have also been used for a long time by local communities, even though scientific information on demersal fish is still very limited, particularly in terms of assessing community structure. Although [33] studied demersal fish in the Melaka Strait, his research was not conducted in the Kuala Langsa estuary area of Langsa City. Similarly, [34] conducted a study in Langsa City's maritime waters, however, the study mainly focused on the characteristics of catch fisheries. Based on this, it is very necessary to conduct an assessment study of the structure of the demersal fish community in the Kuala Langsa estuary, Langsa City. This aims to determine the diversity, niche width, distribution, and structure of the demersal fish community in the Kuala Langsa estuary, Langsa City.

2 Materials and methods

The study was conducted from May to July 2022 in six (6) observation zones. Zone I is at the mouth of the estuary which is a fishing area and fishermen's settlement [35, 36], Zone II is in the mangrove ecotourism area, Zone III is in the port/pier area and residential areas [37], Zone IV is in the area where the Langsa River and Lueng River meet, Zone V is in the upstream part of the Langsa River, while Zone VI is at the upper mouth of the Lueng River (Figure 1). Each observation zone has 3 repeats.

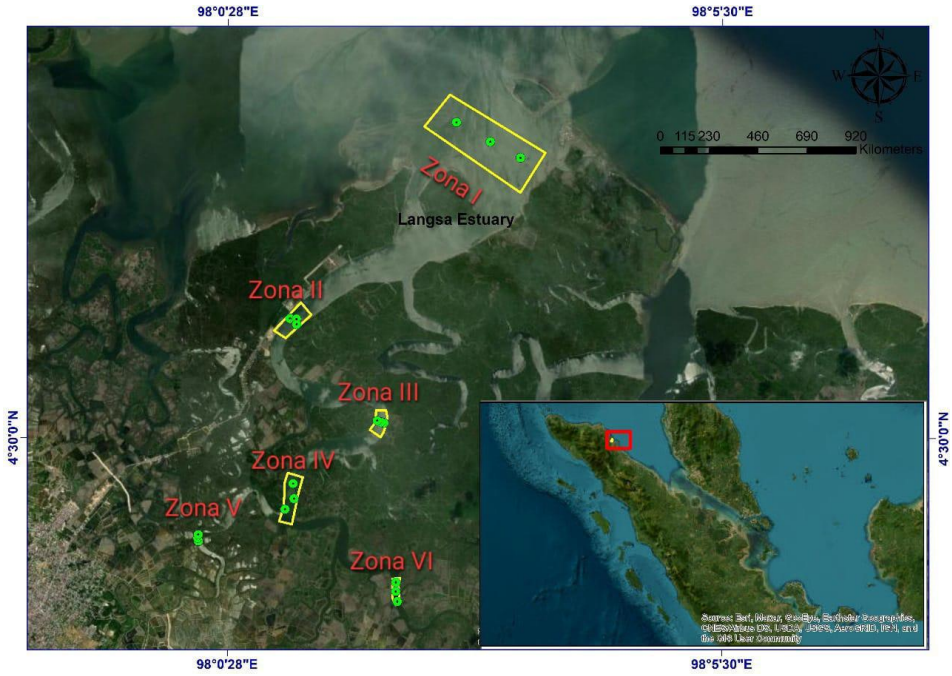

Fig. 1. The study area for sampling in the Kuala Langsa estuary, Langsa City

The demersal fish of the Kuala Langsa estuary in Langsa City were then surveyed at a maximum depth of 15 m using drift gillnet fishing gear with a mesh size of 1.50 inches [34], with a long time to lift the net (towing time) after being unloaded/mounted being around 4 - 5 hours. Demersal fish that have been caught are then identified according to [38], [39], [40], [41], [42], [43] as well as [44] to find out the type, genus, and family. Analysis was carried out using multivariate cluster statistics and nonmetric Multi-Dimensional Scaling (nMDS) ordination according to the Bray-Curtis similarity index to determine the structural variations of demersal fish communities in the Kuala Langsa estuary waters of Langsa City. SIMPER analysis was used to evaluate the difference in the number of individual demersal fish detected between observation zones and depth strata. ANOVA analysis was used to compare the number of individual demersal fish found between the observation zones and the depth strata studied. Statistical investigation Cluster, nMDS, and SIMPER analyses were performed using the PRIMER 7 program, whereas ANOVA statistical analysis was performed using the EXCEL program.

3 Results and Discussion

3.1 Diversity, Niche Width and Distribution

Demersal fish found in the Kuala Langsa estuary waters of Langsa City were identified as 8 species, 8 genera, and 8 families with all species belonging to the Osteichthyes class (bony fish) (Table 1). Each family has one genus and one species represented. The species *Eubleekeria splendens* and *Chelonodon patoca* can make better use of the Kuala Langsa estuary in Langsa City's environmental resources. This is evidenced by the fact that they (*E. splendens* and *C. patoca*) have higher niche width values than other species (04.42 and

04.33, respectively). According to [45], the concept of ecological niche is closely tied to the food web (food chain), offering an overview of a species' place in the food chain. When a species has a wide niche, it tends to overlap with other species (species with a tight niche) [45]. Aside from that, Table 1 also shows that in the estuary waters of Kuala Langsa Kota Langsa the species *Hemibagrus nemurus* is classified as commonly found (frequency found 61 – 80%), while the species *Chanos chanos* is classified as frequently found (frequency found 41 – 60%) and the species *E. splendens*, *Terapon jarbua*, *Scatophagus argus*, *Plotosus canius*, *C. patoca* and *Johnius carouna* are classified as abundantly found (frequency found > 80%). *H. nemurus* is an economically important type of fish in Indonesia that is often consumed [46] with its usual habitat being brackish waters, river estuaries, fresh waters, lakes and flood exposures and other calm waters [47]. Meanwhile, *E. splendens* is a fish that lives in shallow coastal waters and estuaries among mangroves with mud to muddy sand substrates at a maximum depth of 65 m and feeds on small crustaceans and mollusks [48]. Furthermore, *T. jarbua* is a fish that is commonly found in sea waters, coastal areas, river estuaries, fresh water, and a variety of other coastal lagoons [49] and can swim quite far upstream of rivers to freshwater [50] with small fish being the primary food source [51]. Besides, *S. argus* is a fish that is commonly found in river estuaries, waters near docks or harbors, mangrove forests, and the downstream parts of freshwater streams, particularly those with high concentrations of nutrients or minerals, with benthic algae and invertebrates as the primary food source [52].

Table 1. Diversity, niche width, composition and distribution of demersal fish in the Kuala Langsa estuary Langsa City

Species	Family	Niche	Composition (%)	[a]Distribution
Hemibagrus nemurus	Bagridae	03.04	08.33	Common
Eubleekeria splendens	Leiognathidae	04.42	21.83	Abundant
Chanos chanos	Chanidae	02.57	02.38	Frequent
Terapon jarbua	Terapontidae	03.72	11.90	Abundant
Scatophagus argus	Scatophagidae	03.18	15.08	Abundant
Plotosus canius	Plotosidae	02.88	02.78	Abundant
Chelonodon patoca	Tetraodontidae	04.33	05.16	Abundant
Johnius carouna	Sciaenidae	03.46	32.54	Abundant

[a] = [53]

3.2 Community Structural

The number of individual fish detected in the Kuala Langsa estuary waters of Langsa City was *J. carouna* (82 ind and 32.54%), followed by *E. splendens* (55 ind and 21.83%) and *S. argus* (38 ind and 15.08%) (Table 1). Regarding catches based on observation zones, it was found that Zone VI was the area where the most individual demersal fish were found (93 ind), followed by Zone V (58 ind), Zone IV (55 ind), Zone II (24 ind), Zone I (16 ind) and Zone III (6 ind) (Figure 2). Meanwhile, for catches based on water depth, in Zone I, demersal fish were found at depths of 0–4 m and 4–8 m (respectively the number of fish was 5 and 11 ind), in Zone II at depths of 4–8 m and 8 –12 m (respectively the number of fish is 8 and 16 ind), Zone III at depths of 0–4 m, 8–12 m and 12–16 m (respectively the number of fish is 1, 4 and 1 ind), Zone IV at depth 4–8 m (55 ind) and Zones V and VI at depth 0–4 m (respectively number of fish 58 and 93 ind) (Figure 3). Figures 2 and 3 show that the further the observation zone is from the shoreline/sea, the more demersal fish individuals are detected and the fewer fish are found in the depth strata. [54] together with [55] stated that the species *S. argus* and *T. jarbua* are known to be fish that often migrate to estuary areas, while *E. splendens* and *C. chanos* are known to be fish that reside in estuary areas [56, 57]. Furthermore, [58] stated that *J. carouna* is a fish species that is classified as

a carnivore, while *E. splendens* and *S. argus* are fish that are classified as herbivores [59, 60].

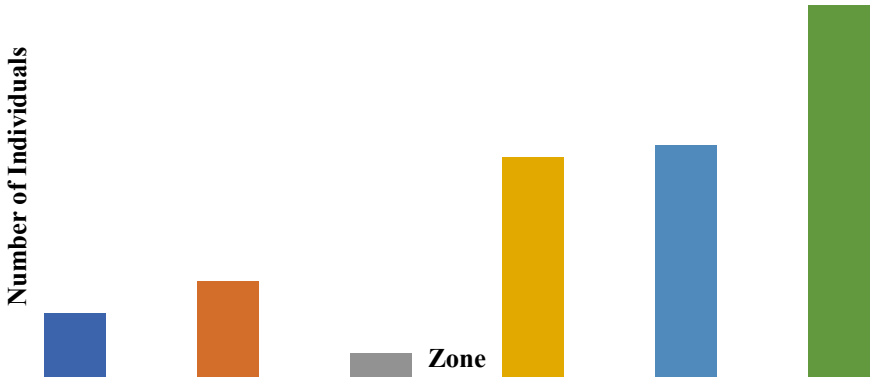

Fig. 2. The number of individual demersal fish found in the estuary waters of Kuala Langsa, Langsa City, based on the observation zone

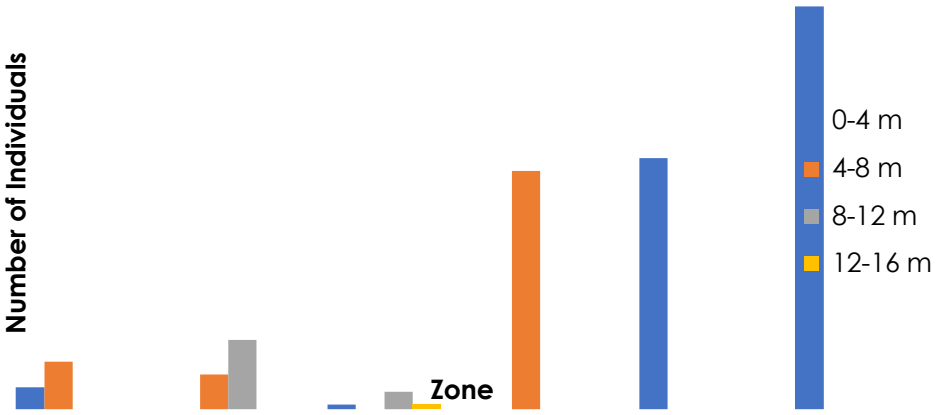

Fig. 3. The number of individual demersal fish found in the estuary waters of Kuala Langsa, Langsa City, based on depth

The results of nMDS and cluster analysis using the Bray-Curtis similarity index of demersal fish communities in the Kuala Langsa estuary waters of Langsa City based on observation zones show that fish communities are divided into two groups, the first of which consists of Zones IV-VI and the second of which consists of Zones I-III (Figures 4 - 5). These findings suggest that there are demersal fish that are more common in Zones I-III but not in Zones IV-VI, and vice versa. According to SIMPER research, the *J. carouna* species distinguishes across Zones I-III and IV-VI, with a dissimilarity of 26.98% (the highest of the two other types of demersal fish, *E. splendens* and *C. patoca*) and a contribution of roughly 40.00% (Table 2). *J. carouna* is a demersal fish from the Sciaenidae family [61] that lives in groups [62] in marine and brackish waters [63]; low temperature, very turbid, and muddy [64] with the main types of food being small fish, crustaceans, worms, and insects [65, 66].

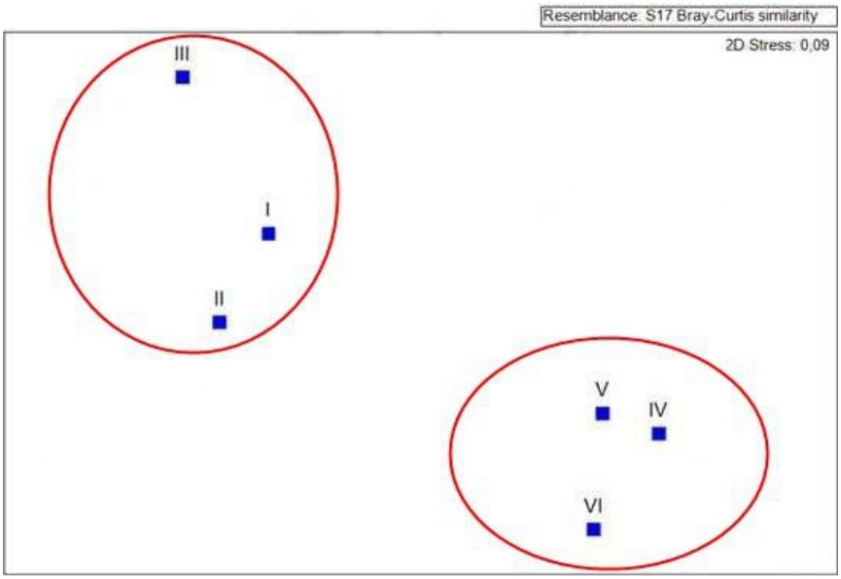

Fig. 4. Grouping of demersal fish structures in the Kuala Langsa estuary waters of Langsa City based on the observation zone on n-MDS analysis

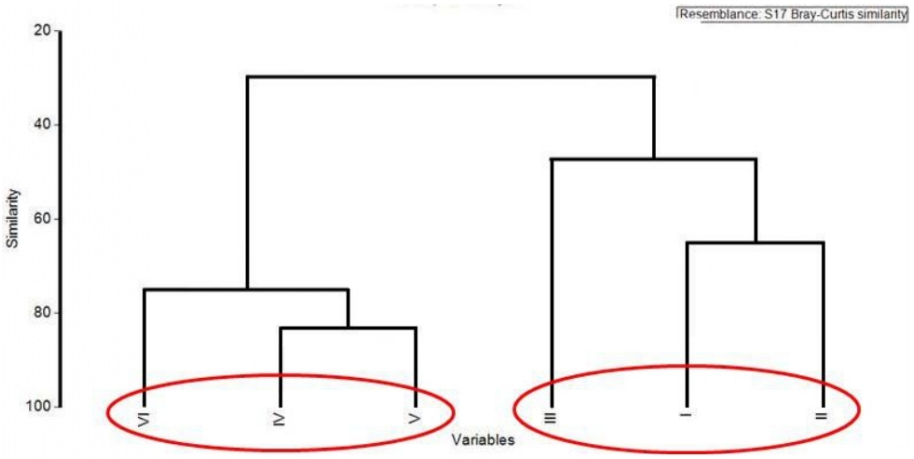

Fig. 5. Grouping of demersal fish structures in the estuarine waters of Kuala Langsa, Langsa City based on the observation zone in cluster analysis

Table 2. Results of SIMPER analysis of demersal fish in Kuala Langsa estuary waters, Langsa City

Group Zone I-III & IV-VI					
***Average Dissimilarity* = 67.46**					
Species	**Grup I-III Av. Abund**	**Grup IV-VI Av. Abund**	**Av. Diss**	**Contrib%**	**Cum.%**
J. carouna	07.00	75.00	26.98	40.00	40.00
E. splendens	12.00	43.00	12.30	18.24	58.24
C. patoca	06.00	32.00	10.32	15.29	73.53

Furthermore, nMDS and cluster analysis using the Bray-Curtis similarity index of

demersal fish communities in the estuary waters of Kuala Langsa, Langsa City based on depth strata show that groups of demersal fish at 4-8 m are more likely to join groups at 8-12 m and 12-16 m. However, groups of demersal fish discovered at depths of 0 - 4 m do not seem to combine with other groups (Figures 6 and 7), demonstrating that demersal fish found at depths of 4 - 8 m are also frequently found at depths of 8 - 16 m. These fish according to SIMPER analysis are *C. chanos*, *C. patoca*, and *J. carouna*, each of which has a contribution of around 18.75% (Table 3). *C. chanos* is a brackish water fish that is tolerant of salinity [67] with its main food types being diatoms, filamentous green algae, and detritus [68, 69, 70]. [71] stated that *C. chanos* is a marine fish species that enters estuaries and rivers. However, *C. chanos* is also often found in offshore sea waters and shallow coastal embankments and also often enters river estuary areas and sometimes penetrates freshwater streams [72]. In addition, *C. chanos* is categorized by [73], [74], and [75] as a benthopelagic and amphidromous fish that lives in tropical seas between 1 and 30 m in depth. Even though *C. patoca* is a native species of marine fish that is also occasionally found in freshwater streams [50, 76] with the substrate type sand and mud [77], although in fact, *C. patoca* is a native species of marine fish that is sometimes also found in freshwater streams [48]. According to [72] and [78], *C. patoca* is never found more than a few kilometers from the sea and is usually found at depths of 1 – 22 m [79].

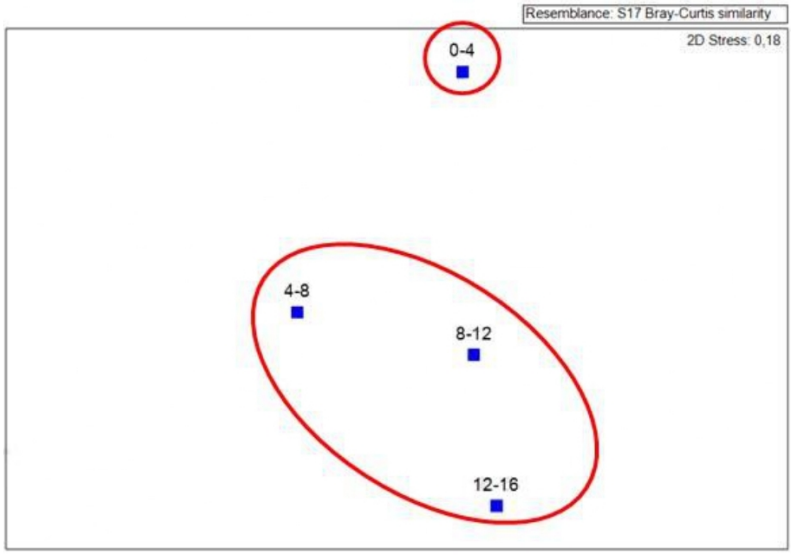

Fig. 6. Grouping of demersal fish structures in the Kuala Langsa estuary waters of Langsa City based on depth on n-MDS analysis

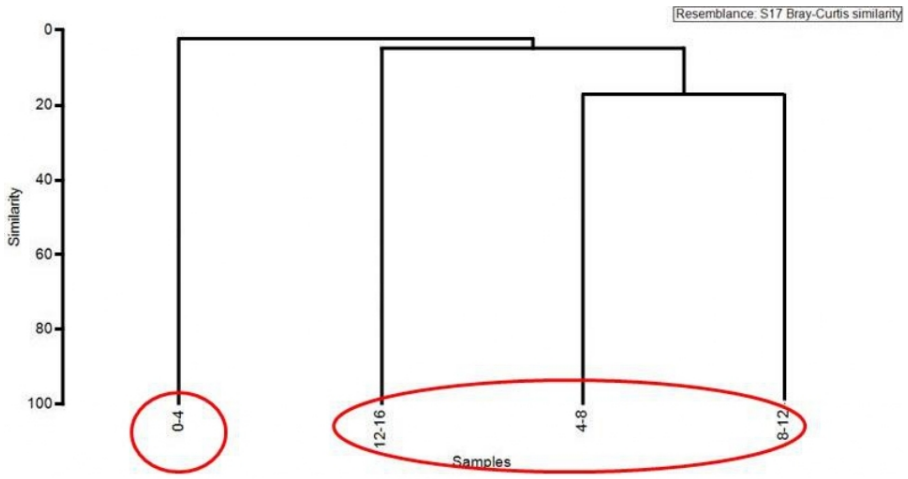

Fig. 7. Grouping of demersal fish structures in the Kuala Langsa estuary waters of Langsa City based on depth in cluster analysis

Table 3. SIMPER analysis results for demersal fish in the Kuala Langsa estuary waters, Langsa City

Depth Group 0-4 m & 8-16 m					
Average Dissimilarity = 34.78					
Species	**Grup 0-4 m Av. Abund**	**Grup 8-16 m Av. Abund**	**Av. Diss**	**Contrib%**	**Cum.%**
C. chanos	00.00	03.00	06.52	18.75	18.75
C. patoca	03.00	06.00	06.52	18.75	37.50
J. carouna	02.00	05.00	06.52	18.75	56.25
H. nemurus	00.00	02.00	04.35	12.50	68.75
S. argus	02.00	04.00	04.35	12.50	81.25

The significance value for the ANOVA test on the differences in the number of demersal fish individuals found between Zones I - III and IV-VI groups, as well as between the observation zones, was < 0.05 ($p < 0.05$), indicating that the difference in the number of individuals occurred (real), both between Zones I - III and IV-VI groups, as well as between each observation zone. Meanwhile, the ANOVA test on the number of individual demersal fish found in the 0 – 4 m and 8 – 16 m depth strata groups as well as between depth strata, showed that the significance value was > 0.05 ($p > 0.05$). This indicates that the number of individual demersal fish found was no real difference (the same), both between depth strata groups of 0 – 4 m and 8 – 16 m or between each depth strata. [80] stated that in the distribution of fish, fish are very dependent on their ability to survive in different types of waters. Furthermore, [81] claimed that as water depth increases, the dispersion of demersal fish decreases. This is due to a lack of dissolved oxygen concentration and a lack of plankton as the primary food source in the waters.

4 Conclusions

The demersal fish community in Langsa City's Kuala Langsa estuary waters was discovered to consist of 8 species, 8 genera, and eight families. The fish *E. splendens* and *C. patoca* occupy a wide range of niches. Meanwhile, *E. splendens, T. jarbua, S. argus, P. canius, J. carouna,* and *C. patoca* were reasonably plentiful, with *J. carouna* having the highest number of individuals. Furthermore, the demersal fish community in the estuary

waters of Kuala Langsa, Langsa City, showed clustering and significant differences in the number of individuals found in each observation zone. Similarly, there was grouping between depth strata, but there was no significant variation in the number of individuals found in each depth stratum.

The author would like to thank The Institution of Research, Community Service, and Quality Assurance (LPPM and PM) Universitas Samudra that has given financial support and facilitate the author in carrying out this research through Superior Basic Research (PDU) year 2022.

References

1. Aoyama, T, The demersal fish stock and fisheries of the South China Sea (FAO: IPFC South China Sea Fisheries Development and Coordinating Programme, Rome, Italy 1973).
2. Q. Bone, R.H Moore, Biology of Fishes-Third Edition (Taylor & Francis Group, United Kingdom, 2008).
3. Walrond, C. (2023). Coastal Fish - Fish of the Open Sea Floor. TeAra – The Encyclopedia of New Zealand. http://www.TeAra.govt.nz/en/coastal-fish/page-5.
4. Broer, M., Aziz K.A., Widodo, J., Djamali, A., Ghofar, A., & Kurnia, R. Potensial, Utilization and Development Opportunities of Marine Fish Resources in Indonesian Waters (Directorate of Research and Exploration of Biological Resources, Directorate General of Marine Research and Exploration Integration, Department of Marine and Fisheries, Marine Fisheries Resources Assessment Commission Center for Coastal and Marine Resources Studies, IPB, Bogor, Indonesia, 2001)
5. E.A. Fairchild, W.H. Howell, Fish Biology **65**, 69-87 (2004)
6. J. Mauchline, J. Gordon, Marine Ecology Progress Series, **27**, 227-238 (1986)
7. Noija, D., Martasuganda, S., Murdiyanto, B., & Taurusman, A.A, Teknologi Perikanan dan Kelautan **5**, 1 (2014)
8. Y.D. Sari, Y. Syaukat, T. Kusumastanto, S. Hartoyo, Sosial Ekonomi Kelautan dan Perikanan **13**,1 (2018).
9. E.K. Lubis, T.Y. Sinaga, Susiana, Akuatik Lestari **4**, 2 (2021)
10. G. Yulianto, K. Suwardi, L. Adrianto, Machfud, Omni-Akuatika **12**, 3 (2016)
11. H. Akbar, S. Pujiyati, M. Natsir, Teknologi Perikanan dan Kelautan **4**, 1 (2013).
12. W. Kastoro, Aswandi, A. Hakim, P.A.W.J. de Wilde, J.M. Everaarts, Netherlands Journals of Sea Research **23**, 463-472 (1989)
13. Rifardi, E. Rufli, A. Rangga, M. Lubis, Y. Roza, & P.M. Sari, Ilmu Lingkungan **5**, 1 (2011)
14. S. Roswaty, M.R. Muskananfola, P.W. Purnomo, Management of Aquatic Resources **3**, 2 (2014)
15. Susiana, Ilmiah Agribisnis dan Perikanan **8**, 1 (2015)
16. T. Jansen, Media Engineering **6**, 2 (2016)
17. M.R. Maturbongs, S. Elviana, S. Sunarni, D. deFretes, Depik **7**, 2 (2017)
18. S.K. Simanjuntak, M.R. Muskananfola, W.T. Taufani, Management of Aquatic Resources **7**, 4 (2018)
19. S. Syam, Environment Science **6,** 2 (2022)
20. M.R. Ridho, E. Patriono, Penelitian Sains **19**, 1 (2017)

21. Lopes, C.L., Sousa, M.C., Ribeiro, A., Pereira, H., Pinheiro, J.P., Vaz, L., & Dias, J.M. Scientifc Reports, 12, 8083 (2022)
22. R. Rositasari, S.K. Rahayu, Oseana, **19**, 3 (1994)
23. Pritchard, D.W. (1967). What is An Estuary: Physical View Point. In: Estuaries (Lauff GH, eds.). American Association for the Advancement of Science Publication No. 83. Washington DC.
24. I.H. Supriadi, Oseana **26**, 4 (2001)
25. Ramadoni, H. Surbakti, T.Z. Ulqodry, Isnaini, R. Aryawati, Maspari, **10**, 2 (2018)
26. K.E. Clark, L.J. Niles, & J. Burger, Condor **95**, 694-705 (1993)
27. C.T. Roman, N. Jaworski, F.T. Short, S. Findlay, R.S. Warren, Estuaries **23,** 743-764 (2000)
28. J.C. Bergstrom, J.H. Dorfman, J.B. Loomis, Coastal Management **32**, 417-432 (2004)
29. A. Zahid, C.P.H. Simanjuntak, M.F. Rahardjo, Sulistiono, Iktiologi Indonesia **11**, 1 (2011)
30. U. Chodriyah, W.A. Pralampita, Bawal **2**, 5 (2009)
31. Effendi, H., Kaswanto, R.L., Wardiatno, Y., & Bengen, D.G. (2020). Policy Brief Water Front City. IPB Professorship Council 012/PB/DGB-IPB/12/2020. Bogor, Indonesia.
32. Yusnita, E.A., & Triajie, H. (2021). Juvenil, 2(2): 157-165
33. Sumiono, B. (2002). Penelitian Perikanan Indonesia, 8(1): 51-67
34. Arkham, M.N., Hamdani, A., Fahrudin, A., Anggraini, N., Krisnafi, Y., Tiku, M., Kelana, P.P., Haris, R.B.K., & Gunawan, A. (2021). Penelitian Perikanan Indonesia, 27(3): 117-127
35. Persada, A.Y., Navia, Z.I., Saputri, A., Putri, K.A., & Fajar, B.A. (2019). Elkawnie, 5(1): 67-75
36. Febrianti, D., Harisandy, M.D., Nadhira, C.A., & Syahputra, M.R. (2022). Jeumpa, 9(2): 758-766
37. Erlangga, Gusnita, H., Syahrial, 'Akla, C.M.N., Imamshadiqin, Ezraneti, R., & Firdaus, R. (2022). Kelautan Tropis, 25(3): 391-399.
38. Carpenter, K.E., & Niem, V.H. (1999). The Living Marine Resources of The Western Central Pacific Volume 3 – Batoid Fishes, Chimaeras and Bony Fishes Part 1 (Elapidae to Linophrynidae). FAO Species Identification Guide for Fishery Purposes. Food and Agriculture Organization of the United Nations. Rome.
39. Carpenter, K.E., & Niem, V.H. (2001a). The Living Marine Resources of The Western Central Pacific Volume 4 – Bony Fishes Part 2 (Mugillidae to Carangidae). FAO Species Identification Guide For Fishery Purposes. Food and Agriculture Organization of the United Nations. Rome.
40. Carpenter, K.E., & Niem, V.H. (2001b). The Living Marine Resources of The Western Central Pacific Volume 5 – Bony Fishes Part 3 (Menidae to Pomacentridae). FAO Species Identification Guide For Fishery Purposes. Food and Agriculture Organization of the United Nations. Rome.
41. Carpenter, K.E., & Niem, V.H. (2001c). The Living Marine Resources of The Western Central Pacific Volume 6 – Bony Fishes Part 4 (Labridae to Latimeriidae) Estuarine Crocodiles, Sea Turtles, Sea Snakes and Marine Mammals. FAO Species Identification Guide For Fishery Purposes. Food and Agriculture Organization ofthe United Nations. Rome.
42. Elliott, M., & Hemingway, K. (2002). Fishes in Estuaries. Blackwell Science Ltd.

Osney Mead, Oxford.

43. Nelson, J.S. (2006). Fishes of the World – Fourth Edition. John Wiley & Sons, Inc. Hoboken, New Jersey.
44. Hastings, P.A., Walker, H.J., & Galland, G.R. (2014). Fishes - A Guide to Their Diversity. University of California Press. Oakland, California.
45. Kurniati, H. (2001). Differences in intraspecific niches of lizards *(Sphenomorphus variegatus)*: An overview of morphometric variation (Lacertilia: Scincidae). Biota, 6(3): 105-108.
46. Prianto, E., Kamal, M.M., Muchsin, I., & Kartamihardja, E.S. (2015). Reproductive aspect of green catfish *(Hemibagrus nemurus)* in Lubuk Lampam floodplain, Ogan Komering Ilir Regency. Bawal, 7(3): 137-146.
47. Kusdiarti, Subagja, J., Arifin, O.Z., & Dewi, R.R.S.P.S. (2020). Modification of rearing environment for *Hemibagrus nemurus* seed to imrprove growth and survival rate. Akuakultur Rawa Indonesia, 8(2): 141-149
48. Larson, H. (2012). *Eubleekeria splendens*. The IUCN Red List of Threatened Species 2012: e.T199624A2607287. http://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T199624A2607287.en.
49. Rao, D.V., Devi, K., & Rajan, P.T. (2000). An Account of Ichthyofauna of Andaman and Nicobar Islanda, Bay of Bengal. Records of the Zoological Survey of India, Occasional Paper No. 178, Kolkata.
50. Talwar, P.K., & Jhingran, A.G. (1991). Inland Fishes of India and Adjacent Countries. Oxford-IBH Publishing Co. Pvt. Ltd., New Delhi.
51. Whitfield, A.K., & Blaber, S.J.M. (1978). Food and feeding ecology of piscivorous fishes at Lake St Lucia, Zululand. Fish Biology, 13(6): 675-691.
52. Collen, B., Richman, N., Beresford, A., Chenery, A., & Ram, M. (2010). *Scatophagus argus*. The IUCN Red List of Threatened Species 2010: e.T155268A4761779. http://dx.doi.org/10.2305/IUCN.UK.2010-4.RLTS.T155268A4761779.en.
53. Sreelekshmi, S., Nandan, S.B., Kaimal, S.V., Radhakrishnan, C.K., & Suresh, V.R. (2020). Mangrove species diversity, stand structure and zonation pattern in relation to environmental factors — A case study at Sundarban delta, east coast of India. Regional Studies in Marine Science, 35: 101111.
54. Aida, S.N. (2015). Reproductive biology of the Kipper fish *(Scatophagus argus)* in the Musi River estuary, South Sumatera. In: Proceedings Seminar Nasional Ikan Ke 8. 3 – 4 June 2014. Bogor, Indonesia. 241-249.
55. Gupta, S., & Banerjee, S. (2016). A short review on the biology of tiger perch, *Terapon jarbua* (Forsskal, 1775). International Journal of Research in Fisheries and Aquaculture, 6: 79-83.
56. Blaber, S.J. (1997). Fish and Fisheries of Tropical Estuaries. Chapman & Hall. London, England.
57. Burhanuddin. (2012). Review of aquaculture research Bandeng fish (*Chanos chanos* Forsk.) in fishponds and floating net cages of river estuaries. In: National Marine Seminar VIII. 24 May 2012. Surabaya, Indonesia. B1-91 - B1-96.
58. Siagian, G., Wahyuningsih, H., & Barus, T.A. (2017). The structure of *Johnius trachycephalus* P. fist in Barumun River at Labuhan Batu Regency of North Sumatra. Biosains, 3(2): 59-65
59. Sjafei, D.S., & Saadah. (2001). Some biological aspects of splendid ponyfish *Leiognathus splendens* Cuvier in Labuan Bay, Banten. Iktiologi Indonesia, 1(1): 13-17.

60. Sulardiono, B., Widyorini, N., & Dewinta, R. (2022). Analysis of food habit and food competition of fish caught in Wonokerto Estuary, Demak, Central Java. Pasir Laut, 6(1): 19-28
61. Sawusdee, A., & Rattanarat, J. (2021). Population dynamics of the caroun croaker *Johnius carouna* (Cuvier, 1830) in coastal fishing ground in the middle gulf of Thailand. Walailak Journal of Science and Technology, 18(17): 13709.
62. Anggraeni, S.N., Solichin, A., & Widyorini, N. (2016). The biological aspects of croackers (*Johnius* sp.) landed in Tawang fish auction market Kendal Regency Central Java. Management of Aquatic Resources, 5(4): 461-467. https://doi.org/10.14710/marj.v5i4.14657.
63. Sasaki, K. (1995). A review of the Indo-West Pacific Scaenid genus *Panna* (Teleostei, Perciformes). Japanese Journal of Ichthyology, 42(1): 27-37.
64. Longhurst, A., & Pauly, D. (1987). Ecology of Tropical Oceans. Academic Press: San Diego. 407 p.
65. Fischer, W., & Bianchi, G. (1984). FAO Species Identification Sheets for Fishery Purposes. Western Indian Ocean (Fishing Area 51).
66. Kottelat, M., Whitten, A.J., Kartikasari, S.N., & Wirjotmodjo, S. (1993). Freshwater Fishes of Western Indonesia and Sulawesi. Bilingual Edition England – Indonesia. Periplus Edition (HK) Ltd. 239 p.
67. Djumanto, Pranoto, B.E., Diani, V.S., & Setyobudi, E. (2017). Makanan dan pertumbuhan ikan bandeng, Chanos chanos (Forsskal, 1775) tebaran di Waduk Sermo, Kulon Progo. Iktiologi Indonesia, 17(1): 83-100. DOI 10.32491/jii.v17i1.306.
68. Rao, L.M., & Sivani, G. (1996). The food preferences of five commercially important fishes of Gosthani estuary. Indian Journal Fisheries, 43(2): 199-202.
69. Franklin, S.M., Mei-Chen, T., & Sin-Ping, Y. (2006). Milkfish *(Chanos chanos)* culture: Situations and trends. The Fisheries Society of Taiwan, 33(3): 229-244.
70. Prayitno, S.B., Sarwan, & Sarjito. (2015). The diversity of gut bacteria associated with milkfish (*Chanos chanos* Forskal) from northern coast of Central Java, Indonesia. Procedia Environmental Sciences, 2 (1): 375-384.
71. Seegers, L., De Vos, L., & Okeyo, D.O. (2003). Annotated checklist of the freshwater fishes of Kenya (excluding the *Lacustrine haplochromines* from Lake Victoria). East African Natural History, 92(1): 11-47. https://doi.org/10.2982/0012-8317(2003)92[11:ACOTFF]2.0.CO;2.
72. Allen, G.R., Midgley, S.H., & Allen, M. (2002). Field Guide to The Freshwater Fishes of Australia. Western Australian Museum. Perth, Australia.
73. Shao, K.T., & Lim, P.L. (1991). Fishes of Freshwater and Estuary - Encyclopedia of Field Guide in Taiwan. Recreation Press, Co., Ltd, Taipei, Taiwan.
74. Jeyaseelan, M.J.P. (1998). Manual of Fish Eggs and Larvae from Asian Mangrove Waters. United Nations Educational Scientific and Cultural Organization (UNESCO) - International Society for Mangrove Ecosystems (ISME).
75. Riede, K. (2004). Global register of migratory species - from global to regional scales. Federal Agency for Nature Conservation, Bonn, Germany.
76. White, W.T., Last, P.R., Dharmadi, Faizah, R., Chodrijah, U., Prisantoso, B.I., Pogonoski, J.J., Puckridge, M., & Blaber, S.J.M. (2013). Market Fishes of Indonesia (= Jenis-Jenis Ikan di Indonesia). ACIAR Monograph No. 155. Australian Centre for International Agricultural Research: Canberra. 438 pp.
77. Kuiter, R.H., & Tonozuka, T. (2001). Pictorial Guide to Indonesian Reef Fishes: Part 3. Jawfishes, Sunfishes, Opistognathidae, Molidae. Zoonetics, Australia.

78. Allen, G.R. (1991). Damselfishes of The World. Mergus Publishers. Melle, Germany.
79. Matsuura, K. (2002). A Review of Two Morphologically Similar Puffers, *Chelonodon laticeps* and *C. patoca*. National Science Museum Monographs, 22: 173-178.
80. Myers, G.S. (1938). Freshwater fishes and West Indian zoogeography. Annual Report of The Board of Regents of The Smithsonian Institution, 92: 339-364.
81. Saeger, J., Martosubroto, P., & Pauly, D. (1976). First report of the Indonesian-German demersal fisheries project (result of a trawl survei in the Sunda Shelf area). Special Report. Contrib of the demersal fisheries project. No. 1. Marine Fisheries Research Report. RIMF-GTZ. 46 pp.