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

Muhammad Fauzan Isma¹, Faiz Isma², Muhammad Hatta³, Fitria Mustika⁴, Syahrial Syahrial⁵*, Cut M. N. Akla⁵, Agus Putra Abdul Samad¹

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, Plootosus 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

© The Authors, published by EDP Sciences. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/).
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 Multidimensional 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
areas, estuary areas, individuals are detected and the further the observation zo...

[57 x 81]number

demersal fish were found at depths of 0 and Zone III (6 ind) (Figure 2). Meanwhile, for catches (93 ind). 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

<table>
<thead>
<tr>
<th>Species</th>
<th>Family</th>
<th>Niche</th>
<th>Composition (%)</th>
<th>*Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemibagrus nemurus</td>
<td>Bagridae</td>
<td>03.04</td>
<td>08.33</td>
<td>Common</td>
</tr>
<tr>
<td>Eubleekeria splendens</td>
<td>Leiognathidae</td>
<td>04.42</td>
<td>21.83</td>
<td>Abundant</td>
</tr>
<tr>
<td>Chanos chanos</td>
<td>Chanidae</td>
<td>02.57</td>
<td>02.38</td>
<td>Frequent</td>
</tr>
<tr>
<td>Terapon jarbua</td>
<td>Terapontidae</td>
<td>03.72</td>
<td>11.90</td>
<td>Abundant</td>
</tr>
<tr>
<td>Scatophagus argus</td>
<td>Scatophagidae</td>
<td>03.18</td>
<td>15.08</td>
<td>Abundant</td>
</tr>
<tr>
<td>Plotosus canius</td>
<td>Plotosidae</td>
<td>02.88</td>
<td>02.78</td>
<td>Abundant</td>
</tr>
<tr>
<td>Chelonodon patoca</td>
<td>Tetraodontidae</td>
<td>04.33</td>
<td>05.16</td>
<td>Abundant</td>
</tr>
<tr>
<td>Johnius carouna</td>
<td>Sciaenidae</td>
<td>03.46</td>
<td>32.54</td>
<td>Abundant</td>
</tr>
</tbody>
</table>

* = [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].

![Number of individuals](image1)

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

![Number of individuals](image2)

**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

<table>
<thead>
<tr>
<th>Species</th>
<th>Group I-III Av. Abund</th>
<th>Group IV-VI Av. Abund</th>
<th>Av. Diss</th>
<th>Contrib%</th>
<th>Cum.%</th>
</tr>
</thead>
<tbody>
<tr>
<td>J. carouna</td>
<td>07.00</td>
<td>75.00</td>
<td>26.98</td>
<td>40.00</td>
<td>40.00</td>
</tr>
<tr>
<td>E. splendens</td>
<td>12.00</td>
<td>43.00</td>
<td>12.30</td>
<td>18.24</td>
<td>58.24</td>
</tr>
<tr>
<td>C. patoca</td>
<td>06.00</td>
<td>32.00</td>
<td>10.32</td>
<td>15.29</td>
<td>73.53</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Species</th>
<th>Grup 0-4 m Av. Abund</th>
<th>Grup 8-16 m Av. Abund</th>
<th>Av. Diss</th>
<th>Contrib%</th>
<th>Cum.%</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. chanos</td>
<td>00.00</td>
<td>03.00</td>
<td>06.52</td>
<td>18.75</td>
<td>18.75</td>
</tr>
<tr>
<td>C. patoca</td>
<td>03.00</td>
<td>06.00</td>
<td>06.52</td>
<td>18.75</td>
<td>37.50</td>
</tr>
<tr>
<td>J. carouna</td>
<td>02.00</td>
<td>05.00</td>
<td>06.52</td>
<td>18.75</td>
<td>56.25</td>
</tr>
<tr>
<td>H. nemurus</td>
<td>00.00</td>
<td>02.00</td>
<td>04.35</td>
<td>12.50</td>
<td>68.75</td>
</tr>
<tr>
<td>S. argus</td>
<td>02.00</td>
<td>04.00</td>
<td>04.35</td>
<td>12.50</td>
<td>81.25</td>
</tr>
</tbody>
</table>

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
19. S. Syam, Environment Science 6, 2 (2022)


