

Biodiversity of important commercial fish in Lhok Bengkuang fish landing, Tapaktuan regency, southern part of Aceh, Indonesia

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Abstract. This study was conducted at the Lhok Bengkuang fish landing in Tapaktuan regency, located in the southern part of Aceh Province, Indonesia, throughout May 2024. Fish samples were collected daily from wild catches using a bottom gill net with a 2.5-inch mesh size. The collected fish were sorted, identified, and recorded for the total number of each species. Over the study period, a total of 2,880 fish specimens from 24 different species were recorded. Notably, 80.66% of the total catch was dominated by three species: *Eubleekeria splendens* (56.94%), *Selaroides leptolepis* (12.78%), and *Gerres oyena* (10.94%). The least abundant species included *Loligo vulgaris* (0.14%), *Carcharhinus amblyrhynchoides* (0.10%), and *Arius thalassinus* (0.07%). The conservation status of these species revealed that 19 species (79.18%) were classified as Least Concern (LC), 2 species (8.33%) as Near Threatened (NT), 2 species (8.33%) as Vulnerable (VU), and 1 species (4.16%) as Data Deficient (DD). The study highlights the impact of environmental factors, seasonal fish migrations, and nutrient availability on fish diversity. These findings provide valuable insights into the composition and community structure of fish species in Lhok Bengkuang coastal waters.

1 Introduction

As vital components of aquatic ecosystems, fish contribute significantly to global economies [1-4]. They are also important sources of high-quality protein [2, 5, 6]. In marine and estuarine coastal habitats, fish communities are considered permanent residents throughout various life stages, including larvae, juvenile, and adult stages [7,8]. Coastal ecosystems provide vital protection for resident fish species, as well as for marine and freshwater species that migrate for reproductive purposes [2, 9], nursing [8], foraging [10], and shelter [5, 6, 11]. Additionally, these ecosystems offer provisioning services such as food production, raw materials, and medicinal resources [5, 12]. They also play a crucial role in regulating and maintaining environmental processes, including nutrient cycling, sediment formation,

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shoreline protection, and preserving genetic resources, along with providing cultural benefits like recreation and tourism [7, 13].

Environmental changes resulting from natural climate variations and human activities significantly impact fish composition [2, 8, 14]. The composition of fish populations and fisheries productivity largely depends on environmental conditions, including the physical and chemical characteristics of rivers, estuaries, marine waters, and surrounding terrestrial habitats [6, 15, 16]. Consequently, significant fluctuations in ecological conditions within estuaries and coastal areas create dynamic habitats for marine fish throughout their life cycles [1, 3, 6, 7]. Fish also exhibit complex life cycles and habitat preferences that may change with different life stages [4, 8, 16].

Fish landing in Lhok Bengkuang of Tapaktuan, Southern Aceh mostly dominated by tuna fish (*Thunnus*), mackarel (*Scomberomorus commerson*), sailfish (*Istiophorus platypterus*) and swordfish (*Xiphias gladius*). They were dominantly caught by purse seine net. However, this present study highlighted fish being caught by using a bottom gill net. Understanding the composition and biodiversity of fish along with the ecological roles and fish species are essential for identifying key biological factors [3, 7, 12]. This knowledge is vital for ensuring sustainable fisheries management of marine ecosystem resources, particularly for species that are heavily targeted and intensely exploited [2, 3, 13] and being listed by the International Union for Conservation of Nature (IUCN) Red List.

Considering the previous discussion, this present study aims to analyse composition and biodiversity of fish species collected from Lhok Bengkuang fish landing, Tapaktuan subdistrict, Aceh Selatan regency at the Southern part of Aceh Province, Indonesia.

2 Materials and methods

2.1 Data collection

All the samples for this study were collected every day in month of May 2024 from Lhok Bengkuang fish landing, Tapaktuan regency at the Southern part of Aceh Province, Indonesia (Fig. 1). Fish were collected from the wild catch using bottom gill net mesh size of 2.5 inch. Daily monthly catch were sorted, identified and recorded for total number of each fish species. Taxonomic identification followed guidelines from the Food and Agriculture Organization (FAO) [17].

2.2 Data analysis

Firstly, the fish composition in terms of number was calculated and expressed as a percentage based on composition formulation: $\%N = n_i / N_t \times 100$ [3]. Secondly, the original data were analysed using various community indices, including Simpson's dominance index (D) [19]: $D = \sum_{i=1}^S (P_i)^{-2}$, Simpson's diversity index (1-D) [20]: $D = 1 - \sum_{i=1}^S (P_i)^2$ and Shannon-Weaver's diversity index (H') [20]: $H' = -\sum_{i=1}^S P_i \cdot \log P_i$. Moreover, other complete indexes such as Pielou's evenness index (J) [21], Brillouin's diversity index (HB) [20], Menhinick's diversity index (Mn) [21], Margalef's species richness index (mD) [22], Equitability evenness index (Ed) [23], Fisher-alpha diversity index (S) [24] and Berger-Parker's diversity index (d) [25] were also performed to analyses a complete diversity indices of this study. Thirdly, data of fish species were finally categorized and levelled into threatened fish species according to IUCN Red List. All data analyses were calculated using Paleontological Statistics (PAST) software version 4.03 [26].

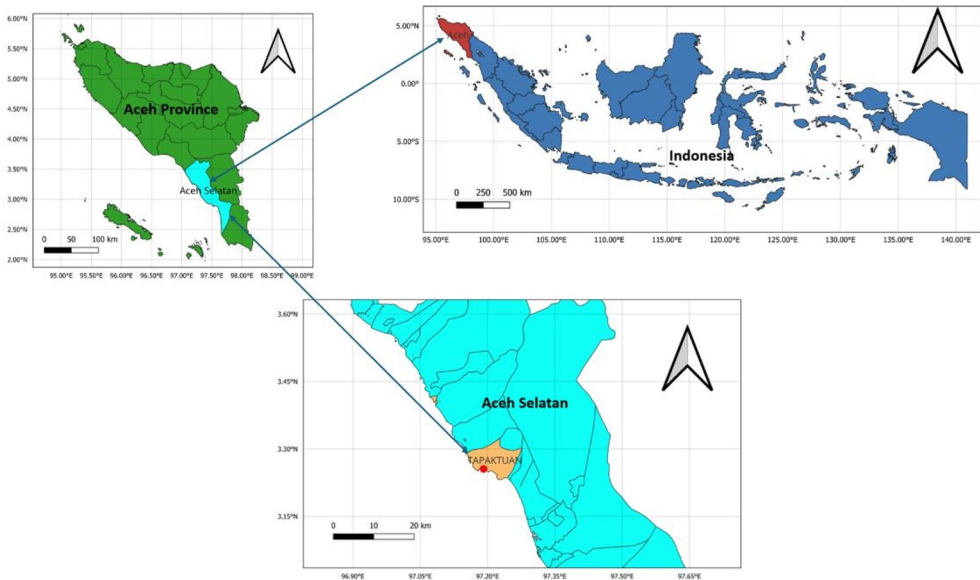


Fig. 1. Maps of the study of Lhok Bengkuang fish landing, Tapaktuan regency at the Southern part of Aceh Province, Indonesia.

3 Results and Discussion

3.1 General fish composition

During the entire study in May 2024, a total of 2,880 fish specimens from twenty-four different species were recorded (Table 1). Among these, 2,323 individuals, or 80.66%, were dominated by three species, including *Eubleekeria splendens* (n=1640, 56.94%), *Selaroides leptolepis* (n=368, 12.78%) and *Gerres oyena* (n=315, 10.94%). The lowest dominated species were found to be *Loligo vulgaris* (n=4, 0.14%), *Carcharhinus amblyrhynchoides* (n=3, 0.10%) and *Arius thalassinus* (n=2, 0.07%).

This study offers insights into the community structure and composition of fish species in Lhok Bengkuang. This composition is typical of fish communities found in tropical shallow coastal waters [5,8,3]. Furthermore, the species composition in Lhok Bengkuang is characterized by a small number of dominant species that contribute significantly to the community, alongside a larger number of species that contribute minimally, which is a common feature observed in estuarine populations [1, 5, 7, 8].

The highest fish compositions, including *E. splendens*, *S. leptolepis* and *G. oyena* were recorded during May, which was considered the dry season in this area of Lhok Bengkuang. This phenomenon may be attributed to the reduced freshwater flow during this period, resulting in clearer waters that favour the abundance of these marine species [4,5, 14]. The improved environmental conditions and the availability of diverse prey also contribute to this abundance [2, 5, 9, 12]. Conversely, the lower species diversity in various habitats may be due to the limited carrying capacity of habitat patches in Lhok Bengkuang. Additionally, rainfall and flooding events that influx to the open coastal from the river directly influence the composition of fish species [4, 6, 8, 16].

As fish mature, they migrate to deeper water to meet their dietary needs and to avoid freshwater influx during the heavy rainy season [4, 7, 8]. The high composition of *E. splendens*, *S. leptolepis* and *G. oyena* can be attributed to factors such as water depth, predator pressure, prey availability, trawling intensity, and water quality parameters [4, 6, 8, 12, 15].

Table 1. Number of species collected and their conservation status.

No	Species	Total individuals				Conservation status
		N	%N	W	%W	
1	<i>Abalistes stellaris</i>	22	0.76	22	8.04	LC
2	<i>Alectis ciliaris</i>	110	3.82	15.7	5.74	LC
3	<i>Arius thalassinus</i>	2	0.07	2	0.73	LC
4	<i>Armatus carangoides</i>	23	0.8	3.8	1.39	LC
5	<i>Caranx ignobilis</i>	15	0.52	4.9	1.79	LC
6	<i>Caranx sexfasciatus</i>	51	1.77	7.3	2.67	LC
7	<i>Carcharhinus amblyrhynchoides</i>	3	0.1	4.5	1.65	VU
8	<i>Chinocentrus dorab</i>	13	0.45	1	0.37	LC
9	<i>Decapterus macarellus</i>	49	1.7	3.8	1.39	LC
10	<i>Drepane africana</i>	7	0.24	3.5	1.28	LC
11	<i>Epinephelus fuscoguttatus</i>	12	0.42	4	1.46	NT
12	<i>Eubleekeria splendens</i>	1640	56.94	71.3	26.07	LC
13	<i>Formio niger</i>	22	0.76	4.5	1.65	LC
14	<i>Gerres oyena</i>	315	10.94	35	12.8	LC
15	<i>Loligo vulgaris</i>	4	0.14	1	0.37	DD
16	<i>Lutjanus kasmira</i>	28	0.97	9.5	3.47	LC
17	<i>Lutjanus synagris</i>	22	0.76	2.4	0.88	NT
18	<i>Megalaspis cordyla</i>	37	1.28	12.5	4.57	LC
19	<i>Nemipterus virgatus</i>	19	0.66	2.7	0.99	VU
20	<i>Priacanthus tayenus</i>	16	0.56	2	0.73	LC
21	<i>Rastrelliger kanagurta</i>	34	1.18	3.1	1.13	LC
22	<i>Selaroides leptolepis</i>	368	12.78	46	16.82	LC
23	<i>Sphyræna obtusata</i>	50	1.74	10	3.66	LC
24	<i>Trichiurus lepturus</i>	18	0.63	1	0.37	LC

*N= number of fish, W=weight of fish (kg), %=percentage, LC= Least Concern, NT= Near Threatened, VU= Vulnerable, DD= Data Deficient.

3.2 Diversity indices parameters

A complete of community indices parameters of fish collected from the present study were provided in figure 2. The value of Simpson's dominance index (D) were found to be 0.36, Simpson's diversity index (1-D) was 0.64, Shannon-Weaver's diversity index (H') was 1.65, Pielou's evenness index (J) was 0.22, Brillouin's diversity index (HB) was 1.65, Menhinick's diversity index (Mn) was 0.45, Margalef's species richness index (mD) was 2.89, Equitability evenness index (Ed) was 0.53, Fisher-alpha diversity index (S) was 3.59 and Berger-Parker's diversity index (d) was 0.57.

The variation of species diversity is a common phenomenon in the estuary area [1, 3, 4]. This study revealed differences in Simpson's dominance index, Simpson's diversity index, Shannon-Weaver's diversity index, Pielou's evenness index, Brillouin's diversity index,

Menhinick's diversity index, Margalef's species richness index, Equitability evenness index, Fisher-alpha diversity index, and Berger-Parker's diversity index. The lower or higher levels of those indices in Lhok Bengkuang can be attributed to the low or high selectivity of the

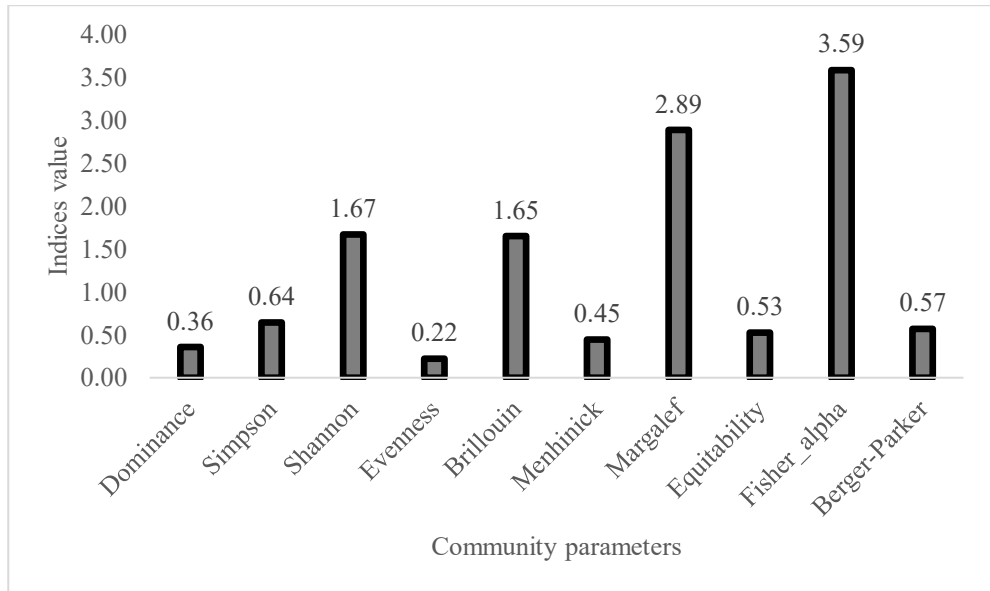


Fig. 2. Diversity indices of fish collected in Lhok Bengkuang fish landing, Tapaktuan regency at the Southern part of Aceh Province, Indonesia

fishing gear employed by local fisherman. The monofilament gill nets used in this study, with a mesh size of 2.5 inch. Additionally, environmental factors, seasonal fish migrations, and variations in nutrient availability in Lhok Bengkuang significantly influence the presence of various fish species [8, 27, 28, 29]. Ecological conditions, encompassing physical, chemical, and biological characteristics, also play a crucial role in shaping the dominance and diversity of fish species [12, 27, 28, 30]. It is hypothesized that the observed increases in fish diversity may be linked to the influx of new individuals into the fish stock, driven by the availability of prey and nutrients, particularly during the dry season that provides a healthy environment condition for fish and the abundance of food supply [9,16, 27, 28].

Variations among different diversity indices can lead to distinct interpretations of community structure [2, 5, 6, 14]. For instance, a region with high species richness but low evenness may show a high Shannon index while exhibiting a low Simpson index. This variation highlights the necessity of choosing the right index according to the specific research objectives. If conservation efforts on the coastal areas are focused on protecting a few dominant species conducted by stake holders or other relevant parties, Simpson's index may be more relevant [20, 22, 25]. Conversely, for a broader understanding of overall ecosystem health, the Shannon-Weaver index might be more advantageous. Additionally, indices like the Berger-Parker index specifically assess the dominance of the most abundant species, which can be particularly valuable in heavily exploited environments where certain species dominate [20, 21, 25]. Furthermore, a conservation status for fish in this area could be related to the number of higher or lower fish groups that still exist and indicate whether the group could become extinct soon.

3.3 Conservation status

A total of 19 species (79.19%) were classified into Least Concern (LC) category, each of 2 species (8.33%) were classified as Near Threatened (NT) and Vulnerable (VU), respectively. 1 fish species (4.17%) was categorized as Data Deficient (DD) of threatened fish species of conservation status (Table 1 and Fig. 3).

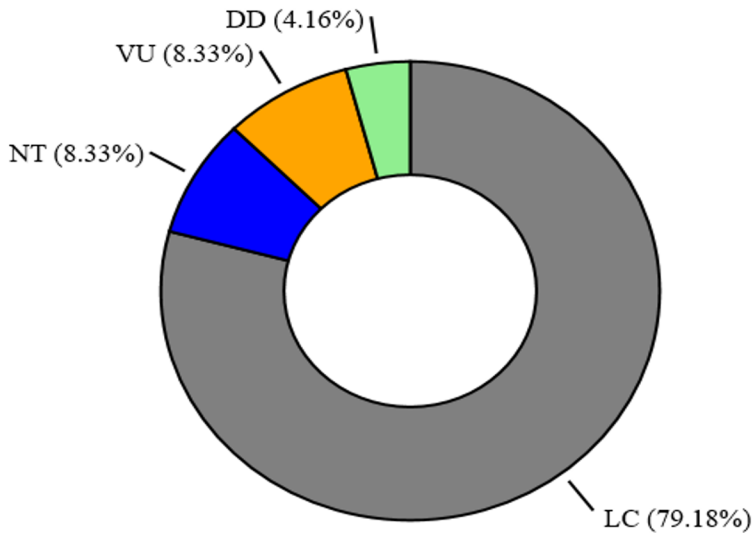


Fig. 3. Percentage of fish conservation status in Lhok Bengkuang fish landing, Tapaktuan regency at the Southern part of Aceh Province, Indonesia. LC= Least Concern, NT= Near Threatened, VU= Vulnerable, DD= Data Deficient.

The findings from our study at Lhok Bengkuang fishing port present a significant overview of the fish species diversity and their conservation statuses as listed by the International Union for Conservation of Nature (IUCN) Red List. Among the 24 species recorded, the majority fall under the Least Concern (LC) category, indicating a relatively stable population in the current environmental context [15, 19]. However, the presence of species classified as Near Threatened (NT) and Vulnerable (VU) raises important conservation concerns [15, 19, 23]. The fact that 19 species (79.19%) are classified as Least Concern is reassuring, suggesting that these species are currently not at immediate risk of population decline [12, 26]. This could be attributed to effective local fishing regulations, favourable environmental conditions, and sustainable fishing practices [18]. However, it is essential to maintain continuous monitoring to ensure these populations remain stable, as changes in environmental conditions or fishing pressure could alter their status.

The identification of 2 species (8.33%) as Near Threatened and another 2 species (8.33%) as Vulnerable highlights potential risks to biodiversity in the region. Near Threatened species are those close to qualifying for or likely to qualify for a threatened category soon. Vulnerable species, on the other hand, face a high risk of extinction in the wild. The presence of these species suggests underlying threats that may include overfishing, habitat degradation, or environmental changes [4, 12, 19]. Targeted conservation efforts, such as habitat protection, sustainable fishing practices, and possibly the establishment of marine protected areas, are crucial for mitigating these risks and ensuring the survival of these species [20, 26].

The categorization of one species (4.17%) as Data Deficient indicates a lack of sufficient information to make a direct or indirect assessment of its risk of extinction [2, 4]. While most

fish species in the Lhok Bengkuang region are not currently at high risk, targeted conservation efforts are essential for those that are Near Threatened, Vulnerable, or Data Deficient. Ensuring the health and diversity of marine ecosystems requires a balanced approach that integrates scientific research, sustainable practices, and active conservation management.

4 Conclusion

This study investigates the composition and diversity in Lhok Bengkuang. A total of 2,880 fish specimens representing 24 species were recorded. It was observed that *E. splendens*, *S. leptolepis* and *G. oyena* had greater number and dominated over others coexisting species. There were 19 species classified into Least Concern (LC) category, each of 2 species were classified as Near Threatened (NT) and Vulnerable (VU), and 1 fish species (4.17%) was categorized as Data Deficient (DD) of threatened fish species of conservation status. Environmental factors, seasonal fish migrations and variations in nutrient availability played a significant role in the variation of diversity indices, particularly during the dry season when water conditions enhanced fish composition. This study provides important insights into the composition and communities parameter of fish species inhabiting in Lhok Bengkuang coastal waters.

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