Fish Diversity in the Tropical Nearshore-Coastal Waters of Bintulu, Sarawak

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Received: 11 November 2022
Accepted: 28 December 2022

Abstract

A study was conducted to observe the diversity and composition of fish at two locations, Bintulu Waterfront (WF) and ABF Beach (ABF) in Bintulu, Sarawak. A standard three-layer mesh gill net of 2.5 cm, 5.0 cm and 7.5 cm mesh size with a length of 15 m were used to collect the fishes. A total of 18 families and 24 species of fish were recorded during the study period. The most dominant family was Carangidae (23.4%) and the most dominant species of fish was *Leiognathus equula* (26.5%). The number of species recorded at WF (15 species) were higher than at ABF (13 species). Nine fish species were recorded only at ABF where the dominant species is *Leiognathus equula*. There were 11 fish species present at WF where *Megalaspis cordyla* was the dominant species. The diversity index at WF (2.192) was higher compared to ABF (1.691). The evenness index was higher at WF (0.809) and ABF (0.659). Twenty-two species of fish recorded were of commercial importance. It was observed that more than 80% of fish individuals were at the juvenile stage indicating the role of coastal lines, to a certain extent as a nursery area. The findings of this study would help prior to conserve and manage the fishery resources of Bintulu coastal water in future.

Keywords: Fish, Diversity, Tropical, Coastal, Diversity

Introduction

Malaysia which consists of West Malaysia and East Malaysia is in the Indo-Pacific region. This region also comprises the Philippines and Indonesia coastal areas (Sanciangco *et al.,* 2013). The total coastline length is 4,800 km for Malaysia. West Malaysia has 2,100 km and East Malaysia has 2,700 km of coastline. West Malaysia and East Malaysia are separated by the southwestern portion of the South China Sea, and are roughly 1200 km apart, while the western coast of West Malaysia is bordered by the Malacca Strait, with the Andaman Sea to the north and the Java Sea to the south (Mazlan *et al.,* 2005). Inside the tropical world, a huge continental shelf region is present in Malaysia. This region is very rich in biodiversity compared to other regions. It is also known to consist of the greatest diversity of species of marine life in the world (Arai, 2014).

Generally, it has been estimated that around 1500 fish species are present in Malaysian waters. A comprehensive account of the marine fish and fisheries of Malaysia and neighbouring countries was described in the published reference material by (Mohsin and Ambak, 1996). A total number of 710 species (Elasmobranchii and Teleostei) were recorded. Later there are 358 marine fish

species which are commercially valuable in the South China Sea (Mansor *et al.,* 1998). These species numbers have been reported based on specimens' systematic identification which the fish samples are gathered from fish landing ports, central market sampling from different coastal towns or city centres and South China Sea research cruises (Mazlan *et al.*, 2005).

Shabdin (2014) states that Malaysia, specifically Sarawak, is one of the world's mega-diversity regions which is situated in the Indo-Malay-Philippine archipelago, part of the Indo-Western Pacific region. Sarawak's coastline is approximately 1035 km long, consisting of sandy beaches, mudflats and rocky shores in its coastal marine habitats (Zawawi *et al.,* 2014). It includes a vast continental shelf area, high biological productivity areas, elevated marine coastal biodiversity and a dense coastal human population.

In Sarawak, the landings of deep-sea fisheries increased from 31,153 tonnes in 2015 to 64,858 tonnes in 2018 (Lee et *al.,* 2020). Vidthayanon (1998) has reported a detailed survey of marine fishes from the coastal region of Sarawak. A total of 518 species from 24 orders and 111 families were reported from various coastal towns in Sarawak via research cruises and market surveys (Shabdin, 2014). Perciformes is the dominant order compared to the other orders. The study also documented 103 and 106 economic species, respectively, reported in both trawling and market surveys (Shabdin, 2014).

Nyanti *et al.* (2014) state that a total of 1336 individuals were taken from the study field, comprising 42 families, 73 genera and 120 species; where the dominant family reported was Carangidae, which accounted for 17.8% of the individuals while *Parastromateus niger* was the dominant species, covering 13.1% of the individuals. The fish species prevalent in the study site was the common fish species recorded in other areas in the Sarawak coastal region (Nyanti and Gambang, 2010). The captured fish sizes were also similar to those reported in the Semariang mangrove area and Lutong river area (Nyanti *et al.*, 2012).

A total of 24 species of fish belonging to 14 families and four (4) orders were recorded from Pahang Estuary, Pahang, during the study period (Jalal *et al.,* 2012). The most dominant family is Ariidae (69.32%) and *Plicofollis layardi* was the most dominant species with 47% of total catch from the sampling area (Jalal et al., 2012). In total, 40 species of fish belonging to 29 families were identified from the estuarine area of Marudu Bay, Sabah, Malaysia (Khatib, 2015). In terms of species diversity, Carangidae is the most dominant family with three (3) species which are *Atule mate*, *Scomberoides tol* and *Carangoides malabricus* (Khatib, 2015). This study was conducted to observe the diversity and composition of fish at two locations, Bintulu Waterfront (WF) and ABF Beach (ABF) in Bintulu, Sarawak.

Materials and Methods

The study area is located at two stations within the coastal area of Bintulu, Sarawak, Malaysia which is connected with the South China Sea (Figure 1). The stations were A: ABF Beach (ABF) (3° 13' 9.8796" N 113° 3' 14.3928" E) and B: Bintulu Waterfront (WF) (3° 10' 50.4336" N 113° 2' 0.9924" E). Station A represented marine-coastal habitat, which was facing the South China Sea while Station B represented riverine-coastal habitat, which was influenced by the Kemena river. Sampling was conducted at both stations during daylight when the tides were high in December 2020. A standard three-layer mesh gill net of 2.5 cm, 5.0 cm and 7.5 cm mesh size and the net are approximately 15 m in length were used to collect the fishes. During the sampling period, two sets of the net were used.

The gillnet was placed in the water for three to four hours during incoming high tide. This method was used in a study at Similajau coastal waters, Bintulu which the gill nets were employed and were placed at each station for four hours (Nyanti *et al.*, 2014). At both ends of the gill net top, cable rope was tied with a buoy. For the bottom cable rope, a weight was tied at the end to ensure that the gill net was not moving. All fish caught were kept in plastic and brought back to the laboratory for further analysis.

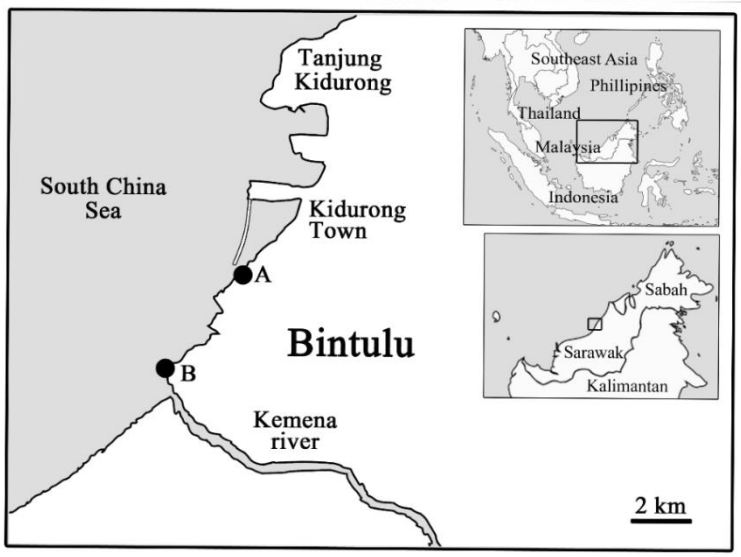

Figure 1. Study area and sampling stations: (A) ABF and (B) WF (from Google Maps)

The fish samples were then processed for identification, measurements, and weight. Picture of fish samples was captured. The fish fins were extended picture taking. The number of individuals and total weights of each species was taken. Fish samples were weighted using an electronic balance with the nearest reading ±0.01 g. The fishes were identified to species level through key morphological characteristics (Mohsin and Ambak, 1996; Mansor *et al.* 1998; Matsunuma *et al.*, 2011; and Froese and Pauly, 2000). The latest classification and systematics were checked with WoRMS Editorial Board (2021). Fish samples were then sorted according to the family and species. The diversity of the fish community was examined by looking at the number of species attained in each random sample and expressed in terms of Shannon-Wiener diversity index (H′) and Shannon's equitability evenness index (EH) (Shannon and Weaver, 1963). The diversity indices were calculated based from fish abundance data using the Multivariate Statistical Package (MVSP) software.

Results and Discussion

A total of 18 families and 24 species were recorded from Bintulu coastal area during the study period (Table 1). The dominant family was Leiognathidae (30.6%), and including the other families: Carangidae, Engraulidae, Apogonidae, Mugilidae and Gerreidae, the fishes represented 83.5% of the total catches.

Table 1. Fish Family Composition in Bintulu Coastal Waters

No.	Family	WF (%)	ABF (%)	Total (%)
1	Leiognathidae	4	67	30.6
2	Carangidae	38	5	23.4
3	Engraulidae	20	2	12.2
4	Apogonidae	16	0	9.2
5	Mugilidae	9	0	5.1
6	Gerreidae	0	7	3
7	Haemulidae	4	0	2
8	Pristigasteridae	4	0	2
9	Lutjanidae	0	5	2
10	Ariidae	2	2	2
11	Ephippidae	0	2	1
12	Nemipteridae	0	2	1
13	Clupeidae	0	2	1
14	Scatophagidae	2	0	1
15	Paralichthyidae	0	2	1
16	Tetraodontidae	0	2	1
17	Terapontidae	2	0	1
18	Sciaenidae	2	0	1
	Total (%)	100	100	100

WF: Bintulu Waterfront; ABF: ABF Beach

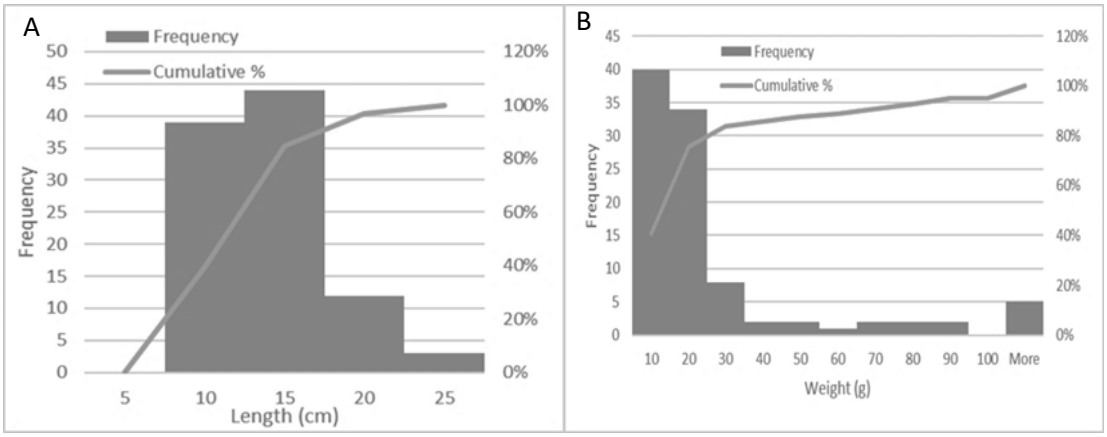

Figure 2. (A) Histogram of fish total length (cm) found in Bintulu Coastal Waters (B) Histogram of fish weight (g) found in Bintulu Coastal Waters

The other 19.5% of total fish catches were represented by the accumulation from all the other fish families that represented either 2% and 1% respectively. Fishes from the family of Haemulidae, Pristigasteridae, Lutjanidae and Ariidae comprised 2% of the total catches. Ephippidae, Nemipteridae, Clupeidae, Scatophagidae, Paralichthyidae, Tetraodontidae, Terapontidae, and Sciaenidae represents 1% of the total catches. It was observed that more than 80% of fish individuals were less than 15 cm in length and 30 g in weight (Figure 2).

The dominant fish species was *Leiognathus equula* (26.5%), and followed by *Megalaspis cordyla* (16.3%), and *Thryssa hamiltonii* (11.2%). They formed a more dominat species group with another four fish species namely*Apogon* sp., *Carangoides malabaricus*, *Osteomugil cunnesius*, and *Aurigequula fasciata* to contribute comprises 77.5% of total catch (Table 2).

Table 2. Fish species composition in Bintulu coastal waters

No.	Species	WF (%)	ABF (%)	Total (%)
1	*Leiognathus equula*	4	57	26.5
2	*Megalaspis cordyla*	29	0	16.3
3	*Thryssa hamiltonii*	18	2	11.2
4	*Apogon* sp.	16	0	9.2
5	*Carangoides malabaricus*	5	5	5.1
6	*Osteomugil cunnesius*	9	0	5.1
7	*Aurigequula fasciata*	0	10	4.1
8	*Lutjanus monostigma*	0	5	2
9	*Gerres filamentosus*	0	5	2
10	*Arius maculatus*	2	2	2
11	*Pomadasys argenteus*	4	0	2
12	*Ilisha elongata*	4	0	2
13	*Gerres oyena*	0	2	1
14	*Nemipterus virgatus*	0	2	1
15	*Tenualosa toli*	0	2	1
16	*Platax teira*	0	2	1
17	*Coilia dussumieri*	2	0	1
18	*Alepes melanoptera*	2	0	1
19	*Pseudorhombus arsius*	0	2	1
20	*Takifugu oblongus*	0	2	1
21	*Terapon jarbua*	2	0	1
22	*Scatophagus argus*	2	0	1
23	*Nibea soldado*	2	0	1
24	*Scomberoides commersonnianus*	2	0	1
	Total (%)	100	100	100

WF: Bintulu Waterfront; ABF: ABF Beach

Leiognathus equula, Carangoides malabaricus, Thryssa hamiltonii and *Arius maculatus* were found at both locations. There are nine fish species that were recorded at ABF which are *Aurigequula fasciata, Gerres filamentosus, Gerres oyena, Lutjanus monostigma, Platax teira, Nemipterus virgatus, Tenualosa toli, Pseudorhombus arsius* and *Takifugu oblongus.* There were 11 fish species present at WF: *Megalaspis cordyla, Scomberoides commersonnianus, Alepes melanoptera, Apog*on sp., *Osteomugil cunnesius, Coilia dussumieri, Pomadasys argenteus, Ilisha elongata, Scatophagus argus, Terapon jarbua* and *Nibea soldado.* The study found that the number of species and diversity index recorded at WF (n=15 species; H'=2.192) were comparatively higher than ABF (n=13 species, H'=1.691). The evenness index was higher at WF (0.809) compared to ABF (0.659) (Table 3).

Table 3. Species number and diversity indices: diversity index and evenness index of fisheries abundance in bintulu coastal waters

Station	Diversity Index (H')	Evenness Index	Species Number (n)
WF	2.192	0.809	15
ABF	1.691	0.659	13

From the total of 24 fish species recorded, there were 22 commercial fish species. The dominant commercial fish species was *Leiognathus equula*. The species of fish prevalent in the study area were typical of the fish species reported elsewhere in Sarawak. *Leiognathus equula, Thryssa hamiltonii* and *Gerres oyena* were also found in the seagrass habitat of Lawas, Sarawak (Johan *et al.*, 2020). In Kuala Nyalau River Estuary, Bintulu, *Coilia dussumieri, Nibea soldado, Arius maculatus, Ilisha elongata* and *Leiognathus equula* were obtained (Abu Hena *et al.*, 2016). Most of the species collected in Bintulu coastal waters were also found in studies conducted in different Sarawak waters. *Leiognathus equula, Arius maculatus, Carangoides malabricus, Gerres oyena* and *Thryssa hamiltonii* were found in Marudu Bay, Sabah (Khatib, 2015) and *Ilisha elongata* is found in Tropical Estuary, Pahang (Jalal *et al.*, 2012).

The number of species recorded in the current study was comparatively similar to the Pahang estuary (Jalal *et al.*, 2012), but was lower compared to other studies in Malaysia such as Marudu Bay, Sabah, (Khatib, 2015), Kuala Nyalau river estuary (Abu Hena *et al.*, 2016), and Lawas seagrass habitat (Johan *et al.*, 2020) (Table 4). Only one of the dominant fish species in the current study, *Ilisha elongata* was similarly reported in Similajau coastal waters near Bintulu, from a total of 120 species and 42 families of fish (Nyanti *et al.*, 2014). Only one species (*Carangoides malabaricus*) of fish was recorded at ABF and WF stations. Most of the fish species from both stations are commercial fish such as *Carangoides malabaricus, Leiognathus equula* and *Megalaspis cordyla*. The result obtained from Bintulu coastal waters showed that most of the fish species are in the juvenile stages. This is because the sampling location is at the shoreline of inshore water where the fish species are smaller compared to nearshore and offshore fish species.

Few factors caused a lower number of individuals and species in the current study compared to other studies. The main factor is the sampling location. In the current study, the sampling was conducted at the shoreline of inshore water. Previous studies in Similajau coastal waters consisted of the river mouth, small bays, and seabed (Nyanti *et al.*, 2014) and the study in Lawas, Sarawak, consisted of seagrass bed (Johan *et al.*, 2020).

Table 4. Fishery resources found in Malaysian waters

Location	Findings	Dominant Fish Species
Tropical Estuary, Pahang (Jalal *et al.,* 2012)	14 families and 24 species	*Arius tenuispinis, Arius thalassinus, Ilisha elongata, Ilisha melastoma, Pennahia microdon, Thryssa mystax*
Similajau Coastal Waters, Bintulu (Nyanti *et al.,* 2014)	42 families and 120 species	*Coilia macrognathus, Harpodon nehereus, Ilisha elongata, Ilisha megaloptera, Parastromateus niger, Setipinna taty*
Marudu Bay, Sabah (Khatib 2015)	29 families and 40 species	*Arius maculatus, Carangoides malabricus, Gerres oyena, Leiognathus equula, Nemipterus nemurus, Thryssa hamiltonii*
Kuala Nyalau River Estuary, Bintulu (Abu Hena *et al.,* 2016)	25 families and 37 species	*Ambassis interrupta, Arius maculatus, Coilia dussumieri, Ilisha elongata, Leiognathus equula, Nibea soldado*
Lawas Seagrass Habitat, Sarawak (Johan *et al.,* 2020)	37 families and 60 species	*Gerres erythrourus, Gerres oyena, Hyporhamphus limbatus, Leiognathus equula, Lethrinus lentjan, Thryssa hamiltonii*
Current Study Bintulu Coastal Waters	18 families and 24 species	*Arius maculatus, Carangoides malabaricus, Coilia dussumieri, Gerres oyena, Ilisha elongata, Leiognathus equula, Nibea soldado, Thryssa hamiltonii*

In the current study, the sampling was conducted during the wet season, and of different months when compared with other studies (Nyanti *et al.,* 2014 and Johan *et al.,* 2020). Besides, the type and size of fishing gear are also different for each study. In the current study, two sets of three-layer mesh gill nets were used where the size is smaller compared to other studies and the gill net was deployed only once per sampling for four hours. While at Similajau coastal waters, the fish were collected using monofilament gill nets of three different mesh sizes of 2.5 cm, 5.0 cm, and 7.5 cm with a length of about 310 m each and the gill nets were employed for four hours. A monofilament drift net with a mesh size of 12.5 cm and length of 2.7 km was also used in this study where the drift net was placed for two and a half hours (Nyanti et al., 2014). In a study at Lawas seagrass habitat, the fishes were collected with an encircling gillnet of mesh size of 4.45 cm with a length of 152 m where the gill net was deployed six times at the seagrass bed during each sampling (Johan *et al.,* 2020).

A high value of the diversity index would be representative of a diverse and equally distributed community and lower values represent a less diverse community. A value of 0 would represent a community with just one species. The diversity index of fish at WF (2.192) was higher compared to ABF (1.691). This means that the fish species in WF are more diverse and equally distributed

compared to ABF. The value of the evenness index ranges between 0 and 1, with 1 being complete evenness which means that the species are evenly distributed. Factors that influence the high and low diversity value and evenness are the migration of fish out or in the observation area, so not all fish are recorded (Ulfah *et al.*, 2019). The evenness index recorded at WF (0.809) was relatively higher compared to ABF (0.659). The fish species are not evenly distributed at ABF, where the evenness is lower, thus indicated that the presence of species dominance in the community. At ABF, the dominant species was *Leiognathus equula* which comprised 57% of the total catchment. While at WF, the dominant species was *Megalaspis cordyla*, which only comprised 29% of the total catchment.

Conclusion

The study was able to record 24 fish species from 18 families, where the diversity and composition of fish were vastly different between the two stations. Only one species, *Carangoides malabaricus* occurred at both stations. Nine fish species were recorded only at ABF where the dominant species is *Leiognathus equula*. There were 11 fish species present only at WF where *Megalaspis cordyla* was the dominant species. The fish diversity index and evenness at WF were higher than ABF. The lower evenness index ABF indicated the presence of single fish dominance by *Leiognathus equula* in the catch. More than 90% of fish recorded were commercial fish species indicating that the Bintulu coastal waters are rich in commercial fish species. It was observed that more than 80% of fish individuals were at the juvenile stage indicating the role of coastal lines, to a certain extent as a nursery area. The findings of this study would help prior to conserve and manage the fishery resources of Bintulu coastal water in future.

Acknowledgements

The authors extend gratitude to the staff and student members from the Department of Animal Science and Fisheries, especially Mr Awangku Ahmad Nizam, Mr Meruni Mechang, Ms Nur Eliza Abdul Rahman, Marylyn Chagai and Helenda Eling for their assistance in fieldwork. This work was partly supported by the UPM/800/2/2/4-Geran Putra (Vot: 9662800), Universiti Putra Malaysia.

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