

Diversity of Brackish Water Fish in Several Rivers in Babulu Laut Village, Sub-district Babulu, District Penajam Paser Utara (PPU), East Kalimantan

Lariman, Andy Triawan Muhtazam , Dan Sus Trimurti

Department of Biology, Faculty of Mathematics and Natural Sciences, Mulawarman University, Samarinda, East Kalimantan, Indonesia

Received: 03 February 2023; Accepted: 16 February 2023; Published: 15 March 2023

Abstract: - Babulu Laut Village is an area where there is a brackish water river that is used by local residents as a source of water for pond cultivation. Until now, there is no information about the types of brackish water fish found in the river. This research aims to find out the diversity of brackish water fish in several rivers in Babulu Laut village, sub-district Babulu, district Penajam Paser Utara (PPU), East Kalimantan. This research conducted on October-December 2021. Sampling used purposive sampling and random sampling methods at three research stations. Fish sampling conducted by installing gill nets for 2 hours with checking every 30 minutes and using fishing rods for 1-2 hours. The results of the research was found 17 species of fish which represented 12 families among others Otek fish (Ariidae), Barokang fish (Ariidae), Keting fish (Ariidae), Terkulu fish (Carangidae), Bandeng fish (Chanidae), Bulu Ayam fish (Engraulidae), Teri fish (Engraulidae), Bungo fish (Gobiidae), Gerot fish (Haemulidae), Arut fish (Haemulidae), Kakap Merah fish (Lutjanidae), Bulan-Bulan fish (Megalopidae), Belanak fish (Mugilidae), Kiper fish (Scatophagidae), Gelama fish (Scianidae), Tetet fish (Scianidae), and Sumpit fish (Toxotidae). The results of the diversity index of fish species in the Babulu Laut Village River were classified as moderate with a diversity index (H') value of 2.26, an evenness index of 0.80 and a dominance index of 0.16.

Keywords: Diversity of types, fish, river.

I. Introduction

Indonesia has around 8.500 species of fish (Supriatna, 2008) including 800 species of fish in fresh and brackish waters. In Kalimantan alone there are around 394 species of fish with 149 endemic fish species (Ajai, 2020). However, this number may change as a result of the large number of exploitations carried out, damage, decreased quality of fish habitat and the conversion of water bodies to other uses are the main factors causing fish populations to continue to decline (Haryono, 2017).

Babulu Laut Village geographically is one of the villages in Sub-district Babulu, District Penajam Paser Utara, East Kalimantan with a total area of 129.990 Ha (Kurniawan, 2008). This village is a strategic place in fisheries production activities such as pond cultivation with a pond area up to 5.000 hectares (Rahmani, 2018). In this village there is a brackish water river which is influenced by the tidal cycle of sea water which is used by local residents as a source of water for pond cultivation activities.

There is no complete information about the types of brackish water fish found in the river, so this research aims to determine the diversity of brackish water fish species in the river in Babulu Laut Village

II. Research Methods

This research was conducted using purposive sampling and random sampling methods at 3 sampling stations. Station I is the estuary of the Babulu Laut River, geographically located at 1°31'22"S and 116°31'57"E. Station II is the estuary of the Sarang Elang Kecil River, geographically located at 1°32'07"S and 116°32'12"E. Station III is the estuary of the Sarang Elang Besar River, geographically located at 1°32'37"S and 116°32'25"E.



Figure 1. Map of Research Locations in the Babulu River, East Kalimantan

The tools and materials used in this research included camera, bucket, meter, meter cloth, ruler, gill net with a net length of 30 m, net width of 1 m, mesh of 1-2 inches and string size of 0.30 cm, fishing rods, thermometer, secchidisk, refractometer, DO meter, pH meter, GPS, pingpong ball, stopwatch, label paper, rafia rope, styrofoam box and identification book (*Freshwater Fishes Of Western Indonesia and Sulawesi* by Maurice Kottelat, Anthony J. Whitten, Sri Nurani Katikasari and Soetikno Wirjoatmodjo and *Field Guide Commercial Marine and Brackish Water Species of Pakistan* by Gabriella Bianchi).

Sampling of fish conducted simultaneously with measuring the quality of the waters. Sampling of fish using gillnets conducted by purposive sampling with a net length of 30 m, a net width of 1 m and a mesh size of 1-2 inches and using fishing rods with hook size number 1-5, ballast, and bait in the form of shrimp live and dead shrimp. Fish sampling conducted 8 times in 2 months at each sampling station. Gill nets were installed vertically on the edge of the river mouth for 2 hours and checking the gill nets conducted 4 times with a time span of checking every 30 minutes. Fishing rods are used randomly (random sampling) at each sampling station for 1-2 hours.

Data analysis by measuring species diversity index, evenness index, dominance index and similarity index. The species diversity index was calculated using the Shannon-Wiener diversity index formula (Odum, 1996), namely:

$$H' = - \sum P_i \ln P_i$$

Where, $P_i = \frac{n_i}{N}$

Description:

n_i = Number of individuals of each type

N = Total number of all types

H' = Shannon-Wiener diversity index

P_i = Abundance index

(Sulistyani, 2014).

Odum (1996) stated the criteria for the range of the Shannon-Wiener diversity index as follows:

$H' < 1$ = Low level of diversity

$H' 1-3$ = Moderate level of diversity

$H' > 3$ = High level of diversity

The evenness index is calculated using the following formula:

$$E = \frac{H'}{H' Maks}$$

Description:

E = Evenness index (value between 0-1)

H' = Diversity of fish species

$H' maks$ = Maximum diversity index ($\ln S$)

S = Number of types

(Yudistira, 2019)

Odum (1996) stated the criteria for the evenness index range as follows:

E is close to 0 ($\leq 0,5$) so the distribution of the number of individuals tends to be uneven.

E is close to 1 ($> 0,5$) so the distribution of the number of individuals tends to be even.

The similarity index is calculated using the Jaccard similarity index formula (Magurran, 1998), namely:

$$Jaccard\ Similarity\ Index\ (Cj) = \frac{J}{a + b - J}$$

Description:

Cj = Jaccard similarity index

J = Number of species found in the two communities being compared

a = Number of species in the community A

b = Number of species in the community B

(Tuhumury, 2014).

Magurran (1987) stated the criteria for the similarity index range are as follows:

Cj is close to 1 so, have a complete similarity in which a species with another species is identical

Cj is close to 0 so, do not have the same species.

The dominance index is calculated using the following formula:

$$C = \sum \left(\frac{n_i}{N}\right)^2$$

Description:

C = Dominance index

N = Number of individuals of all species

ni = Number of individuals of each species

(Sirait, 2018).

Odum (1996) stated the criteria for the dominance index range are as follows:

$0,00 < C \leq 0,50$ so, low dominance

$0,50 < C \leq 0,75$ so, moderate dominance

$0,75 < C \leq 1,00$ so, high dominance

III. Results and Discussion

Based on research conducted in several rivers in Babulu Laut Village, 17 species of fish were found belonging to 12 families, as shown in Table 1.

Table 1. Diversity of Fish Species in Several Rivers in Babulu Laut Village, East Kalimantan.

No	Famili/species	Local Name	Station			Total (n)
			I	II	III	
1.	Ariidae					
	1. <i>Arius argyropleuron</i>	Otek	-	-	17	17
	2. <i>Arius sagor</i>	Barokang	-	-	4	4
	3. <i>Ketengus typus</i>	Keting	-	-	7	7
2.	Carangidae					
	4. <i>Caranx ignobilis</i>	Terkulu	1	2	8	11
3.	Chanidae					
	5. <i>Chanos chanos</i>	Bandeng	-	1	2	3
4.	Engraulidae					
	6. <i>Coilia dussumieri</i>	Bulu Ayam	-	-	32	32
	7. <i>Stolephorus commersonii</i>	Teri	4	5	-	9
5.	Gobiidae					
	8. <i>Glossogobius giuris</i>	Bungo	-	3	-	3
6.	Haemulidae					
	9. <i>Pomadasys argenteus</i>	Gerot	-	1	-	1
	10. <i>Pomadasys argyreus</i>	Arut	5	-	-	5
7.	Lutjanidae					
	11. <i>Lutjanus agentimaculatus</i>	Kakap Merah	-	3	1	4

8.	Megalopidae					
	12. <i>Megalops cyprinoides</i>	Bulan-Bulan	-	-	1	1
9.	Mugilidae					
	13. <i>Mugil cephalus</i>	Belanak	1	8	1	10
10.	Scatophagidae					
	14. <i>Scatophagus argus</i>	Kiper	12	9	1	22
11.	Scianidae					
	15. <i>Dendrophysa russelli</i>	Gelama	8	3	2	13
	16. <i>Johnius belangerii</i>	Tetet	38	29	2	69
12.	Toxotidae					
	17. <i>Toxotes jaculatrix</i>	Sumpit	3	-	-	3
Individu Totals (n)			72	64	78	214
Species Totals			8	10	12	17

Description:

- I : Babulu Laut River
- II : Sarang Elang Kecil River
- III : Sarang Elang Besar River

The highest number of fish species found from all observation stations consisted of the families Ariidae (3 species), Engraulidae (2 species), Haemulidae (2 species) and Scianidae (2 species). According to Cem (1990) the Ariidae family is commonly found in streams and estuaries because this family is a demersal amphidromous predatory fish and is a bottom feeder. In addition, this family utilizes mangrove environmental waters as a nursery and feeding ground which preys on invertebrates and small fish. According to Kottelat (1993) the Ariidae family is generally found in the sea and river estuaries in the tropics and subtropics. The Engraulidae family is found throughout tropical, subtropical and temperate oceans and several species from this family often enter river estuaries and fresh waters. The Haemulidae family generally lives in shallow tropical sea waters. The Scianidae family are seawater fish that live throughout temperate and tropical climates, several species use river estuaries to breed and spawn or to raise their young. According to Puteri (2017) the Haemulidae family is a group of fish visiting the period during high tide and are marine fish that enter the mangrove area to look for food during high tide. The diversity of fish species is closely related to the condition of mangrove vegetation, the higher the intensity of disturbance in the mangrove area, the lower the number of fish species.

Table 2. Number of Individuals, Species, Families, Diversity Index, Evenness Index, and Dominance Index of Fish Species in Several Rivers in Babulu Laut Village, East Kalimantan

Code	Total			Total
	I	II	III	
N	72	64	78*	214
S	8	10	12	17
F	7	9	9	12
H'	1,48	1,76	1,81*	2,26
E	0,71	0,77*	0,73	0,80
C	0,33*	0,25	0,24	0,16

Description:

- N : Number of individuals
- S : Number of species
- F : Number of families
- H' : Species diversity index
- E : Evenness index
- C : Dominance index
- * : The highest score
- I : Babulu Laut River
- II : Sarang Elang Kecil River
- III : Sarang Elang Besar River

Based on the standard Shannon Wiener diversity index value, according to (Odum 1996) states that diversity is low if the diversity index value (H') < 1; moderate (H') = 1-3 and high (H') > 3. So, the diversity in locations I, II, and III is moderate. The value of diversity is influenced by the number of species found. The more species found, the greater the diversity value and otherwise, although this value is highly dependent on the number of individuals of each species (Insafitri, 2010).

The evenness index in the three research locations ranges from 0.71 to 0.77 indicating that the three locations have evenness that tends to be even because it is getting closer to the value of 1. According to (Odum 1996) states that the distribution of the number of individuals tends to be uneven if the evenness index (E) is close to 0 (≤ 0.05) and tends to be even if the evenness index (E) is close to 1 (> 0.5). The level of evenness of species in a habitat can be known by the absence of dominant species in that habitat. The level of evenness of species will be high if each species has the same number of individuals and the level of evenness will be low if each species has a large number of individuals (Kurniawan, 2018).

The dominance index at the three research locations ranges from 0.24 to 0.33 indicating that these three locations have a low dominance because they are getting closer to the value of 0. According to (Odum 1996) states that dominance is low if the dominance index value is ($0.00 < C \leq 0.50$); moderate dominance ($0.50 < C \leq 0.75$) and high dominance ($0.75 < C \leq 1.00$). A high dominance level indicates that a certain species dominates the community and a low dominance level indicates that no species dominates the community (Sirait, 2018).

Table 3. Fish Species Similarity Index Between Stations in Several River in Babulu Laut Village East Kalimantan

Station	I	II	III
I			
II	0,5		
III	0,33	0,46	

Description:

- I : Sungai Babulu Laut River
- II : Sarang Elang Kecil River
- III : Sarang Elang Besar River

The similarity index values at the three research locations ranged from 0.33 to 0.5 indicating that the three locations had low species similarity because the three research locations were still in the same river flow with the same vegetation. According to Ridwan (2016) that the conditions of an environment can affect the distribution of fish in waters, this is because each individual likes environmental conditions and habitats that are different from other individuals.

Table 4. Presence of Fish Species at Each Station in Babulu Laut Village River East Kalimantan

No	Local Name	Scientific Name	Station		
			I	II	III
1.	Bandeng	<i>Chanos chanos</i>	-	+	+
2.	Barokang	<i>Arius sagor</i>	-	-	+
3.	Belanak	<i>Mugil cephalus</i>	+	+	+
4.	Bulan-Bulan	<i>Megalops cyprinoides</i>	-	-	+
5.	Bulu Ayam	<i>Coilia dussumieri</i>	-	-	+
6.	Bungo	<i>Glossogobius giuris</i>	-	+	-
7.	Gerot	<i>Pomadasys argenteus</i>	-	+	-
8.	Arut	<i>Pomadasys argyreus</i>	+	-	-
9.	Gelama	<i>Dendrophysa russelli</i>	+	+	+
10.	Tetet	<i>Johnius belangerii</i>	+	+	+
11.	Kakap Merah	<i>Lutjanus argentimaculatus</i>	-	+	+
12.	Kiper	<i>Scatophagus argus</i>	+	+	+
13.	Otek	<i>Arius argyropleuron</i>	-	-	+
14.	Teri	<i>Stolephorus commersonii</i>	+	+	-
15.	Terkulu	<i>Caranx ignobilis</i>	+	+	+
16.	Keting	<i>Ketengus typus</i>	-	-	+
17.	Sumpit	<i>Toxotes jaculatrix</i>	+	-	-

Description:

(+) : found

(-) : not found

At station I, there were two types of fish which were not found at other stations, namely *Pomadasys argyreus* and *Toxotes jaculatrix*. According to Fahmi (2014) that *Toxotes jaculatrix* is a type of fish that is resistant to changes in salinity so that it can live in fresh waters, estuaries to coral reef waters. According to Adiguna (2018) *Pomadasys argyreus* belongs to the *Haemulidae* family which is a marine fish and is a demersal fish that looks for food in mangrove areas during high tides. *Caranx ignobilis* also found at this station which is a fish from the *Scianidae* family which is suitable for living at temperatures of 24-30°C, is tolerant of a wide range of salinities between 10-35 ‰ and the dissolved oxygen content suitable for this fish is 4-7 mg/l (Datunsolang, 2021). Kiper fish (*Scatophagus argus*) is a type of fish that lives in estuaries, seas, mangroves and tributaries which are still influenced by tides. This fish has a wide tolerance for salinity, which is 2.0 to 37‰ (Manangkalangi, 2022).

At station II there were two types of fish which were not found at other stations, namely *Pomadasys argenteus* and *Glossogobius giuris*. According to Adiguna (2018) that *Pomadasys argenteus* is a marine fish that often looks for food in mangrove areas during high tides. According to Krismono (2018) *Glossogobius giuris* is included in the *Gobiidae* family which is a type of fish that has a high tolerance for changes in salinity so that it can live in fresh water habitats, estuaries to the sea and some of these families spawn in estuarine habitats. At this station, *Johnius belangerii* fish was also found, which is a type of fish from the *Sciaenidae* family that inhabits shallow coastal waters. This fish is able to live in waters with low temperature conditions, very turbid and muddy (Maryani, 2022). *Mugil cephalus* is a fish from the *Mugilidae* family which is capable of migrating from the coast to river mouths or creeks with a substrate of sand, muddy sand or rocky sand (Mote, 2017). According to Mahdalena (2021) the brightness of the water suitable for mullet is 40-51 cm. Red Snapper (*Lutjanus argentimaculatus*) is a type of fish that lives in mangrove areas during their youth and when they are adults they live in a marine environment. (Marei, 2022).

At station III there were five species of fish which were not found at other stations namely *Arius sagor*, *Arius argyropleuron*, *Coilia dussumieri*, *Ketengus typus* and *Megalops cyprinoides*. According to Maturbongs (2019) *Arius sagor*, *Arius argyropleuron* and *Ketengus typus* belong to the Ariidae family which are often found in estuaries and mangrove areas, these fish are euryhaline because of their habit of living in marine and brackish water environments and are amphidromous demersal. This family also utilizes waters with a mangrove environment as a nursery and feeding ground which preys on invertebrates and small fish. According to Hutubessy (2022), *Coilia dussumieri* belongs to the Engraulidae family group which can be found in various types of habitats such as mangroves, estuaries and river estuaries. In addition, Khairul (2014) stated that *Megalops cyprinoides* utilizes mangrove habitat to find food. At this station also found *Chanos chanos* fish which is a fish from the Chanidae family originating from brackish waters. This fish can live in several types of water including fresh water, brackish and salt water. According to Wicaksono (2018) Milkfish (*Chanos chanos*) is a type of fish that has a habitat in brackish waters. Milkfish lives in brackish waters with a DO range of 3-6 ppm. The pH for milkfish growth is 7.0-8.5. Salinity for milkfish life ranges from 0-35 ppt (Larasati, 2022). Good brightness for the growth of milkfish is 30-40 cm (Wahyuni, 2020).

Table 5. Environmental Factors in Several Rivers in Babulu Laut Village East Kalimantan

No	Parameter	Unit	Station		
			Babulu Laut River	Sarang Elang Kecil River	Sarang Elang Besar River
1.	Temperature	°C	30-32	30-32	29-32
2.	pH	Unit	7,3-7,7	7,2-7,7	7-7,4
3.	DO	Ppm	5,8±6,6	4,0±5,9	3,1±5,3
4.	Salinity	Ppm	10±28	5±29	3±22
5.	Brightness	M	0,28-0,4	0,22-0,47	0,23-0,48
6.	Flow Speed	m/s	0,15-0,27	0,13-0,24	0,04-0,22
7.	Base Substrate		Mud	Mud	Mud
8.	Water Color		Murky Brown	Murky Brown	Murky Brown

Observations results showed that the water temperature at the three stations ranged from 29-32°C. According to Adiguna (2018) temperatures in the range of 28-32°C are good temperatures for marine biota in estuary and mangrove ecosystems. Water pH measurements at the three stations ranged from 7-7.7. According to Adiguna (2018) that pH 5-9 can support the life of aquatic biota in a waters. Measurements of DO (Dissolved Oxygen) waters at the three stations ranged from 3.1 to 6.6 ppm. According to Adiguna (2018) that the DO that supports the life of marine biota is > 5 ppm.

Measurements of water salinity at the three stations ranged from 3-29 ppm. The low salinity at station III is due to the additional input of fresh water from the headwaters of the Sarang Elang Besar River. The high salinity at station II is caused by the direct entry of seawater. According to Adiguna (2018) salinity in the range of 0-34 ppm is good salinity for the life of aquatic biota in mangrove or estuary ecosystems. Water brightness measurements at the three stations ranged from 0.22-0.48 m. According to Faisal (2017) the brightness range for brackish waters is 30-45 cm.

Current velocity measurements at the three stations ranged from 0.04-0.27 m/s. The difference in current velocity values is due to the fact that at the time of measurement there are differences in the water cycle where at station I when the tide starts, at station II when it is low tide, and at station III when the tide is high. According to Ramadhani (2022) classifies rivers based on their current speed, namely very fast currents (> 100 cm/sec), fast currents (50-100 cm/sec), moderate currents (25-50 cm/sec), slow currents (10-25 cm/sec) and very slow current (<10 cm/sec), at station I with a current speed of 0.15-0.27 including moderate current, at station II with a current speed of 0.13-0.24 including slow current and at station III with a current speed of 0.04-0.22 including slow current.

IV. Conclusion

There were 17 species consisting of 12 families of the total number of fish that were collected as many as 214 in the Sungai Desa Babulu Laut, East Kalimantan. The diversity of fish species in the Babulu Laut Village River, East Kalimantan, is in the medium category (H' = 1-3) with a diversity index value (H')

evenly distributed (E) close to 1 E (> 0.5) of 0.798 and the dominance index belongs to the low category ($C \leq 0.50$) of 0.16. The species diversity index at each station ranged from 1.48-1.81, the evenness index ranged from 0.71-0.77 and the dominance index ranged from 0.24-0.33. The highest diversity index was at station III (1.81) and the lowest was at station I (1.48). The three stations have the same river flow and with the same vegetation so that the similarity index values between stations are not much different, ranging from 0.33 to 0.5.

References

1. Adiguna, I. G. A. B. P., Restu, I. W. & Ekawaty, R. (2018). Struktur Komunitas Ikan di Muara Sungai Badung Kawasan Mangrove Taman Hutan Raya (Tahura) Ngurah Rai, Bali. *Current Trends in Aquatic Science*. 1(1), 72-79.
2. Ajai, O. N., Anwari, M. S. & Dirhamsyah. (2020). Keanekaragaman Jenis Ikan di Sungai Embaloh Desa Banua Ujung Kecamatan Embaloh Hulu Kabupaten Kapuas Hulu. *Jurnal Hutan Lestari*. 8(1), 61-68.
3. Cem, P.S. (1990). Some Aspects of the Biology of *Arius truncatus* (C.&V.) and *Arius caelatus* (Val.) (Osteichthyes, *Tachysurudae*) in the Sungai Salak Mangrove Estuary, Sarawak, Malaysia. *Fish. Bull.* 63, 1-28.
4. Datunsolang, F., Kusen, D., Kalesaran, O. J., Undap, S. L., Sambali, H., Wantasen, A. S. & Salindeho, I. (2021). Kelayakan Lokasi Budidaya Ikan Kuwe (*Caranx* sp.) Ditinjau Dari Parameter Fisika Kimia Kualitas Air Pada Karamba Jaring Apung di Desa Tuntung Timur Kabupaten Bolaang Mongondow Utara. *E-Journal Budidaya Perairan*. 9(2), 25-33.
5. Fahmi, M. R. & Permana, A. (2014). Kematangan Gonad Ikan Sumpit (*Toxotes jaculatrix* Pallas 1767) Pada Salinitas Berbeda. *Jurnal Iktiologi Indonesia*. 14(3), 235-245.
6. Faisal, T. M., Putriningtias, A. & Kusnafizal, T. (2017). Analisis Kelayakan Budidaya Perikanan Air Payau Berdasarkan Analisis Kualitas Air Dalam Pengelolaan Wilayah Pesisir Alue Kumba, Kabupaten Aceh Timur. *Jurnal Ilmiah Samudra Akuatika*. 1(2), 1-10.
7. Haryono. (2017). Fauna Ikan Air Tawar di Perairan Kawasan Gunung Sawal, Jawa Barat, Indonesia. *Jurnal Ilmu-Ilmu Hayati*. 16(2), 147-156.
8. Hutubessy, G. (2022). Pra-Menetap Larva Ikan Pelagis Kecil di Teluk Ambon Berbasis Distribusi Panjang. *Jurnal Iktiologi Indonesia*. 22(2), 93-107.
9. Insafitri. (2010). Keanekaragaman, Keseragaman, dan Dominansi Bivalvia di Area Buangan Lumpur Lapindo Muara Sungai Porong. *Jurnal Kelautan*. 3(1), 54-59.
10. Khairul., Wahyuningsih, H. & Jumilawati, E. (2014). Distribusi dan Pola Pertumbuhan Ikan Bulan-Bulan (*Megalops cyprinoides* Broussonet, 1782) di Sungai Belawan. *Jurnal Perikanan dan Kelautan*. 19(2), 57-61.
11. Kottelat, M., Whitten, A.J., Kartikasari, S.N., & Wiroatmodjo, S. (1993). *Freshwater Fishes of Western Indonesia and Sulawesi (Ikan Air Tawar Indonesia Bagian Barat dan Sulawesi)*. Jakarta: Periplus Editions Limited.
12. Krismono., Nurfiarini, A., Sugianti, Y. & Hendrawan, A. L. S. (2018). Pengelolaan Perikanan di Danau Limboto Pasca Pengerukan. *Jurnal Kebijakan Perikanan Indonesia*. 10(2), 63-74.
13. Kurniawan, E., Djuhriansyah & Helminuddin. (2008). Pemanfaatan Hutan Mangrove oleh Masyarakat Desa Babulu Laut Kecamatan Babulu Kabupaten Penajam Paser Utara. *Jurnal Kehutanan Tropika Humida*. 1(1), 16-23.
14. Kurniawan, A. J., Prayogo, H. & Erianto. (2018). Keanekaragaman Jenis Burung Diurnal di Pulau Temajo Kecamatan Sungai Kunyit Kabupaten Mempawah Kalimantan Barat. *Jurnal Hutan Lestari*. 6(1), 230-237.
15. Larasati, M. C. P. & Budijastuti, W. (2022). Morfometri dan Meristik Ikan Bandeng di Pertambakan Sekitar Mangrove Wonorejo Surabaya. *Lentera Bio*. 11(3), 473-492.
16. Mahdalena, S. & Khairul. (2021). Korelasi Kepadatan Populasi Tiga Spesies Ikan Belanak Dengan Beberapa Faktor Fisika Kimia Perairan. *Jurnal Pendidikan Biologi dan Sains*. 4(1), 12-17.
17. Manangkalangi, E., Syafei, L. S., Lapadi, I., Lefaan, P. T., Widiastuti, N. & Rahardjo, M. F. (2022). Biologi Reproduksi Ikan Kiper, *Scatophagus argus* (Linnaeus, 1766) di Teluk Pabean, Indramayu. *Jurnal Sumberdaya Akuatik Indopasifik*. 6(3), 215-226.
18. Marei, S. & Maruanaya, Y. (2022). Inventarisasi Jenis dan Penyebaran Ikan Pada Kawasan Mangrove di Kampung Arui Distrik Mora Kabupaten Nibire. *Jurnal Perikanan dan Kelautan*. 3(1), 47-63.
19. Maryani, S. & Machrizal, R. (2022). The Population Dynamics of Belanger's Croaker (*Johnius belangerii*) at Barumun River, Panai Hilir District, Labuhanbatu Regency. *Biosfer: Jurnal Tadris Biologi*. 13(1), 75-82.
20. Maturbongs, M. R., Elviana, S., Rani, C. & Iqbal, A. B. (2019). Keterkaitan Parameter Fisik-Kimia Perairan Dengan Kelimpahan Jenis Ikan Demersal di Sungai Maro Pada Fase Bulan Berbeda Musim Peralihan I. *Jurnal Agribisnis Perikanan*. 12(1), 162-173.
21. Odum, E. P. (1996). *Dasar-Dasar Ekologi Edisi Ketiga*. Yogyakarta: Gajah Mada University Press.
22. Puteri, D., Sitorus, H. & Muhtadi, A. (2017). Keragaman Ikan di Perairan Ekosistem Mangrove Desa Jaring Halus Kabupaten Langkat, Sumatera Utara. *Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan*. 6(2), 145-152.

23. Rahmani, M. R., Noor, M. & Hasanah, N. (2018). Peran Dinas Perikanan Dalam Pengelolaan Peningkatan Produktivitas Perikanan Pembudidaya Tambak di Kecamatan Babulu Kabupaten Penajam Paser Utara. *Jurnal Ilmu Pemerintahan*. 6(3), 1087-1098.
24. Ramadhani, D., Adijaya, M. & Hadinata, F. W. (2022). Keragaman Jenis Ikan Pada Aliran Sungai Beduai Kabupaten Sanggau Kalimantan Barat. *Aurelia Journal*. 4(1), 63-70.
25. Ridwan, A. K., Setyawati, T. R. & Yanti, A. H. (2016). Inventarisasi Jenis-Jenis Ikan Yang Ditemukan di Estuari Sungai Tanjung Belimbing Kabupaten Sambas. *Jurnal Protobiont*. 5(3), 47-53.
26. Sirait, M., Rahmatia, F. & Pattuloh. (2018). Komparasi Indeks Keanekaragaman dan Indeks Dominansi Fitoplankton di Sungai Ciliwung Jakarta. *Jurnal Kelautan*. 11(1), 75-79.
27. Sulistyani, T. H., Rahayuningsih, M. & Partaya. (2014). Keanekaragaman Jenis Kupu-Kupu (Lepidoptera: Rhopalocera) di Cagar Alam Ulolanang Kecubung Kabupaten Batang. *Journal of Life Science*. 3(1), 9-17.
28. Supriatna, J. (2008). *Melestarikan Alam Indonesia*. Jakarta: Yayasan Obor Indonesia.
29. Tuhumury, R. (2014). Struktur Komunitas Ikan Karang di Perairan Pulau Pasi Kabupaten Kepulauan Selayar. *Journal of Fisheries Development*. 1(1), 45-52.
30. Wahyuni, A. P., Firmansyah, M., Fattah, N. & Hastuti. (2020). Studi Kualitas Air Untuk Budidaya Ikan Bandeng (*Chanos chanos* Forsskal) di Tambak Kelurahan Samataring Kecamatan Sinjai Timur. *Jurnal Agrominansia*. 5(1), 106-113.
31. Wicaksono, A., Muhammad, F., Hidayat, J. W. & Suryanto, D. (2018). Pengaruh Komposisi *Azolla pinnata* Pada Pakan Terhadap Pertumbuhan Ikan Bandeng (*Chanos chanos* Forsskal) di Balai Besar Perikanan Budidaya Air Payau (BBPBAP) Jepara. *Berkala Ilmiah Biologi*. 20(2), 113-122.
32. Yudistira, Jusmaldi, & Hendra, M. (2019). Keanekaragaman dan Komposisi Ikan Pada Kondisi Pasang dan Surut di Muara Sungai Kelay. *Jurnal Pendidikan Matematika dan IPA*. 10(2), 173-182.