

Assessment and Composition of Fish in the River District Maro Merauke

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Abstract. Maro River is one of the major rivers in Merauke Regency that has a width of about 43-900 m and length of 300 km. The purpose of this study is to find out the type and composition of fish caught using gill net in Maro River, Merauke Regency. This study was conducted in Maro River, Merauke Regency from May to June 2014. It was conducted using survey method. The data analysis included: species composition, relative abundance, availability frequency, diversity index and dominance index. The results of showed 1,084 fish in 17 species with the following composition; 490 of *Kurtus gulliveri* species (37,01%), 212 of *Eleutheronema tetradactylum* species (20,33%), 170 of *Polydactylus plebeius* species (16,30%), 75 of *crassilabris Cinetodus* species (7,19%), 64 of *Cinetodus froggatti* species (6,14%), 37 of *Argyrosomus amoyensis* species (3,55%), 20 of *Mugil cephalus* species (1,92%), 15 of *Megalops cyprinoides* species (1,53%), 15 of *Thryssa scratchleyi* species (1,4%), 12 of *Leptobrama sp* species (1,15%), 9 of *Lates calcarifer* species (0,86%), 7 of *Marilyna meraukensis* species (0,67%), 7 of *Scomberomorus commerson* species (0,67%), 5 of *Nibea squamosal* species (0,48%), 4 of *Rhinoptera javanica* species (0,38%), 3 of *Harpadon microchir* species (0,29%) and 1 of *Datnioides campbelli* species (0,10%). Based on the availability frequency, there are 37 species with a percentage of 100%, 37 species with 67% and 7 species with 33%. The diversity of fish has a moderate value of $1 < H' < 3$. The obtained dominance index value is close to 0, then it is stated that there is no species found to be dominant.

Keywords: River; Species Composition; Abundance; Availability; Diversity and Dominance.

1. INTRODUCTION

Merauke Regency has a brackish water resources potential of 22.204 Kg [1]. The data concerning the number of potential local consumption of fish/Kg by type per District in Merauke Regency showed a total of 4.094.426 Kg [11]. The abundant natural resources are strongly supported by many rivers that flows into the Arafura sea, such as, Digul river, Bian river, Maro river and others. [2]

Maro River is one of the great rivers in Merauke that has a width of about 43-900 m and a length of 300 km. This river has a historical value for Merauke, because the name Merauke derives from the name of this River. It can be interpreted that the characteristics of the area around the river is highly fertile, as it has great mangrove forests, and has mud substrate, so that the water turbidity is fairly high and has a relatively high water acidity as it is a meeting point between the freshwater and seawater along the river that becomes a unique habitat for fish and other living organisms contained in this river [3]. Based on the research conducted by [4]. there are many species of fish that exist in this Maro river, among others, eeltail catfish (*Neosilurus sp*), fly river gizzard shad (*Nematalosa flyensis*), oxeve herring (*Megalops cyprinoids*), nursery

fish (*Kurtus gulliveri*), Belanak (*Mugil sp*) and fly river thryssa (*Thryssa rastrosa*).

13% of the people in Gudang Arang, Maro Village, are fisherman who actively fishing. Fishing in the Maro River, especially for the Gudang Arang area, in the upstream, is an activity that has been done by people, especially for those living along the river [5]. Nevertheless, there is no vailable data in Merauke Regency about the composition of fish species caught, especially for Maro River in Gudang Arang. Therefore, it is necessary to conduct a study on the types and composition of fish to maintain and pay attention to its sustainability in nature and to be the basis of information about the types and composition of fish and sustainable management of fish resources.

Knowing the right to find out the types and composition of fish caught using gill net in Maro River in Gudang Arang, Maro Village, Merauke Regency.

2. RESEARCH METHOD

2.1. Location and Time of Research

The research is conducted from May to July 2014 at the Maro River in Gudang Arang, Maro Village, Merauke Regency.

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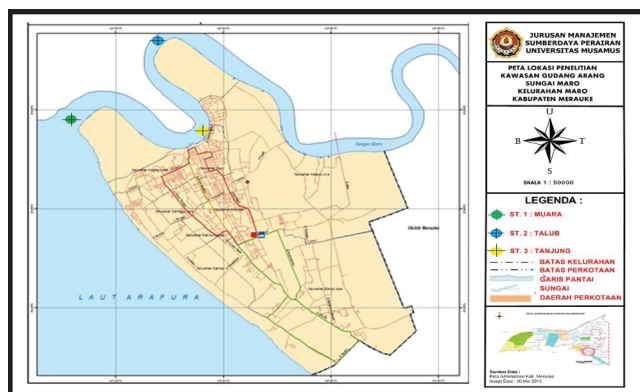


Fig 1. Map of Research Location (Maro River in Gudang Arang, Maro Village, Merauke Regency)

2.2. Tools and Materials

The tools used in this study were gill net (with a mesh size of 1 and 2 inch), boats, cool box, thermometer, pH meter, salinometer, analytical scales, hanging scales, plastic jars, plastic tray, tweezers, tissue, bucket, camera, stopwatch, fit bottle, raffia string, GPS, calculator, ruler, stationery, notebook and identification book. The materials used were ice cubes and types of caught fish.

2.3. Research Method

The method used in this research was survey method. Soehartono (1995) [6] suggests that the survey method is a method to obtain the existing data at the time of research conducted. This survey method can be a descriptive survey which aims to collect information a number of samples of people, object and others [7]. Such descriptive research uses survey method, while the data collection techniques used were as follows.

2.3.1. Observation

Sampling was conducted every Monday, Wednesday and Friday with 3 repetitions. The sampling technique used was purposive random sampling [8].

2.3.2. Interview

Interview is a data collection technique in survey methods that uses verbal questions to research subjects, which is conducted if the researcher needs communication to the respondents [6].

2.4. Research Procedures

2.4.1. Measurement of physical factors, water chemistry

Measuring the water temperature, flow velocity, salinity and water pH.

2.4.2. Collection of specimens or samples

Sampling was done every Monday, Wednesday and Friday with 3 repetitions. The sample of fish was taken at low tide at three locations or stations, namely

station 1 located in Estuary which is ± 5 km away before the meeting point with location II in Floodgate which is ± 5 km away after the meeting point with location III which is on the Cape. Fish sampling at each location was done at three points, i.e., the right, middle, and left bank of the river. In the right and left bank, fish sampling was conducted by using the gill net with a mesh size of 1 inch and in the middle bank by using the gill net with a mesh size of 2 inches.

The samples were collected in mesh pockets at each of the three stations: station I (Estuary), station II (Floodgate) and station III (Cape).

2.4.3. Identification of Fish

The identification was conducted by using manual identification (Allen, 1989, and Allen 1991) [9,10] to determine the name of the collected species.

2.5. Data Analysis

The data analysis used descriptively is to process data obtained in field and compare with literature study. [16]

2.5.1. Type Composition

The type composition was obtained from the data of the size and number of nekton species obtained from each location with a predetermined station [12].

2.5.2. Relative Abundance

The calculation of relative abundance of each species was conducted by calculating the percentage of the number. The equation used was [13]

$$K_r = \frac{n_i}{N} \times 100\%$$

Information :

K_r = relative abundance

n_i = i-th individual species

N = total number of individuals of all species

2.5.3. Availability Frequency

Availability Frequency was used for showing the spread of local distribution of certain species. This is evident from the frequency (%) of fish caught by using the following equation [14]

$$F_i = \frac{t_i}{T} \times 100\%$$

Information :

F_i = availability frequency of i-th caught species (%)

t_i = the number of stations in which the i-th species is caught

T = the number of all stations

2.5.4. Diversity Index

In order to determine the diversity of fish, it used the Shannon-Wiener index [15]:

$$H' = - \sum_{i=1}^n \left(\frac{n_i}{N} \right) \ln \left(\frac{n_i}{N} \right)$$

Information:

H' = Sahnnon -Wiener Diversity Index

n_i = i-th individual species

N = total number of individuals of all species

2.5.5. Determination of Criteria:

The ranges of diversity index value, according to Krebs (1989) are as follows: (1). $H' < 1$: low diversity, narrow spread of individual species and low community stability. (2). $1 < H' < 3$: moderate diversity, moderate spread of individual species and moderate community stability. (3) $H' > 3$: high diversity, high spread of individual species and high community stability.

2.5.6. Dominance Index

In order to determine whether the fish are available, the Simpson's dominance index was used, as follow (Odum, 1996):

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

Information:

C = Simpson's Diversity Index

ni = i-th individual species

N = total number of individuals of all species

Legendre, (1983) states the value of dominance index ranges from 0-1; index 1 indicates very high dominance by one species (there is only one type in one station). While index 0 indicates that there is no dominance among the species found.

3. RESULT AND DISCUSSION

3.1. Types of Fish Caught

Table 1. Number of Species Caught per Station in The Research Location in Maro River, Gudang Arang, Maro Village, Merauke Regency

No	Number of Species Caught in The Research Location		
	Station I (Estuary)	Station II (Floodgate)	Station III (Cape)
1	<i>Cinetodus froggatti</i>	<i>Cinetodus froggatti</i>	<i>Cinetodus froggatti</i>
2	<i>Cinetodus crassilabris</i>	<i>Cinetodus crassilabris</i>	<i>Cinetodus crassilabris</i>
3	<i>Kurtus gulliveri</i>	<i>Kurtus gulliveri</i>	<i>Kurtus gulliveri</i>
4	<i>Argyrosomus amoyensis</i>	<i>Argyrosomus amoyensis</i>	<i>Argyrosomus amoyensis</i>
5	<i>Polydactylus plebeius</i>	<i>Polydactylus plebeius</i>	<i>Polydactylus plebeius</i>
6	<i>Eleutheronema tetradactylum</i>	<i>Eleutheronema tetradactylum</i>	<i>Eleutheronema tetradactylum</i>
7	<i>Marilyna meraukensis</i>	<i>Marilyna meraukensis</i>	<i>Marilyna meraukensis</i>
8	<i>Mugil cephalus</i>	<i>Mugil cephalus</i>	<i>Mugil cephalus</i>
9	<i>Megalops cyprinoides</i>	<i>Megalops cyprinoides</i>	<i>Megalops cyprinoides</i>
10	<i>Thryssa scratchleyi</i>	<i>Thryssa scratchleyi</i>	<i>Thryssa scratchleyi</i>
11	<i>Harpadon microchir</i>	<i>Harpadon microchir</i>	<i>Harpadon microchir</i>

No	Number of Species Caught in The Research Location		
	Station I (Estuary)	Station II (Floodgate)	Station III (Cape)
12	<i>Datnioides campbelli</i>		
13	<i>Nibea squamosal</i>		
14	<i>Lates calcarifer</i>		
15	<i>Leptobrama sp</i>		
16	<i>Rhinoptera javanica</i>		
17	<i>Scomberomorus commerson</i>		
Total Species	17	7	10

Based on Table 1, there were 17 fish species caught in Maro River in Gudang Arang. Based on Table 1, there were 17 fish species found in station I, 7 species found in station II and 10 species found in station III.

3.2. Composition of Species

Based on the results of research conducted in Maro River, Gudang Arang, Maro Village, Merauke Regency, there were 17 species with total composition of fish caught can be seen in Table 2.

Table 2. Total fish caught in Maro River, Gudang Arang, Maro Village, Merauke Regency

No	Species	Number of Fish Caught in Research Location			Total
		Station I (Estuary)	Station II (Floodgate)	Station III (Cape)	
1	Lizardfish (<i>Harpadon microchir</i>)	3	0	0	3
2	Flathead grey mullet (<i>Mugil cephalus</i>)	8	0	12	20
3	Smallmouthed salmon catfish (<i>Cinetodus froggatti</i>)	32	12	20	64
4	Thick-lipped catfish (<i>Cinetodus crassilabris</i>)	40	12	23	75
5	Nurseryfish (<i>Kurtus gulliveri</i>)	248	37	101	386
6	New Guinea Tiger Perch (<i>Datnioides campbelli</i>)	1	0	0	1
7	Scale Croaker (<i>Nibea squamosal</i>)	5	0	0	5
8	Barramundi (<i>Lates calcarifer</i>)	9	0	0	9
9	Amoy Croaker (<i>Argyrosomus amoyensis</i>)	27	2	8	37
10	Striped threadfin (<i>Polydactylus plebeius</i>)	116	16	38	170

No	Species	Number of Fish Caught in Research Location			Total	No	Species	Percentage (Kr) of Fish Caught in the Research Location (%)			Total (%)
		Station I (Estuary)	Station II (Floodgate)	Station III (Cape)				Station I (Estuary)	Station II (Floodgate)	Station III (Cape)	
	Fourfinger threadfin (<i>Eleutheronema tetradactylum</i>)	146	20	46	212	7	(<i>Datnioides campbelli</i>) Scale Croaker (<i>Nibea squamosa</i>)	0,73	0	0	0,48
11	Oxeye Herring (<i>Megalops cyprinoides</i>)	14	0	2	16	8	Barramundi (<i>Lates calcarifer</i>)	1,31	0	0	0,86
12	Chinese Herring (<i>Leptobrama sp</i>)	12	0	0	12	9	Amoy Croaker (<i>Argyrosomus amoyensis</i>)	3,93	1,98	3,14	3,55
13	Flapnose ray (<i>Rhinoptera javanica</i>)	4	0	0	4	10	Striped threadfin (<i>Polydactylus plebeius</i>)	16,89	15,84	14,90	16,30
14	Puffer fish (<i>Marilyna meraukensis</i>)	3	2	2	7	11	Fourfinger threadfin (<i>Eleutheronema tetradactylum</i>)	21,25	19,80	18,04	20,33
15	Narrow-barred Spanish mackerel (<i>Scomberomorus commerson</i>)	7	0	0	7	12	Oxeye Herring (<i>Megalops cyprinoides</i>)	2,04	0	0,78	1,53
16	Freshwater Anchovy (<i>Thryssa scratchleyi</i>)	12	0	3	15	13	Chinese Herring (<i>Leptobrama sp</i>)	1,75	0	0	1,15
17	Total	687	101	255	1043	14	Flapnose ray (<i>Rhinoptera javanica</i>)	0,58	0	0	0,38
						15	Puffer fish (<i>Marilyna meraukensis</i>)	0,44	1,98	0,78	0,67
						16	Narrow-barred Spanish mackerel (<i>Scomberomorus commerson</i>)	1,02	0	0	0,67
						17	Freshwater Anchovy (<i>Thryssa scratchleyi</i>)	1,75	0	1,18	1,44
							Total (%)	100	100	100	100
							Total (fish)	687	101	255	1043

Based on the results (Table 2), the number of fish caught in 3 months (May to July 2014) in the Maro River, Gudang Arang, Maro Village, Merauke Regency, there were 1043 fish from 17 species spread over three research locations or stations. Where Station I (Estuary) is the location with the most fish caught of 687 and Unit III (Cape) is the location with the 2nd most fish caught of 101 and Unit II (Floodgate) is the location with the third most fish caught of 225. Moreover, *Kurtus gulliveri* is the most type of fish caught in three stations with a total of 386.

3.3. Relative Abundance

Table 3. Percentage of Relative Abundance

No	Species	Percentage (Kr) of Fish Caught in the Research Location (%)			Total (%)
		Station I (Estuary)	Station II (Floodgate)	Station III (Cape)	
1	Lizardfish (<i>Harpadon microchir</i>)	0,44	0	0	0,29
2	Flathead grey mullet (<i>Mugil cephalus</i>)	1,16	0	4,71	1,92
3	Smallmouthed salmon catfish (<i>Cinetodus froggatti</i>)	4,66	11,88	7,84	6,14
4	Thick-lipped catfish (<i>Cinetodus crassilabris</i>)	5,82	11,88	9,02	7,19
5	Nurseryfish (<i>Kurtus gulliveri</i>)	36,10	36,63	39,61	37,01
6	New Guinea Tiger Perch	0,15	0	0	0,10

Based on the results in Table 3, the highest relative abundance is found in Nurseryfish (*Kurtus gulliveri*) in Station III with a percentage of 39,61%. From the data in Table 3, the highest number of fish species caught is in station I with a total of 687 fish and the lowest is in station II with a total of 101 fish.

3.4. Availability Frequency

The Availability Frequency based on location of observation can be seen in Table 4.

Table 4. Percentage of Availability Frequency

No	Species	Availability Frequency			Fi (%)
		Station I (Estuary)	Station II (Floodgate)	Station III (Cape)	
1	Lizardfish (<i>Harpadon microchir</i>)	√	-	-	33
2	Flathead grey	√	-	√	67

No	Species	Availability Frequency			Fi (%)
		Station I (Estuary)	Station II (Floodgate)	Station III (Cape)	
3	mullet (<i>Mugil cephalus</i>) Smallmouthed salmon catfish (<i>Cinetodus froggatti</i>)	√	√	√	100
4	Thick-lipped catfish (<i>Cinetodus crassilabris</i>)	√	√	√	100
5	Nurseryfish (<i>Kurtus gulliveri</i>)	√	√	√	100
6	New Guinea Tiger Perch (<i>Datnioides campbelli</i>)	√	-	-	33
7	Scale Croaker (<i>Nibea squamosal</i>)	√	-	-	33
8	Barramundi (<i>Lates calcarifer</i>)	√	-	-	33
9	Amoy Croaker (<i>Argyrosomus amoyensis</i>)	√	√	√	100
10	Striped threadfin (<i>Polydactylus plebeius</i>)	√	√	√	100
11	Fourfinger threadfin (<i>Eleutheronema tetradactylum</i>)	√	√	√	100
12	Oxeye Herring (<i>Megalops cyprinoides</i>)	√	-	√	67
13	Chinese Herring (<i>Leptobrama sp</i>)	√	-	-	33
14	Flapnose ray (<i>Rhinoptera javanica</i>)	√	-	-	33
15	Puffer fish (<i>Marilyna meraukensis</i>)	√	√	√	100
16	Narrow-barred Spanish mackerel (<i>Scomberomorus commerson</i>)	√	-	-	33
17	Freshwater Anchovy (<i>Thryssa scratchleyi</i>)	√	-	√	67

Information. √ : Available
 - : Unavailable

The results of Table 4 show the value of the availability frequency of the fish species in each station. The availability frequency value is related to the area of distribution. The greater the availability frequency value, the greater the area of distribution. The availability frequency value of fish species shows that there are 7 species with the percentage of 100% availability, means that the species have widespread distribution. Meanwhile, there are 3 species with a percentage of 67% availability, indicating moderate distribution and 7 species with a percentage of 33% availability, indicating the low distribution.

3.5. Diversity

The diversity based on the observation location can be seen in Table 5 below.

Table 5. Diversity Index

No	Species	Diversity Index			Total (H')
		Station I (Estuary)	Station II (Floodgate)	Station III (Cape)	
1	Lizardfish (<i>Harpadon microchir</i>)	0,0237	0	0	0,0168
2	Flathead grey mullet (<i>Mugil cephalus</i>)	0,0519	0	0,1438	0,0758
3	Smallmouthed salmon catfish (<i>Cinetodus froggatti</i>)	0,1428	0,2531	0,1996	0,1713
4	Thick-lipped catfish (<i>Cinetodus crassilabris</i>)	0,1656	0,2531	0,2170	0,1893
5	Nurseryfish (<i>Kurtus gulliveri</i>)	0,3678	0,3679	0,3668	0,3679
6	New Guinea Tiger Perch (<i>Datnioides campbelli</i>)	0,0095	0	0	0,0067
7	Scale Croaker (<i>Nibea squamosal</i>)	0,0358	0	0	0,0256
8	Barramundi (<i>Lates calcarifer</i>)	0,0568	0	0	0,0410
9	Amoy Croaker (<i>Argyrosomus amoyensis</i>)	0,1272	0,0777	0,1086	0,1184
10	Striped threadfin (<i>Polydactylus plebeius</i>)	0,3003	0,2919	0,2837	0,2957
11	Fourfinger threadfin (<i>Eleutheronema tetradactylum</i>)	0,3291	0,3207	0,3089	0,3238
12	Oxeye Herring (<i>Megalops cyprinoides</i>)	0,0793	0	0,0380	0,0641
13	Chinese Herring (<i>Leptobrama sp</i>)	0,0707	0	0	0,0514
14	Flapnose ray (<i>Rhinoptera javanica</i>)	0,0300	0	0	0,0213
15	Puffer fish (<i>Marilyna meraukensis</i>)	0,0237	0,0777	0,0380	0,0336
16	Narrow-barred Spanish mackerel (<i>Scomberomorus commerson</i>)	0,0467	0	0	0,0336
17	Freshwater Anchovy (<i>Thryssa scratchleyi</i>)	0,0707	0	0,0523	0,0610
Jumlah (H')		1,9318	1,6419	1,7568	1,8973

The diversity index value (Table 5) of species of fish caught for three months in Maro River, Gudang Arang, is 1,8973. This result indicates moderate diversity, moderate distribution of individual number of each species, and moderate community stability.

3.6. Dominance

The dominance index based on the observation location can be seen in Table 6 below

Table 6. Dominance Index

No	Species	Dominance Index			Total (C)
		Station I (Estuary)	Station II (Floodgate)	Station III (Cape)	
1	Lizardfish (<i>Harpadon microchir</i>)	0,00001936	0	0	0,00000841
2	Flathead grey mullet (<i>Mugil cephalus</i>)	0,00013456	0	0,00221841	0,00036864
3	Smallmouthed salmon catfish (<i>Cinetodus froggatti</i>)	0,00198916	0,01411344	0,00614656	0,00376996
4	Thick-lipped catfish (<i>Cinetodus crassilabris</i>)	0,00338724	0,01411344	0,00813604	0,00516961
5	Nurseryfish (<i>Kurtus gulliveri</i>)	0,130321	0,13417569	0,15689521	0,13697401
6	New Guinea Tiger Perch (<i>Datnioides campbelli</i>)	0,00000225	0	0	0,000001
7	Scale Croaker (<i>Nibea squamosa</i>)	0,00005329	0	0	0,00002304
8	Barramundi (<i>Lates calcarifer</i>)	0,00017161	0	0	0,00007396
9	Amoy Croaker (<i>Argyrosomus amoyensis</i>)	0,00154449	0,00039204	0,00098596	0,00126025
10	Striped threadfin (<i>Polydactylus plebeius</i>)	0,02852721	0,02509056	0,022201	0,026569
11	Fourfinger threadfin (<i>Eleutheronema tetradactylum</i>)	0,04515625	0,039204	0,03254416	0,04133089
12	Oxeye Herring (<i>Megalops cyprinoides</i>)	0,00041616	0	0,00006084	0,00023409
13	Chinese Herring (<i>Leptobrama sp</i>)	0,00030625	0	0	0,00013225
14	Flapnose ray (<i>Rhinoptera javanica</i>)	0,00003364	0	0	0,00001444
15	Puffer fish (<i>Marilyna meraukensis</i>)	0,00001936	0,00039204	0,00006084	0,00004489
16	Narrow-barred Spanish mackerel (<i>Scomberomorus commerson</i>)	0,00010404	0	0	0,00004489
17	Freshwater Anchovy (<i>Thryssa scratchleyi</i>)	0,00030625	0	0,00013924	0,00020736
Total (C)		0,21249212	0,22748121	0,22938826	0,21622669

The value of dominance index (Table 6) of the type of fish caught for three months in the Maro River, Gudang Arang, is 0,21622669. This result shows that, among the species found, there is no dominance. Furthermore, based on the overall species of fish caught, the highest dominance index value, in general close to 0, is found in Kurtus gulliveri in Station 3 with a dominance value of 0,15689521.

3.7. Physical Parameters and Water Chemistry

The results of physical parameters, water chemistry, can be seen in Table 7 below:

Table 7. The Results of Physical Parameters and Water Chemistry

No	Parameter	Unit	Station			Range (ST1+ST2+ST3)
			I (Estuary)	II (Floodgate)	III (Cape)	
1	Temperature	°C	28 - 29	29 - 31	29 - 30	28 - 31
2	Flow Velocity	m/dt	0,26	0,28	0,30	0,26 - 0,30
3	Salinity	Ppt	28,0 - 30,0	18,0 - 20,0	18,0 - 19,0	18,0 - 30,0
4	Water pH		7 - 8	6 - 6,5	7 - 7,5	6 - 8

4. CONCLUSIONS

There were 17 fish species caught in Maro River, Gudang Arang, Maro Village, Merauke Regency, namely: *Kurtus gulliveri*, *Eleutheronema tetradactylum*, *Polydactylus plebeius*, *Cinetodus crassilabris*, *Cinetodus froggatti*, *Argyrosomus amoyensis*, *Mugil sp*, *Megalops cyprinoides*, *Thryssa scratchleyi*, *Leptobrama sp*, *Lates calcarifer*, *Marilyna meraukensis*, *Scomberomorus commerson*, *Nibea squamosa*, *Rhinoptera javanica*, *Harpadon microchir*, *Datnioides Campbelli*.

5. REFERENCES

- Dinas Kelautan dan Perikanan Kabupaten Merauke, 2010. Jumlah Produksi Ikan. Dinas Kelautan Dan Perikanan Kabupaten Merauke.
- Puslittan. 1986. Survey dan Pemetaan Tanah Tingkat Tinjau Daerah Merauke S. Digul-Pantai Kasuari, Propinsi Irian Jaya. Laporan Akhir No. 13/1986.
- Dinas Pekerjaan Umum Kabupaten Merauke, 2008. Data Pengambilan Sampel Air Sungai Maro. Dinas Pekerjaan Umum Kabupaten Merauke.
- Hendra Satria, 2007. Jenis ikan di sungai Maro. Jurnal Biologi Reproduksi ikan di Sungai Maro, Merauke, Propinsi Papua.
- Kelurahan Maro Disrik Merauke Kabupaten Merauke, 2013. Data Jumlah Penduduk dan Batas Wilayah Kelurahan Maro Disrik Merauke Kabupaten Merauke.
- Soehartono, Irawan. 1995. Metode Penelitian Sosial. Bandung : PT Remaja Rosda Karya.
- Zikmund, William G., (1997). *Business Research Methods*. USA: Dryden Press. Hill, New York.
- Mantra, Ida Bagoes dan Kasto. 1989. 'Penentuan Sampel' dalam *Metode Penelitian Survei*. Masri Singarimbun dan Sofian Effendi, eds. Edisi Revisi. Jakarta: LP3ES.
- Allen, G.R., 1989. *Freshwater fishes of Australia*. T.F.H. Publications, Inc., Neptune City, New Jersey.
- Allen, G.R. (1991). *Freshwater Fishes of New Guinea*. Cristensen Research Institute, Madang Papua New Guinea. 268 p.
- Dinas Kelautan dan Perikanan Kabupaten Merauke, 2009. Jumlah Produksi Ikan. Dinas Kelautan Dan Perikanan Kabupaten Merauke.
- Royce, W. F. 1972. *Introduction to the fisheries sciences*. Academic Press, inc. New York. 351 p.
- Krebs C. J. 1972. *Ecology, the Experimental Analysis of Distribution and Abundance*. Harper and Rows Publisher. 694 p.
- Misra, R. 1968. *Ecology Workbook*. Oxford & IBH Publishing Co. New Delhi Bombay-Calcutta. 244 p.

15. Odum, E. P. 1996. Dasar - Dasar Ekologi. Gajah Mada University Press: Yogyakarta.
16. Setyobudiandi, I. dkk. 2009. *Sampling dan Analisis Data Perikanan dan Kelautan. Terapan Metode Pengambilan Contoh di Wilayah Pesisir dan Laut*. Penerbit : FPIK Institut Pertanian Bogor.
17. Legendre, L dan P. Legendre, 1983. *Numerical Ecology. Elsevier Scientific Publish Company*. Amsterdam. Netherland. 419 p.