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Research Article

A survey on Marine Fish Species In River of Mahakam East Kalimantan, Indonesia

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ABSTRACT

A first survey on a community marine species in river of Mahakam East Kalimantan was performed in December 2015 and May 2016. Fish samplings were carried out from two locations the lower and the middle part of Mahakam. Whilst hydrometric observation of current velocity, water depth and tide was measured not only at the locations but also along the river from 2013 to 2017, tide was only observed in the lower part of Mahakam. However, marine fish species were recognized to reach up the middle part of Mahakam, 230 km from coastline. To describe a community fish structure and its dissimilarity of the two surveyed locations, diversity and bray Curtis index were applied. Almost 15 marine fish species identified in river of Mahakam was demersal fish and index of the similarity of marine fish community between the locations only 0.106.

Keywords: Mahakam river, marine fish, lower part of mahakam, hydrometric measures, samarinda

1. Introduction

Mahakam is the biggest river (more than 900 km in length) in East Kalimantan province. Its associated floodplain such as lake Semayang and Melintang in the middle part and the estuarine waters of the Mahakam Delta in the lower part have valuable natural resources for people who live along the river. According to Yang et al. (2005) that growth rate of intertidal wetlands at the delta front depends on the riverine sediment supply. These areas are used not only for fishing and aquaculture activities but also for other purposes like sand mining source and local traditional ferry (Suyatna, 2007). An annual sediment load of the Mahakam river ranges from 50 to 100 Mt/yr (Milliman and Farnsworth, 2011) while Krishna river in India 170.4 Mt/yr (Vaithiyanathan et al., 1988). Sediments are an essential component of rivers that functions as the input for the food chains and trophic webs and the migration trigger of fish (Eric and Eric, 2012). However, suspended sediments including turbidity may affect fish survival rates by altering their physiology, behaviour and habitat (Berman et al., 2001), and are significant contributors to decline in populations of aquatic organisms in lotic waters through local food chain beginning at the primary trophic level (Henley et al., 2000). A river with high sedimentation decreases light penetration into the water column and hence, reduces photosynthesis (Rosli and Yahya, 2012). Kalimantan already lost a large part of its original rain forest because of massive logging from the 1970s to the 1990s for reasons of timber production (Jorde, 2013) and other purpuses such as palm plantation, in December 2013 the province had granted location permits to a total of 344 companies, covering 3.9 million hectares; IUP permits to 215 companies, covering 3.1 million hectares; and HGU concessions to 127 plantation companies, covering 1.1 million hectares (Anerson et al., 2015). Research findings on impact of the oil palm plantations conducted in West Kalimantan and Papua as well as coal mining indicated soil erosion and water pollution (Obidzinski et al., 2012 and Rashid et ai., 2014) i.e excessively high sediment loads as mentioned by Buschmans et al., (2011) and Porter-Bolland et al., (2011) and effluent from palm oil mills and chemical and fertilizer run-offs that enters rivers causing a high concentration of heavy metals, particularly lead, in the fish (Shell et al., 2009), such economic development has not been only worried affecting to fish life of their migration but also to people health that consume as foods, and globally riverine fish face many anthropogenic threats including riparian and floodplain habitat degradation, altered hydrology, migration barriers, fisheries exploitation, environmental (climate) change, and introduction of invasive species (Cooke et al., 2012). Fish of Mahakam and from its floodplain have been poorly studied in the past, with very rarerly published fish information available. In relation to this, the study was not only focusing on fish community structure but also to identify marine and introduced species found in Mahakam environment, the hydrological aspect was also discussed.

2. Materials and Methods

Data of hydrometric measures such as current velocities, water (river) surfaces (tide) and river depths was gathered in different dates and various years, 2013 to 2017. The hydrometric surveys were realized in collaboration with coal mines and oil palm companies prior to constructed their loading ports. The surveys used tide staff for leveling surface water (every 30 minutes observation), Braystoke current flow meter made in UK for measuring current velocities (at surface, middle and bottom of river) and echosounder GPS map 2108 Garmin for measuring depth. In December 2015, fish samplings were carried out in an area of floodplain of Semayang lake, Kotabangun located in the middle part of Mahakam (230 km from coastline) using trap net of Sawaran. Principally, sawaran (fish trap) consisted of main guiding barrier net 110m in length equipped with wing net 10m in length and its height of 1.0m on both sides, all fish from around swamp plants that move to the lake would follow the guiding barrier net into a chamber sizing 4.0m (l) x 2.0m (w) x 1.75m (h) where fish were collected after being left for 24 hours, from morning to the next morning. And In June 2016, fish samplings were done in river of Mahakam at Sungai Meriam located in the middle part of Mahakam (44 km from coastline) using minitrawl measuring 11m long and 13.5 m wide, main net mesh size 2.0 inches and cod end net 0.5 inches, motorized with a boat sizing 11m x 1.2m x 1.0m to tow the net from 5.0 to 10 minutes (hauling). Fish identification was referred to the field manuals according to Kottelat (1992); Anam and Mostarda (2012); Matsunuma et al. (2011); Allen (2000), Peristiwady (2006); Masuda et al., (1975); Seah et al. (2009); Iqbal (2011). Diversity index such as Shannon-Weaver, Sympson, Margalef species richness (using *log*) including Bray Curtis index of dissimilarity between two locations were made by statistical program of the PAST version 3.13 (Palaeontological Statistics) while mapping was realized with Map INFO v. 8.5.

3. Results and Discussion

Hydrography

It is important that all measured sampling points of hydrometric survey is shown to indicate their distributions along river especially at sampling location of fish (Figure. 1). On the basis of survey downtown of Samarinda which belongs to the lower part of Mahakam was significantly influenced by tide of Makassar strait but not for the middle part of Mahakam and its associated floodplains such Semayang lake (Table 1).

The Table 1 showed the various water level by date. Lower part of Mahakam indicated daily regular fluctuation of water level of two high and low a day, the highest level recorded 1.45m. The river that experienced two nearly equal high and low water level each day is classified as the type of tide mixed semidiurnal (Hicks, 2006). While the middle part of Mahakam did not show such fluctuation that means there was no effect from the sea, the level just descended or ascended depending on the season (wet and dry season). In the wet season 2017 (measured by tide staff, a vertical graduated rod) recorded water level from February to May increased 4.11m (from 2.77m to 6.88m see the Table 2. Mislan (2015) monitored water level in the middle part of Mahakam within 21 years from between 1989 and 2010 reached up to 11.28m (observation starting from 3.06m to 14.34m), the lowest level was occured in the year of 1997 and almost lakes being dried out completely (Sarwono, 1989). This phenomenon may positively correlate between water depth and current velocity and fish diversity (Lakra et al., 2010) even with fish habitat suitability as well (Macura, 2016).

The results of measurement of water depths and velocities along the Mahakam and its associated floodplains Semayang and Melintang lake during the study are presented in the table below.

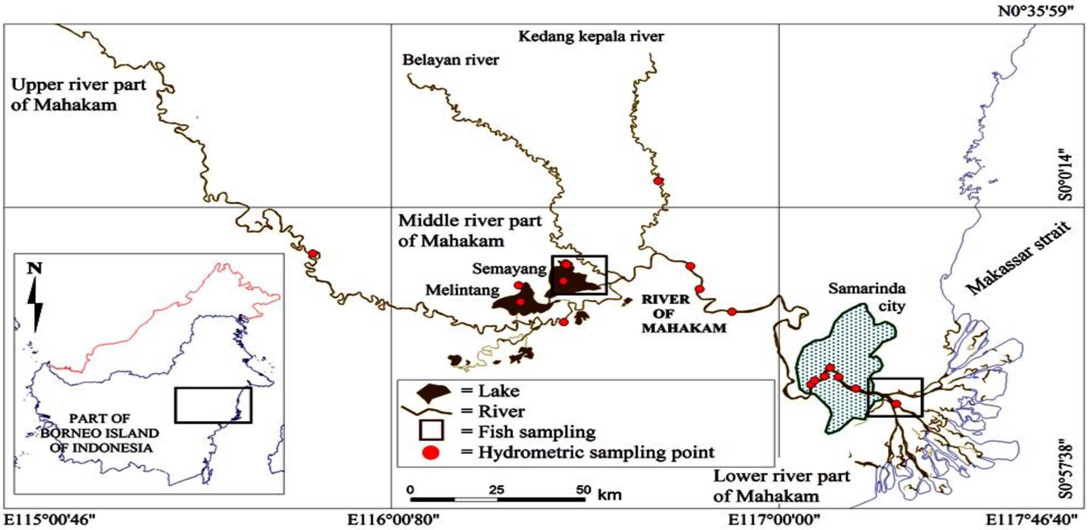

Figure 1. A map showing fish sampling area in the lower part of Mahakam Anggana and in the middle part of Mahakam Kotabangun (small box) and sampling points of hydrometric survey along the Mahakam (red circle) , East Kalimantan, Indonesia.

Table 1. The result of water level measurement in lower part of Mahakam (S Samarinda and SM Sungai Meriam) and middle part of Mahakam (Kotabangun and M Kaman).

Date	Location	Geographic position (50M)	Duration (hours)	Range of tide height (m)	Highest (m)
28/8/2013	Samarinda SM	516144 9944342	15.0	0.30 to 1.75	1.45
29/8/2013	Samarinda SM	516144 9944342	9.0	0.64 to 1.75	1.11
04/7/2014	Samarinda S	522142 9937377	14.0	1.19 to 2.55	1.36
05/7/2014	Samarinda S	522142 9937377	24.0	1.25 to 2.37	1.12
06/7/2014	Samarinda S	522142 9937377	24.0	1.28 to 2.23	0.95
08/7/2014	Samarinda S	522142 9937377	11.0	1.56 to 2.18	0.62
			97.0		1.45
08/2/2015	Kotabangun	435042 9989183	6.5	2.92 to 2.97	0.02
09/2/2015	Kotabangun	435042 9989183	24.0	2.92 to 2.99	0.02
10/2/2015	Kotabangun	435042 9989183	24.0	3.02 to 3.07	0.05
11/2/2015	Kotabangun	435042 9989183	17.0	3.07 to 3.10	0.03
11/2/2017	Kotabangun	435042 9989183	Once observ.	-	2.77
14/5/2017	Kotabangun	435042 9989183	Once observ.	-	6.88
01/4/2015	M Kaman	477280 9971806	7.5	2.22 to 2.44	0.22
02/4/2015	M Kaman	477280 9971806	24.0	2.10 to 2.38	0.28
03/4/2015	M Kaman	477280 9971806	24.0	2.05 to 2.38	0.33
04/4/2015	M Kaman	477280 9971806	16.0	2.04 to 2.40	0.36
			143.0		0.36

Table 2. The results of the measurement of the water depth and current velocities in the part of middle and lower river of Mahakam.

Lower part of Mahakam					
Palaran	1190	24.7	-	Jul-14	Samarinda
S. Kunjang	560	24.9	1.06	Aug-13	Samarinda
Mangkupalas	970	34.2	0.55	Agust 2013	Samarinda
Mahulu	400	19.5	0.22	Aug-13	Samarinda
K Asam	498	18.5	0.56	Aug-12	Samarinda
Samarinda	353	20	0.69	Nov-12	Samarinda
S. Meriam	1261	11,5	0.56		Anggana
Tributary					
Middle part o Mahakam					
River	Width(m)	Depth(m)	Veloc.(m/sec)	Date of survey	Subdistrict
Kedang kepala	196	11.70	1.22	Dec 2011	Senyiur*
Kedang kepala	85	10.3	1,10	Nov2015	Senyiur
Semayang hulu	30	6.60	0.19	Des 2011/Jan 2012	Muara Wis
Semayang hilir	36	5.70	0.33	Des 2011/Jan 2012	Kotabangun
Enggelam	42	6.30	0.25	Des 2011/Jan 2012	Kenohan
Floodplain					
Semayang lake	± 6000	1.90	nd	Des 2011/Jan 2012	Kotabangun
Melintang lake	± 8000	4.60	nd	Des 2011/Jan 2012	Muara Wis
Mahakam river					
M Kaman	350	26.50	0.40	Jan 2013	Muara Kaman
M Muntai	350	31.83	0.61	Des 2012	Muara Muntai
M Kaman	375	17.50	1.18	April 2015	Muara Kaman
Sebulu	500	15.40	0.96	Oct 2010	Sebulu
Mook Manar	364	8.10	1.27	Oct 2013	Mook Manar**

Notes : *District of Kutai Timur (East),**district of Kutai Barat (West), others are district of Kutai Kartanegara and city of Samarinda, nd (not detected).

Figure 2. The comparison of water depth and bottom profile of the two locations (river, left and and its floodplain, right) where fish samplings were performed.

According to the table 2, between depth of Mahakam and associated floodplains was differed, depth of Mahakam, tributary that flowed into Semayang, floodplains of Semayang and Melintang were measured 34.2 m, 4.6 m, 6.6 m and 1.9 m and respectively (Table 2), while depths of two sampling fish locations (lower and middle part of Mahakam) are presented in the Figure 2.

Current velocities varied from 0.19 to 1.22 m/sec. Velocities flowing from the middle to the lower part of Mahakam being progressively decreased (1.27 to 0.22m/sec), velocities in floodplains (Semayang and Melintang) were not detected. Hooper and Kohler (2000) reported the main factors that affect the velocity are such as slope gradient (gradient is the drop of the elevation of a river), the roughness of the channel and size of river and tide, and according to Syvitski et al. (2012) the bottom river of Mahakam from 0 m downstream to 591 km upstream has slope gradient 100 m above sea level and therefore tide was only observed to affect within the lower part of Mahakam.

Fish structure community

Number of fish identified from two sampling locations were 45 species which consisted of 20 species from the lower part of Mahakam, Sungai Meriam Anggana representing 14 families, seven orders, one class (Actinopterygii) and 29 species in the middle part of Mahakam Kotabangun (floodplain or lake Semayang) representing 20 families, seven orders and two classes (Actinopterygii 27 species and Osteichthyes 2 species). Length-weight size distribution of all fish species of the two locations was presented as shown in the Table 3.

Table 3. The species and the individual number caught in Mahakam river and its floodplain area during the study.

		Size distribution		Location			
*	Scientific name	Lenght (cm)	Weight (g)	No of ind	Middle part	Lower part	Habitat
1	*Barbichthys laevis*	12.2 - 21.5	15.4 - 85.6	536	√		Freshw.
2	*B. schwanenfeldii*	8.8 - 15.5	32.9 - 55.6	433	√		Freshw.
3	*Pristolepis fasciata*	6.1 - 10.3	3.9 - 22.2	188	√		Freshw.
4	*Pterygoplichthys multiradiatus*	13.7 - 15.8	21.1 - 31.4	2	√		Freshw.
5	*Channa striata*	14.4 - 41.5	51.3 - 505	56	√		Freshw.
6	*C. micropeltes*	17.8	63.6	1	√		Freshw.
7	*Kryptopterus sp*	10.5 - 28.5	4.9 - 103	7	√		Freshw.
8	*K. limpok*	14.5 - 22	18.8 - 65.1	51	√		Freshw.
9	*K. parvanalis*	9.5 - 31	8.2 - 128.1	67	√		Freshw.
10	*Osteochilus repang*	8.3 - 28	5.3 - 318.9	1343	√		Freshw.
11	*O. hasselti*	11 - 18.2	5.3 - 73.2	306	√		Freshw.
12	*Trichogaster pectoralis*	10.6 - 16	16.2 - 120	158	√		Freshw.
13	*Anabas testudineus*	9.7 - 15.5	13.8 - 62.4	142	√		Freshw.
14	*Leptobarbus hoevenii*	10.8 - 31	10.7 - 344.4	114	√		Freshw.
15	*Thynnichthys thynnoides*	10.5 - 21.5	11.1 - 77.2	429	√		Freshw.
16	*Notopterus borneensis*	15.6 - 34.5	23.3 - 330	298	√		Freshw.
17	*Mystus pelaniceps*	11 - 13.8	7.4 - 19.2	81	√		Freshw.
18	*Oxyleotris marmorata*	9.3 - 22.5	9.2 - 145.7	4	√		Freshw.
19	*Monopterus albus*	44.8	96.2	1	√		Freshw.

20	*Oreochromis niloticus*	9.8 - 26	16.6 - 865.2	200	√		Freshw.
21	*Synaptura sp*	10.8 - 15.8	13.6 - 44.8	6	√		Freshw.
22	*Glossogobius sp*	15.5	26.9	1	√		Freshw
23	*G. aureus*	15.8 - 22.8	32.3 - 88.7	4	√		Freshw.
24	Syncrossus *hymenophysa*				√		Freshw.
25	*Pangasius macronema*	21 - 31.5	88.8 - 210	2	√		Freshw.
26	*Macrognathus acuelatus*	21	49.9	1	√		Freshw.
27	*M. maculatus*	24.9	49.4	1	√		Freshw.
28	*Cyprinus carpio*	31.6 - 743.5	25.3 - 743.5	45	√		Freshw.
29	*Helostoma temminckii*	6.2 - 15.5	3.7 - 76.7	460	√		Freshw.
30	*Papuaengraulis sp*	6 - 21.8	1.4 - 78.1	156	√	√	Marine
31	*Champsodon sp*	12.8	21.1	1		√	Marine
32	*Arius maculatus*	7.6 - 36	2.9 - 548	22		√	Marine
33	*Leiognatus equulus*	4.3 - 7.8	1.3 - 7.5	26		√	Marine
34	*Ambassis sp*	5 - 8.5	1.3 - 7.3	16		√	Marine
35	*Nibea sp*	7.5 - 16.5	2.3 - 78.1	148		√	Marine
36	*Lutjanus sp*	14	46.6	1		√	Marine
37	*Toxotes jaculatrix*	13.4	45	1		√	Marine
38	*Paraplotosus albilabris*	32.7 - 40	150.3 - 307.7	2		√	Marine
39	*Arius sp*	6.2 - 36	1.6 - 548	158		√	Marine
40	*Pellona sp*	5 - 9.5	1 - 5.3	48		√	Marine
41	*Stolephorus sp*	4 - 4.6	0.4 - 0.7	4		√	Marine
42	*Tetraodon biocellatus*	6.4	6.7	1		√	Marine
43	*Aulopareia cyanomos*	13.3 - 13.8	10.4 - 13.3	3		√	Marine
44	*Setipinna sp*	16	23	21		√	Marine
				5568			

Note : * =local and common name.
= 1) Berukung (Sucker barb), 2) Salap (Sucker barb), 3) Tempe (Malayan leaffish), 4) Cicak (Plecostomus), 5) Haruan (Striped snakehead), 6) Toman (Giant snakehead), 7) Lais (Glass catfish), 8) Lepok (Asian glass catfish), 9) Bentilap (Glass catfish), 10) Repang (Minnow (Barb), 11) Puyau (Hard-lipped barb), 12) Sepat Siam (Snakeskin gou.),13) Betok (Climb. perch), 14) Jelawat (Mad barb), 15) Kendia (Cambodian fish),16) Belida (Borneo knife fish), 17) Kalibere (Bagrid catfishes), 18) Betutu (Marble goby), 19) Belut (Swamp-eel), 20) Nila (Nile tilapia), 21) Sebelah (Sole), 22) Beloso/Butu Cina (Goby), 23) Butuh Cina (Gold.flath.goby), 24) Botia Macan (Tiger botia), 25) Lancang (Shark catfish), 26) Sili (Peacock (spiny) Eel), 27) Layur (Frecklefin eel), 28) Mas (Carp), 29) Biawan (Kissing gourami), 30) Lampa (Hamilton's Anchovy), 31) Gabus sungai (Gaper), 32) Manyung (Sea catfish), 33) Pepetek (Ponyfish), 34) Kaca (Commerson's glassy), 35) Gulamah (Soldier croaker), 36) Kakap (Snapper), 37) Sumpit (Archerfish), 37) Sumpit (Archerfish), 38) Sembilang (Gray eel catfish), 39) Otek (Sea catfish), 40) Puput (Yellowfin river pellona), 41) Teri (Indian anchovy), 42) Buntal (Eyespot puffer), 43) Tempakul (Goby), 44 Bulu Ayam (Longfn anchovy, *Setipinna sp*).

Of 20 fish species observed in the lower part of Mahakam, 13 fish were marine species including brackishwater fish (Figure 3). While from 29 fish species observed in the middle part of Mahakam, only one species was commonly living in marine area, Lampa-lampa or Bilis (Bareback anchovy, *Papuaengraulis micropinna*).

Figure 3. Some of the marine fish species found in Mahakam river and its floodplain, East Kalimantan of Indonesia : 1) Lampa (Bareback anchovy, *Papuaengraulis micropinna*), 2) Bulu Ayam (Long fin anchovy, *Setipinna tenuifilis,* 3) Puput (Ditchelee, *Pellona ditchela*), 4) Kaca (Sailfin perchlet, *Ambassis interruptus*), 5) Kapas (Whipfin silver-biddy, *Gerres filamentosus*), 6) Pepetek (Ponyfish, *Leiognathus equulus*), 7) Teri (Indian anchovy, *Stolephorus imdicus*), 8) Kakap (Black bass, Lutjanus bohar), 9) Buntal (Puffer, *Tetraodon sp*), 10) Sembilang (catfish, *Paraplotosus albilabris*), 11) Gulamah (Croaker, *Nibea sp*), 12) Sumpit (Archerfish, *Toxotes jaculatrix*).

Table 4. The indices of fish structure community and the similarity of the two location of fish sampling.

	Middle part of Mahakam				Lower part of Mahakam					
Sampling code	A	B	C	D	H8	H7	H5	H3	Index of BC	
Taxa_S	16	17	20	23	7	9	9	7	Dissimilarity	Similirity
Individuals	1093	492	1228	2185	278	142	89	61		
Shannon_H	2.15	2.354	2.371	1.937	1.317	0.856	1.317	1.192	0.894	0.106
Dominance_D	0.147	0.117	0.121	0.219	0.364	0.656	0.418	0.459		
Evenness_e^H/S	0.536	0.619	0.535	0.302	0.533	0.262	0.415	0.471		
Margalef	2.154	2.611	2.682	2.867	1.091	1.709	1.996	1.842		

All marine fish species found both in the lower and middle part of Mahakam was known to distribute along coastal and sea waters of Makassar strait from southern to northern of Panajam Paser Utara district (Bappeda and Fpik Unmul, 2017), Kutai Kartanegara district (Suyatna et al., 2010), Bontang city (Suyatna et al., 2016) and Sangatta Utara district (Juliani and Suyatna, 2014). Both marine and freshwater fish species in the lower part of Mahakam was also reported in the result of a biophysical observation of Mahakam river (Suyatna et al., 2017).

Based on the Table 4, number of fish species of both locations belonged to moderate. However, higher value of shannon and evenness index observed in the middle part of Mahakam (floodplain of Semayang) explained the population size of fish was more homogenous and no species dominance. Species richness was also higher at the same sampling location. While the value of the bray curtis index showed the similarity of fish species number between the lower part and the middle part of Mahakam was only 0,106 meaning significant different.

4. Conclusion

This study succeeded observing a marine fish species community in river of Mahakam. Thirteen species was identified in the lower part of Mahakam, 44km from coastline and only one species was found in the middle part of Mahakam, 230km from coastline. On the basis of a community of fish, the two sampling locations showed almost completely different. Unexpected fish the introduced fish of Carp (*Cyprinus carpio*) and Nile Tilapia (*Oreochromis niloticus*) were also observed in the middle part of Mahakam.

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