Evaluation Of Batu Bumbun Sanctuary Ecosystem And Management Strategy Affected By Climate Change In Mahakam Watershed, Kutai Kartanegara, Indonesia

Lariman, Wawan Kustiawan, A.Safei Sidik, Sigit Hardwinarto

ABSTRACT: Batu Bumbun Sanctuary (Middle Mahakam Lake) is very important for the fishermen community and Mahakam Irrawaddy Dolphin life concerned to its function as the source of fish and as the feeding ground of Irrawaddy Dolphin (Orcaella brevirostris). The changes in the forest function and the climate (such as rainfall and water surfaces) are predicted to have caused suppression in the ecosystem of Batu Bumbun Sanctuary. The aim of this study is to evaluate the current ecosystem changes of Batu Bumbun Sanctuary and suggest a suitable management strategy as a way to conserve its function. The research was conducted during the dry season (April – June) and rainy season (November – December) 2014, by using survey methods. The measured parameters were including water quality (DO, pH, temperature, TSS, TDS, alkalinity, and clarity), vegetation composition, rainfall, water surface elevation, and sediment. The data of fish community were analysed by using Shanon-Wiener index. The result showed that: (1) The current condition of Batu Bumbun biophysical ecosystem has been experiencing a heavy degradation, showed by a high fluctuation of the water surface in two extreme seasons such as the flood in rainy seasons and silt up in the dry season. (2) The vegetation composition in the riverbanks was composed of five species including Bungur (Lagerstroemia speciosa), Rambai Punai (Chaetocarpus Castano carpus), Kendikara (Dillenia excelsa), Kademba (Mytragina speciosa), and Rengas (Gluta renghas). The dominant tree species was Putat (Barringtonia asiatica) and Perupuk (Lophopetalum javanicum). (3) Batu Bumbun Sanctuary has been experiencing a heavy siltation caused by silt material that piles up the weeds during the rainy season. Since 1985, Batu Bumbun was predicted to have rates of silting around 8 cm/year. From those result, it can be concluded that Batu Bumbun has been experiencing a heavy degradation showed by a high fluctuation of water surface, vegetation composition, and heavy siltation. Then, the most suitable suggestion for its management was (a) dredging, (b) revegetation, (c) restocking native fish, (d) establishing an appropriate institute, (e) preventing illegal fishing, and (f) increasing its security.

Keywords: climate change, ecosystem, Batu Bumbun Sanctuary, management.

INTRODUCTION

Batu Bumbun Sanctuary (Middle Mahakam Lake) is very important for the fishermen community and Mahakam Irrawaddy Dolphin life concerned to its function as the source of fish and as the feding ground of Irrawaddy Dolphin (Orcaella brevirostris). The changes in the forest function and tehe climate (such as rainfall and water surfaces) are predicted to have caused suppression in the ecosystem of Batu Bumbun Sanctuary. The definition of sanctuary fishery is a water protected area for the management of water resources, therefore some activities that potentially damage the area is prohibited (Direktorat Bina Sumber Hayati, 1993). In another word, the general definition of sanctuary fishery is a protected water area functioned to support the aquatic ecosystem that is in a critical condition and endangered (including its endemic species). Sanctuary fishery is an important habitat for fish to breed and spawn, therefore its main goals are conserving the germplasm and the ecosystem, and also every life stage inside the sanctuary (Sarnita, 2000).

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To reach the main goals, the sanctuary should comply the requirements of a good habitat and water quality (physical, chemical, and biological) that can support productivity in the waterbody. Therefore, the water quality should still support the life inside the waterbody both in the dry and rainy season.

MATERIALS AND METHODS

The research was conducted in Batu Bumbun sanctuary (300 ha) located in 115º26' east longitude, 117º36' west longitude, 1º28' north latitude, and south latitude, in East Kalimantan (Figure 1). The research was conducted in February until December 2014 (during siltation period in the dry season and flood period in rainy season). The location was chosen based on its function as the habitat of fish community that can supply of eggs to the hatchery and Irrawady Dolphin habitat in the middle of Mahakam River (Kreb, 2004). Equipment used in this study were GPS, digital camera, camcorder, identification book, and Water Quality Checker-Horiba U-10 as measurement tools. The measurement of water quality was conducted three times at random including temperature, pH, DO (Dissolved Oxygen), alkalinity, and water clarity. Fish sampling was conducted by using experimental gillnet, net, and fish trap. The collected fish specimens were directly identified based on Weber & Beaufort (1913, 1916, 1922), Kotelat (1993), and Saanin (1984), while the vegetation was identified based on Heyne (1987), Lemmens etc. (1989), Ngatiman and Budiono (2009), and Bratawinata (2011).

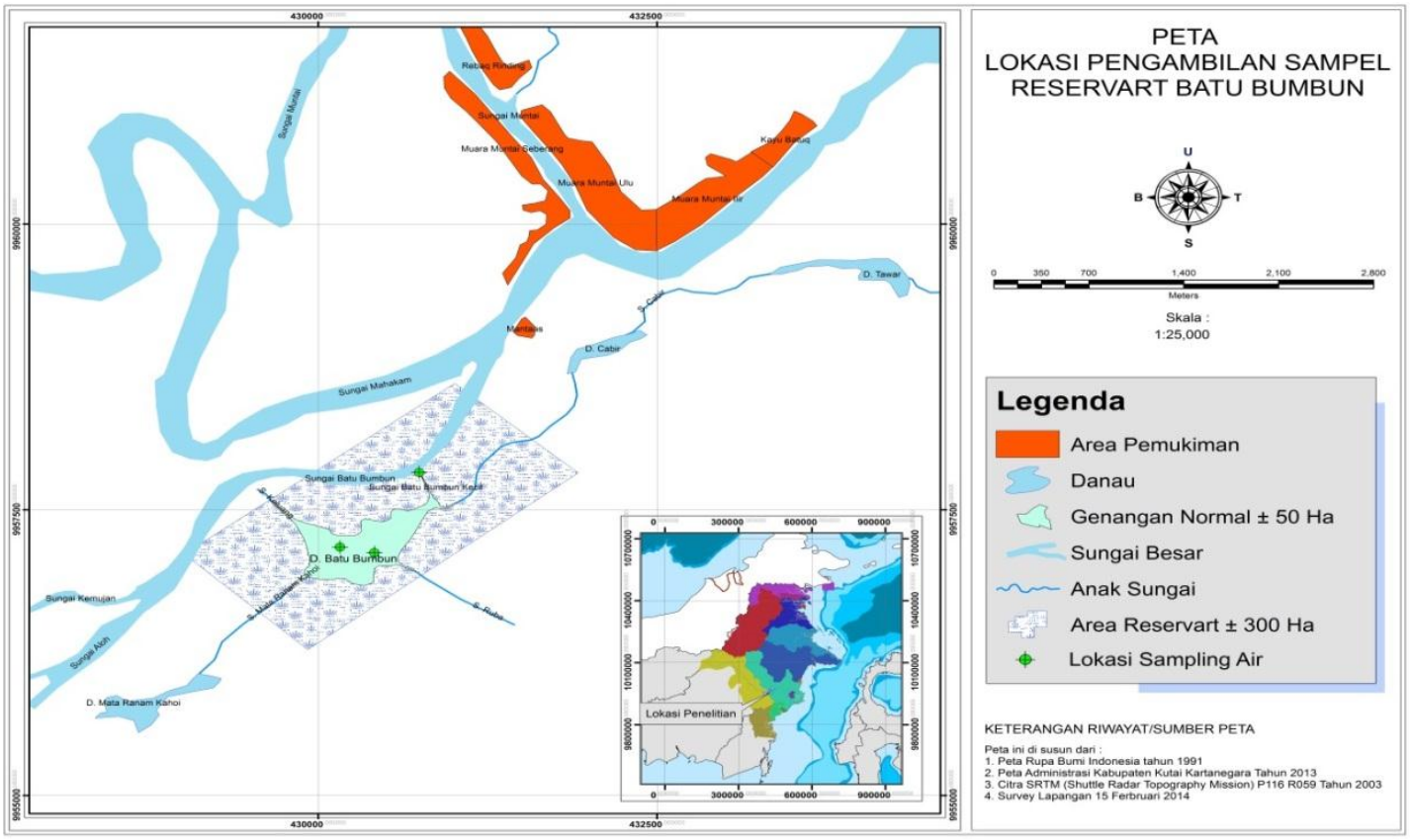

Figure 1. *Map of Batu Bumbun Sanctuary showing sampling location.*

RESULTS AND DISCUSSIONS

1. Climate in Batu Bumbun Sanctuary

Rainfall is one of climate element that varies in each location, it also determines the water input from the atmosphere to the water system. Rainfall variation, both spatial and temporal including its quantity, depends on the circulation of global climate, topography, and land used. Data of rainfall in Batu Bumbun Sanctuary is very important due to its relation with the water surface of the sanctuary. The nearest rainfall station is in Bangun city, called Balai Wilayah Sungai Kalimantan III, therefore data of rainfall was collected from Mahakam watershed in Bangun city during 1986 until 2013.

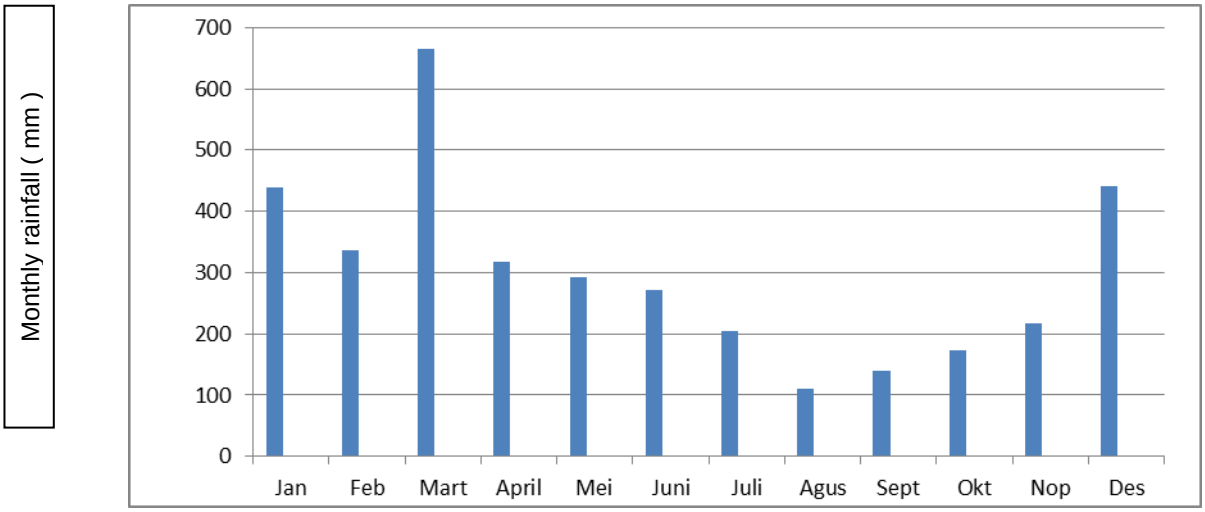

Figure 2. *The average monthly rainfall in Bangun city.*

The recorded data of rainfall in Bangun city during the latest 28 years (1986-2013) showed that the monthly rainfall was ranged between 110 mm to 664 mm. There were two peaks of rainfall in a year. The highest rainfall occurred in March that was started from January and February. The rainfall was decreasing started from April and reached the lowest value in August, then it started to increase in September and reached the second peak of rainfall in December (Figure 3).

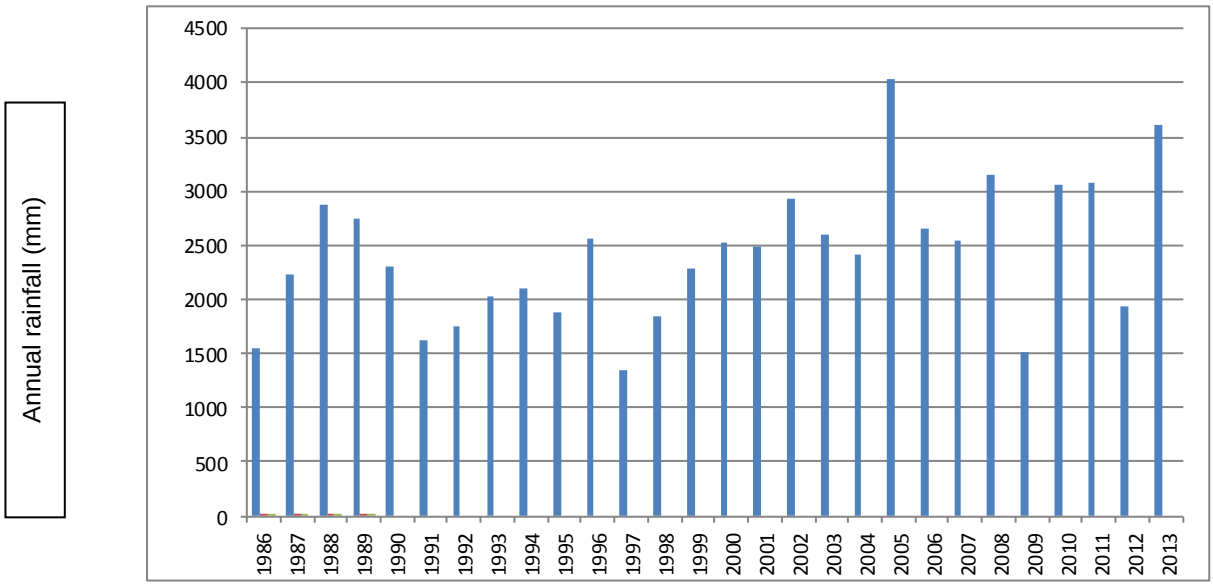

Figure 3. *The average annual rainfall in Bangun city.*

The recorded data of rainfall during 1986-2013 (Figure 4) showed that the highest rainfall occurred in 2005 (4.037 mm), followed by the year 2013 (3.606 mm) and 2008 (3.149 mm). The lowest rainfall occurred in 1997 (1.346 mm), followed by the year 2009 (1.512 mm) and 1986 (1.552 mm). Two rainfall peaks occurred between January–May and October–December. The longest wet season reached to 12 months occurred in 1989, 2001, 2010, 2011, and 2013, while the longest dry season reached to 5 months occurred in 1997. The highest total of rainy days reached 193 days in 1988 and 1996. The highest maximum rainfall was 230 mm in 2010 and 2011, while the lowest maximum rainfall reached 73 mm in 1993. The rain that happened in Batu Bumbun classified as frontal rain due to the caused by deforestation (i.e. for agriculture and residences) or forest fire, causing the region has a higher temperature compared with the region covered by natural vegetation. A higher temperature caused the air to expand and stimulate the surrounding air to move towards the region. This movement affected the clouds to move, cover the region, and then trigger a heavier rain.

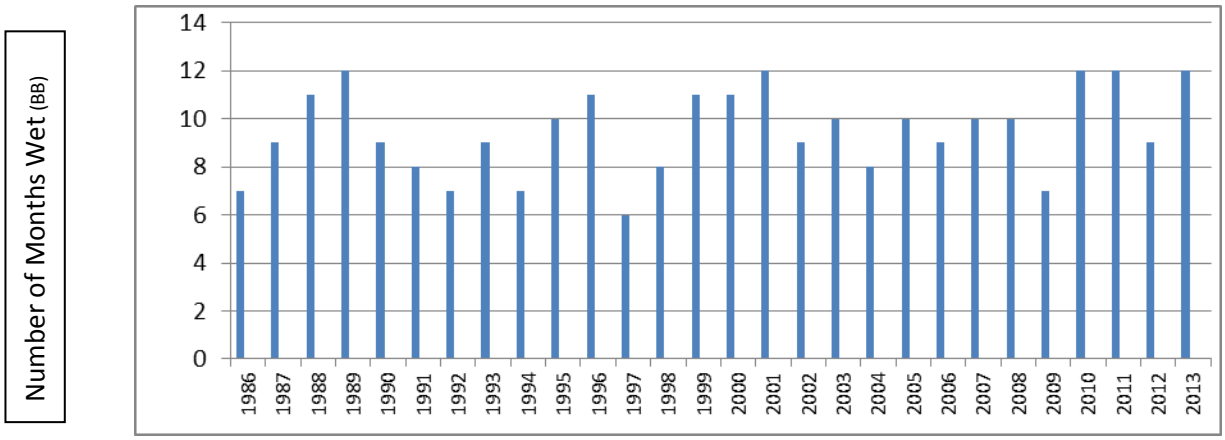

Figure 4. *A number of the wet seasons (months in a year) started from 1986 to 2013 in Bangun city.*

The data of wet season in each year (Figure 5) started from 1986 to 2013 showed that wet months were varied between 6-12 months in a year. The differences of wet months in each year predicted to highly affected siltation in the sanctuary. Flood inflows during the wet season that happened almost throughout the year (10–12 months) carried out dissolved solids and resulted in thick sediment at the bottom of sanctuary fishery. The opposite was happened during a long dry season (4 –5 months in a year). During that period, no water got into the sanctuary fishery while the rest of water flowed into Mahakam river, thus drying the sediment and then overgrown with the weeds.

Repeated events of siltation and flood during 1986 to 2013 have caused a heavy siltation followed by the constriction of the sanctuary.

The Condition of Sanctuary Fishery and Conservation Efforts

Batu Bumbun Sanctuary-wide has reduced, from 450 ha to 300 ha, and has experienced a heavy degradation. The occurring siltation disconnected the groove that linking the sanctuary with its surrounding river. During the rainy season, water from the surrounding river was flooded and got into the sanctuary with 5-6 m depth, and then drowned the weeds.

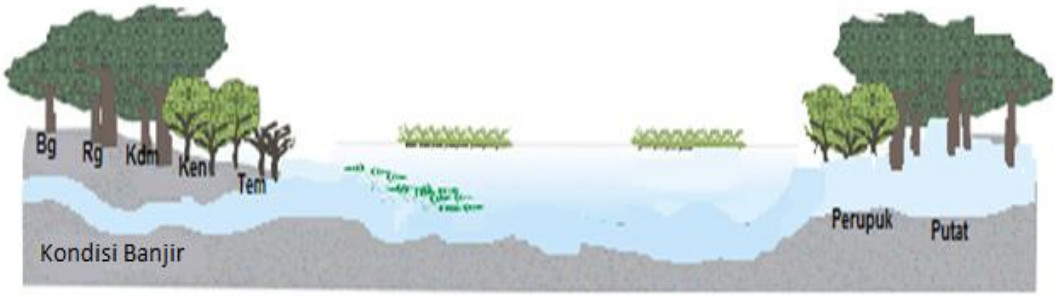

Figure 5. *The vegetation of Batu Bumbun Sanctuary during a long wet season.*

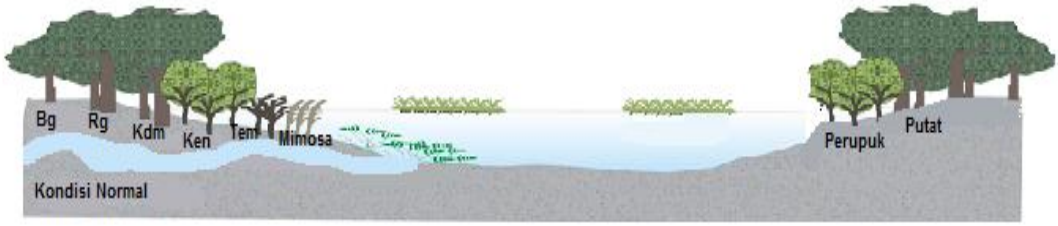

Figure 6. *The vegetation of Batu Bumbun Sanctuary in normal condition.*

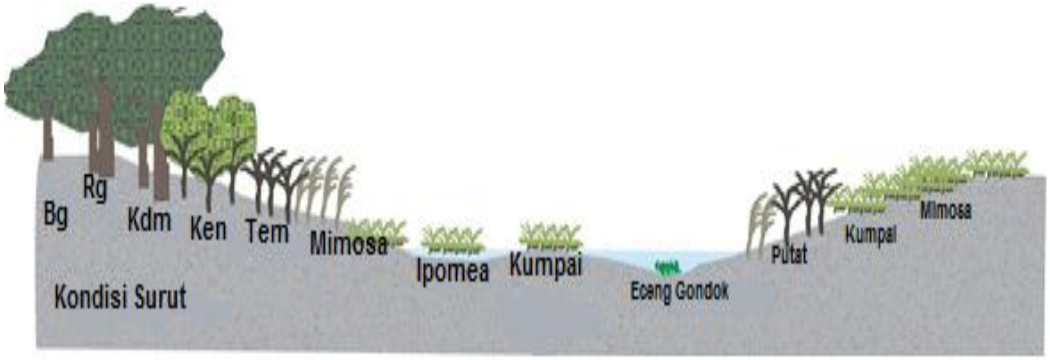

Figure 7. *The vegetation of Batu Bumbun Sanctuary when the water level decreased during a long dry season.*

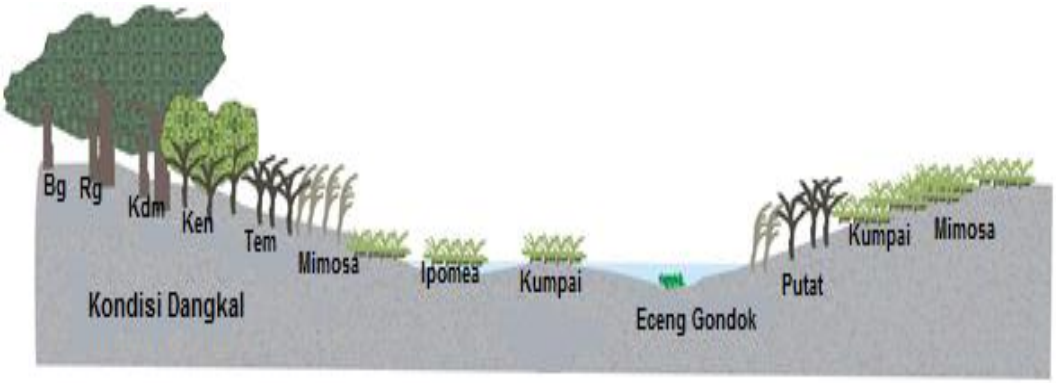

Figure 8. *The vegetation of Batu Bumbun Sanctuary when the water level decreased during a long dry season.*

During a dry season, water stagnation occurred only in the 0,75 ha of sanctuary fishery and mostly covered by mud cracks overgrown with weeds, such as common water hyacinth, grass, water spinach, etc. In a longer dry season, some of the weeds was burned by the officer to reduce siltation in the next wet season. According to the biophysical condition of the sanctuary during the research, the most suitable management and rehabilitation plans are:

a. Mapping the area; the most recent condition of the sanctuary can be monitored by the officer, therefore they can take a significant action to prevent a heavy siltation.
b. Rehabilitation of the monitoring post to increase its effectiveness.
c. Dredging some parts of the sanctuary fishery that have a quite high silting.
d. Revegetation in some certain parts of the sanctuary fishery, especially in the spawning ground.
e. Restocking native fish into the sanctuary and common species of high economic value.
f. Transportation procurement optimization services to guard against illegal fishing.
g. Increase the monitoring system to prevent illegal fishing and the use of harmful tools/materials.
h. Integrating an appropriate unit comprised of the department of forestry, department of fisheries and marine resources, department of public works (BWS Kalimantan III), environmental unit, conservation of natural resources unit, BAPEDA, subdistrict, village, and village institutions.

Conclusion

From those result, it can be concluded that Batu Bumbun has been experiencing a heavy degradation showed by a high fluctuation of water surface, vegetation composition, and heavy siltation. Then, the most suitable suggestion for its management was (a) dredging, (b) revegetation, (c) restocking native fish, (d) establishing an appropriate institute, (e) preventing illegal fishing, and (f) increasing its security.

References

[1] Anonim. 2001, Peraturan Pemerintah Republik Indonesia Nomor 82 Tahun 2001 Tentang pengelolaan kualitas air dan pengendalian pencemaran air.

[2] Badjoeri, M. & Lukman. 1998, Pemanfaatan tumbuhan air kumpai dari Danau Semayang sebagai pakan sapi. Dalam: Anonimus (Eds). Pendayagunaan dan Rehabilitasi Lingkungan Perairan Danau Semayang Kalimantan Timur, Puslitbang Ekonomi dan Pembangunan LIPI, Jakarta. Hal.125-133.

[3] Doi, A. R. Komatsu & D. I. Hartoto, 2000, Fish occurring in a black water oxbow lake in South Borneo. Report of the Suwa Hydrobiological Station Shinshu University No.12 (ISSN 916-3255): 25-28.

[4] Effendie, M.I.,1979, Metoda biologi perikanan. Yayasan Dewi Sri. Cetakan I, Bogor. 112 hlm.

[5] Hartoto, D.I.,1989, Profil Oksigen dan Suhu. Dalam:A. Nontji dan D.I. Hartoto (Eds). Limnologi Situ Bojongsari, Pusat Penelitian dan Pengembangan Limnologi, Lembaga Ilmu Pengathuan Indonesia: 30-50

[6] Hartoto D.I. & E. Mulyana, 1996, Hubungan antara parameter kualitas air dan struktur ikhtiofauna perairan darat Pulau Siberut. [The relationship of water quality parameter and inland water Ichthyofauna Structure of Siberut Island.] Oseanologi dan Limnologi di Indonesia (OLDI), No. 29: 41-55.

[7] Hartoto, D.I.,1997, Notes on limnologi condition of Lake Loakang as feshery reserve and its potential as food supplay habitat for Mahakam Freshwater Dolphin. In Rehabilitasi Lingkungan Perairan Danau Semayang, Kalimantan Timur. Puslitbang Ekonomi dan Pembangunan LIPI, Jakarta. p.63-65.

[8] Hartoto, D.I.,2000, An overview of some limnological parameters and management status of fishery reserves in Central Kalimantan. Report of the Suwa Hydrobiological Station Shinshu University No.12 (ISSN 916-3255): 49-74.

[9] Hartoto, D.I.,2004, Perlindungan, mitigasi dan restorasi habitat untuk pengelolaan perikanan tangkap di perairan umum. Makalah disajikan pada Lokakarya Pengelolaan Perikanan Perairan Umum Wilayah Kalimantan dan Sumatera, 7-9 Juli 2004, Palangkaraya, Kalimantan Tengah. 40 hal.

[10] Hartoto, D.I. & Yustiawati, 2006, The level of humic acid levels at various type of inland water in Central Kalimantan. Oseanologi dan Limnologi di Indonesia, No. 39:1-20

[11] Krebs, C.J.,1985, Ecology, The experimental analysis of distribution and abundance. 3 rd edition. Harper and Row Publisher, New York. 694 p.

[12] Kreb, D.,2004, Facultative river dolphins. Conservation and social ecology of freshwater and coastal Irrawaddy dolphins in Indonesia. Copyright© D. Kreb 2004 (ISBN: 90-76894-515): 230 pp.

[13] Lukman, 1998, Kualitas air Danau Semayang pada periode pra penyurutan dan pra penggenangan. LIMNOTEK, Perairan Darat Tropis Di Indonesia, V(1):77-84.

[14] Lukman & Gunawan, 1998, Lake Semayang and Melintang, East Kalimantan as the habitat of Freshwater Dolphin. Dalam: Anonimus (Eds). Pendayagunaan dan Rehabilitasi Lingkungan

Perairan Danau Semayang Kalimantan Timur, Puslitbang Ekonomi dan Pembangunan LIPI, Jakarta. Hal. 51-68

[15] Nasution, S.H., D.I. Hartoto, Dharmadi, & D. Oktaviani,2008, Kelimpahan ikan Putihan dan hubungannya dengan pemunculan Pesut Mahakam. Jurnal Oseanologi dan Limnologi Di Indonesia, 34(2):133-149.

[16] Nasution, S.H., D.I. Hartoto, Dharmadi & D. Oktaviani, (In publication). Struktur komunitas dan kelimpahan fitoplankton di lingkungan habitat Pesut Mahakam. 16 hal. (Dalam proses penerbitan di Jurnal Penelitian Perikanan Indonesia).

[17] Pescod, M.B.,1973, Investigation of Rational Effluent and Stream Standards for Tropical Countries. AIT Bangkok. 59 p.

[18] Purnomo, K., D.W. H. Tjahjo, H.Suharto, C. Umar & A. Sarnita, 1992, Penelitian potensi sumberdaya perairan Danau Semayang, Melintang dan Jempang di Kalimantan Timur. Prosiding Seminar Hasil Penelitian Perikanan Air Tawar 1991/1992. Balitkanwar, Bogor. Hal.274-284.

[19] Priyono, A.,1994, Telaah habitat Pesut (Orcaella brevirostris Gray, 1866) di Danau Semayang dan sekitarnya. Media Konservasi. Fak. Kehutanan IPB, Bogor. 4(3):53-60.

[20] Purnomo, K.,1994, Potensi sumberdaya perikanan di Danau Semayang dan Melintang. Frontir. Universitas Mulawarman. Samarinda, 14:123-136.

[21] Riyanto, W.,1996, Komposisi jenis ikan di beberapa tipe habitat Danau Semayang, Kalimantan Timur. Dalam: Anonimus (Eds). Pendayagunaan dan Rehabilitasi Lingkungan Perairan Danau Semayang Kalimantan Timur, Puslitbang Ekonomi dan Pembangunan LIPI, Jakarta: 53-66.

[22] Ridgway, S.H. & S.R. Harrison, 1989, Handbook of marine mammals. Vol.4, River Dolphins and the Larger Toothed Whales. Academic Press Limited, Toronto. 441 p.

[23] Weber, M. & K.L.F. de Beaufort, 1913, The fisheries of Indo-Australia archipelago. Vol. II. E.J. Brill. Ltd., Leiden: 404 pp.

[24] Weber, M. & K.L.F. de Beaufort, 1916, The fisheries of Indo-Australia archipelago. Vol. III. E.J. Brill. Ltd., Leiden: 455 pp.

[25] Weber, M. & K.L.F. de Beaufort, 1922, The fisheries of Indo-Australia archipelago. Vol. IV. E.J. Brill. Ltd., Leiden: 410 pp.

[26] Welcomme, R.L.,1979, Fisheries Ecology of Floodplain River. Longman Inc., London. 317 p.

[27] Welcomme, R.L.,2001, Inland Fisheries, Ecology, and Management. Fishing News Books, A Division of Blackwell Science Ltd, London. 358 p.

[28] Yustiawati & D.I. Hartoto, 2004, 7. Distribution of Aquatic Humic Substances in Lake Loa Kang Floodplain System. In: Monograph No. 3. Ecological Integrity of A Mahakam Floodplain System, by D.I. Hartoto and Yustiawati (Eds), Research Centre for Limnology, Indonesian Institute of Sciences, ISBN 979 3688-25- 4:73-80.