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THE IMPACT OF FOREST AND PEATLAND EXPLOITATION TOWARDS DECREASING BIODIVERSITY OF FISHES IN RANGAU RIVER, RIAU-INDONESIA

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Abstract: *This survey study was periodically conducted in July, 6 times every year. There were 3 periods: 1st period (2002); 2nd period (2008) and 3rd period (2014). It sheds light on the impact of forest and peat land exploitation on decreasing biodiversity of fishes in Rangau River, Riau-Indonesia. Using some catching tools such as landing net, fishing trap, fishnet stocking and fishing rod. The sampling activity was administered at eight stations which were conducted by applying "catch per unit effort technique" in primary time: 19.30-07.30, for 3 repetitions for each fish net measurement within 30 minutes at every station, at position or continuously casting. The sampled fish were selected which were relatively in minor size but had represent their features and species. The fish were labelled and were preserved with 40% formalin. The determination and identification of fish were conducted at laboratory. Secondary data was collected by mean of interviewing the local fishermen about the surrounding environment condition of Rangau river. Data analysis consisted of biodiversity data, biodiversity index and fish existence frequency. The finding in 1st period, in 2002, total caught fish were 60 species: 36 genera and 17 families. In 2nd period in 2008, total caught fish were 38 species which consist of 30 genera and 16 families. In 3rd period, in 2014, there were 23 of fish species were found comprising 17 genera, 12 families. The highest biodiversity index (H^1) through out the survey was in VIII stations, in period 1, 2 and 3 with (H^1) 1.99; 1.85 and 1.80. On other hand, (H^1) the lowest biodiversity index (H^1) in 1st period was at IV station (0.95). In 2nd period, there were no fish identified at station-III ($H^1 = 0$) and in 3rd period, there were no fish at station II, III and VII. In 1st period, there were 4 commercial value fish were found. In 2nd period, there were 2 species were found in 3rd period, there was only 1 commercial value fish species were caught. The fish highest existence frequency was Cyprinidae family. The second highest was the fish group of Siluridae and Bagridae family. Conclusion, impact of forest and peat land exploitation towards the decreasing biodiversity of fishes in Rangau River.*

Keywords: *Pearland Exploitation, Biodiversity of fish, Rangau River, Riau.*

1. INTRODUCTION

Riau province has 3214 islands, 4 main rivers, some tributaries and peat swamps. The 4 main rivers are Siak river, Kampar river, Indragiri river and Rokan river.

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The down stream of Rokan river is located in Rokan Hulu (ROHUL) regency and upstream lies in Rokan Hilir (ROHIL) regency. Rangau river is one of tributaries of Rokan river which is located in upstream of Rokan river, across the watershed surrounded by dense forest and peat swamps.

Riau province is a region which is richly endowed with natural resources. One of sources is the wide tropical forest areas. The areas are then exploited and are mapped as conservation and biosphere reserves.

The balance data of forest resources of Riau Province in 2012 indicates that area with total width of 7.127.237 hectares serves as production forest, conservation and biosphere reserves (Gema BNPB, 2014). Such huge forest appears to have triggered the forest and peat land fire.

Bandono S (2003) explains that Riau province owns high potential cultivation development areas for plantation that covers 3.13 million ha or 33.14% from the total width of region 0.39 million ha area is the boggy low lands which were affected by tides of sea.

Typology characteristic of low land ecosystem of Riau province is the low land tropical forest and peat bog. Local community rapidly exploits the natural environment for subsistence farming or uses it for a great deal of development activities in forestry, plantation, mining and industrial sites. Slash and burn method therefore seems to have been common strategy in land clearance (Adi nugroho dkk, 2005 and Haris Gunawan, et al., 2014).

It had been observed from 2010; forest and peat land fires produced 1.527 hot spots and drastically increased with 4.675 hot spots in 2013. The fire period usually falls in February and March 2014, highest rank of peat land fire occurred in Bengkalis (7.836 ha), Meranti (6.339 ha), Rokan Hilir (2.504 ha) and Siak (1.116 ha) (BPBD Riau, 2014).

At present, Riau Province is recorded as one of the most severe province in forest and peat land fires disaster. In 2014, forest and peat land fires reached 302.279,43 ha. of hot spots and width of burnt areas

Since 1997, forest and peat land fires disaster in Riau had occurred for more than 17 years.. The general deteriorating effect of this disaster is the longer of dry season and shorter of rainy season than before.

Deforestation effect not only result in a climate change acceleration, but also the micro local climate change such as the absence of regular flood of main river and prolonged drought across the water shed which has happened in last 17 years.

Siregar et al. (1993) reveals that fish life in water of eastern Sumatra deeply depend on main river stream which regularly overflowed once or two times

annually. Most of big fish moves out of main river stream and get in to inlet and marsh or puddle in forest for spawning and foraging.

The peat land forest exploitation across the watershed of Rangau river has been assumed to have contributed to variety of change of fish habitat, flood cycle change and other climate conditions.

Studies on impact of peat land and forest exploitation across the watershed of Rangau River on declining of biodiversity of fish species are therefore deserved to be conducted. They are expected to be empirical information and as indicators in deciding conservation policy and inputs in ecology material development and instruction, particularly the topic on impact of forest and peat land exploitation on biodiversity. This idea is in line with what Yuli at all (2013) argue that continued environment-centred learning do need the educators' creativity in responding issues on environment in everyday life for contextual instruction materials.

2. METHOD

This research was conducted in Rangau river, Rantau Kopar village, Rokan Hilir regency, Riau province. It is a survey study which was done in 3 periods in June within 6 years. The periods are as follows: 1st period (2002); 2nd period (2008); and 3rd period (2014).

The sampling was administered orderly in 8 research stations, from station 1 to station 8 : (1) Rangau river down stream, (2) Black tributary, (3) Pematang Cempedak tributary, (4) Timber location, (5) Fish auction counters, (6) Residential canals, (7) Farmer tributary, (8) The upstream of Rangau river. Primary data: (1) Qualitative data collection in form of gathering of fish specimen as much as possible based on number of species across Rangau river.

The applied sampling technique was "catch per unit efforts" by exploitation techniques using fish net stocking was conducted from 19.30-07.30. The catching was done at this time for it is thought to be the primary time of fish for foraging. It was acknowledged from the high percentage of gastric emptying and vertical migration of plankton and zoon plankton at night, so that fish will come up to surface (Yustina, 1998).

The sampling was done three times repetitions for each fish net measurement for 30 minutes at each station in irregular casting areas. The coughed fish were put in container which weigh 3-5 kg and had been contained with half of water. The selected sampled fish were relatively small but had represented the features of their species. The fish were preserved with 40% of formalin and were labelled with notes: local name, catching tools, location, time and place or the catching station. After wards, identification and determination of fish was conducted at laboratory by referring to library literacy. The secondary data were collected in form

of interviewing the local fishermen on condition of Rangau River, species diversity data analysis, diversity species index, frequency of fish existence. Such qualitative data collection refers to Yustina (1998).

3. FINDINGS AND DISCUSSION

3.1. Findings

The result demonstrates the declining of biodiversity of fish species in each periods observation (Figure 1), and biodiversity of fish species index (H^1) provided in Figure 2.

The distribution status of fish species based on fish existence throughout the observation provided in appendix 1 and fish species which are commercially valuable were not found (Table 1), profile of hue environment across the watershed in Table 2.

The survey result (Figure 1) in 2002 says that 17 families, 36 genera and other 60 fish species were identified. The catching result in 2008 (the second period) found 16 families, 30 genera and 38 fish species. In 3-rd period, in 2014, 12 families, 17 genera and 23 fish species were found. The graphic implies that there had been decreasing of biodiversity interims of genera and family. Such extreme declining occurred in 3-rd period in 2014.

The highest biodiversity index of fish (H^1) during the survey was at station 8, in the 1, 2 and 3 with (H^1) 1.99; 1.85 and 1.80. The lowest was in 1st period at station 4 (0.95), in 2nd period, fish were not found at station 3, and in 3rd period, fish were not at station 2, 3 and 7. It indicates that index biodiversity of fish is null (Figure 2).

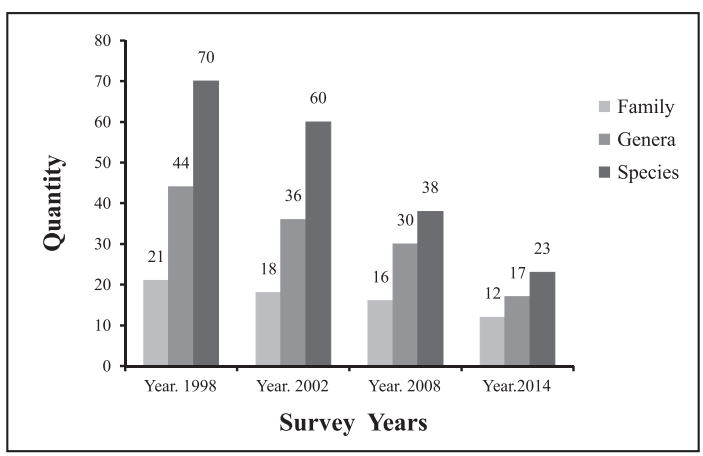

Figure 1: Biodiversity of fish species based on family, Genera and species during the observation years: 2002, 2008 and 20014 compared to data in 1998).

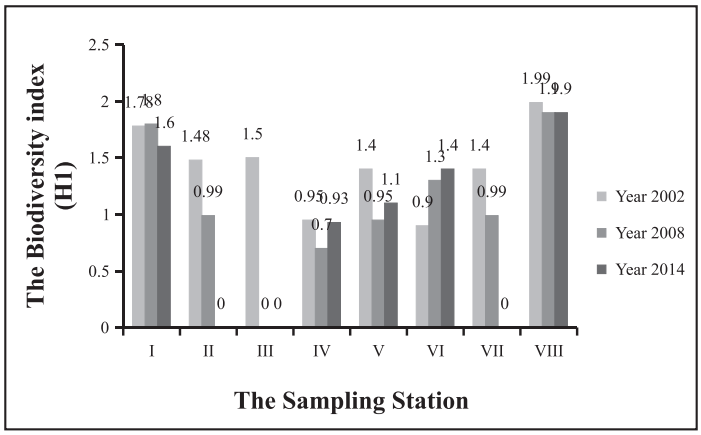

Figure 2: The biodiversity of fish species index based on catching station of survey result in 2002, 2008 and 2014 in Rangau River, Riau province

The status of fish based on existence frequency can be seen in appendix-1 that account for highest of fish existence frequency across Rangau river at 1st sampling from the 1st period to 3rd period were the f Cyprinidae family or the "white fish" group. Then, second highest was the "Cat fish" group of Siluridae, Bagridae family, and lowest frequency was the fish group of "Blackfish": Ordo trichogaster, Anambas, Channa and Clarias.

The frequency distribution of fish existence experienced declining of all species of fish in 2008; however, in 2014 observation, fish existence frequency demonstrated an extreme declining.

Detailed observation about the fish status refers to highest commercial value fish (Table 1), shows that 5 of 6 of commercial fish across Rangau River, only 1 species was identified: *Channa micropeltes* (Cuvier)

Tabel 1
The commercial value Fish species which were not identified during the observation in 2002, 2008 and 2014 compared with data in 1998

Commercial value fish species which were not found in 1998	*Local Name/ Family*	*2002*	*2008*	*2014*
Oxyeleotris marmorata (Blkr)	Betutu/Eleotridae	*x*	*x*	*x*
Belandotichys dinema (Blkr)	Singarek/Siluridae	*v*	*x*	*x*
Wallago leerii (Blkr)	Tapah/Siluridae	*x*	*x*	*x*
Notopterus notopterus (Pall)	Belida/Notopteridae	*v*	*x*	*x*
Channa micropeltes (Cuvier)	Toman/Channidae	*v*	*v*	*v*
Pangasius pangasius (Ham Buch)	Jambal/Patin/Pangasidae	*v*	*v*	*x*
Number of commercial value fish which were still found in first observation of first year		4	2	1

Description: *x* (not found); *v* (found)

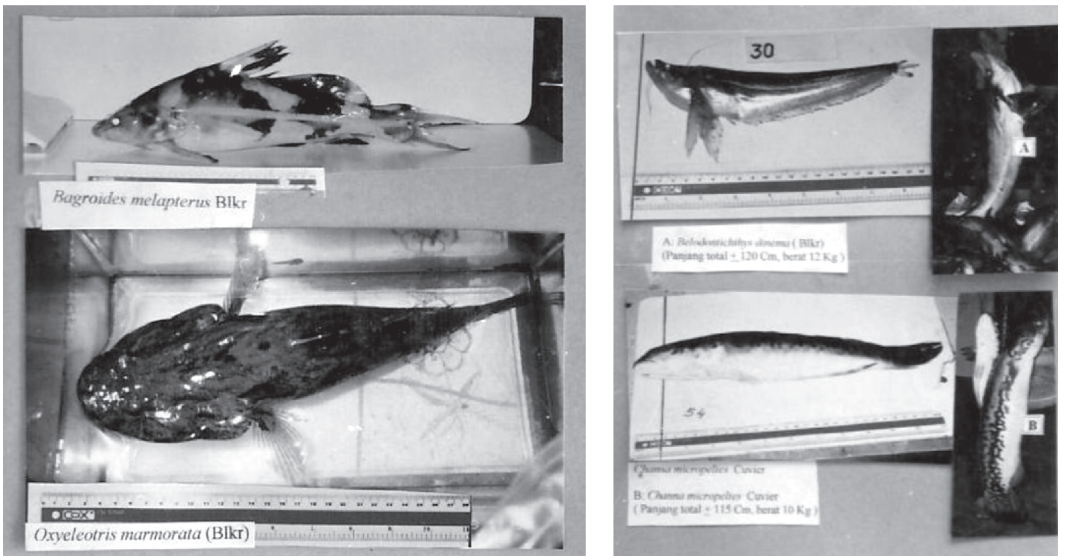

Figure 3: Some commercial fish across Rangau river
(Document: Yustina, 1998)

Hue environment across the Rangau river watershed has contributed to scarcity of some commercial fish and low fish existence frequency.

The Watershed profile of Rangau river is provided in (Table 2) as follows:

Table 2
Hue environment profile across the Rangau river watershed in 2002, 2008 and 2014 compared with 1998

Year	*Forest Vegetation across the Watershed*	*Number of hot spots across Watershed*	*Number of tributaries across Rangau river*	*Number of Canals*	*Regular flood in main river*
1998	Dense and canopied	None	4 tributaries	None	1-2 times annual flood
2002	The land had changed into oil palm plantation	There were 2 locations	The water flow of Cempedak tributary had decreased.	Three were 1 canal	1 time flood within 3 years.
2008	Oil palm plantation	There were 5 location	The water flow of Cempedak tributary had been had stopped	Three were 4 canals	1 time flood within 5 years.
2014	Some of sandy fruit oil palm	There were 10 location	pematang campedak tributraty, black tributary and farmer tributary were drained	There were 10 canals	There was no regular flood within 5 years.

Figure 4: The peatland exploitation by burning across the watershed of Rangau river

3.3. Discussion

The biodiversity of fish species across Rangau river (Figure 1) in 2002, 2008 and 2014 had demonstrated the declining of fish population. Consecutively, in 1st period there were 60 species, 38 species in 2nd and 23 species in 3rd. In terms of genera, 1st period, 36 were identified, 2nd, there were 30 and in 3rd period, there were 17. Meanwhile, in family classification, in 1st period, 18 were found, 16 in 2nd and 12 in 3rd period. These data reveals that there had been drastic decreasing of biodiversity of fish in each period.

The severe reduction of biodiversity of fish species in 3rd period (2014), compared with survey done by Yustina (2001) says that biodiversity of fish across Rangau river, Riau province consists of 21 families, 44 genera, and 70 species. Furthermore, Dorlan and Yustina (2002) explains that in peat swamp areas across the water shed of Rangau river, there had been 13 fish species of commercially caught *black fish* group either for consumption or decoration.

From the 1st, 2nd and 3rd period, highest index biodiversity of fish ($H^{1)}$ was at eight stations (upstream of Rangau River). It was caused by draining of peat land and tributaries which may lead to declining number of fish micro habitat. Some fish species tend to concentrate on swimming across the river main stream (down stream and up stream of Rangau), especially the fish of cyprinidae family and other fish species with low stream micro habitat, i.e., siluridae (Lais).

Station IV and II, III and VII were categorized in to low index biodiversity (null), since there had been drought in three stations (tributaries are lack of water) and peat land had changed in to oil palm plantations. The drastic change of fish micro

habitat had contributed to loss of their habitat and consequently the fish existence is automatically severely scarce particularly at II, III and VII stations.

During the sampling process through out the survey (three periods), cyprinidae family or the *white fish* group was the highest existence. The second highest existence was the "cat fish" group from siluridae and bagride families. Meanwhile, lowest existence was the "black fish" group such as ordo trichogaster, anambas, channa and clarias.

The decreasing of biodiversity of fish in 2008, seems to have occurred in cyprinidae family of "*white fish*" group. It is associated with reduction of water surface, canopy cover and peat water infiltration that may lead to rise of water temperature and oxygen solubility.

Yustina (1998;2001) explains that fish of cyprinidae family is a group of fish which can not endure to low level oxygen. The low level oxygen is closely connected to water rise temperature or to polluted water area. The high of water temperature across Rangau river is caused by canal construction.

The increasing numbers of canals along the watershed of Rangau river are as follows: in 2002, there was 1 canal, in 2008, 5 canals and 2014, 10 canals were constructed (table 2). The forest and peat land exploitation had been changed in to oil palm plantation. The land use for oil palm plantation was begun with construction of canals. They were intended as means of for: (1) transporting wood at time of land clearance; (2) drying the peat land areas for growing the oil palm.

The increasing number of canals was closely associated with reduction and cessation of water flow of tributaries due to drought. Of four tributaries flowing across the Rangau river. In 1998, there were Black River tributary, Cempedak tributary, Natural channel flow of residential and Farmer tributary.

In 1st period, it was observed that water flow across Cempedak tributary had reduced. In 2nd period, flow of Cempedak tributary had stopped; in 3rd period, three tributaries: Cempedak tributary, Black Tributary and Farmer tributary tend to be drained.

According to Yustina (1998), Black tributary is a tributary that own high micro habitat across the Rangau River. It has a wide variety of forest plant vegetations which are naturally grow in major sizes (the diameter is above 3 meters). There were also reservoirs which coexist with peat bogs surrounding the forest; access to Black tributary is therefore blocked.

The canopy of plan canopy vegetation contributed to stable and cold water temperature either in dry or rainy season. Across the Black river is home for a great variety of biodiversity of fish particularly from the black fish species compared to

other seven sampling stations. Black tributary owns specification in its own right with black colour water which is similar to coffee or used oil and tasteless. When being observed comprehensively, there was striking difference when the black tributary flow meets with water flow of Rangau River which was white and turbid. The water source and plants surrounding the peat land may be the leading factor of black colour of river (Yustina, 1998).

The increasing of forest and peat land exploitation across the watershed has led to change of hue environment of surrounding aquatic habitat. The water become widely opened and exposed without any shades (the tree vegetation canopy). This condition has affected the water rise temperature, land erosion due to insufficient of rooting of plant tree.

The characteristic typology of volatile peat land which is similar to sponge: become fragile in dry season and hollow will be easily led to fire and propagate through the hollow which contain oxygen. The peat land condition in Riau province with varied depth which may reach above 15 meters had made the fire propagation like the fire in husk. It keeps spreading and flaring when the wind blows. It may be worst with lack of access and is difficult to reach the scene of peat land fire to be extinguished. It may accelerate and expand fired areas which take a long time (during the dry season) or it may be stopped by torrential rain continuously which may wet through the peat land.

Suwondo et al. (2011; 2015) says that heterogeneous of tropical forest has a characteristic area with multiple vegetations and grow closely. The morphology and physical of forest are humid both in dry and rainy season.

Tropical forest plays a strategic role in conditioning daily weather and annual climate. The characters of forest and peat land in this area are wet and watery which is naturally never dry. The tree root and forest plant form the air void and soil porosity which naturally acquire an ability to reserve water greater than the land which are not closed by vegetation or forest. The plant root formation of peat land and forest in tropical area produce the barn water system so that high rain fall can not cause flooding as the soil feature enable to absorb and reserve water in very big volume.

The peat land also has dynamic capacity when encountering a high rain fall. The peat layer will expand to form a dome of water. The dynamic character of peat which enable to expand and counteract depend on incoming water volume. Water dome serves as water reserves in peat land forest.

Rangau River has affected the local physical changes such as land drying, reduction of tributary flow, increasing of water temperature and change of flooding season regularly across Rangau River.

Naturally, Rangau river experiences flooding regularly every year. The peak of flooding season falls on November and December, afterwards, water will recede towards the main river in February and March.

When the water recedes, fish seeds abundance increases as the fish which had implemented spawning will make effort to return to main stream (Yustina, 2001).

Furthermore, Yustina and Arnentis (2002) stress that at time of flood, water overflows from the main river and block the watershed, peat land and forest across the river. When the flooding comes, fish will migrate to forest and peat for discovering places for foraging, nesting and spawning under litter and plant roots for seeking refuge. Such fish activity has produced a wide variety of fish micro habitats which present during the flood season both in forest and peat land areas. The availability of abundant feed in peat swamp and puddle in forest will stimulate the acceleration process of gonad cutting of fish and then are ready for spawning.

Yustina (2001) emphasizes that biodiversity level is closely related with features and variety of habitat. Meanwhile, abundance of fish is clearly correlated with water temperature in dry season. Conversely, in rainy season, stream speed, organic material level as well as the oxygen level dissolves. The biodiversity index ($H^{1)}$ of fish species in dry season are clearly correlated with both water temperature and organic material level.

Siegert et al. (2001) states firmly that forest fire may lead to forest degradation and deforestation, soil erosion, mal function of flood control, decreasing of biodiversity and weather anomalous which were triggered by forest fire. Sargeant H.J (2001) stresses that change of peat land use in Riau, Jambi and south Sumatra has contributed to smog and haze that has spread to neighbouring countries such as Singapore and Malaysia peninsula. It is further emphasized that degradation of burnt peat land threatens the livelihood in fishery and agriculture sectors.

4. CONCLUSION

The forest and peat land exploitation, construction of canals have contributed to draining swamp and creeks. The forest and peat land fire have caused the change of local climate (the rise of water and air temperature, and change of flood cycle), decreasing number of micro habitat variety which are the home for fish for foraging, nesting and spawning has led to reduction number of biodiversity of fish across Rangau River.

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Appendix 1
The Distribution of Fish Species based on frequency existence through out the survey in 2002, 2008 and 2014.

Fish group in 1998	*Famili/ genus*	*2002*	*2008*	*2014*
I. Cyprinidae (White fish)	1. *Puntius schwanenfeldii* (Blkr)	H	M	L
	2. *Puntius bulu* (Blkr)	M	L	L
	3. *Cyclochilichtyus apogan* (V)	H	Nd	Nd
	4. *Hampala macrolepidota* (V)	H	M	L
	5. *Dangila ocellata* (Heckel)	H	M	Nd
	6. *Dangila fasciata* (Blkr)	Nd	Nd	Nd
	7. *Leptobarbus melanopterus* (W&B)	Nd	Nd	Nd
	8. *Leptobarbus hoeveni* (Blkr)	L	Nd	Nd
	9. *Thynichthys thymnoides* (Blkr)	H	M	Nd
	10. *Osteochillus hasselti* (V)	M	L	L
	11. *Osteochilus kelabau*	M	L	L
	12. *Osteochillus schlegeli* (Blkr)	L	M	L
	13. *Oxygaster oxygastroides* (Blkr)	Nd	Nd	Nd
	14. *Rasbora argyrotaenia* (Blkr)	L	Nd	Nd
	15. *Rasbora einthovenii* (Blkr)	Nd	Nd	Nd
	16. *Rasbora kalochroma* (Blkr)	Nd	Nd	Nd
	17. *Luciosoma trinema* (Blkr)	L	Nd	Nd
II. Siluridae	18. *Kriptopterus palembangensis* (Blkr)	L	L	L
	19. *Kriptopterus apogon* (Blkr)	M	L	L
	20. *Kriptopterus limpok* (Blkr)	L	Nd	Nd
	21. *Kriptopterus schilbeides* (Blkr)	L	Nd	Nd
	22. *Kriptopterus cryptopterus* (Blkr)	M	L	L
	23. *Ompok hypophthalmus (*Blkr)	L	Nd	L
	24. *Wallago leeri* (Blkr)	Nd	Nd	Nd
	25. *Belodontichthys dinema* (Blkr)	Nd	Nd	Nd
	26. *Wallago heterorhynchos* (Blkr)	L	Nd	Nd
	27. *Ceratoglanis scleronema* (Blkr)	L	M	Nd
	28. *Kriptopterus macrocephalus* (Blkr)	L	L	L
III. Catfish Bagridae	29. *Mystus nemurus* (Valenciennes)	M	L	Nd
	30. *Mystus nigriceps* (Valenciennes)	L	L	L
	31. *Mystus micracanthus* (Valenciennes)	L	L	L
	32. *Mystus bimaculatus* (Vogt)	L	L	L
	33. *Mystus wolfii* (Blkr)	L	Nd	Nd
	34. *Mystus wyckii* (Blkr)	L	Nd	Nd

Fish group in 1998	*Famili/ genus*	*2002*	*2008*	*2014*
	35. *Leiochasis leiocanthus* (M. Web & de Beaufort)	L	L	L
	36. *Bagroides melapterus* (Blkr)	L	Nd	Nd
IV. Pangasidae	37. *Pangasius micronema* (Blk)	L	L	Nd
	38. *Pangasius pangasius* (Ham Bach)	L	L	Nd
V. Clariidae	39. *Clarias leiacanthus* (Blkr)	L	L	Nd
	40. *Clarias nieuwhofi* (V)	Nd	Nd	Nd
	41. *Clarias batrachus* (L)	L	M	Nd
	42. *Clarias maladerma* (Blkr)	L	L	L
VI. Cynoglossidae	43. *Ceraloglanis scleronema* (Blkr)	L	L	L
	44. *Cygnoglossus microlepis* (Blkr)	Nd	L	L
VII. Anabantidae	45. *Anabas testudinoides* (B.I)	L	L	L
	46. *Pristolepi grooti* (Blkr)	L	L	L
VIII. Belontiidae	47. *Betta fuscan* (Regan)	L	L	L
	48. *Belontia hasselti* (C)	L	M	L
	49. *Trichogaster leeri* (Blkr)	Nd	Nd	Nd
	50. *Trichogaster trichopterus* (Pall)	L	L	L
	51. *Trichogaster pectoralis* (Regan)	L	Nd	Nd
IX. Helostomatide	52. *Helostoma temminckii* (C.V)	L	L	Nd
X. Osphronemida	53. *Osphronemous gouramy* (Lac)	L	M	Nd
XI. Notopteridae	54. *Notopterus notopterus* (Pall)	L	Nd	Nd
	55. *Notopterus borneensis* (Blkr)	L	Nd	Nd
XII. Channidae	56. *Channa micropeltes* (C)	L	L	L
	57. *Channa striatus* (B.I)	Nd	Nd	Nd
	58. *Channa melasoma* (Blkr)	Nd	Nd	Nd
	59. *Channa lucius* (C)	L	Nd	Nd
XIII. Eleotridae	60. *Oxyeleotris marmorata*	Nd	Nd	Nd
XIV. Mastacembelidae	61. *Macrognathus acuelatus* (BI)	Nd	Nd	Nd
	62. *Mastacembelus erythrotaenia* (Blkr)	L	L	L
	63. *Mastacembelus keithi* (Herre)	Nd	L	Nd
XV. Tertaodontide	64. *Tetraodon palembangensis*	L	L	L
XVI. Belonidae	65. *Tylosurus strongylura* (V.Hass)	L	L	L
XVII. Chandidae	66. *Parambasis wolffi* (Blkr)	L	L	L
	67. *Ambasis sp*	L	Nd	Nd
XVIII.	68. *Chaca bakkaensis* (Blkr)	L	Nd	Nd