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Fish Fauna Composition of Batang Kayan and Its Tributaries, Lundu, Sarawak

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This project is submitted in partial fulfillment of the requirement for Degree of Bachelor of Science with Honours (Aquatic Resource Science and Management)

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DECLARATION

No portion of the work referred to in this dissertation has been submitted in support of an application for another degree qualification of this any other university or institution of higher learning.

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Fish Fauna Composition of Batang Kayan and Its Tributaries, Lundu, Sarawak

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ABSTRACT

This study was done to document the fish fauna composition of Batang Kayan and its tributaries. The study was carried out at five selected stations located at the mouth of five tributaries of Batang Kayan namely Sungai Tangilang, Sungai Stenggang, Sungai Bawang, Sungai Tong Senggi and Sungai Stom Lundu. Sampling method used was gill nets of various mesh sizes and three layer gill nets. A total of 324 individuals of fish were caught comprising of 25 species, 17 genera, and 8 families. Among the 8 families, the most dominant family is Cyprinidae. The most dominant species is *Chela laubuca* with a total of 57 individuals. Four species are present at all stations namely *Hemibagrus nemurus*, *Chela laubuca*, *Hampala macrolepidota*, and *Osteochilus waandersii*. The station with the largest number of individuals caught is from station 4 with a total of 87 individuals meanwhile the station with lowest number caught is at station 2 with a total of 47 individuals. Species diversity and richness is highest at station 1 which is located at the most upstream of the study site with a value of 1.038 and 7.860 respectively. The fish fauna composition is mainly affected by the habitat characteristics of the river.

Keyword: fish, diversity, Sarawak, freshwater, composition

ABSTRAK

Kajian ini dijalankan untuk mendokumentasikan komposisi fauna ikan di Batang Kayan dan anak-anak sungainya. Kajian ini dilakukan di lima stesen terpilih yang terletak di muara lima anak sungai Batang Kayan iaitu Sungai Tangilang, Sungai Stenggang, Sungai Bawang, Sungai Tong Senggi, dan Sungai Stom Lundu. Kaedah persampelan yang digunakan ialah pukat insang berbagai saiz mata jaring dan pukat tiga lapis. Sebanyak 324 ekor ikan telah ditangkap yang terdiri daripada 25 spesis, 17 genera, dan 8 famili. Daripada 8 famili, famili yang paling dominan ialah famili Cyprinidae. Spesis yang paling dominan ialah Chela laubuca dengan jumlah 57 individu. Empat spesis boleh ditemui di kesemua stesen iaitu Hemibagrus nemurus, Chela laubuca, Hampala macrolepidota, dan Osteochilus waandersii. Stesen dengan bilangan individu yang paling banyak ditangkap ialah pada stesen 4 dengan jumlah 87 individu dan stesen dengan bilangan individu paling sedikit ditangkap ialah pada stesen 2 dengan jumlah sebanyak 47 individu. Nilai kepelbagaian dan kekayaan spesis paling tinggi pada stesen 1 dengan nilai sebanyak 1.038 dan 7.860 masing-masing dan stesen ini merupakan anak sungai yang paling hulu. Komposisi ikan lebih dipengaruhi oleh ciri-ciri habitat sungai tersebut.

Kata kunci: ikan, kepelbagaian, Sarawak, air tawar, komposisi

1.0 INTRODUCTION

1.1 Freshwater Habitat

The freshwater habitat is a part of Malaysia's diverse ecosystem consisting of riverine, lacustrine and palustrine habitats (World Wide Fund Malaysia, 2002). There are about 1,500 rivers which stretch at a length of 35,000 kilometers in Malaysia (Anonymous, 1998). Among the 1,500 rivers found in Malaysia, 94 rivers are considered as major importance and out of the 94 rivers, 21 rivers are located in Sarawak (Yap, 1992). These rivers are the habitats of the freshwater fishes and are crucial in determining some of the most crucial attribute in distribution and diversity of these fishes.

Habitat comes in many forms and generally can be divided into two categories, which is lentic and lotic ecosystem. Lentic ecosystem is the non-flowing or stagnant water body such as lakes, swamps and paddy fields meanwhile lotic ecosystem is the flowing water body which consists of streams, irrigation canals, and rivers (Mohsin & Ambak, 1990). These forms mold most of the freshwater fish distribution in an ecosystem. Lakes such as Tasik Chini is a closed ecosystem and the balance of its ecosystem is fragile and usually lower order fish (primary consumer) is abundant in lake ecosystem than the higher order fish (secondary consumer) (Kutty, 2009). In river ecosystem on the other hand, the freshwater fish distribution is mostly depending on the stream order and the migration of fish.

Any water body comes with different characteristics which determine the types of freshwater fish that can flourish in the desired environment. In a well developed stream or river, the distribution of freshwater fish can be divided into the rhithron (lower order stream) and potamon (high order stream) (Wootton, 1992). The distribution of fish within the stream order of a river is according to the feeding nature of the fishes. The source of carbon for fishes may exist either from autochthonous which is source of food originating from the river system such as phytoplankton and zooplankton and also from allochthonous which the food source are not originating or comes from outside of the river system such as particulate organic matters (Webster *et al.*, 1999; Hein *et al.,* 2003). The allochthonous materials usually are abundant at the rhithron region because of the riparian cover and the great quantity of organic matter at the river banks meanwhile autochthonous materials are usually abundant near to the potamon region which sunlight is present to supply energy for the phytoplankton. Due to this feature, fish are distributed according to the feeding habit it possess whether they consume autochthonous or allochthonous materials.

Freshwater fish are seasonal and free moving and do not usually stays at an area for a long period of time. This is due to migration in river which is associated with the spawning season or the existence of new feeding ground due to the inundation of the river as a result of seasonal changes (Wootton, 1992). Migration may also caused by other factors such as refuge-seeking migrations and post-displacement movements, recolonisation and exploratory type of migration (Lucas *et al.*, 2001). Migration influences the distribution of freshwater fish in a river system especially during the monsoon season. Topography also influences the distribution of fish fauna. For instance, high altitude retain less and only specialized adapted fish can thrive in such a habitat than lower and middle zone altitude (Nyanti, 1995).

Habitats of freshwater fish can also be associated with the diversity of fish fauna. Long-term ecological isolation caused by the great difference of hydrological elements such as flow speed and sediment may cause the differentiation of species with each species having formed its own morphology (Chu and Zhou, 1989).

1.2 Threats of Deforestation

Total freshwater fish in Southeast Asia is approximated at 900 to 1,000 species (Kottelat *et al.*, 1993) and Malaysia has been estimated to hold more than 400 – 500 species (Bishop, 1973; Ali, 1992; Khan & Yeo, 1993; National Conservation Strategy, 1993; Ministry of Science, Technology and Environment, 1997; Zakaria-Ismail, 1997). But this number could decrease up to 58% from the present if habitat alteration and destruction continues at its present rate (Dennis & Aldhous, 2004; Salam & Gopinath, 2006). For example, Singapore has faced the extinction of a total of 19 species in 30 years (Mohsin & Ambak, 1990). A study done in Pusu River of Klang River Basin has shown that more than 40% of the native species is lost due to the adjacent development activities in the past few years (Zakaria-Ismail, 1997). It is a big issue because it is estimated that tropical countries are losing 127,300 km^2 of forest annually, another 55,000 km^2 of tropical forest are logged each year and a rough estimation of 30,000 km^2 more is burnt each year (Chapman & Chapman, 2002) which will affect the vegetations adjacent to the streams. Other than that, the upper reaches are the least known habitat which means more species are to be discovered and the rate of endemism is also high (Kottelat & Whitten, 1996; Hui, 2009). The deforestation process may contribute to the loss of freshwater habitats and at the same time encouraging the extinction of some sensitive freshwater fish species especially in

Sarawak which fish inventory of rivers in Sarawak is not much documented (Salam & Gopinath, 2006).

At the same time, Sarawak cannot run from deforestation activities because the replacement of forest areas into developments is required to support the greatly increasing population needs. The areas are utilized into aquaculture farm for food security, residential area for the growing population, industrial operation, timber harvesting or logging area to cope with the lumber industry, and agricultural conversion especially oil palm plantation which took up 4.2 million hectare of land in Malaysia in 2005 and will continue to grow (Fitzherbert *et al.*, 2008). All these developments are leading to deforestation which is a big issue in the pursuit of development as it directly and indirectly alters the biodiversity of an area not only the forest itself but also the river nearby the area (Ali, 1992; Kouamelan *et al.*, 2003; Salam & Gopinath, 2006; Fitzherbert *et al.*, 2008). For instance, deforestation reduces the riparian forest cover thus give serious impact to the growth and survival of allochthonous stream fish species which rely on the particulate organic matter for food from the forest and also reducing the shady areas for the juvenile fish to get its protection (Raghavan *et al.*, 2008).

It is a challenge for economists and biologists to achieve a well balanced environment between development of agricultural activity and biodiversity richness especially in Sarawak. This is a problem as there are not many studies done on the fish fauna composition in Sarawak especially to assess the fish fauna composition (Meijaard *et al.*, 2005; Salam & Gopinath, 2006). Overall, the main objective of this study was to record the fish composition at Batang Kayan and its tributaries.

2.0 LITERATURE REVIEW

2.1 Stream Ecology

The general habitat characteristics for most freshwater fish is fast flowing water, shaded area, substrate either consist of mud, silt, rocky and sandy bottom (Lee & Ng, 1994). Apart from this, there are also some environmental factors that affect the patterns of fish distribution in streams or rivers such as nutrients, aquatic plants, canopy closure, depth, width, temperature, pH level, total dissolved solid (TDS) and dissolved oxygen (DO) (Samat, 1990; Kouame *et al.*, 2008).

One of the most important factors is nutrient. As nutrients support the vegetation of a river or stream, the vegetation may also support the population of fish in term of protection, reproduction and food supply (Zakaria *et al.*, 1999). The overhanging vegetation plays a role in the determination of temperature, determination of the primary production and determination of the physico-chemistry within a river or stream (Kouame *et al.*, 2008). Substrate may also contribute to the growth and abundance of vegetation either at the bank or the subsurface (Zakaria *et al.*, 1999) and also gives protection to fish in term of camouflage from predators. Other than that, low total dissolved solid (TDS) and high dissolved oxygen (DO) favor almost all species of fish (Shah *et al.*, 2009). The width of river influence the number of fish species as it increase the diversity of habitat type, while providing a larger area to accommodate more fish species and results in the different rates of immigration (Angermeier & Schlosser, 1989). Depth of a river or stream also plays a role in contributing the distribution of fish but it depends on the size and the feeding habits of the fish (Kouame *et al.*, 2008).

Species composition tends to increase from the river mouth to the upstream area (Koumelan *et al.*, 2003). This matter is true for a pristine river as there is no disturbance but for a disturbed river, the species composition and diversity will be different from the downstream to the upstream according to the level of disturbance. In addition, altitude also plays a very important role in the species composition. Species are likely to be found abundant at low altitude region compared to high altitude region (Nyanti, 1995).

2.2 Fish Fauna Diversity

Little attention has been given to the freshwater fish fauna of Malaysia since the earliest days of ichthyological exploration in the region (Roberts, 1989) which have actually started in the mid-19th century (Zakaria-Ismail, 1991) and most of them have been conducted in Peninsular Malaysia (Salam & Gopinath, 2006). Perhaps the most comprehensive study in East Malaysia is done by Inger & Chin (1962) and Kottelat & Lim (1995). However, most of the Malaysian river systems have never been studied intensively. Most of the previous study only concerned on species checklist, fisheries status (Khan & Yeo, 1993; Ali, 2000) and ichthyofaunal study (Ho & Tan, 1997; Yap *et al.*, 1997; Zakaria-Ismail & Salleh, 1997) but all the available studies are considered as incomplete because the study is being carried out in a short term period and lack of monitoring have been done to follow up the changes in distribution and habitats (Zakaria-Ismail, 1987).

Despite all the study done, no researcher has been able to give or list the actual or reliable number of freshwater fish present in Malaysia (Zakaria-Ismail, 1991; Ng *et al.*, 1992; Ali, 2000). According to available literatures, it is generally estimated that there are over 300 species of freshwater fish in Malaysia (Bishop, 1973; Ali, 1992; Khan & Yeo, 1993; Zakaria-Ismail, 1997). Other sources of number of freshwater species in Malaysia is from National Conservation Strategy (1993) which stated that there are 546 species including the 160 species in East Malaysia and Ministry of Science, Technology and Environment (1997) mentioned that a total of 449 freshwater fish species are present in Malaysia.

In East Malaysia especially Sarawak, the ichthyological survey has not been extensive (Salam & Gopinath, 2006). The earliest known survey done in Sarawak was carried out by the Department of Agriculture in three major rivers which are Sungai Rajang, Batang Ai, and Sungai Baram in 1985. The study reported that 59 species found in Sungai Rajang, 31 species in Batang Ai and 43 species can be found in Sungai Baram. This ichthyological survey however, was considered incomplete due to its confinement in a small geographical area (Salam & Gopinath, 2006). Another study has been done by Kottelat & Lim (1995) which covers throughout Sarawak and Brunei and listed a total of 249 freshwater fish species. Rahim *et al.* (2009) also have been doing studies at Batang Kerang, Balai Ringin, Sarawak and have reported different composition at two different water with 36 species in the brown water meanwhile in the black water, there are only 12 species can be found. But then again, the study is only focuses to the Balai Ringin area.

Cyprinidae dominates almost 30% of species population for both Peninsular and Borneo while Channidae and Anabantidae comprise another 26% and the remainders are distributed amongst the nine other families (Salam & Gopinath, 2006). Among the most common cyprinids can be found includes sebarau (*Hampala macrolepidota*) and lampam sungai (*Barbodes schwanefeldii*). Other than that is the Bagridae family which are baung

(*Mystus* spp.) (Tweedie & Harrison, 1954). Alongside with the population of the native species of Malaysia freshwater fish, there is also the presence of invasive alien species. Some of them are *Barbodes gonionotus*, *Trichogaster pectoralis* and *Osphronemus goramy*. These species were introduced into Malaysian waters in the early 20th century (Ang *et al.*, 1989).

2.3 Land Use Impacts

Rivers are one of the most degraded ecosystems in Malaysia which give impacts on fish populations through land clearing especially caused by oil palm plantation and habitat encroachment (Ali, 1992; Kouame *et al.*, 2008). In the past years, there is reduction in the number of freshwater fish caught in Malaysia and it is believed that devastation of their natural habitats is the main factor for the decline (Khan *et al.*, 1996). No buffer zone between the disturbed area and the stream or river will contribute to sedimentation problem (Shah *et al.*, 2009). Deforestation and habitat degradation lead to a decline in exogenous food sources including insects and their larvae as well as reduction in leaf debris due to shade loss and reduce protection from the canopy (Raghavan *et al.*, 2008).

3.0 MATERIALS AND METHODS

3.1 Study Site

The study site is at Batang Kayan, Lundu, 52 km from the town of Kuching, Sarawak. Four fieldtrips have been carried out on 3-4 August 2010, 28-29 October 2010, 1-2 December 2010 and 9-10 February 2011. The stations of the study are selected according to the accessibility of the sampling site. Since Batang Kayan is near to agricultural conversion land, most of the tributaries are inaccessible due to obstacles such as abandoned logs, woods, and fallen trees and trunks resulting from the land clearing activity. In addition, the shallow and narrow characteristics of the tributaries also were a problem. Due to these factors, most of the stations are located at the mouth of the tributaries near to the main Batang Kayan. The fish fauna survey was carried out at five stations as shown in Table 1 and Figure 1.

Table 1: Location and coordinate for every station.

Station	Coordinates	Location
Station 1	N 01º 31.735’ E 109º 58.454’ Elevation: ±3.66 metres	Sungai Tangilang
Station 2	N 01º 31.731’ E 109º 58.450’ Elevation: ±3.66 metres	Sungai Stenggang

Station 3	N 01º 30.774' E 109º 57.799' Elevation: ±4.57 metres	Sungai Bawang
Station 4	N 01º 30.324' E 109º 57.573' Elevation: ±3.96 metres	Sungai Tong Senggi
Station 5	N 01º 30.277' E 109º 55.378' Elevation: ±4.88 metres	Sungai Stom Lundu

Figure 1: Sampling stations for fish fauna survey at Batang Kayan, Lundu.

3.2 Sample Collection

Monofilament gill nets with different mesh sizes and three layers gill net were used in this study. The mesh sizes of the monofilament gill nets used include 2.5 cm and 7.6 cm of mesh sizes. A total of three nets which consists of a 2.5 cm monofilament gill net, a 7.6 cm monofilament gill net and a three layers gill net were deployed at each station. The monofilament gill nets and three layers gill net were left at the stations overnight before being retrieved the next day.

3.3 Sample Preservation

Fish samples were fixed at the field by using 10% formalin and were left in the laboratory for approximately 72 hours. After 72 hours, the samples were washed, rinsed and soaked in tap water before transferred and kept into 70% ethanol solution for further laboratory analysis and preservation purpose.

3.4 Sample Identification

The fish samples were identified using the taxonomy method according to Roberts (1989), Mohsin & Ambak (1990), Gunther (1993), Kotellat *et al.* (1993), Inger & Chin (2002), and Tan (2006). The total length and standard length were measured by using Wildco measuring board with steel caliper which are fixed with graduated centimeter scale for measurement. The total length was measured from the anteriormost of the head or mouth to the most end of the caudal fin, with lobe squeezed together. The standard length was taken from the anteriormost of the head or snout to the end of fleshy caudal peduncle and is taken straight and not according to the curve of body (Figure 2) (Mohsin & Ambak, 1990). The weight was measured by using Adventurer ARA520 OHAUS analytical balance. The dorsal fin rays, pectoral fin rays, pelvic fin rays, anal fin rays and lateral line scales were also counted for identification purpose of each sample.

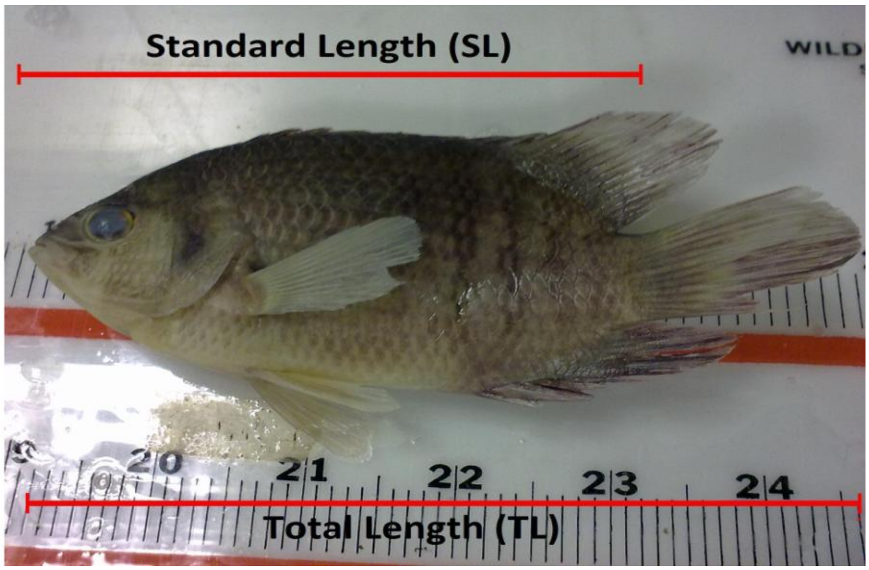

Figure 2: Standard length and total length

3.5 Indices

The diversity, richness and evenness indices were analyzed for each station by using the Shannon – Weiner's Diversity Index (H'), Margalef's Species Richness Index (D), Pielou's Evenness Index (J) and Sorensen's Index (S).

- *Shannon-Weiner's Diversity Index* (Shannon & Weaver, 1963)

$$H' = \frac{n \text{ Log } n - \Sigma \text{ fi Log fi}}{n}$$

n = sample size
fi = number of individuals per species

- *Margalef's Species Richness Index* (Margalef, 1958)

$$D = \frac{(S - 1)}{\text{Log } N}$$

S = total number of species
N = total number of individuals

- *Pielou's Evenness Index* (Pielou, 1966)

$$J = H / \ln S$$

H = Shannon – Weiner's Diversity Index
S = total number of species

- *Sorensen's Index* (Sorensen, 1948)

$$S = 2j / (a + b)$$

S = coefficient of association between site A and B
j = number of species common to both site A and B
a = number of species present at site A
b = number of species present at site B

3.6 Statistical Analysis

Microsoft® Office Excel® 2007 was used to calculate the mean and standard deviation for standard length (SL), total length (TL) and body weight (BW) of the samples. Microsoft® Office Excel® 2007 was also used to aid in constructing pie charts and any relevant graphs. Besides that, it was also used in calculating the fish indices which are the species diversity, richness and evenness.

4.0 RESULTS

4.1 Study Site Description

Most of the stations along Batang Kayan have been disturbed due to anthropogenic factors. Station 2 and station 4 which are Sg. Stenggang and Sg. Tong Senggi respectively have been disturbed by oil palm plantation activities. The forest at station 1 and station 3 which are Sg. Tangilang and Sg. Bawang respectively had just recently been cleared. Station 5 or Sg. Stom Lundu has been experiencing human anthropogenic especially from the boat's engine and nearby access by road. The habitat description of every station is shown in Table 2.

Table 2: Habitat descriptions of sampling station.

Stations	Habitat Description
Station 1 (Sg. Tangilang)	The tributary was fully shaded with branches from small trees along its bank. Slight erosion could be seen at the banks of the tributaries with the muddy soil at the top of sandy soil. The bottom substrate was muddy and a bit sandy and the water was brownish white. Logs and trunks could be observed and no access to the upstream of Sg. Tangilang from the river mouth.
Station 2 (Sg. Stenggang)	Sg. Stenggang was partially shaded. No erosion was observed as aquatic macrophytes grow along the bank. The bottom substrate was sandy and the water was brownish. The river was accessible to the upstream area but too shallow during low water level. The water was fast flowing.
Station 3 (Sg. Bawang)	The vegetation along the river bank was bushes and no shade is provided to the river. There was also no erosion seen as the bushes gives good support to the river bank. The bottom substrate was muddy and the water was humic red nearly to black in color. Upstream area was impassible as the water depth was too shallow.

Station 4 (Sg. Tong Senggi)	Sg. Tong Senggi is the river where palm oil mill effluent is occasionally discharge. The river was fully shaded. Slight erosion could be seen occurring at the river bank. The bottom substrate was sandy and the water is dark. Logs and tree trunks limits the access to the upstream area.
Station 5 (Sg. Stom Lundu)	This tributary was fully shaded and erosion could be observed along its bank. The bottom substrate was sandy and muddy at some area. The color of the water was light brown. Sg. Stom Lundu could be very shallow during the low water level or drought season which can expose the riverbed and small channel of flowing water could be seen.

4.2 Fish Fauna

A total of 324 individuals were caught at five different stations belonging to 25 species, 17 genera and 8 families (Table 3). The highest number of fish caught can be observed at station 4 with a total of 87 individuals (26.9%) followed by station 1 with the total of 81 individuals (25.0%), station 5 with 61 individuals (18.8%), station 3 with 48 individuals (14.8%) and the least number of fish caught is at station 2 with the total of 47 individuals (14.5%) (Figure 3).

Table 3: List of family, species and number of individuals (N) caught at Batang Kayan, Lundu.

No.	Family	Species	N
1	Anabantidae	*Osphronemus goramy*	3
		Trichogaster pectoralis	1
2	Bagridae	*Hemibagrus micracanthus*	13
		Hemibagrus nemurus	13
		Leiocassis micropogon	7
3	Clariidae	*Clarias leiacanthus*	1
4	Cyprinidae	*Barbonymus gonionotus*	13
		Barbonymus schwanenfeldii	4
		Chela laubuca	57
		Cyclocheilichthys apogon	53
		Cyclocheilichthys armatus	10
		Cyclocheilichthys repasson	10
		Hampala macrolepidota	17
		Osteochilus waandersii	16
		Puntius binotatus	1
		Puntius sealei	1
		Rasbora argyrotaenia	9
		Rasbora caudimaculata	35
5	Eleotridae	*Oxyeleotris urophthalmus*	1
6	Mastacembelidae	*Mastacembelus erythrotaenia*	3
7	Nandidae	*Pristolepis grootii*	4
8	Siluridae	*Kryptopterus apogon*	10
		Kryptopterus limpok	1
		Kryptopterus platypogon	40
		Pangasius micronemus	1
		Total Individuals	**324**