A SURVEY ON FISH DIVERSITY IN TASIK PERGAU JELI, KELANTAN

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A SURVEY ON FISH DIVERSITY IN TASIK PERGAU JELI, KELANTAN

by

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DECLARATION

I declare that this thesis entitled "A Survey on Fish Diversity in Tasik Pergau Jeli, Kelantan" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : _____

Name : _____

Date : _____

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A SURVEY ON FISH DIVERSITY IN TASIK PERGAU JELI, KELANTAN

ABSTRACT

A survey study on fish species and abundance in Pergau Lake was undertaken by using trawls as capture tools. This research was done to know the diversity and abundance of fish at Pergau Lake which well-known of Taman Santuari Tasik Pergau (TSTP). Fish samples were collected around Pergau Lake at seven different sections that were determined based on the random picked coordinates of latitud and longitude. Seven fish trawl traps were used to catch fish. This study shows that *Hemibagrus nemurus* (Baung) and *Hampala macrolepidota* (Sebarau) have the dominant species compare to other species of fish. Section B has the highest catchment of different species which is 5 species compare to others. Identification of fish species in this research was done by referred the book tittle "Fishes of Malaysia" second edition publication in University Malaysia Terengganu (UMT). However, from the survey interview of fishermen and angler, it found that *Channa micropeltes* (Toman) has the most dominant species among others fish abundance. This is due to they used bigger size of fish trap and fishing rod as their capture tools.

KAJIAN TERHADAP DIVERSITI IKAN DI TASIK PERGAU, JELI, KELANTAN

ABSTRAK

Sebuah kajian pemerhatian terhadap spesies ikan dan bilangan di Tasil Pergau Jeli, Kelantan dilakukan mengguna pukat sebagai alat penangkapan. Kajian ini dilakukan untuk mengetahui kepelbagaian dan kelimpahan ikan di Tasik Pergau atau dikenali sebagai Taman Santuari Tasik Pergau (TSTP). Sampel ikan dikumpulkan di sekitar Tasik Pergau di tujuh bahagian yang berbeza dan ditentukan berdasarkan pengambilan secara rawak koordinasi latitud dan longitud. Tujuh pemasangan pukat ikan telah digunakan untuk menangkap ikan. Kajian ini menunjukkan *Hemibagrus nemurus* (Baung) dan *Hampala macrolepidota* (Sebarau) mempunyai species ikan paling banyak berbanding species ikan yang lain. Bahagian B mempunyai spesies ikan penangkapan yang tertinggi iaitu 5 spesies ikan yang berlainan berbanding dengan bahagian lain. Identifikasi spesies ikan di dalam kajian ini dilakukan dengan merujuk buku "*Fishes of Malaysia*" edisi Kedua yang telah diterbitkan oleh Universiti Malaysia Terengganu (UMT). Bagaimanapun, menurut kaji selidik pemerhatian daripada nelayan dan pemancing, spesies *Channa micropeltes* (Toman) adalah paling dominan dengan bilangan jumlah yang banyak. Hal ini kerana mereka menggunakan perangkap ikan yang lebih besar dan joran sebagai alat penangkapan ikan.

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LIST OF ABBREVIATION

KESEDAR	Lembaga Kemajuan Kelantan Selatan
MNS	Malaysian Nature Society
GPS	Global Positioning System
TSTP	Taman Santuari Tasik Pergau
RISDA	Rubber Industry Smallholders Development Authority
cm	centimeter
kg	kilogram

CHAPTER 1

INTRODUCTION

1.1 Background of study

Malaysia has been well known to be among the mega-diverse countries in terms of flora and fauna, and possesses various ecosystems and diversity for various life forms, including the fish fauna (Ambak *et al.*, 2012). The water bodies in earth have covered many of different species and diversity of freshwater fishes (Ambak *et al.*, 2012). The earth heritage is one of the significant aesthetic value because of environmental ecosystem of biodiversity (Hiddink *et al.,* 2006). Humanity is one part of the life chain that connects each living thing to its environment and other life on earth (Hiddink *et al.,* 2006). Biodiversity can be divided into three levels of diversity which are genetic diversity, species diversity and ecosystem diversity (Hiddink *et al.*, 2006). Biodiversity must be managed and cared for so that it can guarantees the ecosystem cycle for next generation (Samat, 2010).

Besides that, biodiversity combines the concepts of plants and animal in which they live as genetic resources, the diversity of species and the habitats (Kutty *et al.,* 2009). Therefore, biodiversity has totality and contain variety of living things on earth (Hiddink *et al.,* 2006). Terrestrial rainforests, the freshwater lakes and river systems, the coral reefs and marine ecosystems are the place their live within the diversity of the species and the habitats and ecosystems (Samat., 2010).

Living organism such as humans have always been intimately linked with rivers, lakes and wetlands for water, food, medicines and places for habitation (Ambak *et al.*, 2012). But over-exploitation by the human affect many of the world's fresh waters have been exploited and their ecosystems greatly destroyed (Reid *et al.*, 2013). Pollution, habitat loss, excessive water abstraction, construction of dams, drainage and the introduction of invasive non-native species is one of the impact to the loss of biodiversity (Reid *et al.*, 2013).

This is due to cause by of factors such as urbanization, intensification of agriculture, navigation, flood alleviation and inappropriate aquaculture (Reid *et al*., 2013). Virtually everything that alters the natural hydrological cycle in a river basin affects the levels behavior, character and therefore the ecology of rivers, lakes and wetlands (Margalef, 1958). According to the World Development Indicators, while Malaysia has only 0.2% of the worlds land mass, its own diversity of flora and fauna species makes it one of the richest countries in the world in terms of biodiversity per unit area (Ambak *et al*., 2012). There are five habitat major type of fish which are freshwater fish, marine fish, tropical fish, cold water and aquarium fish (Samat, 2010).

Each type of fish depending upon the habitats and characteristics of fish species and also there are a variety of fish available on the world (Nelson, 2006). The difference of freshwater fish between others habitat type of fish are because they found in the water bodies such as lakes and rivers in which the salinity is less than 0.05% (Gene *et al.*, 2009). In fact, about 41 species of the fishes belong to the fresh water habitat (Nelson, 2006). Some of them are bala sharks, betta fish, candiru fish, gold fish, and oscur fish (Nelson, 2006).

Besides that, the surface water resources are significant function to aquatic organism. Pergau Lake recently has undergone devastating situation since there was development of tin mining before Pergau Lake Resorts have been established. This study would also to identify what are the characteristics, the ability of the species of fresh water fish to live in the ecosystem as well as their own ability adapted to their advantage to live in the lake (Ismail *et al.,* 2013). Each of fish species have their own characteristic of biological indicator to be adapt with environment (Khanna *et al.,* 2007). The more pollution the water, the least the fish species live there (Khanna

et al., 2007).

There are many lakes and reservoirs in Malaysia which mostly are man-made (Mohsin & Ambak, 1996). Lake and reservoirs are important water resources which are usually managed and regulated by various governmental agencies. More than 73 man-made lake or reservoirs which were created for water supply (domestic and industrial use), irrigation, hydroelectric generation and flood mitigation (Sharip *et al.,* 2008).

The background of my study is Pergau Lake is located 100 kilometers from the Jeli city famous which endows its own variety of beauty to nature lovers. From the observation, this lake surround with a variety of flora and fauna. It is well-known as eco-tourism. According to KESEDAR information, Pergau Lake had been attracted more than 30,000 visitors even not a well-known place but its natural beauty that always draws visitors especially from neighboring countries such as Singapore and Thailand, as well as Europe and Japan because of the abundance collection of flora and fauna. The main activity that can be done in Pergau Lake are kayaking, team building, water confident activity, jungle trekking and so on.

This place also known as Pergau Lake Sanctuary Park which encompasses a 460- hectare lake has been produces high productivity of fish population. The lake offers a conducive habitat and protection for a diverse number of fish species with surrounded by a lush green tropical rainforest. The facts and information were obtained from Southern Kelantan Development Board (KESEDAR). However, there do not seem to be many investigation on fish diversity of Pergau Lake. In this study research, fish samples at Pergau Lake will be collected by using portable traps. The presence of a competitor or predator, or the quantity and quality of habitats can influence patterns of species richness, community composition and abundances around the lake (Brown *et al.*, 2000).

1.1 Problem Statement

Pergau Lake was man-made lake, because of the construction of the hydroelectric dams near the Pergau Dam. At present there are no development on the around the lake except for a jetty and small hut for the fisherman. There are a lot of activities have been carried out at Pergau Lake since eco-tourism development and tourist without knowing what these activities may do to the diversity and abundance of fish. Even thought, some research at Pergau Lake carried out, there is no research of fish sampling documented information was found on the abundances and diversity of fish at this lake. Therefore, this study was the first attempt to investigate the abundance and diversity of fish.

1.2 Objective

- To checklist and identify the species of fish in Pergau Lake.
- To measure the diversity of fish in Pergau Lake.

CHAPTER 2

LITERATURE REVIEW

2.1 Survey

A survey is one type of methodology studies to obtain the sampling of individual's unit from a population (Rindfleisch *et al.*, 2008). It is survey include data collection techniques as a method to obtains the information needed to increase the accuracy of the research (Varun *et al.*, 1993). It also contains interview or discussion with individuals about a specific topic (Floyd & Fowler, 2014). The purpose of the survey is to produce quantitative or numerical descriptions about some aspects of the study population (Varun *et al.*, 1993).

Through species of diversity abundance, the number of species in Malaysia is not known with certainty flora and fauna especially the smaller organisms such as insects and worms (Adeyemi *et al.*, 2010). In the Biodiversity in Malaysia books by Ministry of Natural Resources and Environment, it states has been estimate there are more than 170,000 fish species in Malaysia (Adeyemi *et al.*, 2010). This is likely just random estimate, as there are still many species that have not been discovered and studied yet.

2.2 Fish

Fish is one of the members in Animalia Kingdom and classified into Phylum Chordata and Vertebrata Subphylum (Nelson, 2006). Fishes poses notochord, tubular nerve chord, and paired gills, segmentation of the body parts, post anal tail, ventral heart, and an endoskeleton to be the member of the Chordata (Nelson, 2006). In order to be a vertebrate, it poses backbone. The fish with backbones exhibit the greatest biodiversity of the vertebrates with over 22,000 species (Gene *et al.,* 2009). This back bone functions to supports and protects the spinal cord. Fish come in many shapes and sizes (Nelson, 2006).

Fish are cold-blooded animals with a backbone (vertebrates), gills for breathing underwater, and paired fins for swimming (Nelson, 2006). A fish can be defined as an aquatic animal vertebrate with gills and with limbs in the shape of fins (Gene *et al*., 2009). Fish are found in nearly all natural aquatic environments (Nelson, 2006). They live in water bodies where must dependent on water for dissolved oxygen, support, food, and shelter (Gene *et al*., 2009).

They also divide in many categories: Marine mammals (whales, dolphins, seals, sea otters), reptiles (turtles), amphibians (frogs and salamanders), shellfish (oysters, clams, and mussels), and aquatic invertebrates (crayfish, starfish, lobster) are not fish (Gene *et al*., 2009). Although they may not look like fish, seahorses and eels but they still include in fish categories (Gene *et al.,* 2009). All the species of the fish found in the world are classified into the following three groups (Gene *et al.,* 2009).

Fish population characteristics can be used as indicators of environmental health (Sedeno *et al.,* 2013). Although changes in population structure may act as a sensitive indicator of changing environmental conditions, the timing, degree and nature of the feedback response to altered conditions will vary with the intensity, identity and the number of stressors, as well as the availability of energy (Sedeno *et al*., 2013). They essentially live in the water bodies such as lake, river, swamps, ocean, sunless caves, ponds and others (Matsunuma, 2011). Most about 60% of living fishes are primarily marine and the remainder live in freshwater and about 1% move between salt and freshwater as a normal part of their life cycle (Gene *et al.*, 2009).

2.2.1 Fish Diversity

Fishes constitute more than half of all living vertebrates that are 54,711 species (Ambak *et al.,* 2012). There are over 30,000 species of fishes on planet earth living in various types of habitats places, including freshwater ecosystems (Ambak *et al*., 2012). There are grouped into 62 orders, 515 families and 4,494 genera (Gene *et al*., 2009). The most diversified group is the order Perciformes, and the least diversified group is Bowfin (Ambak *et al.,* 2012).

The Pergau Lake is endowed with fish, other aquatic animals which are highly diverse ecosystems and support extensive fish diversity. Differences in natural habitat conditions of these areas basically provide different type of macro and micro habitats for the fishes (Azmir & Samat, 2010). Freshwater is identified to be the most threatened out of all the ecosystems in the world (Ormerod, 2003).

This is due to over exploitation and maximum food protein sources by human (Ormerod, 2003). It is also cause of human activities and pollution in environmental issue (Kubecka, 2009). The impact of scarcity, water pollution, eco-shift, unbalance ecological and extinction of biological lives such as human health (Zainudin, 2005). Nowadays, contamination such as heavy metals pollution in aquatic environment has become a worldwide problem (Haruna *et al.,* 2006). This issues affect the biodiversity marine life. The impact mainly attributed to their persistent stability and toxic effect to aquatic as well as terrestrial creatures (Haruna *et al*., 2006).

In the author's opinion, the factors that determine the diversity (the number) of fish species in a lake are the number and identity of taxa which have had opportunity to colonize a lake (Ambak *et al.,* 2012). It is also depend on unique, historical events and geological connections with other bodies of water inhabited by fishes and the composition of those faunas (Azmir & Samat, 2010). Beside that the speciation of the colonizing taxa can also influence the number of species (Azmir & Samat, 2010).

The biological diversity of life on earth is actually under serious issues and continuing threat from the impacts of human activities (Adam, 2002). Among environmental pollutants, metals are of particular concern, due to their potential toxic effect and ability to bio accumulate in aquatic ecosystems (Adam & Greeley, 2000). Ultimately, diversity will be limited if the ability of the species to exist and coexist within a lake results in an equilibrium between the acquisition of species by colonization and speciation and loss by extinction (Azmir& Samat, 2010).

2.2.2 Freshwater fish

Freshwater fishes are species that lives all, or a critical part of its life in freshwater (Rahim *et al.*, 2009). It has been estimated that the total number of all fishes is 32,500 species (Nelson, 2006). Considering that freshwater may constitute less than 0.3% of available global water, it is remarkable that there are more than 15,000 freshwater fish species (Nelson, 2006). While marine communities contain more species in total, freshwaters are far richer per unit volume of habitat (Nelson, 2006).

Comprising approximately 25% of all vertebrates, freshwater fishes are an important component of global biodiversity (Reid *et al*., 2013). The freshwater habitat in Malaysia is exclusive contain highly diverse such as pond, lake, river, swamps, reservoirs, ex-mining pools, peat swamps and rice fields (Chew, 1996). A recent discovery of new fish species in Malaysian waters will most likely increase the diversity of fishes in this country in the future (Ambak *et al*., 2012).

In Malaysia, fresh water aquatic ecosystems have large numbers of species of plants and animals (Chew, 1996). Approximately 7,956 of all fish species (30%) are contained within just 6 of the 515 taxonomic families (Rahim *et al*., 2009). Natural freshwater ecosystems are very resilient, they can cope with episodic extremes and longer-term change provided they are able to adjust naturally and there are sufficient refuges and sources of re-colonization (Adams, 2002).

But when environmental stresses caused by human interference become excessive or too frequent, freshwater ecosystem functioning breaks down, food webs become distorted, plant and animal communities change and some species disappear (Adams, 2002).

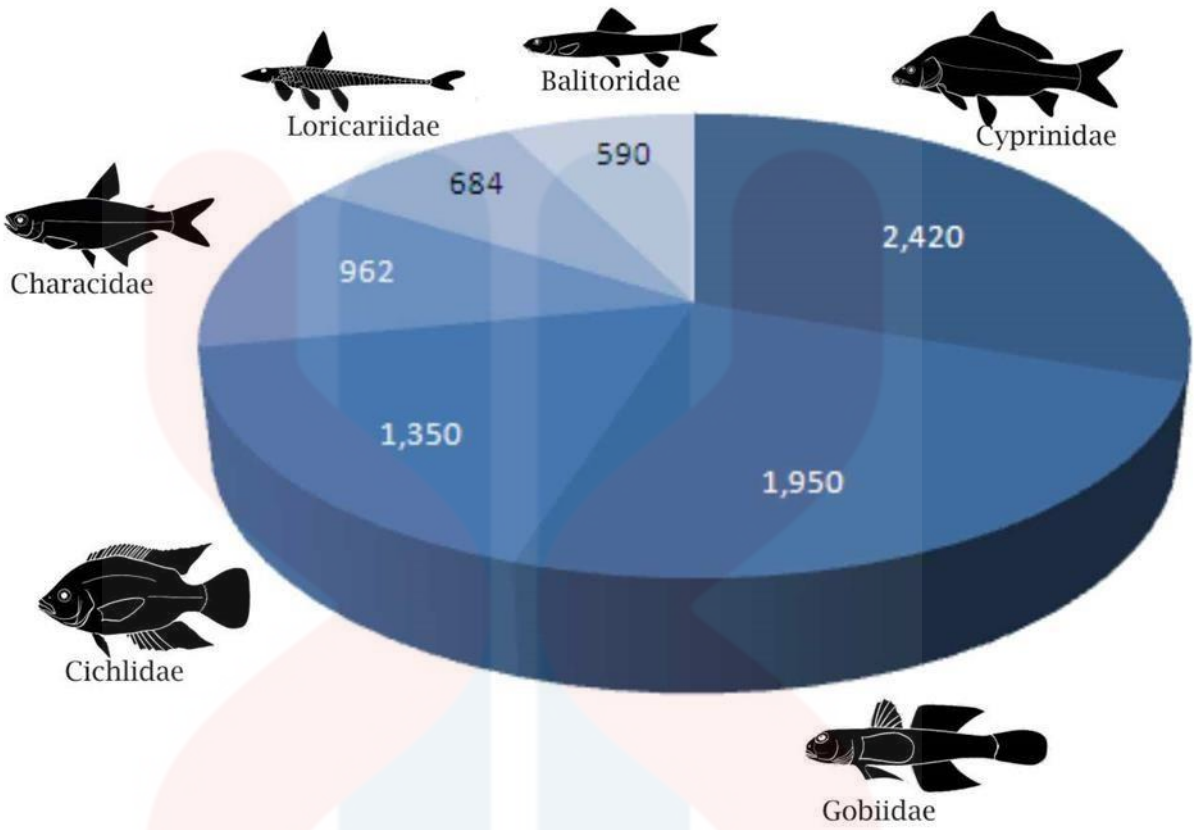


Figure 2.1: The figure shows about 6,100 (77%) of species representative families live in freshwater habitat in the world (Lim & Tan, 2002)

According to Lim and Tan (2002), there are at least 278 native species have been recognized and 24 exotic species that were introduced in Peninsular Malaysia. The estimated species families live in freshwater habitat as shown in Figure 2.1.

Besides that, species composition of freshwater fish in Peninsular Malaysia is heavily influenced by Siamese and Indonesian elements (Zainudin, 2005). Freshwater is identified to be the most threatened out of all the ecosystems in the world (Zainudin, 2005). An estimated 54% of the world's fresh water resources are reported to be in use presently (Zainudin, 2005).

The heavy load of exploitation has increases to a long effect of challenging problems, including in Asian countries (Khanna *et al.*, 2007). The scarcity, water pollution, eco-shift, ecological misbalanced and extinction of biological lives have an ultimate effect on the health of man and its environment (Khanna*et al*., 2007). Many of the most valuable fish stock in the underground are almost exploited or over fished and relatively new-stocks are unveiled and exposed to exploitation (Bankole & Mbagwu, 1995).

2.3 Lake Ecosystem

Lakes are invaluable ecological resources that serve many human needs and therefore, enchain our lives by providing a lot of opportunities (Adeyemi *et al*., 2010). To increase the understanding of freshwater habitats, their sustainability and the importance of the ecosystems they support must emphasis and taken noted. This becomes especially salient when considered in the context of sustainable fishing and the difficulties currently faced economically, nutritionally and socially by communities either with long fishing traditions or with a reliance on fishing as a main food source (Rochet, 2000).

The ecosystem diversity provided thousands valuable aesthetic to our environmental benefits (Chew, 1996). Humans are recognizing that healthy ecosystems provide vital "services" such as clean water, fresh air and prevent ecological disruptions like floods and landslides (Reid *et al.*, 2013). For example the biogeochemical cycles like the hydrological cycle and carbon cycle in ecological processes ensures clean water and fresh air as part of natural functioning of the ecosystem (Alabaster & Lloyd, 1982).

Therefore, it is very crucial to the human community by providing services such as food sources, clean water, and for the fish habitat (Adeyemi *et al*., 2010). Meanwhile, the other factor affect the large number of species is because of the wet tropical climate, favorable conditions for the growth and evolution of plants and animals, as well as the presence of great diversity of habitats in Malaysia (Gaston & Kevin, 2000).

These habitats for species include the seas, lakes, rivers, forests and mountains (Gaston & Kevin, 2000). Many depend heavily on the resources of water bodies as their main source of animal protein and family income (Haruna *et al*., 2006). Kelantan state in particular and Jeli in general is blessed with nature beauty and Pergau Lake is man-made lake due to construction of hydroelectric dams.

2.4 Importance of Fish Diversity

Biodiversity creates many variations of genetic and life forms of populations, species, communities and ecosystems (Hiddink *et al.*, 2006). Nutrient cycling and clean water are one of their providing goods and services from ecosystem (Hiddink *et al.*, 2006). In water bodies, there live aquatic habitat of biodiversity which contain rich and beautiful variety of plants and animals such as crayfish, catfish, mussels and mayflies (Adeyemi *et al.*, 2010).

Each of them have the number of different native species and species richness (Haruna *et al*., 2006). Ecosystem services of aquatic diversity provide culture services because they have aesthetic and intrinsic values (Ambak *et al.*, 2012). Many of us admired the wonderful colors and shapes of fishes on coral reefs and in other coastal habitats (Hiddink *et al*., 2006).

Moreover, fish diversity is significant for the maintain ecosystem future sustainability of marine natural resources that include commercial fisheries (Regier & Robson, 1966). The importance of fish gives many benefit to human and environment ecosystem (Hiddink *et al.,* 2006). Fishes are very valuable as food source such as protein to human (Gene *et al.,* 2009). They form a staple diet and an important element of economy in the countries (Hiddink *et al*., 2006).

On Earth 97.5% of the water is salt water leaving only 2.5% as fresh water (Sedeno *et al.,* 2013). Two thirds of this 2.5% is frozen as glaciers and ice caps and the remaining freshwater is largely underground which this leaves only the tiniest fraction of freshwater either above the ground or airborne (Sedeno *et al*., 2013).

With demand for freshwater already exceeding supply and the global population increasing at an unprecedented rate, it is show how crucial of its worst in this era globalization (Sedeno *et al*., 2013). In Malaysia, the fisheries sector are actually contributes approximately 2% of the national GDP (Azmir & Samat, 2010). In addition, it is an important source of income and living cost for the population (Azmir *et al.,* 2010). Billions of fish are exported every year into many parts of the countries (Lim & Tan, 2002). Due to this, many fish are hunted down to extinction and over-exploitation (Lim & Tan, 2002). Fishes are diverse and there is need to conserve and protect their diversity for natural heritage (Furtado & Mori, 1982).

However, in the last century, the chain's threads have been snapping. The biological diversity of life on earth is actually under serious issues and continuing threat from the impacts of human activities (Ormerod, 2003). Biodiversity combines the concepts of plants and animal as genetic resources, the diversity of species and the habitats in which they live, in one term (Ormerod, 2003).

Therefore, it is totality and contain variety of living things on earth as present usage term of biodiversity. The place their live within the diversity of the species and the habitats and ecosystems, such as the terrestrial rainforests, the freshwater lakes and river systems, the coral reefs and marine ecosystems (Day, 1967). The fundamental units of life, the species, have been disappearing at 100 to 1,000 times the natural rates of extinction, giving rise to fears of large scale extinctions in the coming decades (Rochet, 2000).

Freshwater habitats have a variety of factors acting on them such as light penetration, vegetation, temperature and other environmental factors (Khanna *et al*., 2007). A high genetic diversity within a fish population may protect it against environmental stressors such as climate change, pollutants and the spread of diseases (Hiddink *et al*., 2006). Furthermore, aquatic habitats also provide the resources like food, water, shelter, and space essential for the survival of aquatic animals and plants (Sedeno *et al.,* 2013). In a conclusion, people need to protect our biodiversity life because the greater the diversity of habitats, the greater the biodiversity will be in both land and water.

2.5 Fish as Biological Indicator

During this research, biological indicator is needed for an organism in an ecosystem to analyze as an indication of the ecosystem's heath (Lasheen *et al*., 2012). Bio indicators are responses to environmental effects that occur at higher levels of biological organization than sub-organism as biomarkers (Lasheen *et al.*, 2012). This kind of responses can be measured at different high levels of biological organization, from individual, through population (reproductive success, mortality, size distribution, reduction in abundance and biomass), community (primary production, disruption of the nutrient cycle) to ecosystem levels, whose main characteristic is that the measure change with exposure to negative environmental factors (Sedeno *et al*., 2013).

Fish muscle is commonly analyzed to determine contaminant concentrations and to assess the health risks because it is the main part consumed by humans (Harris, 1995). Fish can be as one of the most significant indicators in freshwater systems for the impact of metal pollution (Lasheen *et al*., 2012). The status of a fish population is totally depending on condition of the aquatic environment in which that population lives (Zainudin, 2005). The biological indicator was significant to test what type of species that inherit or owns their habitat in Pergau Lake and can live in this condition of water (Zainudin, 2005). The studies of spatial and temporal patterns of diversity, distribution and species composition of freshwater fishes are useful to examine factors influencing the structure of the fish community (Harris, 1995).

The distribution and composition of the fish species in each habitat were closely associated with various factors such as the availability of food, breeding sites, water current, depth, topography and physicochemical properties of water (Harris, 1995). Among environmental pollutants, metals are of particular concern, due to their potential toxic effect and ability to bio accumulate in aquatic ecosystems (Sedeno *et al*., 2013). Heavy metal concentrations in aquatic ecosystems are usually monitored by measuring their concentrations in water, sediments and biota which generally exist in low levels in water and attain considerable concentration in sediments and biota (Lasheen *et al.*, 2012). Fish muscle is commonly analyzed to determine contaminant concentrations and to assess the health risks because it is the main part consumed by humans (Zainudin, 2005).

Fish can be as one of the most significant indicators in freshwater systems for the impact of metal pollution (Zainudin, 2005). The commercial and edible species have been widely investigated in order to check for those hazardous to human health (Lasheen *et al.*, 2012). Fisheries management is based on the principle of the sustainable use of a renewable living resource (Paller *et al*., 1996). Despite the development of increasingly sophisticated tools (global, analytical, stock-recruitment models), the majority of fisheries throughout the world have now passed their peak, many stocks are overfished and some of them have experienced a crash in catches (Garcia & Newton, 1997). For the last, the capacities of fish populations to adapt to stress especially the selection of adaptive strategies concerning especially growth and reproductive traits and these factors must also be included in biological indicators (Adams, 2002).

CHAPTER 3

MATERIALS & METHODS

3.1 Study Area

Fishes were sampled from variety type of species habitats in Pergau Lake which is located in the northwest of Kelantan, Batu Melintang, and Jeli district. This reservoir located within latitudes of 5˚35′ to 5˚38′ N and longitudes 101˚38′ to 101˚41′ E. The lakes were encompassing about 460 hectare sizes according to Lembaga Kemajuan Kelantan Selatan (KESEDAR) facts. The survey has been carry out on in September and October 2016.

Figure 3.1: Screenshot screen which view the map of Pergau Lake from the image satellite taken showing the location of the study area (Source: Goggle Map)

Surveys were conducted during the rapid assessment of the freshwater fisheries of Pergau Lake, between 2th Sept until 16th Sept and 17th Sept until 18th Oct 2016. The first survey aimed to survey the study area, establish contacts with local fishermen/middlemen, and to interview questionnaire with the anglers and fishermen before finalizing the study methodologies. A total of 7 sampling sections were sampled in the lake. The random sections were picked, which was determined by coordinates latitude and longitude. Each of the sampling sites will be determine by using Global Positioning System (GPS).

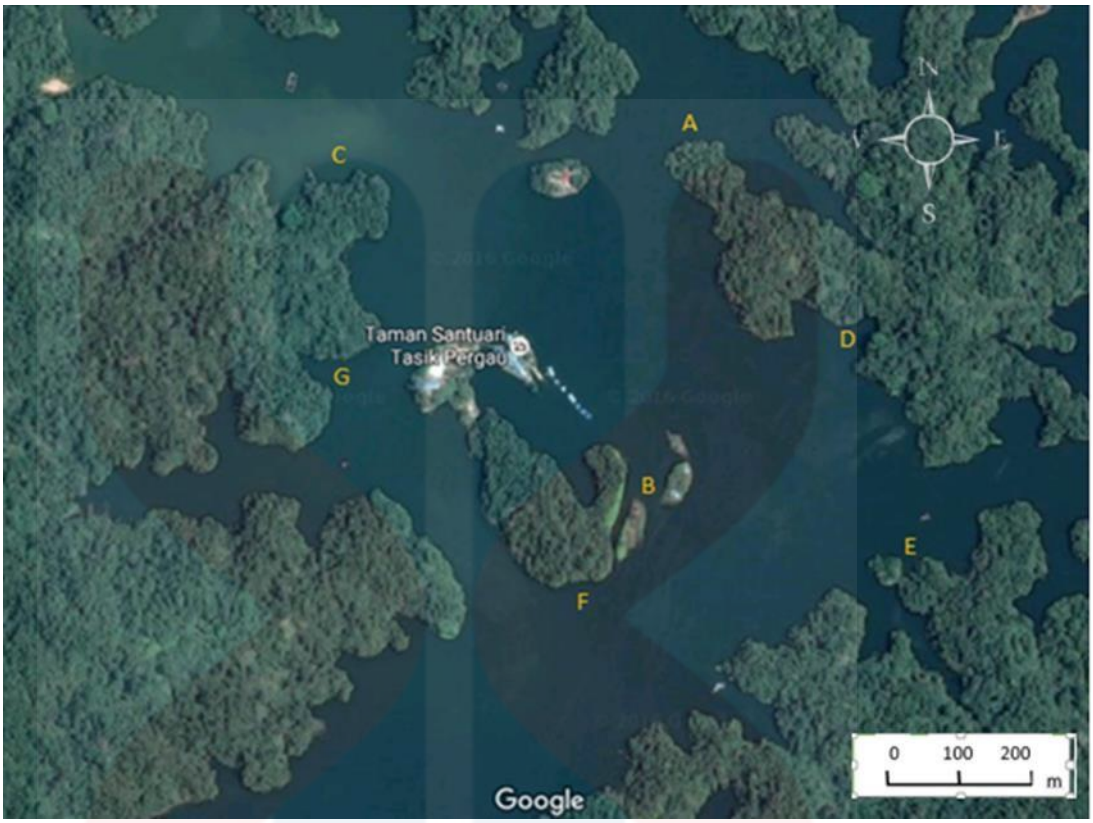


Figure 3.2 the map shows that the location coordinates of each sampling section in Pergau Lake.

(Source: Goggle Map)

NO	SAMPLING SECTION	COORDINATE
1	A	5.617311, 101.688569
2	B	5.611828, 101.687774
3	C	5.616729, 101.683127
4	D	5.613883, 101.690761
5	E	5.611035, 101,691670
6	F	5.610270, 101.686717
7	G	5.613623, 101.682902

3.2 Material

The material used in this research are glove, bucket, Global Positioning System (GPS), trawls or fish net to identify the fish diversity in Pergau Lake.

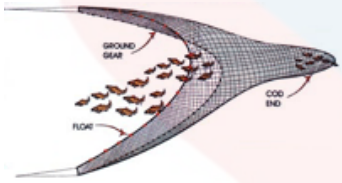
Equipment	Quantity	Function
Trawl Fish Net 	7	Use to trap fish
Rubber Glove 	2	Use to hold fish
Global Positioning System (GPS) 	1	Use to locate position, tracking and sampling positioning
Bucket 	1	Use to fill the fish that have been catch

Figure 3.3: Table of material uses and its own function

3.3 Method

3.3.1 Fish Sampling

The sampling objective is undertaken to obtain information about characteristics of fish populations or communities, often in relation to the habitats they occupy (Portt *et al.*, 2006). The characteristics that are of interest and the accuracy with which these must be estimated determine the sampling approach that is required (Portt *et al.*, 2006). Normally, there need factors to consider when determining the fish sampling methods use. The factor that necessary to be noted are habitat considerations, selectivity and efficiency, quantification of effort and also fish injury and survival (Spangler & Collins, 1992).

Seven portable traps were used to catch fish inside reef areas. During this research, the size of a trawl trap with model 0.15mm, mesh 6cm, depth 30md and length A (30). The reason is used trawl trap because are an effective but highly selective method that is relatively simple to use. The small fish was use as bait was placed in each trap. The traps were deployed at each section at 18:30 pm and collected the next day morning. The time of traps deployment and retrieval was recorded. The fish samples were collected at the end of the deployment period.

3.3.2 Fish data collection

Data collection in this study, the commercial and recreational fisheries were conducted using direct observation and interviews with the fishermen, anglers and middlemen. The survey was conducted between 08:00 am until 19:00 pm. Observation of fishery activities by local fishers and recreational anglers were conducted at the Pergau Lake jetty. However, this method was time consuming and dependent on the willingness of fishermen to share information. Therefore, commercial fish landings data were collected by direct observation, while detecting and estimate the suitable location to place fish trap placement from the fishermen.

Fish sample were photographed while fresh and were placed in trap stored fish and collected the data each according to their section, weight and length. Fish sample were stored in icebox filled with ice for further analysis. The fish that could not be identified in the field were fixed in 10% formalin solution for permanent storage in the fish collection. The samples were then transported back to the laboratory for further counting and taxonomic identification (Ambak *et al.*, 2012). The data were observed and identification the type of fish species will take note. Identification of fish species in this research was done by referred the book tittle "Fishes of Malaysia" second edition publication in University Malaysia Terengganu (UMT). After that, the data needed analyze and result to be in lists of fish species.

3.3.3 Analysis method

Fish length was measured to the nearest 0.01cm by measuring tape. Picture was taken for each fish for the identification of the species. Sample was identified based on the description by Ambak *et al*. (2012). The number of fish for each species collected at each section were recorded for data analysis.

The studies will be analyzing the quantity and abundance of diversity in fish species catch data obtained from the survey. The catchability, efficiency, selectivity and catch-per-unit-effort cover the Pergau Lake will be investigating and expected mainly influenced by tendency of food and prey-predator and also human activities. Fishes were identified up to species level.

3.3.4 Statistical analysis

The diversity and abundance of fish was determined using following parameters:

i. The relative abundance (percentage of catch)

Relative abundance of a species (by any measure), divided by the total abundance of all species combined. Relative abundance has no units. Alternatively, relative abundance can be expressed as a percentage.

Formula

Percentage of catch = Abundance of Fish/ Total Abundance of All Species

i. Simpson's Index of Diversity

Simpson's Diversity Index is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat. It takes into account the number of species present, as well as the abundance of each species.

The formula is: SID = 1-D

Where D is a measure of diversity, computed as follows:

$$D = 1 - \left(\frac{\Sigma\, n(n-1)}{N(N-1)} \right)$$

n = the total number of organism of a particular species

N = the total number of organism in all species

The value of D ranges between 0 and 1. With this index, 1 represents infinite diversity and 0, no diversity. The higher the Simpson Diversity Index, the more diverse sample is (Simpson, 1982). Or the higher probability of sampling two different species in a plot.

ii. Community similarity

The percent of fish sampled in each species in section A, B, C, D, E, F and G was measure to compare the similarity of the same species but in different areas.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Fish Occurrence

From the research data, this study show that section B has the highest species of fish which is 6 species compare to other sections meanwhile section A, D, E and G has the least number of fish species with only 2 species (Table 4.1). *Hemibagrus nemurus* (Baung) species can be found most of the section followed by *Hampala macrolepidota* (Sebarau) species. In section F, *Leptobarbus hoevenii* (Jelawat) has the highest average size which was 72cm and 5.64kg compare to other species in other section (Table 4.1).

Table 4.1 Fish occurrence at 7 section at Pergau Lake in September and October.

NO	SECTION	FAMILY NAME	FISH SPECIES	Local name
1	**A**	1.Bagridae-bagrid catfishes 2. Cyprinide- carps and minnows	*1-Hemibagrus nemurus* *2- Hampala macrolepidota*	Baung Sebarau
2	**B**	1. Claridae-airbreathing catfishes 2. Cyprinide- carps and minnows 3. Channidae-snakeheads 4. Cyprinide- carps and minnows 5. Bagridae-bagrid catfishes	*1- Clarias batraches* *2- Hampala macrolepidota* *3- Channa striata* *4- Cyprinus carpio* *5- Hemibagrus nemurus*	Keli kayu Sebarau Haruan Lee Koh Baung
3	**C**	1. Cyprinide- carps and minnows 2. Pangasiidae-shark catfishes or panges catfish 3. Bagridae-bagrid catfishes	*1-Poropuntius deauratus* *2- Pangasius hypothalamus* *3- Hemibagrus nemurus*	Tengas Daun Patin Baung
4	**D**	1. Cyprinide- carps and minnows 2. Cichlidae-cichlids	*1-Hampala macrolepidota* *2- Oreochromis niloticus niloticus*	Sebarau Tilapia Merah
5	**E**	Cichlidae-cichlids	*1-Oreochromis niloticus niloticus* *2- Oreochromis mossambicus*	Tilapia Merah Tilapia Hitam

NO	SECTION	FAMILY NAME	FISH SPECIES	Local name
6	**F**	1. Cyprinide- carps and minnows 2. Bagridae-bagrid catfishes 3. Cyprinide- carps and minnows	*1-Leptobarbus hoevenii* *2- Hemibagrus nemurus* *3- Neolissochilus hexagonolepis* *4- Tor tambra*	Jelawat Baung Tengas Kelah
7	**G**	Cyprinide- carps and minnows	*1-Osteochilus hasseltii* *2- Neolissochilus soroides*	Terbol Kelah Putih

4.2 Percentage of Catch

This study found that *Hampala Macrolepidota* (Sebarau) is the dominant species in three section which are section A, Section B and Section D with 57.14%, 40% and 75% respectively. *Hemibagrus nemurus* (Baung) was the second dominant species in four section which are Section A, Section B, Section C and Section E with 42.86%, 20%, 66.67% and 40% respectively. Section C same as *Hampala macrolepidota* (Sebarau) has the higher percentage than *Oreochromis niloticus niloticus* (Tilapia Merah) with only 25%. It is observed that *Oreochromis niloticus niloticus* (Tilapia Merah) got the more number of fish abundance compare to *Oreochromis mossambicus* (Tilapia Hitam) with 33.34% difference percentage of catch. *Osteochilus hasseltii* (Terbol) and *Neolissochilus soroides* (Kelah Putih) both have same percentage of catch which are 50%. In section B, both Haruan and Lee Koh species are the least caught percentage with 10%. Total of fish was catch are 37 fish (Table 4.2).

Table 4.2 Percentage of catch at Pergau Lake in September and October 2016.

NO	SECTION	FISH SPECIES	LOCAL NAME	TOTAL NUMBER	Percentage of catch (%)
1	**A**	*1-Hemibagrus nemurus*	Baung	3	42.86
		2- Hampala macrolepidota	Sebarau	4	57.14
2	**B**	*1-: Clarias batraches*	Keli Kayu	2	20.00
		2- Hampala macrolepidota	Sebarau	4	40.00
		3- Channa striata	Haruan	1	10.00
		4- Cyprinus carpio	Lee Koh	1	10.00
		5- Hemibagrus nemurus	Baung	2	20.00
3	**C**	*1-Poropuntius deauratus*	Tengas	1	16.67
		2- Pangasius hypothalamus	Daun	1	16.67
		3- Hemibagrus nemurus	Patin Baung	4	66.67
4	**D**	*1-Hampala macrolepidota*	Sebarau	3	75.00
		2- Oreochromis niloticus Niloticus	Tilapia Merah	1	25.00
5	**E**	*1-Oreochromis niloticus Niloticus*	Tilapia Merah	2 1	66.67 33.33
		2- Oreochromis Mossambicus	Tilapia Hitam		
6	**F**	*1-Leptobarbus hoevenii*	Jelawat	1	20.00
		2- Hemibagrus nemurus	Baung	2	40.00
		3- Neolissochilus hexagonolepis	Tengas Kelah	1 1	20.00 20.00
		4- Tor tambra			
7	**G**	*1-Osteochilus haseltii*	Terbol	1	50.00
		2- Neolissochilus soroides	Kelah Putih	1	50.00

Based from the observation, Family Cyprinide in section A has the more total percentage number of catch than Family Bagridae which are 57.14%. In section D, the difference percentage of catch between Cyprinide and Cichlidae are 2% meanwhile there was same percentage between Family Cyprinide and Pangasiidae which only 16.67% in section C. Beside that there were 100% abundance of Family Cichlidae in section E live habitat in that area as same as Family Cyprinid in section G (Table 4.3). The tilapiines species of Family Ciclidae comes from North Africa have been intorduced and farmed extensively in many parts of Asia include Malaysia. It has been increasingly common aquaculture targets and farming.

Table 4.3 Percentage of catch of fish in Family in section at Pergau Lake.

NO	SECTION	FAMILY	TOTAL NUMBER	PERCENTAGE OF CATCH (%)
1	A	1.Bagridae-bagrid catfishes	3	42.85
		2.Cyprinide-carps and minnows	4	57.14
2	B	1.Claridae-airbreathing catfishes	2	20.00
		2. Cyprinide-carps and minnows	5	50.00
		3. Channidae-snakeheads	1	10.00
		4. Bagridae-bagrid catfishes	2	20.00
3	C	1.Cyprinide- carps and minnows	1	16.67
		2.Pangasiidae-shark catfishes or	1	16.67
		panges catfish	4	66.67
		3. Bagridae-bagrid catfishes		
4	D	1.Cyprinide-carps and minnows	3	75.00
		2. Cichlidae-cichlids	1	25.00
5	E	1. Cichlidae-cichlids	3	100.00
6	F	1.Cyprinide- carps and minnows	4	66.67
		2. Bagridae-bagrid catfishes	2	33.33
7	G	1.Cyprinide- carps and minnows	2	100.00

This study found that Family Cyprinide is the dominant Family in Pergau Lake with exactly 50%. The second dominant Family is Family Bagridae is also the dominant in all section with more that 28% percentage of catch. The least number of family are Family Channidae and Family Pangasiidae. They have same percentage of catch which are 2.63% (Table 4.4).

Table 4.4 Total Percentage of catch (%) in Family at Pergau Lake.

FAMILY	TOTAL NUMBER	TOTAL PERCENTAGE OF CATCH (%)
Bagridae-bagrid catfishes	11	28.95
Cyprinide- carps and minnows	19	50.00
Claridae-airbreathing catfishes	2	5.26
Channidae-snakeheads	1	2.63
Pangasiidae-shark catfishes or panges catfish	1	2.63
Cichlidae-cichlids	4	10.53

4.3 Simpson's Diversity Index

Pergau Lake contain several differences species have a similar abundance that reproduce their laying eggs and live in their own community. A community dominated by one or two species is considered growth in that particular area. Simpson's Diversity Index is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. It need to show that the diversity of fish in Pergau Lake as species richness and evenness increase, so diversity will increase.

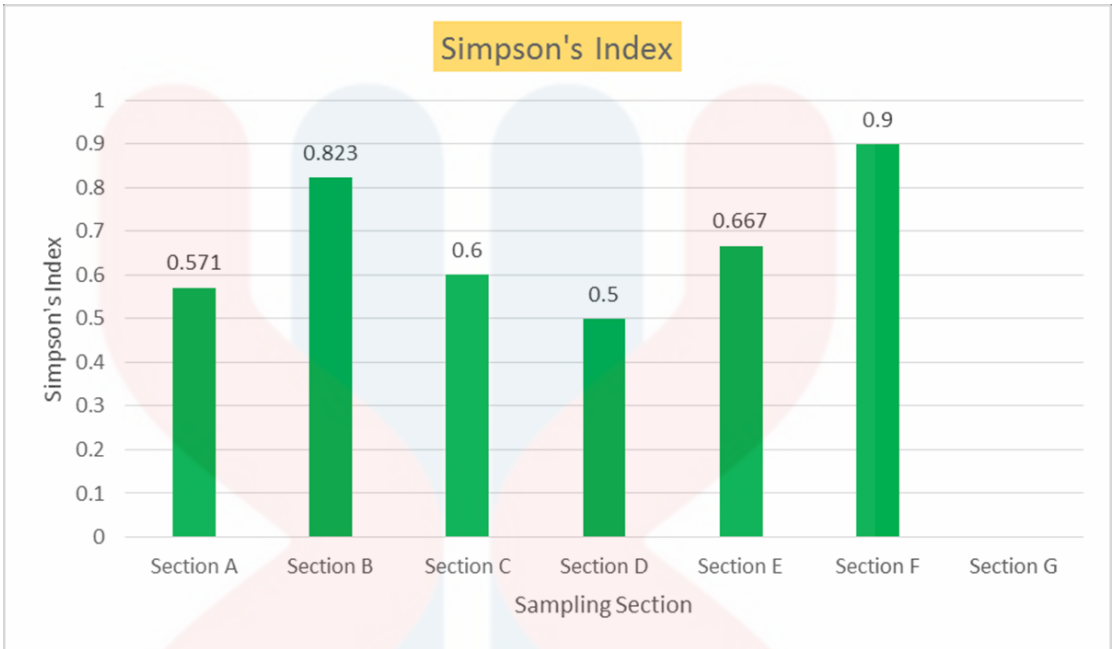
$$D = 1 - \left(\frac{\Sigma\, n(n-1)}{N(N-1)} \right)$$

n = the total number of organism of a particular species

N = the total number of organism in all species

The value of D ranges between 0 and 1. With this index, 1 represents infinite diversity and 0, no diversity.

Table 4.5 Simpson's Index of diversity from all section at Pergau Lake in September and October 2016



This study show that section F has higher Simpson's index compare to other section. When Simpson's Index for some habitat is closest to one, the diversity of organism in that area is more diverse. The greater the value, the greater the sample diversity. The catchment of fish sample that have predicted was 50 samples. However, there were not enough of fish sample as the weather conditions was bad due to raining, drought and monsoon season in period sampling month. Therefore, Simpson's index for section G cannot be count because insufficient amount of sample and least of fish catchment. The count mathematical formula of index shows the zero.

4.4 Community similarity

This study show that the percent similarity between community which can compare the similarity between same species in different section. There is no species abundance has same similarity in each section. However, there was one species similarity can found in 4 section which is *Hemibagrus nemurus* species. The next similarity was *Hampala macrolepidota* species that can be found in section A, B and D. The most abundance fish species was located at section B compare to other section as shown in (Table 4.6)

Table 4.6 Community similarity from section A, B, C, D, E, F and G at Pergau Lake in September & October 2016.

Species/ Section (%)	**A**	**B**	**C**	**D**	**E**	**F**	**G**
1-Hemibagrus nemurus (Baung)	42.86	20	66.67	0	0	40	0
2- Hampala macrolepidota (Sebarau)	57.14	40	0	75	0	0	0
3-Clarias batraches (Keli Kayu)	0	20	0	0	0	0	0
4-Channa striata (Haruan)	0	10	0	0	0	0	0
5-Cyprinus carpio (Lee Koh)	0	10	0	0	0	0	0
6-Poropuntius deauratus (Tengas Daun)	0	0	16.67	0	0	0	0
7-Pangasius hypothalamus (Patin)	0	0	16.67	0	0	0	0
8-Oreochromis niloticus niloticus (Tilapia Merah)	0	0	0	25	66.67	0	0
9-Oreochromis mossambicus (Tilapia Hitam)	0	0	0	0	33.33	0	0
10-Leptobarbus hoevenii (Jelawat)	0	0	0	0	0	20	0
11-Neolissochilus hexagonolepis (Tengas)	0	0	0	0	0	20	0
12-Tor tambra (Kelah)	0	0	0	0	0	20	0
13-Osteochilus haseltii (Terbol)	0	0	0	0	0	0	50
14-Neolissochilus soroides (Kelah Putih)	0	0	0	0	0	0	50
TOTAL FISH SAMPLE	**7**	**10**	**6**	**4**	**3**	**5**	**2**

4.5 Fish Abundance

The occurrence of *Clarias batraches, Hampala macrolepidota, Channa striata, Cyprinus carpio* and *Hemibagrus nemurus* make Section B has the highest species richness of fish which are total 5 species compare to other all sections. This means that section B has most optimum condition for fish to live. When we compare section by another section using geography and human activities. Section B sample was located the most nearest human activities which there was a resort.

From my interview with Encik Za'aba, he was one of the KESEDAR director. He said before this the location was dominated by *Oreochromis niloticus niloticus* species (Tilapia Merah) and *Oreochromis mossambicus* species (Tilapia Hitam). This place was the place for fish farming which owned by KESEDAR and RISDA. They put a lot of fish cage about 26 cage for KESEDARAN and a few cage for RISDA to farm it. Unlike those carnivorous fish, tilapia can feed on algae or any plant-based food. Indirectly it reduces the cost of tilapia farming, decrease in fishing pressure on prey species and prevent concentrating toxins that accumulate at higher levels of the food chain.

But then, these cage were destroyed due to decrease of water level from dam construction. The fish was all died due to low of oxygen level and not suitable for *Oreochromis niloticus niloticus* (Tilapia Merah) and *Oreochromis mossambicus* (Tilapia Hitam) to live. These species start decreases and swim to find their new places which is now most of these species can found at section D and E.

The shift in the dominant fish species caught commercially is a clear indication that the dynamics of the fish populations and their composition has changed over time (Patrick *et. al.*, 2013). It is apparent that *Hemibagrus nemurus* species (Baung) and *Hampala macrolepidota* species (Sebarau) have now become the most dominant species.

Followed by another fish species such as *Clarias batraches* (Keli Kayu), *Channa striata* (Haruan), and *Cyprinus carpio* (Lee Koh) also have live in section B area. This might because of the waste from food that was used for fish farming may attracted other fish to eat and live there thus increase the amount of fish that live there. However, Section G has the least amount of sample because it may not attractive for fish to live at that area. It is also a quiet place with least habitat fish.

This study found that size range and average size for each species are different. The tools used to measure the size and length of fish sample was measuring tape. The biggest size range fish sample was up 72cm that is *Leptobarbus hoevenii* (Jelawat). The smallest fish can be found at Pergau Lake was *Tor tambra* species which is kelah fish size range about 14.4 cm to 27.2 cm. Fish trawl trap were use in this study to avoid damaging coral. During the survey, I was trying to use the minimum method to obtain the sample. So that there are no small fish were caught in this survey because the mesh size for the trap is big enough for it to escape from the trap if it was caught inside.

In order to observe fish abundance in each section we also can comparing the percentage of catch in each section. Table 4.2 show the percentage of catch in section A, B, C, D, E, F and G in Pergau Lake. In section A, *Hampala macrolepidota* (Sebarau) has the higher percentage which is 57.14 % than *Hemibagrus nemurus* (Baung) with 42.86 %.

While in section B, *Hampala macrolepidota* (Sebarau) also dominant in that area which is 40% compare to *Clarias batraches* (Keli Kayu), *Channa striata* (Haruan), *Cyprinus carpio* (Lee Koh) and *Hemibagrus nemurus* (Baung). The difference percentage of catch between section C and F of *Hemibagrus nemurus* species (Baung) are 26.67%. In section F, there were three species have same percentage of catch which are *Leptobarbus hoevenii* (Jelawat), *Neolissochilus hexagonolepis* (Tengas) and *Tor tambra* (Kelah) with only 20%. Among the species in all section, *Hemibagrus nemurus* (Baung) and *Hampala macrolepidota* (Sebarau) has same catch which are 11 total number of fish sample each and also result in highest percentage of catchment.

However, from the result it can observed that Family Cyprinide (carps and minnows) has the highest percentage of abundance among other family with 50% which means 19 total number of fish sample. The difference percentage between the last and second last percentage of catchment in family are 2.63%. During the sampling, we can clearly see that most of the sample obtained is *Hemibagrus nemurus* (Baung) and *Hampala macrolepidota* (Sebarau).

However, many of the anglers and fishermen I met, most of them said Giant snakehead fish which is *Channa micropeltes* species was also dominated in this place. Toman fish was popular called by local people in Malaysia. The habitat of Giant snakehead fish was suitable live in the area.

As mention before this, Mosambique tilapia and Nile Tilapia inhabit the place and cover the Pergau Lake area. This is because they able to survive extreme reduction of temporary waterbodies with highly euryhaline (Ambak *et al.*, 2012). They grow and reproduces in freshwater and can be reared under hypersaline conditions (Ambak *et al.*, 2012). Basically human activities give huge impact to the fish diversity in the marine ecosystem around the world.

Pergau Lake was well known as eco-tourism which beauty nature view and landscape, flora and fauna. Human activities also cause the extinction of native species and the establishment of non-native species. After the construction of Pergau dam, the abundance diversity of Mosambique tilapia and Nile Tilapia fish decreases due to cannot tolerates too low dissolved oxygen levels and cannot utilise the atmospheric oxygen when water oxygen levels drop (Ambak *et al.*, 2012). As presence of a predator, which are Giant snakehead fish and Asian redtail fish (Baung), it totally changes the quantity and quality of Mosambique tilapia and Nile Tilapia habitats around the lake. These have been influence patterns of species richness, community composition and abundances of fish species. Therefore, Giant snakehead fish continues inhabits all parts of Pergau Lake due to they can live in open waters of lake. Continuously the other habitat fish also inhabit and reproduces their eggs.

4.6 Fish Diversity

Species diversity has two parts which are richness that refers to the number of species found in a community and evenness refers to the relative abundance of each species. When a community have high species diversity if many nearly equally abundant species are present. If a community has only a few species or if only a few species are very abundant, then species diversity is low.

Table 4.5 which show the Simpson's Index of diversity from sample section A, B, C, D, E, F and G in Pergau Lake. This study show that section B has highest Simpson's Index compare to other 6 sections. This means that section B has more diversity of fish. But the difference between the most diversity of fish with the second highest which is section F was only 0.05. Simpson's Index for section G cannot be count because insufficient amount of sample.

When Simpson's Index for some habitat is closest to one, the diversity of organism in that area is more diverse. One representing perfect evenness (all species present in equal numbers) (Rindfleisch *et al.*, 2008). The distributions of individuals or species evenness (E) in the 7 section were uneven. The value of E varied between 1 and 0. The closer to 1 the more even the populations of fish that form the community (Rindfleisch *et al.*, 2008). From the figure, we also can conclude that the ecology at section B is more diverse compare to others. Higher species diversity is generally thought to indicate a more complex and healthier community because a greater variety of species allows for more species interactions, hence greater system stability, and indicates good environmental conditions.

The similarity between same species in different section can be calculate using community similarities. It is a good way to compare communities in different places to examine community similarity. There is no species that has same similarity in sample section. The percent similarity is quite low because there is some species live in their same habitat section but not live in other habitat section. The least amount of sample has become a problem in order to calculate communities' similarities.

4.7 Comparison of Fish Catch composition by Families abundance between PergauLake, Jeli and Muda Lake, Kedah

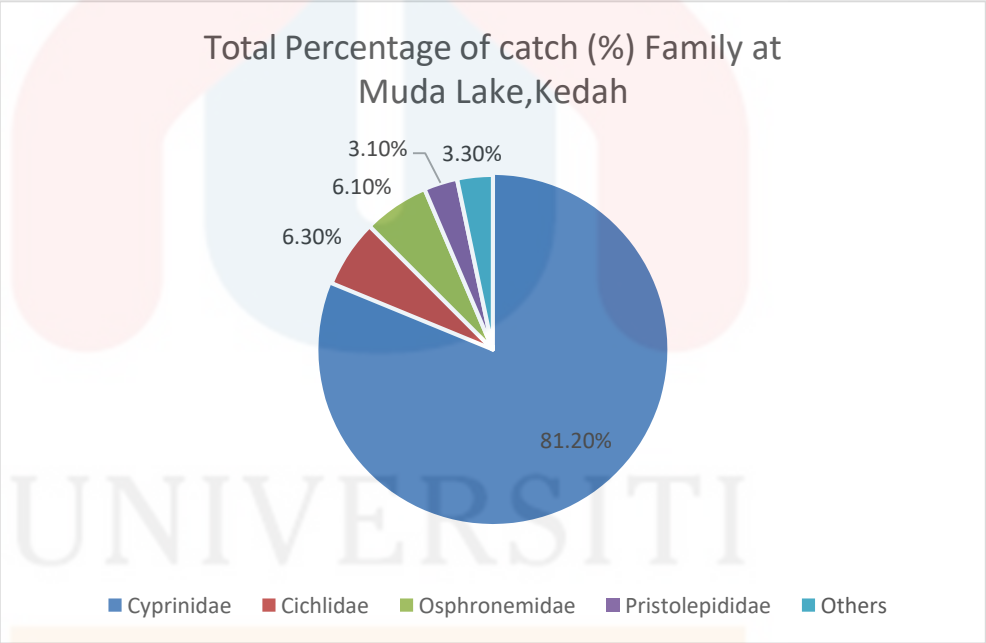


Figure 4.7 the pie chart show the total percentage of Family at Muda Lake, Kedah (Patrick *et al*., 2013)

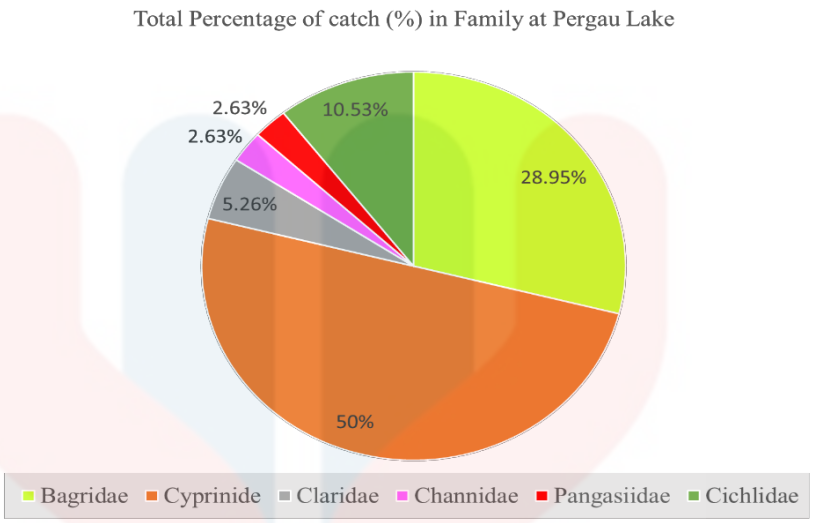


Figure 4.8 the pie chart shows the total percentage of Family at Pergau Lake, Jeli.

The comparison between Muda Lake, Kedah and Pergau Lake, Jeli show the same similarities where both Family Cyprinide recorded the highest percentage of catchment in the freshwater habitat. According to Ambak *et. al.*, (2012), it stated that Family Cyprinide is the largest family of freshwater fishes. In Malaysia, it is a largest freshwater fish family in terms of the number of genera and species and is abundant in rivers and lakes. Besides that, most of Cyprinide are riverine and spawned during the first rainy season after a long period of drought as they exhibit a variety of spawning habits (Ambak *et. al.*, 2012). In addition, the second largest family in Muda Lake is Family Cichlidae about 6.3% and Family Bagridae in Pergau Lake about 28.95%. There are more Family of fish at Pergau Lake that total family are 6 families compares to Muda Lake which only 5 families only.

4.8 Limitation

There is no journal or primary research was found about Freshwater fish habitat in Pergau Lake. Only the secondary information from anglers and fishermen and also KESEDAR about the type of fish and its abundance data was collected from them. According to KESEDAR, there was 18 species belonging 15 genera of 7 families.

There are also not enough people to conduct the trap because the fish trawl trap was limited. Luckily, there were some kindness from fishermen to help me conduct the research. Environment also affect the sampling data because during the research, sometimes it rain as the Monsoon season in October until the end of the year that may make it difficult to collect data of fish sample.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

This study shows that highest percentage of catchment can be found in section B due to good environmental condition water. The abundance of fish diversity was decreased because of human activities, from boat and also effect from construction of Pergau Dam released high amount of water to support nearby Jeli village and reduced flood causes. It is an opposite result from the expected result.

The dominance species *Hemibagrus nemurus* species (Baung) and *Hampala barb* (Sebarau) can be found with the highest percentage of catch. The Pergau Lake water condition is the optimum environment the growth of Sebarau species. Meanwhile, *Channa micropeltes* species (Toman) obtained the highest vote from the anglers and fishermen include data information from KESEDAR. This study found that Family Cyprinide (carps and minnows) is the dominant Family in Pergau Lake with exactly 50%. Section F has higher Simpson's index. These show that higher species diversity is indicate a more complex and healthier community because a greater variety of species allows for more species interactions, hence gives greater system stability, and indicates good environmental conditions.

5.2 Recommendations

It is recommended to avoid certain problems during this research. In this study, there were problems encountered during the sampling. Before doing the sampling, all equipment and sampling apparatus must be check properly and prepare to avoid error and mistake when doing sampling. Make a clear mark on the pole that hold the trap so that it easier to find it. Besides that, avoid doing the research between Septembers until December due to Monsoon season. The fish sample collection will be very few to collect the enough data and result. For the next research, it is recommending to use other method of catchment fish such as cast net, fishing rod, electro shocker, or bigger size of fish net.

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APPENDICES

Appendices A
Catchment using trawl

Length of fish = 23cm Weight = 0.127kg

Order Siluriformes
Family Claridae-airbreathing catfishes
Scientific name : *Clarias batraches*
English name : Walking catfish
Local name : Keli kayu

Length of fish = 25cm Weight = 0.236kg

Order Siluriformes
Family Bagridae-bagrid catfishes
Scientific name : *Hemibagrus nemurus*
English name : Asian redtail fish
Local name : Baung

Length of fish = 28cm Weight = 0.270kg

Order Cypriniformes
Family Cyprinide- carps and minnows
Scientific name : *Hampala macrolepidota*
English name : Hampala barb
Valid local name : Sebarau

Length of fish = 40cm Weight = 0.318kg

Order Perciformes(Suborder Channoidei-Ophicephaliformes)

Family Channidae-snakeheads

Scientif name : *Channa striata*

English name : Snakehead murrel or Common snakehead

Local name : Aruan, haruan, Toman Paya

Valid local name : Haruan

Length of fish = 23cm Weight = 0.150kg

Order Cypriniformes

Family Cyprinide- carps and minnows

Scientific name : *Osteochilus hasseltii*

English name : Silver sharkminnow

Local name : Ikan Terbol

Length of fish = 72cm Weight = 5.640kg

Order Cypriniformes

Family Cyprinide- carps and minnows

Scientific name : *Leptobarbus hoevenii*

English name :Hoven's carp or Sultan's fish

Local name : Jelawat

Length of fish = 22cm Weight = 0.682kg

Order Perciformes(Suborder labroidei)

Family Cichlidae-cichlids

Scientific name : *Oreochromis niloticus niloticus*

English name : Nile Tilapia

Local name : Tilapia merah

Length of fish = 24.5cm Weight = 0.703kg

Order Perciformes(Suborder labroidei)

Family Cichlidae-cichlids

Scientific name : *Oreochromis mossambicus*

English name : Mosambique tilapia

Local name : Ikan mudjair, Tilapia hitam

Length of fish = 32.7cm Weight = 1.025kg

Order Siluriformes

FamilyPangasiidae-shark catfishes or panges catfish

Scientific name : *Pangasius hypothalamus*

English name : Sutchi Catfish

Local name : Ikan Patin

Length of fish = 21cm Weight = 0.249kg

Order Cypriniformes

Family Cyprinide- carps and minnows

Scientific name : *Neolissochilus hexagonolepis*

English name : Copper mahseer

Local name : Kejar, tengas

Length of fish=23cm Weight =0.263kg

Order Cypriniformes

Family Cyprinide- carps and minnows

Scientific name : *Cyprinus carpio*

English name : Common carp

Local name : Lee Koh

Length of fish = 21.5cm Weight=0.126kg

Order Cypriniformes

Family Cyprinide- carps and minnows

Scientic name : *Tor tambroides*

English name : River carp

Local name : Kelah

Length = 24.6cm Weight = 0.355kg

Order Cypriniformes

Family Cyprinide- carps and minnows

Scientific name : *Poropuntius deauratus*

English name : Carp

Local name : Tengas Daun

Length = 21.5cm Weight = 0.243kg

Order Cypriniformes

Family Cyprinide- carps and minnows

Scientific name : *Neolissochilus soroides*

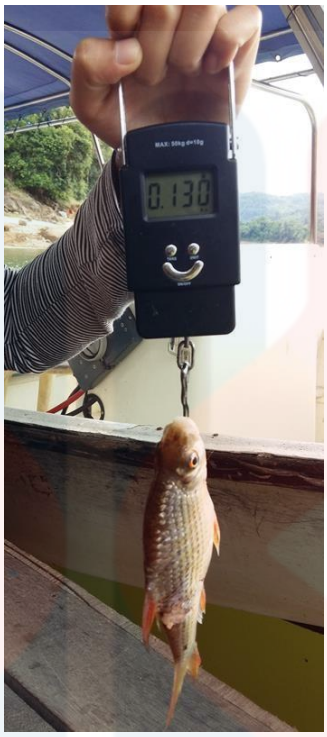
English name : Brook carp

Local name : Kelah putih

Appendices **B**

Information Board of TSTP

Measuring Tape



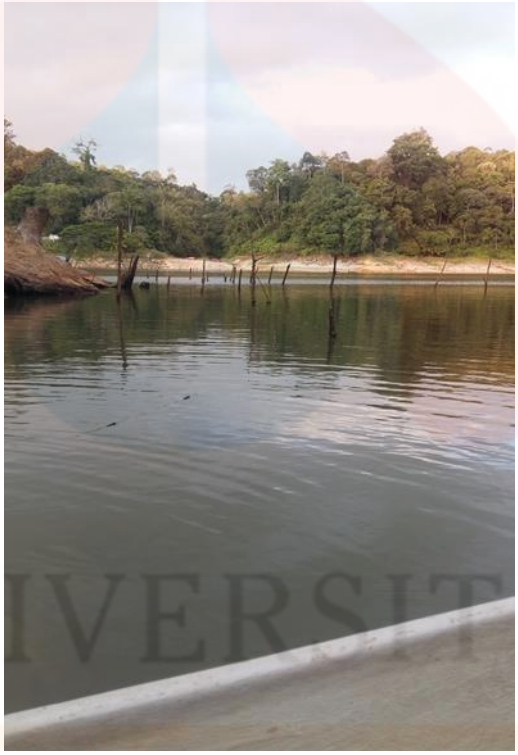
Weighing scale

Sample

Spotting Ikan Haruan

My fish trawl trap

One of the section sample location (Section B)



Another of section sample location (Section F)

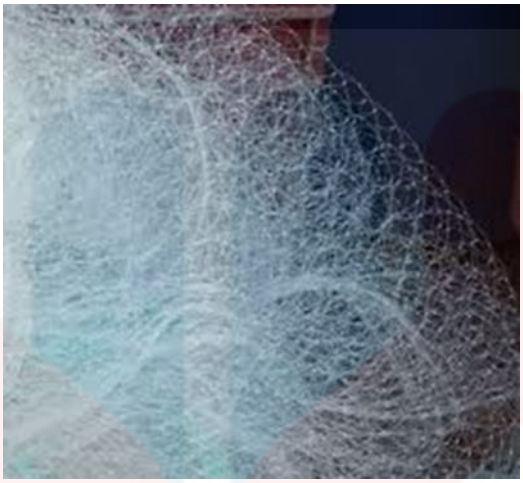
Nature beauty view of Pergau Lake

Fish trap by KESEDAR and RISDA (long time ago)

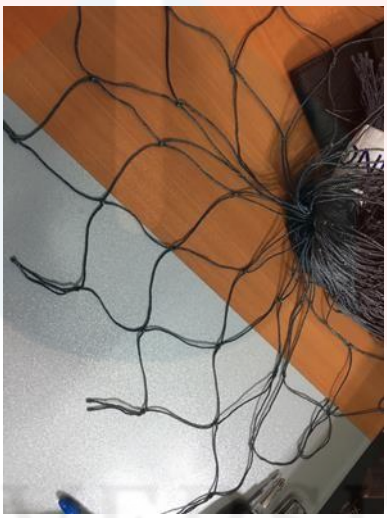
(Source by KESEDAR)

Setting fish trawl trap in the morning

Returning in the evening to check the trawl trap



Fish Trawl Trap



Rope to tie the wood pile

(Source: http://www.tradekorea.com/product/detail/P594642/fishing-net-(--Purse-seine-net-,-fish-farm-net,-trawl-net).html)

Sample collection