UNIVERSITI PUTRA MALAYSIA

POPULATION DYNAMICS OF MAJOR FISH SPECIES AND SOCIOECONOMIC STATUS OF INLAND WATER FISHERIES IN THE KEBBI STATE, NIGERIA

DALHATU YAHAYA BAWA

FP 2019 59

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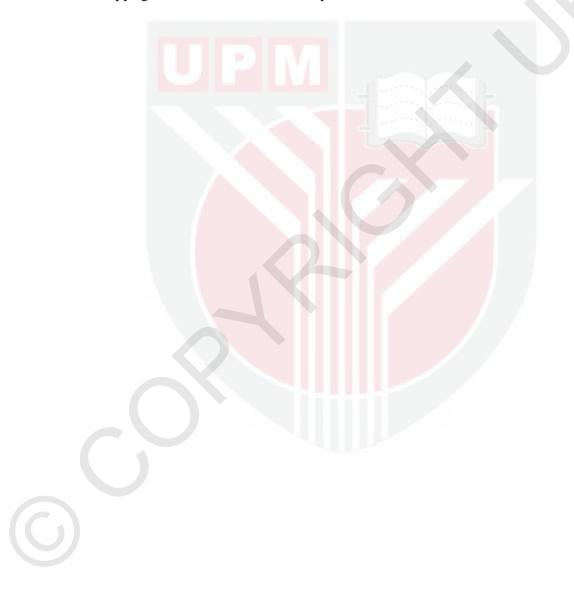
By

DALHATU YAHAYA BAWA

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

July 2019

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DEDICATION

This thesis is dedicated to Almighty Allah for his protection, provision, guidance and strength throughout this study

To my parent who always kept praying for me to achieve my goal

To the memory of my late brother Sirajo who is no longer alive to share the

Joy with me

POPULATION DYNAMICS OF MAJOR FISH SPECIES AND SOCIO-ECONOMIC STATUS OF INLAND WATER FISHERIES IN THE KEBBI STATE, NIGERIA

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Kebbi State is blessed with abundant fisheries resources in their riverine system that contributes to the artisanal fishermen's life in Kebbi State. However, basic information such as fish species composition, age structure, growth, mortality, habitat status and socioeconomic profile of fishermen for fisheries management are not available in the Kebbi State so far. A study was conducted on fish species composition, catch-per-unit-effort (CPUE), population dynamics of three (3) selected major species and socioeconomic status of small-scale fisheries from the Kebbi State, Nigeria between January and December 2017. Fish sample were collected from three (3) selected fishing communities namely Argungu, Sabiyel and Yauri. Water quality parameters were recorded *in situ* using YSI 556 MDS (YSI Incorporated, USA) professional handled multi-parameter recorder, these include dissolved oxygen, pH, temperature, ammonia, phosphate and total dissolved solid, meanwhile chlorophyll-a were determined *ex-situ*. The age, growth, mortality and recruitment of major fish species *(Bagrus bayad, Hyperopsis bebe occidentalis and Synodontis nigrita)* were investigated based on monthly length-frequency data, using FISAT software. A set of structured questionnaire was used to collect all information from the fishermen and total of 289 fishermen were approached and the data collected was analyzed using SPSS software (version 22.0). In total 18 fish species belonging to 11 families were identified from the waters of Kebbi State. Among the 11 families Mormyridae was the highest with (16.66%) comprising of three species. The average monthly CPUE was 37.44 kg/ gill net/hour and the highest catch was recorded during July to September. The CPUE of fishes varied significantly ($p < 0.05$) among the different stations. A total of 11 different types of gears fishing gears was recorded, these include: gill net, surrounding net, cast net, beach seine net, trap net, gura trap, Indrutu, hook and line, Ara trap and Kawari. The study of population dynamics parameters revealed that *Bagrus bayad, Hyperopsis bebe occidentalis and Synodontis nigrita*

attained an average growth rate/year of 4.56cm, 3.73cm and 3.71cm respectively with a recruitment pattern of two major recruitment events per year. The natural mortality rate (M) of *B. bayad, H. occidentalis* and *S. nigrita* were 0.97 yr^{-1}, 0.91 yr^{-1} and 0.90 yr^{-1} while fishing mortality rate (F) was 0.56 yr^{-1}, 0.75 yr^{-1} and 0.99 yr^{-1} respectively. Results from the analysis of the exploitation rate (E) shows that *B. bayad* (0.37 yr^{-1}) and *H. occidentalis* (0.45 yr^{-1}) were 26% and 10% under fished while *S. nigrita* (0.52 yr^{-1}) was slightly above optimum level of exploitation (E = 0.50). This implies that the fish stocks in the study area are underexploited as a subsistence fishery. The socio-demographic study revealed that most of the fishermen were between 31 and 40 years old (31.8%). All the fishermen are Muslim (100%); with 97.9% fishermen were engaged in fishing as their occupation. However, only 41.9% had the formal education in Islamic field of studies. Meanwhile, about 49.5% were categorized in the low income earners of the fisher's community. This result implies that the fish stocks in the study area are underexploited. Fishermen community largely depends on fishing as their source of livelihood and daily income was USD 1.50 which is sufficient to survive sustainably. This finding confirms the close relationship between fishery resource exploitation rates and the socioeconomic development of fishermen at the individual level and as an alternative source of available resources at the community and State level in general. There is a need to diversify into aquaculture to reduce the impact on wild fish population.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

POPULASI DINAMIK BAGI SPESIS IKAN UTAMA DAN SOSIO-EKONOMI STATUS KAWASAN PENDALAMAN AIR DI NEGERI KEBBI, NIGERIA

Oleh

DALHATU YAHAYA BAWA

Julai 2019

Pengerusi : Profesor Madya SM Nurul Amin, PhD
Fakulti : Agriculture

Negeri Kebbi diberkati dengan sumber perikanan yang berlimpah dalam sistem sungai mereka yang menyumbang kepada kehidupan nelayan artisanal di Kebbi State. Walau bagaimanapun, maklumat asas seperti komposisi spesies ikan, struktur umur, pertumbuhan, mortaliti, keadaan habitat dan profil sosioekonomi nelayan untuk pengurusan perikanan tidak hadir di Negari Kebbi setakat ini Satu kajian telah dijalankan berkaitan komposisi spesies ikan usaha tangkapan per unit usaha (CPUE) bagi populasi dinamik untuk tiga spesies ikan utama dan status sosioekonomi perikanan berskala-kecil dari negeri Kebbi, Nigeria, dari Januari sehingga Disember 2017. Sampel ikan diambil dari tiga komuniti nelayan yang dipilih iaitu Argungu, Sabiyel dan Yauri. Parameter kualiti air telah direkod secara *in-situ* dengan menggunakan YSI 556 MDS (YSI Incorporated, USA) perakam pelbagai parameter kendalian profesional, termasuk oksigen terlarut, pH, suhu, ammonia, klorofil-a, fosfat dan jumlah pepejal terlarut, manakala klorofil-a ditentukan melalui *ex-situ* Umur, pertumbuhan, kematian dan rekrut bagi spesies ikan utama *(Bagrus bayad, Hyperopsis bebe occidentalis* dan *Synodontis nigrita)* ditentukan berdasarkan data frekuensi-panjang bulanan dengan menggunakan perisian FISAT. Soalan kaji selidik berstruktur digunakan bagi mendapatkan semua maklumat daripada nelayan dan sebanyak 289 data daripada nelayan dikumpul dan dianalisis dengan menggunakan perisian SPSS (versi 22.0). Secara keseluruhannya, terdapat 18 spesies ikan mewakili 11 keluarga telah dikenal pasti terdapat di perairan Kebbi. Diantara 10 keluarga ini, dua keluarga iaitu Mormyridae (16.66%) adalah yang paling dominan, setiap satu terdiri daripada empat dan tiga spesies. Purata CPUE bulanan pula adalah 37.44 kg / pukat insang / jam dan tangkapan tertinggi direkodkan pada bulan July sehingga September. Usaha tangkapan per unit (CPUE) ikan diantara stesen adalah berbeza secara signifikan ($p < 0.05$). Terdapat 11 jenis alat tangkapan ikan telah direkodkan. Ini termasuk: pukat insang, pukat tunda, jala, pukat pantai, bubu, gura perangkap indurutu, kail dan tangsi, ara perangkap dan kawari. Kajian tentang parameter populasi dinamik menunjukkan

Bagrus bayad, Hyperopsis bebe occidentalis dan *Synodontis nigrita* mempunyai kadar purata pertumbuhan dalam setahun ialah 4.56 cm, 3.73 cm dan 3.71 cm dan terdapat dua kali rekrut bagi tiga spesies ini. Kadar kematian semula jadi (M) bagi *B. bayad*, *H. occidentalis* dan *S. nigtrita* adalah 0.97 tahun-1, 0.91 tahun-1 dan 0.90 tahun-1, manakala kadar kematian memancing (F), masing-masing adalah 0.56 tahun-1, 0.75 tahun-1 dan 0.99 tahun-1. Keputusan bagi analisis kadar eksploitasi (E) menunjukkan bahawa *B. bayad* (0.37 tahun-1) dan *H. occidentalis* (0.45 tahun-1) adalah 26.0% dan 10.0% dibawah paras eksploitasi, manakala *S. nigrita* (0.52 tahun-1) berada diatas paras eksploitasi optimum (E = 0.50). Ini menunjukkan bahawa stok ikan di kawasan kajian kurang dieksploitasi sebagai perikanan sara hidup. Bagi status sosioekonomi pula, kajian mendapati 31.8% nelayan berumur antara 31-40 tahun. Majoriti nelayan adalah muslim (100%), dan 97.9% manakala majoriti nelayan. Walaubagaimanapun, hanya menyatakan menangkap ikan sebagai pekerjaan utama 41.9% mempunyai pendidikan formal dalam pengajian bidang islamik. Manakala sebanyak 49.5% dikategorikan orang berpendapatan rendah dalam komuniti nelayan. Secara keseluruhannya, stok ikan bagi tiga spesies utama berada dibawah paras eksploitasi. Masyarakat nelayan sebahagian besarnya bergantung kepada aktiviti menangkap ikan sebagai sumber kehidupan mereka dengan pendapatan harian USD 1.50 yang cukup bagi kehidupan yang mampan. Penemuan ini mengesahkan perhubungan yang erat antara kadar eksploitasi sumber ikan dan pembangunan sosioekonomi para nelayan di peringkat individu dan sebagai peluang sumber alternatif alternatif yang tersedia di peringkat komuniti dan negeri Kebbi pada umumnya. Terdapat keperluan untuk kepelbagaian dalam akuakultur untuk mengurangkan kesan ke atas populasi ikan liar.

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ACKNOWLEDGEMENTS

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CHAPTER 1

GENERAL INTRODUCTION

1.1   Introduction

Tsinghis chapter presents background of the study, problem statements, significance of the study and research objectives.

1.2   Background

Fishing is an essential activity globally, contributing to the livelihoods of 200 million people, imparting in surplus of 100 million tons of fish and fish products annually for which over a billion individuals are depend upon for their protein, social and cultural desires (Fletcher et al., 2005).

Fish population is renewable natural resources if harnessed in a sustainable way. Hence, fishery represents a significant basis of income to the economy of many countries and a significant food segment for humans (Dwivedi et al., 2009). It is an important food resource for humans which accounts for about 15.7% of the world animal protein consumption (Bostock et al., 2010). Accumulative trends of humans' activities, overfishing, fish habitat destructions, habitat fragmentation and pollution have been acknowledged as threats to aquatic biodiversity. Fish population are been exposed to natural control processes that continuously modify the structure and abundance of their population in various life stages in response to these factors (Milner et al., 2003). Fisheries inventory assessment is notably used for some decision-making method and as the procedure becomes more quantitative, the demand for on stock evaluation is growing (Hilborn & Walters, 1992).

A particular population develops or shrinks over time, as controlled by birth and death, as well as immigration or emigration, which can be described as population dynamics (Krause et al., 1998). Understanding fisheries pattern and matters such as habitat destruction, predation and optimum harvesting rate are the basis of population dynamics studies (Kohler et al., 1995). Over-simplistic modeling of fisheries has caused in the collapse of the key stocks (Anderson, 1996). Therefore, care is required when applying population dynamics actual global fisheries (Pauly, 1984).

The planning and management of aquatic species resources cannot be achieved until an understanding of several population parameters such as asymptotic length (La) and growth coefficient (K), mortality (natural and fishing) and exploitation level (E) is obtained. There are many tools in estimating various population parameters and status of stocks. Of these, FISAT (FAO-ICLARM Stock Assessment Tools) is often used to estimate population parameters of fishes and shrimps (Amin et al., 2009) as it requires

length-frequency data. It is imperative that any fish stock can be accessed via this technique within 1 year if sufficient length-frequency data is available.

Nigeria which has a population of about 140 million (Grema et al., 2011) is a multi-ethnic nation with a land space of about 2 923,768km, having an inland shelf area of 47,2934 km and a length of 853 km (Grema et al., 2011). It similarly has an enormous network of inland waters like rivers, flood plains, natural and man-made lakes and reservoirs (Kudi et al., 2008). However, the whole production of the rivers and lakes is flying between 500,000 to 700,000 metric tons of fish per annum, but Nigeria requires a minimum of million metric tons of fish to cater for a population of over 140 million (Grema et al., 2011). Fisheries establish a significant area of agriculture in Nigeria, providing cherished food and job to millions and also aiding as a basis of livelihoods mostly for women in rural areas (Kates & Parris, 2003). One of the main roles played by fisheries in the economy of Nigeria is its contribution to the dietary needs of the populace. Increased food production, both in quantity and quality is necessary to build a healthy nation.

Kudi et al. (2008) viewed that fisheries dominate a distinctive place in the agricultural segment of the Nigerian economy. In relations to gross domestic product (GDP), the fishery sub-sector has achieved the fastest growth rate in agriculture to the GDP (CBN Report, 2005). The contribution of the fishery sub-sector to GDP as at 2001 current factor cost increased from N76.76 billion to N162.61 billion in 2005 (CBN Report, 2005). Fish and fish products consist of more than 40% of total protein consumption in adults particularly in the remote areas (Adekoya & Miller, 2004). Despite its abundance in vitamins, it also has so many quantities of phosphorus, calcium, fats and other nutrient required for human growth and health. Therefore, it is understood that fish is more nutritious than meat (Dauda, 2009).

In Nigeria artisanal fishing is associated with a number of characteristics, which include its labor-intensive nature, non-availability or poorly developed infrastructural facilities such as storage and processing plants. Other problems associated with artisanal fisheries include the difficulty involved in evacuation and distribution of fish products from hardly accessible fishing units scattered in remote villages. These characteristics contribute significantly to the high percentage of fish spoilage and wastage and hence poor returns on investment by fishermen.

The potentials for large-scale increase in fish production in Nigeria is reduced as a result of problems of water weeds, prohibitive cost of fishing inputs, poor monitoring, and surveillance mechanism on the water bodies, poor management of some water bodies and non-continuity in the sensitization of fishermen. Other reasons cited as problems associated with artisanal fishing in Nigeria include: Non rendering of proper fish production records, the communal crisis in some fishing areas, non implementation of fishery policies and policy inconsistency (Akeredolu, 1990).

In Nigeria, the artisanal fishery is made up of brackish water canoe fishery, coastal canoe fishery, riverine and lake canoe fishery and the flood pond fishery (Unongo, 2010). Mabawonku and Olomola (1986) reported that artisanal fishery sector accounts for about 87% of the total fish production in Nigeria. Fish production in Nigeria, like many other third world countries is a source of poverty reduction or total eradication (Neiland et al., 2005), source of food (FAO, 2006), and it is undergoing some form of modernization (Bolorunduro, 2003). Fresh water fisheries both captured and cultured are good source of cheap animal protein for low income coastal and rural populace. Apart from being used as food, fish is also progressively demanded for use as feed component in the livestock production and manufacturing industries (Delgado, 2003).

Despite the relevance of fishery resources for the sustenance of most fishing and non-fishing communities in the third world countries including Nigeria, the resources have been allowed to degrade slowly and continuously for decades (Akpoko, 2003). This degradation started with increase human population whose activities led to a decline in fish stocks (Tafida et al., 2011). About 100,000 fishermen in over 500 fishing settlements exploits the inland water bodies of Kebbi State. Capture fisheries is practiced by peasant fisherman who cannot afford to purchase some of the necessary fishing inputs due to lack of capital. The most critical challenge facing capture fisheries today in Kebbi State is the diminishing returns from fishing because of no proper control of the water bodies. Fishing regulations are not enforced in the State therefore the used of under-sized gears and beach seine which results in total harvest of fish including fingerlings and fry is the major problem of the fisheries sector in the State.

According to a survey conducted in 1997 (Nigerian-German Kainji Lake promotion project) regarding the usage of fishing gears in the Kainji Lake, it was discovered that mesh sizes for all nets varied in size between 0.5-1 inches, with the most commonly used nets having sizes of 2.0-2.5 inches (Mdaihli & Omorinkoba, 1999).This contradict State fisheries edict which stipulates that only gill nets with mesh size of 3.0 inches and above should be used 68% of the being used by fishermen are illegal. This implies that majority of the nets targets juveniles or immature fish other challenges of the fisheries sector in the State comprise high cost of fishing inputs and non-availability of preservation facilities.

1.3   Problem Statement

World fisheries are in crisis due to the overexploitation of a large proportion of the stocks. However, according to the FAO 69% of the world's inland water fish stocks are either fully to heavily exploited, overexploited or depleted indicating the likelihood that many fish populations, and the ecosystem of which they are a part, will decline (if they are not already) with current and expanded levels of competitive extraction. This is cause for concern because fishes are an important source of animal protein, hundreds of millions of people are employed as fish workers and in fisheries-related activities and therefore are in need of urgent conservation and management measures.

The causes of the collapse of exploited fish populations have been the subjected the problem of an excessive fishing effort which brings about overexploitation, against those that argue that fluctuations in population dynamics are attributable to natural environmental changes. This process may be attributed either to a lack of appropriate scientific information or, on occasion, and in spite of suitable assessments, to faulty management systems or failure to enforce the compliance of the fishers.

The problems of sustaining inland fisheries resources in Nigeria can be characterized as both human and natural. The human problems of inland fisheries sustainability can be viewed from the perspectives of policy implementation, auditing and sampling, analysis and taxonomy, management, pollution and land reclamations (Asiwaju, 2011), policy: investigation of inland fisheries in Nigeria include those of wetlands come under the mandate of the Nigerian Institute for Freshwater Fisheries Research (NIFFR).

Generally, lack of laws and regulations controlling the misuse of the fisheries of most African inland waters, even where such laws and regulations (such as registration and licensing of fishermen, mesh size regulation, gear size regulation, ban of the use poison and explosives, fishing with electrical materials as well as closed season area) occur, they are not frequently practice (Asiwaju, 2011).

However, in Nigeria the running of inland water is stared as the sole obligation of the State to that these water bodies are found. Although there is a Sea Fisheries Decrees Act of 1971, as well as the relevant Fishery regulations and the Exclusive Economic Zone (EEZ) Decree of 1978, which allow the federal government to take charge, regulate and protect the sea fisheries resources.

Though it can be claimed that these waters are around State borders and should however be subjected to State legislation, the waters typically cross more than one State. Due to the fact that fish are not restricted to State boundaries, travelling fish usually cross canals that cut across more than one State. Subsequently, action taking by one State can have a deep magnitude on the fishery resources and fishing in another State. Furthermore, roaming fishermen usually trespass State borders using illegal methods to catch fish, also putting of poisonous substance or industrial wastes in one State, which does not give significance to fisheries, and can result to mass damage of cherished fishery resources downstream in another State where fishing may be of abundant significance.

In Nigeria artisanal fishing is associated with a number of characteristics, which include its labor-intensive nature, non-availability or poorly developed infrastructural facilities such as storage and processing plants. Other problems associated with artisanal fisheries include the difficulty involved in evacuation and distribution of fish products from hardly accessible fishing units scattered in remote villages. These characteristics contribute significantly to the high percentage of fish spoilage and wastage and hence poor returns on investment by fishermen.

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The potentials for large-scale increase in fish production in Nigeria is reduced as a result of problems of water weeds, prohibitive cost of fishing inputs, poor monitoring, and surveillance mechanism on the water bodies, poor management of some water bodies and non-continuity in the sensitization of fishermen. Other reasons cited as problems associated with artisanal fishing in Nigeria include: Non rendering of proper fish production records, the communal crisis in some fishing areas, non-implementation of fishery policies and policy inconsistency (Akeredolu, 1990).

Drought and predation are two outstanding natural problems. Bukar & Gubio, (1985) reported ichthyofauna biodiversity changes, resulting from drought in Lake Chad, they noted that, the reduction in Lake water level in increased temperature, nutrients, carbon dioxide, hydrogen sulphate, pH, dissolved oxygen, competition, death and decomposition. Predation was a serious biodiversity problem as the food web involved various taxa. Olatunde (1977) reported that the population of *Eutropius nilotus* and *Schilbe mytus,* two important fish species in Lake Kainji, were preyed upon by the Nile perch *(Lates niloticus).*

More than millions of people around the globe, particularly in Africa, Asia and Latin America, depend on small-scale fisheries for their food, income or as a support to their livelihoods. However, in spite of the integral function small-scale fisheries play in contributing to food security, poverty alleviation and rural transformation, this segment has remained wholly unnoticed by fisheries managers over the years in desire of the industrial fisheries sectors (McGoodwin, 1990; Satia & Staples, 2003).

The lack of understanding of the dynamic and diverse nature of small-scale fisheries has added to their abandonment and the failure to design and implement suitable management system and policies to cater for their special characteristics (Berkes, 2001; Kent, 1997; McGoodwin, 1990). Though, lack of reliable information on the socio-economic status of the small-scale fisheries is one of the serious weaknesses in the successful carrying out of developmental programmes. To preserve the function of small-scale fisheries in rural areas, recent information is needed to check the outcomes of management measures, government policies and regulations in aid of the economic and financial health of fisheries (Tietze, 2005).

Kebbi State is blessed with abundance fisheries resources in their riverine systems that contribute to the livelihood of artisanal fishermen in Kebbi State. However, basic information such as fish species composition, age structure, growth, mortalities, habitat condition and socio-economic profile of the fishermen for the fisheries management is absent in the Kebbi State so far. In recognition of the utmost importance to Kebbi State government in management purpose, it is essential to understand population dynamic, stock assessment, exploitation level, water quality standard and socio-economic status of its fishermen, because lack of idea about these parameters, it will be difficult to undertake any effective management program on its waters. In this present study, we intend to analyze the present State of the Kebbi State inland waters artisanal fisheries paying special attention to the State of the fisheries resources available, the socio-economical context, and to suggest the management

policies to be use and to see the relationship between fish resources available and socio-economic conditions of the fishermen.

1.4 Research Objectives

1) To identify fish species composition available in the inland waters of Kebbi State, Nigeria.
2) Determine environmental parameters and their relationship with catch-per-unit-effort of fish species in the inland waters of Kebbi State
3) To determine population dynamic parameters such as growth, recruitment, natural and fishing mortalities of three major fish species.
4) To investigate the socio-economic profile viz. demographic, fishing activities and level of income of small-scale fishermen in Kebbi State, Nigeria.

1.5 Significance of the Study

This research contributes to the knowledge by providing useful information on the Kebbi State inland waters fisheries on fish population such as: fish species composition and abundance, age structure, fish growth and mortalities, level of fish exploitation and socio-economic profile of the Kebbi Sate fishermen to enable the government design and implement suitable management system and policies.

1.6 Thesis Organization

This study is divided into eight independent but related chapters. Chapter one discusses the general background of the study in which fishery sub sector contributes to Nigerian population in terms of economy, source of income, provision of food and source of livelihood. It further introduces the problem statement and objectives of the study, significance of the study and research objectives. Chapter two reviewed previous studies on the concept of small scale fisheries and fishing gears, fish species composition in Nigerian waters, population dynamics and socio-economic of small scale fisheries and other theoretical and empirical literature related to the study, models, and techniques of analysis used in the previous literature. Chapter three discusses the general research methodology that covered location of the study area, fish sample collection and identification, population of the study. Data analysis consisting of analytical techniques was also discussed. Chapter four of this study presents results and discusses the findings on fish species composition and distribution in the study area. Chapter five present the results and discussion of catch-per-unit-effort of gill net and environmental parameters. Chapter six present the results and discussion of population dynamics of major fish species found in the study area. Chapter seven presents the results and discussion socio-economic profile of the small-scale fish farmers in the study area. Chapter eight summarized the entire study and make recommendations for future research were put forward and finally concluded based on the aim and findings of this research work.

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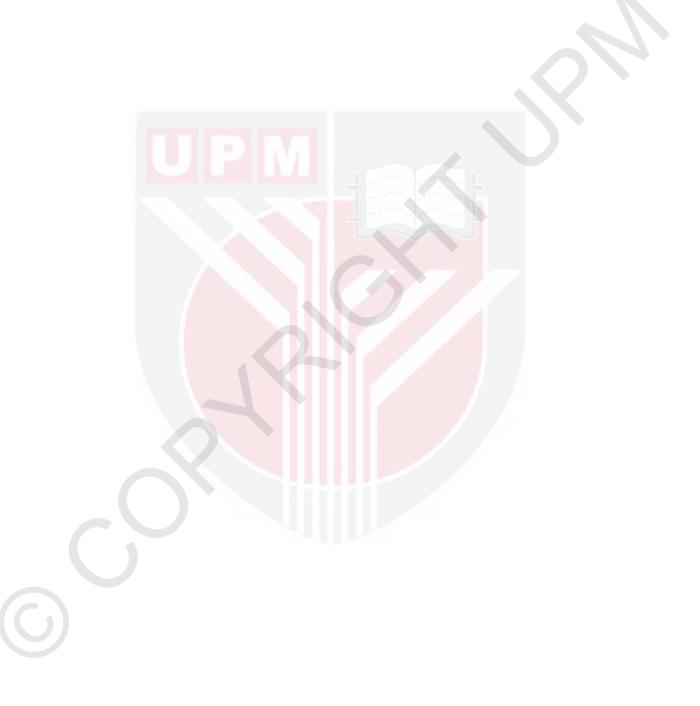
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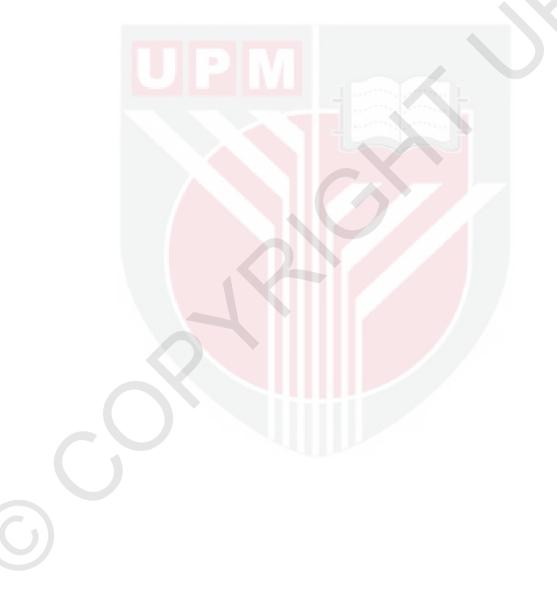
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