



**UNIVERSITI PUTRA MALAYSIA**

**DIVERSITY, ECOLOGY, AND DISTRIBUTION OF NON-INDIGENOUS  
FRESHWATER FISH IN MALAYSIA**

**KHAIRUL ADHA BIN A.RAHIM**

**FS 2012 48**

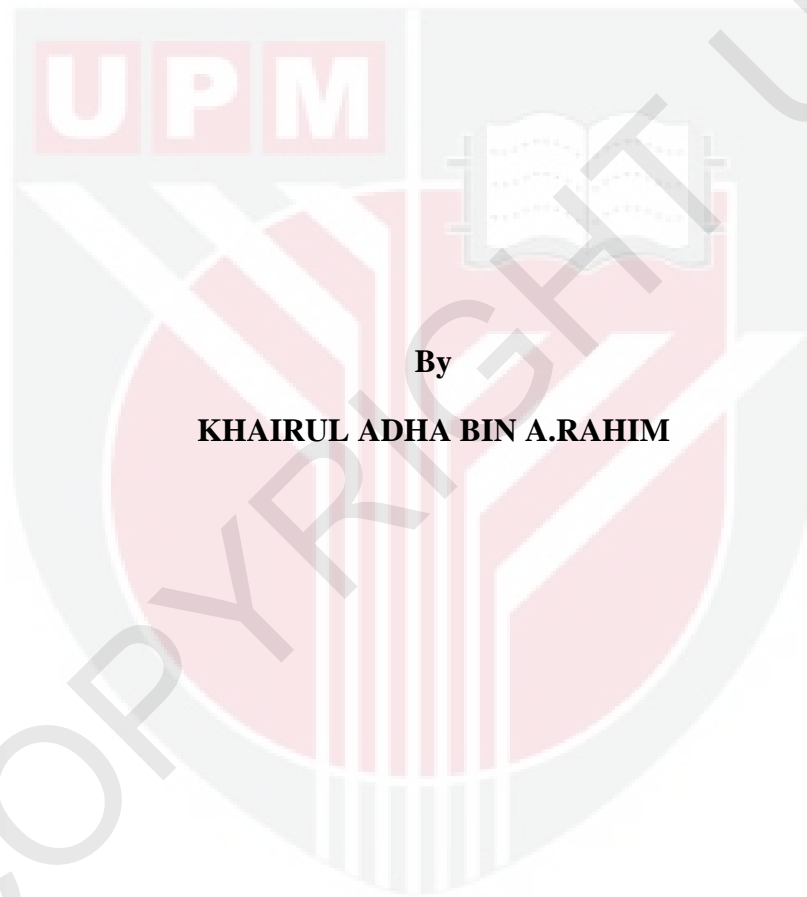
**DIVERSITY, ECOLOGY, AND DISTRIBUTION OF NON-INDIGENOUS  
FRESHWATER FISH IN MALAYSIA**

**KHAIRUL ADHA BIN A.RAHIM**

**DOCTOR OF PHILOSOPHY  
UNIVERSITI PUTRA MALAYSIA**

**2012**

**DIVERSITY, ECOLOGY, AND DISTRIBUTION OF NON-INDIGENOUS  
FRESHWATER FISH IN MALAYSIA**



**By**

**KHAIRUL ADHA BIN A.RAHIM**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in  
Fulfillment of the Requirement of the Degree of Doctor of Philosophy**

**January 2012**

## DEDICATION

To my wife, Norliza Samsuri, sons and daughters, for your patience, love, and support



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

**DIVERSITY, ECOLOGY, AND DISTRIBUTION OF NON-INDIGENOUS  
FRESHWATER FISH IN MALAYSIA**

By

**KHAIRUL ADHA BIN A.RAHIM**

**January 2012**

**Chairman: Associate Professor Siti Khalijah Daud, PhD**

**Faculty: Faculty of Science**

Introduction of non-indigenous species have resulted in major global change, harming indigenous species and communities throughout the world and also have caused enormous economic damage. Thus, the main objectives of this study were to examine the composition, ecology, and distribution of non-indigenous fish species in natural water bodies and also evaluate the role and contribution of non-indigenous fish species through aquaculture or stock enhancement in socio-economic development in Malaysia. The studies were carried out at five locations in Peninsular Malaysia and six locations in Sabah and Sarawak. The habitats surveyed in Malaysia include rivers and streams in highland and lowland areas, floodplain and large river system, rice fields, irrigation canal, ex-mining lakes, national park, and estuaries. A total of 4055 individual fish representing 150 species belonging to 38 families were captured. This included 67 species and 24 families from Peninsular Malaysia, and 113 species from 30 families of indigenous fish as well as non-indigenous from Sabah and Sarawak. Out of 150 fish species, 17 species from eight families were identified as non-indigenous. The family

Cichlidae represented the highest species collection (5 species) followed by Cyprinidae (4 species), two species from families of Clariidae and Pangasiidae, and one species from families of Charachidae, Helostomatidae, Belontiidae and Loricariidae respectively.

The present study has shown that non-indigenous fish occurred and inhabited diverse habitats including highland and isolated streams, rivers, rice fields, swamps, drainage, dam and reservoirs, ex-mining lakes and estuaries in Malaysia. The intentional and unintentional introduction of non-indigenous fish species for various purposes, such as aquaculture development, aquarium fish industry, recreational fishing activities, natural disasters, biological control, and continuous released by Buddhist followers as part of their religious activities have caused a widespread distribution and establishment of non-indigenous species in local ecosystems. In addition, the occurrence of non-indigenous species, not only changed the structure of indigenous ichthyofauna group but also caused ecological and economical damages to local fishermen. The present finding provided evidence that there are no restrictions or limitation of spreading of non-indigenous fish in natural habitats of Malaysia.

In the present study, a total of 42 non-indigenous species were recorded. Based on the records and field surveys, the number of introduced fish species was increased almost double than the previous records. Most of the species introduced mainly for aquaculture development and only a few introduced fish species for recreational fisheries, biological control and aquarium fish industries. The aquaculture industry has also encouraged

introduction of 'aquaculture species' and has become the major reason for introducing non-indigenous fish species into Malaysia. The non-indigenous fishes that have been introduced for food fisheries and aquaculture development include Chinese carps (*Hypophthalmichthys nobilis*, *Cirrhina molitorella*, *Ctenopharyngodon idella*, *Cyprinus carpio*, *Hypophthalmichthys molitrix*); Indian carps (*Catla catla*, *Cirrhina mrigala*, *Labeo rohita*); Javanese carp (*Barbonymus gonionotus*); African catfish (*Clarias gariepinus*) and broadhead catfish (*Clarias macrocephalus*); snakeskin gouramy (*Trichogaster pectoralis*) and red promflet (*Colossoma* sp). The tilapias (*Oreochromis* spp.) together with their hybrids such as Mozambique tilapia (*Oreochromis mossambicus*), Nile tilapia (*O.niloticus*, *O. urolepis hornorum*), hybrid tilapia (*O. hornorum* and *O. mossambicus*, red tilapia hybrid) and redbelly tilapia (*Tilapia zillii*) are also the important species in aquaculture development in Malaysia. This study has recorded a potential new species, *Scortum barcoo*, for aquaculture development in Malaysia. It showed that the rate and number of non-indigenous fishes introduced in local habitat has greatly increased since the early twentieth century.

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

**EKOLOGI, KEPELBAGAIAN, DAN TABURAN SPESIS IKAN ASING  
AIRTAWAR DI MALAYSIA**

Oleh

**KHAIRUL ADHA BIN A.RAHIM**

**Januari 2012**

**Pengerusi: Profesor Madya Siti Khalijah Daud, PhD**

**Fakulti: Fakulti Sains**

Pengenalan spesies asing bukan sahaja telah menyebabkan kesan perubahan secara global seperti ancaman kepada spesies tempatan dan komuniti, tetapi juga telah menyebabkan kesan negatif kepada ekonomi. Oleh itu, tujuan utama kajian ini adalah untuk mengenalpasti komposisi spesies, ekologi dan taburan spesies ikan asing di habitat semula jadi, dan menilai peranan dan sumbangan spesies ikan asing dalam pembangunan sosio-ekonomi di Malaysia melalui pembangunan akuakultur. Kajian ini telah dijalankan di lima lokasi di Semenanjung Malaysia dan enam lokasi di Sabah dan Sarawak. Habitat yang telah dikaji termasuklah sungai dan anak sungai di kawasan tanah tinggi dan rendah, dataran banjir dan sistem sungai yang besar, sawah padi, tali air, tasik bekas lombong, taman negara dan juga di kawasan muara. Sebanyak 4055 individu ikan daripada 150 spesies yang mewakili 38 famili telah ditangkap. Ini termasuklah 67 spesies daripada 24 famili di Semenanjung Malaysia dan 113 spesies daripada 30 famili ikan tempatan dan juga ikan asing di Sabah dan Sarawak. Daripada 150 spesies ikan



tersebut, 17 spesies daripada lapan famili merupakan spesies ikan asing. Sebanyak 5 spesies ikan asing dari famili Cichlidae, diikuti oleh Cyprinidae (4 spesies), dua spesies daripada keluarga Clariidae, dan Pangasiidae dan satu spesies dari keluarga Charachidae, Helostomatidae, Belontiidae dan Loricariidae telah dikenalpasti.

Kajian ini menunjukkan bahawa spesies ikan asing telah hadir dan mendiami pelbagai habitat dari kawasan tanah tinggi dan terencil, sungai, sawah padi, paya, saluran, empangan dan takungan, tasik bekas lombong dan kawasan muara sungai di Malaysia. Kemasukan spesies ikan asing secara sengaja dan tidak disengajakan adalah disebabkan pelbagai tujuan seperti pembangunan akuakultur, industri, ikan akuarium, aktiviti perikanan rekreasi, bencana alam, kawalan biologi dan perlepasan ikan berterusan dari pengikut Buddha dalam kepercayaan agama mereka. Kegiatan ini telah menyebabkan taburan dan penyebaran spesies ikan asing menjadi lebih meluas di ekosistem tempatan. Selain itu, kehadiran spesies ikan asing di dalam ekosistem tempatan bukan sahaja telah merubah struktur komposisi semulajadi spesies ikan tempatan, tetapi juga telah memberi kesan buruk kepada persekitaran dan ekonomi nelayan tempatan. Penyelidikan ini telah mendapati bahawa tidak ada sebarang sekatan atau halangan kepada penyebaran ikan asing dalam habitat semulajadi Malaysia.

Sebanyak 42 spesies ikan asing telah direkodkan dalam kajian ini. Berdasarkan rekod dan hasil dari kajian lapangan, kadar kemasukan spesies ikan asing di negara ini telah meningkat sebanyak dua kali ganda daripada yang telah dicatatkan sebelumnya. Kebanyakan spesies ikan asing yang dibawa masuk ke Malaysia adalah untuk tujuan pembangunan akuakultur, perikanan rekreasi, kawalan biologi dan juga untuk industri

ikan akuarium. Industri akuakultur telah juga menggalakkan lagi pengenalan ' spesies ikan akuakultur ' yang juga menjadi penyebab utama pengenalan spesies ikan asing ke Malaysia.

Spesies ikan asing yang telah dibawa masuk untuk perikanan makanan dan pembangunan akuakultur termasuklah ikan kap Cina (*Hypophthalmichthys nobilis*, *Cirrhina molitorella*, *Ctenopharyngodon idella*, *Cyprinus carpio*, *Hypophthalmichthys molitrix*); Kap India (*Catla catla*, *Cirrhina mrigala*, *Labeo rohita*); lampam jawa (*Barbonymus gonionotus*), ikan keli Afrika (*Clarias gariepinus*) dan ikan keli bunga (*Clarias macrocephalus*), ikan sepat (*Trichogaster pectoralis*) dan bawal merah (*Colossoma* sp). Spesies ikan Tilapia seperti *Oreochromis mossambicus*, *O.niloticus*, *O. urolepis hornorum*, bersama dengan spesies tilapia hibrid (*O. hornorum* dan *O.mossambicus*, juga merupakan spesies penting dalam pembangunan akuakultur di Malaysia. Kajian ini telah mencatatkan satu species berpotensi baru, *Scortum barcoo* untuk pembangunan akuakultur di Malaysia. Ia menunjukkan bahawa kadar dan spesies bilangan ikan asing yang diperkenalkan di dalam habitat tempatan telah menunjukkan peningkatan sejak awal abad ke-20.

## ACKNOWLEDGEMENTS

First and foremost, I thank Allah the Most Gracious and Most Merciful for giving me strength and perseverance in coming through with this dissertation. I would like to express my sincere thanks and deeply indebted to my supervisor Associate Prof. Dr. Siti Khalijah Daud and also to my PhD committee advisor; Prof. Dr. Siti Shapor Siraj and Prof. Dr. Aziz Arshad, for the help, stimulating suggestions, mentorship, guidance and advice during the course of my study and dissertation writing.

I would like to extend my sincere thanks to Director of The Department of Fisheries, Malaysia, Director of The Department of Wildlife, Malaysia, Forest Department of Malaysia, FELDA and FELCRA agencies, Inland Fisheries Division, Tarat, Department of Agriculture, Sarawak (Dr. Stephen Sungan), for granting me research permission together with their support, information and encouragement. I respectfully express my sincere gratitude to Prof. Dr. Shabdin Mohd Long, Dean for Faculty of Resources Science and Technology, Head of Department and all members in Department of Aquatic Sciences, FSTS, Universiti Malaysia Sarawak for their moral support and encouragement.

I am obliged especially to Prof. Dr. Indraneil Das, Prof. Dr. Mohd. Tajuddin Abdullah, Prof. Dr. Hamsawi Sani and Dr. Ramlah Zainuddin for their assistance and kind sharing of their knowledge and experience. I thank Assoc. Prof. Dr. Ismail Jusoh and Mr. Charlie Laman for helping with statistical programming and analyses.

I am very grateful to my team members, especially to Dr. Yuzine Esa, Associate Prof. Dr. Awang Ahmad Sallehin, Dr. Samsur Mohammad for their commitment and support. A warm thank you to laboratory and fields assistants; Zaidi Ibrahim, Zulkifli Ahmad, Richard Toh, Haris and other faculty members for tirelessly assisting me in the field.

Also I would like to thank to the local fishermen and villagers; Munit Latif, Jeman Marzuki, for their great experiences, assistance, support and information for this study. The people of Balai Ringin, Kg. Siniawan, Ba' Kelalan in Sarawak, Hulu Jempol in Negeri Sembilan and Parit Tiga Timur (Haji Azman Samsuri and family), Sungai Besar in Selangor with whom I worked and played for their helps.

My last but not least appreciation is to my wife Norliza Samsuri, my children; Muhammad Imran, Fatin Hidayah, Nor Atiqah, Nurul Husna, Muhammad Iqbal Hafizi and Fitri Izzah Maisarah. Thank you for the patient, love, continuous moral support, unfailing encouragement and sacrifices throughout the preparation of this thesis. Finally, I thank my parents: Haji A.Rahim bin Haji. Ismail and Hajah Azizah binti Haji. Sulaiman, and my brothers and sister for their support and encouragement to pursue my dreams.

I certify that a Thesis Examination Committee has met on **30 January 2012** to conduct the final examination of **Khairul Adha bin A. Rahim** on his thesis entitled "**Diversity, Ecology and Distribution of Non-Indigenous Freshwater Fish in Malaysia**" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy

Members of the Thesis Examination Committee were as follows:

**Name of Chairperson, PhD**

Dr. Hishamuddin Omar

Faculty of Science

Universiti Putra Malaysia

(Chairman)

**Name of Examiner 1, PhD**

Professor Dr. Ahmad Ismail

Faculty of Science

Universiti Putra Malaysia

(Internal Examiner)

**Name of Examiner 2, PhD**

Associate Professor Dr. Che Roos Saad

Faculty of Agriculture

(Internal Examiner)

**Name of External Examiner, PhD**

Title (e.g. Professor/ Associate Professor/ Ir) – omit if irrelevant

Name of Department and/or Faculty

Name of Organisation (University/ Institute)

Country

(External Examiner)

---

**SEOW HENG FONG, PhD**

Professor and Deputy Dean

School of Graduate Studies

Universiti Putra Malaysia

Date:

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of **Doctor of Philosophy**. The members of the Supervisory Committee were as follows:

**Siti Khalijah Daud, PhD**

Associate Professor  
Faculty of Science  
Universiti Putra Malaysia  
(Chairman)

**Siti Shapor Siraj, PhD**

Professor  
Faculty of Agriculture  
Universiti Putra Malaysia  
(Member)

**Aziz Arshad, PhD**

Professor  
Department of Aquaculture  
Faculty of Agriculture  
Universiti Putra Malaysia  
(Member)

---

**BUJANG BIN KIM HUAT, PhD**

Professor and Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date:

## DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

---

**KHAIRUL ADHA BIN A.RAHIM**

Date: 30 January 2012

## TABLE OF CONTENTS

	<b>Page</b>
<b>ABSTRACT</b>	iii
<b>ABSTRAK</b>	vi
<b>ACKNOWLEDGEMENTS</b>	ix
<b>APPROVAL</b>	xi
<b>DECLARATION</b>	xiii
<b>LIST OF TABLES</b>	xviii
<b>LIST OF FIGURES</b>	xxiii
<b>LIST OF APPENDICES</b>	xxix
<b>LIST OF ABBREVIATIONS</b>	xxx
<b>CHAPTER</b>	
<b>1</b>	
<b>INTRODUCTION</b>	1
1.1 Introduction	1
1.2 Current status of non-indigenous fish introduction in Malaysia	3
1.2 Statement of problem	5
1.3 Objectives	8
	9
<b>2</b>	
<b>LITERATURE REVIEW</b>	
2.1 Definition of non-indigenous species	9
2.2 History of non-indigenous fish introduction in Malaysia	10
2.3 List of the common indigenous fish species introduced into Malaysian water	15
2.4 List of the common non-indigenous fish species introduced into Malaysian water	20
2.5 Aquaculture of non-indigenous fish in Malaysia	47
2.6 Ecology and distribution of non-indigenous fish species	51
2.7 The establishment of non-indigenous fish introduction in Malaysia	56
2.8 Impacts of non-indigenous fish introduction on aquatic community and ecology	59
2.9 Impact of non-indigenous fish introduction on socio-economy	50
<b>3</b>	
<b>GENERAL METHODOLOGY</b>	66
3.1 Description of study area	66
3.2 Study areas in Peninsular Malaysia	71
3.2.1. Jempol River, Negeri Sembilan	71
3.2.2 Serting River, Negeri Sembilan	74
3.2.3 Irrigation, drainage canals and estuary in the District of Sabak Bernam, Selangor	77
3.2.4 Ex-mining lake in Kampung Air Kuning, Tanjung, Tualang, Kampar, Perak	80
3.2.5 Kuala Koh National Park, Kelantan	82



3.3	Study areas in Sabah and Sarawak	84
3.3.1	Balung River, Tawau, Sabah	84
3.3.2	Kelalan River, Ba Kelalan Highland, Sarawak	87
3.3.3	Bakong River, Miri, Sarawak	90
3.3.4	Spak River, Betong, Sarawak	93
3.3.5	Sarawak Kanan River, Sarawak	95
3.3.6	Batang Kerang, Balai Ringin, Sarawak	98
3.4	Fish Sampling	100
3.5	Fish Diet Analyses	101
3.6	Physicochemical Water Parameter	102
3.7	Data Analyses	102
<b>CHAPTER</b>		
<b>4</b>	<b>DIVERSITY, ECOLOGY AND DISTRIBUTION OF NON-INDIGENOUS FRESHWATER FISH IN PENINSULAR MALAYSIA</b>	<b>105</b>
4.1	Introduction	105
4.2	Materials and Methods	108
4.2.1	Description of study area	108
4.2.2	Fish sampling	108
4.2.3	Fish diet analysis	110
4.2.4	Physicochemical water parameters	110
4.2.5	Data analyses	110
4.3	Results	111
4.3.1	Fish composition in Jempol River, Negeri Sembilan	111
4.3.2	Fish composition in Serting River, Negeri Sembilan	115
4.3.3	Fish composition in irrigation and drainage canals in the District of Sabak Bernam, Selangor	119
4.3.4	Fish composition from ex-mining lake in Kampung Air Kuning, Tanjung Tualang, Perak	122
4.3.5	Fish composition from Sungai Lebir in Kuala Koh National Park	124
4.3.6	Physicochemical water parameter	126
4.3.7	General fish composition and distribution in Peninsular Malaysia	129
4.3.8	General fish diversity	132
4.3.9	General composition and distribution of non-indigenous fish	134
4.3.10	General similarity index	140
4.3.11	General feeding habit of non-indigenous fish species	147
4.4	Discussion	140
4.4.1	Fish diversity and composition	149
4.4.2	Ecology and distribution of non-indigenous fish species	152
4.4.3	Feeding habit of non-indigenous species	156
4.4.4	Current status of non-indigenous fish in Peninsular Malaysia	157
4.5	Conclusion	159

<b>CHAPTER</b>		
<b>5</b>	<b>DIVERSITY, ECOLOGY AND DISTRIBUTION OF NON-INDIGENOUS FRESHWATER FISH IN SABAH AND SARAWAK</b>	<b>161</b>
	5.1 Introduction	161
	5.2 Materials and Methods	164
	5.2.1 Description of study area	127
	5.2.2 Fish sampling	164
	5.2.3 Fish diet analysis	166
	5.2.4 Physicochemical water parameters	166
	5.2.5 Data analyses	166
	5.3 Results	167
	5.3.1 Fish composition in Balong River, Tawau, Sabah	167
	5.3.2 Fish composition in Kelalan River, Ba Kelalan Highland, Lawas, Sarawak	169
	5.3.3 Fish composition in Bakong River, Miri, Sarawak	173
	5.3.4 Fish composition in Spak River, Betong, Sarawak	177
	5.3.5 Fish composition in Sarawak Kanan River, Sarawak	179
	5.3.6 Fish composition in Batang Kerang, Balai Ringin, Sarawak	184
	5.3.7 General physicochemical water parameters	190
	5.3.8 General fish composition and distribution in Sabah and Sarawak	193
	5.3.9 General fish Diversity	198
	5.3.10 General composition and distribution of non-indigenous fish	200
	5.3.11 General similarity index	207
	5.3.12 General feeding habit of non-indigenous fish species	215
	5.4 Discussion	216
	5.4.1 Fish diversity and composition	216
	5.4.2 Ecology and distribution of non-indigenous fish species	220
	5.5 Conclusion	228
<b>CHAPTER</b>		
<b>6</b>	<b>THE ROLE AND CONTRIBUTION OF NON-INDIGENOUS FISH FOR AQUACULTURE DEVELOPMENT IN MALAYSIA</b>	<b>229</b>
	6.1 Introduction	229
	6.2 Materials and Methods	214
	6.2.1 Data Gathering on Fish Distribution	234
	6.2.2 Survey and evaluation of non-indigenous fish price in Malaysia	235
	6.2.3 Data analyses	236
		238

6.3 Results	
6.3.1 The history, record and collection of non-indigenous fish in Malaysia	238
6.3.2 Non-indigenous fish fry production from the government hatchery	245
6.3.3 Stocking of non-indigenous fish fry in public water bodies	247
6.3.4 Production of non-indigenous fish from public water bodies	249
6.3.5 Production of non-indigenous fish from various culture methods	253
6.3.6 Comparison of retail price of indigenous and non-indigenous fish at major fish markets in Peninsular Malaysia.	257
6.3.7 Comparison of retail price of indigenous and indigenous fish species from market surveyed	259
6.4. Discussion	263
6.4.1 The history, record and collection of non-indigenous fish in Malaysia	263
6.4.2 The importance of non-indigenous fish species in aquaculture development	267
6.4.3 Aquaculture Production of Non-indigenous fishes in Malaysia	270
6.4.4 The future of non-indigenous fish status in aquaculture development	273
6.5 Conclusion	275
<b>CHAPTER 7</b>	
<b>GENERAL DISCUSSION</b>	276
7.1 Current status of freshwater fish fauna in Malaysia	256
7.2 Ecology and distribution of non-indigenous fish in Malaysia	285
7.3 Aquaculture of non-indigenous fish species	289
7.4 Current status of non-indigenous fish in Malaysia	293
<b>CHAPTER 8</b>	
<b>SUMMARY, GENERAL CONCLUSION AND RECOMMENDATIONS FOR FUTURE RESEARCH</b>	304
8.1 Summary and general conclusion	304
8.2 Recommendations for future research	308
<b>REFERENCES</b>	310
<b>APPENDICES</b>	356
<b>BIODATA OF STUDENT</b>	376
<b>LIST OF PUBLICATIONS</b>	377