UNIVERSITI PUTRA MALAYSIA

SYSTEM SIMULATION OF THE BEHAVIOUR OF TRAWL FLEET UNDER ALTERNATIVE MANAGEMENT POLICIES IN THE WEST COAST OF PENINSULAR MALAYSIA

MOE SHWE SIN

IKDPM 2016 2

SYSTEM SIMULATION OF THE BEHAVIOUR OF TRAWL FLEET UNDER ALTERNATIVE MANAGEMENT POLICIES IN THE WEST COAST OF PENINSULAR MALAYSIA

By

MOE SHWE SIN

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

September 2016

COPYRIGHT

DEDICATION

This thesis is especially dedicated to:

My beloved parents**,**

U KYAW SEIN
DAW YI YI

My beloved family and beloved daughter**,**

KYAW LWIN OO
MOE THUZAR
MIN SAN TUN
CHIN HOW BOON
&
HAN NWAY NYEIN @ CHU CHU @ CHIN SU ANN

Who always support and encourage me to do the best.

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

SYSTEM SIMULATION OF THE BEHAVIOUR OF TRAWL FLEET UNDER ALTERNATIVE MANAGEMENT POLICIES IN THE WEST COAST OF PENINSULAR MALAYSIA

By

MOE SHWE SIN

September 2016

Chairman : Tai Shzee Yew, PhD
Institute : Agricultural and Food Policy Studies

The Malaysian trawl fishery is besetting with many issues including overcapacity, overfishing, trash fish landings, IUU fishing etc. The fishery resources in the West Coast of Peninsular Malaysia are alleged to be overexploited due to the rapid development and expansion of the trawl fleets since 1960s. Management policies have been implemented in the hope of attaining sustainable exploitation of the fisheries resources in the region. The zonal licensing scheme was applied to control the overcapacity of trawlers by restricting access through the issuance of vessel licenses. However, problems such as excessive fishing effort and overexploitation of the demersal fish stocks by trawlers, encroachment of trawlers into the inshore areas, and conflicts among traditional fishermen and trawlers still exist in the West Coast of Peninsular Malaysia.

In the context of management of trawl fishery in the West Coast of Peninsular Malaysia, the responses of fishers to management measures need to be evaluated in order to predict the appropriate management interventions. Therefore, the study is conducted with the objective to evaluate the impact of alternative management policies on the trawl industry in the West Coast of Peninsular Malaysia. To achieve the above objective, a system simulation model is developed to evaluate the performance of trawl fleets and, based on the results of simulations, management policy recommendation will be proposed for the Zone B and Zone C trawl fishery of the West Coast of Peninsular Malaysia.

The system simulation model is developed with the three-way interaction between fish stocks, industry and management measures and is used to simulate and evaluate the performance of fishery. These interactions will be tested in the simulation model, including sensitivity analysis. The interconnection between the three main modules such as biological module, economic module, and industry module is evaluated. Under

each main module, the interface variables such as sustainable catch, profit, and effort are computed through the estimation of the relevant parameters in each module. Moreover, the system model is validated in order to get the closely mimic the real world system through the sensitivity analysis. The behavior and performance of the industry are simulated using the system model with two scenarios such as open-access and simulated behavior in response with the alternative management policies.

The performance of the industry is evaluated through some key performance variables such as fishing effort, total sustainable catch of the three targetted species groups, total profit and profit per vessel in order to propose the proper combination of the management policy implication in the West Coast trawl fishery in Peninsular Malaysia. The data used in this study include both primary and secondary data for the estimation of the parameters and constants of the mathematical equations. The annual catch and effort data of the three targetted species groups is used from the Annual Fishery Statistics of Department of Fishery, Malaysia. The economic data especially for the cost data such as operation costs: bait, fuel, maintenance, gear replacement or repair and food for the workers, and fixed costs: haul, engine, equipment and the possible opportunity cost of the vessels will be collected from survey data.

In Zone B, the open-access simulation result showed that fishing efforts are increasing over time from 2012 until 2062. However, the catches of the targeted species groups are declining and the CPUEs of the three targeted species groups are also decreasing. This condition can be explained due to the unlimited increasing of fishing effort. Even with the increasing of fishing effort, the catches of all target species groups are decreasing. Base on the results of the open-access simulation analysis, this may suggest that the zone B trawl fishery will be overexploited in the long run. The results of policy (1) analysis of reduction in vessel license, the results indicated that decreasing licenses give the decreasing of fishing effort and the higher catch and the proper level of license issued reduction in zone B is policy 1 C and 1D of 30 per cent and 50 per cent license reduction levels. The results of policy (2) of fuel price subsidy reduction showed that there is no significant effect on fishing effort, catches and profits of the industry and this can be seen that fuel price subsidy reduction policy can be low impact to the Zone B trawl fishery. The results of policy (3) of increasing landing charge imposing with different levels showed that increasing landing charge caused the increasing cost and lowered the profit level which in turn reduced the fishing effort. The results of policy (4) analyzes of Zone B showed that the higher catch and also higher profit can be ascertained from policy 4C of 50 percent license reduction coupled with 20 percent fuel price subsidy reduction and 15 percent landing charge. In the numerical expression of proposed policy for zone B trawl fishery, the license issued for the Zone B is 1,500 licenses with 20 per cent fuel price subsidy reduction and the landing charge of 15 percent of total revenue should be imposed in the effort control management of West Coast Zone B trawl fishery from 2012 to 2042.

In Zone C, the open-access simulation results showed that fishing efforts are increasing over time until 2062. However, the catches of the targeted species groups are also increasing and decreasing trend was found in only in the later 15 years of simulation from 2047 to 2062. Base on the results of the open-access simulation, this may suggest that Zone C trawl fishery can be regarded as it is not in overexploited condition yet.

Therefore, the fishing effort in Zone C can be increased to the certain level which can give higher catch and profit for the industry. The results of policy (1) analysis: increasing in vessel licenses, showed that the proper level of license issued increasing in Zone C is policy 1C and 1 D of 50 percent and 100 percent license increasing from the 2012 level. The policy (3) of increased landing charge imposing with different levels showed that the proper level of landing charge percentage should be considered in Zone C of the West coast trawl fishery. The results of policy (4) analyzes showed that increasing license issued gives more catch and get higher profit per vessel, and in this study, 100 % license increasing (policy 4C and 4 D) gives more profit than 50 % license reduction (policy 4A and 4B). Therefore, the proper policy combination for Zone C is policy 4C and it is the combination of 100 % license increasing and 15 percent landing charge. In the numerical expression, the license issued for the Zone C is 1,400 licenses coupled with landing charge of 15 percent of total revenue should be imposed in the effort control management of West Coast Zone C trawl fishery from 2012 to 2042.

Base on the results of West Coast trawl fishery, the fish resources in Zone B are overexploited and it is needed to control the fishing effort by reducing the trawl vessels in this area. However, the fish resources in Zone C are not overexploited yet and the potential for the higher catch with increasing fishing effort is still out there. Despite being needed to be banned the trawlers, the option of removing the trawlers from near shore to offshore fishing will be another policy option to ascertain the resource sustainability. From the simulation results from the study indicated that the zone B trawlers should be decreased and whereas of Zone C still can be increased to the certain level. The recommendation for the proposed policy option is to reduce the zone B trawlers and transformed to Zone C licensed trawlers by pushing them to further away from near shore fisheries. Therefore, the viable policy option is to transfer the excess trawl fishing fleet from Zone B to Zone C without adversely affecting the socioeconomic conditions of trawlers in Zone B. However, the success of the policy recommendation in this study requires the perfect enforcement by the management authorities. The limitation of the license issued for the trawl vessels might be the minimum bound of the number of vessels and the number of vessels might be higher than the recommended values because of the IUU fishing in this area. Therefore, the strict and perfect enforcement of the policy is critically required in the successful management of the trawl fishery in the West Coast of Peninsular Malaysia.

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

SISTEM SIMULASI BAGI KELAKUAN TUNDA FLEET BAWAH DASAR PENGURUSAN ALTERNATIF DALAM PANTAI BARAT SEMENANJUNG MALAYSIA

Oleh

MOE SHWE SIN

September 2016

Pengerusi : Tai Shzee Yew, PhD
Institut : Kajian Dasar Pertanian dan Makanan

Perikanan tunda Malaysia yang melanda dengan banyak isu termasuk lebihan kapasiti, penangkapan ikan berlebihan, pendaratan ikan baja, "memancing IUU" dan lain lain sumber perikanan di Pantai Barat Semenanjung Malaysia dikatakan ada pengekstrakan berlebihan disebabkan oleh perkembangan pesat dan pengembangan armada tunda sejak tahun 1960-an.Dasar pengurusan telah dilaksanakan dengan harapan untuk mencapai eksploitasi mampan sumber perikanan di rantau ini. Skim pelesenan zon telah digunakan untuk mengawal lebihan kapasiti pukat tunda dengan menghadkan akses melalui pengeluaran lesen kapal. Walau bagaimanapun, masalah seperti usaha penangkapan ikan berlebihan dan eksploitasi berlebihan stok ikan "demersal" oleh pukat tunda, pencerobohan pukat tunda ke kawasan pantai dan konflik dalam kalangan nelayan tradisional dan kapal pukat tunda, masih wujud di Pantai Barat Semenanjung Malaysia.

Dalam konteks pengurusan tunda perikanan di Pantai Barat Semenanjung Malaysia, jawapan nelayan kepada langkah-langkah pengurusan perlu dinilai untuk meramalkan campur tangan pengurusan yang sesuai. Oleh itu, kajian ini dijalankan dengan objektif untuk menilai kesan dasar-dasar pengurusan alternatif kepada industri tunda di Pantai Barat Semenanjung Malaysia. Untuk mencapai matlamat di atas, model simulasi sistem dibangunkan untuk menilai prestasi armada tunda dan berdasarkan keputusan simulasi, pengurusan dasar cadangan akan dicadangkan bagi Zon B dan Zon C tunda perikanan di Pantai Barat Semenanjung Malaysia.

Simulasi sistem model binar dengan tiga cara interaksi antara stok ikan, industri dan langkah-langkah pengurusan digunakan untuk merangsang dan menilai prestasi perikanan. Interaksi ini akan diuji dalam model simulasi, termasuk analisis sensitiviti. Sambungan antara ketiga-tiga modul utama seperti modul biologi, modul ekonomi dan modul industri dinilai. Dibawah setiap modul utama, pembolehubah antara muka

seperti tangkapan mampan, keuntungan dan usaha yang dikira melalui anggaran parameter yang berkaitan dalam setiap modul. Selain itu, model sistem ini disahkan dalam usaha untuk mendapatkan mimik yang amat serupa dengan sistem dunia sebenar melalui analisis sensitiviti. Tingkah laku dan prestasi industri ini disimulasikan menggunakan model sistem dengan dua senario seperti akses terbuka dan tingkah laku simulasi sebagai tindak balas dengan dasar-dasar polisi pengurusan alternatif.

Prestasi industri itu dinilai melalui beberapa pembolehubah prestasi seperti usaha menangkap ikan, jumlah tangkapan yang mampan daripada tiga kumpulan spesies disasarkan, jumlah keuntungan dan keuntungan setiap kapal untuk mencadangkan kombinasi implikasi dasar pengurusan dalam pukat tunda Pantai Barat perikanan yang betul di Semenanjung Malaysia. Data yang digunakan dalam kajian ini termasuk kedua-dua data rendah dan menengah bagi anggaran parameter dan pemalar persamaan matematik. Tangkapan dan usaha data tahunan disaaaruan sebanyak tiga spesies kumpulan digunakan daripada Perangkaan Tahunan Perikanan Jabatan Perikanan, Malaysia. Data ekonomi terutamanya bagi data kos seperti kos operasi: umpan, bahan api, penyelenggaraan, penggantian gear atau pembaikan dan makanan untuk pekerja dan kos tetap: haul, enjin, peralatan dan kemungkinan kos lepas kapal akan diambil dari data kajian.

Di Zon B, hasil simulasi akses terbuka menunjukkan bahawa usaha menangkap ikan semakin meningkat dari masa ke semasa dari 2012 hingga 2062. Walaubagaimanapun, hasil tangkapan spesies yang disasarkan kumpulan semakin berkurangan dan CPUEs daripada tiga kumpulan sasaran spesies juga turut berkurangan. Keadaan ini dapat dijelaskan kerana peningkatan usaha penangkapan ikan tidau terhad. Walaupun dengan peningkatan usaha menangkap ikan, hasil tangkapan semua kumpulan spesies sasaran semakin berkurangan. Berdasarkan keputusan terbuka akses analisis simulasi, ini mungkin menunjukkan bahawa tunda perikanan Zon B akan dieksploitasi secara berlebihan dalam jangka masa panjang. Keputusan polisi (1) analisis pengurangan dalam lesen kapal, menunjukkan bahawa Pengurangan lesen memberikan pengurangan kepada usaha penangkapan ikan dan tangkapan yang lebih tinggi dan tahap yang sepatutnya lesen dikeluarkan pengurangan Zon B dasar 1 C dan 1D sebanyak 30 peratus dan 50 peratus tahap pengurangan lesen. Keputusan polisi (2) pengurangan subsidi harga minyak menunjukkan bahawa tidak memberi kesan yang besar kepada usaha penangkapar ikan, hasil tangkapan dan keuntungan industri dan ini dapat dilihat bahawa dasar harga minyak pengurangan subsidi boleh menjadi impak yang rendah Zon B tunda perikanan. Keputusan polisi (3) untuk peningkatan caj pendaratan dikenakar dengan tahap yang berbeza menunjukkan bahawa peningkatan caj pendaratan disebabkan kos yang semakin meningkat dan menurunkan paras keuntungan yang seterusnya mengurangkan usaha perikanan. Keputusan polisi (4) analisis Zon B menunjukkan bahawa tangkapan yang lebih tinggi dan keuntungan juga lebih tinggi boleh dipastikan dari dasar 4C pengurangan lesen 50 peratus serta 20 peratus harga minyak pengurangan subsidi dan 15 peratus caj pendaratan. Dalam ungkapan berangka dasar cadangan untuk Zon B tunda perikanan, lesen yang dikeluarkan bagi Zon B adalah 1,500 lesen dengan 20 peratus harga minyak pengurangan subsidi dan caj pendaratan sebanyak 15 peratus daripada jumlah pendapatan patut dikenakan dalam pengurusan kawalan usaha Pantai Barat Zon B tunda perikanan dari 2012 hingga 2042.

Dalam Zon C, keputusan simulasi akses terbuka menunjukkan bahawa usaha menangkap ikan semakin meningkat dari masa ke semasa sehingga 2062. Walaubagaimanapun, trend hasil tangkapan spesies kumpulan sasaran yang meningkat dan berkurangan ditemui dalam hanya dalam simulasi 15 tahun kemudian dari 2047 hingga 2062. Berdasarkan kepada keputusan simulasi akses terbuka, kemungkinar menunjukkan bahawa tunda perikanan Zon C boleh dianggap tidak berada dalam keadaan eksploitasi berlebihan lagi. Oleh itu, usaha menangkap ikan di zon C boleh meningkat ke tahap yang tertentu yang boleh memberikan hasil tangkapan yang lebih tinggi dan keuntungan bagi industri. Keputusan polisi (1) analisis: peningkatan dalam lesen kapal, menunjukkan bahawa tahap yang sepatutnya lesen yang dikeluarkan meningkat di zon C 1C dasar dan 1 D 50 peratus dan 100 peratus lesen meningkat dari tahap 2012. Dasar (3) meningkatkan caj pendaratan dikenakar dengan tahap yang berbeza menunjukkan bahawa tahap yang sepatutnya peratusan caj pendaratan perlu dipertimbangkan dalam Zon C Pantai Barat tunda perikanan. Keputusan polisi (4) analisis menunjukkan bahawa peningkatan lesen dikeluarkan memberi lebih banyak tangkapan dan mendapat keuntungan yang lebih tinggi bagi setiap kapal dan dalam kajian ini, lesen 100 paratus meningkat (4C dasar dan 4 D) memberikan keuntungan yang lebih daripada 50 paratus pengurangan lesen (dasar 4A dan 4B). Oleh itu, gabungan dasar yang betul bagi Zon C adalah dasar 4C dan ia adalah gabungan 100 paratus lesen meningkat dan 15 peratus caj pendaratan. Dalam ungkapan berangka, lesen yang dikeluarkan bagi Zon C 1,400 lesen ditambah dengan caj pendaratan sebanyak 15 peratus daripada jumlah pendapatan patut dikenakan dalam pengurusan kawalan usaha Pantai Barat Zon C tunda perikanan 2012 hingga 2042.

Berdasarkan keputusan Pantai Barat tunda perikanan, sumber ikan di Zon B eksploitasi berlebihan dan ia diperlukan untuk mengawal usaha penangkapar ikan dengan mengurangkan kapal pukat tunda di kawasan ini. Walaubagaimanapun, sumber ikan di Zon C tidak dieksploitasi berlebihan lagi dan potensi untuk menangkap ikan yang lebih tinggi dengan peningkatan usaha menangkap ikan masih ada di luar sana. Walaupun perlu mengharamkan pukat tunda, pilihan untuk membuang pukat tunda dari pesisiran pantai ke laut dalam akan menjadi satu lagi pilihan dasar untuk memastikan kelestarian sumber. Dari hasil simulasi daripada kajian menunjukkan bahawa zon B pukat tunda perlu dikurangkan dan manakala zon C masih boleh ditingkatkan ke tahap yang tertentu. Cadangar untuk pilihan dasar yang dicadangkan adalah untuk mengurangkan pukat tunda Zon B dan berubah ke Zon C pukat tunda yang dilesenkan dengan menolak mereka lebih jauh dari perikanan pantai. Oleh itu, pilihan dasar yang berdaya maju adalah untuk memindahkan kapal nelayan pukat tunda yang berlebihan dari Zon B untuk Zon C tanpa menjejaskan keadaan sosioekonomi pukat tunda di Zon B. Walaubagaimanapun, kejayaan cadangan polisi di dalam kajian ini memerlukan penguatkuasaan yang sempurna oleh pihak pengurusan yang berkuasa. Had lesen yang dikeluarkan untuk kapal tunda mungkin minimum berikutar terikat bilangan kapal dan jumlah kapal yang mungkin lebih tinggi daripada nilai yang dicadangkan kerana "memancing IUU" di kawasan ini. Oleh itu, penguatkuasaan polisi yang ketat dan sempurna secara kritikal diperlukan dalam menjayakan pengurusan perikanan pukat tunda di Pantai Barat Semenanjung Malaysia.

ACKNOWLEDGEMENTS

I am deeply indebted to my supervisor, Professor Dr. Tai Shzee Yew, Chairman of the supervisory committee, for his patience, understanding, valuable advice, enthusiastic guidance, supervision, encouragement and constructive comments throughout my research. I would like to express my special gratitude to my co-supervisors; Associate Professor Kuasairi B Mohd. Noh, Associate Professor Dr. Shaufique Fahmi Sidique and Professor Dr. Bilash Kanti Bala for their supervision, encouragement, valuable comments and suggestions.

I would like to take this opportunity to acknowledge my appreciation to Prospect Burma for providing me the scholarship during my study. I also would like to acknowledge to FRGS (Fundamental Research Grant Scheme) by Universiti Putra Malaysia for the research project under which I could finish my study without any difficulties. My sincere gratitude goes to all lecturers and staff of the Institute of Agricultural and Food Policy Studies (IKDPM), UPM for their friendship and kind hospitality. My deep appreciation also goes to Ms. Aswani Fahana, Research Officer at IKDPM who always help me heartedly throughout my study not only as a colleague but also as a best friend. Her valuable help and sharing of knowledge make me unexpectedly smooth the long journey of my study.

Last but not least, I express the most gratitude to my beloved parents, my husband and my family for their love and encouragement during my study. I am indebted with the great gratitude for the patience and endurance of my family to be successfully finished my study especially to my beloved only daughter, Chu Chu @ Su Ann @ Han Nway Nyein. My work is deeply dedicated to them.

I certify that a Thesis Examination Committee has met on 6 September 2016 to conduct the final examination of Moe Shwe Sin on her thesis entitled "System Simulation of the Behaviour of Trawl Fleet under Alternative Management Policies in the West Coast of Peninsular 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:

Normaz Wana binti Ismail, PhD
Associate Professor
Faculty of Economics and Management
Universiti Putra Malaysia
(Chairman)

Mohd Shahwahid bin Hj Othman, PhD
Professor
Institute of Agricultural and Food Policy Studies
Universiti Putra Malaysia
(Internal Examiner)

Tan Sri Datuk Nik Mustapha bin Raja Abdullah, PhD
Professor
Faculty of Economics and Management
Universiti Putra Malaysia
(Internal Examiner)

Indah Susilowati, PhD
Professor
Diponegoro University
Indonesia
(External Examiner)

NOR AINI AB. SHUKOR, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 27 December 2016

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 supervisory committee were as follows:

Tai Shzee Yew, Ph.D
Professor
Faculty of Economic and Management
Universiti Putra Malaysia
(Chairman)

Kuasairi B Mohd Noh
Associate Professor
Institute of Agricultural and Food Policy Studies
Universiti Putra Malaysia
(Member)

Shaufique Fahmi Sidique, Ph.D
Associate Professor
Institute of Agricultural and Food Policy Srudies
Universiti Putra Malaysia
(Member)

Bilash Kanti Bala, Ph.D
Research Fellow
Institute of Agricultural and Food Policy Srudies
Universiti Putra Malaysia
(Member)

ROBIAH BINTI YUNUS, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

Declaration by graduate student

I hereby confirm that:

- this thesis is my original work;
- quotations, illustrations and citations have been duly referenced;
- this thesis has not been submitted previously or concurrently for any other degree at any other institutions;
- intellectual property from the thesis and copyright of thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- written permission must be obtained from supervisor and the office of DeputyVice-Chancellor (Research and Innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- there is no plagiarism or data falsification/fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software.

Signature: _____ Date: _____

Name and Matric No.: Moe Shwe Sin (GS 31538)

Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature: _____
Name of Chairman of Supervisory Committee: Tai Shzee Yew

Signature: _____
Name of Member of Supervisory Committee: Kusairi Mohd Nor

Signature: _____
Name of Member of Supervisory Committee: Shaufique Ahmad Sidique

Signature: _____
Name of Member of Supervisory Committee: Bilash Kanti Bala

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 The Malaysian Fishery Sector

The fishery sector of Malaysia is an important contributor to national Gross Domestic Product (GDP) and it contributed about 1.1 % to country's GDP in 2011(Annual Fisheries Statistics, Malaysia, 2011). The Malaysian fishery sector is also an important role to the income, employment, foreign exchange and the supply of protein especially for the rural population (Abu Tablib, et.al., 2003; Safa, 2004; Raduan et al., 2007; Teh and Teh, 2014). The fisheries sector consists of 134,110 fishermen working on licensed fishing vessels and 28,599 fish culturists working in aquaculture systems in 2011 (Annual Fisheries Statistics, Malaysia, 2011). Fisheries sector of Malaysia provide as major source of protein and it is up to two-thirds of Malaysia's population (Saharuddin, 1995, Teh and Teh, 2014).

The fisheries sector in Malaysia includes marine (offshore and inshore), freshwater and aquaculture fisheries. The marine capture fishery sector in Malaysia contributed significantly to the national economy. In 2010, the marine fisheries sector produced about 1.4 million tons of fish and contributed about 1.3 % to country's GDP (FAO, 2011). Marine capture fisheries subsector produced 1.37 million tons (82.43% of total landings) of fish valued at 6,939.47 million ringgit (73.98%) in 2011 and it is decreased by 3.9% in terms of quantity and 4.32 % increasing in terms of value (Annual Fisheries Statistics, Malaysia, 2011). In marine capture fishing industry, the inshore fishery is the main contributor of the fish landings and it provides about 80 % of the total landings and deep sea fishery contributes about 15 % of total landings (Safa, 2004). The marine fishery sector provides employment for the local fishermen and also the foreign workers including Vietnam, Indonesia and Thailand. A total of 134,110 fishermen working on licensed fishing vessels and 98,135 fishermen out of this were local fishermen and 35,975 were non-Malaysian foreign fishermen (Annual Fisheries Statistics, Malaysia, 2011).

Malaysia is divided into two geographical regions: Peninsula Malaysia and East Malaysia (Figure 1.1). The East Coast is facing to the South China Sea and subjected to severe weather during monsoon season and it makes difficult in fishing. Unlike the East Coast, the West Coast of Peninsula Malaysia is less exposed as it is bordered by the Strait of Malacca and the coast is characterized by shallow muddy mangrove. The fishing operation on the West Coast is possible throughout the year. The eight states of Malaysia located on the West Coast and are economically developed and also with crowded population (Teh and Teh, 2014). The West Coast of Peninsular Malaysia marine fisheries produce 44 % of total marine landings in 1997 and 86% of this produced from commercial (large-scale) vessels (Abu Talib, et al., 2003). West Coast of Peninsular Malaysia fisheries have been more heavily capitalized and the fish resources are intensely exploited than the East Coast (Labon, 1974, Ooi, 1990, Abtalib

et al., 2003). In Malaysia, fish is regarded as the most important source of animal protein for all races and the marine fisheries sector produced about 85% of total seafood production (Choundhury and Yahaya, 2012).

Figure 1.1: Map of Malaysia including Peninsular Malaysia, Sabah and Sarawak. (Source: Teh and Teh, 2014.)

Marine inshore fishery of Malaysia is operated within 30 nautical miles from shore and it includes traditional small- scale fishery and commercial fishery. The artisanal fishery includes a larger number of vessels but it can only contribute 27 percent of the total value of the fishery. The commercial fishery includes trawl, purse seines, hook and line and drift and gill nets. These highly commercial fisheries are becoming most popular especially in West Coast of Peninsular Malaysia (Flewwelling and Hosh, 2011). Among the commercial fishing gears, trawl vessels are significantly higher in number than purse seine vessels. The number of trawl vessels increased from 1980 and gradually decreases in the subsequent years (Figure 1.2).

The total number of licensed fishing vessels in the west coast of Peninsular Malaysia such as drift net (the dominant gear type of artisanal fishery aiming for high value pelagic) and two dominant commercial gears, trawl and purse seine, are shown in Figure 1.2. Among the two commercial gears, trawl vessels are seen as significantly higher in number than purse seine vessels. The number of trawl vessels increased from 1980 and the peak number was 3487 in 1984. The gradually decreasing trend was found in the subsequent years until 2005 however rapid decreasing of about 80 percent occurred with the number of 2784 in 2012. The increasing number of trawl vessels in early 1980s is due to the superior technology improvement and adoption of trawlers. The decreasing in number of trawl vessels in subsequent year may be reflected by the resources availability in the productive fishing ground in this area (FAO, 2009). The historical increase of fishing capacity in Malaysia marine capture fisheries has shown that the marine fisheries stocks are in severely depleted and proposed actions needed to be taken to reduce capacity in the future (Taupek and Nasir, 2003).

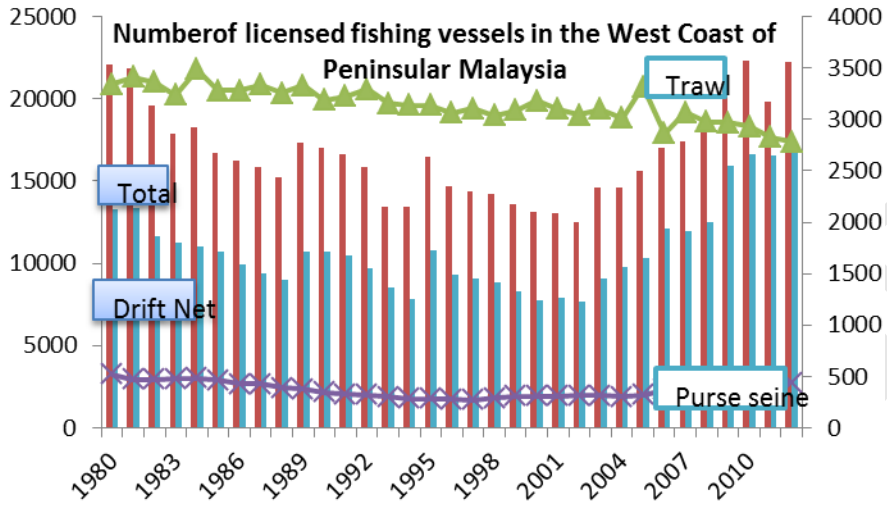

Figure 1.2: Number of licensed fishing vessels in the west coast of Peninsular Malaysia.

The impressive development of Malaysia marine fisheries was achieved due to the adoption of advanced technologies such as the trawl fishery during the 1980s and early 1990 (Yahaya and Abdullah, 1993). The increasing number of trawl vessels in early 1980s is due to the adoption of superior technologies by the trawlers. The decreasing in number of trawl vessels in the later year may be reflected by the resources availability in the fishing grounds of this area (FAO, 2009). However, the advanced technology together with increasing fishing effort has intensified pressures on fisheries resources (Abdullah and Kuperan, 1997), and evidently has led to the overexploitation of marine fishery resources in Malaysia (FAO, 2001).

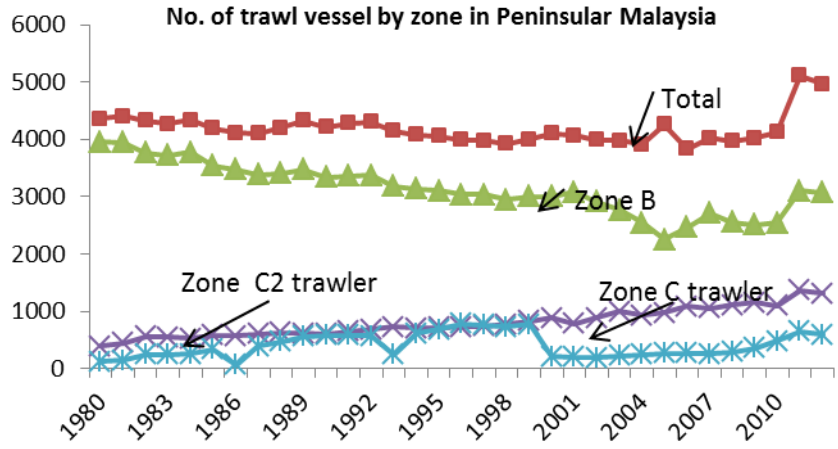

Figure 1.3: Number of licensed trawl vessels by zone in Peninsular Malaysia.

The commercial fishing gears operating in Malaysia fishery sector showed the significant amount of landings of all species groups including pelagic, demersal, crustacean, Mollusca and trash fish (i.e; small and undersize fish of no commercial value). Among the commercial fishing gears, landings of all fish species and trash fish are the significantly higher amount by the trawlers (Figure 1.4). In 2012, the total marine fish landing by trawlers is 700,000 metric ton, by fish purse seine is 350,000 metric ton, by anchovy seine is 11,060 metric ton and by other seine is 28,000 metric ton in Malaysia marine fishery (Annual Fishery Statistics, Malaysia, 2012). The trash fish landings by trawlers are 230,786 metric ton, by purse seines are 17,000 metric ton, by anchovy seines are 526 metric ton and by other seines are 13,000 metric ton in 2012 (Annual Fishery Statistics, Malaysia, 2012). The significantly higher landings of trash fish by trawlers is found in Malaysia marine fishery and it might be the sign of over-exploited fishing operation in this area (FAO, 2006).

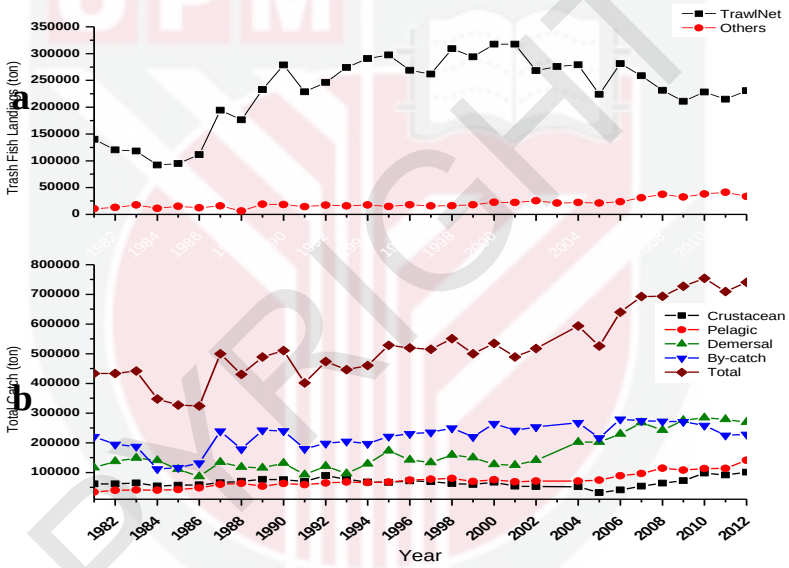

Figure 1.4: (a) The trend of trash fish landings by trawlers and other methods of fishing, (b) Landings of fish in species groups by trawlers in Malaysia.

The resource studies showed that Malaysia fisheries resources are heavily stressed and currently being exploited beyond their MSY (WWF, Malaysia, 2013; Talib, 2002; Talib, et al., 2000; Chee, 2000; Talib, et al., 1995; Chee, 1991). The recent studies indicated that the fish stocks, especially in the west coast of Peninsular Malaysia have been overexploited, (Tai, 2006; Tai and Heap, 1996; Tai, 1992). The overexploitation of fisheries resources has been an important issue and it was the cause of excessive fishing inputs and efforts (FAO, 2007). The historical increase of fishing capacity in Malaysia marine capture fisheries has shown that the marine fisheries stocks are in severely depleted and proposed actions needed to be taken to reduce capacity in the future (Taupek and Nasir, 2003).

Malaysia fisheries management established the goal to achieve sustainable coastal fisheries (FAO, 2002) and various management strategies were formulated to control excessive fishing effort for the purpose of promoting and rehabilitation of marine resources (Pitcher, 2006). The objectives of fisheries management in Malaysia are: (1) to eliminate the competition and the ensuing conflict between artisanal and trawler fishermen in the inshore waters; (2) to restructure the ownership pattern of fishing units within the context of the New Economic Policy; (3) to equitably distribute fishing throughout the waters under jurisdiction of Malaysia; (4) to prevent overexploitation of the fisheries resources in the inshore waters; and (5) to promote the development of offshore industrial fisheries. The management objectives were mainly oriented to social and biological goals primarily and, later on, economic efficiency in resource utilization (Tai, 1992).

There are various management regulations used in Malaysia since 1960s including (1) National Jurisdictions: Emergency (essential Powers) Ordinance N0.7, 1969 and Continental Shelf Act 1966; (2) Management legislations: Fisheries Act 1963, Merchant Shipping Ordinance 1952, Fisheries (Cockles Conservation & Culture) Regulations 1964, Fisheries (Maritime) Regulation 1967, Fisheries (Prohibition of Method of Fishing) Regulation 1971, Fisheries (Prohibition of Import of Piranhas) Amendment Regulations 1979, Fisheries (Amendments) Regulations 1979, and Fisheries Act 1985; (3) Development Legislation: Lembaga Kemajuan Ikan Malaysia Act 1973; (4) Organizational Legislation: Investment Incentive Act 1968; (5) Fishing Vessels & Merchant Shipping Regulations: Boat Rules 1953, Merchant Shipping (Amendment) Act 1973, Examination of Engine Drivers Rule 1953, and Examination for certificates and competency (Amendment) Rules 1974; and (6) Pollution Legislation: Environment Quality Act 1974 (Jahara and Yamamoto, 1988; Tai, 1992).

Fisheries management legislations are provided for the control of fishing effort and are the amendment of Fisheries Act 1963 provided the Fisheries (Amendment) Regulations 1980 to control the problems of overexploitation and overcapitalization in inshore fisheries. The allocation of fishing grounds by zoning and licenses are issued in specific zones and the four main zones were established in this regulation such as zone A, B, C, and C2. Zone A is within 5 nautical miles from shoreline reserved for traditional fishing gears, Zone B is between 5 and 12 nautical miles reserved for trawlers and purse seiners less than 40 GRT, Zone C is between 12 to 30 nautical miles reserved for trawlers and purse seiners between 40-70 GRT and Zone C2 is from 30 nautical miles until the EEZ of Malaysia waters reserved for the fishing vessels of greater than 70 GRT (Ti, 1992; Abdullah ad Kuperan, 1997).

The specific objective of the zoning system is to provide zonal regulations for high capacity and powerful gear types, especially trawlers. The trawl net can be used only in Zone B and onward beyond 5 nautical miles from the coast (Government of Malaysia, 1985). The trawlers are allowed to operate in zones B, C and C2 till outer boundary of the EEZ of Malaysia waters. With the effort to reduce the fishing pressure in the coastal waters, the number of trawlers operating in the near shore or Zone B was reduced in 1996 and the total number of trawl vessels was a decline (Taupek and Nasir, 2003).

Department of Fisheries (DOF) Malaysia is the entrusted agency for the management of the fisheries industry in the country. The DOF, Malaysia is responsible for the overall management planning and implementation, including marine parks. Another three key groups of departments involving in the fisheries industry in Malaysia include (1) the "Ministry of Science, Technology and the Environment (MOSTE)" providing scientific foundation for fisheries management, (2) the "Fisheries Development Authority Malaysia (FDAM) which is responsible for enhancement of livelihood of fishers, value-added processing and marketing to maximize benefits to the industry, and (3) the law enforcement agencies for the coastal and offshore fisheries law enforcement such as "Fisheries Marine Service", "Navy, Coast Guard and Marine Police". (Flewwelling and Hosch, 2006).

Fisheries regulations undoubtedly affect the fish stocks being managed and the fishers also respond accordingly to the type of regulations imposed (Tai and Heap, 1996). The current management regulations on the trawl fishing industry of the west coast of Peninsular Malaysia will impact on the socio-economic welfares of communities and also resources sustainability. Sound management of the complex interaction between resources stocks and fishers under the proposed regulation should take these impacts into consideration. The fishery system is complex and also dynamics in nature. Analyzing the effect of management regulations and to establish the alternative management regulations needs to take cognizance of the complexities inherent in the marine fisheries system and which will enable policy makers to choose the effective policies towards achieving the predetermined goals and objectives of fisheries management (Stouten, et al., 2006).

1.2 Marine Fishery in the West Coast of Peninsular Malaysia(WCPM): Trawl Fishing Industry

There are four areas of Malaysian waters: the West Coast and East Coast of Peninsular Malaysia, the coast of Sarawak and the coast of Sabah. The West Coast of Peninsular Malaysia marine fishery is more capitalized and increasing fishing capacity than other three coastal marine fisheries and contributed about 44 % of total marine landings in 1997. The commercial and large-scale fisheries in WCPM contributed about 71% of landings and it consists of 53 % demersal fish, 29 % pelagic fish, 5% squid and 13% prawn (Abu Talib, et al., 2003). The fishing vessels operating in WCPM is significantly higher than East Coast of Peninsular Malaysia (ECPM) and it was 21,395 licensed fishing vessels in WCPM and 9,097 licensed fishing vessels in ECPM in 2012. The commercial fishing vessels operating in the marine fishery of WCPM include trawl, purse seine, and grill/drift net. In terms of employment, the fishermen working on licensed fishing vessels in WCPM is significantly higher and was 55,000 fishers working on licensed fishing vessels in WCPM and it was 34,000 fishermen working on licensed fishing vessel in ECPM in 2012 (Annual Fisheries Statistics, Malaysia, 2012).

Among the commercial fishing gears, trawlers are providing large numbers of landings in WCPM marine fishery just like in the whole Malaysia. The number of trawlers operating in WCPM was over 5,000 units from 1979 to 1985. However, the number is reduced to 3,035 in 1997 and the reduction is the results of government policy since

1987 to reduce effort in coastal areas with encouraging the development of offshore fishery. The reduction of the number of trawlers is found especially in the trawl vessels with less than 40 GRT (Zone B trawlers) about 40 % during 1981 to 1997, however, the bigger trawlers with 40-70 GRT is increasing and one reason for this issue was the difficulty in getting crew especially the local crews who are not willing to work at low-income fishing industry (Abu Talib et al., 2003). The shortage of the fishermen is growing and it is the results of high dependence on foreign fishers working at Malaysian vessels above 40 GRT trawlers and it is now facing in smaller vessels of less than 40 GRT trawlers (Flewwelling and Mosch, 2011). Annual catch per unit of effort (CPUE) is increasing during 1981 to 1997 because of decreasing fishing vessels of about 38 % especially for the trawlers of less than 40 GRT (Abu Talib, 2002).

The marine fisheries resource in the West Coast of Peninsular Malaysia has been reported to be overexploited mainly by the destructive trawl fishing. Although there is the most destructive effect is found by the trawlers, the trawlers are the main types of fishing gear accounting for about 60 % of total landings in WCPM (Alias, 2003). The fishery in the WCPM is multispecies and trawl landings include a multitude of fish species, invertebrate and trash fish. In WCPM, trawlers catch variable composition of fish species indiscriminately and about one-third of this is trash fish including juvenile of commercially valuable fish. The overfishing of trash fish will cause the loss of valuable fish landings over time (Viswanathan, et al., 2002).

The trawlers in WCPM are the only commercial fishing gear which causes exploitation of demersal fish. About 84 % of demersal fish landings is from trawlers in WCPM and traditional fishing gears contributed only 16 % of demersal fish landings. The composition of landings by trawlers in WCPM consists mainly of trash fish of 51 %, demersal fish of 15 % and pelagic fish of 13 % and the dominant characteristic of trawlers is huge landings of trash fish. The study of WCPM trawl survey research showed that the biomass in the coastal and offshore areas are decreasing and the abundance of resources has been reduced from 50 % to 10-15 % (Alias, 2003). The decreasing of fish resources in the West Coast is found in the decreasing trend of CPUE. The resources exploitation occurs with the over capacity of trawlers especially in the inshore waters of less than 30 nautical miles in which trawlers of less than 70 GRT class are allowed to fishing (Nurudin and Isa, 2013).

Trawl fishery in Malaysia is currently managed by entry limitation system with the licensing policy and the licenses must be renewed for every year. The license issued for trawlers have only one type and there is no separate license type for the different type of trawlers, for example, shrimp trawlers, sergestid trawlers and otter bottom trawlers. Once the license is issued for the trawlers the fishing vessel can operate fishing with any operating methods and it caused more overcapacity and exploitation of the fish stocks. The licensing policy is a part the Fisheries Act 1985 and the possible mitigation measure for licensing on a specific type of trawlers should be based on the review of existing regulation (Nurudin and Isa, 2013).

1.3 Statement of the Problem

Open access and common property nature of the fishery resources contributed to the termed as 'the tragedy of common' by Hardin (1968). Under the condition of pure open access with no regulation on access or no property rights, overcapacity with dramatic overexploitation may lead to depletion and possible extinction of fishery stocks (Homans and Wilen, 1997). Even under 'regulated open access' scenario, there is a tendency to expand fleet capacity and increasing fishing effort in order to capture a large share of the catch. This nature of 'race for fish' is also associated with the symptoms of increasing by-catch and discards and low valued fish. Therefore, effective management is necessary for the over and fully exploited stocks caused by overcapacity and overfishing due to new and advanced technologies such as trawlers (Sanchirico and Wilen, 2007).

There are a number of issues related to the trawl fisheries in West Coast of Peninsular Malaysia although the number of trawlers is less than that of other commercial fishing gears. Overcapacity is one of the major issues related to the trawlers, especially in the inshore waters. The destructive fishing nature of the trawlers is dragging out the seabed and it destroys the habitat of the fishery and increasing landings of trash fish. The increasing number of fishing vessels coupled with increasing fishing capability of the trawlers greatly increased the fishing pressure on the fish stocks. The increasing fishing pressure on the stocks causes the overexploitation and depletion of available fish stocks. The use of overcapacity of trawlers in WCPM and the overexploited conditions of fish resources still exists based on the resource studies in this area. The decreasing of commercially important species composition apparently occur both in inshore and offshore waters of the West Coast fishing ground in Peninsular Malaysia (Taupek and Nasir, 2003).

The main cause for the overexploitation of resources stocks is overcapacity of trawl fleets. The two main reasons for why the overcapacity of the effort occurs in the fishery are common property nature of fish resources and ineffective management policies. The fishers increased their effort unlimitedly to catch more fish as common property resources and which lately induces the undesirable consequences of overcapacity. As the results of over capacity, however, the catch is declining over time with increasing fishing effort. Thus, overcapacity can be referred as 'too many efforts chasing too few fish'. Another reason for overcapacity is ineffective management policies such as unclear target or goals of the management of fishing industries and financial supports for inputs in terms of subsidies and catch incentives. Therefore, the management policy implication which can ascertain the controlling overcapacity is one of the important tools in the sustainable management of trawl fishery in West Coast of Peninsular Malaysia.

The common problem in Malaysia coastal marine fisheries is the encroachment of trawlers to inshore waters (Goh, 1976; Viswanathan, et al., 1999). The predetermined objectives of Malaysian fisheries management include controlling effort in trawl fishery to lessen the overfishing pressures on the fish stocks and reducing conflict among fishermen. To assess the predetermined objectives, management authorities implemented the area licensing policy which limits the number of vessels and fishing

capacity by gear types, vessels sizes and type of ownership (Ooi, 1990). Although the number of trawlers is restricted with limited entry regulations, the number of arrested vessels in the inshore waters which is reserved for traditional vessels was increased since past decades by 300% during the 1980s and also increased in late 1999s due to poor enforcement system (Viswanathan et al., 1999). Hence, the encroachment of more productive trawlers becomes increased to inshore and leading to the conflict among commercial fishermen and artisanal fishermen. The conflict among fishermen often addressed with the prohibition of gear or restrictions by zoning and the typical controlling should be managed through monitoring, surveillance and enforcement upon those regulations (Sutinen et al., 1990).

Management of fisheries seeks to influence the responses by fishing industries on policy regulations through various effective measures to ensure sustainability of proposed regulation such as enforcement of the policy regulations (Needle, 2011). Moreover, management plans to be applied to the fishery industry must deliver in line with what the goal of management expect to be achieved in future (Kell, et al., 2006). In the context of management of trawl fishery on the West Coast of Peninsular Malaysia, the impact of management measures needs to be evaluated in order to predict the appropriate combination of management interventions. The management interventions include controlling effort in terms of a number of licenses issued for trawl vessels in different zoning area, the control of inputs such as adjusting the fuel subsidy and proposed licenses fees and managing the operation cost through imposing a jetty charge. In order to ascertain the predetermined goals, the plans must be tested prior to implementation or must be reevaluated in the case of currently applied management plans or regulations. Crucially, it is needed for the evaluation of current management measures and understanding the adjustment process of fishing effort for designing and implementing efficient and equitable fishery management policies (Tai and Heap, 1996).

The direct implementation of the new policy alternatives in the management of the industry would not be wise because it might be inappropriate and inefficient without empirically tested on the specific problem issue. Empirically simulated management alternatives for the specific case is inevitably needed with the aim of generating the empirical evidence to inform the decisions makers about the current situation and the possible and suitable management policy alternatives can be proposed and be implemented. In the case of West Coast trawl fishery, the empirical analysis on the impact of current policy regulations and analyzing on the alternative policy implications with the management of the sustainable fishery is crucially needed. For the trawl fishing industry on the West Coast of Peninsular Malaysia, few studies have been done (Tai and Heap, 1996; Tai, 1992) on the analysis of effort dynamics and simulation on the impact of management regulations. Therefore, the research questions call for what type and level of policy intervention should be applied to the management of sustainability of trawl fisheries on the west coast of Peninsular Malaysia.

1.4 Research Justification

The two main causes of the overexploitation of the fishery stocks are (1) overcapacity of the trawl fleets, and (2) illegal, unreported and unregulated (IUU) fishing in the Malaysia waters. The IUU fishing occurs due to the encroachment of foreign vessels in contravention of laws and regulations. Moreover, IUU fishing can also be due to the use of illegal gears such as otter trawling, pair trawling, push net, fish bombing and cyanide fishing (Zakariah, 2004) and the encroachment of trawlers into Zone A fishing grounds which caused conflicts among trawlers and fishers using artisanal fishing gears. IUU fishing is caused also by weak enforcement of the fishery laws and regulations. Although IUU fishing is a major problem in the trawl fishery of the West Coast of Peninsular Malaysia, it is not the focus of the study. Instead, this research focuses on the managing the overcapacity problem of the trawl fisheries.

The exclusion of the analysis on IUU fisheries may be justified by the following reasons:

(1) By resolving for overcapacity problem, the trawl fisheries can be managed sustainably. The sustainable management on the trawl fisheries indirectly may reduce the problem of gear conflicts. Since the fishery resources in a sustainably managed fishery can support the trawl fleets in Zone B and there is no incentives for Zone B trawlers to encroach into Zone A. With reduced incidence of encroachment, there is less needs for the enforcement of the zonal regulation for trawlers. Hence, sustainable management of the trawl fisheries in the West Coast of Peninsular Malaysia by managing the overcapacity of the trawl fleet may be able to resolve part of the IUU fishing problem.
(2) In addition, information and data related to IUU fishing are mostly classified as confidential and are not accessible by the public for a more detailed and comprehensive analysis of this problem.

1.5 Research Objective

The general objective of the study is to evaluate the impact of alternative management policy implications and targets on the trawl industry in the West Coast of Peninsular Malaysia. In order to achieve the general objective, the specific objectives of the research are:

(1) To develop a system simulation model to evaluate the performance of trawl fishery in Zone B and Zone C.
(2) To evaluate the impact of current and alternative management policy implications based on the simulation model being developed.
(3) To propose recommendation for the management of trawl fishery in Zone B and zone C of the West Coast of Peninsular Malaysia.

1.6 Significance of the Study

The simulation model developed in this study can serve as a tool for the evaluation of the impact of management policy implication for the trawl fishery on the West Coast of Peninsular Malaysia. The simulation models could also be used to figure out the dynamics complexity of the fisheries system and options for the management for the trawl fishery in WCPM. The changes of the policy implementation can be tested and evaluated using system simulation model before implementing in the real fisheries system. This prior testing of the impact of policy implication would probably limit the risk of undesirable outcomes of policy implication to the real system. Moreover, the simulation model can illustrate the selected policy implication which is the combination of policy instruments in balance when attempting to meet the best policy implication in the management of the fishery. For instance, the right level of fuel price subsidy and the proper amount of jetty charge imposing together with the major policy variable of a number of licensed issues for the trawlers in each zone of the WCPM could be selected based on the performance of the fishery simulated over time. Finally, the study outcomes and the simulation model developed in this study certainly have the future role in advising fisheries policy makers for the sustainable management of the trawl fishery in West Coast of Peninsular Malaysia.

1.7 Organization of the Thesis

The organization of the thesis is as follow. The brief literature review of Theories of Fisheries Management, Fisheries Management Regulations, and Fisheries Management Models are presented in Chapter 2. The conceptual model, the details of the model specification and its variables and parameters used and the system simulation procedure is discussed in Chapter 3. The estimation of the parameters and initial values of the variables used in the simulation model and validation of the model are presented in Chapter 4. The results of the simulation analysis with two scenarios of Open-access and Alternative Management Policy Scenario for zones B and C are discussed in Chapter 5. The summary of the study, the main finding of the study and recommendation of the study is presented in Chapter 6.

REFERENCES

Abdullah, N.M.R., & Kuperan, K. (1997). Fisheries management in Asia: The way forward. *Marine Resource Economics*, 12: 345-353

Adasiak, A., (1979). Alsska's experience with limited entry. *Journal of the Fisheries Research Board of Canada* 36(7): 770-782.

Alden, D., & Connor, R. (1999). Indicators of the Effectiveness of Quota Markets: South East Trawl Fishery of Australia. Use of Property Rights in fisheries management. FAO Technical paper 404/2.

Amundsen, E.S., Bjorndal, T., & Conrad, J.M. (1995). Open Access Harvesting of the Northeast Atlantic Minke Whale. *Environmental and Resource Economics* 6: 167-185

Anderson, L.G., & Seijo, J.C. (2010). Bio-economics of Fisheries Management. Wiley-Blackwell.

Annala J. H. (1996). New Zealand's ITQ system: have the first eight years been a success or a failure? *Rev in Fish biol. and Fisheries* vol. 6 (1): 43-62

Arnason, R. (1996). Property Rights as an Organizational Framework in Fisheries: The Cases of Six Fishing Nations. In B.L. Crowley (ed.) *Taking Ownership: Property Rights and Fisheries Management on the Atlantic Coast*. Atlantic Institute for Market Studies, Halifax.

Arnason, R. (1999). Property Rights as a Mean of Economic Organization. Use of Property Rights in fisheries management. FAO Technical paper 404/1.

Arreguin-sanchez, F. (1996). Catchability: a key parameter for fish stock assessment. Reviews in *Fish Biology and Fisheries* 6: 221-242

Asche, F., Guttormsen, A.G., Sebulonsen, T., & Sissener, E.H. (2005). Competition Between Farmed and Wild Salmon: The Japanese Salmon Market. *Agricultural Economics*, 33 :333–400.

Barlas, Y. (1996). Formal aspects of model validity and validation in system dynamics. *System Dynamics Review*. 12 (3): 183-210

Barlas, Y., & Carpenter, S. (1990). "Philosophical roots of model validation: two paradigms.", *System Dynamics Review*, 6(2): 148 – 166

Batstone, C.J., & Sharp, B.M.H. (1999). New Zealand's quota management system: The first ten years. *Marine Policy*. 23:177-190.

Batstone, C.J., & Sharp, B.M.H. (2003). Minimum information management systems and ITQs fisheries management. *Journal of Environmental Economics and Management* 45: 492-504.

Bene, C & Tewfik, A. (2001). A."Fishing effort allocation and fishermen's decision making process in amulti- species small-scale fishery: analysis of the conch and lobsterFishery in Turks and Caicos islands". *Human Ecology*, 29(2): 157-186.

Beverton, R. J. H., & Holt, S. J. (1957). On the dynamics of exploited fish populations. UK Ministry Agriculture and Fisheries. 19: 533 pp.

Berck, P., & Perloff, J.M. (1982). An Open-Access Fishery with Rational Expectations. CUDARE working paper 187.

Bjorndal, T., Herrero, I., Newman, A., Romero, C., & Weintraub, A. (2002). Operational research in the natural resource industry. *International Transactions in Operational Research*, *19*(1-2): 39-62.

Bockstael, N. E., & Opaluch, J. J. (1983). Discrete modeling of supply response under uncertainty: the case of the fishery. *Journal of Environmental Economics and Management*, 10: 125–137.

Branch, T.A., Hilborn, R., Haynie, A. C., & Fay, G. (2006). Fleet dynamics and fishermen behavior: lessons for fisheries managers. *Canadian Journal of Fisheries and Aquatic Sciences*; 63(7): 1647

Bulte, E., Folmer, B., & Heijma, W. (1995). Open access, common property and scarcity rent in Fisheries. *Environmental and Resource Economics* 6: 309-320

Bjorndal, T. & Conrad, J.M. (1987). The Dynamics of an Open Access Fishery. *The Canadian Journal of Economics / Revue canadienne d'Economique*, 20(1):74-85.

Brown, D.R. (2000). A Review of Bio-Economic Models. Cornell University.

Bulte, E. (1997). Essays in Economics of Renewable Resources. Ph.D. Dissertation, Wageningen University, Wageningen.

Bulte, E. H., Damania, R., & Deacon, R. T. (2005). Resource intensity, institutions, and development. *World Development*, 33(7):1029–1044

Caddy, J. F. (2002). Limit reference points, traffic lights, and holistic approaches to fisheries management with minimal stock assessment input. *Fisheries Research*, 56(2):133-137.

Casey, K.E., Dewees, C.M. , Turris, B.R., and Wilen, J.E., 1995. Effects of individual vessel quotas in the British Columbia halibut fishery. *Marine Resource Economics*. 10:211-230.

Chang, I.Z. (2010). A Simple Biomass-Based Length-Cohort Analysis for Estimating Biomass and Fishing Mortality. *Transactions of the American Fisheries Society*, 139:911–924

Chee, P.E. (2000). The Pelagic Fishery of the West Coast of Peninsular Malaysia. In: Shariff, M., Yusoff, F.M. , Gopinath, N. , Ibrahim, H.M. , & Nik Mustafa,

R.A. (eds.). Towards Sustainable Management of the Straits of Malacca. Malacca Straits Research and Development Centre (MASDEC), Universiti Putra Malaysia, Serdang, Malaysia.

Chee, P.E. (1991). The Maximum Sustainable Yield of the Demersal Fishery of the West Coast of Peninsular Malaysia and its Use in Managing the Fishery. In: Proceedings of the Annual Fisheries Research. Conference 1991. Fisheries Research Institute Department of Fisheries, Ministry of Agriculture, Malaysia.

Chowdhury, Md. A., &Yahaya, K. (2012). Sustainable Seafood Production: Malaysian Status and Comparison with the World Conference paper. International Conference Aquaculture Indonesia (ICAI) -2012. Novotel Hotel, Semarang, Indonesia, 23-24 October 2012

Clark, C.W. (1976). Mathematical Bio-economics: The Optimal Management of Renewable Resources. Wiley-Interscience, New York.

Clark, C.W. (1990). Mathematical Bio-economics: The Optimal Management of Renewable Resources, 2nd ed. Wiley-Interscience, New York.

Clarke, R.P., Yoshimoto, S.S., & Pooley. S.G. (1992). A Bio-economic Analysis of the North-Western Hawaiian Islands Lobster Fishery. *Marine Resource Economics* 7(2):115–40.

Coppola, G., & Pascoe, S. (1998). A Surplus ProductionModel with a Non Linear Catch-Effort Relationship. *Marine Resource Economics, Volume 13: 37-50*

Costanza, R., Darge, R., de Groot, R., Farbar, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R., Paruelo, R.V., Raskin, R.G., Sutton, P., & van den Belt, M. (1997). The value of the world's ecosystem services and natural. *Nature*, 387: 253-260

Crowley, R. W., & Palsson, H. (1992). Rights Based Fisheries Management in Canada. *Marine Resource Economics*, 7: 1-21.

Deacon, R. T., Finnoff, D., & Tschirhart, J. (2011). Restricted capacity and rent dissipation in a regulated open access fishery. *Resource and Energy Economics*, 33: 366-380

Dreyfus Leon, M.J., & Maruo Monroy, H.G. (1990). Application of a bio-economic model to the fishery of Yellowfin tuna (Thunnus albacares) in the Eastern Pacific ocean. *Marine Science*. 16(3): 63-76

Dudley, R.G. (2008). A Basis for Understanding Fishery Management Complexities. *System Dynamics Review.* 24(1): 1–29 .

Dudley. R.G., & Soderquist, C.S. (1999). A Simple Example of How System Dynamics Modeling can Clarify and Improve Discussion and Modification of Model Structure. Presentation paper: 129th Annual Meeting of the American Fisheries Society, Charlotte, North Carolina. August 1999.

Eggert, H. (1998). Bio-economics analysis and management. *Environmental and Resource Economics.* 11(3-4): 399-411

FAO. (1997). FAO Technical Guidelines for Responsible Fisheries No. 4: Fisheries Management. FAO, Rome.

FAO. (2000). Code of conduct for responsible fisheries. Rome (Italy): FAO, Available: http://www.fao.org/docrep/005/v9878e/v9878e00.HTM. Accessed May 19, 2009.

FAO. (2001). Country Synopsis: Malaysia

FAO. (2002). UN Atlas of the Oceans: Malaysia

FAO, (2007). The State of World Fisheries and Aquaculture 2006. Food and Agriculture Organization of The United Nations Rome, 2007

FAO, (*2009).* The State of World *Fisheries* and Aquaculture 2008. Food and Agriculture Organization of The United Nations . Rome, 2009

FAO, (2010). From drain to gain in capture fisheries rents. A synthesis study. FAO Fisheries And Aquaculture Technical PAPER 538.

FAO. (2011)**.** Review of the state of world marine fishery resources. FAO Fisheries And Aquaculture Technical Paper 569.Food And Agriculture Organization Of The United Nations. Rome, 2011

Field, B.C. (2008). Natural Resource Economics: An Introduction, Second Edition. Waveland Press.

Flatten, O. (1988). The Economics of Multispecies Harvesting: Theory and Application to the Barents Sea fisheries. Springer-Verlag, Berlin.

Flewwelling, P., & Hosch, G. (2006). Country Review: In: Malaysia. Review of the state of world marine capture fisheries management: Indian Ocean. FAO fisheries technical paper 488. Edits: Cassandra De Young. pp 143-154

Fournier, D.A., Hampton, J., & Sibert, J.R. (1998). MULTIFAN-CL: a length-based, age-structured model for fisheries stock assessment, with application to South Pacific albacore (Thunnus alalunga). *Canadian Journal of Fisheries and Aquatic Sciences*, 55: 2105-2116.

Forrester, J. W. (1961). Industrial Dynamics. Portland, OR: Productivity Press. 464 pp.

Forrester, J. W., & Senge, P. M. (1980). "Tests for building confidence in system dynamics models."in A.A. Legasto, JR, J. W. Forrester, & J. M. Lyneis (Ed.), *System Dynamics: TIMS Studies in the Management Science*, 14: 209 –228. Amsterdam: North-Holland

Fox, W.W. (1970). An Exponential Surplus-Yield Model for Optimizing Exploited Fish Populations. *Transactions of the American Fisheries Society*, 90: 80-88.

Gissurarson, H.H. (1999). The Politics of Enclosures with Special Reference to the Icelandic ITQ System. An Introduction to Rights-Based Management . FAO Publication**.**

Goh, C.T. (1976). The fishing conflict in Penang and Perak: personal memoir. *Malaysian Economic Studies*, 12(1 & 2):17-25.

Gordon, H.S. (1954). The economic theory of a common property resource: the fishery. *Journal of Political Economy* 62, 124-142.

Government of Malaysia. (1985). Laws of Malaysia, Act 317, Fisheries Act 1985, Government Printer, Kuala Lumpur, Malaysia.

Graham, M. (1935). Modern Theory of exploiting a fishery and application to North Sea trawling. *ICES journal of Marine Science*, 10: 264-274

Hardin, G. (1968). The Tragedy of the Commons. *Science*. 162: 1243-1248

Hartwick, J.M. (1982). 'Free access and the dynamics of the fishery.' In: Mirman, L.J., and Spulber, D.F. (eds.), Essays in the Economics of 'Renewable Resources. (Amsterdam, New York, Oxford: North-Holland)

Heizer, S. (1999). The commercial Geoduck (*Panopea adrupta*) fishery in British Columbia, Canada- An operational perspective of a Limited Entry fishery with Individual Quotas. Use of Property Rights in fisheries management. FAO Technical paper 404/2.

Hennessey, T., & Healey, M. (2000). Ludwig's ratchet and the collapse of New England groundfish stocks. *Coastal Management,* 28(3): 187–213

Hilborn, R., & Walters, C.J. (1992). Quantitative fisheries stock assessment: choice, dynamics and uncertainty. Chapman & Hall, New York. Pp-570

Hillborn, R. & Ledbetter, M. (1985). Determination of catching power in the British Columbia salmon purse seine fleet. *Canadian Journal of fish and Aquaculture Science*, 42: 51-56

Hoff, A., & Frost, H. (2008). Modeling combined harvest and effort regulations: the case of the Dutch beam trawl fishery for plaice and sole in the North Sea. *ICES Journal of Marine Science,* 65.

Holland, D., & Brazee, R.J. (1996). Marine Reserves for Fisheries Management. *Marine Resource Economics*.

Homans, F. R., & Wilen, J. E. (1997). A Model of Regulated Open Access Resource Use. *Journal of Environmental Economics and Management 32: 1-21*

Homans, F. R., & Wilen, J. E. (2005). Markets and rent dissipation in regulated open access fisheries. *Journal of Environmental Economics and Management* 49: 381-404.

Imeson, R., van den Bergh, J.C.J.M., & Hoekstra, J. (2002). Integrated models of fisheries management and policy. *Environmental Modelling and Assessment*, 7(4): 259-271

Jahra, Y., & Yamamoto, T. (1988). A Socio-Economic study of Fisheries Management and Conservation with particular Reference to Two artisanal Fishing villages in Penang, Peninsular Malaysia. CENU International Publication Series No.1, College of Economics, Nihon University, Tokyo, Japan.

Jensen, C. (1999). Rights Based Systems: Sovereignty and Property. Use of Property Rights in fisheries management. FAO Technical paper 404/1.

Jensen, A.L. (2002). The maximum harvest of a fish population that has the smallest impact on population biomass. *Fisheries Research*, 57: 89-91

Karpoff, J. M. (2003). Characteristics of Limited Entry Fisheries and the Option Component of Entry Licenses. *Land Economics*, 65 (4): 386-393

Kell, L. T., De Oliveira, J. A. A., Punt, A. E., McAllister, M. K., & Kuikka, S. (2006). Operational management procedures: An introduction to the use of evaluation frameworks, *in* L. Motos and D. G. Wilson (eds.), The Knowledge Base for Fisheries Management, Elsevier, Amsterdam

Kelly, D.L., & Kolstad, C.D. (1999). Integrated assessment models for climate change control. In: Folmer, H., and Tietenberg, T., (eds.) The International Yearbook of Environmental and Resource Economics 1999/2000. Edward Elgar, Cheltenham.

Khan, M.S.U., (2007). Optimal Stock, Harvest and Effort Level of Bangladesh Trawl Shrimp Fishery – A Nonlinear Dynamic Approach. *Journal of Agriculture and Rural Development*, 5(1&2): 143-149

King, J. R., McFarlane, G.A. (2006). A framework for incorporating climate regime shifts into the management of marine resources. *Fisheries Management and Ecology*, 13(2): 93–102.

Lane, D.E. & Stephenson, R.L. (1998). A framework for risk analysis in fisheries decision-making. ICES Journal of Marine Science, 55: 1-13.

Lansford, M. & Howorth, L. (1994). Legal Impediments to Limited Entry Fishing Regulation in the Gulf States. Natural Resource Journal, 34: 411-112

Larkin, S., et al., 2011. "Practical Considerations in Using Bioeconomic Modelling for Rebuilding Fisheries", *OECD. Food, Agriculture and Fisheries Working Papers*, No. 38, OECD Publishing

Mainardi, S. (2008). A surplus production model with latent truncation and species targeting, with an application to Papua New Guinean fisheries. *Fisheries Research*. 95 (2): 296-308

Marchal, P. L., Richard, L., & Thebaud, O. (2011). "Quota allocation in mixed fisheries: a bioeconomic modelling approach applied to the Channel flatfish fisheries." *ICES Journal of Marine Science: Journal du Conseil* 68 (7): 1580-1591.

May, R.M., Beddington, J.R., Clark, C.W., Holt, S.J., & Laws, R.M. (1979). Management of multispecies fisheries. *Science* 205, (4403): 267-277

McCay, B.J. (1999). Resistance to Changes in Property Rights or, why not ITQs? Use of Property Rights in fisheries management. FAO Technical paper 404/1.

Menasveta, D**. (**1997). Fisheries Management Frameworks of the Countries Bordering the South China Sea, FAO Regional Office for Asia and the Pacific, Bangkok, Thailand. RAP Publication 1997/33, 151p.

Moore, H. L. (1922). Elasticity of Demand and Flexibility of Prices. Journal of the American Statistical Association,18 (137): 8-19

Mora, C., Myers, R.A., Coll, M., Libralato, S., Pitcher, T.J., Sumaila, R. U., Zeller, D., Watson, R., Gaston, K.J., and Worm, B., 2009. Management effectiveness of the World's marine fisheries. *Journal of Applied Biology,* 7(6): 120-134

Moxnes, E. (1998a). Not only the tragedy of the commons, misperceptions of bioeconomics. *Management Science,* 44(9): 1234-1248.

Moxnes, E. (1998b). Overexploitation of renewable resources: The role of misperceptions. *Journal of Economic Behavior and Organizations,* 37(1): 107-127.

Needle, C.L. (2011). Fleet Dynamics in fisheries management strategy evaluations. Ph.D thesis. University of Strathclyde. Glasgow.

Nurul Islam, G.M, Mohd Noh, K., & Tai, S.Y. (2011). Measuring productivity in fishery sector of Peninsular Malaysia. *Fisheries Research*, 108: 52-57.

OECD, (1998). Organization for Economic Cooperation and Development. OECD Review of Fisheries in OECD Countries: Policies and Summary Statistics. OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264240223-en

Ola Flaaten. (2010). Fisheries Economics and Management. Norwegian College of Fishery Science. University of Tromso, Norway.

Ooi, I. B. (1990). Development Problems of an Open Access Resource: The fisheries of Peninsular Malaysia. Occasional paper N0. 86. Institute of South East Asian Studies, Singapore.

Opaluch, J. J., & *Bockstael*, N. E. (1984). "Behavioral Modelling and Fisheries Management." *Journal of Marine Resource Economics,* 1: 105-115.

Pauly, D., Christensen, V., Guenette, S., Pitcher, T.J., & Sumaila, U.R. (2002). Towards sustainability in world fisheries. *Nature,* 418: 689–695.

Pella, J.J., &Tomlinson, P.K. (1969). A generalized stock production model. *Inter-American Tropical Tuna Commission Bulletin*, 13: 419–496

Pintassilgo, P., Brasao, A., & Duarte, C. (1999). Bio-economic Modelling of Northern Atlantic Bluefin Tuna. FEUNL Working Paper No. 331

Pitcher, T.J., Kalikoski, D., Pramod, G., & Short, K. (2009). Not honoring the code. *Nature*, 457: 658–659

Puga, R., Vazquez, S.H., Martinez, J.L., & de Leon, M.E. (2005). Bio-economic modeling and risk assessment of the Cuban fishery for spiny lobster *Panulirus argus*. *Fisheries Research*. 75: 149-163

Quinn, T.J., and Deriso, R.B. (1999). Quantitative Fish dynamics. Oxford: Oxford University Press.

Reish, R.L., Deriso, R.B., Ruppet, D., & Carroll, R.J. (1985). An investigation of the population dynamics of Atlantic menhaden (Brevoortia tyrannus). *Canadian Journal of Fisheries and Aquatic Science*. 42 (Suppl 1): 147-157

Rothschild, B.J., Chen, C., & Lough, R. G. (2005). Managing fish stocks under climate uncertainty. *ICES Journal of Marine Science,* 62(7): 1531–1541

Rotmans, J., & de Vries, B. (1997). Perspective on Global Change: The TARGETS approach. Cambridge University Press, Cambridge, UK.

Ruth, M., and Lindholm, J. (1996). Dynamic modeling of multispecies fisheries for consensus building and management. *Environmental Conservation,* 23:332-342.

Safa, M.S. (2004) Potential Fishery Industry activities and Financial Aspects of East Malaysian Marine Fisheries. MPRA Paper. No. 10887. IIFET 2004 Japan Proceedings.

Salas, S. and Gaertner, D. (2004).The behavioral dynamics of fishers: management implications. Fish And Fisheries, 5: 153-167

Sanchirico, J.N. & Wilen, J.E. (2007). Global Marine fishery resources: status and prospectus. *International Journal of Global Environmental*. 7: 106–118.

Schaefer, M.B. (1954). Some aspects of the Dynamics of Populations Important to the Management of the Commercial Marine Fisheries. Bulletin of Inter-American Tuan commission, 1: 27-56.

Schaefer, M.B. (1957). Some considerations of population dynamics and economics in relation to the management of marine fisheries. *Journal of the Fisheries Research Board of Canada*, 14: 669-681.

Schaffernicht, M. (2005). Are you Experienced? – A Model of Learning Systems Dynamics Thinking Skills. Working Paper Series (WPS). Año 3, Nº 5.

Schnute, J. (1977). Improved Estimates from the Schaefer Production Model: Theoretical Considerations. *Journal of the Fisheries Research Board of Canada,* 34(5):583–603.

Scott, A. (1988). Development of Property in the Fishery. *Marine Resource Economics,* 5: 289-331.

Seijo, J.C. (1986). Comprehensive simulation model of a tropical demersal fishery: red grouper *(Epinephelus morio*) of the Yucatan Continental Shelf. Ph.D. Dissertation, *Michigan State University:* 210 pp.

Seijo, J.C., Defeo, O., & Salas, S. (1998). Fisheries Bio-economics: Theory, Modelling and Management. FAO technical paper, Issue 368.

Sissenwine, M.P., & Mace, P.M. (1992). ITQs in New Zealand: the era of fixed quota in perpetuity. *Fishery Bulletin, US.* 90:147-160.

Smith, V.L. (1969). Economics of Production from Natural Resources. *American Economic Review,* 58: 409-431

Smith, M.D. (2004). Limited-Entry Licensing: Insights From A Duration Model *American Journal of Agricultural Economics,* 86(3): 605–618

Solah Mohamed.. (2007). A Bioeconomic analysis of Maldivian Skipjack Tuna Fishery. Master thesis, International Fisheries Management. Norwegian College of Fishery Science. University of Tromso.

Squires, D., Campbell, H., Cunningham, S., Dewees, C., Grafton, R.Q., Herrick, S.F., Kirkley, J., Pascoe, S., Salvanes, K., Shallard, B., Turris, B., & Vestergaard, N. (1998). Individual transferable quotas in multispecies fisheries. Marine Policy, 22 (2): 135-159.

Sterman, J.D. (2000). Business Dynamics: Systems Thinking and Modeling for a Complex World. Irwin/McGraw-Hill: Boston, MA.

Stouten, H., Polet, H., Depestele, J., Vanderperren, E., Heene, A., & Gellynck, X., (2006). System Dynamics in sea fisheries policy building. 7th System dynamics PhD Colloquium ; 2006. International conference of the System Dynamics Society.Nijmegen, The Netherlands

Sutinen, J. G., Rieser, A., and Gauvin, J. R. (1990). Measuring and explaining noncompliance in federally managed fisheries. *Ocean Development and International Law.* 21:335-372.

Sutton G. & Wagner, T. (2007). Stock Assessment of Blue Crab (*Callinectes Sapidus*) In Texas Coastal Waters. Management Data Series No. 249

Talib, A. (2002). Demersal Fisheries: Have We Surpassed the Straits' Sustainable Capacity? Pp 155-173. In: Yusoff, F.M., Shariff, M., Ibrahim, H.M. , Tan, S.G., and Tai, P.Y. (eds). Tropical Marine Environment: Charting Strategies

for the Millennium; Malacca Straits Research and Development Centre (MASDEC), Universiti Putra Malaysia, Serdang, Malaysia

Talib, A., Mahyam, M.I., Mohamad-Saupi, I., & Sharum, Y. (2000). Abundance and Distribution of Demersal Fish Resources in the Northern Part of the Straits of Malacca. In: Shariff M., F.M. Yusoff, N. Gopinath, H.M. Ibrahim and R.A. Nik Mustafa (eds). Towards Sustainable Management of the Straits of Malacca. Malacca Straits Research and Development Centre (MASDEC), Universiti Putra Malaysia, Serdang, Malaysia.

Talib, A.A., Mohd Isa, A.M. Malek, D., & Teoh, L.T. (1995). The Fifth and Sixth Prawn Resource Survey off the West Coast of Peninsular Malaysia. *Fisheries Bulletin* No. 100, Ministry of Agriculture, Malaysia. 47p.

Tai, S.Y. (1992). Management of small pelagic fishery on the northwest coast of Peninsular Malaysia: A Bio-socioeconomic simulation analysis. Ph.D thesis, Simon Fraser University, Canada.

Tai, S.Y. (1996). Optimal Bioeconomic Exploitation of the Demersal Fishery in Northwest Peninsular Malaysia. *Pertinika J. Soc.Sci. & Hum.* 4(1): 65-76 (1996)

Tai, S.Y., & Heap, T. (1996). Effort Dynamics and Alternative management Policies for the small Pelagic Fisheries of Northwest Peninsular Malaysia. *Marine Resource Economics*, 11: 85-103

Tai, S.Y. (2006). Economic valuation of marine fisheries resource changes in the Straits of Malaysia: A resource accounting approach. In: B. Mohd Nizam & D. Amir (eds.), Building a Comprehensive Security Environment in the Straits of Malacca. Proceedings of the MIMA International Conference on the Straits of Malacca,11 - 13 October, 2004.

Taupek, Mhd., & Nasir, Mhd. (2003). Monitoring, Measurement and Assessment of fishing capacity-The Malaysia experience. In: Pascoe, S., & Greboval, D. (eds.) Measuring capacity in fisheries. FAO Fisheries Technical Paper 445.

Terkla, D.G., Doeringer, P.B., & Moss, P.I. (1985). Common Property Resource Management with Sticky Labour. The Effects of Job Attachment on Fisheries Management. Discussion Paper No. 108, Department of Economics, Boston University, ME.

Turner, R.K., van den Bergh, J.C.J.M., & Brouwer, R. (eds.), 2003. Managing Wetlands: An Ecological Economics Approach. Edward Elgar Publication, Cheltenham.

Turner, R.K., van den Bergh, J.C.J.M., Soderqvist, T., Barendregt, A., van der Straaten, J., Maltby, E., & van Ierland, E.C. (2000). Ecological-economics analysis of wetlands: Scientific integration for management and policy. *Ecological economics*, 35(1): 7-23

Ulricha, C., Le Gallicb, B., Dunnc, M.R., & Gascuela, D. (2001). A multi-species multi-fleet bio-economic simulation model for the English Channel artisanal fisheries. *Fisheries Research*, 58 :379–401

van den Bergh, J.C.J.M., Barendregt, A., and Gilbert, A. (2004). Spatial Ecological-economics Analysis for wetland management: Modelling and Scenario Evaluation of Land-Use. Cambridge University Press, Cambridge, UK.

van den Bergh, J. C. J. M., Faber, A., Idenburg, A. M., & Oosterhuis, F. H. (2006). Survival of the greenest: Evolutionary economics and policies for energy innovation. *Environmental Sciences*, *3*(1), 57–71.

van den Bergh, J.C.J.M., Barendregt, A., Gillbert, A., van Herwijnen, M., van Horssen, P., Kandelaars, P., and Lorenz, C. (2001). Spatial economic-hydroecological modeling and evaluation of land use impacts in the Vecht Wetlands area. *Environmental Modelling Assessment, 6*(2): 87-100

Vermad, Y., Lehtat, S., Mahevas, S., Marchal, P. & Gascuel, D. (2012). Combining Fleet dynamics and population dynamics for a volatile fishery: the example of the anchovy fishery of the Bay of Biscay. Working paper, IFREMER, Fisheries and Ecological Modelling Department.

Viswanathan, K. K., Omar, I.H., Jeon, Y., Kirkley, J., Squires, D., & Susilowati, I. (2002). Fishing Skill in Developing Country Fisheries:The Kedah, Malaysia Trawl Fishery. *Marine Resource Economics,* 16: 293-314

Viswanathan, K.K., Raja Abdullah, N. M. , Susilowati, I. , Siason, I.M., & Ticao, C. (1999). Enforcement and Compliance with Fisheries Regulations in Malaysia, Indonesia and the Philippines. Proceedings of the International Workshop on Fisheries Co-management. Penang.

Von Bertalanffy, L. (1938). A quantitative theory of organic growth (Inquiries on growth laws. II). *Human Biol*ogy, 10: 181-213.

Walker, J.M., Gardner, R., & Ostrom, E. (1990). Rent dissipation in a Limited-Access common-pool resources: experimental evidence. *Journal of environmental economics and management*, 19: 203-211

Wang, C. H. (2000). Applied the improved surplus production method to assess the South Pacific albacore stocks, (*Thunnus alalunga*), 1967-1998. ALB-2/SCTB13, July 5-12, 2000, Noumea, New Caledonia.

Ward, J. M., & Sutinen, J. G. (1994). Vessel entry–exit behavior in the Gulf of Mexico shrimp fishery. *American Journal of Agricultural Economics*, 76: 916–923.

Wilen, J.E. (1976). 'Common property resources and the dynamics of over-exploitation: the case of the North Pacific fur seal. Paper No. 3 in the Programme in Resource Economics. Department of Economics, University of British Columbia

Wilen, J.E. (1979). Fisherman behavior and the design of efficient fisheries regulations programs. *Journal of Fisheries Research Board of Canada,* 36:855-858

Wilen, J. E. (1988). Limited entry licensing: a retrospective assessment. *Marine Resource Economics*. 5: 313-324

WWF, Malaysia (2013). An Assessment of Fisheries and Marine Ecosystem in Peninsular Malaysia

Yahaya, J., & Raja Abdullab, N.M. (1993). Fisheries Resources Under Stress: The Malaysian Experience. Conference paper. International Association for the Study of Common Property Fourth Annual Common Property Resource Conference, 16-19 June 1993, Manila,Philippines